Deliverable AMBER Y2

Modelling future nutrient emissions - Effects of socio-economic development and climate change on scenario calculations in the Oder River Basin

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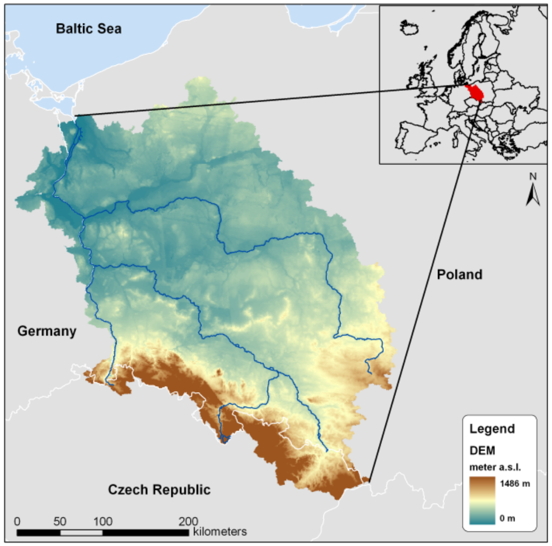
Research area – Oder River Basin



- Located in the south of the Baltic Sea
- 118.000 km² catchment area distributed to Poland (89%), Czech Republic (6%) and Germany (5%)
- 60% of catchment area under agricultural use
- 15.5 million Inhabitants mainly distributed to bigger cities and urban agglomerations
- With start of 1990's serious transformation processes in agriculture occurs
- Oder is one of the most important nutrient emitters into the Baltic Sea

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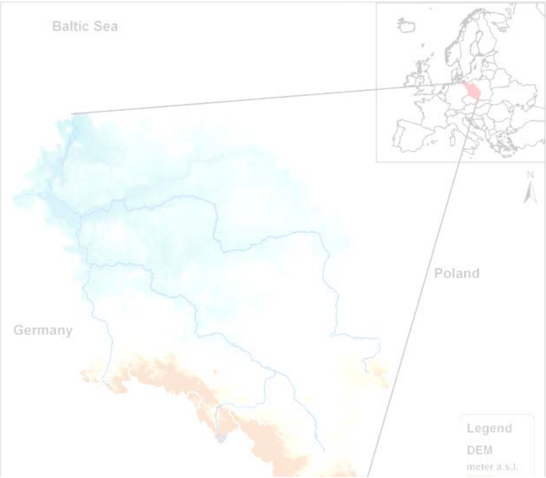
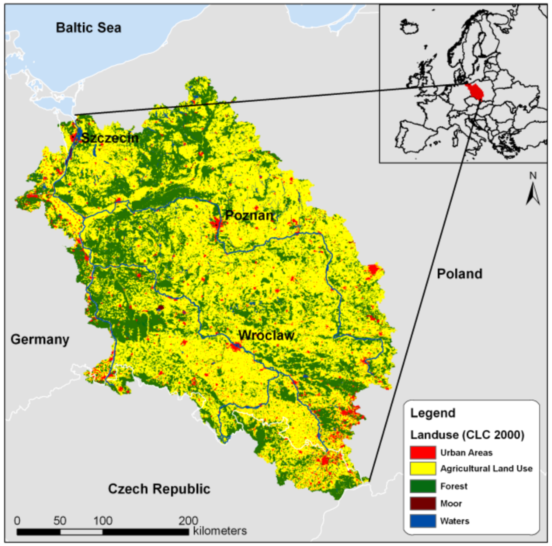
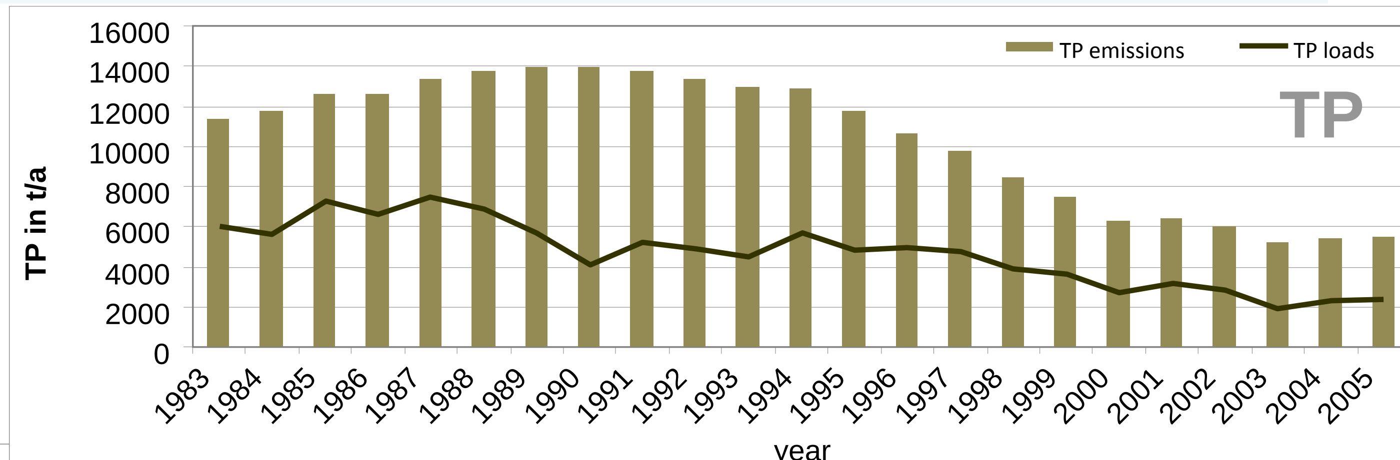
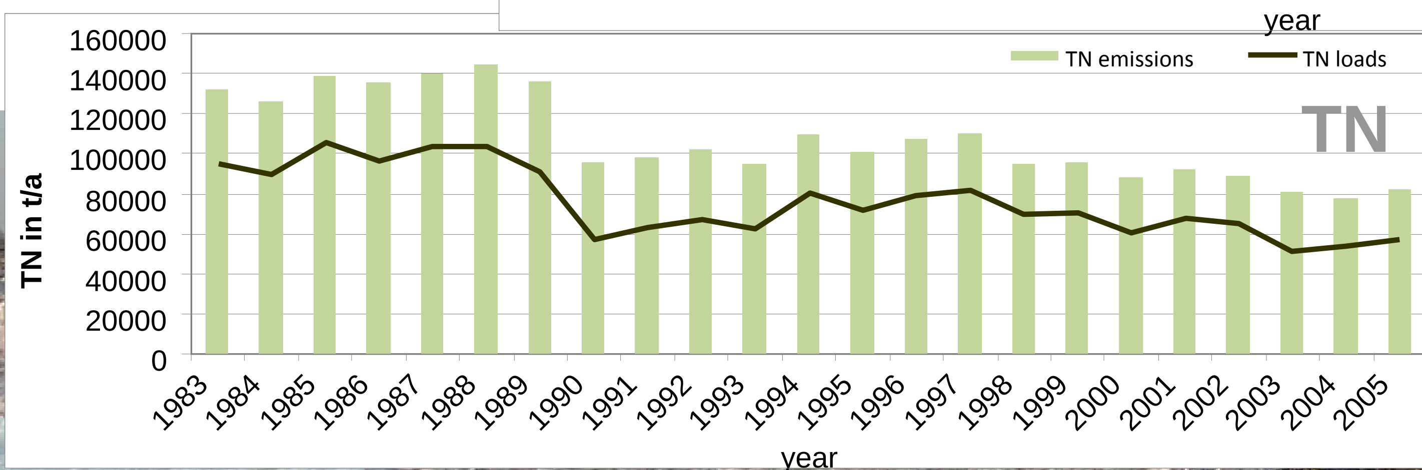




Development of TN and TP emissions

- Significant decrease of TN emissions at starting nineties
- Followed by in- and decreasing TN emissions until present-day level
- Increase of TP emissions until maximum at ending eighties, followed by continuous decrease, because of P-storage in soil





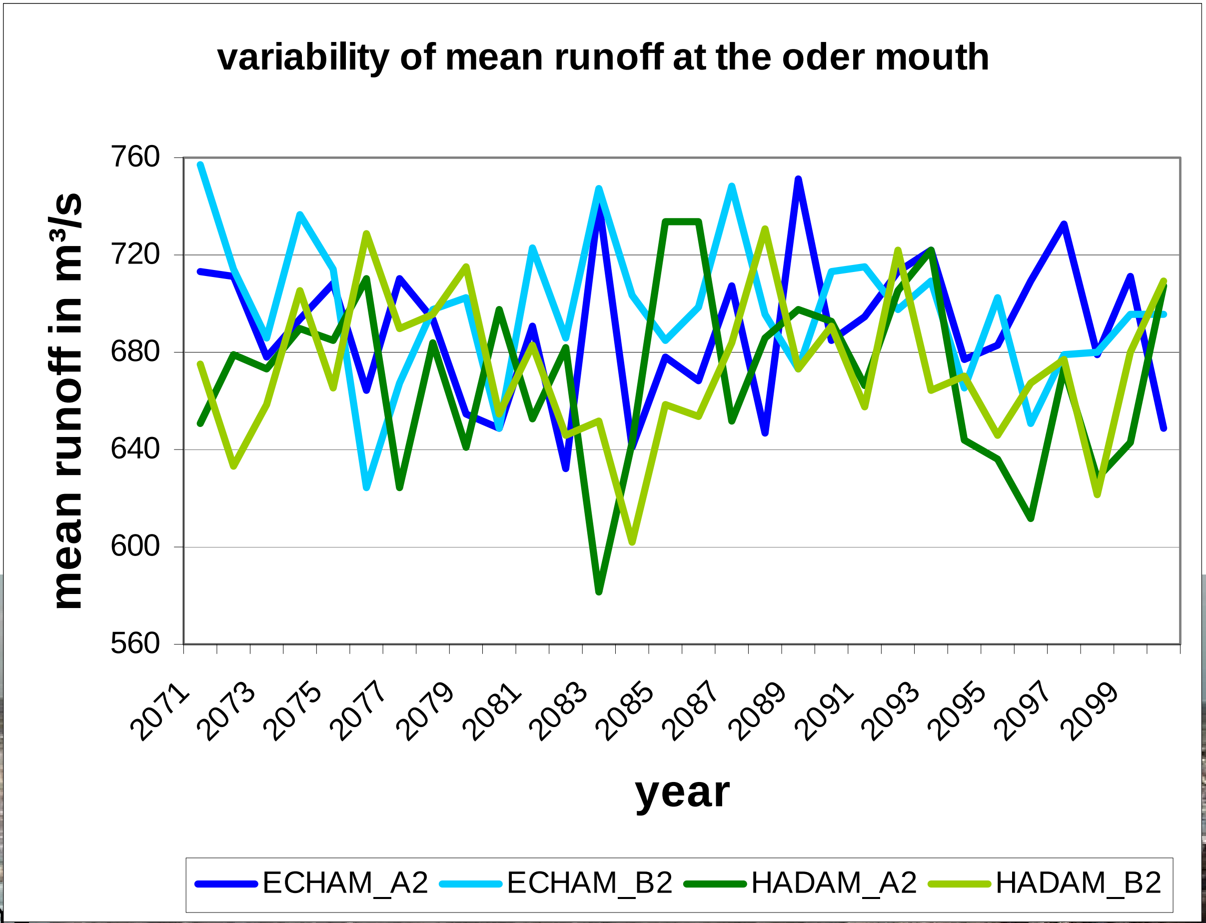
Methods I

- Modelling nutrient emissions and loads by MONERIS (**MO**delling **N**utrient **E**missions in **RI**ver **S**ystems) http://moneris.igb-berlin.de

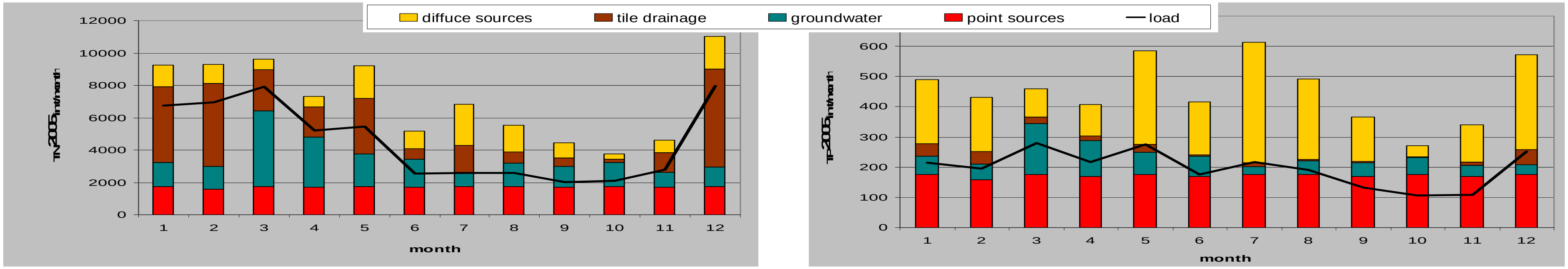
- For the comparison of different nutrient emission and load situations, climate scenarios (Models: ECHAM4 & HADAM3; Scenarios A2 & B2) for the time period between 2071-2100 and the year 2005 were used
- In case of climate scenarios:
  - we used the relative changes in **precipitation** up to a mean precipitation in the control scenario and add it to a mean value in the validated time period (1983-2005)
  - we derived **runoff** values by a factor based on each AU and month between precipitation and runoff, this factor was applied to the precipitation values of the climate scenarios

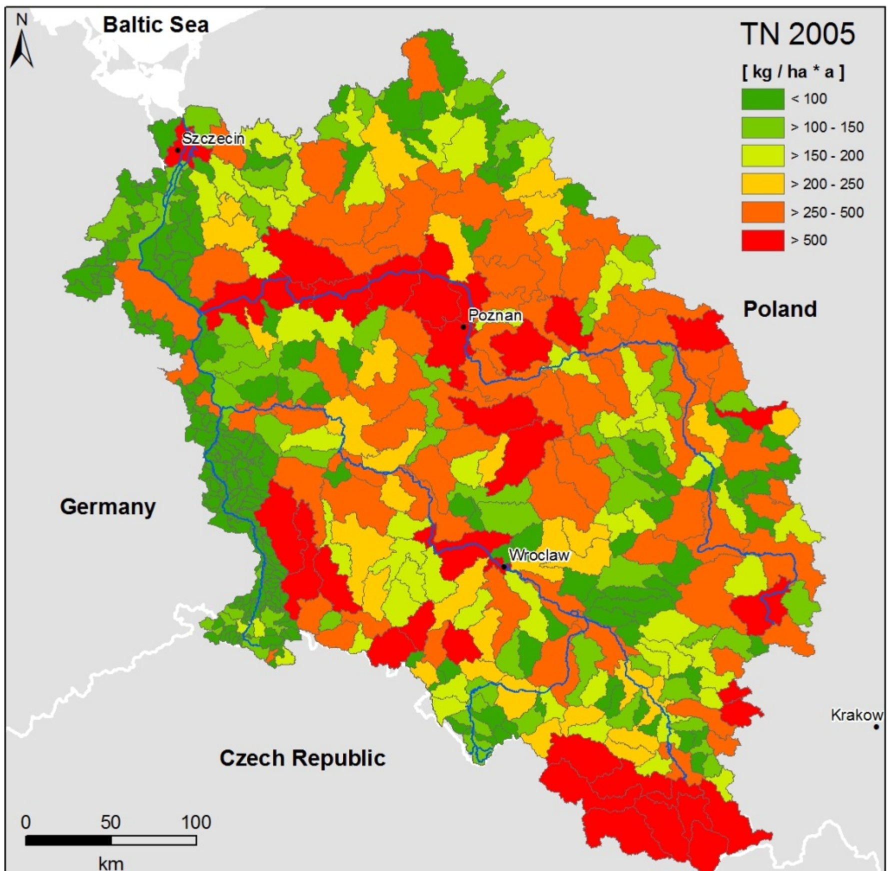
Runoff I

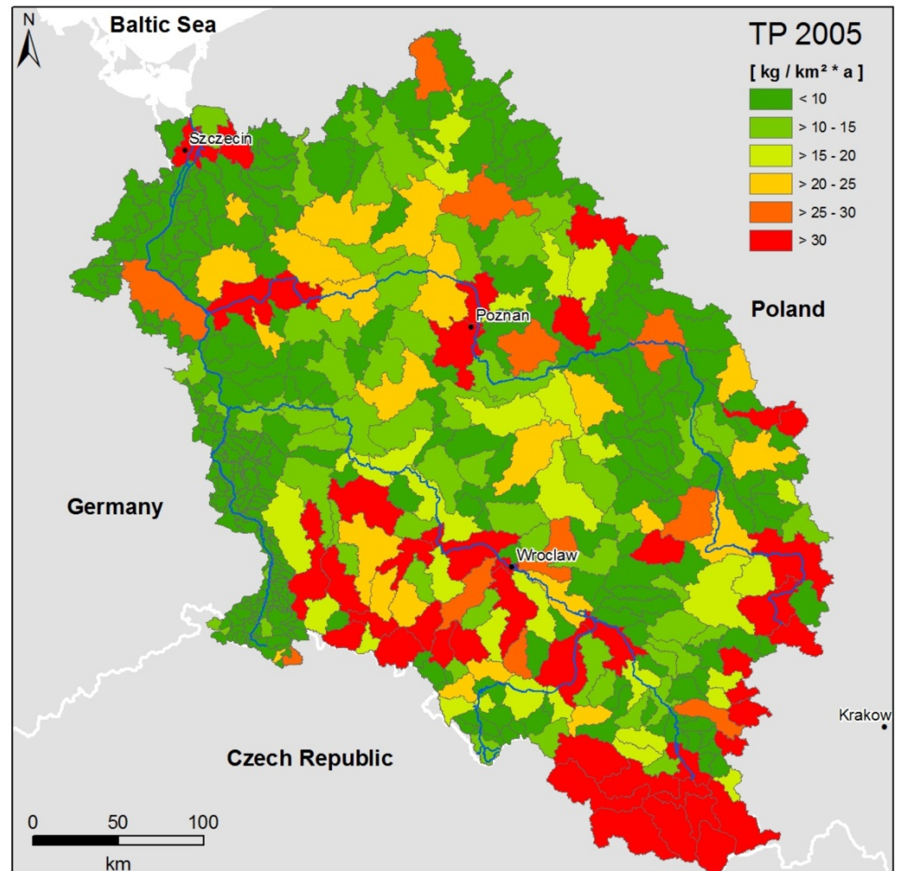
- Period of reference, validated by measured values (mean runoff 1983-2005 566 m³/s)
- Runoff by climate scenarios can not be validated



YEAR 2005: monthly variation & annual spatial distribution of nutrient emissions

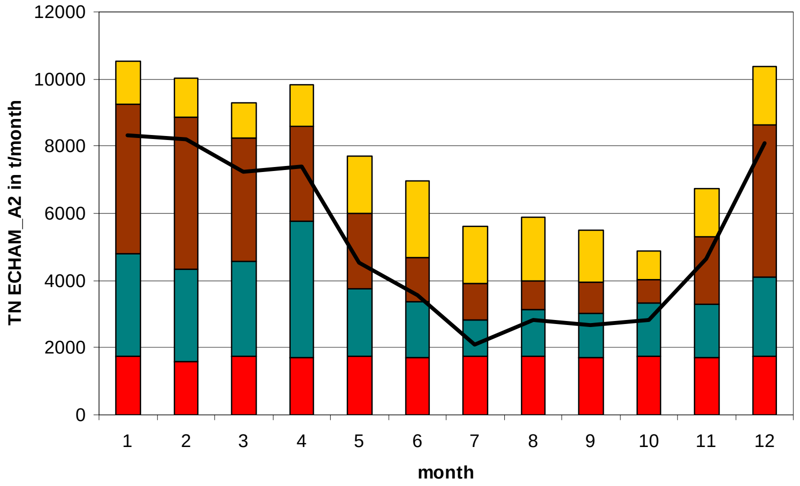


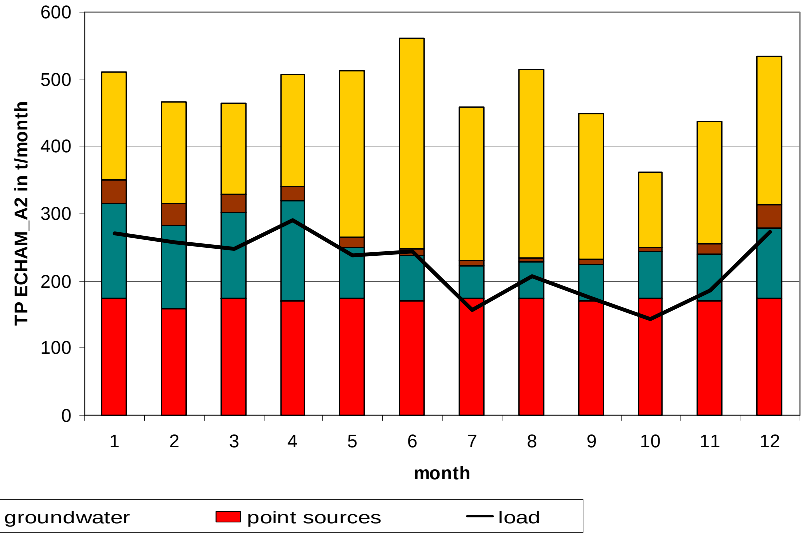




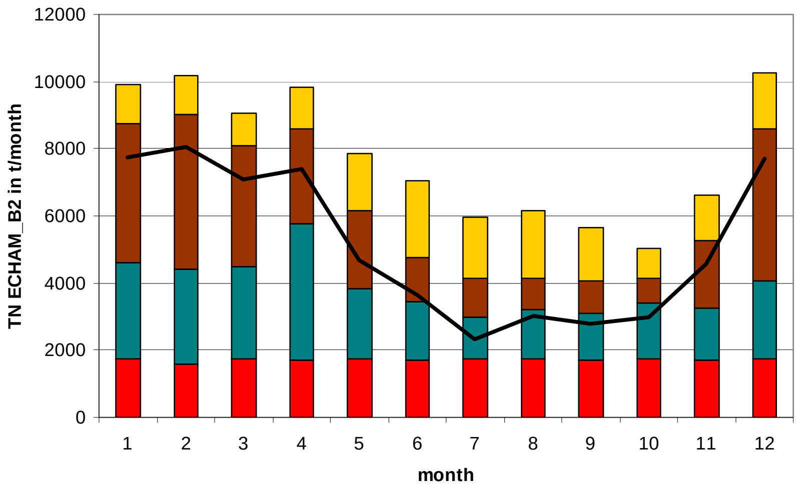
ECHAM4 2071 – 2100 : mean monthly variation in nutrient emissions and loads

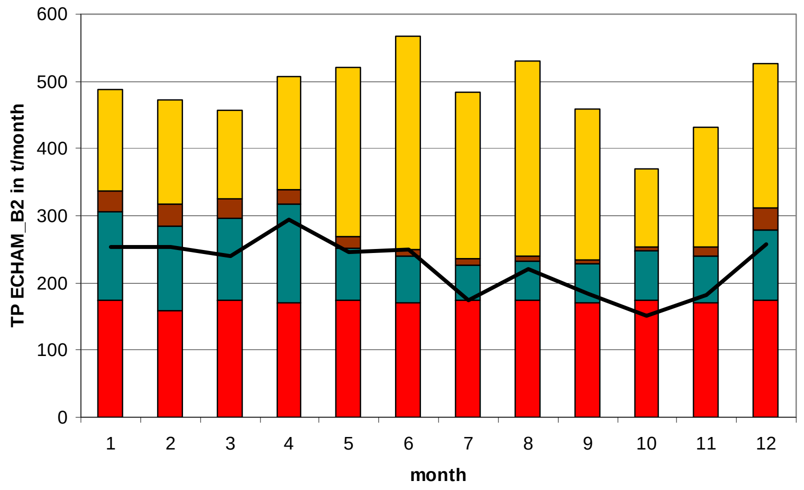
Scenario A2





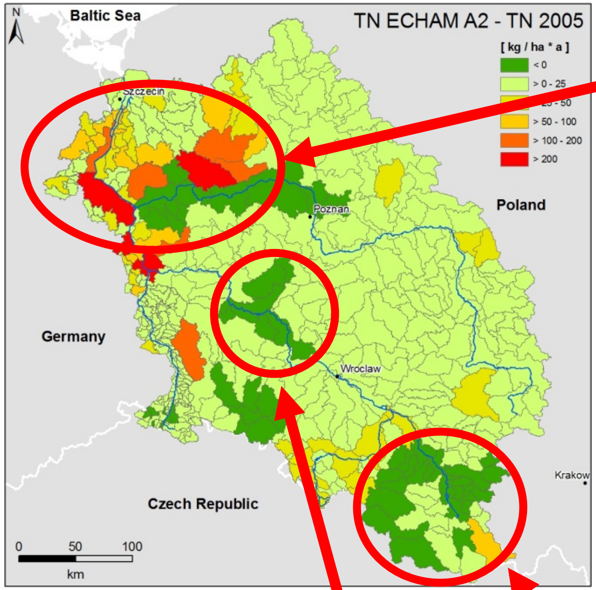
Scenario B2



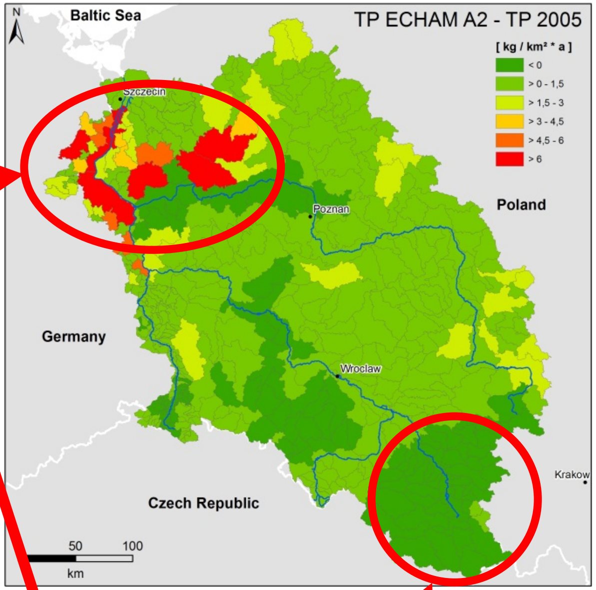


ECHAM4 2071-2100 : mean (2071-2100) annual differences in nutrient emissions in comparison to 2005

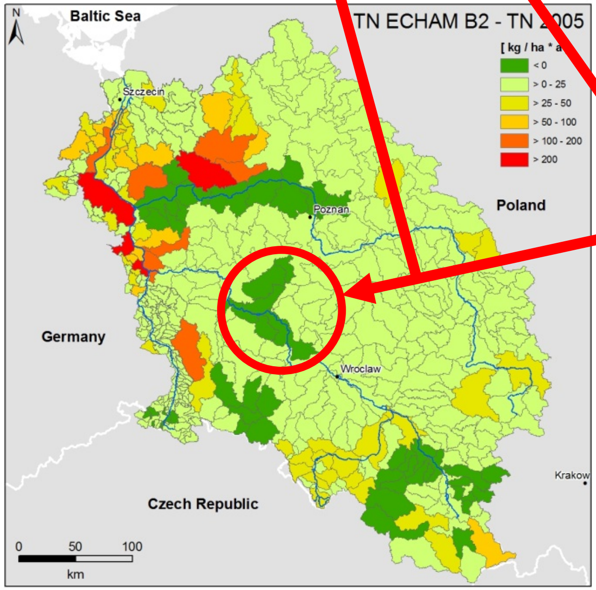
Scenario A2



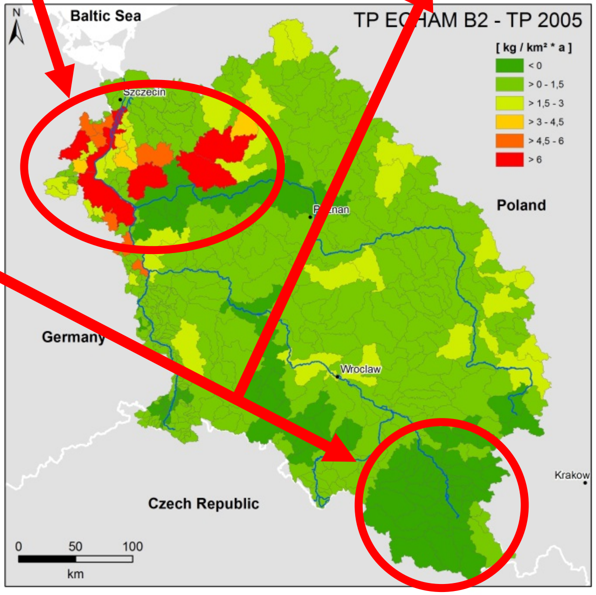
Increase nutrient Emissions due to application of climate scenarios



Scenario B2



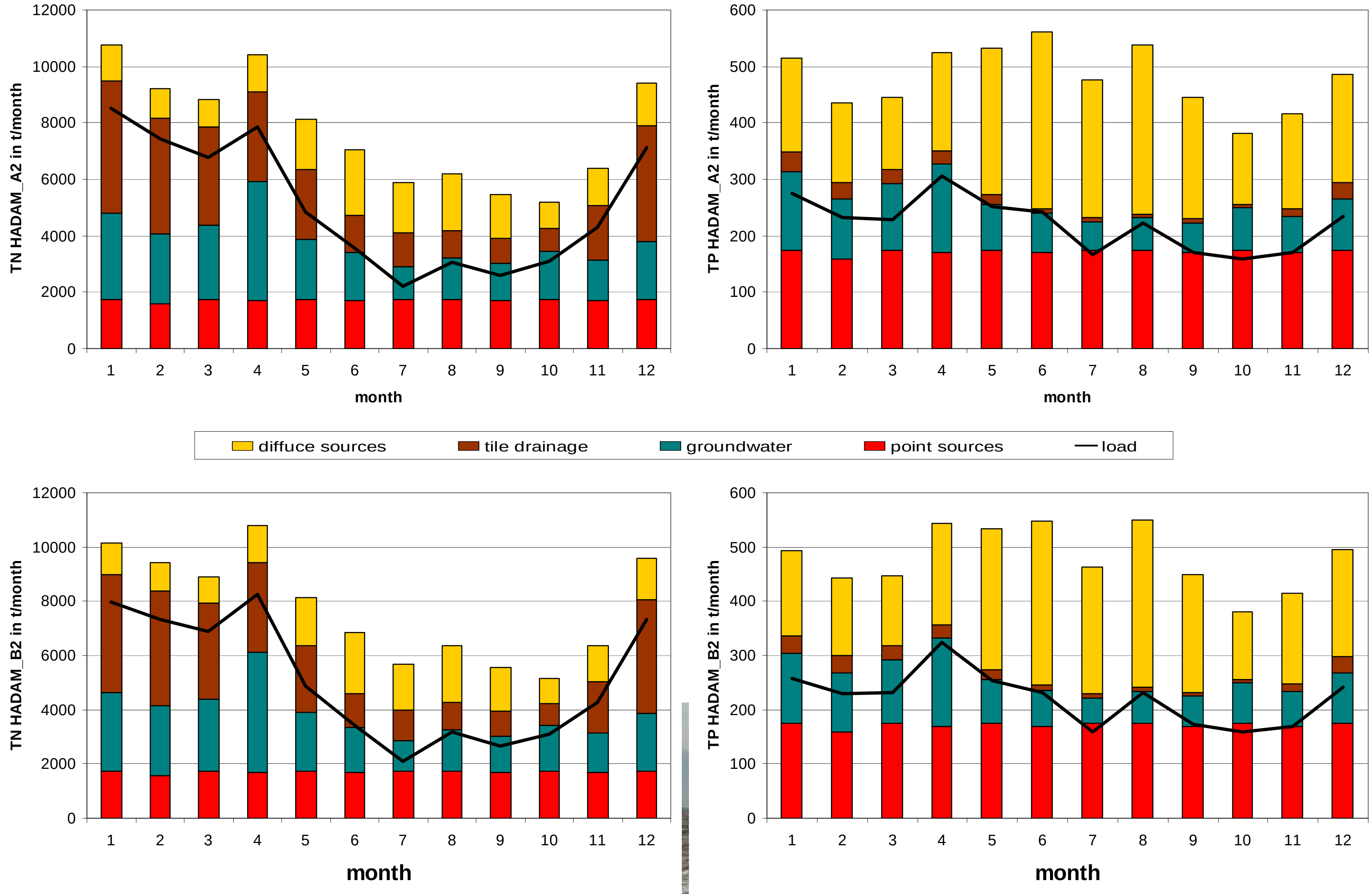
decrease nutrient Emissions due to application of climate scenarios



HADAM3 2071 – 2100 : mean monthly variation in nutrient emissions and loads

Scenario A2

Scenario B2



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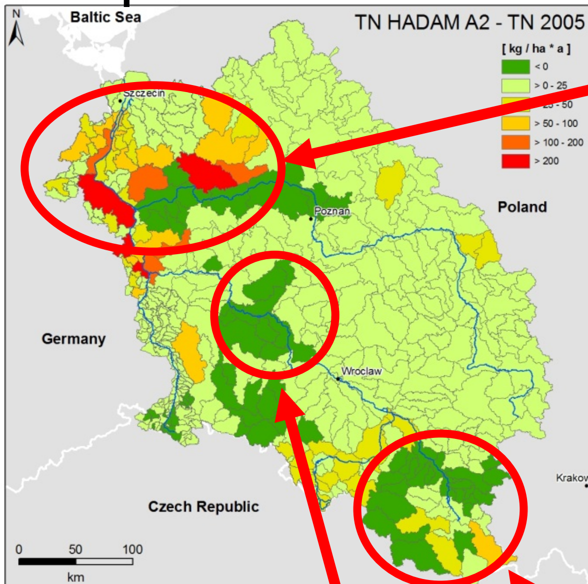

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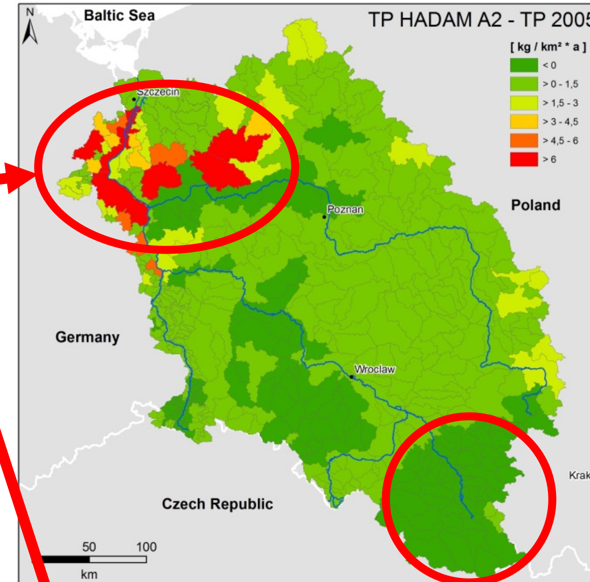

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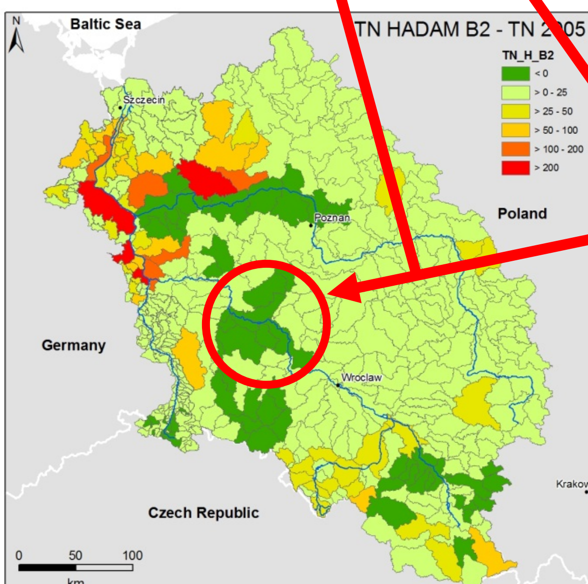

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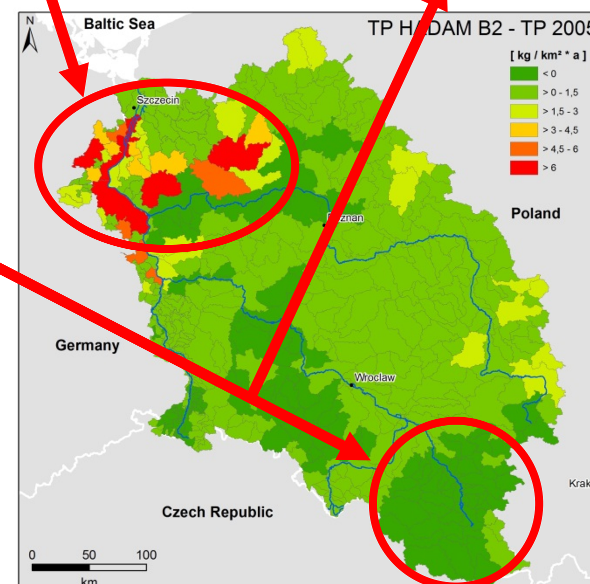


Methods II

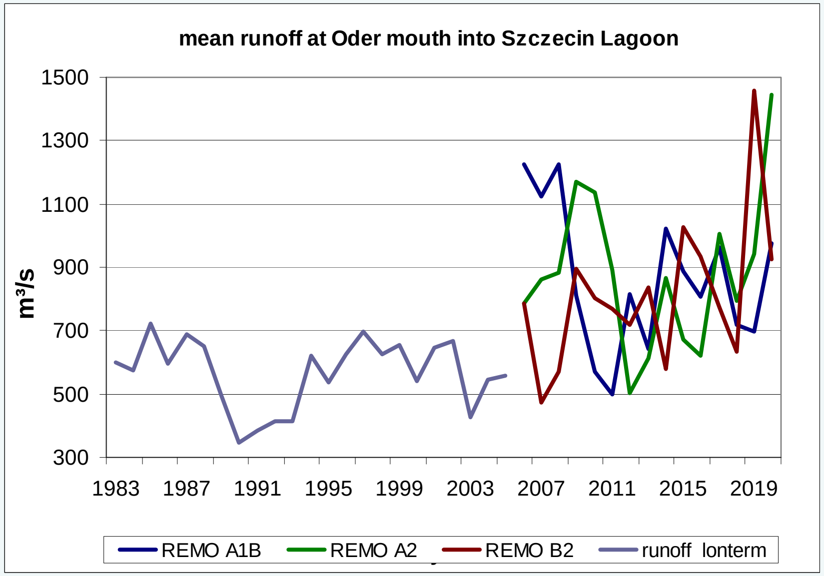
- Modelling nutrient emissions and loads by MONERIS (**MO**delling **N**utrient **E**missions in **RI**ver **S**ystems) http://moneris.igb-berlin.de

- Application of scenarios
  - Socio-economic development scenarios until 2020 (Jesko Hirschfeld, IÖW Berlin)
  - Climate scenarios until 2020 (REMO) (MPI, Hamburg)
    - IPCC scenarios A1B, A2 and B2

Business as usual „BAU 2020“	Liberalisation „LIB 2020“	Regionalisation „REG 2020“
• Implementation of actual European agricultural strategies (CAP)	• Assumption of totally liberalised EU agricultural market • No political interventions in land use • Extensification of land use	• Still subsidised EU-agriculture • Protection of EU-agricultural market • Intensification of land use

Runoff II

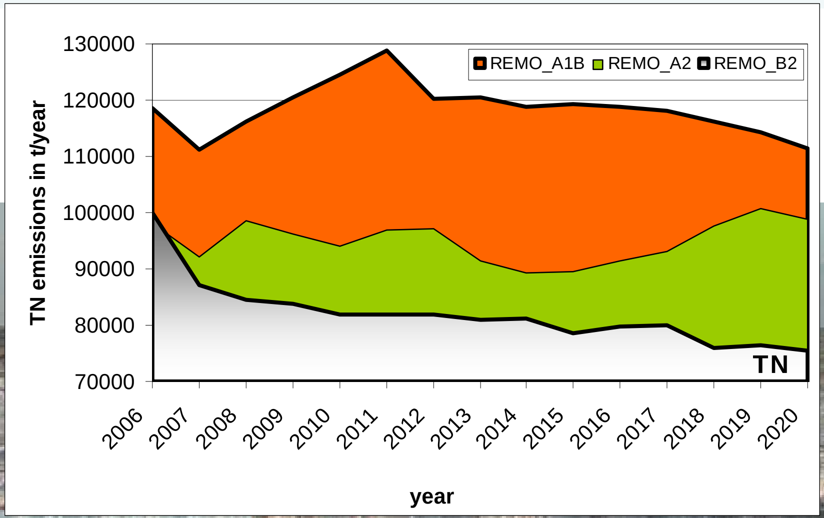
- Period of reference, validated by measured values
- Runoff by climate scenarios can not be validated
- mean runoff
  - 1983-2005 566 m³/s
  - 2006-2020
    - A1B   866 m³/s
    - A2   879 m³/s
    - B2   812 m³/s

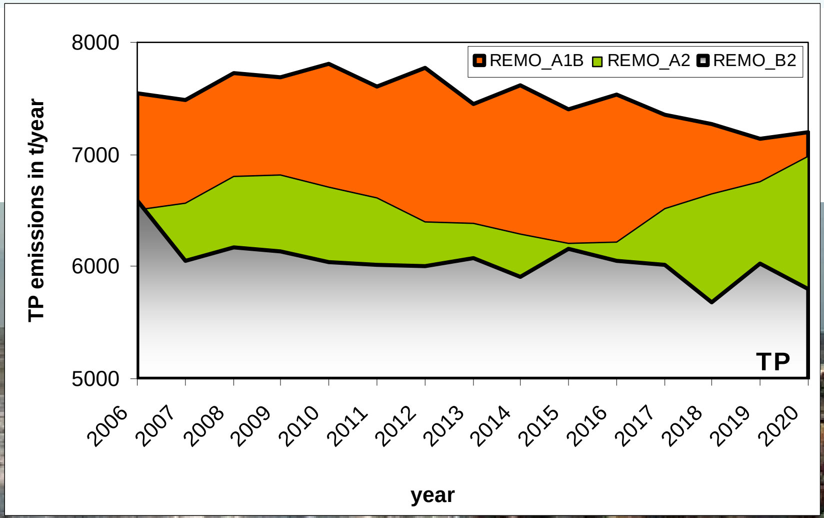


- Basically higher runoff conditions affect nutrient emissions and loads in an increased way

Estimation of possible future nutrient emissions

- Range of possible nutrient emissions until 2020
- Climate scenarios in combination with socio-economic development scenarios
- Upper border: „regionalisation“ scenario combined with climate scenario A1B conditions
- Lower border: „liberalisation“ scenario combined with climate scenario B2 conditions
- Basically decreasing trend





Development of area weighted possible nutrient emissions in 2020

- Mean emissions by long term conditions 7.3 kg/(ha·yr) TN and 0.48 kg/(ha·yr) TP
- Low changes due to socio-economic development scenarios
- Higher changes by combined modelling

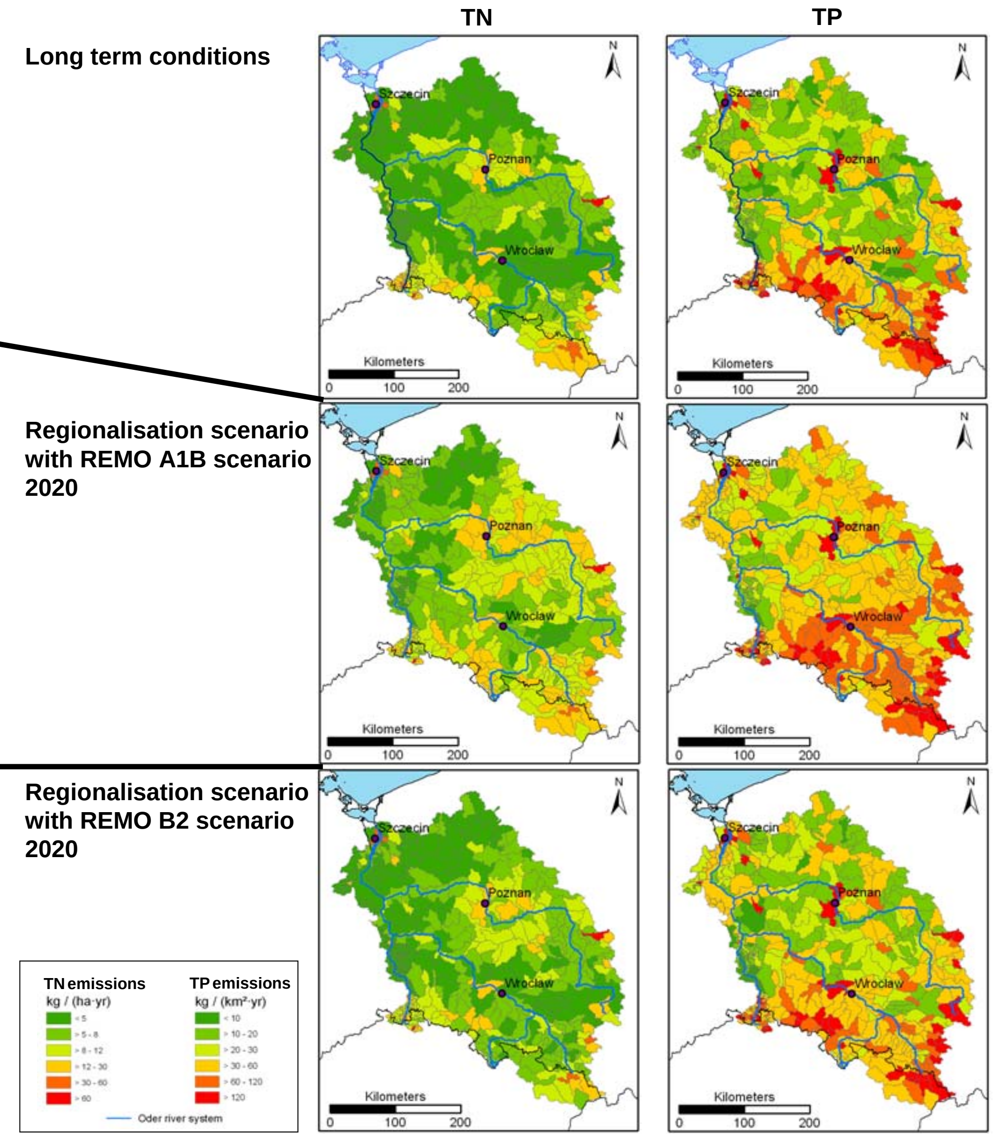
		socio-economic development scenarios			
		BAU 2020	LIB 2020	REG 2020	
long term climate (1983-2005) conditions		7.6	7.2	8.0	TN in kg/(ha·yr)
		0.48	0.48	0.48	TP in kg/(ha·yr)
climate scenarios	REMO A1B	8.9	8.4	9.4	TN in kg/(ha·yr)
	REMO A2	8.3	7.8	8.7	
	REMO B2	6.7	6.4	7.1	
	REMO A1B	0.61	0.60	0.61	TP in kg/(ha·yr)
	REMO A2	0.59	0.59	0.59	
	REMO B2	0.49	0.49	0.49	

Spatial distribution of potential nutrient emissions 2020

- Increased emissions in mountainous and central, mostly intensive agriculturally used, areas

- TP: areal increased emissions, intensification in mountainous areas
- TN: intensification on intensive agricultural used areas

- TP: slight decrease in mountainous areas
- TN: slight increase in central areas, partly decrease in mountainous areas



Conclusion

- MONERIS is suitable to calculate future nutrient emissions
- Climate change scenarios modelled by REMO are highly affecting the combined scenario calculations within MONERIS due to hydrology
- Only low changes in emission conditions by socio-economic development scenarios:
    - consideration of land use changes like energy crops (maize, rape…)or increased animal production is necessary for future adaption