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The road towards an EU-wide tiered approach assessment of pesticide concentration at drinking water abstraction locations - a combined approach of GIS analysis and modelling on catchment level

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BACKGROUND

- Surface water (SW) is an important source of drinking water (DW) in many European countries.
- Plant Protection Products (PPP) concentrations at DW abstraction locations are of interest in the EU but no generic guidance available to address them.
  ➔ one aspect: exposure concentration at point of DW abstraction.
- An exception is the national approach of the Netherlands: DROPLET model [1]. A simplistic first Tier approach using edge-of-field concentrations in SW considering catchment characteristics (e.g. use intensity, cropping area, application practice).

GOAL

Explore the feasibility of a general tiered EU-wide approach by means of GIS analysis and catchment-based modelling to derive realistic PPP concentrations at DW abstraction locations in the EU.

INTERMEDIATE OBJECTIVES

- Characterization of drinking water catchments on EU level.

- Identification of representative and vulnerable DW catchments for generic and regulatory use.

- Quantification of dispersion and attenuation factors and enabling of substance specific modelling for agricultural area/crop using a landscape-level assessment model.

THEORY & METHODS

Impact Factors on PPP dispersion and attenuation

- substance properties (e.g. dissipation, sorption)
- catchment characteristics (e.g. land use, size)
- abstraction type (e.g. bank infiltration, reservoir abstraction)
- market share

➔ A mixing factor MF [-] could be calculated in analogy to the DROPLET approach:

$$MF = f_{la}^{-1} \cdot f_{tim}^{-1} \cdot f_{con}^{-1} \cdot f_{dis}^{-1} \cdot f_{use}^{-1} \dots f_{n}^{-1}$$

where f_{la} is the land use fraction [-], f_{tim} the fraction caused by application timing [-], f_{con} the field connectivity fraction caused by distance to stream [-], f_{dis} the fraction caused by substance dissipation & dispersion, f_{use} the fraction caused by pesticide use intensity [-]; f_n symbolizes any other impact factor within a DW catchment.

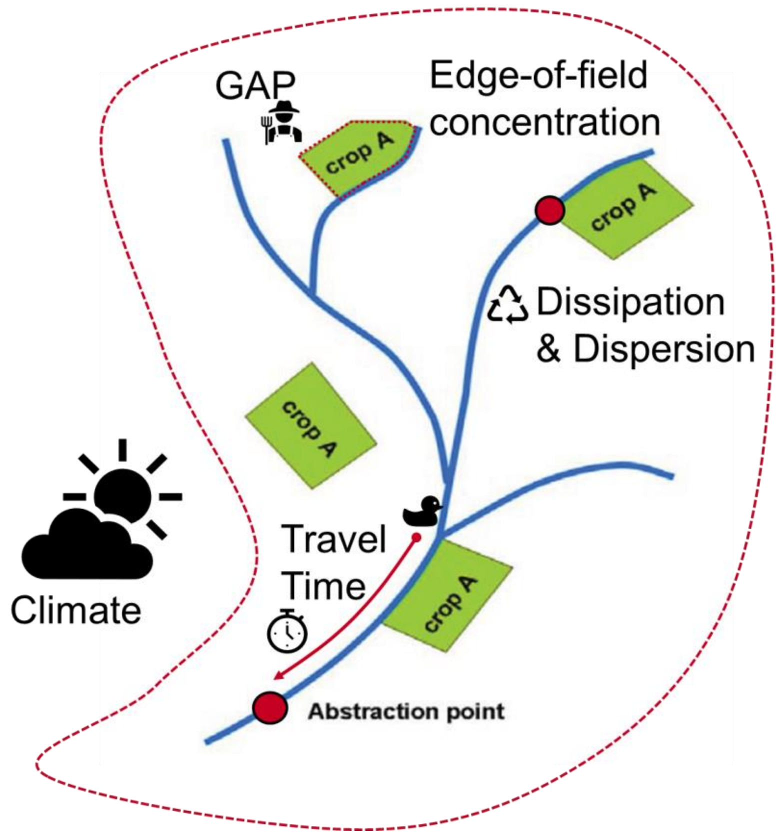

***Figure 1**: Major key factors affecting surface water dispersion and attenuation in a DW catchment (adapted from DROPLET [1]).*

THEORY & METHODS

GIS Analysis

- Combine information from CORINE land cover 2018 (CLC; resolution 100 m [2]), the pan-European river and catchment database (CCM) [3] ranging from small channels to large rivers, and information from abstraction locations
  → typical DW catchment characteristics with focus on land cover and size of DW catchments
- Information on abstraction locations very difficult to obtain!

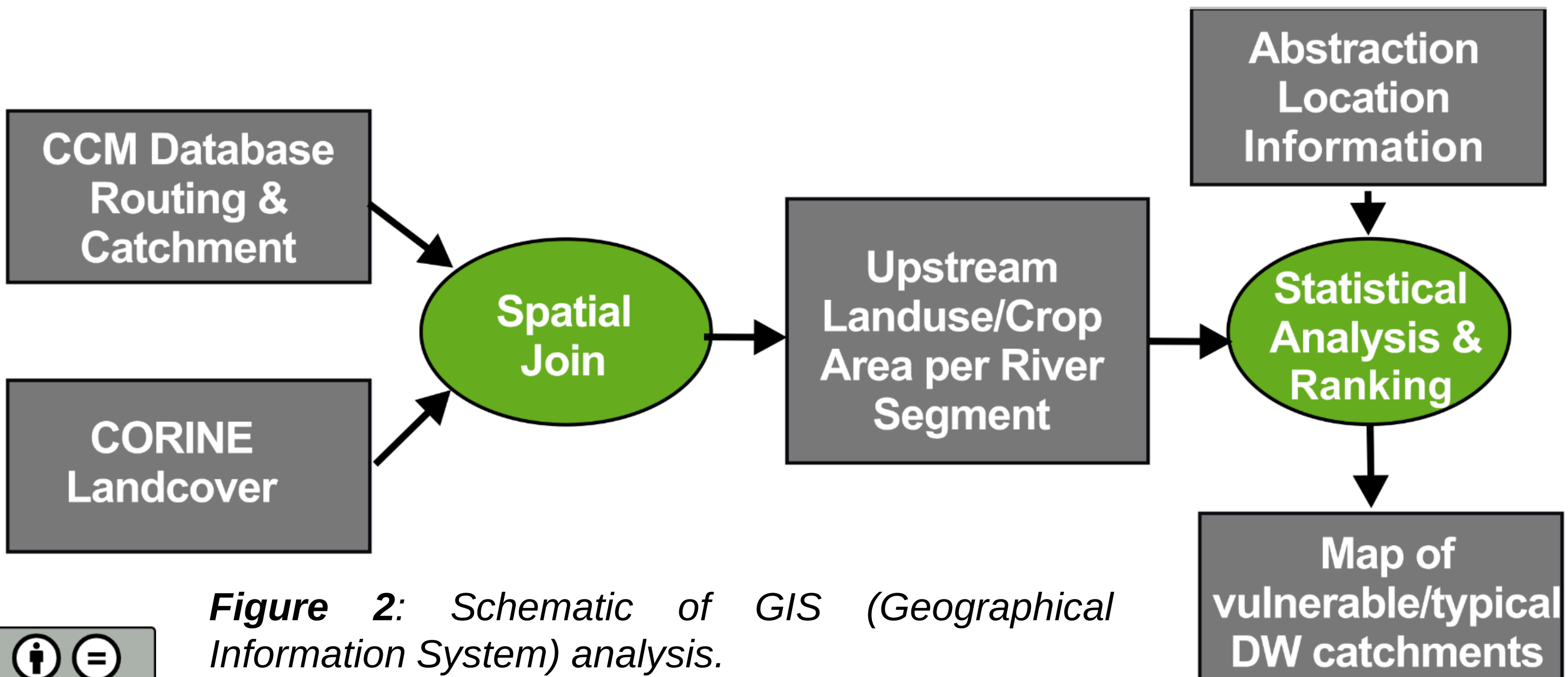

***Figure 2**: Schematic of GIS (Geographical Information System) analysis.*

RESULTS – LANDCOVER

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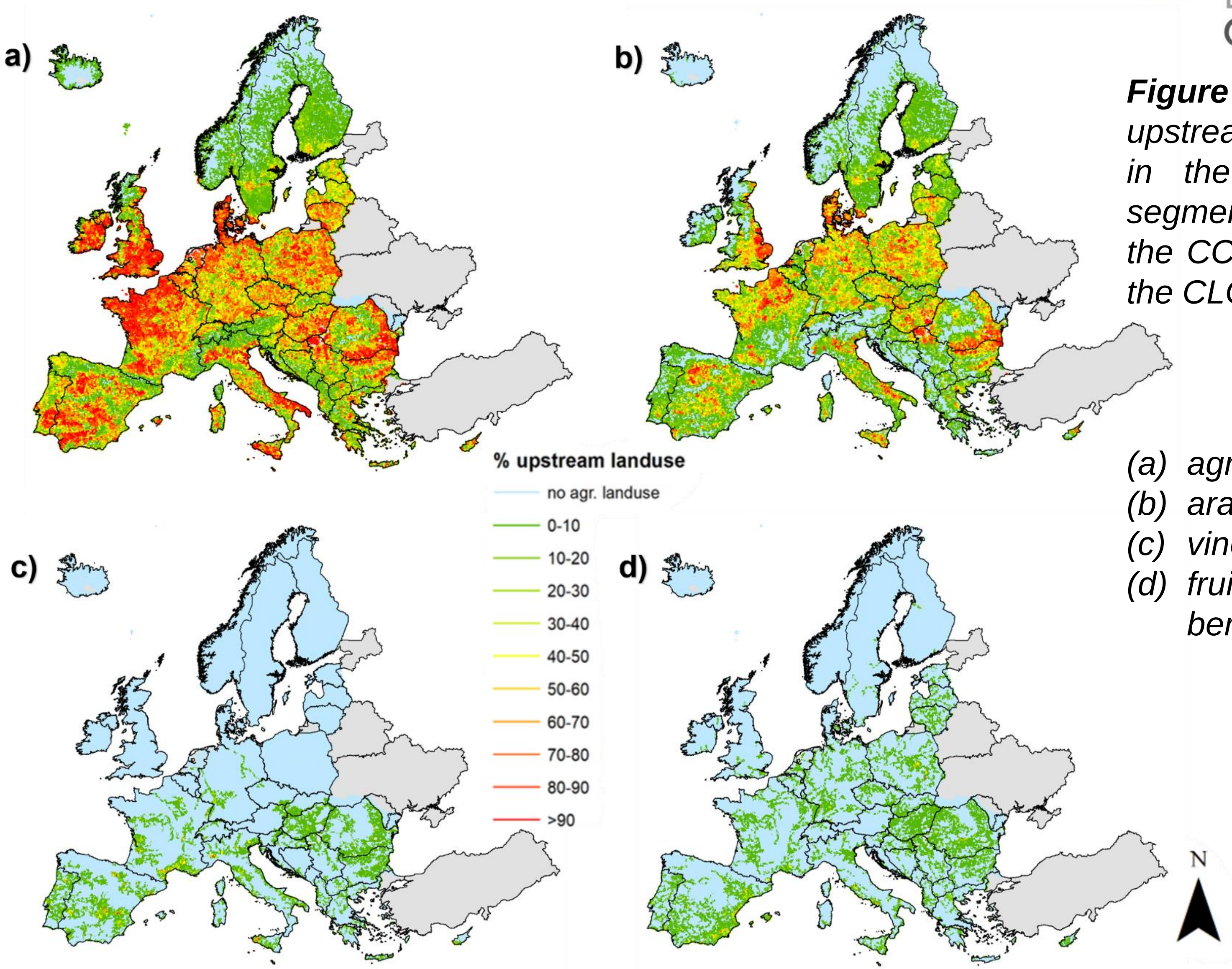

Figure 3: *Cumulative upstream land use area in the EU per river segment on the basis of the CCM database and the CLC.*

(a) agricultural area
(b) arable land
(c) vineyards
(d) fruit trees and berries

RESULTS – POTENTIAL MIXING FACTORS

- Different impact factors can be conducted by synthetic model tracer experiments on landscape level for selected catchments (e.g. using SWAT [4])

- Example Langenau [5,6]:
  - In-stream surface water abstraction from Danube river water (ca. 1 % of tot. annual discharge)
  - 41 % agricultural land use

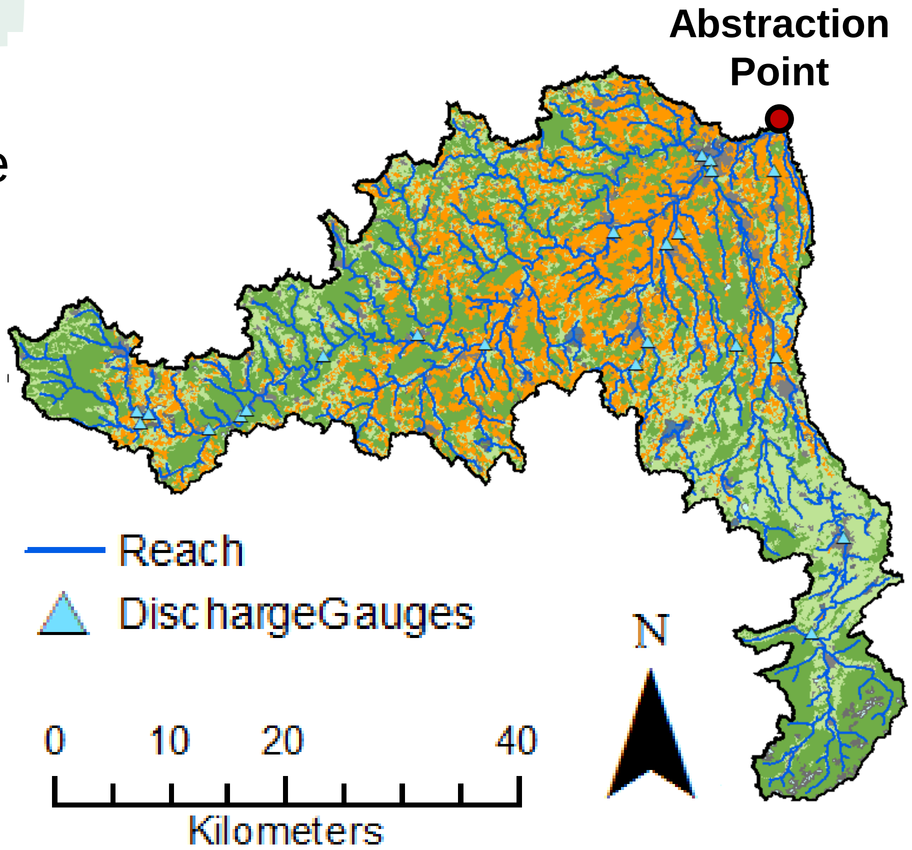

***Figure 4**: The Danube catchment at the surface water abstraction point located near Langenau (Germany)*

RESULTS – POTENTIAL MIXING FACTORS

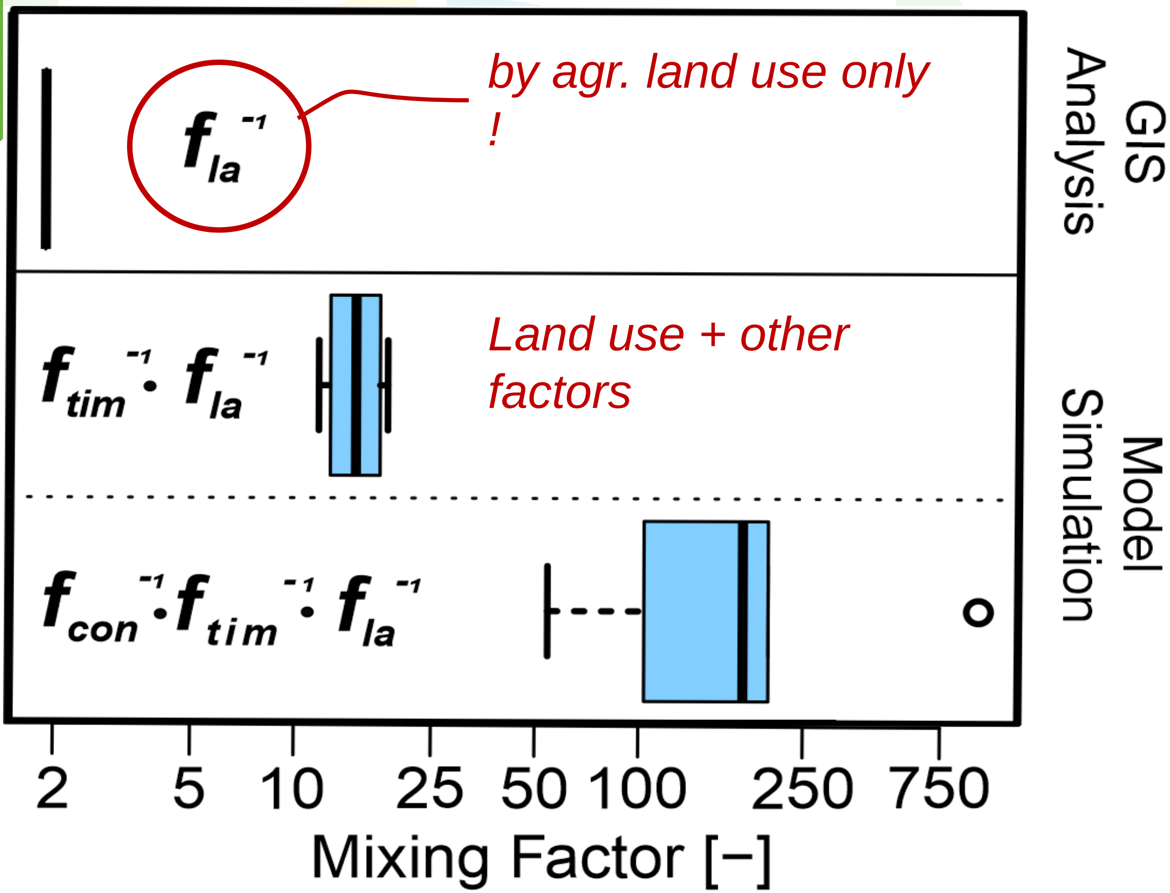

***Figure 5**: Estimated MFs at the Langenau abstraction location.*
MF calculation based on

- *agricultural land use (upper).*
- *SWAT tracer experiment including application timing (middle) and realistic field connectivity to stream (lower) for different years (1996-2000) .*

Conclusions & Outlook

- EU-wide analysis on the basis of CCM data and CLC is a novel approach enabling the identification and characterization of SW catchments for the purpose of dispersion and attenuation (mixing factor) assessments at DW abstraction points.

- Robust information on abstraction locations is difficult to obtain (e.g. security, jurisdiction). This hinders a subsequent realistic analysis and identification of DW catchments in the EU.

- Derivation of first Tier mixing factors for selected/representative crop-based DW catchments based on a GIS analysis can be refined further using model tracer experiments. The inclusion of substance specific properties/use patterns are further promising steps towards a Tiered approach.

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