A NEW TOOL FOR THE TOOLBOX: PREDICTING MULTI-PATHWAY EMISSION AND FATE OF CONTAMINANTS ENTERING FRESHWATER SYSTEMS IN EUROPE

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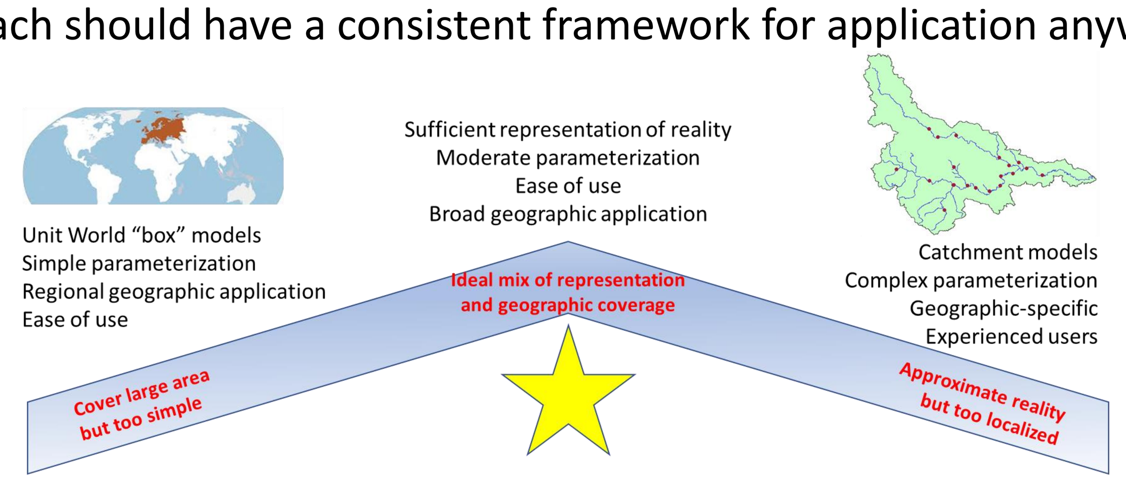
BACKGROUND AND OBJECTIVES

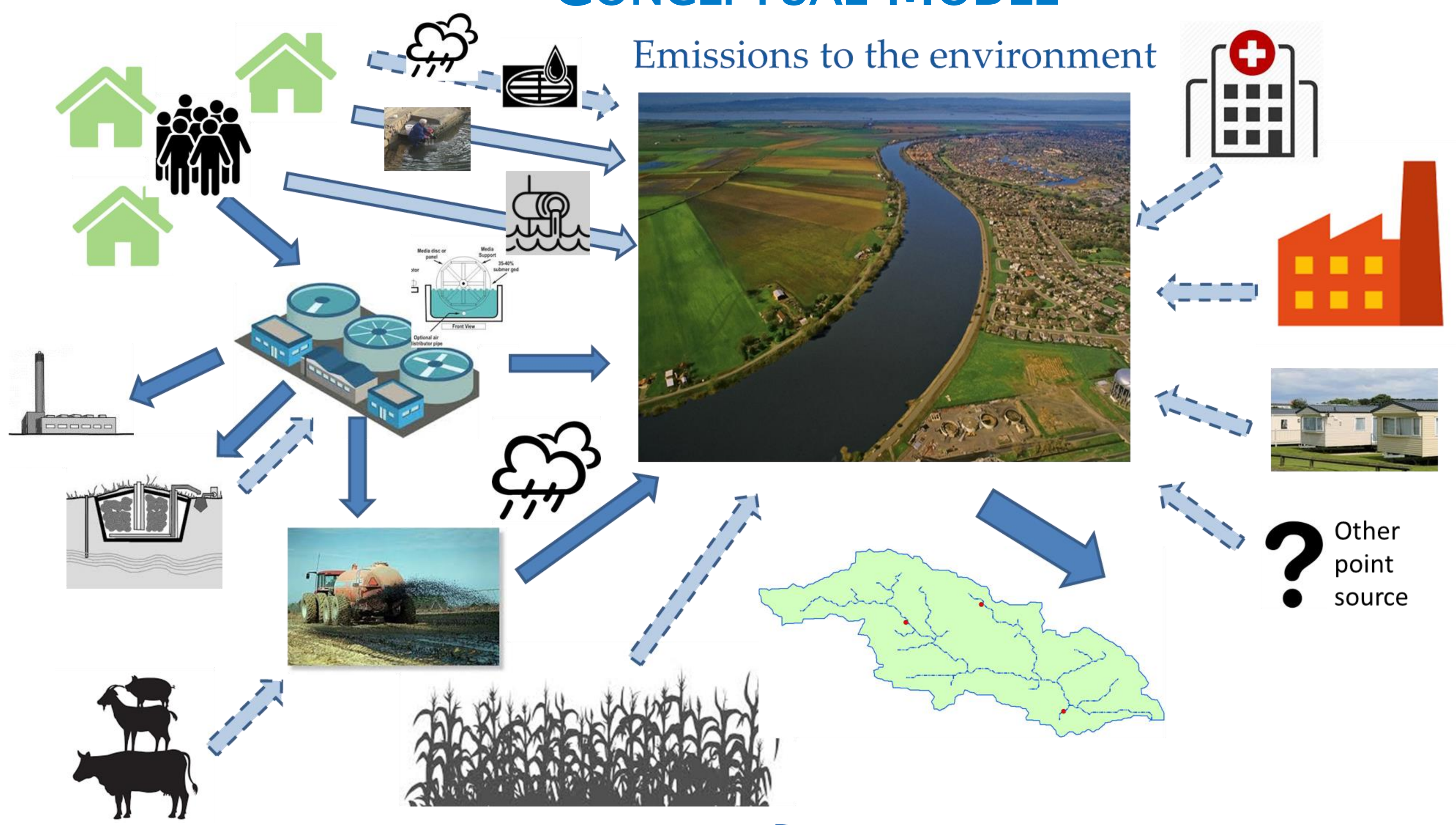
Exposure models help to prospectively assess the potential for ecological exposures from releases of substances into the environment. Availability of newer data, increasing computing power and improved methods provide continuing opportunity to improve our ability to predict environmental exposures through models and add to our “toolbox”.

The intent is to find the balance between spatial extent and ease of use, and mechanistic processes and parameterization complexity. The model should have a sufficient representation of the emissions and fate components needed to inform decision making, without being limited by simplicity or over-complexity. This approach should have a consistent framework for application anywhere in the world.

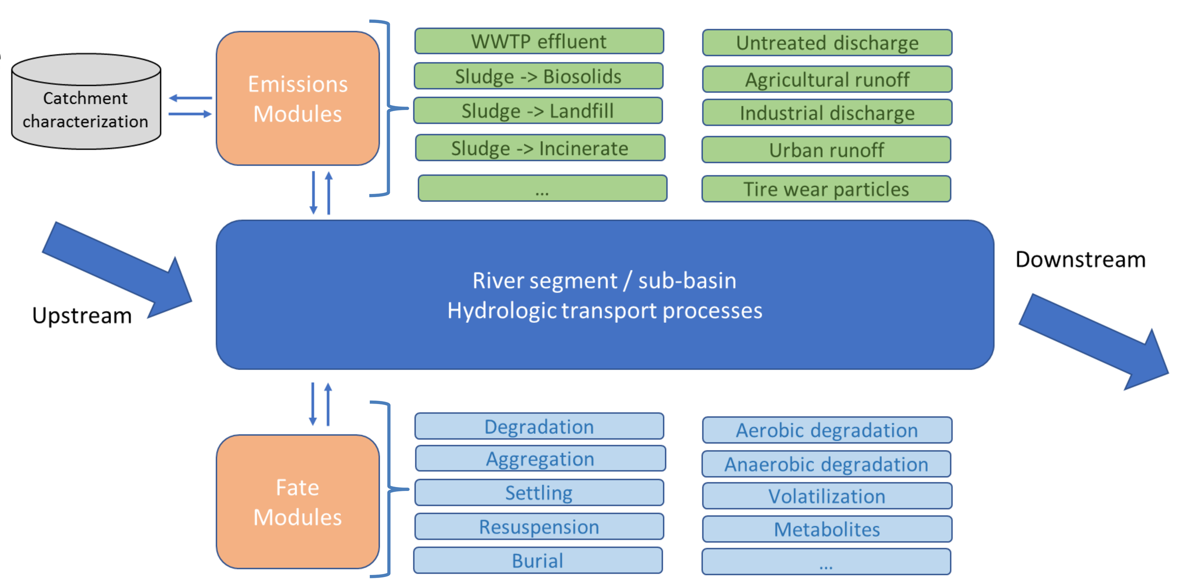


We present a new model designed to encompass multi-pathway environmental emissions coupled with environmental fate components, contained in a modular and transparent framework which is scalable and portable to multiple geographies. This spatially-explicit model (presented here for Europe) is based on publicly available datasets, combined with a hydrologic framework containing geographically variable emissions linked to a river network simulating environmental transport via surface water.

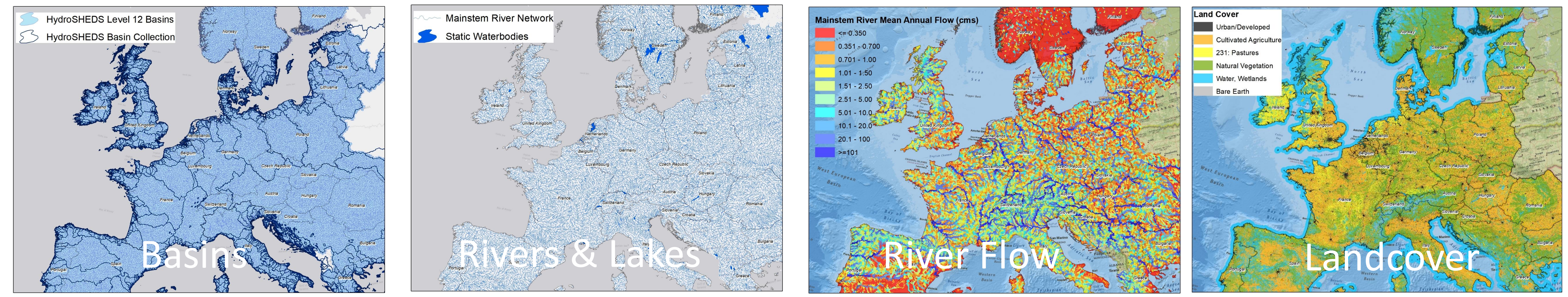
CONCEPTUAL MODEL



The schematic diagrams illustrate the emissions (above) that may enter a catchment based on the substance being modeled. Likewise, relevant fate processes (right) can be applied specific to substance and ability to parameterize. A modular approach allows for flexible generation and execution.



GLOBAL



HydroSHEDS provides the framework for characterization and routing

Mainstem river and lakes from HydroSHEDS (and CCM above 60N)

55 years of flow data available from FLO1K, overlaid on river mainstem

Urban, agriculture and pasture landcover from JRC Corine Land Cover

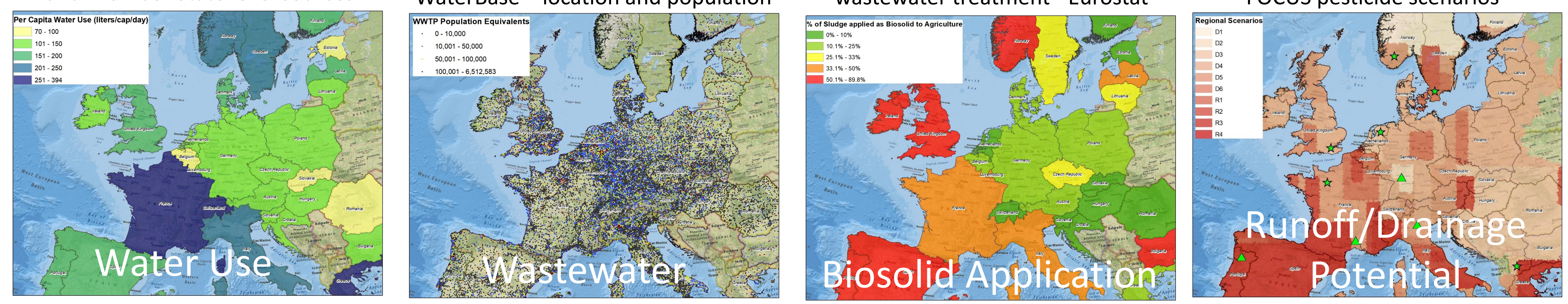
REGIONAL

Per capita water use from Eurostat and Member State level sources

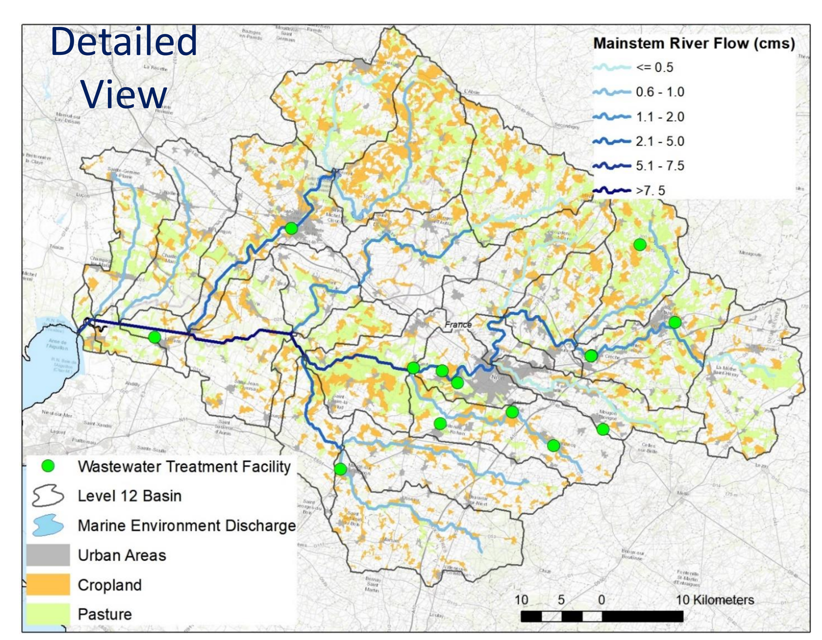
Municipal facilities from EEA’s WaterBase – location and population

Sewage sludge disposal from wastewater treatment - Eurostat

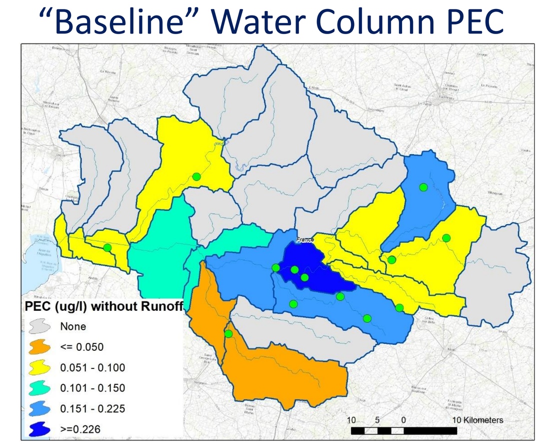
Runoff potential based on simplified FOCUS pesticide scenarios



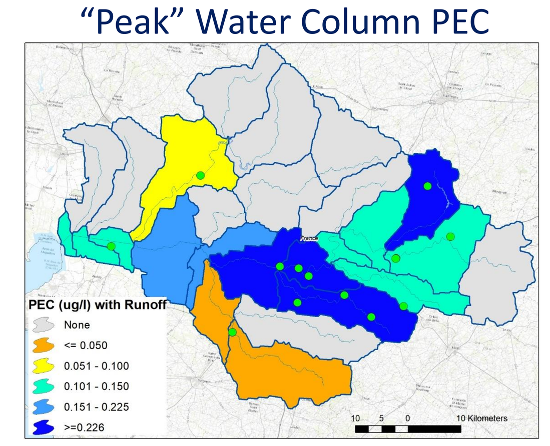
The sub-basin (catchment) is the unit of analysis for the model. Each sub-basin (n=38,444 for EU-30) is attributed within a separate input database. The spatial scale of the attribution can be refined over time without modifying the model code.



“Baseline” Water Column PEC



“Peak” Water Column PEC



A “baseline” PEC is calculated excluding episodic events such as biosolid runoff. This represents the constant daily effluent from WWTPs. Episodic events add additional mass for a short “peak” duration. (Scenario 3)

EXAMPLE SCENARIOS

Three scenarios below present different substance fate characteristics for the same usage scenario, highlighting the influence of fate properties and emission pathways. The ultimate environmental disposition of the substance represents the percentage of emitted substance mass present in each media/compartment.

Scenario 1:

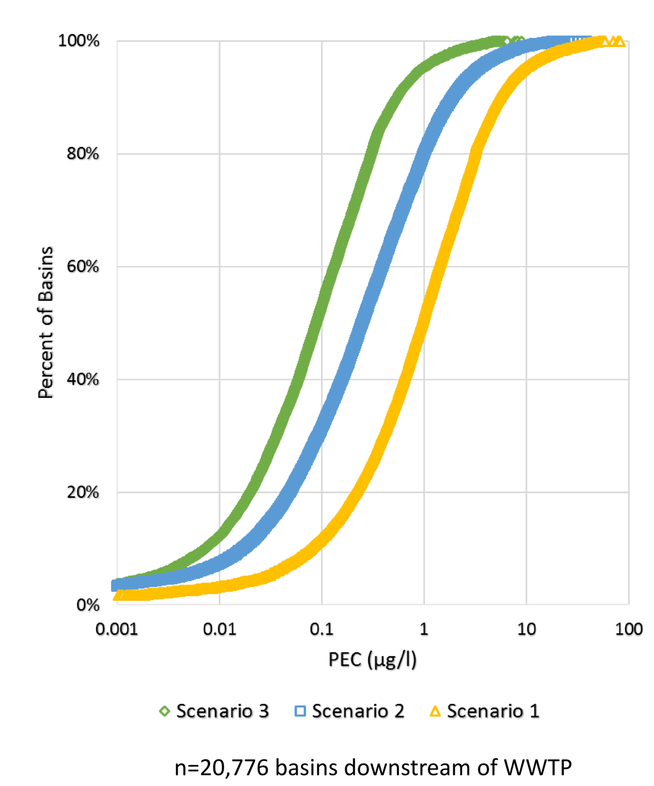
Per cap use:	10 mg/day
WWTP to effluent:	90%
WWTP to sludge:	10%
-degradation:	0%
Kd:	500
Soil aerobic half-life:	90 days
In-stream removal to sediment (k):	0 (stable)

Scenario 2:

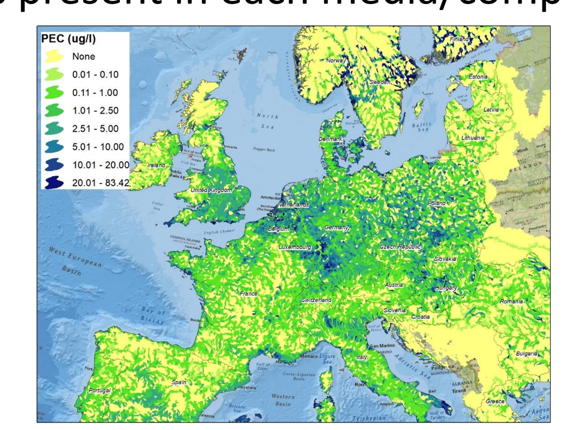
Per cap use:	10 mg/day
WWTP to effluent:	50%
WWTP - to sludge:	50%
- degradation:	0%
Kd:	500
Soil aerobic half-life:	90 days
In-stream removal to sediment (k):	0.5 (1.4d T½)

Scenario 3:

Per cap use:	10 mg/day
WWTP to effluent:	10%
WWTP - to sludge:	90%
- degradation:	0%
Kd:	500
Soil aerobic half-life:	90 days
In-stream removal to sediment (k):	0.1 (69d T½)

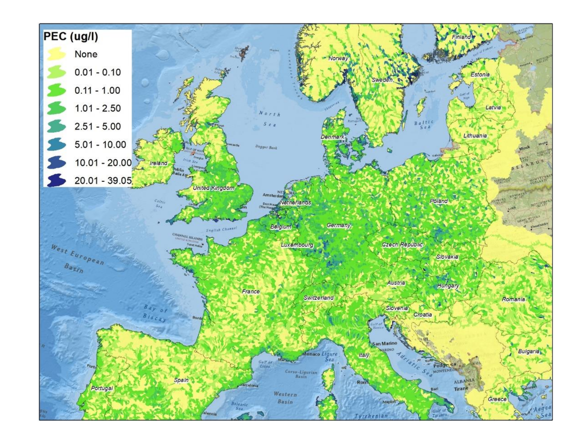


n=20,776 basins downstream of WWTP



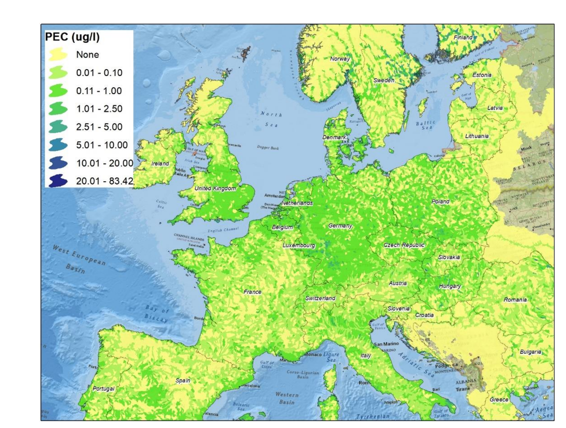
Environmental Disposition

Marine	16.9%
Freshwater	73.4%
Sediment	0%
Soil	4.2%
WWTP Degraded	0%
Incinerated	2.5%
Landfill	1.0%
Other*	2.0%



Environmental Disposition

Marine	7.9%
Freshwater	31.9%
Sediment	11.4%
Soil	21.1%
WWTP Degraded	0%
Incinerated	12.6%
Landfill	5.1%
Other*	10.0%



Environmental Disposition

Marine	2.2%
Freshwater	9.4%
Sediment	0.5%
Soil	38.0%
WWTP Degraded	0%
Incinerated	22.7%
Landfill	9.2%
Other*	18.1%

*Other category includes sludge composting & other sludge disposal.

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