Physics-based basin-scale modelling of water quantity and sediment dynamics using wflow

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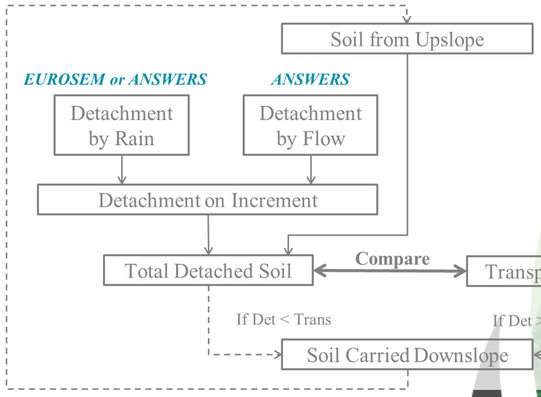
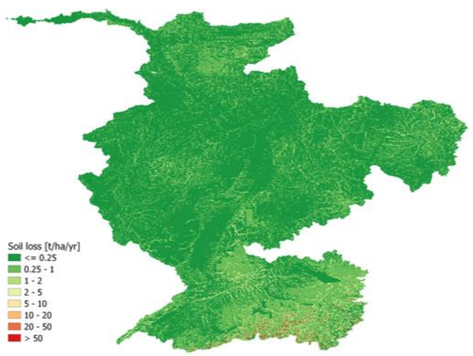
Abstract

Sediment dynamics, from the mountains to the sea, play a key role in inland water systems for water resources and disaster management in general, river morphodynamics, ecology and water quality in particular. To better understand and assert these issues, a good quantification of the sediment budget on the catchment to reach scale and at a relevant temporal scale, is therefore needed.

The wflow_sediment model was developed to address basin-scale geomorphological processes and problems. It is a distributed physics-based model that uses the results of the wflow_sbm hydrological model in order to estimate soil erosion, delivery to the river, transport and deposition. Both the hydrologic and sediment dynamics wflow models are open-source and use openly available global datasets and parameter estimation in order to limit calibration and be applicable even in data scarce environments. Terrestrial processes include splash and overland flow erosion, as well as transport over the grid using either a total flow transport capacity or a transport capacity with particle differentiation. In-stream routing and erosion/deposition processes are adapted from the semi-distributed SWAT model. The wflow_sediment model was first tested in the Rhine basin (Western Europe) at a daily resolution and on a 1 km (0.008333°) grid. Both the inland and instream parts of the model gave promising results, showing the potential of this new tool for a very diverse range of applications.

Terrestrial processes

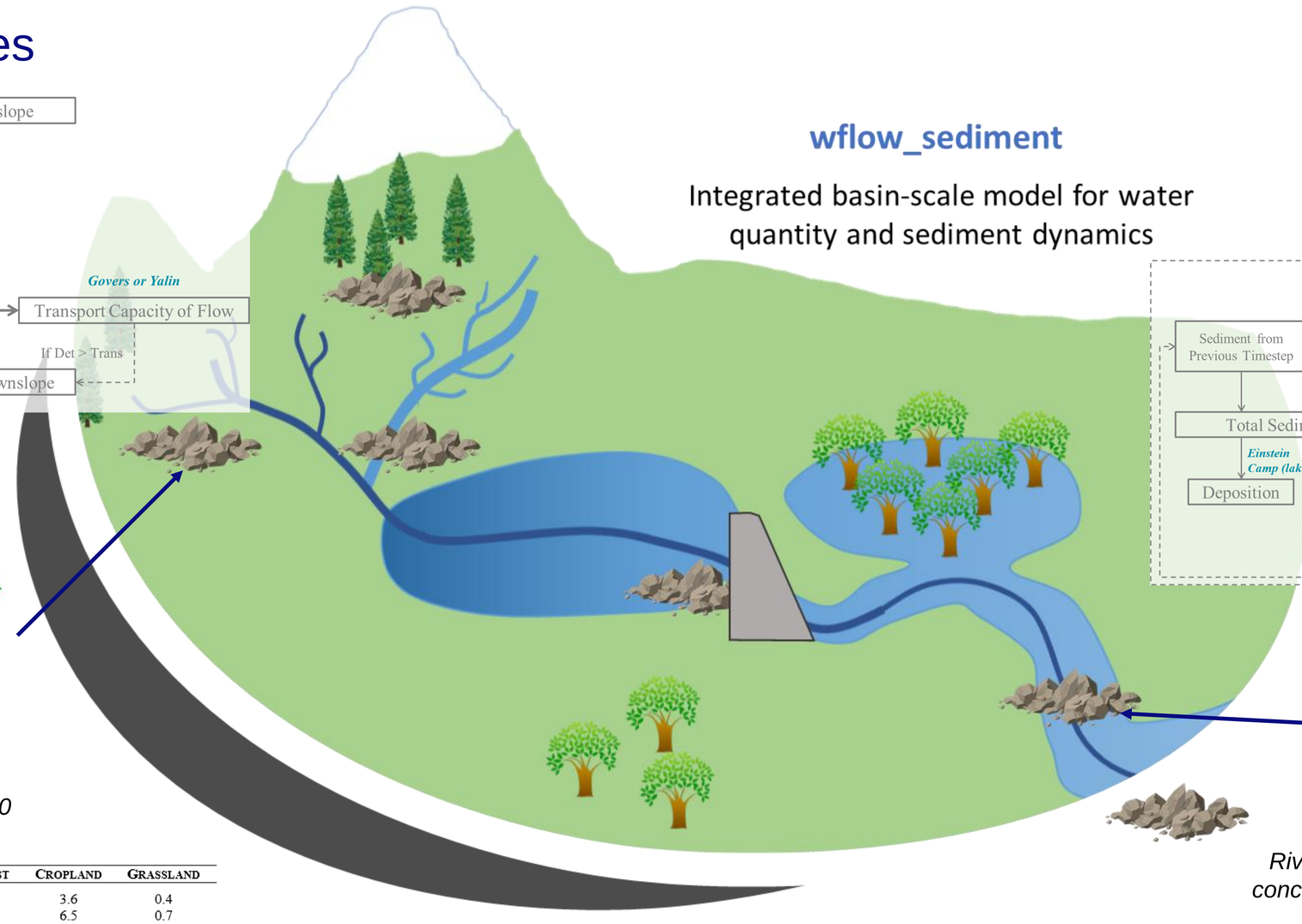




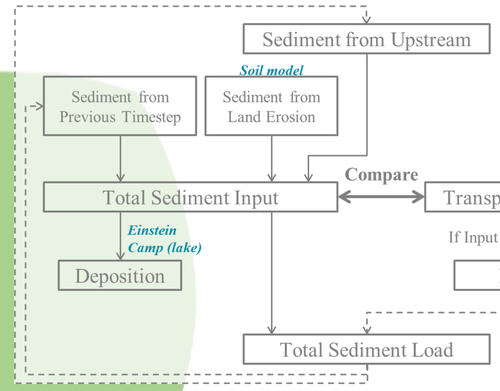
Modelled Soil loss in the Rhine in 2010

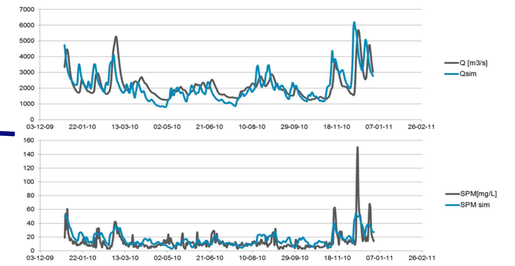
Table 2. Mean soil loss per land use type (tons.ha^{-1}.yr^{-1})

SOURCE	FOREST	CROPLAND	GRASSLAND
CERDAN (EUROPE)	0.2	3.6	0.4
MAETENS (EUROPE)	0.7	6.5	0.7
RUSLE2015 (RHINE, 2010)	2.61	2.16	2.53
PESERA (RHINE, 2003)	0.33	1.62	0.73
WFLOW_SEDIMENT (RHINE, 2010)	0.35	0.91	0.46



In-stream processes





River discharge (top) and suspended solids concentrations (bottom) for the calibration year

More info: https://wflow.readthedocs.io/en/latest/wflow_sediment.html

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