„Indicators of Europe's changing climate"

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Structure of the report

- Introduction (purpose+scope)
- Background (past+future CC, policies)
- CC impacts in Europe (indicators)
- Adaptation
- Uncertainties, data availability+future needs

Presentation of an indicator

- **Key messages** : summarises trends and effects on environment and society
- **Key graph + photograph** : illustrates trends and impacts
- **Relevance** : explains relevance to policy, socio-economy and environment, describes data availability and uncertainty
- **Past trends + Projections** : describes past trends and future projections

Categories of Indicators

- **Atmosphere and climate (4)**
- **Glaciers, snow and ice (3)**
- **Marine systems (4)**
- **Terrestrial ecosystems + biodiversity(5)**
- **Water (1)**
- **Agriculture (1)**
- **Economy (1)**
- **Human health (3)**

---→ Examples

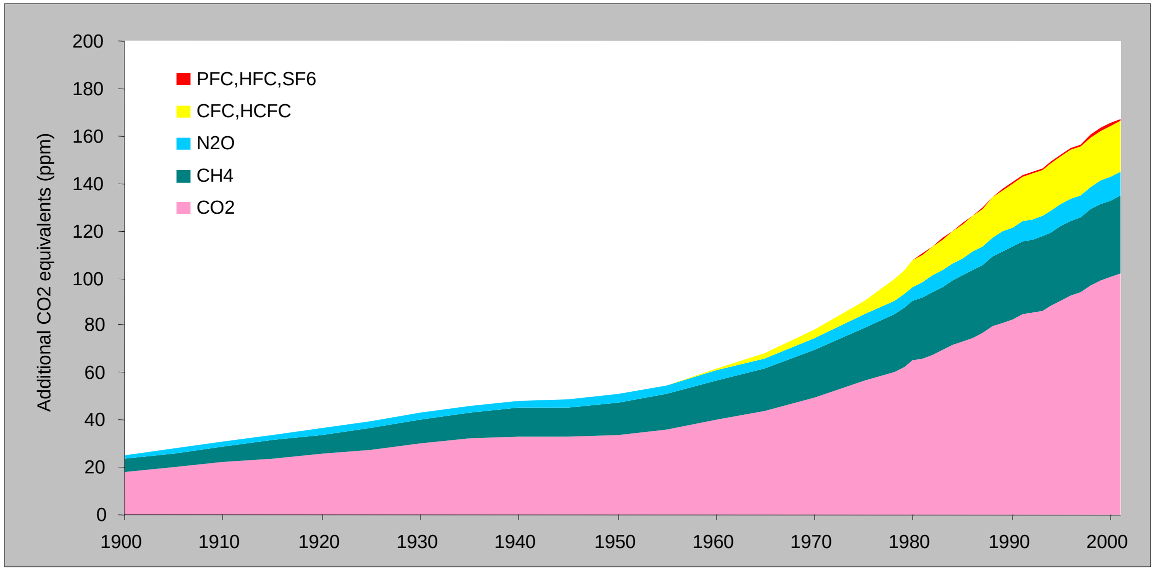
Atmosphere and climate

Greenhouse gas concentration

Greenhouse gas concentration

past trends

- Concentration of CO_2 has increased by 95 ppm (34%) to 375 ppm (global + Europe)
- All greenhouse gases rose by 170 ppm CO_2-equivalent (61% CO_2, 19% methane, 13% CFCs and HCFCs, and 6% N_2O)



Rise of greenhouse gases (1900–2000) compared to the year 1750

future projection

- Increase to 650 - 1215 ppm CO_2-equivalent is projected by 2100

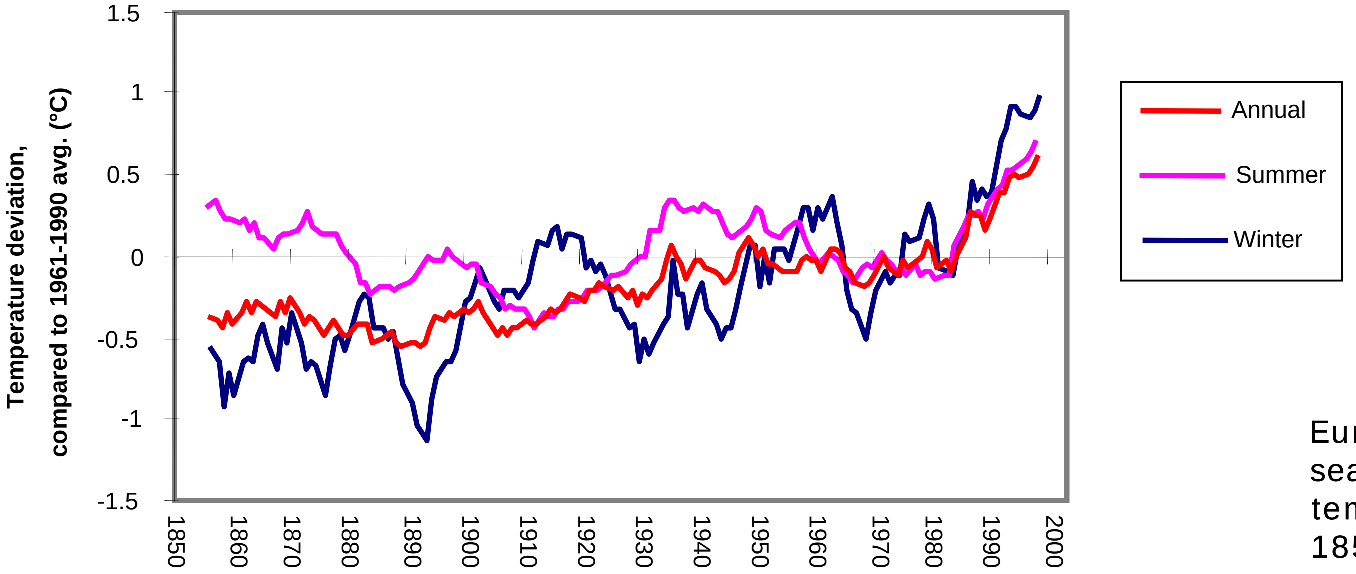
Data-sources: IPCC

Air Temperature

Air Temperature

past trends

- Global temperature: + 0.7 ±0.2 °C over past 100 years
- Europe: mean annual +0.95 °C
- Summer +0.7°C ; Winter +1.1°C



European annual and seasonal mean temperature deviations, 1850-2002

future projection

- Global projection (1990–2100): + 1.4–5.8 °C
- Europe: + 2.0–6.3°C

Data-sources: IPCC, WMO, CRU, ...

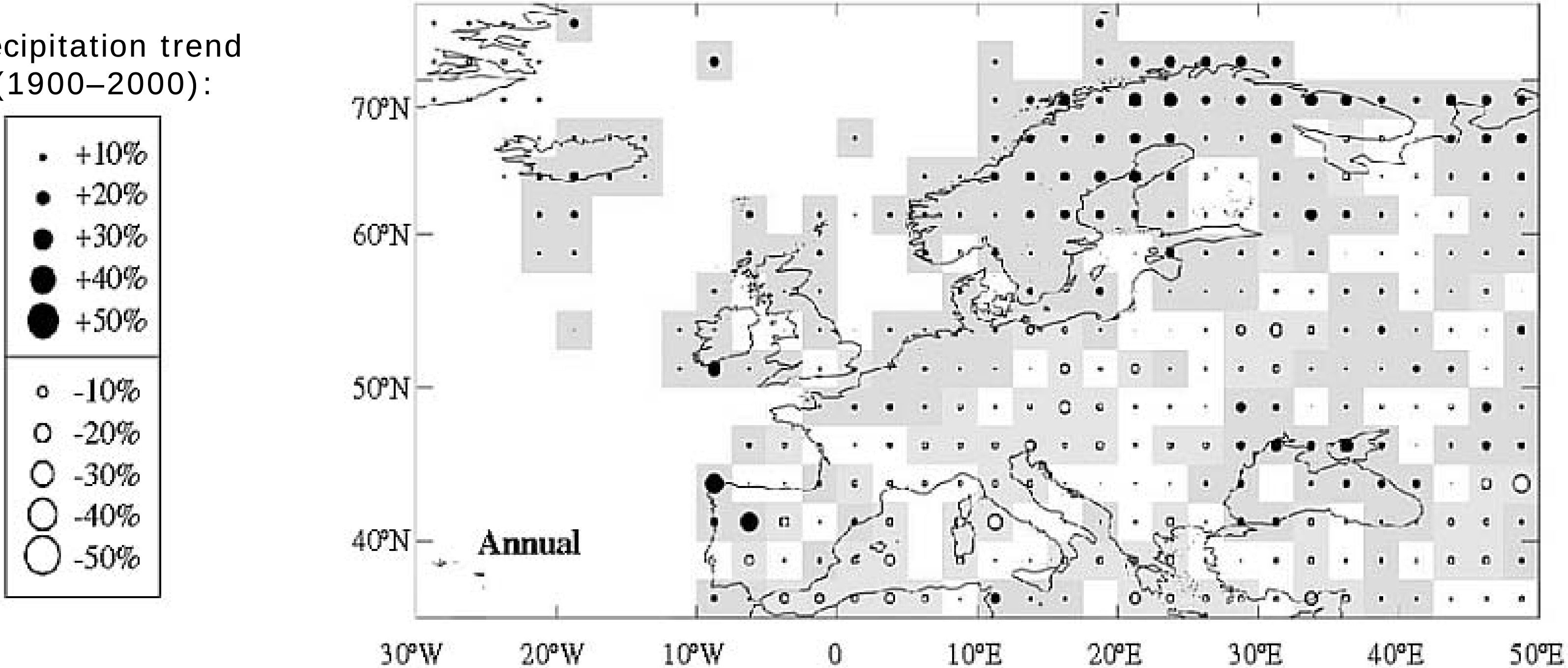
Precipitation

Precipitation

- Heterogeneous trends (1900–2000):
  - northern Europe 10-40 % wetter
  - southern Europe up to 20 % drier

past trends

Precipitation trend (1900–2000):



- Projection:
  - 1-2% increase per decade for northern Europe
  - up to 1 % per decade decrease in southern Europe

future projection

Data-sources: IPCC, WMO, CRU, NOAA …

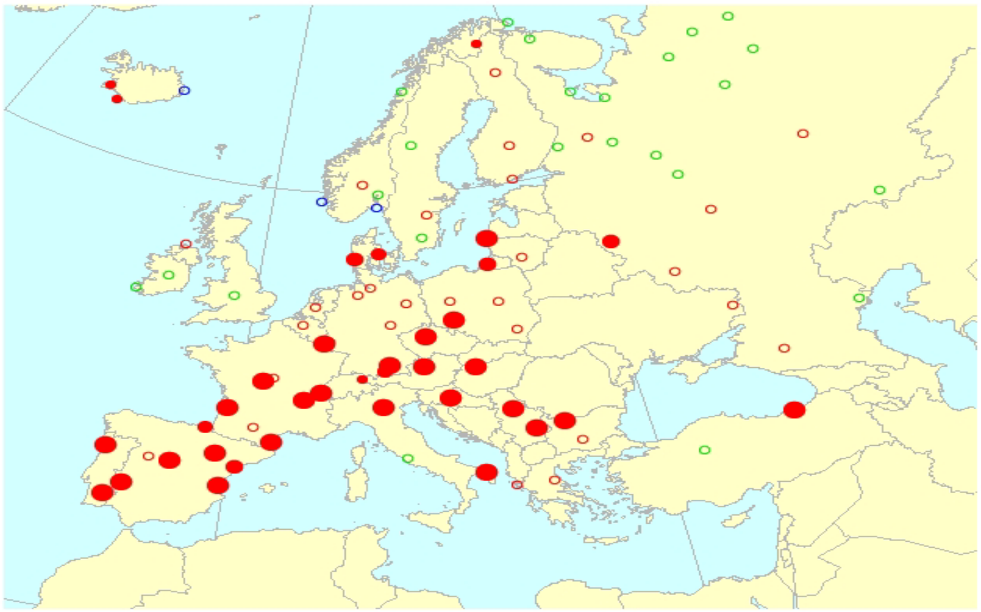
Temperature and precipitation extremes

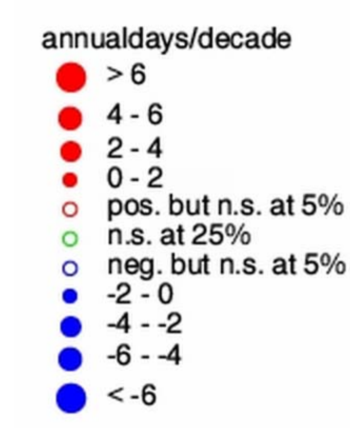
Temperature extremes

1976–1999:

- Number of cold and frost days decreased
- Number of summer days increased

past trends





Summer days (T_{max} >= 25 °C)
Changes in 1976–1999

Projections:

- Cold winters disappear almost entirely by 2080
- Hot summers much more frequent

future projection

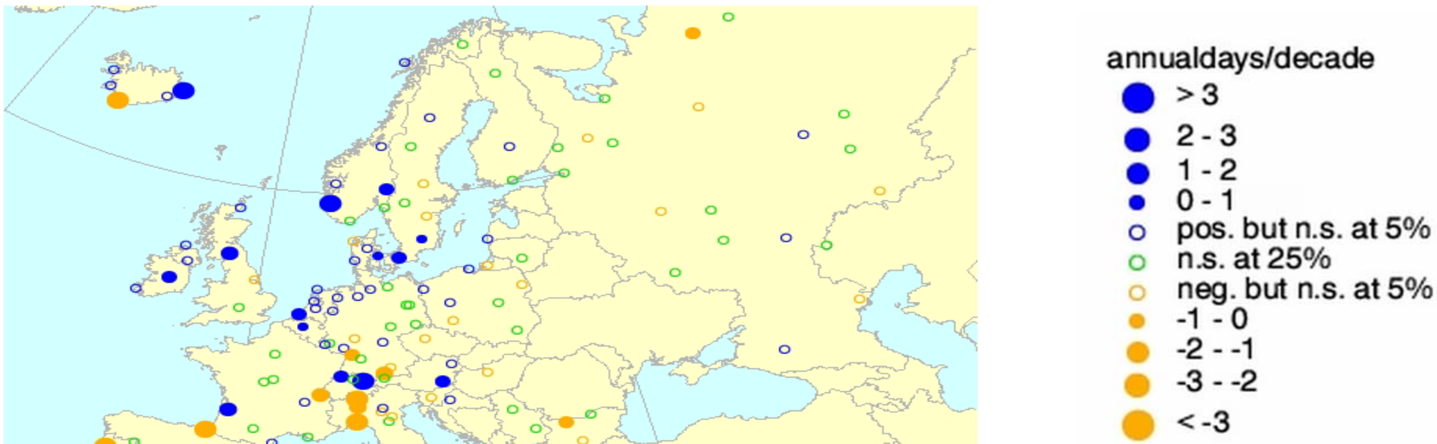
Data-sources: ECA, IPCC, ACACIA, ...

Precipitation extremes

1976–1999:

- Southern Europe: decrease
- Mid and northern Europe: increase

past trends



Very heavy precipitation days (p >= 20mm)
Changes in 1976–1999

Projections:

- Likely more frequent droughts and intense precipitation events

future projection

Data-source: ECA, IPCC, ACACIA, ...

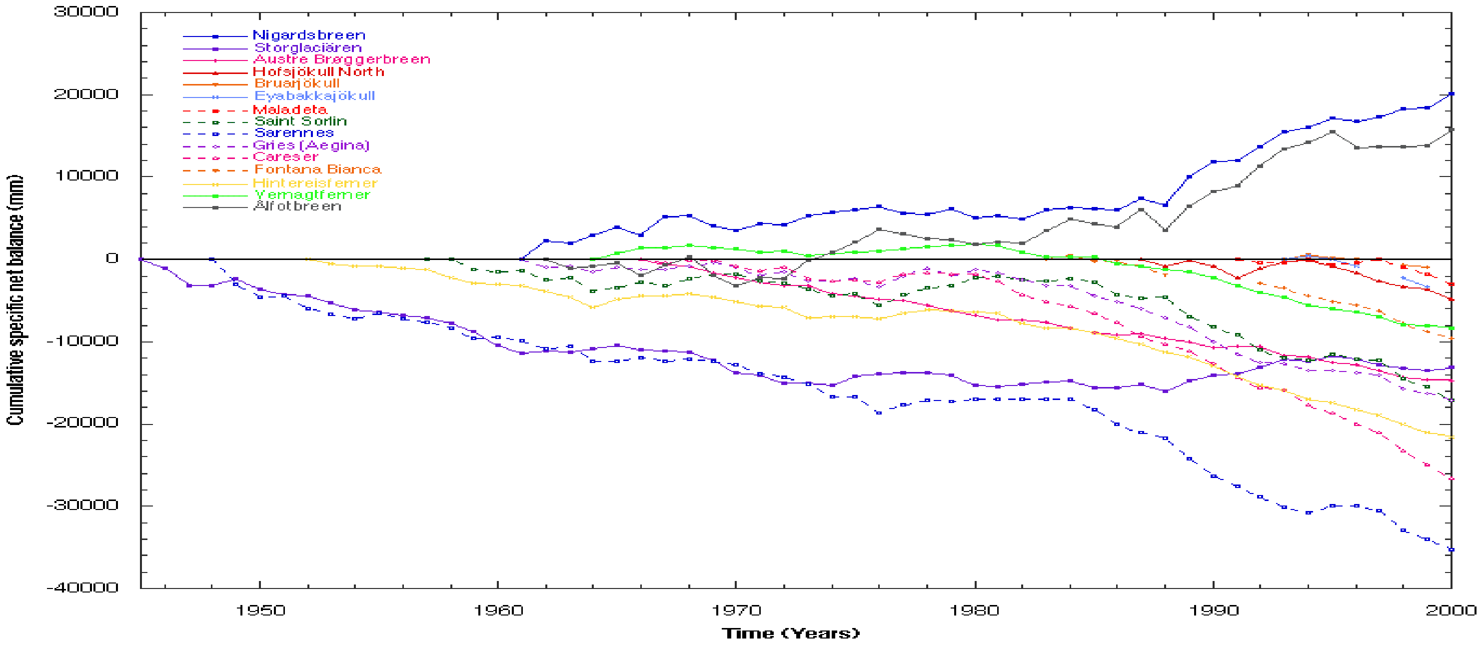
Glaciers, snow and ice

Glaciers

Glaciers

- Retreat in eight out of the nine glacial European regions
- Loss of one third of area and one-half of mass from 1850-1980 in the Alps
- Since 1980 – 2000 about 20-30 % loss of the remaining ice (additional -10% in last summer)

past trends



- Very likely that glacier retreat will continue

future projection

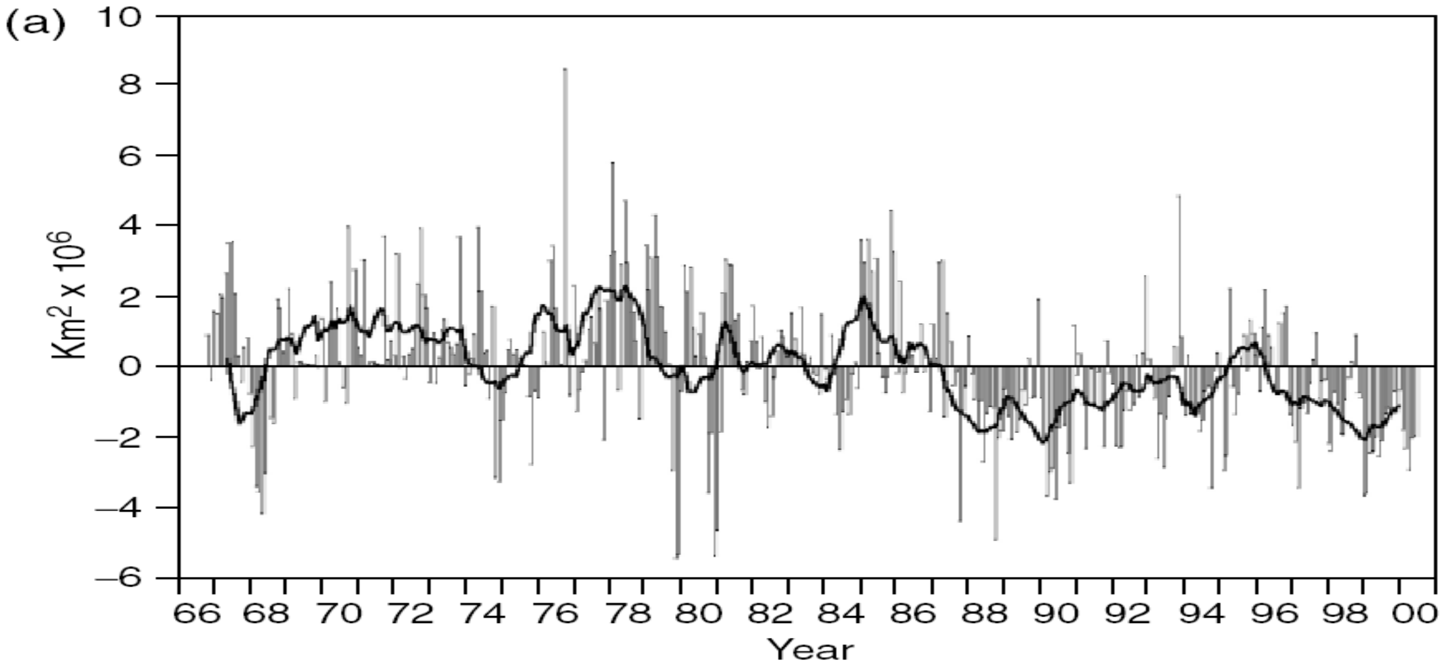
Data-sources: WGMS, NSDIC, BADW,...

Snow Cover

Snow Cover

past trends

- Northern Hemisphere's snow cover extent has decreased by 10 % since 1966.
- Snow cover period shortened by an average rate of 8.8 days per decade between 1971 and 1994.



Anomalies of monthly snow cover extend over the Northern Hemisphere (1966–2000)

- Snow cover extent is projected to decrease further during the 21st Century

future projection

Data-sources: IPCC, NSIDC, SLF, NVE, National Weather Services,...

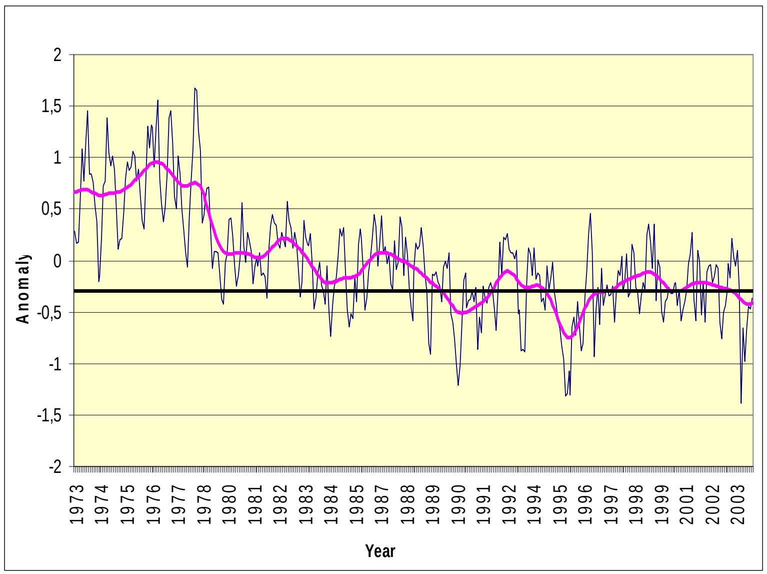
European Environment Agency

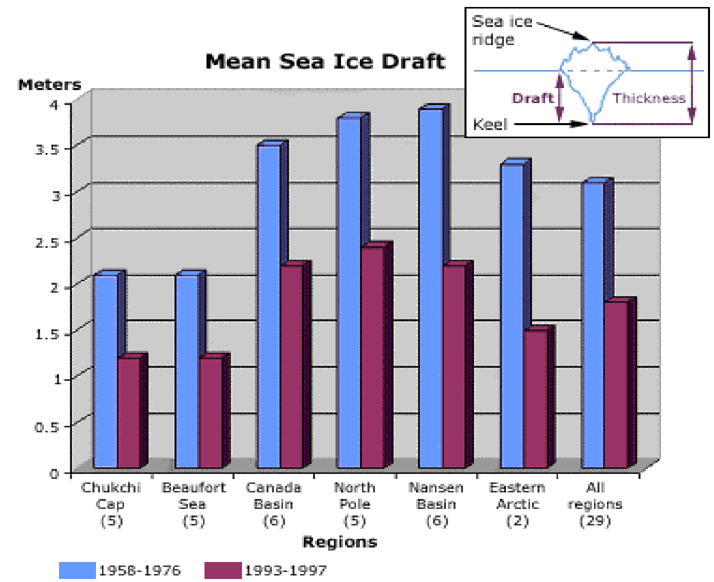
Arctic Sea Ice

Arctic Sea Ice

- Arctic sea ice extent has decreased by more than 7 % from 1978 to 2003 (particularly during summer)
- Ice thickness has decreased by 40 % on average over the period 1960's-1990's with large regional variability

past trends





- Projections show a predominantly ice free Arctic Ocean in summer by 2100

future projection

Data-sources: IPCC, NSDIC, NVE, AWI,AARI… (Cryo-sat, Ice-sat)

European Environment Agency

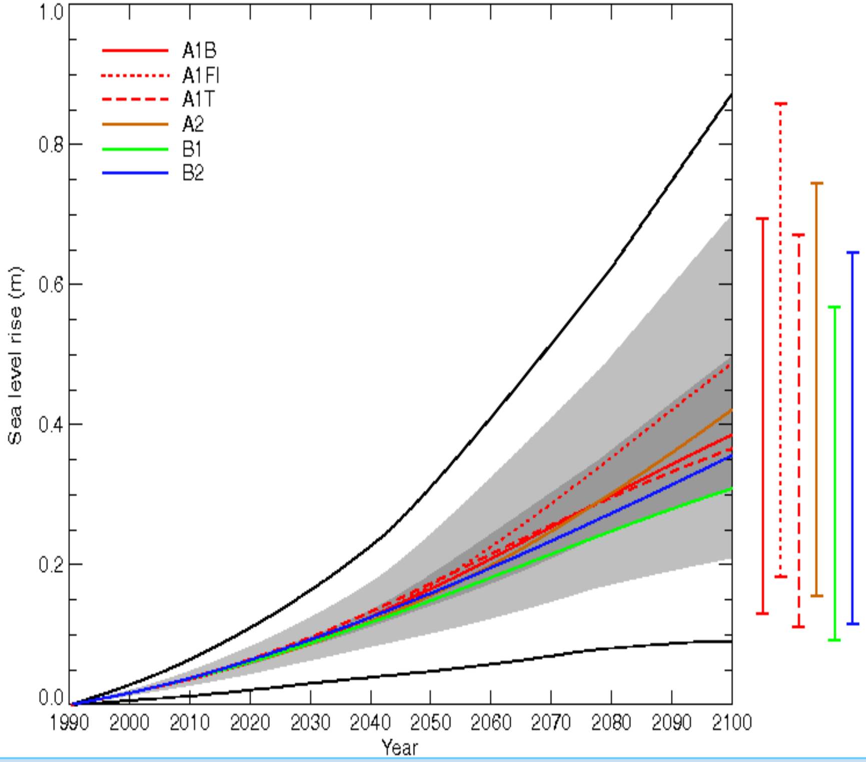
Marine systems

Sea level rise

Sea level rise

- Sea levels around Europe increased by between 0.8 mm/yr (Brest and Newlyn) and 3.0 mm/year (Narvik)

past trends



- Projected rate of SLR in the 21st century is 2.2 to 4.4 times higher
- Sea level is projected to continue to rise for centuries

future projection

Data-sources: PSMSL, ESEAS,...

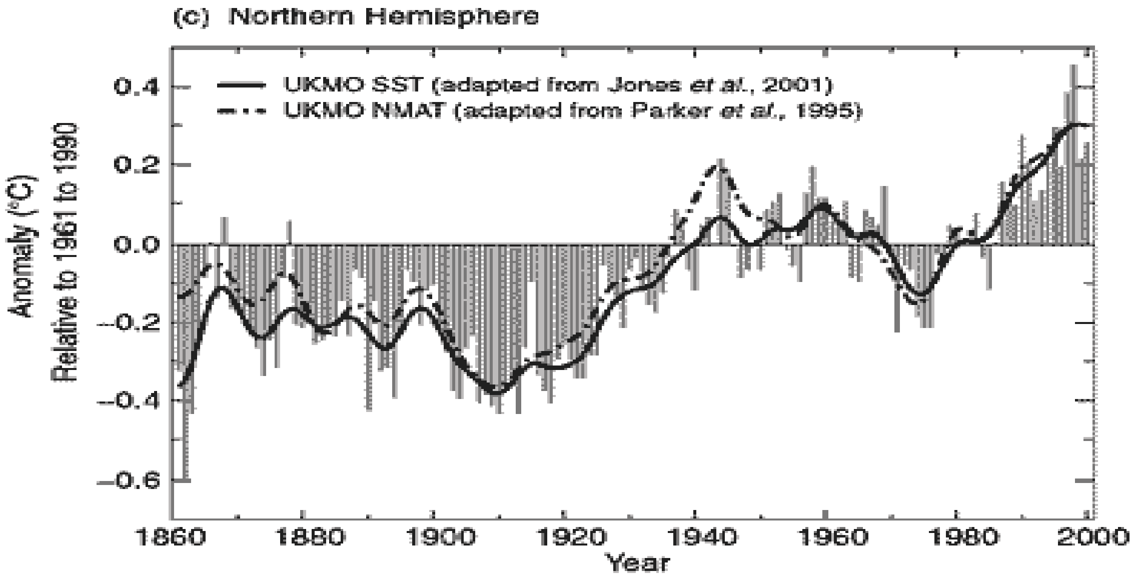
European Environment Agency

Sea Surface Temperature

Sea Surface Temperature

- Global average sea surface temperature has increased by 0.6 ± 0.1 °C since late nineteenth century
- No European sea shows a significant cooling
- Baltic and North Seas show warming of 0.5 to 1.0 °C over the past 15 years

past trends

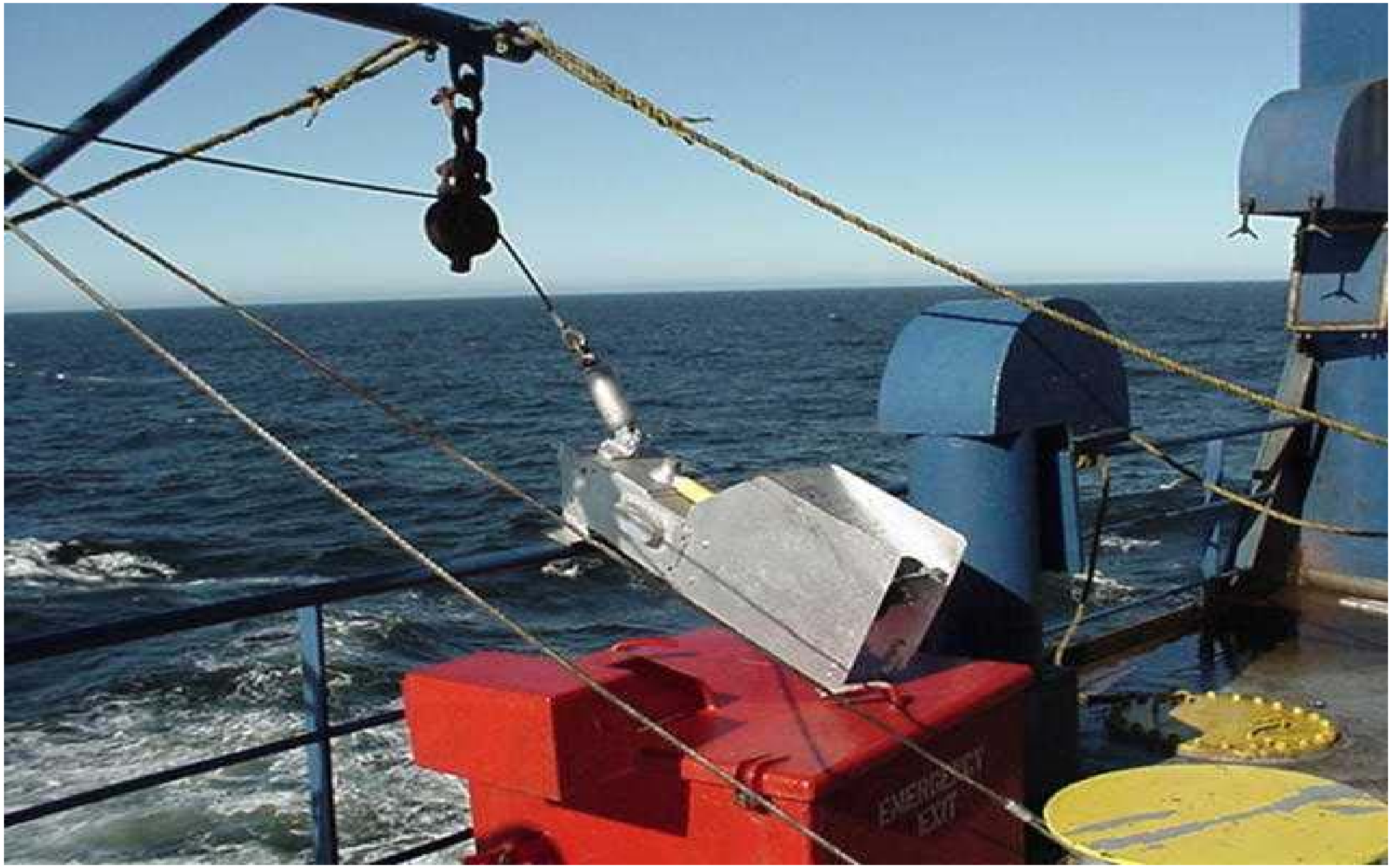


- Oceans will warm less than the land, by 1.1 °C to 4.6° from 1990 -2100

future projection

Data-sources: ICES, NASA, NOAA,...

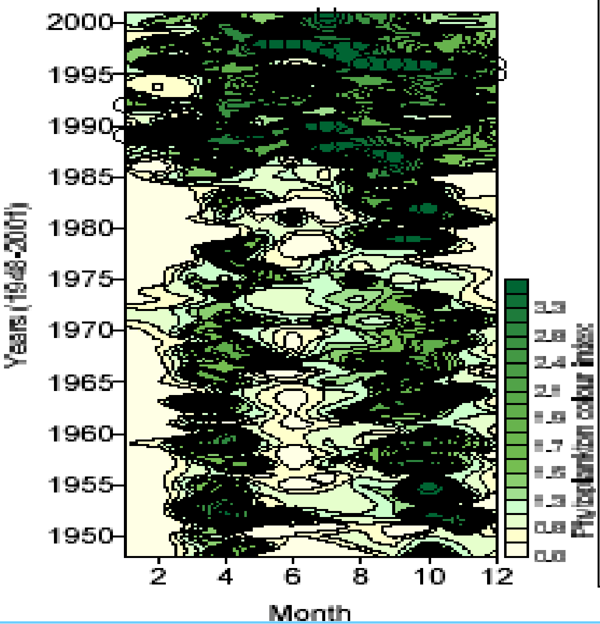
Marine growing season

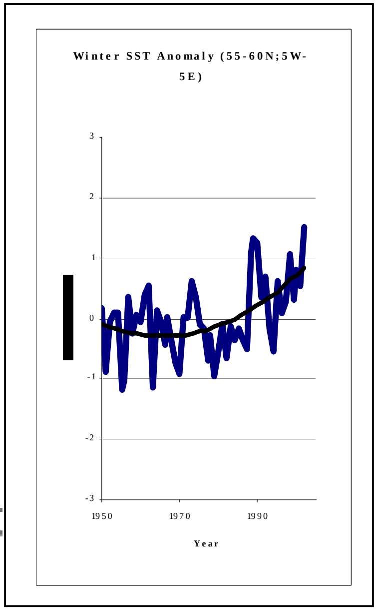


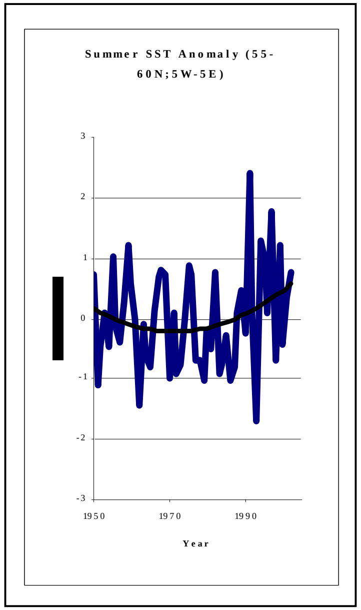
Marine growing season

past trends

- Increasing phytoplankton biomass and extension of seasonal growth period in North Sea and North Atlantic over the last decades
- In the 1990s, seasonal development of decapods larvae (zooplankton) occurred much earlier (by 4–5 weeks)







- Further changes are expected

future projection

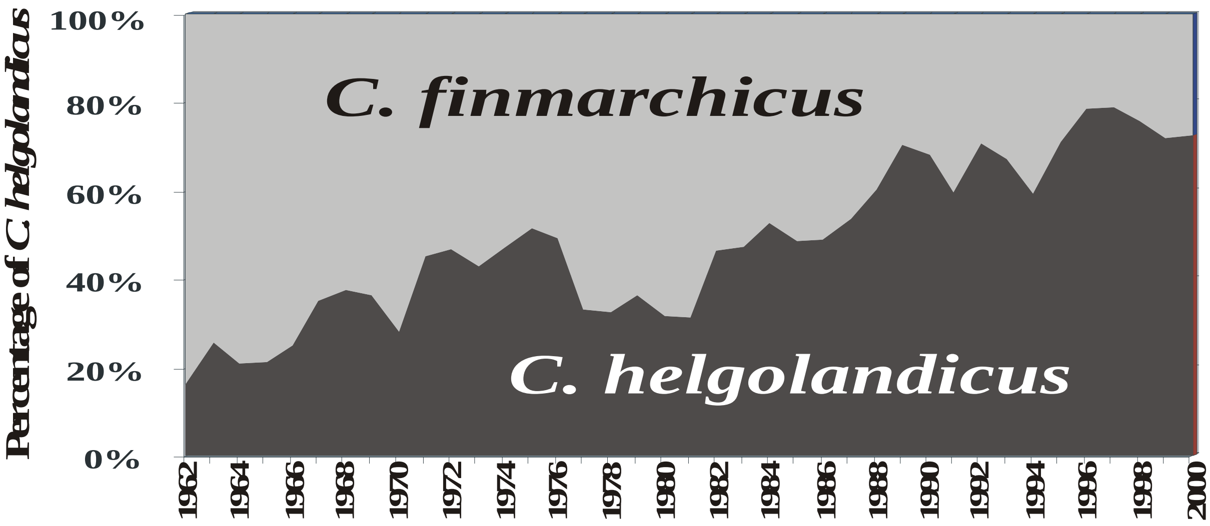
Data-sources: SAHFOS (CPR),...

Marine species composition

Marine species composition

past trends

- Northward shift of zooplankton species by up to 1 000 km and major reorganisation of plankton ecosystems over last 30 years
- Increase of presence and number of sub-tropical species in the North Sea over the last decade



future projection

- Further northward shift

Data-sources: SAHFOS (CPR), ...

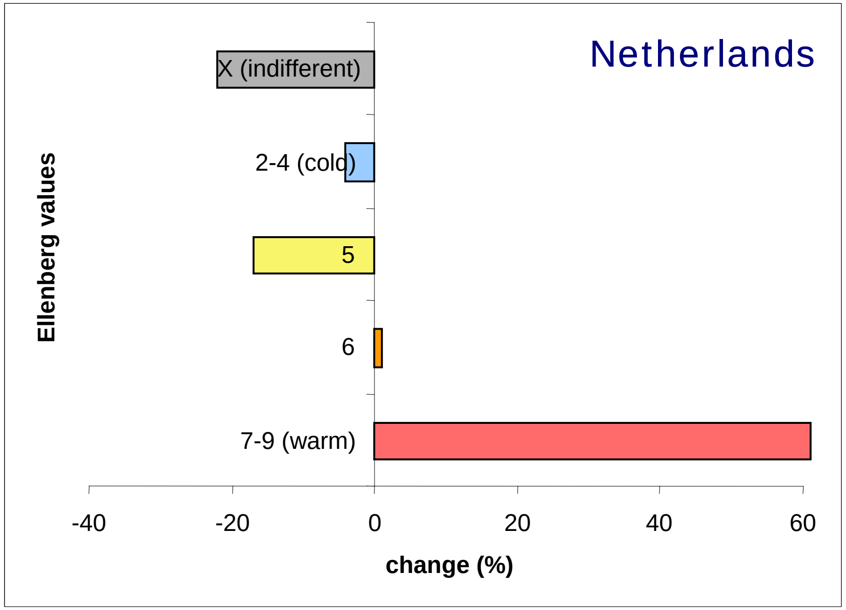
Terrestrial ecosystems and biodiversity

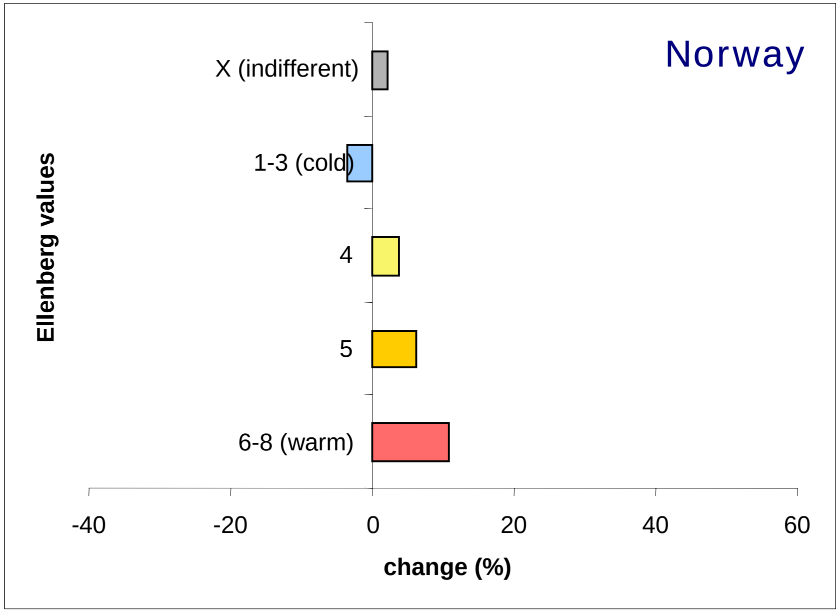
Plant species composition

Plant species composition

- Population decreases and disappearance of certain plant species
- Plant species diversity has increased in north-western Europe

past trends





Change in species composition (1975–1984 vs. 1985–1999)

- further northward movement of many plant species
- Non-climate related factors will limit the migration and adaptation capabilities

future projection

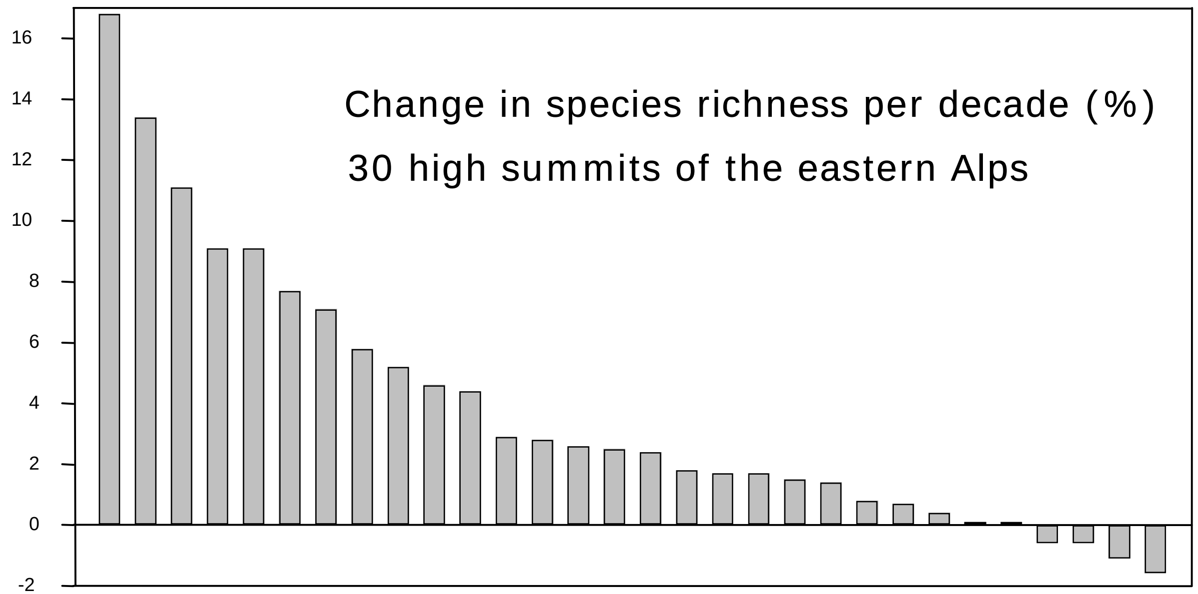
Data-sources: National data sets, IMAGE2/EuroMove, ATEAM, IPCC, ...

Plant species in mountains

Plant species in mountains

past trends

- Endemic mountain plant species are threatened to some extent
- Upward migration has led to an increase in plant species richness



future projection

- Considerable loss of endemic species in mountain regions is projected

Data-sources: GLORIA, IPCC, ...

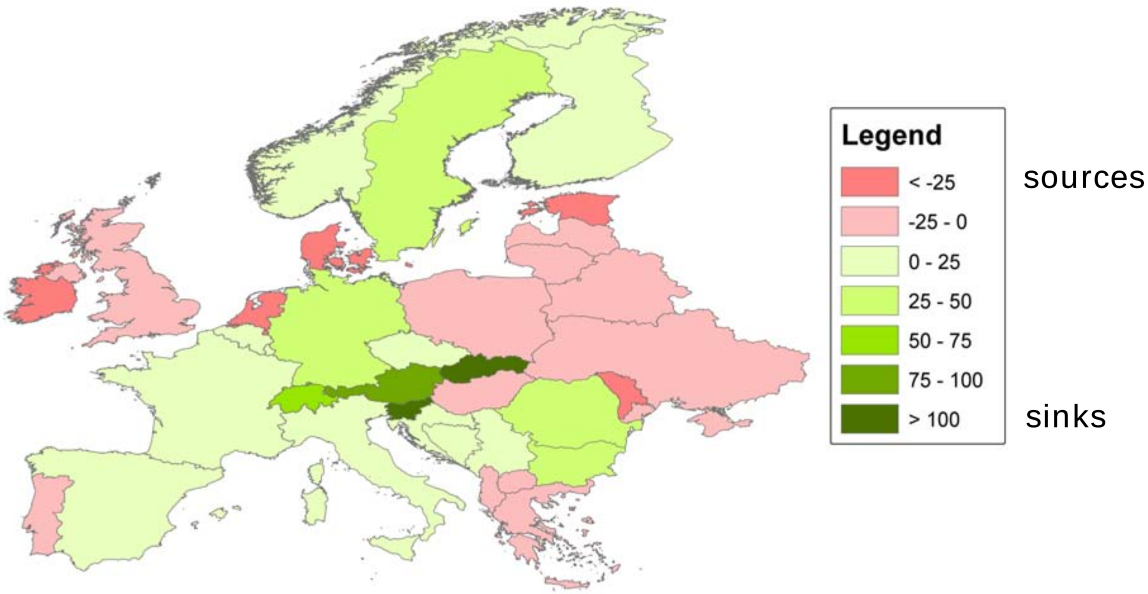
Terrestrial carbon uptake

Terrestrial carbon uptake

past trends

- 1990–1998 the European terrestrial biosphere was a net sink for carbon
- Additional potential storage capacity for the EU is relatively small

Change in terrestrial C stock (g m-2 land area a-1)



future projection

- Projected increase in temperature is likely to reduce this potential

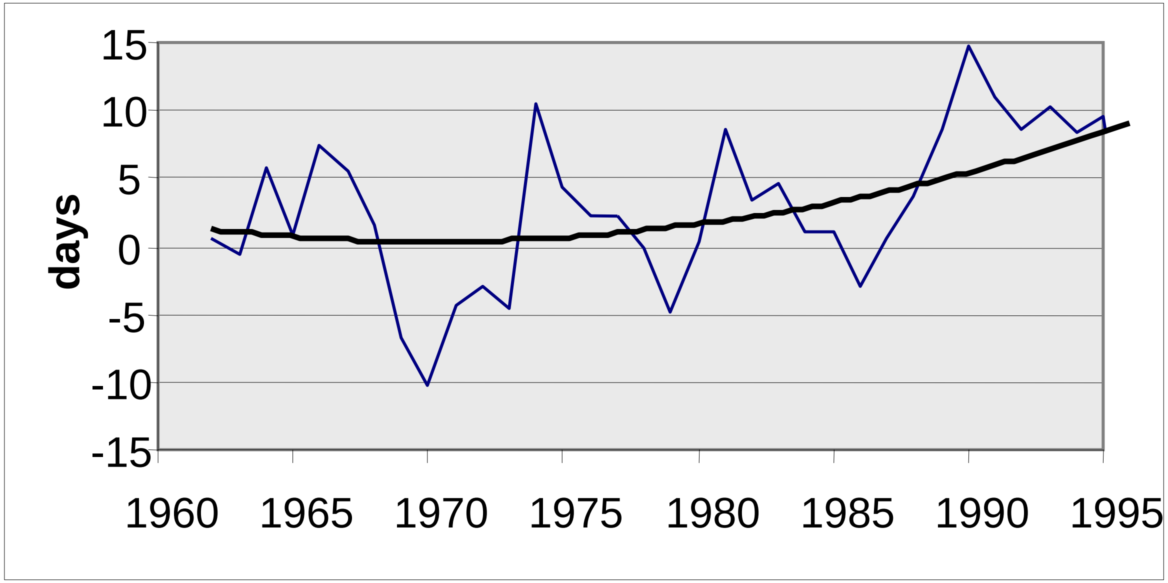
Data-sources: CarboEurope, ATEAM, IPCC, ...

Growing season & phenology

Growing season & phenology

past trends

- Growing season has extended by ≈10 days from 1962–1995
- ‘Greenness’ increased by 12% from 1982–1999



Observed changes in growing season length from 1962–1995

future projection

- Further extension of growing season
- Mid and northern Europe: increasing biomass production
- Southern Europe: risk of drought stress ⇒ decreasing production

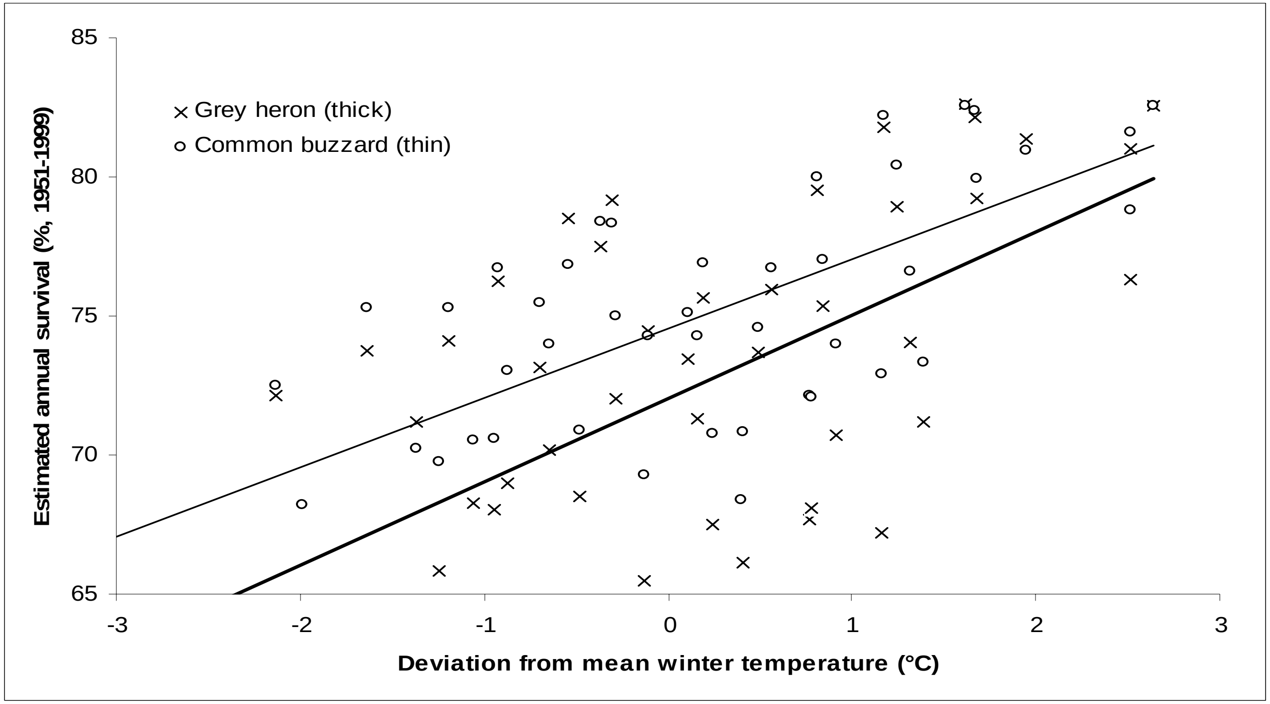
Data-sources: EPN, ATEAM, national phenological services, ...

Bird survival

Bird survival

• Survival of different bird species wintering in Europe has increased

past trends



Bird survival against deviation from mean winter temperature

• It is likely to increase further due to projected rise in winter temperature

• Not clear what impact increasing survival will have on bird populations

future projection

Data-sources: ETC/NPB, IPCC, …

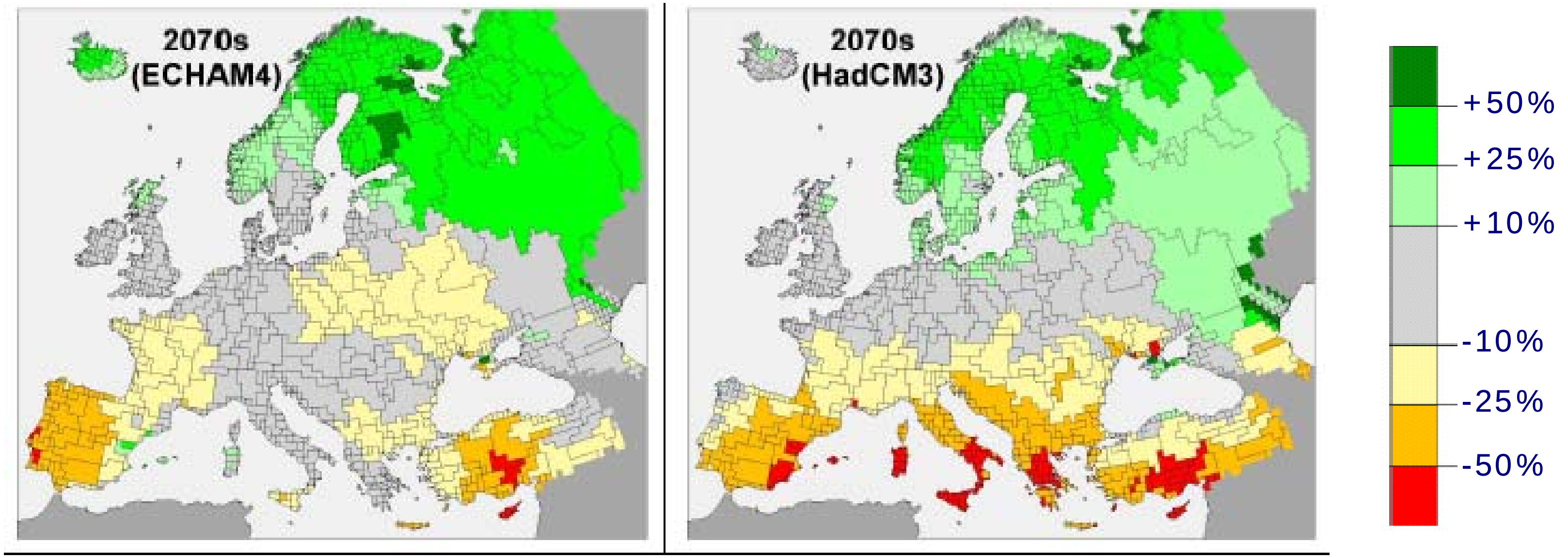
Water

River discharge

River discharge

past trends

- River discharge has changed over the last decades across Europe



- Projected changes in precipitation and temperature will mean further changes in river discharge
- Strong decline in southern and south-eastern Europe
- Increase in almost all parts of northern and north-eastern Europe

future projection

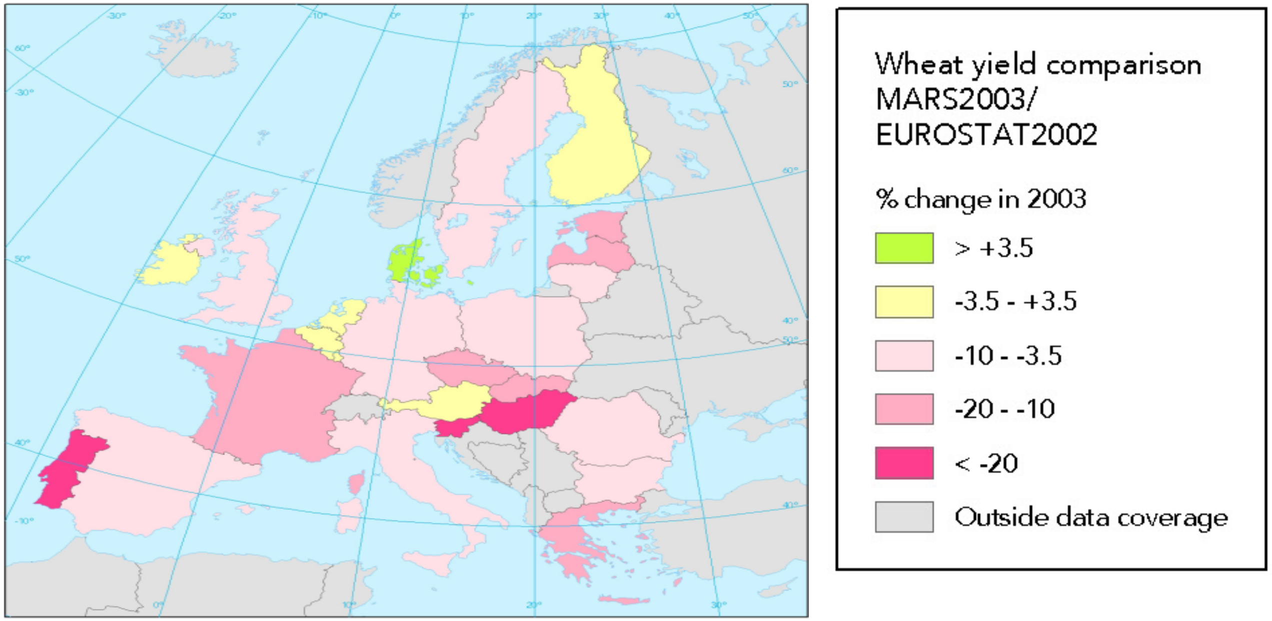
Data-sources: Center for Environmental Systems Research, national institutions

Agriculture

Crop yield

Crop yield

• Yields per hectare have increased in the last 40 years (tech. progress)



• Benefit from increasing CO_2 concentrations and rising temperatures
• Southern Europe: risk of more water stress
• More frequent bad harvests

past trends

future projection

Data-sources: FAO, EUROSTAT, MARS, IPCC, national services, ...

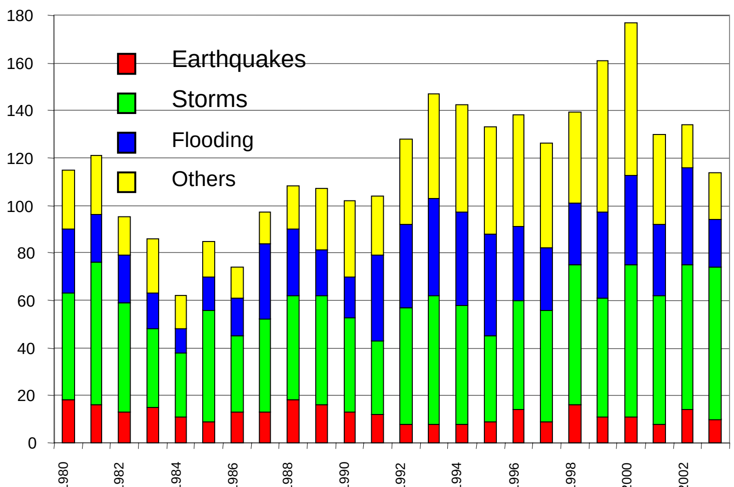
Economy

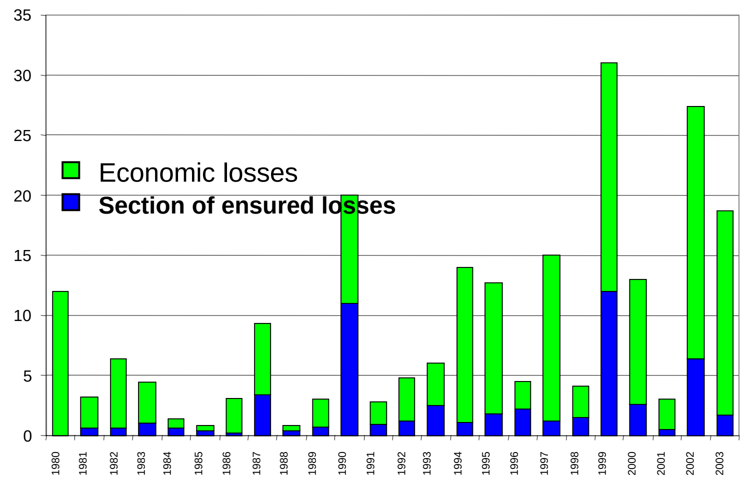
Economic losses

Economic losses

past trends

- 64% of all catastrophic events and 79 % of economic losses since 1980 attributable to weather and climate extremes
- Doubling of annual disastrous weather climate related events over 1990s
- Economic losses increased from decadal average less than 5 in the 1980s to about more than 11 billion US$ in 1990s)





- Increasing likelihood of extreme events ⇒ higher losses

future projection

Data-sources: Munich-Re, Swiss-Re, EMDAT (CRED), …

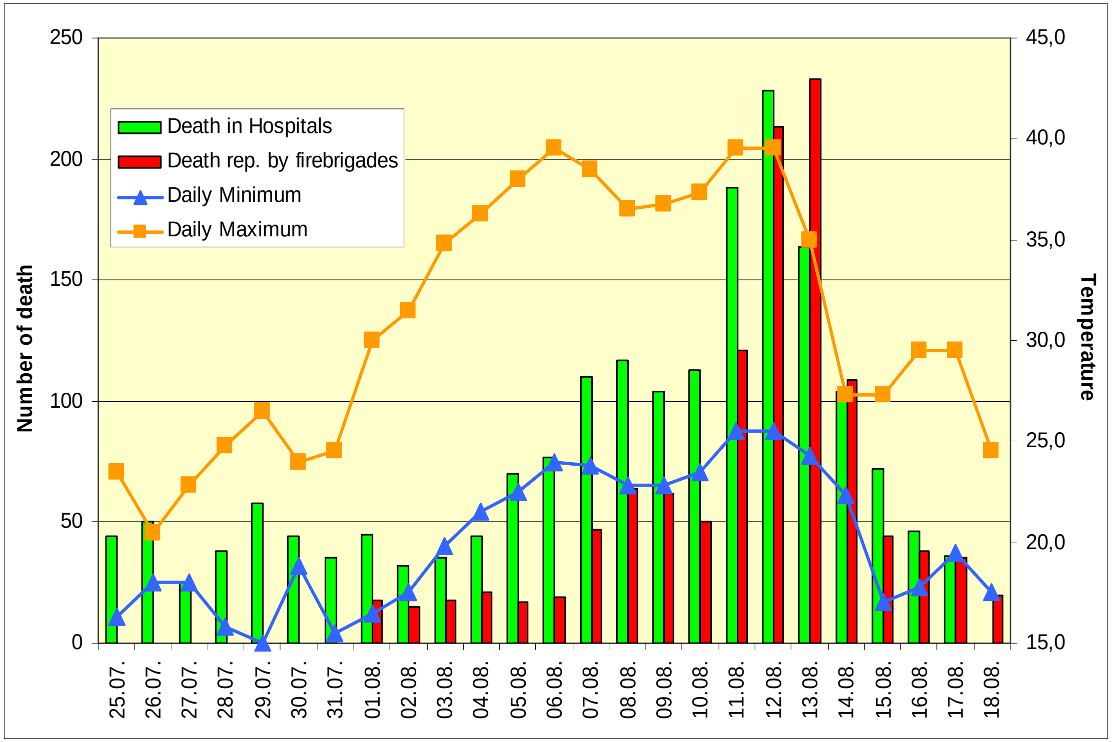
Human Health

Heat waves

Heat waves

past trends

- More than 20,000 excess deaths in Western and Southern Europe in the summer of 2003



(Daily number of excess death during the heatwave in summer 2003 in Paris)

future projection

- The number of excess deaths due to heat is projected to increase in the future

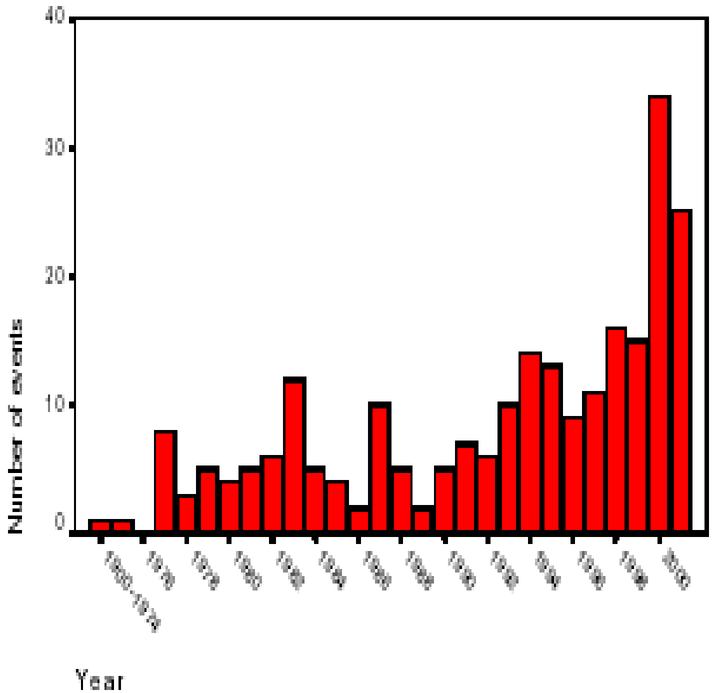
Data-sources: IVS, WHO, ...

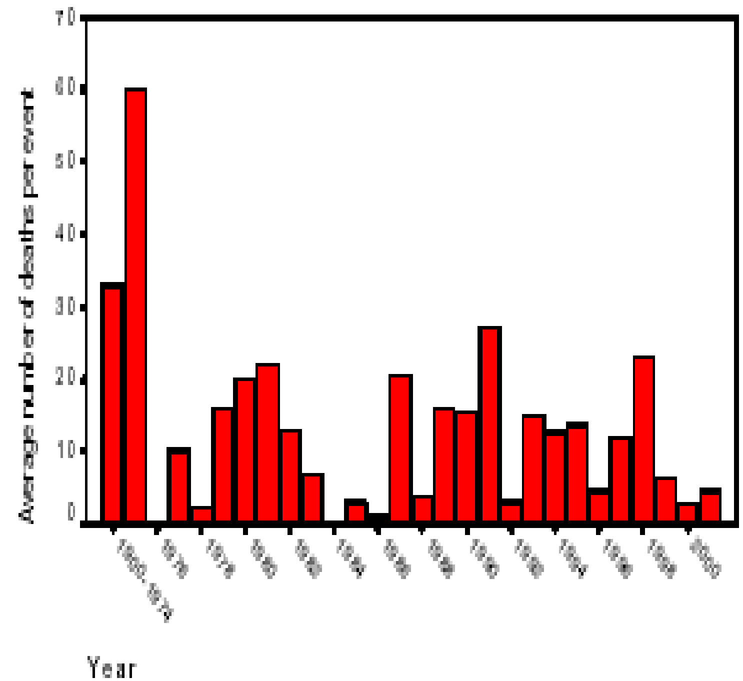
Flooding (Health)

Flooding (Health)

past trends

- Between 1975 and 2001 238 floods have been recorded
- The number of flood-events increased
- The number of deaths by flood events decreased





future projection

- Increasing likelihood of floods

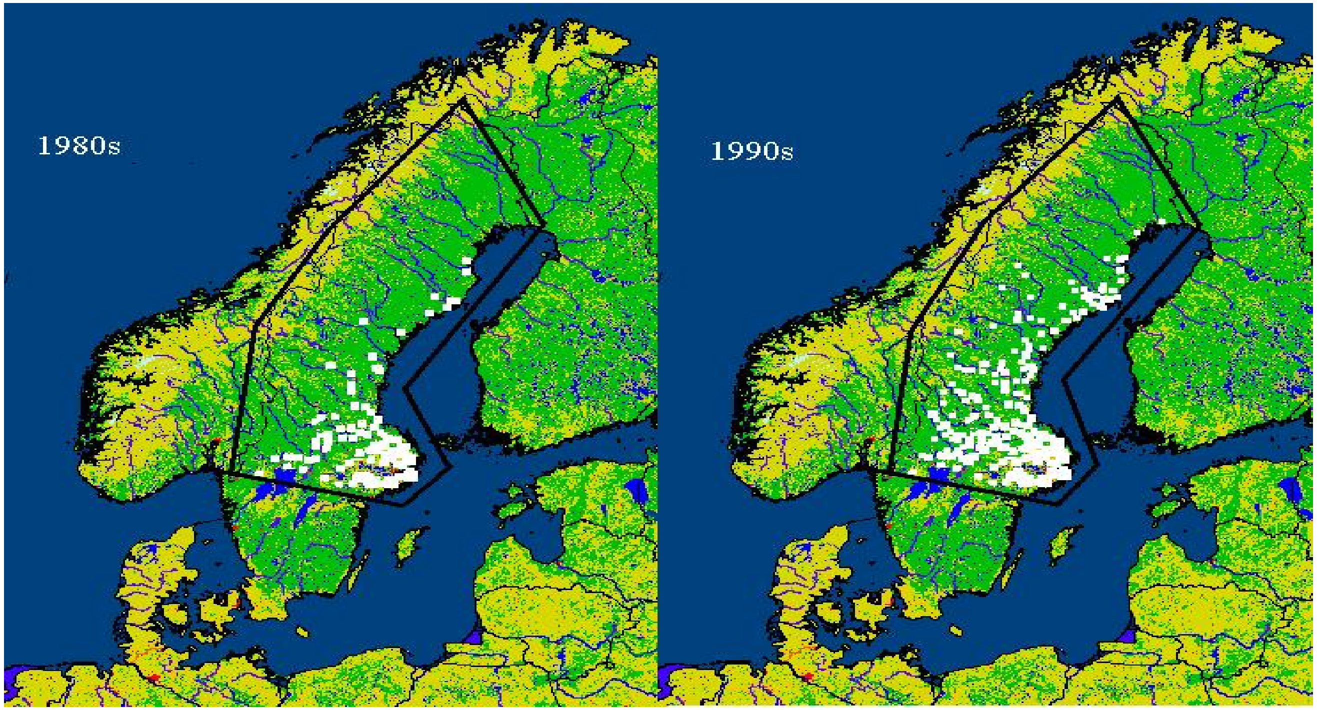
Data-sources: EMDAT(CRED), Munich-Re, Swiss-Re, ...

Tick borne diseases

Tick borne diseases

- Tick-borne encephalitis cases increased between 1980 and 1995 in the Baltic region and central Europe
- Unclear how many of 85 000 cases of Lyme borreliosis annually in Europe due to the temperature increase

past trends



- Projections uncertain

future projection

Data-sources: Univ. of Stockholm, SZU, …

European Environment Agency

Uncertainty

Past trends

- Data availability
  + atmosphere (temperature, precipitation etc.)
  – biodiversity, health, …
- Attribution to climate change, multiple forcing
  + temperature
  – climate extremes, biodiversity, health, agriculture, …

Future Projections

- Uncertainty about future emission of greenhouse gases
  e.g. CO_2 concentration 2100 (SRES): 540–970ppm (490–1260ppm)
- Gaps in knowledge (⇒uncertainty in models)
  + global temperature
  – regional precipitation, extremes
  – biodiversity, health, agriculture, …

But: all indicators show a clear trend, indicating that the impacts of climate change are already apparent in Europe.
More severe consequences are expected in future.

Impact, Adaptation, Vulnerability

exposure

sensitivity

adaptation,
adaptive capacity

impact

vulnerability

Outlook

- Publication of the report (late summer)
- Update of existing fact sheets on relevant indicators
- Preparation of fact sheets (and report?) on additional (mid-term)-indicators
- Cooperation with UEA in the EEA-project on vulnerability assessment

Internet:

ETC/ACC: **http://etc-acc.eionet.eu.int/**
EEA: **http://www.eea.eu.int/**