Impact of climate change scenarios on sediment load assessments

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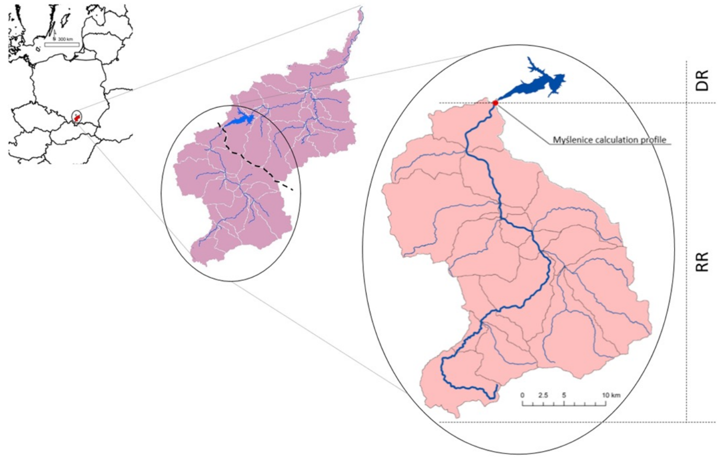
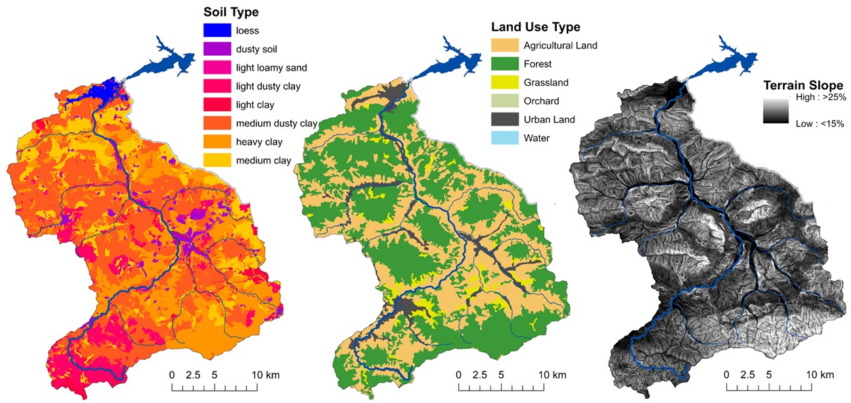
Impact of climate change scenarios on sediment load assessments

- Modelling of sediment yields & loads
- Scenarios' variants
- Model response under 3 different climate change scenario choices:
  - data choice/availability – point vs. areal approach
  - reference period – 10 vs. 30 years
  - dry, wet, and average scenario ensembles
- Take-home message for modellers

Modelling sediment loads



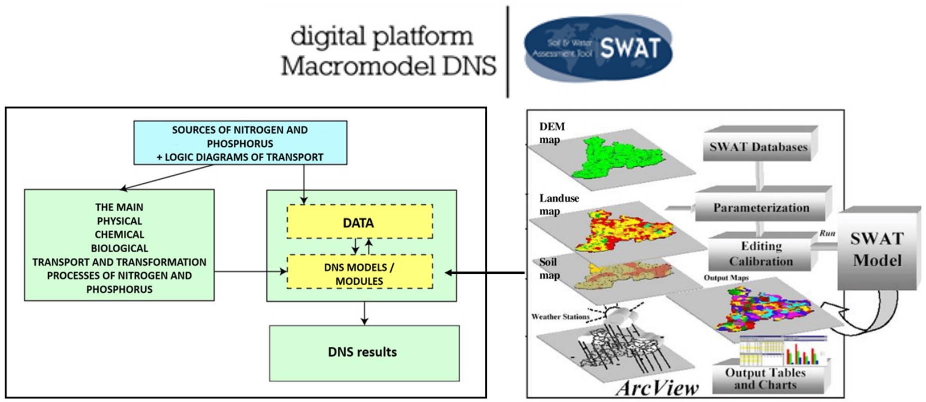
- Upper Raba River, Carpathian Mts.
- 768 km^2 of the catchment
- Dammed reservoir as a trap for sediments
- Soil loss enhanced by climate changes



Source: Wilk et al. 2022

Modelling sediment yields & loads

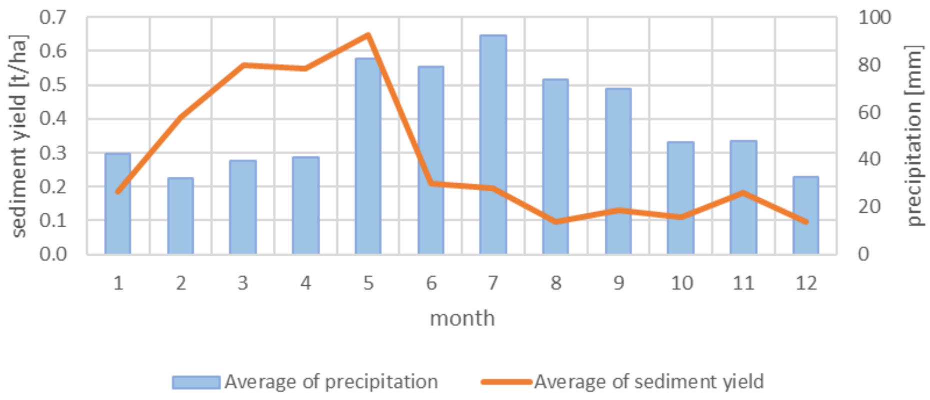
- Digital platform DNS/SWAT *(Discharge-Nutrient-Sea/Soil Water Assessment Tool)*
- Baseline scenario created based on:
  - Digital Elevation Model
  - Soil and land use maps
  - Meteorological Data
  - Point and non-point pollution sources

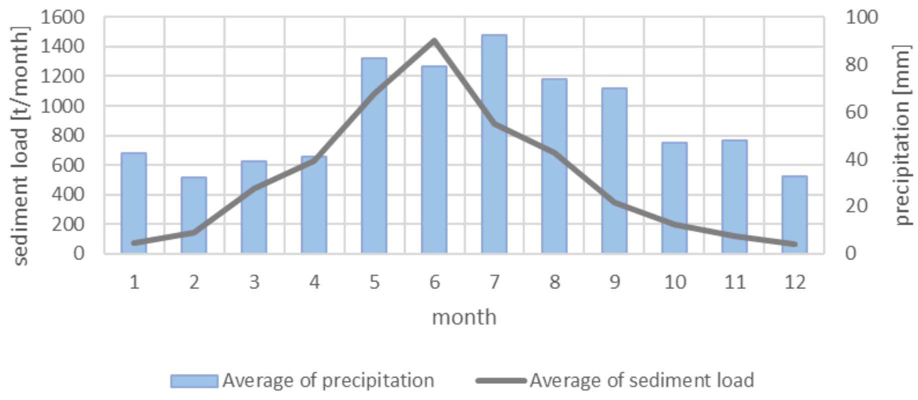


- Land phase: *sediment yield – t/ha*
- River bed phase: *sediment load - t/y,m,d*

Source: Wilk et al. 2022

Baseline scenario

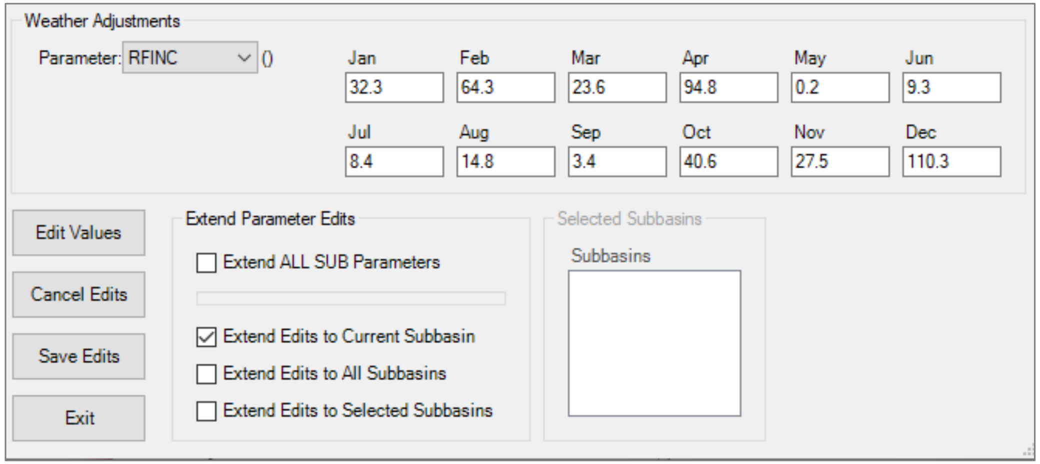




	Sediment yield	**Sediment load**
Average yearly	3.4 t/ha/y	6 096 t/y
Average monthly	0.3 t/ha/m	508 t/m

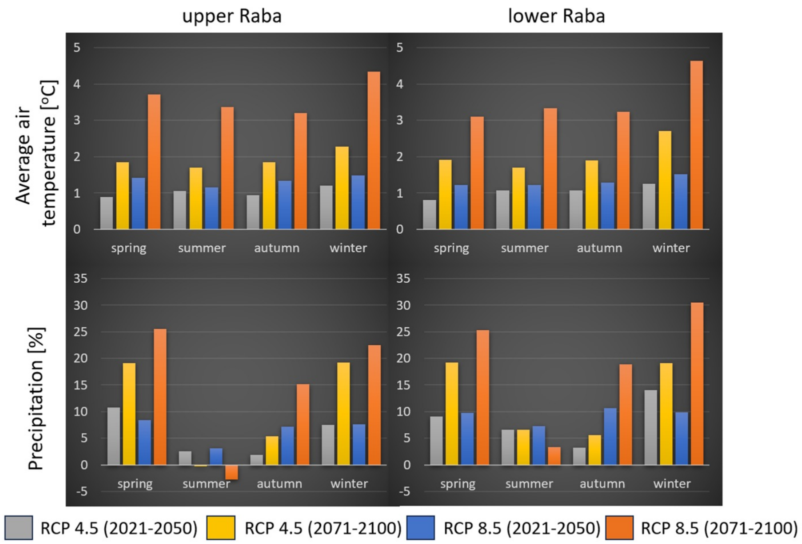
Scenarios' variants

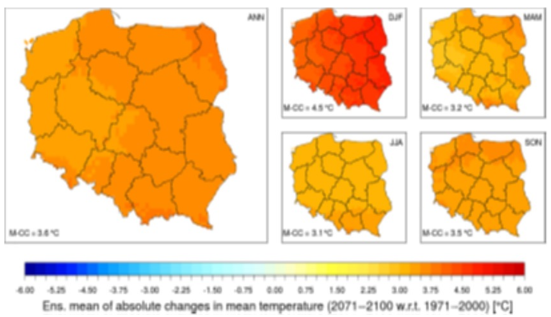
- Variant scenarios in the SWAT model
- Land use
- Agricultural practices
  - Fertilization,
  - Crop rotation,
  - Buffer zones
- Climate change

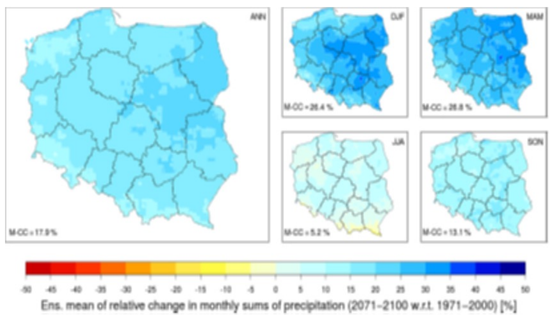


Climate change scenarios (1st)

- Projection of climate change for Poland based on *CHASE-PL - downscaling the EURO-CORDEX data (Mezghani et al., 2017);*
- Precipitation and temperature changes (RCP4.5 & RCP 8.5);
- Future horizons: 2021-2050 & 2071-2100

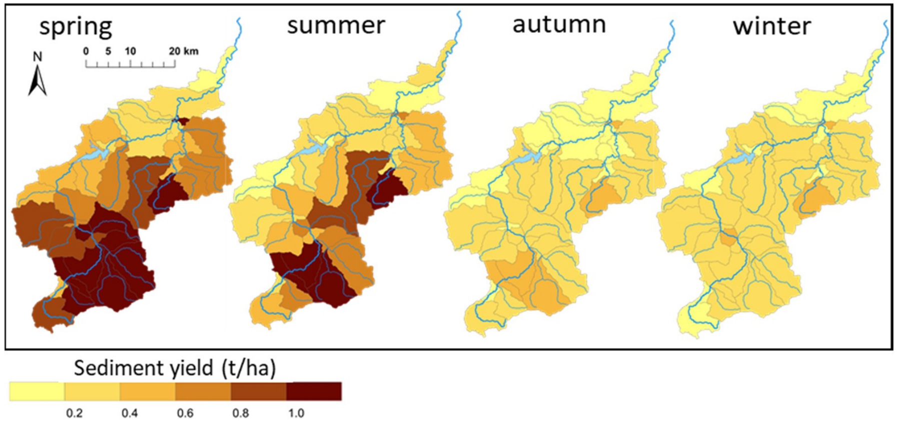


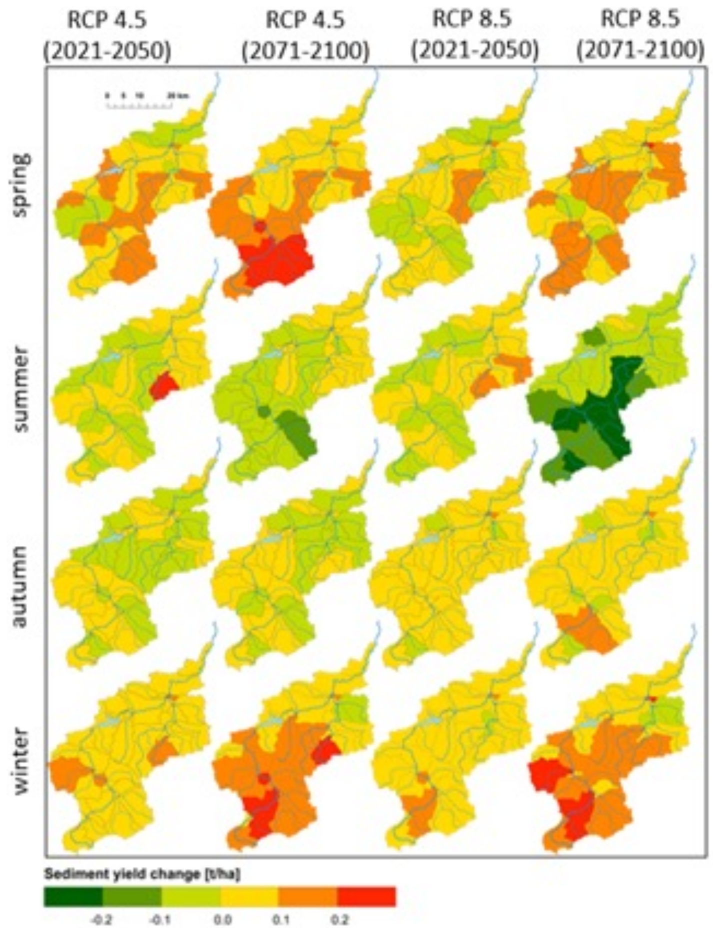




Source: Orlińska-Woźniak et al., 2020

Climate change scenarios (1st)



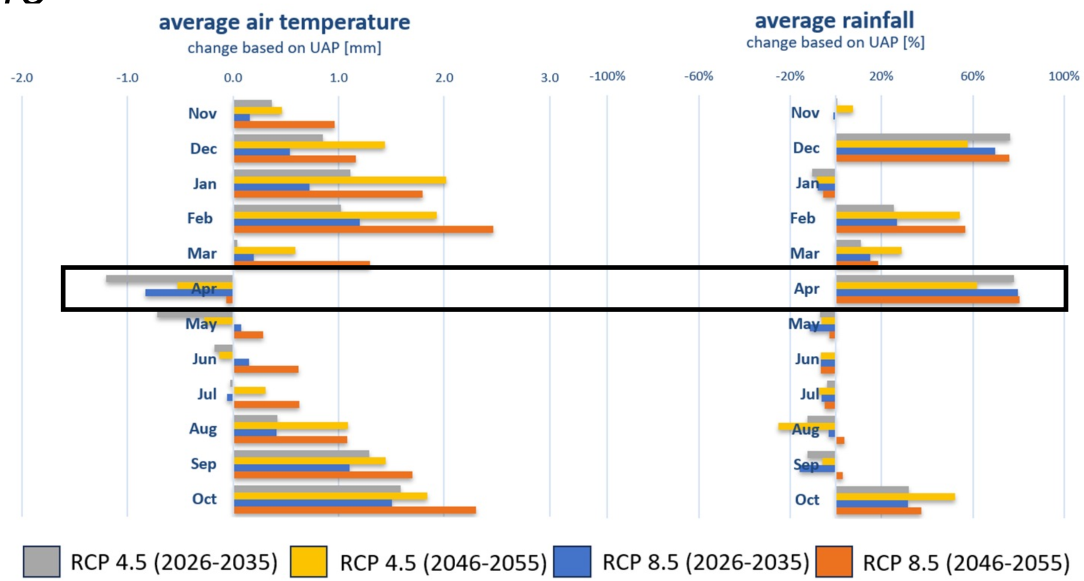


Sediment yield changes: baseline scenario vs. changes in individual climate scenarios

Source: Orlińska-Woźniak et al., 2020

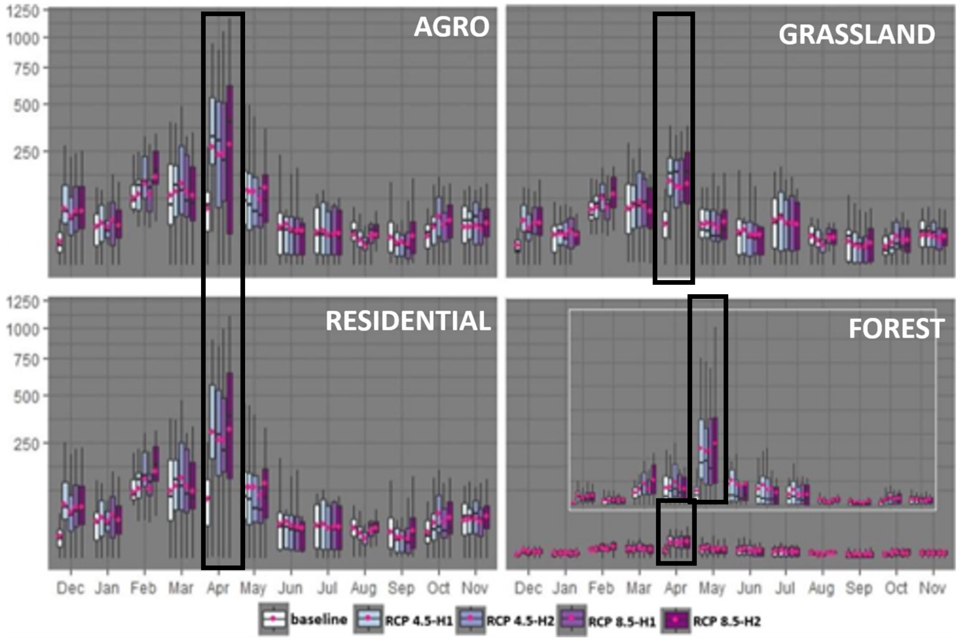
Climate change scenarios (2nd)

- Projection of climate change for Cracow - *Development of Urban Adaptation Plans (UAP) for cities with more than 100,000 inhabitants in Poland*
- Precipitation and temperature changes (RCP4.5 & RCP 8.5);
- Future horizons:
  2026-2035 & 2046-2055



Source: Szalińska et al., 2021

Climate change scenarios (2nd)



Sediment yields from different type of land use

Why April?!

Also in other catchments…

Source: Szalińska et al., 2021; Wilk et al., 2022

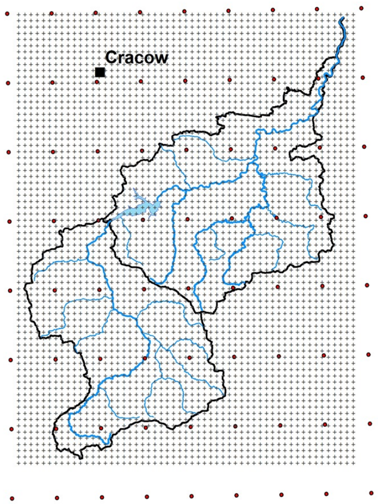
Climate change scenarios (3rd)

- Is the data from a single meteorological station good enough? (point vs. areal approach)

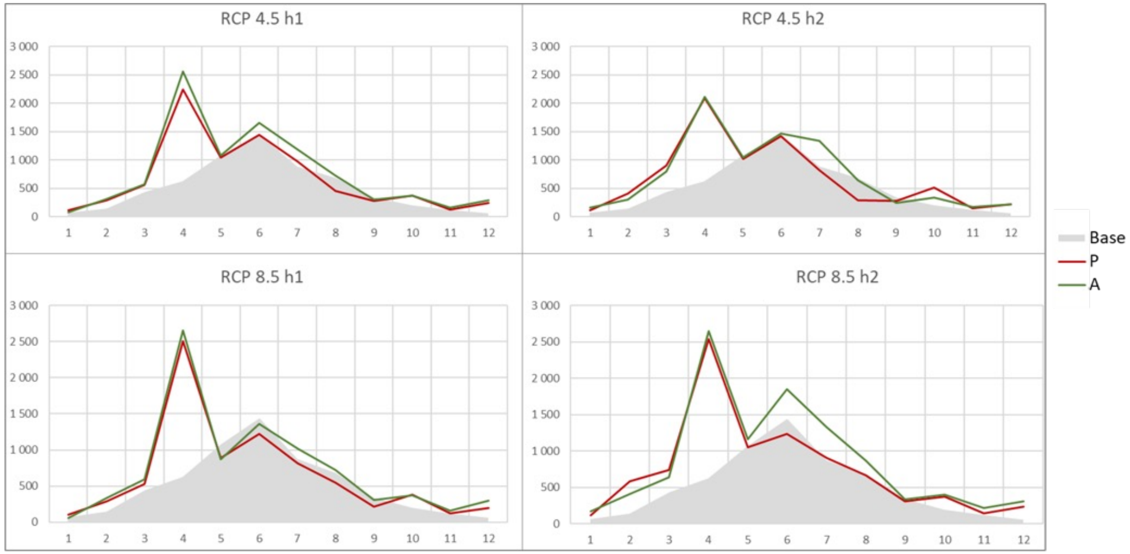
- Does the reference period matter? (10 vs. 30 years)

- What are the differences between models? (dry, wet, or average ensembles)

Point (P) vs. areal approach (A)



10-year reference period (2006-2015)

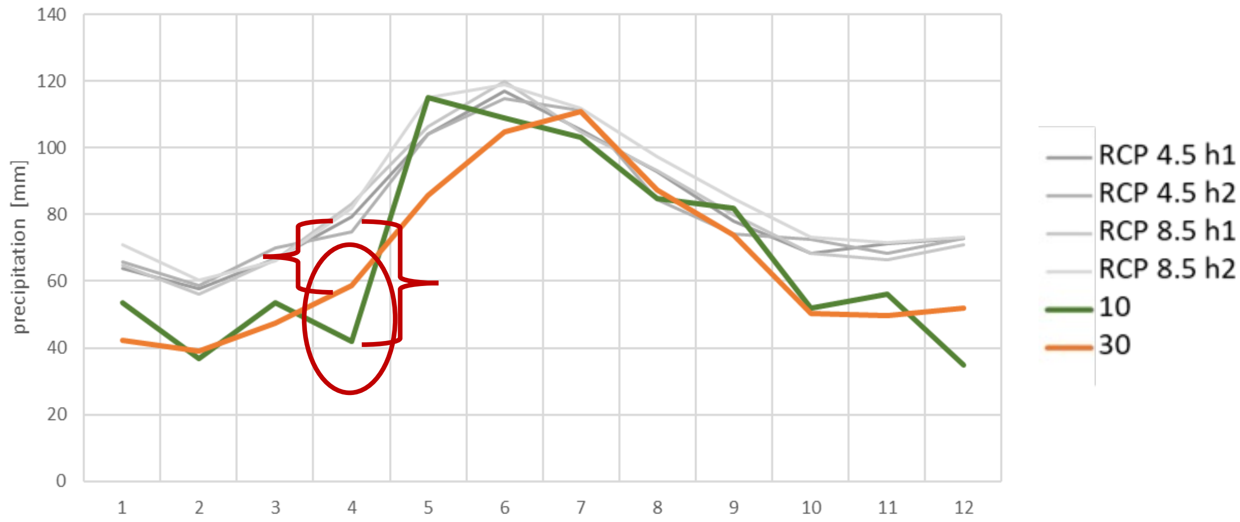


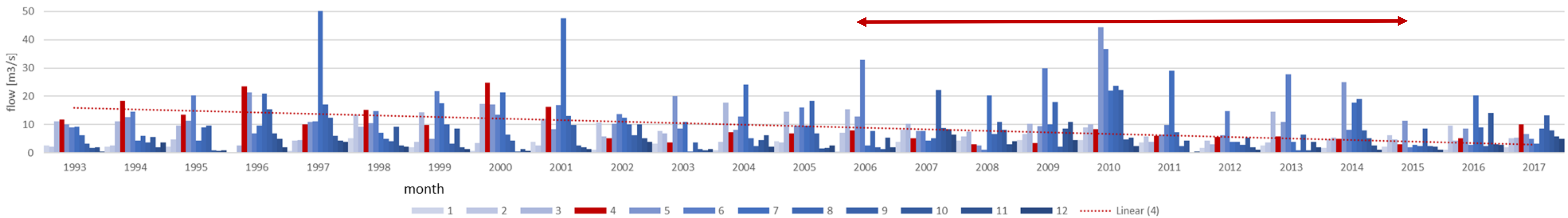
	base	RCP451 P	RCP452 P	RCP851 P	RCP852 P	RCP451 A	RCP452 A	RCP851 A	RCP852 A
Sediment loads t/y	**6 096**	**8 133**	**8 232**	**7 817**	**8 928**	**9 284**	**8 841**	**8 751**	**10 372**

Reference period – 10 vs. 30 years

10 years (2006-2015)

30 years (1991-2020)

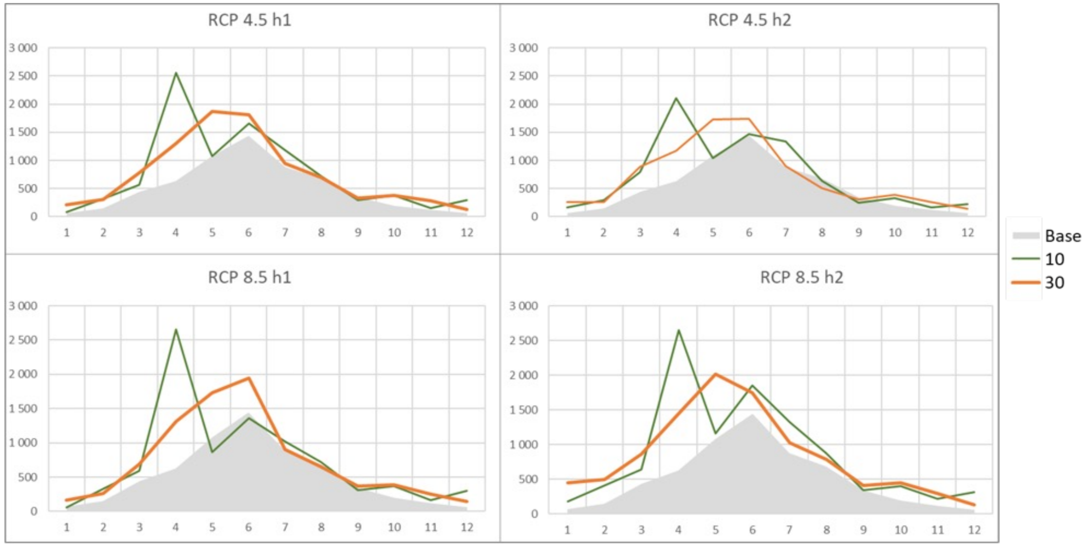




Reference period – 10 vs. 30 years

10 years (2006-2015)

30 years (1991-2020)



	base	RCP451 10	RCP452 10	RCP851 10	RCP852 10	RCP451 30	RCP452 30	RCP851 30	RCP852 30
Sediment loads t/y	**6 096**	**9 284**	**8 841**	**8 751**	**10 372**	**9 066**	**8 543**	**8 797**	**10 127**

Moisture content in scenarios

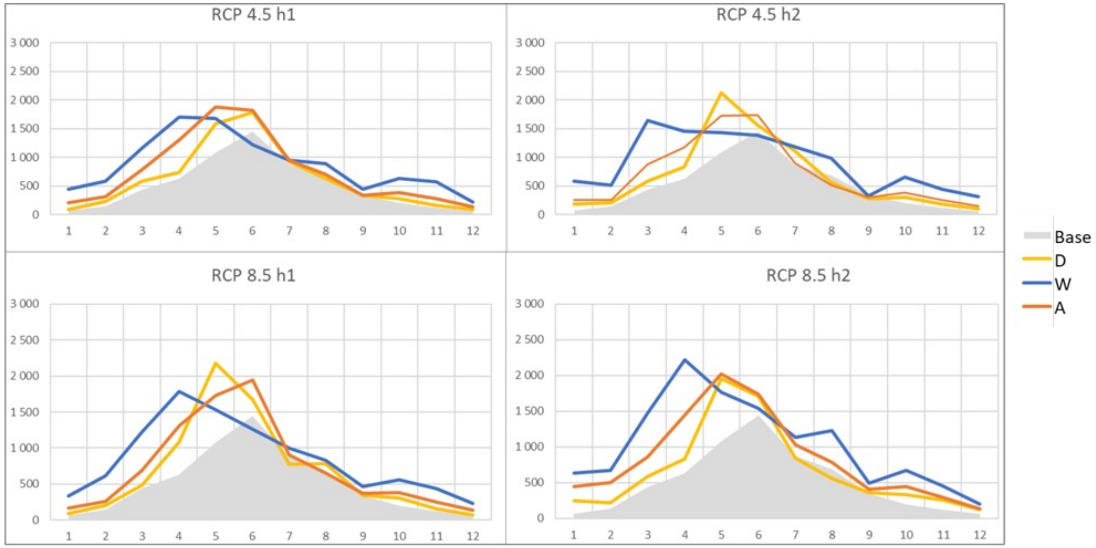
	CNRM_CLM	CNRM-AL.	CNRM_SMHI	ICHEC_KNMI	ICHEC_DMI	ICHEC_CLM	ICHEC_KNM	ICHEC_SMH	IPSL_WRF	MPI_CLM	MPI_MPI	MPI_SMHI	MPI_WRF	NCC_DMI
JAN	50.8	14.7	32.2	37.4	75.0	39.9	38.9	39.1	70.8	70.6	56.1	50.4	44.3	111.7
FEB	49.9	18.3	25.9	31.7	27.5	25.9	25.0	12.0	63.6	59.8	50.8	28.8	29.2	67.6
MAR	32.9	41.6	45.1	-18.2	52.0	25.0	-0.8	11.4	39.5	53.2	49.7	35.6	31.9	85.7
APR	33.9	38.0	53.5	-17.0	19.8	12.5	-16.9	21.7	30.7	51.5	25.9	57.8	24.2	72.1
MAY	-4.9	26.7	27.0	-0.4	30.0	-5.3	7.1	44.4	49.7	-4.1	0.3	33.9	17.4	33.6
JUN	-29.0	1.0	28.7	-5.4	23.2	-14.0	-6.0	29.7	22.5	3.9	-4.6	12.7	30.9	1.9
JUL	-46.3	-0.1	8.3	-25.0	16.6	-34.5	-12.2	-4.5	-14.8	16.9	-4.8	0.0	19.0	7.2
AUG	-32.0	-6.9	-1.8	-13.7	28.6	-20.9	-3.6	-10.6	-28.6	7.1	4.4	10.7	33.4	17.3
SEP	1.1	1.0	8.1	-6.4	43.4	-19.4	-12.1	1.0	-2.6	3.7	-12.9	8.6	-16.3	11.9
OCT	37.3	11.8	33.3	18.8	73.0	25.3	16.6	42.3	24.0	49.4	35.9	50.2	43.9	61.6
NOV	39.8	17.6	15.7	10.1	35.3	7.9	17.8	-3.2	51.7	35.9	21.7	24.1	11.9	68.6
DEC	23.1	-8.8	-0.4	12.9	55.8	6.8	2.6	-10.1	54.3	45.8	42.1	23.5	16.4	56.8
mean	13.0	12.9	23.0	2.1	40.0	4.1	4.7	14.4	30.1	32.8	22.1	28.0	23.9	49.7
		dry		dry	wet	dry	dry			wet		wet		wet

Precipitation differences = 100 * ($Model_{future}$ / $Model_{reference}$ – 1)

< 0 – dry; 25th percentile < 1.1 - dry; 75th percentile > 39.2 - wet

Moisture content in scenarios

Sub-ensembles:
- Dry (D)
- Wet (W)
- Average (A)



Sediment loads t/y

base	RCP451 A	RCP452 A	RCP851 A	RCP852 A	RCP451 W	RCP452 W	RCP851 W	RCP852 W	RCP451 D	RCP452 D	RCP851 D	RCP852 D
6 096	**9 066**	**8 543**	**8 797**	**10 127**	**10 487**	**10 920**	**10 286**	**12 497**	**7 445**	**8 041**	**8 150**	**8 050**

Take-home message

- Point vs. Areal – areal better reflects catchment features (if variable);
- 10 vs. 30 – longer reference period more reliable for precipitation changes, but necessary for flows/yields/loads (monthly distribution);
- Dry, Wet, Average – check your model ensemble for the moisture content;

- Make friends with a climatologist ☺

Thank you

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