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

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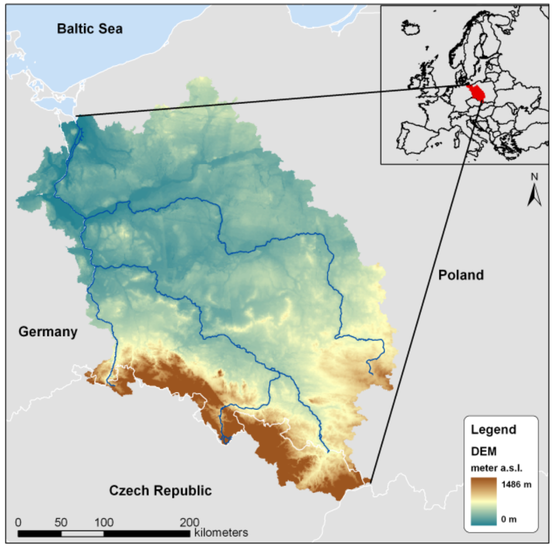
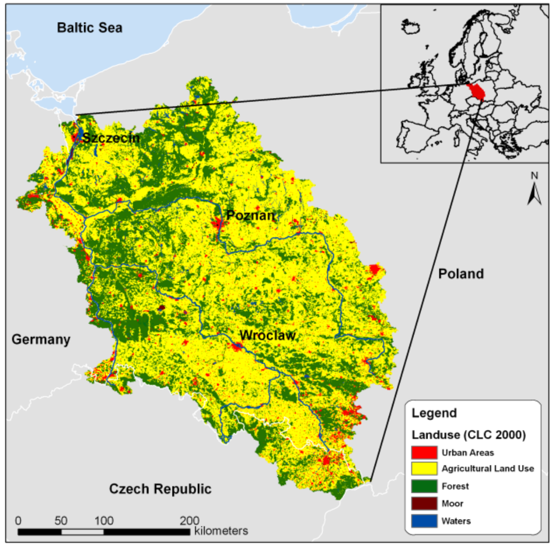
Research area – Oder River Basin

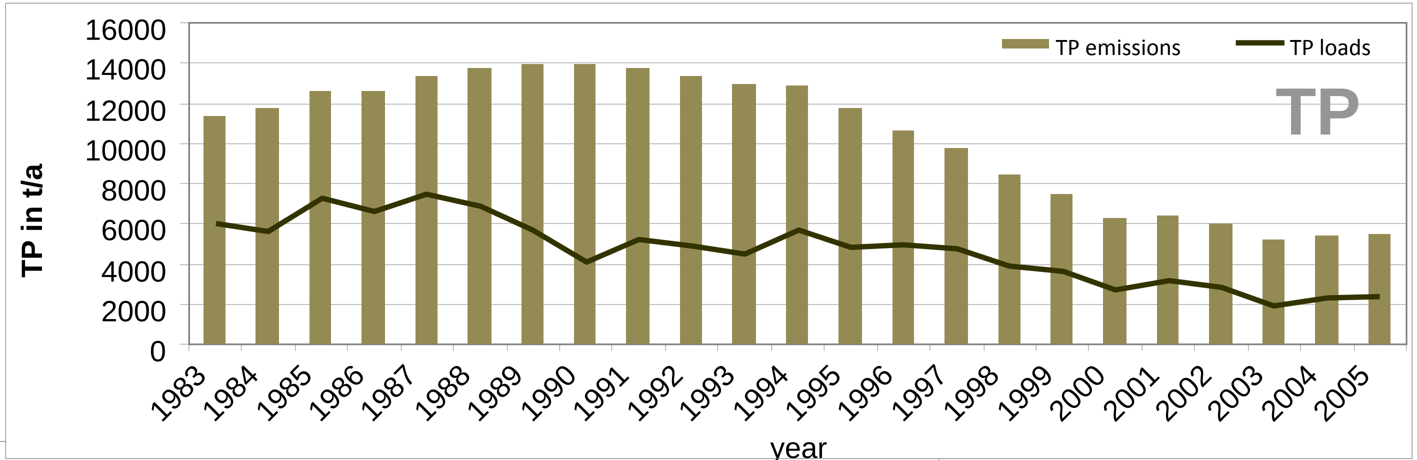
- Located in the south of the Baltic Sea
- 118.000 km² catchment area distributed to Poland (89%), Czech Republic (6%) and Germany (5%)
- 60% of catchment area under agricultural use
- 15.5 million Inhabitants mainly distributed to bigger cities and urban agglomerations
- With start of 1990's serious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

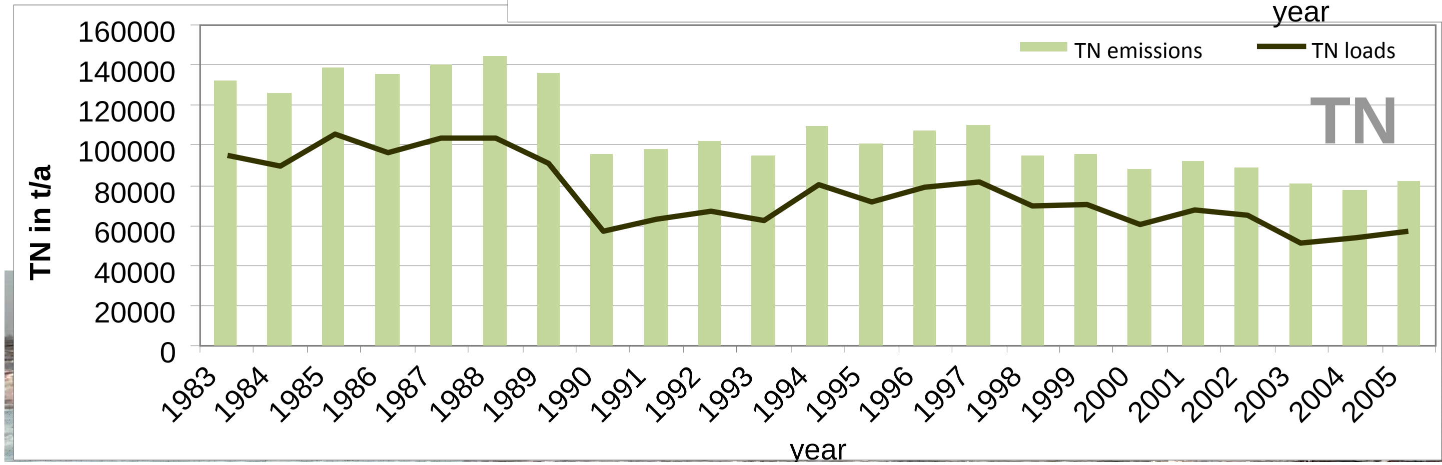




Development of TN and TP emissions between 1983 and 2005

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





Research results

1. Future scenarios on the Oder river basin – lagoon – coastal sea system until 2020 (IOW, IGB and IÖW)

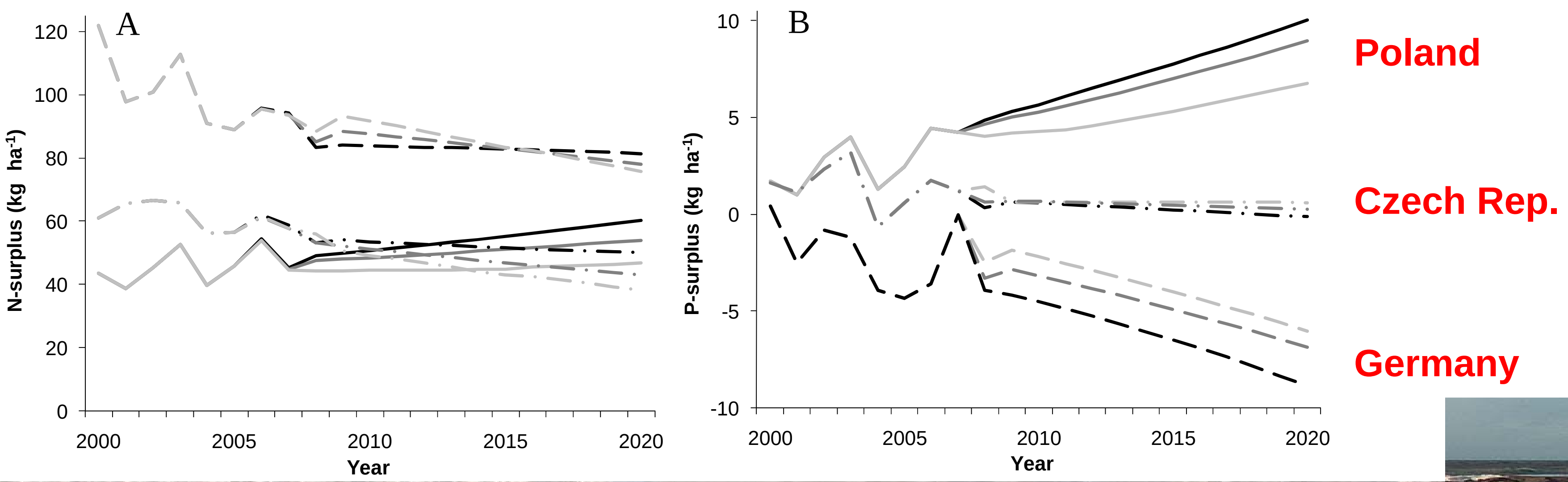
   Krämer, I., J. Hürdler, J. Hirschfeld, M. Venohr, G. Schernewski (accepted): Nutrient fluxes from land to sea: consequences of future scenarios on the Oder river basin -- lagoon -- coastal sea system. International Review of Hydrobiology

2.

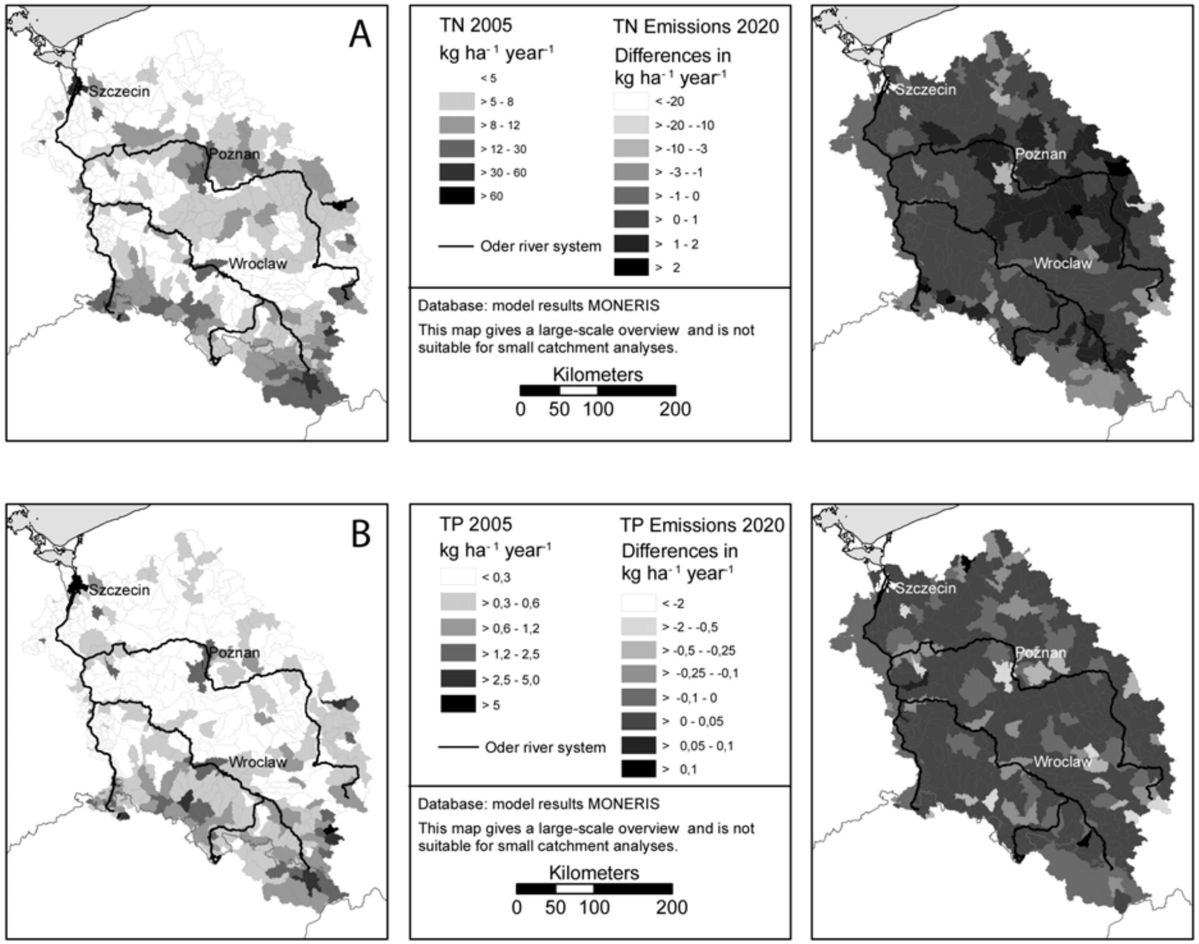
3.

Research results 1

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

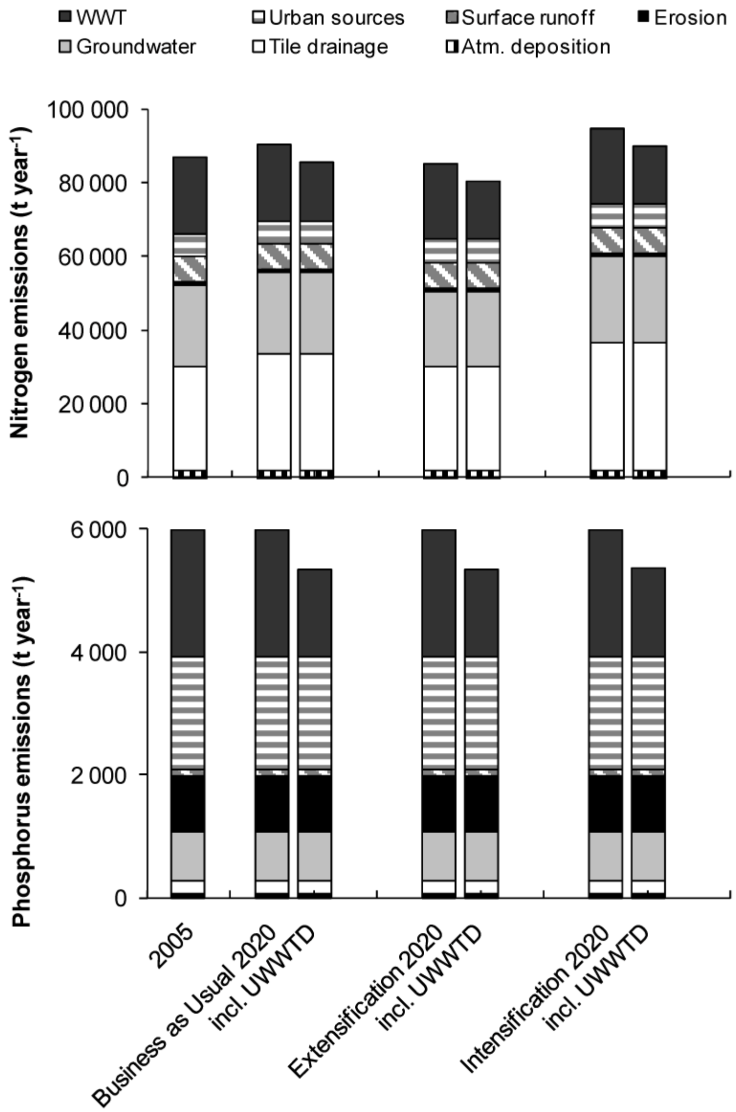


Research results 1



- Differences between nutrient emissions by “intensification” scenario 2020 and the recent state 2005
- General decreasing trends in CZ and GER Oder catchment parts
- Increasing emission trend for PL parts
- Positive effects by application of EC UWWTD

Research results 1



	TN (kg ha^{-1} year^{-1}) without UWWTD	TN (kg ha^{-1} year^{-1}) incl. UWWTD	TP (kg ha^{-1} year^{-1}) without UWWTD	TP (kg ha^{-1} year^{-1}) incl. UWWTD
2005	7.3		0.48	
Scenarios 2020				
'Business as usual'	7.6	7.2	0.48	0.43
'Extensification'	7.2	6.8	0.48	0.43
'Intensification'	8.0	7.6	0.48	0.43
Wildcards 2020				
'Energy maize'	8.4	7.9	0.48	0.43
'Animal stocks'	8.7	8.2	0.48	0.43
'Transfer'	9.0	8.6	0.48	0.43

- Progress of TN and TP emissions into the Oder river system by socio-economic development scenarios, with and without application of EC-UWWTD
- Effect to spatial distribution of nutrient emissions, heavy effect by "wildcard simulations"

Research results

1. Future scenarios on the Oder river basin – lagoon – coastal sea system until 2020 (IOW, IGB and IÖW)

2. Combined effects of socio-economic development and climate change scenarios until 2020 (IGB)
   (1 publication in preparation, 3 Presentations, 1 Poster)

3.

Research results 2

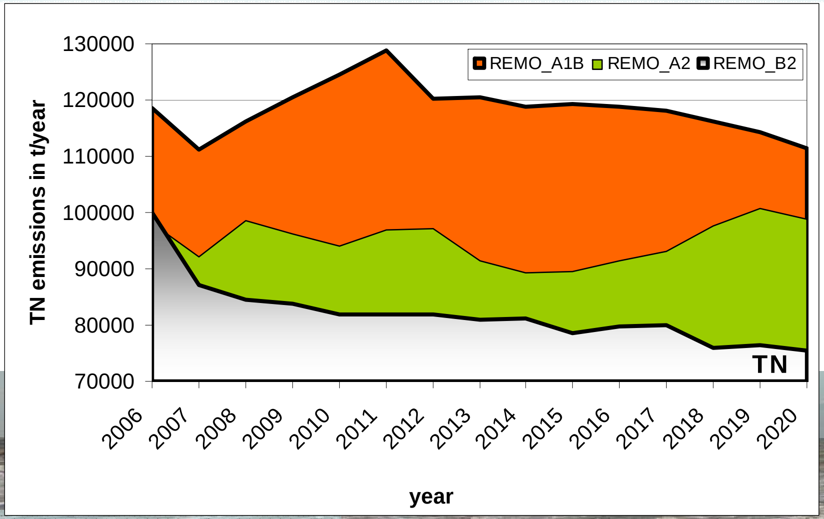
- Modelling nutrient emissions and loads by MONERIS (**MO**delling **N**utrient **E**missions in **RI**ver **S**ystems) http://moneris.igb-berlin.de

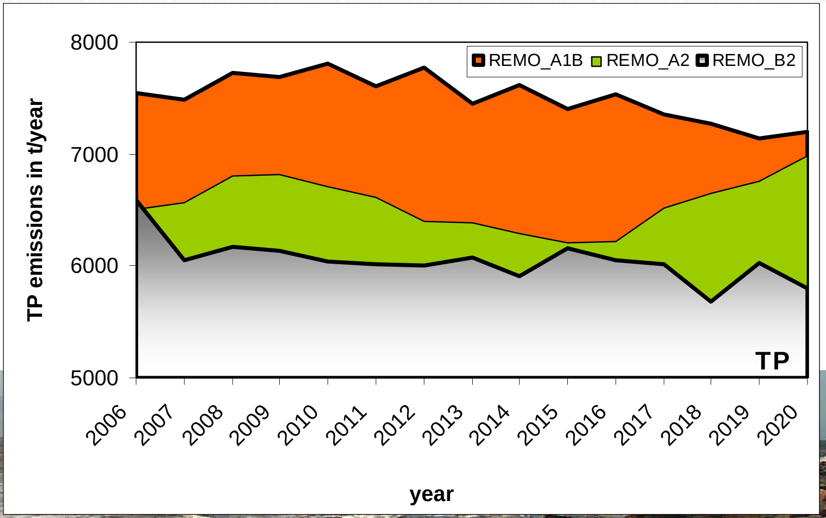
- Application of scenarios
  - Socio-economic development scenarios until 2020 (Jesko Hirschfeld, IÖW Berlin)
  - Climate scenarios until 2020 (REMO)
    - IPCC scenarios A1B, A2 and B2
    - Comparative high precipitation and run off values

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

Research results 2

- Range of possible nutrient emissions until 2020
- Climate scenarios in combination with socio-economic development scenarios, without UWWTD application
- Upper border: „regionalisation“ scenario combined with climate scenario A1B conditions
- Lower border: „liberalisation“ scenario combined with climate scenario B2 conditions
- Basically decreasing trend





Research results 2

- 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, without UWWTD application
- 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)
long term climate (1983-2005) conditions		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)
climate scenarios	REMO A2	8.3	7.8	8.7	TN in kg/(ha·yr)
climate scenarios	REMO B2	6.7	6.4	7.1	TN in kg/(ha·yr)
climate scenarios	REMO A1B	0.61	0.60	0.61	TP in kg/(ha·yr)
climate scenarios	REMO A2	0.59	0.59	0.59	TP in kg/(ha·yr)
climate scenarios	REMO B2	0.49	0.49	0.49	TP in kg/(ha·yr)

Research results

1. Future scenarios on the Oder river basin – lagoon – coastal sea system until 2020 (IOW, IGB and IÖW)

2. Combined effects of socio-economic development and climate change scenarios until 2020 (IGB)

3. Future scenario calculations for the period 2071-2100 by use of climate change scenarios (IGB)

   (1 publication …)

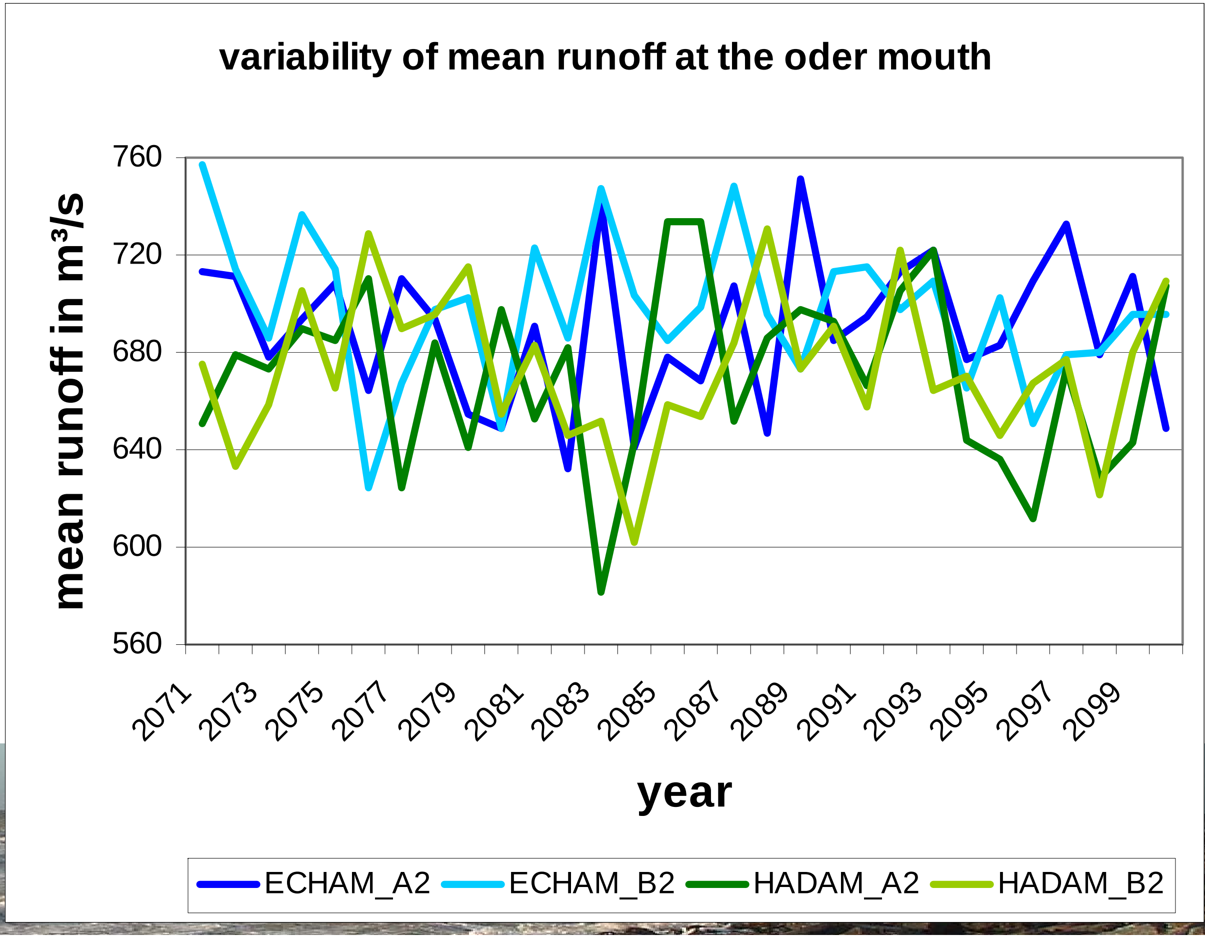
Research results 3

- 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 & HADAM3H; 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

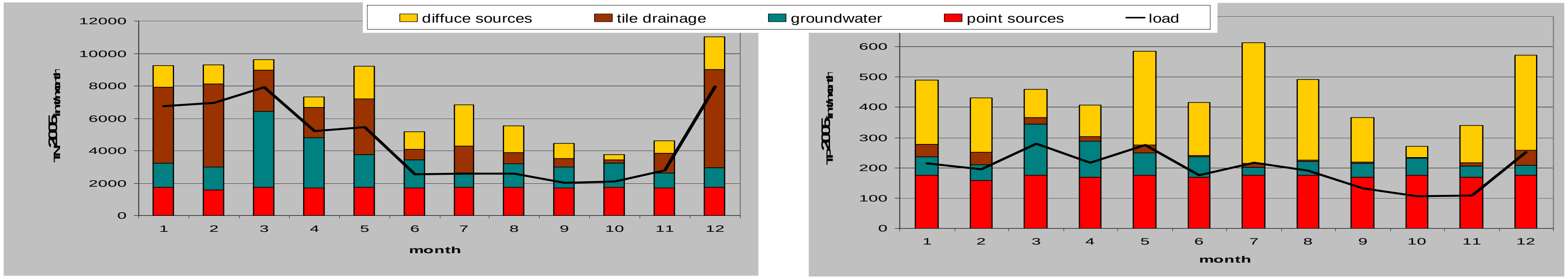
Research results 3

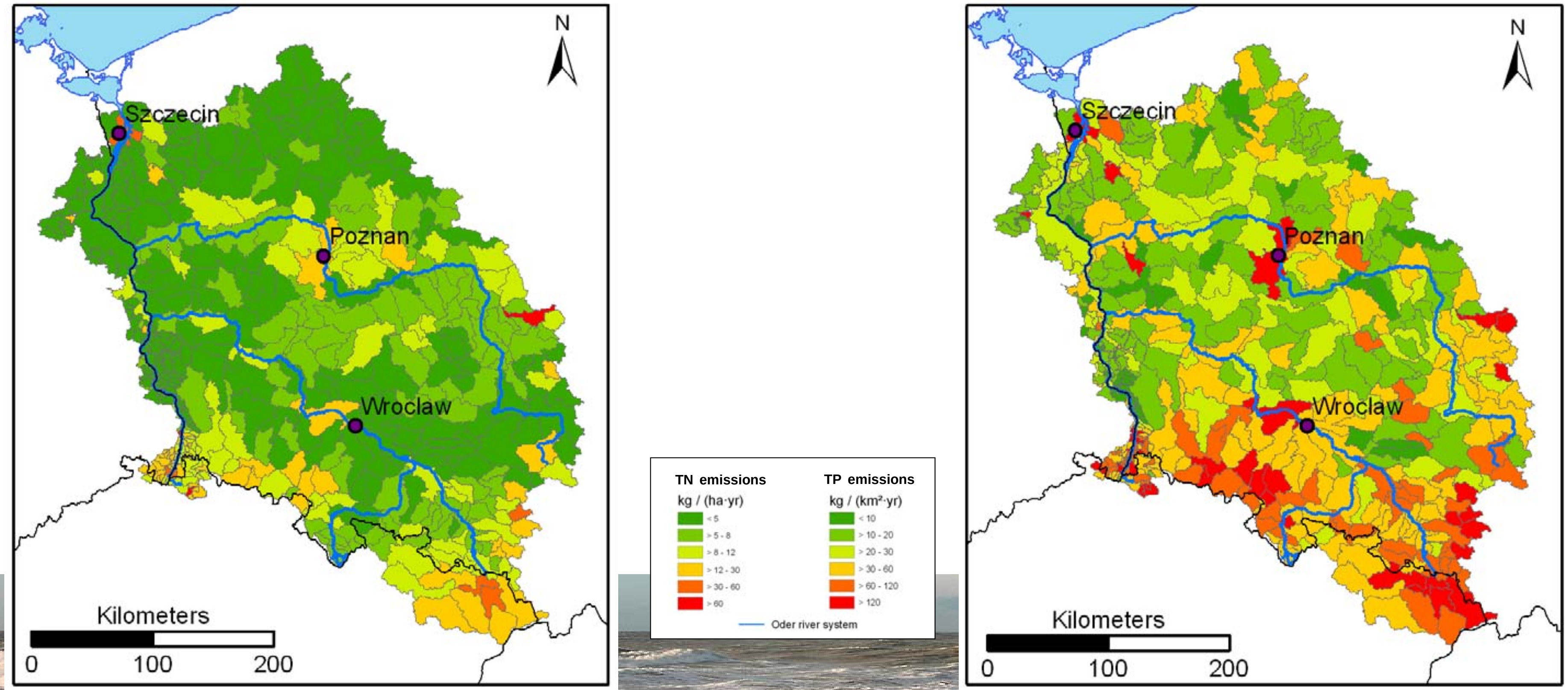
- Period of reference, validated by measured values (mean runoff 1983-2005 566 m³/s)
- Runoff by climate scenarios can not be validated

mean run off 2071-2100 in m³/s	
ECHAM_A2	690
ECHAM_B2	697
HADAM_A2	671
HADAM_B2	674



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

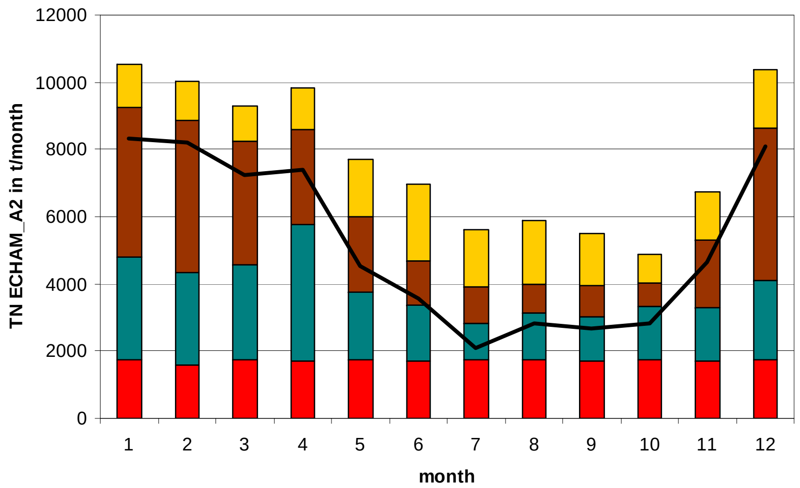


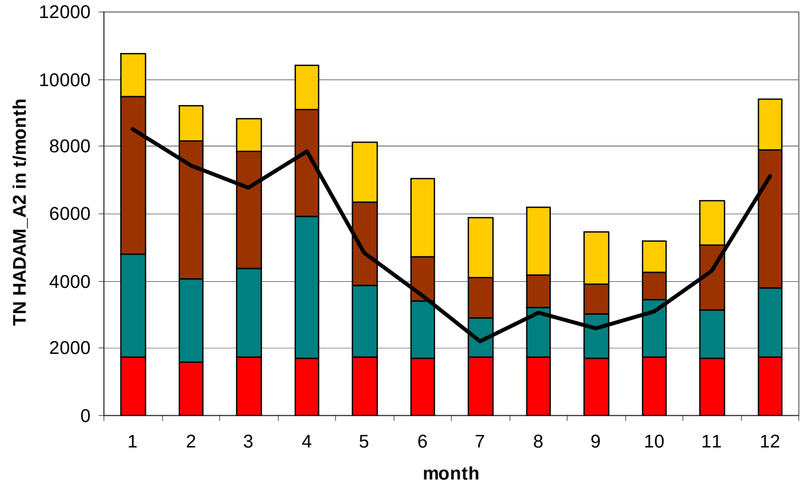


2071 – 2100 : mean monthly variation in nutrient emissions and loads

ECHAM4 | HadAM3H

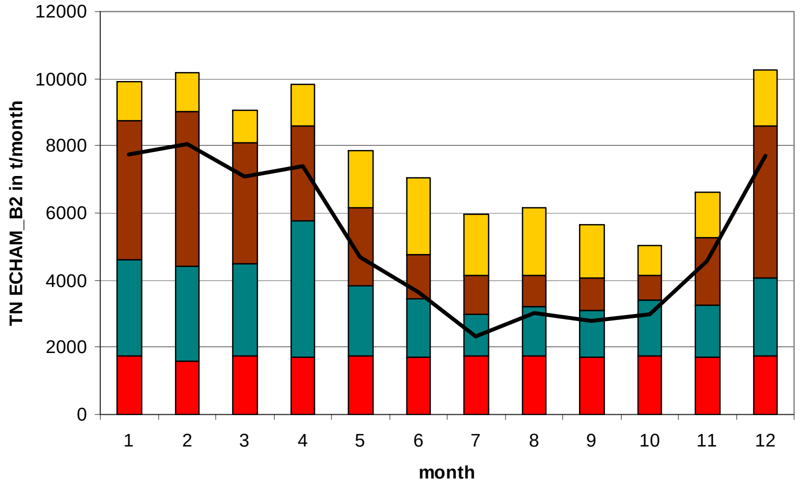
Scenario A2

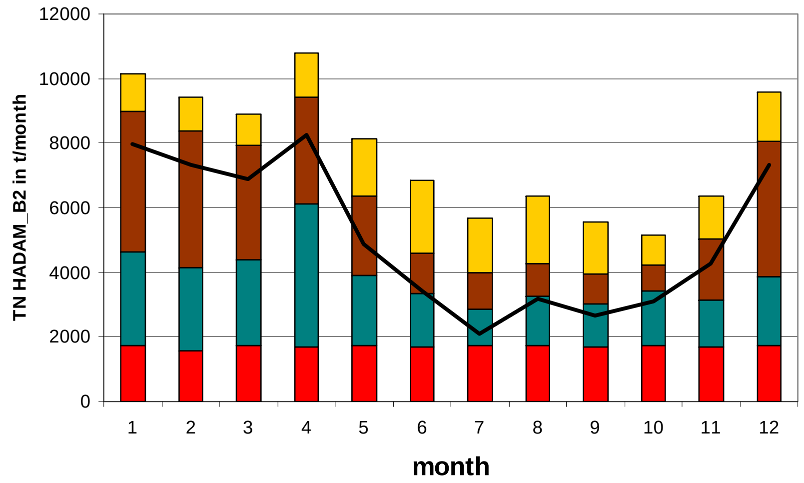




diffuce sources | tile drainage | groundwater | point sources | load

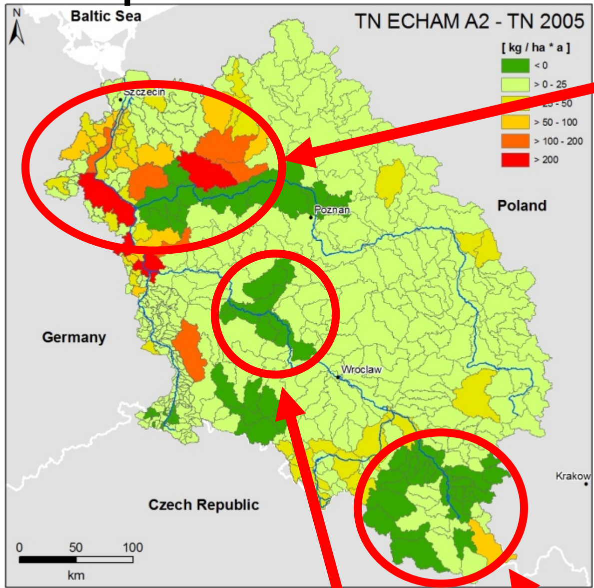
Scenario B2



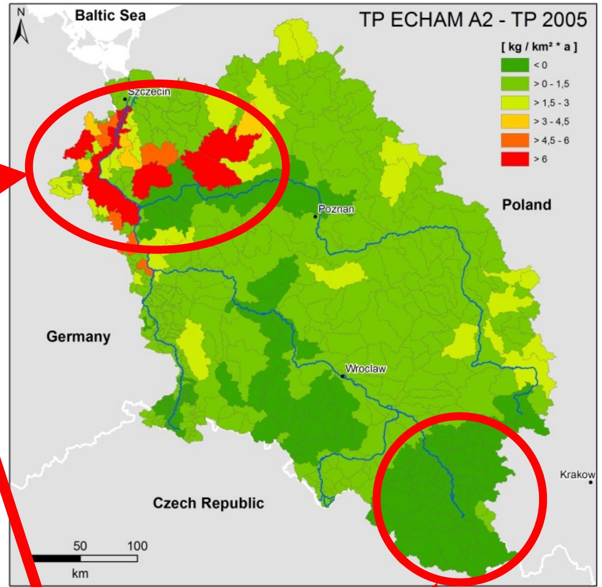


ECHAM4 2071-2100 : mean (2071-2100) annual differences in nutrient emissions in comparison to 2005

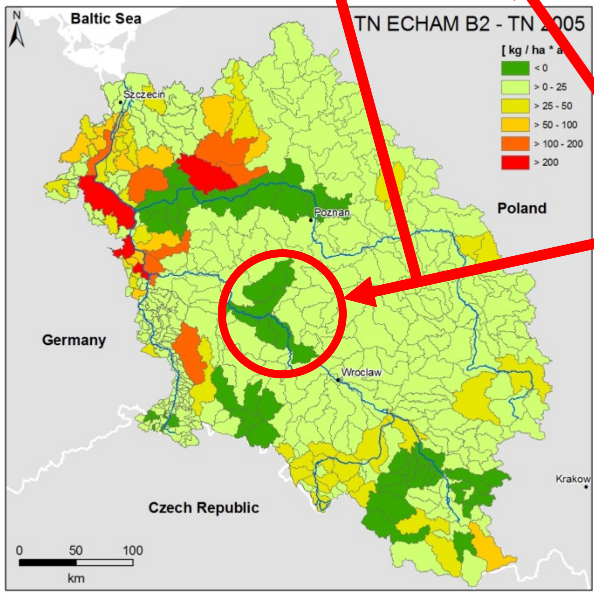
Scenario A2



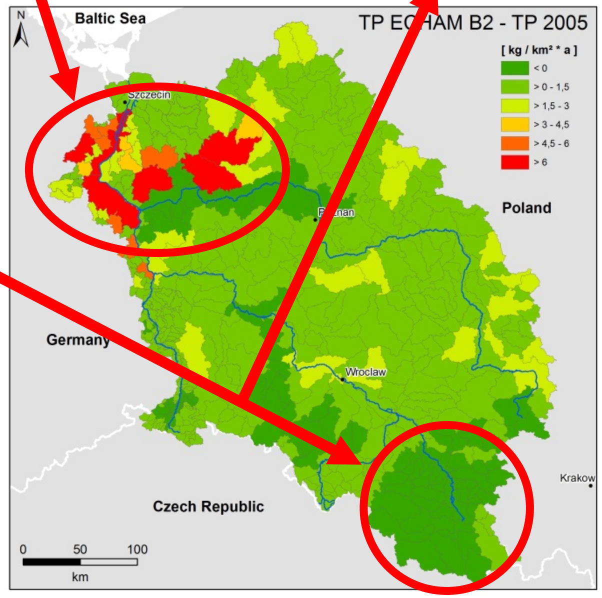
Increased nutrient Emissions due to application of climate scenarios



Scenario B2



decreased nutrient Emissions due to application of climate scenarios

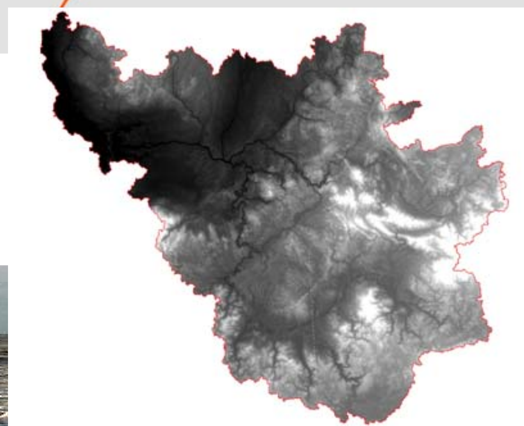


Conclusion

- Climate change scenarios are highly affecting the combined scenario calculations
- Only low changes in emission conditions by basic socio-economic development scenarios
- Consideration of land use changes like energy crops (maize, rape…)or increased animal protein consumption is necessary

Research area – Nemunas River Basin

- Nemunas Sub-catchments by CORPI (Arturas)
- Build up the Database for MONERIS with the given datasets:
  - Landcover
  - DEM (90m SRTM)
  - Pedology data
  - Settlements
  - River system
  - GPCC
- Update the model by run off and water quality data (monthly values between 2001 and 2006)
- Implementation of WWTP data



Thank you for your attention