Uncertainty Concepts and IPCC

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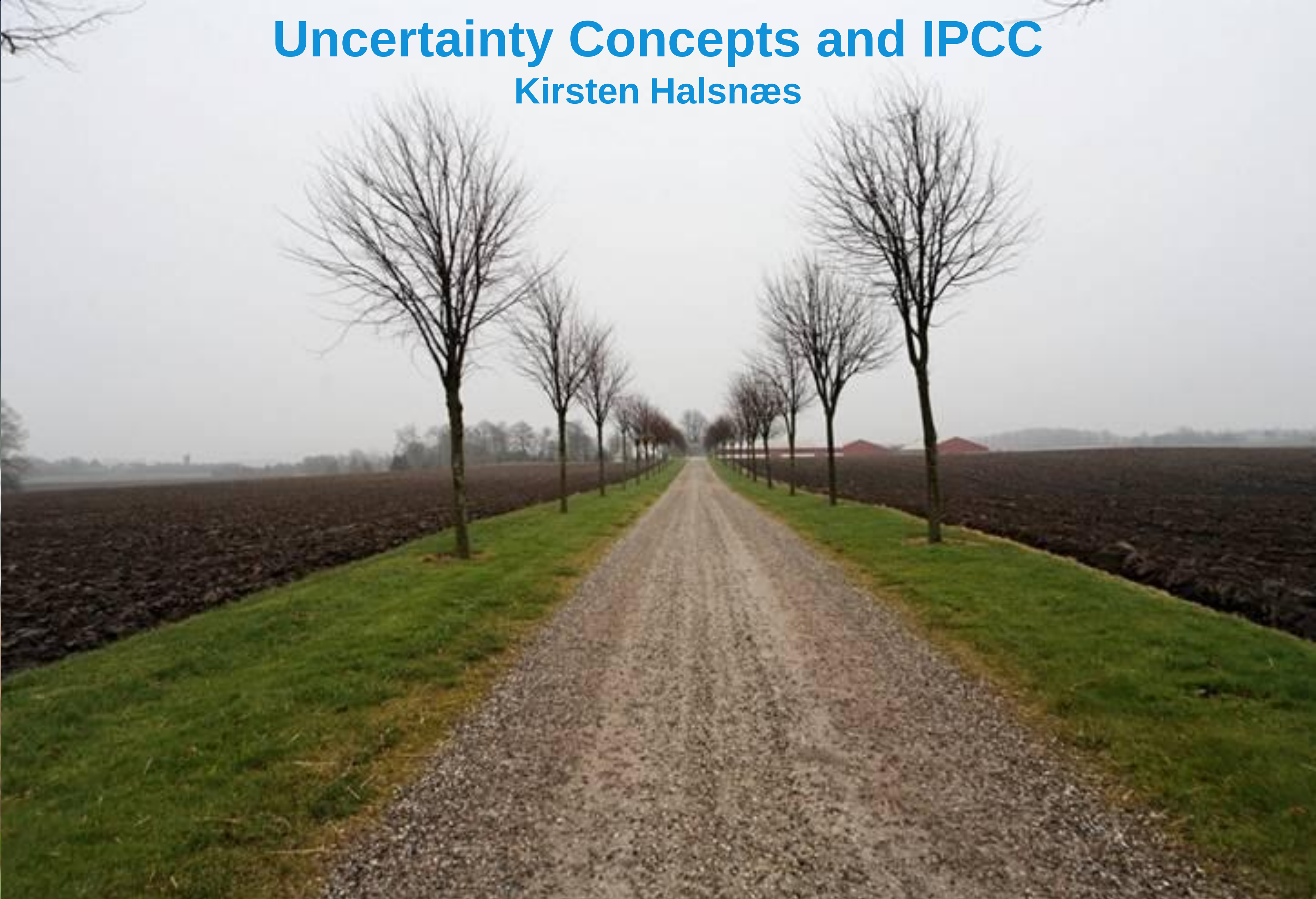
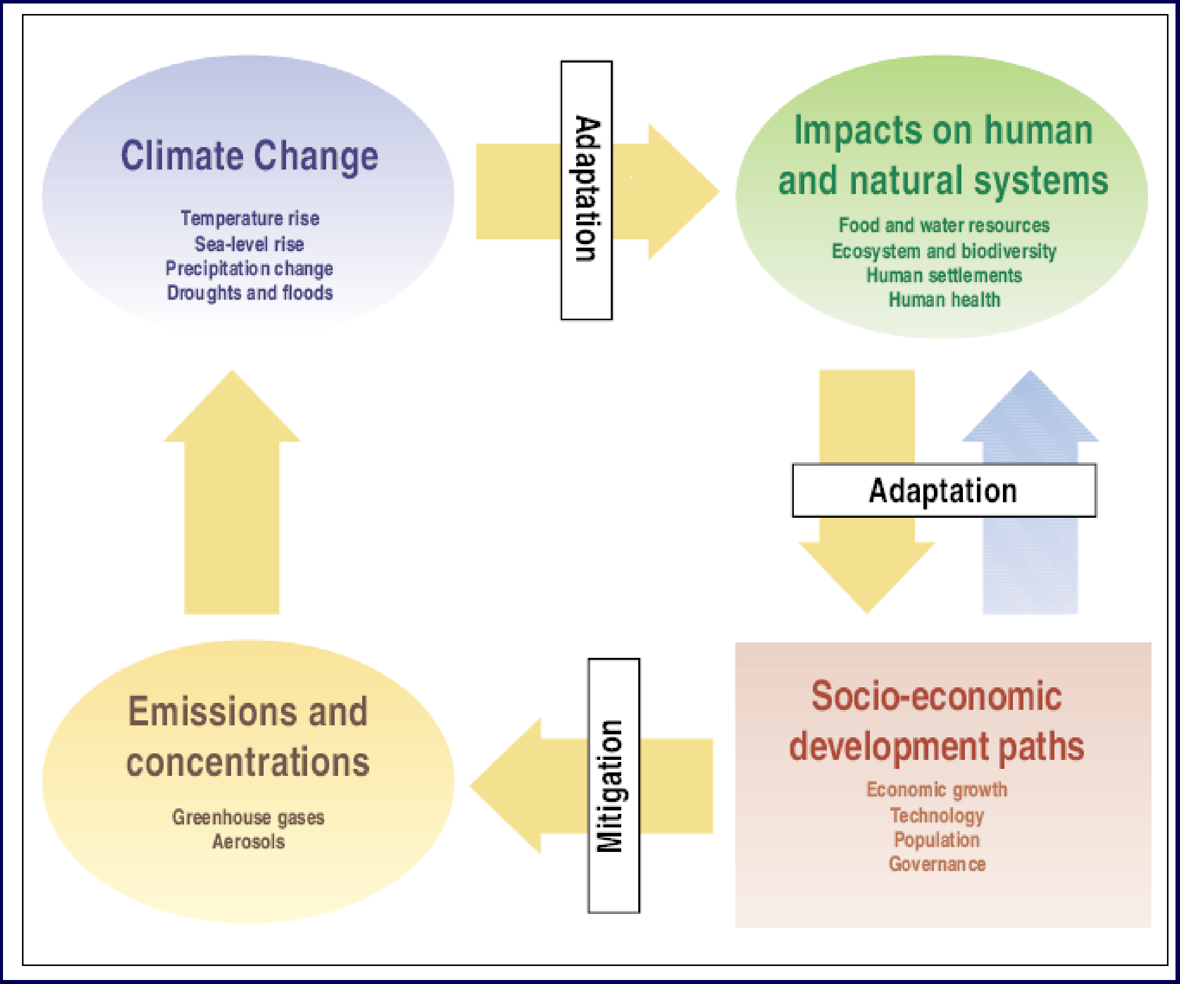




Climate Change
Temperature rise
Sea-level rise
Precipitation change
Droughts and floods
Adaptation
Impacts on human and natural systems
Food and water resources
Ecosystem and biodiversity
Human settlements
Human health
Adaptation
Socio-economic development paths
Economic growth
Technology
Population
Governance
Mitigation
Emissions and concentrations
Greenhouse gases
Aerosols

Table 1. A simple typology of uncertainties

Type	Indicative examples of sources	Typical approaches or considerations
Unpredictability	Projections of human behaviour not easily amenable to prediction (e.g. evolution of political systems). Chaotic components of complex systems.	Use of scenarios spanning a plausible range, clearly stating assumptions, limits considered, and subjective judgments. Ranges from ensembles of model runs.
Structural uncertainty	Inadequate models, incomplete or competing conceptual frameworks, lack of agreement on model structure, ambiguous system boundaries or definitions, significant processes or relationships wrongly specified or not considered.	Specify assumptions and system definitions clearly, compare models with observations for a range of conditions, assess maturity of the underlying science and degree to which understanding is based on fundamental concepts tested in other areas.
Value uncertainty	Missing, inaccurate or non-representative data, inappropriate spatial or temporal resolution, poorly known or changing model parameters.	Analysis of statistical properties of sets of values (observations, model ensemble results, etc); bootstrap and hierarchical statistical tests; comparison of models with observations.

A *level of confidence*, as defined in Table 3, can be used to characterize uncertainty that is based on expert judgment as to the correctness of a model, an analysis or a statement. The last two terms in this scale should be reserved for areas of major concern that need to be considered from a risk or opportunity perspective, and the reason for their use should be carefully explained.

Table 3. Quantitatively calibrated levels of confidence.

Terminology	Degree of confidence in being correct
Very High confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Box 2.1 Risk and uncertainty vocabulary used in this report

Uncertainty cannot always be quantified, and thus the vocabulary displayed in Table 2.2 is used to qualitatively describe the degree of scientific understanding behind a finding or about an issue. See text for discussion of Table 2.2's dimensions, the amount of evidence and the level of agreement.

Tabel 2.2: *Qualitative definition of uncertainty*

Level of agreement (on a particular finding) ↑			
	High agreement, limited evidence	High agreement, medium evidence	High agreement, much evidence
	Medium agreement, limited evidence	Medium agreement, medium evidence	Medium agreement, much evidence
	Low agreement, limited evidence	Low agreement, medium evidence	Low agreement, much evidence

Amount of evidence (number and quality of independent sources) →

Source: IPCC Guidance Notes on risk and uncertainty (2005).

The understanding of anthropogenic warming and cooling influences on climate has improved since the TAR, leading to *very high confidence*[7] that the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W m^{-2} (see Figure SPM.2). {2.3., 6.5, 2.9}

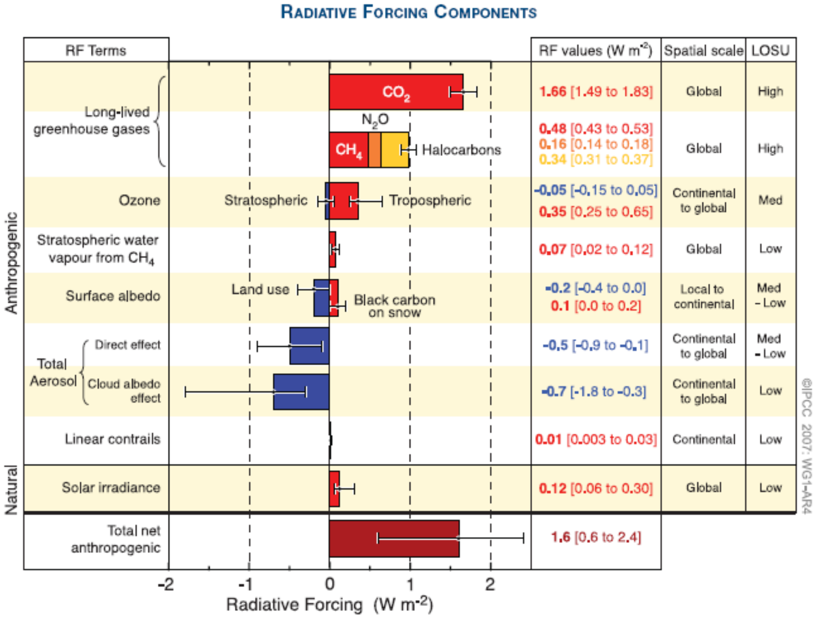


Figure SPM.2. *Global average radiative forcing (RF) estimates and ranges in 2005 for anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms, and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness. {2.9, Figure 2.20}*

. In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur. Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels (see Table SPM.5, and Figure SPM. 8)[26] (*high agreement, much evidence*).

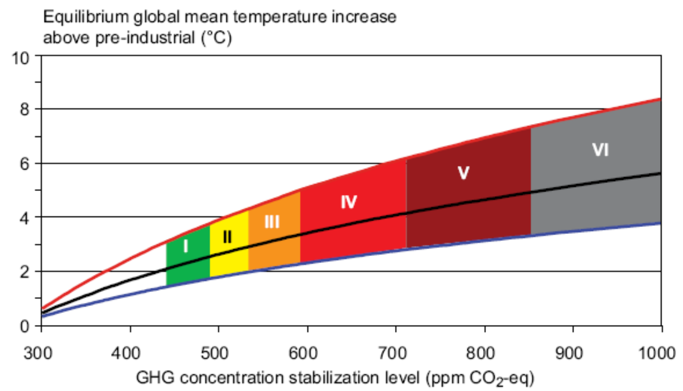


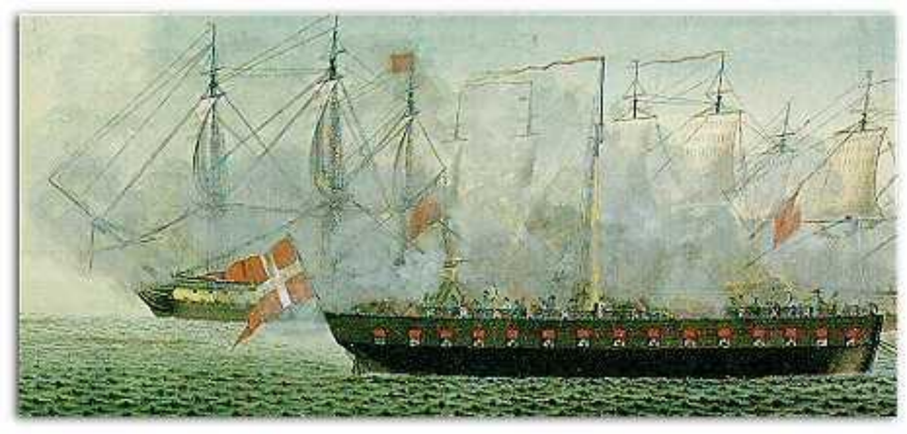
Figure SPM.8: *Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3°C (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5°C (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2°C (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories I to VI as indicated in Figure SPM.7. The data are drawn from AR4 WGI, Chapter 10.8.*

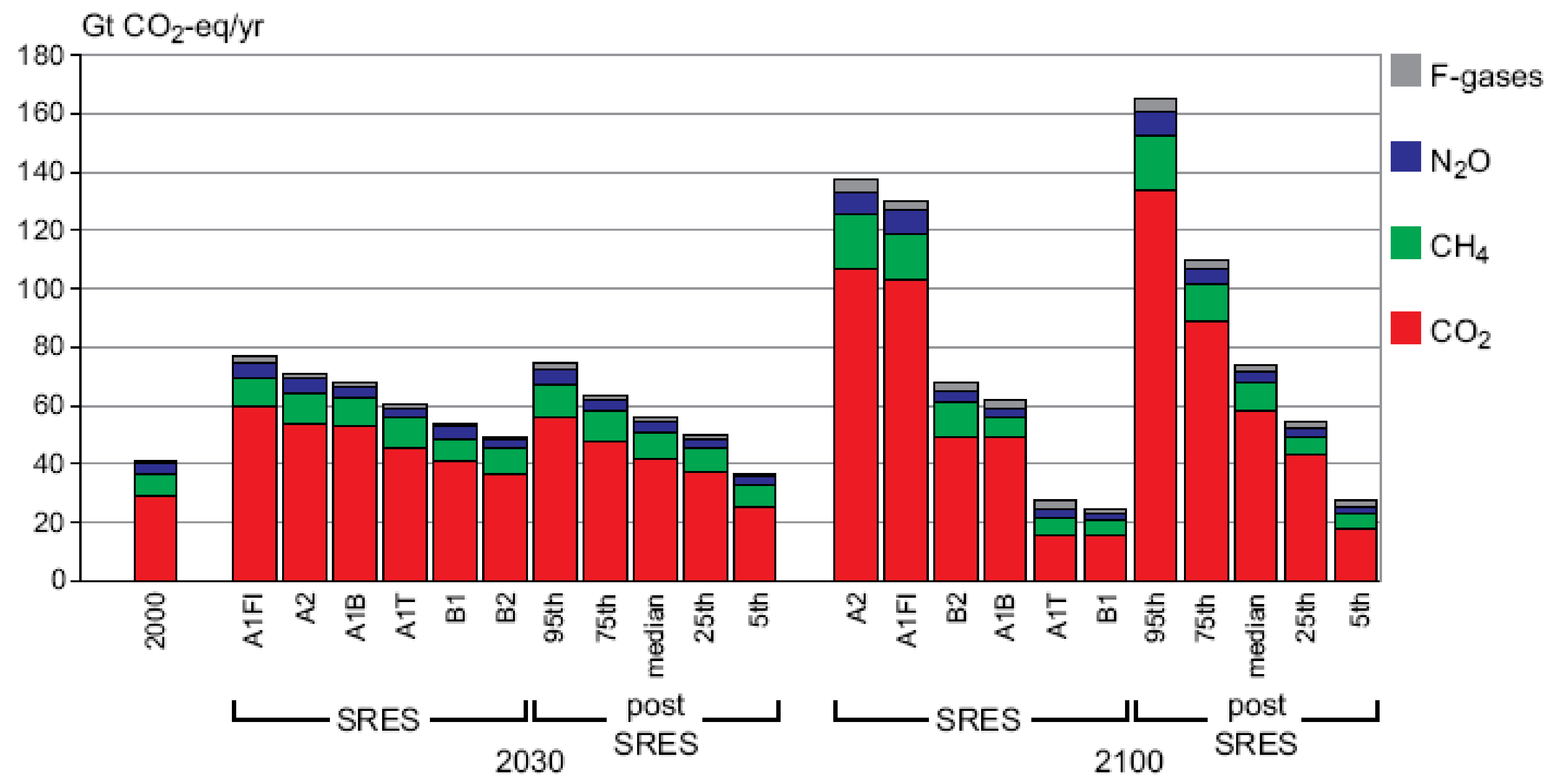
Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (Figure SPM.1). *{1.1}*

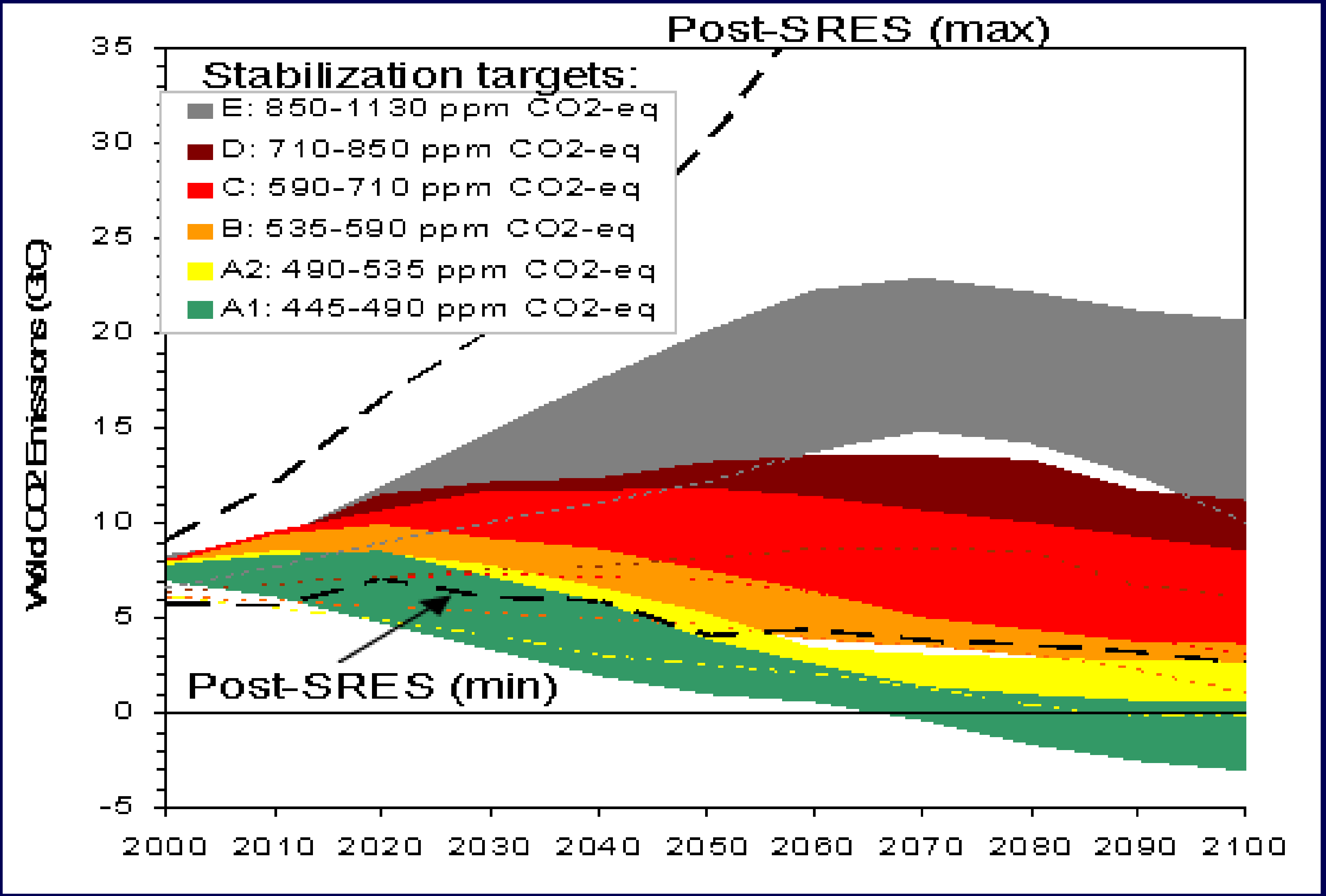
Determining what constitutes "dangerous anthropogenic interference with the climate system" in relation to Article 2 of the UNFCCC involves value judgements. Science can support informed decisions on this issue, including by providing criteria for judging which vulnerabilities might be labelled 'key'. *{Box 'Key Vulnerabilities and Article 2 of the UNFCCC', Topic 5}*

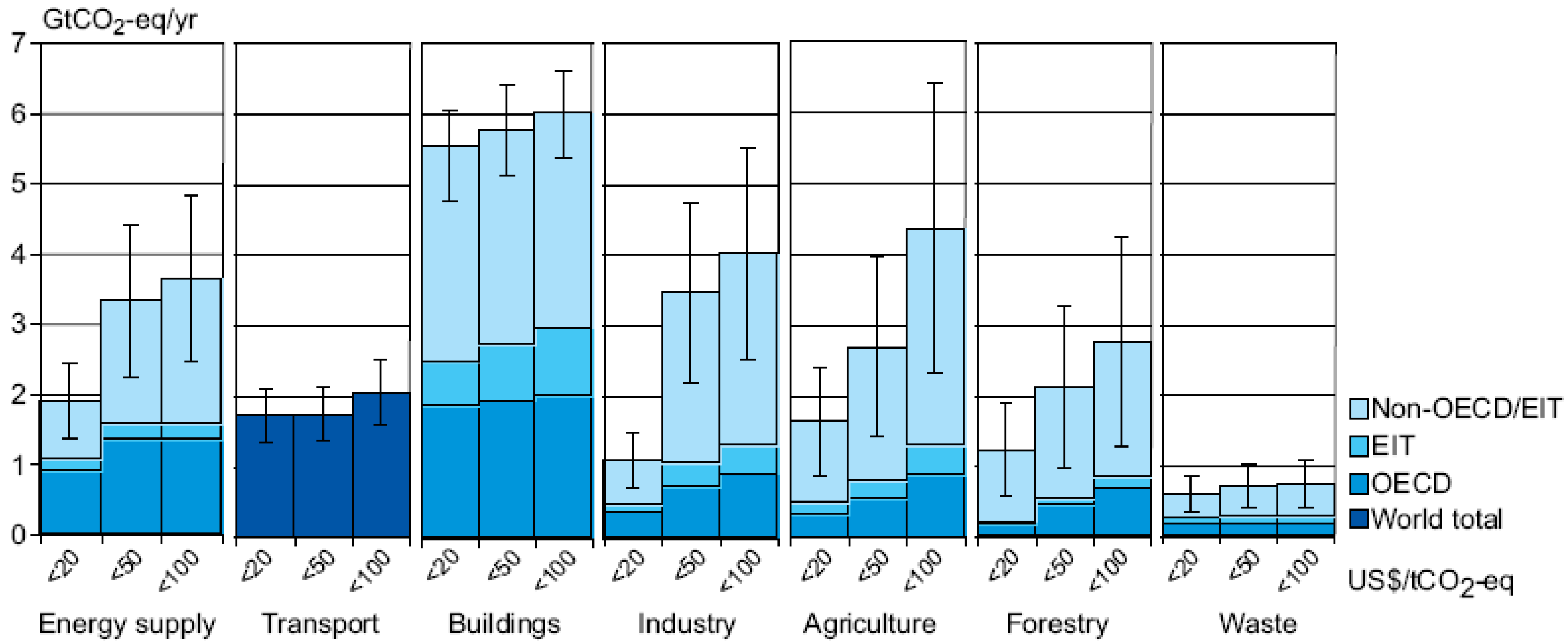
Responding to climate change involves an iterative risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity and attitudes to risk. *{5.1}*

It is not always very easy to predict……




Gt CO2-eq/yr
180
160
140
120
100
80
60
40
20
0
F-gases
N2O
CH4
CO2
2000
A1FI
A2
A1B
A1T
B1
B2
95th
75th
median
25th
5th
A2
A1FI
B2
A1B
A1T
B1
95th
75th
median
25th
5th
SRES
post SRES
2030
SRES
post SRES
2100


Post-SRES (max)
Stabilization targets:
E: 850-1130 ppm CO2-eq
D: 710-850 ppm CO2-eq
C: 590-710 ppm CO2-eq
B: 535-590 ppm CO2-eq
A2: 490-535 ppm CO2-eq
A1: 445-490 ppm CO2-eq
Post-SRES (min)
World CO2 Emissions (GtC)
35
30
25
20
15
10
5
0
-5
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100

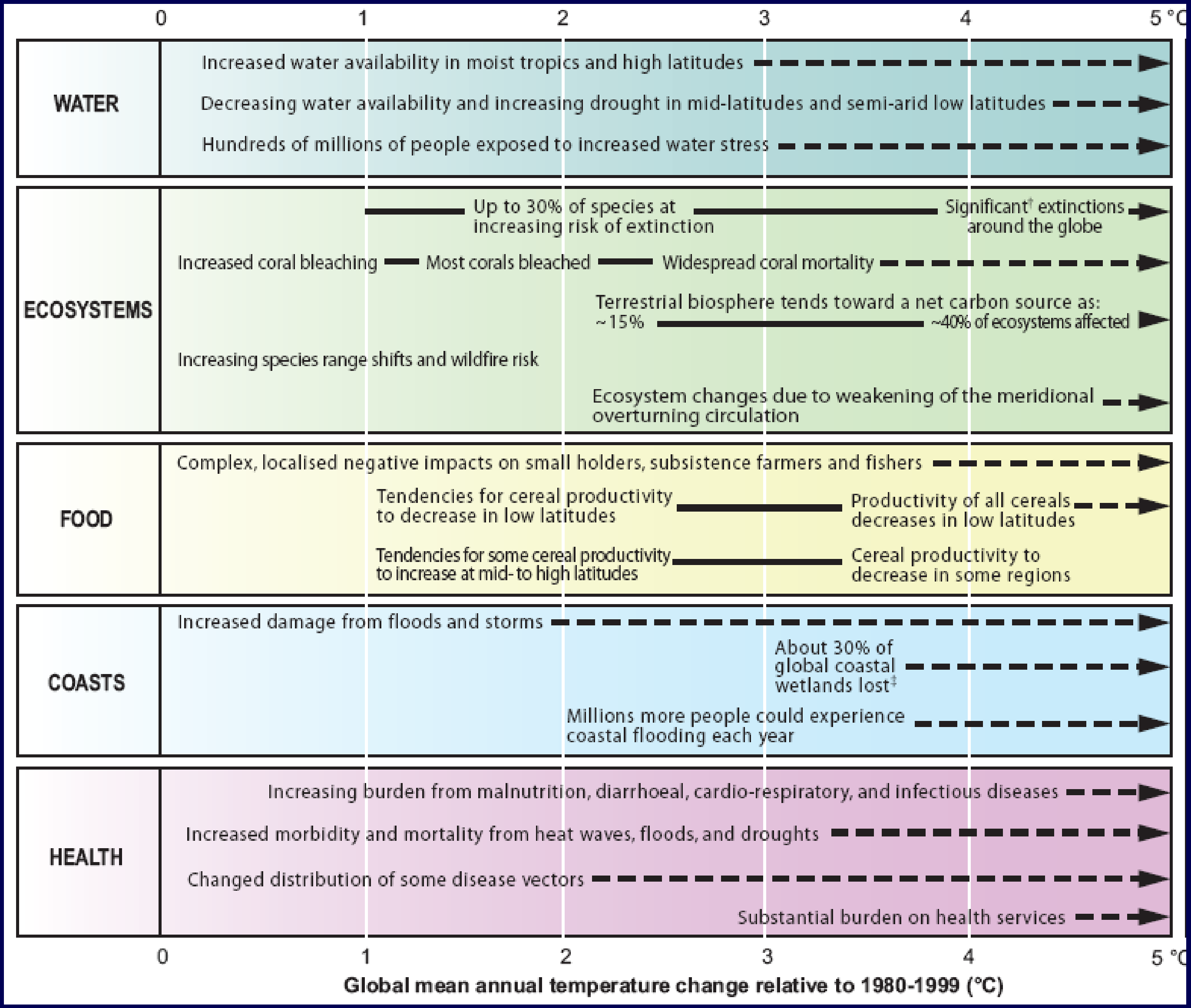


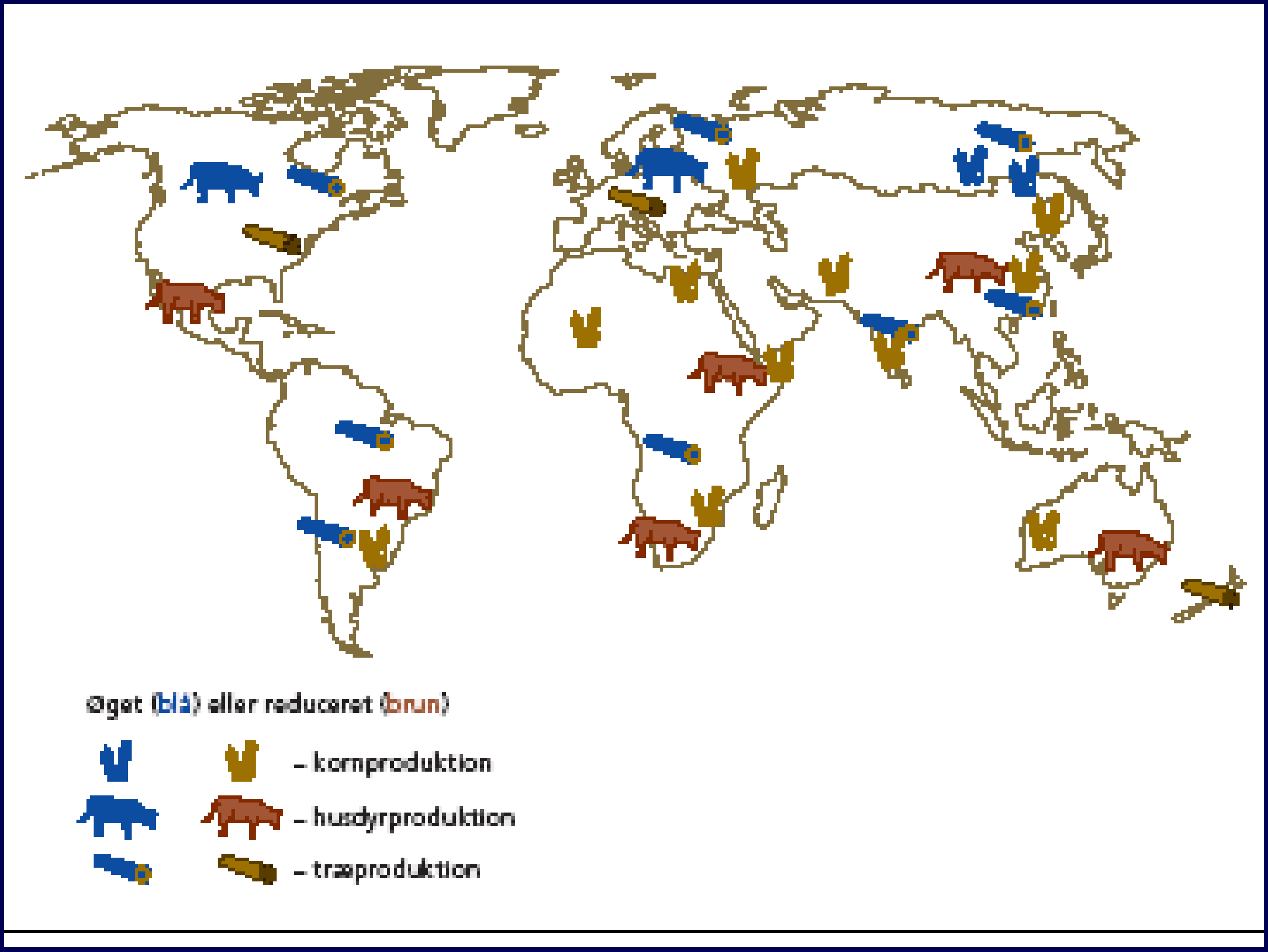
(potential at <US$100/ tCO_2-eq: 2.4 - 4.7 Gt CO_2-eq/yr)	*(potential at <US$100/ tCO_2-eq: 1.6 - 2.5 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 5.3 -6.7 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 2.5 - 5.5 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 2.3 -6.4 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 1.3 - 4.2 Gt CO_2-eq/yr)*	*(potential at <US$100/ tCO_2-eq: 0.4 - 1 Gt CO_2-eq/yr)*

Figure SPM.6: *Estimated sectoral economic potential for global mitigation for different regions as a function of carbon price in 2030 from bottom-up studies, compared to the respective baselines assumed in the sector assessments. A full explanation of the derivation of this figure is found in Section 11.3.*

Mitigation Costs

- Kyoto: 2008-2012 GHG emissions 5,5 % below 1990 level for industrialised countries:
  - 0,1-1% of GDP, IPCC 3. Assessment
- 3^0C stabilization scenario. 2050 cost:
  - 1,3% of GDP, IPCC 4. Assessment
- 2^0C stabilization. 2050 costs:
  - 5,5% of GDP, IPCC 4. Assessment
- Costs of climate change impacts:
  - 3% of GDP BNP in 2100 for 3^0C scenario, Nordhaus and Tol
  - 5% of GDP in 2100 for 3^0C scenario, Stern


0 1 2 3 4 5 °C
WATER
Increased water availability in moist tropics and high latitudes
Decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes
Hundreds of millions of people exposed to increased water stress
ECOSYSTEMS
Up to 30% of species at increasing risk of extinction
Significant† extinctions around the globe
Increased coral bleaching
Most corals bleached
Widespread coral mortality
Terrestrial biosphere tends toward a net carbon source as:
~15%
~40% of ecosystems affected
Increasing species range shifts and wildfire risk
Ecosystem changes due to weakening of the meridional overturning circulation
FOOD
Complex, localised negative impacts on small holders, subsistence farmers and fishers
Tendencies for cereal productivity to decrease in low latitudes
Productivity of all cereals decreases in low latitudes
Tendencies for some cereal productivity to increase at mid- to high latitudes
Cereal productivity to decrease in some regions
COASTS
Increased damage from floods and storms
About 30% of global coastal wetlands lost‡
Millions more people could experience coastal flooding each year
HEALTH
Increasing burden from malnutrition, diarrhoeal, cardio-respiratory, and infectious diseases
Increased morbidity and mortality from heat waves, floods, and droughts
Changed distribution of some disease vectors
Substantial burden on health services
0 1 2 3 4 5 °C
Global mean annual temperature change relative to 1980-1999 (°C)


Øget (blå) eller reduceret (brun)
– kornproduktion
– husdyrproduktion
– træproduktion

Uncertainties Related to Developing Countries

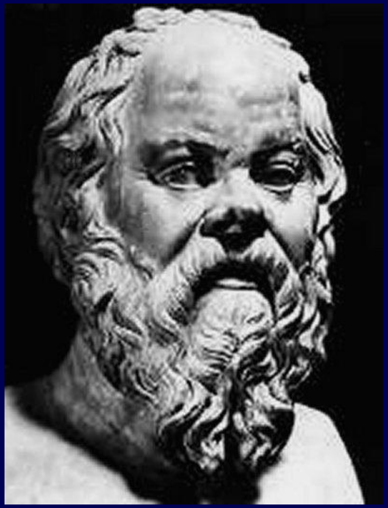
- Detailed Climate data is absent
- Short term forecasts are particularly valuable (precipitation)
- Climate change vulnerability follows from development issues
- Many development projects focus on climate sensitive sectors like water, agriculture, infrastructure, and health

Time and Economic Valuation

- The utility of present generations related to activities causing GHG emissions has an impact on the utility of future generations
- Valuation of future assets are based on the preferences of present generations
- What is the utility of our ancestors of wetlands, churces, nature habitats etc, etc.:
  - Higher due to increasing income?
  - Lower due to new lifestyle patters?
  - Based on substitutes?
- What should present generations be willing to pay today to save environmental values for the future?

Conclusions

- Climate is a multi disciplinary subject involving a broad range of uncertainty concepts
- Mitigation costs are covered by many studies, high degree of consensus
- Climate change impacts and adaptation costs are covered by few studies. There are little consensus, and “deep” uncertainty issues relate to theoretical and methodological limitations
- Uncertainties can be reduced by specific multidisciplinary studies of climate impacts: Water management, agriculture, health, infrastructure etc.



Sokrates: I know, what I do not know