SIXTH FRAMEWORK PROGRAMME

FOOTPRINT

Functional Tools for Pesticide Risk Assessment and Management

The FOOT-CRS (Catchment and Regional Scale) tool

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The FOOT-CRS tool

- To be used at catchment level by local authorities, stewardship managers and water managers
- Emphasis on:
  1. Identifying the areas most contributing to the contamination of water resources by pesticides
  2. Defining and/or optimising action plans at the scale of the catchment
- Add-on in ArcGIS

CRS

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FOOT-CRS capabilities

- The tool will consist of two modules with different outputs
- The "landscape analysis module" will provide a map showing the spatial distribution of the dominant pesticide contamination pathways (i.e. leaching, drainflow, runoff/ erosion, drift) in the catchment of concern
- The "diagnostic module" will provide answers to the following questions:
  - Where are the hot spots in the catchment?
  - Is there a potential risk in the catchment for groundwater resources?
  - Which mitigation measures must be implemented? Where? To what extent so that pesticide contamination of the water resources reaches an acceptable level?
  - Ultimately, with what frequency is a pesticide concentration of x µg L^{-1} in surface water (typically 0.1 µg L^{-1}) exceeded in a given period at the catchment outlet? (very ambitious!)

How will the landscape analysis module work? (1)

- Two levels possible depending on data availability:
  - Use of the FOOTPRINT scenarios (FOOTPRINT soil types, crop cover)
  - Input of user data if available at a finer resolution
    - conversion of a given soil map to FOOTPRINT soil types → refined FOOTPRINT soil map
    - integration of crop cover information (land use map + census data)
- Transfer beyond 1 m depth
  - assessed qualitatively as described yesterday (simple groundwater vulnerability assessment)
  - can be replaced by more detailed information regarding groundwater where available
- Major transport pathways in the landscape provided by HOST/CORPEN approach and/or IDPR

How will the landscape analysis module work? (2)

> Two options for accounting for landscape features (hedges, buffer strips) mitigating pesticide inputs

- aerial photos or satellite imagery available:
  - identification of mitigation features in the landscape
  - provision of semi-automatic tools to help the identification
- no aerial photos or satellite imagery available or scales too large
  - user inputs types of landscapes using reference photographs and graphics

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How will the diagnostic module work? (1)

> We have:

- A catchment with a gauge or drinking water abstraction site at the outlet.
- „Agro-environmental scenarios" (unique combinations of soil, climate and climate-specific crop scenario), which are distributed over the catchment area.
- For each agro-environmental scenario there are summary statistics of pesticide loss time series calculated with meta-models of MACRO and PRZM.

> However, the agro-environmental scenarios cannot be localized exactly:

- A soil mapping unit (SMU) has a distribution of soil scenarios (FOOTPRINT soil classes) with different area proportions or probabilities of occurrence each (e.g. 40 % soil A, 20 % soil B etc.).
- A crop mapping unit (e.g. from CLC2000) has a distribution of crops with different area proportions or probabilities of occurrence each (e.g. 40 % winter wheat, 20 % winter barley, 20 % maize etc.)
- That is, each basic unit in the map has exactly 1 climate scenario, but an area distribution of crops, soils and thus of "agro-environmental scenarios".

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How will the diagnostic module work? (2)

- As a consequence, scenarios and losses will be assigned to the areas in the catchment statistically.
- Conversion of losses to inputs (separately for each input path):
  - For each pixel the pathway of pesticides to the nearest water body is traced in the GIS.
  - Subsequently, the shares of pesticide losses from each pixel that eventually reach a water body are calculated, taking account for mitigation landscape elements on the pathway.
  - Detailed methodology to be finalised.
- Finally, inputs are aggregated over the catchment separately for each input path (runoff, drainage etc.) and concentrations at the outlet (or in groundwater, resp.) are calculated.
- Required user input for the diagnostic module:
  - Pesticide application statistics: pesticide(s), treated crop(s), application rate(s), the percentage of crop area treated and the date(s) of application.
  - Point sources: assessment methods and necessary user inputs are being discussed

Remaining challenges in FOOT-CRS

- All these points are being discussed (!)
  - How to convert calculated losses from fields into inputs in water bodies (reduction by „mitigating landscape elements")?
  - How to identify and quantify mitigating landscape elements?
  - How to include the knowledge from the landscape analysis in the calculation of losses and PEC? That is, coupling of "landscape analysis module" and "diagnostic module"?
  - What capabilities of image processing, (half-) automated object classification, distance calculations etc. must FOOT-CRS have?
  - At which scales (in terms of km^2) is FOOT-CRS supposed to be used and/or working?
  - How do we exactly deal with point sources?
  - Aggregation of inputs into surface water bodies at the catchment scale and PEC_{sw} calculation at the catchment outlet?
  - PEC_{sw} calculation methods determine model output that has to be stored and distributed with the software. Do we need only loss percentiles of the whole time series or loss percentiles of each calendar month?

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Example: Calculation of PEC_{sw} at the catchment outlet

> Calculation of Predicted Environmental Concentrations in surface water (PEC_{sw}) and risk assessment are relatively straightforward in FOOT-FS und FOOT-NES, since only „edge-of-field“ water bodies are considered.

> At the catchment scale the aim is concentrations at the outlet, however. More precisely: Exceedance frequencies of x µg L^{-1} (usually 0.1 µg L^{-1}) in a given period.

> → Results must be aggregated meaningfully

> → Need to take account of:

- different flow lengths and travel times from each field to the catchment outlet („geomorphological dispersion“)
- transport and dispersion in the water course
- sorption and degradation in the water course?

(these three issues can be tackled with the Gustafson approach)

- spatial and temporal variability of weather and application dates

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Suggestions for PEC calculation at the outlet so far (1)

> Separate calculation for each input path of loads and PEC_{sw} at the catchment outlet.

- For instance, runoff might lead to higher peak concentrations at the outlet, but to less frequent exceedances of 0.1 µg L^{-1} than drift inputs.
- Having the PEC separately for each pathway will also make it easier to recommend mitigation measures and evaluate their effect at the catchment scale.
- This method can be justified because the input events from the different pathways probably will not coincide on the same date.

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Suggestions for PEC calculation at the outlet so far (2)

> Currently proposed method (for each input path separately):

1. select a given percentile (e.g. the 99.7th) of the surface water input for each pixel (weighted average over all agro-env. scenarios this pixel possesses)
2. sum up these inputs over the catchment → 99.7th percentile load for the whole catchment.
3. divide by the mean daily discharge of the catchment at the outlet (monthly mean discharges can be obtained freely on a half-degree basis for the whole of Europe; also daily discharge series of single stations freely available from the GRDC in Koblenz) to obtain a fictitious "initial" 99.7th percentile concentration
4. apply Gustafson's equation to this fictitious „initial" concentration, using the mean river length in the catchment (computed from surface water network) and some generic mean streamflow velocity. The result is a "99.7th percentile" PEC at the outlet (though admittedly uncertain).
5. Repeat 1.-3. for other percentiles of the input time series.
6. Read off the frequency / return period for each percentile → interpolate frequency of exceedance of e.g. 0.1 µg L^{-1}

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