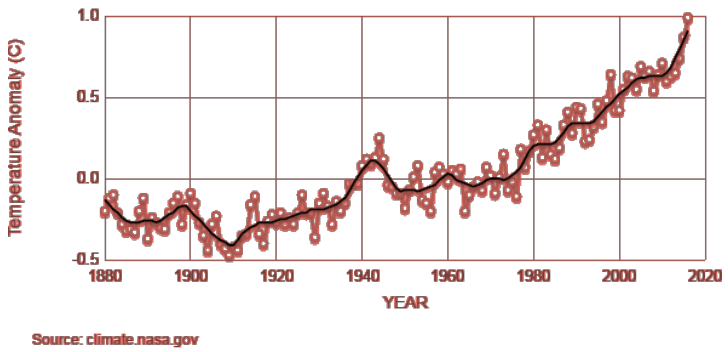
Modelling the combined effects of land use and climate changes on water availability and quality in the Odense Fjord catchment (Denmark)

Eugenio Molina-Navarro
Hans E. Andersen
Anders Nielsen
Hans Thodsen
Dennis Trolle

Department of Bioscience, Aarhus University.

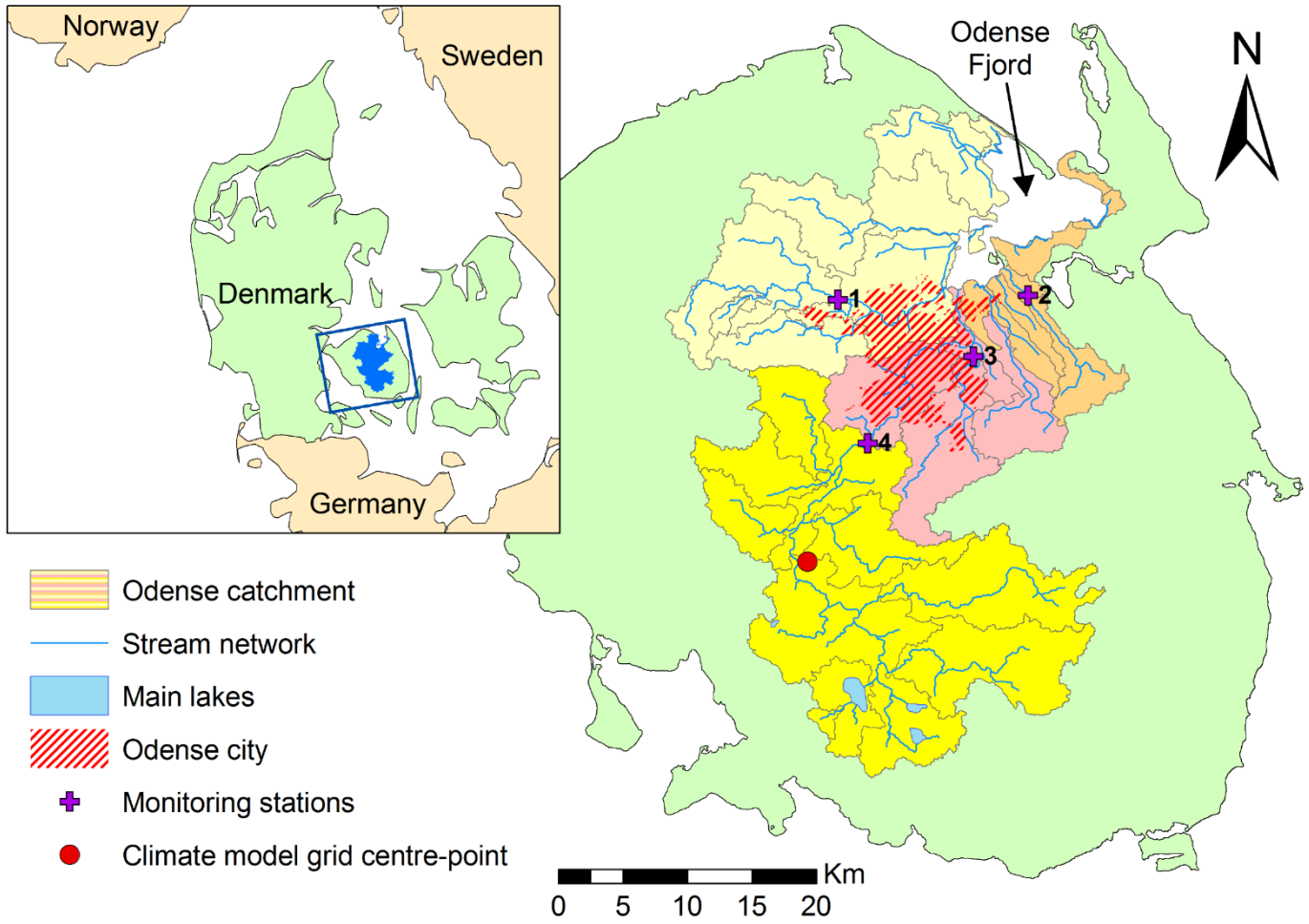

CLIMATE
Change
is
REAL


Yes,
it is!



Source: climate.nasa.gov

STUDY AREA: Odense Fjord catchment

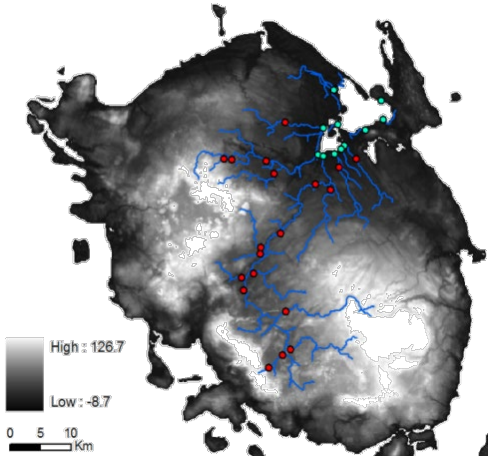


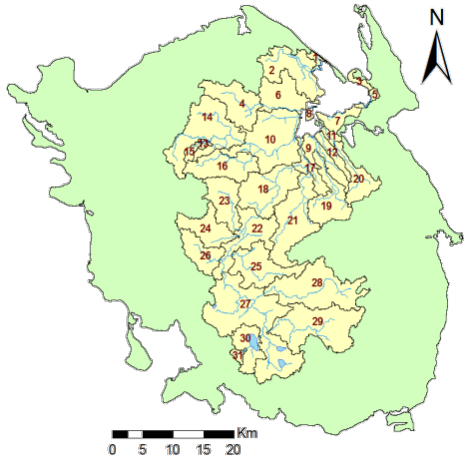
FACT BOX:

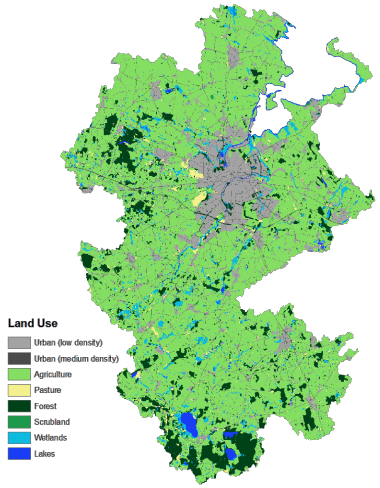
- **Area:** 1601 km^2
- **Climate:** Oceanic
- **Av. P:** 812 mm
- **Av. T:** 8.7 °C
- **Altitude:** -8 - 125 m a.s.l.
- **Slopes:** Half of area below 2%
- **Land use:** 68% agriculture
- **Soils:** Sandy-loam

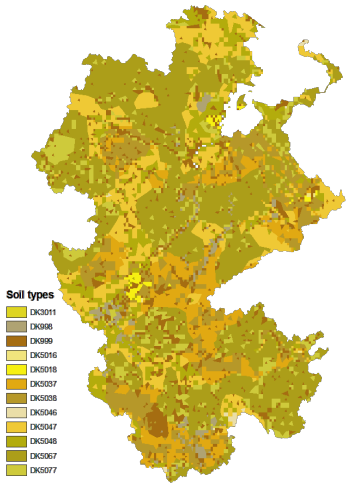
Only 36% of streams and 12% of lakes have a good or high ecological status. The fjord do not meet the WFD criteria.

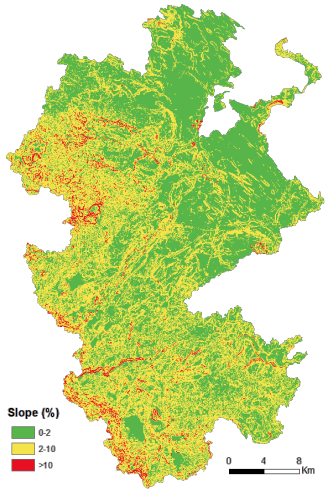
METHODOLOGY: 1. Model set-up

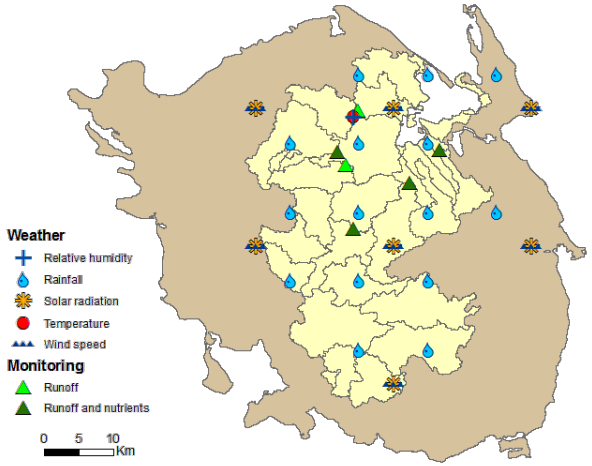




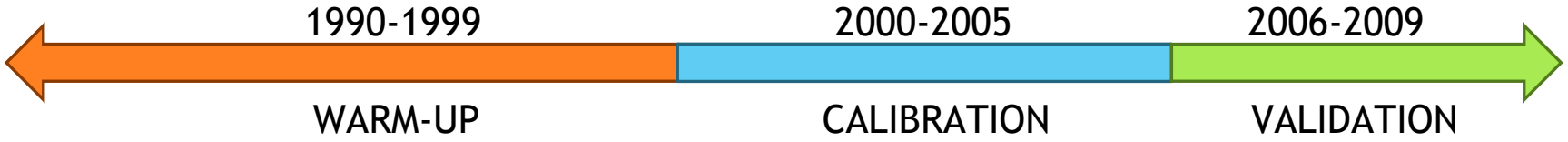








METHODOLOGY: 2. Calibration

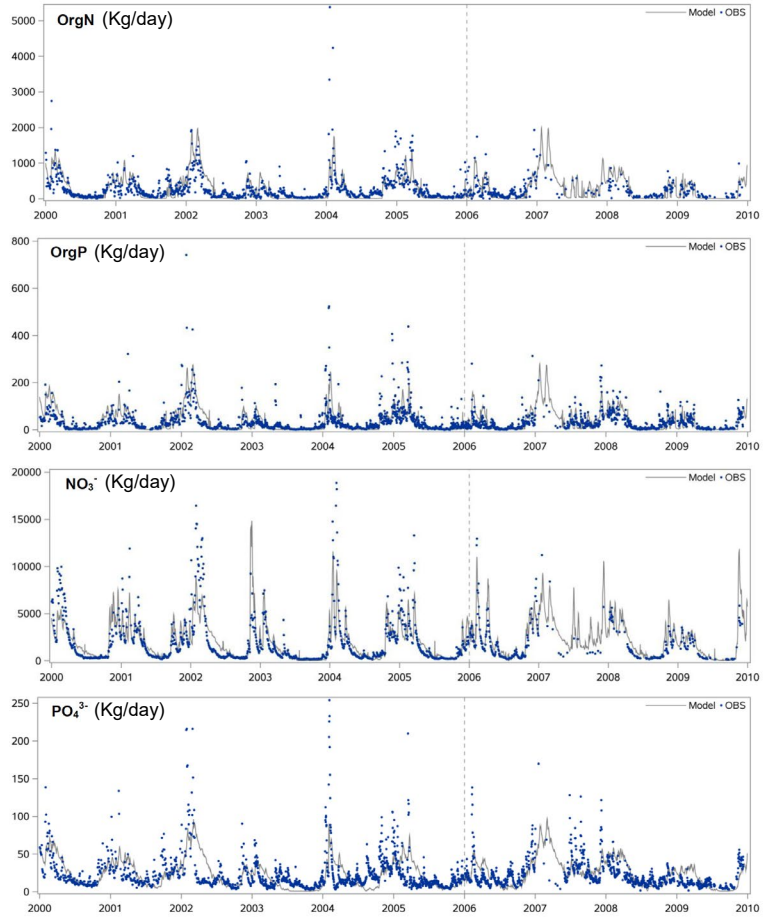


Observed data:
- 4 stations
- Flow data
- 4 nutrients

Parameters:
- Flow: 73
- Nutrients: 94

Expert knowledge

Molina-Navarro *et al.* (2017)
Environmental Modelling & Software



METHODOLOGY: 3. Scenarios

SCENARIOS DEFINITION:

3 climate and land use change scenarios corresponding to MARS storylines:

HT

HIGH-TECH AGRICULTURE

Agricultural conversion
↑ livestock density
↓ Fertilizer application
High emissions scenario
(RCP 8.5)

AN

AGRICULTURE FOR NATURE

↓ Agricultural area
↓ Farming intensity
↓ Fertilizer application
Low emissions scenario
(RCP 4.5)

MD

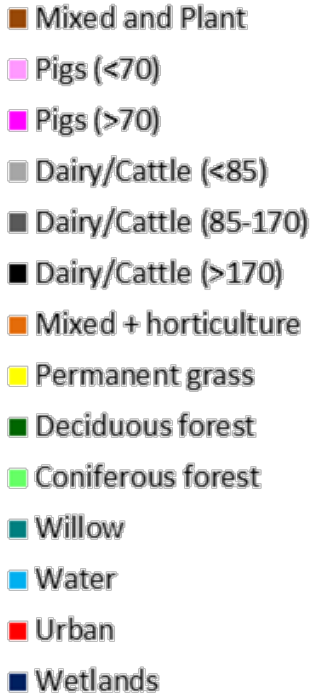
MARKET DRIVEN AGRICULTURE

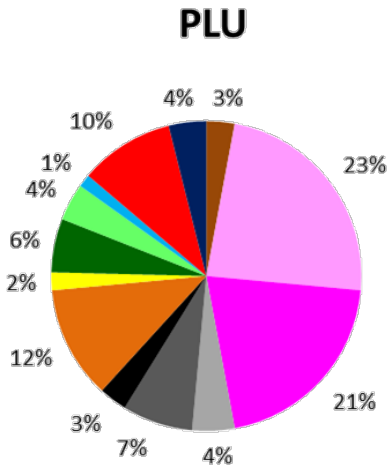
↑ Agricultural area
↑ Farming intensity
↑ Livestock density
↑ Fertilizer application
High emissions scenario
(RCP 8.5)

METHODOLOGY: LU Change scenarios

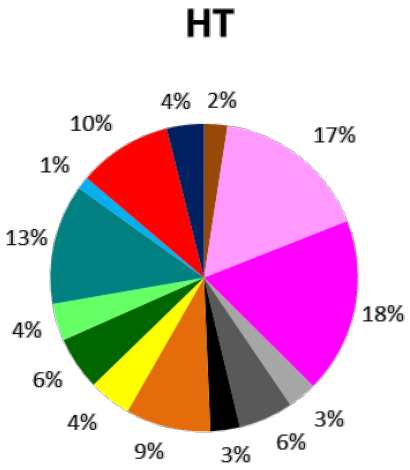
TASK 1:

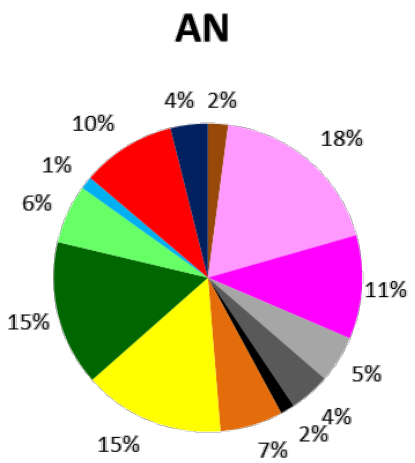
- CHANGE OF THE PROPORTIONS OF THE LAND USE TYPES
- INTRODUCTION OF WILLOW IN SCENARIO 1

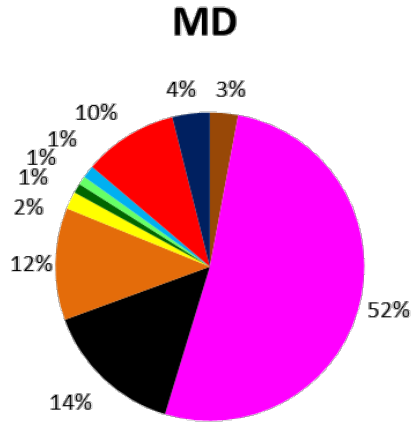




PLU: Present Land Use

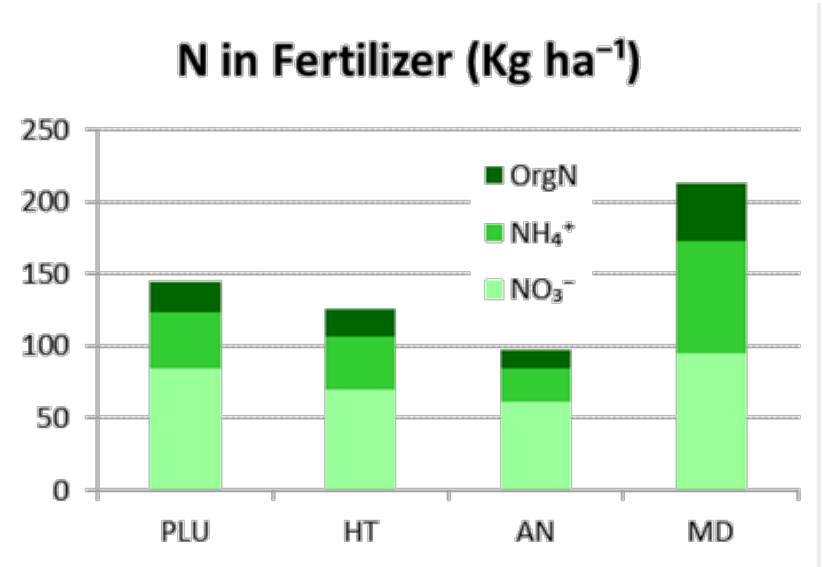


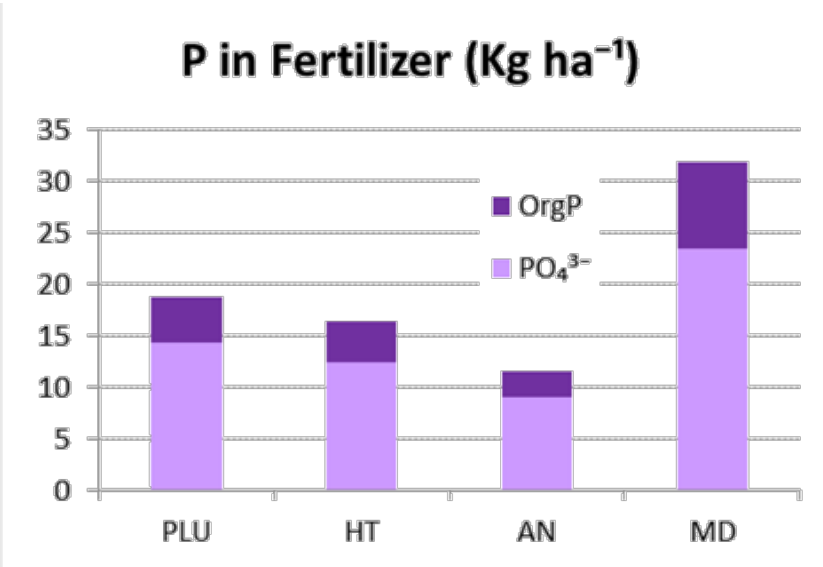




METHODOLOGY: LU Change scenarios

TASK 2: CHANGE IN FERTILIZER APPLICATION RATES



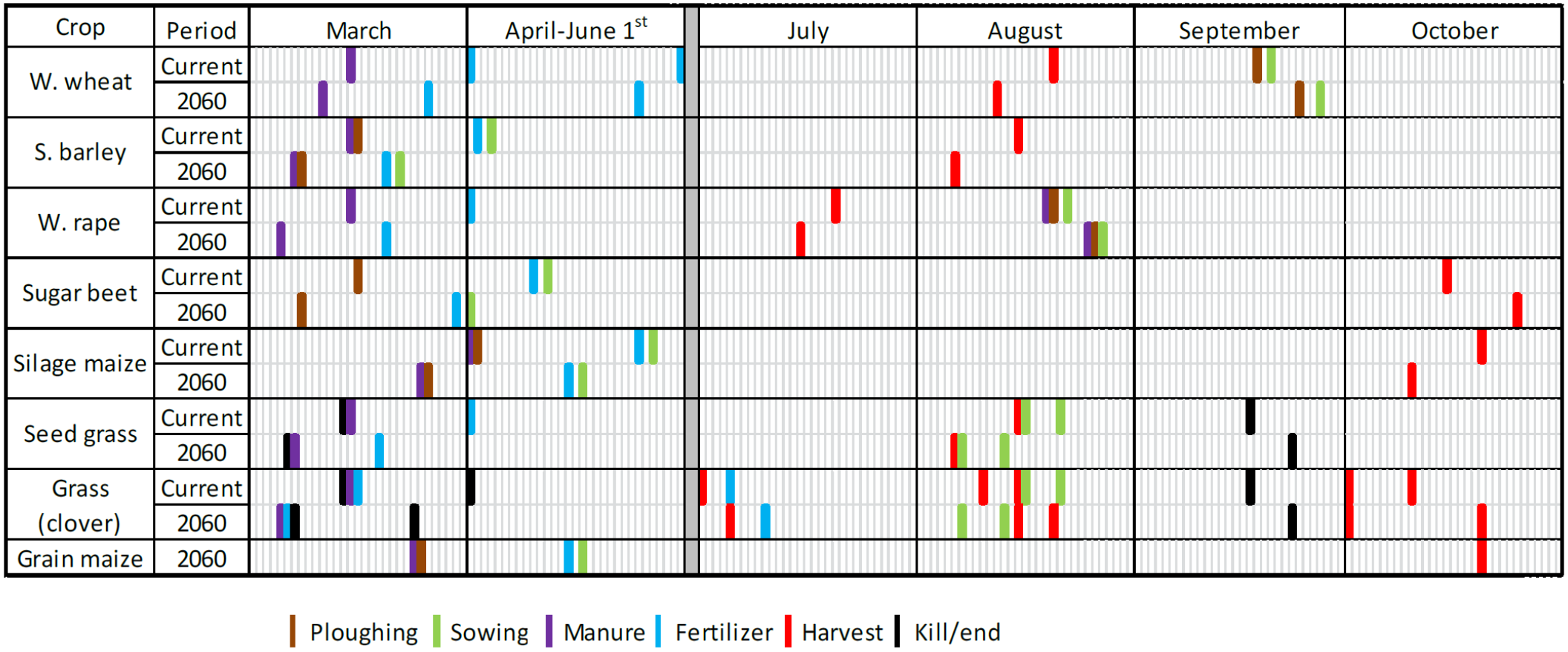


TASK 3: PIG FARMS IN FUTURE (2060) SCENARIOS: Grain maize replaces winter wheat

		ROTATION SCHEME				
Farm Type	Manure N (KgN ha^{-1})	Year 1	Year 2	Year 3	Year 4	Year 5
Pig	>70	W. Rape S. barley	W. wheat Seed grass	Grain maize S. barley	Grain maize W. wheat	S. barley Grain maize

METHODOLOGY: LU Change scenarios

TASK 4: CHANGE THE TIMING OF CROP MANAGEMENT FOR 2060 SCENARIO



METHODOLOGY: Scenarios combination

12 MODEL SET-UPS

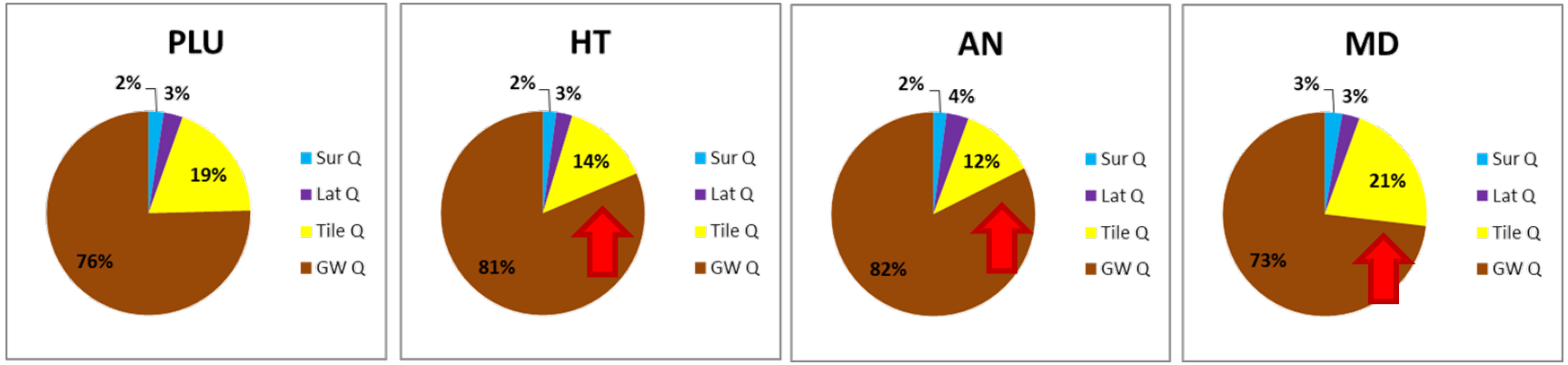
	ONLY LAND USE SCENARIOS			
Climate	Present land use	Agriculture for nature	High tech agriculture	Market driven agriculture
OBSERVED (2001-2010)	PLU_Obs	AN_Obs	HT_Obs	MD_Obs

	MARS Storylines: Land use + climate change scenarios		
Climate model	RCP 4.5	RCP 8.5	
Baseline (2011-2020)	PLU_45	PLU_85	
2030 (2025-2034)	AN_30	HT_30	MD_30
2060 (2055-2064)	AN_60	HT_60	MD_60

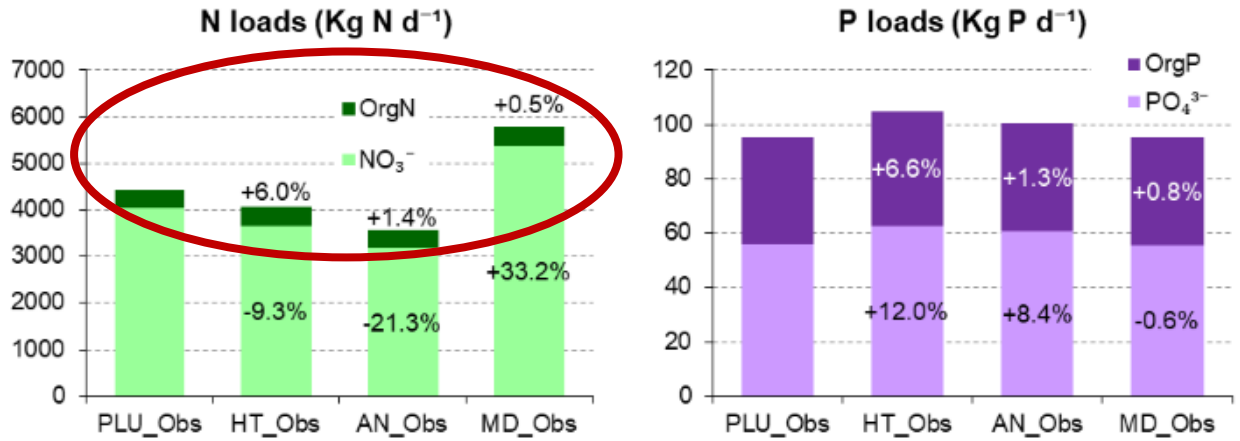
* Plus 5 years warm-up period in every time horizon

RESULTS: 1. Land use change isolated

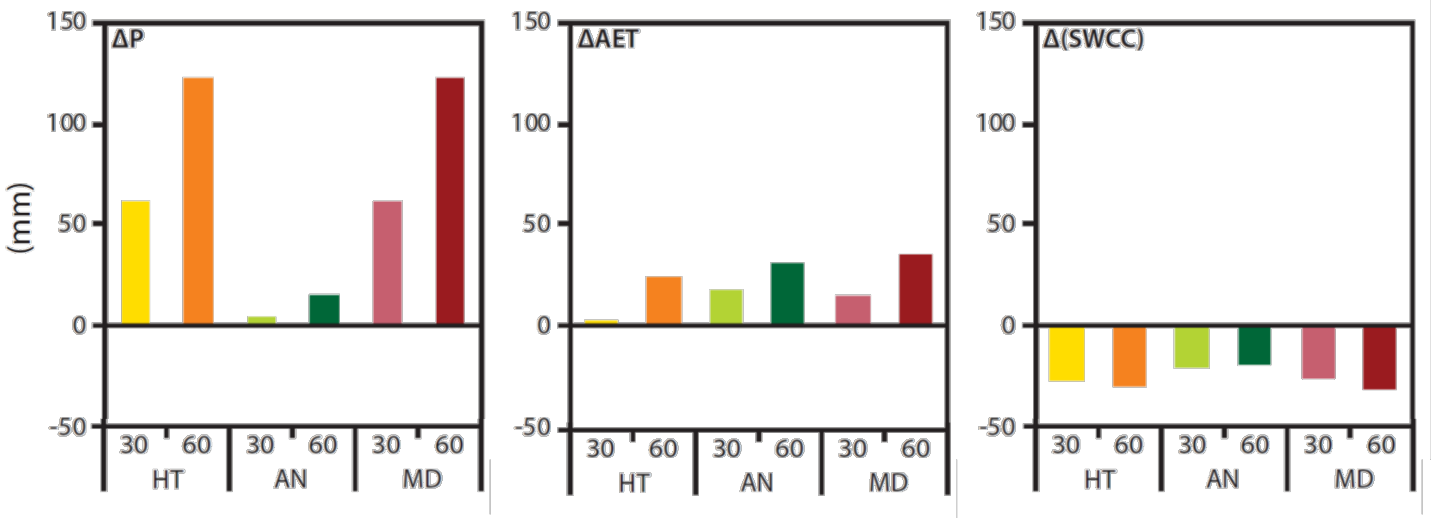
- Little impact on hidrology, flow components contribution changes



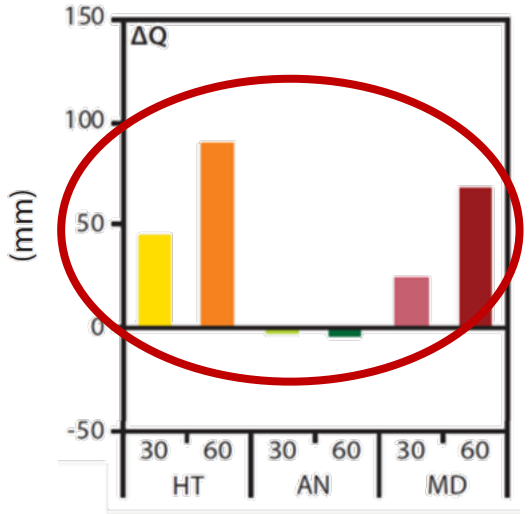
- OrgN, OrgP and MinP slightly affected. Changes in fertilization affect NO_3^- losses



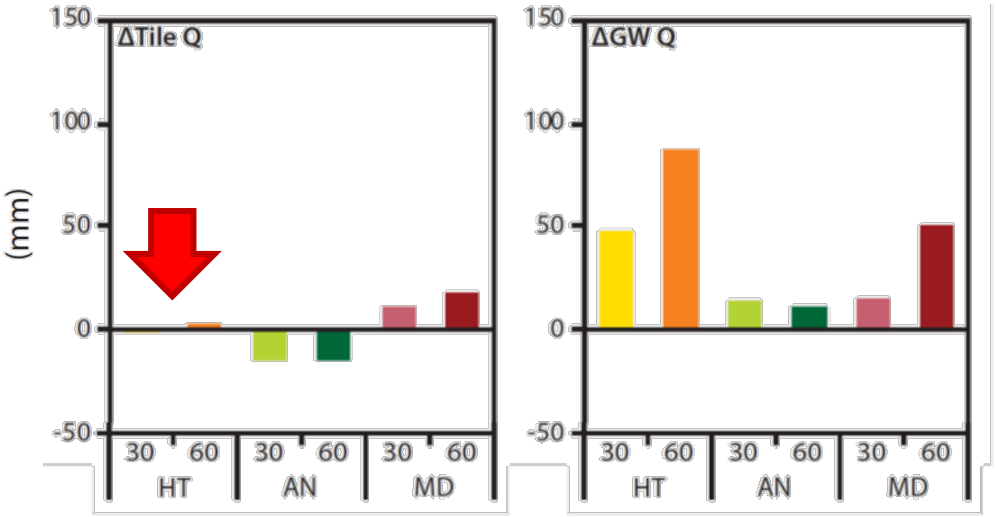
RESULTS: 2. Future storylines: FLOW



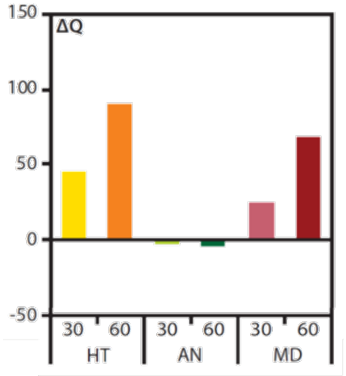
Q increases in HT and MD, but remains stable in AN ➔ Different climate input

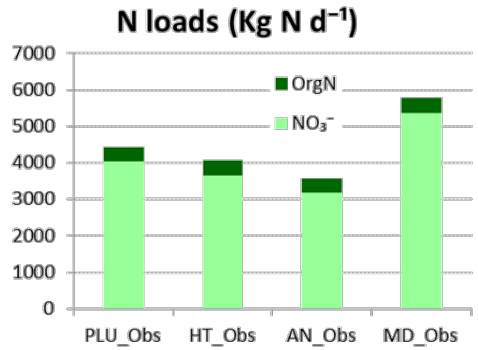


Land use – climate interactions governed the changes in flow components



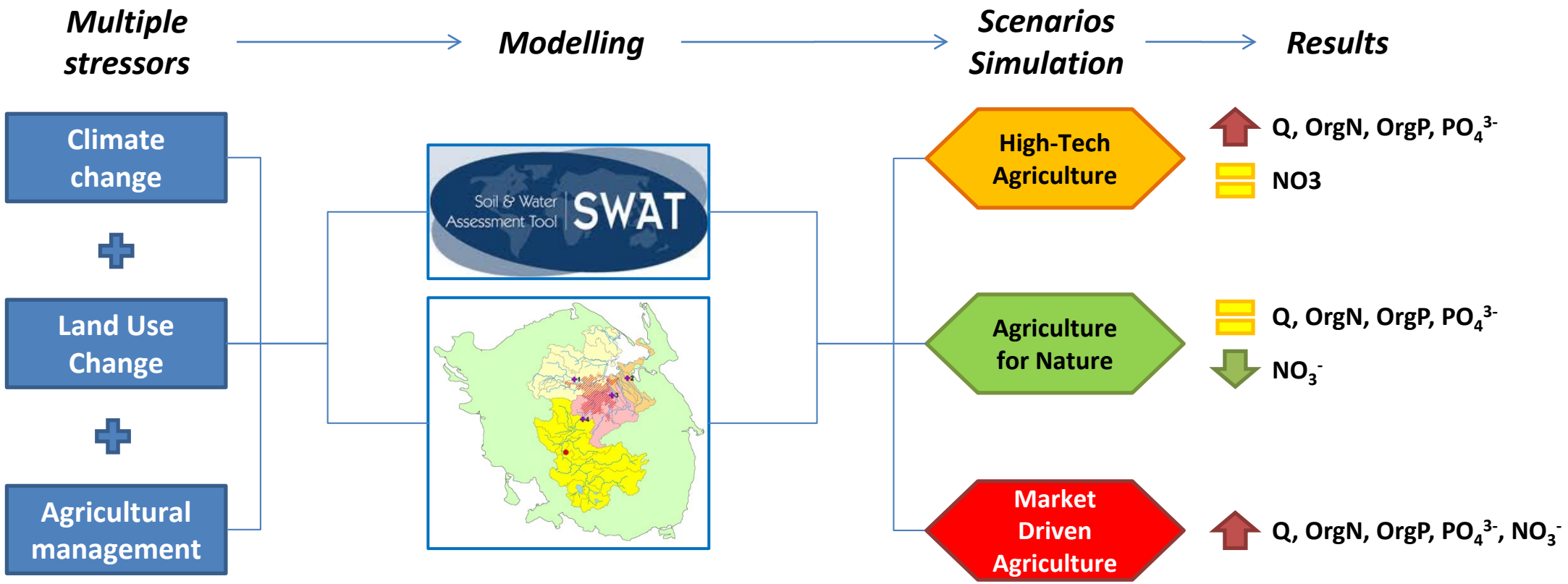
RESULTS: 3. Future storylines: NUTRIENTS





- River discharge is the main driver of OrgN, OrgP and MinP loads. A high emission scenario might threaten the ecological status of the aquatic ecosystems.
- NO_3^- load is driven by both climate and land use changes. Although many studies predict an increase in NO_3^- load, they will ultimately depend on LU management.

CONCLUSIONS



Molina-Navarro et al. (STOTEN, 2018)

MANGE TAK!

¡MUCHAS GRACIAS!

QUESTIONS?
COMMENTS?

AARHUS
UNIVERSITY
DEPARTMENT OF BIOSCIENCE

AARHUS
UNIVERSITY