

Challenges for European research on climate change impacts and adaptation

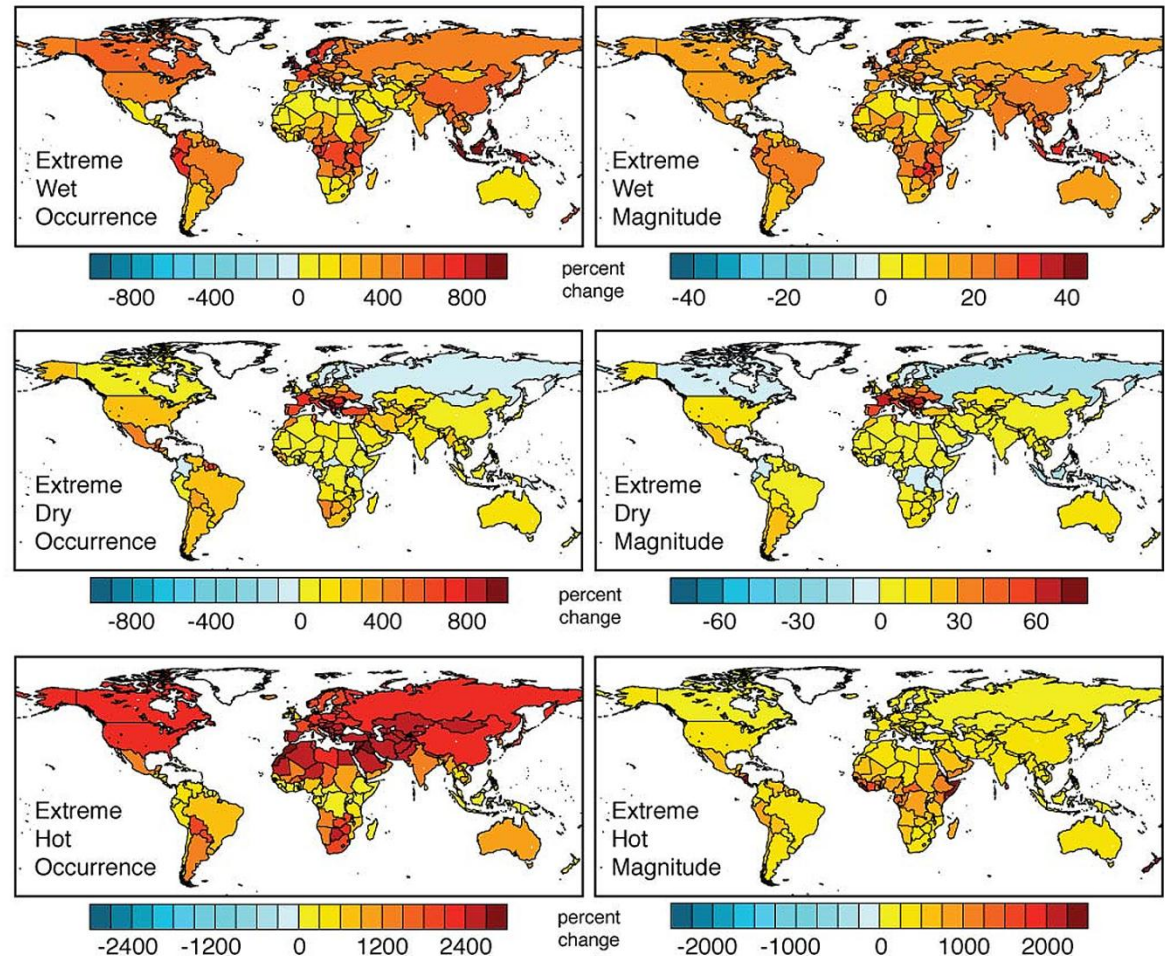
Professor Jørgen E. Olesen



Challenges of agriculture in 21st century

To manage changes in mean and extreme climate:

- › Increasing atmospheric CO₂ concentration
- › Increasing temperatures
- › Changes in rainfall
- › Changes in extreme events:
 - › Heat waves
 - › Droughts
 - › Floods
 - › Hail
 - › Storms



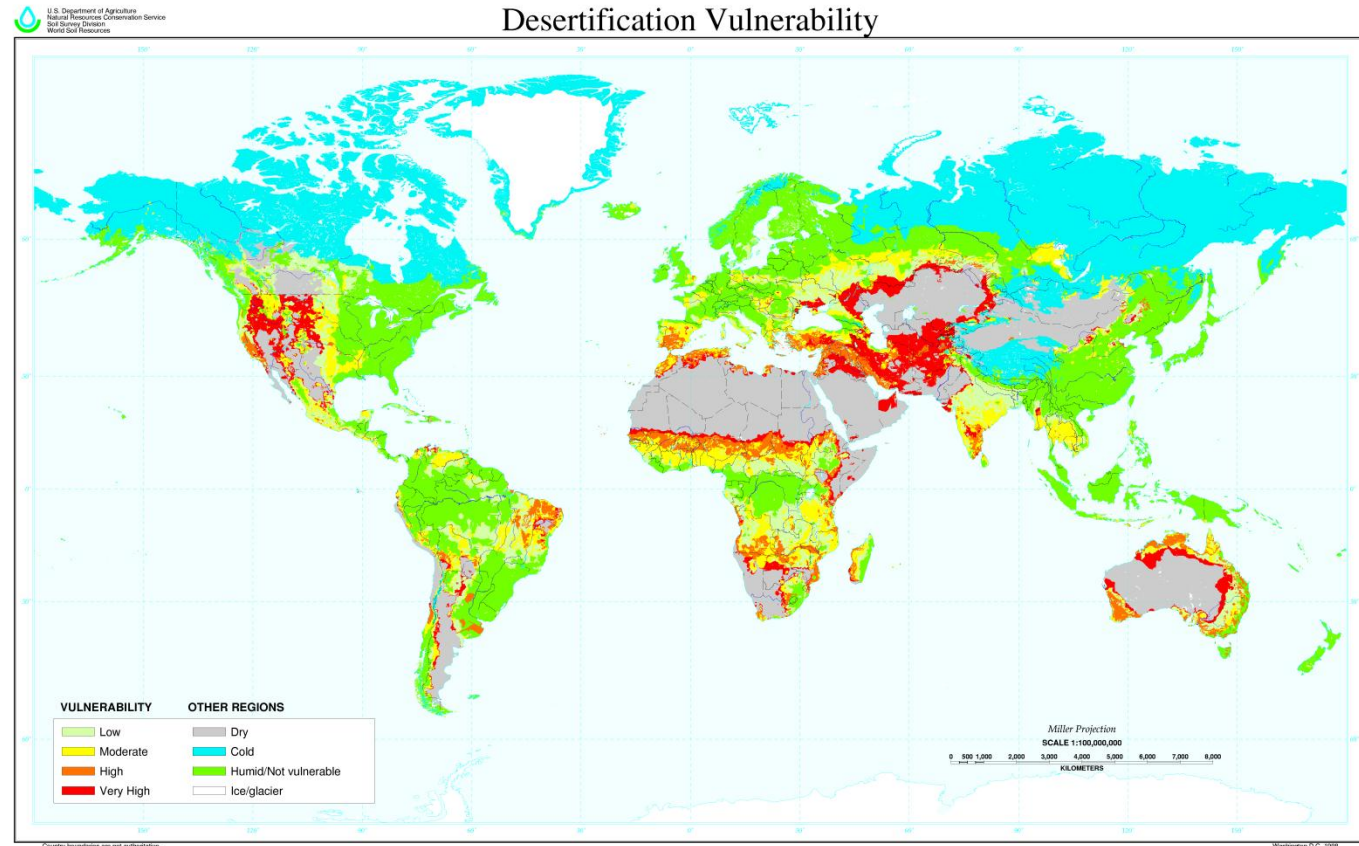
Issues for studying agriculture and climate change

- › Impacts on crop yield and quality
 - › Direct effects from changes in CO₂, temperature and rainfall and their variability
 - › Effects of extreme events (drought, flood, storms)
 - › Indirect effects through nutrient availability, pests and diseases
- › Adaptation
 - › Autonomous adaptation (sowing date, crop choice, cultivar choice)
 - › Planned adaptation (water supply for irrigation, breeding, support for abandonment)
- › Environmental and resource effects
 - › Nitrogen and phosphorous losses to the environment
 - › Water overuse from surface and groundwater
 - › Soil degradation
- › Effects on greenhouse gas emissions
 - › Changes in soil carbon from soil and crop management and from climate
 - › Emissions of nitrous oxide and methane from farming systems
- › Mitigating greenhouse gases from agriculture

Soil degradation

- ✓ Erosion
- ✓ Reduction i soil carbon (humus)
- ✓ Compaction (especially in subsoil)
- ✓ Pollution
- ✓ Salinisation
- ✓ Desertification

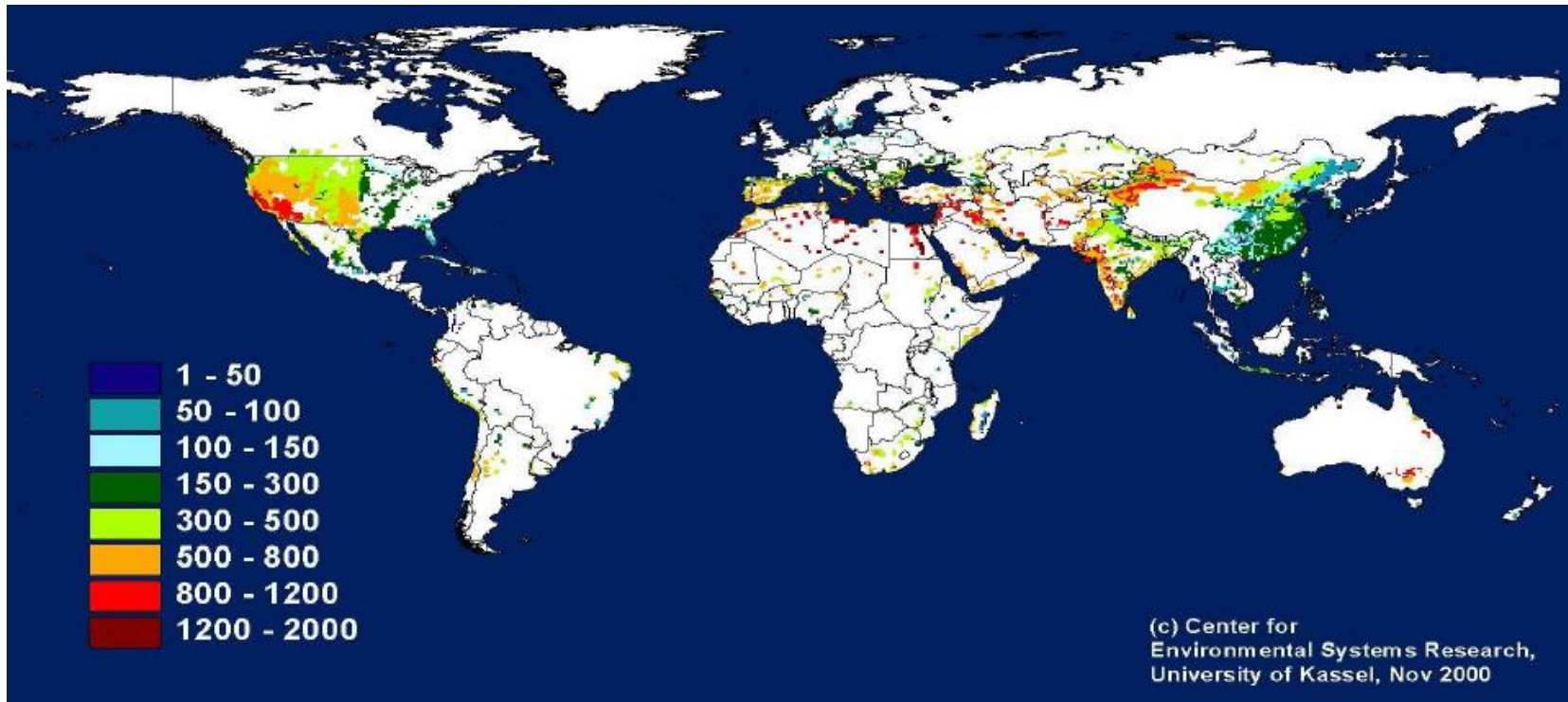
Many of these processes are exacerbated by climate change



Pressure on freshwater resources

- ✓ 14% of world agricultural area is irrigation
- ✓ 40% of agricultural production comes from irrigated agriculture
- ✓ 70% of freshwater abstraction is used for irrigation
- ✓ Increasing problems with drying out and pollution of rivers and lakes

Water consumption for irrigation



Nutrient losses from agriculture affect ecosystem services of other parts of the landscape



Linking adaptation and mitigation

Adaptation

Responsiveness

Mitigation

Management

Agricultural system

Diversity
Fertility
Efficiency

Resilience

Technologies

Methods of studying climate change impacts

- › Crop simulation models
- › Empirical (statistical) models
- › Agroclimatic indices
- › Space for time - analogies
- › Expert knowledge
- › Manipulation experiments (controlled environment or free air)

Current and future crop rotations on loamy soil in Denmark (analogy and expert knowledge)

Area coverage	Present crop rotation	Future crop rotation
80% (arable/pig farms)	Winter barley Winter rape Winter wheat Winter wheat Spring barley	Winter barley Winter rape Winter wheat Grain maize Spring barley
20% (dairy farms)	Spring barley (undersown) Grass seed Grass seed Silage maize Silage maize	Spring barley (undersown) Grass seed Grass seed Silage maize Silage maize

Current and future management of winter wheat in Denmark (analogy and expert knowledge)

Operations	GS	Date present	Input present per ha	Date future 2050	Input future per ha
Ploughing		12 Sep		28 Sep	
Sowing		15 Sep		1 Oct	
Application of insecticides	21			20 Oct	0.15 Karate
Application of herbicides	13-21	20 Oct	Boxer EC + DFF + Oxitril (1+0.04+0.12)	20 Oct	Boxer EC + DFF + Oxitril (1,15+0.05+0.12)
Application of nitrogen	25	15. Mar	80 kg N	10 Mar	80 kg N
Application of herbicides	30	1 Apr	0.4 Starane XL	20 Mar	0.4 Starane XL
Application of PGR	31	5 May	none	25 Apr	None
Application of fungicides 1	32	10 May	0.25 Folicur	1 May	0.25 Folicur
Application of nitrogen	32	10 May	85 kg N	1 May	85 kg N
Application of fungicides 2	55	5 Jun	0.75 Bell	28 May	0.75 Bell
Application of insecticides	71	30 Jun	0.15 Karate	20 Jun	0.15 Karate
Application of glyphosate	89	1 Aug	2 l glyphosate	20 Jul	2 l glyphosate
Harvest		15 Aug		1 Aug	

Current and future pesticide treatment frequency index for crop rotations on loamy soil in Denmark (analogy and expert knowledge)

Area coverage	Present rotation	crop	TFI	Future rotation	crop	TFI
80% (arable/pig farms)	Winter barley		1,6	Winter barley		2,2
	Winter rape		4,3	Winter rape		5,6
	Winter wheat		3,3	Winter wheat		3,9
	Winter wheat		2,7*	Grain maize		2,5
	Spring barley		1,7	Spring barley		1,3
	Gns BI per year		2,7			3,1
20% (dairy farms)	Spring (undersown)	barley	1,8	Spring (undersown)	barley	1,3
	Grass seed		2,3	Grass seed		2,7
	Grass seed		2,3	Grass seed		2,7
	Silage maize		1,6	Silage maize		2,5
	Silage maize		1,6	Silage maize		2,5
			1,9			2,3

* glyphosat not included

Challenges (and opportunities) for research

- › Include indirect effects of climate change into impact studies
- › Study effects of climatic extremes on impacts and adaptation
- › Study effects of climate change on resources (soil quality, water availability)
- › Study effects of climate change and agricultural management on environmental impacts (N and P losses, GHG emissions)
- › Link impact studies with adaptation and mitigation
- › Quantify uncertainties related to impacts at regional scale
- › Estimate costs of adaptation and mitigation measures at regional scale
- › Apply a wider range of methodologies in the studies

- › We have done the easy stuff – now lets deal with the important issues