CLIMATE CHANGE AND SUSTAINABILITY

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Outline

-Drivers of unsustainability

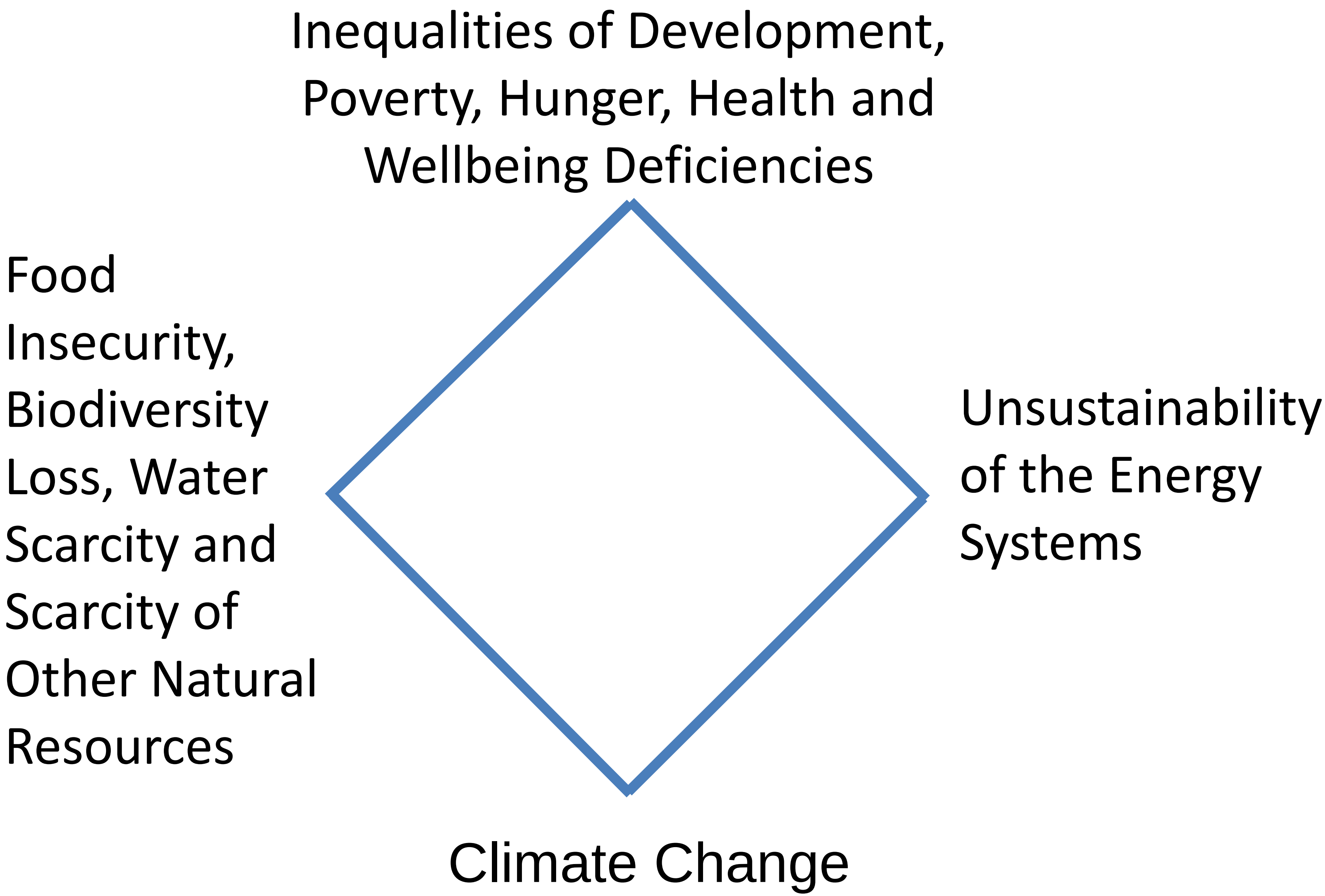
-Planetary boundaries

-Natural resources scarcity

-Climate change: Mitigation and Adaptation

-Climate change mitigation and adaptation at the local level

The Square of Unsustainability



ENERGY SUSTAINABILITY

- Access to energy sources

- Price and competitiveness

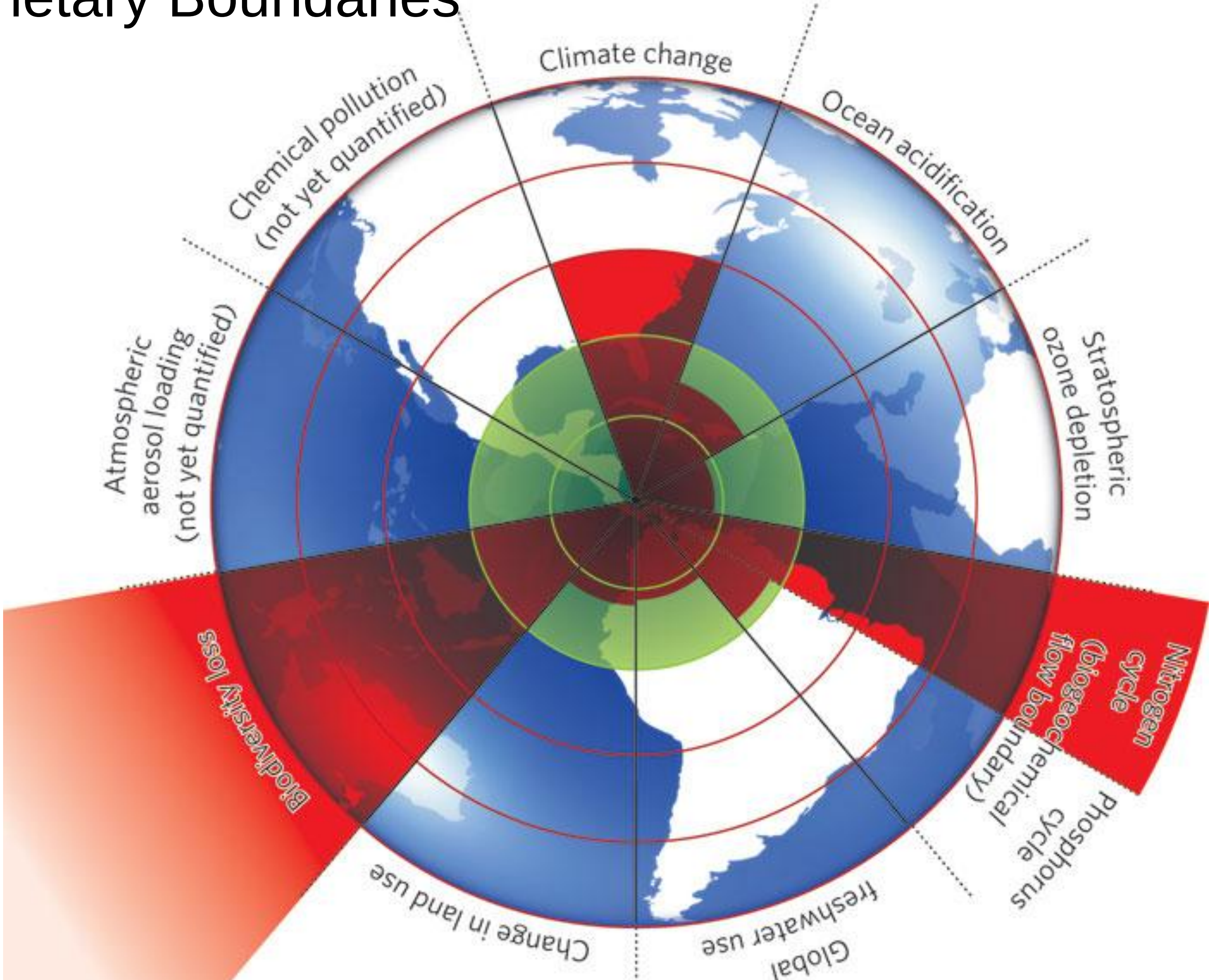
- Environmental compatibility.

Approximately 80% of the world energy primary sources are fossil fuels – This strong dependence implies a strong connection between energy and climate change

-All 4 drivers of unsustainability are strongly interconnected and interdependent

-To reach sustainable development the 4 drivers should be simultaneously addressed

Planetary Boundaries



SOURCE: J. Rockstrom et al.,Nature, 461(2009) 472, 24 September

GMO Commodity Index: The Great Paradigm Shift SOURCE GMO LLC

Note: The GMO commodity index is an index comprised of the following 33 commodities, equally weighted at initiation: aluminum, coal, coconut oil, coffee, copper, corn, cotton, diammonium phosphate, flaxseed, gold, iron ore, jute, lard, lead, natural gas, nickel, oil, palladium, palm oil, pepper, platinum, plywood, rubber, silver, sorghum, soybeans, sugar, tin, tobacco, uranium, wheat, wool, zinc.

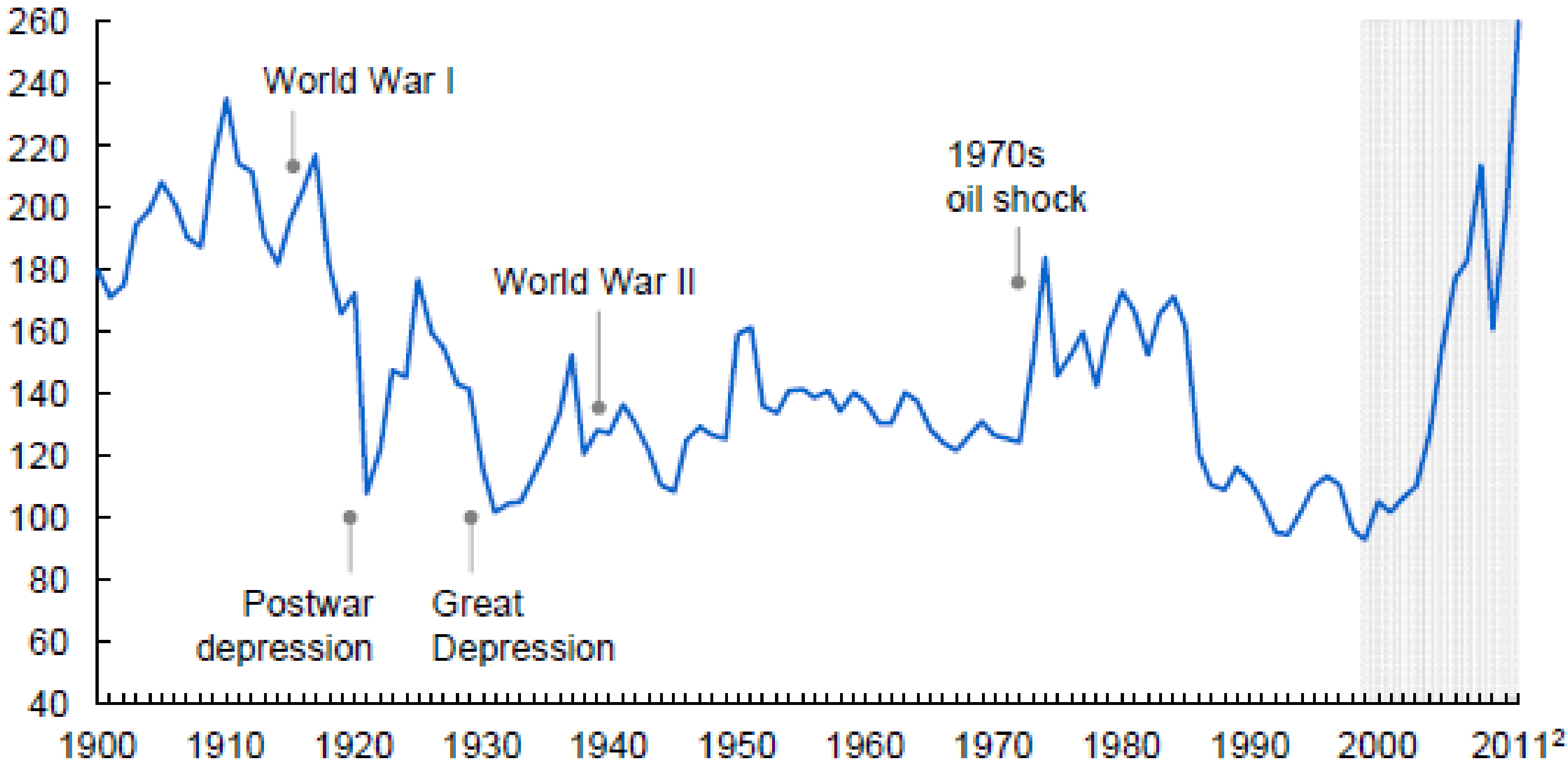
Source: GMO As of 2/28/11

SOURCE: World Bank, IMF, FAO, OECD, McKinsey

Exhibit E1

Commodity prices have increased sharply since 2000, erasing all the declines of the 20th century

MGI Commodity Price Index (years 1999–2001 = 100)[1]

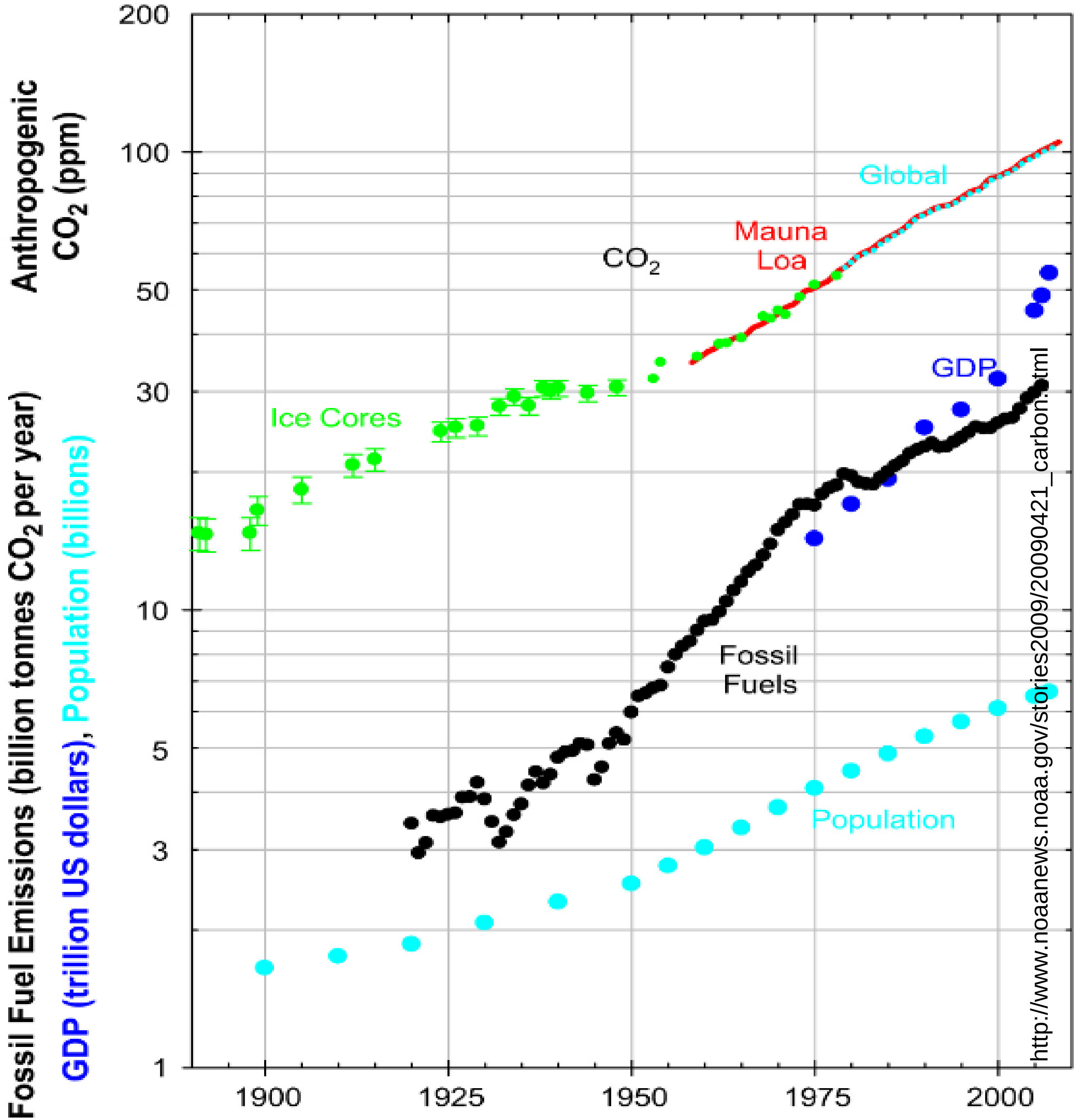


1 See the methodology appendix for details of the MGI Commodity Price Index.
2 2011 prices are based on average of the first eight months of 2011.

SOURCE: Grilli and Yang; Stephan Pfaffenzeller; World Bank; International Monetary Fund (IMF); Organisation for Economic Co-operation and Development (OECD); UN Food and Agriculture Organization (FAO); UN Comtrade; McKinsey analysis

Anthropogenic atmospheric carbon dioxide, fossil fuel emissions, world gross domestic product (GDP), and world population for the past century. Carbon dioxide data from Antarctic ice cores (green points), Mauna Loa Observatory (red curve), and the global network (blue dots).

SOURCE: NOOA, April 2009



Fonte: NOOA, April 2009

Extreme Energy – Energia Extrema

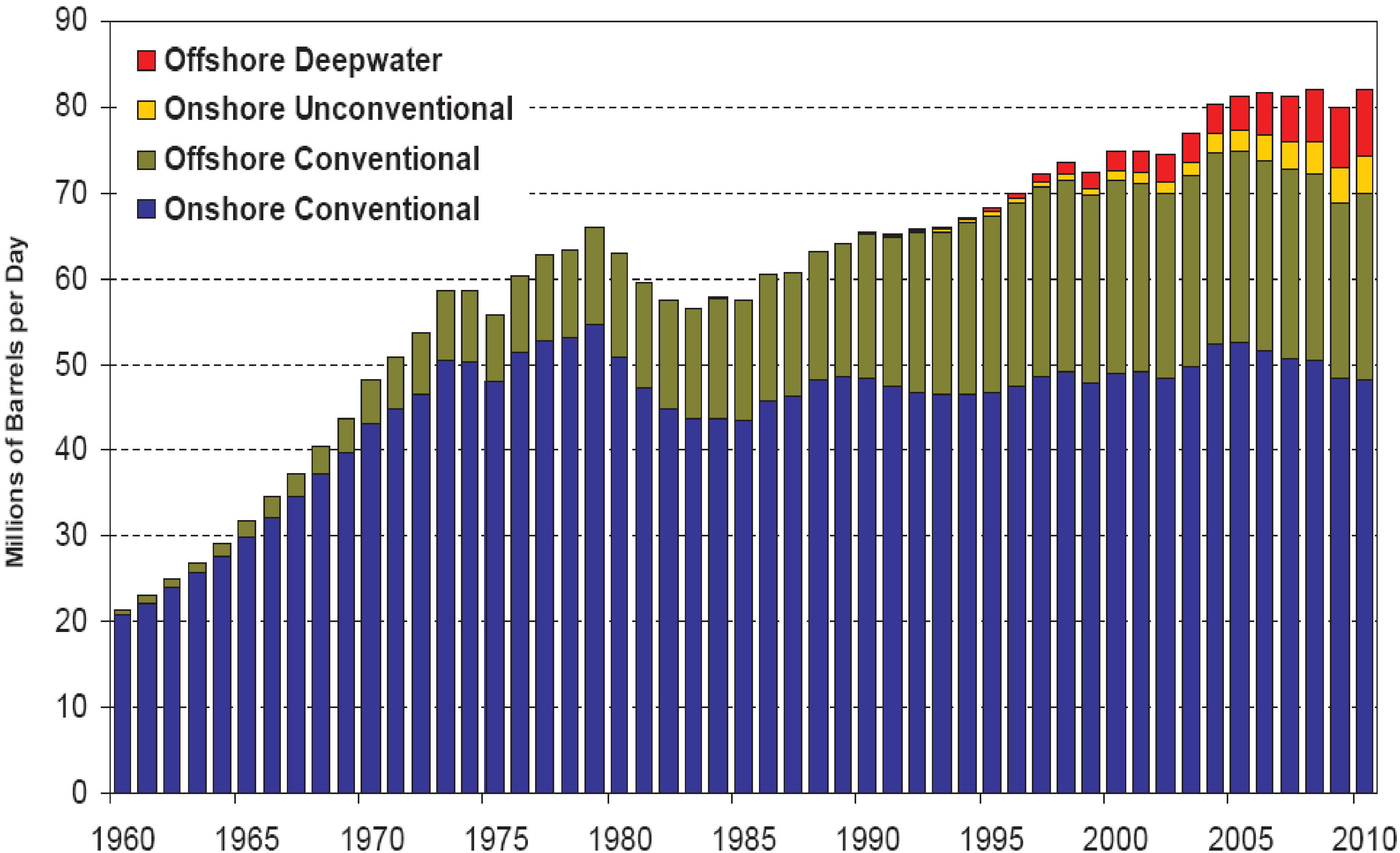
Unconvencional oil – Petróleo Não Convencional

Oil sands – Areias betuminosas (Canadá)
Tight oil – Xistos petrolíferos (Dakota do Norte, EUA)
Offshore deepwater – Offshore muito profundo (Brasil e EUA - Golfo do México)

Unconventional gas – Gás Não Convencional

Shale gas – Gás de xisto (EUA)

Global Oil Production – Onshore and Offshore, Conventional and Unconventional

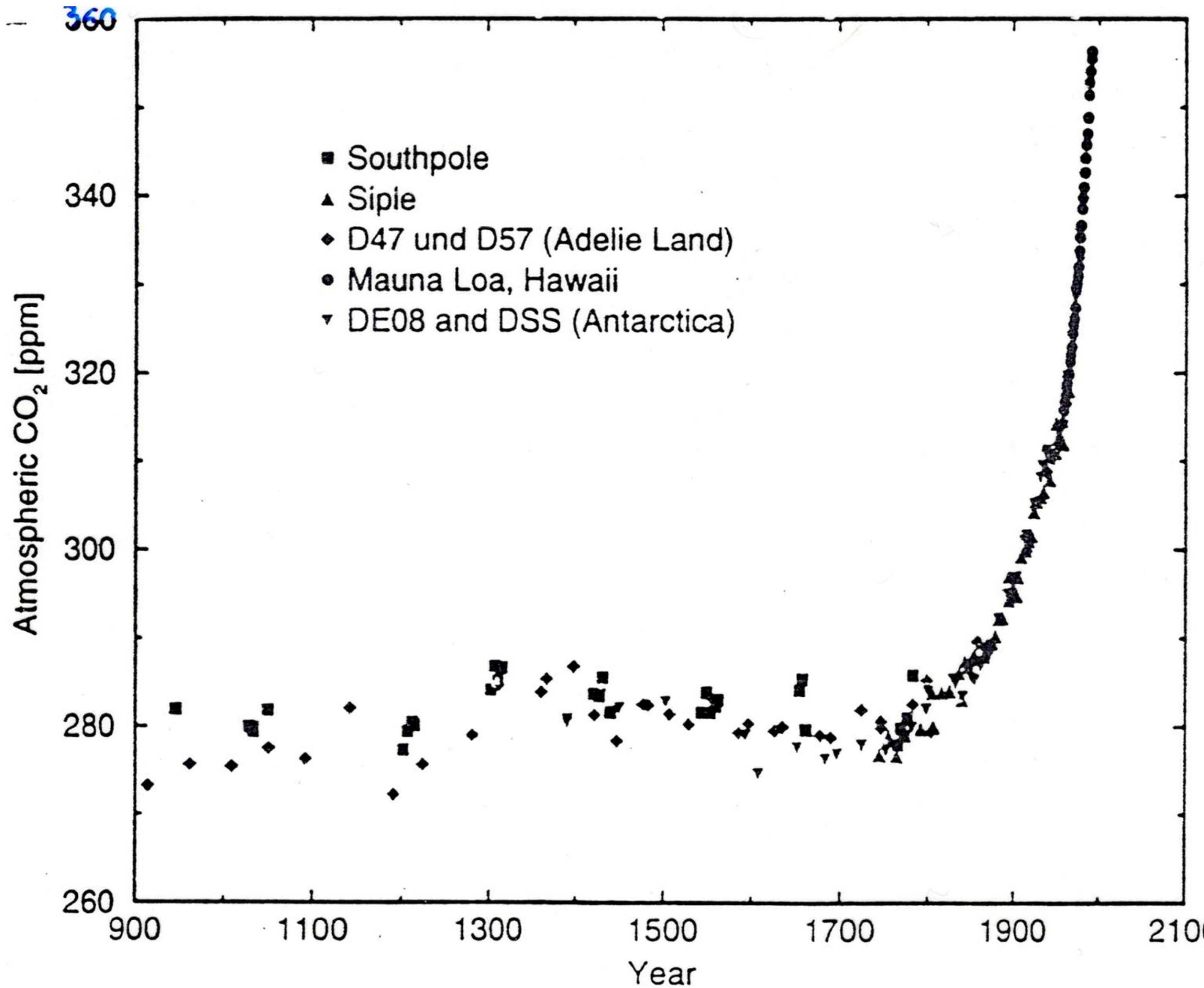


Source: Energyfiles, Energy Information Administration, BP Statistical Review of World Energy, Wood Mackenzie As of 12/31/10

AREIAS BETUMINOSAS

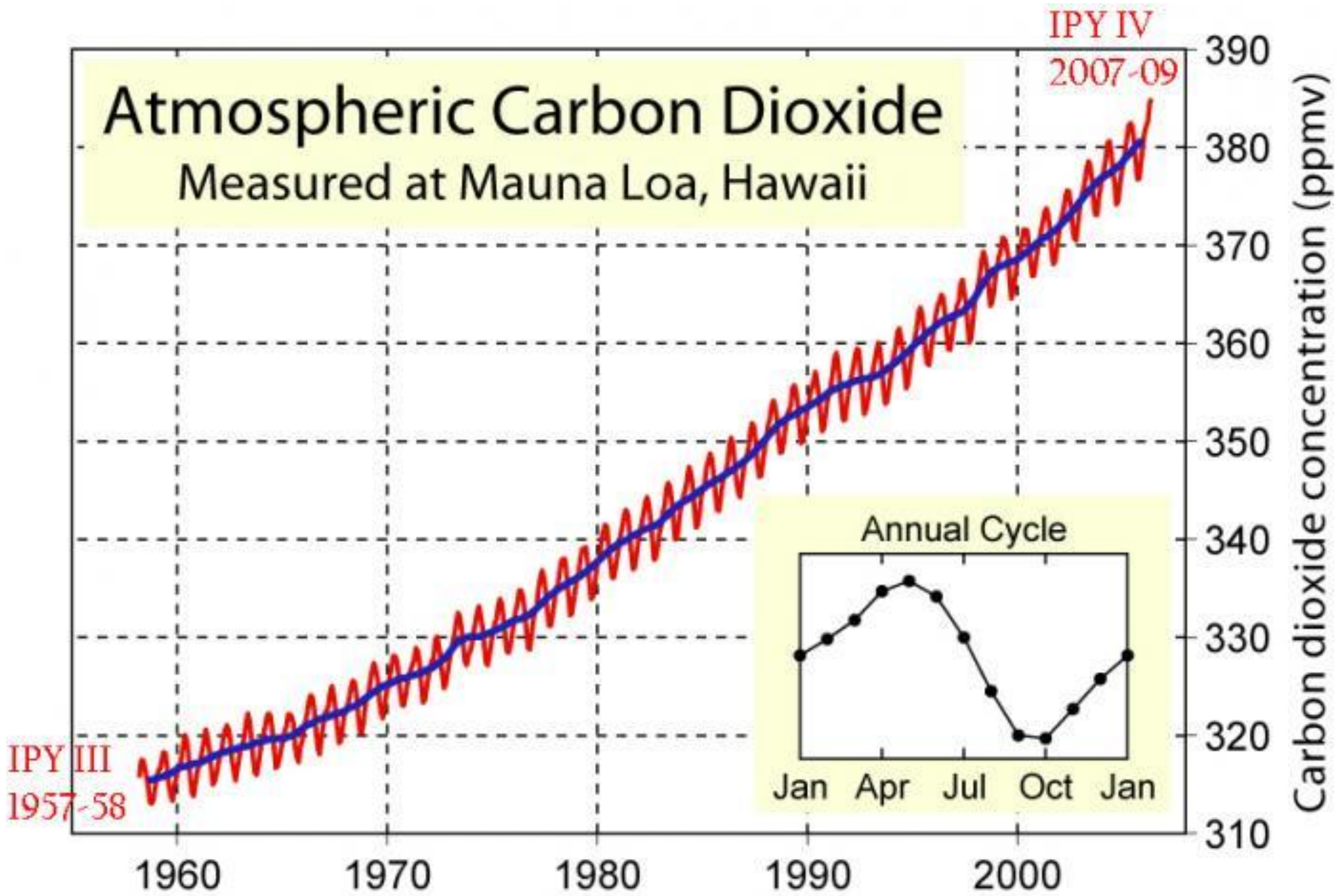
Alberta Tar Sands

© Garth Lenz

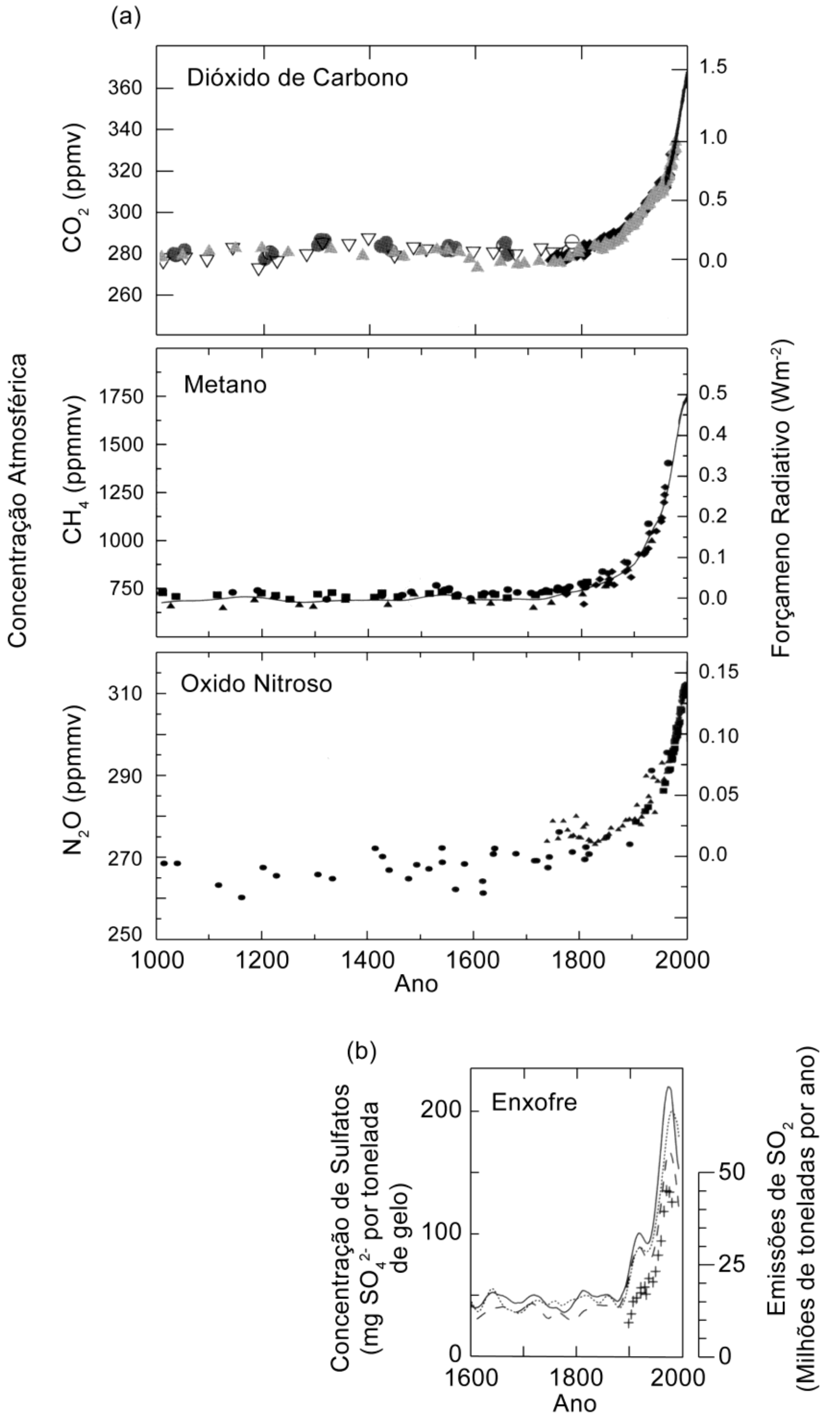


360
340
320
300
280
260
Atmospheric CO_2 [ppm]
Southpole
Siple
D47 und D57 (Adelie Land)
Mauna Loa, Hawaii
DE08 and DSS (Antarctica)
900
1100
1300
1500
1700
1900
2100
Year

Fonte, IPCC

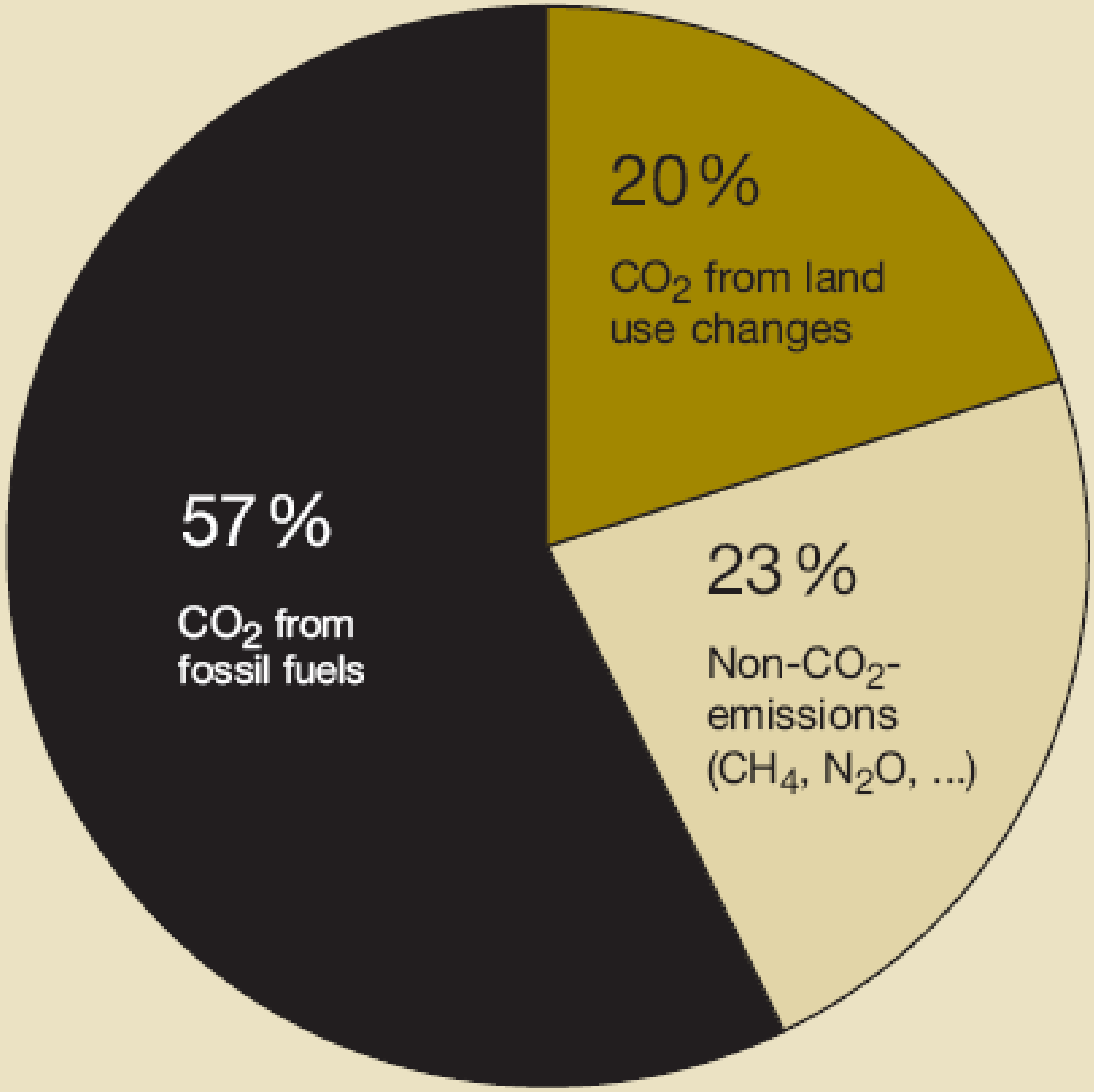


Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
IPY IV
2007-09
IPY III
1957-58
Annual Cycle
Jan
Apr
Jul
Oct
Jan
390
380
370
360
350
340
330
320
310
Carbon dioxide concentration (ppmv)
1960
1970
1980
1990
2000



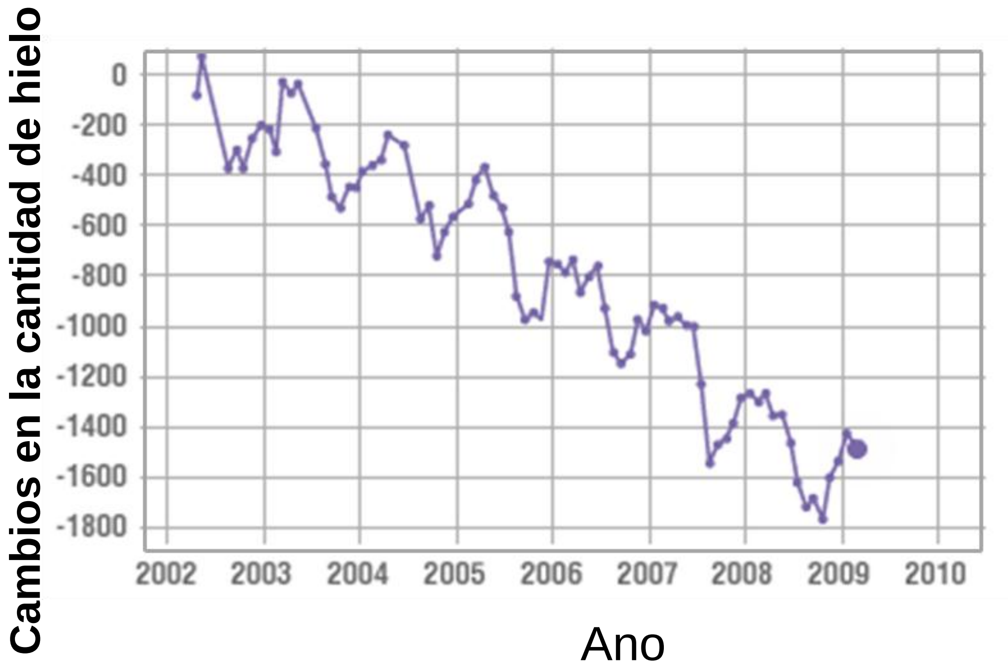
Evolução das concentrações de vários componentes da atmosfera (IPCC, 2001a). (a) Concentrações de três dos principais gases com efeito de estufa (GEE), com emissões antropogénicas – CO_2, CH_4 e N_2O – nos últimos 1 000 anos. Dados obtidos a partir de furos nos gelos da Antárctica e Gronelândia e de observações directas nas últimas décadas (indicada por uma linha no caso do CO_2). No gráfico relativo ao CH_4 a curva representa a média global. O forçamento radiativo provocado pela presença destes gases na atmosfera está representado à direita. No caso do CH_4 e N_2O a concentração está representada em partes por milhar de milhão em volume (ppmmv). (b) Concentrações de sulfatos obtidas a partir de furos nos gelos da Gronelândia em três locais (curvas) e emissões totais de SO_2 na Europa e nos Estados Unidos da América (indicadas com +).

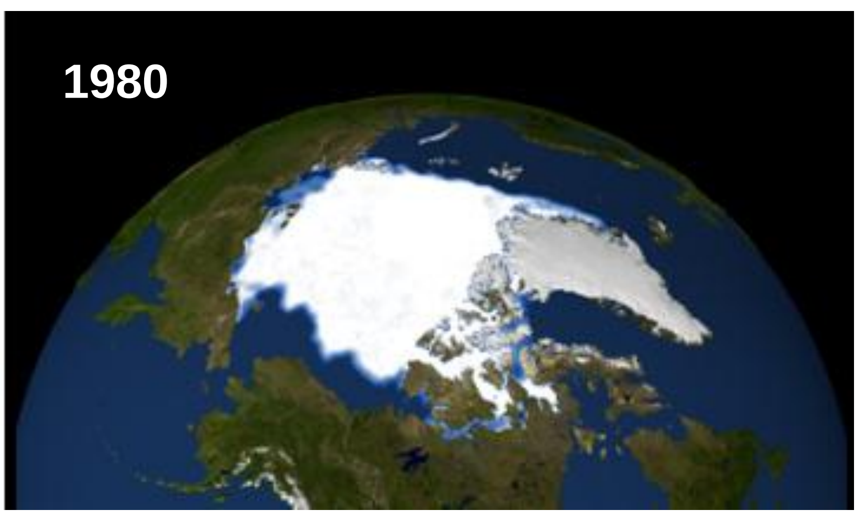
Fonte, IPCC

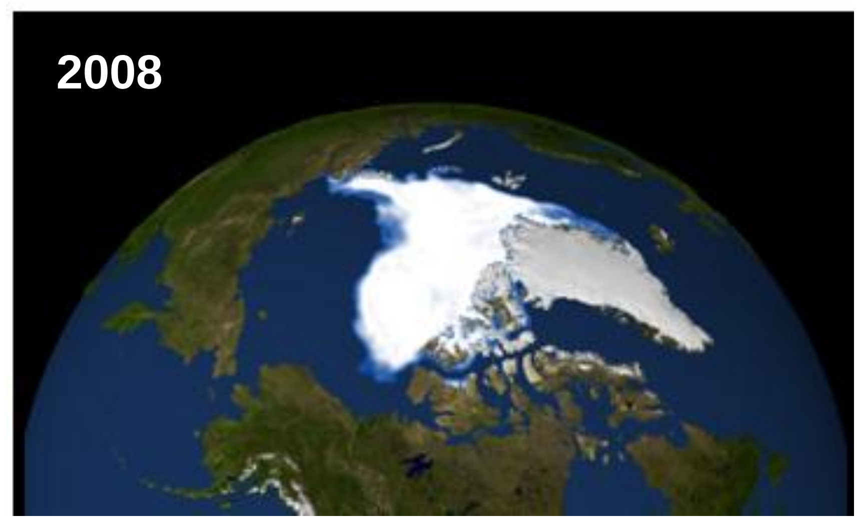


Rough breakdown of global greenhouse gas emissions in 2004.
Source: WBGU, based on IPCC, 2007c

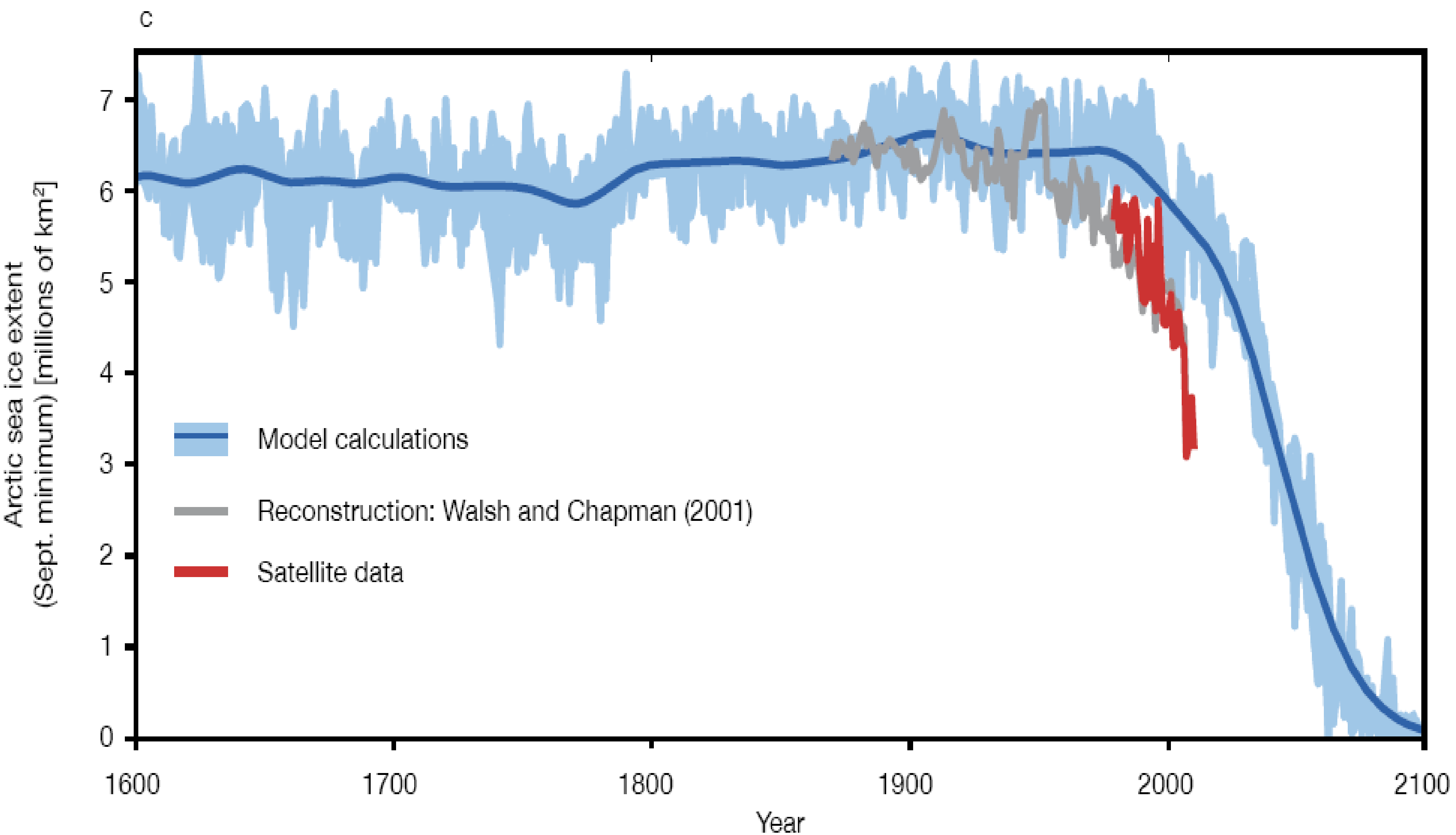
Arctic Sea Ice Area







SOURCE: NASA -University of California Irvine. 2010.



c) Extent of Arctic sea ice at the summer minimum (September), according to observed data, reconstruction (Walsh and Chapman, 2001) and a series of model calculations by the Max Planck Institute for Meteorology, Hamburg (based on Jungclaus et al., 2010).

Source: based on WBGU, 2009, amended

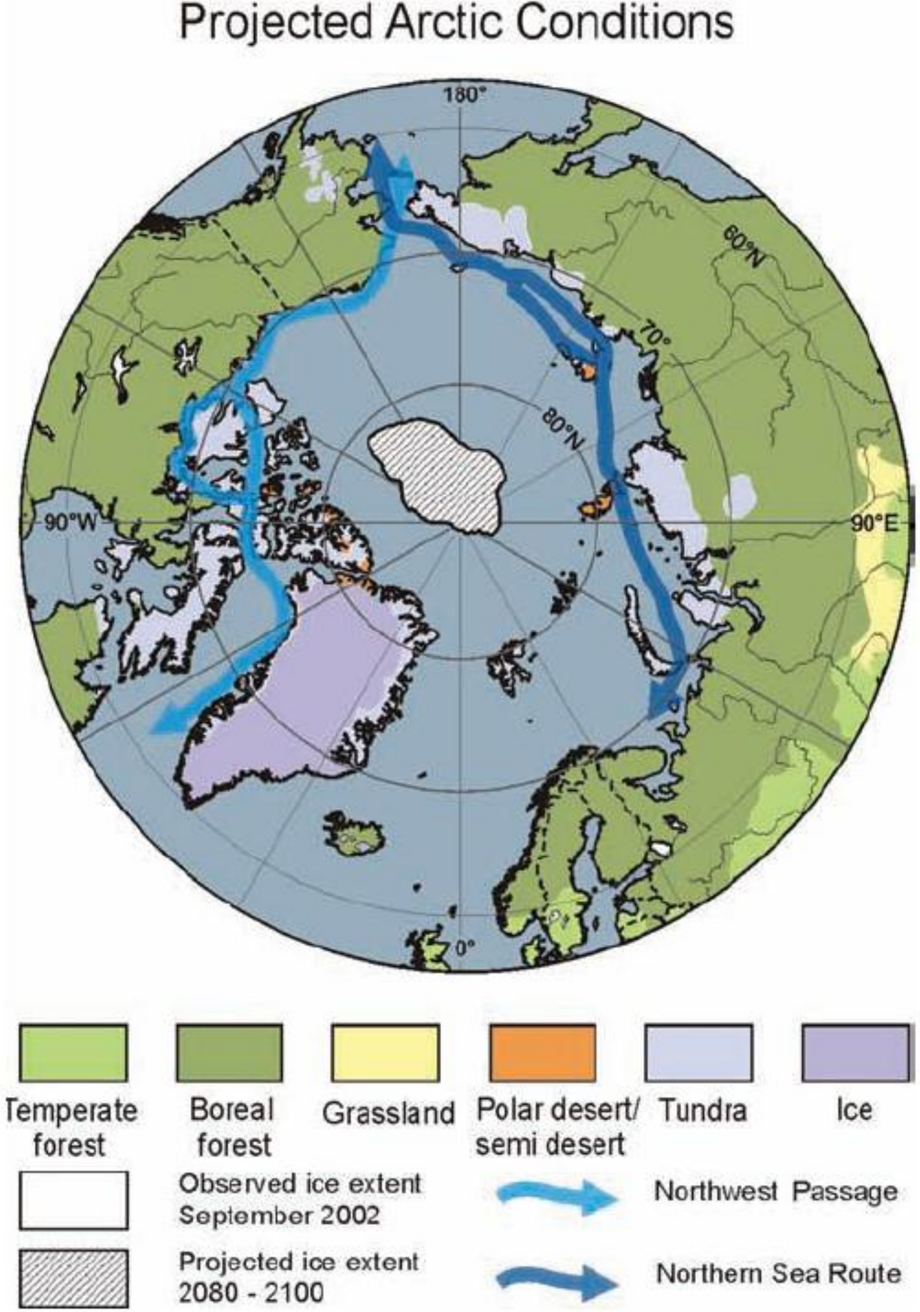


Figure TS.16. *Vegetation of the Arctic and neighbouring regions. Top: present-day, based on floristic surveys. Bottom: modelled for 2090-2100 under the IS92a emissions scenario. [F15.2]*

Peril hierarchy and terminology

Munich RE

Geophysical events	Meteorological events	Hydrological events	Climatological events
Earthquake	**Storms** – Tropical storm – Extratropical storm – Local windstorm	**Flooding** – River flood – Flash flood – Storm surge	**Extreme temperatures** – Heatwave – Freeze – Extreme winter conditions
Volcanic eruption		**Mass movement (wet)** – Rock fall – Landslide – Avalanche – Subsidence	**Drought**
Mass movement (dry) – Rock fall – Landslide – Subsidence			**Wildfire**

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SOURCE: Munich RE, 2011

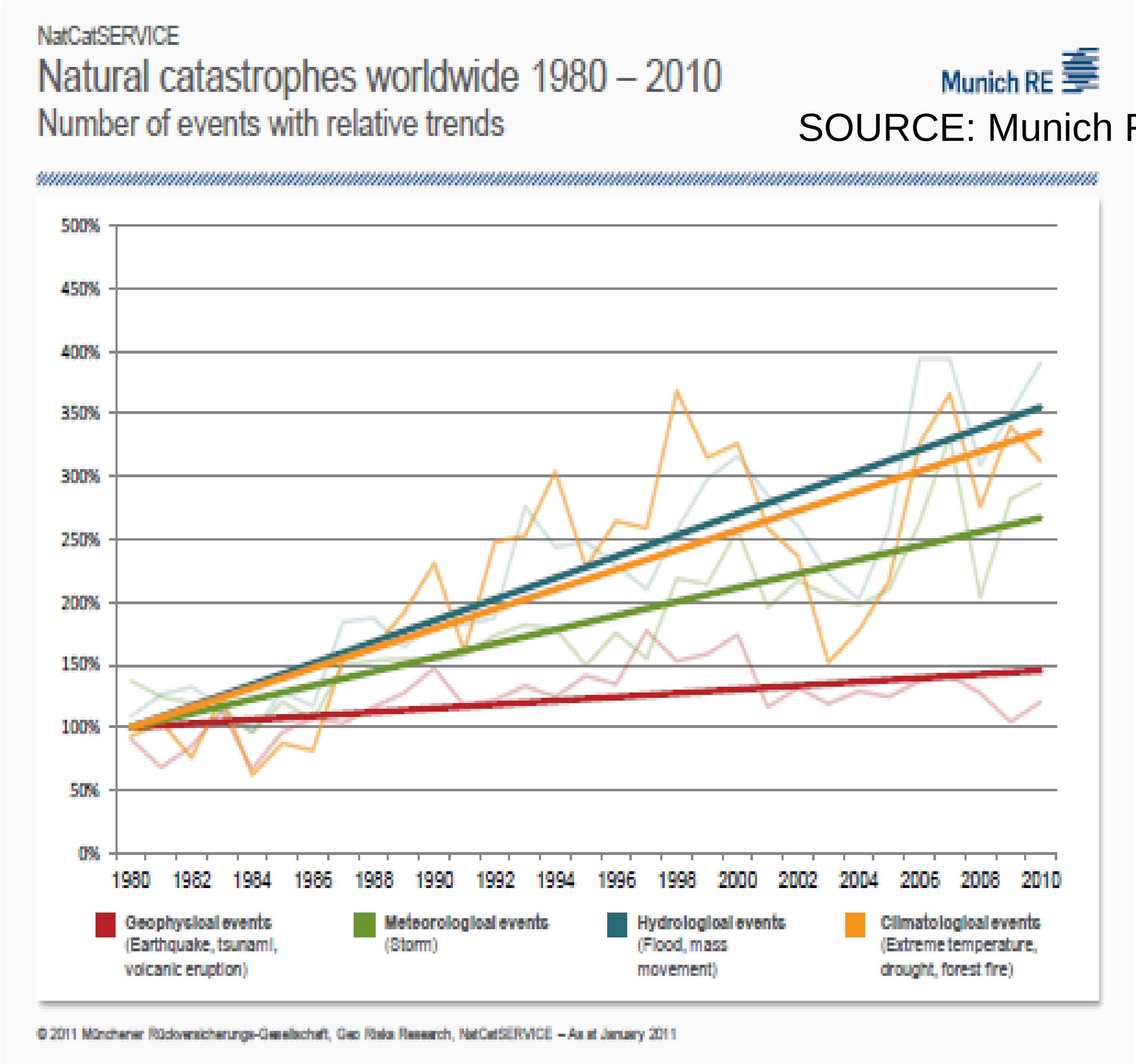


Fig. 1: Relative trends of loss relevant natural extreme events of the different perils

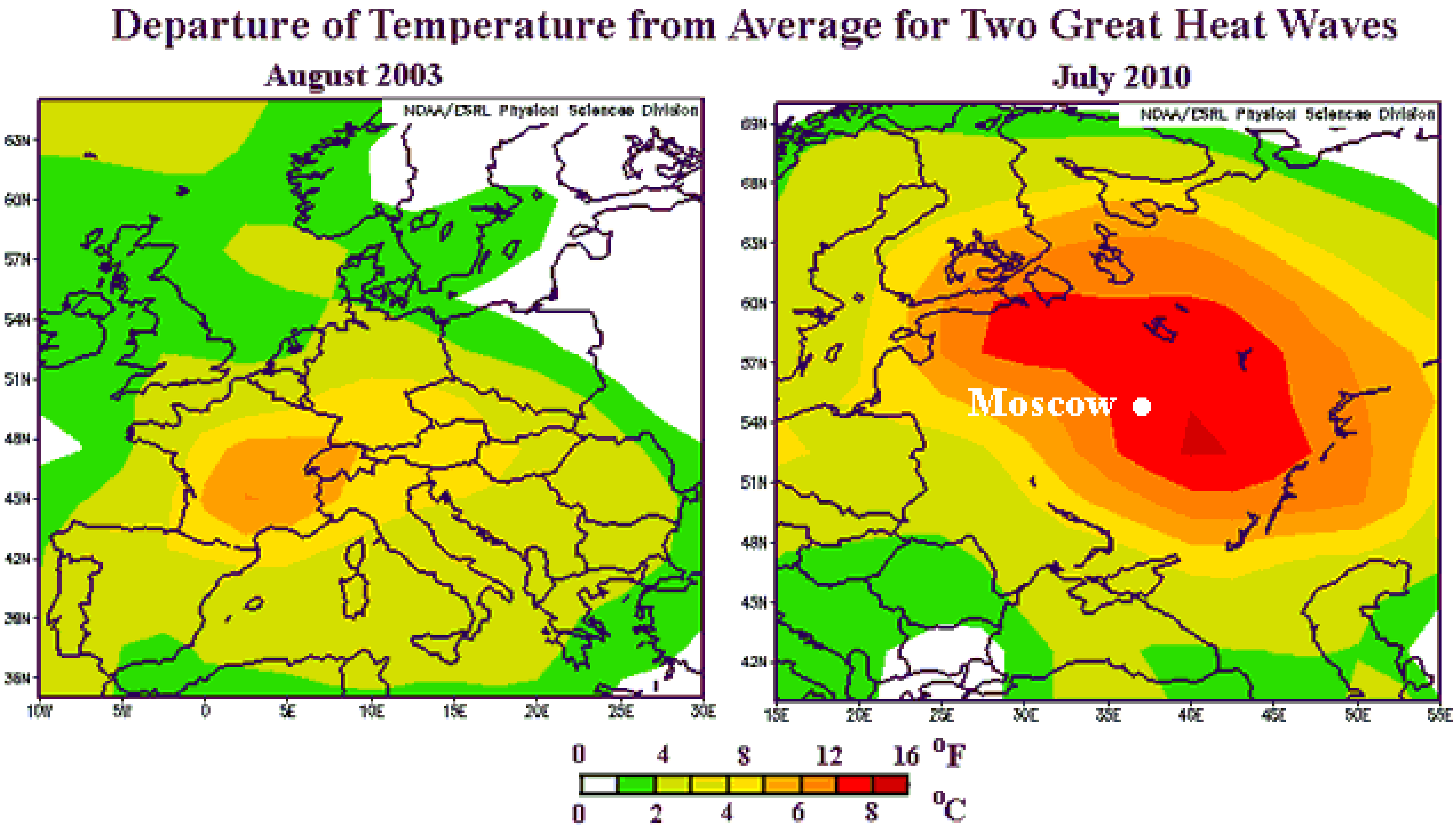


Figure 1. A comparison of August temperatures, the peak of the great European heat wave of 2003 (left) with July temperatures from the Great Russian Heat Wave of 2010 (right) reveals that this year's heat wave is more intense and covers a wider area of Europe.

SOURCE: NOAA – ESRL, Physical Sciences Division

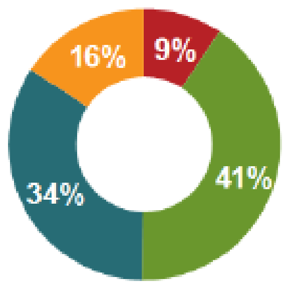
NatCatSERVICE

Natural catastrophes in Europe 1980 – 2010

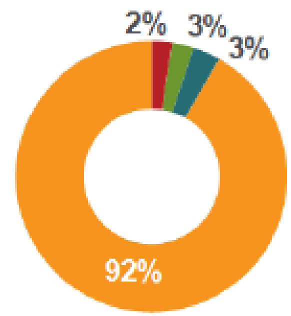
Percentage distribution

Munich RE

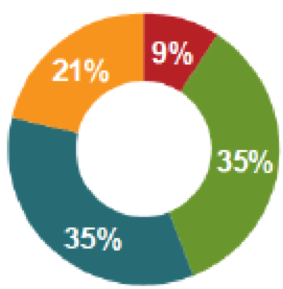
4,100 Loss events



150,000 Fatalities

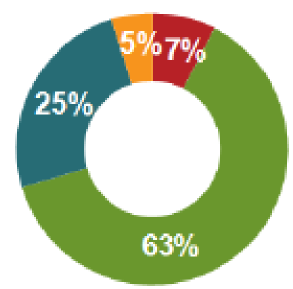


Overall losses* EUR 415bn



*in 2010 values

Insured losses* EUR 130bn



*in 2010 values

- **Geophysical events** (Earthquake, tsunami, volcanic eruption)
- **Meteorological events** (Storm)
- **Hydrological events** (Flood, mass movement)
- **Climatological events** (Extreme temperature, drought, forest fire)

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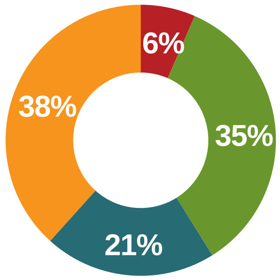
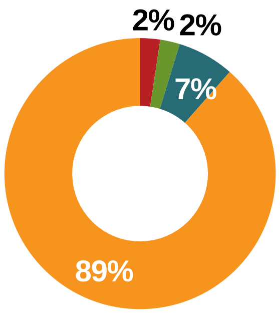
Natural catastrophes in Portugal 1980 – 2011

Percentage distribution

107 loss events

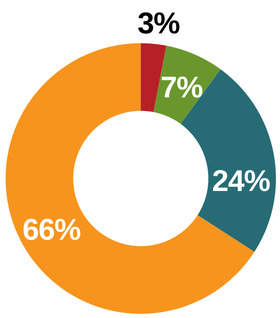


3,000 fatalities*



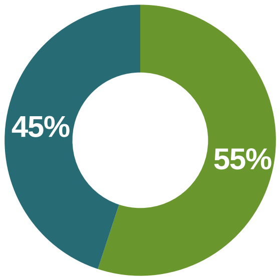
*Heat wave 2003: 2,500 fatalities

Overall losses** US$ 6,900m



**in 2011 values

Insured losses** US$ 160m



**in 2011 values
Storm and flood only

- **Geophysical events** (Earthquake, tsunami, volcanic eruption)
- **Meteorological events** (Storm)
- **Hydrological events** (Flood, mass movement)
- **Climatological events** (Extreme temperature, drought, wildfire)

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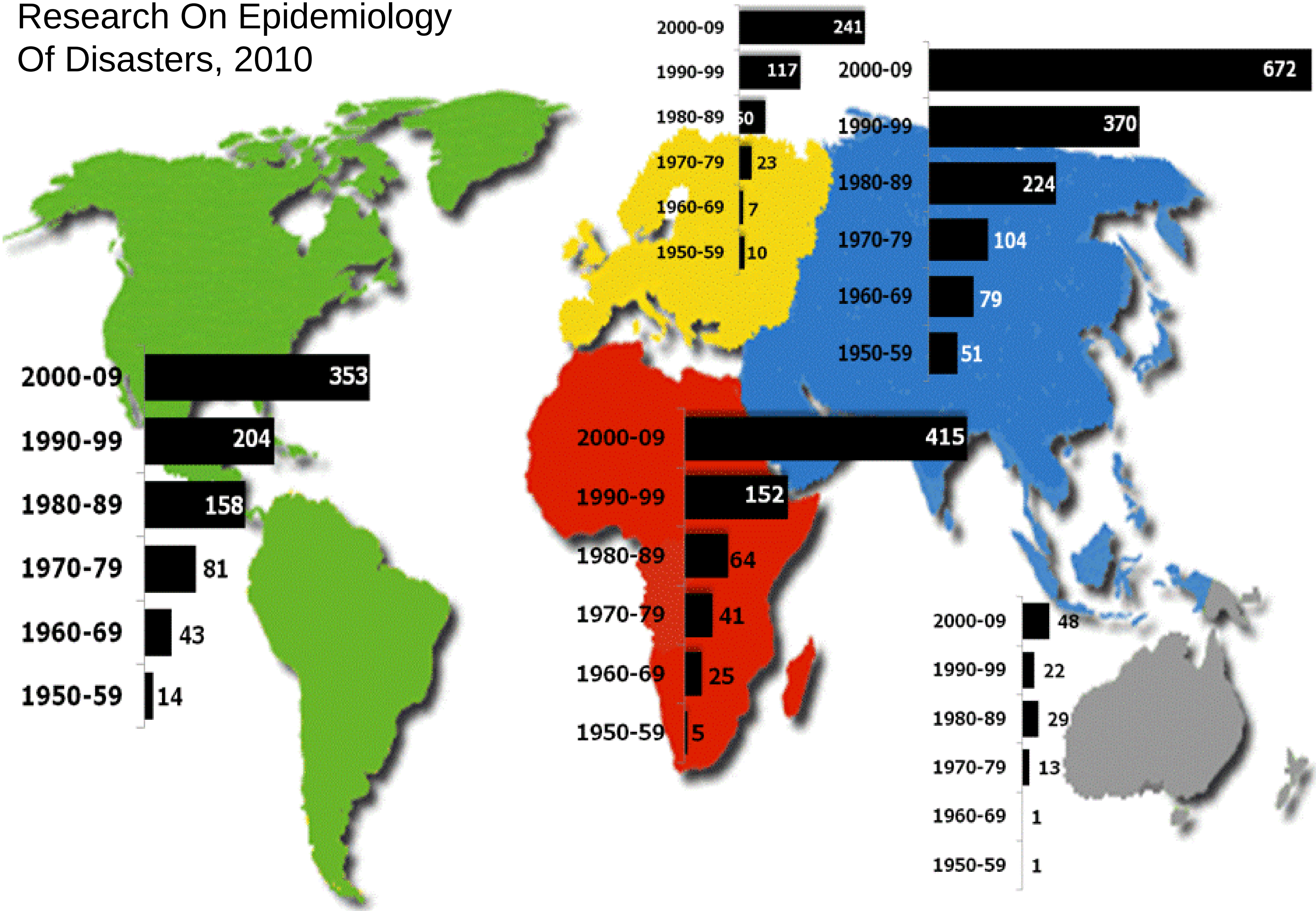
Floods 1950-2009

SOURCE: Center for Research On Epidemiology Of Disasters, 2010



Fuente: The international disaster data base. Center for Research on Epidemiology of Disasters. 2010.

Ilha da Madeira, 20 de Fevereiro de 2010

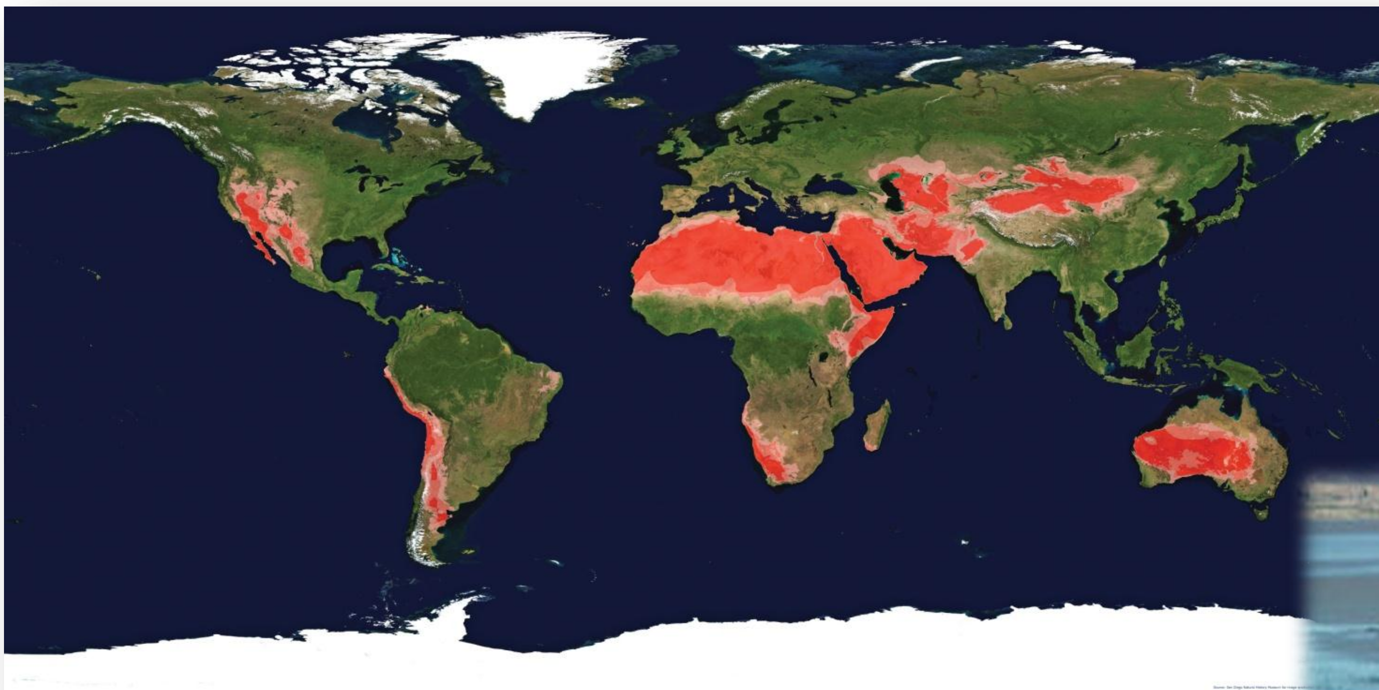
Droughts

About 400,000,000 people live under extreme drought conditions

Land considered "very dry" at global level:

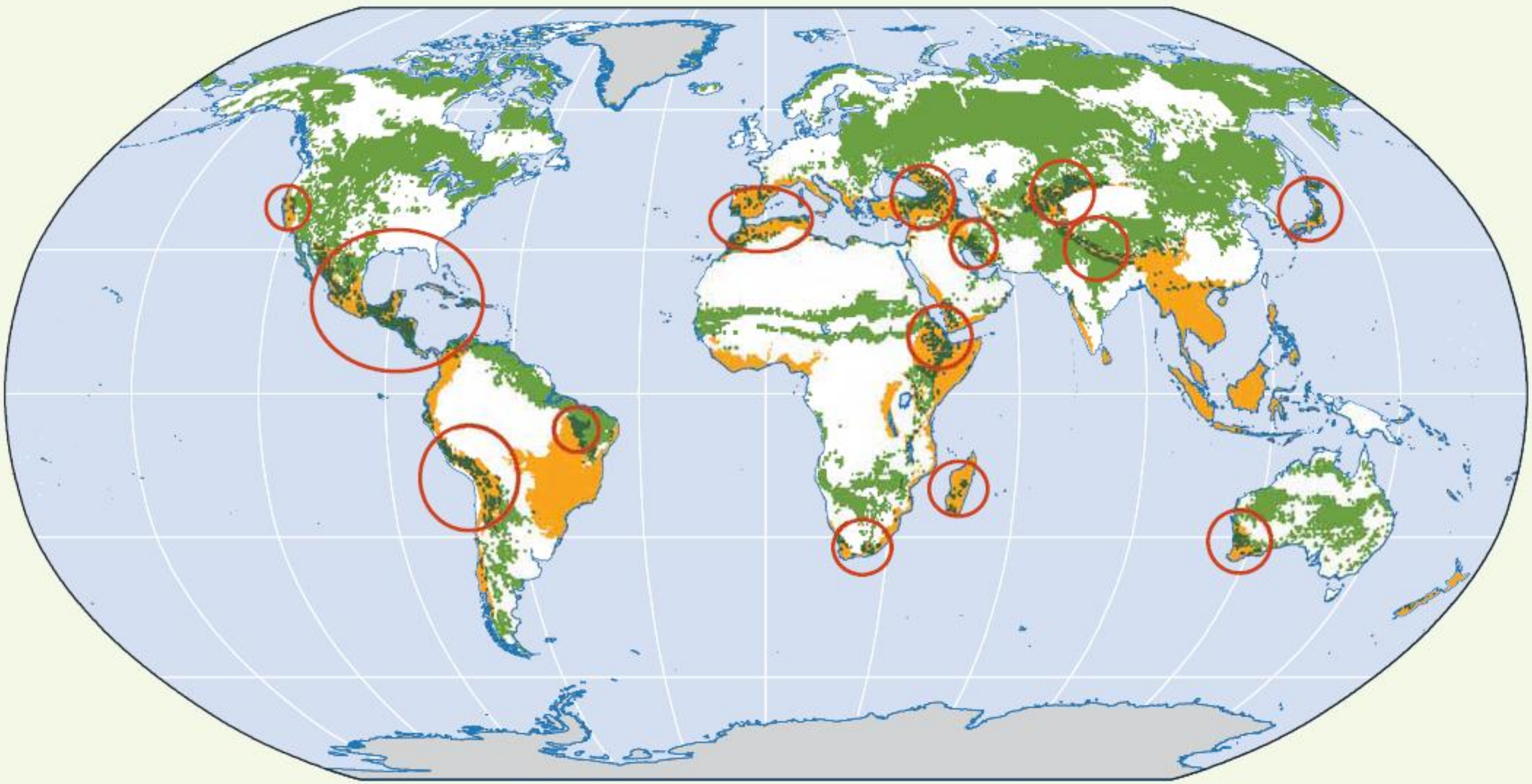
15% em 1970

38% em2010



Deforestation in Amazonia, seen from satellite. The roads in the forest follow a typical "fishbone" pattern SOURCE, NASA, 20 September 2006

Map FB.1 While many of the projected ecosystem changes are in boreal or desert areas that are not biodiversity hotspots, there are still substantial areas of overlap and concern



SOURCE: Myers et al., 2000
Fischlin et al., 2007

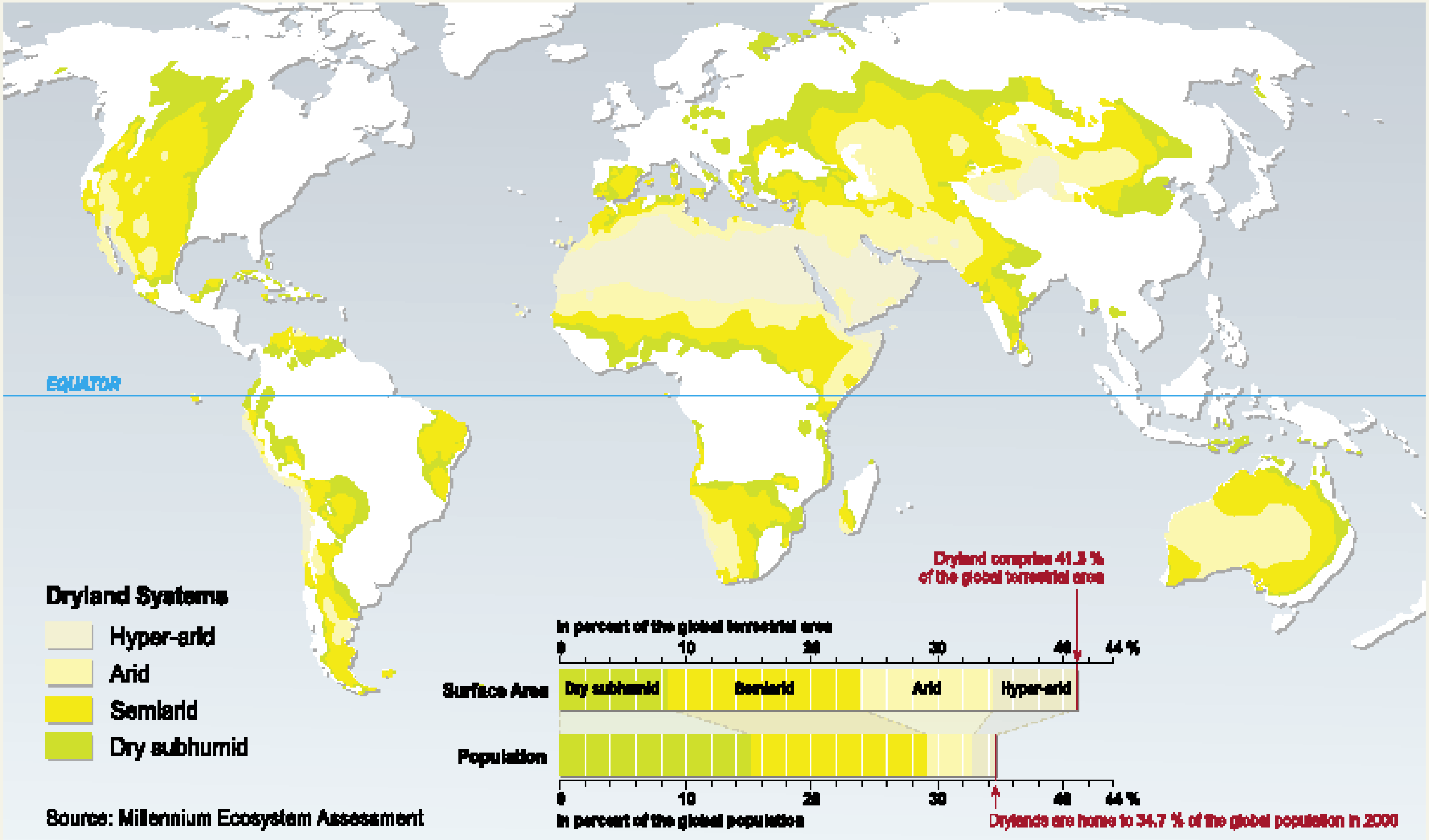
Source: WDR team based on Myers and others (2000) and Fischlin and others (2007).

Note: The figure shows the overlap between biodiversity hotspots (Conservation International and Myers and others 2000) and the projected changes in terrestrial ecosystems by 2100 relative to the year 2000, as presented by the Intergovernmental Panel on Climate Change in Fischlin and others (2007), figure 4.3 (a), p. 238. The changes should be taken as only indicative of the range of possible ecosystem changes and include gains or losses of forest cover, grassland, shrub- and woodland, herbaceous cover, and desert amelioration.

Present-day Drylands and Their Categories

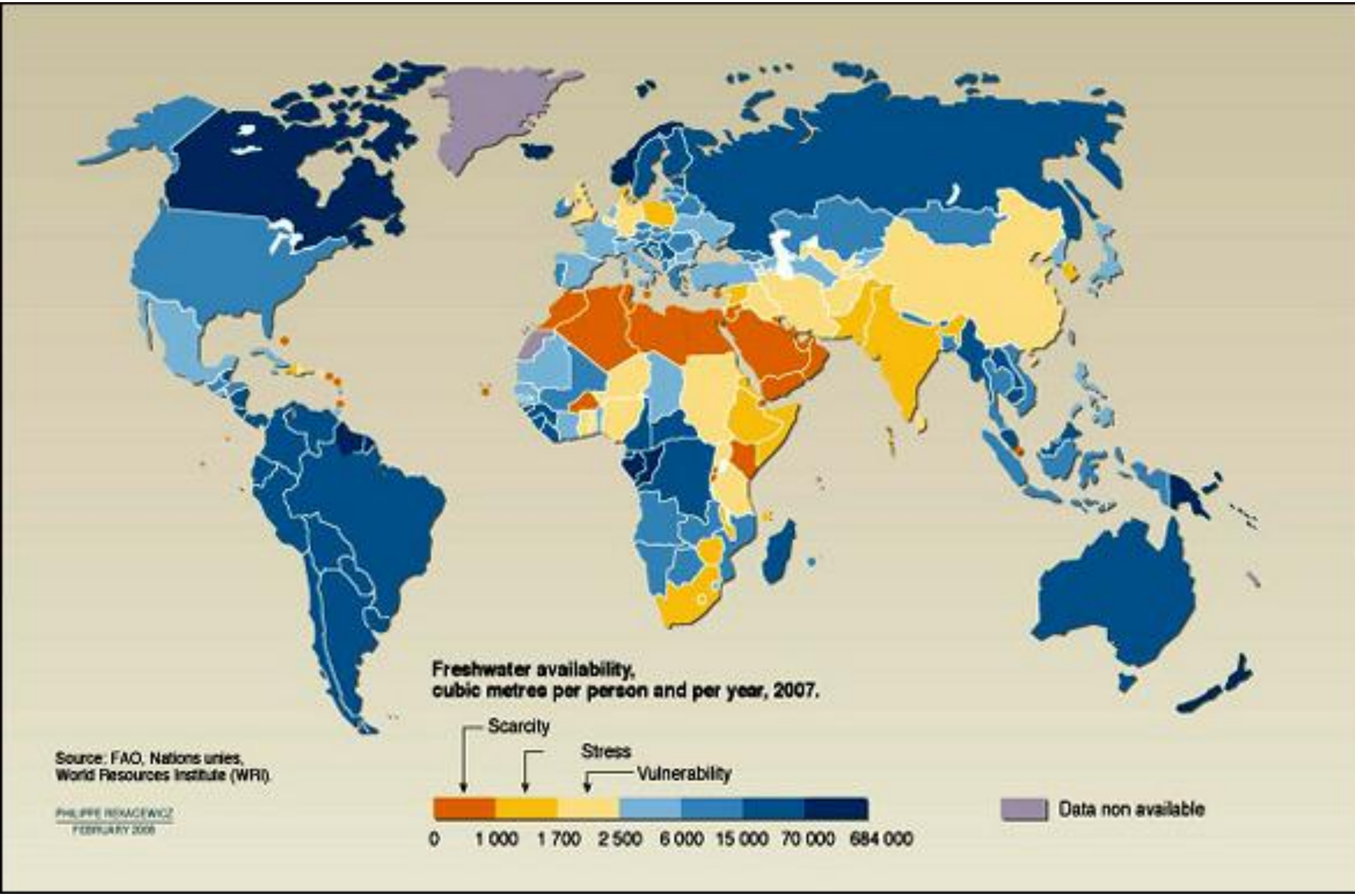
SOURCE: UNEP

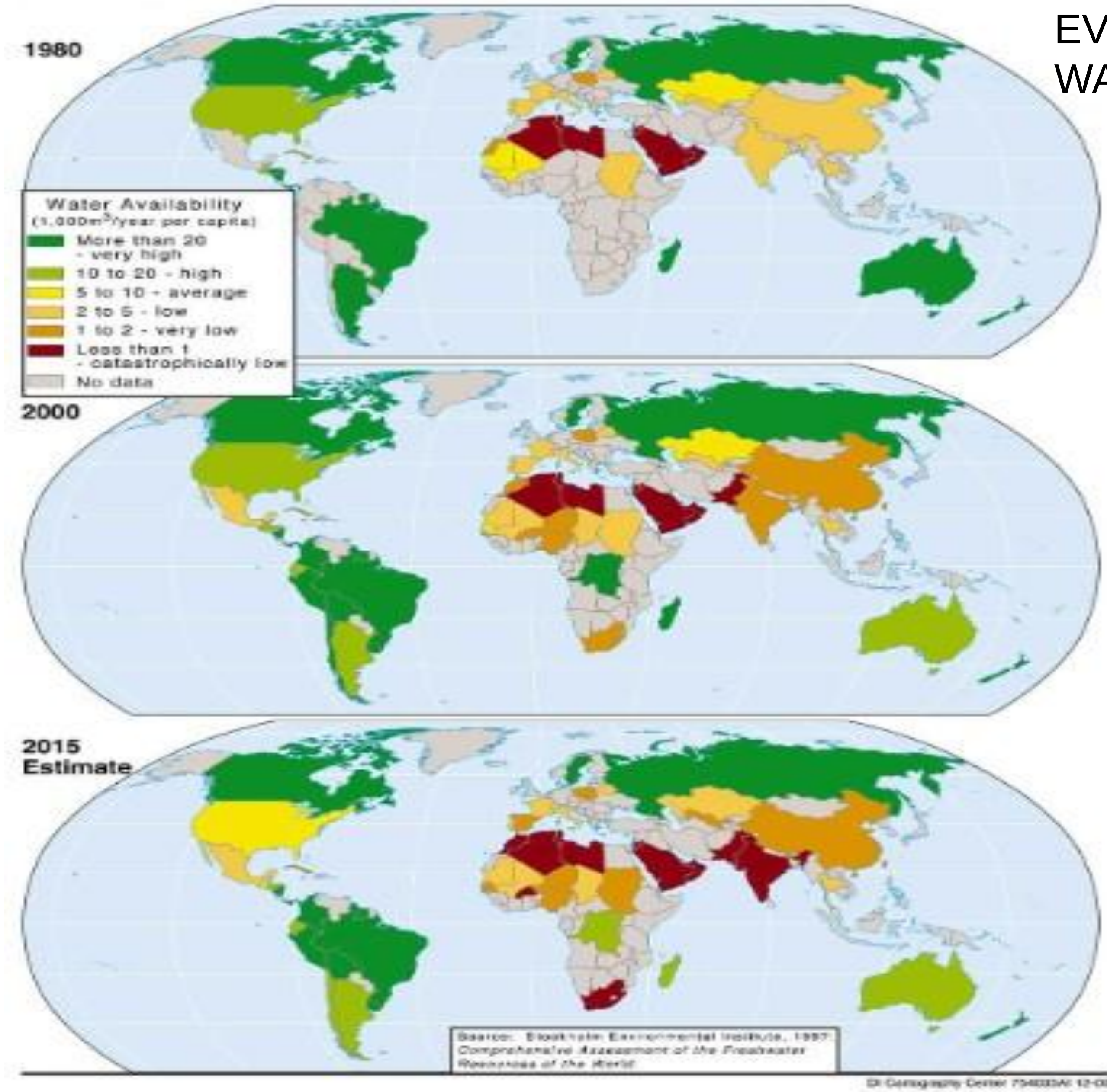
Drylands include all terrestrial regions where the production of crops, forage, wood and other ecosystem services are limited by water. Formally, the definition encompasses all lands where the climate is classified as dry subhumid, semiarid, arid or hyper-arid. This classification is based on Aridity Index values†.



† The long-term mean of the ratio of an area's mean annual precipitation to its mean annual potential evapotranspiration is the Aridity Index (AI).

Notes: The map is based on data from UNEP Geo Data Portal (http://geodata.grid.unep.ch/). Global area based on Digital Chart of the World data (147,573,196.6 square km); Data presented in the graph are from the MA core database for the year 2000.


Freshwater availability,
cubic metres per person and per year, 2007.
Scarcity
Stress
Vulnerability
0
1 000
1 700
2 500
6 000
15 000
70 000
684 000
Data non available
Source: FAO, Nations unies,
World Resources Institute (WRI).



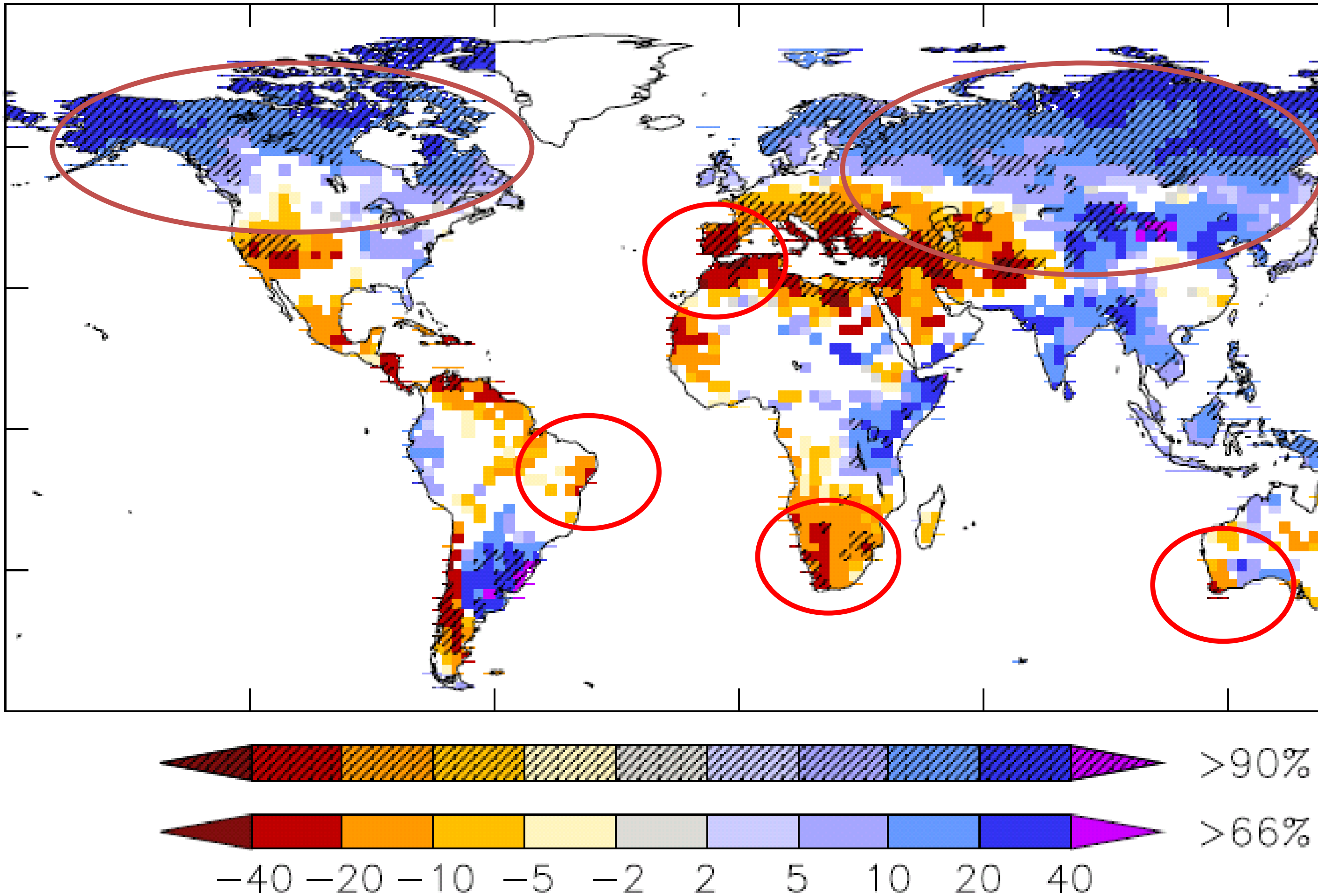
EVOLUTION OF WATER AVAILABILITY,

From very high to very low

SOURCE: Stockholm Environmental Institute, 1997

National Intelligence Council, *Global Trends 2015*, Dec. 2000, p. 29 citing original source as Stockholm Environmental Institute, *1997: Comprehensive Assessment of the Freshwater Resources of the World*

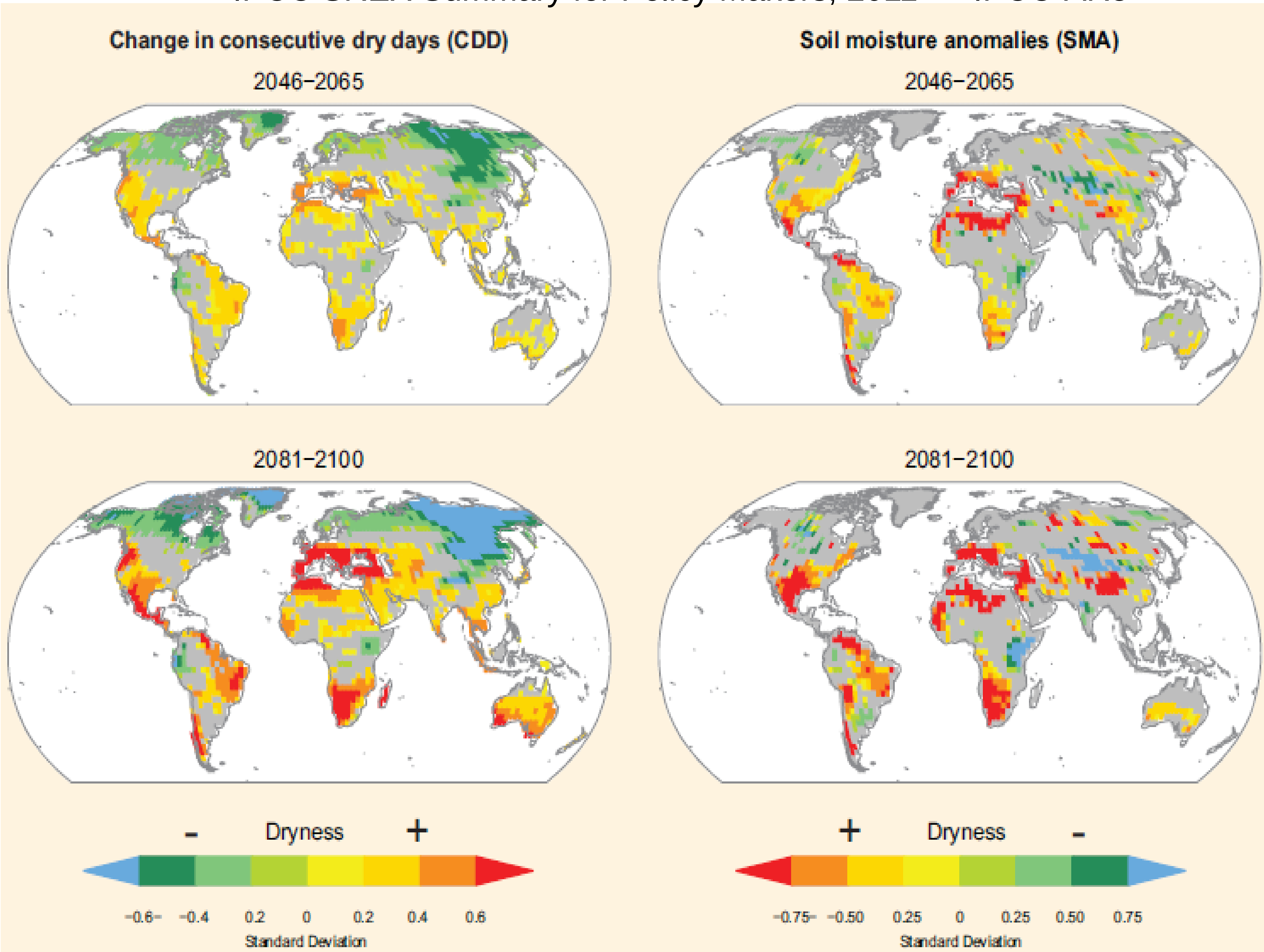
Expected change in annual runoff - 2060



Multimodel mean changes in annual runoff by 2060, in percent, indicating also degree of agreement between the 12 models used Scenario A1B, i.e. very rapid economic growth, convergence among regions and technological change in energy systems. Illustration from Milly et al 2005.

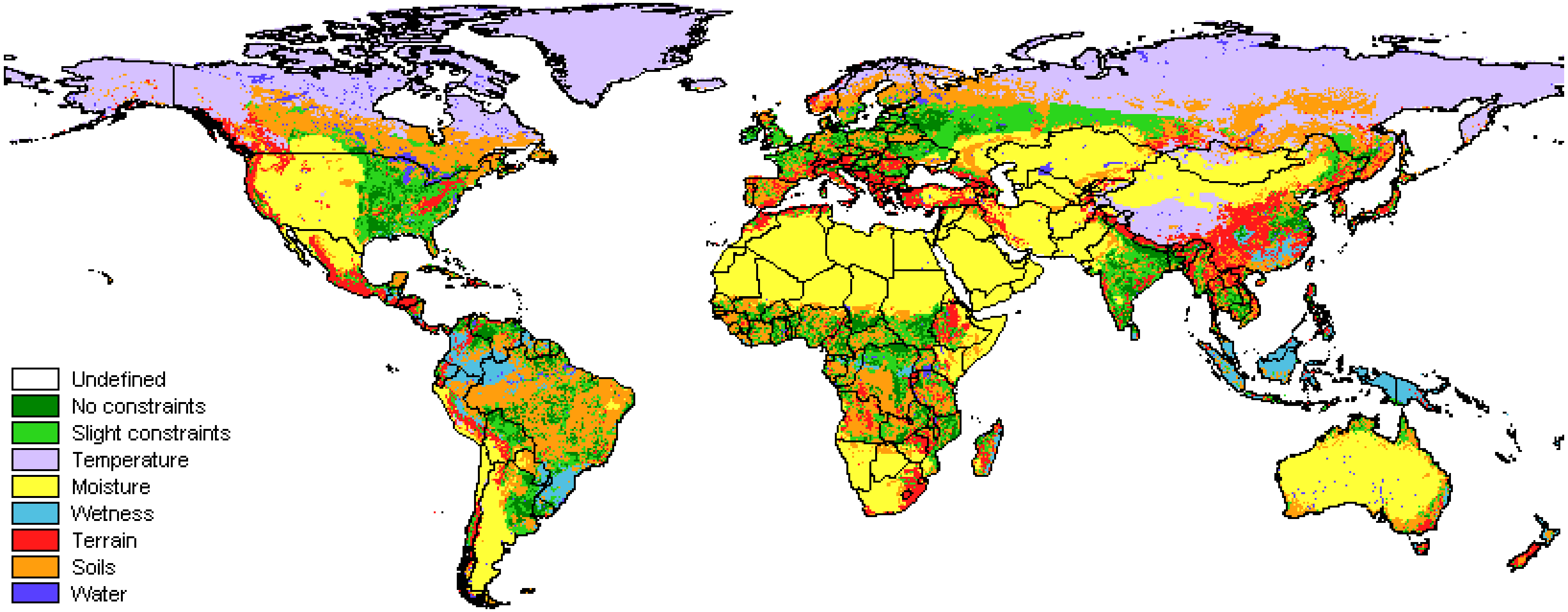
SOURCE: Milly et al., 2005

IPCC SREX Summary for Policy Makers, 2011 IPCC-AR5



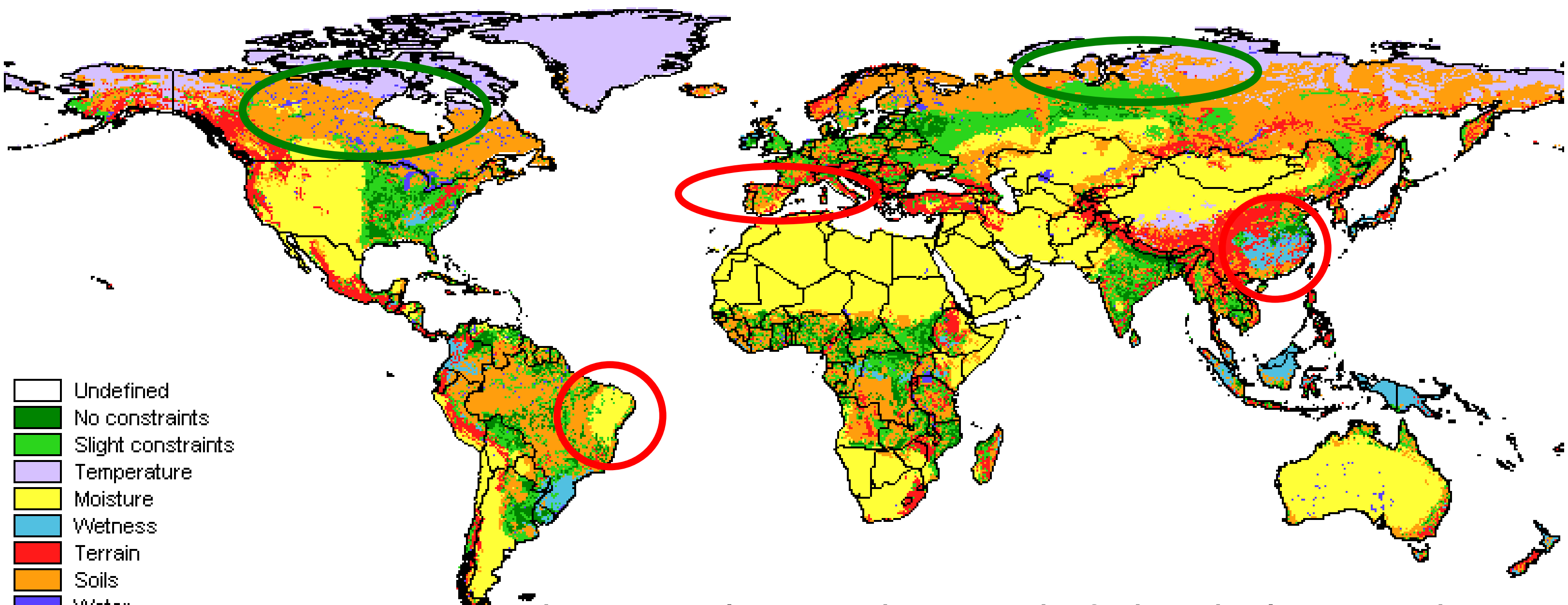
SOURCE: IIASA

IMPACTS OF CLIMATE CHANGE ON RAIN-FED AGRICULTURE



3.7

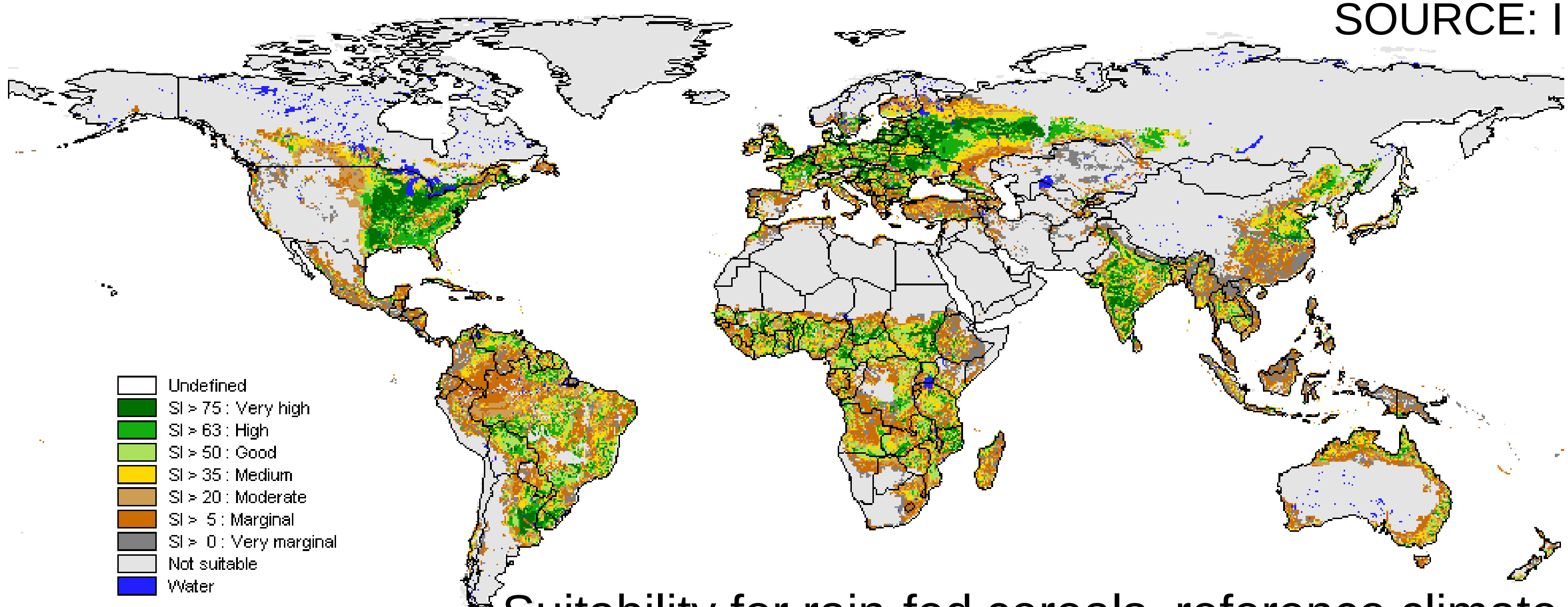
Environmental constraints to rain-fed agriculture, reference climate 1961-90



3.8

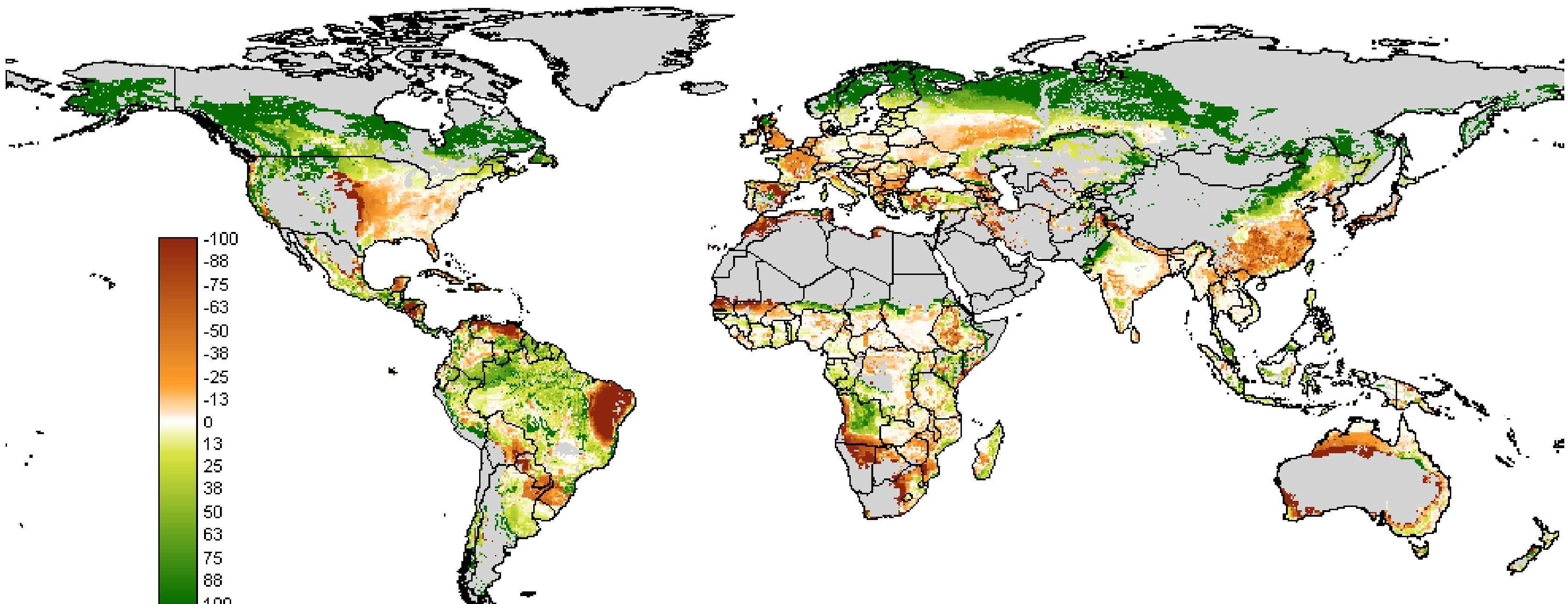
Environmental constraints to rain-fed agriculture, HadCM3-A1FI 2080s

SOURCE: IIASA



3.12a

Suitability for rain-fed cereals, reference climate 1961-90.



3.12b

Change in suitability for rain-fed cereals, HadCM3-A1FI, 2080s

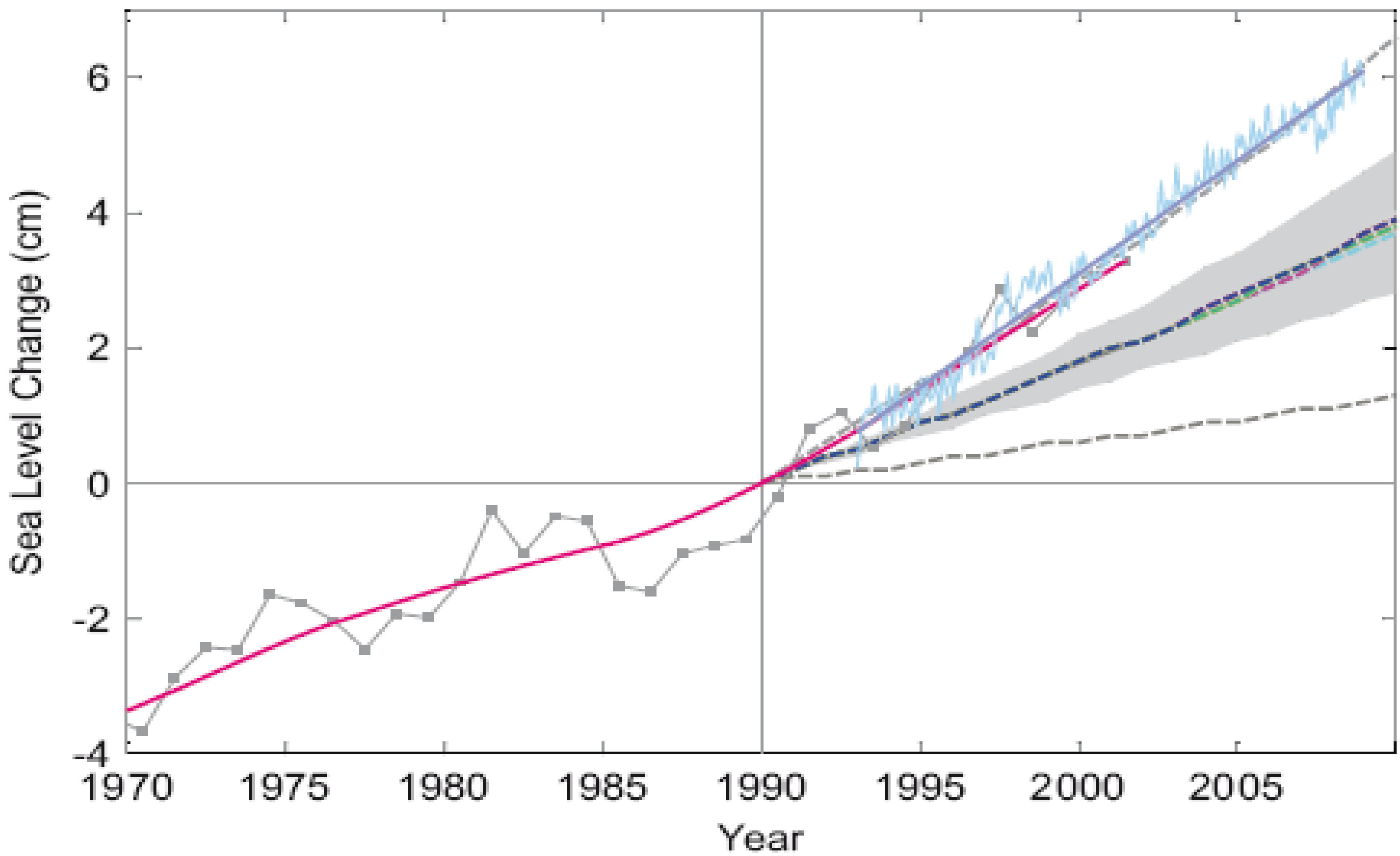
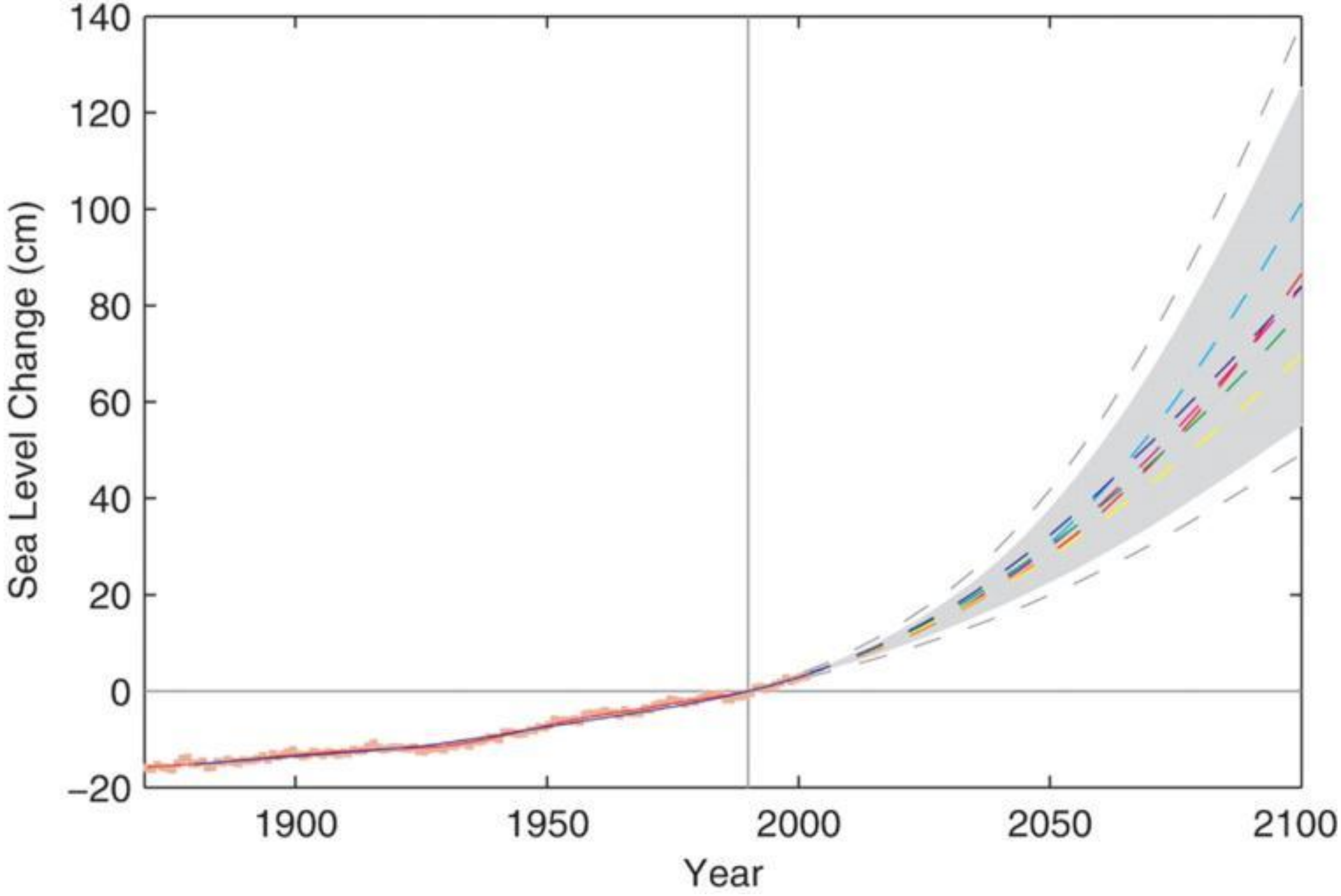


Figure 1

Change in sea level from 1970 to 2008, relative to the sea level at 1990. The solid lines are based on observations smoothed to remove the effects of interannual variability (light lines connect data points). Data in most recent years are obtained via satellite based sensors. The envelope of IPCC projections is shown for comparison; this includes the broken lines as individual projections and the shading as the uncertainty around the projections[3].



Rahmstorf, 2007

Bangladesh

SOURCE: OECD, 2010

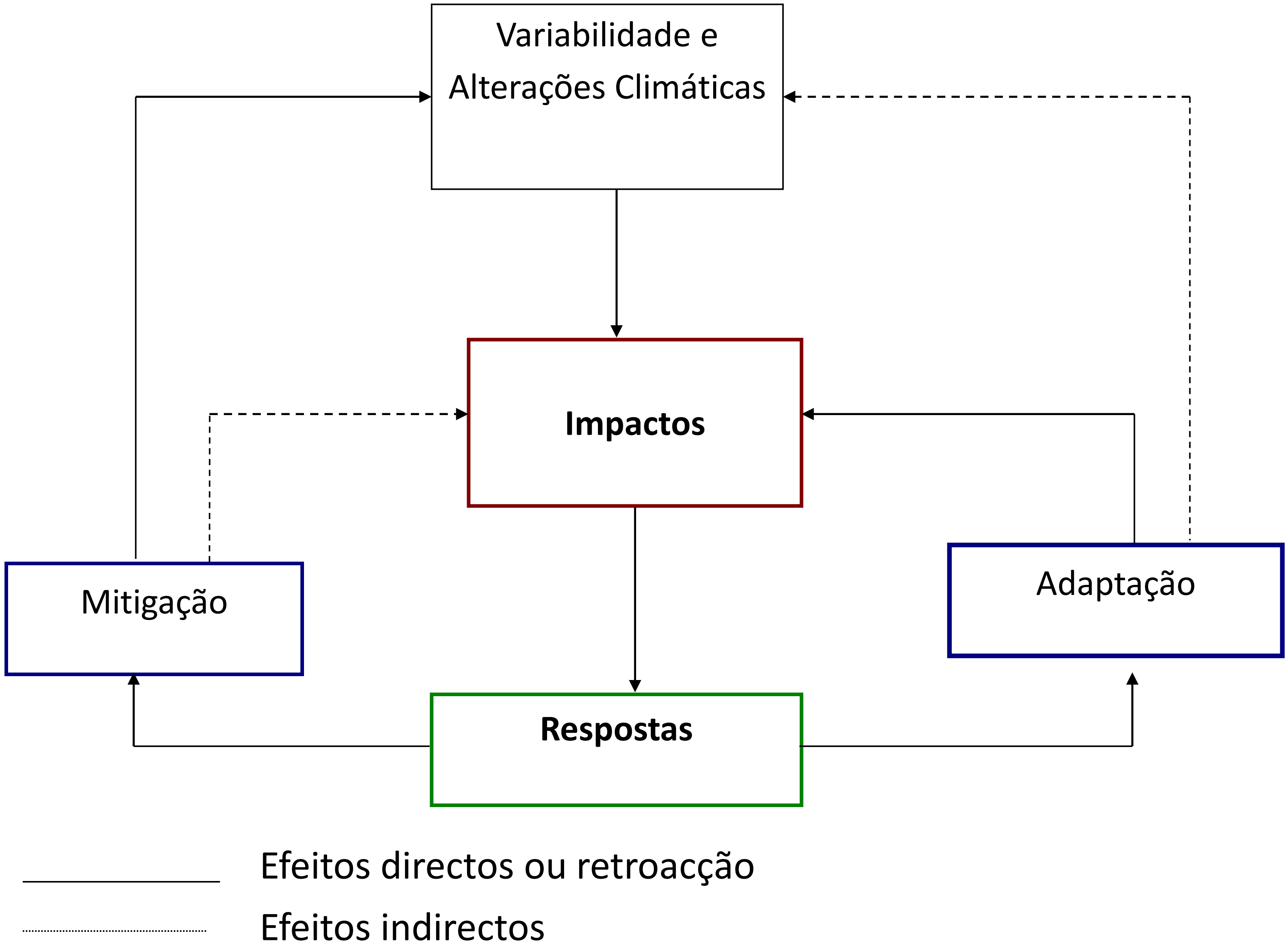
Table 1.2-1

Concentration of cities in coastal zones. For various population figures, the proportion of cities along the coast is shown. Major cities are particularly often located in coastal regions.

Source: OECD, 2010d

CONCENTRATION OF CITIES IN COASTAL ZONES

	Population figure				
Region	**‹100,000 [%]**	**100,000–500,000 [%]**	**500,000–1 million [%]**	**1–5 million [%]**	**›5 million [%]**
Africa	9	23	39	50	40
Asia	12	24	37	45	70
Europe	17	22	37	41	58
Latin America	11	25	43	38	50
Australia and New Zealand	44	77	100	100	–
North America	9	19	29	25	80
Small island states	51	61	67	100	–
World	13	24	38	44	65


Variabilidade e
Alterações Climáticas
Impactos
Mitigação
Adaptação
Respostas
Efeitos directos ou retroacção
Efeitos indirectos

GEE

Mudanças Climáticas

Impactos

Mitigação

Adaptação

1. Enquadramento

Efeito global

Efeito local

Acção global e local

Acção local

Mitigação

Adaptação

Figure 3.4 Intensive beef production is a heavy producer of greenhouse gas emissions

Food item (1 kg)	Emissions (kg CO_2e)	Driving distance equivalent
Wheat	0.80	3.6 km
Potato	0.24	1.2 km
Chicken	4.60	22.7 km
Pork	6.40	31.6 km
Beef	16.00	79.1 km

Source: Williams, Audsley, and Sandars 2006.

Note: The figure shows CO_2 equivalent emissions in kilograms resulting from the production (in an industrial country) of 1 kilogram of a specific product. The car and road image conveys the number of kilometers one must drive in a gasoline-powered car averaging 11.5 kilometers a liter to produce the given amount of CO_2e emissions. For example, producing 1 kilogram of beef and driving 79.1 kilometers both result in 16 kilograms of emissions.

Adaptar os edifícios

OPORTUNIDADE!

Green roofs and walls

Example of an mitigation/adaptation measure

ENERGY USE

24%*-50%**

CO_2 EMISSIONS

33%***-39%**

WATER USE

40%**

SOLID WASTE

70%**

Green Buildings Can Reduce...

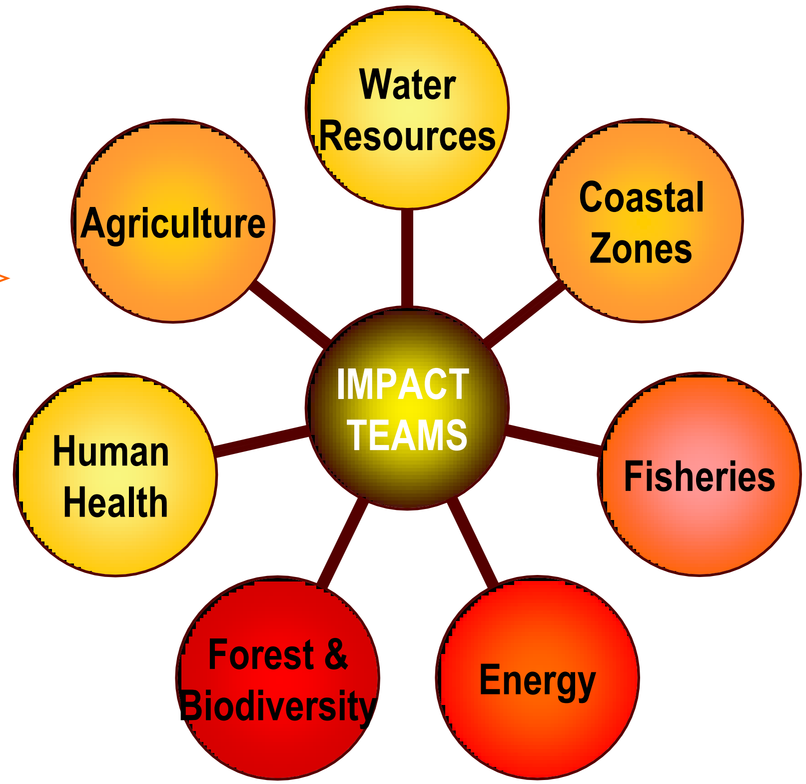
* Turner, C. & Frankel, M. (2008). Energy performance of LEED for New Construction buildings: Final report.

** Kats, G. (2003). The Costs and Financial Benefits of Green Building: A Report to California's Sustainable Building Task Force.

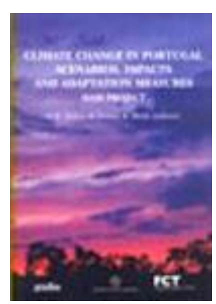
*** GSA Public Buildings Service (2008). Assessing green building performance: A post occupancy evaluation of 12 GSA buildings.

Climate Change in Portugal: Scenarios, Impacts and Adaptation Measures (SIAM Project)

- SIAM I study was the first integrated study on the impacts of climate change in Portugal (and in any Southern European country)
  - Integration Team
  - Scenario Teams
    - Climate
    - Socio-economic
  - Impact Teams



- Health Study
  - National focus
  - Team
    - Elsa Casimiro
    - Jose Calheiros
    - Suraje Dessai



http://www.siam.fc.ul.pt/SIAM_Book

Mais Informação ...

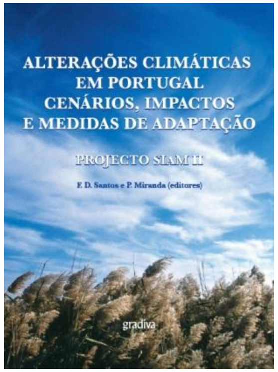
SIAM Project :

Climate Change in Portugal: Scenarios, Impacts and Adaptation Measures

http://www.siam.fc.ul.pt/

http://www.siam.fc.ul.pt/SIAM_Book

SIAM I - 2002



SIAM II - 2006

Climate Change Strategy for the Sintra Municipality

Report available at

www.siam.fc.ul.pt/siam-sintra

Climate Change Strategy for the Cascais Municipality

Report available at

www.siam.fc.ul.pt/PECAC/

Impactos nos Recursos Hídricos

- Redução caudais dos rios

- Redução da quantidade de água nas albufeiras e nos aquíferos

- Escassez de água no Verão

- Redução da qualidade da água

Impactos nas Zonas Costeiras

- Subida do Nível Médio do Mar

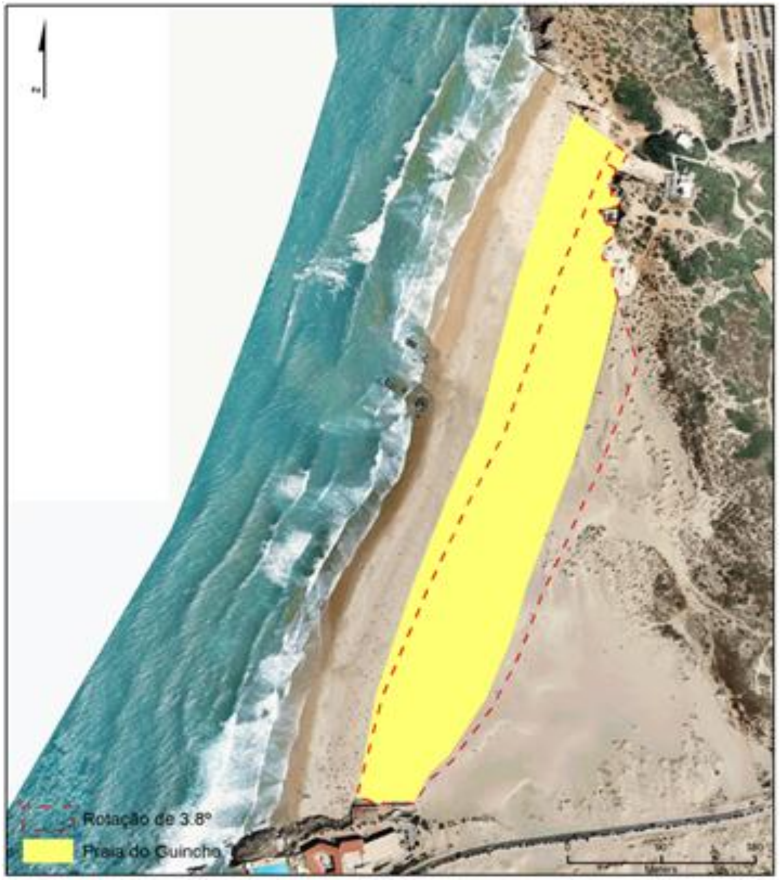
- Rotação das ondas

Foz do Douro, 9.10.2010

Evolução das praias

Redução dos areais

Guincho	-3% a -5%
R.Cascais	-47% a -78%
Conceição	-52% a -81%
Tamariz	-53% a -84%
S.Pedro	-40% a -67%
Carcavelos	-41% a -64%



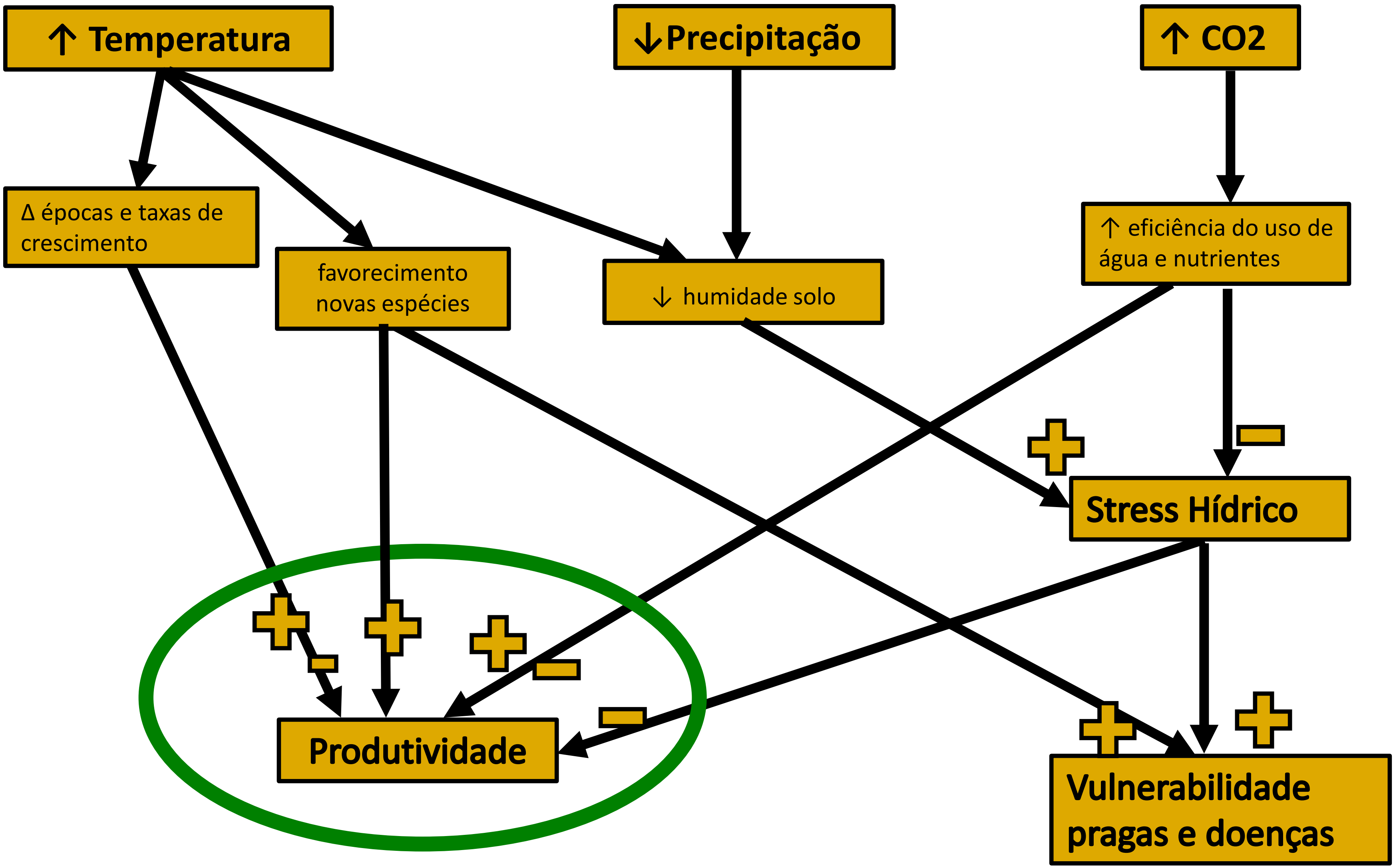
Impactos na Saúde

- Stress Térmico (Ondas de Calor)
- Poluição do Ar
- Doenças transmitidas pela água e alimentos
- Doenças transmitidas por vectores e roedores

Impactos no Turismo

- Alterações na sazonalidade natural
- Alterações na satisfação dos turistas (conforto e segurança)
- Alterações nos produtos/ atracções na oferta
- Efeitos nas operações de turismo
    - Abastecimento e qualidade da água
    - Custos de aquecimento/ arrefecimento
    - Necessidades de irrigação
    - Encerramentos temporários

Impactos na Agricultura



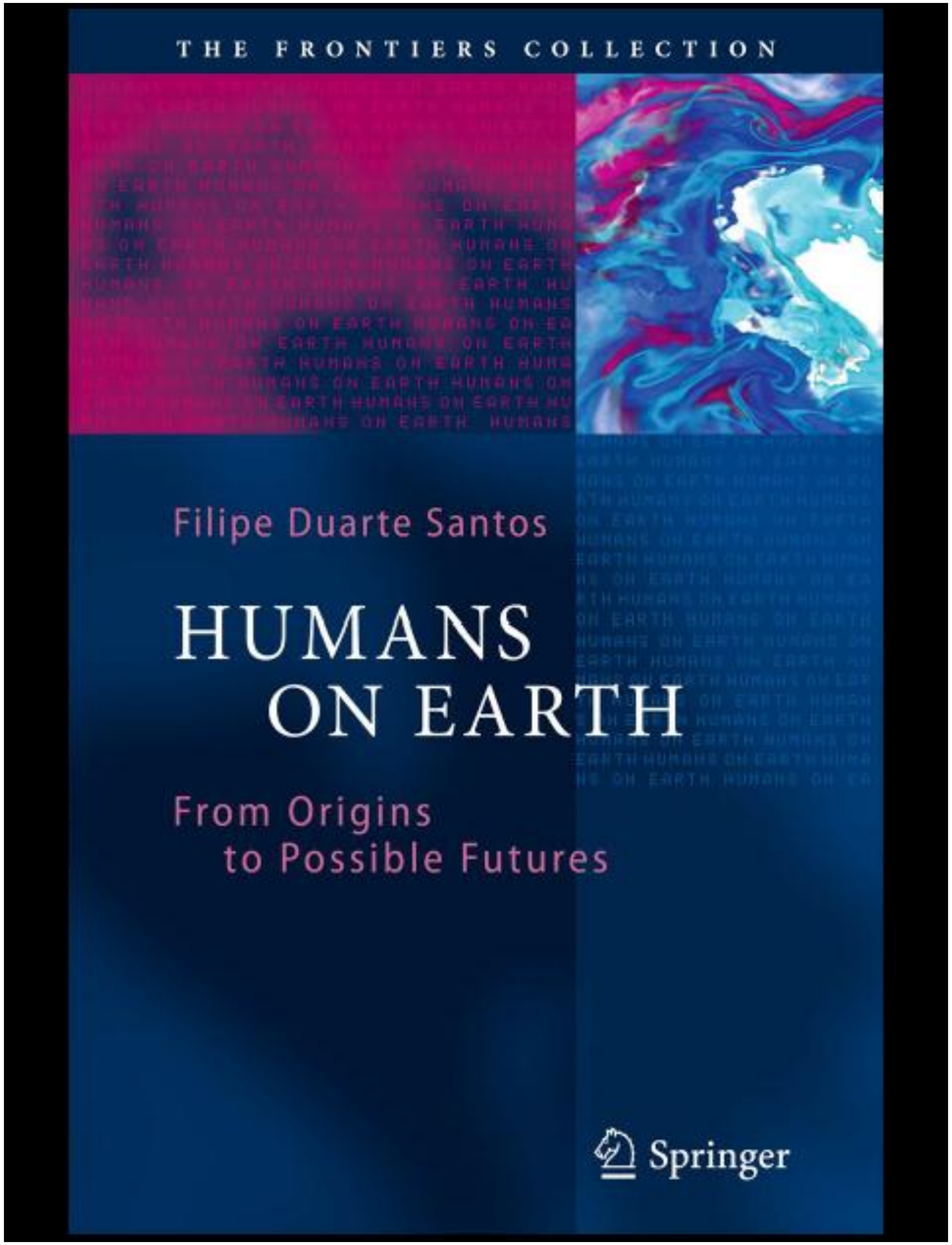
Impactos nas Florestas

• Alteração dos tipos florestais dominantes

• Aumento da incidência de pragas e doenças

• Aumento drástico do risco meteorológico de incêndio; prolongamento da época de incêndio

Fonte, SIAM



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Thank you for your attention