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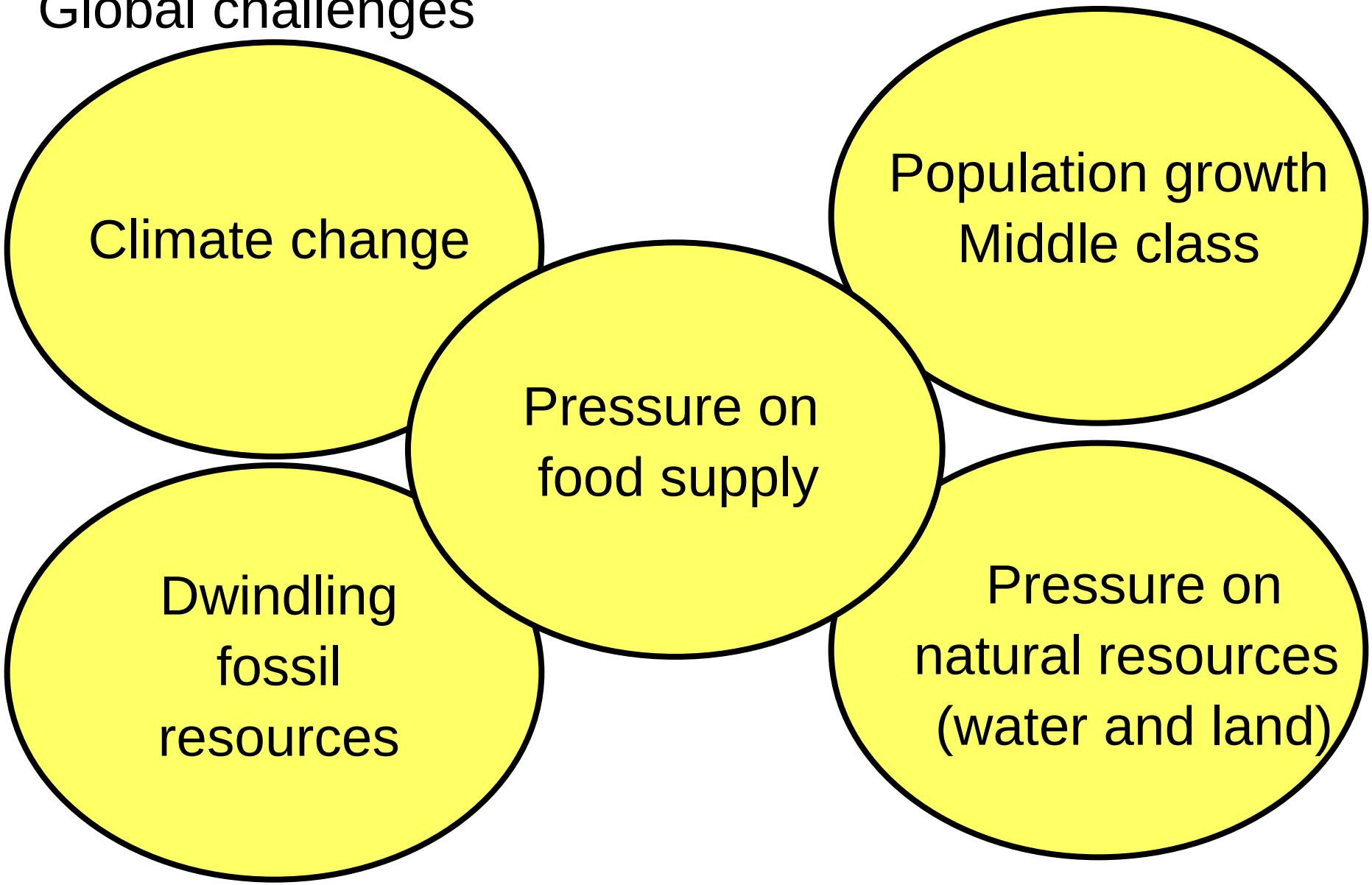
# Future cattle production considering climate and environment

Professor Jørgen E. Olesen

# Global challenges



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# The grand challenges for agriculture (and society)

› Sufficient high quality foods for 9.2 billion people in 2050

› Biomass for a rapidly growing market for biofuels (and other bioenergy)

› Contribute to economic development (growth) and poverty eradication

› Managing increasingly scarce resources (land, soil, water, nutrients)

› Reducing environmental and climate impacts of agricultural practices

› Adapting to a warmer and more variable climate (6 $^{o}$C global warming?)

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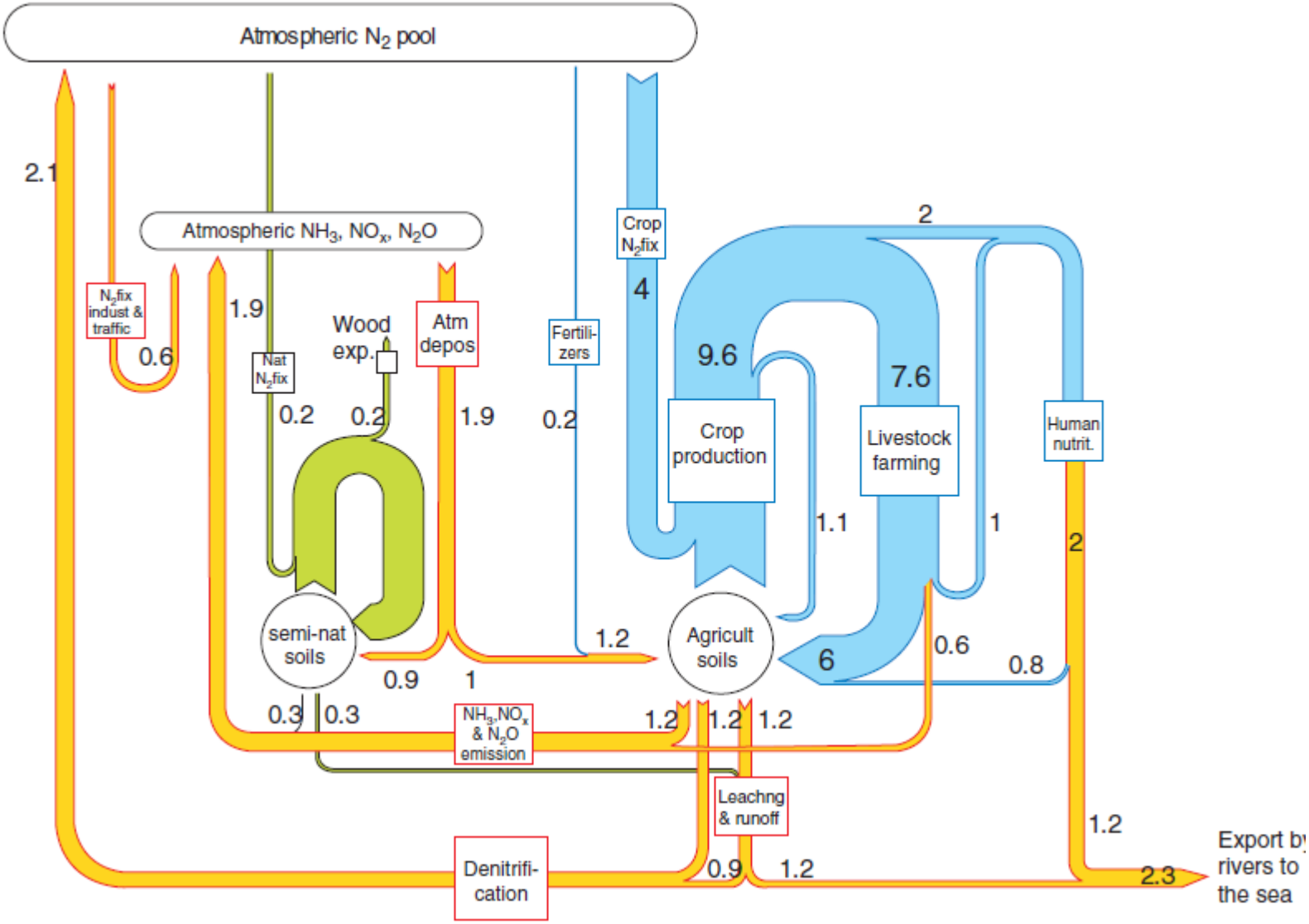
# The European (EU27) nitrogen balance around 1900




The European Nitrogen Assessment

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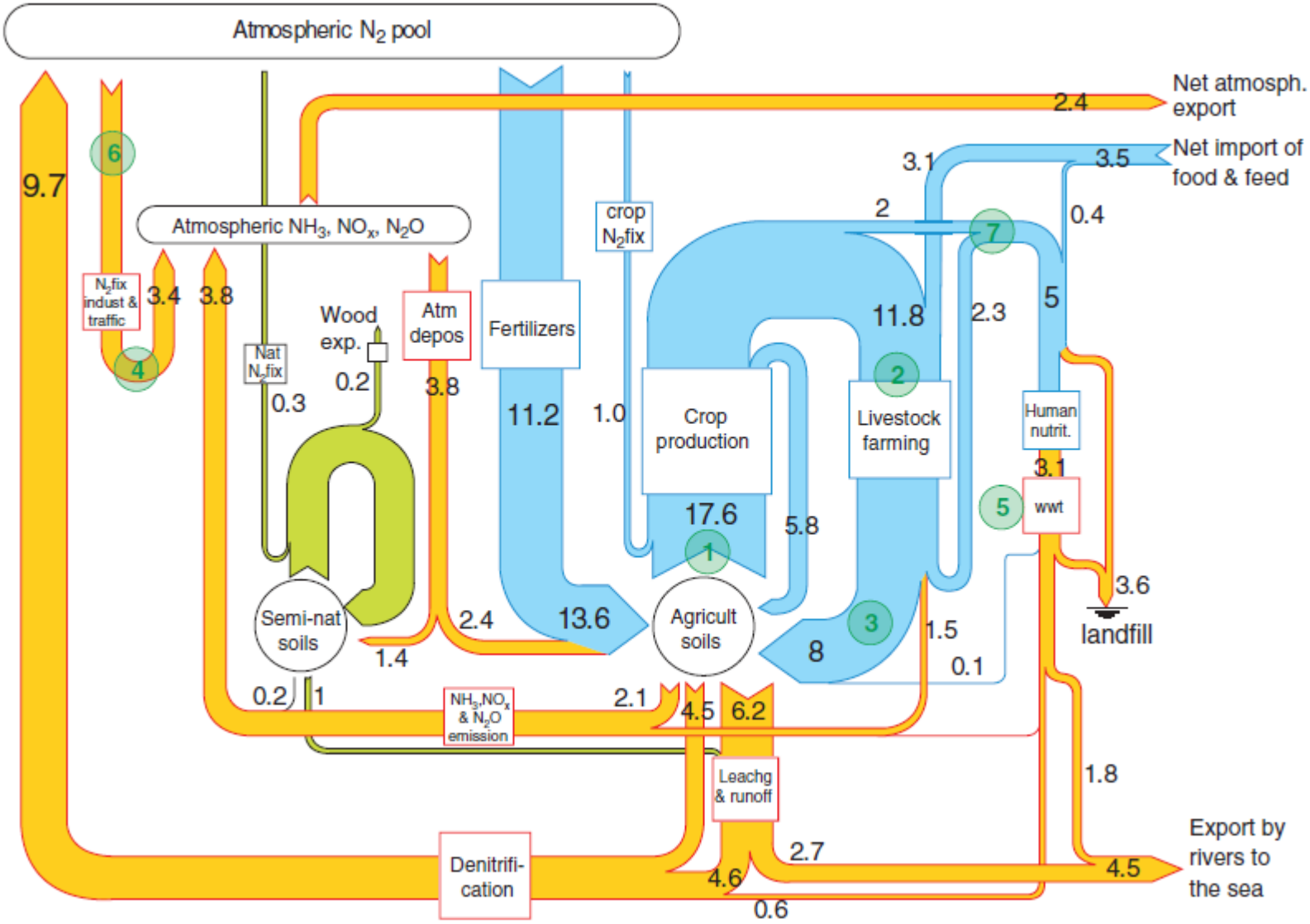
# The European (EU27) nitrogen balance around 2000




The European Nitrogen Assessment

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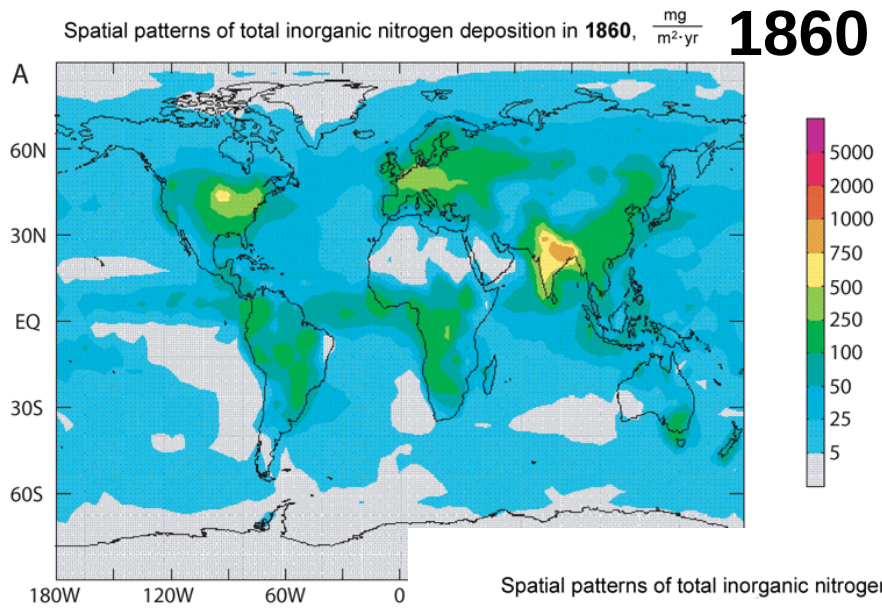
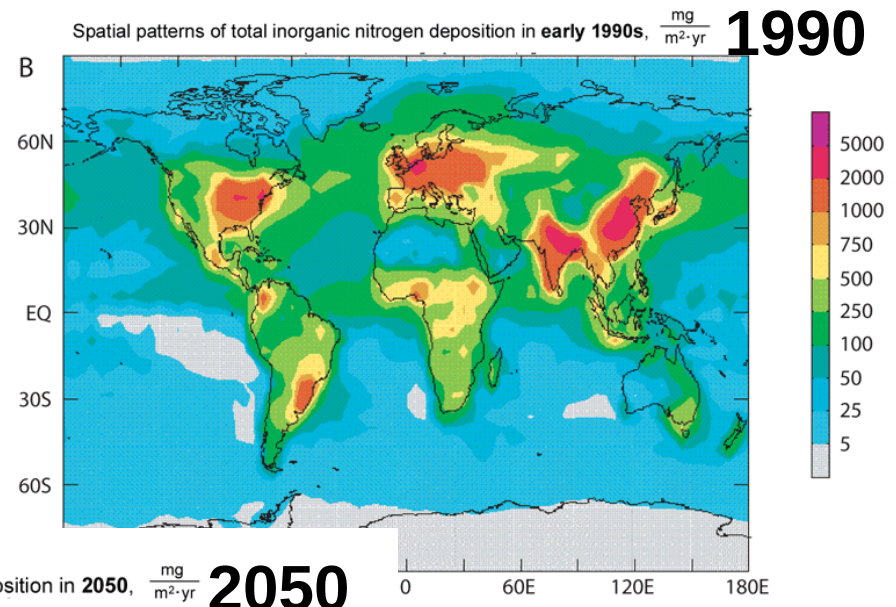
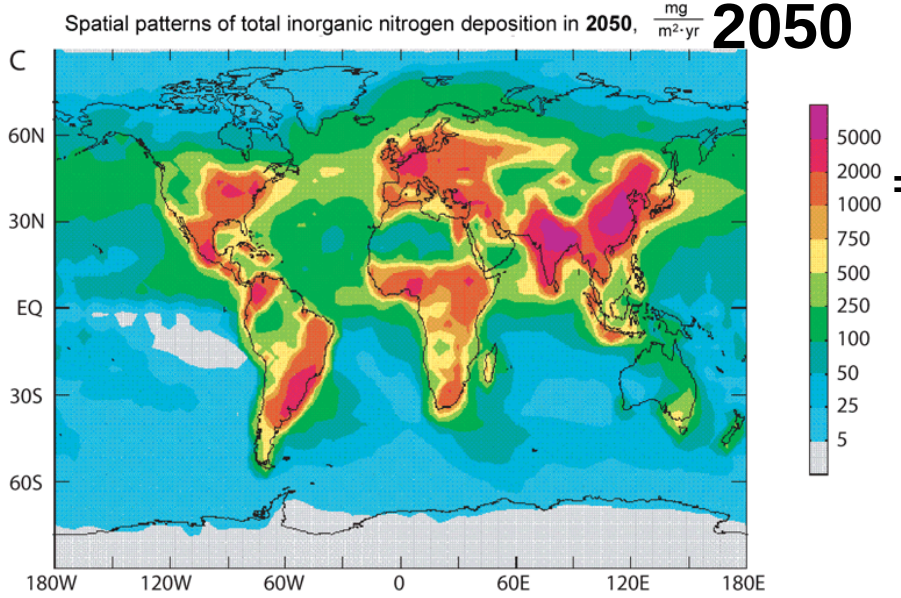
# Nitrogen deposition in the last century and in future



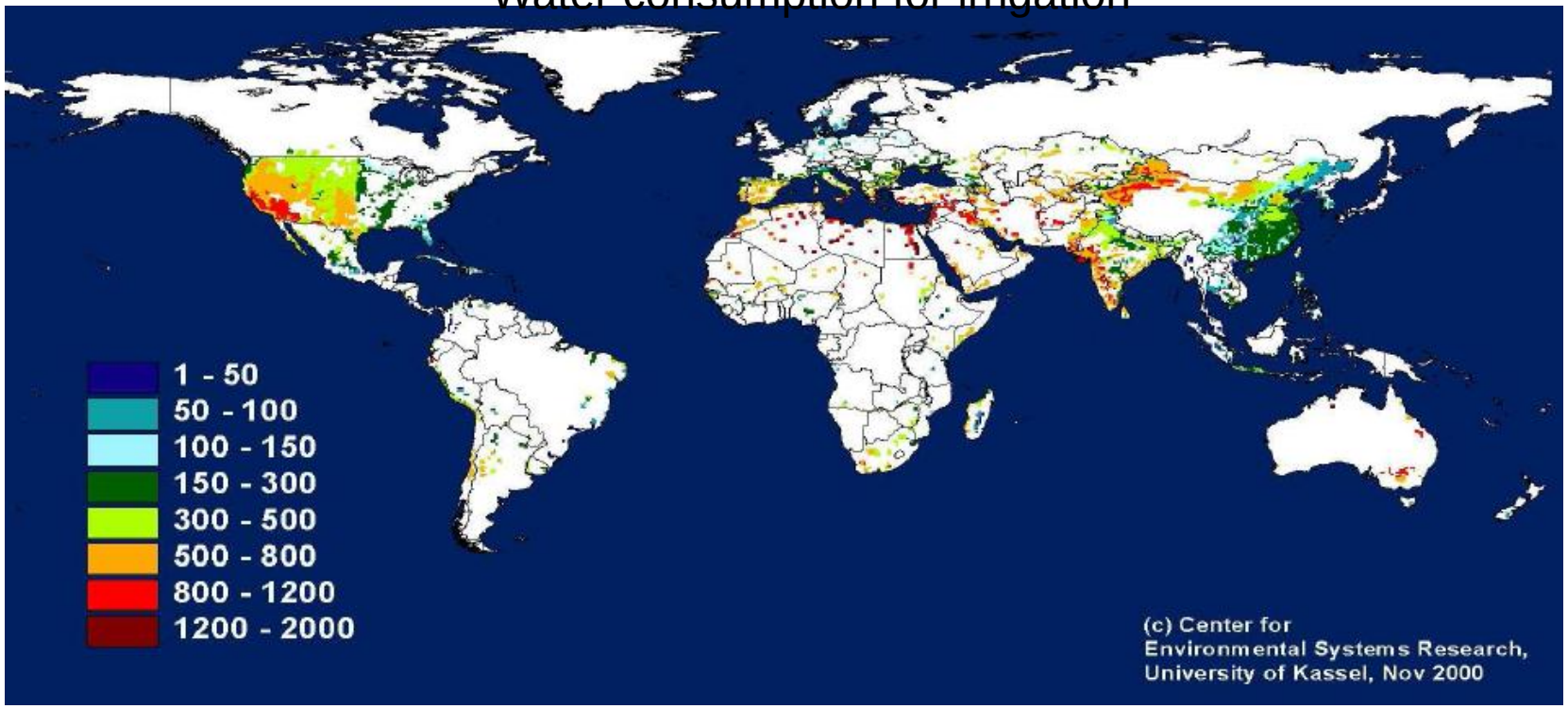




**=20-50 kg N/ha**

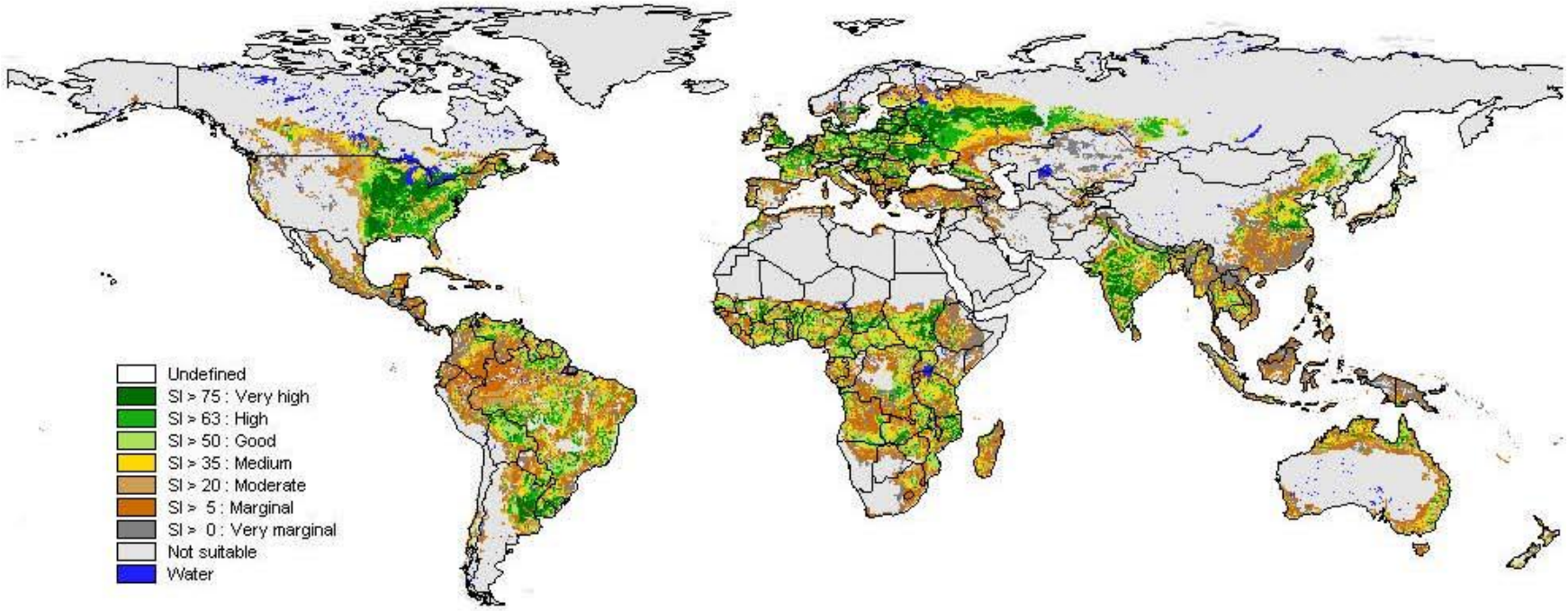
# Pressure on freshwater resources

- 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

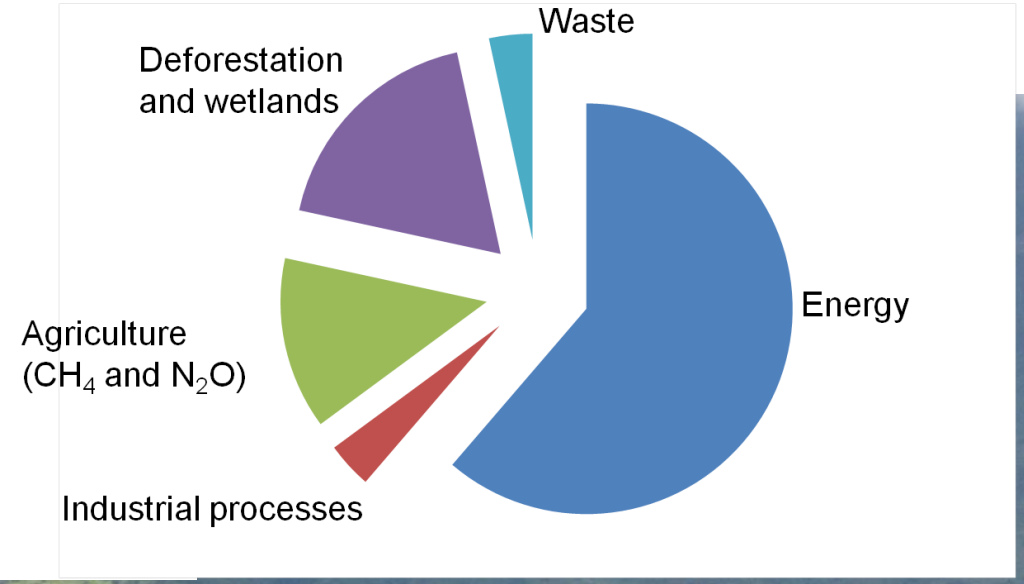


# Suitability for rainfed grain production 1961-90

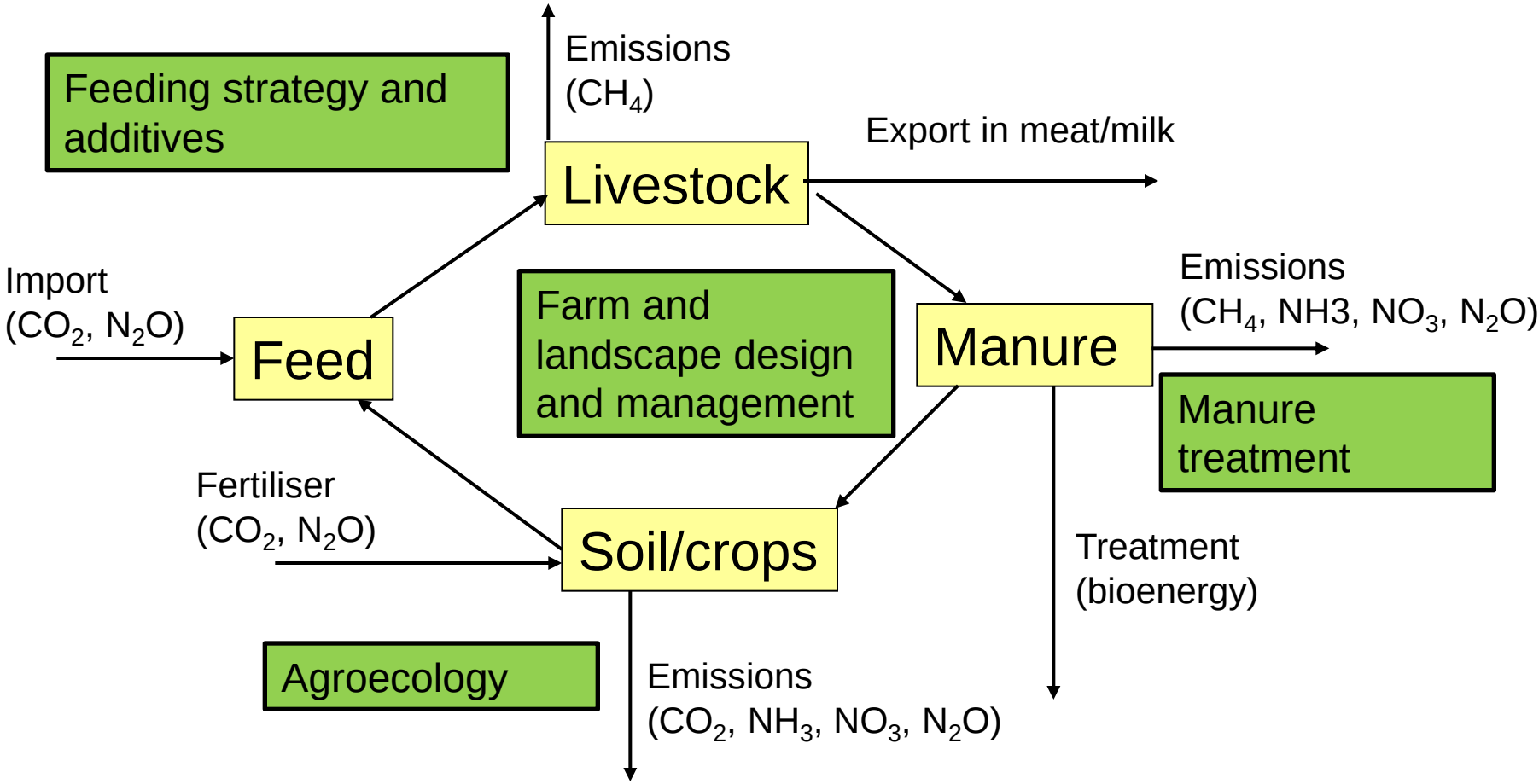



The area for agricultural production is limited,
but it is still not sufficiently well used

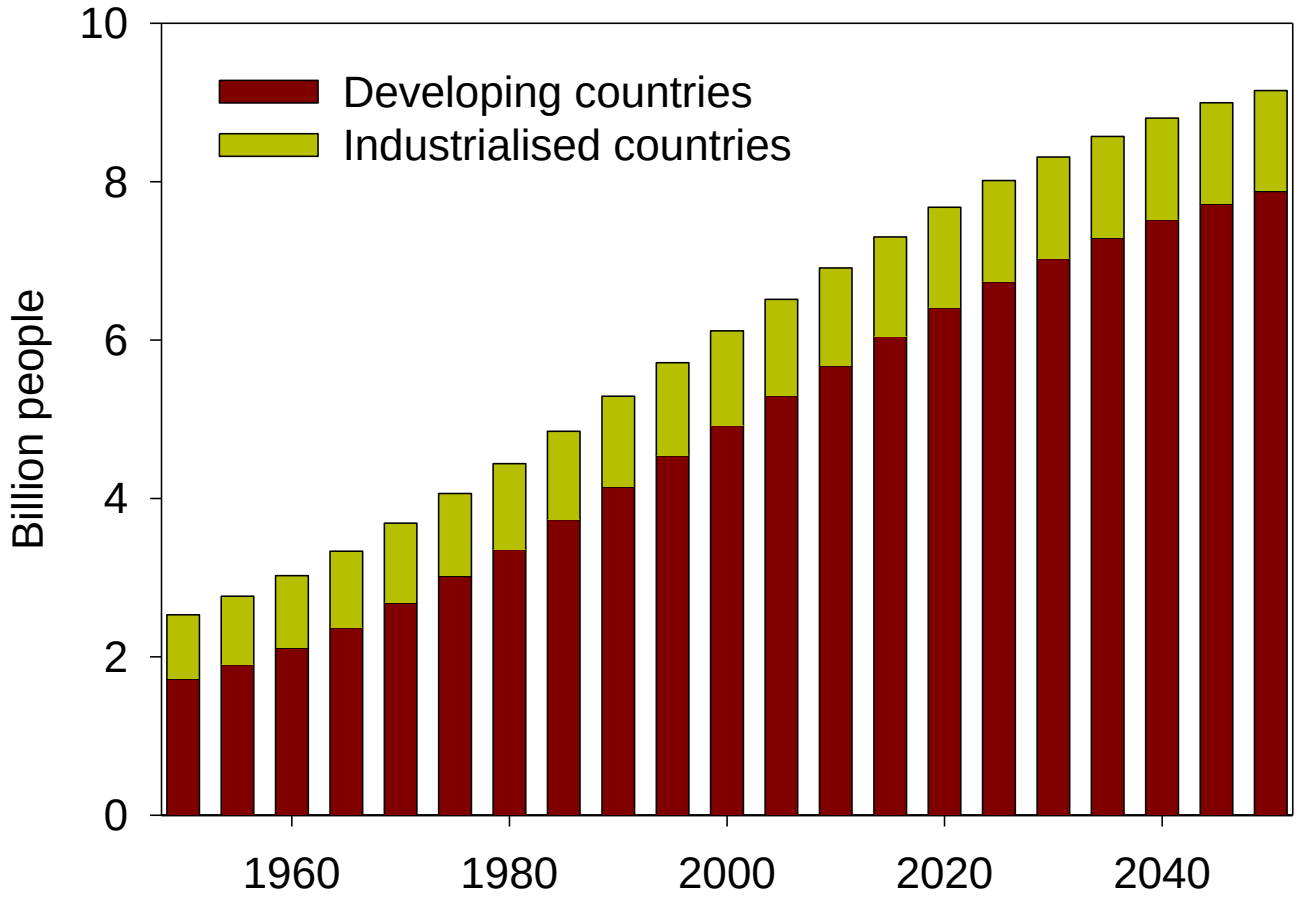
# Global contributions to greenhouse gas emissions



# Carbon and nitrogen flows on farms



# The global population grows






**But the global middle class grows even faster (3 billion more by 2050)**

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# Headlines in China Daily, Marts 2012

EMISSIONS, POVERTY ADDRESSED

## High crop yields will help tame inflation

Reducing carbon emissions from the agricultural and forestry industries could help to eliminate poverty in the Chinese countryside, according to Lin Erda, a member of the Chinese People's Political Consultative Conference National Committee.

China last year raised the poverty line, quadrupling the number of people who are poor.

China: 1.3 billion people

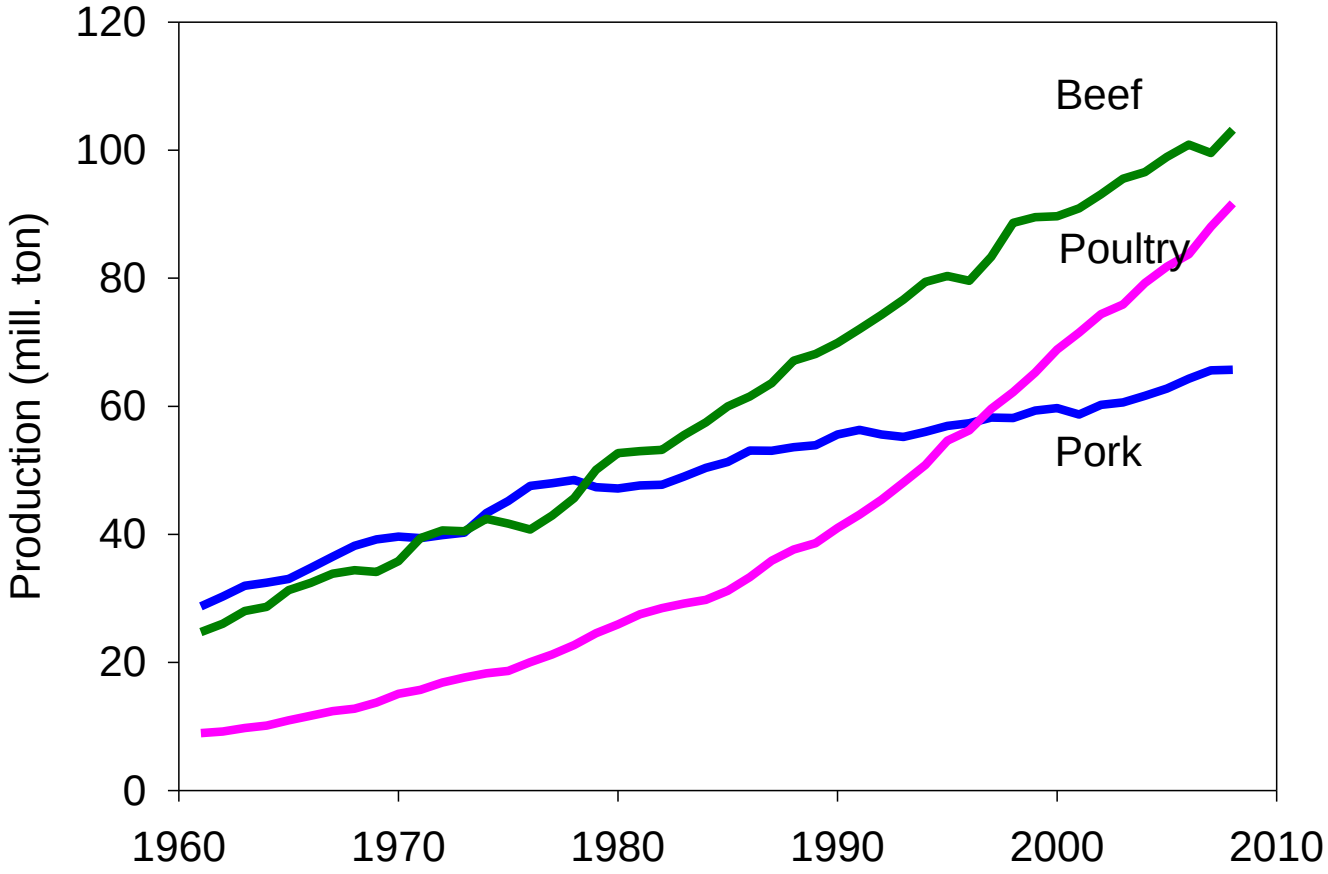
## Beefing up sales as diets change

People are eating more of the red meat because of its reasonable price and nutritional value

By WU YUNHE
bw@chinadaily.com.cn

Beijing college student He Rongxi goes to the Jade Palace Hotel in Haidian district at least twice a month with her parents because she likes the beefsteaks the buffet serves in

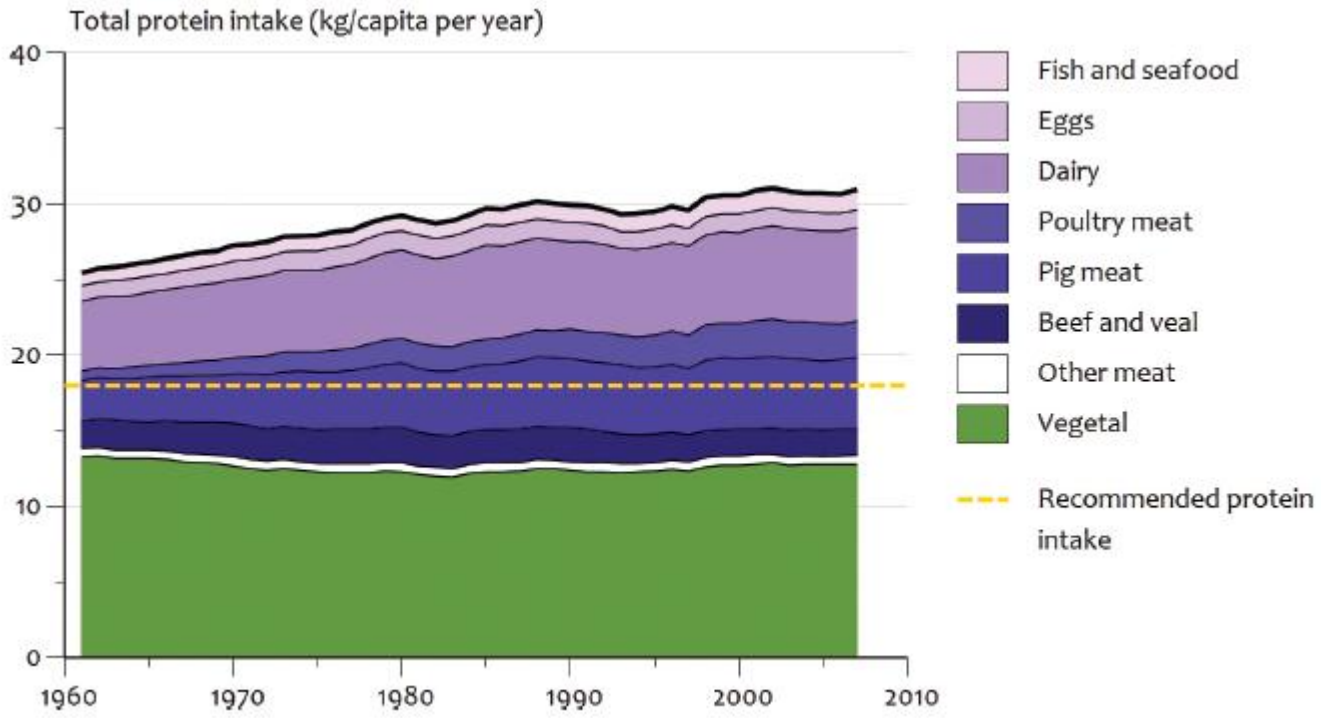
# World meat production increases



# Developments in consumption of meat, milk and eggs (million tons)

| Product | Year | Industrialised | Development | Whole world |
|---|---|---|---|---|
| Meat | 1980 | 89 | 48 | 137 |
| | 2007 | 110 | 176 | 286 |
| Milk | 1980 | 351 | 115 | 466 |
| | 2007 | 358 | 314 | 671 |
| Eggs | 1980 | 18 | 10 | 27 |
| | 2007 | 19 | 49 | 68 |

# Over-supply of protein in foods (EU27)

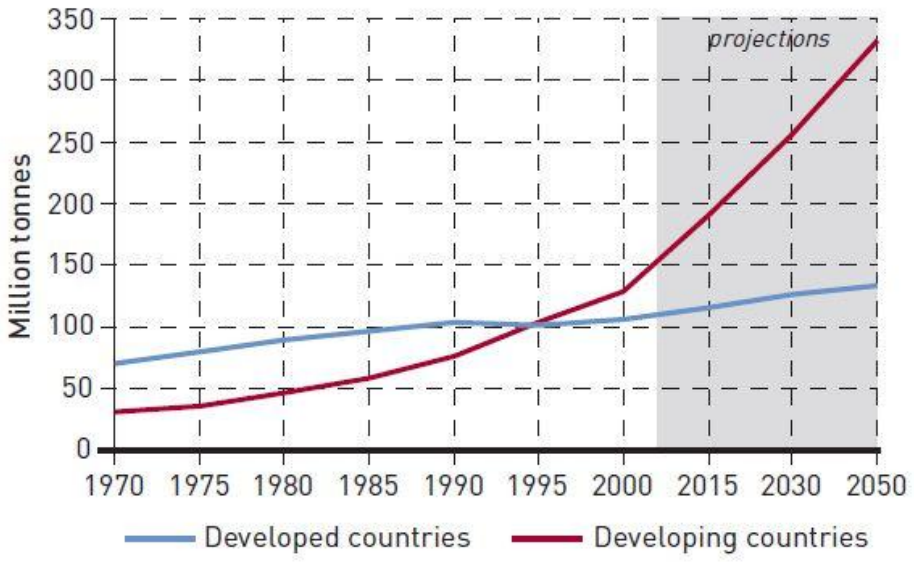



**World meat production will likely have to be doubled by 2050**

The European Nitrogen Assessment

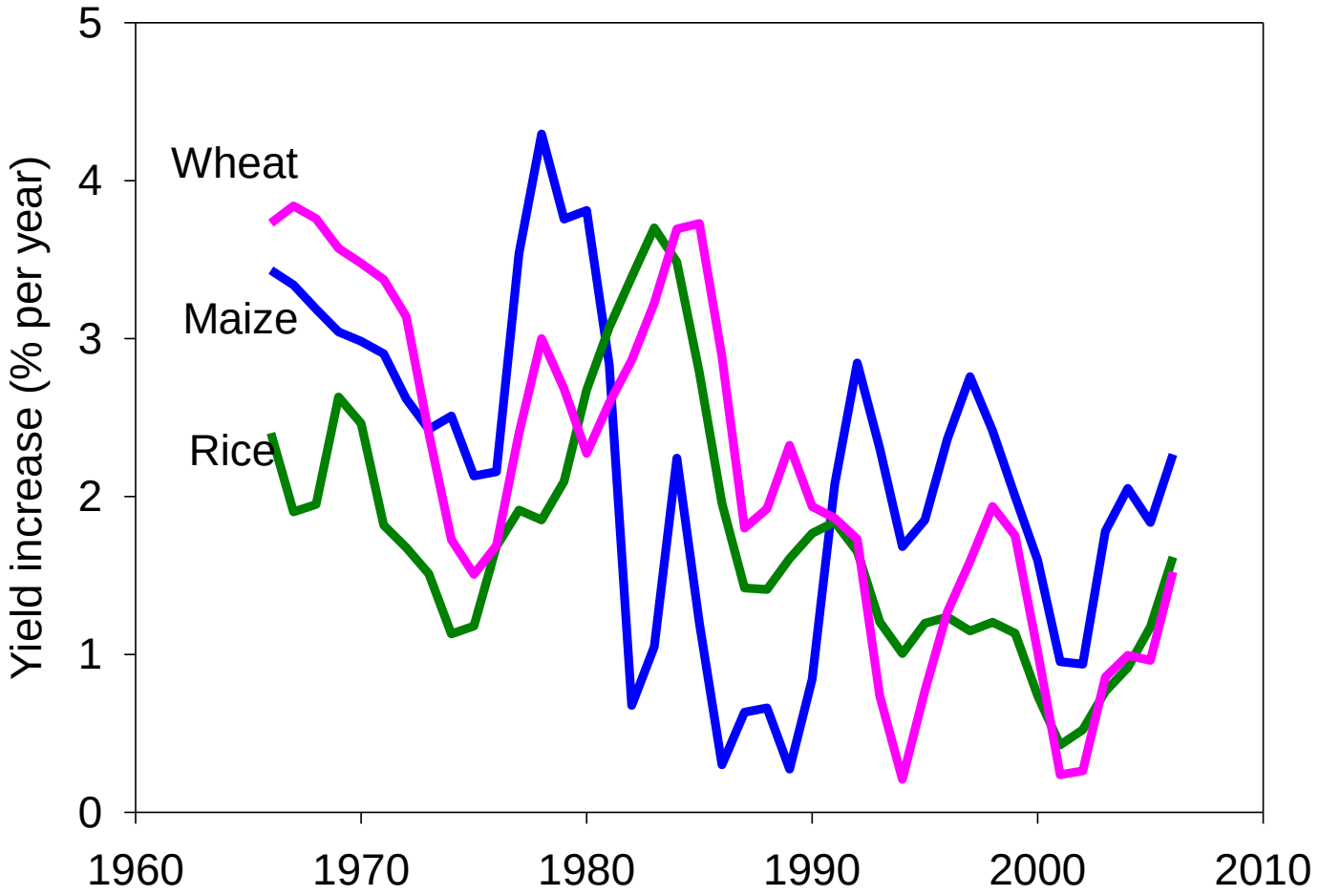
# Projected development in meat production

Figure 1.6 Past and projected meat production in developed and developing countries from 1970 to 2050

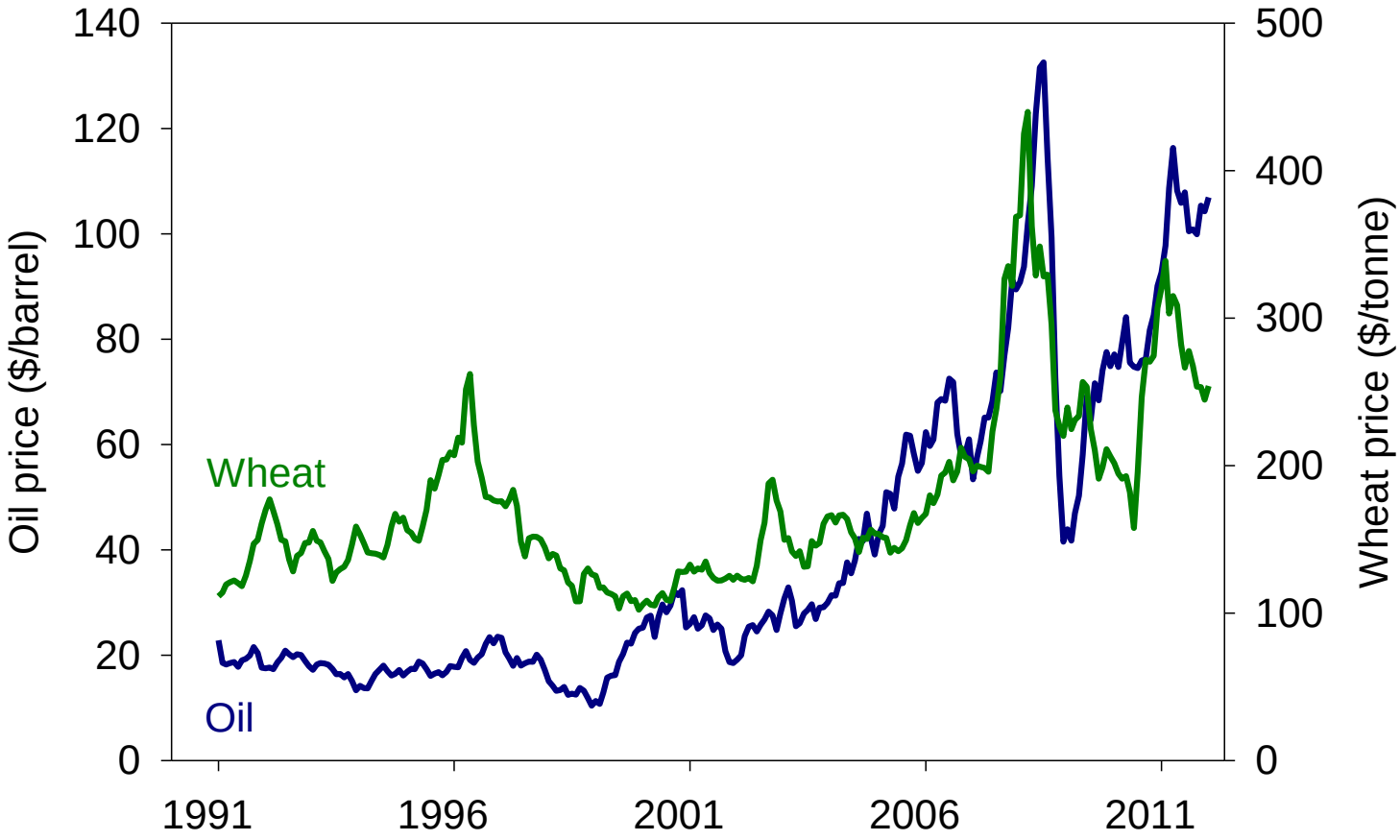



*Source:* FAO (2006a) and FAO (2006b).

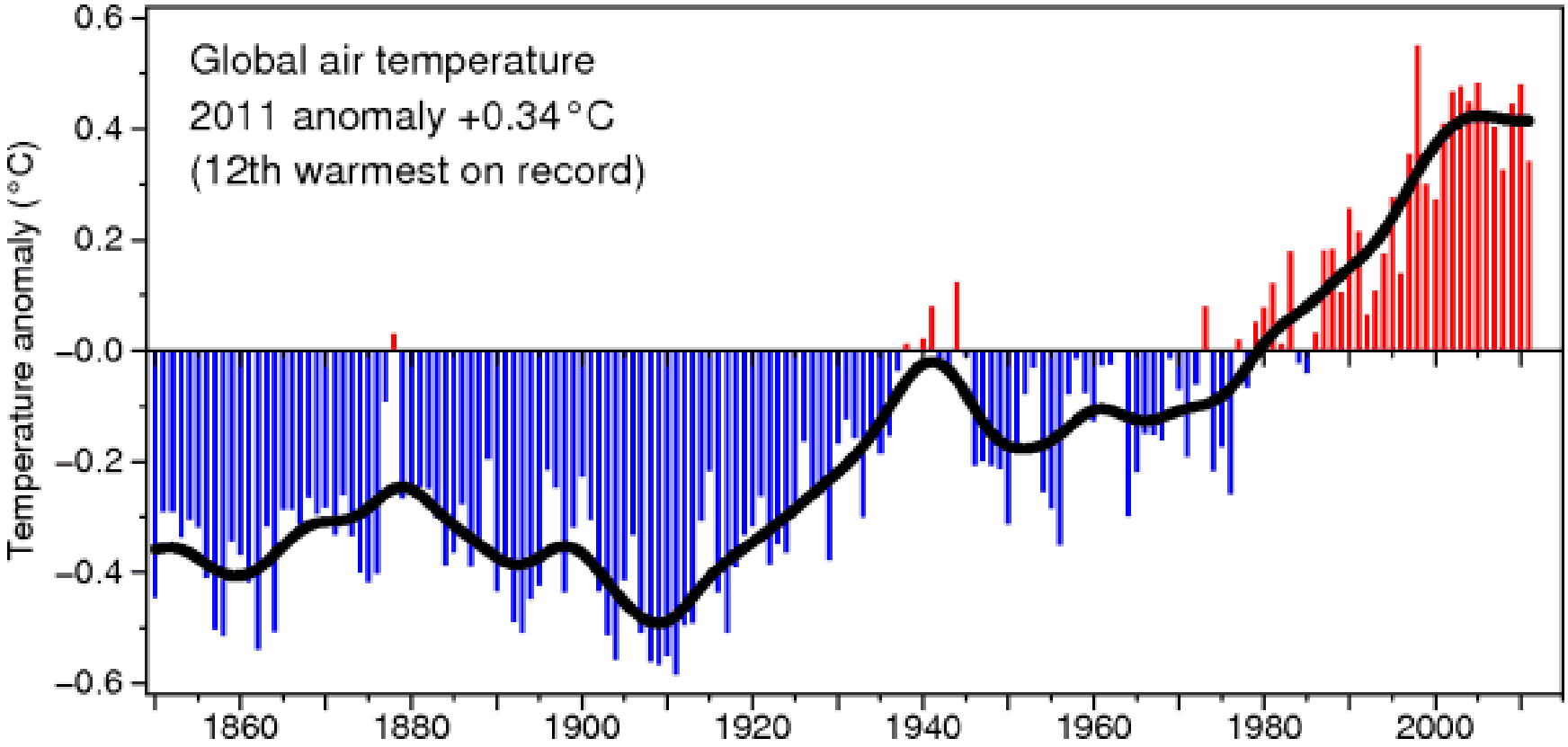
# Declining yield increases in cereal crops



# Prices of olie and wheat – are being aligned

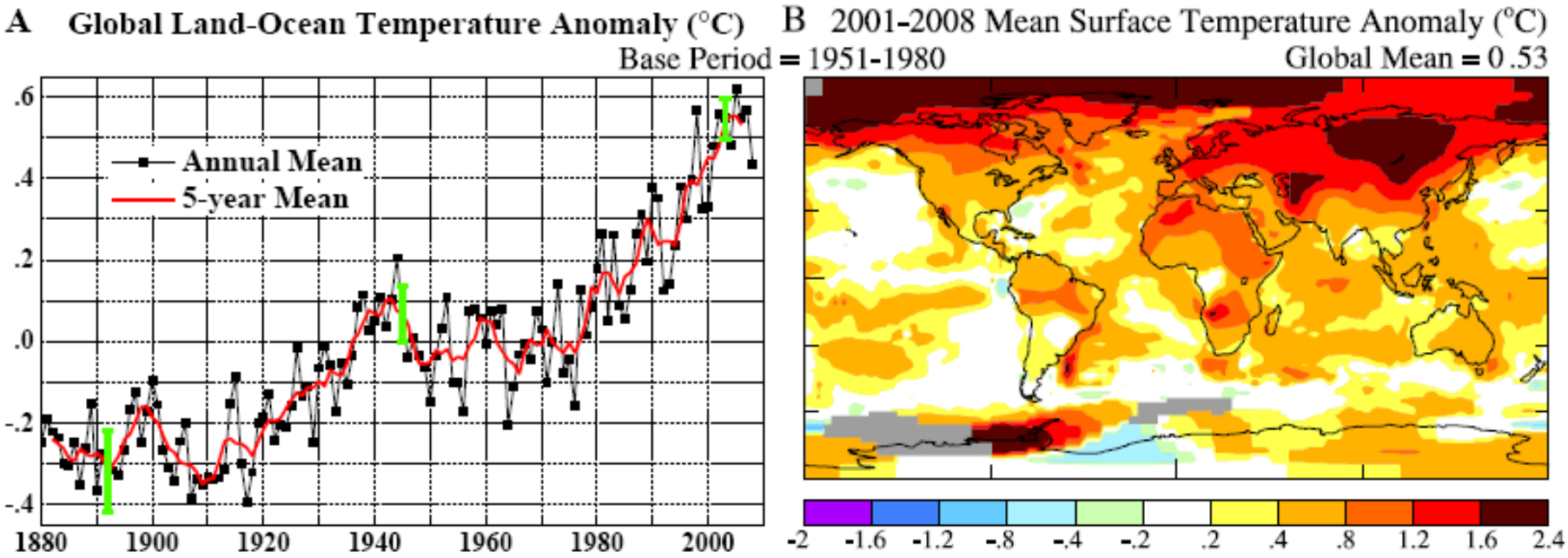


# Observed temperature change (measured)



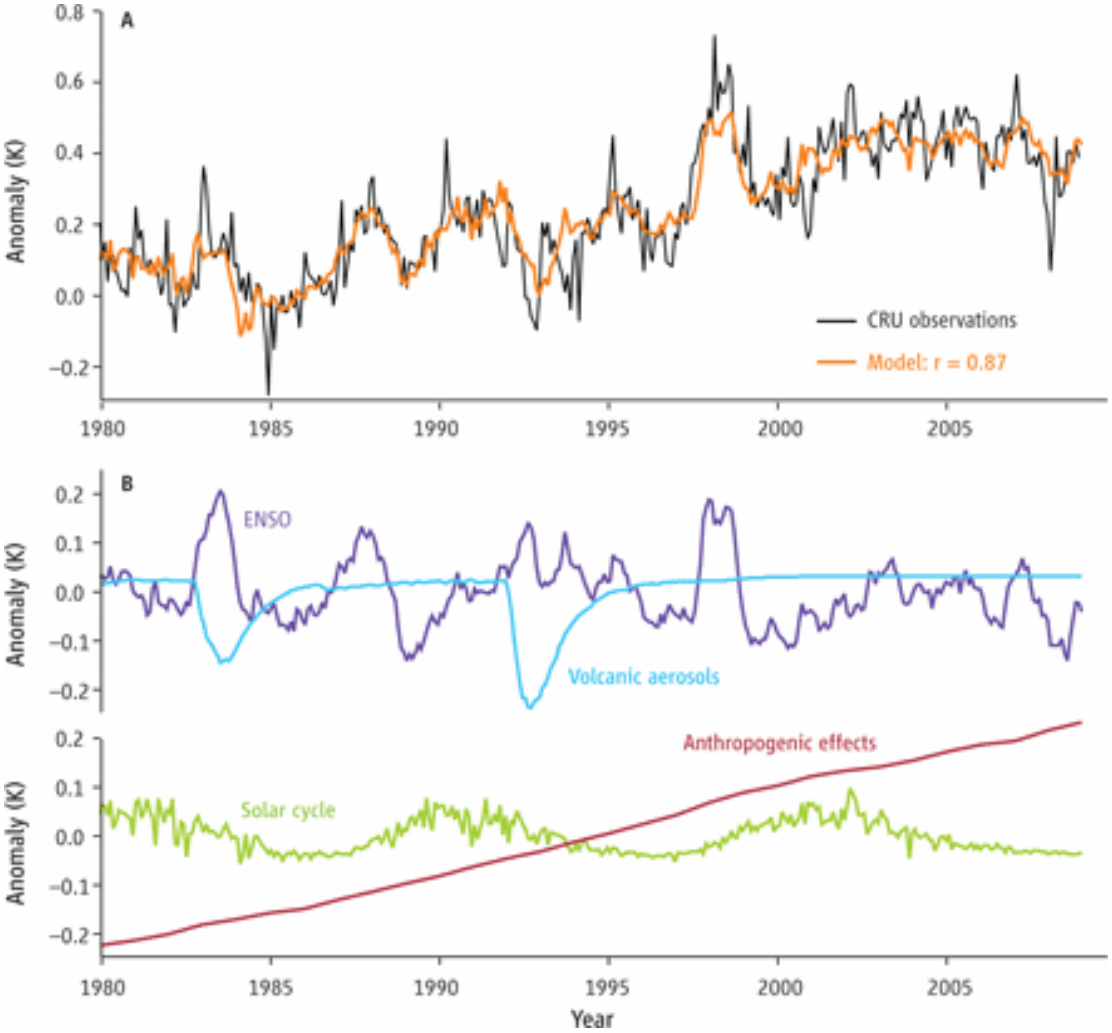

CRU, UEA

# Observed temperature change over land and sea



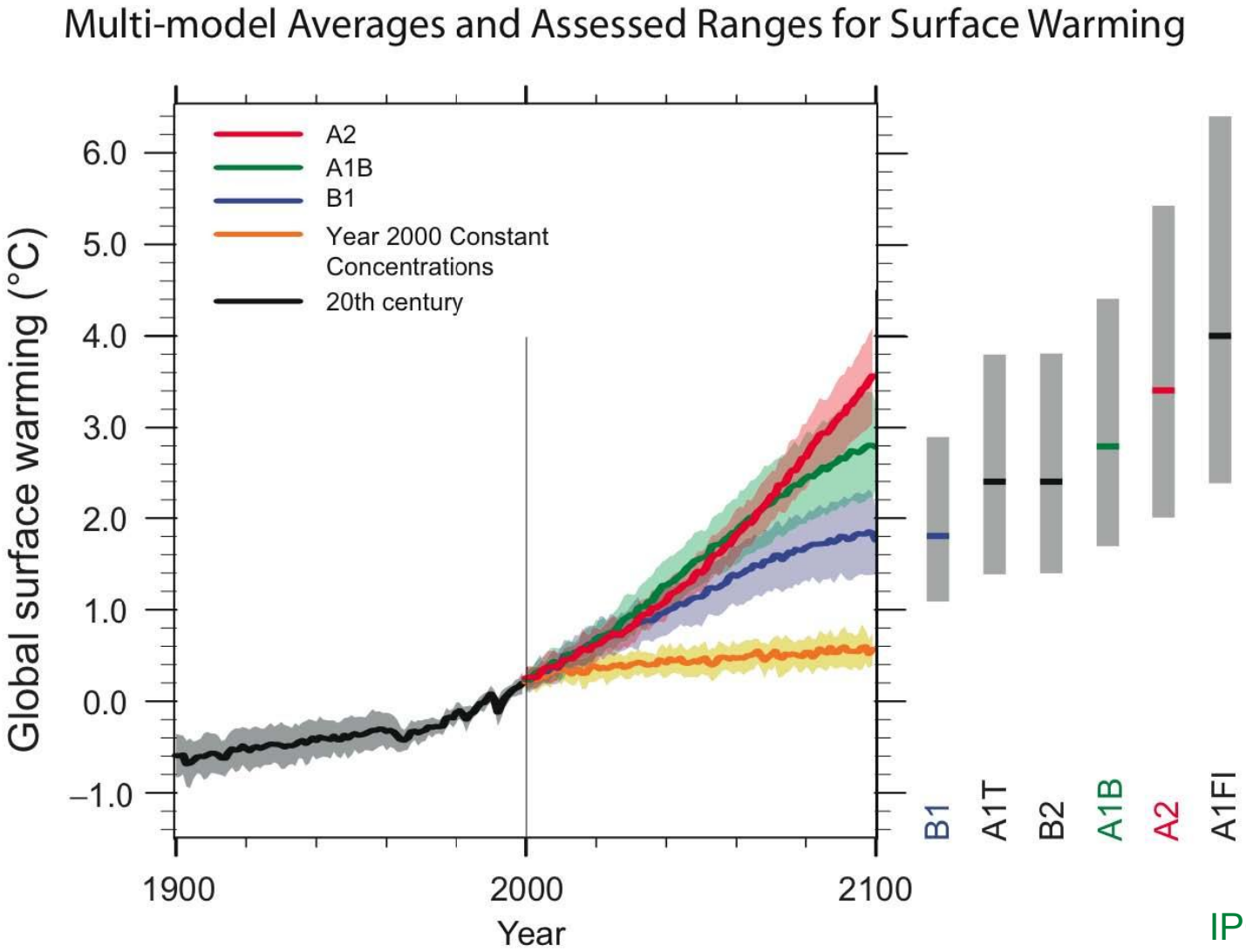

NOAA

# Caused of climatic variation – we know the most important ones!!!




McCarthy (2009)

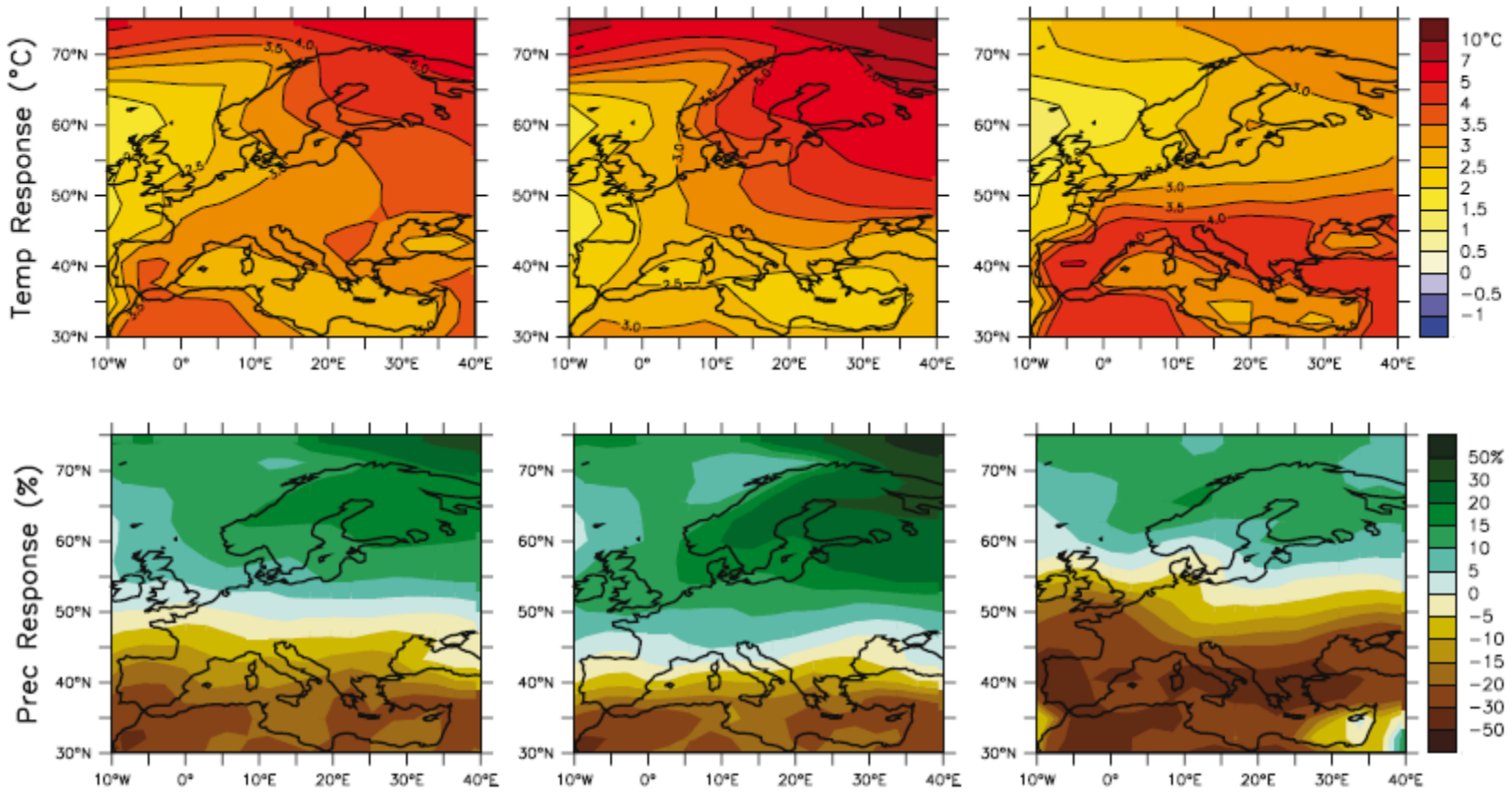
# Projections of globale temperature increases




IPCC WG-I (2007)

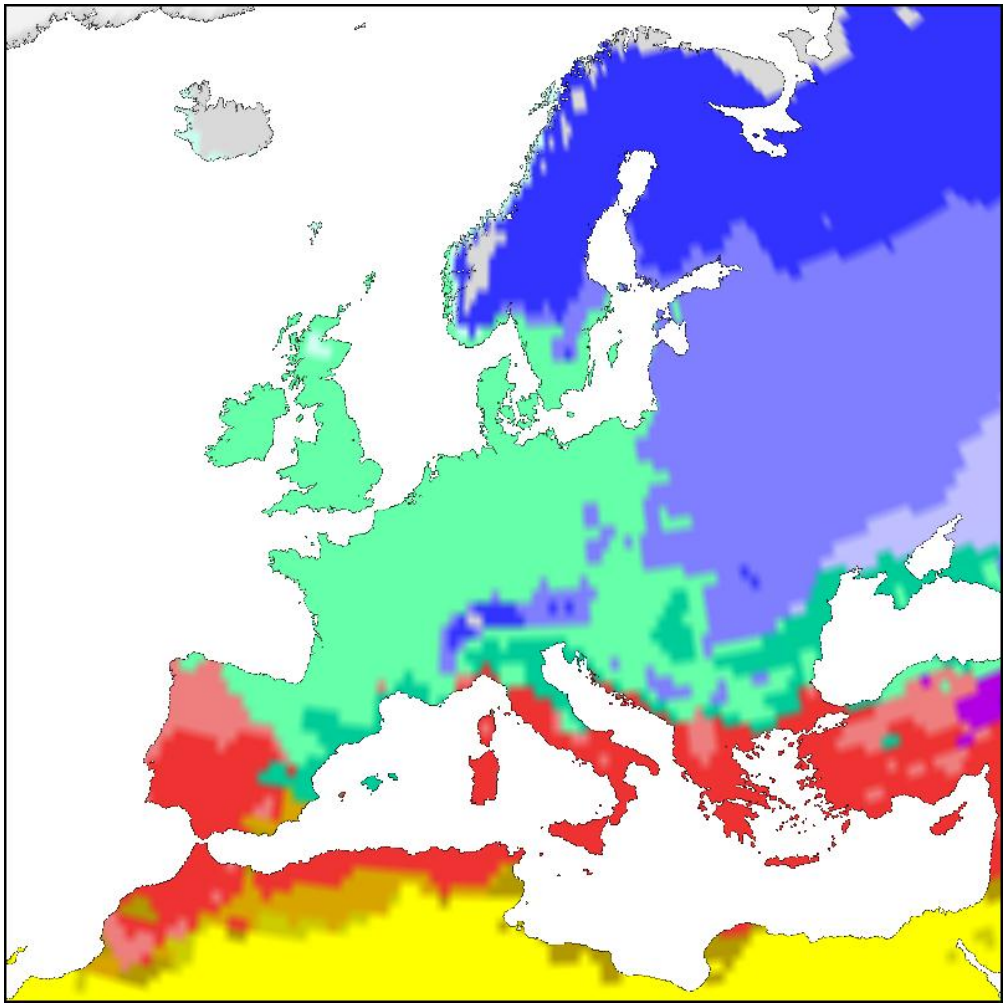
# Projections of temperature and precipitation in Europe from 1980-1999 to 2080-2099 (scenario A1B)

Året Vinter Sommer




IPCC

# Köppen climate regions, 1961-1990



Warm climate
- Dry
- Very dry

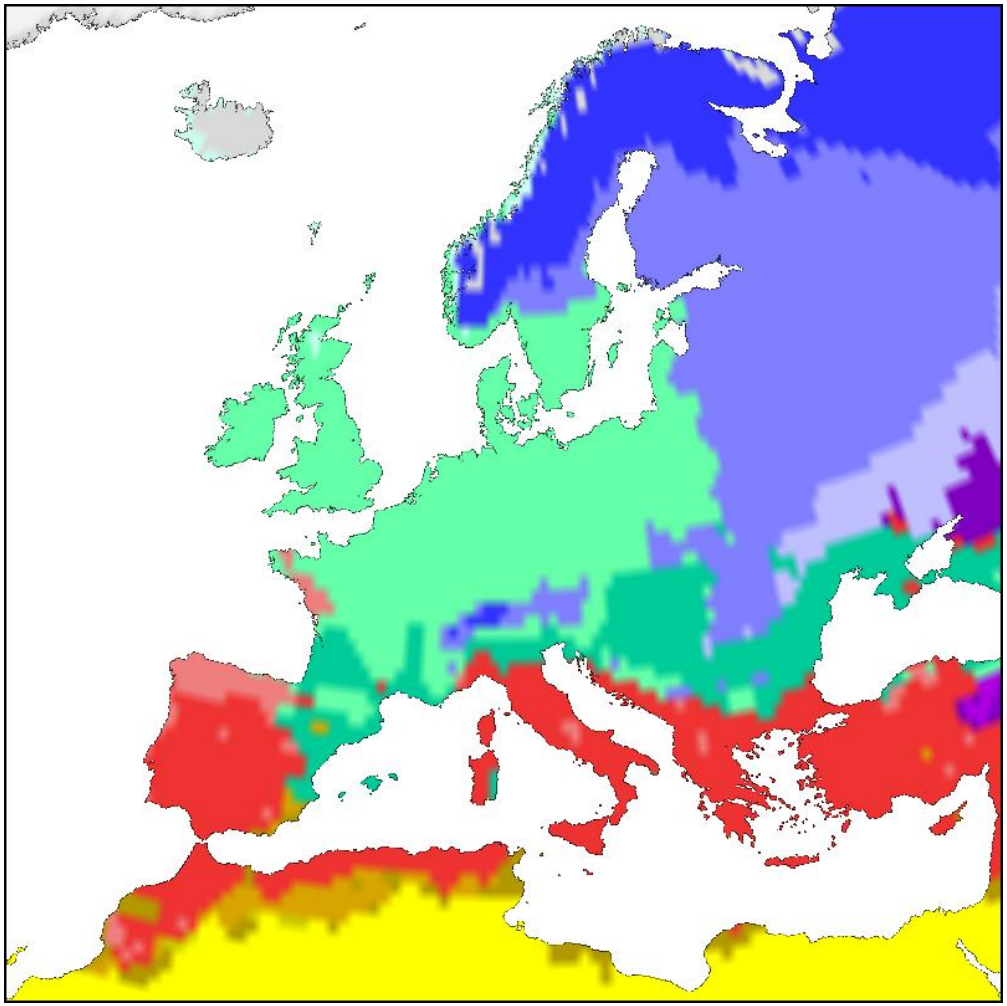
Mild climate
- Dry summer
- Rain all year

Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

*Jylhä (2007)*

# Köppen climate regions, 2020 (A2)



Warm climate
- Dry
- Very dry

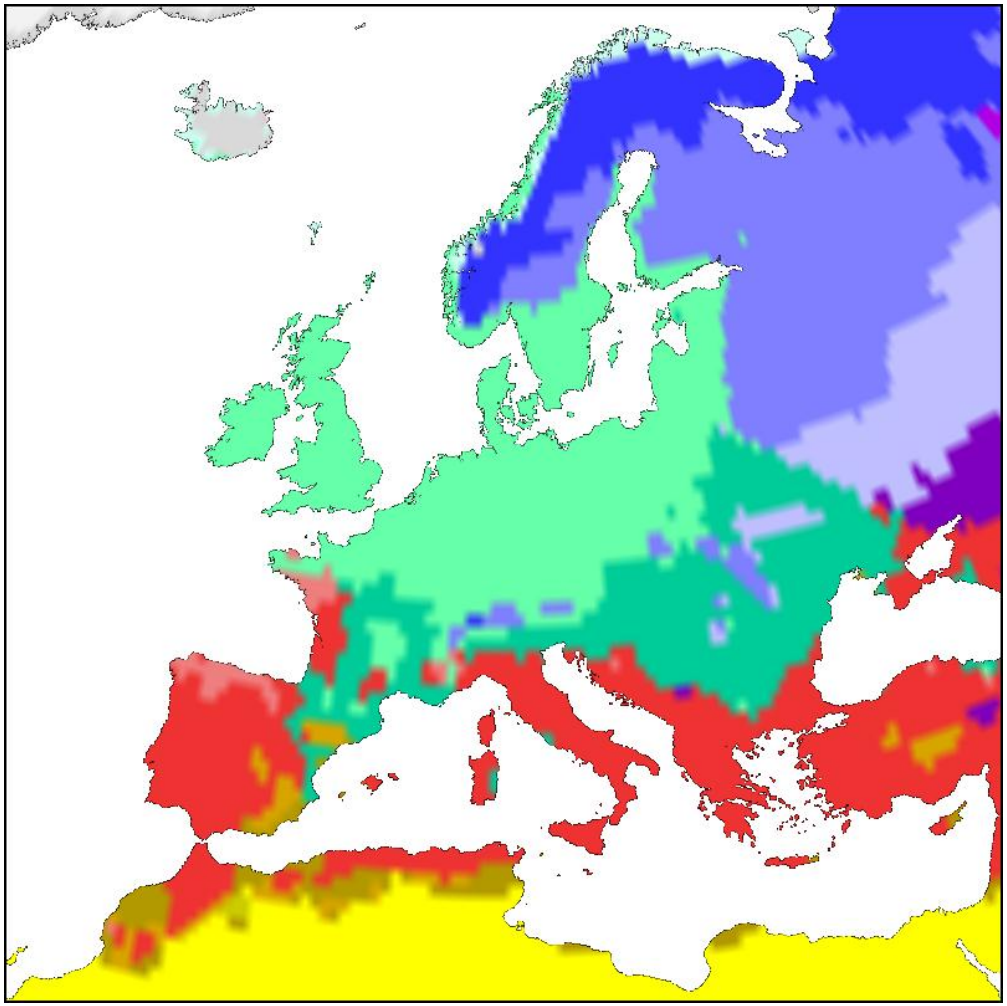
Mild climate
- Dry summer
- Rain all year

Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

*Jylhä (2007)*

# Köppen climate regions, 2050 (A2)



Warm climate
- Dry
- Very dry

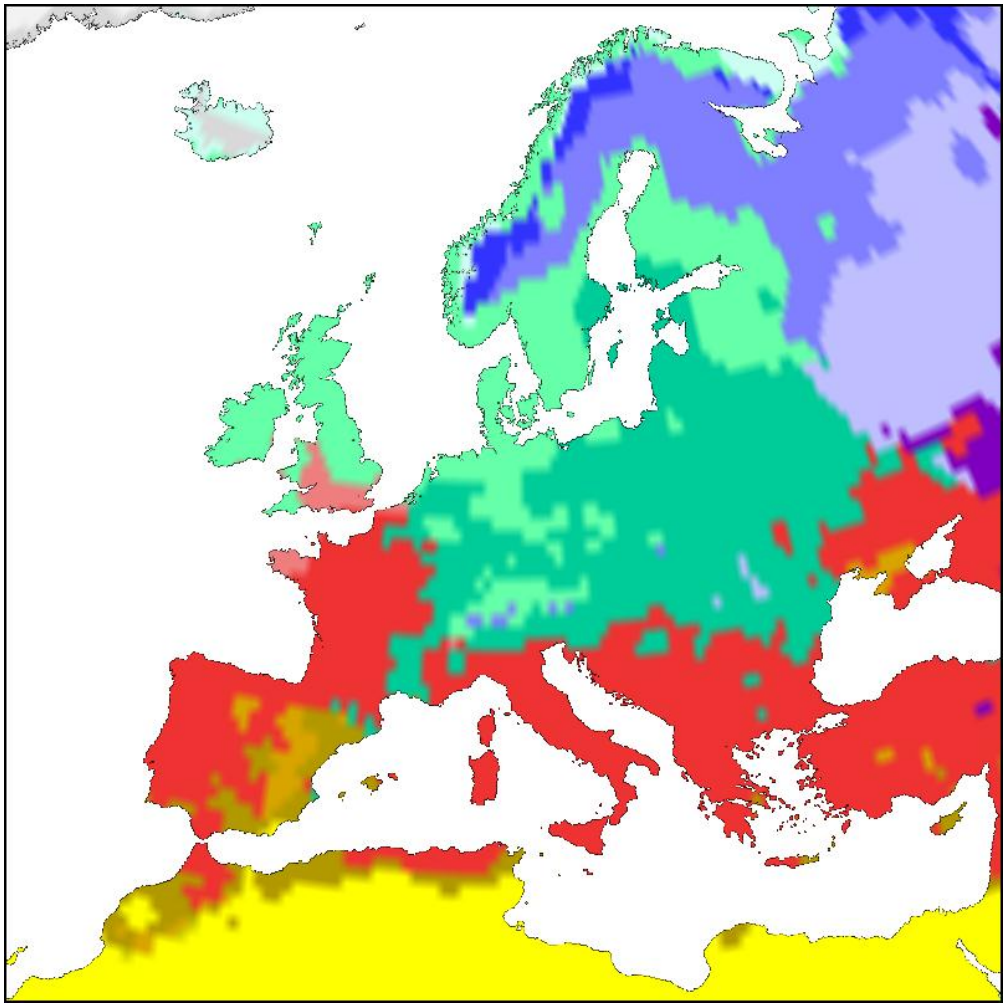
Mild climate
- Dry summer
- Rain all year

Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

*Jylhä (2007)*

# Köppen climate regions, 2080 (A2)



Warm climate
- Dry
- Very dry

Mild climate
- Dry summer
- Rain all year

Cool climate
- Dry summer
- Rain all year

Polar climate
- Tundra
- Ice/snow

*Jylhä (2007)*

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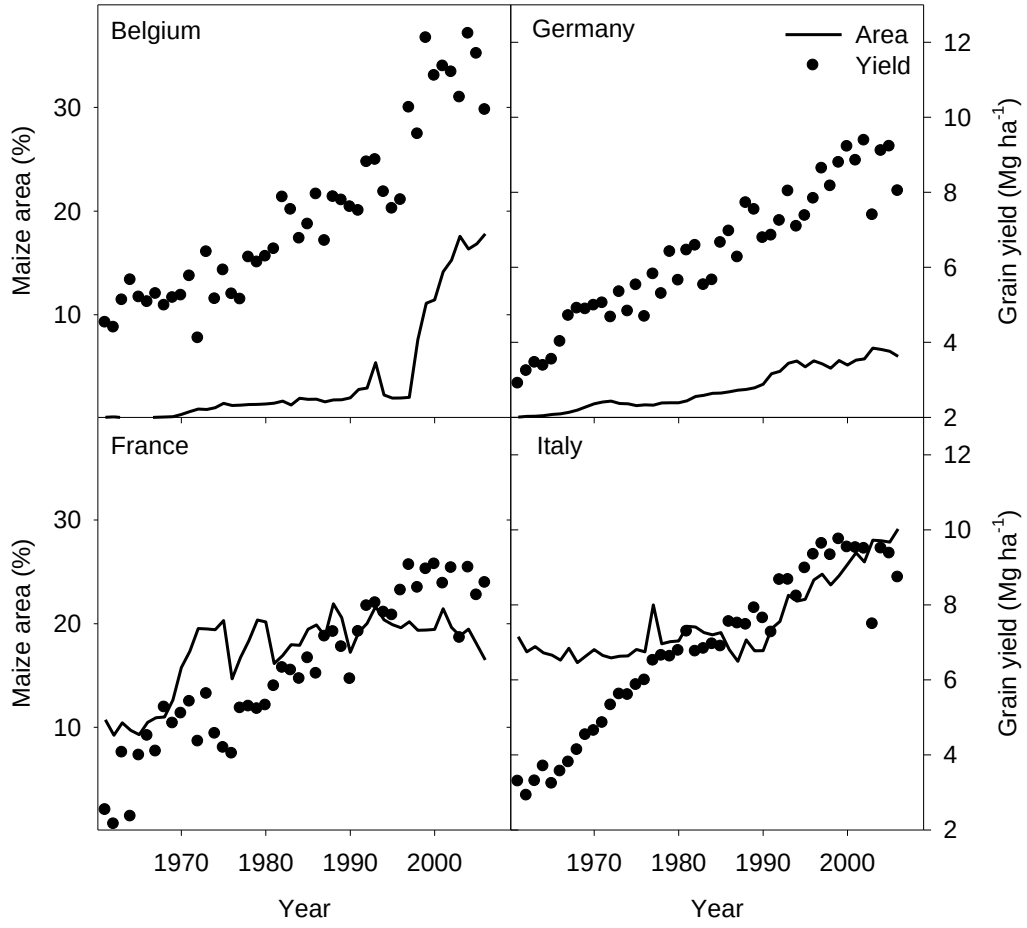
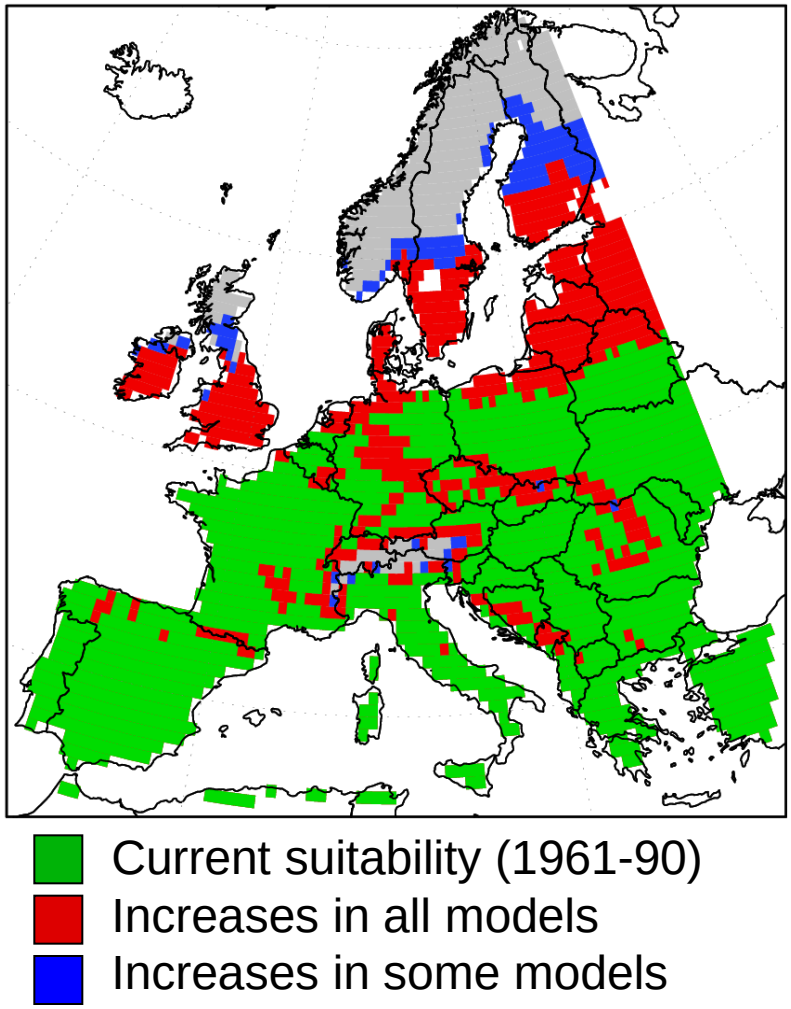
# Grain maize (current and future development)

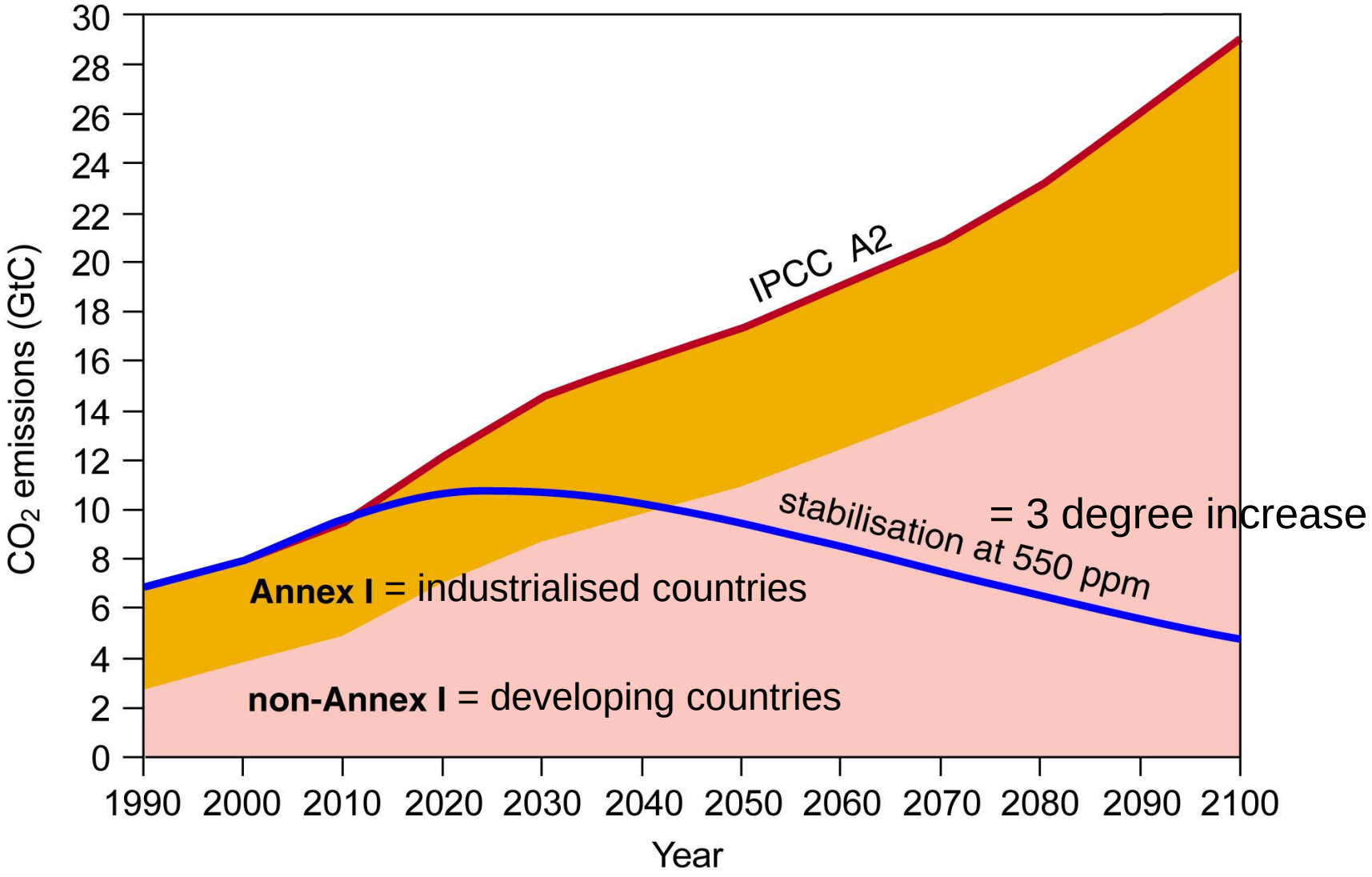
## Current trends in area and yields



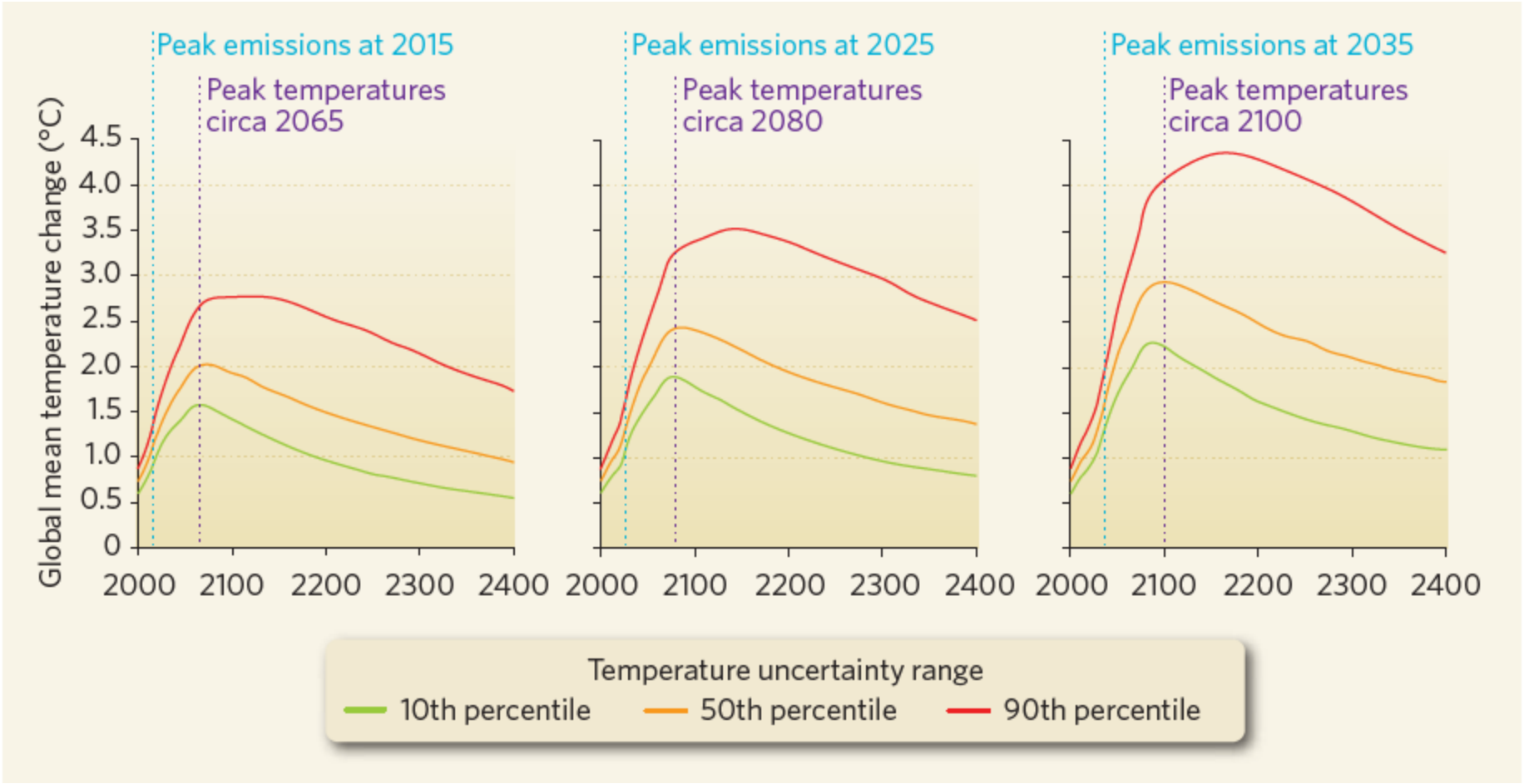

## Suitability in 2080



# The grand challenge!!!

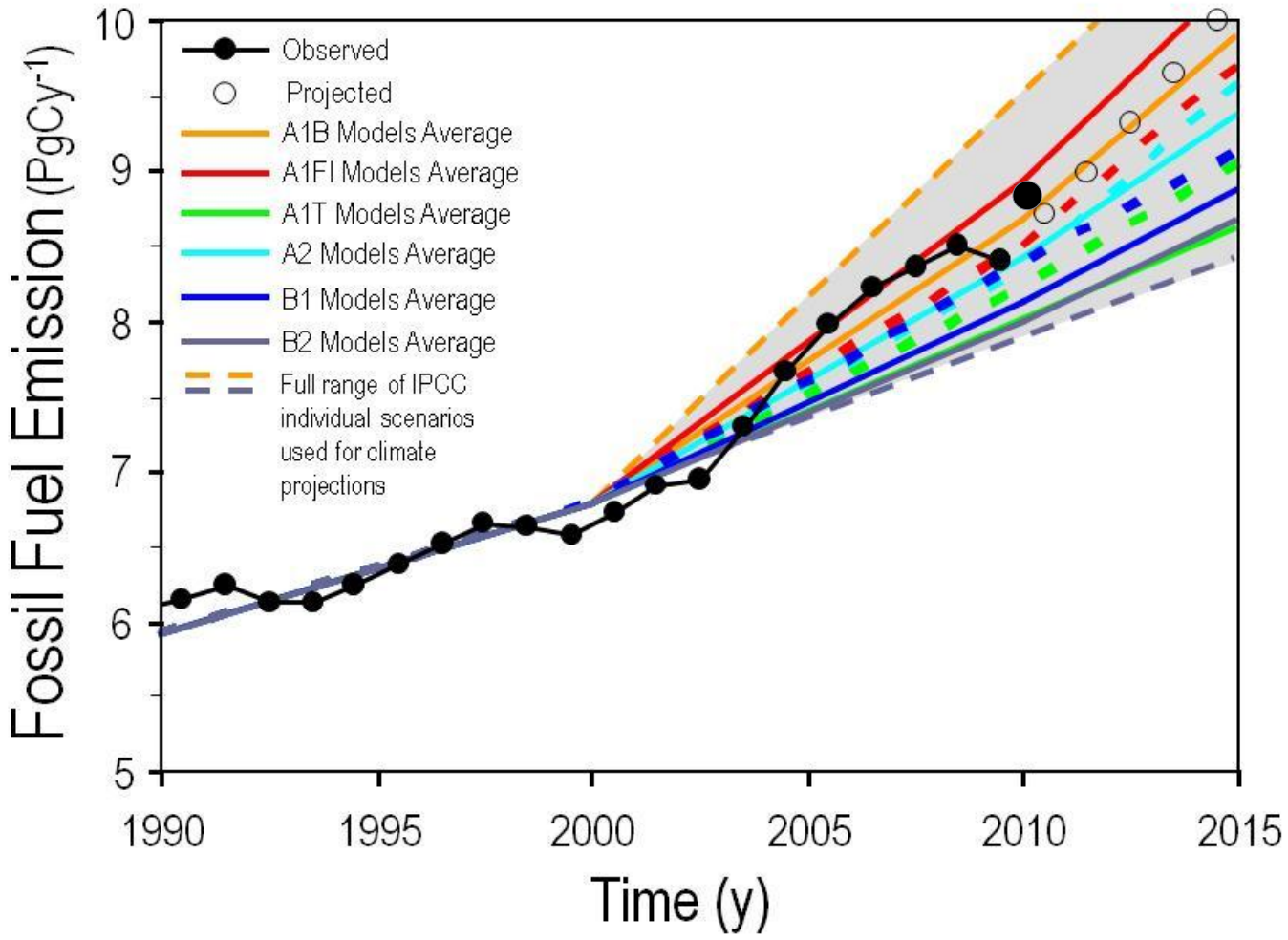


# Action is urgent



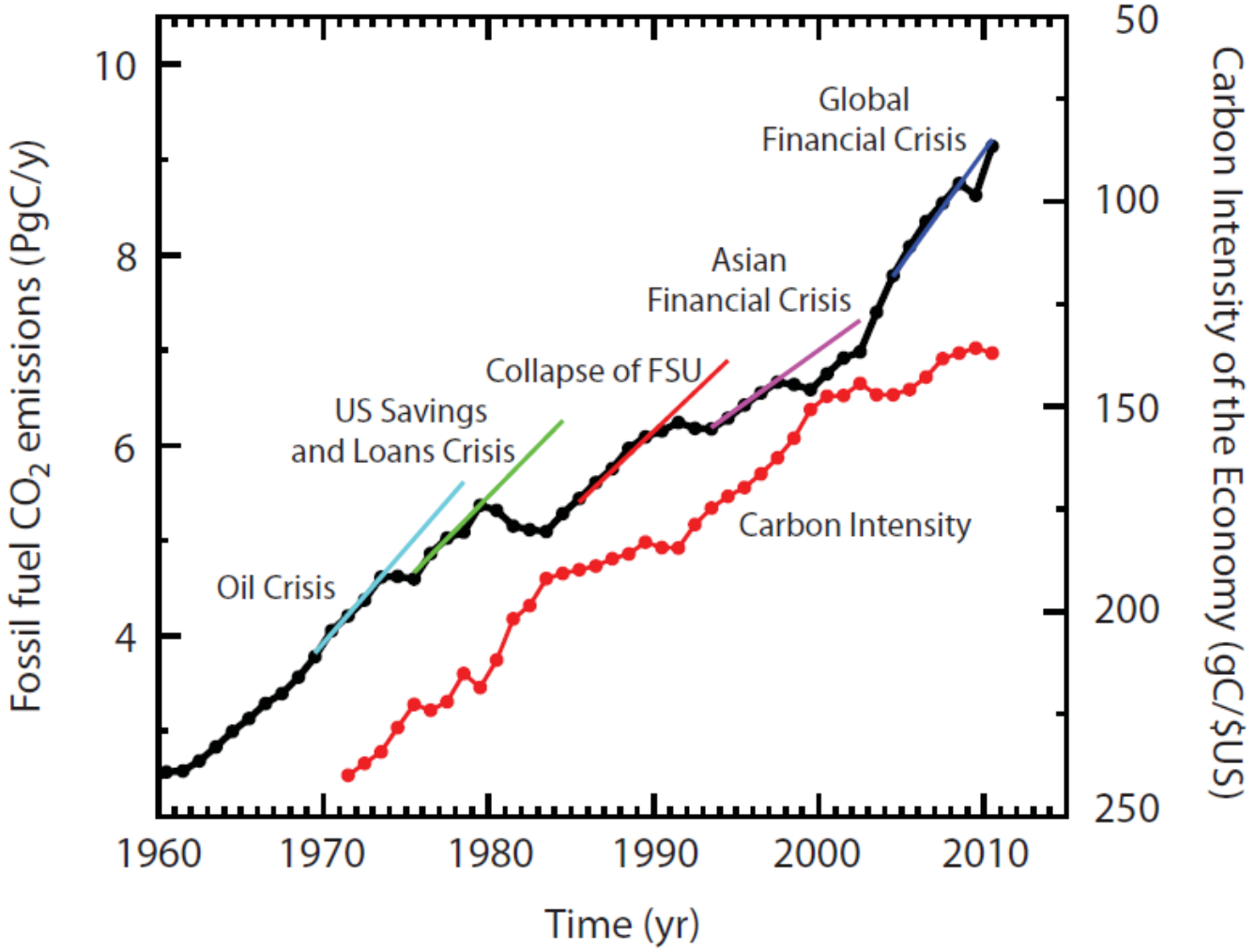

Parry et al. (2009)

# $CO_2$ emissions from use of fossil energy



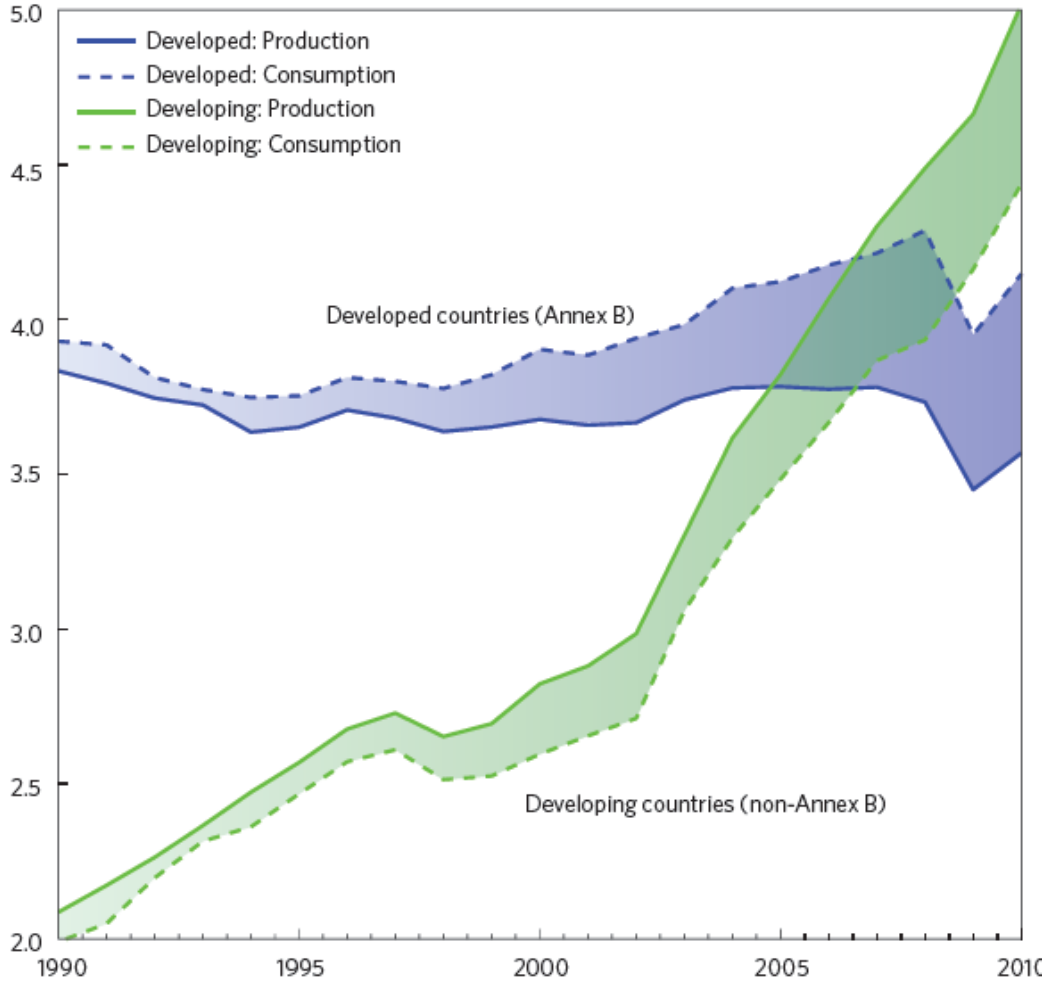

Global Carbon Project

# $CO_2$ emissions of fossil energy after ”crises”




Peters et al. (2011)

# $CO_2$ emissions from production versus consumption




Peters et al. (2011)

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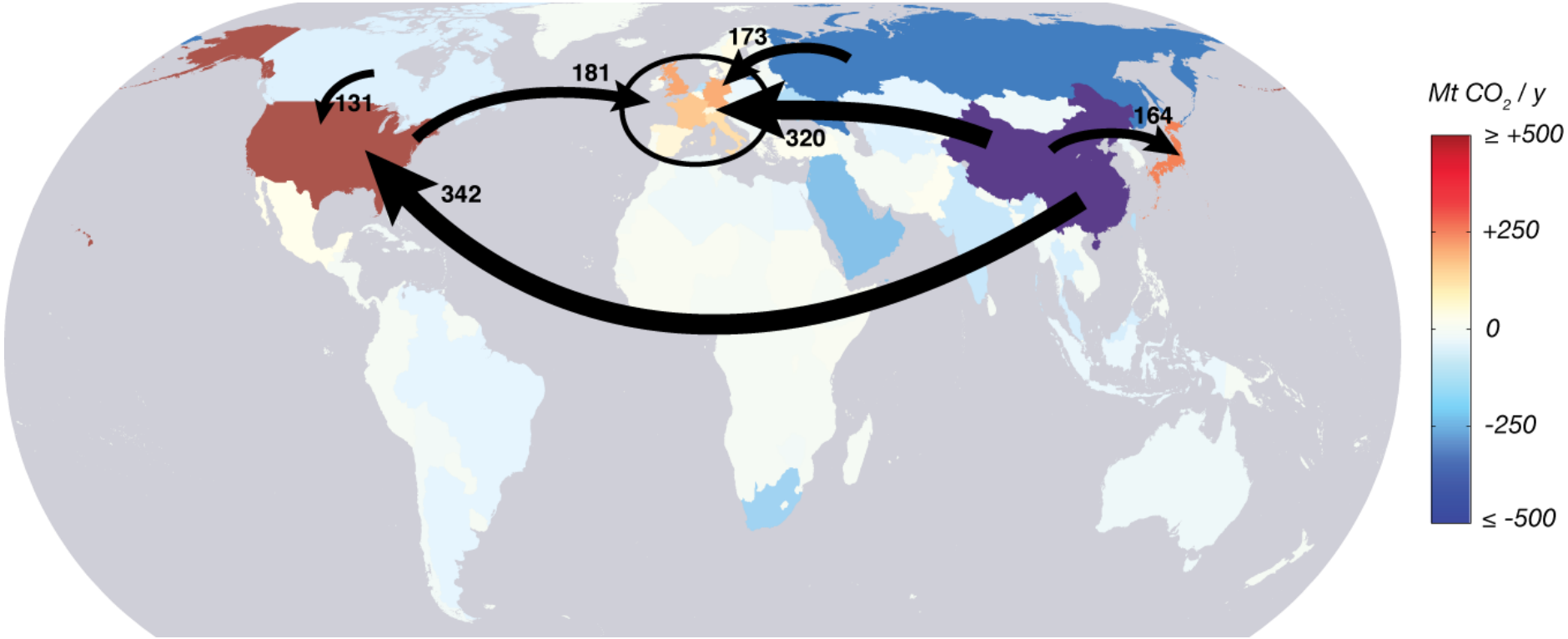
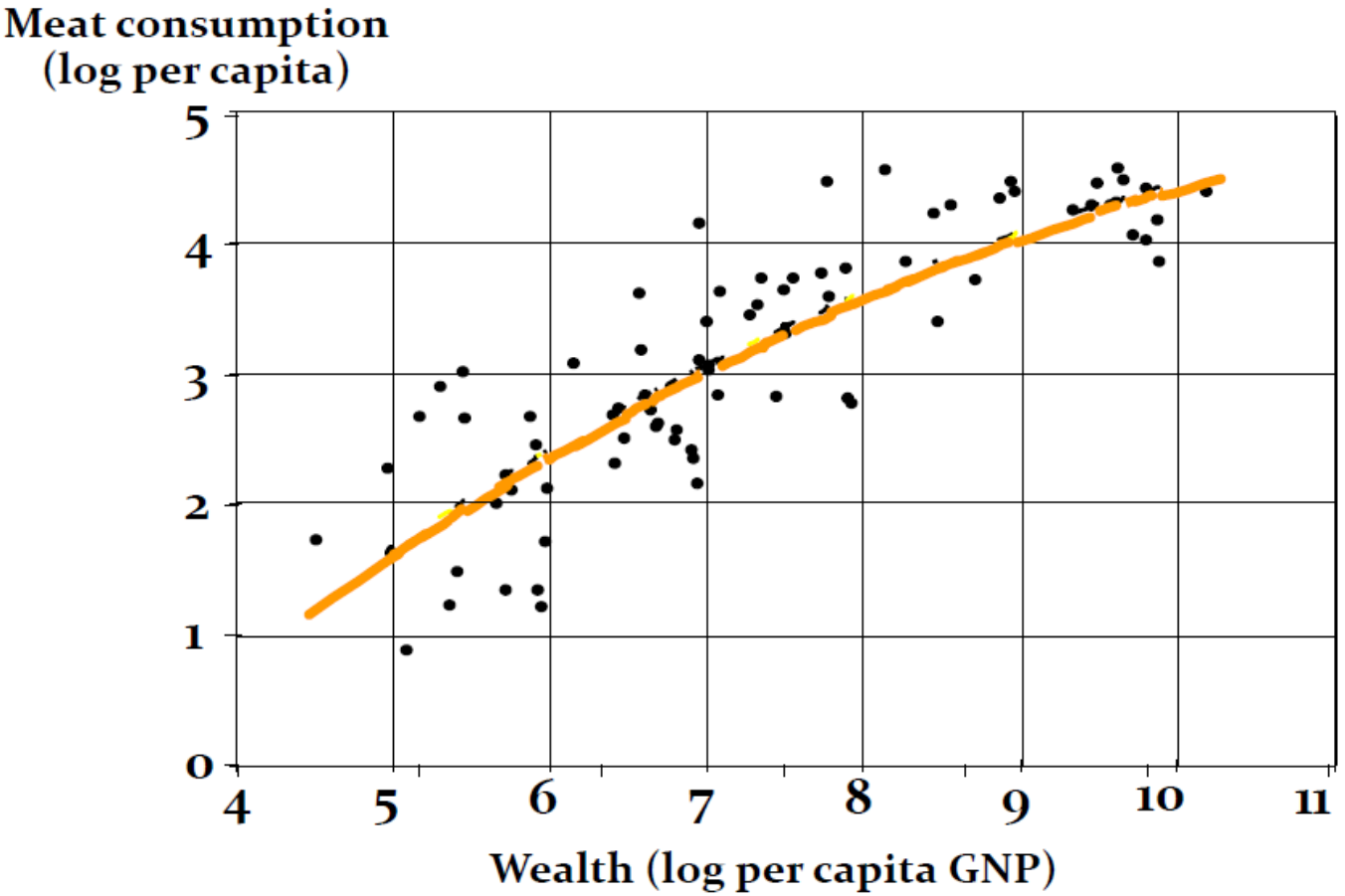
# $CO_2$ i product trade




Net exporting countries (blue) to net importing countries (red)

Davis et al. (2011)

# Wealth and meat consumption




IFPRI, FAO, ILRI

# Resource use for animal production in EU-27

| Product | Feed conversion (kg feed/ kg product) | Area use ($m^2$/kg product) | GHG emissions (kg $CO_2$-eq/ kg product) |
|---|---|---|---|
| Milk | 1.2 | 2.4 | 1.3 |
| Beef | 19.8 | 37.3 | 22.6 |
| Pork | 4.1 | 11.7 | 3.5 |
| Poultry | 3.3 | 9.2 | 1.6 |
| Eggs | 2.8 | 9.0 | 1.7 |

Lesschen et al. (2011)

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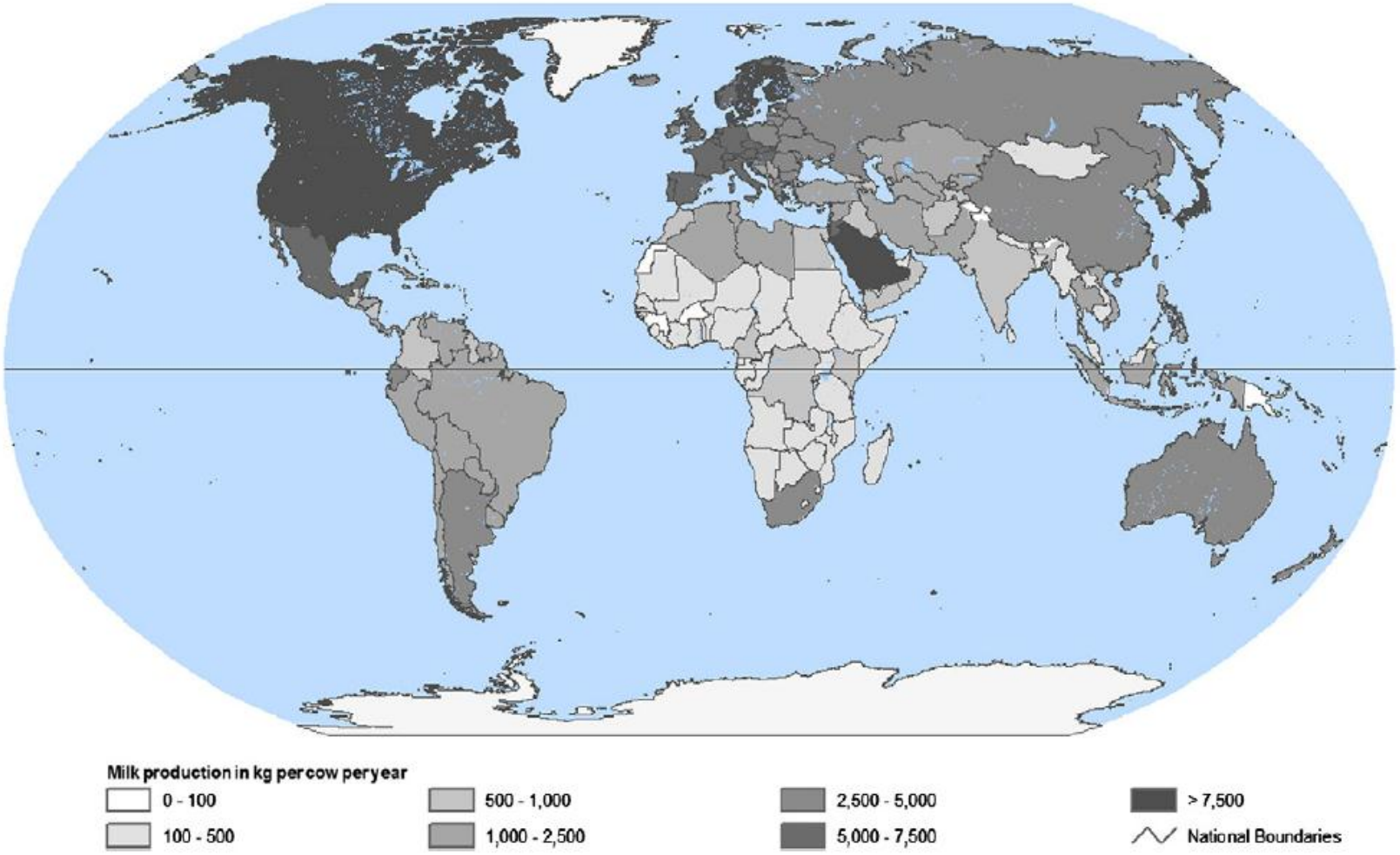
# Area use for food production (DK norms)

1 kg wheat
1,5 $m^2$

1 kg pork
8 $m^2$

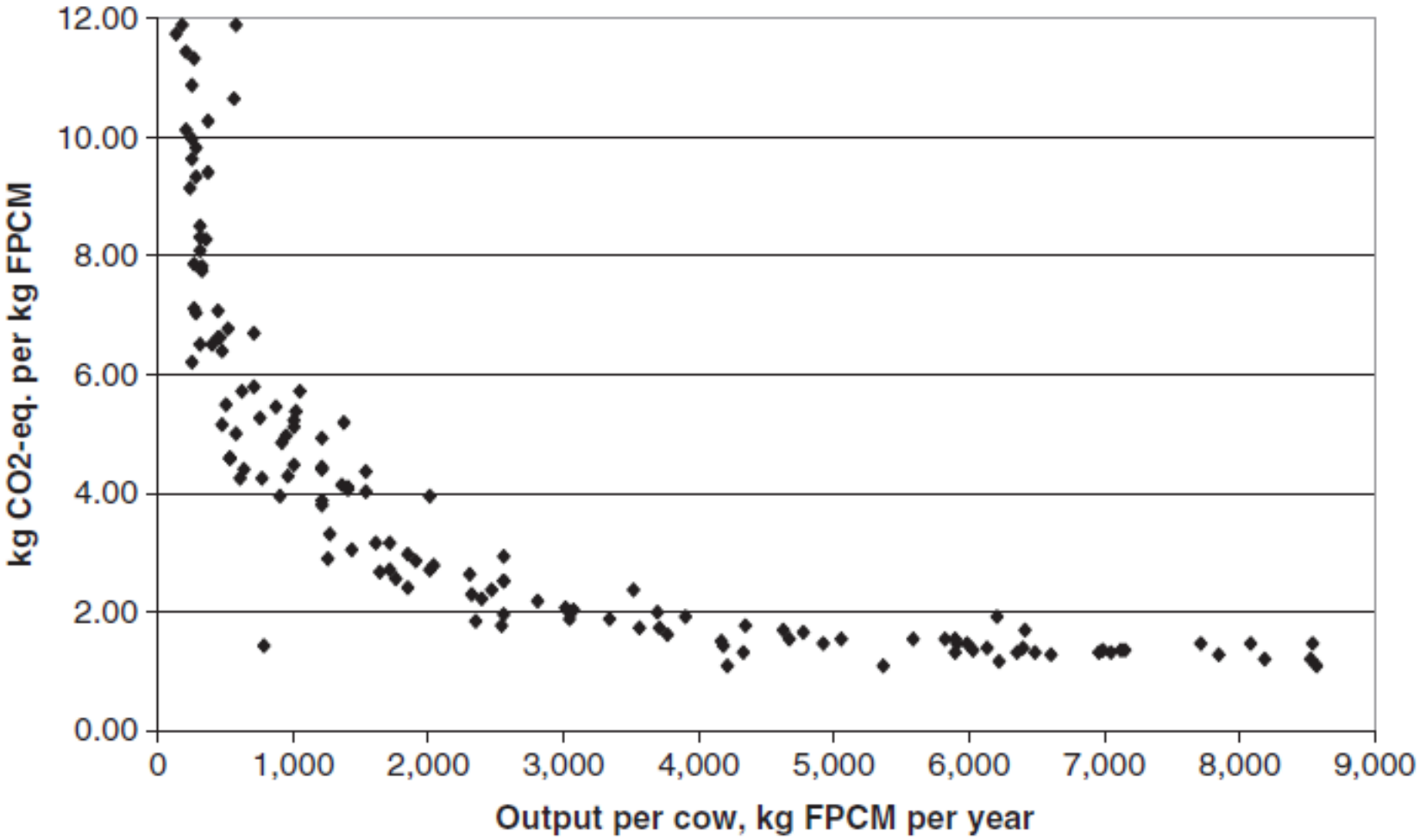
1 kg beef
24 $m^2$

# Milk production per cow per year



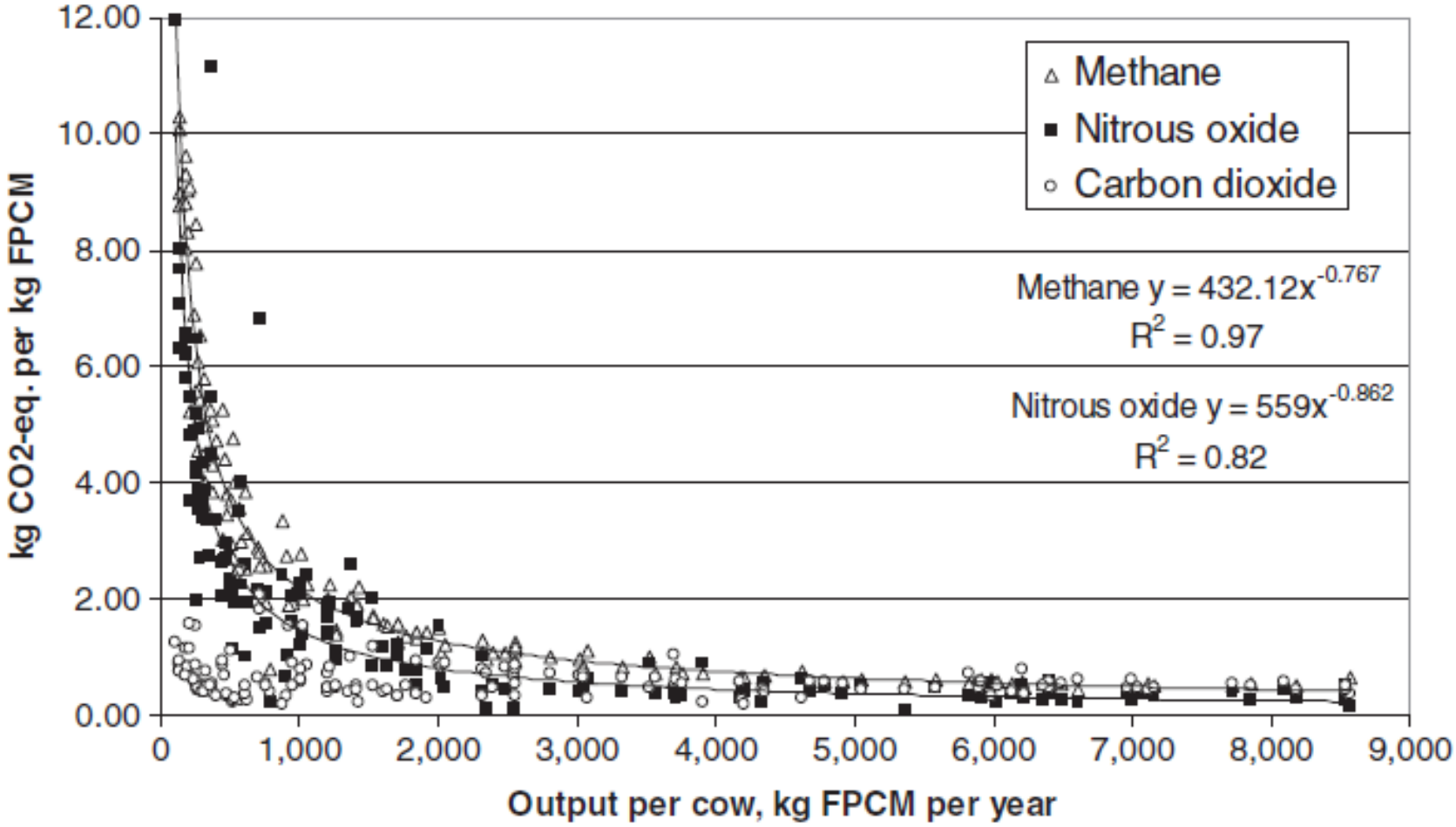

Gerber et al. (2011)

# GHG emissions per kg milk



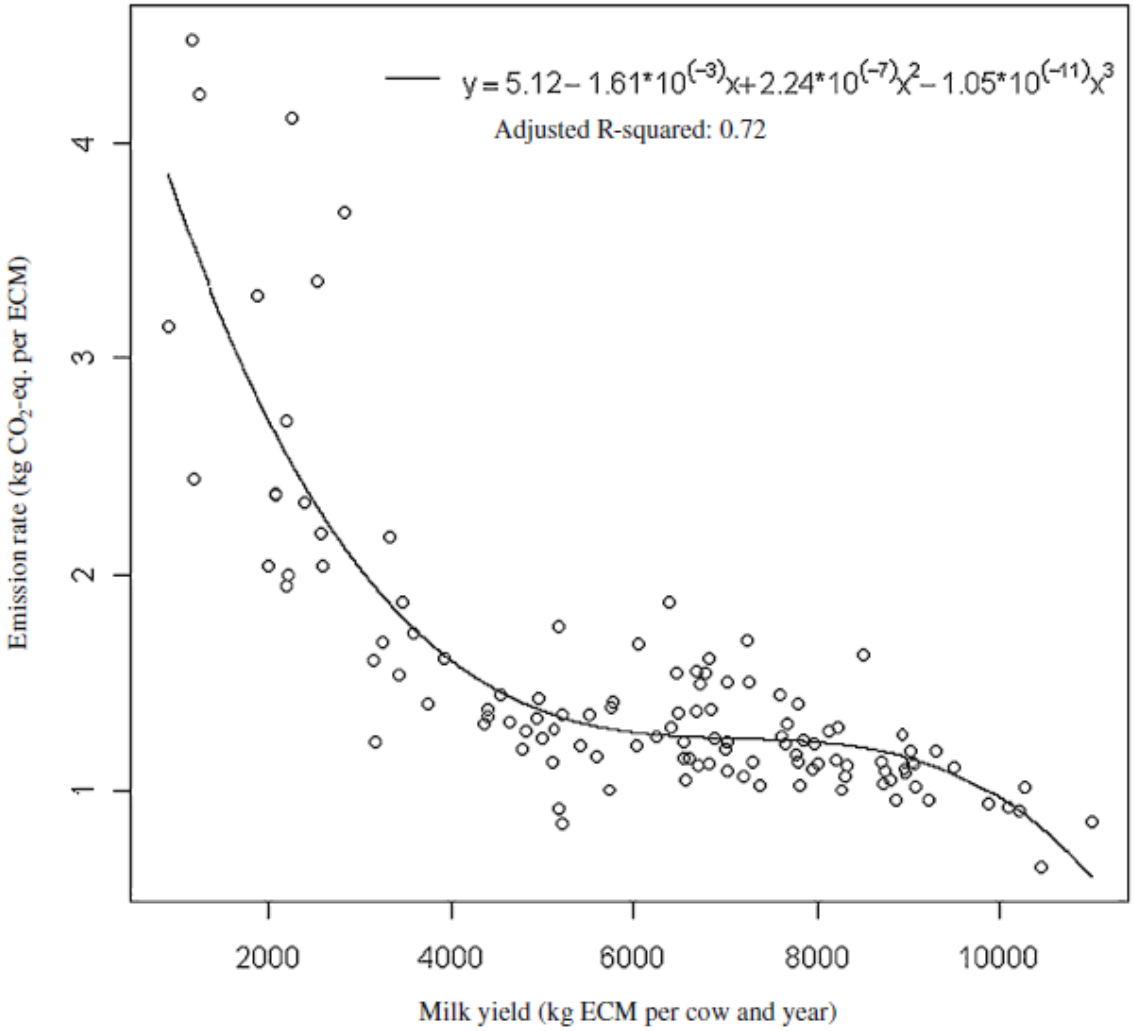

Gerber et al. (2011)

# GHG emissions per kg milk



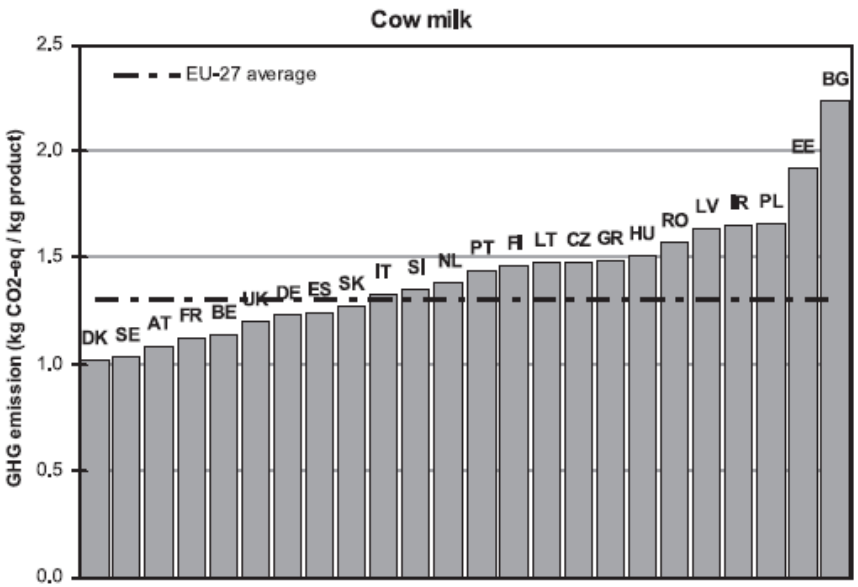

Gerber et al. (2011)

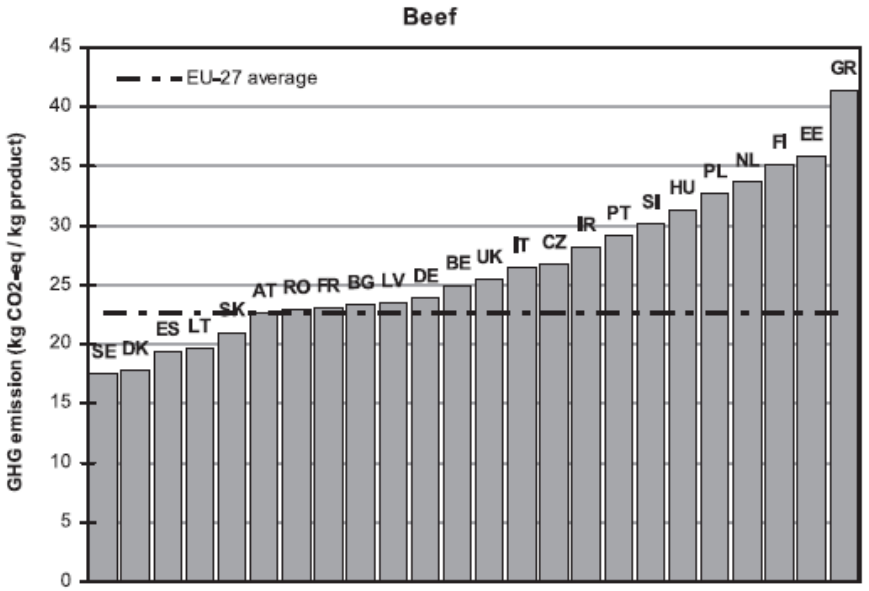
# GHG emissions per kg milk




Hageman et al. (2012)

# GHG emissions per kg milk and meat




Lesschen et al. (2011)

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# What can cattle and dairy farming do?

## › Feeding of cattle

- Methane emissions from cattle may be reduced through feeding (e.g., fat, starch, nitrates), but some effects are reduced with farm interactions are included
- High feeding effeciency is very important
- Breeding of animals for low methane emissions

## › Handling of manure

- Methane emissions from slurry can be reduced through biogas (combined with separation) and acidification
- Nitrous oxide emissions from applied manure can be reduced through biogas possibly combined with nitrification inhibitors
- Give priority to N-fixation in grass-clover, so that mineral fertilisation can be reduced

## › Bioenergy

- There will increasingly be new available feedstuffs as co-products from production of biofuels (e.g. C4-melasses)

## › Soil carbon storage

- Grasslands should maintain as such (permanent)
- Cover crops should be grown where possible

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# Will we (as humankind) solve the climate challenge?

- **Hardly (the pessimistic view)**
  - The will among leading politicians (and among voters) to act is not present
  - Our society is deeply dependent on use of fossil resources (energy, water, minerals)
  - Environmental, climate and ecosystem impacts are colossal and increasing

- **Maybe (the optimistic view)**
  - There is a rapidly growing research, knowledge base and innovation in green and sustainable solutions (although many of them are still wanting)
  - There is a growing consensus that costs of non-action will be larger than the costs of action

- **New thinking and new rhetoric (the hopeful view)**
  - Sustainable solutions are not the same as refraining for living prosperous lives.
  - We need to redefine the good life – caring about nature and the future is also a value.
  - We need positive thinking – new and good solutions. Returning to the past is not an option.
  - Sustainable solutions gives new opportunities, new sources of income, and better lives for ourselves, our children and for the nature.

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# Demands for sustainable (green) solutions opens new markets in the food sector

- The middle class is the most rapidly growing segment globally
- There is a growing (global) awareness on the need for sustainable solutions, products and life styles
- The market for green and sustainable products will grow
- Consumers are increasingly willing to pay for green products
- Are we in the agricultural and food sector up to the challenge?