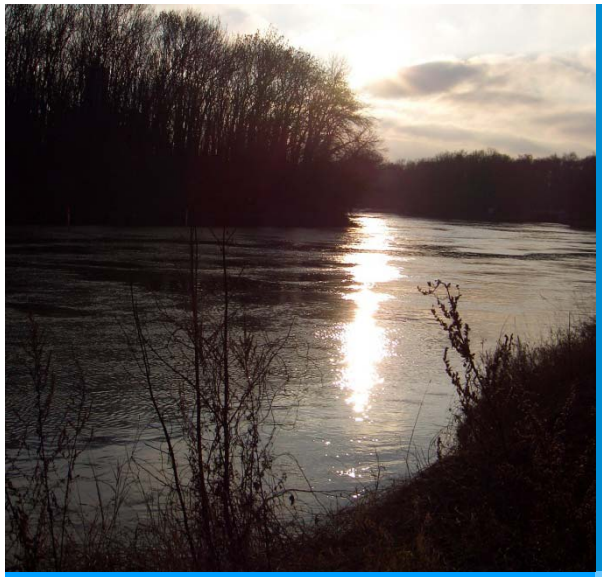
Effects of land management regulations and measures on N leaching in the German Baltic Sea catchment

Modeling recent trends and environmental objectives in the German Baltic Sea catchment



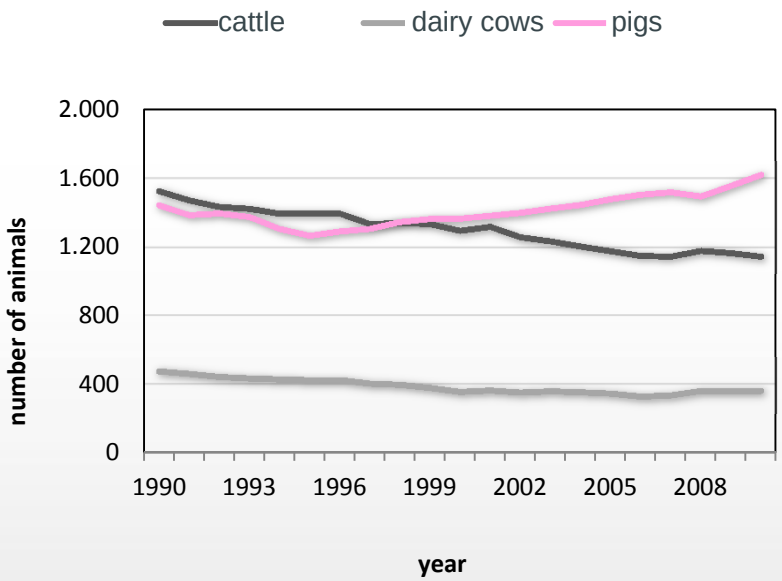
Andrea Wagner, Claudia Heidecke, Peter Kreins, Markus Venohr

Szczecin 13.05.2014

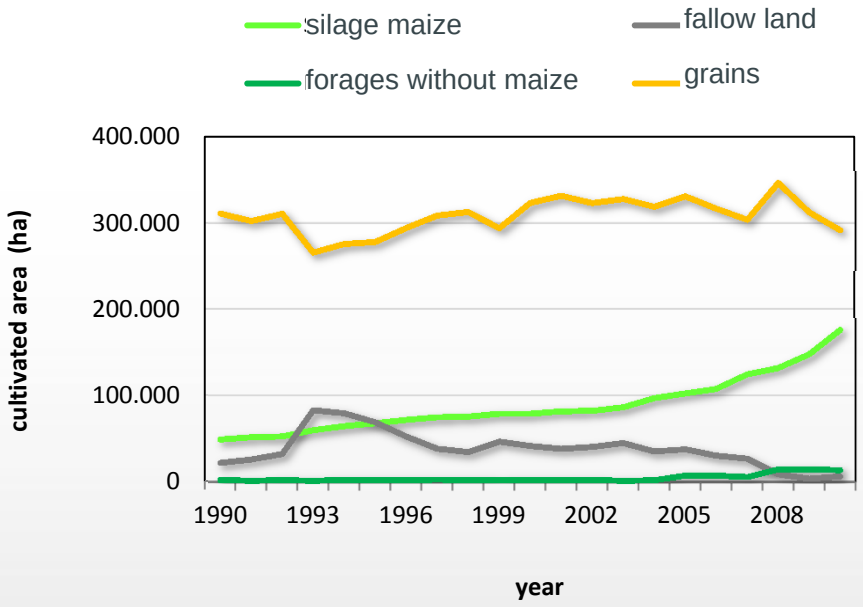
Trends in agricultural production

development from 1990 until 2010

in animal husbandry

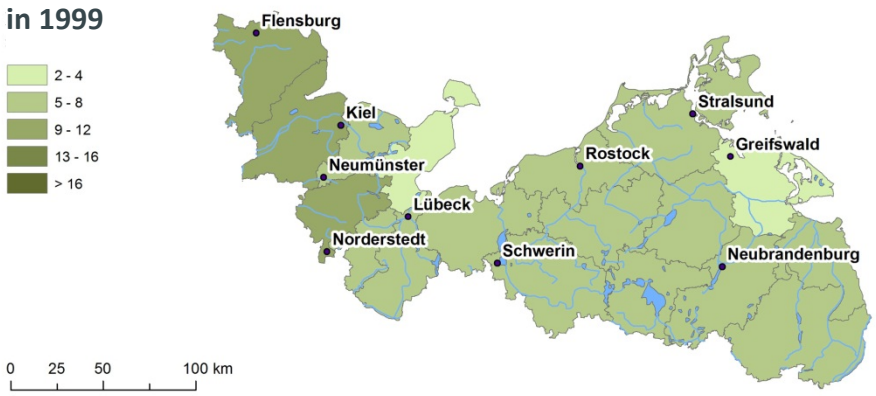


in plant cultivation



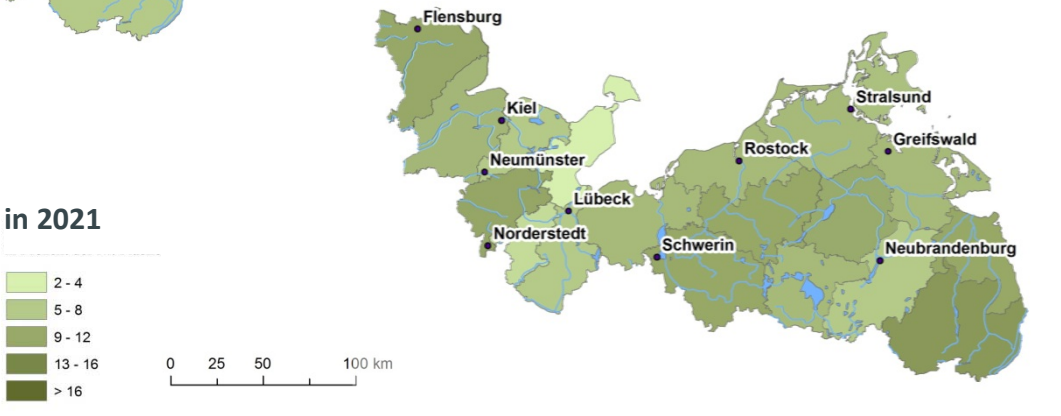
Promotion of biomass cultivatoin since 2000 and increase of maize cultivation

Share of energy maize per UAA

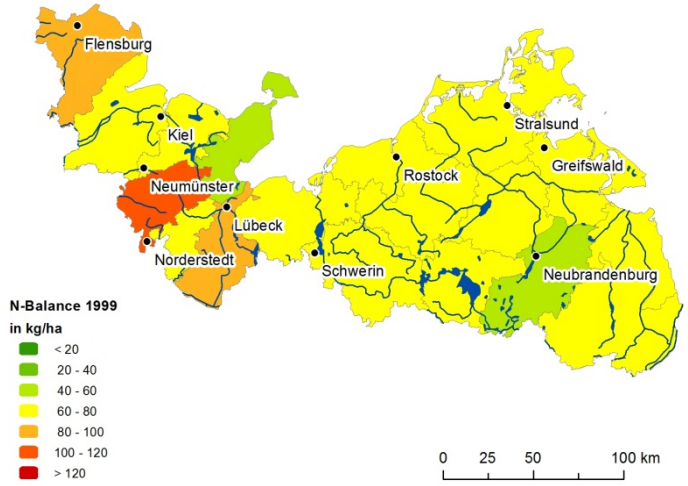


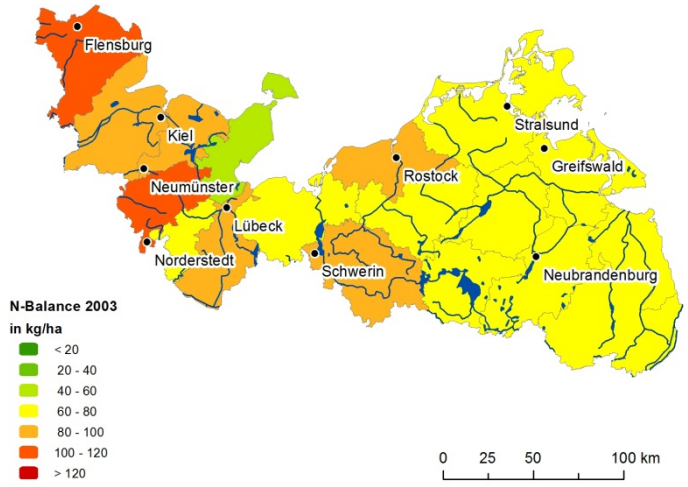
- 2000: 1rst renewable energy law (EEG) enacted
- promotion of biomass cultivation as renewable energy source

- sharp increase of maize cultivation until 2012 (EEG revision)
- until 2021 slight increase of maize areas expected
- overall + 2 kg N/ha UAA N surplus effect



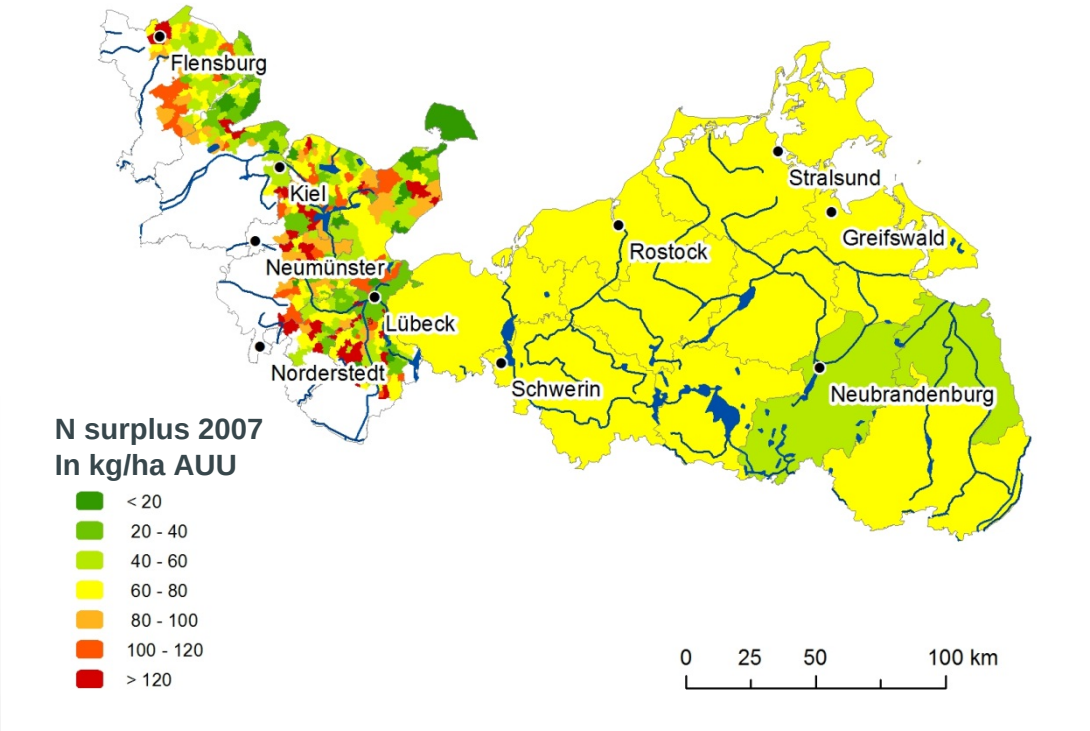
Agricultural N surpluses in the past





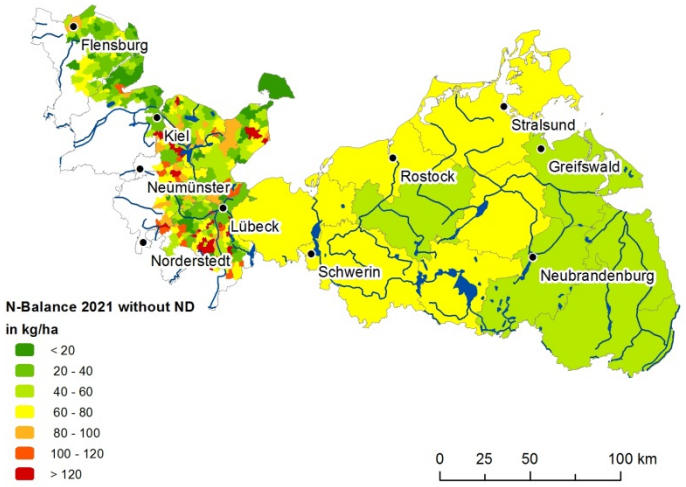
- > 60 kg N/ha surplus in many regions
- range 20 to 120 kg N/ha
- increase from 1999 to 2003
- in 2003 increase in surplus of > 80 kg N/ha
- especially in regions with animal husbandry

Status quo of agricultural N surplus in 2007

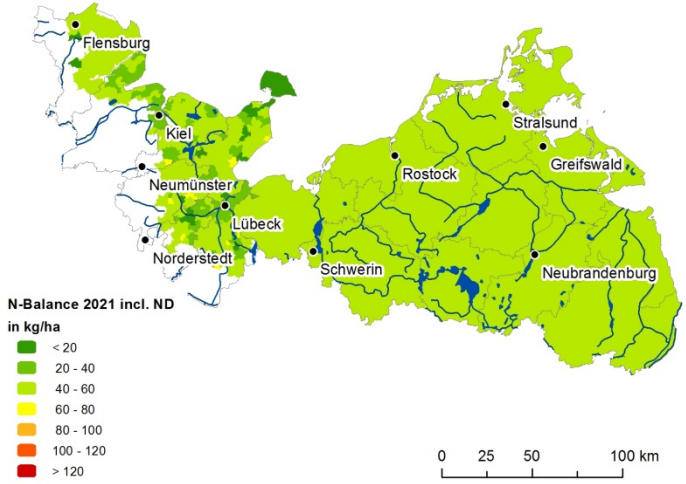


- regional gradients and hot spots in agricultural N surpluses
- often >60 kg N/ha
- high leaching potential especially in areas with great animal stocks
- since 2000 increase in silage maize cropping for biogas production due to promotion of energy crops -> fermentation residues

Forecast of agricultural N surplus for 2021



- further decrease in N inputs and surpluses
- due to technological progresses and adaptation of regulations – limitation of energy maize utilisation in biogas plants
- regional hot spots remain and may become more pronounced - still > 60 kg N/ha



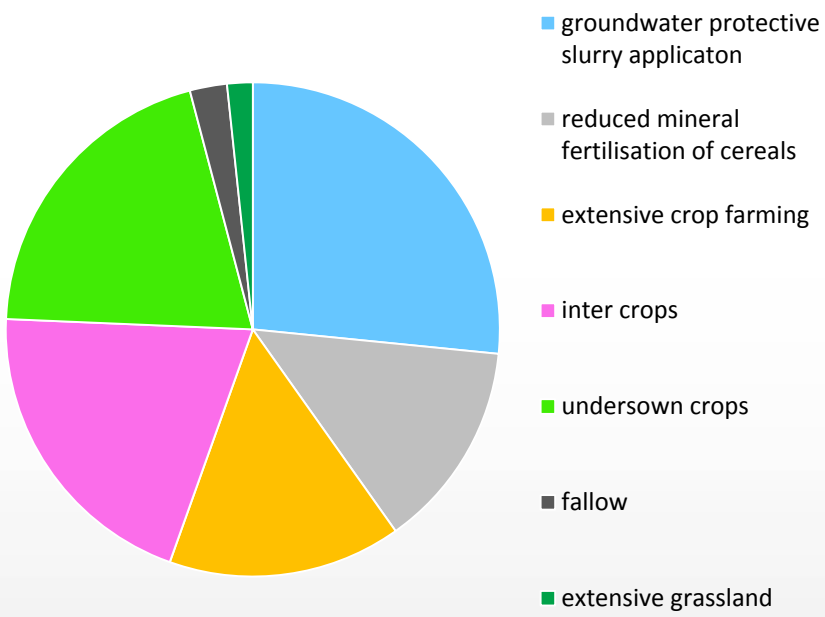
- Nitrate Directive: maximum surplus of 60 kg N/ha
- distinctive decrease of N surpluses
- diminished leaching potential and loads to groundwater and surface water bodies
- still insufficient to reach WFD and MSFD targets in all water bodies in 2021

GAP measures

measure	description	impact on N surplus (kg N/he)	costs (€/hectares)
no application of organic fertilizer after harvest	no application of organic fertilizer after harvest of main crop	15	15
inter crops	seeding of legume free plant until 01.09.; change of cover after 15.01/15.02.	20	80
undersown crops	seeding of legume free undersown crop; No application of fertilizer after harvest; change of cover after 15.02.	7,5	70
extensive crop farming	cultivation of plants with low nitrogen requirements: winter brewing barley, oil flux, etc.	40	70
extensive grassland production	average annual livestock unit 1,4 RGV/ha HFF; no mineral fertilizer application	30	100
reduced mineral fertilizer application in cereal production	reference value for fertilizer application minus 10 or 20 %	30	80
groundwater protective application of slurry	trailing hose, trailing show or slot techniques or exact spreading techniques, manure testing	15	30
fallow land	planting or maintenance of legume-free winter hardy grasses, no pasturing or nitrogen fertilization	60	127
transformation of cropland to extensive grassland	planting of legume-free grass mixtures, removal of the green matter, period of use 4.5 years	50	320
ecological farming	operation of the entire farm in accordance with the regulations for organic farming	60	170

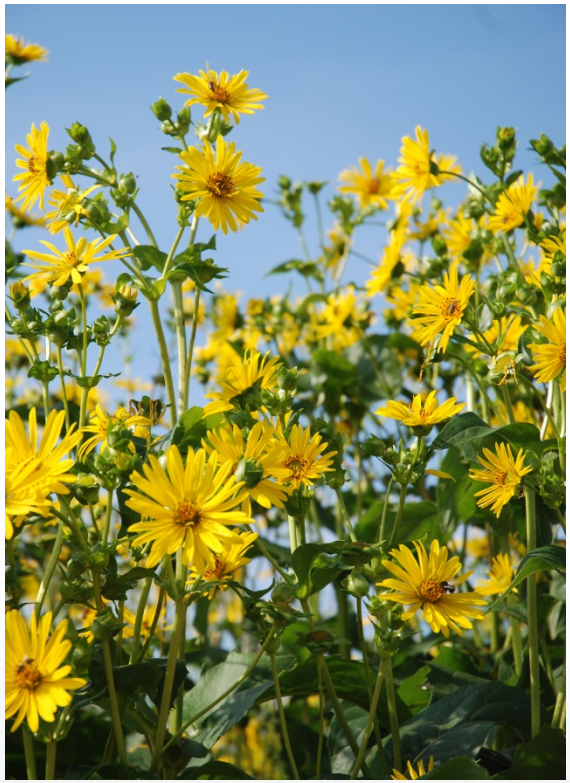
Necessary AEM expansion to reach MSFD targets

share of additional potential measures



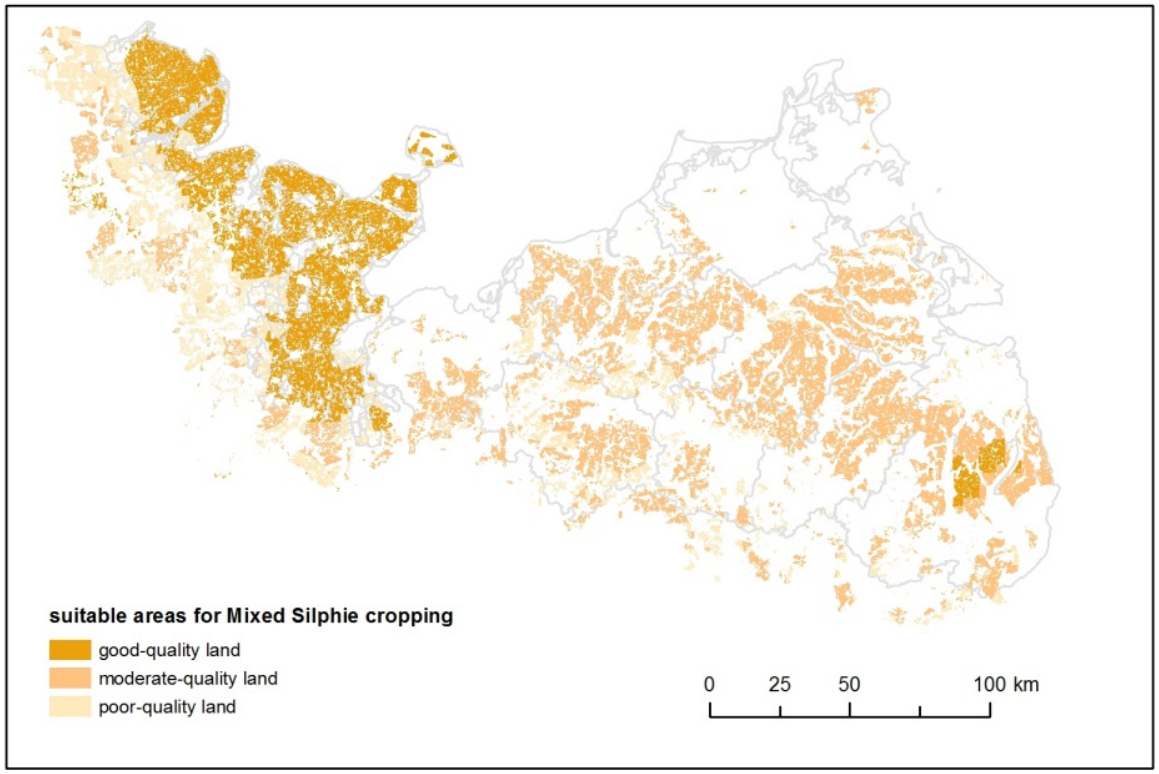
- Furthermore agro-environmental measures necessary to achieve MSFD targets until 2021:
  - approx. 4 Mio. hectars
  - approx . 200 Mio. € / 800 Mio. Zloty
  - to attain a reduction of 10.000 t of N surplus in the German Baltic Sea Catchment

Mixed Silphie (Silphium perfoliatum)



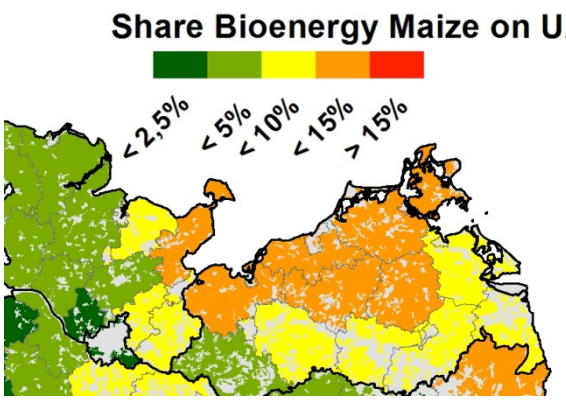
- perennial flowering shrub – cultivated up to 15 years
- resistent to frost and good drought tolerance due to early sprouting and well developed root system
- deep rooting – efficient uptake and utilisation of soil moisture and nutrients
- feasible for sandy soils
- at 400-500 mm precipitation yields comparable to silage maize can be achieved
- sustainable substrat for biogas production
- compliant to fertilisation with fermentation residues
- after 1rst year no herbicides and soil management

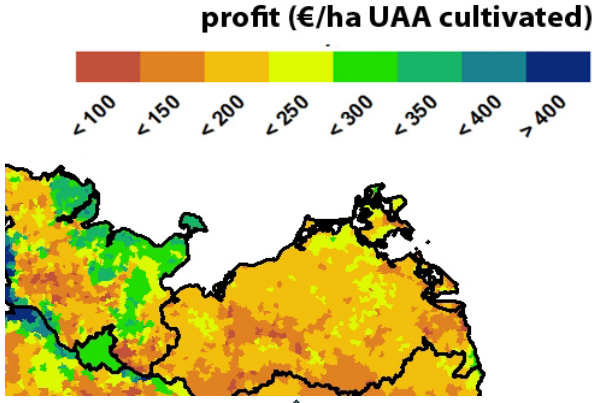
Areas suitable for cultivating Mixed Silphie

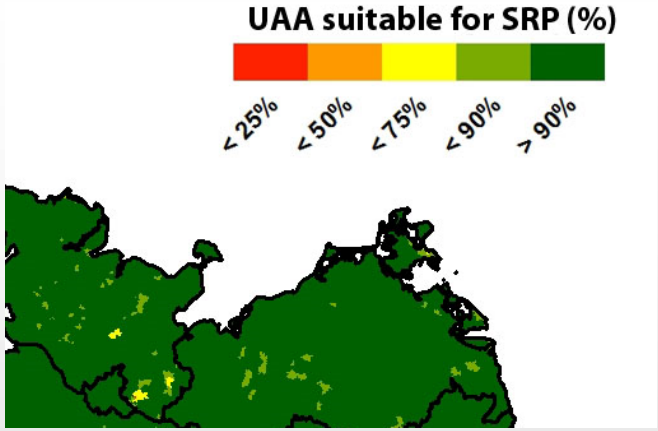


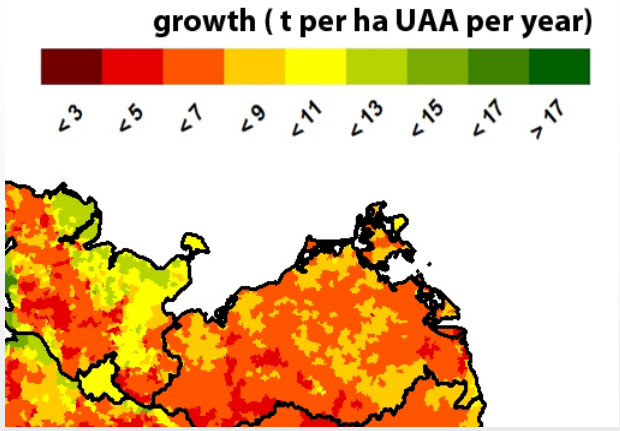
- in MV: some areas with poor-quality land suitable for cultivating Mixed Silphie, but high spatial potential of moderate quality land
- in SH: mainly good-quality land and poor-quality land available for cropping Mixed Silphie

Evaluation of energy maize alternatives









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Regional Adaptation Strategies for the German Baltic Sea Coast

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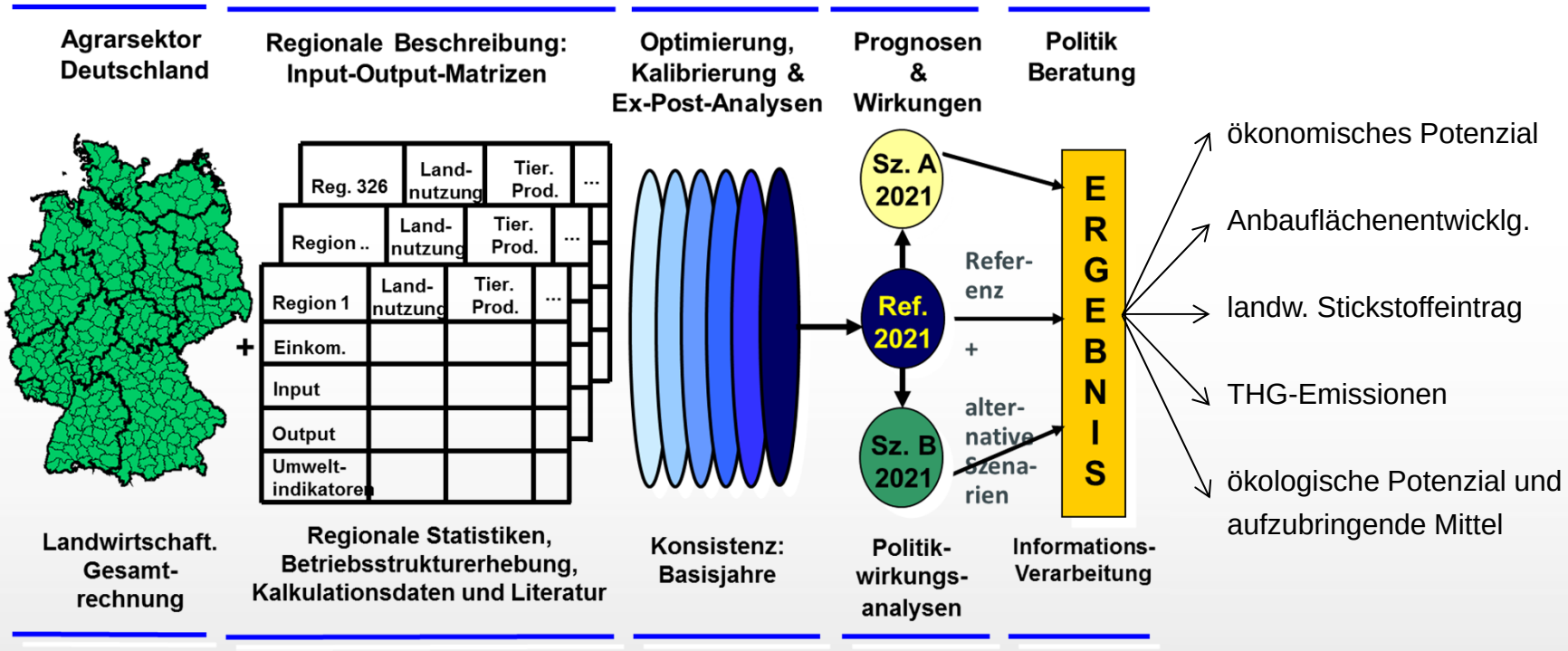
Thank you

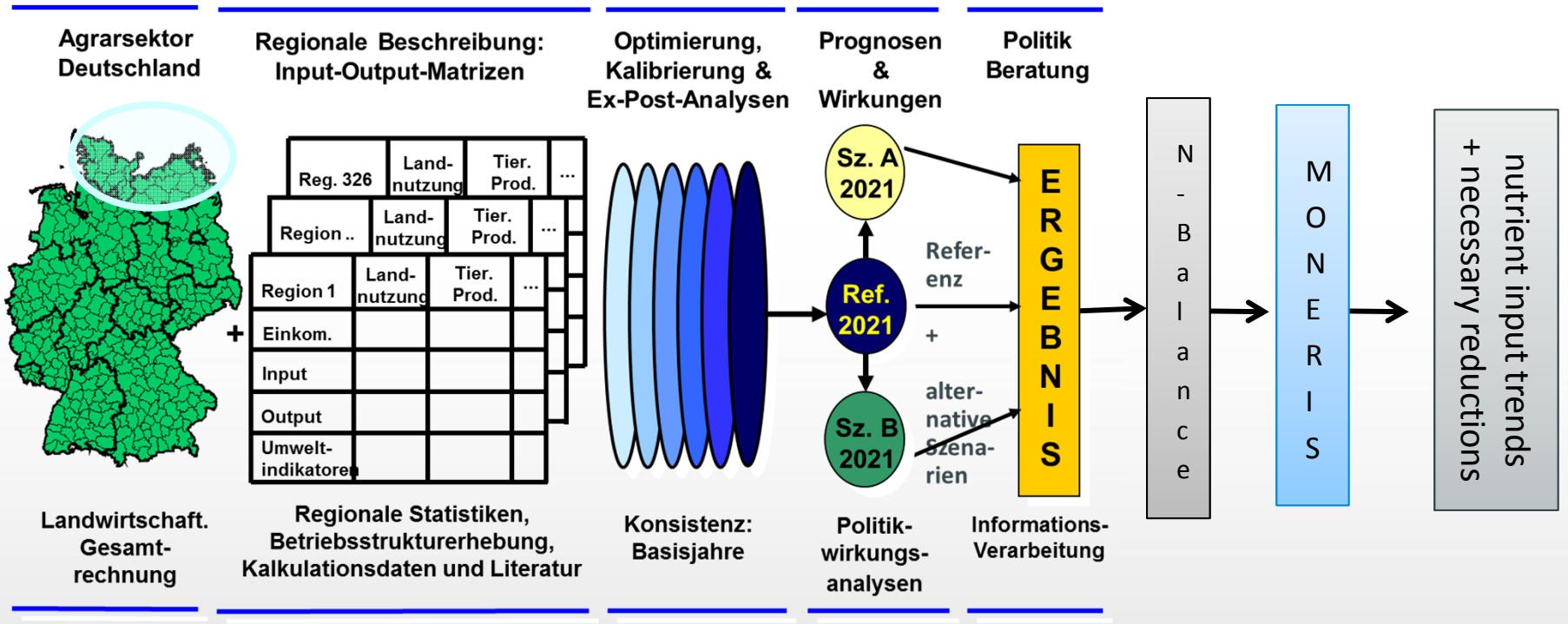
Agro-environmental model RAUMIS

input, scenarios and output

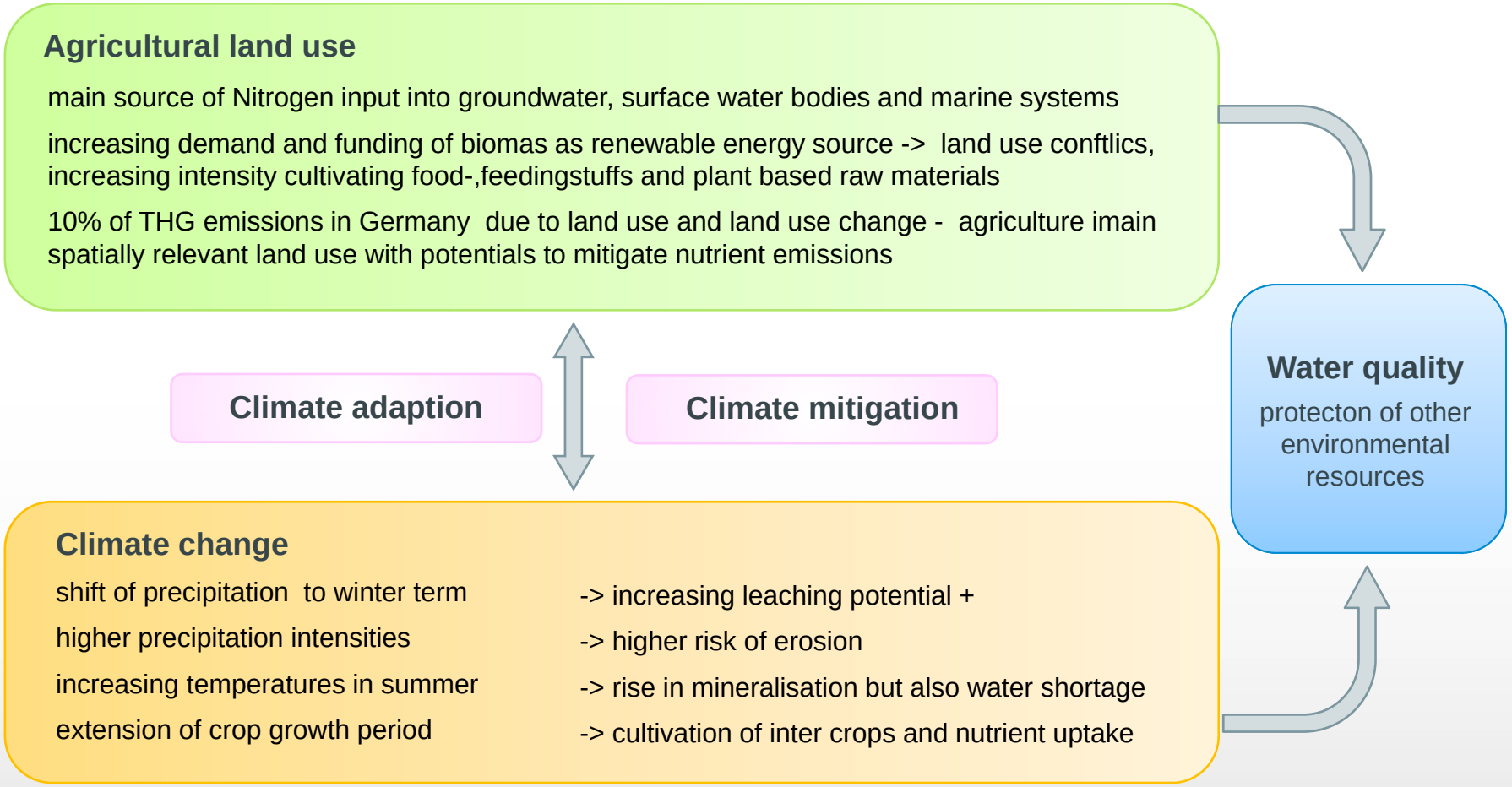


Interdisciplinary modeling approach

RAUMIS – MONERIS - RAUMIS



Future challenges in land use and water quality status



Alternative crops which provide co-benefits?

- are there alternatives to energy maize?
- suitable for cropping in the Baltic Sea region
- high potential to adapt to climate changes to occure
- can be cultivated with common methods mostly
- future economic potentials
- suitable arable land
- contribute to good water quality, additional environmental protection, climate mitigation, … spin-offs?






Mixed Silphie (Silphium perfoliatum L.)
Agricultural cultivation and economical potentials

cultivation

- **options for initiation:**
  - planting
  - seeding
  - and additional irrigation of small plants
- **fertilisation options:**
  - organic or mineral fertilisation
- **recultivation for following crop**

mean biomass and CH_4 yields (KTBL, 2012)

	mixed silphie				silage maize		
biomass yield (t FM/ha):	43	48	58	>	38	48	58
CH_4 yield (m³/ha):	23 000	3 500	4 000	<	4 000	5 000	6 000
electricity yield (kWh/ha):	11 000	13 000	14 000	<	15 000	18 000	23 000
heat yield (kWh/ha):	14 000	17 000	19 000	<	19 000	24 000	29 000

Site specifities

	mineral soil	organic soil	dry sites	medium sites	moist sites
Mixed Silphie	+	+	+	+	0
Tall Wheatgrass	+		+	+	+
SRP	+		-	++	++
Paludicultures		+	-		+++

Positive effects

	cultivation period	reduced Nitrogen input	reduced erosion risk	reduced GHG emissions	biodiversity
Mixed Silphie	<15	++	++	+	++
Tall Wheatgrass	8	++	+++	+	+
SRP	20	+++	+++	+	+++
Paludicultures	ff	+++	+++*	+++	+++

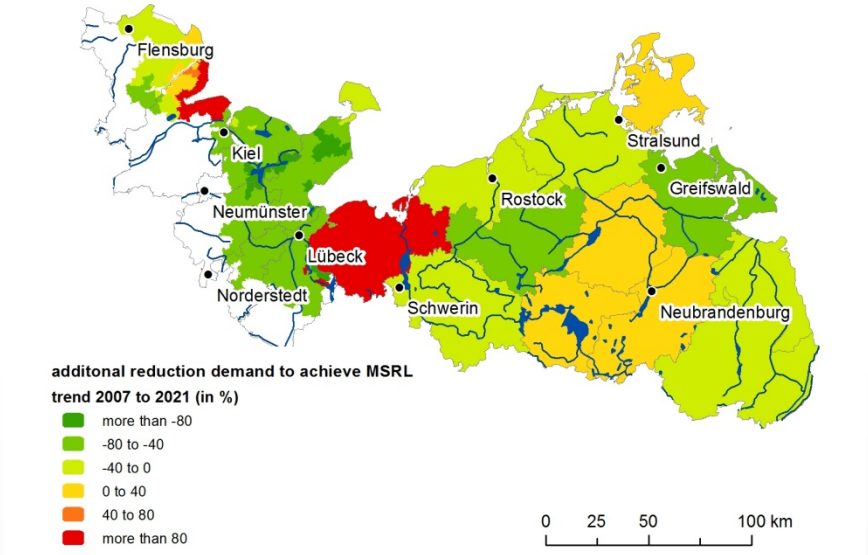
* reduced peat degradation

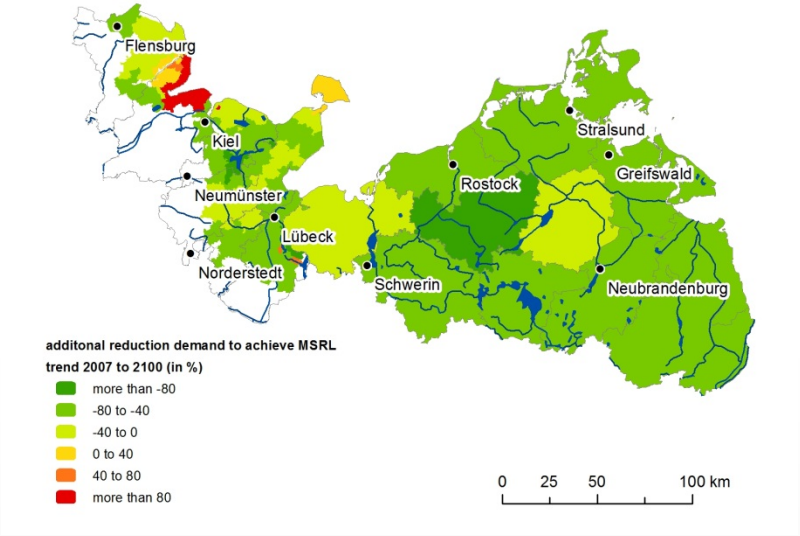
Energy maize alternatives

yield characteristics

	Energy Maize*			Mixed Silphie*			Tall Wheatgrass**			Short Crop Rotations*		
biomass yield (t FM/ha):	38	48	58	43	48	58	35	50	90	11,5	19	27,5
CH_4 yield(m³/ha):	3 956	4 945	5 934	2 871	3 509	3 832	6 465	6 611	6 757			
electricity (kWh/ha):	14 593	18 241	22 890	10 622	12 982	14 163	23 919	24 459	24 999			
heat output (kWh/ha):	19 129	23 911	28 693	13 923	17 018	18 565	31 353	32 061	32 769	6 312	10 729	15 776

*according to KTBL data on energy plant cropping 2012 **according to literature and expert assessments





- 2007 to 2021 overall decrease of overall reduction demand to achieve WFD targets

- 2007 to 2100 furthermore overall decrease of overall reduction demand to achieve WFD targets