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Sediment quantity modelling in a climate change context

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Sediment quantity modelling in a climate change context

- *Alterations in the sediment transport, future changes, lack of quantity data,….*

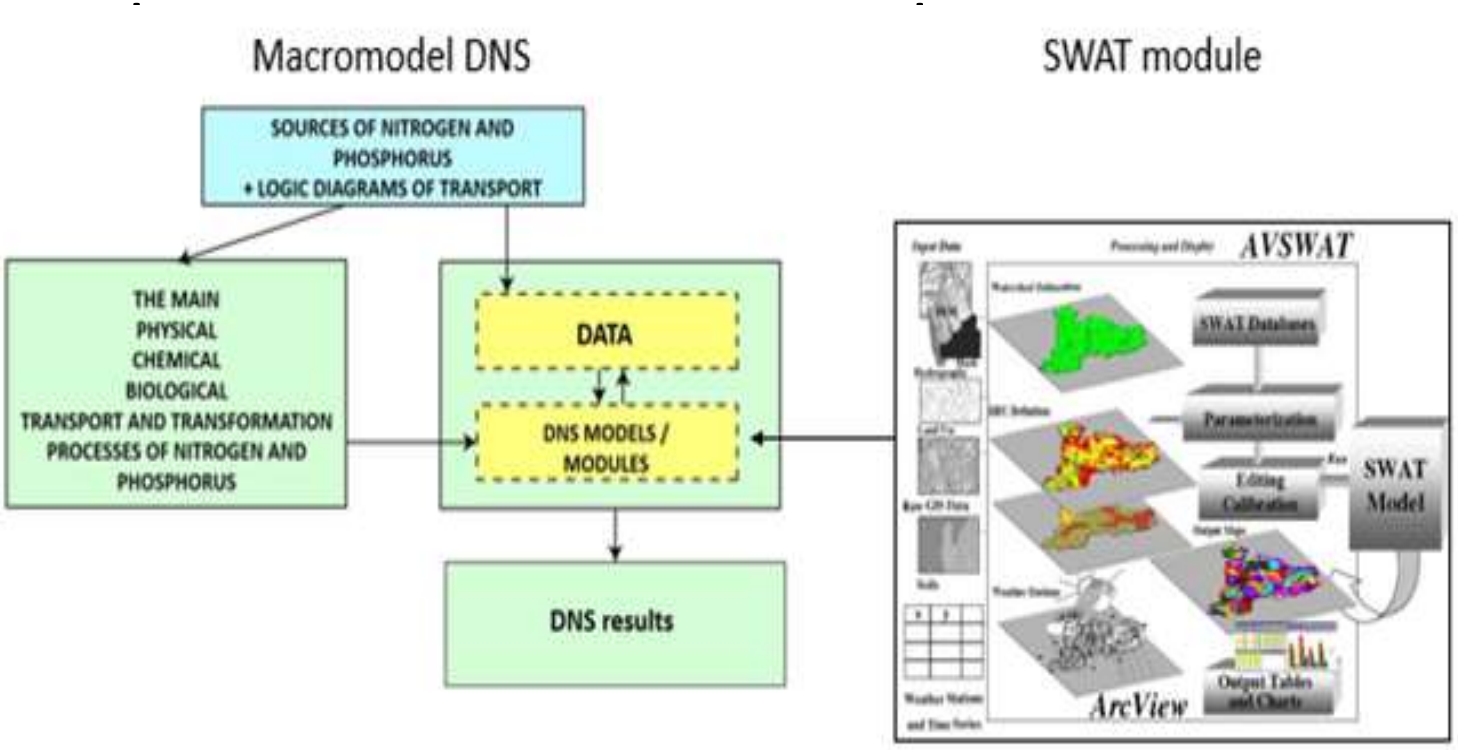
- Modeling tool – Macromodel DNS/SWAT
- Pilot catchment – Raba River (southern Poland)
- Model construction - gathered database
- Possible variant scenarios
- Sediment calculations

Alterations in the sediment transport, future changes, lack of quantity data,….

- Rate and continuity of the sediment transport in catchment-river-sea systems altered;
- Additional changes in the future - climate and land use changes;
- Lack of sediment quantity monitoring data;
- Modeling approach might help the case...

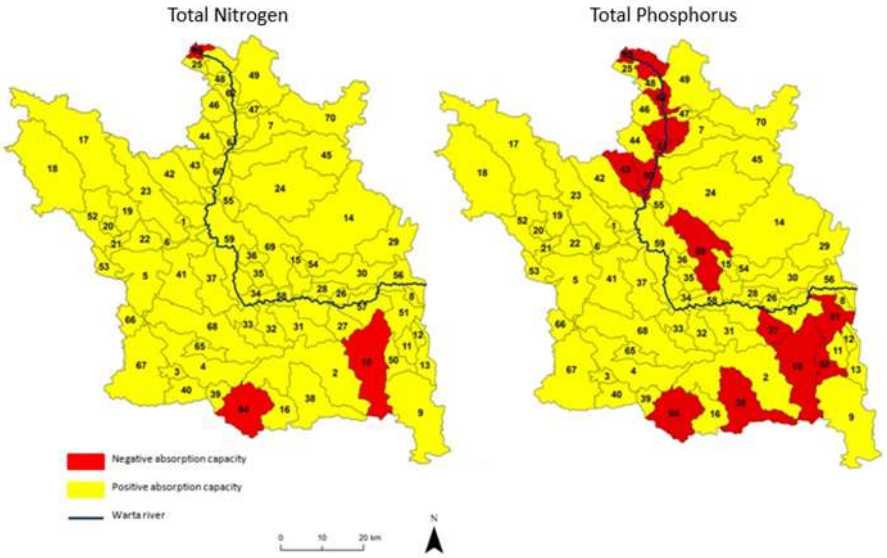
Modeling tool – Macromodel DNS/SWAT

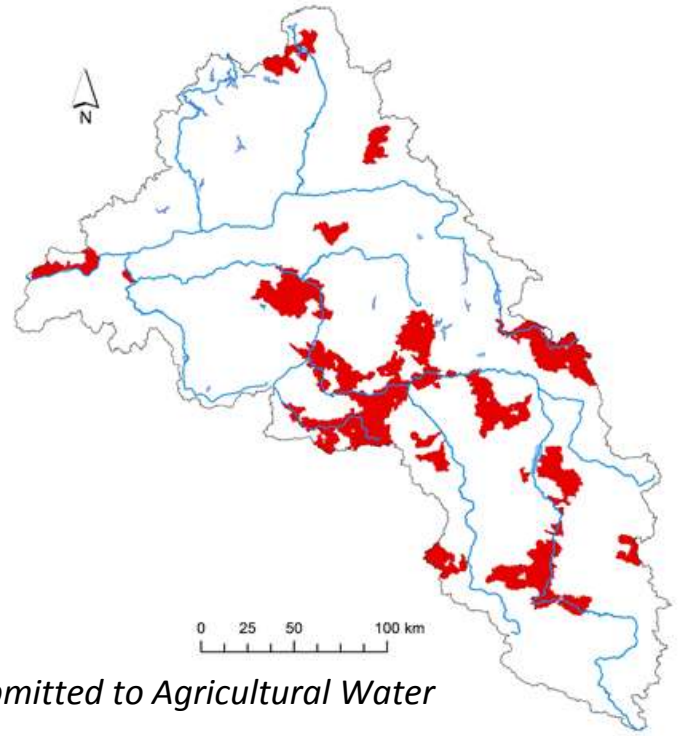
- Macromodel DNS/SWAT - developed in Institute of Meteorology and Water Management – National Research Institute (Poland);
- SWAT
- DNS -



Modeling tool – Macromodel DNS/SWAT

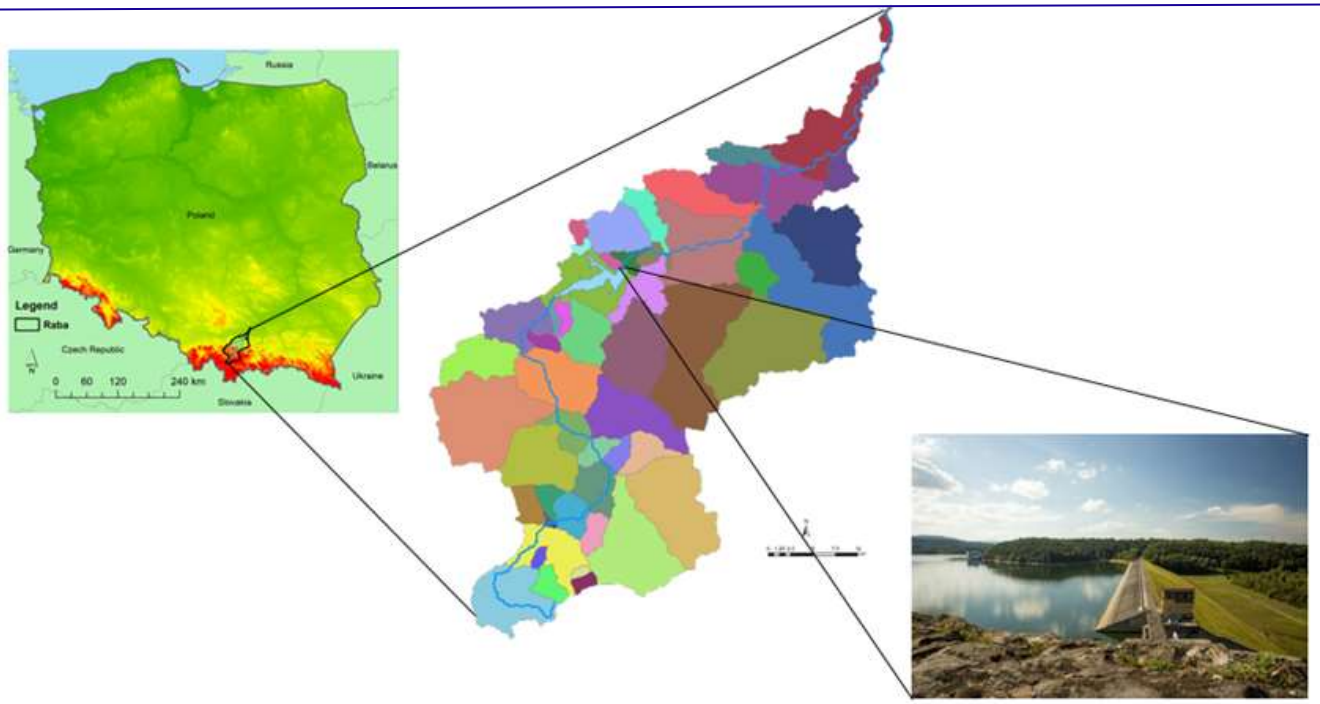
- Calculation of the RAC (River Adsorption Capacity) parameter - the Middle Warta River (*Hydrology & Earth System Sciences; Wilk et al., 2018*)





- Delineation of the nutrient vulnerable zones in the catchment (*Woźniak-Orlińska et al., submitted to Agricultural Water Management*)

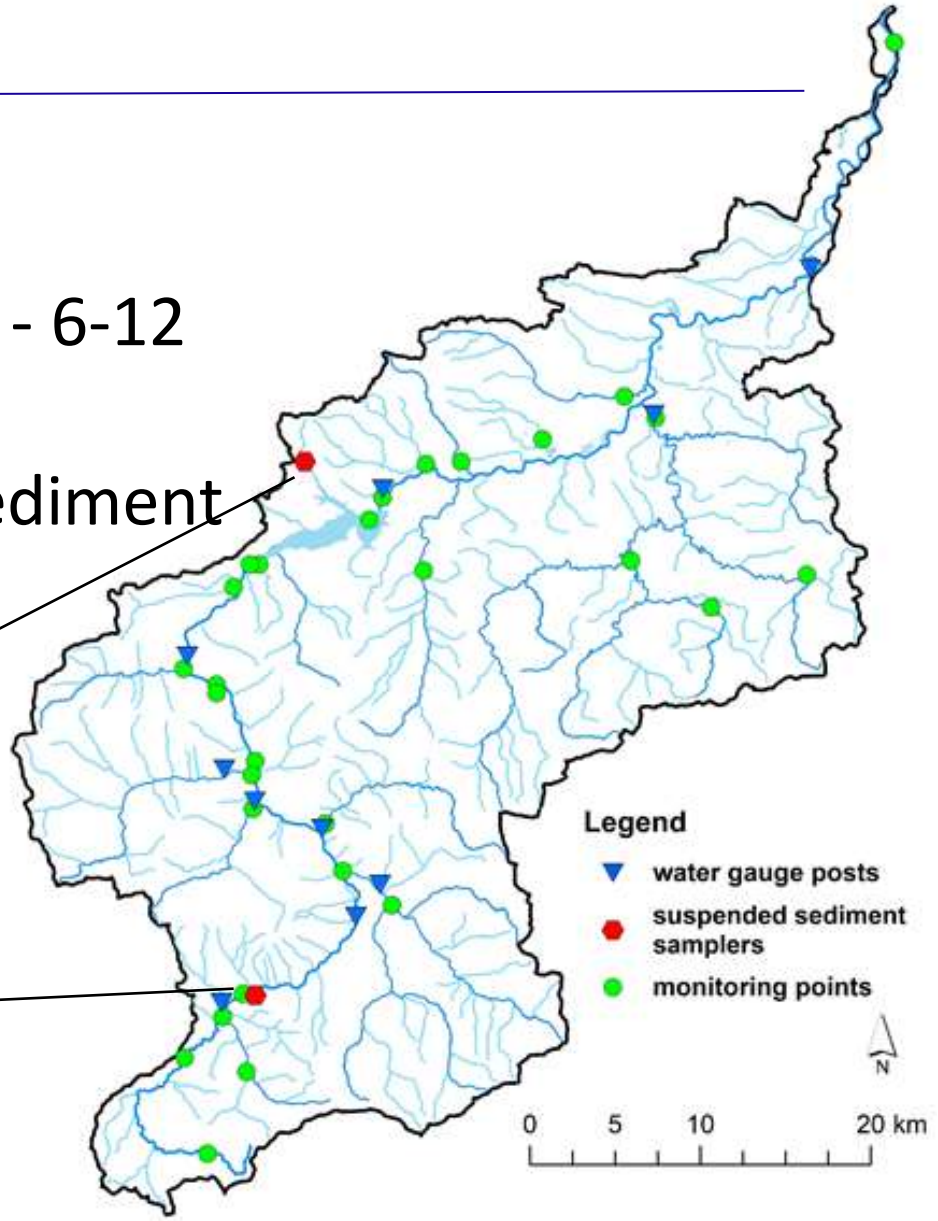
Pilot catchment – Raba River (southern Poland)



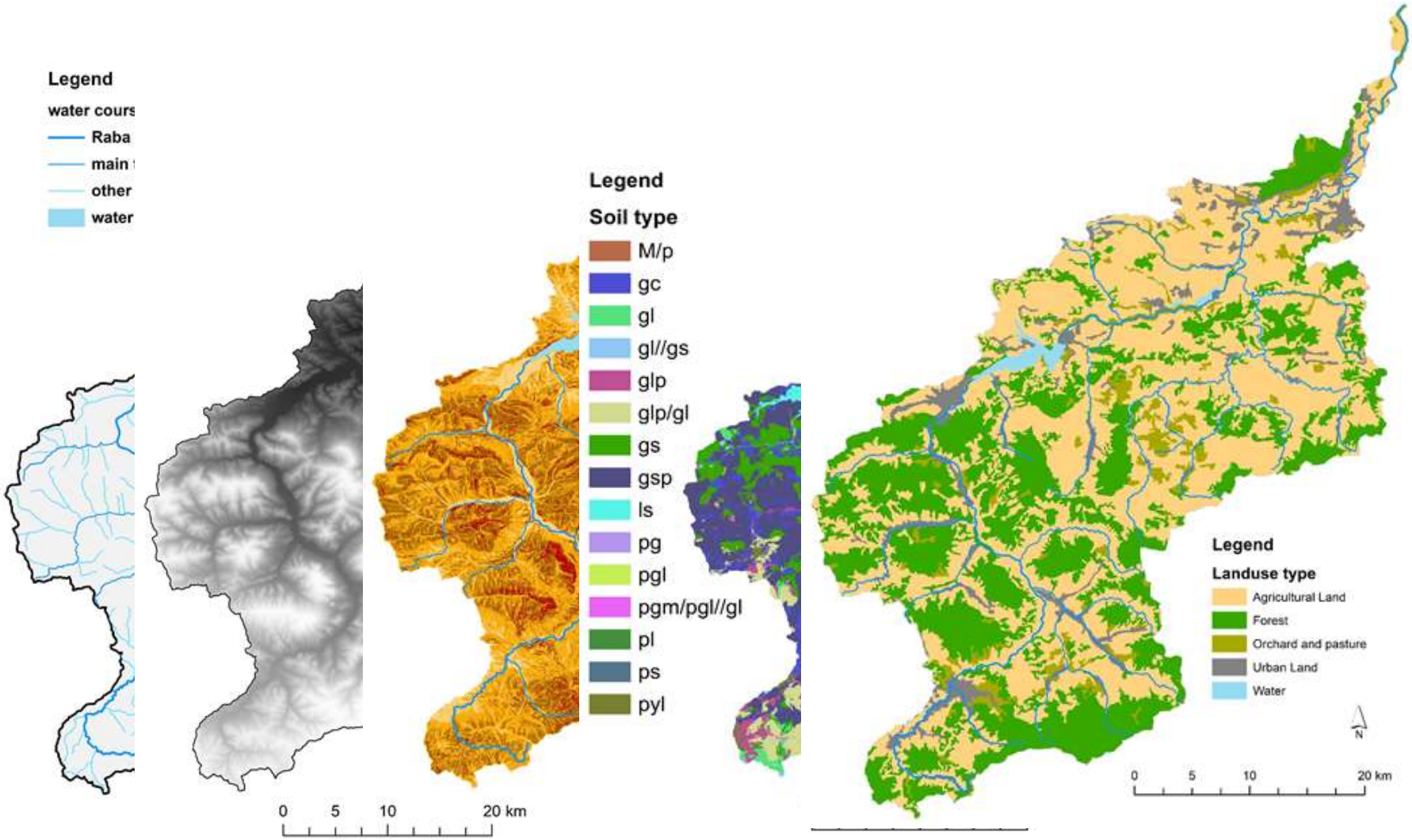
- 132 km long / 1,537 km^2 of the catchment;
- average flow of 17,6 m^3/s (outlet);
- diverse topographic conditions
- drinking water reservoir located at the 60. km

Pilot catchment – Raba River (southern Poland)

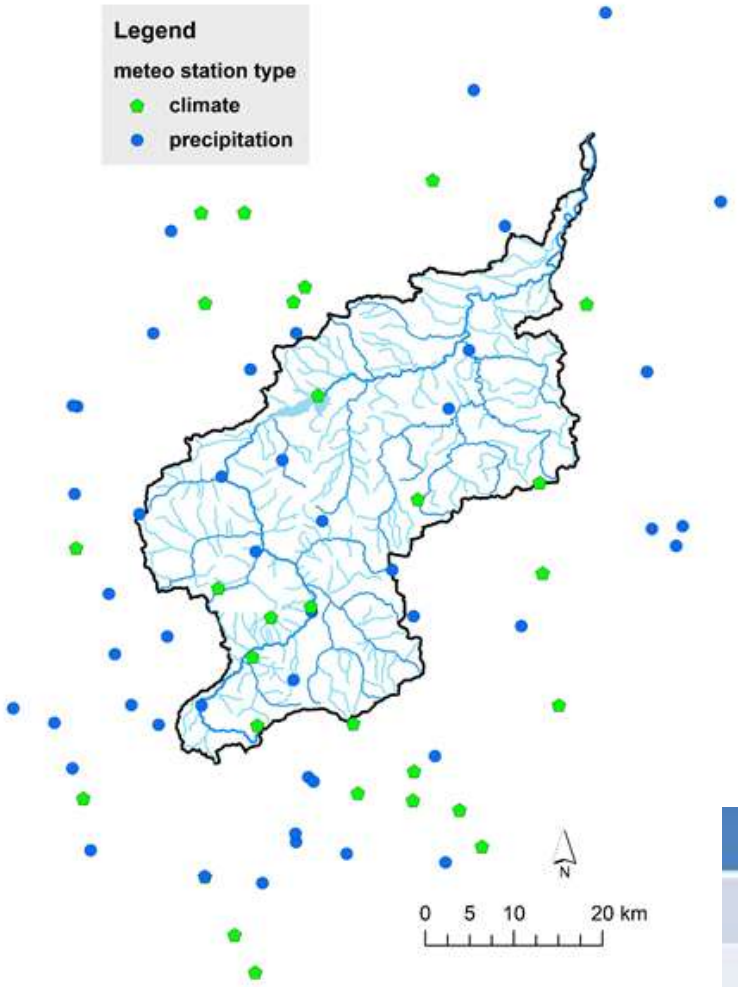
- water gauges - river flow
- water quality monitoring - 6-12 samples per year
- continuous suspended sediment sampling



Model construction - gathered database



Possible variant scenarios - climate



- Historical data from the period of 1991-2017, including:precipitation, temperature, wind speed and direction, relative humidity and solar radiation;
- 73 meteorological stations (climate and precipitation);
- For the first time maximum half-hour rainfall was calculated from the one-minute time step (before rainfall calculated using empirical methods).

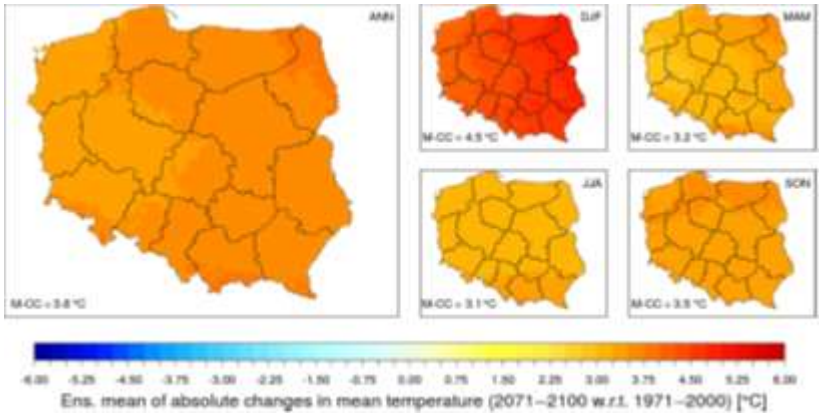
maximum half-hour rainfall– Cracow station	
Empirical method	Minute time step data
18.9 mm	45.9 mm

Source: Polish Atlas of Rainfall Intensity (PANDa) currently being prepared by the RETENCJAPL

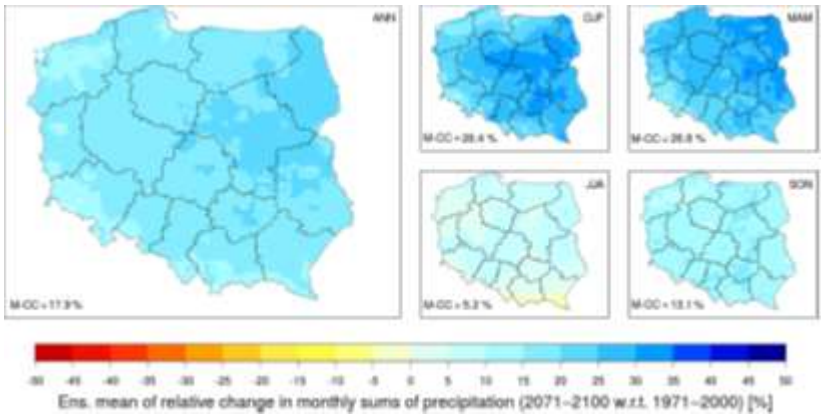
Possible variant scenarios - climate

- Projection of climate change for Poland based on CHASE-PL - downscaling the EURO-CORDEX data (*Mezghani et al 2017*);
- Climate scenario concerning precipitation and temperature assuming RCP4.5 concentration pathway;
- Two future horizons: 2021-2050 , and 2071-2100;
- Annual temperature projected change: +1.1°C/+2°C
- Annual precipitation projected change: +5.9%/+9.7%

projection of temperature changes in Poland



projection of changes in rainfall in Poland



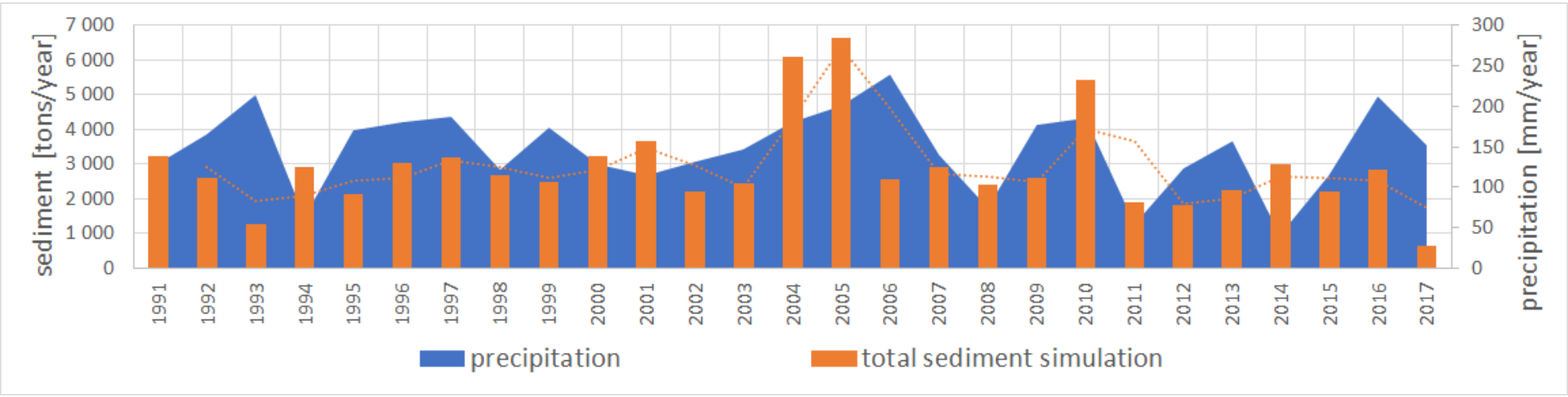
Mezghani, A., Dobler, A., Haugen, J. E., Benestad, R. E., Parding, K. M., Piniewski, M., ... & Kundzewicz, Z. W. (2017). CHASE-PL Climate Projection dataset over Poland–bias adjustment of EURO-CORDEX simulations. Earth System Science Data, 9(2), 905-925.

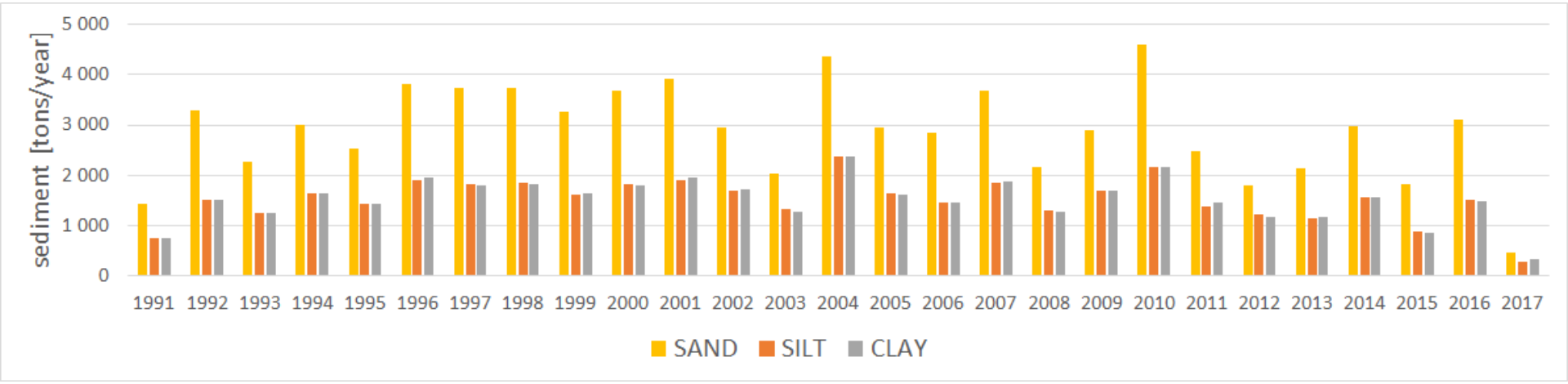
Possible variant scenarios - land use

- Scenarios of changes in land use for selected catchment areas with the greatest problems with soil loss;
- Based on current local research data (*Price et al. 2017*);
- Total forest areas will increase by 16% at the expense of the areas currently used for agriculture until 2060;
- Urban areas will increase by about 6% during this time.

Price, B., Kaim, D., Szwagrzyk, M., Ostapowicz, K., Kolecka, N., Schmatz, D. R., ... & Kozak, J. (2017). Legacies, socio-economic and biophysical processes and drivers: the case of future forest cover expansion in the Polish Carpathians and Swiss Alps. Regional Environmental Change, 17(8), 2279-2291.

Sediment calculations – baseline scenario

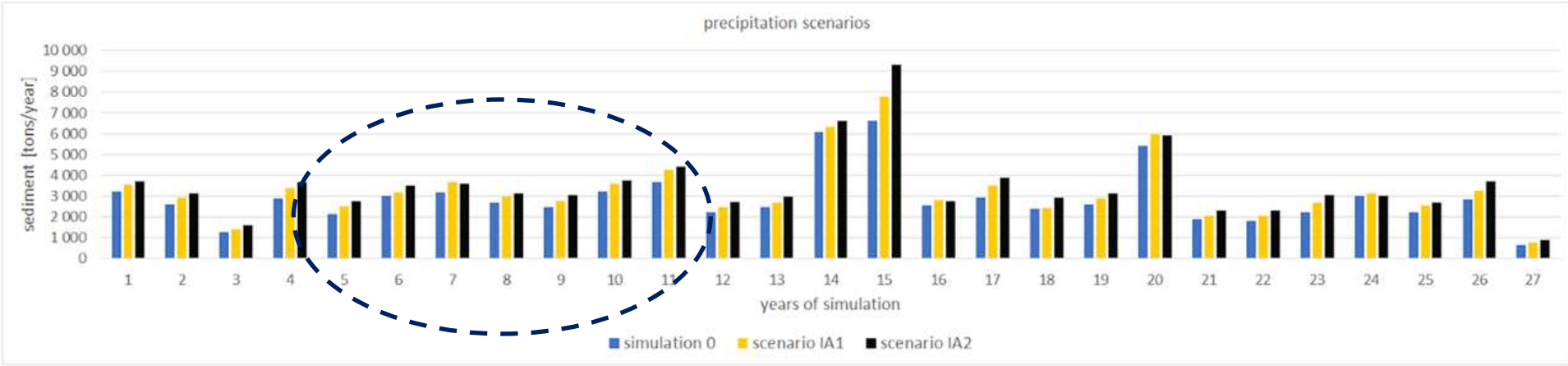


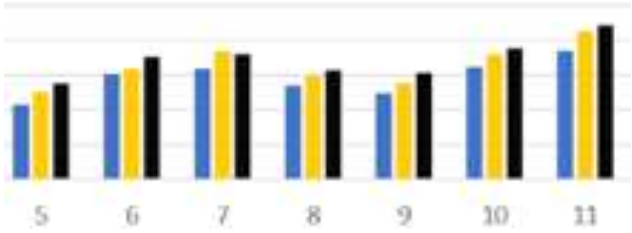


Sediment calculations – climate/land use scenarios

Scenario	Description	Forecast period
I A 1	**precipitation** increase by 5,9%	2021-2050
I A 2	**precipitation** increase by 9,7%	2071-2100
I B 1	**temperature** increase by 1,1^{o}C	2021-2050
I B 2	**temperature** increase by 2^{o}C	2071-2100
I C 1	**forest area** increased by 16%	2019-2060
I C 2	**urban area** increased by 6%	2019-2060

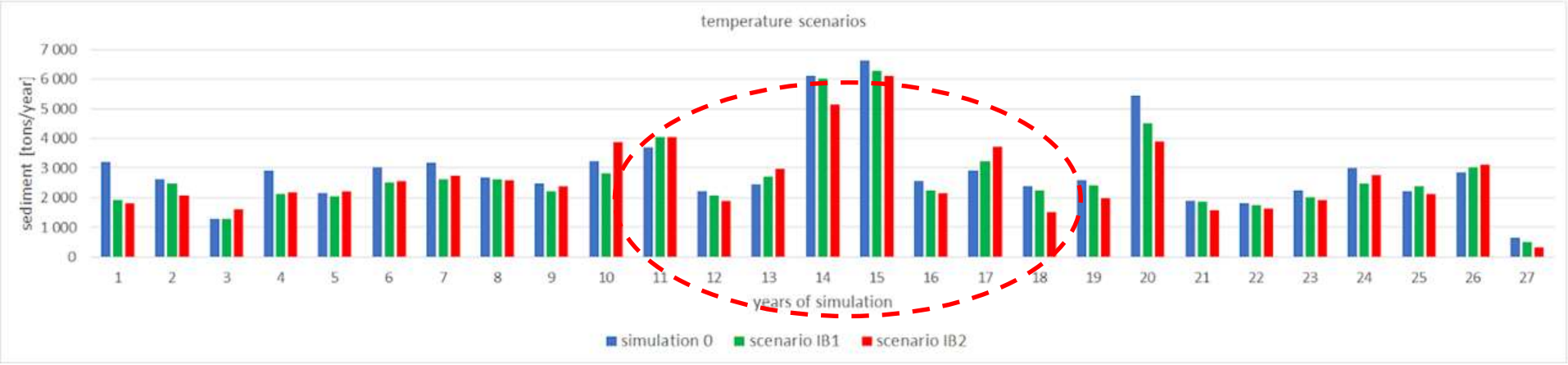
Sediment calculations – precipitation scenarios

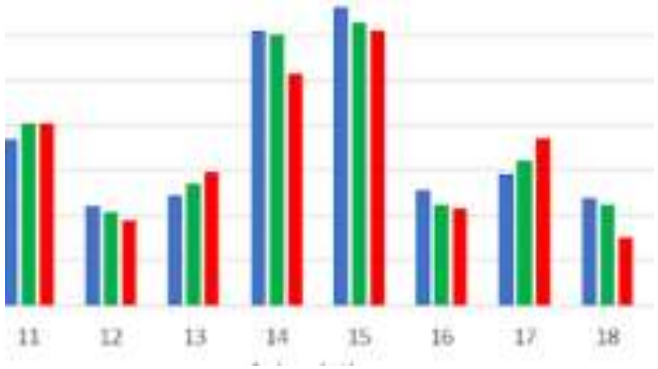




IA1 - P+5.9%
IA2 - P+9.7%

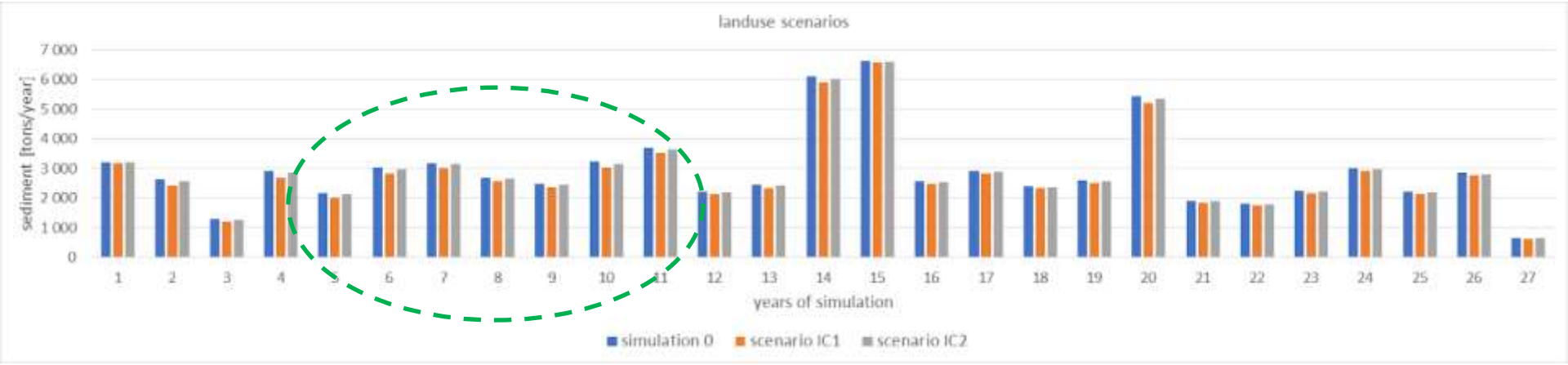
Sediment calculations – temperature scenarios

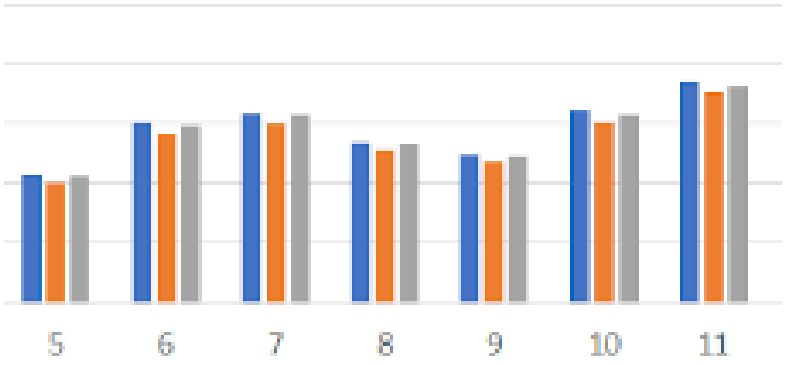




IB1 - T+1.1°C
IB2 - T+2.0°C

Sediment calculations – land use scenarios





IC1 - F+11%
IC2 - U+6%

Sediment calculations – scenario results

Scenario	Description	Average change in sediment loads
I A 1	precipitation increase by 5,9%	**+12%**
I A 2	precipitation increase by 9,7%	**+22%**
I B 1	temperature increase by 1,1^{o}C	**-8%**
I B 2	temperature increase by 2^{o}C	**-10%**
I C 1	forest area increased by 16%	**-4%**
I C 2	urban area increased by 6%	**-2%**

….for the Journal of Soils and Sediments submission

Future “project scenarios”

- one river - two different types of catchment - differences in suspended sediment simulations for the upstream and downstream part of the catchment;
- combining the Macromodel DNS/SWAT with the sediment fingerprinting - evaluation of suspended sediment quality, and contaminant loads;
- combining the Macromodel DNS/SWAT with the PTM model - tracking sediments in the reservoir;
- relationship between land cover changes and catchment erosion;
- livestock population scenarios;
- ……..

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Questions?