
Freie Universität Berlin
AFES-PRESS
UNITED NATIONS UNIVERSITY
UNU-EHS
Institute for Environment and Human Security
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"Global Change and Desertification: Scenarios and Social and Ecological Impact
Keynote speech at the meeting of the Spanish Environment Ministry and the Foundation on Biodiversity on:
Global Change and Desertification
Fuerteventura (Spain), 12 July 2007
MINISTERIO DE MEDIO AMBIENTE
Campus de la Excelencia
Fundación Biodiversidad

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1. Introduction: Questions

- **How does Global Environmental Change (GEC) and human action affect desertification?**
- **What are the implications of GEC and desertification for the Western Mediterranean and Spain until 2020, 2050 and 2100?**
- **Which proactive adaptation, mitigation and coping strategies for the Western Mediterranean, Spain and the Canary Islands are conceivable?**
  - Facing social and political effects: Migration & conflicts
  - Coping with climate change and desertification with adaptation and mitigation policies and measures and sustainable soil, water and agricultural management
  - Using potential of renewable energy for the Canary Islands

1. Introduction: Focus of the Talk

Environmental Challenges of Global Change

- **Global Environmental Change: climate change & desertification**
- **PEISOR model: links GEC with social impacts & pol. response**
- **CC: Global processes and D: regional/local processes**
- Climate change
  - **Impacts**
  - **Scenarios**
- Desertification
  - **Direct: Oversue and bad management (drivers: economy & poverty)**
    - **climate change induced desertification**
  - **Indirect effects:**
    - **environmental: soil erosion, water scarcity and crop yield decline**
    - **socio-political: migration will most likely increase**

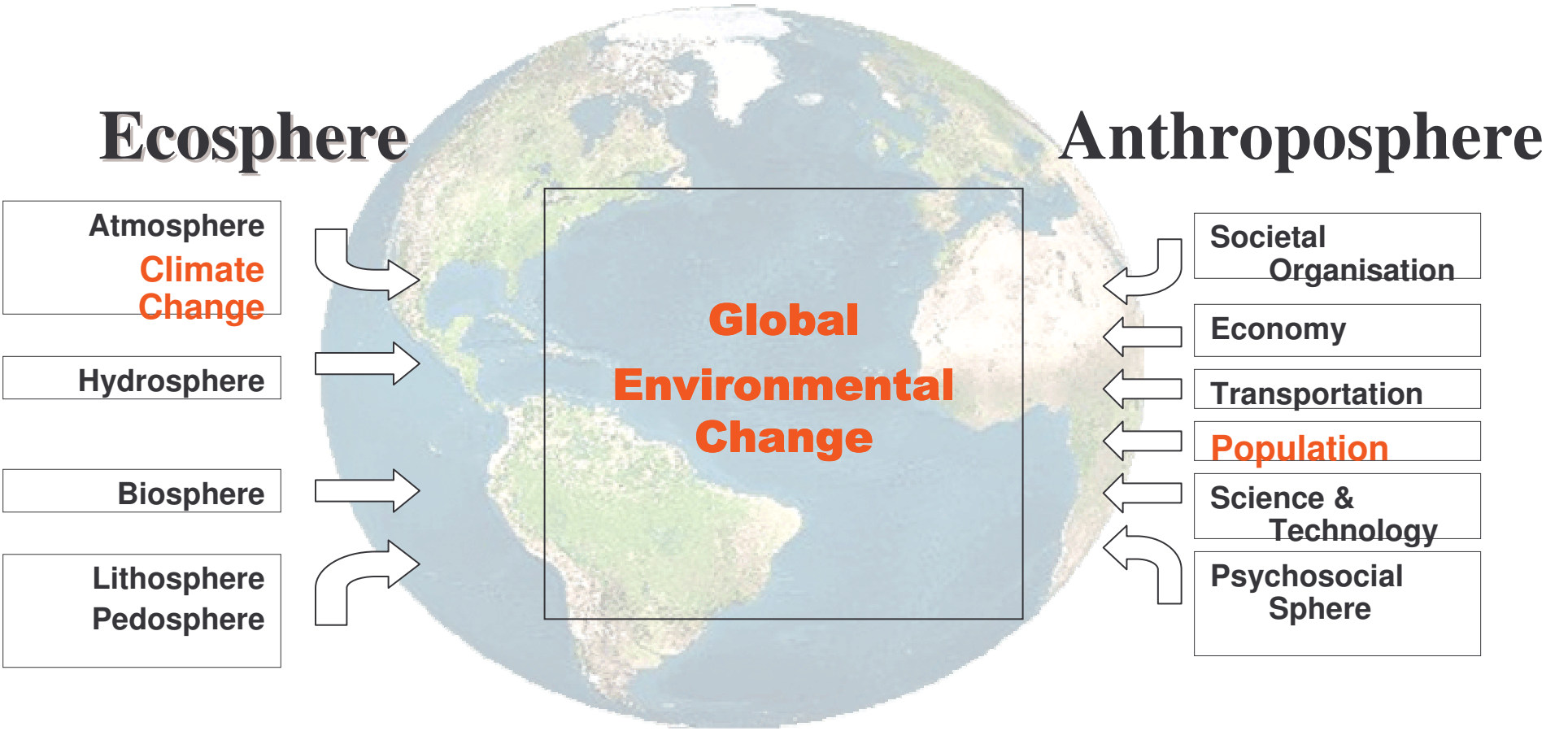
Policy Responses

- **From reactive to proactice strategies, policies and measures**
- **Vision of Fuerteventura for Combating Desertification**

2. Global Environmental Change

- Since 1970/80s: '*global environmental change*' (GEC) a new topic in natural and social sciences
- Since late 1980s and 1990s policy efforts on:
  - Climate Change: 1988: issue of G7; 1990: UN GA mandate; 1992: Rio summit: UNFCC (1992) and Kyoto Protocol (1997)
  - Desertification: UNCCD (1994)
- Since 2000: both are considered as security issues
  - Almeria Symposia: 1994 and 2006: desertification and migration
  - Since 2000: climate change seen as a security threat/risk
  - Valencia: 2003: NATO Conference: Desertification as a security issue in the Mediterranean

2.1. Global Environmental Change (GEC)



GEC poses a threat, challenge, vulnerabilities and risks for human security and survival.

2.2. Definition of GEC

- **German Advisory Council on Global Change (WBGU) is charged to evaluate environmental changes, their impacts and make proposals on coping with them in ecological, social and economic contexts.**

WBGU mission: defined challenges of Global Change

- Human interference in the natural environment reached global proportions.
- Critical global environmental changes include climate change, biodiversity loss, soil degradation and freshwater pollution and scarcity.
- Spread of non-sustainable lifestyles, persistence of absolute poverty and a growing global population accelerate these interventions in environment.
- One consequence of GEC is the mounting vulnerability, especially of developing countries, to natural disasters, food crises and disease.
- Thus, environmental degradation has also become a security issue.
- The new quality of these global human interventions in the Earth System is presenting scientists and politicians with new challenges.
- Global environment and development policy, guided by the principle of sustainable development, seeks to meet these challenges.

2.3. Four GEC Scientific Programmes

- **International Geosphere-Biosphere Programme** (IGBP). research pro-gramme that studies Global Change
- **Goals:** • Analyze interactive physical, chemical and biological processes that define Earth System dynamics
  • changes occurring in these dynamics
  • role of human activities on changes

- **DIVERSITAS:** integrates biodiversi-ty science for human well-being:
- By linking biology, ecology & social sciences, it produces socially relevant new knowledge to support sustainable use of biodiversity

- **International Human Dimensions Programme (IHDP):** international, interdisciplinary science organization: promoting, & coordinating research, capacity building & networking. Social science perspec-tive on global change and works at the interface between science and practice

- **World Climate Research Programme** draws on climate-related systems, faci-lities & intellectual capabilities of 185 countries to advance understanding of processes that determine our climate.
- Two key objectives of **WCRP** are:
  - to determine predictability of climate;
  - to determine effect of human activities on climate.

2.4. Earth System Science Partnership (ESSP)

- **2001: Amsterdam Declaration on Global Change: IGBP, IHDP, DIVERSITAS, WCRP formed Earth System Science Partnership.**
- **ESSP: partnership for integrated study of the Earth System, changes, & implications for global/regional sustainability.**
  - **Global environmental changes are both accelerating & moving the earth system into a state with no analogue in previous history.**
  - **The Earth System is the unified set of physical, chemical, biological & social components, processes and interactions that together determine the state and dynamics of Planet Earth, including its biodata & human occupants.**
  - **Earth System Science: study of Earth System, with an emphasis on observing, understanding and predicting global environmental changes involving interactions between land, atmosphere, water, ice, biosphere, societies, technologies and economies.**

2.5. UNCCD Definition of Desertification

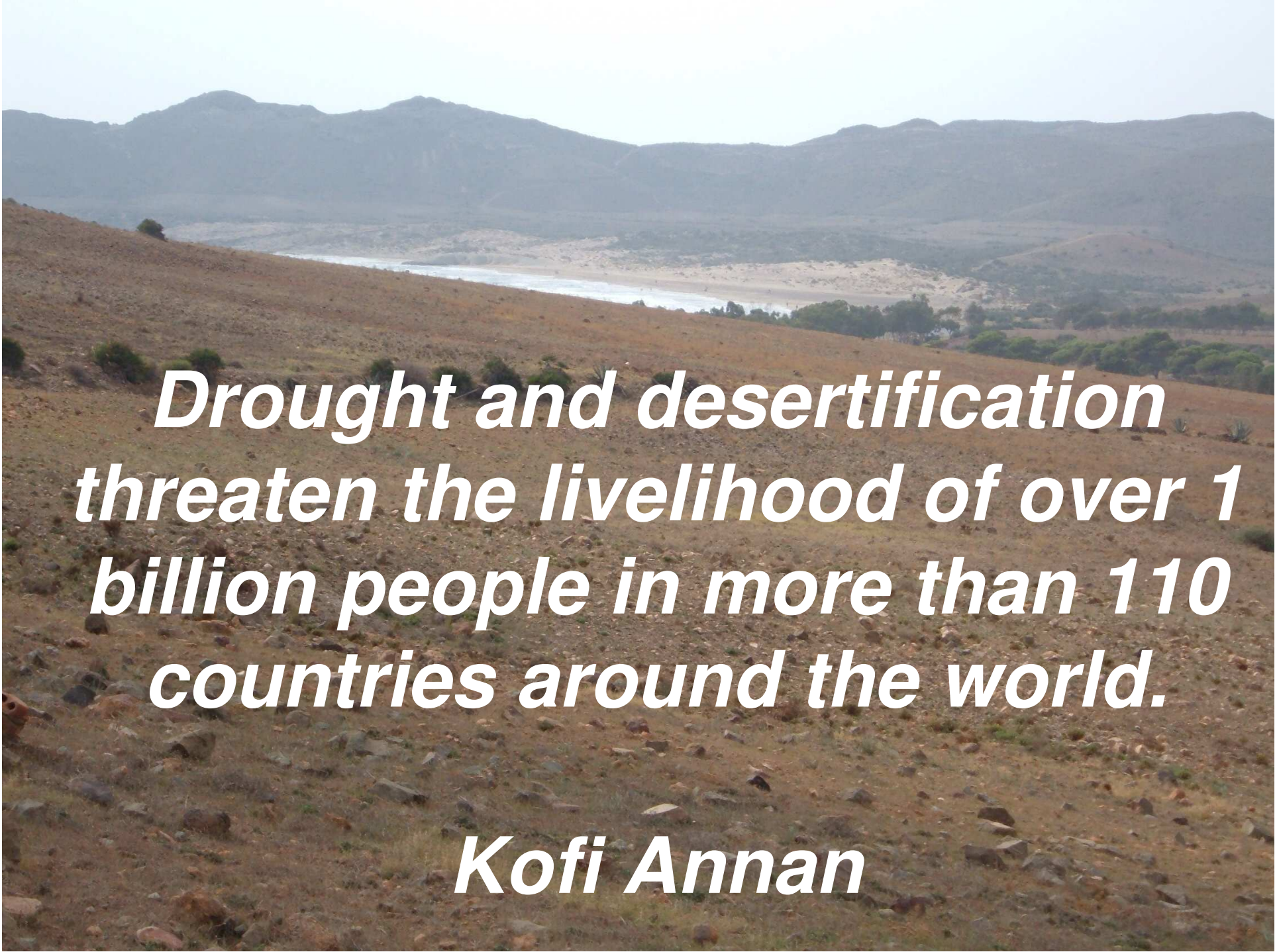
- Art. 1 (b) of *UN Convention to Combat Desertification* of 17 June 1994 on "*combating desertification*" aims at:

  "(i) prevention and/or reduction of land degradation;

  (ii) rehabilitation of partly degraded land; and

  (iii) reclamation of desertified land".

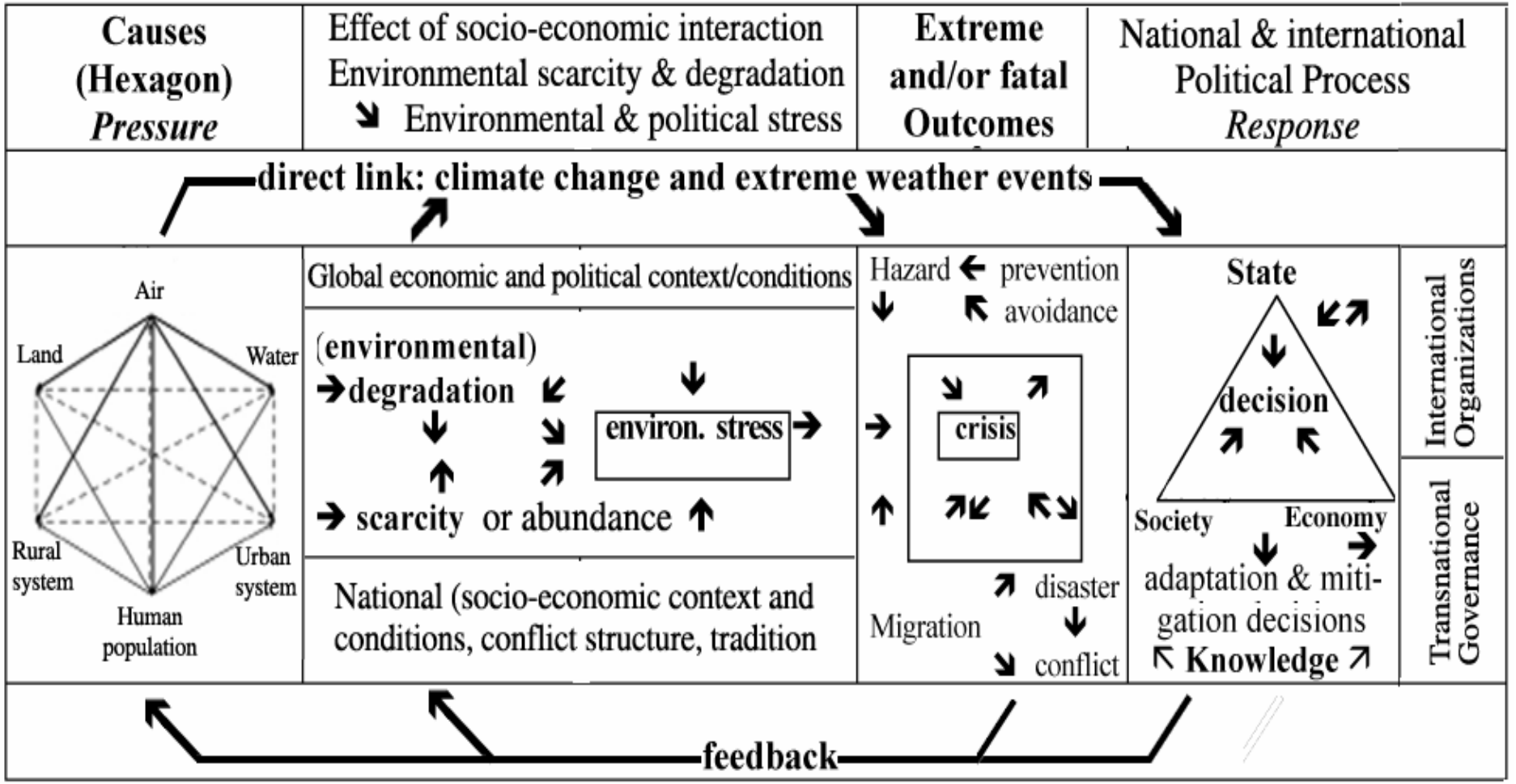
- *Drought* is used for "the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems."


Drought and desertification threaten the livelihood of over 1 billion people in more than 110 countries around the world.
Kofi Annan

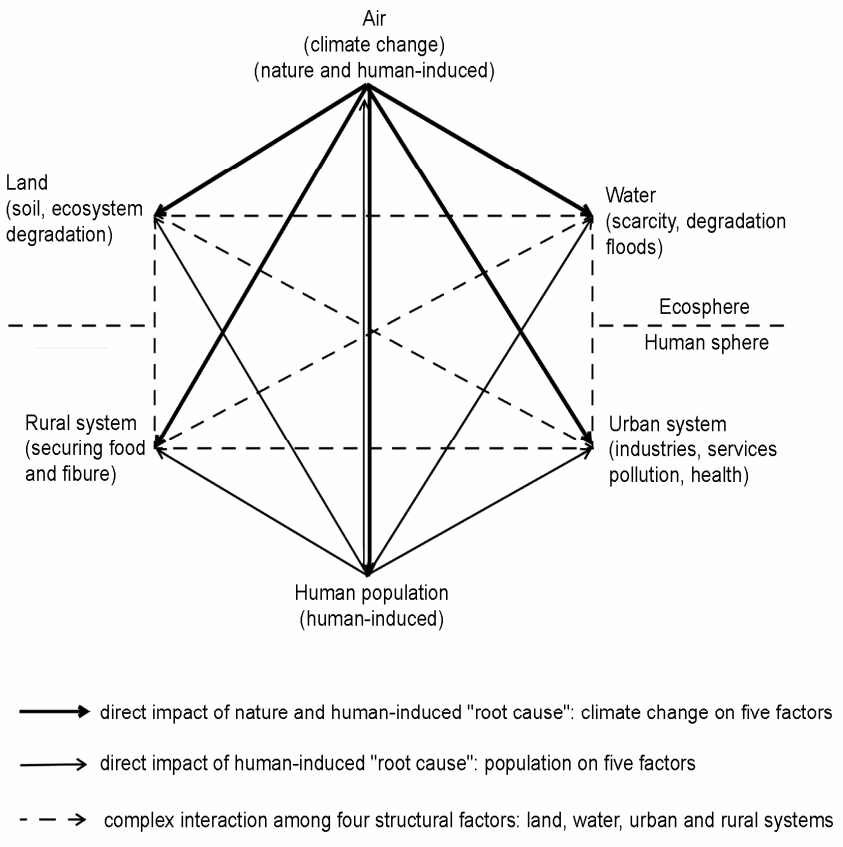
3. PEISOR Model: Global Change, Impacts and Policy Response

- **Other Models: Environment – Response**
  - **OECD: PSR-Model**
  - **UN-CSD** (Committee for Sustainable Development)
  - **EEA** (European Environment Agency)
- **PEISOR model distinguishes 5 stages:**
  - **P: Pressure: Causes of GEC : Survival hexagon**
  - **E: Effect: environm. scarcity, degradation & stress**
  - **I: Impact: Extreme or fatal outcome: hazards**
  - **SO: Societal Outcomes: disaster, migration, crisis, conflict etc.**
  - **R: Response by state, society, the economic sector and by using *traditional* and *modern scientific* knowledge to enhance coping capacity and resilience**

3.1. PEISOR Model: Global Change, Environmental Stress, Impacts & Extreme Societal Outcomes



3.2. PEISOR: Pressure or Causes of GEC (Survival Hexagon)



Six causes of GEC or pressure factors

Nature & human-induced

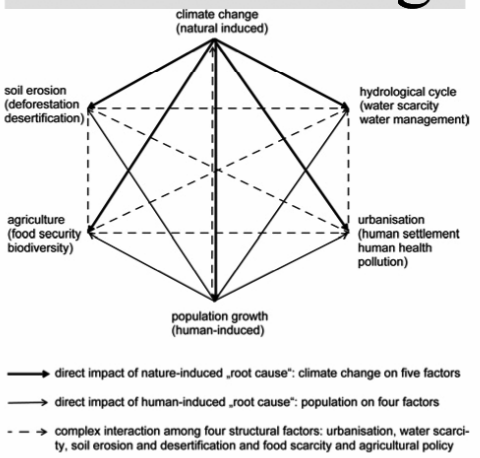
- **Air:** Global climate change
- **Soil** degrad., desertification
- **Water** scarcity, hydrol. cycle

Human-induced factors

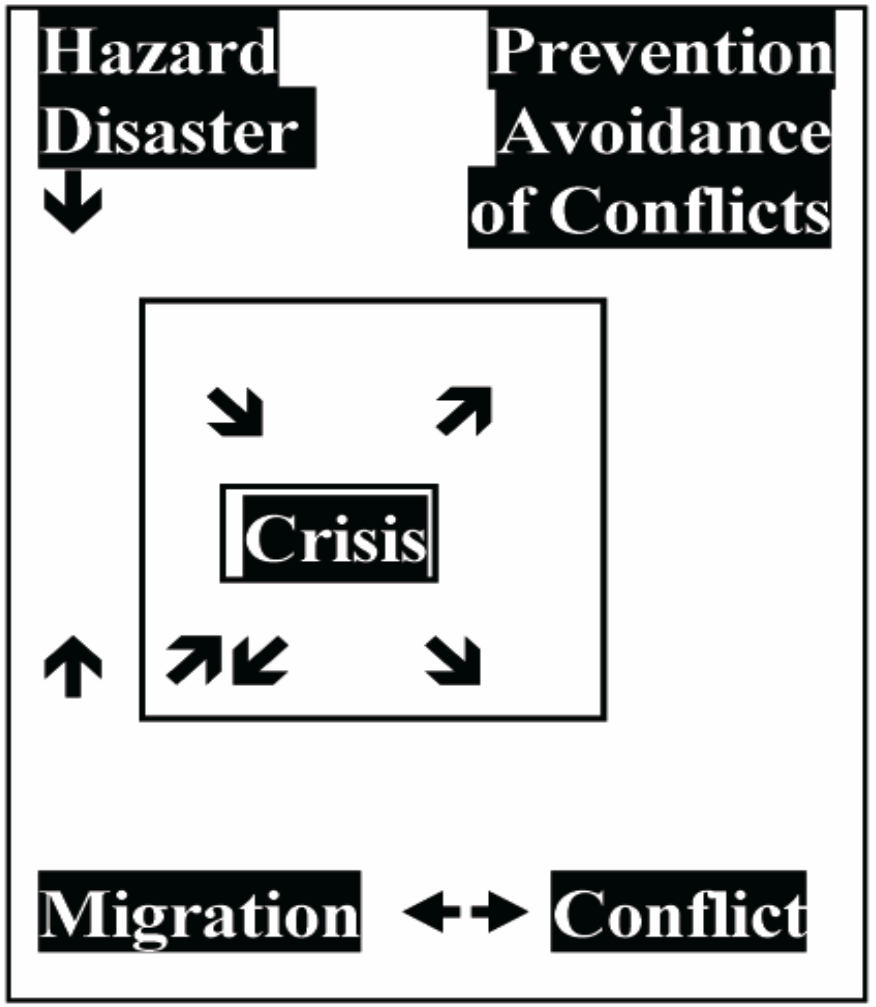
- Population growth
- Urban systems: Urbanisation, Pollution, Health
- Rural systems: Agriculture: Food & Fibre

Six Contextual Factors

3.3. PEISOR: Effect: Environmental Scarcity, Degradation and Stress and Impacts

Causes (Hexagon)	Effect (Interaction)	Environmen-tal Stress	Probable Outcomes
↗→→→→Extreme Weather Events→→→↘			
Climate change 	environmental → **degradation** (soil, water) ↓↑→ → **scarcity** (water, food, housing)	global cond. ↓ Environ-mental stress ↑ nation. cond.	**disaster** conflict avoidance ↗↗ → **Crisis** ↘↘ **migration** **conflict**

3.4. Early Warning of Impact (Hazard & Disaster) & Social Outcomes (Migration, Crises & Conflicts)



Much knowledge on these factors:

- ✓ Hazards, migration, crises, & conflicts

By different scientific communities

Lack of knowledge on linkages among extreme - fatal outcomes

- Disasters & disaster-induced migration
- Famine & environm.-induced migration
- Conflicts & conflict-induced migration

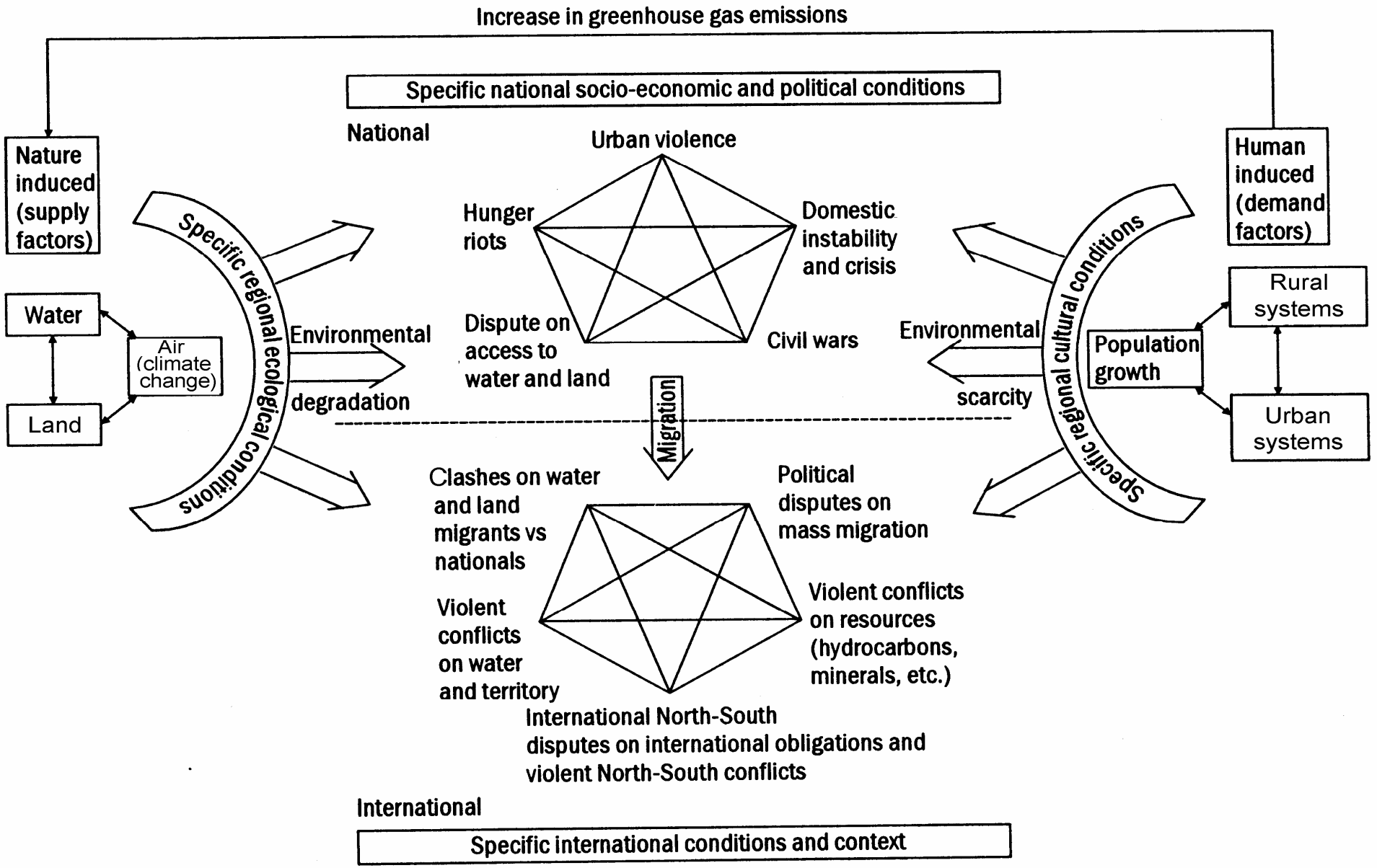
Lack of knowledge on societal consequences: crises & conflicts

- Domestic/international crises/conflicts
- Environmentally or war-induced migration as a cause or consequence of cri-ses and conflicts

Dual Scientific & Policy Goal

- Reduce Vulnerability & Hazard Impact
- Avoid ExtremeSocietal Outcomes

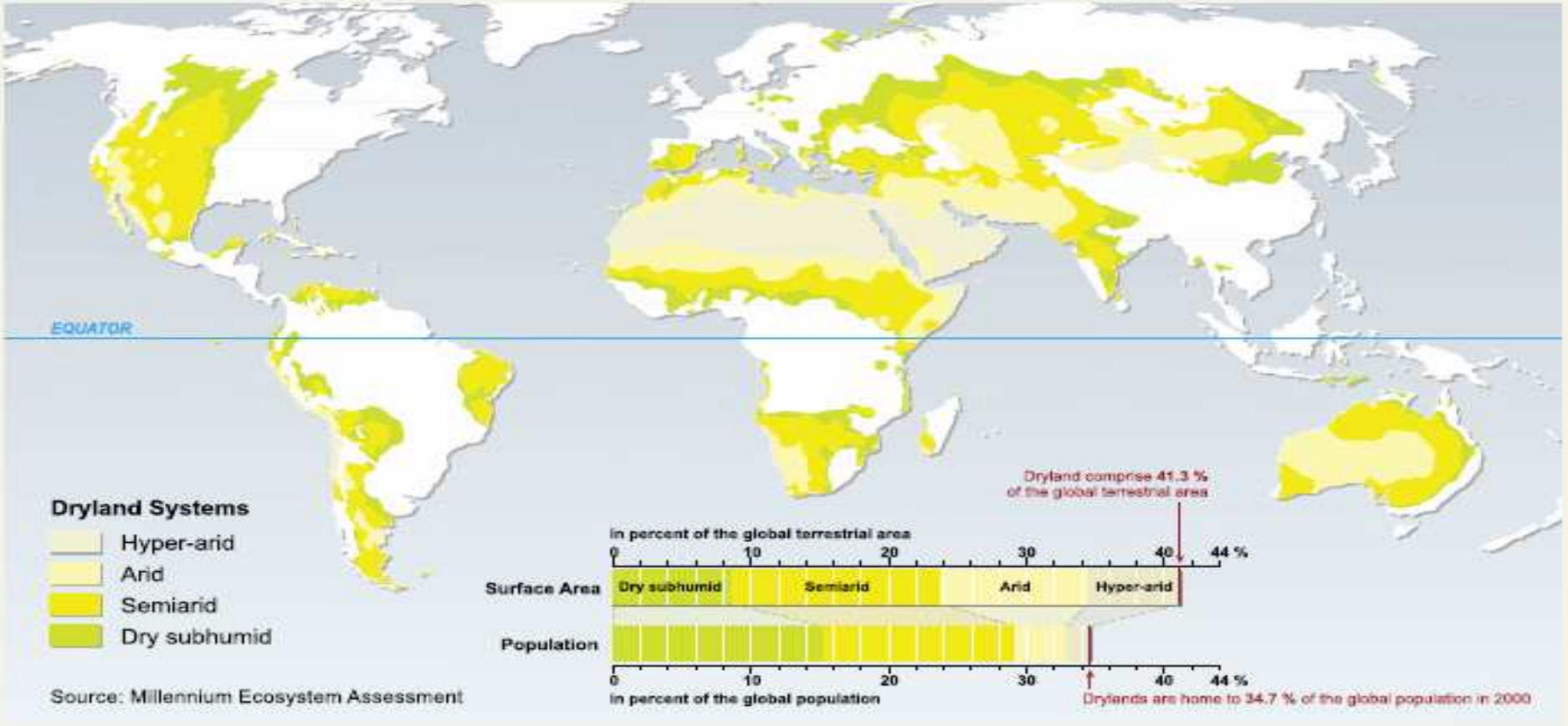
3.5. Pentagon of Extreme Outcomes



4. GEC: Desertification and Drought

Drylands and their Categories

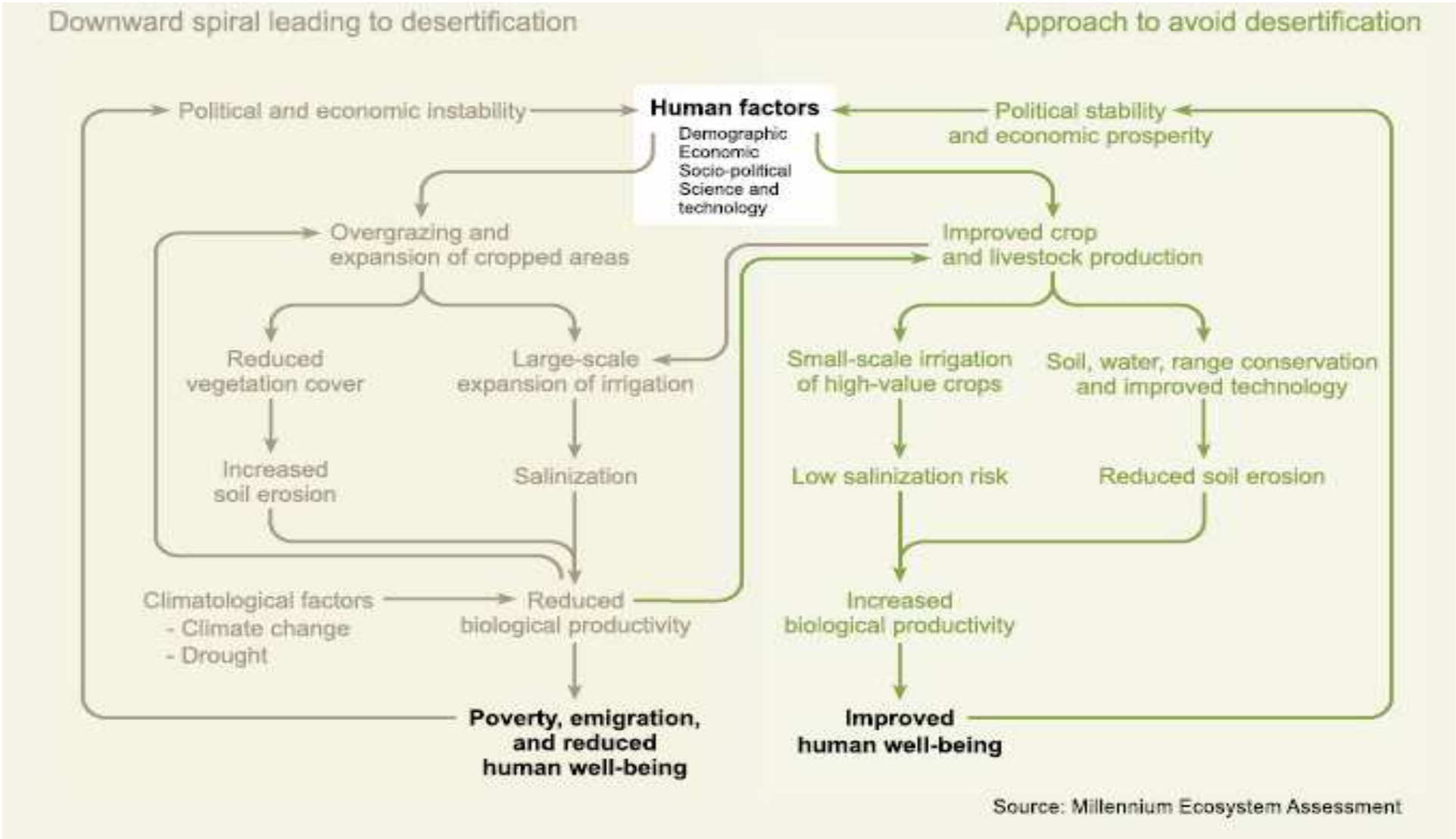
Drylands include all terrestrial regions where the production of crops, forage, wood and other ecosystem services are limited by water. Formally, the definition encompasses all lands where the climate is classified as dry subhumid, semiarid, arid or hyper-arid. This classification is based on Aridity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



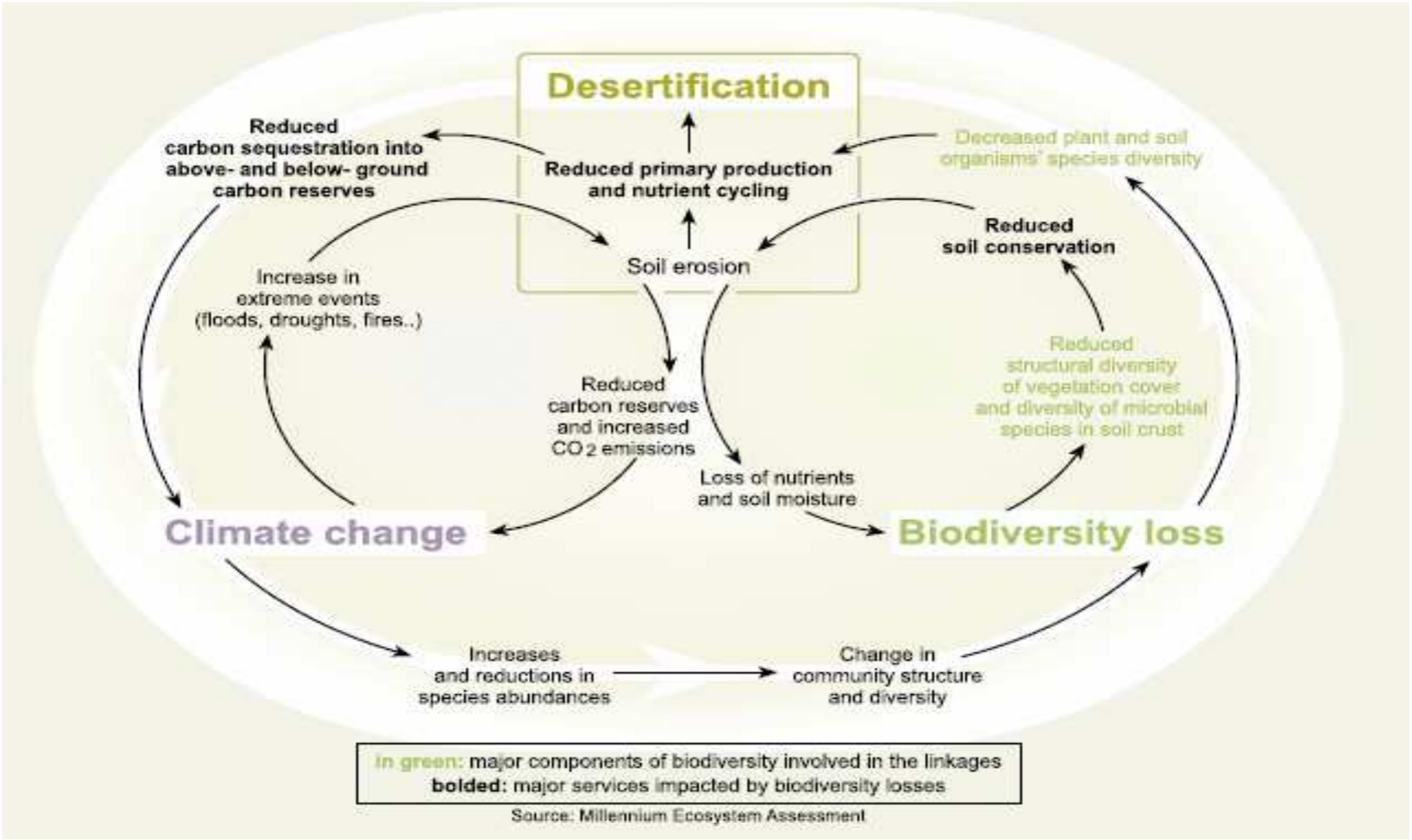
† The long-term mean of the ratio of an area's mean annual precipitation to its mean annual potential evapotranspiration is the Aridity Index (AI).

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.

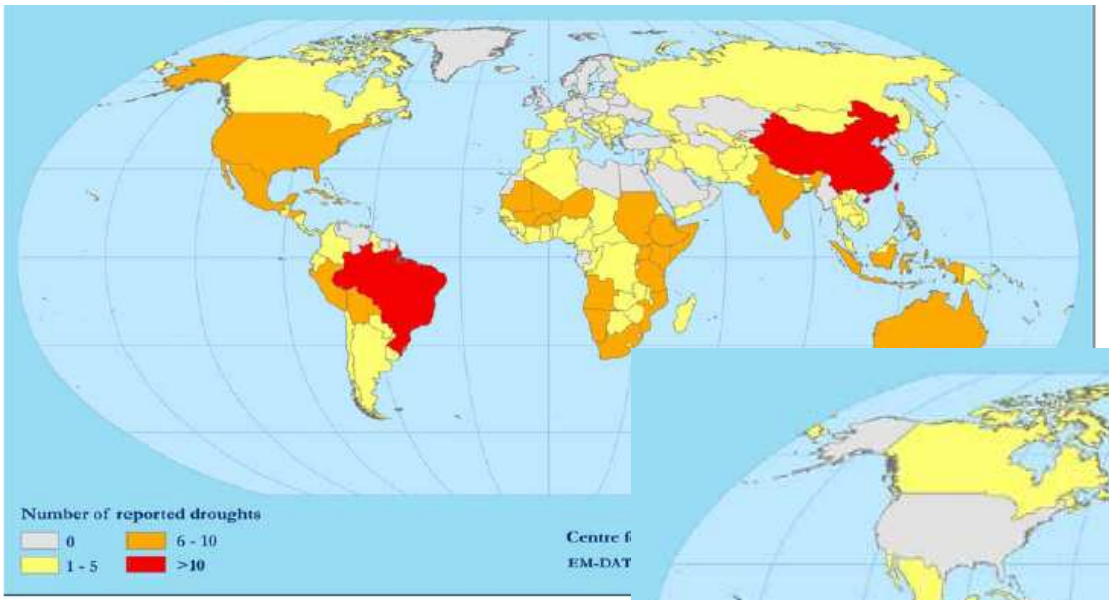
4.1. Development Pathways in Drylands

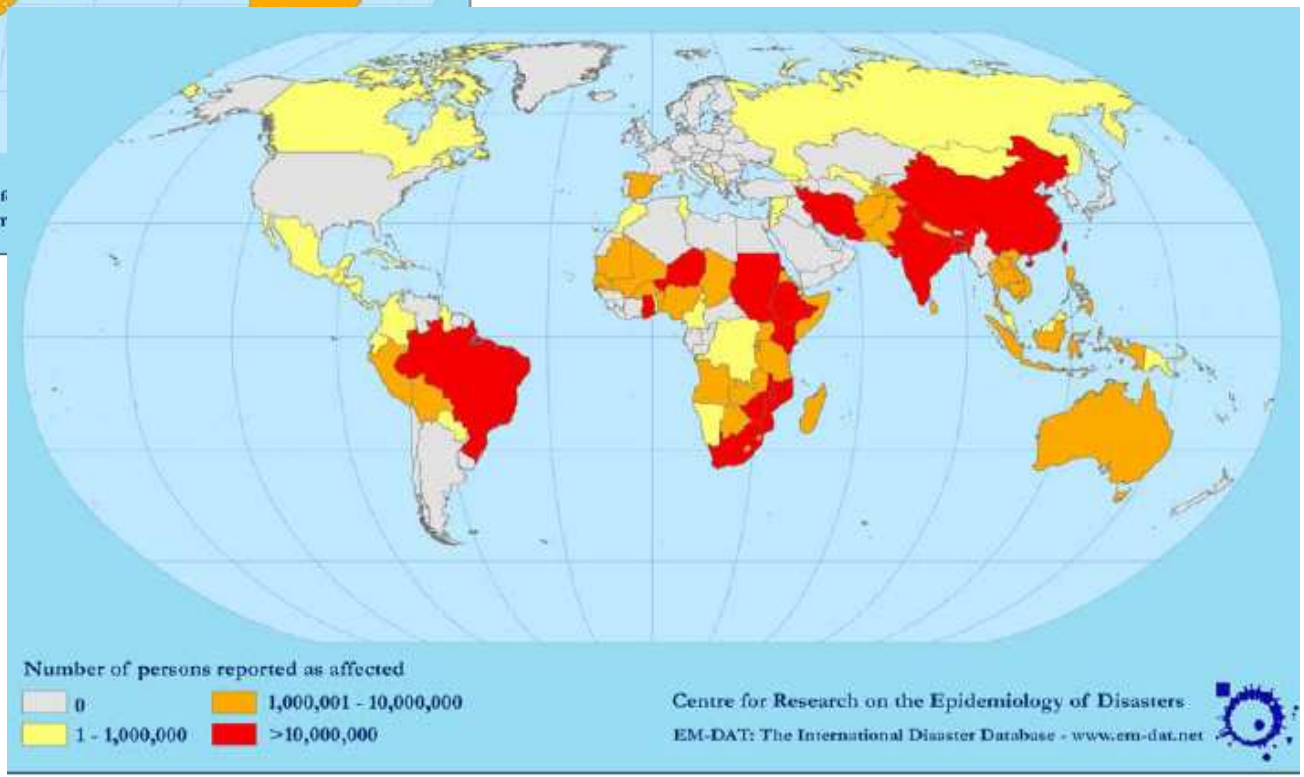


4.2. Linkages & Feedback Loops: Desertification, climate change and biodiversity loss



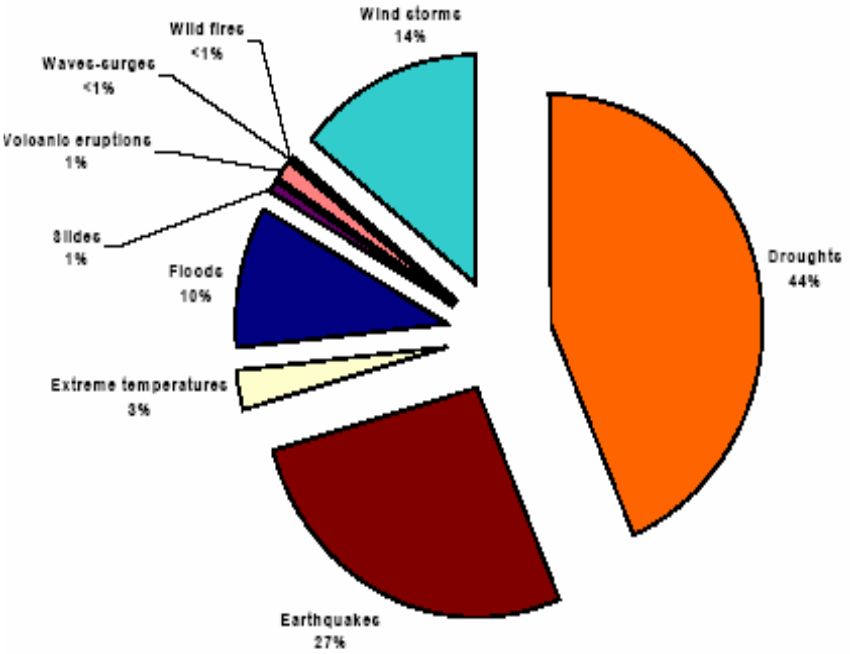
4.3. Number of drought disasters by country & affected persons (1970-2006)



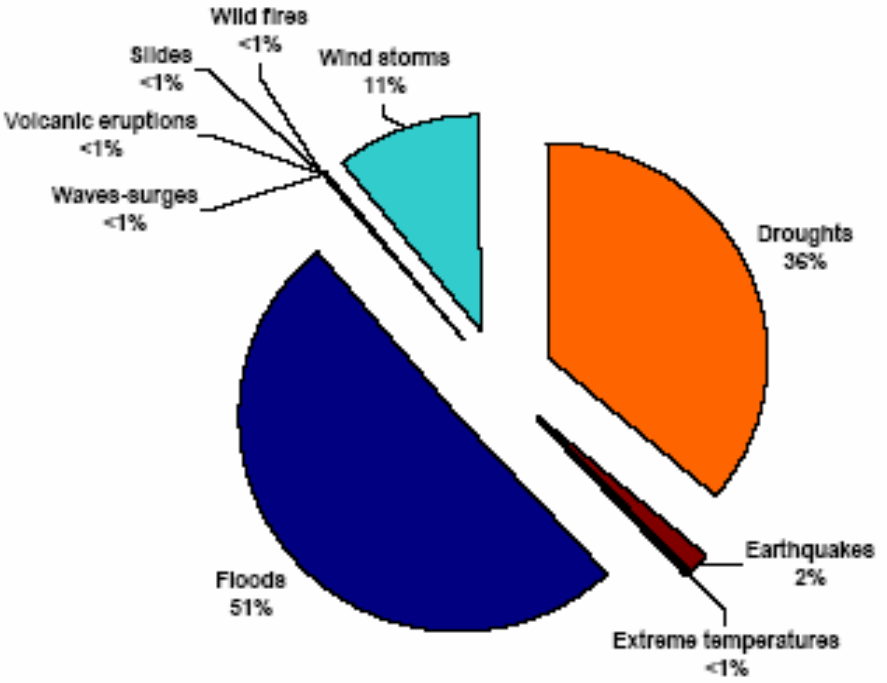


4.4. Impacts of Drought (1974-2003)

Reported Death of Natural Hazards globally: 2.066.273 persons



- **Affected persons of Natural Hazards: 5 076 494 541 .**

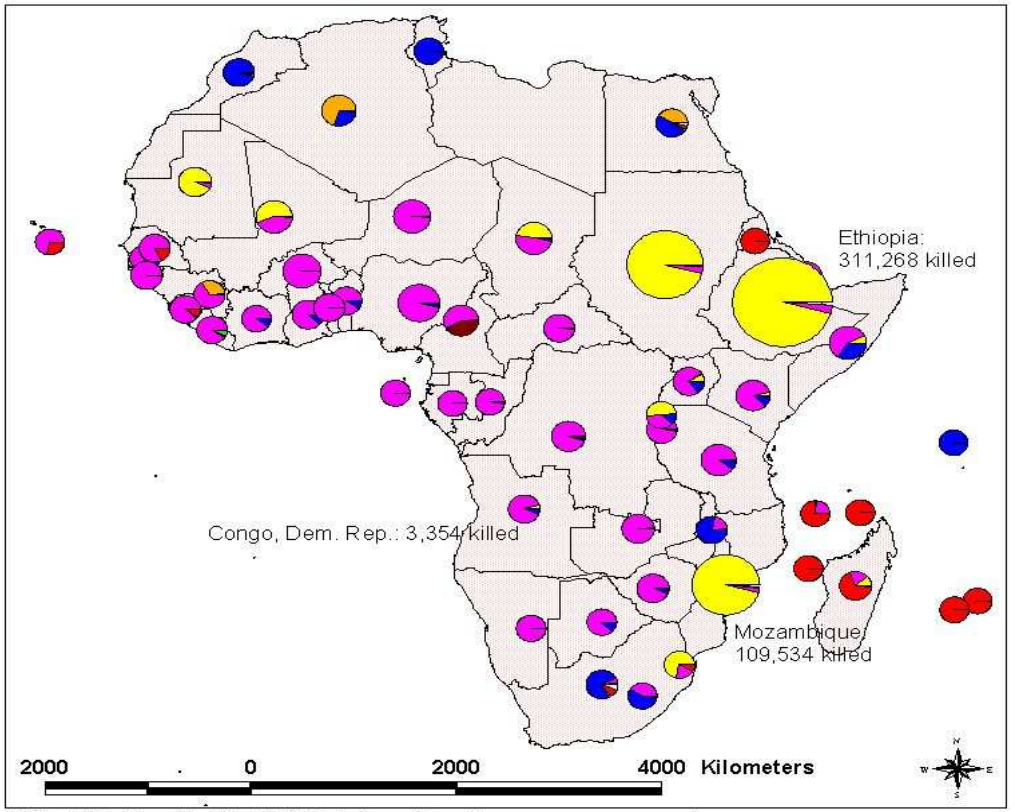


(1) injured + homeless + affected

Source: Hoyois/Guha-Sapir (2004)

4.5. Fatalities & Affected People of Natural Hazards in Africa (1975-2001)

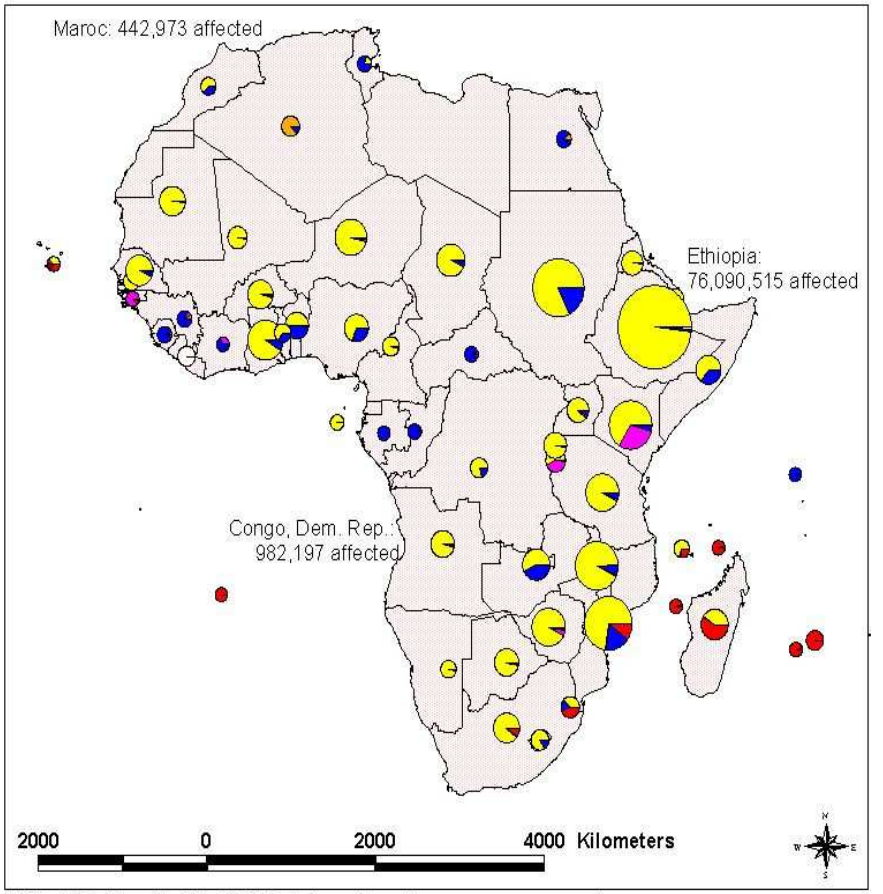
Distribution of natural disasters fatalities, by country and type of phenomena, in Africa (1975-2001)



EM-DAT: The OFDA/CRED International Disaster Database
(http://www.cred.be ; email: cred@epid.ucl.ac.be)

LEGEND
- Volcano
- Earthquake
- Drought/Famine
- Epidemic
- Avalanche/Landslide
- Flood
- Wind Storm
- Other

Distribution of people affected by natural disasters, by country and type of phenomena, in Africa (1975-2001)



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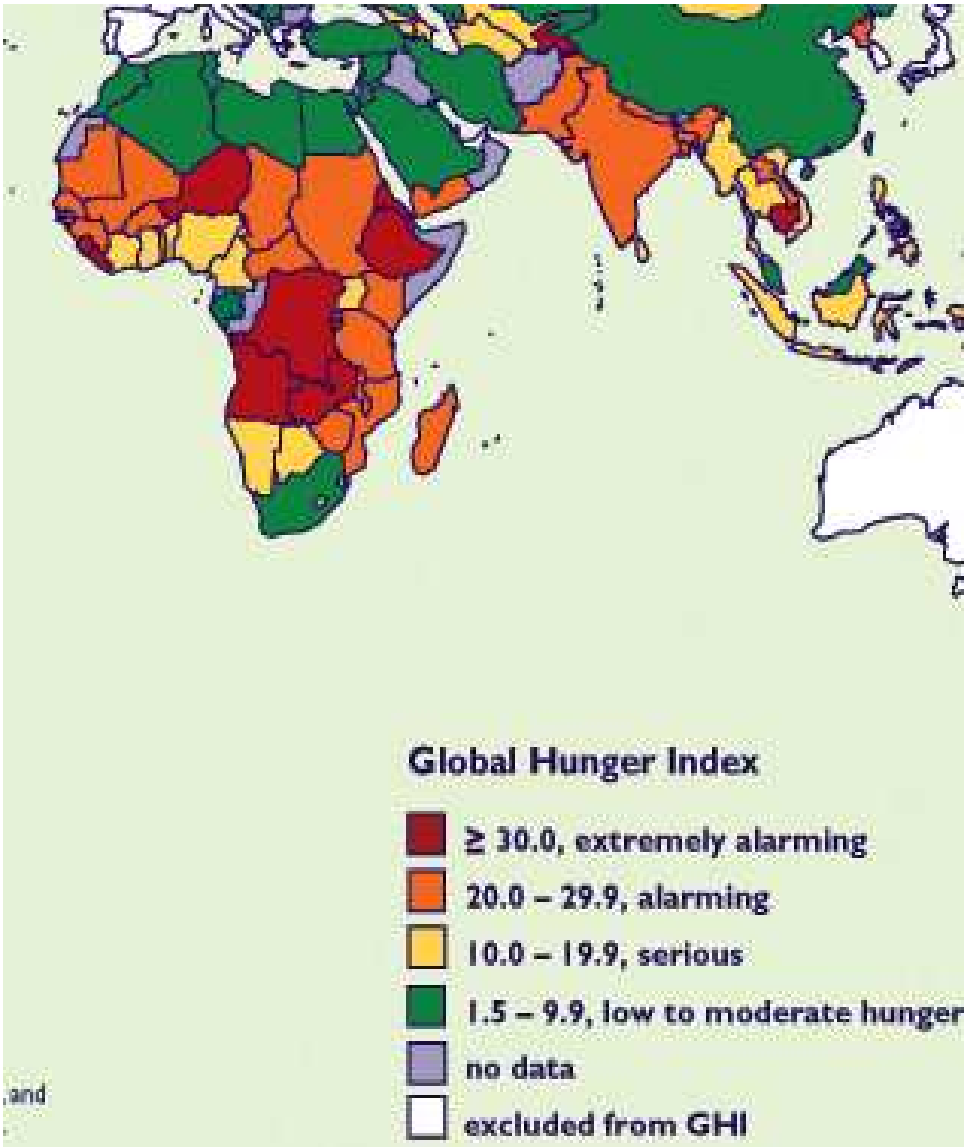
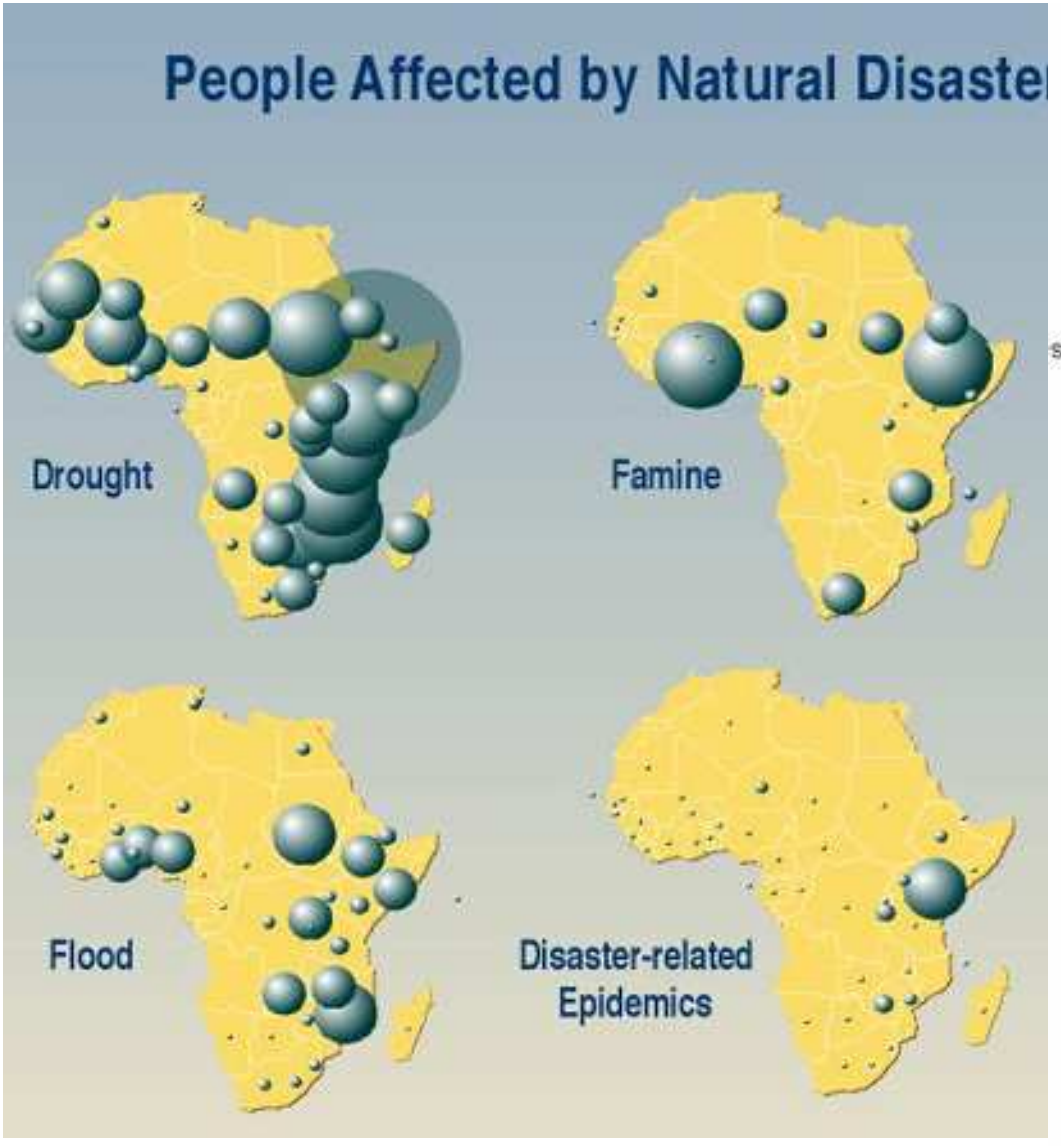
LEGEND
- Volcano
- Earthquake
- Drought/Famine
- Epidemic
- Avalanche/Landslide
- Flood
- Wind Storm
- Other

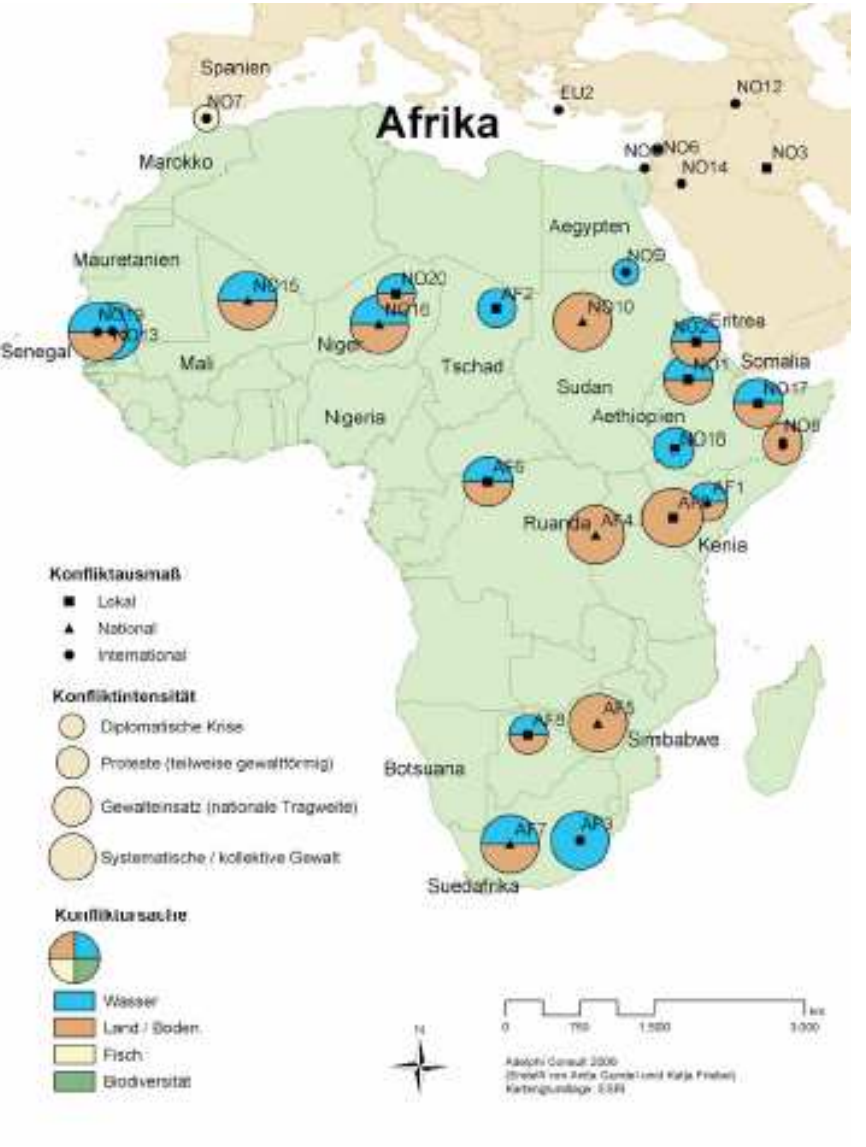
4.6. IFRI: Global Hunger Index: Oct. 2006



- **Global Hunger Index** of Internat. Food Policy Research Institute (IFPRI, Washington)
- **Of 12 countries** with highest hunger levels, **nine** were affected by **civil wars or violent conflicts**.
- **The 10 worst cases are all in Sub-Saharan Africa**.
- Among **most affected** are countries in Nile Basin (**Eritrea, Ethiopia**), in Sahel (**Niger**)
- In all other countries: **alarming**.
- **Situation may get worse:**
  - **demand increase** and
  - **supply decline** due to impects of **Global environmental change**.

4.7. Drought, Famine and Conflicts in Africa





4.8. Spain: Top Natural disasters:
Persons killed & affected. Source: CRED (2007)

Top 10 Natural Disasters – number killed:

Disaster type	Date	No Killed
Extreme Temperature	1-Aug-2003	15,090
Flood	19-Oct-1973	500
Flood	27-Sep-1962	445
Slides	7-Aug-1996	84
Flood	Oct-1957	77
Flood	Oct-1953	50
Flood	25-Aug-1983	45
Flood	19-Oct-1982	43
Extreme Temperature	9-Jan-1985	40
Flood	Nov-1982	34

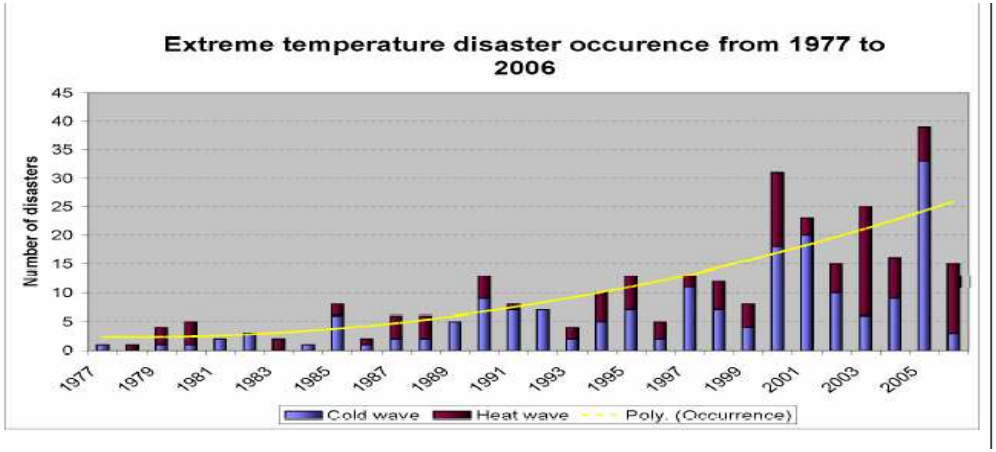
Top 10 Natural Disasters – economic damage:

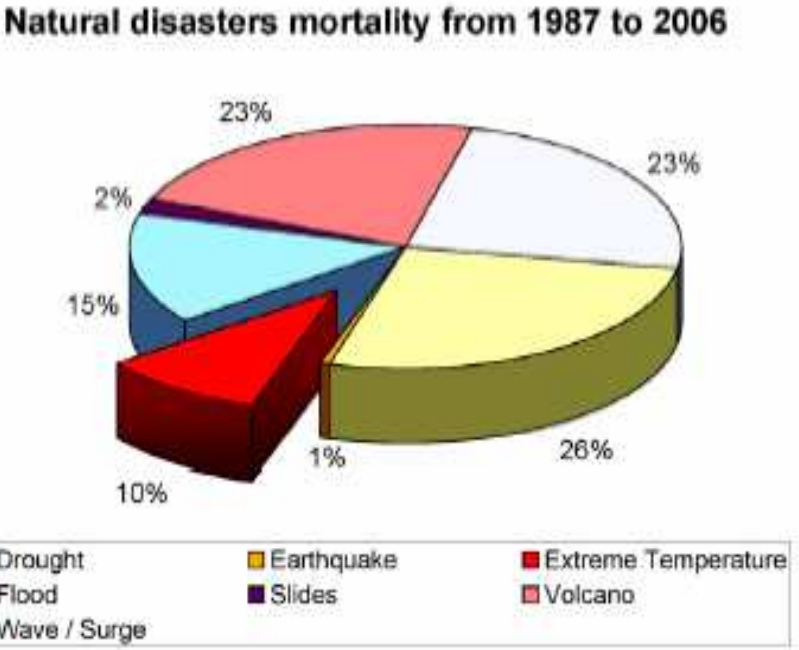
Disaster type	Date	Damage US* (000's)
Drought	Sep-1990	4,500,000
Flood	25-Aug-1983	3,900,000
Drought	Apr-1999	3,200,000
Wild Fires	18-Jul-2005	2,050,000
Drought	1980	1,500,000
Drought	1981	1,460,000
Flood	4-Nov-1987	1,283,000
Wind Storm	4-Oct-1984	1,000,000
Extreme Temperature	1-Aug-2003	880,000
Extreme Temperature	22-Apr-1995	824,300

Summarized Table of Natural Disasters in Spain from 1953 to 2007

	# of Events	Killed	Injured	Home-less	Affected	Total Affected	Damage US$ (000's)
Drought	4	0	0	0	6,000,000	6,000,000	10,660,000
Earthquake	1	0	20	0	0	20	44,004
Epidemic	2	2	0	0	752	752	0
Extreme Temperature	8	15,216	70	0	0	70	2,104,300
Flood	21	1,279	1,700	6,000	734,600	742,300	7,765,885
Slides	1	84	129	0	0	129	0
Wild Fires	14	60	121	0	18,600	18,721	2,754,108
Wind Storm	15	132	62	0	60,350	60,412	1,136,000

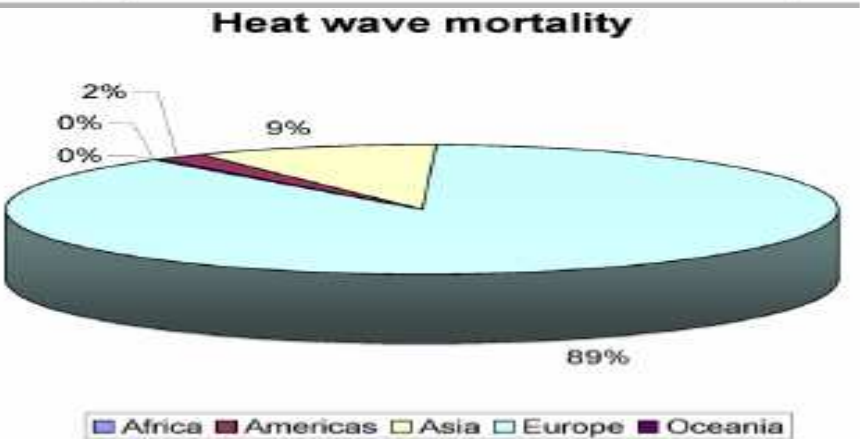
4.10. Extreme Temperature Disasters





Extreme temperature disasters: Summary

	1987-1996	1997-2006	1987-2006
All Events			
Occurrence	79	207	286
Number of killed	6.999	91.497	98.496
Average disaster mortality	88,6	442,5	344,4
Cold Wave			
Occurrence	50	131	181
Number of killed	2.600	8.250	10.850
Average disaster mortality	52,0	63,2	59,9
Heat wave			
Occurrence	29	76	105
Number of killed	4.399	83.212	87.611
Average disaster mortality	151,7	1.094,9	834,4



4.11. Heat Wave of 2003 in Europe

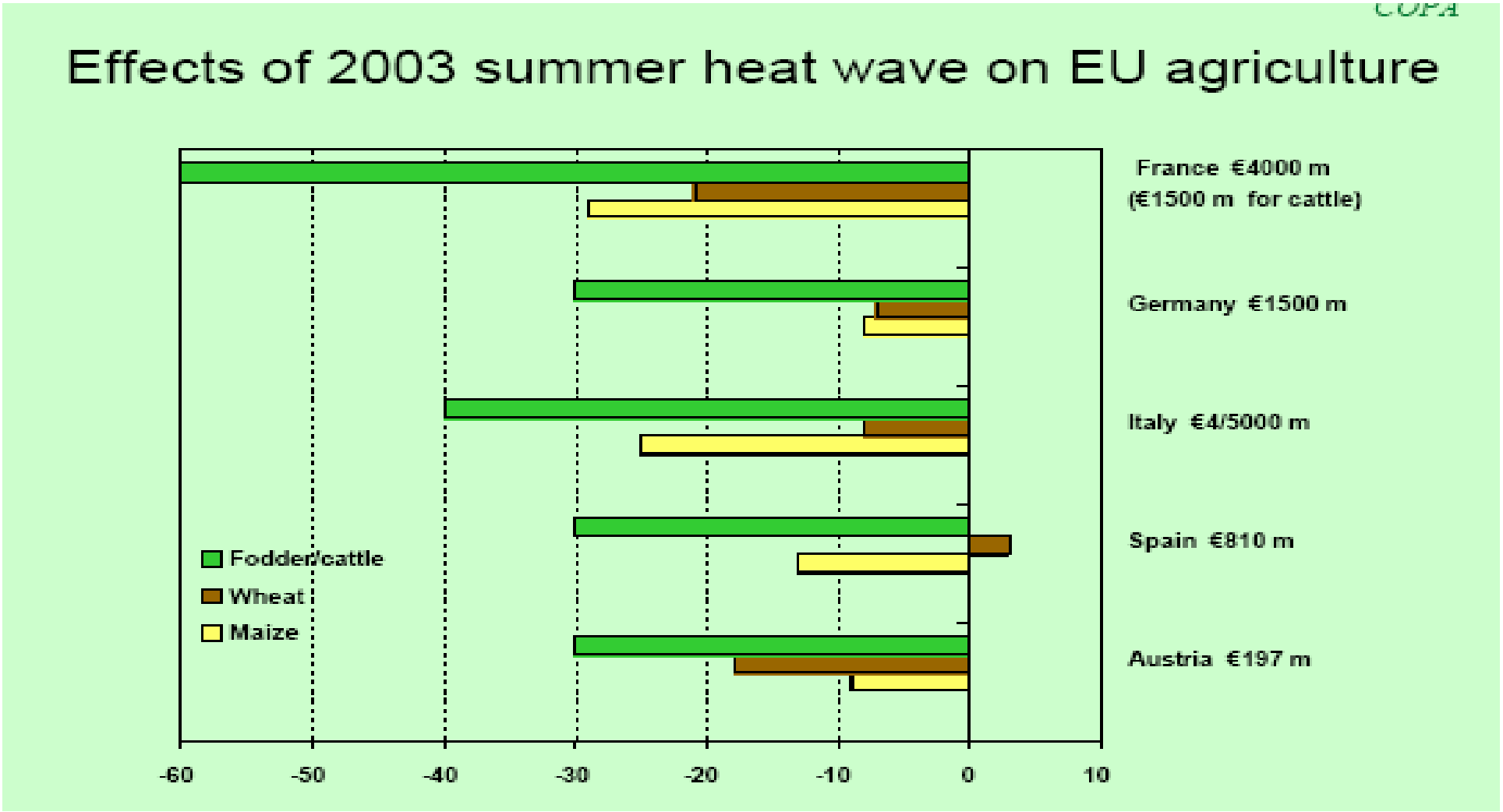
10 Most Deadly Disasters (1987-2006)

Year of occurrence	Disaster type	Region / Country	Number of killed
2003	Heat wave	Europe	72.210
2006	Heat wave	Western Europe	3.392
1998	Heat wave	India	2.541
2003	Heat wave	Indian Subcontinent	1.472
2005	Cold wave	Europe	1.330
2002	Heat wave	India	1.030
1987	Heat wave	Greece	1.000
2002	Cold wave	India	900
2002	Cold wave	Bangladesh	700
1995	Heat wave	United States	670

2003 heat wave mortality	
Country	Number of killed
Italy	20.089
France	19.490
Spain	15.090
Germany	9.355
Portugal	2.696
Belgium	1.175
Switzerland	1.039
Netherlands	965
Croatia	788
Czech Rep	418
Austria	345
United Kingdom	301
Slovenia	289
Luxembourg	170

4.12. Effects of 2003 summer heat wave on agricultural yield in five EU countries

© M. Parry, Meeting of EU Agriculture/ Environment Ministers, 11.9.2005, London



4.13. Global migration & refugees (1960-2005)

Year	Population at mid-year (thousands)	Estimated number of international migrants at mid-year (both sexes)	Estimated number of refugees at mid-year	Growth rate of the migrant stock (percentage)	International migrants as a percentage of the population	Refugees as a percentage of inter-national migrants
1960	3 023 670	75 463 352	2 163 992	0.8	2.5	2.9
1965	3 338 041	78 443 933	3 869 580	0.7	2.4	4.9
1970	3 696 128	81 335 779	3 886 983	1.3	2.2	4.8
1975	4 073 745	86 789 304	4 217 992	2.7	2.1	4.9
1980	4 442 309	99 275 898	9 065 472	2.2	2.2	9.1
1985	4 843 930	111 013 230	13 197 759	6.7	2.3	11.9
1990	5 279 519	154 945 333	18 497 223	1.3	2.9	11.9
1995	5 692 353	165 080 235	18 492 547	1.4	2.9	11.2
2000	6 085 572	176 735 772	15 656 912	1.5	2.9	8.9
2005	6 464 750	190 633 564	13 471 181	0.8	3.0	7.1

4.14. Migration in Mediterranean (1950-2000)

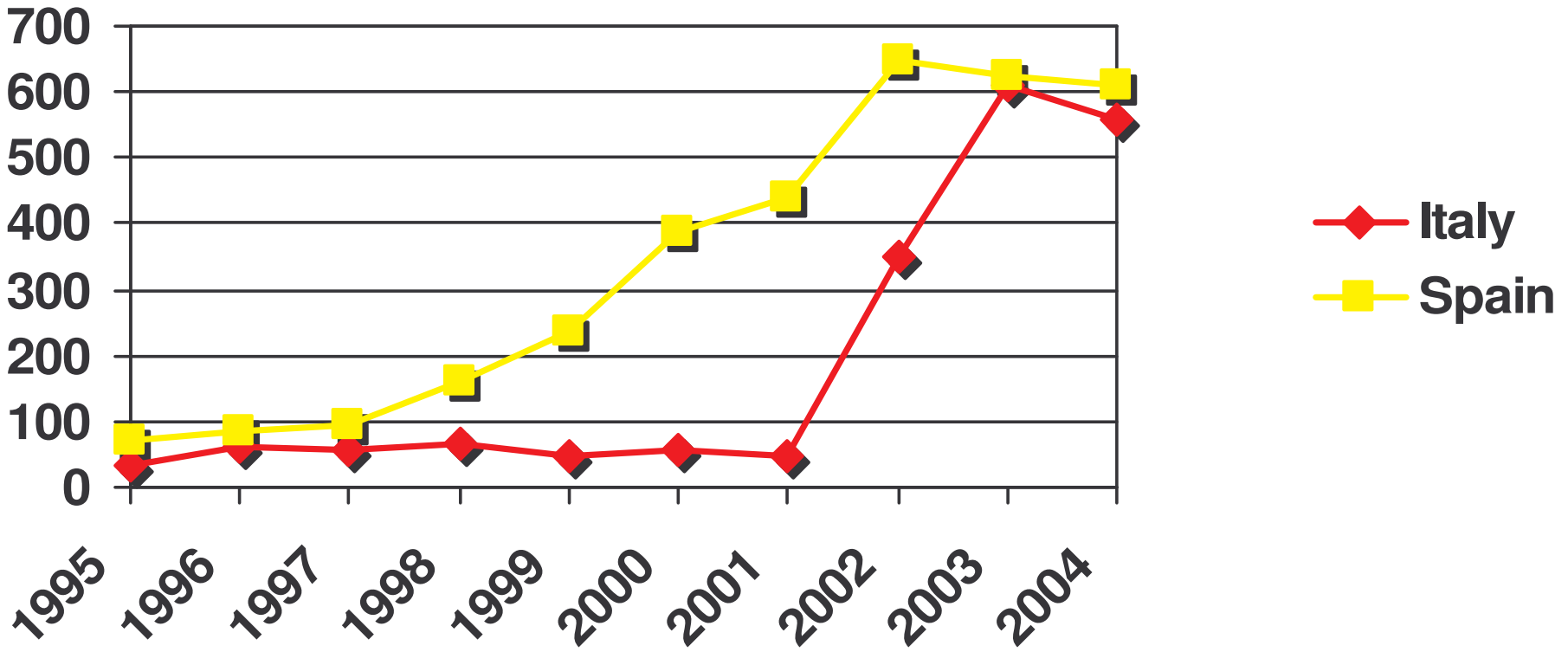
Region	*1950-1960*	*1960-1970*	*1970-1980*	*1980-1990*	*1990-2000*
	Net number of migrants per year (thousands)				
Mediterranean	-2,765	-4,097	-2,127	-839	369
North-western Mediterranean	-1,521	-761	1,079	337	2,124
North-eastern Mediterranean	-823	-1,162	-71	-162	-888
Eastern Mediterranean	576	-406	-1,295	-506	921
Southern Mediterranean	-997	-1,769	-1,840	-508	-1,788
	Net migration rate				
Mediterranean	-1.1	-1.4	-0.6	-0.2	0.1
North-western Mediterranean	-1.2	-0.5	0.7	0.2	1.3
North-eastern Mediterranean	-2.4	-3.1	-0.2	-0.4	-2.0
Eastern Mediterranean	1.7	-0.9	-2.3	-0.7	1.0
Southern Mediterranean	-2.0	-2.8	-2.3	-0.5	-1.4

Source: United Nations (2001). *World Population Prospects: The 2000 Revision*. Disk 2: Extensive Set. (United Nations Publication, Sales No. E.01.XIII.13)

4.15: Increase in migration to Spain (1975-2005)

	1975	1980	1985	1990	1995	2000	2005
Estimated number of international migrants at mid-year	299 953	240 906	405 869	765 585	1 009 021	1 628 246	4 790 074
Estimated number of refugees at mid-year	17 000	23 750	9 600	8 490	5 607	6 851	5 507
Population at mid-year (thousands)	35 596	37 542	38 474	39 303	39 921	40 717	43 064
International migrants as a percentage of the population	0.8	0.6	1.1	1.9	2.5	4.0	11.1
Refugees as a percentage of international migrants	5.7	9.9	2.4	1.1	0.6	0.4	0.1
	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Growth rate of the migrant stock (percentage)	-4.4	-4.4	10.4	12.7	5.5	9.6	21.6

4.20. Migration Saldo in Italy and Spain (1995-2004 (in 1.000)



5. Climate Change Scenarios

- **Temperature rise:**
  - Stern Report. economic
  - IPCC 4AR, WG I: scientific
  - WBGU 2007/2008: political
  - Projections for Western Med and Spain
- **Sea-level rise**
  - IPCC
  - WBGU ocean study
  - UNEP Study: Arctic, Antarctic melting: Photos UOS
- **Extreme weather events**
  - Global (Heat waves, Drought, Forest fires, Flash floods)
    - Munich Re, Swiss Re
    - CRED (30 years, heat waves, drought)
  - National impacts for Spain (death, affected, damage): 1953-2006

5.1. Temperature Increases & Sea Level Rise

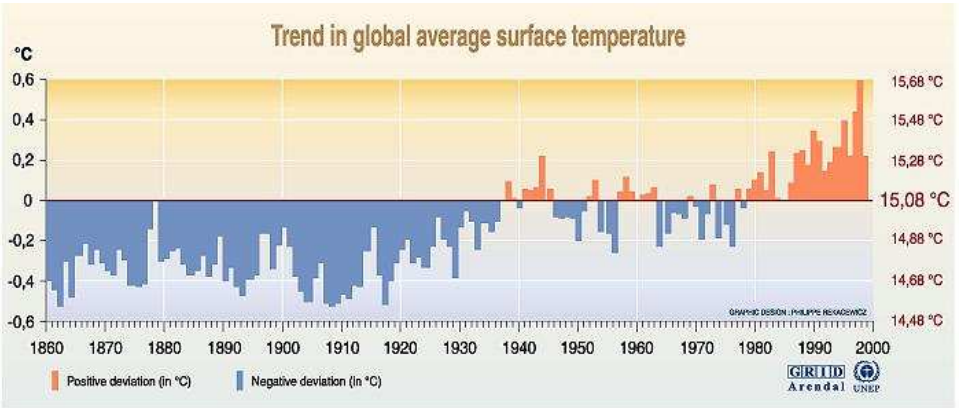
Climate Change Impacts: Temperature & Sea level Rise

- Global average temperature rise in 20th century: + 0.6 ℃
- Proj. temperature rise: 1990-2100: +1.4 – 5. 8 ℃

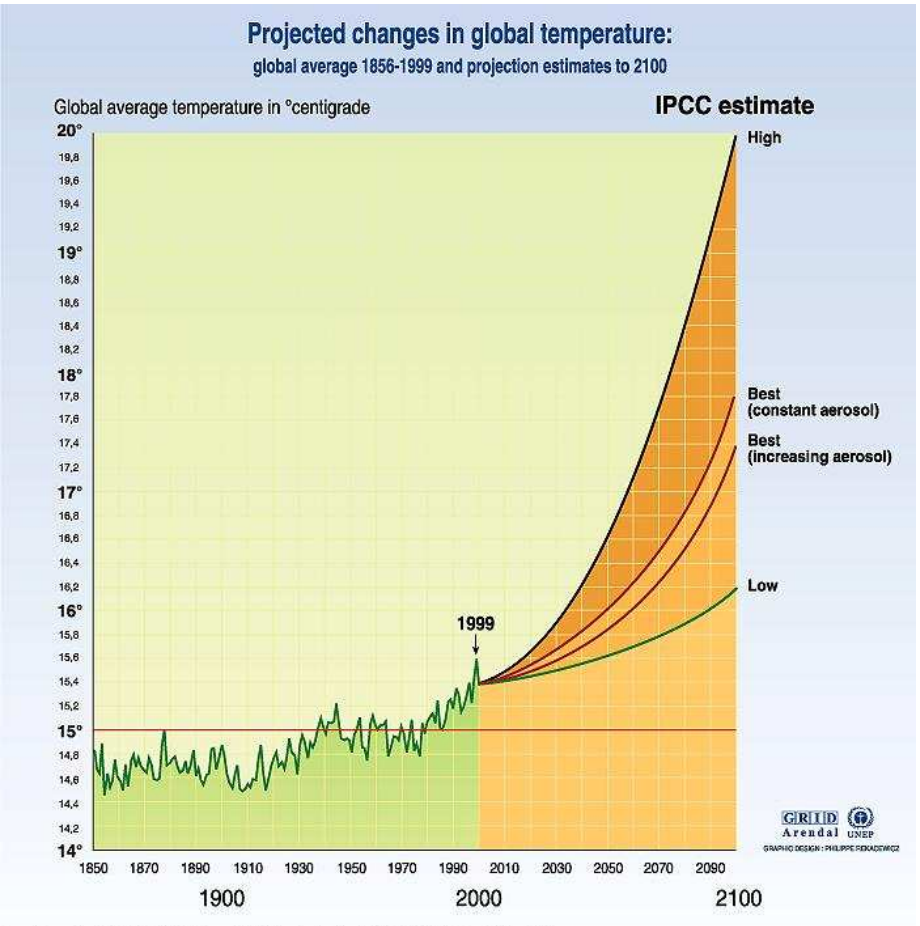
Sources: IPCC 1990, 1995, 2001,2007

Sea level Rise:

- 20th cent.: +0,1-0,2 m
- 21st century: 9-88 cm



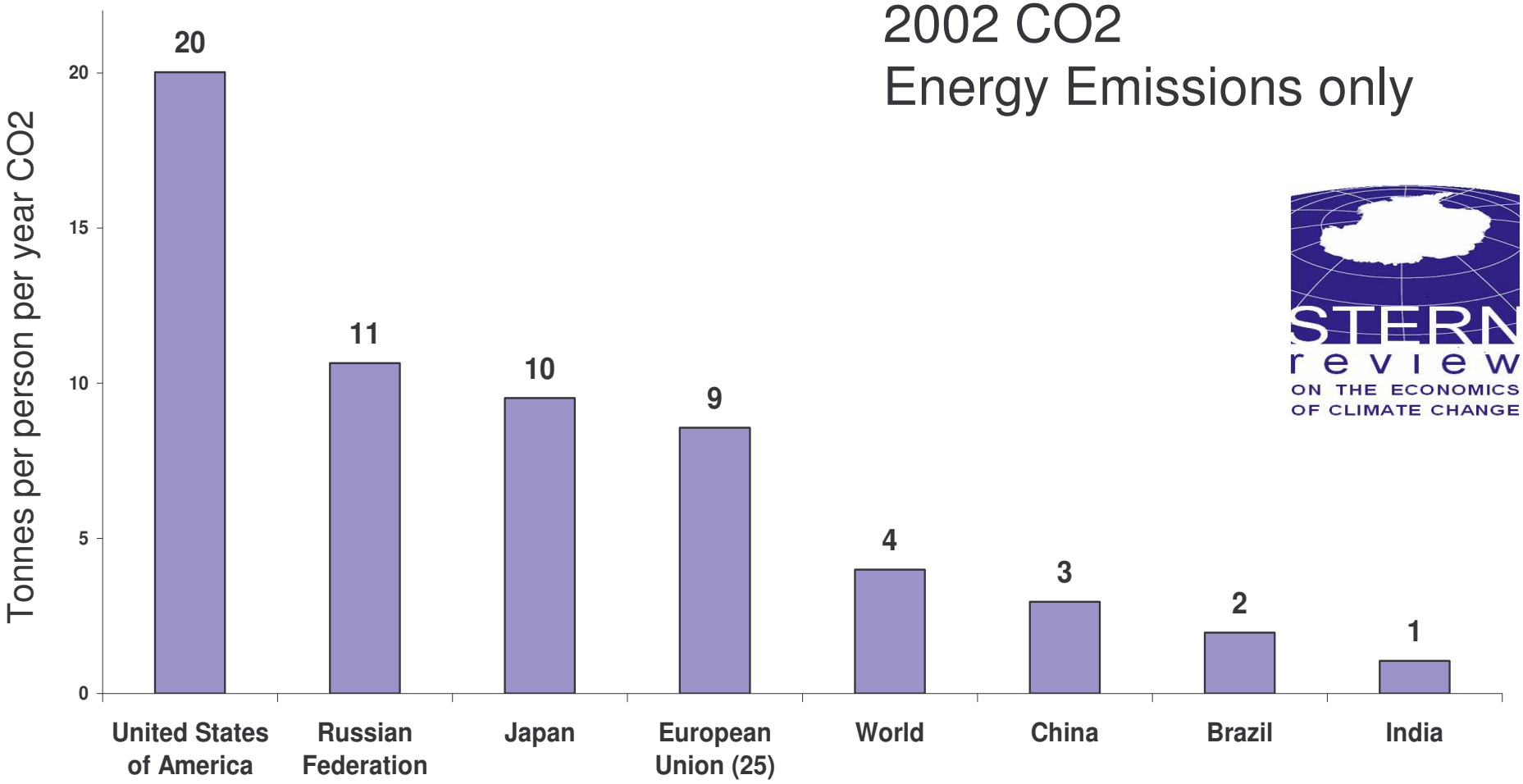
Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.



Source : Temperatures 1856 - 1999: Climatic Research Unit, University at East Anglia, Norwich UK. Projections: IPCC report 95.

5.2. Current emissions per capita are higher in developed countries

2002 CO2
Energy Emissions only



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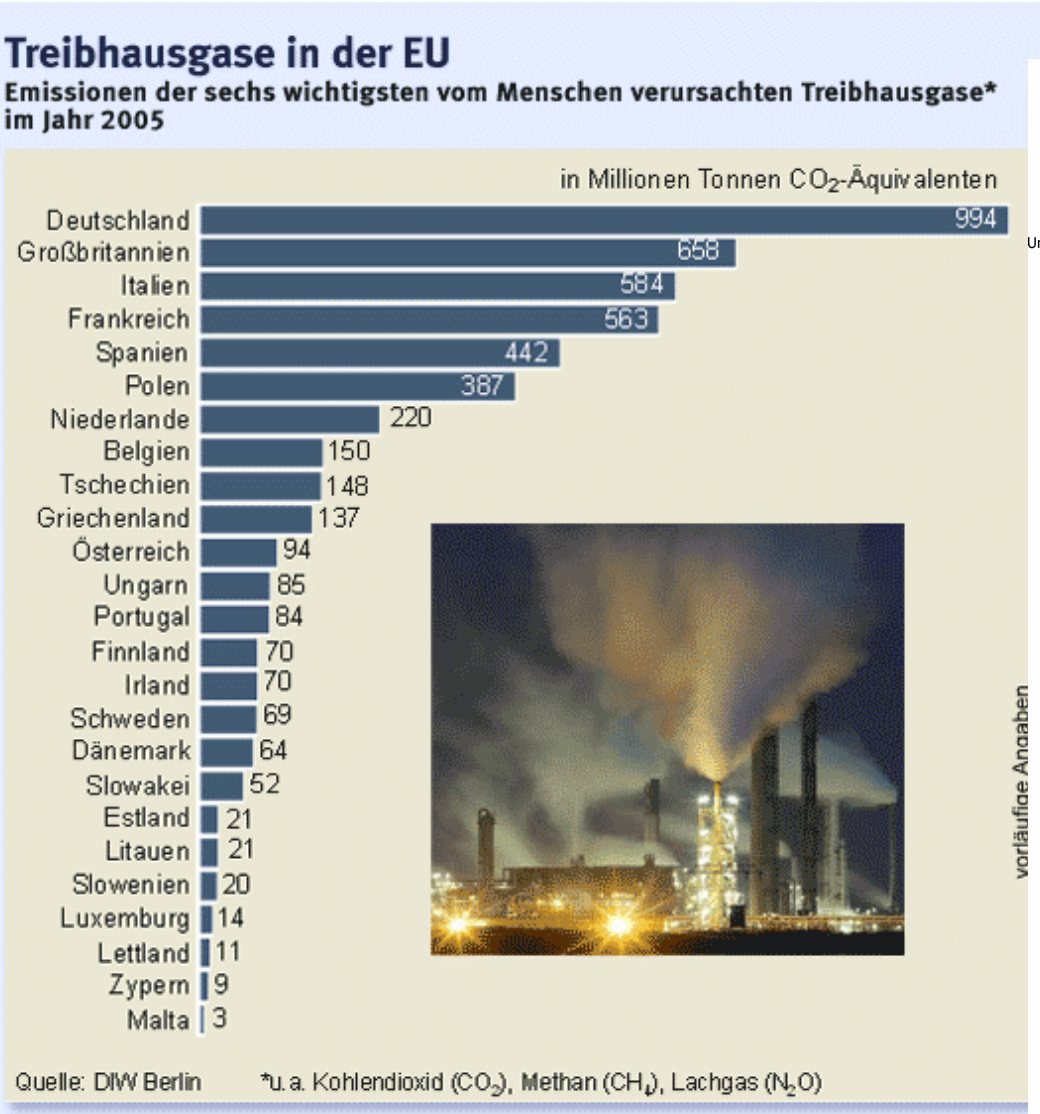
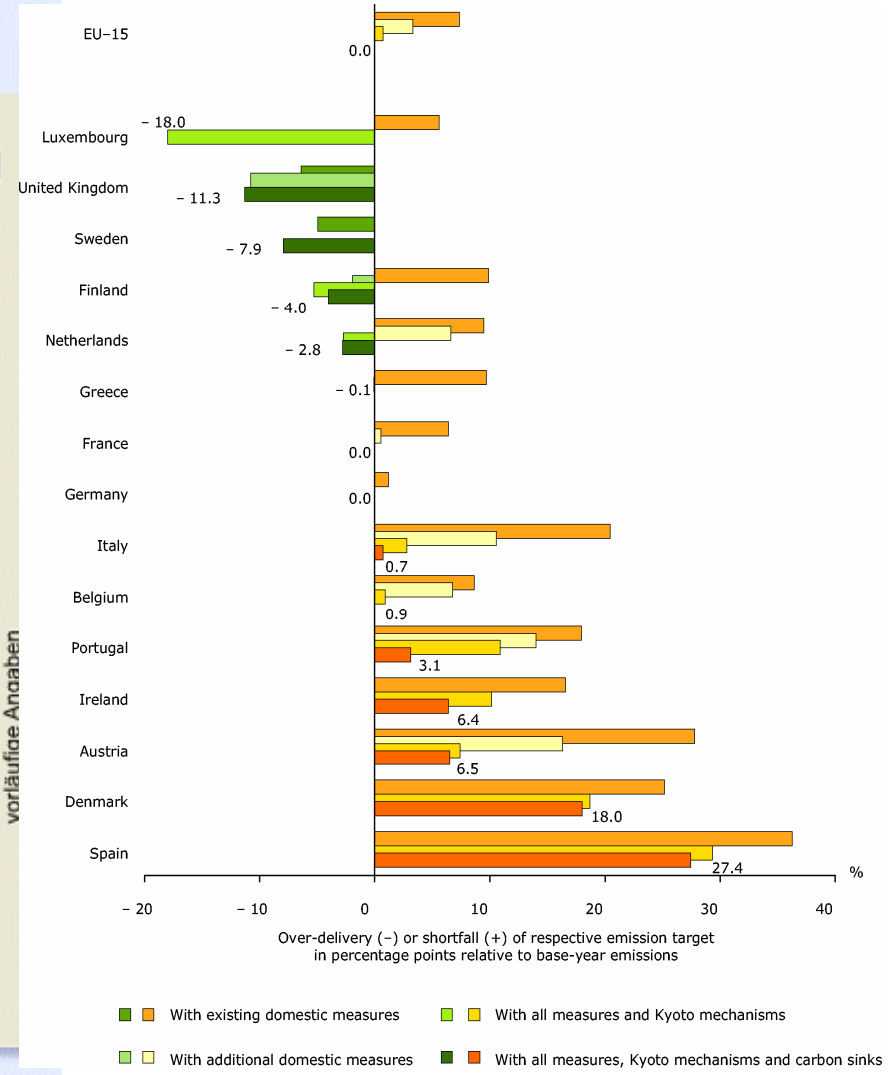
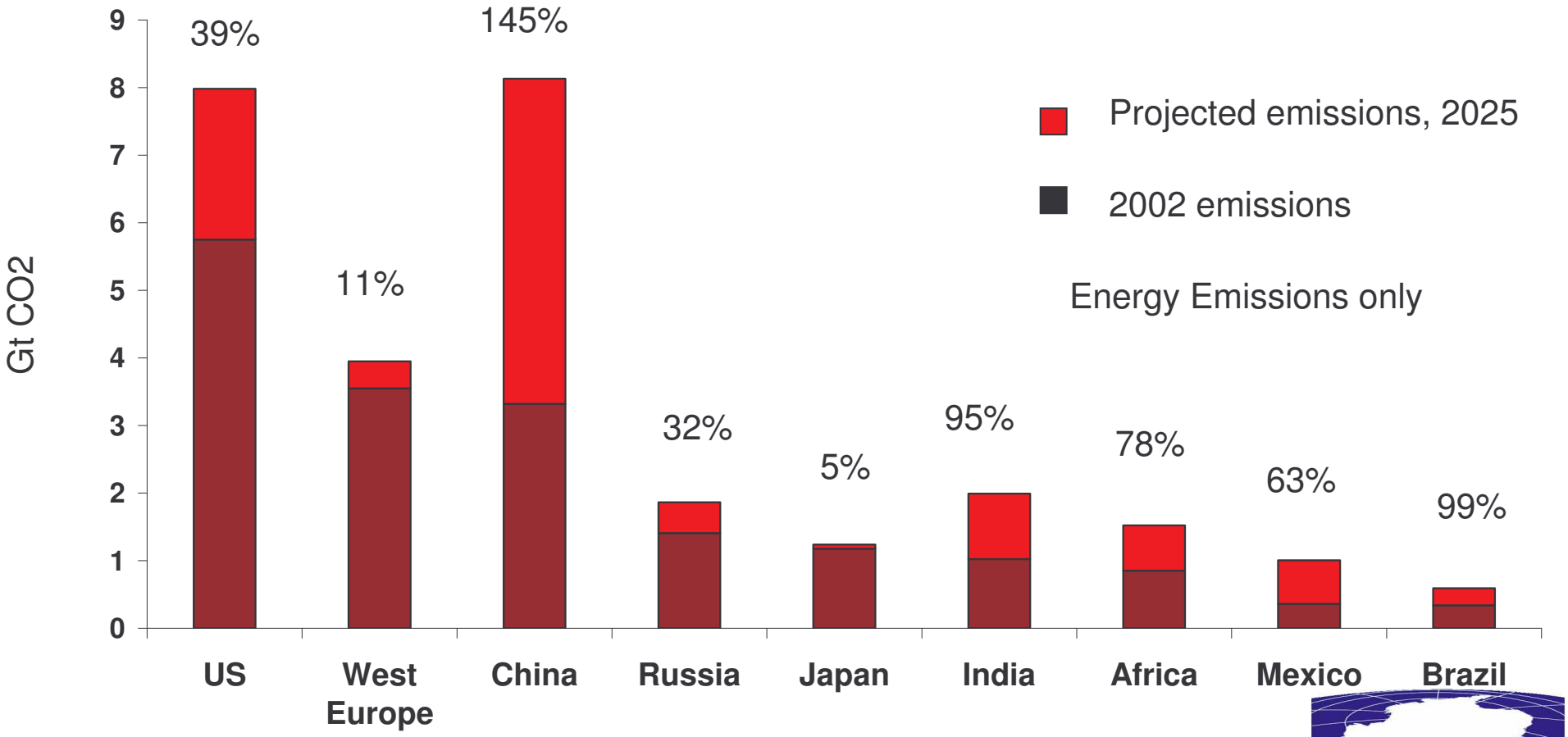
Source: World Resources Institute, CAIT

5.3. Greenhouse emissions of EU countries in 2005, missing the reduction goals





5.4. Larger developing countries account for much of the forecast rise in emissions



Source: World Resources Institute, CAIT Energy Information Administration Reference Scenario, Energy emissions only

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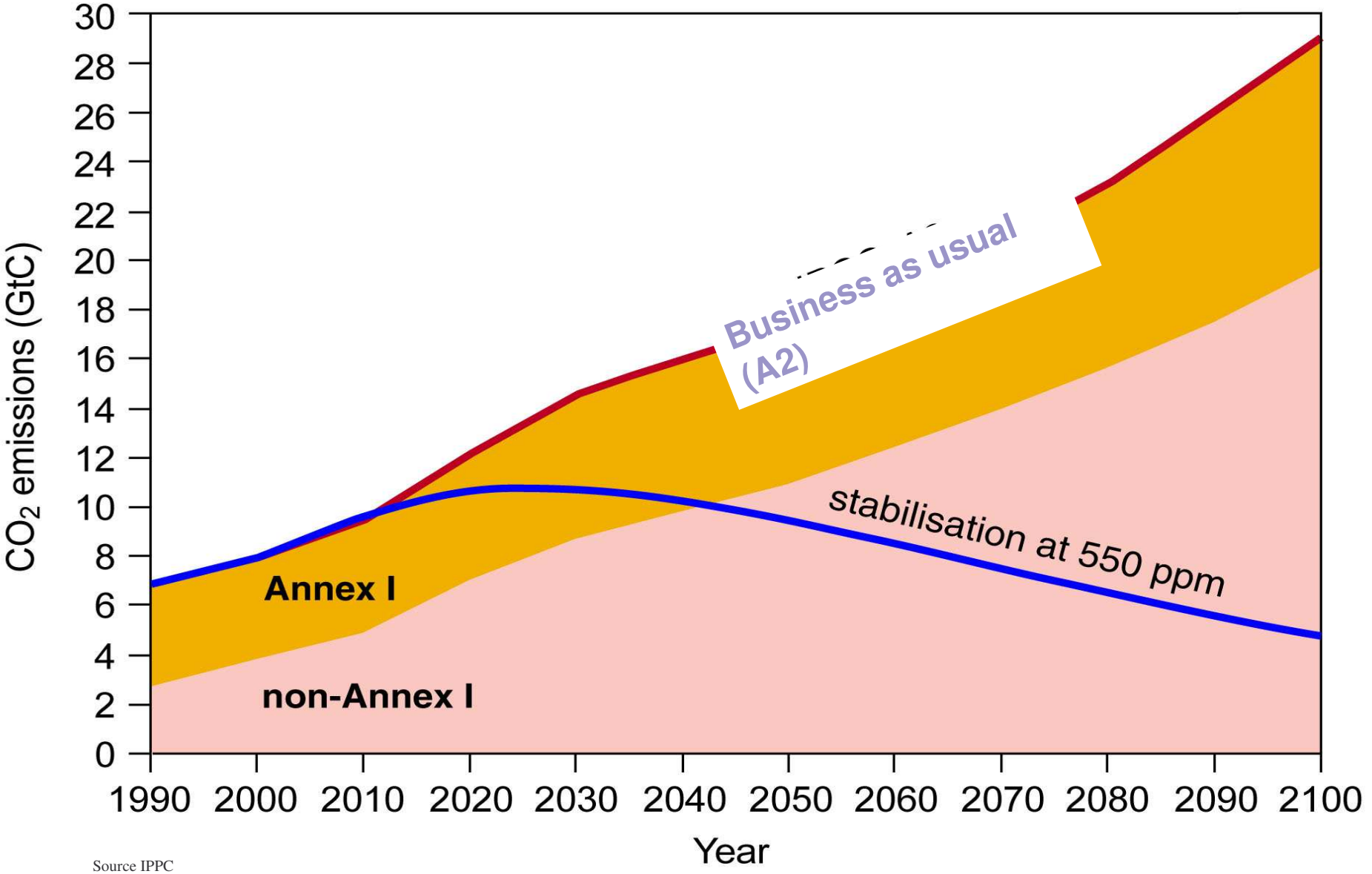
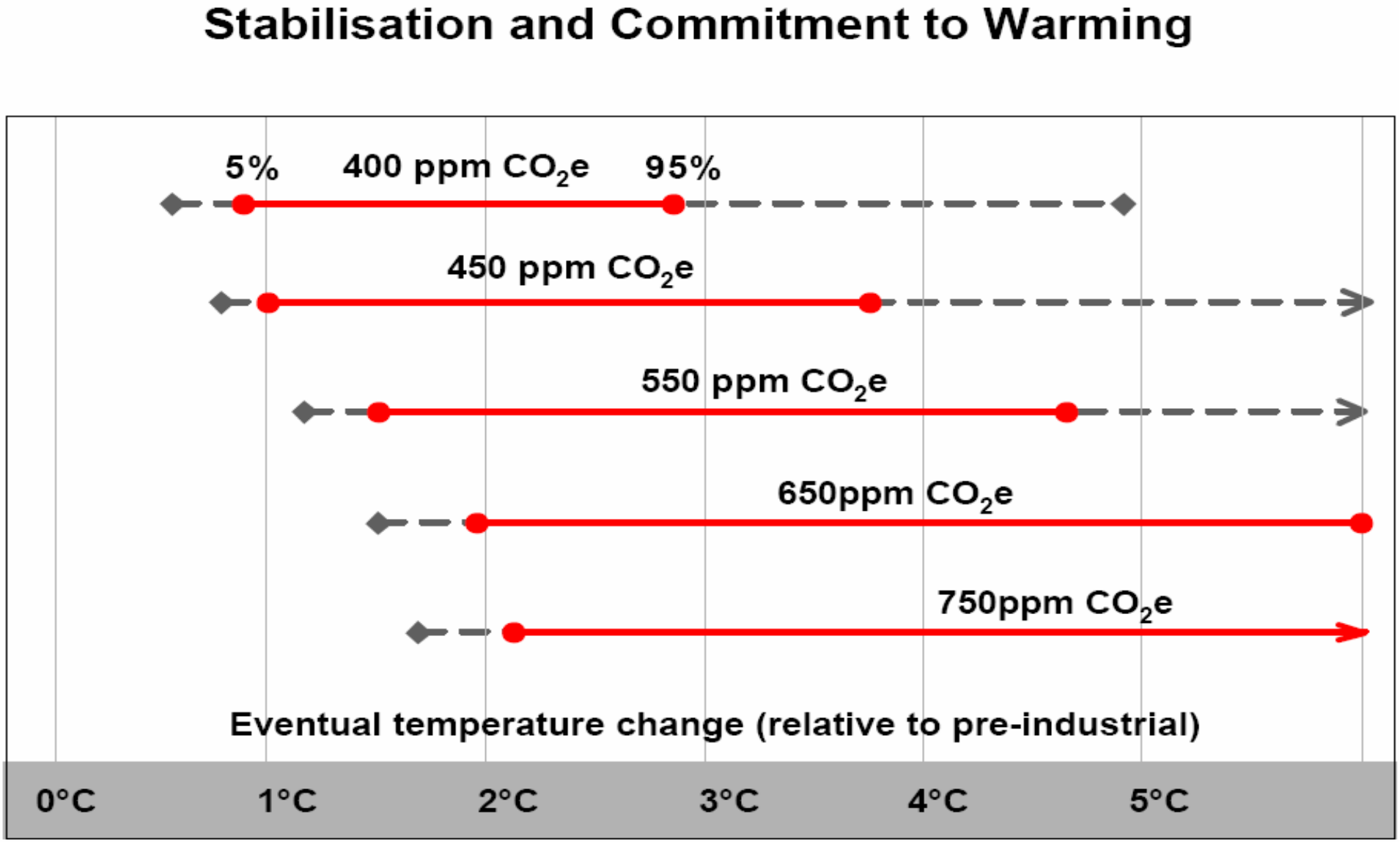
5.5. Projection: Stabilization at 550 ppm

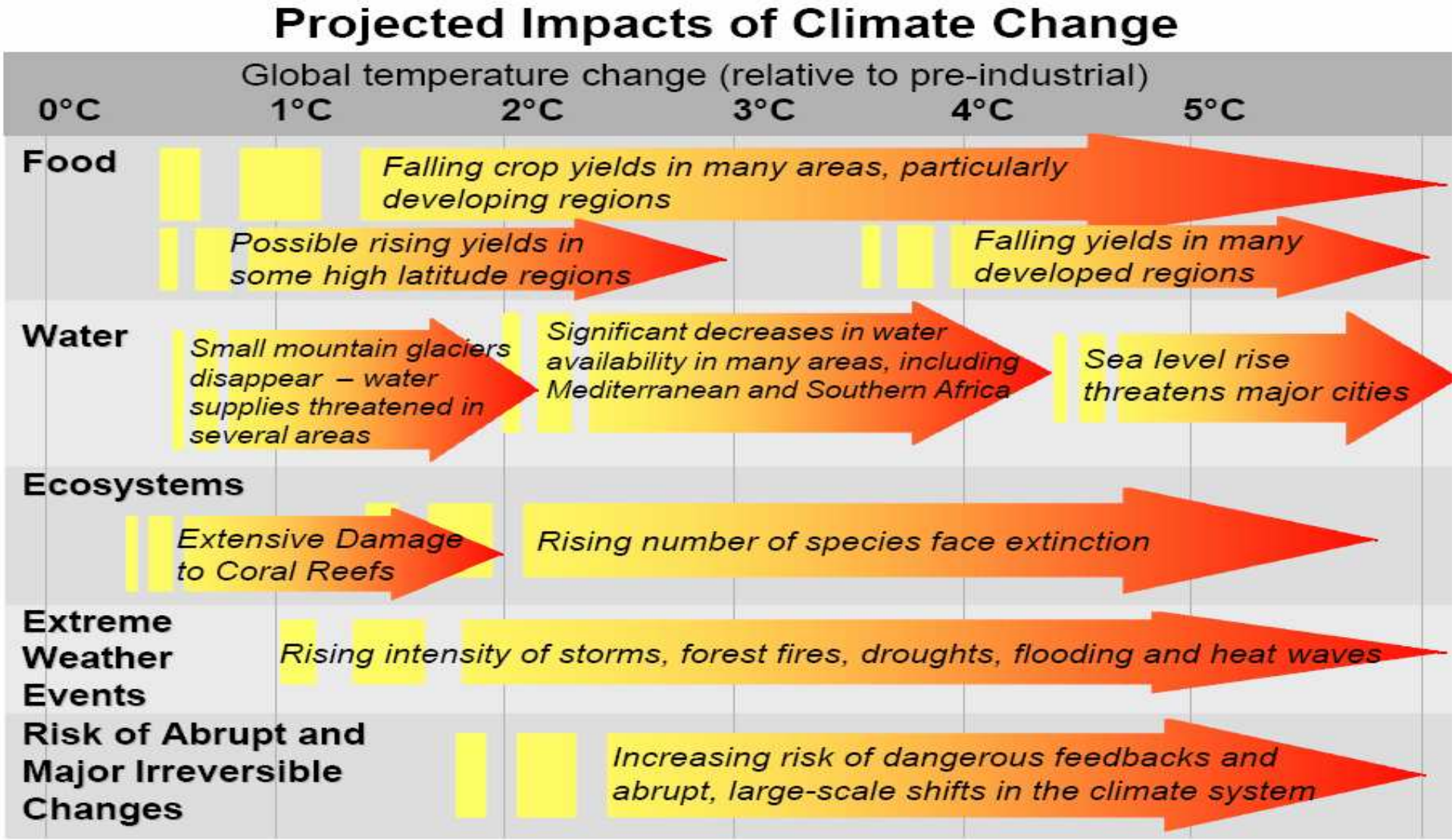


Source IPPC

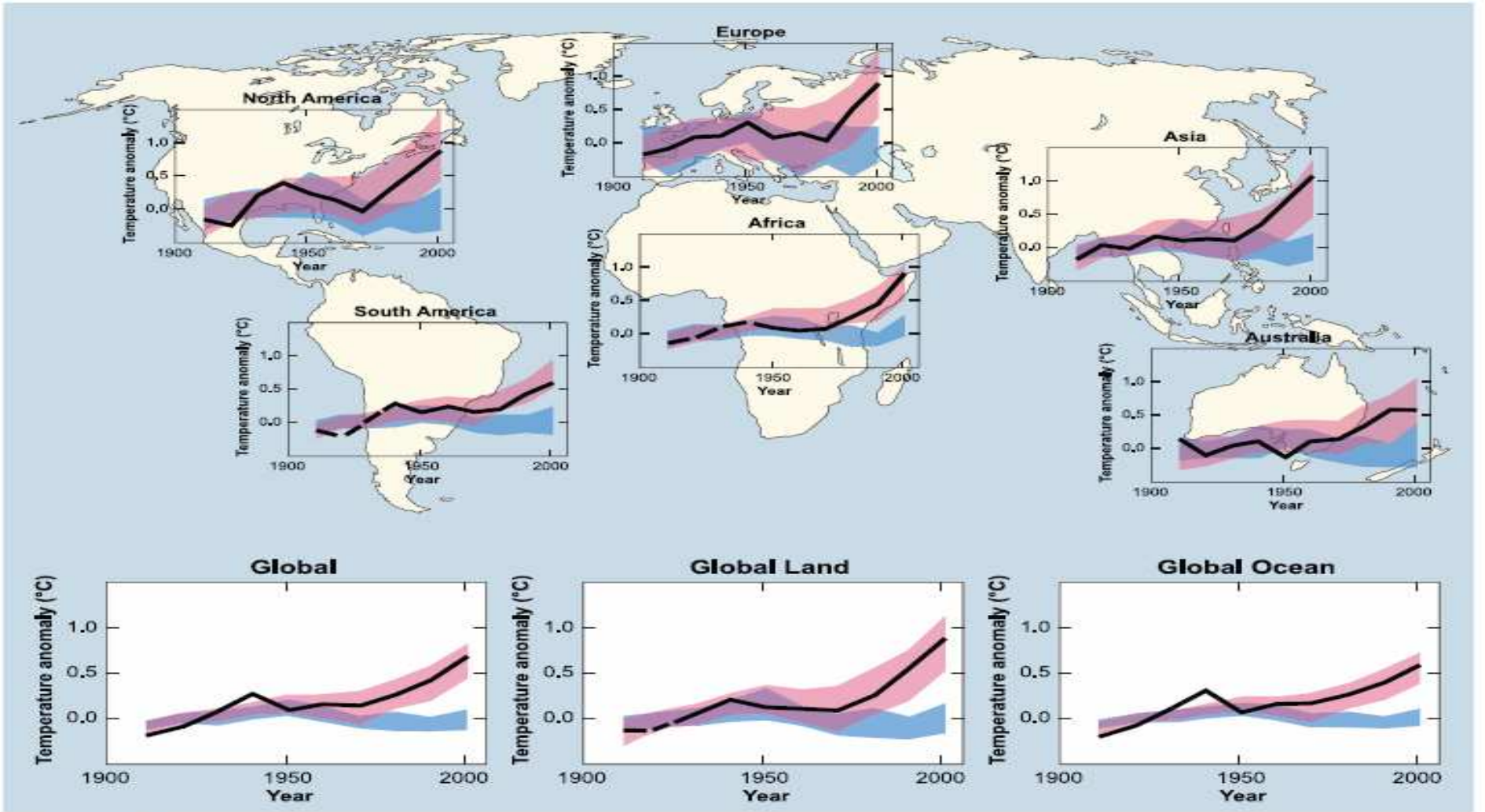
5.6. Stabilization & Temperature Increase



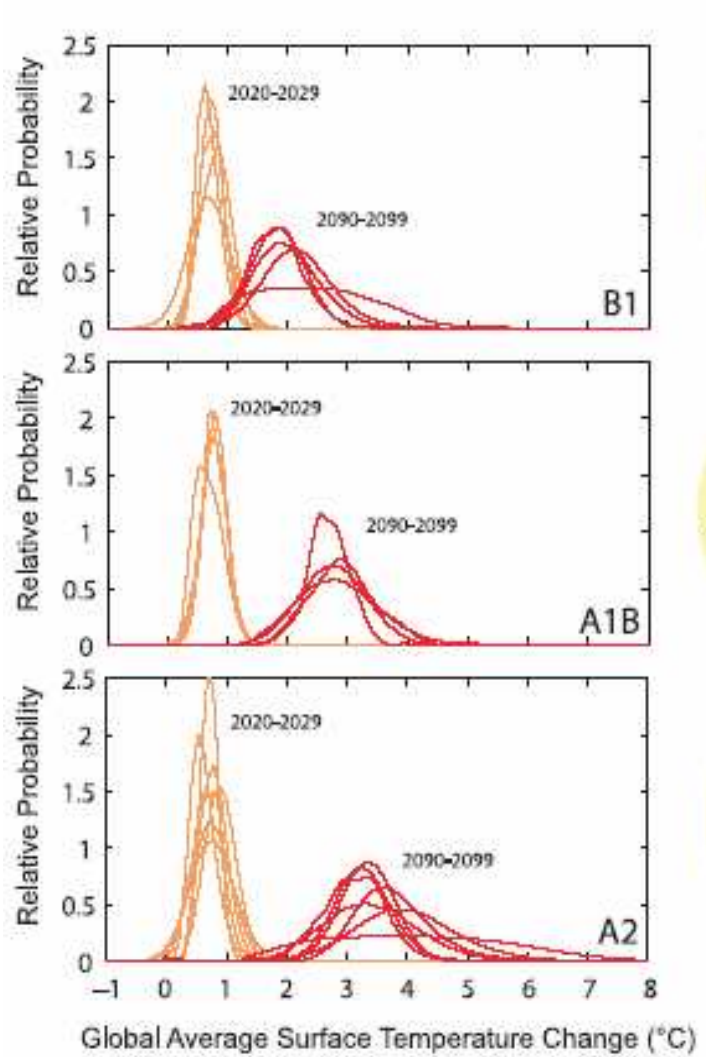
5.7. Projected Impacts of Climate Change

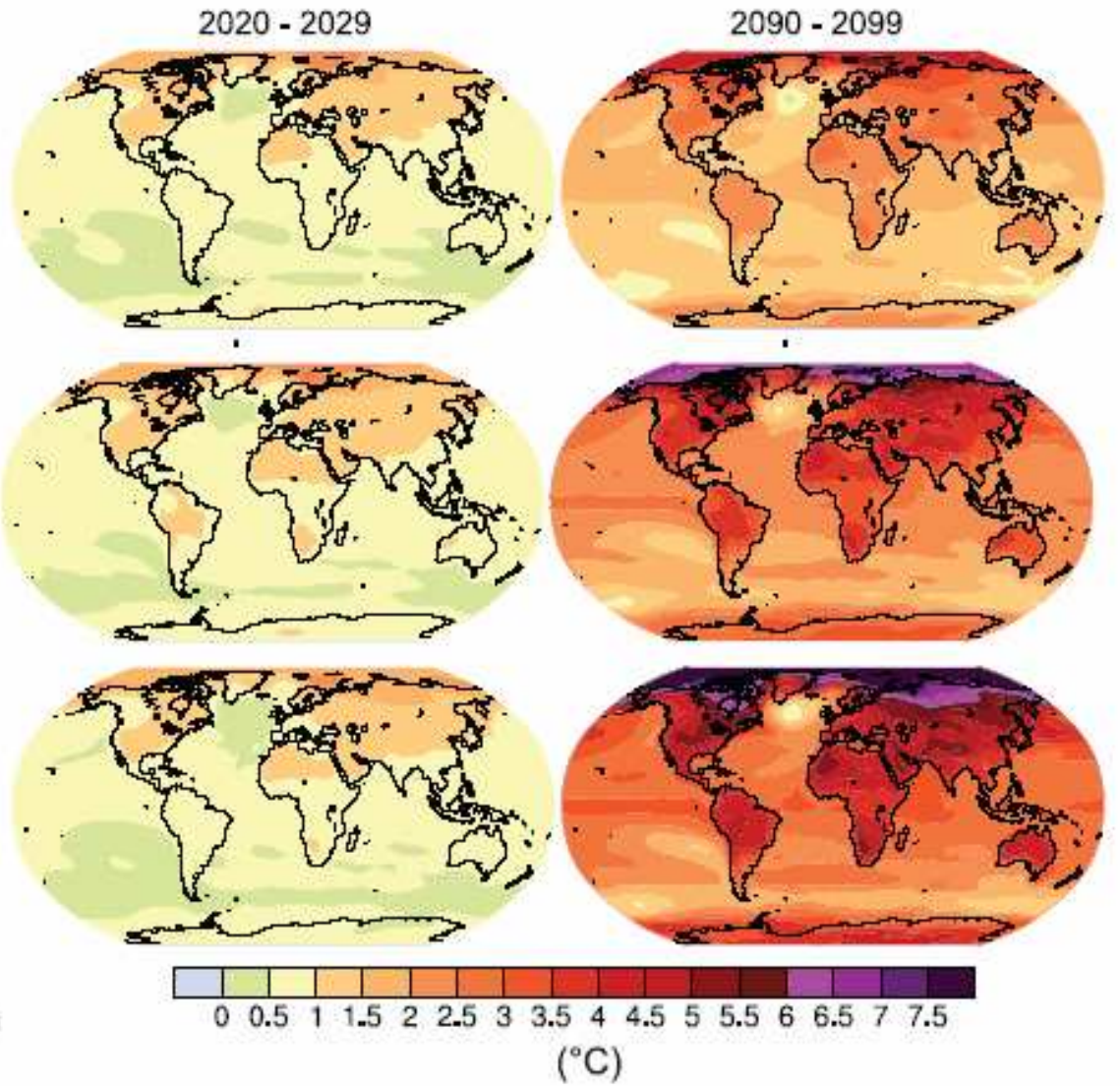


5.8. Global and Regional Change in Temperature (IPCC 2007, WG 1, AR4, S. 11)



5.9. Projection of Surface Temperature (IPCC 2007, WG 1, AR4, p. 15)





5.10. Average Value of Surface Temperature (IPCC 2007, WG 1, AR4, p. 14)

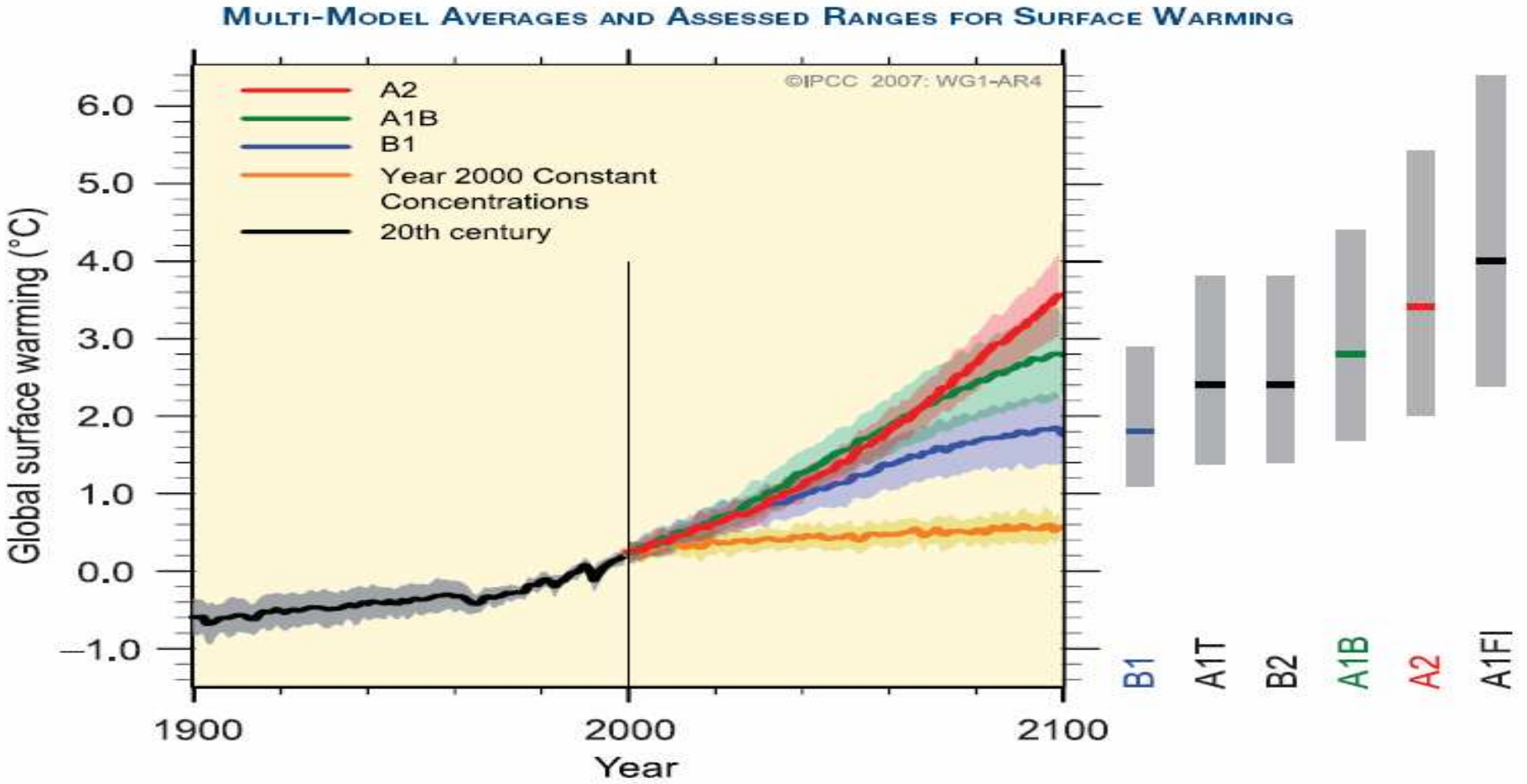
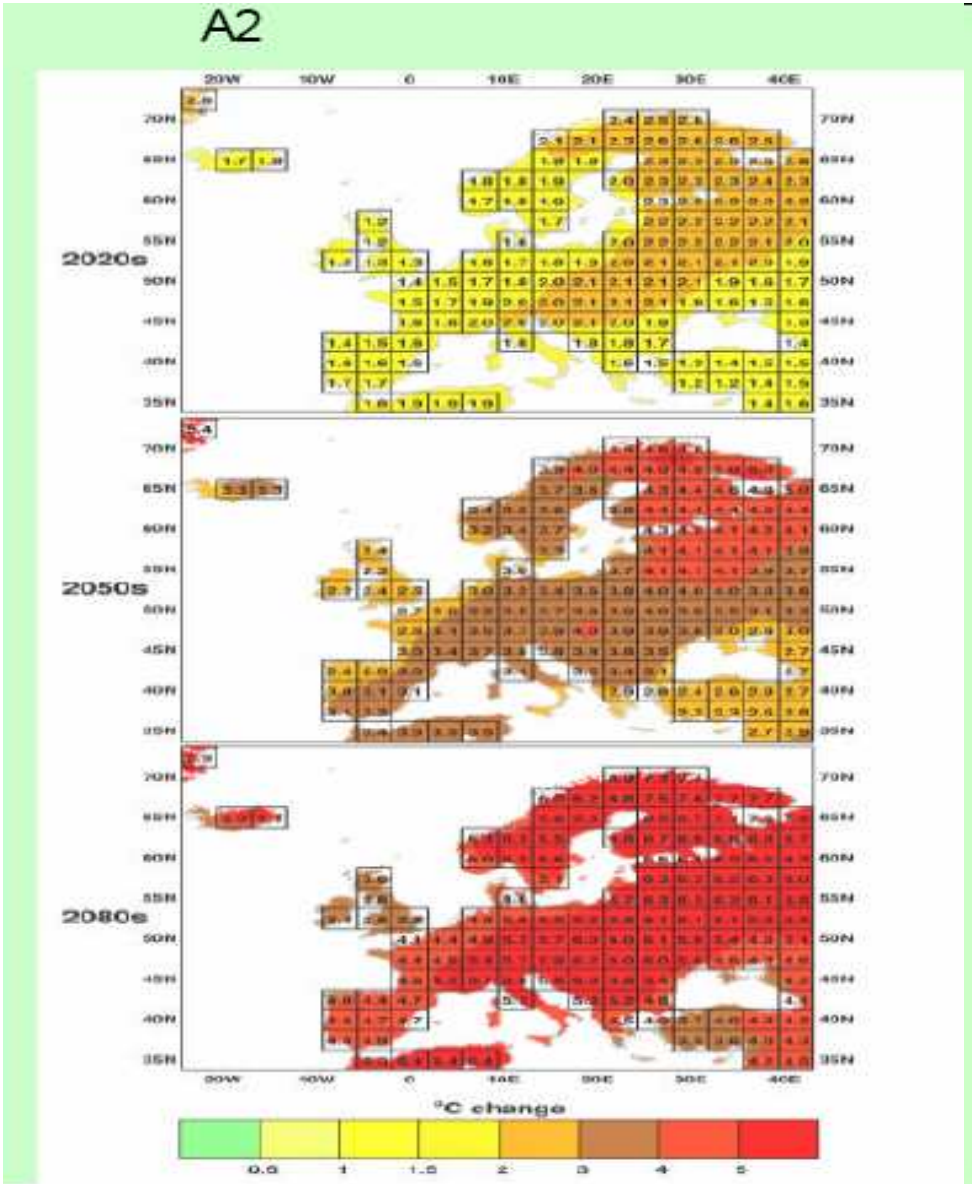
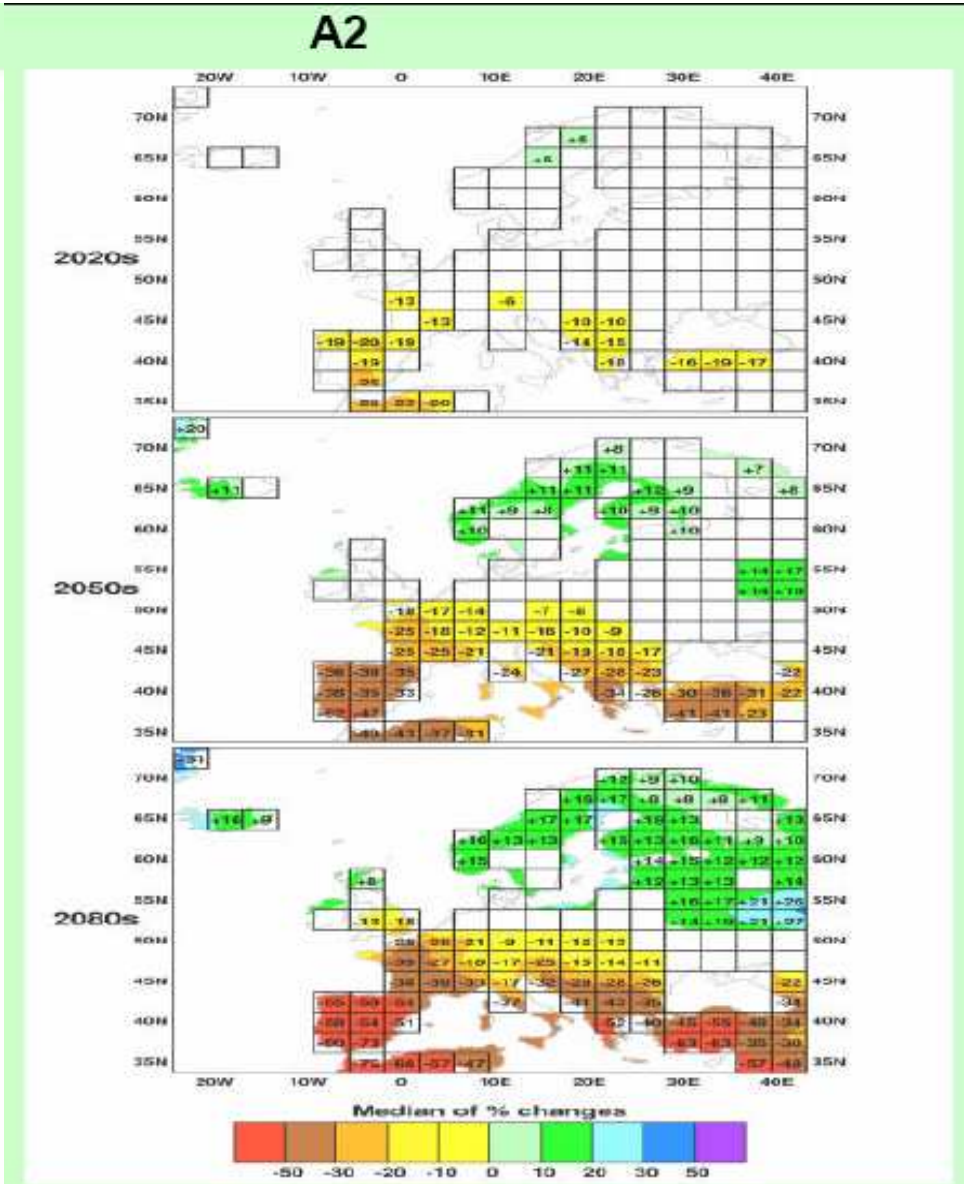


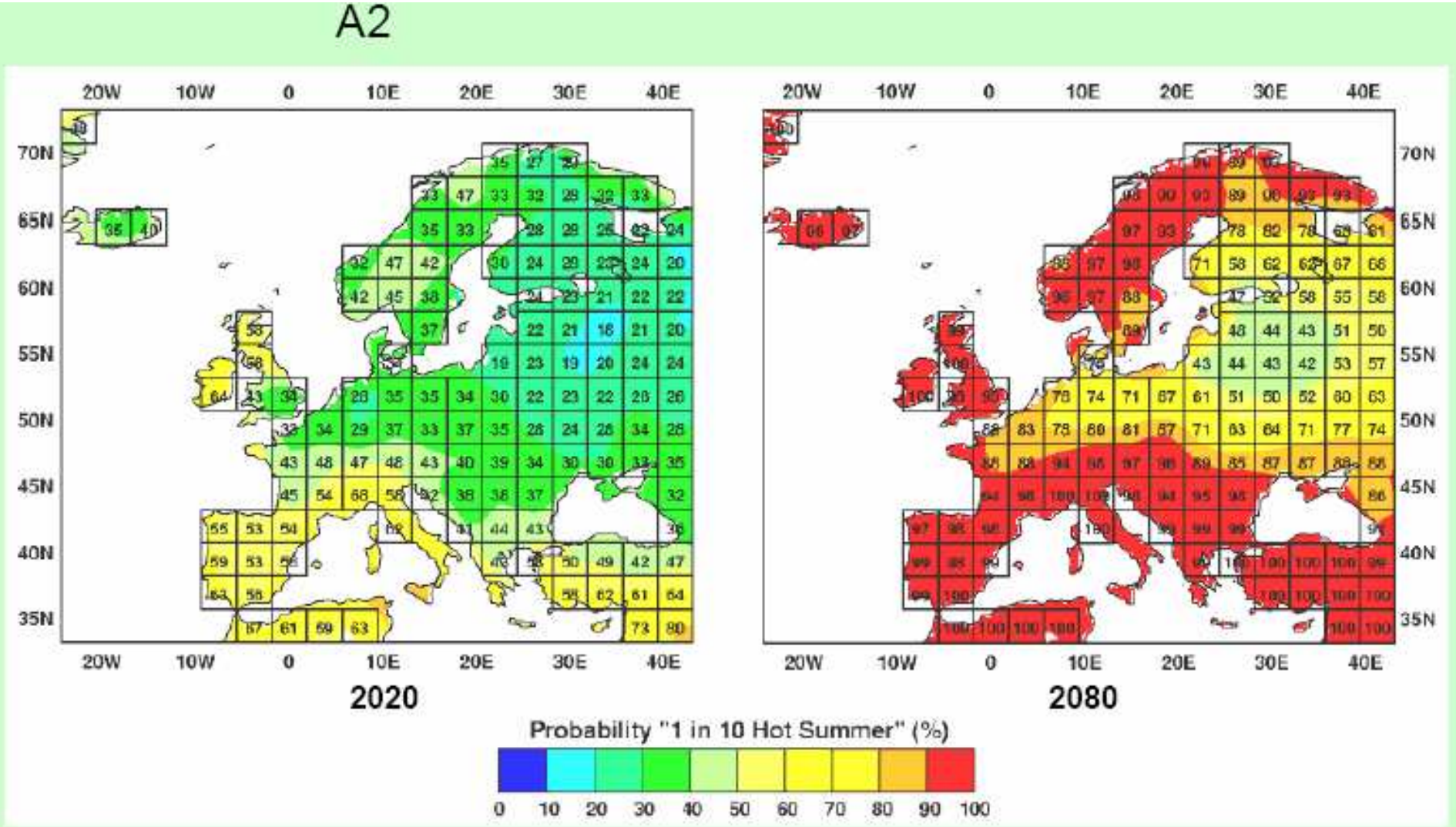
Figure SPM.5. *Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the* ***likely*** *range assessed for the six SRES marker scenarios. The assessment of the best estimate and* ***likely*** *ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. {Figures 10.4 and 10.29}*

5.11. Winter Temperature (2020-2080) Winter Precipitation

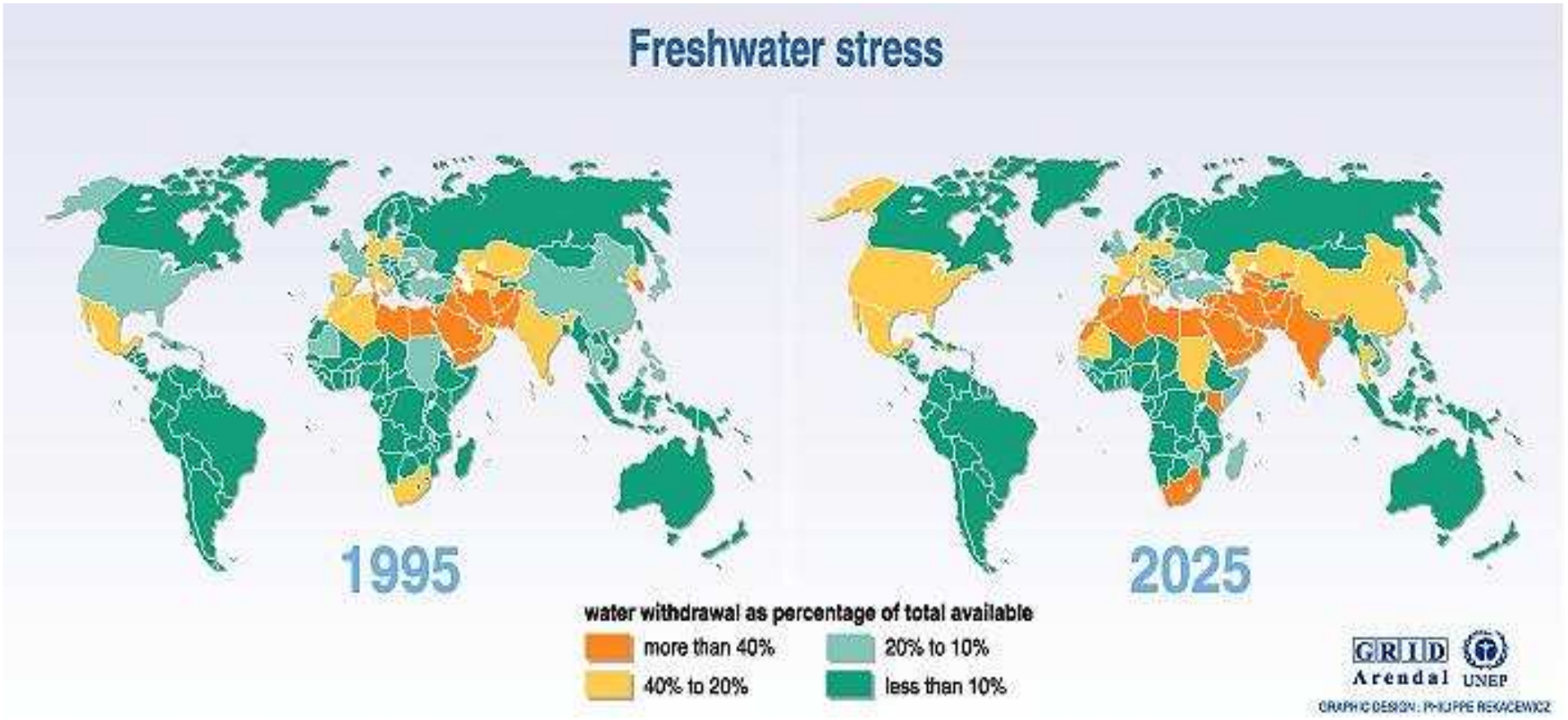




5.12. Probability of Hot Summers (M. Parry, IPCC, London, 2005)



5.13. Freshwater stress, 1995 and 2025

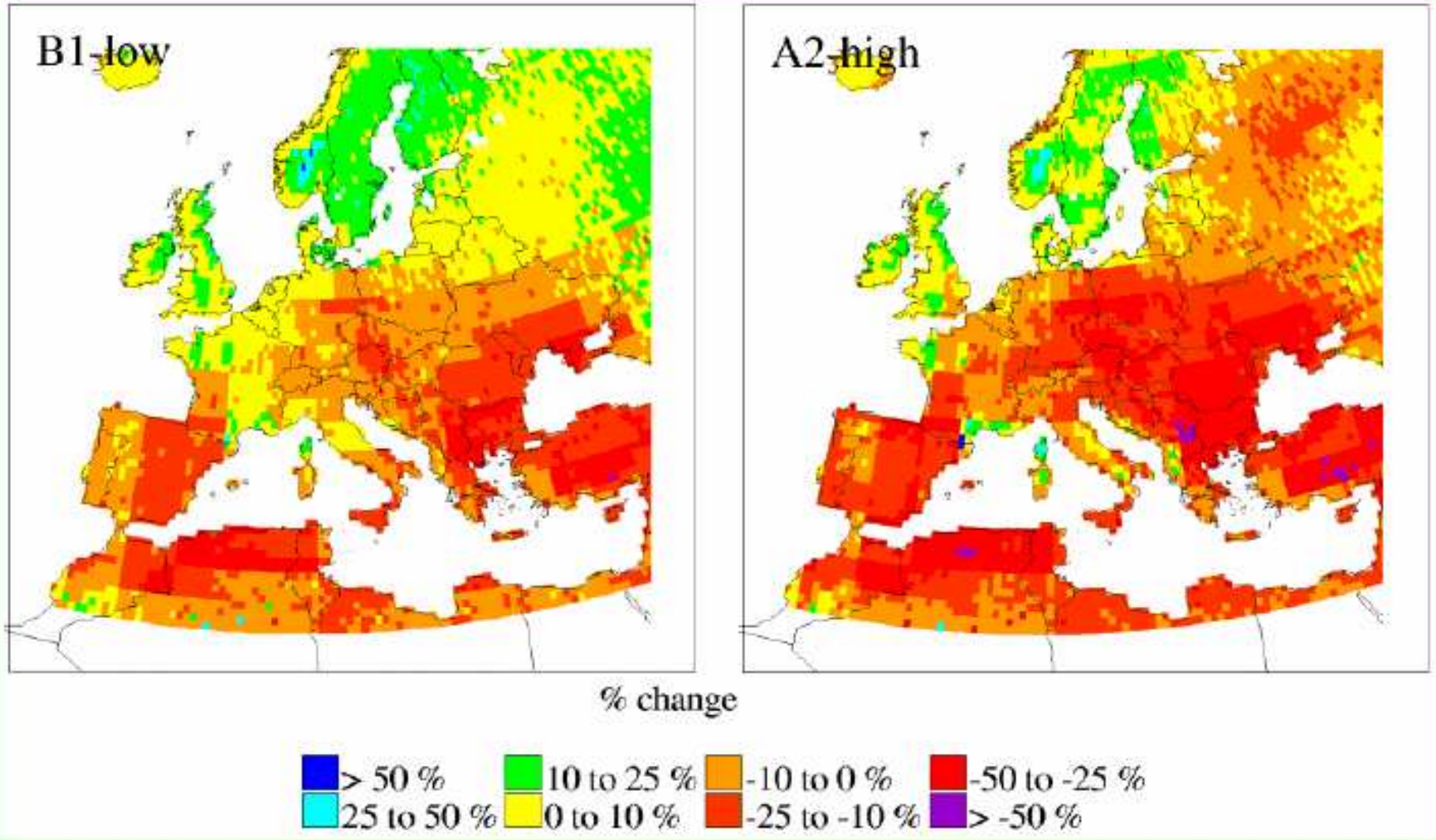


Source: Global environment outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

North Africa was already seriously affected by fresh water stress in 1995 and this stress will intensify by 2025 affecting also Sudan, Kenya and Mauritania.

5.14. Water Availability 2050

(M. Parry, IPCC, London, 2005)



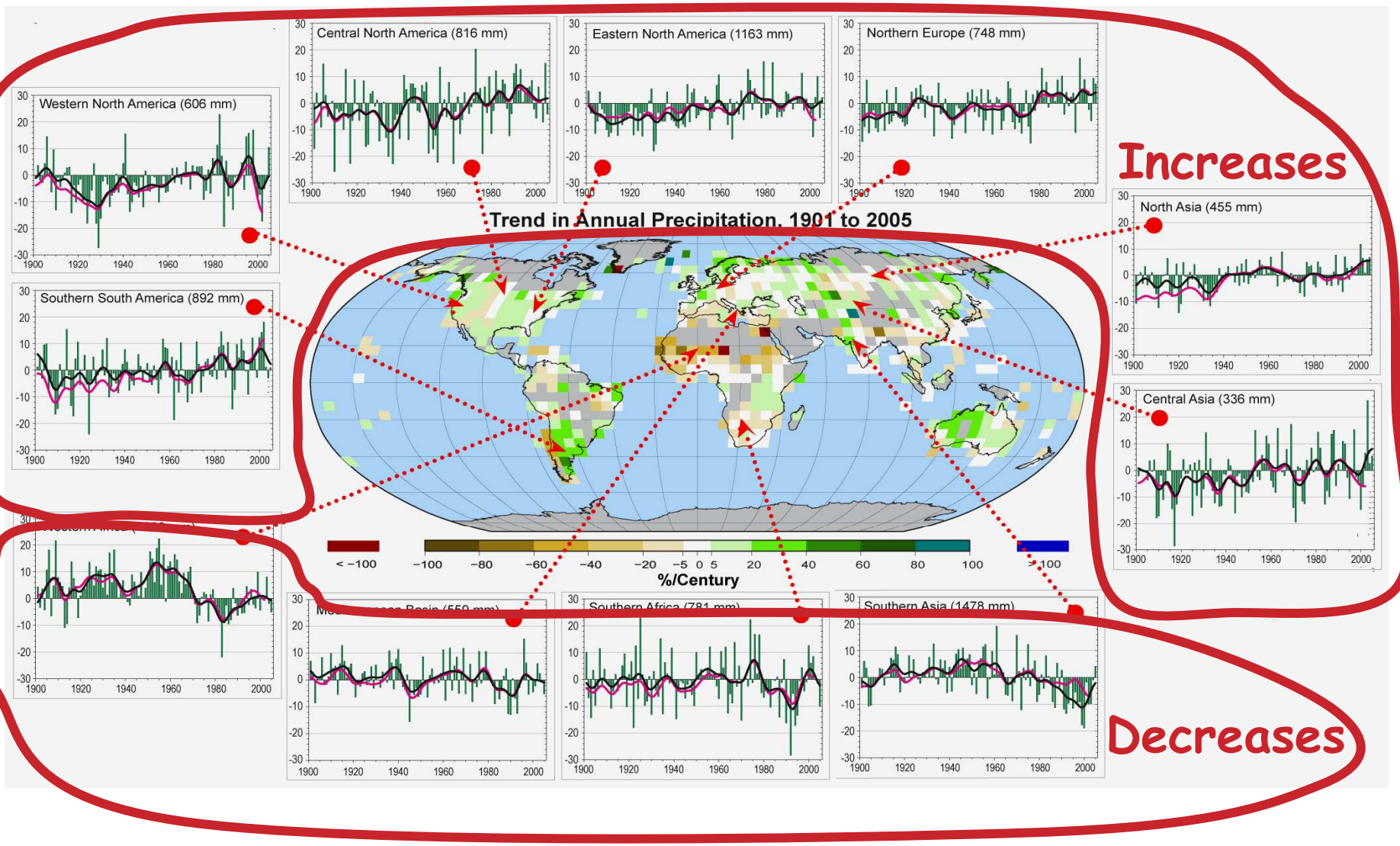
6. Environmental & Social Impacts of Climate Change for Western Mediterranean until 2100

- IPCC 4AR (WG 2, Europe, North and West Africa)
- Parry for the Mediterranean (2005)
- WBGU maps: drought, food yield, flash floods (regional): up to 2100
  - Population density (population change: fertility, mortality, migration)
  - Drought
  - Flash floods
  - Crop yield and food security

6.1. IPCC Chair Pachauri: Projections of future climate

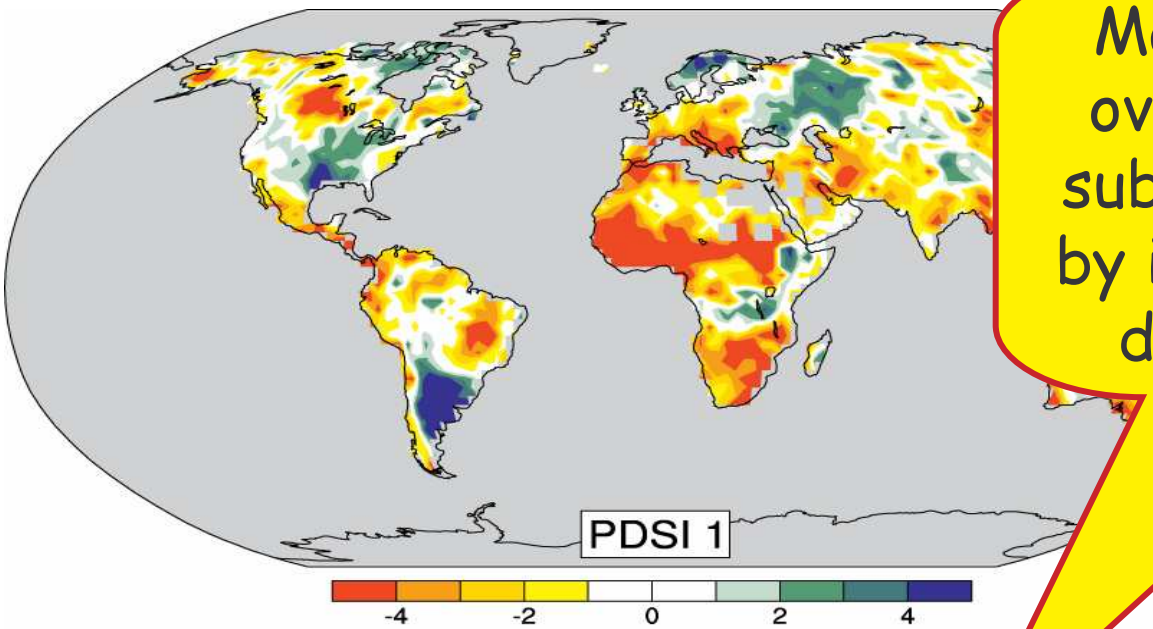
- Sea ice is projected to shrink in both the Arctic & Antarctic
- In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century
- *Very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent
- *Likely* that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation
- Drying in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.
- More intense and longer droughts observed since the 1970s, particularly in the tropics and subtropics.

6.2. Land precipitation is changing significantly in broad areas

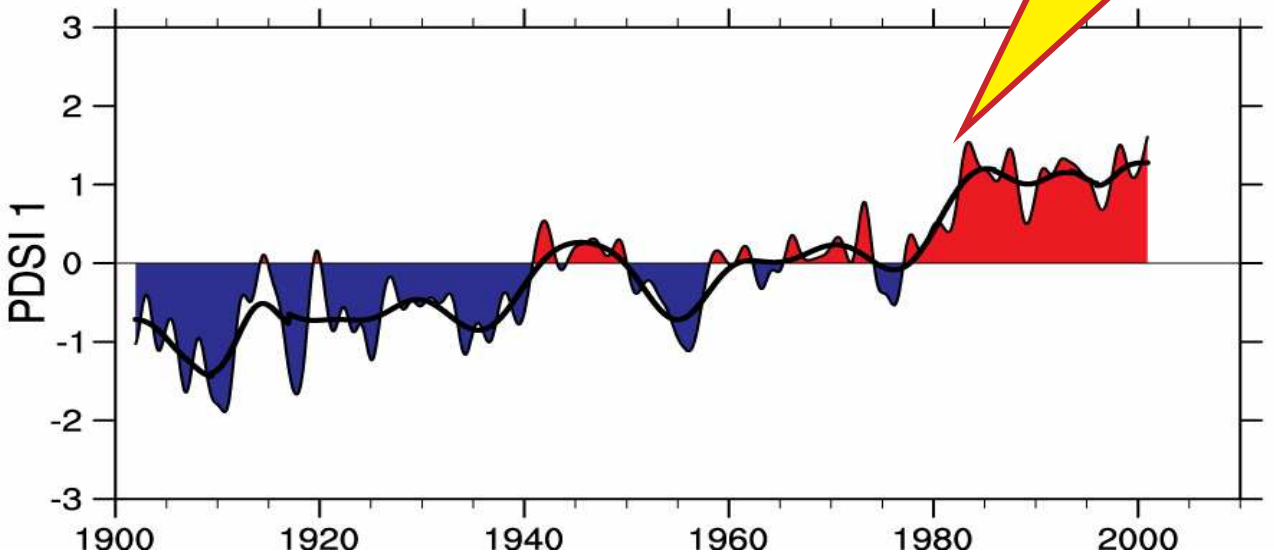


Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

6.3. IPCC Chair Pachauri: Drought is increasing most places



Mainly decrease in rain over land in tropics and subtropics, but enhanced by increased atmospheric demand with warming



6.4. IPCC, AR4, WG 2, Europe: p. 9

Nearly all European regions are anticipated to be negatively affected by some future impacts of climate change and these will pose challenges to many economic sectors. Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion (due to storminess and sea-level rise). The great majority of organisms and ecosystems will have difficulties adapting to climate change. Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080). *** D [12.4]

In Southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity. It is also projected to increase health risks due to heat waves and the frequency of wildfires. ** D [12.2, 12.4, 12.7]

6.5. IPCC, AR4, WG 2, Africa: p. 8

Africa

By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems. ** D [9.4, 3.4, 8.2, 8.4]

Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020. ** N [9.2, 9.4, 9.6]

Local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes due to rising water temperatures, which may be exacerbated by continued over-fishing. ** N [9.4, 5.4, 8.4]

Towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5-10% of Gross Domestic Product (GDP). Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism. ** D [9.4]

New studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. Some adaptation to current climate variability is taking place, however, this may be insufficient for future changes in climate. ** N [9.5]

6.6. Human Influence on Extreme Weather Events (WG I, AR4, Februar 2007: p. 8)

Phenomenon[a] and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend[b]	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	*Very likely*[c]	*Likely*[d]	*Virtually certain*[d]
Warmer and more frequent hot days and nights over most land areas	*Very likely*[e]	*Likely (nights)*[d]	*Virtually certain*[d]
Warm spells/heat waves. Frequency increases over most land areas	*Likely*	*More likely than not*[f]	*Very likely*
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	*Likely*	*More likely than not*[f]	*Very likely*
Area affected by droughts increases	*Likely* in many regions since 1970s	*More likely than not*	*Likely*
Intense tropical cyclone activity increases	*Likely* in some regions since 1970	*More likely than not*[f]	*Likely*
Increased incidence of extreme high sea level (excludes tsunamis)[g]	*Likely*	*More likely than not*[f,h]	*Likely*[i]

6.7. Population Growth: Southern Europe

UN Population Projection (Rev. /2000 & 2004), mio.

Soruce: UN Populations Division: World Population Prospects. 2004 Rev.

	2000 R 1 2000	2000 R.2 2004	2050 R 1 2000	2050 R.2 2004	1950-2050 R.1	1950-2050 R.2	2000-2050 R.1	2000-2050 R.2
France	59,24	59,28	61,83	63,12	20,00	17,45	2,59	3,84
Greece	10,61	10,98	8,98	10,74	1.42	3,18	-1,63	-0,23
Italy	57,53	57.53	42,96	50,91	-4,14	3,81	-14,57	-6,80
Portugal	10,02	10,23	9,01	10,72	60	2,32	-1,01	0,50
Spain	39,91	40,7	31,28	42,54	3,27	14.53	-8.63	1,82
S. Europe	177,3		154,1	178,0	+21,2	41,28	-23,24	-0,88

6.8. Population Growth North Africa

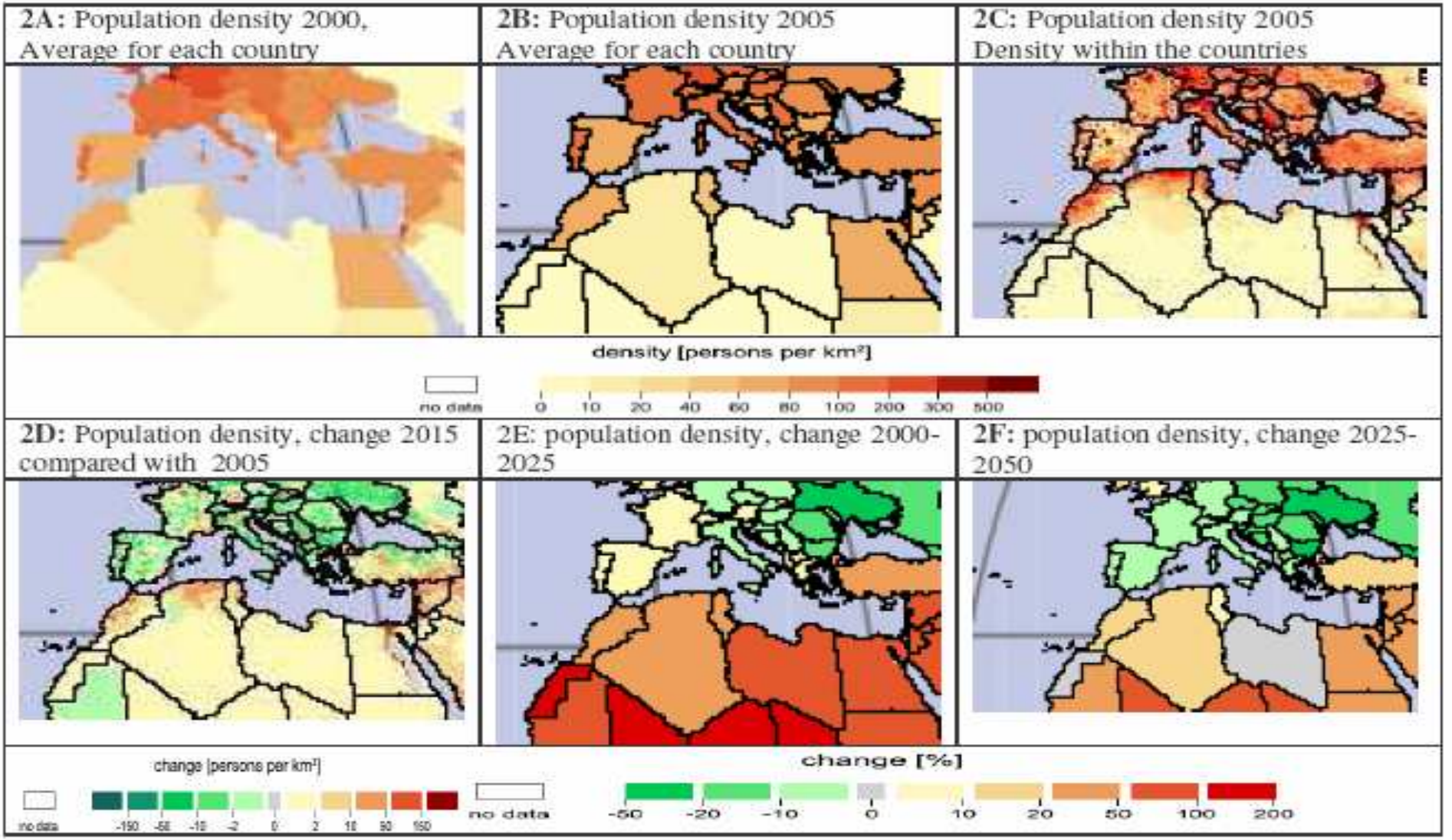
Table: UN Population Projection (Rev. 2000), mio.

Source: UN Populations Division: World Population Prospects. 2000 Rev.

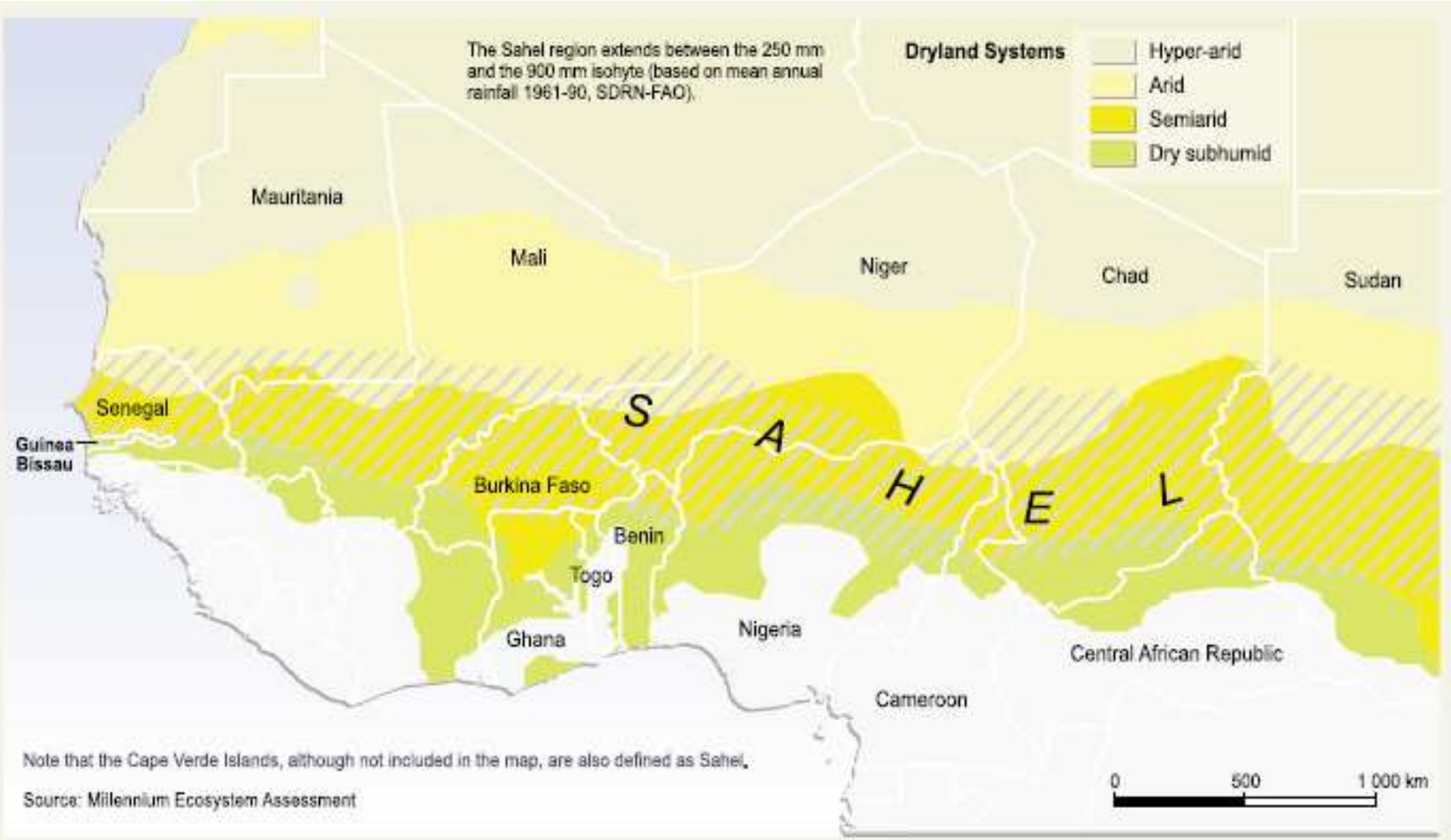
	1850	1900	1950	2000	2025	2050	1950-2050	2000-2050
Algeria	3.0	5.0	8.75	30.29	42.74	51.18	42.43	20.89
Morocco	3.0	5.0	8.95	29.88	42.00	50.36	41.41	20.48
Tunisia	1.0	1.5	3.53	9.46	12.34	14.08	10.55	4.62
Libya	0.6	0.8	1.039	5.29	7.97	9.97	8.94	4.68
Egypt	5.5	10.0	21.83	67.88	94.78	113.84	92.01	45.96
N. Africa	13.1	22.3	44.10	142.8	199.83	239.43	195.33	96.63
East. Med.	12.45	16.05	29.25	89.50	141.43	173.88	144.53	84.28
MENA	25.55	38.35	73.35	232.30	342.73	413.20	339.86	180.90
S. Europe	83.0	103.5	132.9	177.3	172.5	154.1	+21.2	-23.24

6.9. Change in Population Density

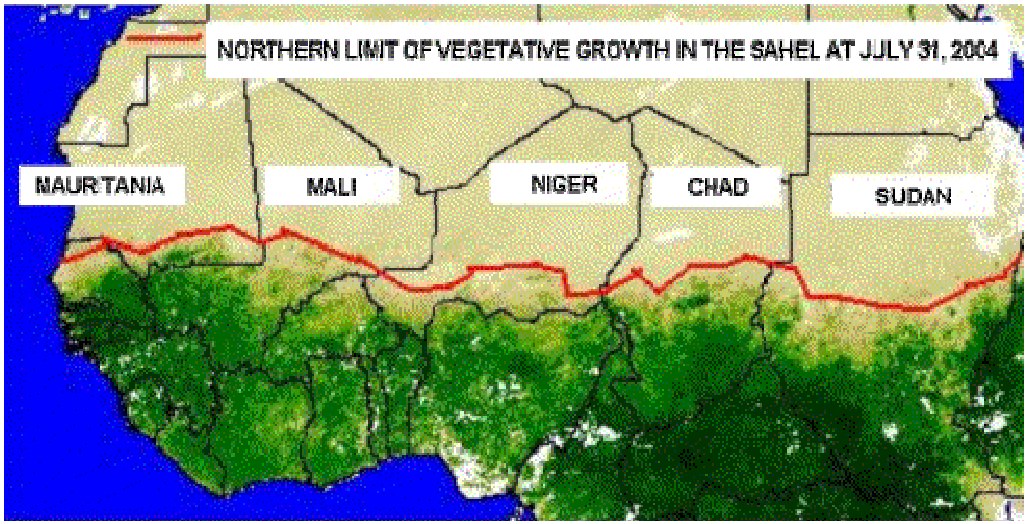
Source: WBGU 2006, produced by Wodinsky

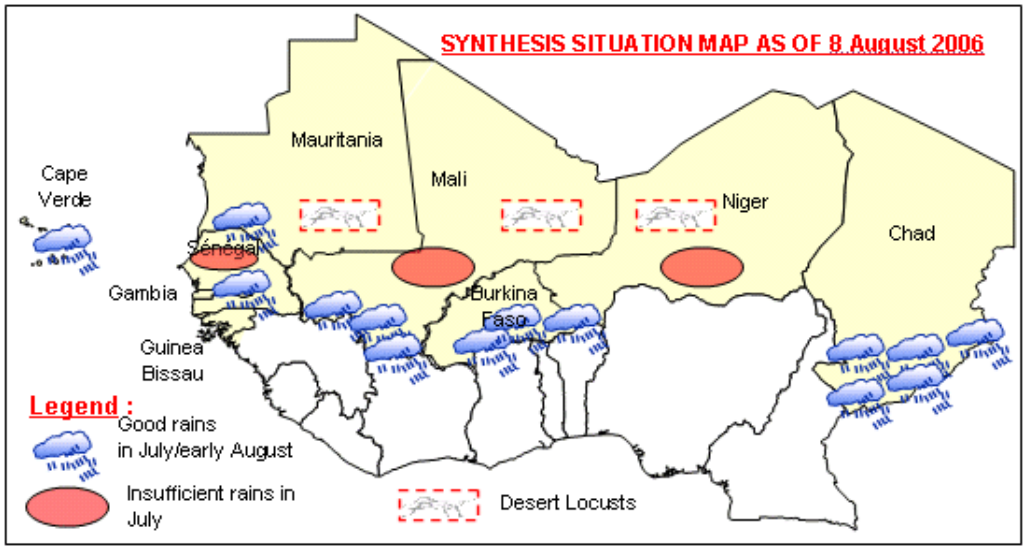


6.10.Droughts in the Sahel Region



6.11. Population Change in Sahel Countries





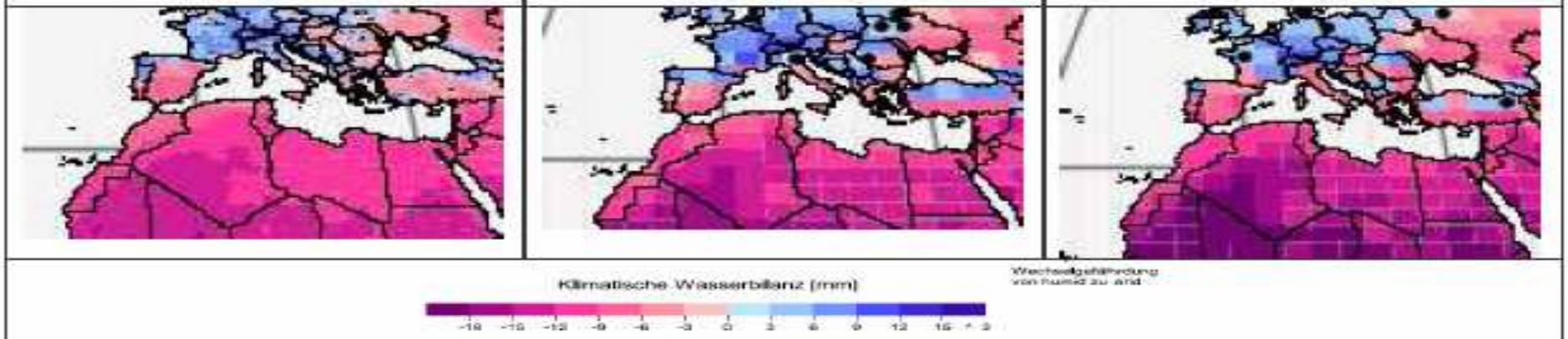
Sahel	1950	2005	2025	2050	2005-2050
Mauretania	0,8	3,1	5,0	7,5	4,5
Mali	3,5	13,5	24,0	42,0	28,5
Niger	2,5	14,0	26,4	50,2	36,2
Chad	2,7	9,7	17,0	29,5	19,8
Senegal	2,5	11,7	17,3	23,1	11,4
Guinea	2,5	9,5	15,8	28,7	19,2
Burkina Faso	4,0	13,9	22,5	39,5	25,6
Total	**18,5**	**75.4**	**128,0**	**220.5**	**145,2**
Nigeria	29,8	131,5	190,3	258,1	126,6

6.12. Potential Danger of Drought
Source: WBGU 2006

4A: Potential danger of drought by country, 1975-2004 (observations) (Climatic water balance)

4B: Potential danger of drought by country, 2050 (2040-2069) (Climatic water balance)

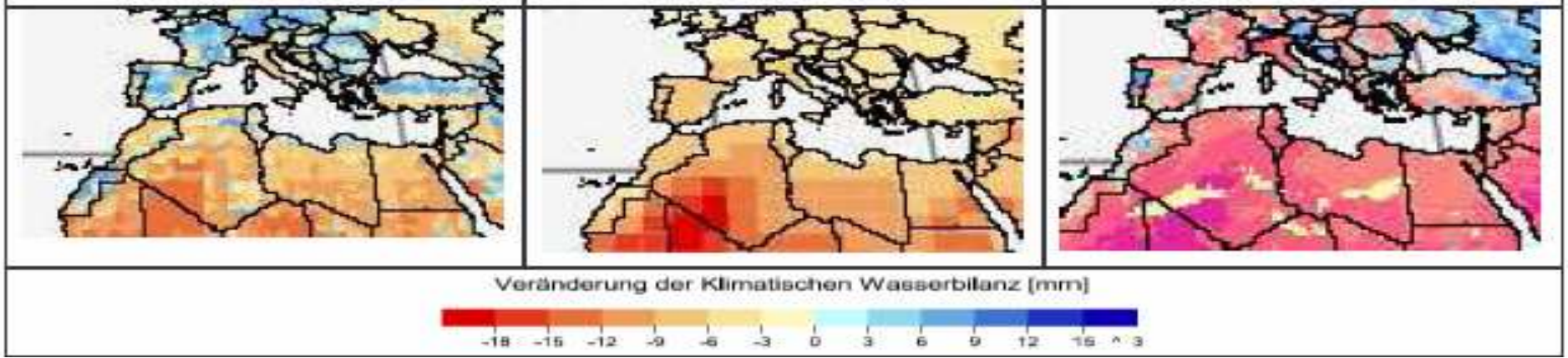
4C: Potential danger of drought by country, 2080 (2070-2099) (Climatic water balance)



4D: Potential danger of drought by country, difference between 2040/2069 and 1975/2004, changes in climatic water balance

4E: Potential danger of drought by country, difference between 2070/2099 and 2040/2069. changes in climatic water balance

4F: Potential danger of drought by country, trends in the climatic water balance 1975-2004

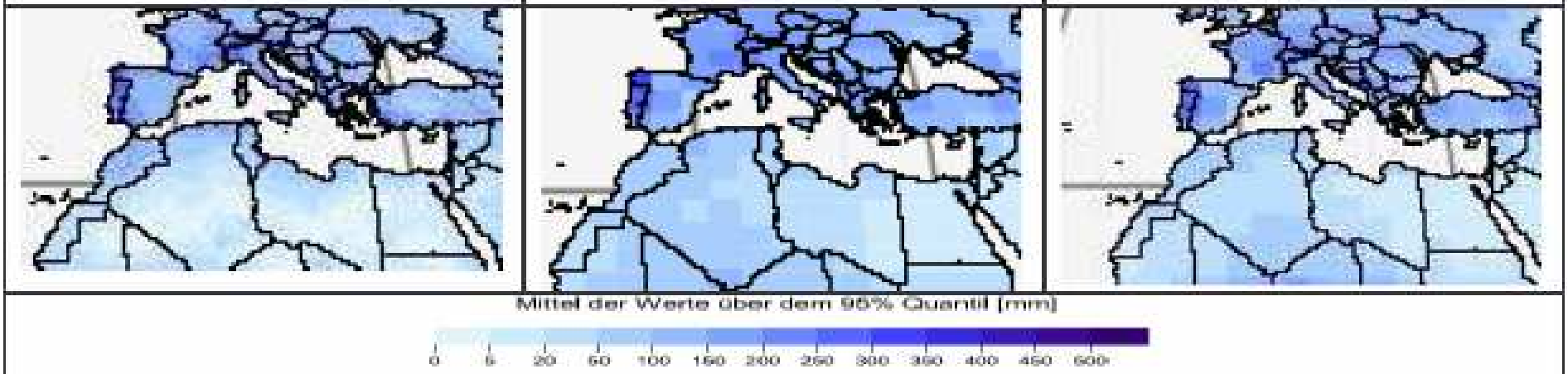


6.13. Potential Danger of Flash Floods
Source: WBGU 2006

3A: Potential flash floods by country, 1975-2004

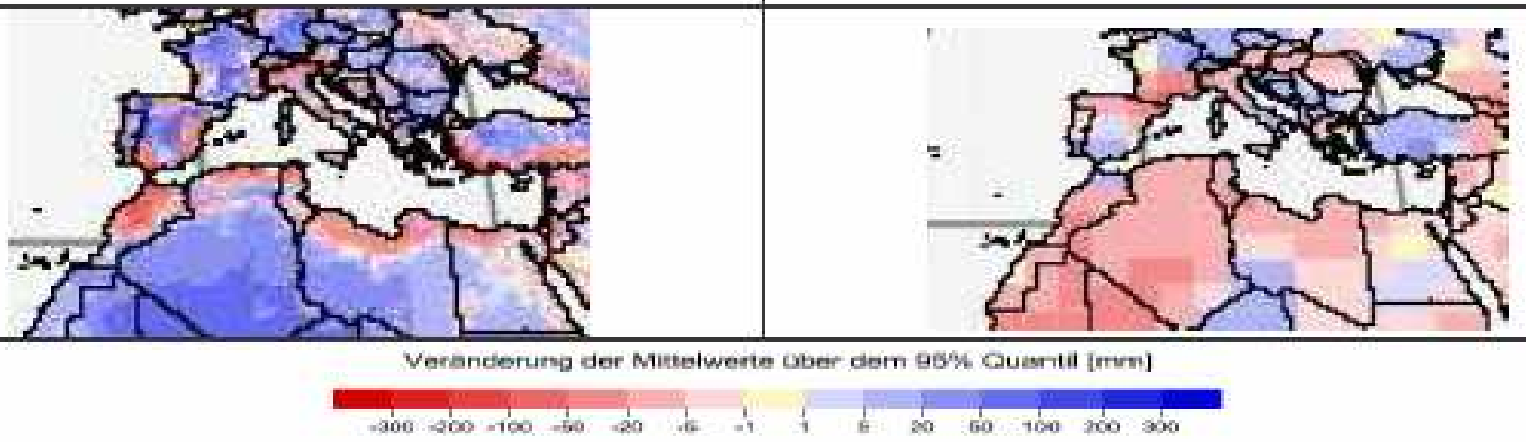
3B: Potential flash floods by country by 2050 (2040-2069)

3C: Potential flash floods by country by 2080 (2070-2099)



3D: Potential flash floods by country by, difference between 1990 and 2050 (2040-2069 -1975/2004)

3E: Potential flash floods by country by, difference between 2050 and 2080 (2070/2099 -2040/2069)

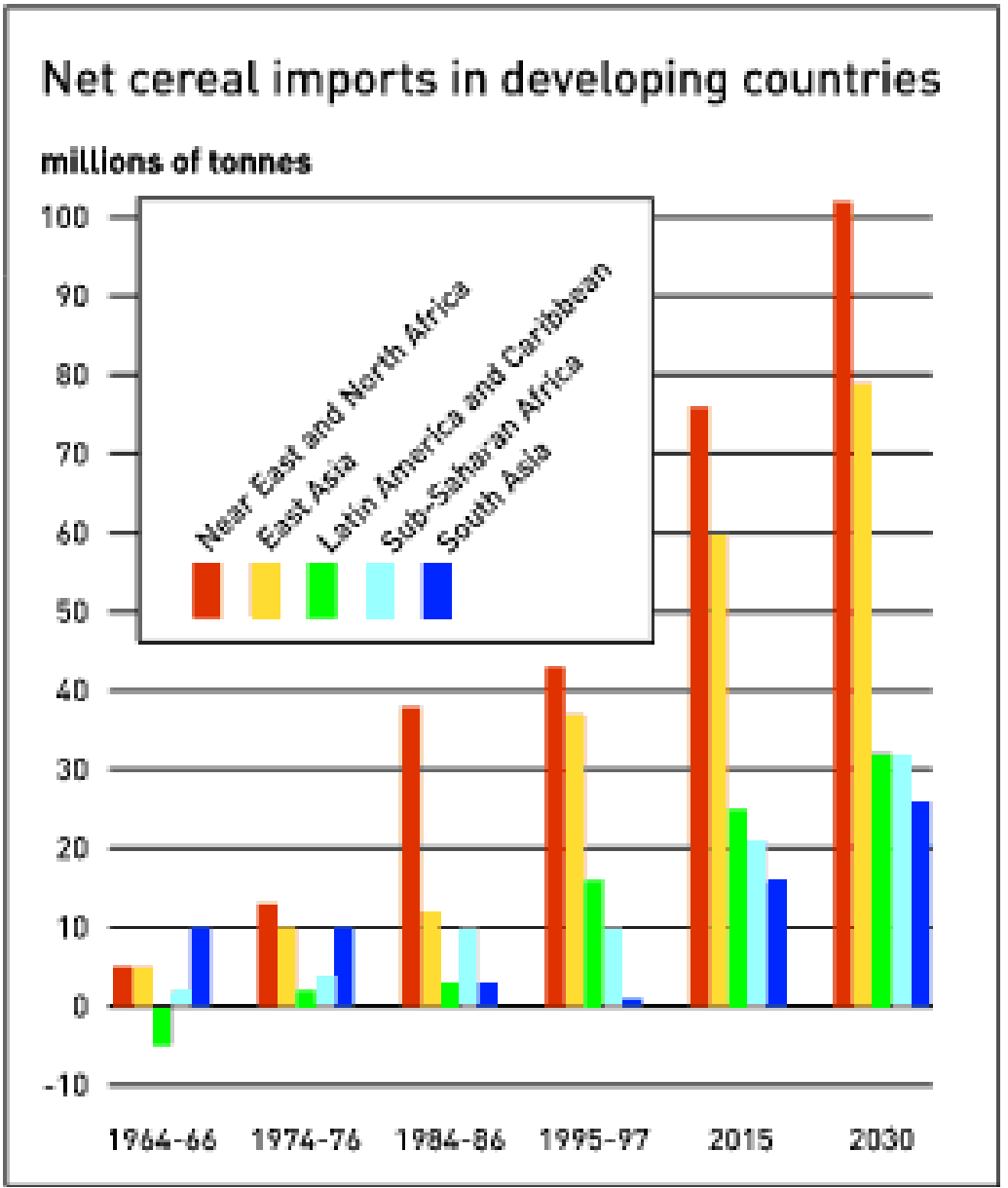


6.14. Food Security in the MENA Region

Table: Cereal balance for the MENA, all cereals (1964-2030).

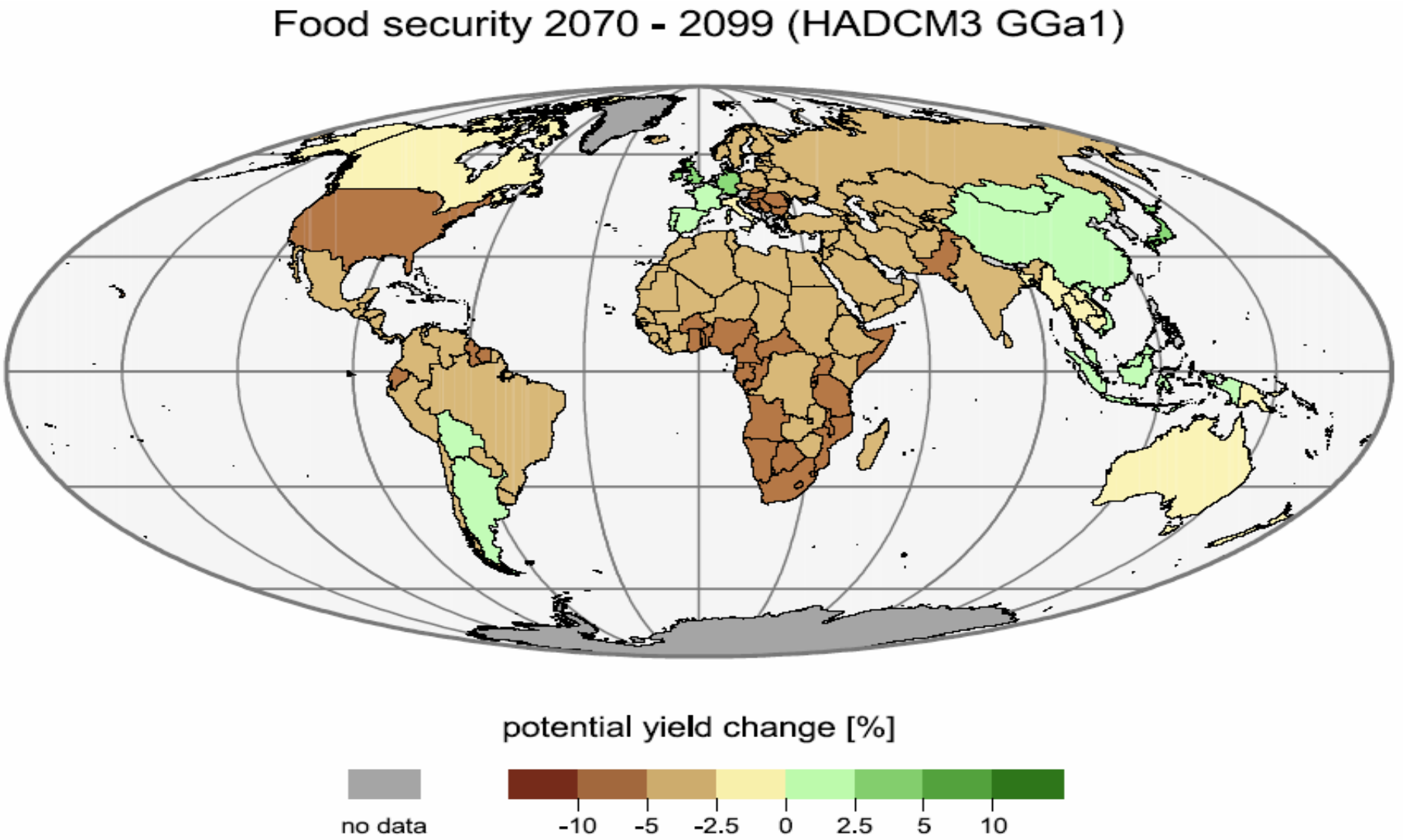
19	Demand				Pro-duc-tion	Net tra-de	Self-suf-fic. rate %	Growth rates, % p.a			
	Per caput (kg)		Total (mio.tons)					Time 19... /20..	Dem and	Pro-duc-tion	Po-pula tion
	food	All uses	food	All uses							
64/66	174	292	28	47	40	- 5	86	67-97	3.6	2.4	2.7
74/76	190	307	40	64	55	- 13	85	77-97	3.1	2.7	2.7
84/86	203	365	56	100	65	-38	65	87-97	2.1	2.0	2.4
95/97	208	357	75	129	84	-43	65	’95- 15	2.0	1.4	1.9
2015	209	359	108	186	110	-85	56	‘15- 30	1.5	1.2	1.4
2030	205	367	130	232	131	-116	54	‘95-‘30	1.8	1.3	1.7

6.16. FAO (2000) Increase in Cereal Imports



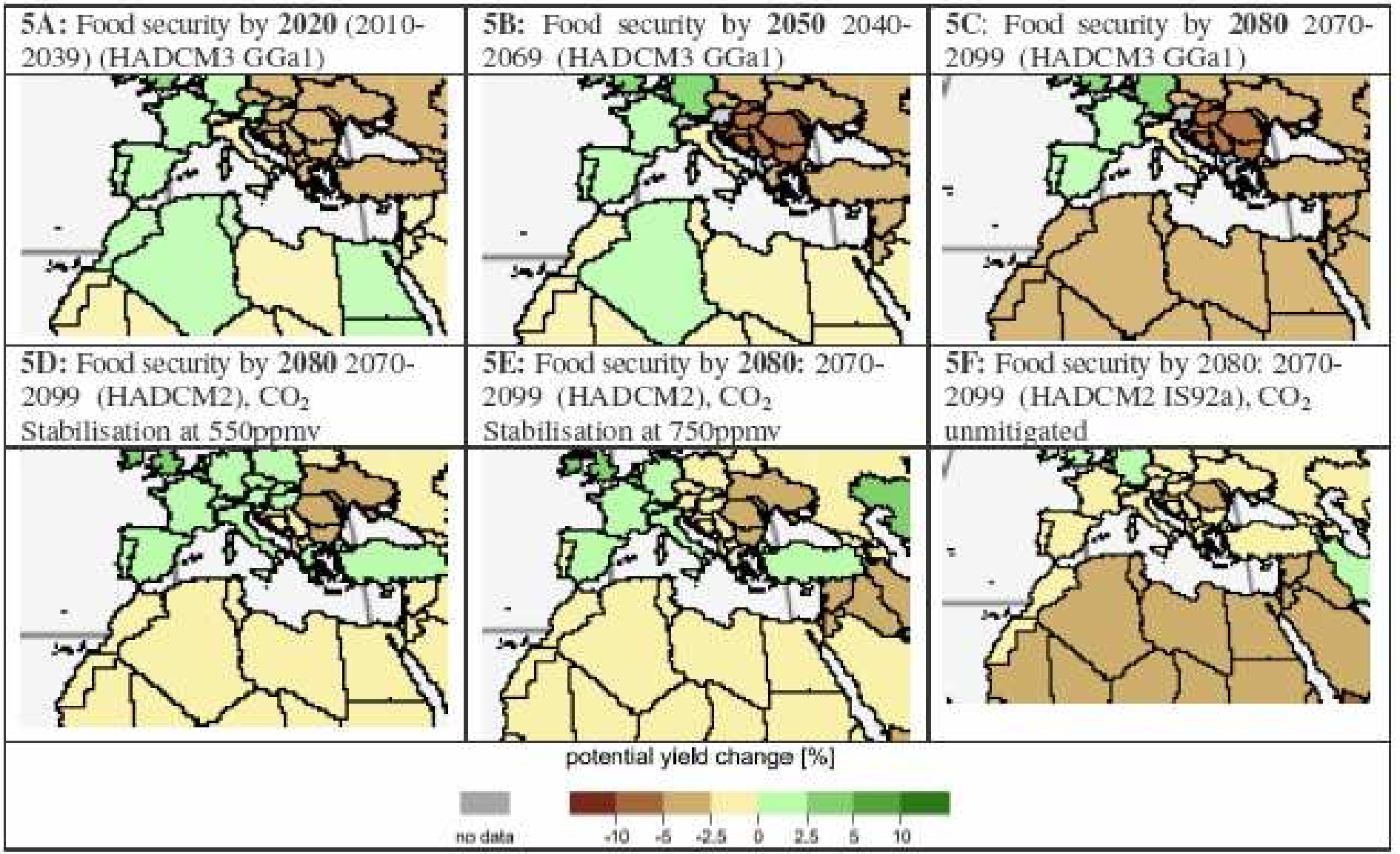
- **FAO: 4 March 2003, Rome**
  World's population will be better fed by 2030, **but hundreds of millions of people in developing countries will remain chronically hungry**.
- Parts of South Asia may be in a difficult position and **much of sub-Saharan Africa** will not be significantly better off than at present in the absence of concerted action by all concerned.
- Number of hungry people is expected to decline from 800 million today to 440 million in 2030.
- **The target of the World Food Summit (1996) to reduce the number of hungry by half by 2015, will not be met by 2030.**

6.17. Food Security by 2080: Changes in Crop Yield



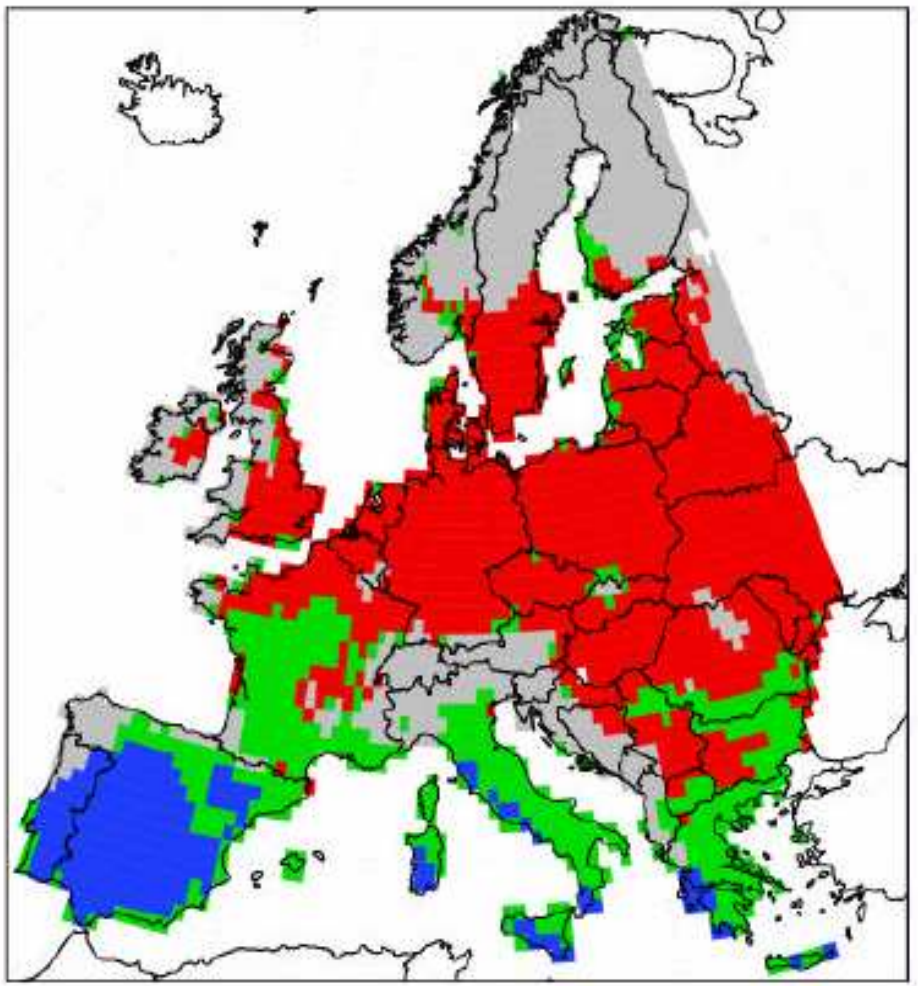
6.18. Climate Change and Food Security

Source: WBGU 2006



6.19. Yields of Wheat by 2080

(M. Parry, IPCC, London, 2005)



Reduced yield in all models

Increased yield in all models

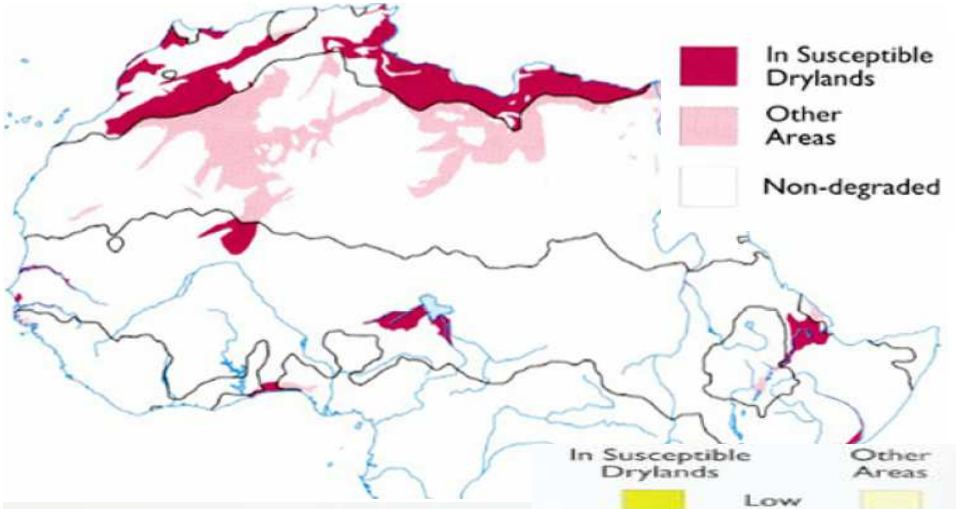
Models do not agree

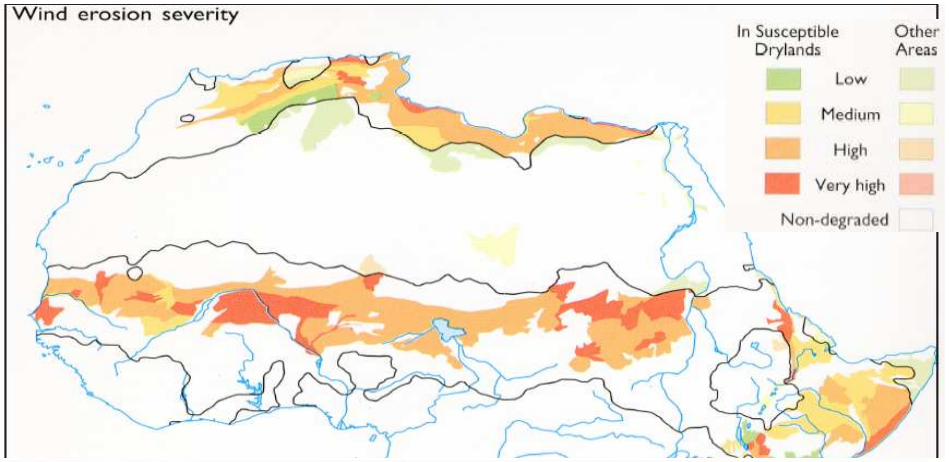
7. Desertification Projections for Northwest Africa and Spain

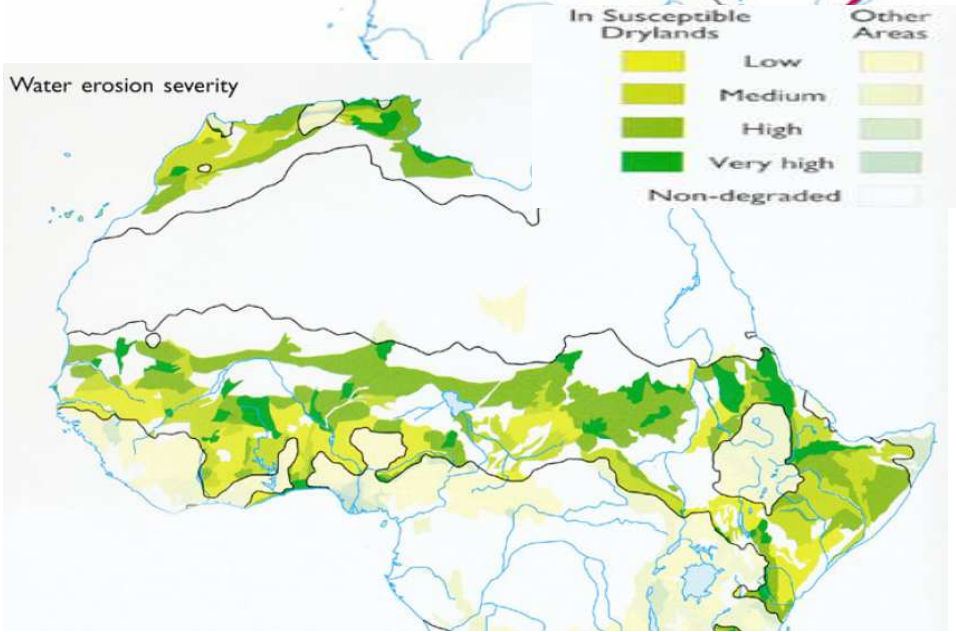
- Assumptions:
  - Globally affected by GEC
  - Locally induced: resource management (water, soil & biodiversity)
    - North. Economy driven
    - South: population and poverty driven
- Global: Millenium Ecosystem Assessment: Global drylands
  - No scenarios and projections
- Regional: WBGU soil maps: Mediterranean and Africa
  - African deserts, drylands and desertification
  - No scenarios and projections
- Research needs: no equivalent knowledge of IPCC
  - Scientific and Technical Advisory Committee of ICCD
  - No equivalent of IPCC on Global Climate Change

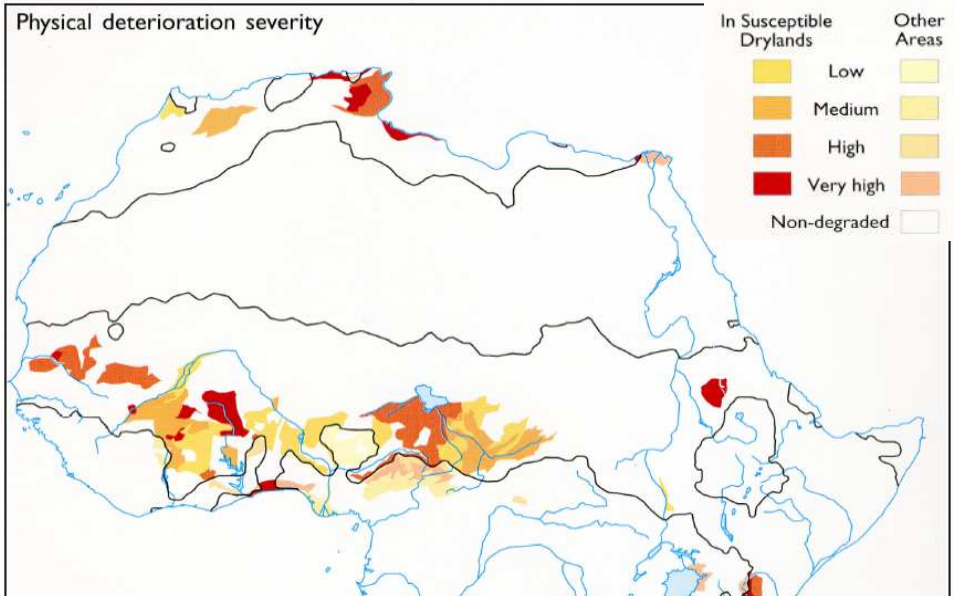
7.1.Global Assessment of Human Induced Soil Degradation (GLASOD): 1990

7.2. Forms of Soil Degradation in Africa: a) salinization; b) water erosion; c) wind erosion, d) physcial deterioration





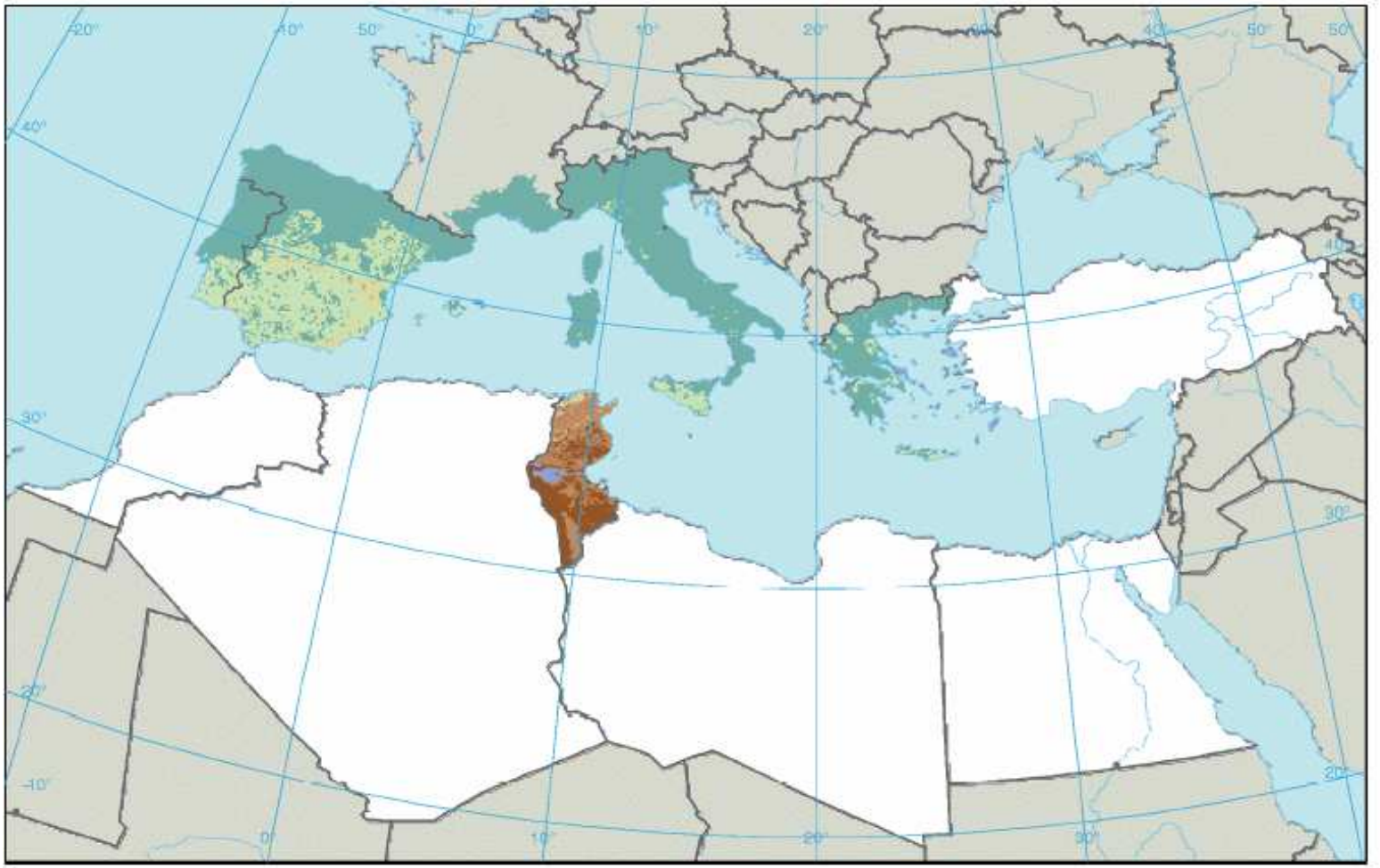




8. Desertification: Environmental and Social Impacts

- Environmental impacts:
  - Water scarcity
  - Soil erosion, loss of soil fertility, salinization
  - Loss of biodiversity
  - Increase in drought, floods, forest fires, heat waves
- Social impacts
  - Declining crop yields
  - Internal population movement (urbanization)
  - Foreign immigration:
    - Emigration from North and West Africa
    - Immigration to Europe and Spain
  - Political crises
  - Small-scale violent conflicts

8.1 Sensitivity to desertification and drought in the Mediterranean Basin



http://dataservice.eea.eu.int/atlas/viewdata/viewpub.asp?id=494

8.2. Projected Extreme Social Outcomes in the Mediterranean Region

- IPCC (2001): Climate change: increase in extreme weather events in 20th century and further increase in 21st century.
- Due to high societal vulnerability in North Africa the number of victims to floods was higher while the economic loss was lower than in Southern Europe.
- Soil erosion, droughts, forest fires and heat waves as well as flash floods have cumulative negative effects and will increase the number of victims and economic losses.
- The ageing of the North and high population growth in South will have different impacts on the Mediterranean landscapes.
- The migration pressure in the MENA will intensify.
- **These trends will affect environmental security and impact on human, societal and regional security!**

8.3. Increase in Human Disasters and Conflicts Impacting on the Mediterranean

- **Question of AFEs-PRESS Expert Study for WBGU: Will the outcomes of GEC and climate change (CC) lead to conflicts?**

Hypotheses

- **Thesis 1:** Population growth, urbanisation and high poverty will increase the societal vulnerability to hazards and disasters.
- **Thesis 2:** Extreme weather events will „very likely“ lead to an increase in hydro-meteorological hazards (droughts, flash floods and storms).
- **Thesis 3:** Environmental stress and hazards may trig-ger distress migration and low level conflict potentials within societies and among states.

8.4. Environmental Change and Conflict in North Africa

- For states in North Africa (2005-2020) **it is unlikely** that **GEC** (climate change, soil erosion, water scarcity) and **their impacts** (declining agricultural yields, extreme weather events) will lead to wars among states of North Africa or with states in Southern Europe.
- **Climate change, desertification & water scarcity cannot be contained with military means.**
- However, the **societal impacts of GEC** may pose a **survival dilemma** for **affected people** and force them to leave their homes and livelihoods to the cities or to other countries.

8.5. Scenarios on the Environmental Dimension of Human Security

- **Between 2000-2050 the population in North Africa will grow by 100 mio. persons** and nearly all of them **will live in the big cities**, many in informal housing, and many without jobs and perspective of the future.
- This poses **major challenges for societal, environmental and human security in all 5 countries**.
- **Reserves of oil and gas will be exhausted in many OAPEC countries,** alternatives to the oil rent as a major source of national inclome are needed.
- With **population growth**, **chaotic urbanization** the need for water and food will grow but simultaneously due to climate change and desertification crop yields may drop as will the self-sufficiency in food production and the dependence on virutal water will rise.
- **Internal conflicts on access to „blue“ drinking water will grow between the urban centres and the rural areas where „green“ water for irrigation may drop.**

8.6. Environmental & Distress Migration Will Rise Significantly until 2020 & 2050

- **Scenario 1:** During **drought** periods water and food will be **scarce, food prices may rise and survival in the rural areas may become more difficult**.
- **Scenario 2:** On this **survival dilemma** for parts of the rural population many young men react by moving to the urban centres (**urbanization**) and if affordable overseas.
- **Scenario 3:** As in the past (1970s-90s) **mass** and **food protests** may challenge the governments
- **Scenario 4:** **Migration**: besides economic reasons, societal and **environmental causes** may become key **triggers**.
- **Scenario 5:** The **countries of North Africa** have already become the goal of **transmigrants** from sub-Sahara Africa, many of them try to get to Europe or North America. This has in some cases resulted in violent conflicts with the police & hosts.

8.7. Conflict & Cooperation Potentials

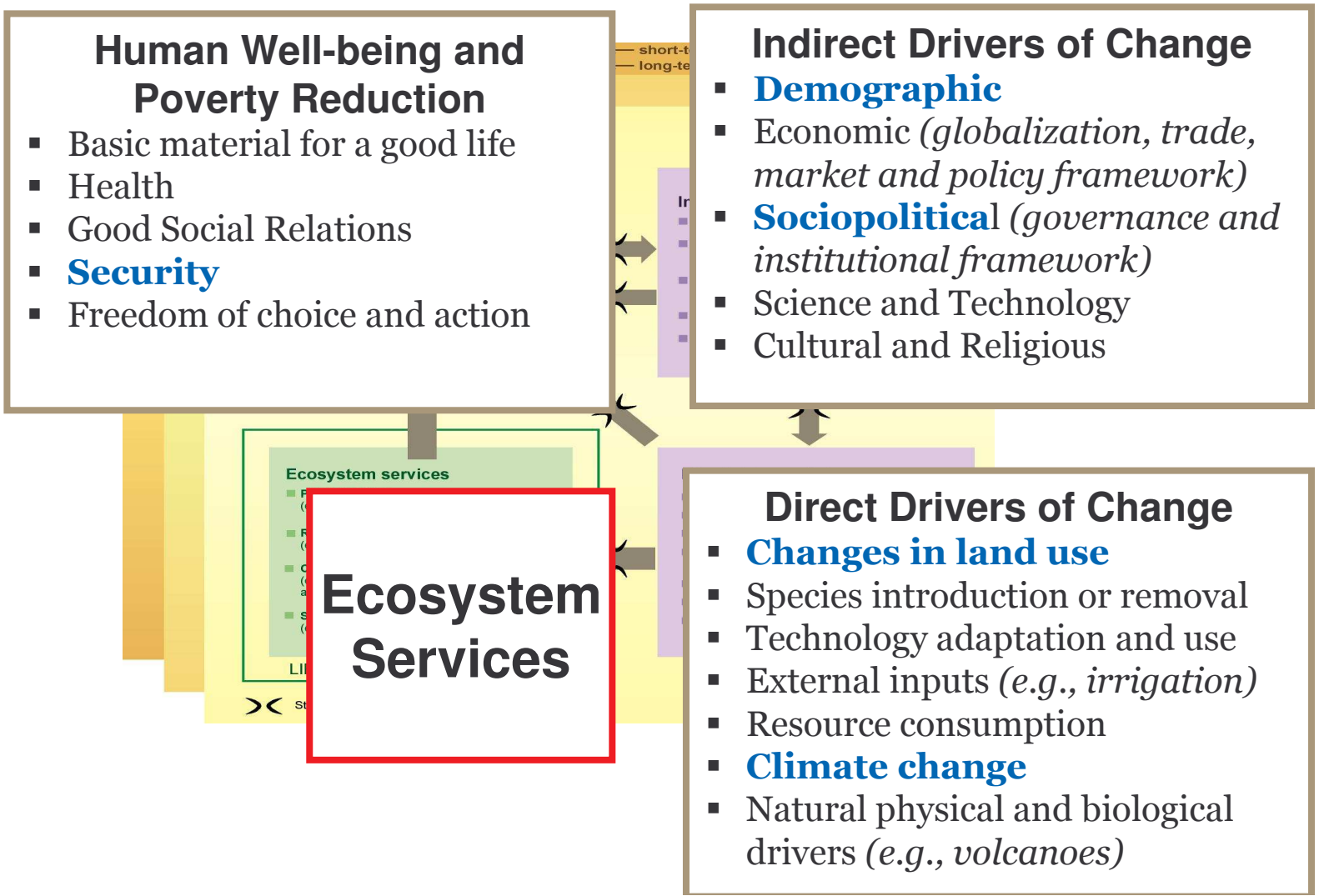
- **Scenario 6:** European counter measures to contain immigration may enhance the protest potential in emigrating countries.
- **Scenario 7:** Diaspora scenario: the uprooted youth who is not integrated in their host countries have contributed to internal insecurity and violence in some recipient countries (e.g. France)
- **Scenario 8:** Combating desertification and greening the military: Military forces is a major resource for combating desertification. Disaster preparedness and response may become a new mission for miltary forces in many affected countries.
- **Scenario 9:** Peaceful solution mechanisms for internal conflicts over water and land-use are needed.
- **Scenario 10:** The Nile Basin has been affected by drought, famine and was a victim of many violent internal conflicts.

9. Towards Proactive Policy Responses

Millennium Ecosystem Assessment (MEA), 2005:

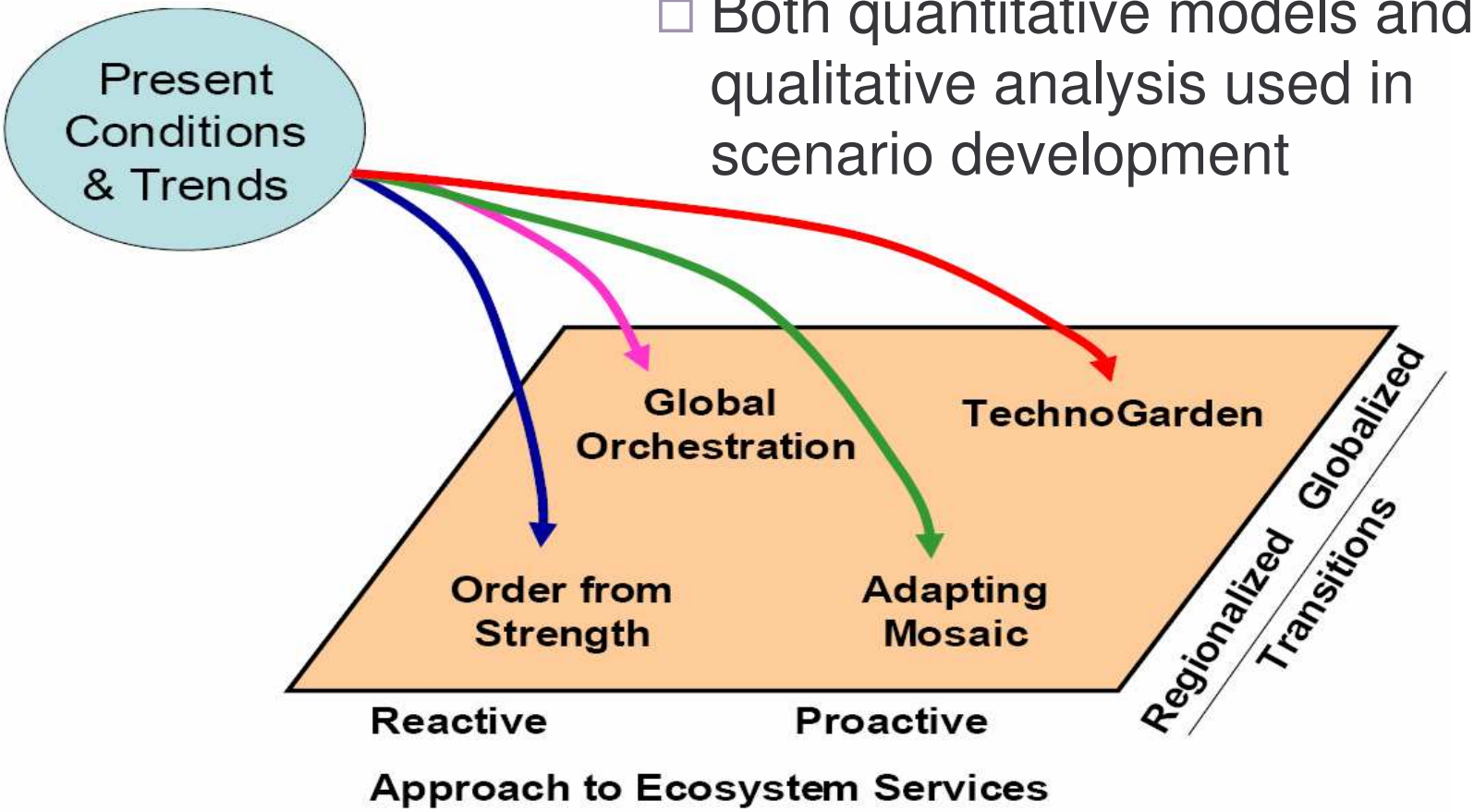
- Over the past 50 years, humans have changed ecosystems more rapidly & extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber & fuel
- The changes that have been made to ecosystems have contributed to **substantial net gains in human well-being** and **economic development**, but these gains have been achieved at growing costs in the form of the **degradation** of many ecosystem services, **increased risks of nonlinear changes**, and the **exacerbation of poverty** for some groups of people.
- **The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals**
- The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the MEA has considered but these involve significant changes in policies, institutions and practices, that are not currently under way.

9.1. MA Framework



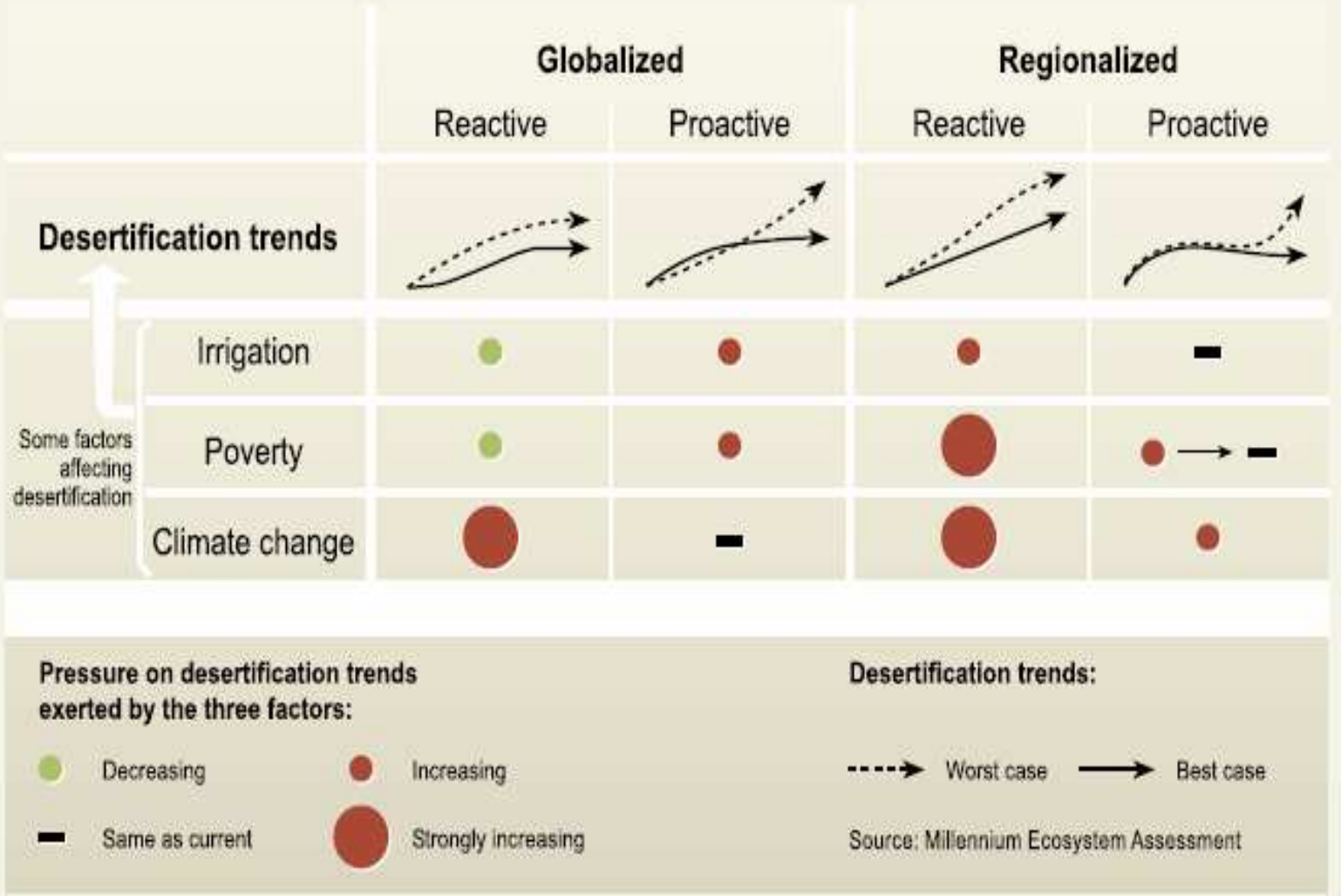
9.2. MA Scenarios

- **No predictions – scenarios are plausible futures**
- Both quantitative models and qualitative analysis used in scenario development

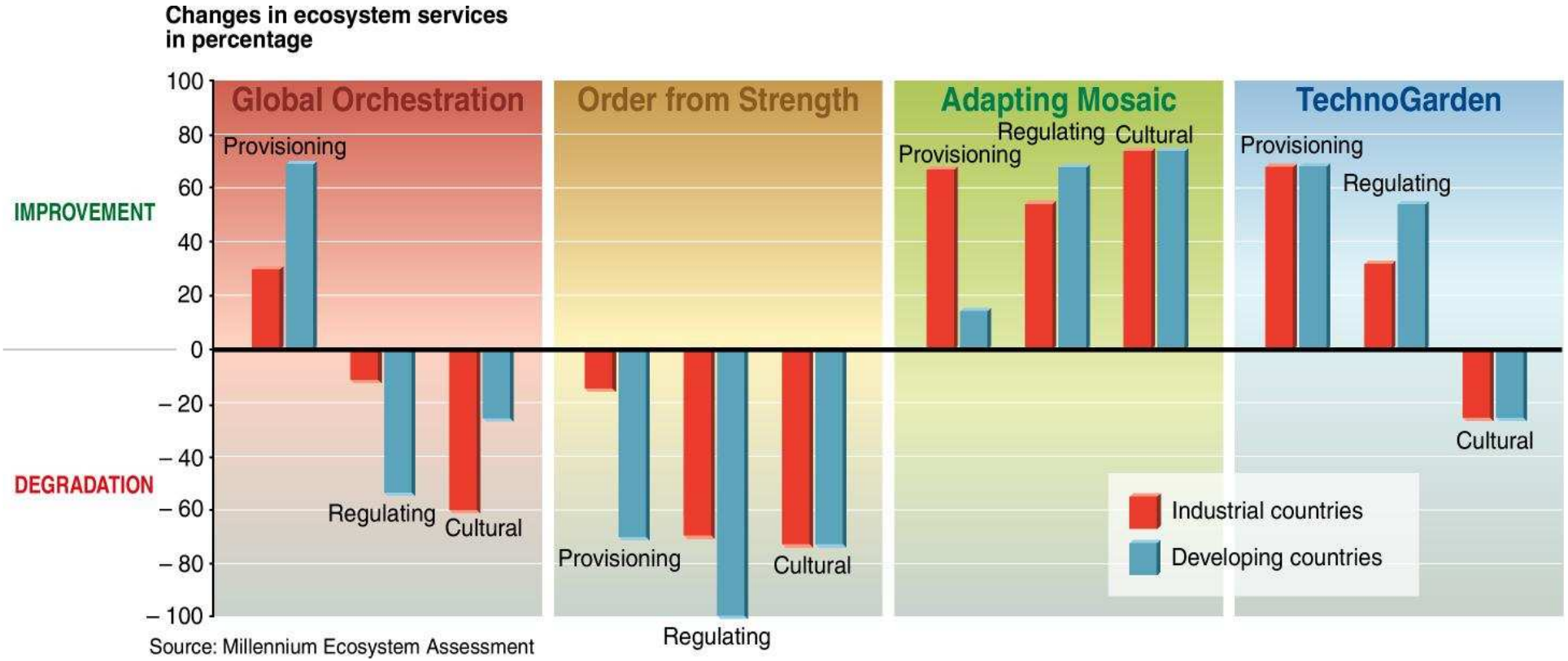


9.3. MEA-Scenarios

Rates of change in the extent of desertified areas in the drylands: Solid lines indicate the best case; dashed lines indicate the worst case for desertification in each of the MA scenarios.



9.4. Improvements in services possible by 2050



- **Three of four scenarios show that significant changes in policy can partially mitigate the negative consequences of growing pressures on ecosystems, although the changes required are large and not currently under way**

9.5. Examples of changes in policies and practices that yield positive outcomes

- **Global Orchestration**
  - **Major investments in public goods (e.g., education, infrastructure) and poverty reduction**
  - Trade barriers and distorting subsidies eliminated
- **Adapting Mosaic (Regional)**
  - **Widespread use of active adaptive management**
  - **Investment in education** (countries spend 13% of GDP on education, compared to 3.5% today)
- **TechnoGarden(Global)**
  - **Significant investment in development of technologies to increase efficiency of use** of ecosystem services
  - Widespread use of 'payments for ecosystem services' and development of market mechanisms

9.6. Responses:Importance of Indirect Drivers

- **Ecosystem degradation can rarely be reversed without actions that address one or more indirect drivers of change:**
  - **population change** (including growth and migration)
  - **change in economic activity** (including economic growth, disparities in wealth, and trade patterns)
  - **sociopolitical factors** (including factors ranging from the presence of conflict to public participation in decision-making)
  - **cultural factors**
  - **technological change: knowledge & technology**
- **Collectively these factors influence the level of production and consumption of ecosystem services and the sustainability of the production.**

9.7.Responses: Technological

- ***Development and diffusion of technologies designed to increase the efficiency of resource use or reduce the impacts of drivers such as climate change and nutrient loading are essential***
- **Promising Responses**
  - **Promotion of technologies that enable increased crop yields without harmful impacts related to water, nutrient, and pesticide use**
  - Restoration of ecosystem services
  - **Promotion of technologies to increase energy efficiency and reduce greenhouse gas emissions**

9.8. Responses: Knowledge

- ***Effective management of ecosystems is constrained by the lack of knowledge & information on ecosystems and by failure to use adequately existing information***
- **Promising Responses**
  - **Incorporation of nonmarket values of ecosystems in resource management decisions**
  - Use of all relevant forms of knowledge and information in assessments and decision-making, **including traditional and practitioners' knowledge**
  - **Enhancement of human and institutional capacity for assessing consequences of ecosystem change for human well-being & acting on such assessments**

9.9. Need for Global Proactive Strategies and Proposals

Developing the TechnoGarden by Technology Sharing

- Two Centres of Excellence for Advanced Research, Technology Development and Training on Renewable Energy
  - Masreq in Cairo (feasibility study, Nov. 2006):
    - project development bilateral: Egyptian-German scientific co-operation
    - project realization interregional: Euro-Mediterranean Barcelona Process
    - project funding
    - hosts: Egyptian-German Technical University in Cairo
  - Maghreb in Tunis (Italy & Tunisia: MEDREP: Mediterranean Renewable Energy Programme (since 2004)

10. Policy Proposals

- **Proactive sustainable environmental management:**
  - i. Coastal management
  - ii. Water management
  - iii. Soil management
  - iv. Urban management
- **2. Developing the TechnoGarden: Modern technology for combating desertification with renewables:**
  - i. Spain: geopolitical and geo-cultural
  - ii. Spain – Germany – North Africa: co-development for renewables (1997)
- **3. Vision of Fuerteventura**
  - i. Role of the Canary Islands: Using the Potential of renewables
  - ii. Solar vision: for a hydrogen economy
  - iii. Training and education for renewables for Africa

10.1. Proposals of Almeria (2006)

- MEA: for regionalized strategy of *Adaptation Mosaic*, & globalized strategy of *TechnoGarden*
  - At **UN** and OECD level : initiate, launch, support proposals for “TechnoGardens” in energy, transportation, housing & other sectors that will become feasible in the 21st century.
  - At regional level: affected countries in Maghreb, Masreq, Sahel, Kalahari, South West and Central Asia, Central and South America and in parts of Caribbean: development of a region-specific *Adaptation Mosaic* is needed.
  - An international Research Centre in Almeria could become a global leader for designing policy relevant pro-active strategies for coping with both desertification and migration.

10.2. Proposals of Almeria (2006)

- **Spain has improved the legal framework for commercialisation of these new sustainable renewable energy sector.**
- **Spain: Techno Garden for renewable energy system & production of solar facilities attract investment. This could weaken the market driven desertification process and create promising employment options.**
- **TechnoGarden: a renewable energy strategy for North Africa**
  - *Short term* the lacking (Morocco) and limited hydrocarbon energy sources (Tunisia) offer good prospects for hybrid renewable electricity generation based on wind, biomass, city waste and solar thermal installations with a natural gas backup.
  - *Medium term* Egypt must substitute its oil and gas reserves with economically competitive renewable energy systems, especially solar thermal and concentrator PV plants in the.
  - L*ong term* construction of large scale solar PV and solar thermal plants in the Sahara desert may supply needed renewable energy sources also for European countries.
- **This could be complemented at the EU level by:**
  - a political framework for co-operation on renewables between the EU and North African countries in framework of the Barcelona process for a sustainable development strategy.
  - In the North, for such a renewable energy strategy Andalucía, Murcia and Valencia are among the most attractive sites in Spain and in the European Union with the highest technical and economic solar potential.

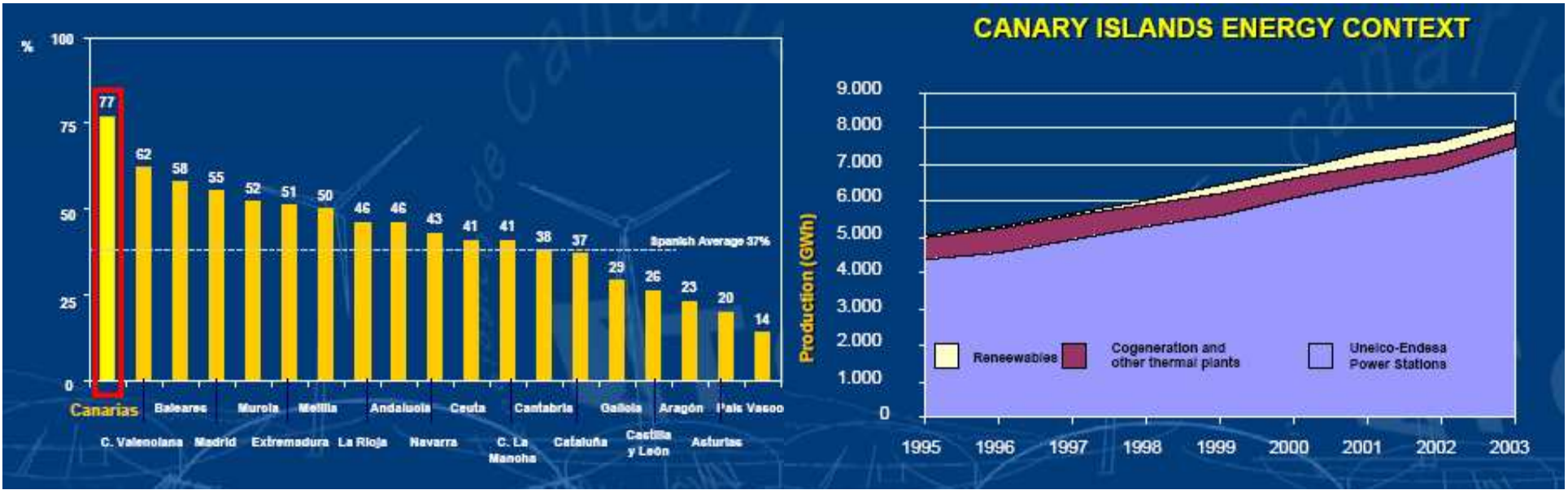
10.3. Towards a Vision of Fuerteventura in Combating Desertification by Renewables

- **Spain‘s obligations under UNFCC/Kyoto Protocol**
  - **Task in achieving Kyoto and EU GHG reduction goals**
    - -8.1% under Kyoto Protocol
    - + 17% under EU agreement
  - **Spanish Renewable Energy Plan for 2005-2010 (*Plan de Energias Renovables*, PER):**
    - **12% of primary energy from renewables by 2010** (6.9% in 2004);
    - Spain: No. 2 after Germany and before USA in renewables
    - 23 Billion Euro in investment (97% private, 2.9% public)
- **Spain‘s geopolitical and cultural opportunities**
  - **Geographic: neighbour to North and West Africa**
  - **Cultural heritage: partner of Latin America**

10.4. Vision of Fuerteventura

- **Canary Islands:** 7 islands, 2 million + 12 mill. tourists
  - Total external energy dependence, 5 insular elect, systems
  - Lack of water resources (desalination since 1960s)
  - Superb renewable potential (wind, sun), low market share
  - Favourable laws: PER (2005), Royal Decree 436/2004
  - Energy Plan of the Canary Islands (PECAN 2006)

http://www.erec-renewables.org/documents/RE-Islands/European%20REIslands%2021%20September%20ITC%20Gonzalo%20Piernavieja%201.pdf



10.5. Vision of Fuerteventura

- **Multiple Goal:**
  - **Sustainable energy vision for the Canary Islands:** (Gonzalo Piernavieja Izquierdo,ITC, Brussels, 21 Sep. 2005)
  - **Sustainable tourism based on renewable energy:**
    - Electricity generation: hybrid: wind, solar, biomass, waste, gas
    - Infrastrcuture of hydrogen economy for the island transportation
    - Center of excellence: development & training in future technology
- **For a Policy of Trilateral Cooperation**
  - **25 years: bilateral cooperation: CIEMAT & DLR: PSA**
  - **Almeria proposal:** trilateral: Spain - Mexico – Germany: (promotion, training, developing the Latin American market)
  - **Fuerteventura** proposal: **Spain – Germany:** cooperation of ministries of development and environment to develop joint renewable energy projects in North and West Africa.

10.6. Concluding Remarks: Towards the COP

- **Many policies towards combating desertification:**
  - **Italy:** Traditional knowledge (Florence Centre, 28-29 June)
  - **Germany:** Desertification and Security (Berlin, 26 June)
- **Spain is affected both by desertification & impacts**
  - Desertification will intensify: due to cliamte change impacts on Mediterranean: drought, heat waves, forest fires, floods
  - Due to impacts of desertification on North Africa and Sahel Zone: desertification is as an additional trigger to migration.
- **Spain may address both: causes and impacts:**
  - **Almeria proposal: Centre on desertification & migration**
  - **Fuerteventura vision for combating desertirtication:**
    - Implementing the TechnoGarden Scenario; PER & PECAN (2006)
    - Developing a vision of sustainable tourism with water desalination & sustainable transport system based on hydrogen from renewables
    - Research, development, traioning and production of renewables.

11. Bibliographic References

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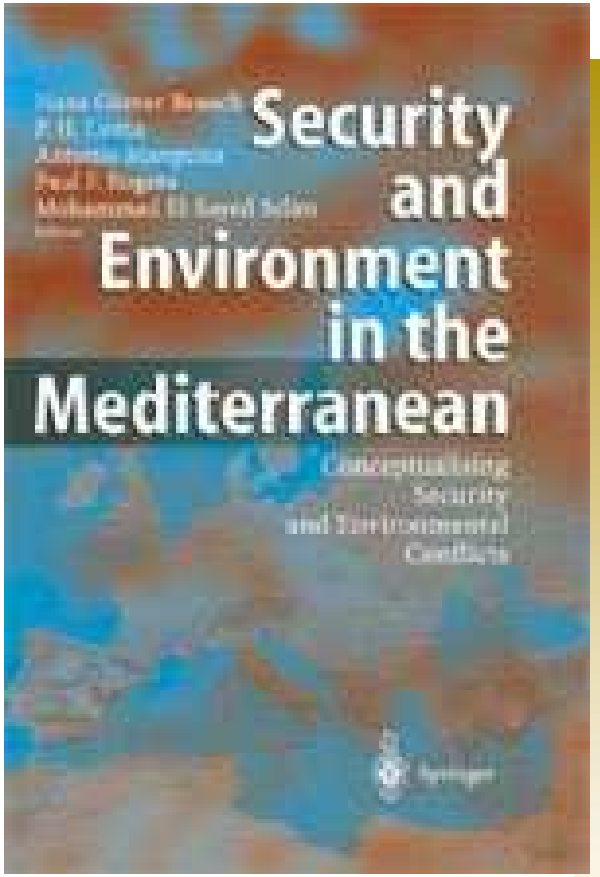
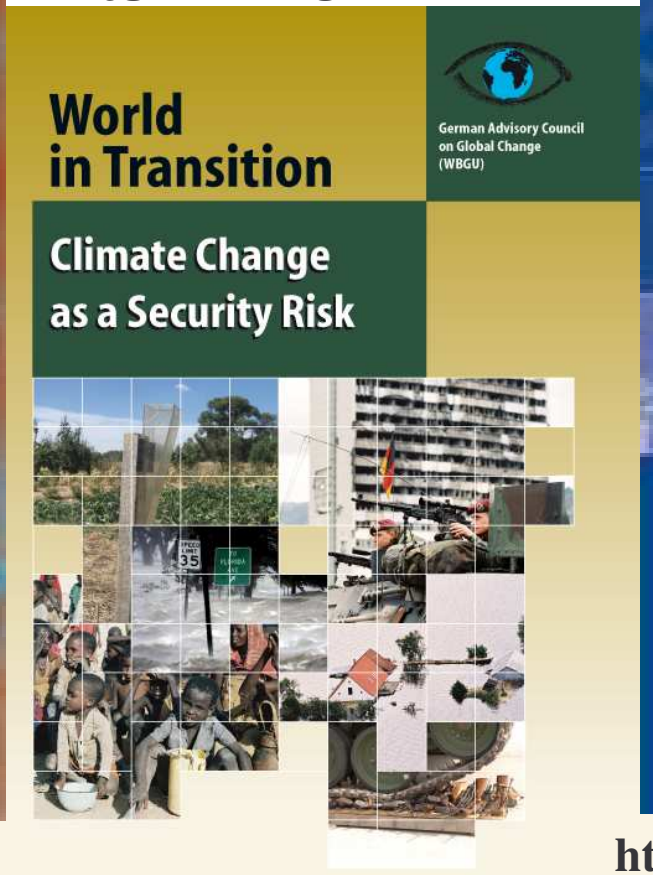
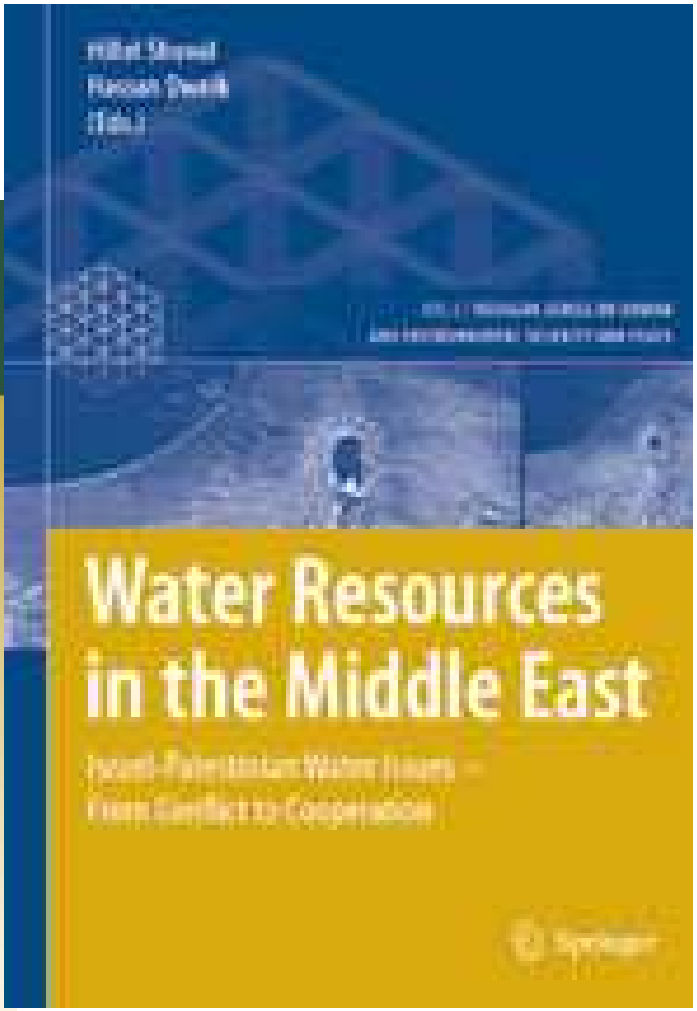


http://www.wbgu.de/wbgu_jg2007_engl.html





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- 1/2005: Paul L. G. Vlek: Nothing Begets Nothing. The Creeping Disaster of Land Degradation, Jan. 2005
- 2/ 2005: Hans Günter Brauch: Environment and Human Security. Towards Freedom from Hazard Impacts. April 2005
- 3/2005: Andreas Rechkemmer: Global Governance and UN Reform – Challenges and Opportunities for Environment and Human Security, September 2005

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- 1/2005: Hans Günter Brauch: Security Threats, Challenges, Vulnerabilities and Risks of Environmental and Human Security, August 2005
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