Large-scale modelling of soil erosion by water and potential Global Change impacts in the Upper Danube basin

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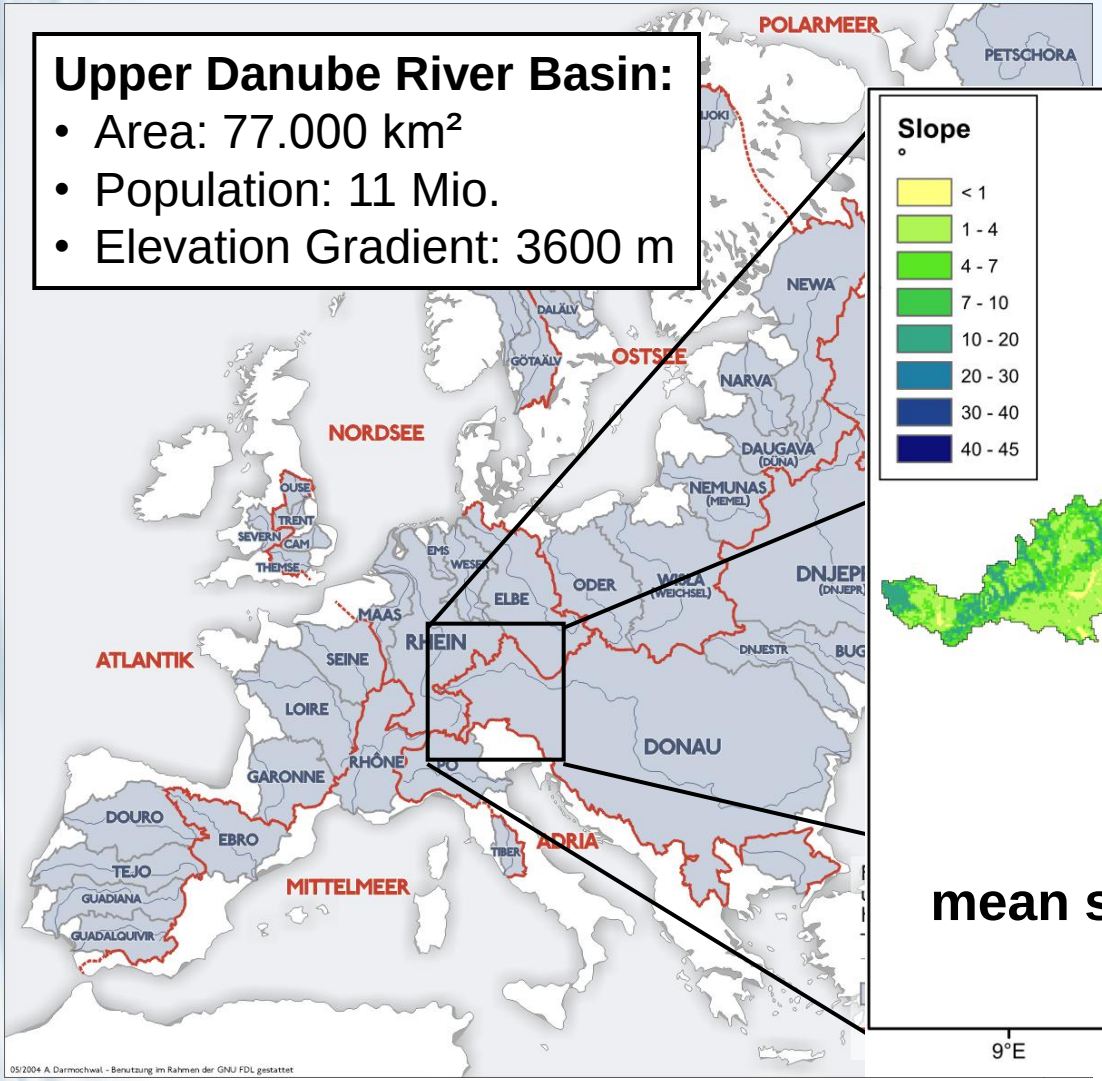
of Education
and Research

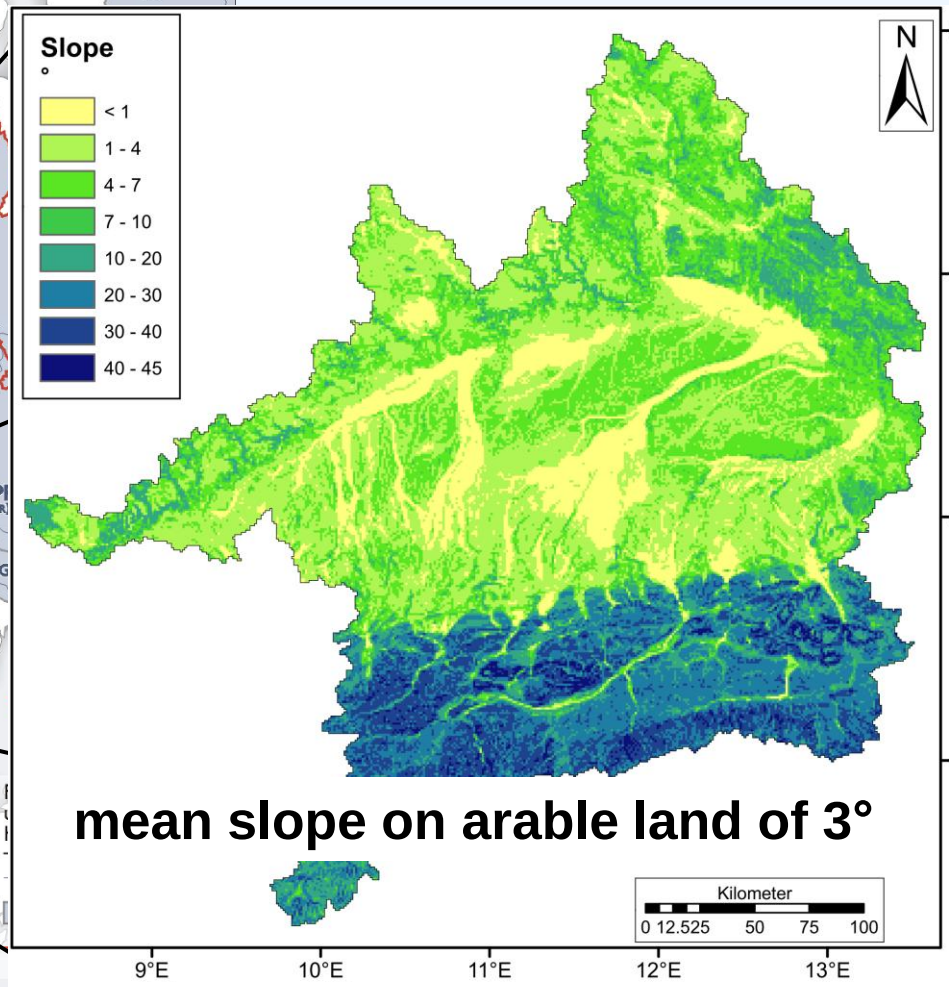
Outline

- Study area & GLOWA-Danube project
- Model basics
- Results: validation & scenarios
- Conclusions & Outlook

Study area - Upper Danube basin

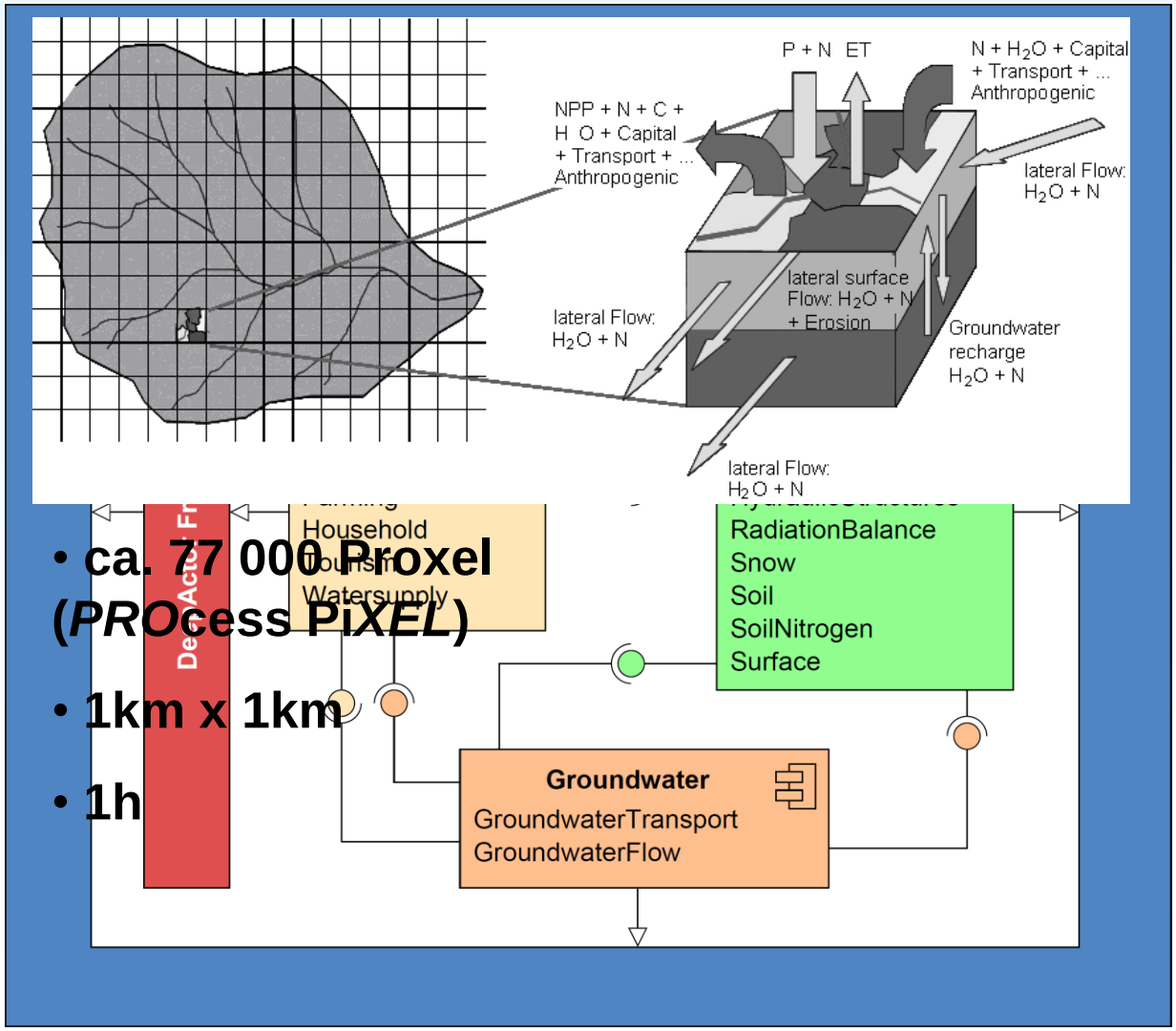
Upper Danube River Basin:
- Area: 77.000 km²
- Population: 11 Mio.
- Elevation Gradient: 3600 m





mean slope on arable land of 3°

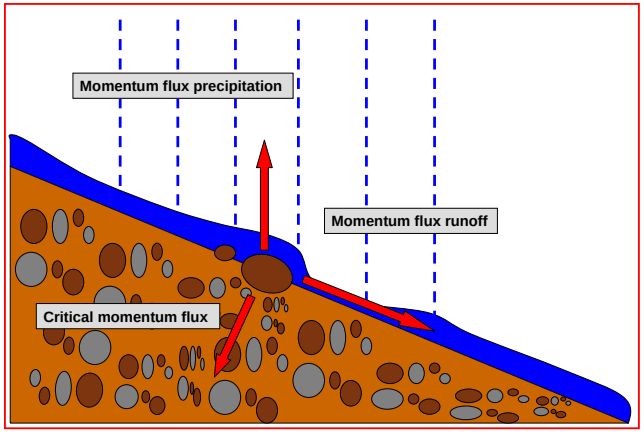
GLOWA-Danube - simulation



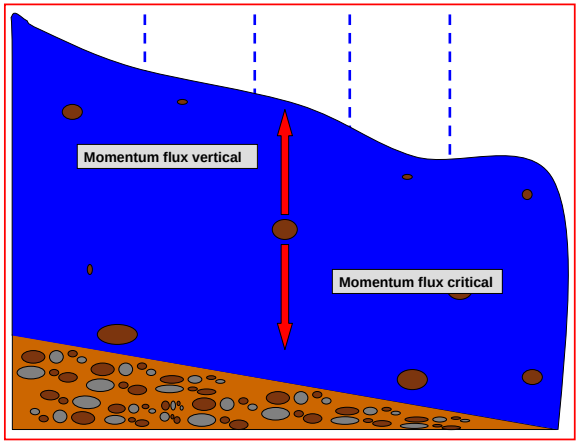
- ca. 77 000 Proxel (*PRO*cess Pi*XEL*)
- 1km x 1km
- 1h

Erosion 2D - Basics

potential detachment



potential transport



detachment > transport

true

false

Actual erosion =

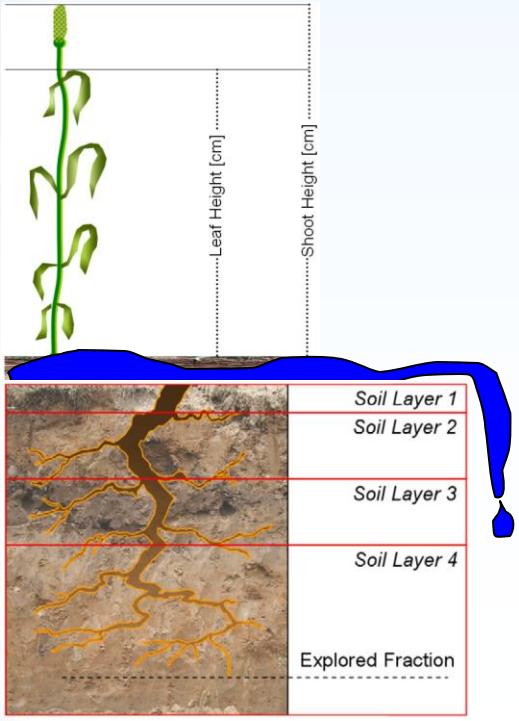
maximum transport capacity

maximum detachment

Erosion module – drivers and dependencies

agricultural management sub-component

sowing, harvest, ploughing, crop residue, etc.



biology sub-component

root development, canopy cover, etc

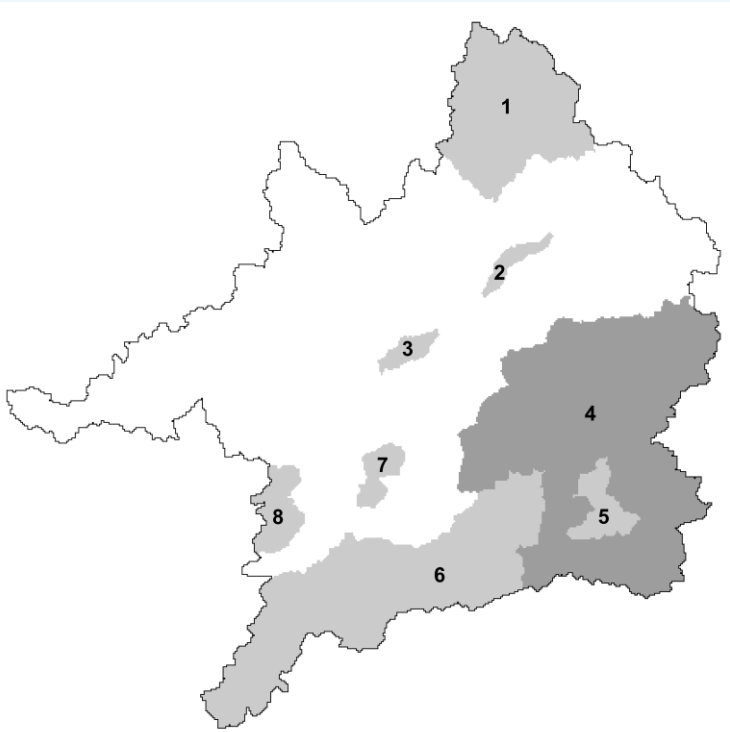
soil sub-component

surface runoff, soil freezing, etc.

Validation - Results

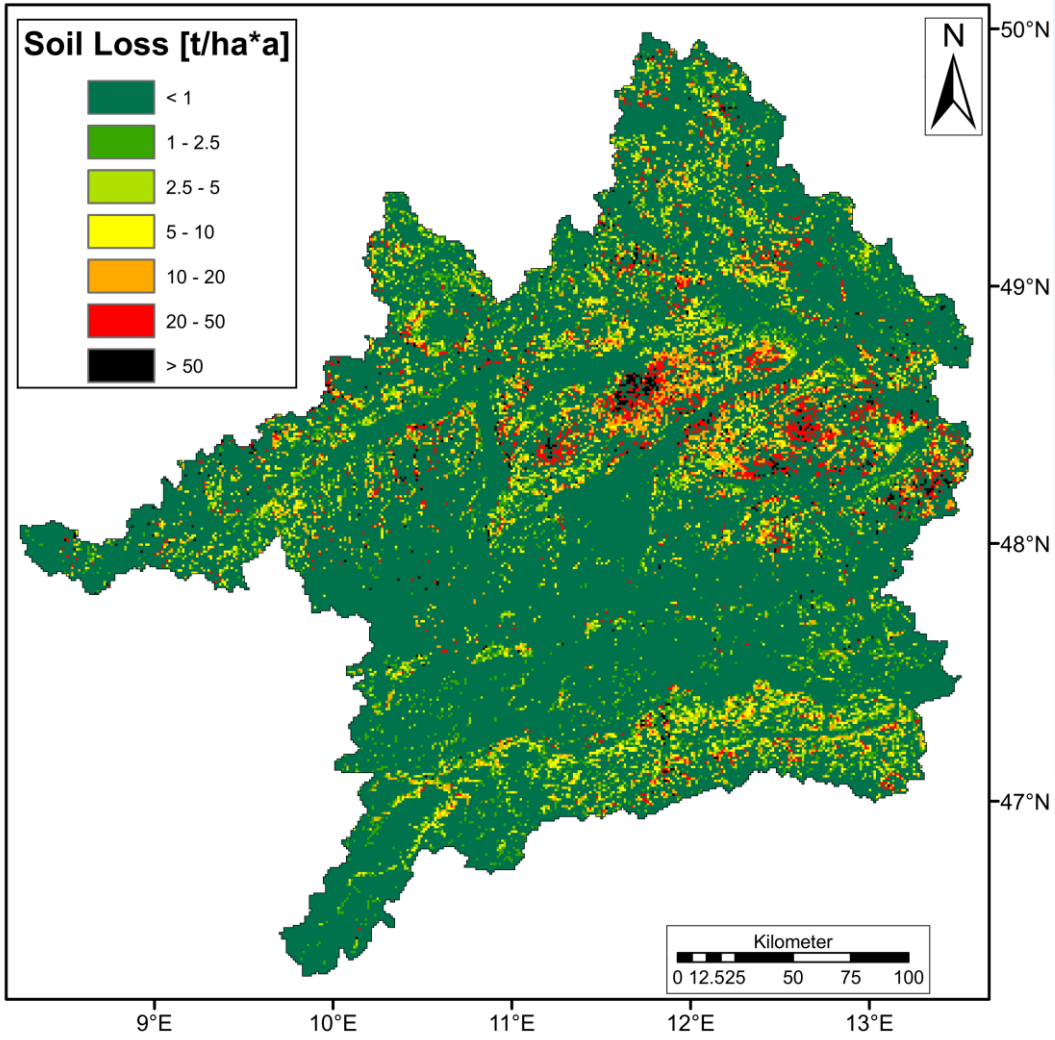
Comparison of modelled soil loss to measured suspended sediment yield (monthly values, 1990 - 2005):

- **Good performance in natural environments**
- **Weaker performance in agricultural areas due to:**
  - **Problems in modelling of surface runoff on these soils**
  - **Partially erroneous harvest dates due to deficient plant parameterisation**
  - **Lack of data: cover crops, management practices**



	Ammer	Grosse Laber	Naab	Glonn	Iller	Inn (Oberaudorf)	Saalach	Inn (Ingling)	Mean
R^2	0.80	0.09	0.39	0.25	0.46	0.30	0.55	0.43	0.41
Pearson	0.90	0.30	0.63	0.50	0.68	0.55	0.74	0.66	0.62
CME (std.)	0.79	-0.40	0.26	0.00	0.36	0.10	0.49	0.32	0.24

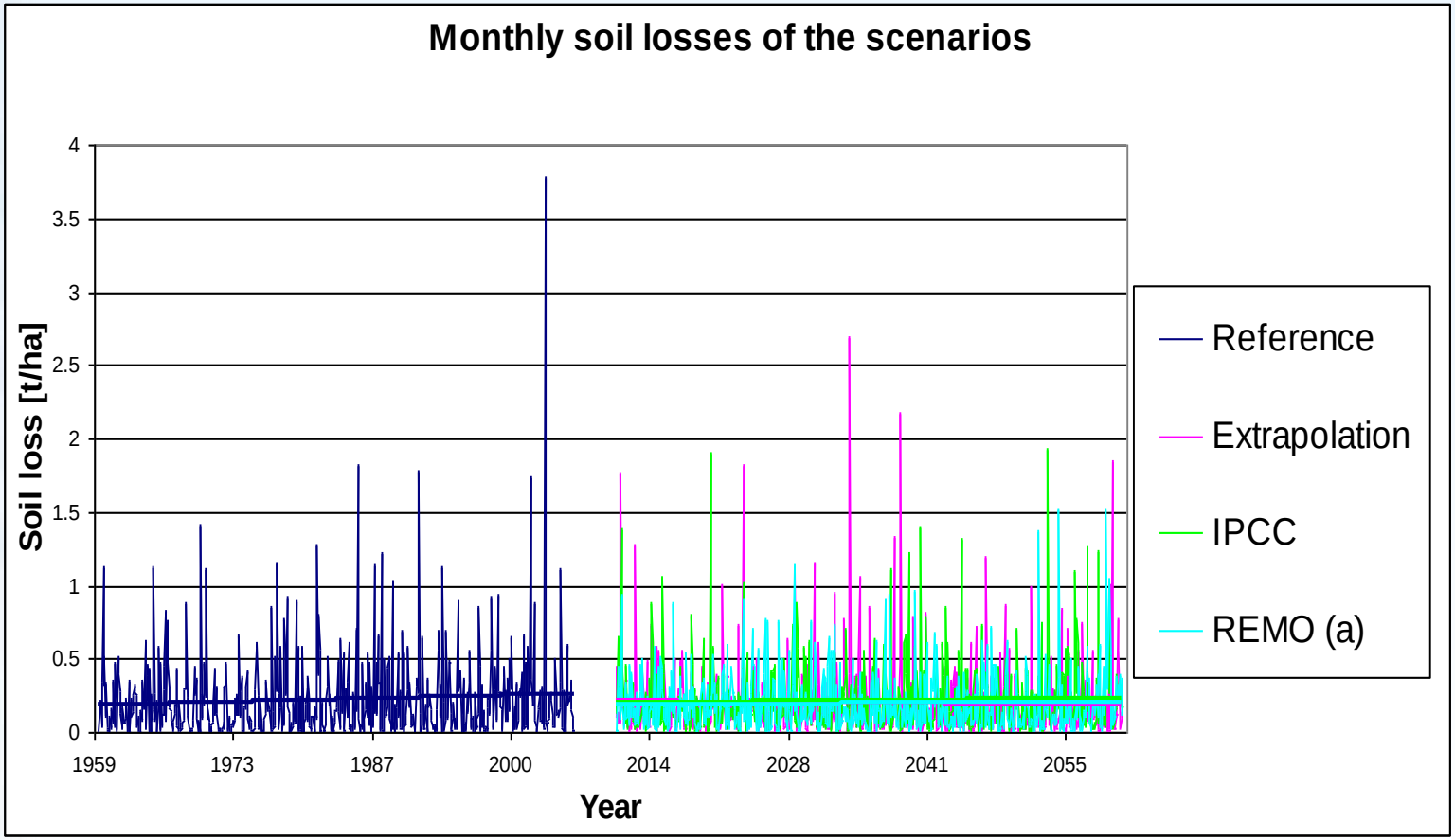
Validation - Results



Modelled mean annual long-term (1990 - 2005) soil loss

Source	Region	Soil loss [t/ha a]
Erosion module	Upper Danube	2.7
PESERA	Upper Danube	0.8
Auerswald et al. (2009)	Germany	2.7
Auerswald & Schmidt (1986)	Bavaria	2.2

Scenarios - Soil loss



Mean

[t / ha a]

2.45

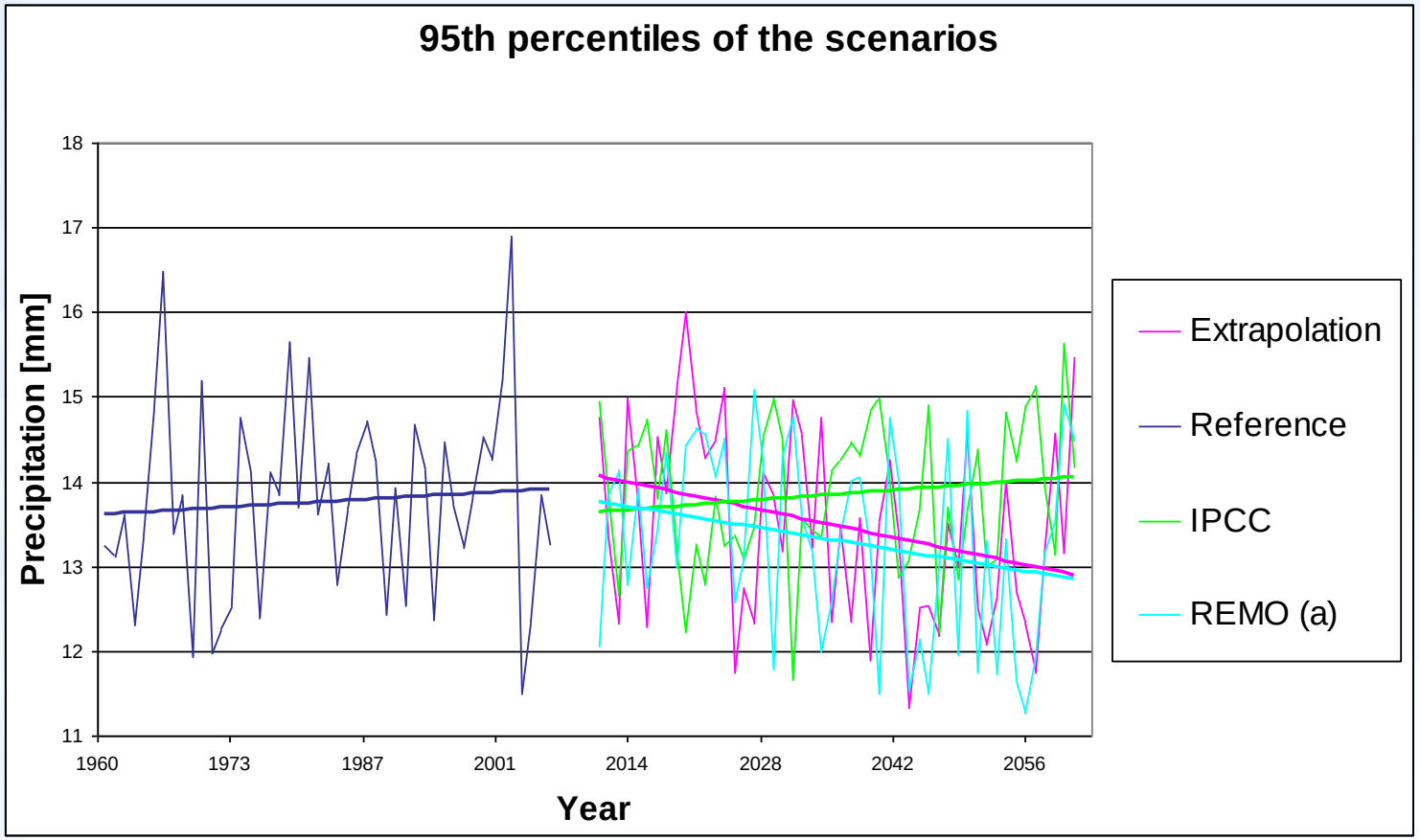
2.41

2.62

2.37

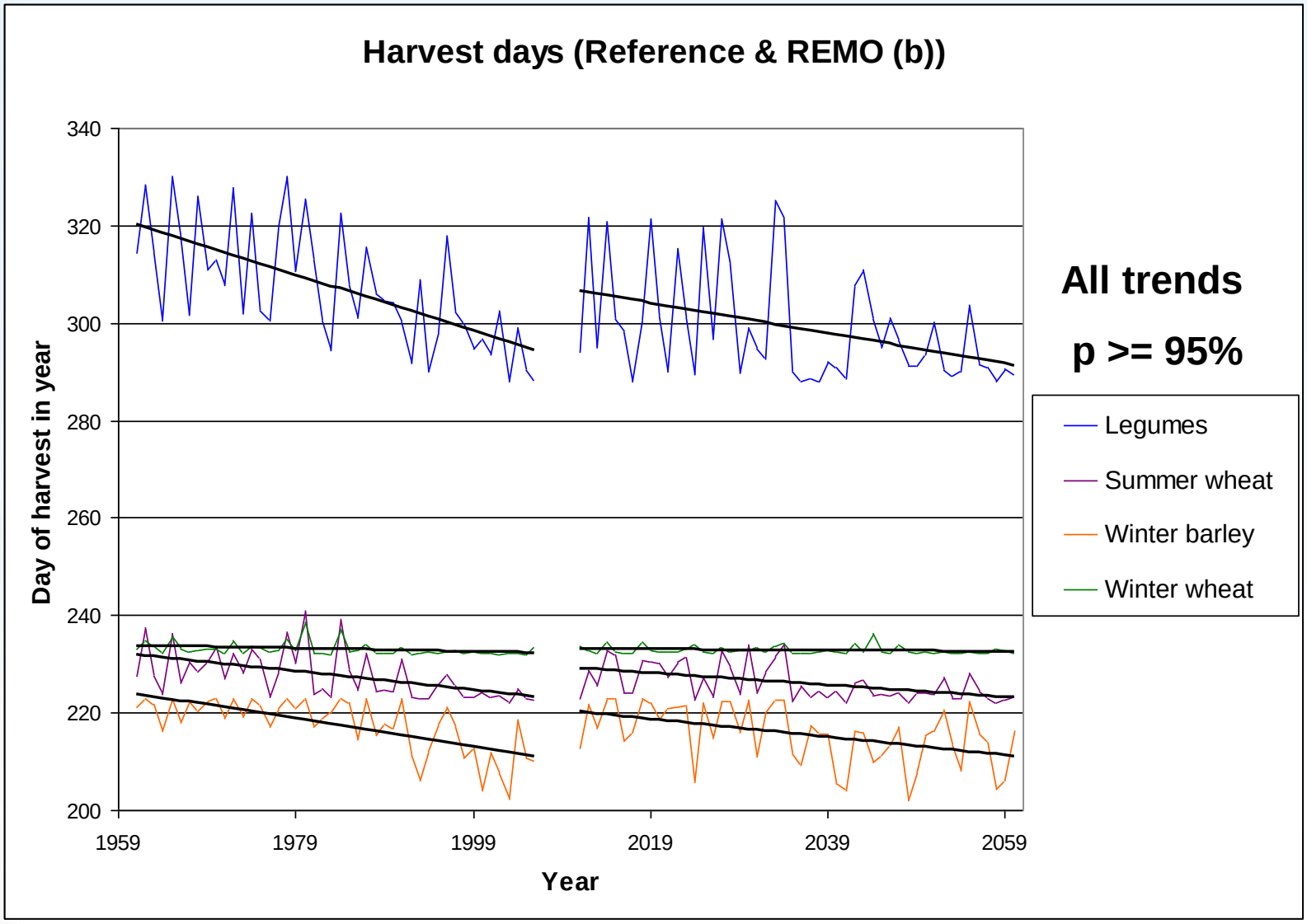
Mann Kendall trend analysis: No significant (p < 90%) trend

Scenarios - Precipitation

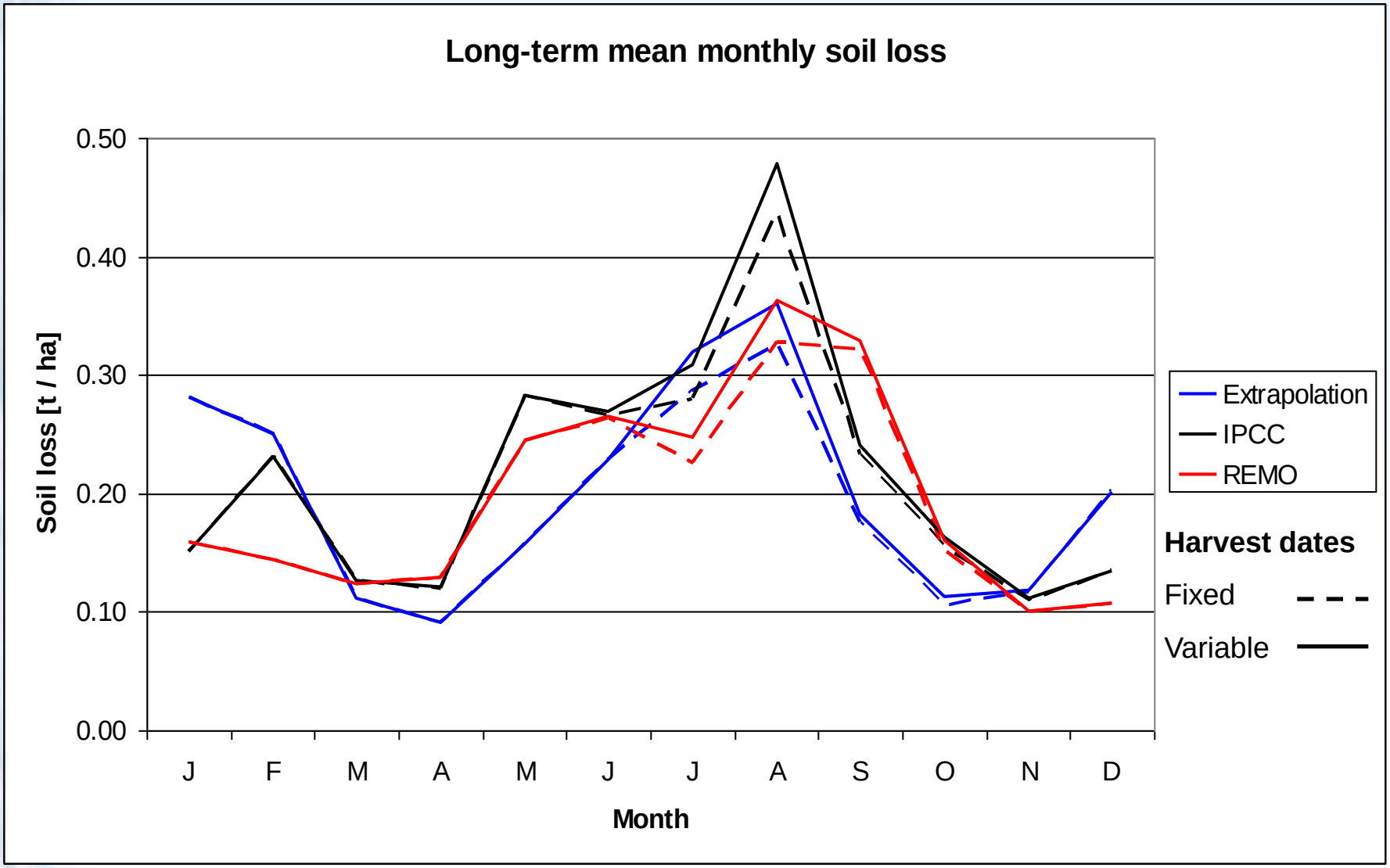


Mann Kendall trend analysis: No significant trend (except „Extrapolation“, p = 90%)

Scenarios – Shift of harvest



Scenarios – Shift of harvest



Conclusions & Outlook

Conclusions

- **Minor impacts on long-term total mean soil loss (- 4% to + 7%)**
- **No significant trends in total soil loss**
- **Observable differences in erosion rates by shift of harvest dates**
- **But: results should be treated with care due to weaker model performance in agricultural areas**

Outlook

- **We need more knowledge about agricultural management**
- **We will analyse *seasonal* trends in soil erosion**


Thank you
very much
for your
attention!
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Scenarios

Scenario	Temperature increase (°C)	Change of precipitation (%) winter	summer	Trend base
IPCC regional	3.3	+7	-14	IPCC (2007)
REMO regional	5.1	-4.9	-31.4	Jacob et al. (2008)
Extrapolation	5.2	+47	-69	Extrapolation of regional trend 1960 - 2006

Results

Scenario	Mean soil loss (t $ha^{-1}a^{-1}$)
Reference (1960 – 2006)	2.45
IPCC regional (2011 – 2060)	2.62
REMO regional (a) (2011 – 2060)	2.37
Extrapolation (2011 – 2060)	2.41
REMO regional (b) (2011 – 2060)	1.62

Erosion module – main drivers

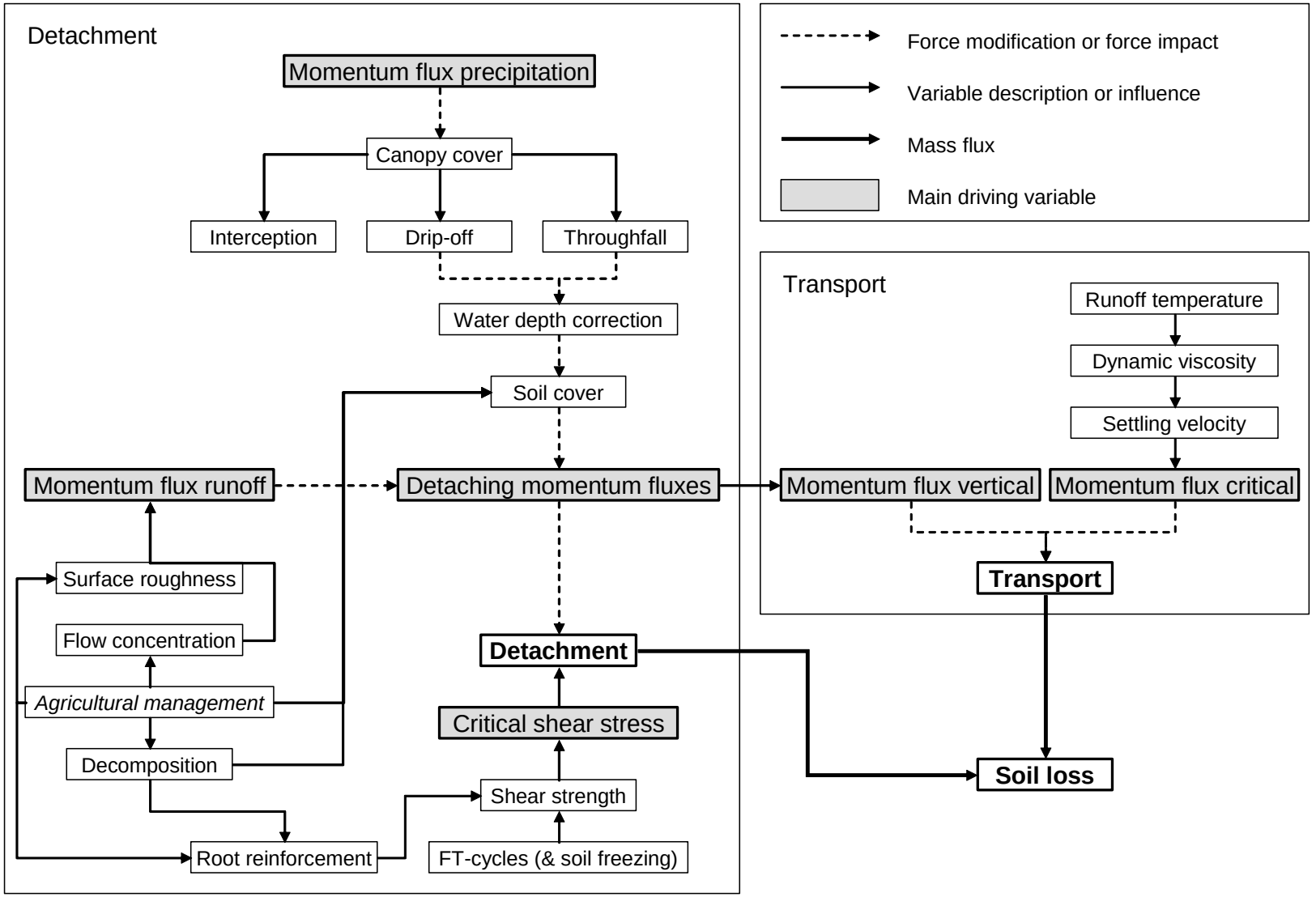
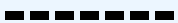
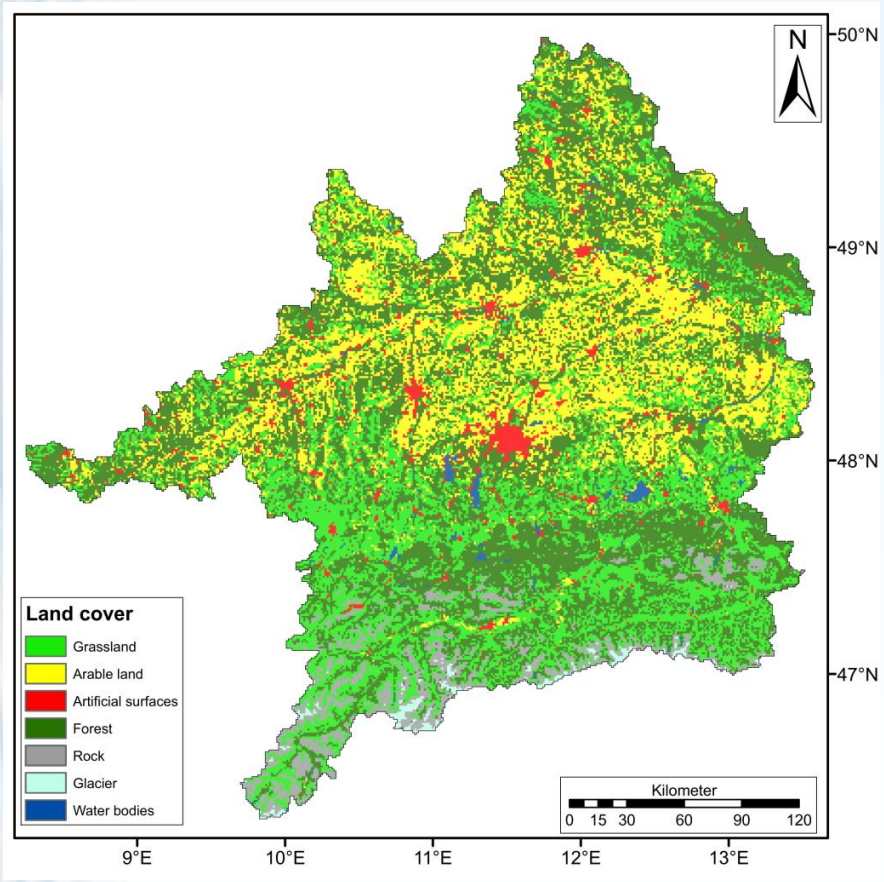


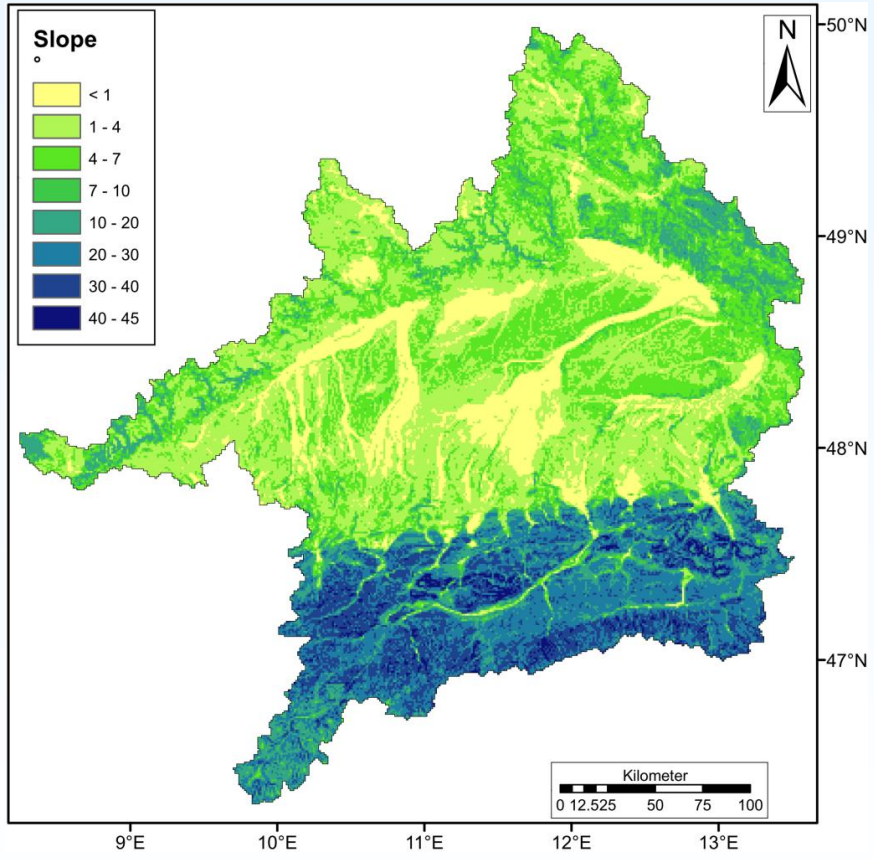
Table A.3: Characteristics of the sub-catchments used for validation. (Arable land excludes agricultural grass land use. Slope statistics are based on a 50 m × 50 m DEM.)

Catchment	Gauge	Area [km^2]	Agricultural (arable) land [%]	Slope min – max (mean) [°]	Main soil texture
Ammer	Weilheim	607	36.7 (1.8)	0.2 – 42.0 (10.8)	loamy sand
Glonn	Hohenkammer	408	66.2 (48.3)	0.6 – 5.2 (2.7)	silt loam, clayey silt
Grosse Laber	Schönach	399	72.2 (62.4)	0.1 – 5.7 (3.4)	silt loam, clayey silt
Iller	Kempten	1006	39.7 (0.1)	0.3 – 44.6 (17.9)	sandy loam, clayey loam
Inn (Ingling)	Ingling	26062	41.8 (9.4)	0.0 – 54.2 (17.8)	clayey and sandy loam, loamy sand
Inn (Oberaudorf)	Oberaudorf	9722	29.8 (1.1)	0.4 – 50.9 (25.4)	clayey loam, loamy sand
Naab	Duggendorf	5436	38.5 (21.8)	0.1 – 14.3 (4.6)	loamy sand, silty sand
Saalach	Unterjettenberg	919	38.7 (0.0)	0.6 – 47.0 (25.2)	clayey loam, loamysand



Study area - Upper Danube basin





23 % arable land

mean slope on arable land of 3°

Scenarios – Monthly soil loss