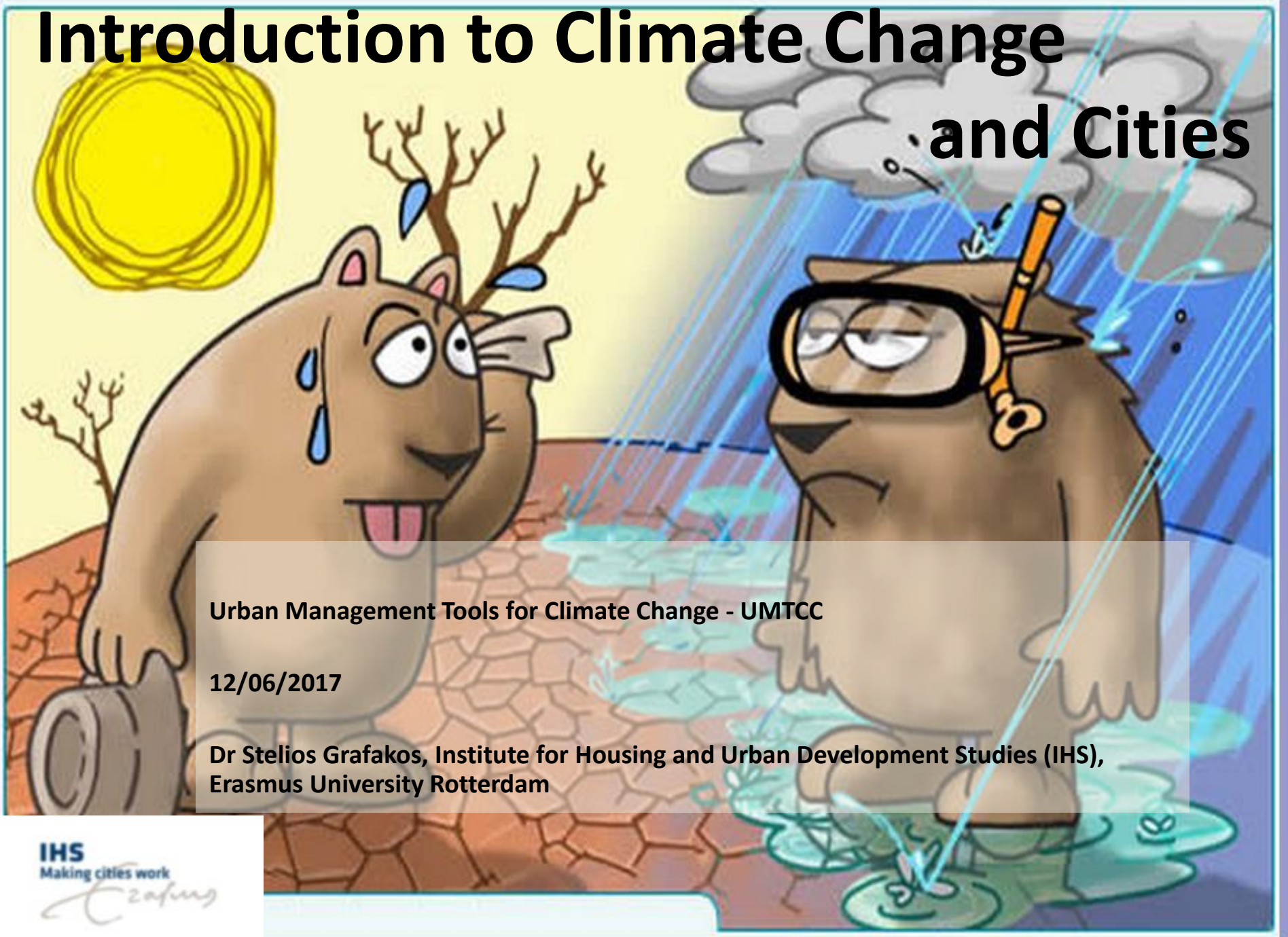
Introduction to Climate Change and Cities



Urban Management Tools for Climate Change - UMTCC

12/06/2017

Dr Stelios Grafakos, Institute for Housing and Urban Development Studies (IHS), Erasmus University Rotterdam

IHS
Making cities work

Source: The Independent

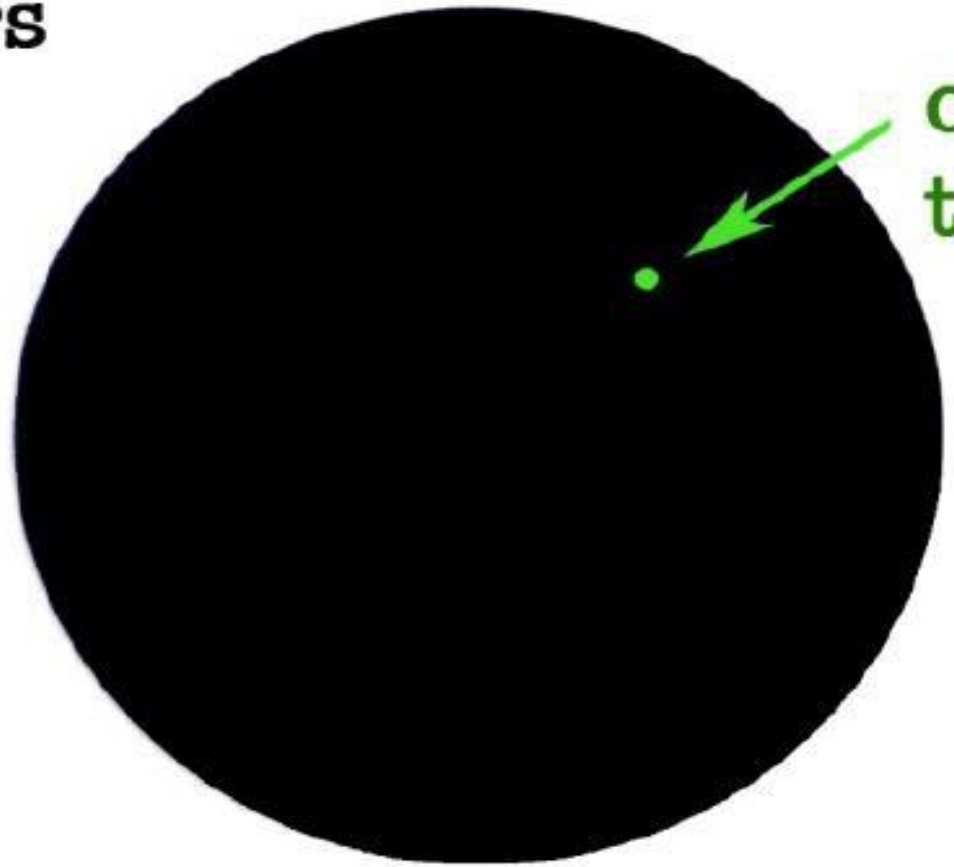
Source: Reuters

Source: NDTV

Outline

- Background on Climate Change (CC)
  - Sources and Effects
- Cities' contributions and Drivers to CC and
- CC impacts in cities

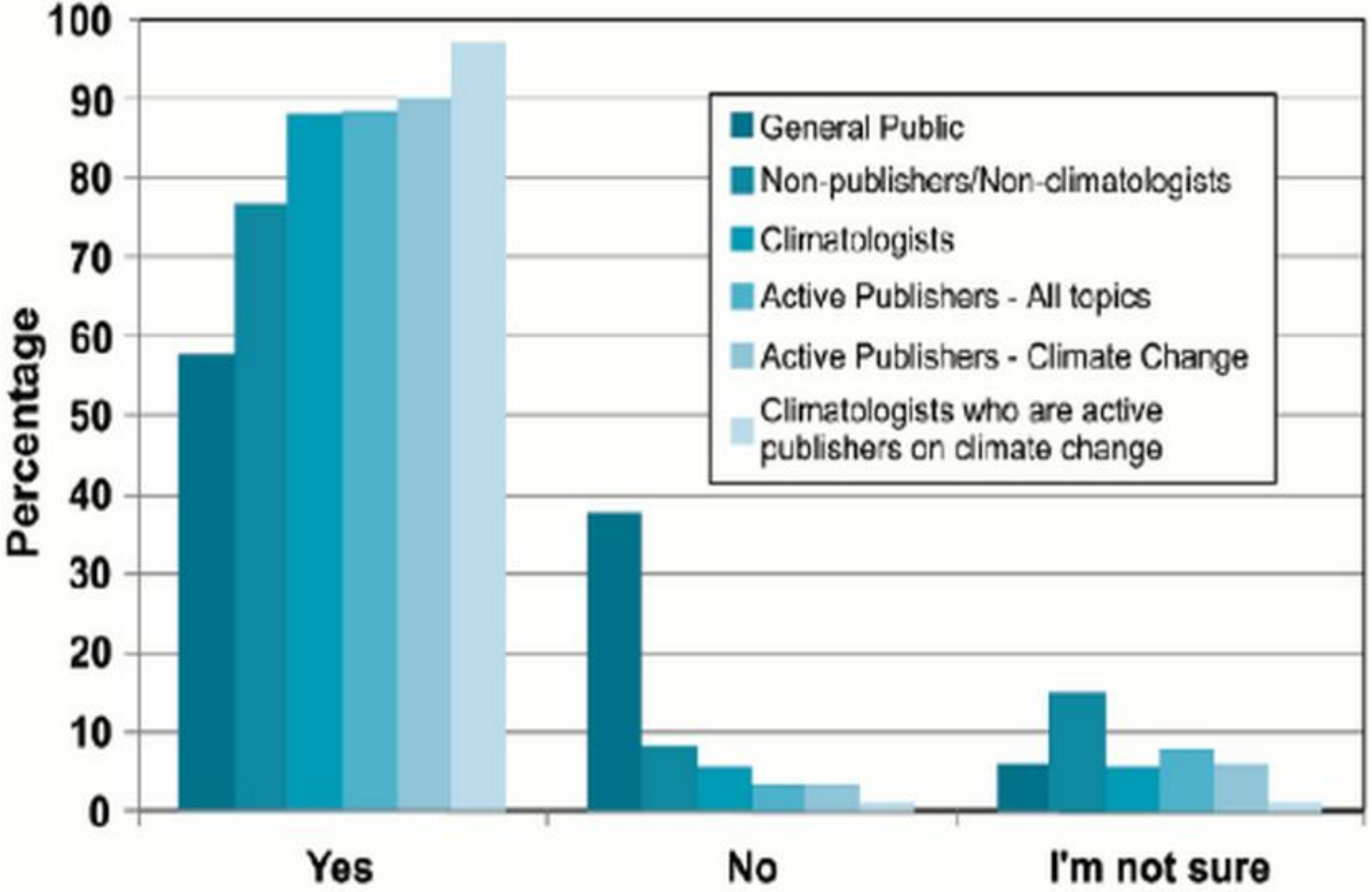
Of 33,700 authors
of peer-reviewed
CLIMATE CHANGE
papers



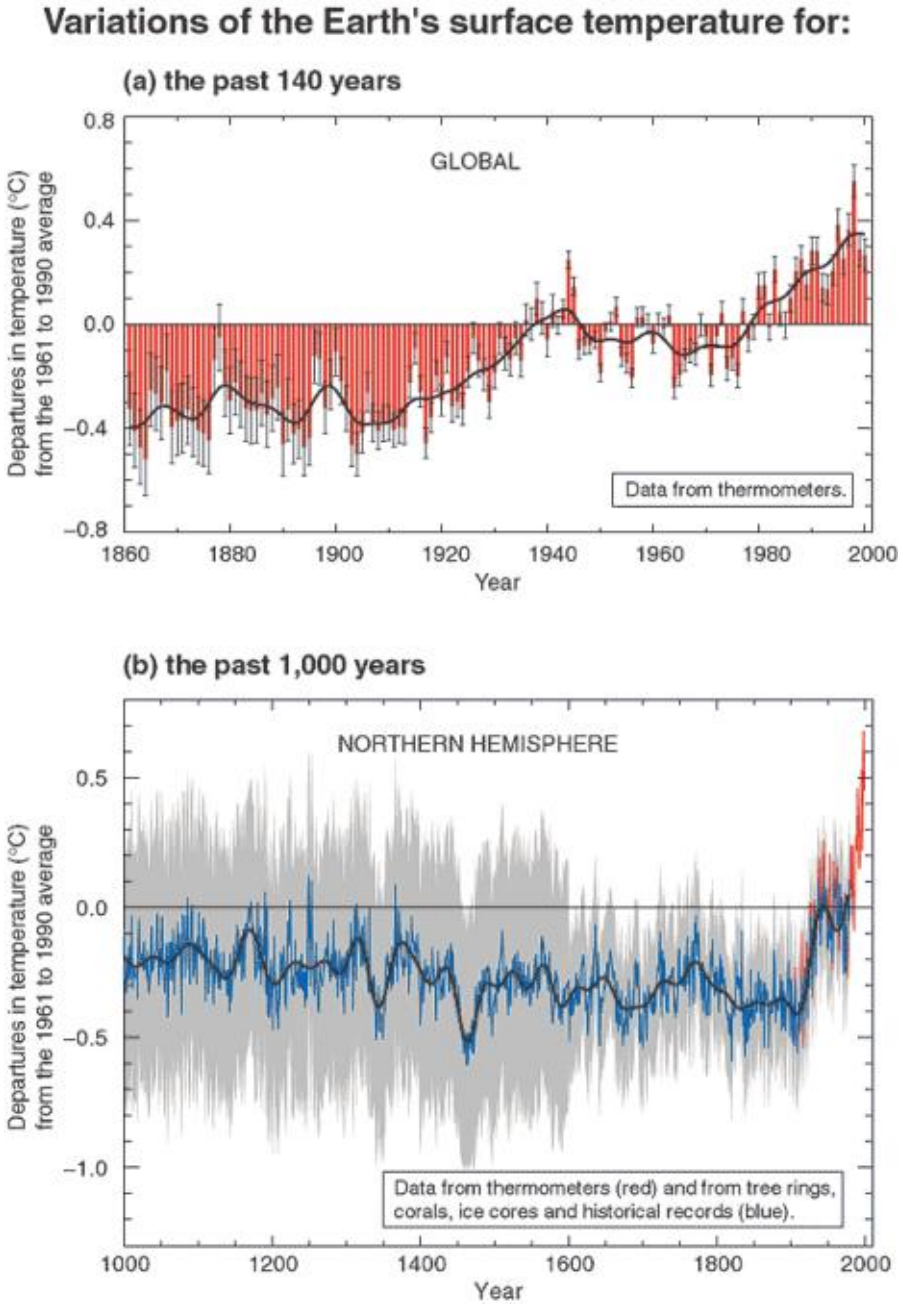
only 34 reject
that it's
CAUSED BY HUMANS

*From Web of Science peer-reviewed scientific articles with keyword phrases "global warming" or "global climate change" published between 1991 and 2011
Research by JL Powell. Full article at: DeSmogBlog.com/Powell

General public?



WARMING IS UNEQUIVOCAL



Over both the last 140 years and 1000 years, the best estimate is that the global average surface temperature has increased by 0.6 ± 0.2°C

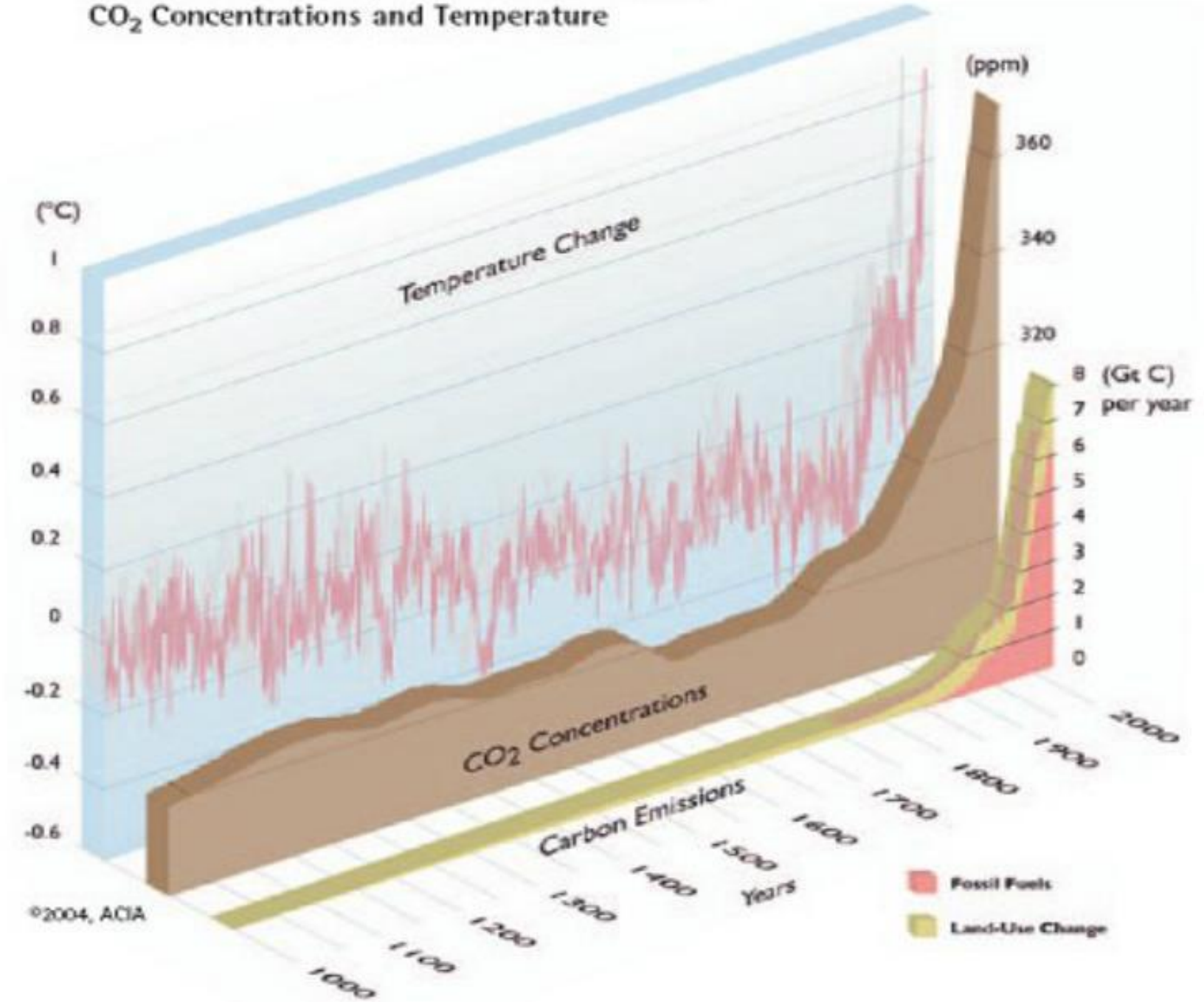
Hockey Stick Graph created by geophysicist Michael Mann.

Despite uncertainty decreases in time (represented by the grey region) the **rate and duration** of warming of the 20th century has been much greater than in any of the previous nine centuries.

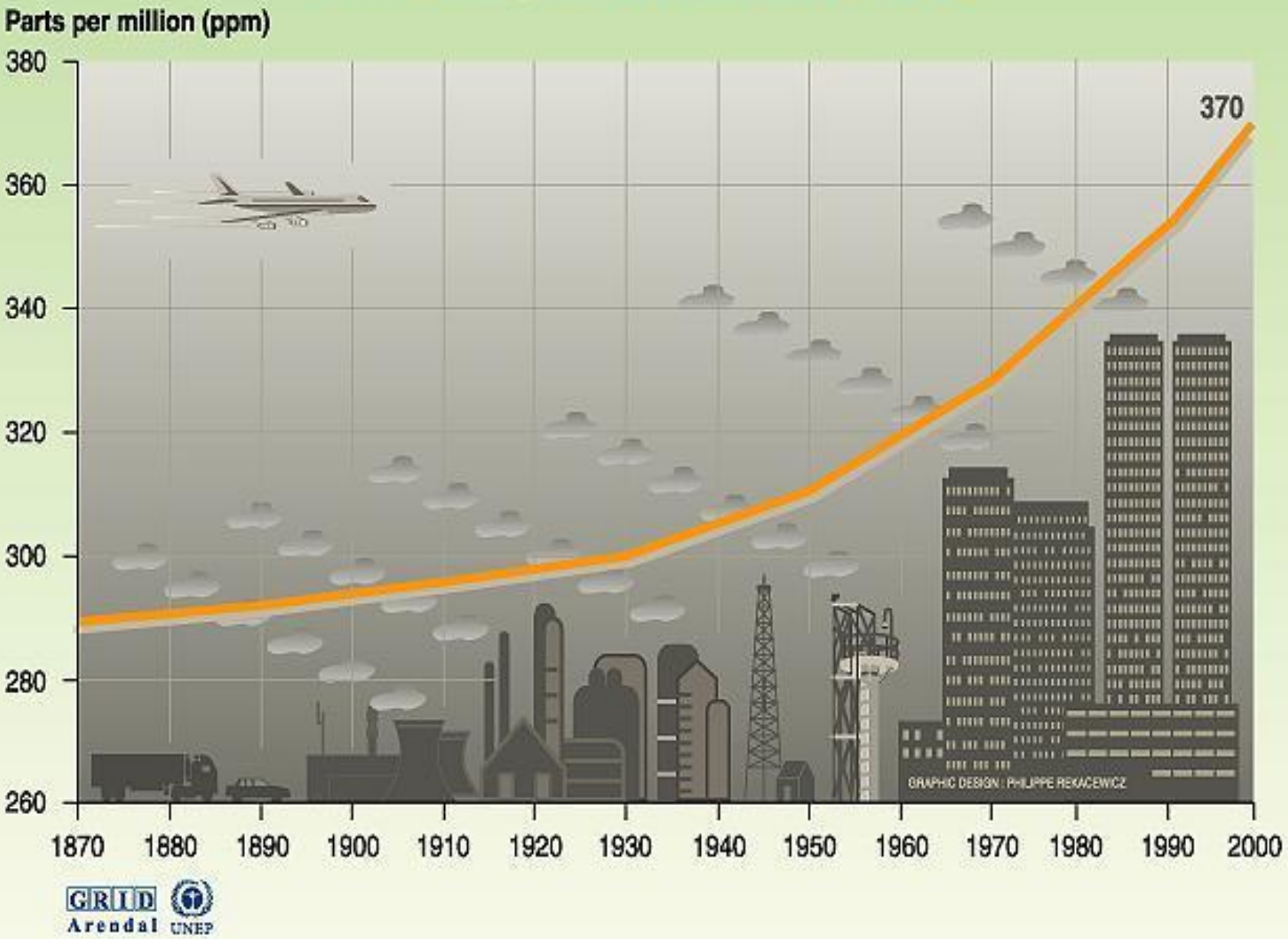
The Climate is Changing

It's changing at an increasingly rapid rate…and

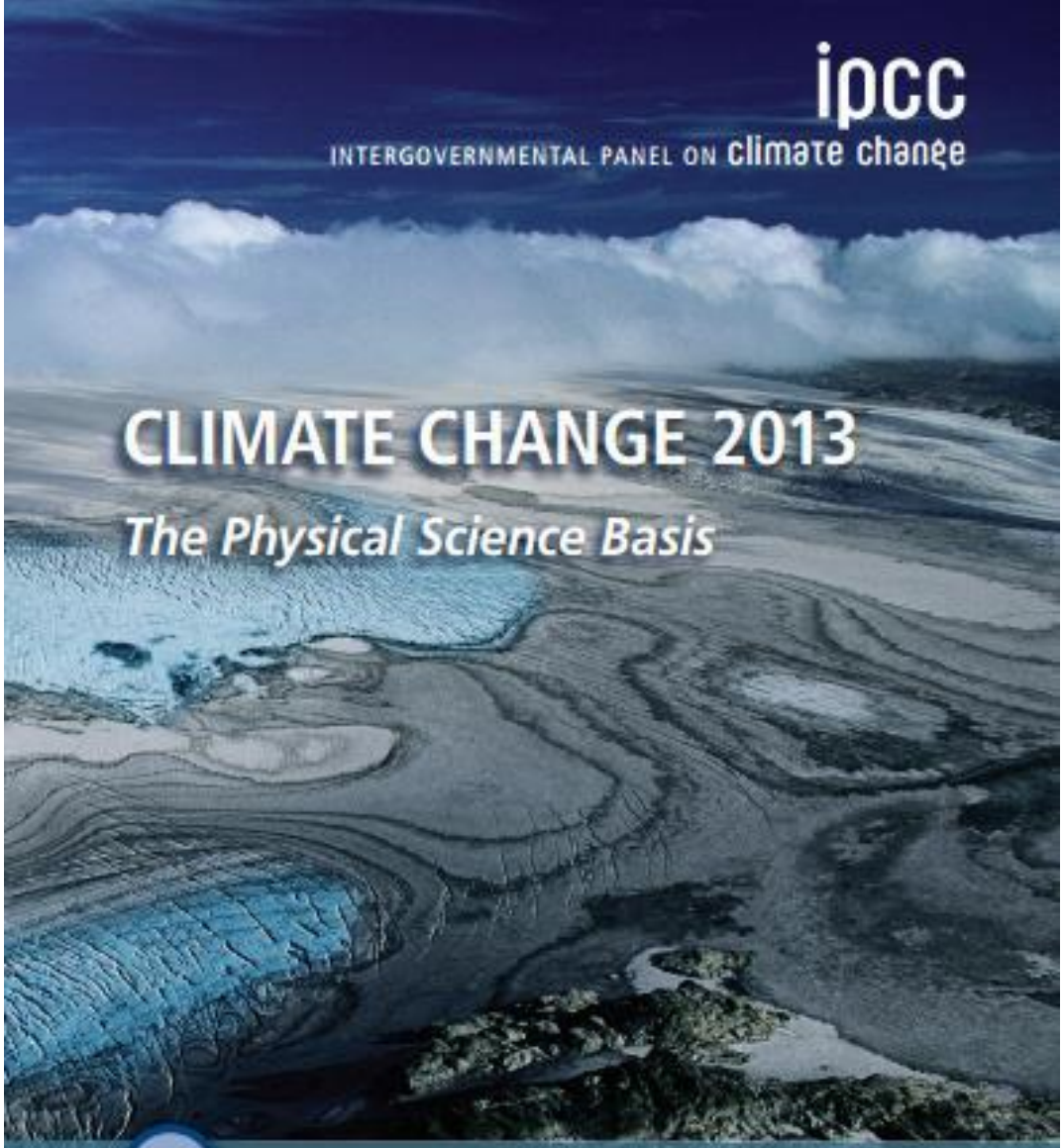
at a rate beyond historic experience…

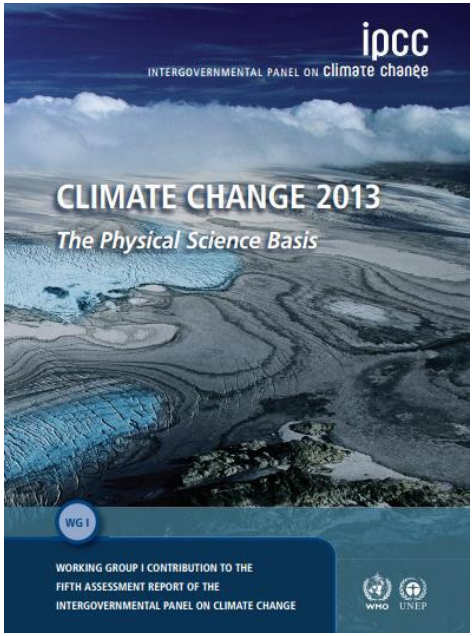

1000 Years of Changes in Carbon Emissions, CO_2 Concentrations and Temperature
(°C)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Temperature Change
(ppm)
360
340
320
CO_2 Concentrations
8 (Gt C)
7 per year
6
5
4
3
2
1
0
Carbon Emissions
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Years
Fossil Fuels
Land-Use Change
©2004, ACIA

Global atmospheric concentration of CO_2



Sources: TP Whorf Scripps, Mauna Loa Observatory, Hawaii, institution of oceanography (SIO), university of California La Jolla, California, United States, 1999


ipcc
INTERGOVERNMENTAL PANEL ON climate change
CLIMATE CHANGE 2013
The Physical Science Basis
WG I
WORKING GROUP I CONTRIBUTION TO THE
FIFTH ASSESSMENT REPORT OF THE
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO
UNEP



IPCC ARC5 (2013)

"It is now considered even **more certain (> 95%) that human influence** has been the **dominant cause** of the observed warming since the **mid-20th century**.

Natural internal variability and natural external forcing (e.g. the sun) have contributed **virtually nothing** to the warming since 1950 – the share of these factors was narrowed down to ± 0.1 degrees."

THE GREENHOUSE EFFECT

Visible energy from the sun passes through the glass and heats the ground

Infra-red heat energy from the ground is partly reflected by the glass, and some is trapped inside the greenhouse

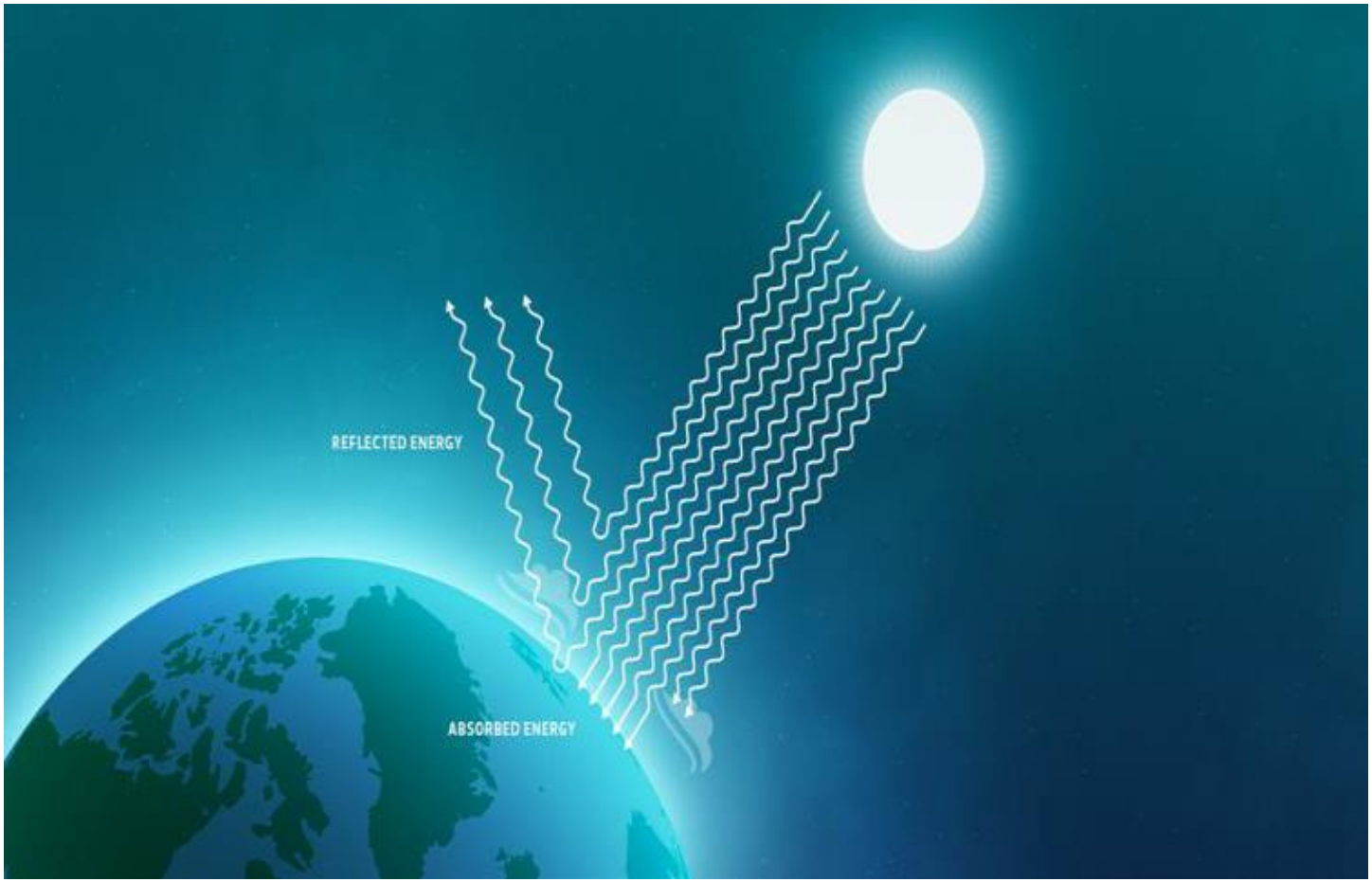
The Met Office

Hadley Centre for Climate Prediction and Research

The Greenhouse Effect

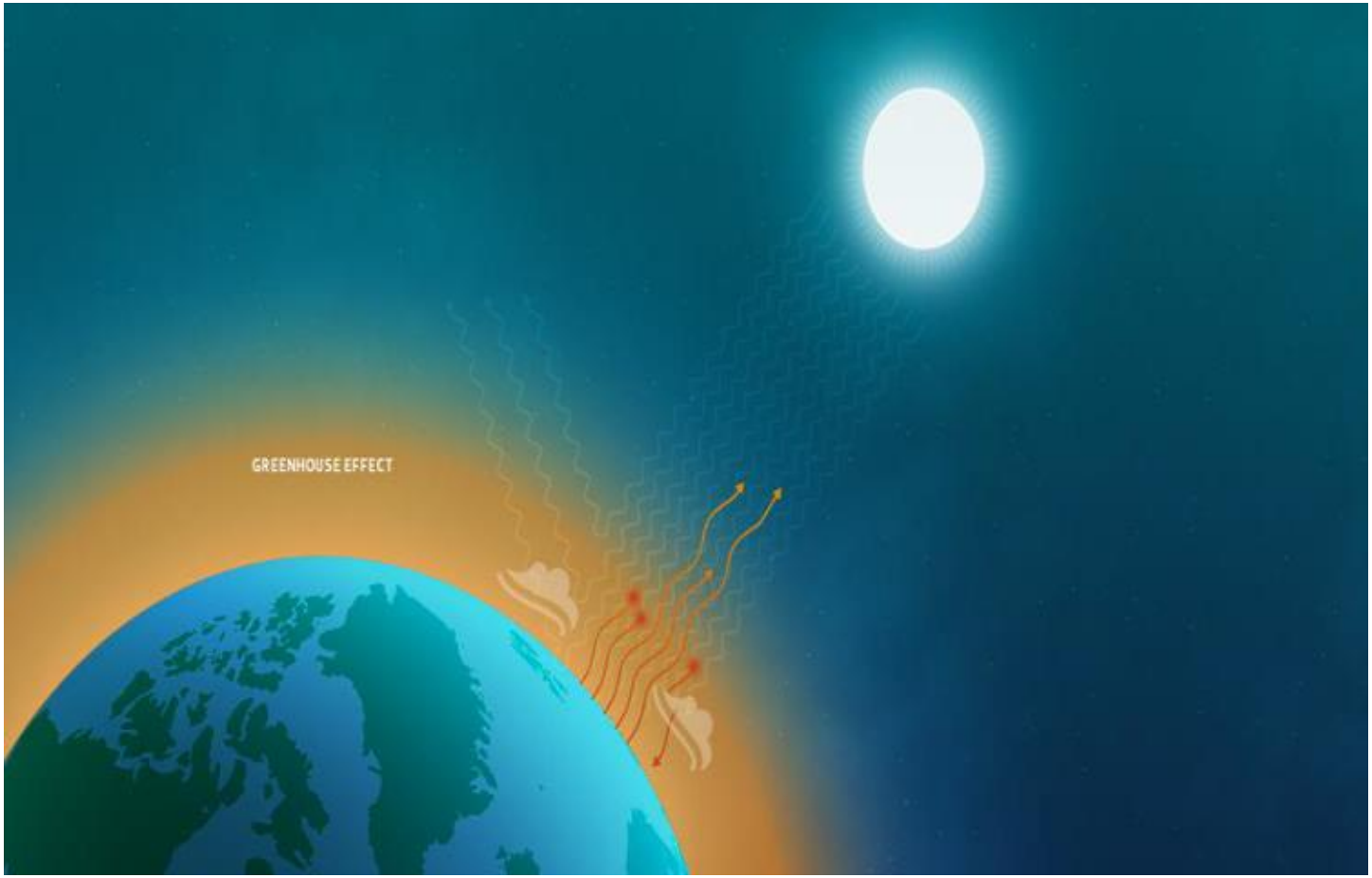
EPA

The Greenhouse Effect



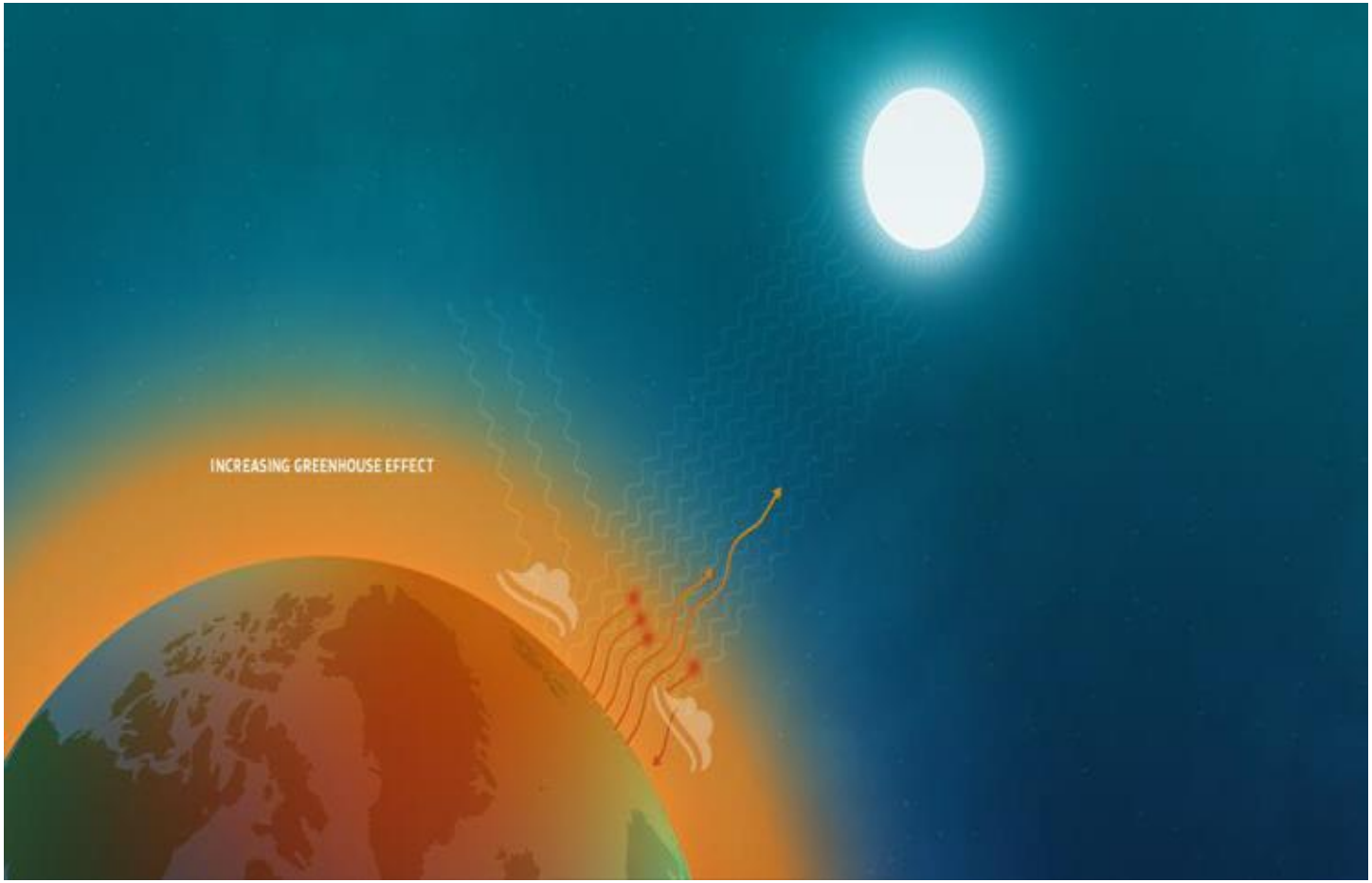
EPA

The Greenhouse Effect



EPA

The Greenhouse Effect



EPA

Which are the main GHGs?

- **Carbon Dioxide (CO2):** power, industry, transport
- **Methane (CH4):** agriculture, livestock, waste management
- **Nitrous Oxide (N2O):** agriculture, fertilizers
- **Hydrofluorocarbons (HFC)**
- **Perfluorocarbons (PFC)**
- **Sulfur hexafluoride (SF6)**

  refrigeration systems, air conditions, fire suppression systems

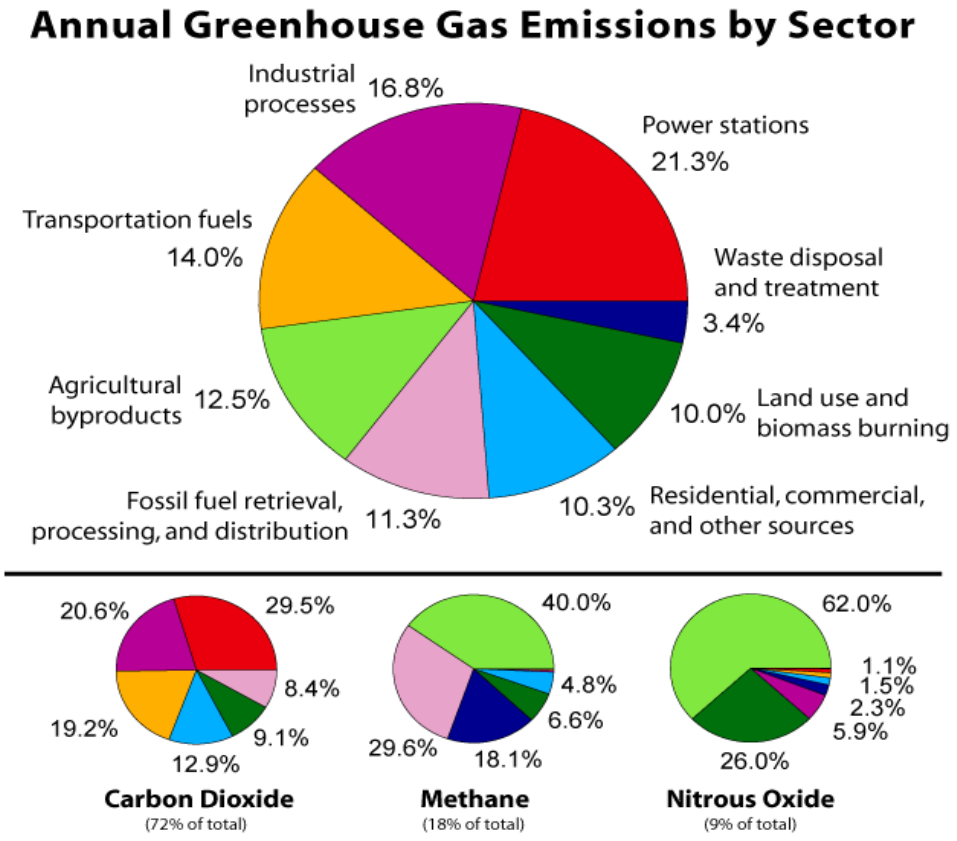
Human activities contributing to Climate Change

Land Use Changes

- Urbanisation (modification land surface)
- Deforestation (reduces the amount of carbon dioxide absorbed)

Fossil Fuel Burning

- Power stations
- Industry
- Transport
- Buildings
- Agriculture



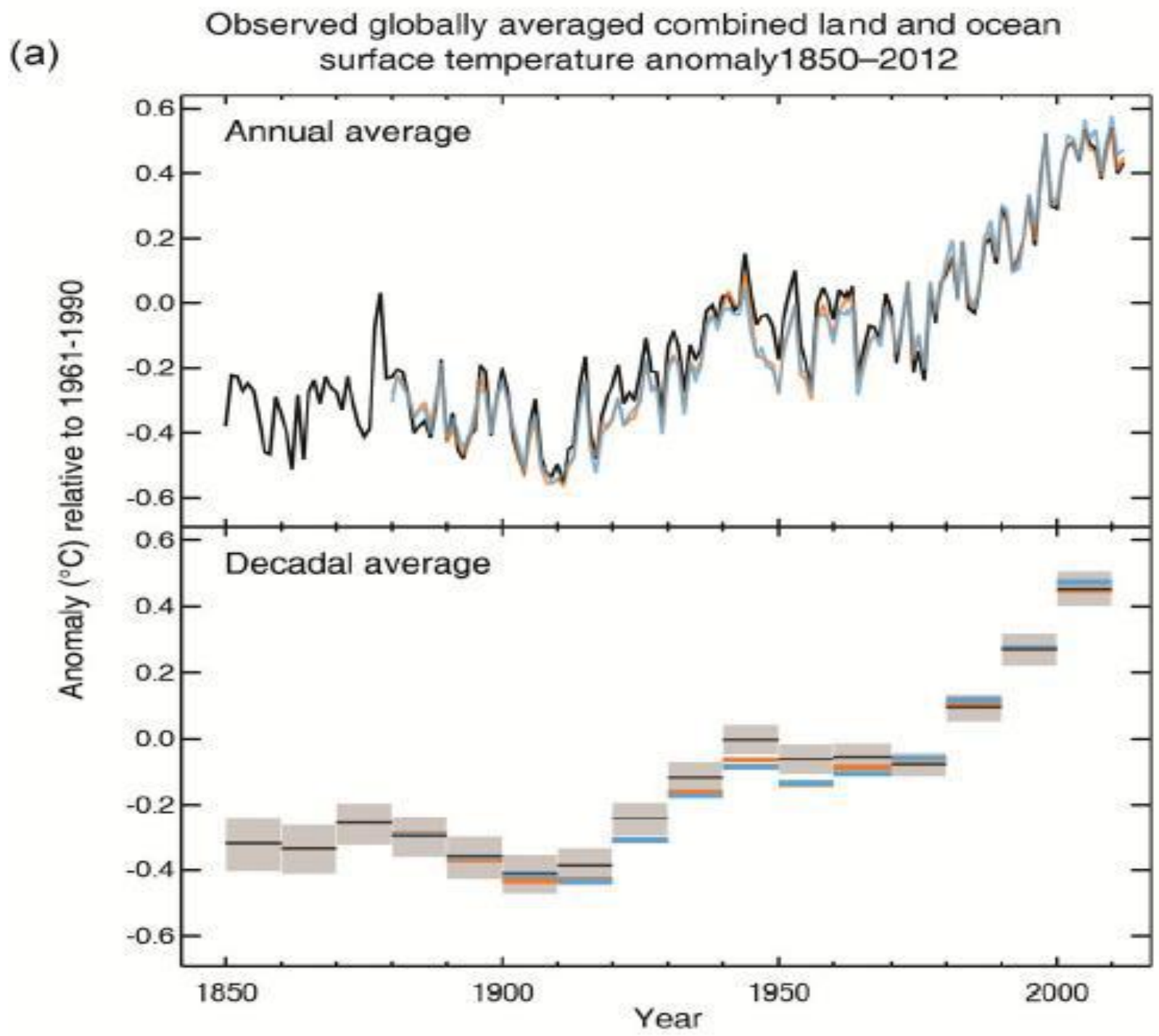
Climate Change **Effects** and **Impacts**

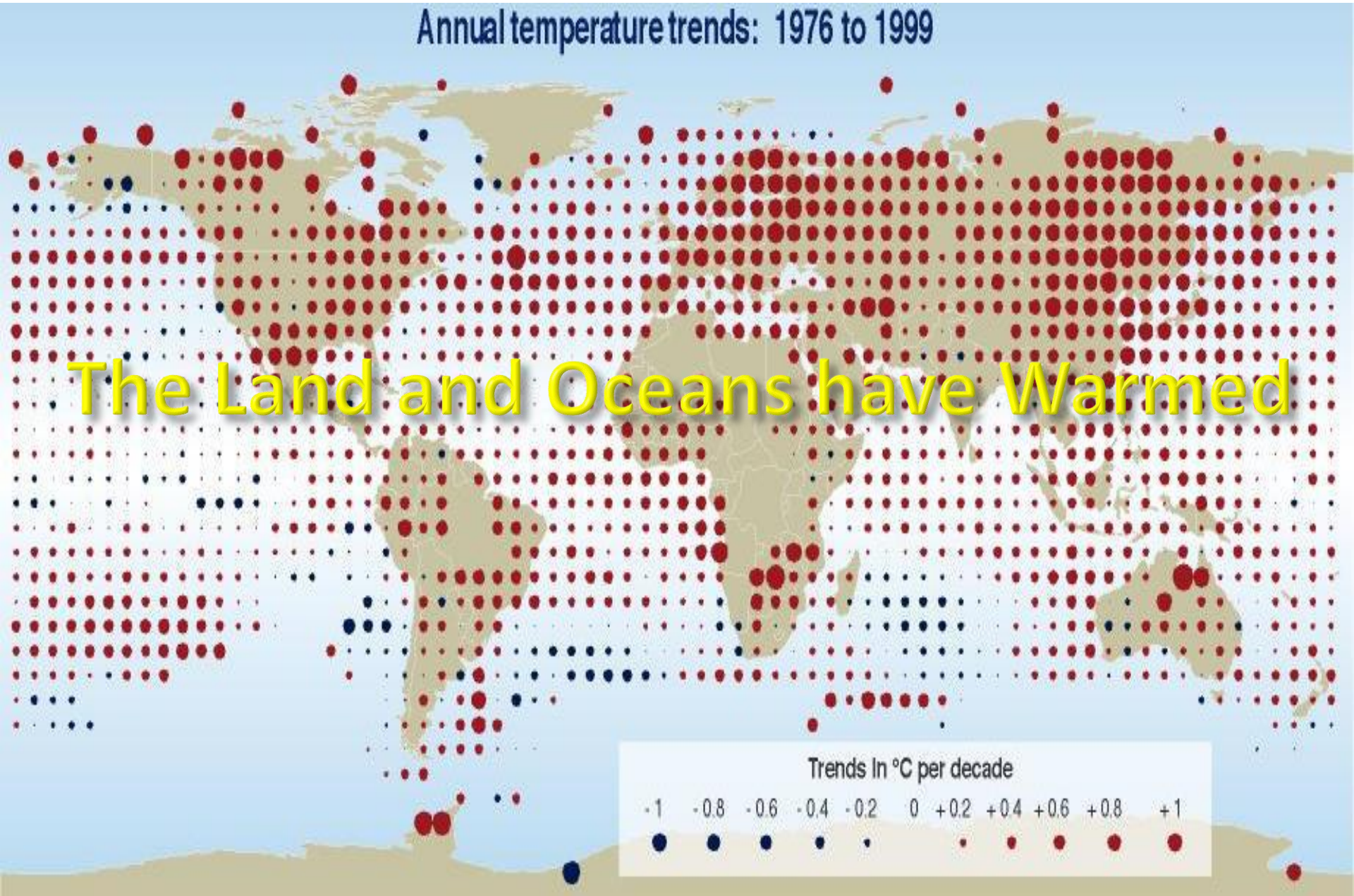
Changes in means

Temperature

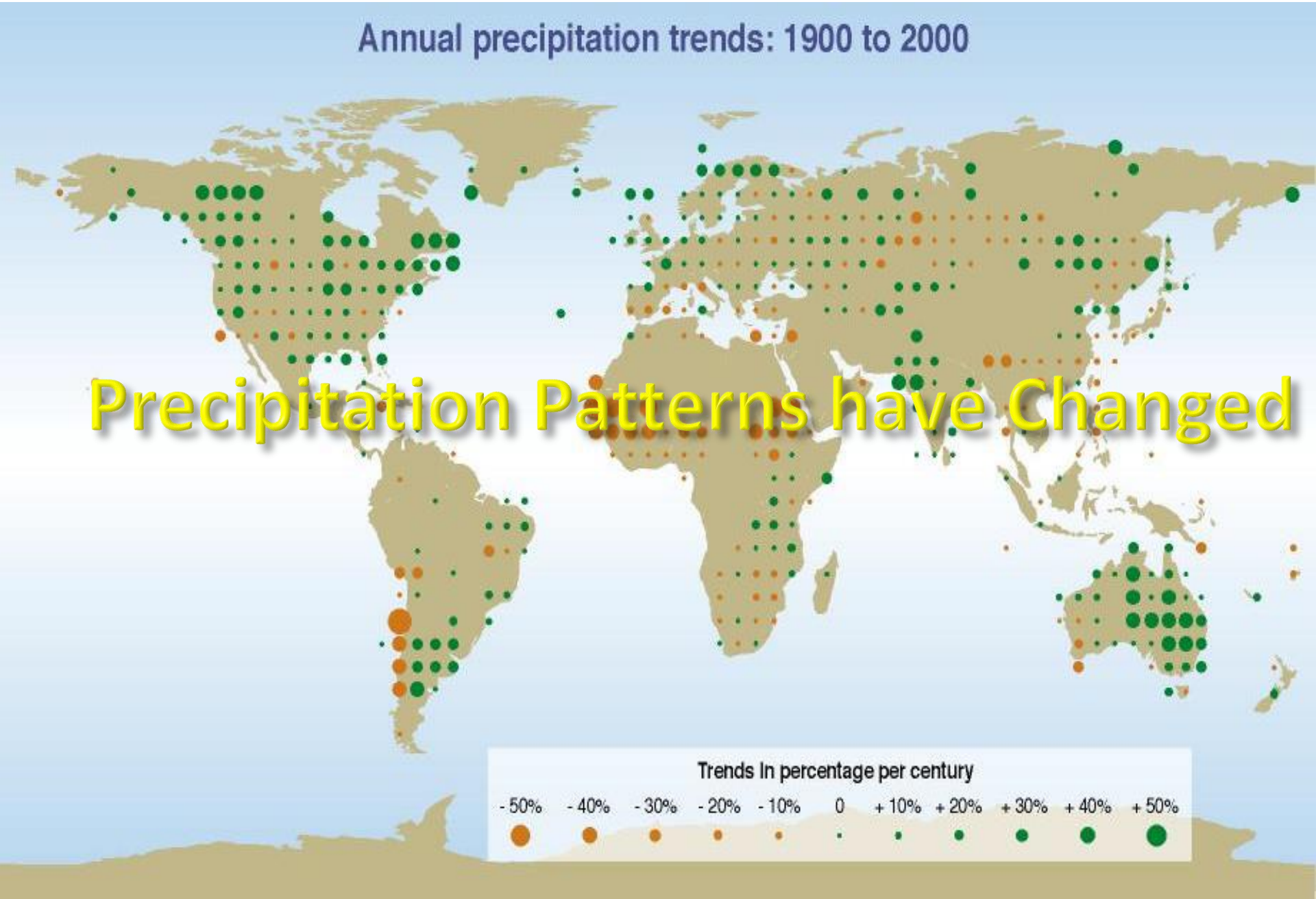
Rainfall

Sea level rise


(a)
Observed globally averaged combined land and ocean surface temperature anomaly1850–2012
Annual average
Decadal average
Anomaly (°C) relative to 1961-1990
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
1850
1900
1950
2000
Year



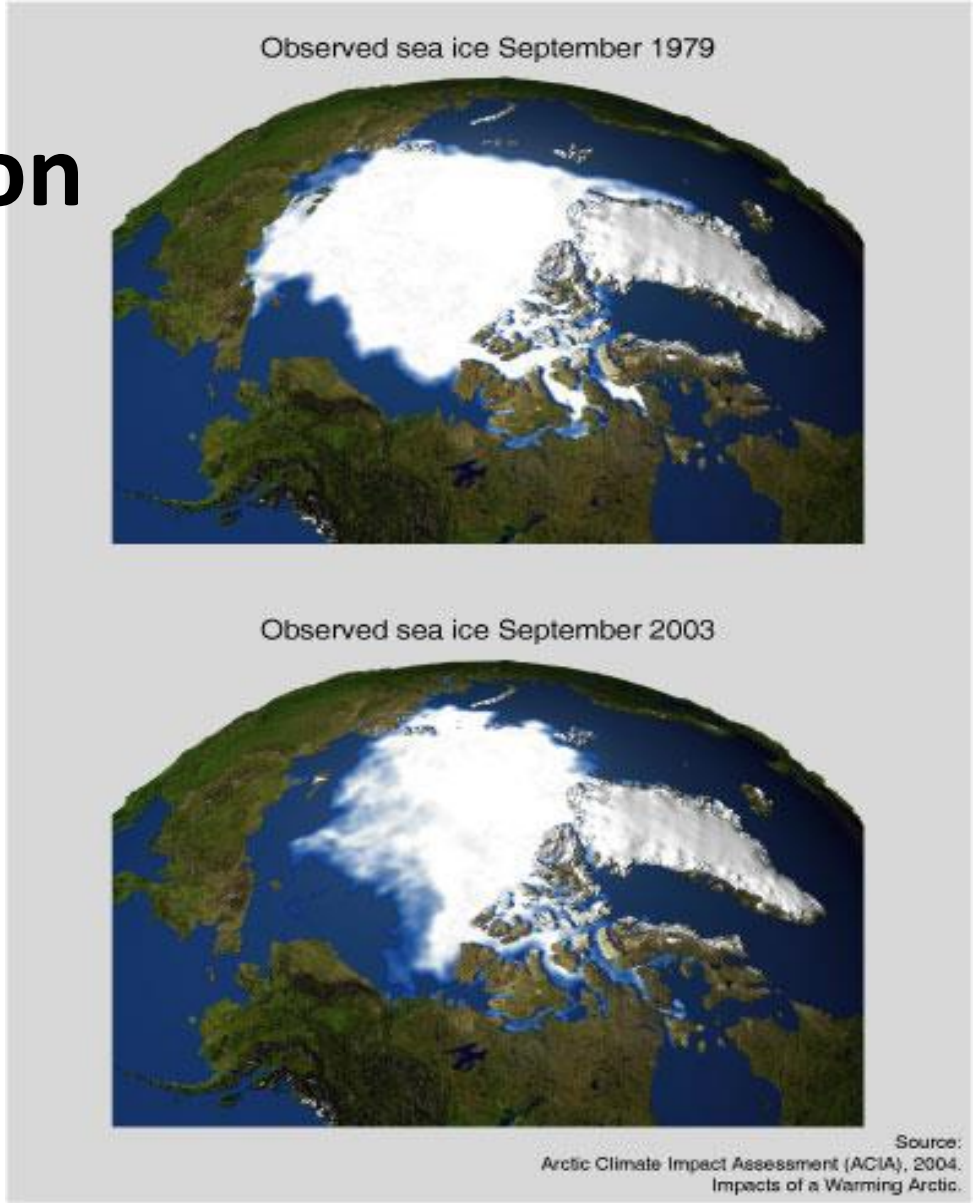
The Land and Oceans have Warmed

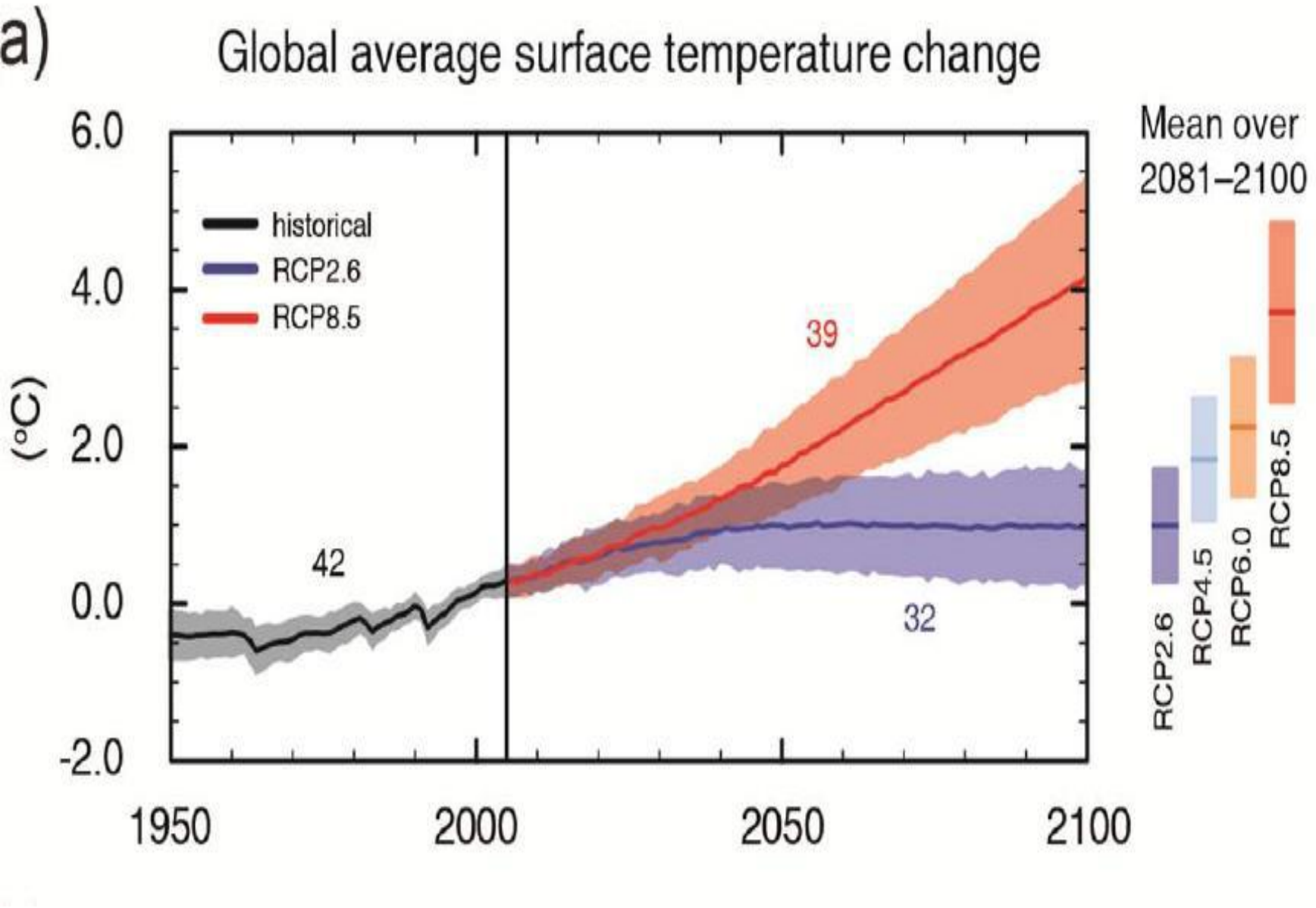

Annual precipitation trends: 1900 to 2000
Precipitation Patterns have Changed
Trends in percentage per century
- 50%
- 40%
- 30%
- 20%
- 10%
0
+ 10%
+ 20%
+ 30%
+ 40%
+ 50%

North Polar cap

25% reduction

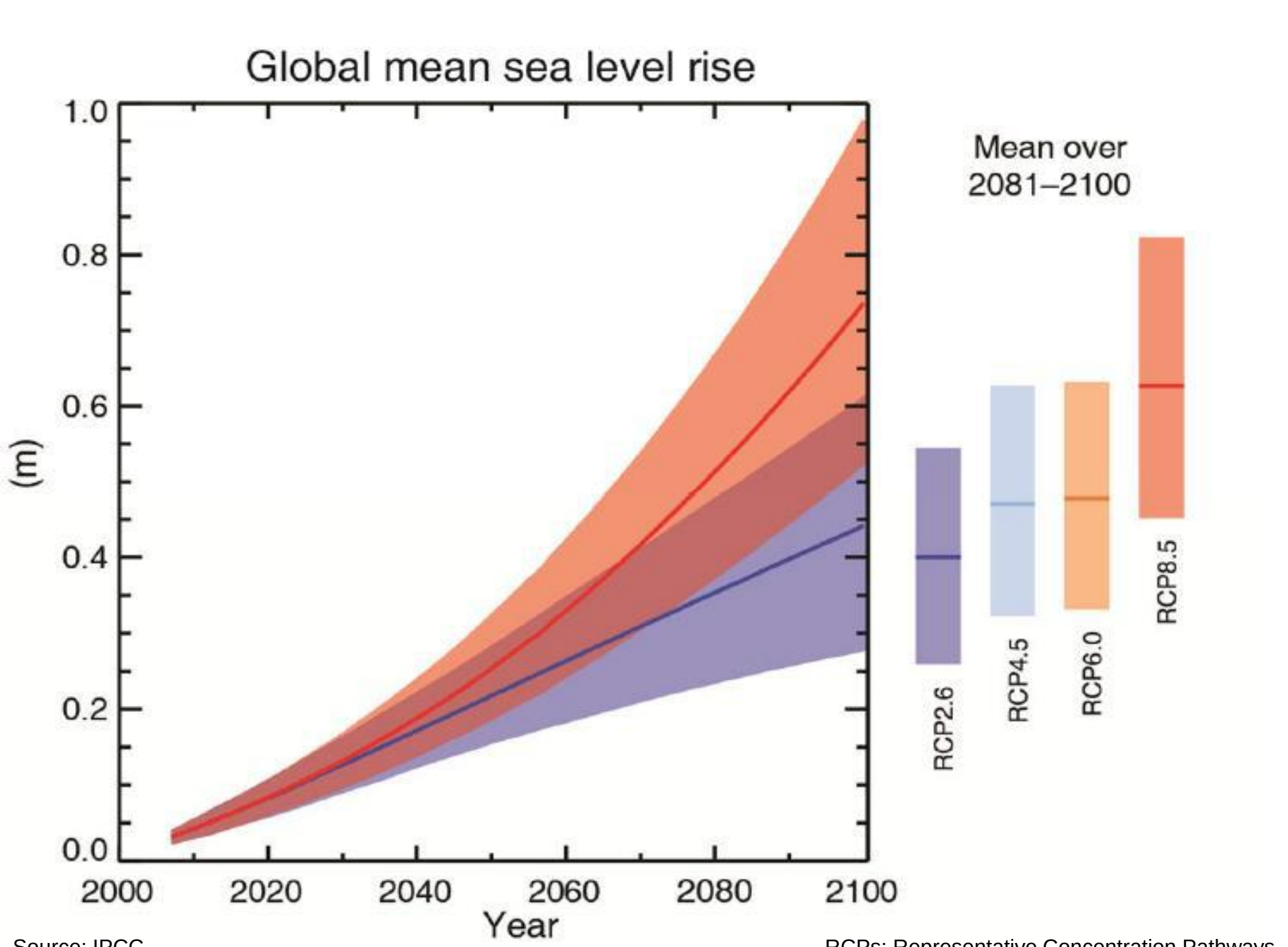
in **25** years





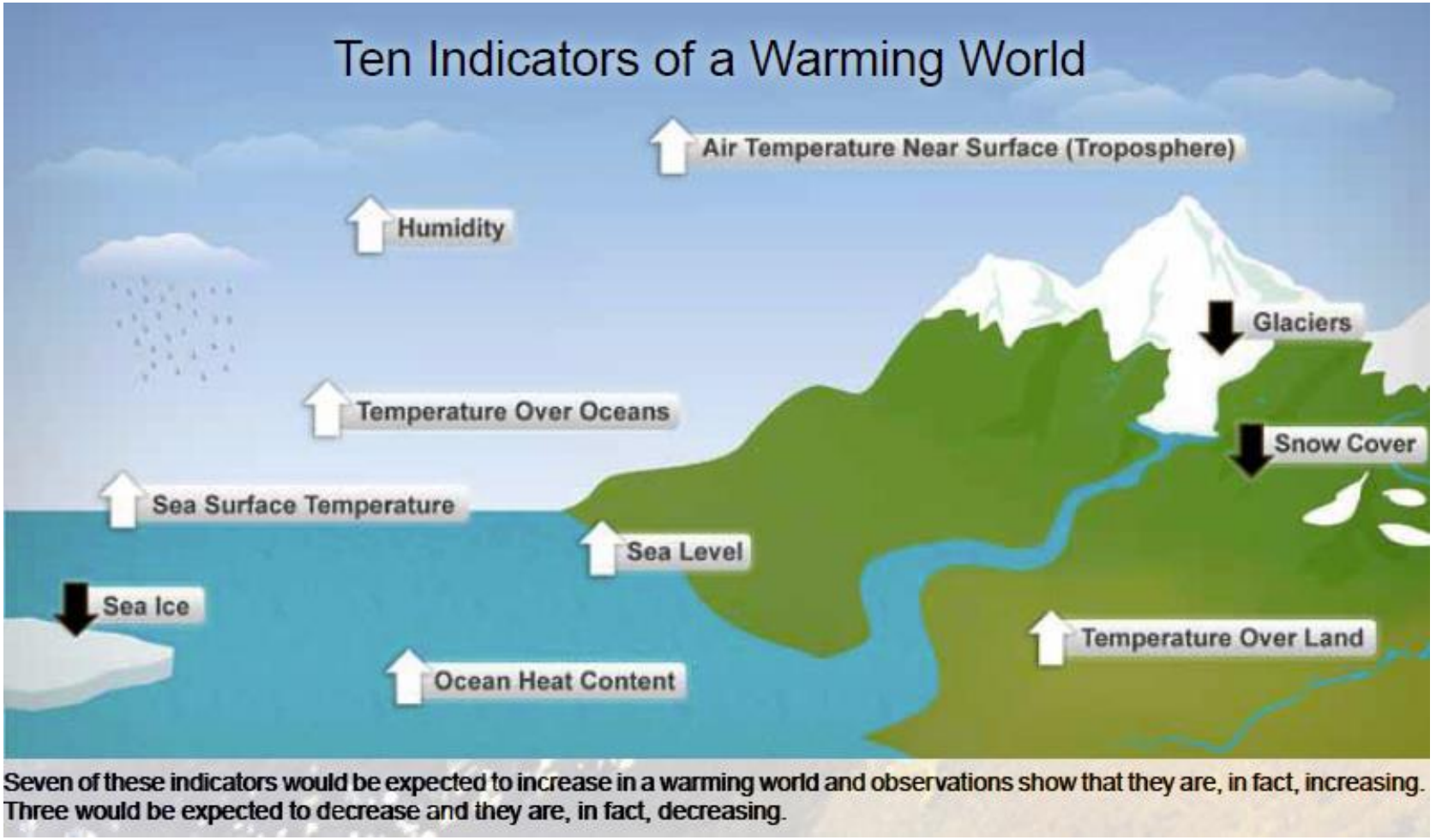
Source: IPCC

RCPs: Representative Concentration Pathways



Source: IPCC

RCPs: Representative Concentration Pathways



Source: NOAA

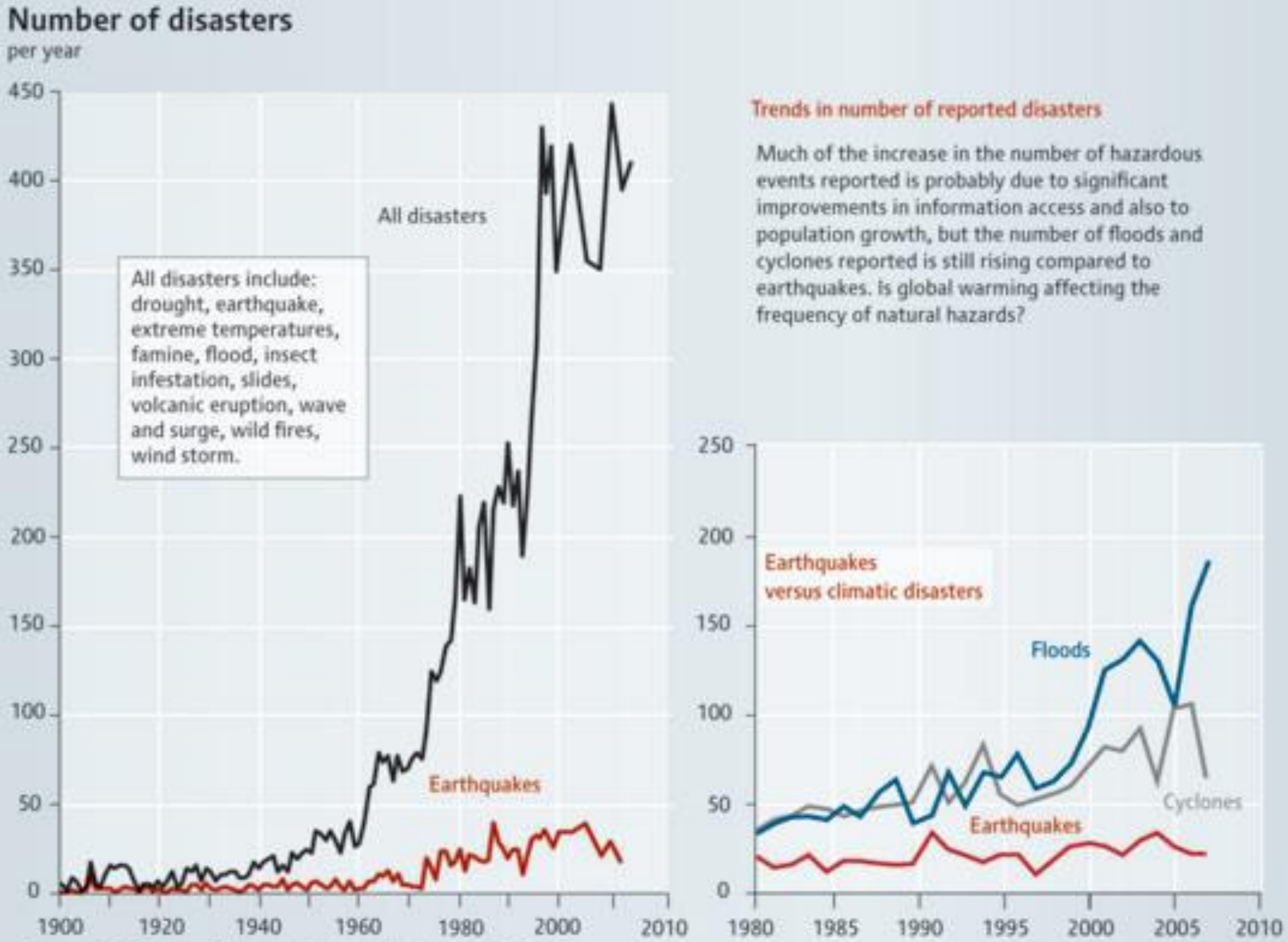
[A detailed description of this evidence can be found on the CLIMATE.NASA website]

Changes in extremes

Djibouti-Ville flooded in April 2004

Hurricanes, cyclones, typhoons

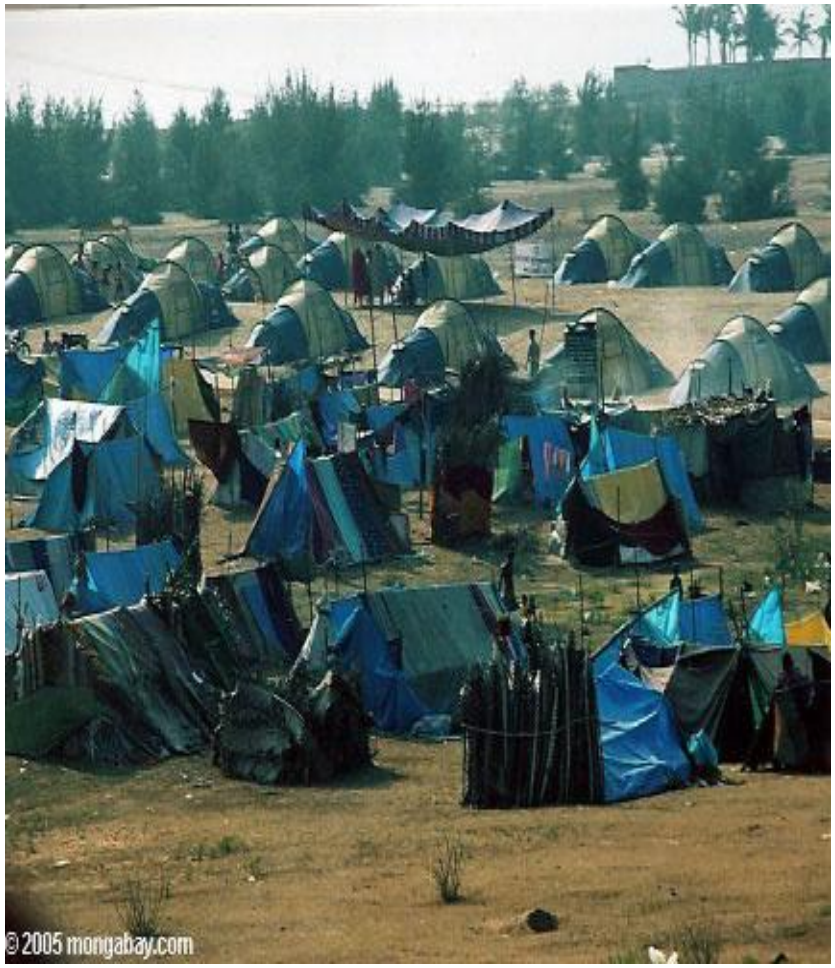

50


Number of disasters
per year
450
400
350
300
250
200
150
100
50
0
All disasters
All disasters include: drought, earthquake, extreme temperatures, famine, flood, insect infestation, slides, volcanic eruption, wave and surge, wild fires, wind storm.
Earthquakes
1900
1920
1940
1960
1980
2000
2010
Trends in number of reported disasters
Much of the increase in the number of hazardous events reported is probably due to significant improvements in information access and also to population growth, but the number of floods and cyclones reported is still rising compared to earthquakes. Is global warming affecting the frequency of natural hazards?
250
200
150
100
50
0
Earthquakes versus climatic disasters
Floods
Cyclones
Earthquakes
1980
1985
1990
1995
2000
2005
2010
Source: CRED Annual Disaster Statistical Review 2006, 2007.

IMPACTS of Climate Change

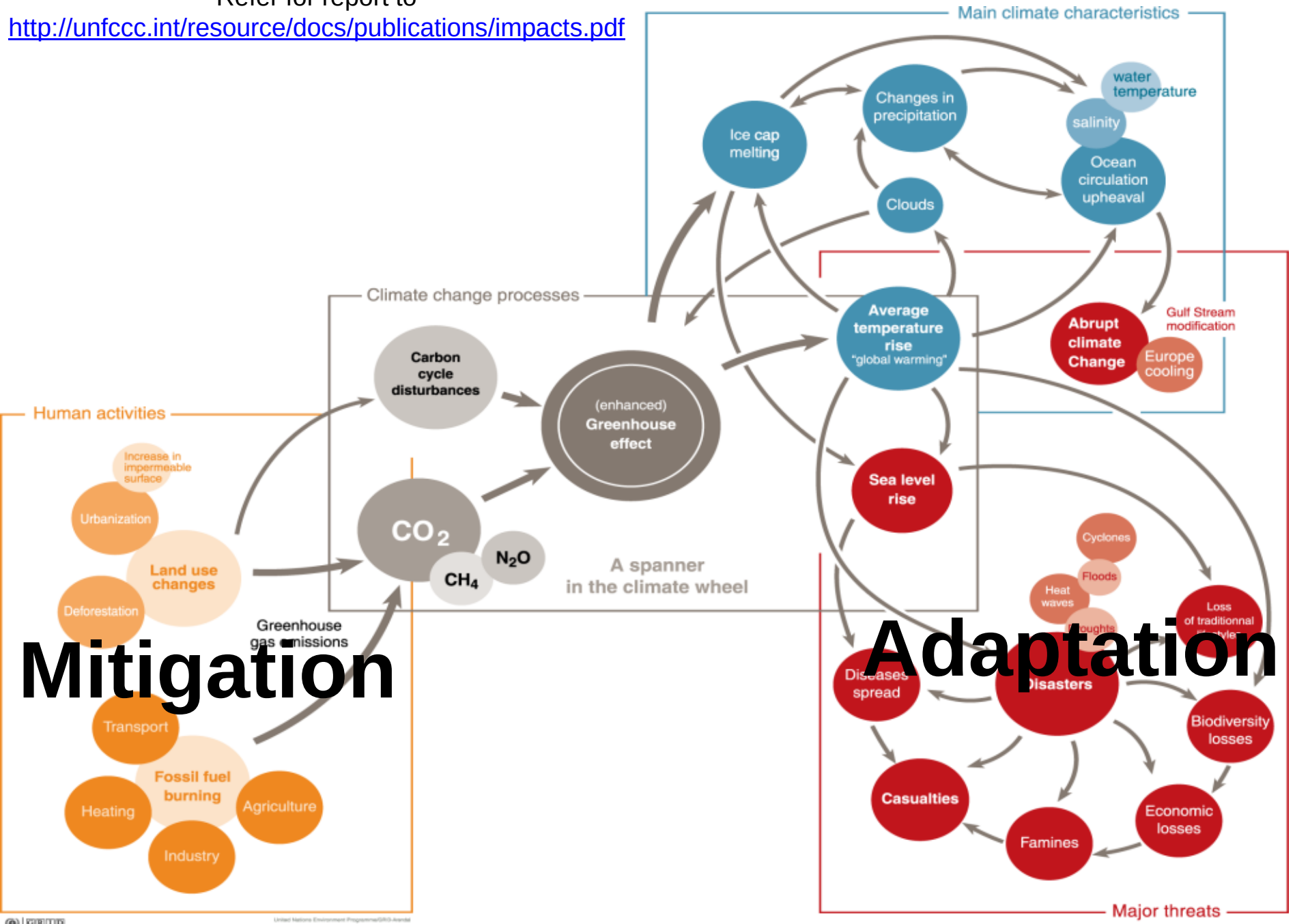
- Casualties
- Famines
- Economic losses
- Diseases
- Infrastructure damages
- Biodiversity loss
- Increased “heat island effect”
- Water scarcity
- Loss of traditional lifestyles

Indirect IMPACTS of Climate Change



- Environmental refugees
- Accelerated urbanization
- Epidemics, worsening public health
- High energy demand for cooling

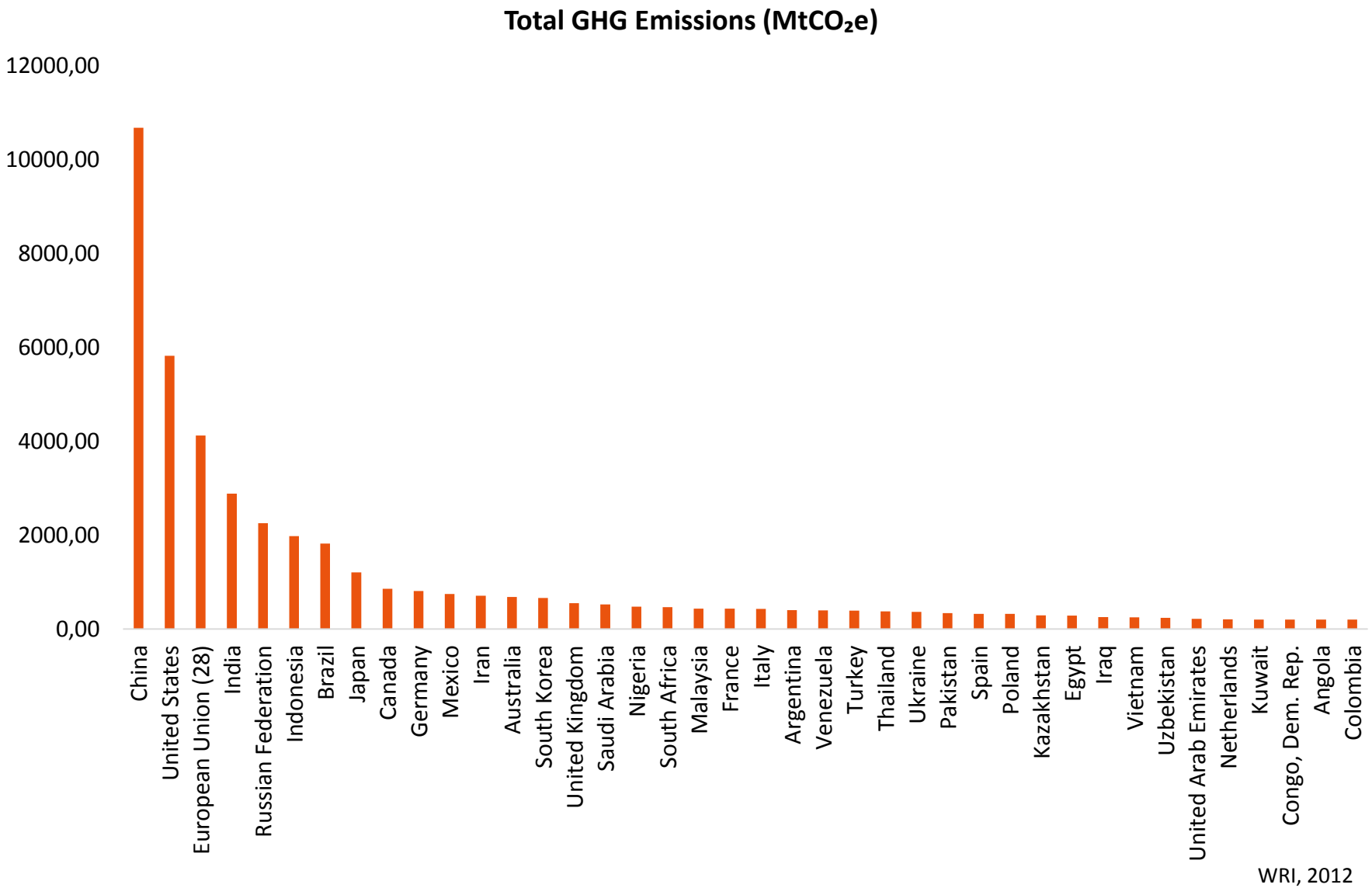
Source: UNEP / GRID-Arendal, 2007
Refer for report to
http://unfccc.int/resource/docs/publications/impacts.pdf



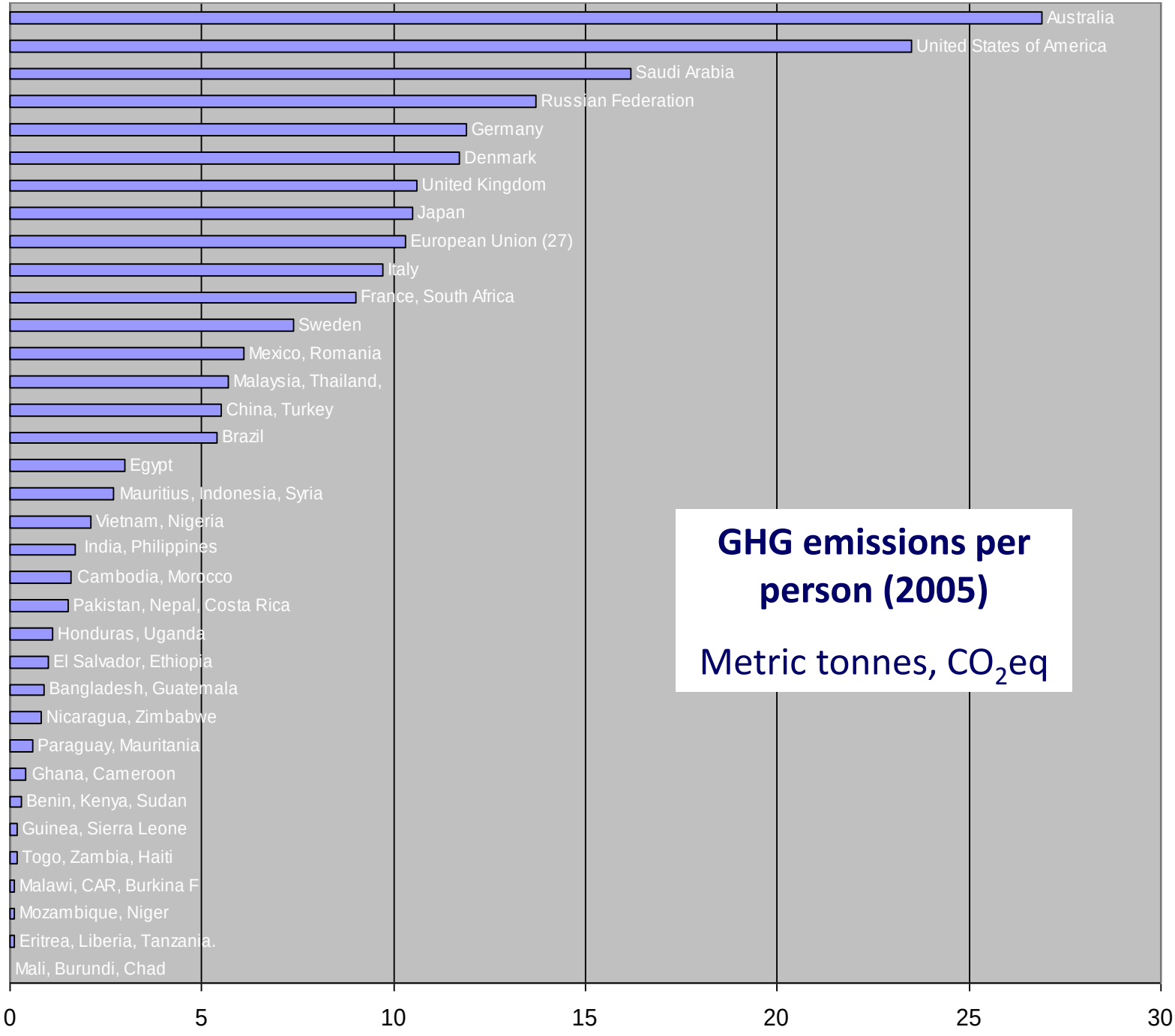
What is driving climate change?

How are humans and cities drive climate change?

Country GHG emissions

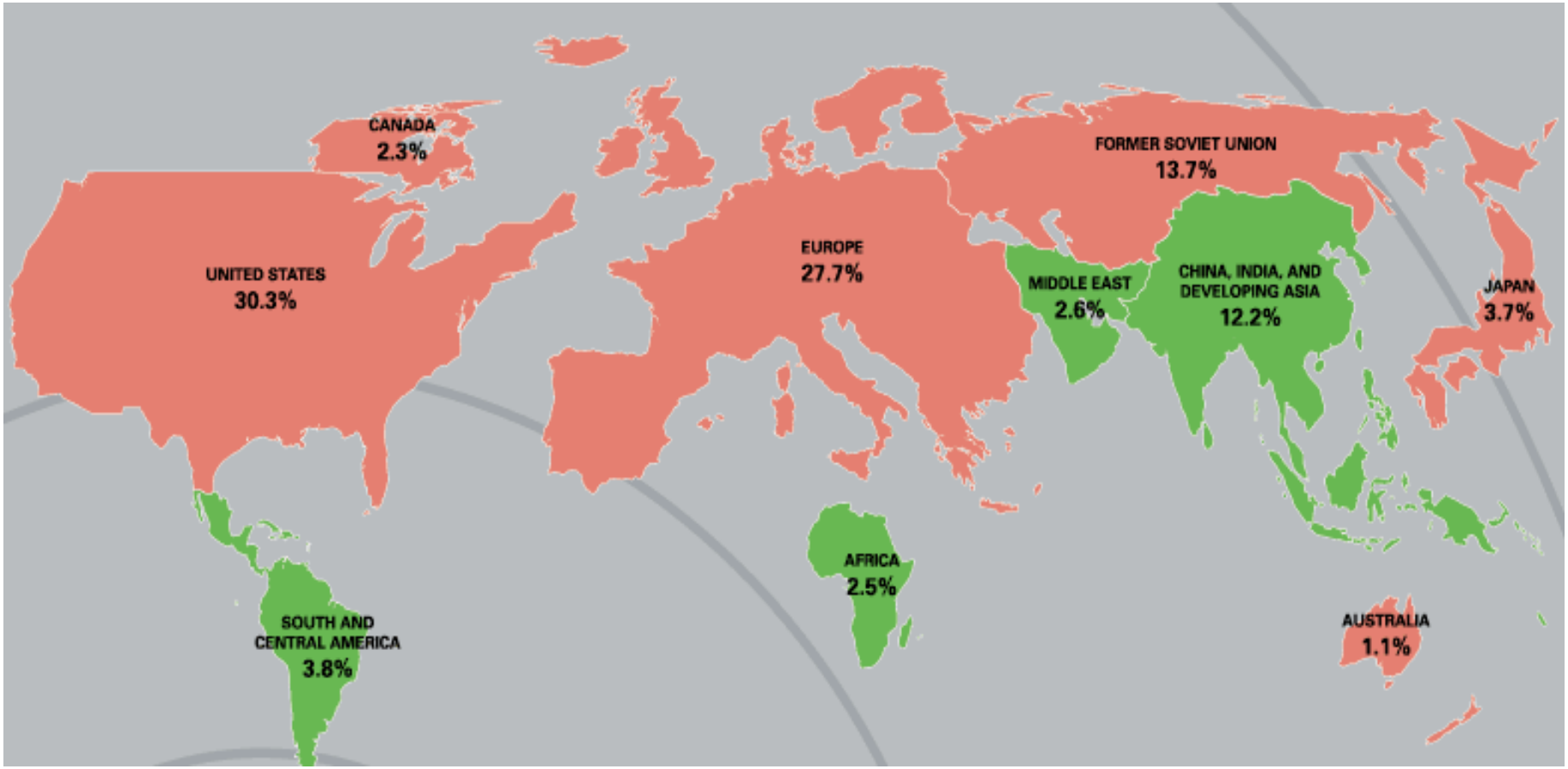


WRI, 2012


Australia
United States of America
Saudi Arabia
Russian Federation
Germany
Denmark
United Kingdom
Japan
European Union (27)
Italy
France, South Africa
Sweden
Mexico, Romania
Malaysia, Thailand,
China, Turkey
Brazil
Egypt
Mauritius, Indonesia, Syria
Vietnam, Nigeria
India, Philippines
Cambodia, Morocco
Pakistan, Nepal, Costa Rica
Honduras, Uganda
El Salvador, Ethiopia
Bangladesh, Guatemala
Nicaragua, Zimbabwe
Paraguay, Mauritania
Ghana, Cameroon
Benin, Kenya, Sudan
Guinea, Sierra Leone
Togo, Zambia, Haiti
Malawi, CAR, Burkina F
Mozambique, Niger
Eritrea, Liberia, Tanzania.
Mali, Burundi, Chad
0
5
10
15
20
25
30
GHG emissions per person (2005)
Metric tonnes, CO_2eq

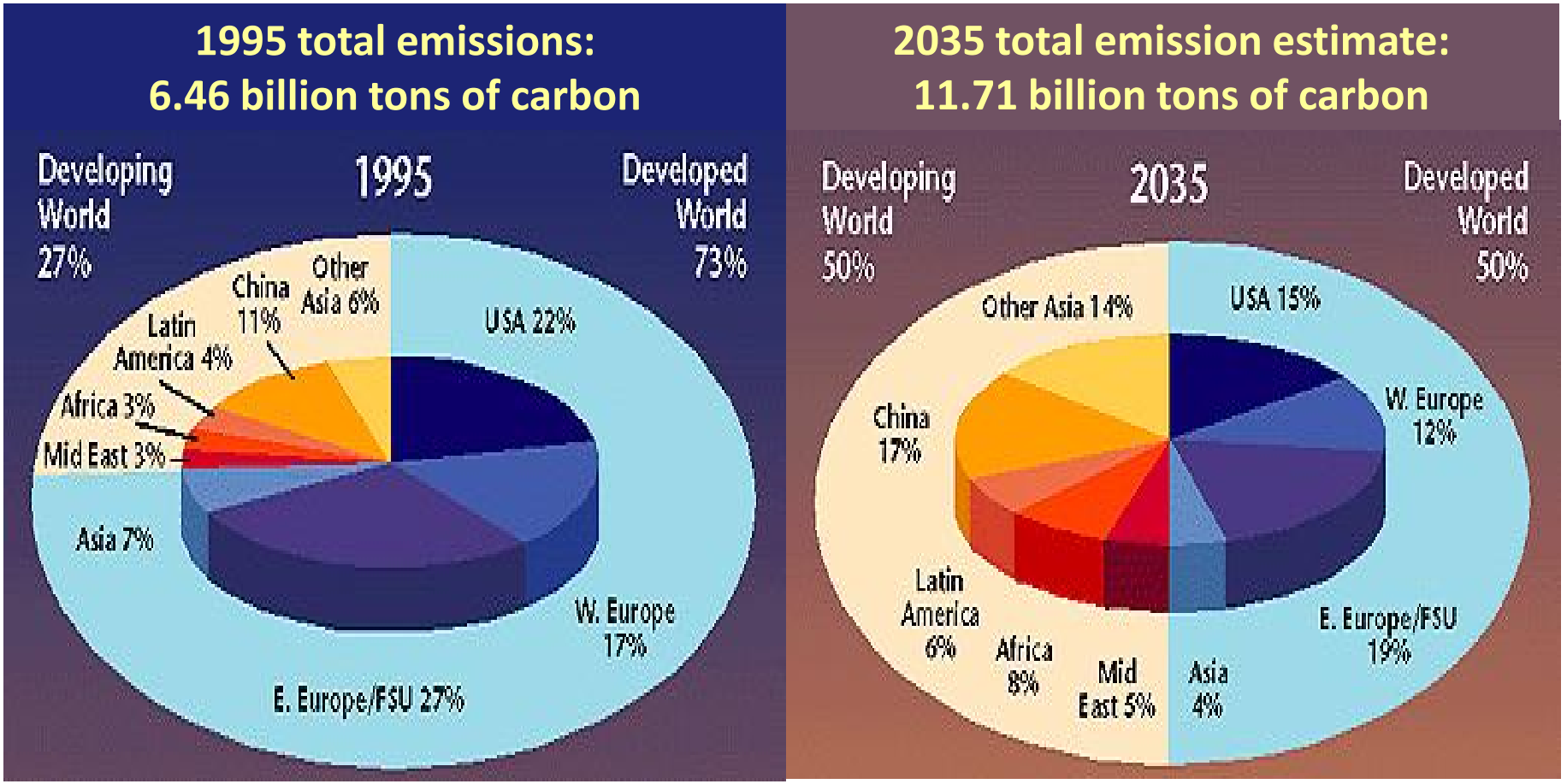
Industrialized countries have emitted the most anthropogenic CO2

(Area proportional to historical CO2 emissions from fossil fuel combustion, 1900-1999)



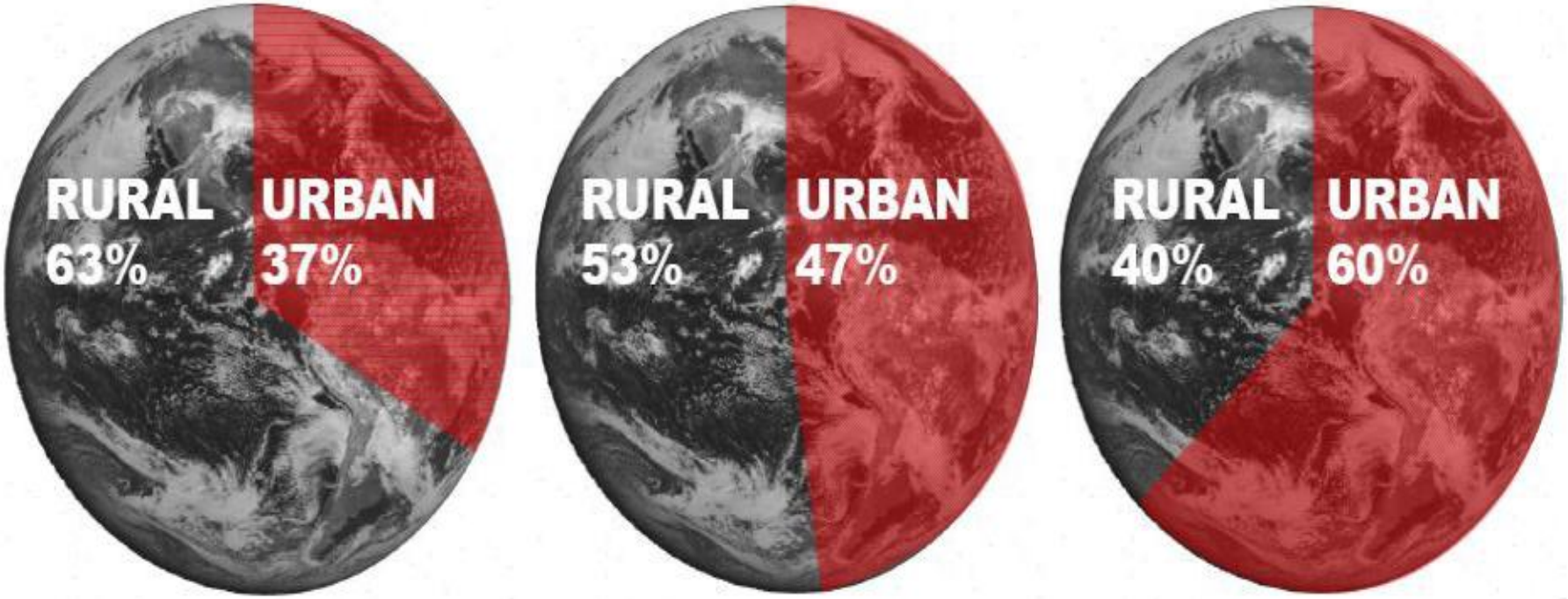
Source: WRI

Share of global GHG emissions



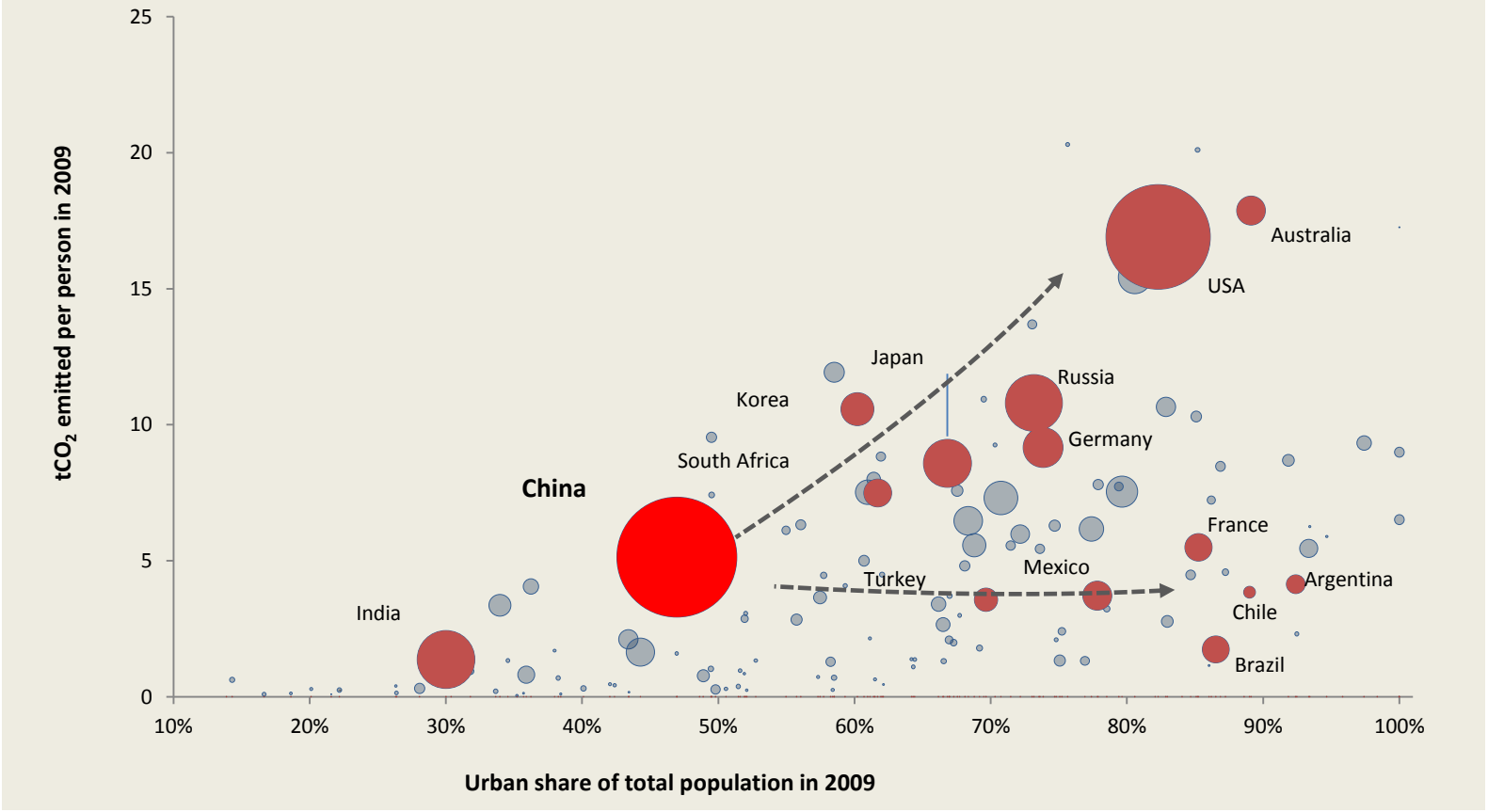
Source: OSTP

Global Population:
Rural / Urban



1970 2000 2030

Key question - Which way will Chinese / Indian cities go?



Note: Bubble size corresponds to total carbon dioxide emissions (kilotons).

Source: World Development Indicators

Cities cover about 2% of the earth's surface but are disproportionately responsible for causing climate change

70%

Source: UN Habitat, 2011

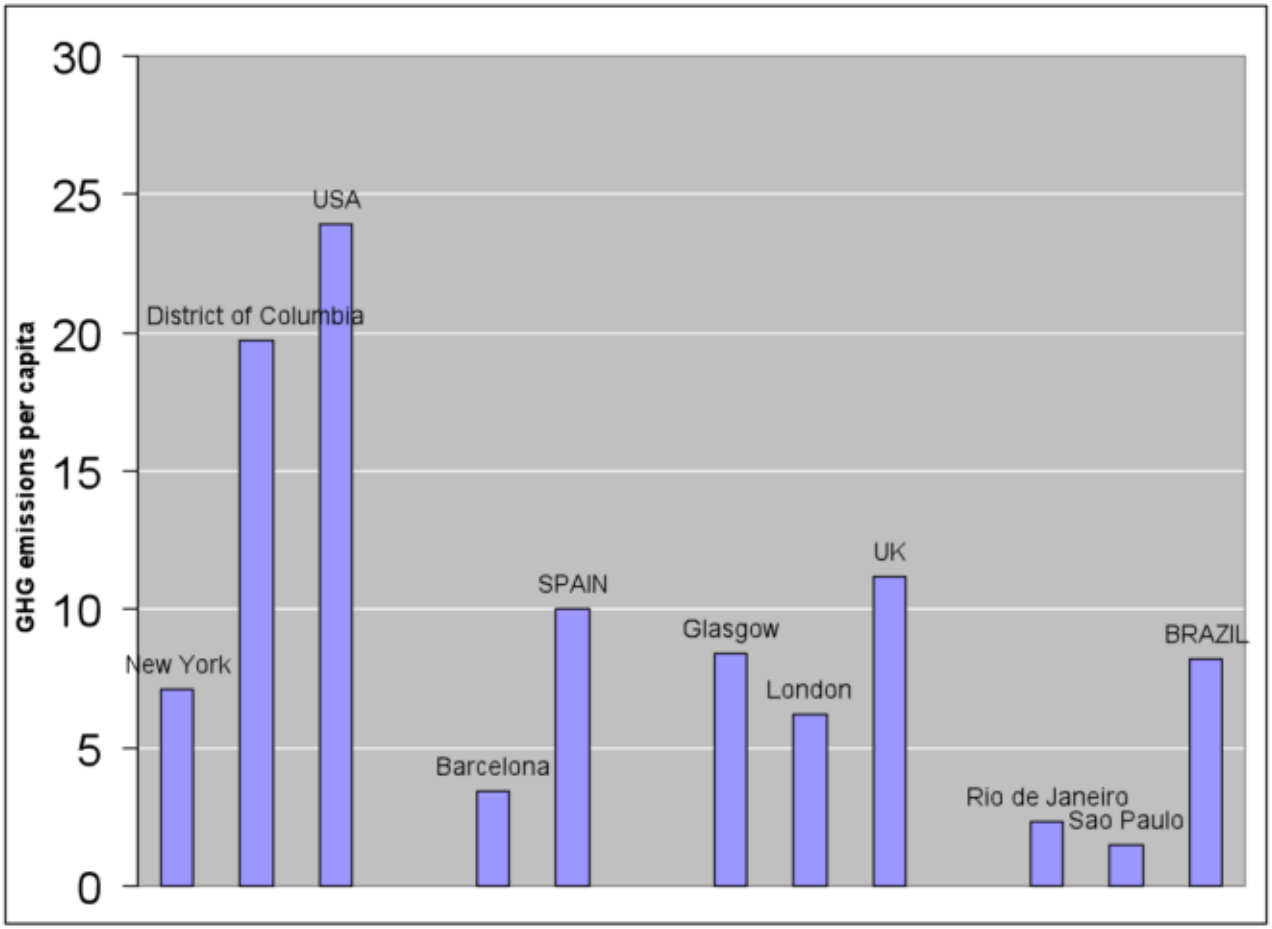
Cities produce surprisingly low carbon emissions per capita

30%

Greenhouse gas emissions of city dwellers are often far **smaller than the national averages** (Dodman, 2009)

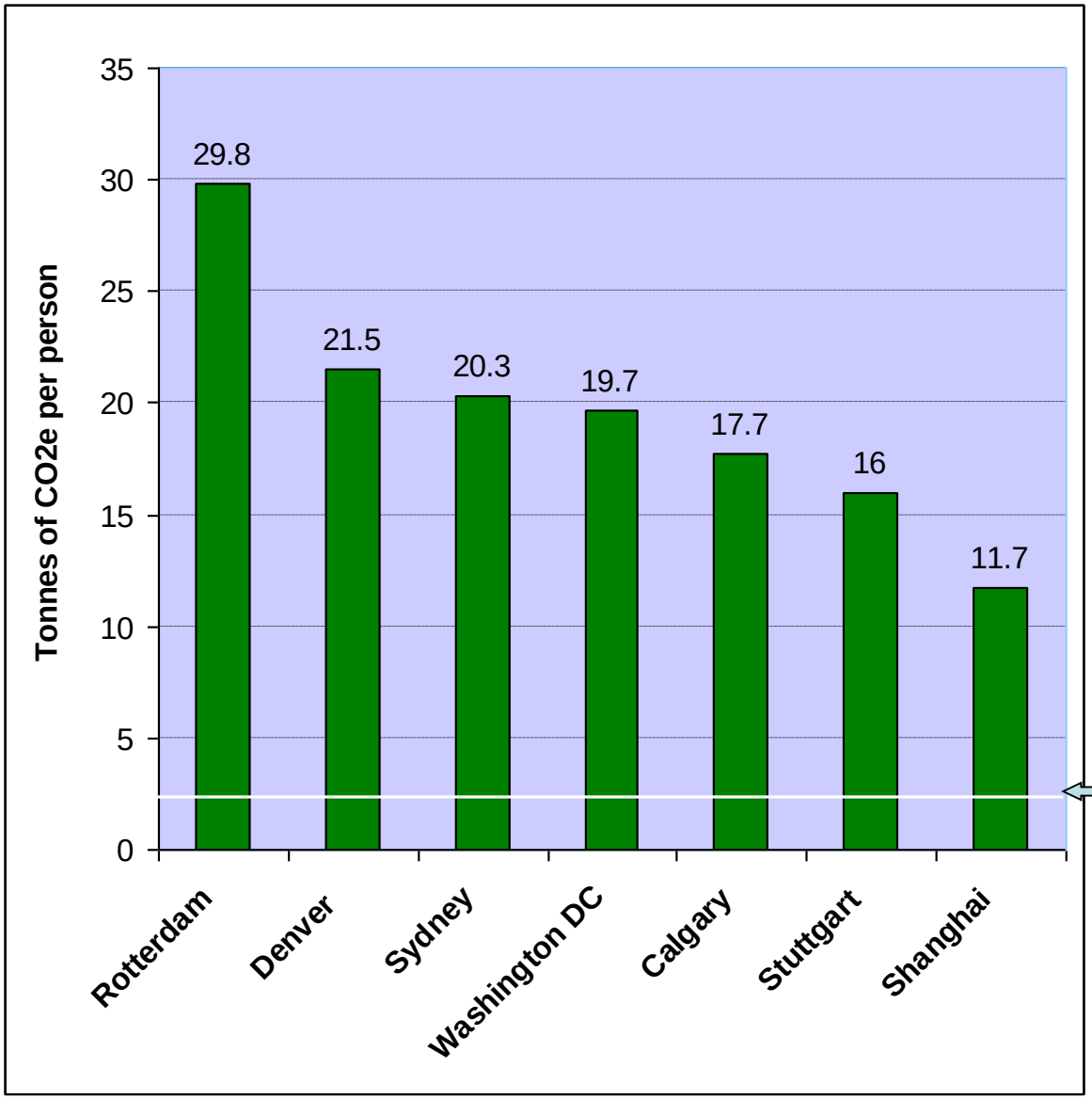
Per person GHG emissions: Cities vs Nations

Figure 1: Comparing cities and their nations for greenhouse gas emissions per person



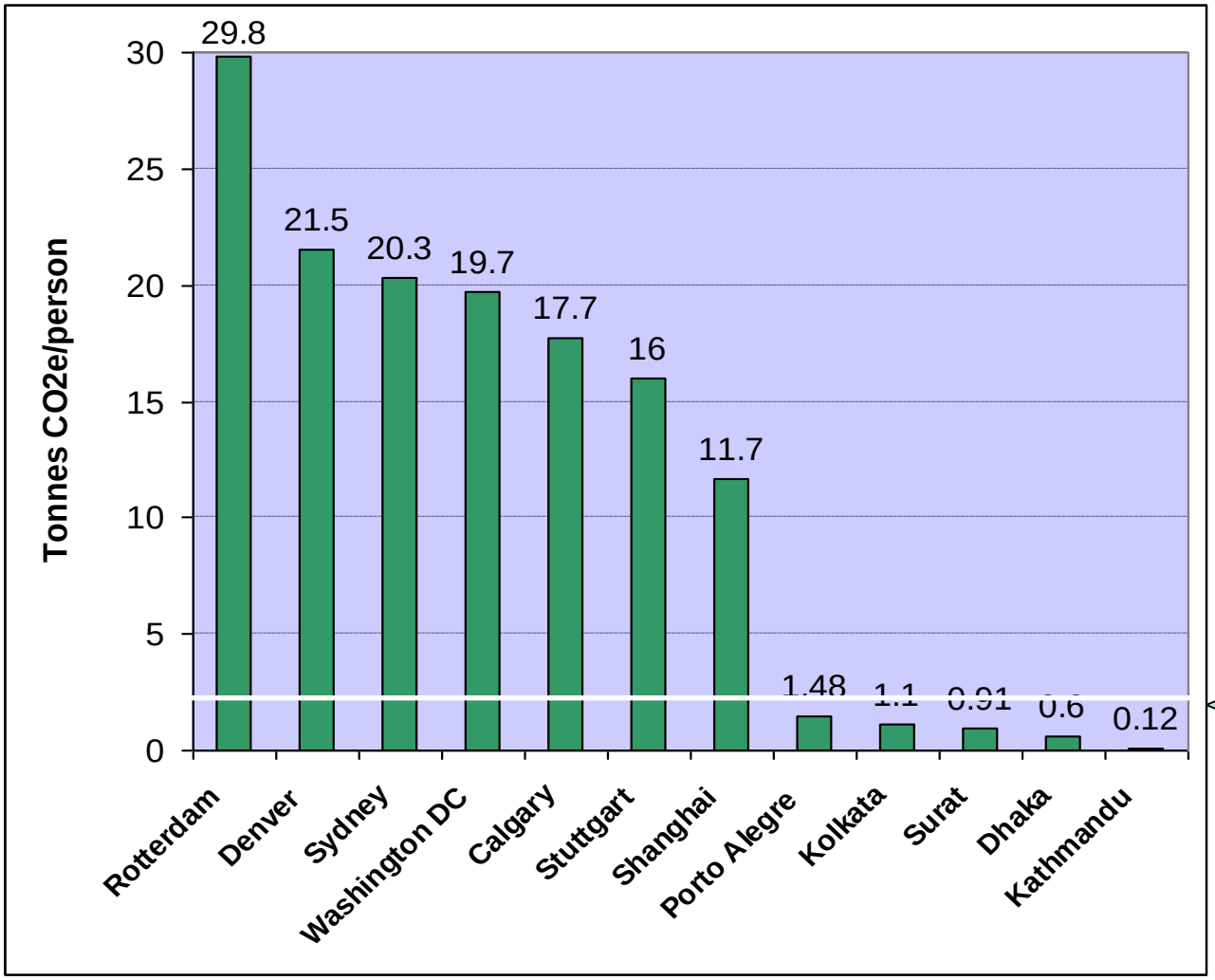
Source: Dodman 2009. NB Care should be taken in comparing figures for the cities in different nations, due to differences in methodologies for counting and assigning greenhouse gas emissions.

GHG emissions/person/year



Source:
Dodman, 2011

GHG emissions/person/year



‘Fair-share’ global average

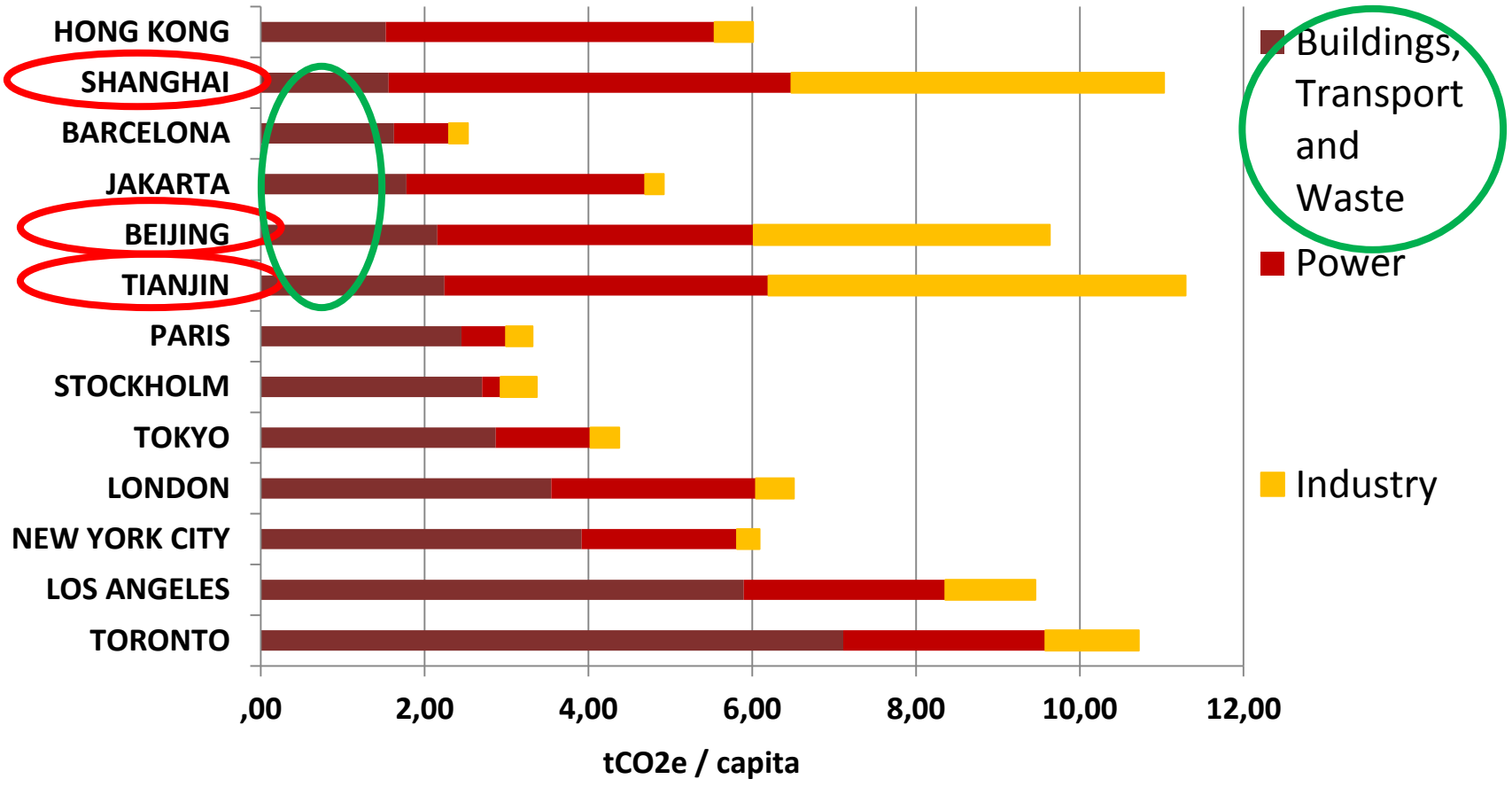
Source: Dodman, 2011

Which are the main drivers of GHG emissions in cities?

- Economic basis (balance of manufacturing / service industries)
- Individual consumption lifestyles
- Urban form and density
- Carbon intensity
- Energy use pattern related to weather conditions

Economic basis

tCO2e/capita for selected cities



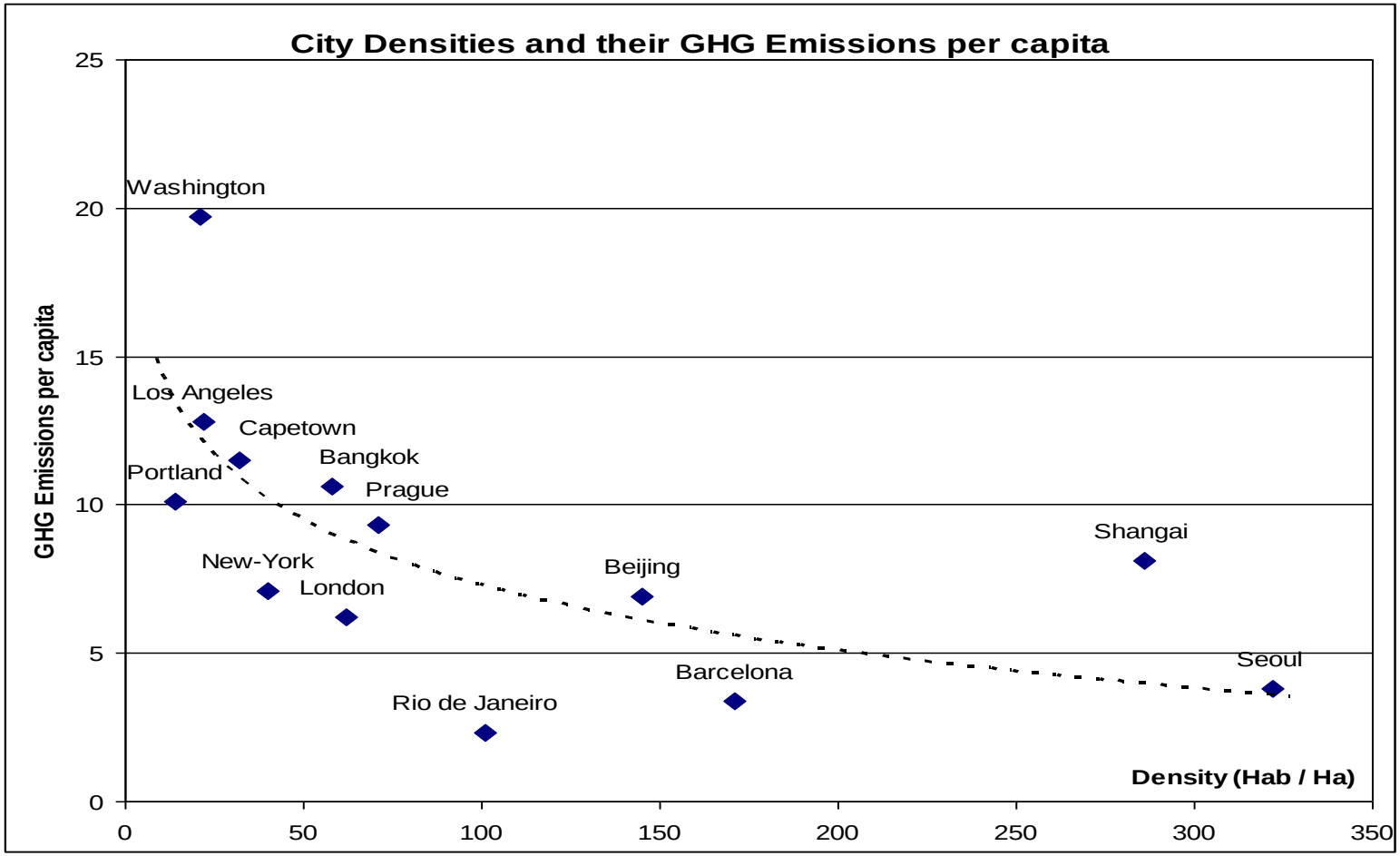
Consumption vs production based approaches

- **Production vs Consumption based figures**
  - Production – location where GHGs are emitted
  - Consumption – GHGs allocated to individuals based on GHG emission implications of the goods & services they use

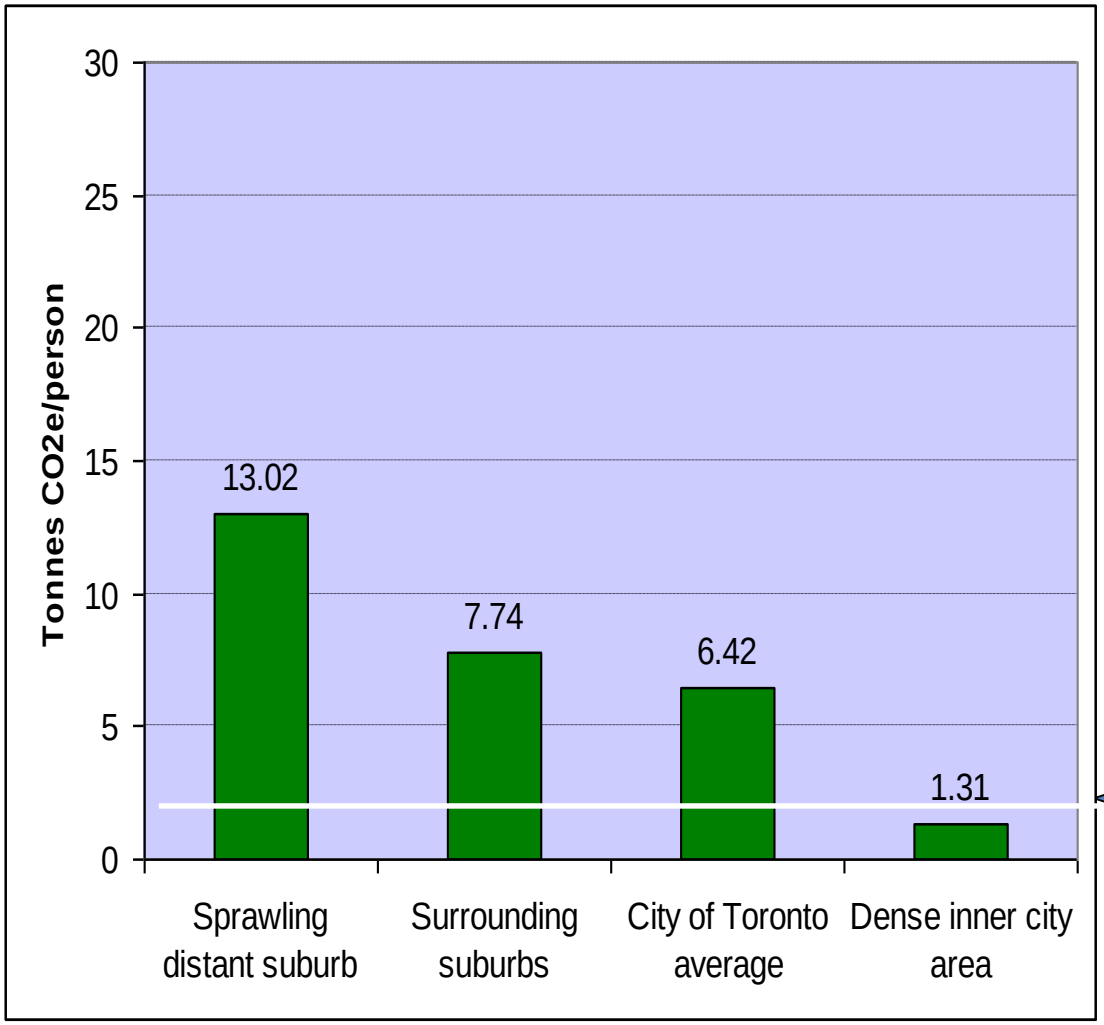
- **Consumption-based GHG allocations change figures**
  - Shanghai down; London up to 12 tonnes CO_2e/person (15%)
  - Setting cap on the half billion largest emitters
  - Giving space for those who are poor & have very low consumption to meet their needs

Urban form and density

Densities matter when it comes to avoiding high-carbon growth patterns



GHG emissions/person/year, Toronto



(Source: Van de Weghe and Kennedy, 2007)

Land-Use and CO_2

Suburban
8 DU/acre
0.25 FAR

Urban
40 DU/acre
2.5 FAR

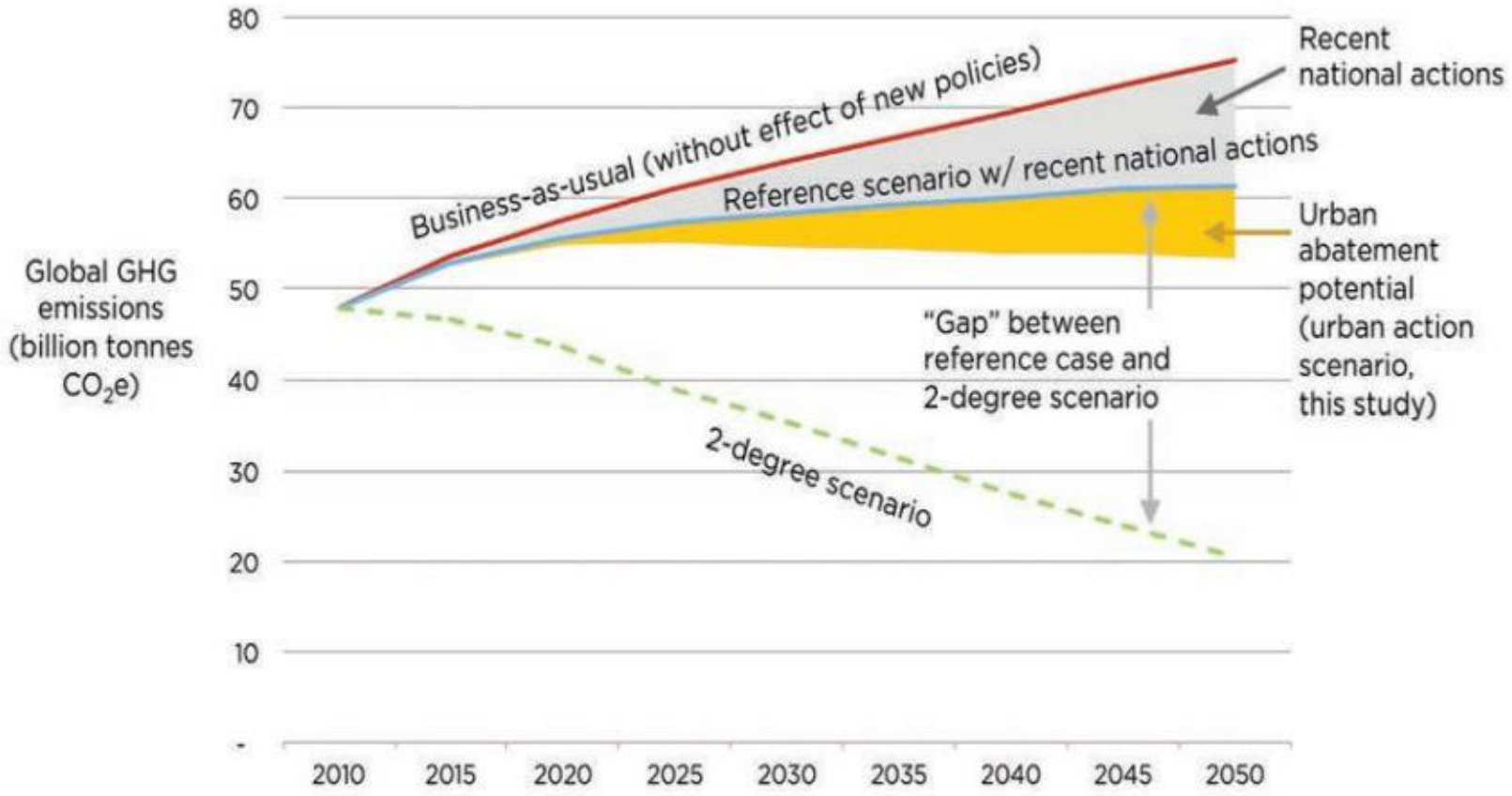
CO_2 Lbs/Yr/Household		
Buildings	25,000	10,000
Transportation	24,000	9,000
Total	49,000	19,000

Source: Eliot Allen, “Cool Spots”

Low carbon cities and quality of life

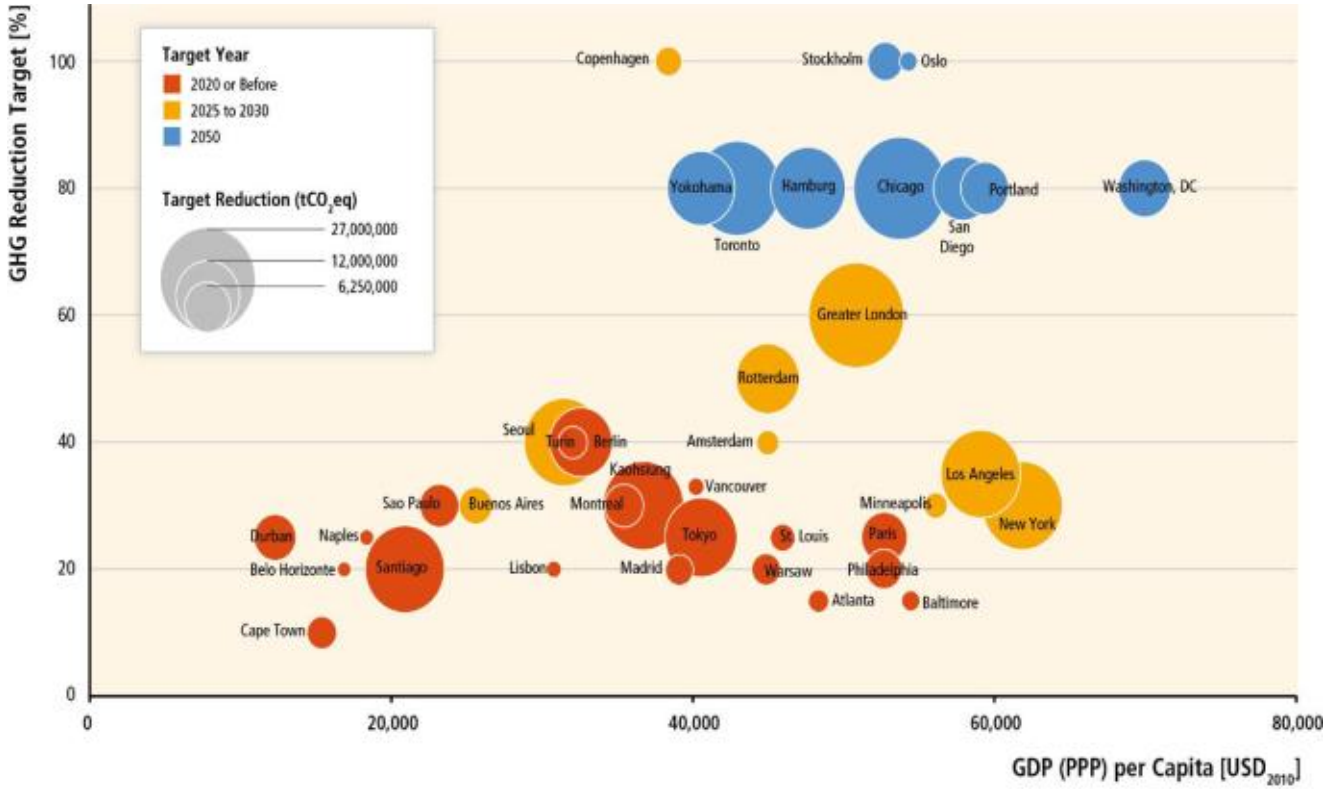
- Places where a very **high quality of life** is possible without high GHGs
- Some evidence
  - **Porto Alegre & Sao Paulo**; the low-energy using residential areas in Toronto
  - **Oslo, Stockholm** below 4 tonnes CO2e/person/year
  - Dramatic reduction in CO_2 emissions in households that walk/bicycle/use public transport
  - **Copenhagen & Amsterdam vs Detroit & Houston**
  - High density low-energy use in homes is easy; many of the world's most expensive/desirable residential areas are high density

Urban actions mitigation potential



Source: C40, 2014

Thousands of cities are undertaking Climate Action Plans and Mitigation commitments



Yet, their aggregate impact on urban emissions is uncertain

Key messages

- Our ability reduce global GHG depends **on what kind of cities and towns we will build**

- A large window of low carbon development opportunities lie in guiding **new urbanization in next 2-3 decades- urban areas are yet to be built**

- **Cities have great potential to reduce GHG emissions** and contribute to global and national mitigation efforts

Climate change impacts, cities and Urbanization

TED talk on Urban CC vulnerability and adaptation

http://www.ted.com/talks/vicki_arroyo_let_s_prepare_for_our_new_climate.html

Climate Change is Affecting Human Health and the Environment

Infrastructure
Water
Transportation
Energy Supply & Use

Climate Changes

Temperature

Precipitation

Sea Level Rise

Cultural Resources

Economic Disruption

Health
Weather-related Mortality
Infectious Diseases
Air Quality -Respiratory Illnesses

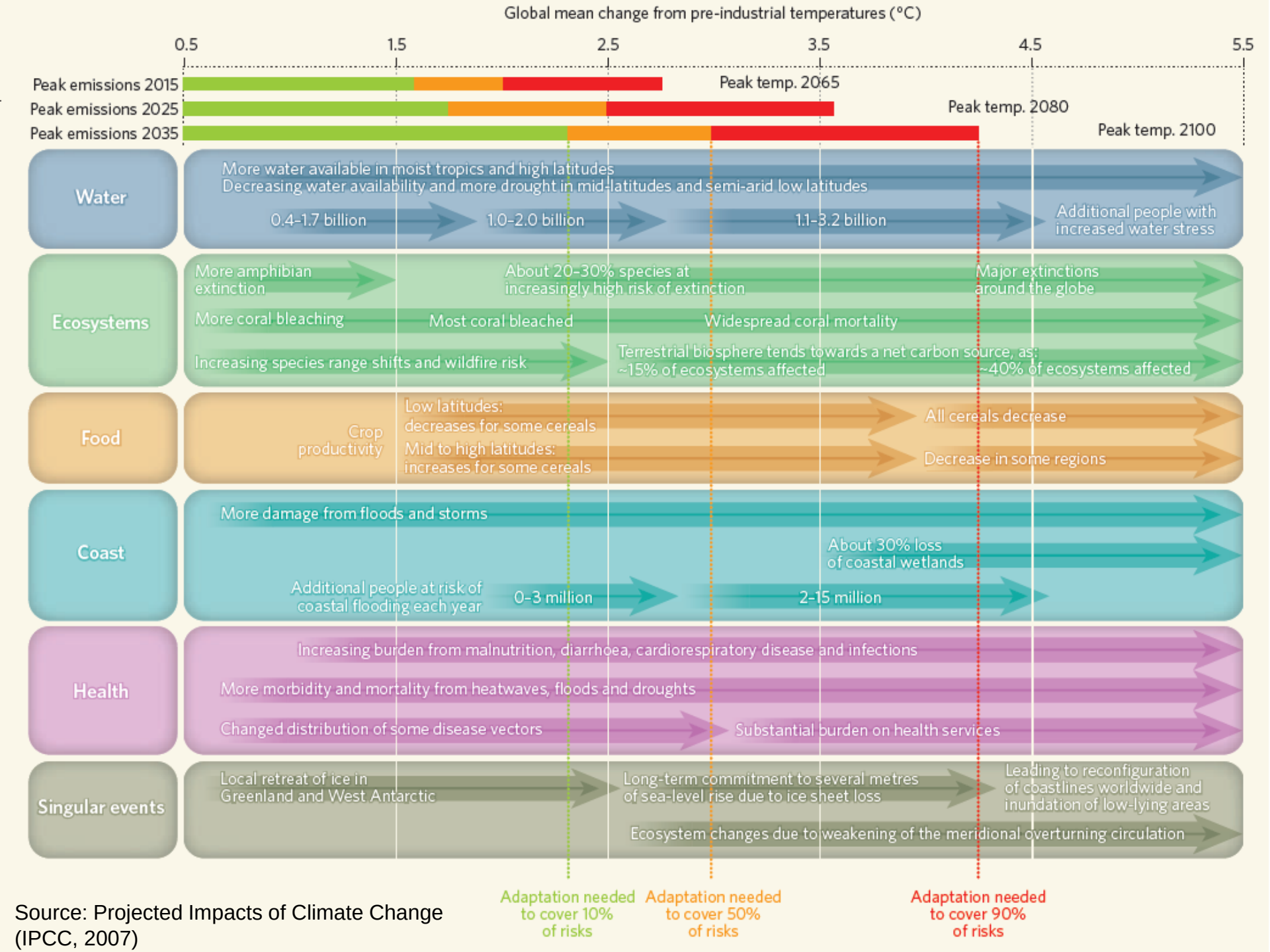
Agriculture
Crop yields
Irrigation demands

Forest
Change in forest composition
Shift geographic range of forests
Forest Health and Productivity

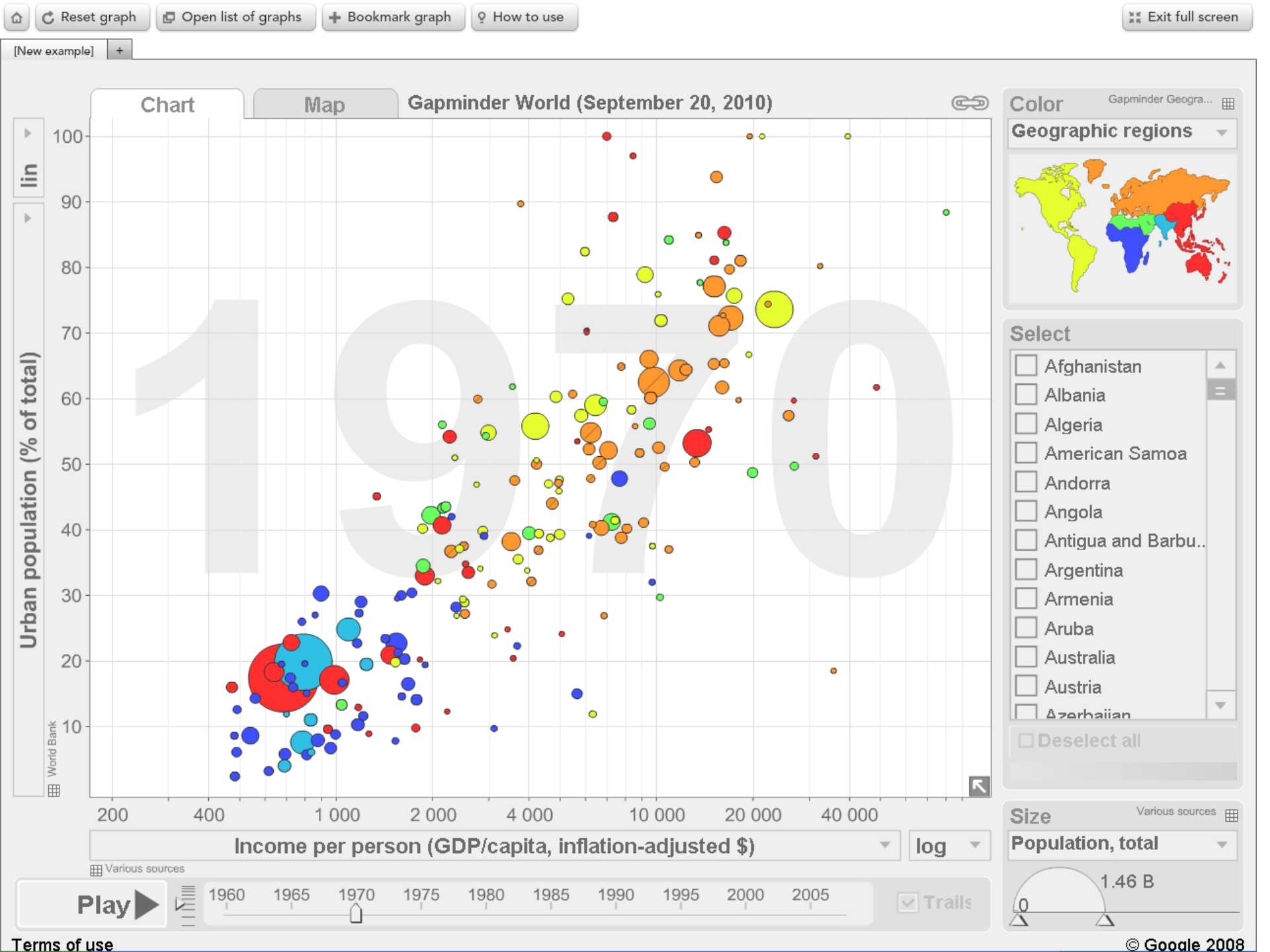
Water Resources
Changes in water supply
Water quality
Increased competition for water

Coastal Areas
Erosion of beaches
Inundate coastal lands
Costs to defend coastal communities

Wildlife and Ecosystems
Shift in ecological zones
Loss of habitat and species
Damage to Coral Reefs



Source: Projected Impacts of Climate Change (IPCC, 2007)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lin
Urban population (% of total)
World Bank
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Income per person (GDP/capita, inflation-adjusted $)
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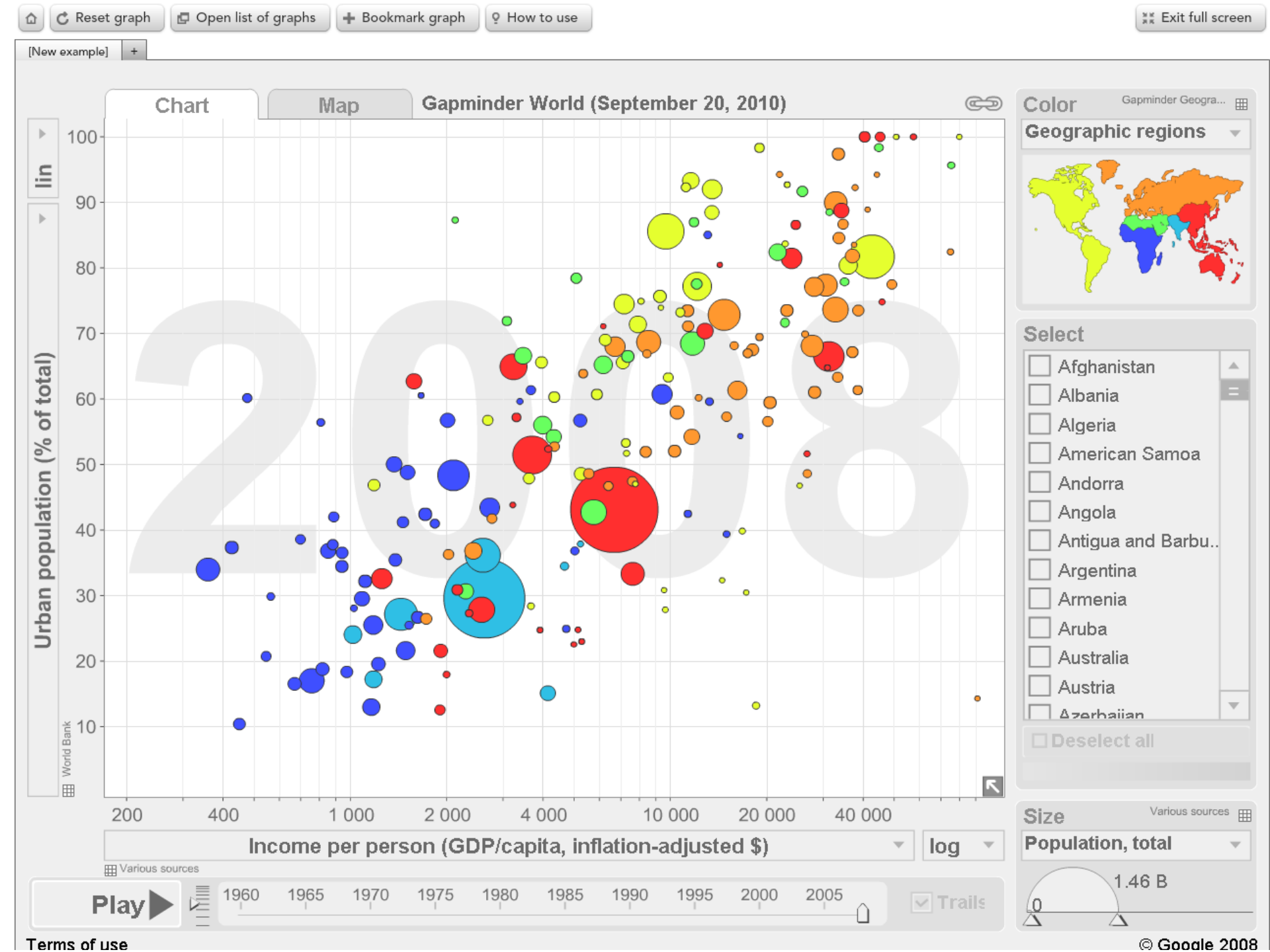
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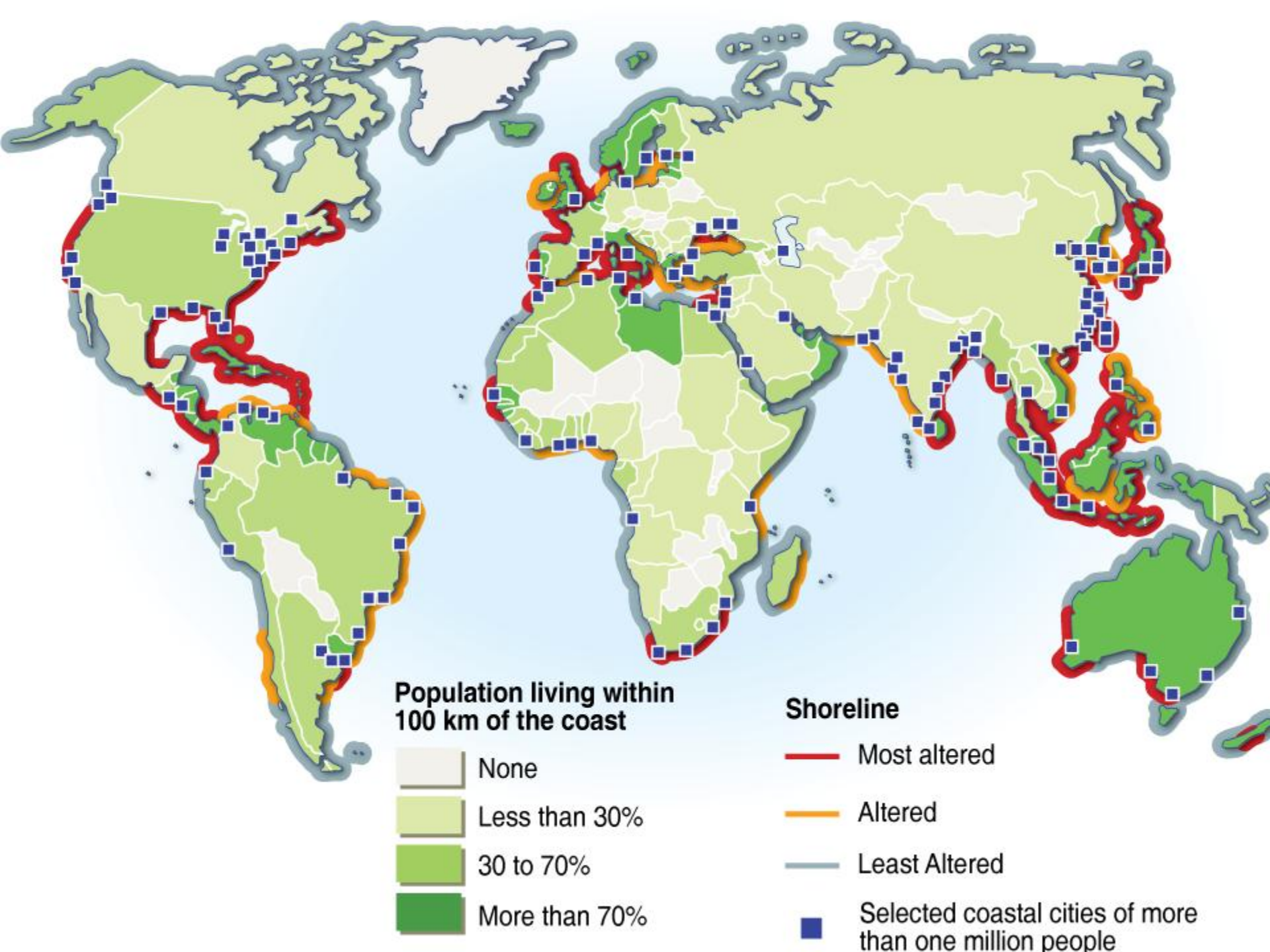
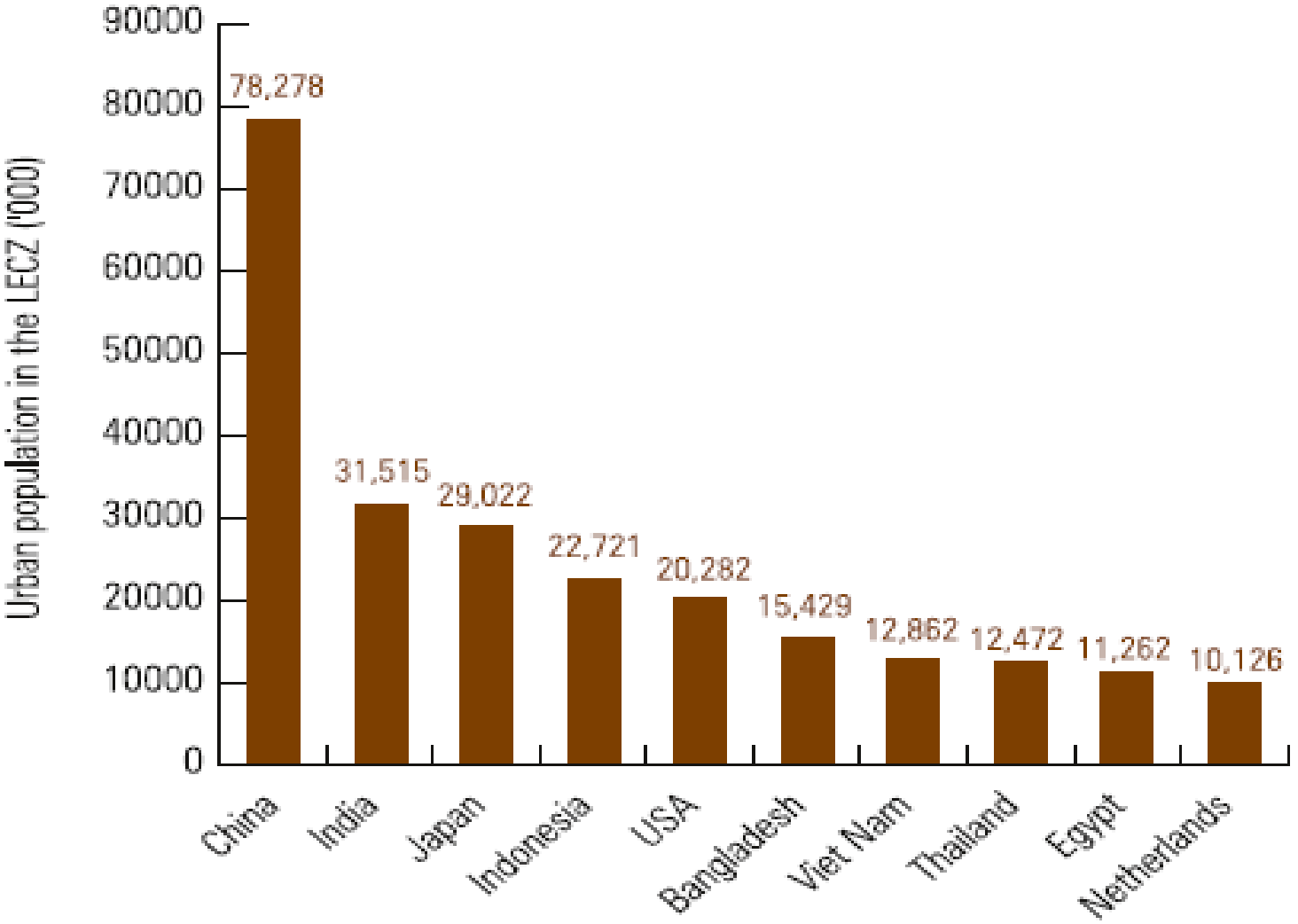

Population living within 100 km of the coast
None
Less than 30%
30 to 70%
More than 70%
Shoreline
Most altered
Altered
Least Altered
Selected coastal cities of more than one million people

Urban Population in Low Elevation Coastal Zones for Selected Countries

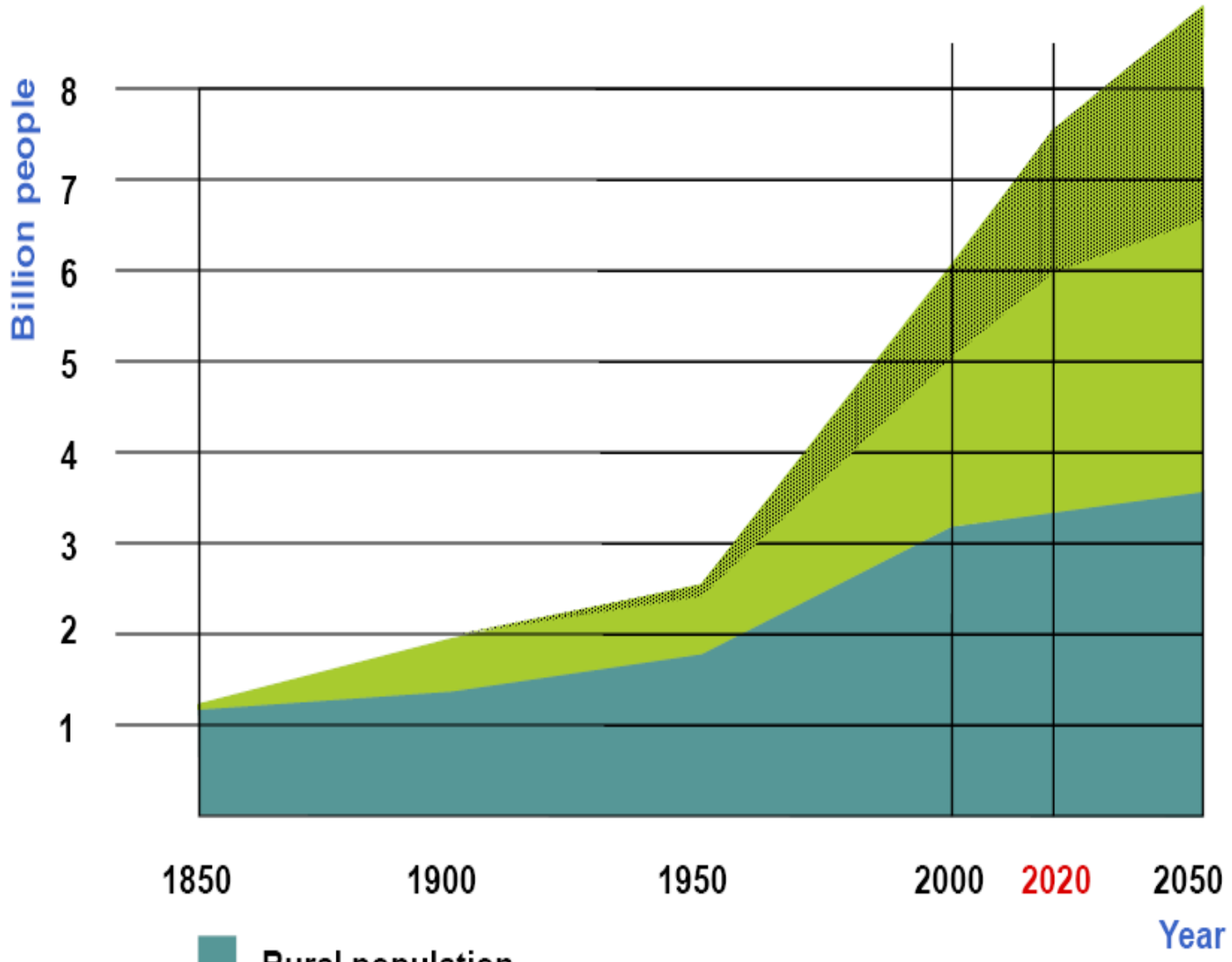


Climate impacts in cities

Cities face the **greatest risks**

- High concentration of **population & assets**
- More **extreme** storms/rainfall, heat waves, sea-level rise

Population of the World



Reference: UN-HABITAT, Global Urban Observatory

Vulnerability of low-income households and neighborhoods

- **Greater exposure** to hazards (e.g. through living on flood plains or unstable slopes);
- **Lack of risk-reducing housing and infrastructure** (e.g. poor-quality housing, lack of drainage systems);
- **Less adaptive capacity** (e.g. lacking the income or assets that allow a move to better quality housing or less dangerous sites);
- **Less state provision** for assistance in the event of a disaster (e.g. needed emergency responses and support for rebuilding or repairing homes and livelihoods; indeed, state action may increase exposure to hazards by limiting access to safe sites for housing); and
- **Less legal and financial protection** (e.g. a lack of legal tenure for housing sites, lack of insurance and disaster proof assets)

(UN-HABITAT, 2011b;Godfrey and Savage, 2012)

What cities can do about climate change?

Dealing with Climate Change: Mitigation and Adaptation

Mitigation activities

Reducing emissions of greenhouse gases

Adaptation activities

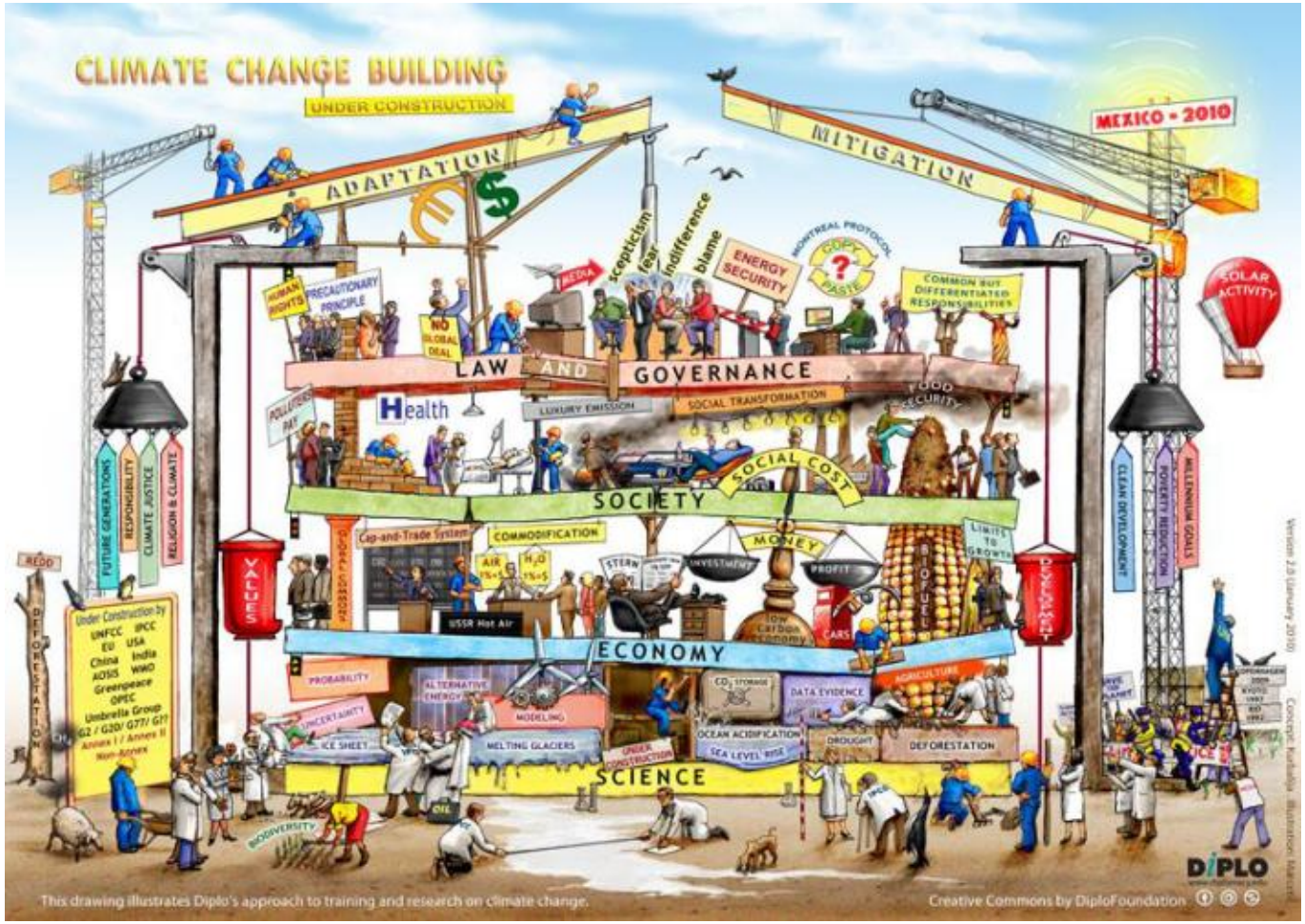
Managing the change and impacts that occur due to climate change.

Concluding remarks

- **High urbanization rate and economic growth** at global south is likely to drive emissions up
- **Which (carbon) development path cities will follow?**
  - **Economic base**
  - **Carbon intensity**
  - **Urban form**
  - **Consumption patterns and lifestyle**
- **Urbanization and climate impacts**

IHS
Making cities work

Thank You



s.grafakos@ihs.nl

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