

Introduction to Climate Change and Cities

Urban Management Tools for Climate Change – UMTCC 2018

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2017

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Bangkok residents flee floods as river threatens to burst banks

27 Oct 2011



Source: The Independent



Source: Reuters



Source: NDTV



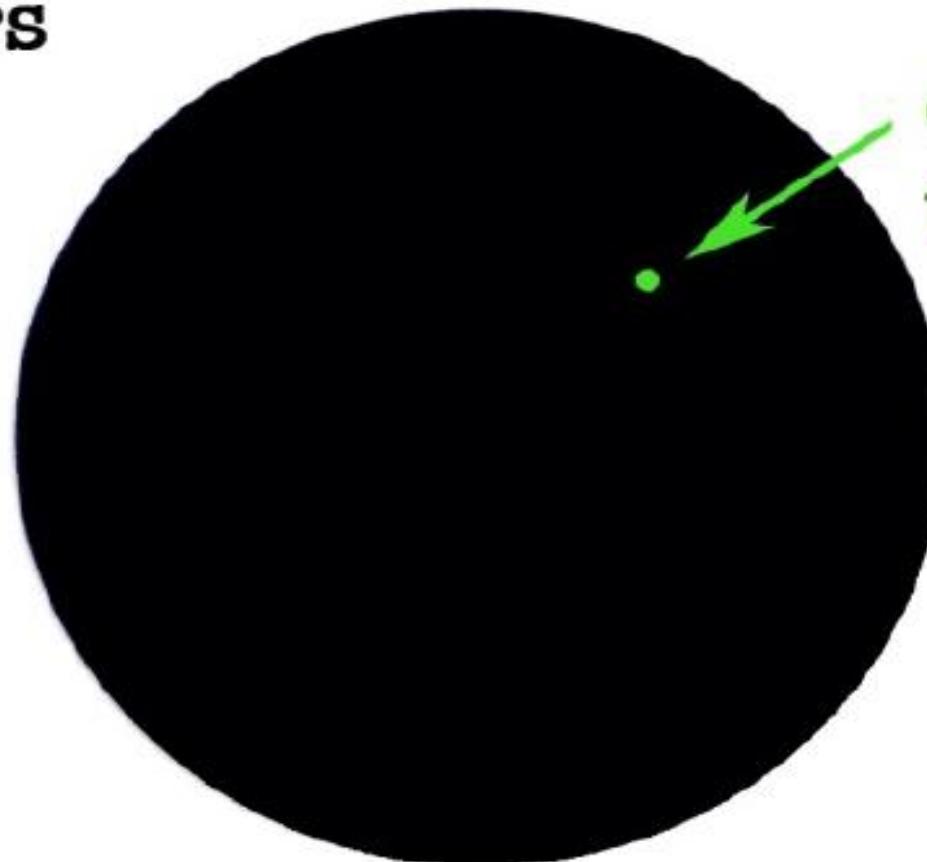
Outline

- 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

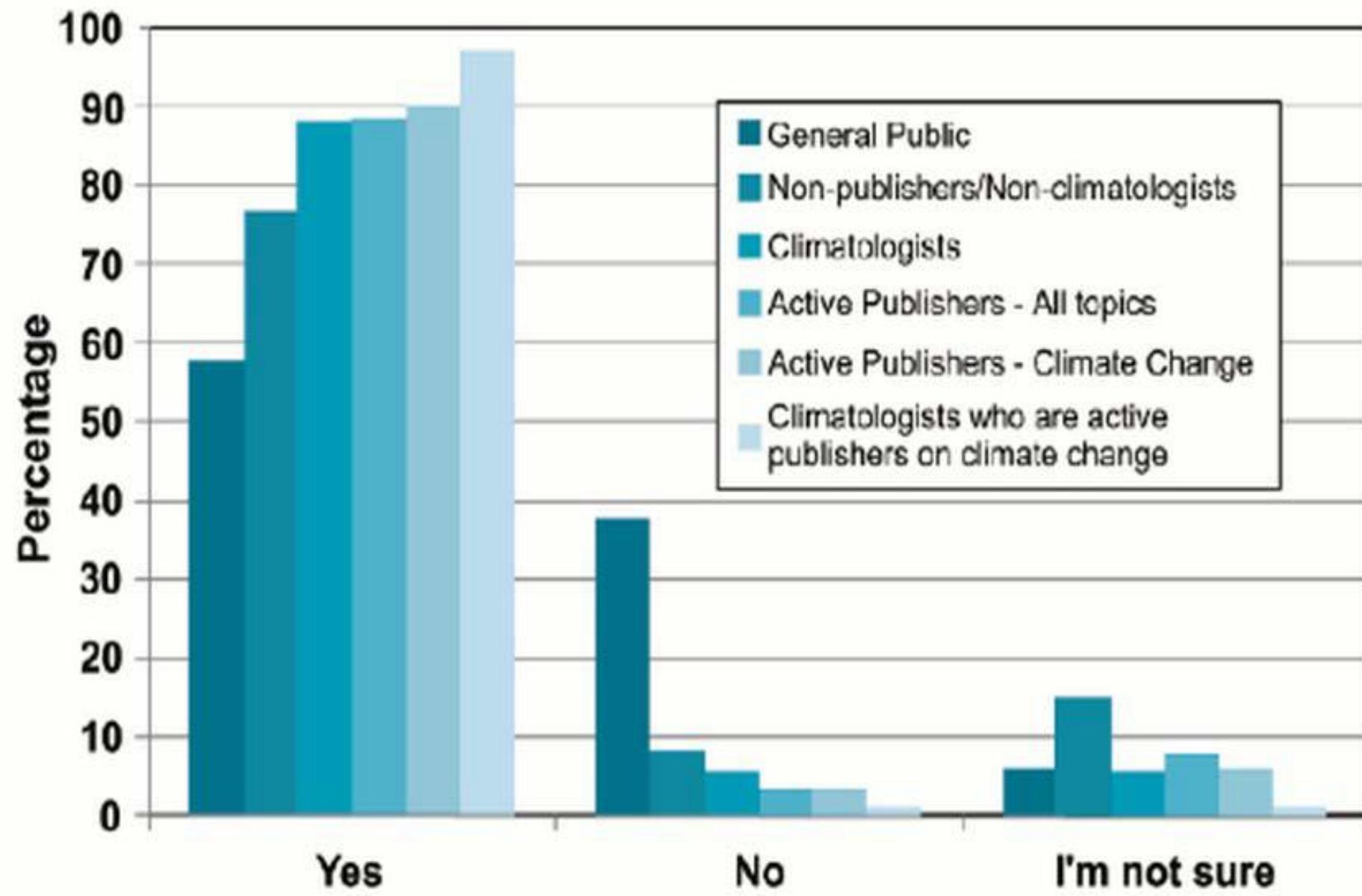
papers



only 34 reject
that it's
**CAUSED
BY
HUMANS**

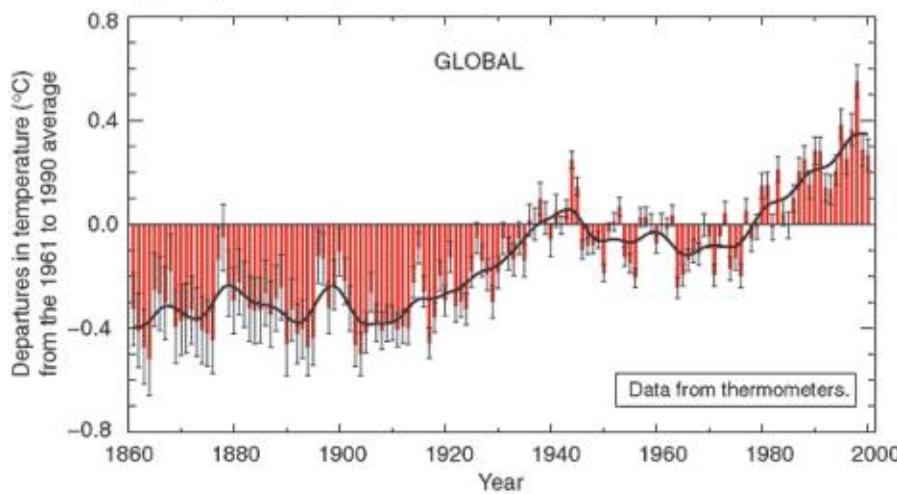
*From Web of Science peer-reviewed scientific articles with keyword phrases
"global warming" or "global climate change" published between 1991 and 2011
Research by JL Powell. Full article at: DeSmogBlog.com/Powell

General public?

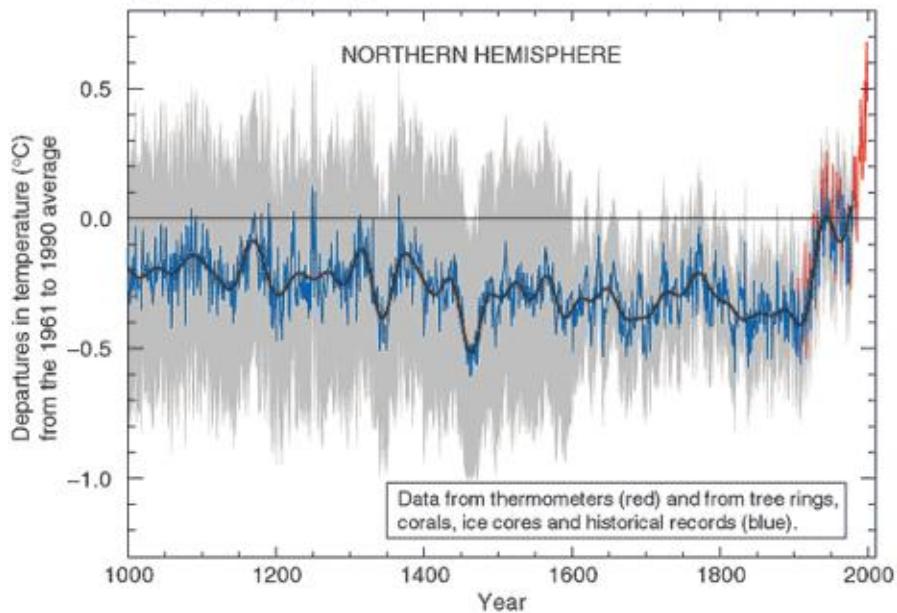


Variations of the Earth's surface temperature for:

(a) the past 140 years



(b) the past 1,000 years



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 $0.6 \pm 0.2^{\circ}\text{C}$

← Hockey Stick Graph created by geophysicist Michael Mann.

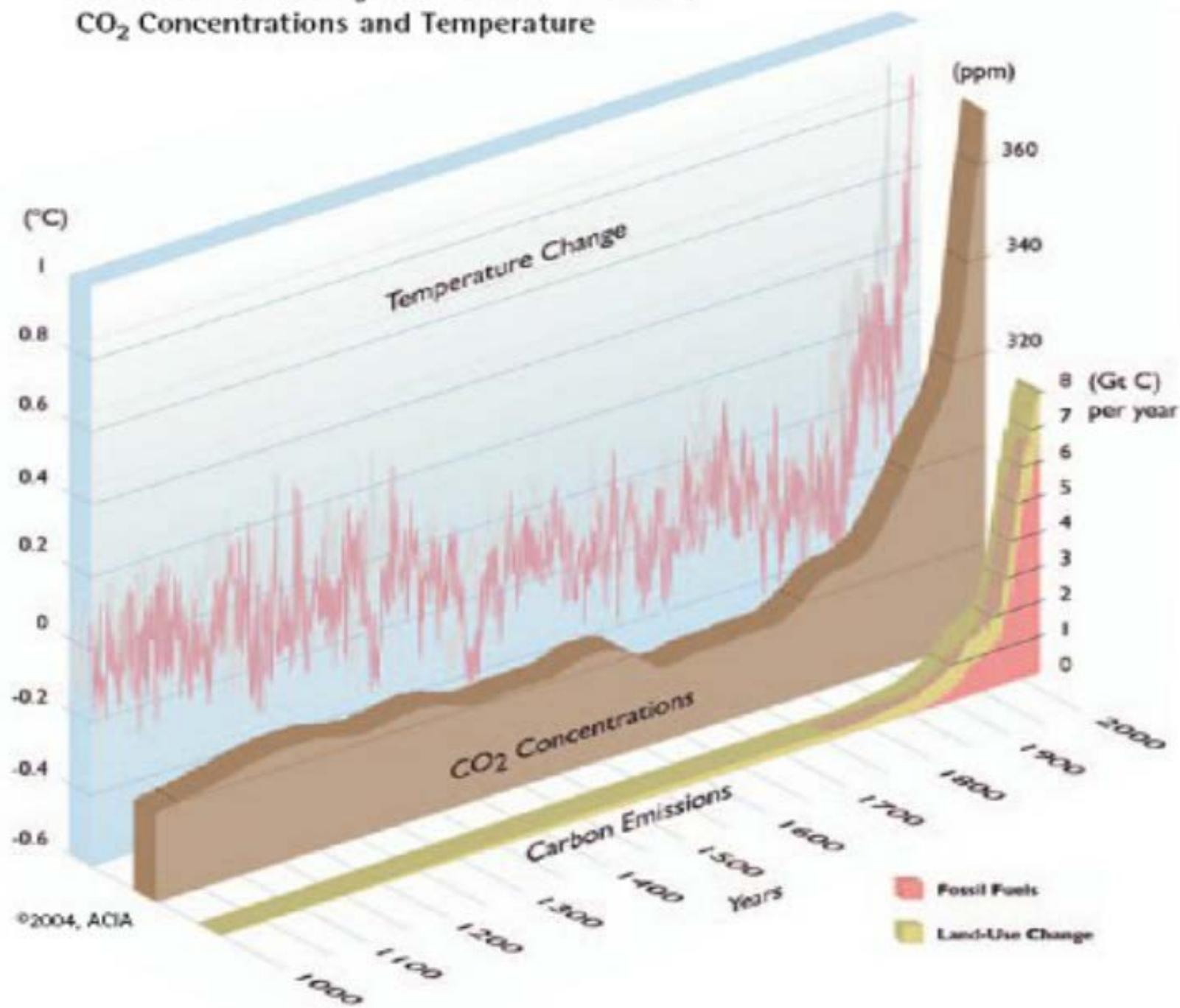
The **rate and duration** of warming of the 20th century has been much greater than in any of the previous nine centuries.

The Climate is Changing

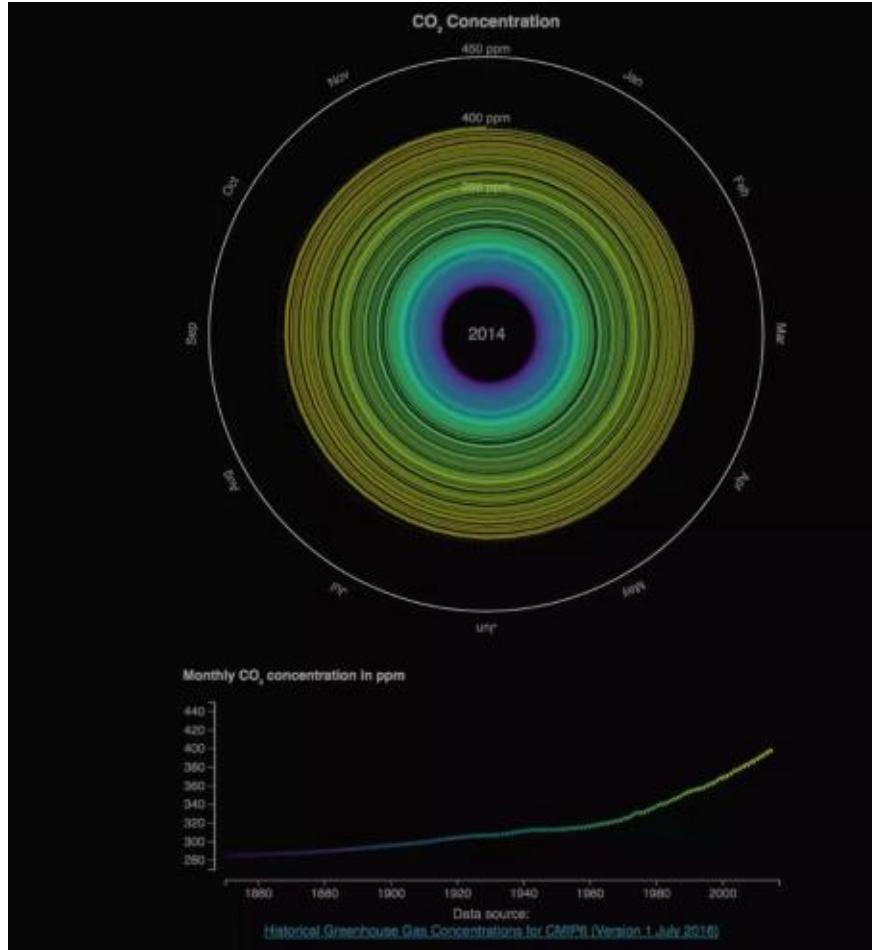
**It's changing at an increasingly rapid
rate...and**

at a rate beyond historic experience...

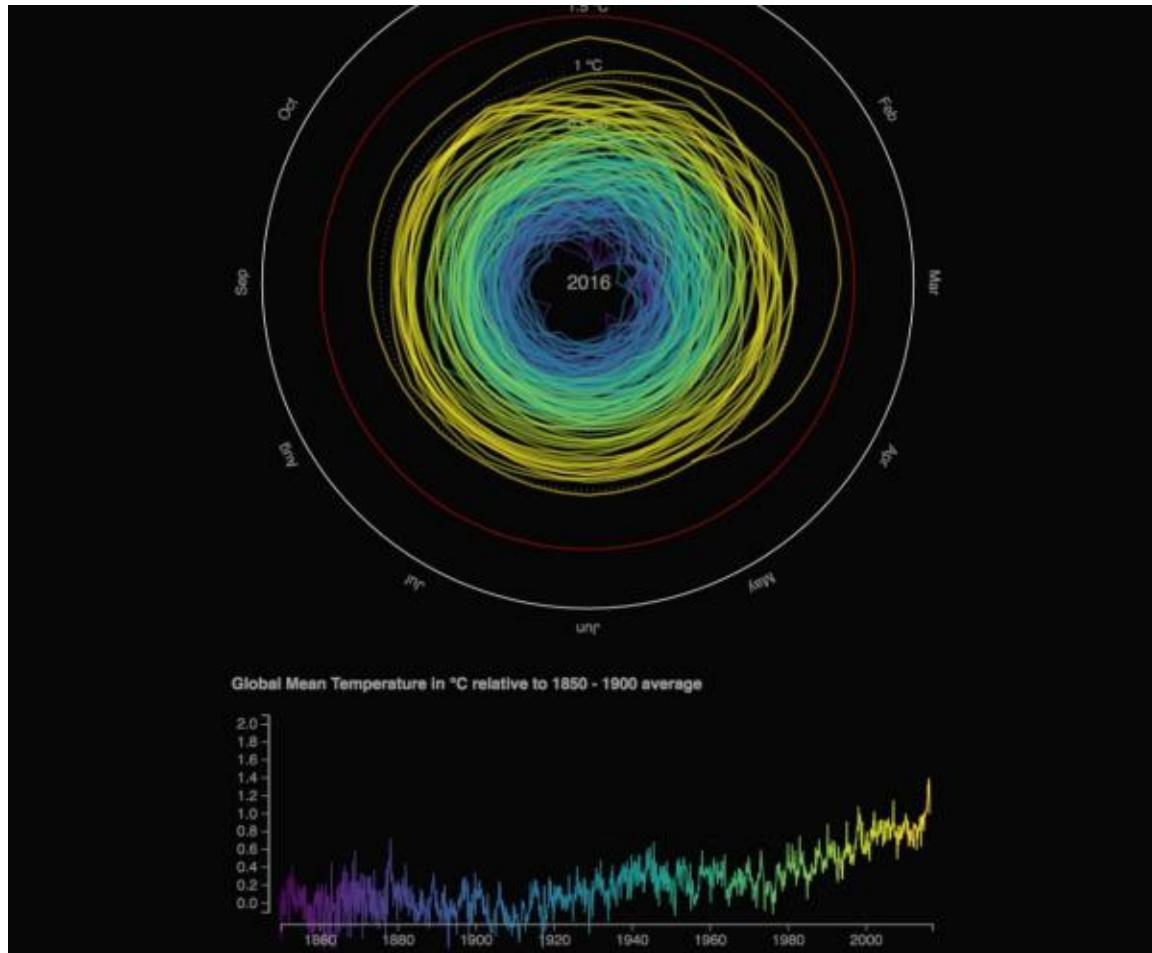
1000 Years of Changes in Carbon Emissions, CO₂ Concentrations and Temperature



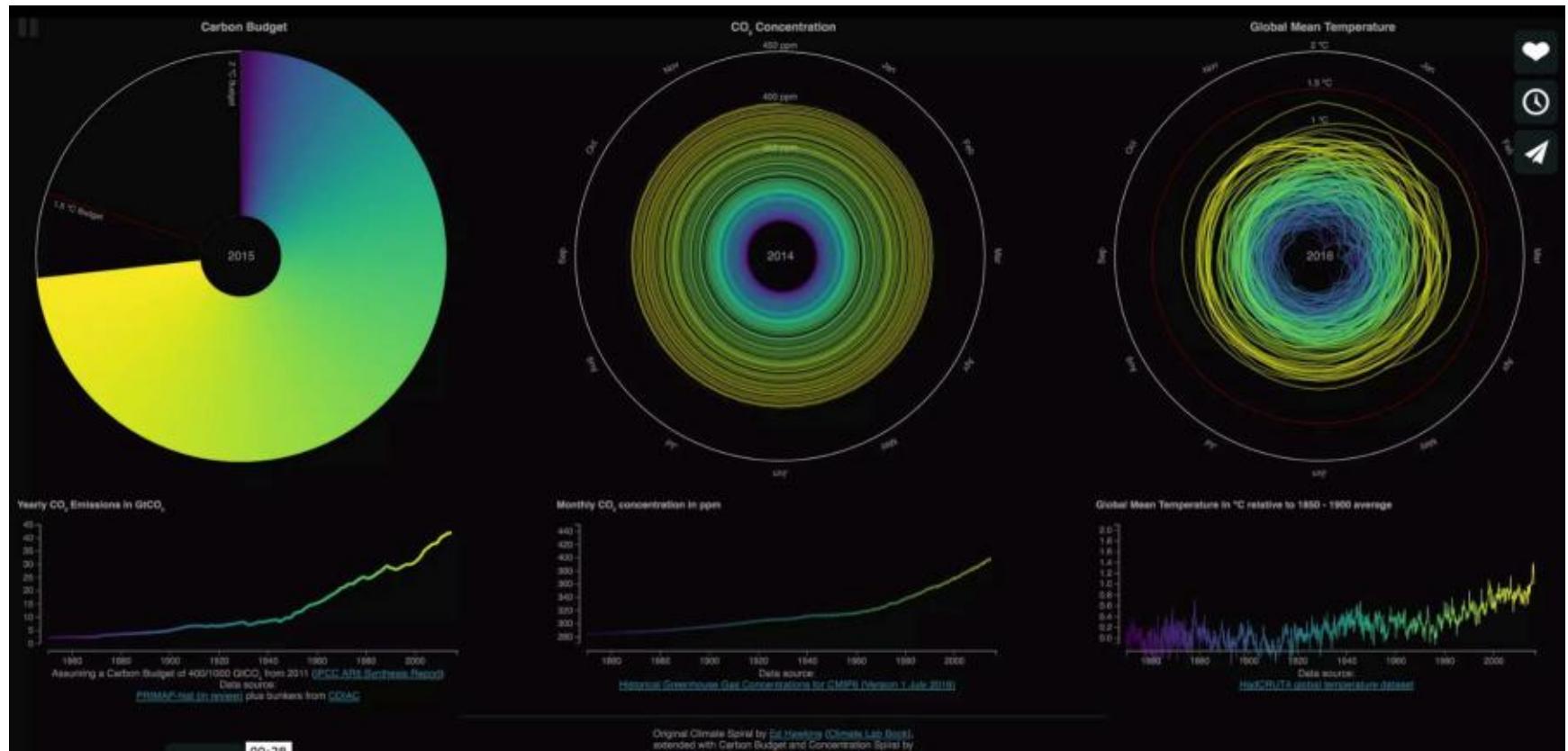
CO₂ concentration

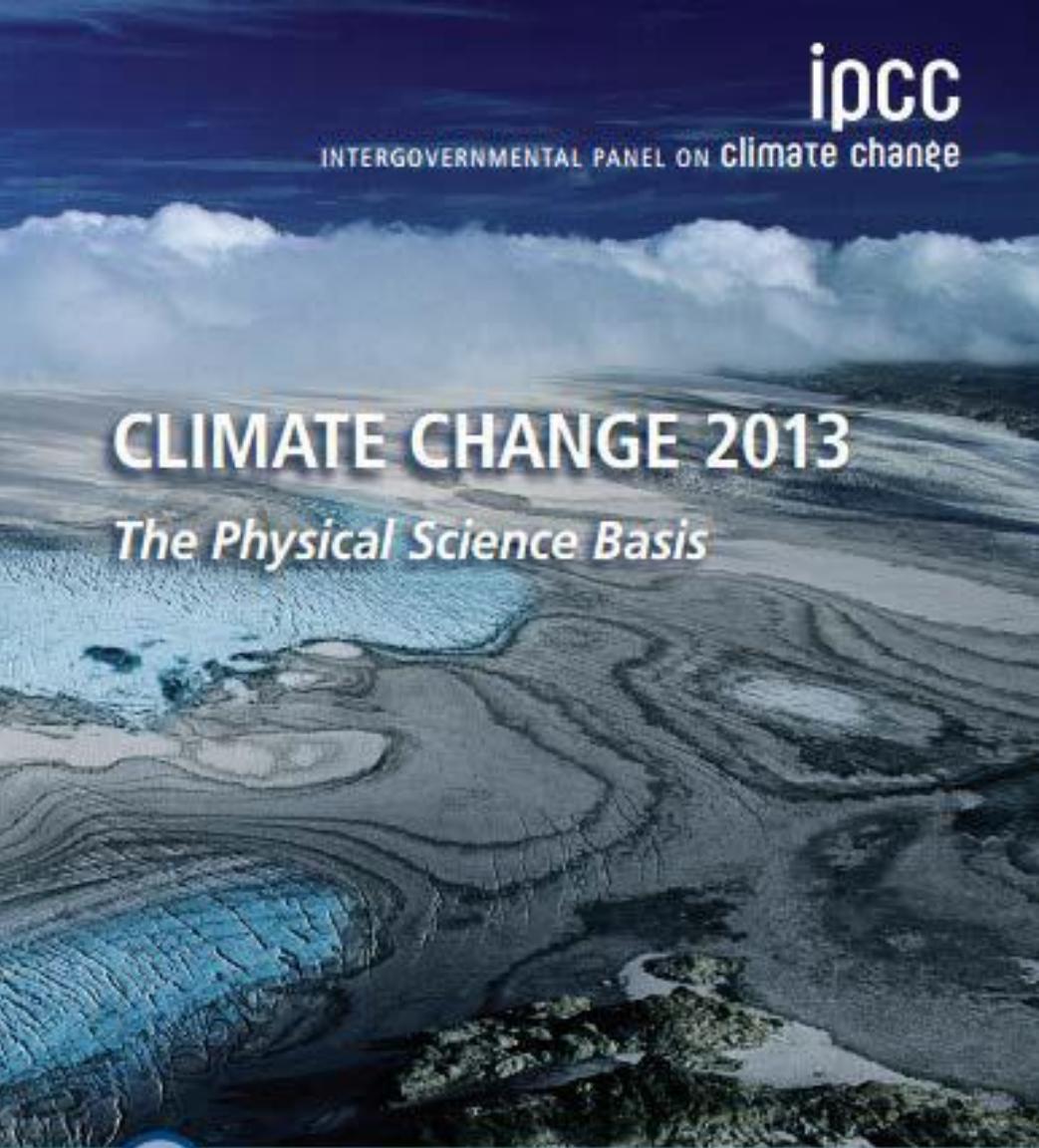


Global Mean Temperature



All 3 indicators



The background image shows a vast, rugged landscape dominated by a large glacier. The glacier's surface is textured with deep, winding crevasses and patches of blue meltwater. In the foreground, a bright blue lake reflects the surrounding environment. The sky above is filled with soft, white clouds.

ipcc

INTERGOVERNMENTAL PANEL ON climate change

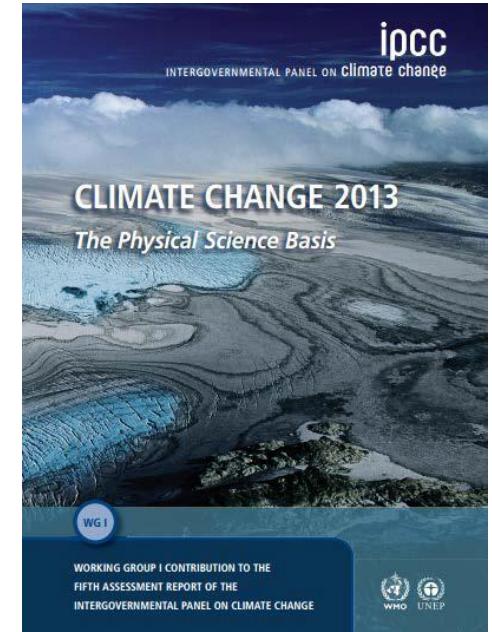
CLIMATE CHANGE 2013

The Physical Science Basis

WG I

WORKING GROUP I CONTRIBUTION TO THE
FIFTH ASSESSMENT REPORT OF THE
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE





IPCC AR5 (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.”

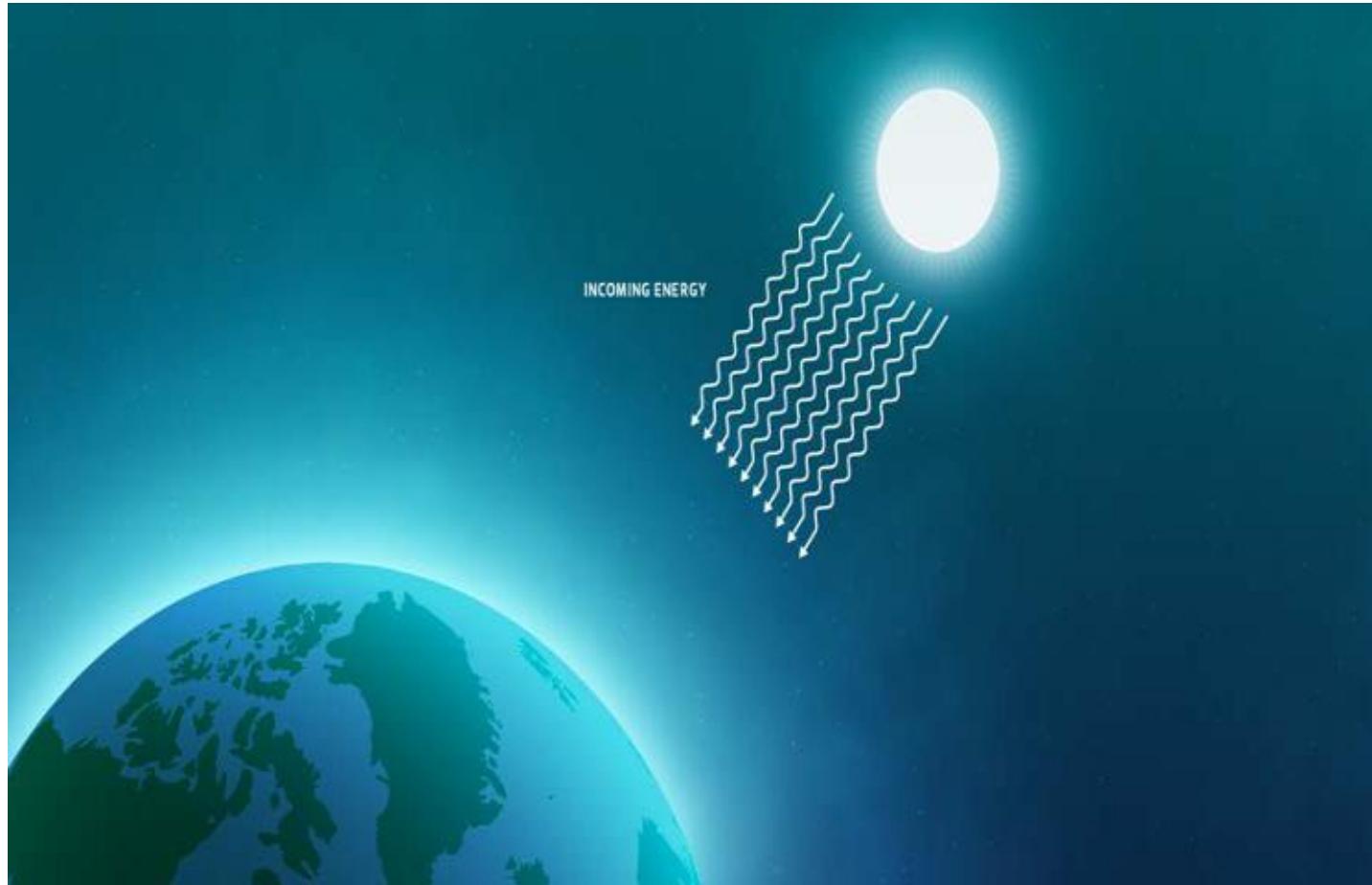
THE GREENHOUSE EFFECT

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

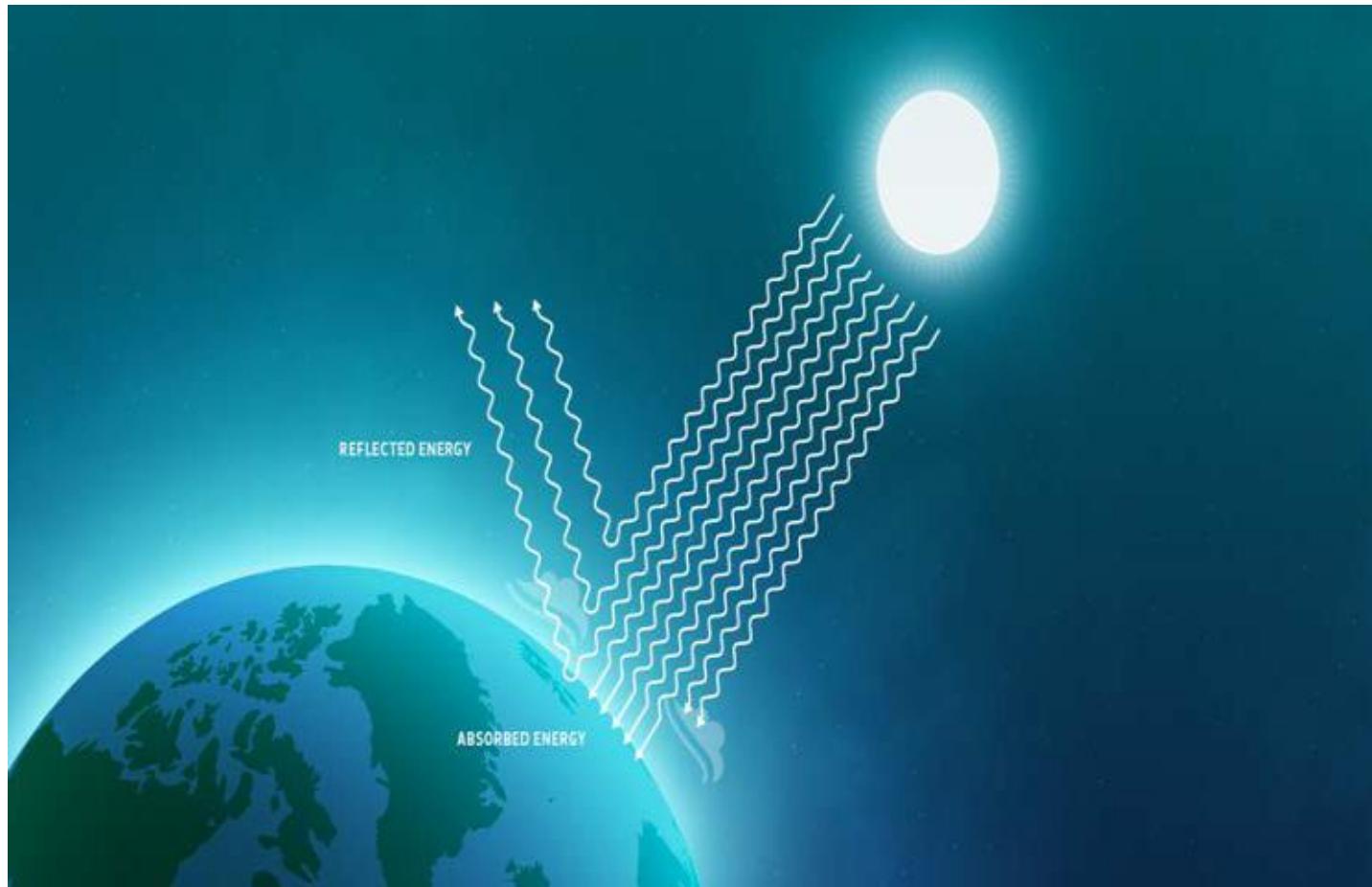


The Greenhouse Effect



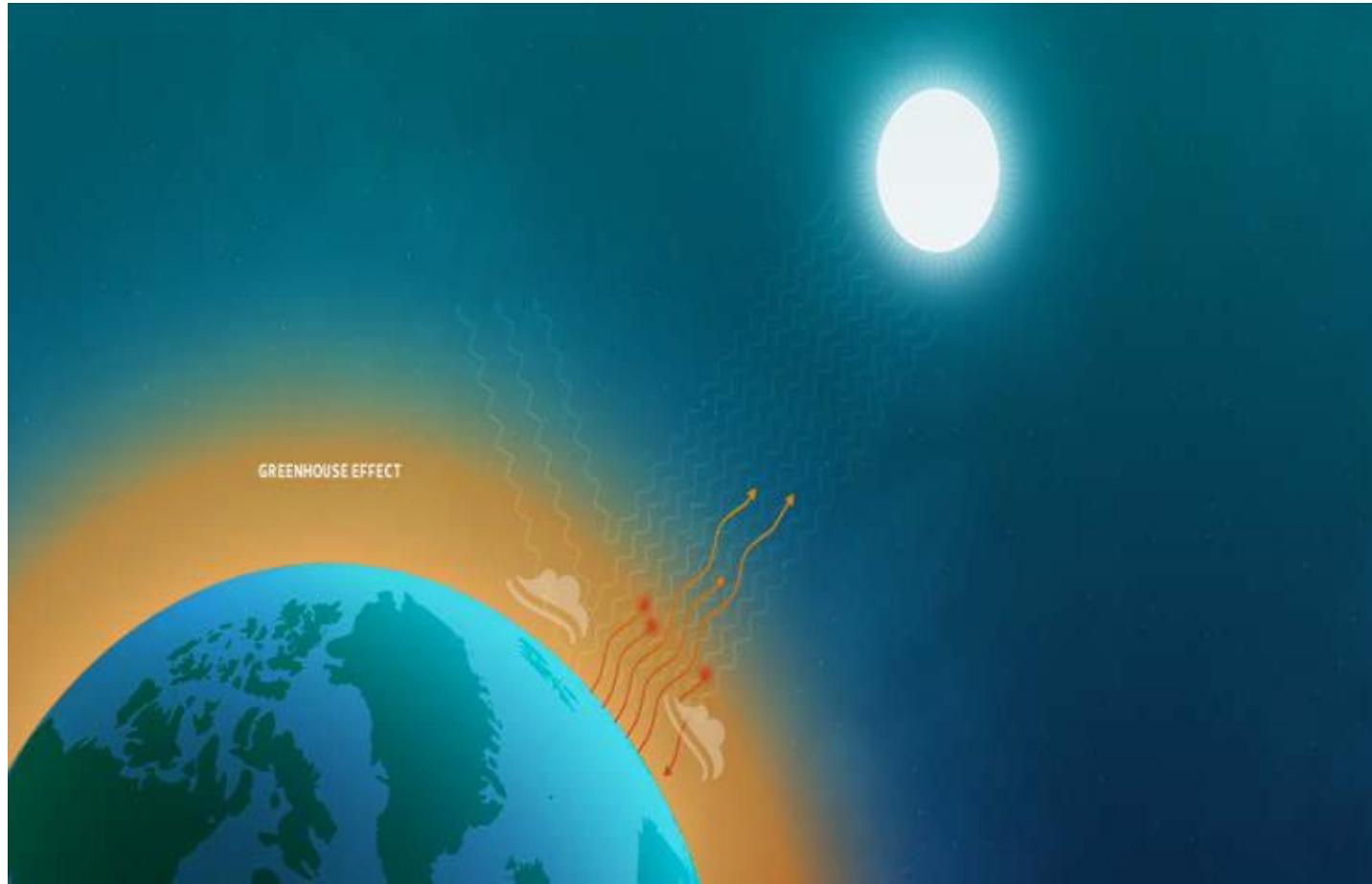
EPA

The Greenhouse Effect



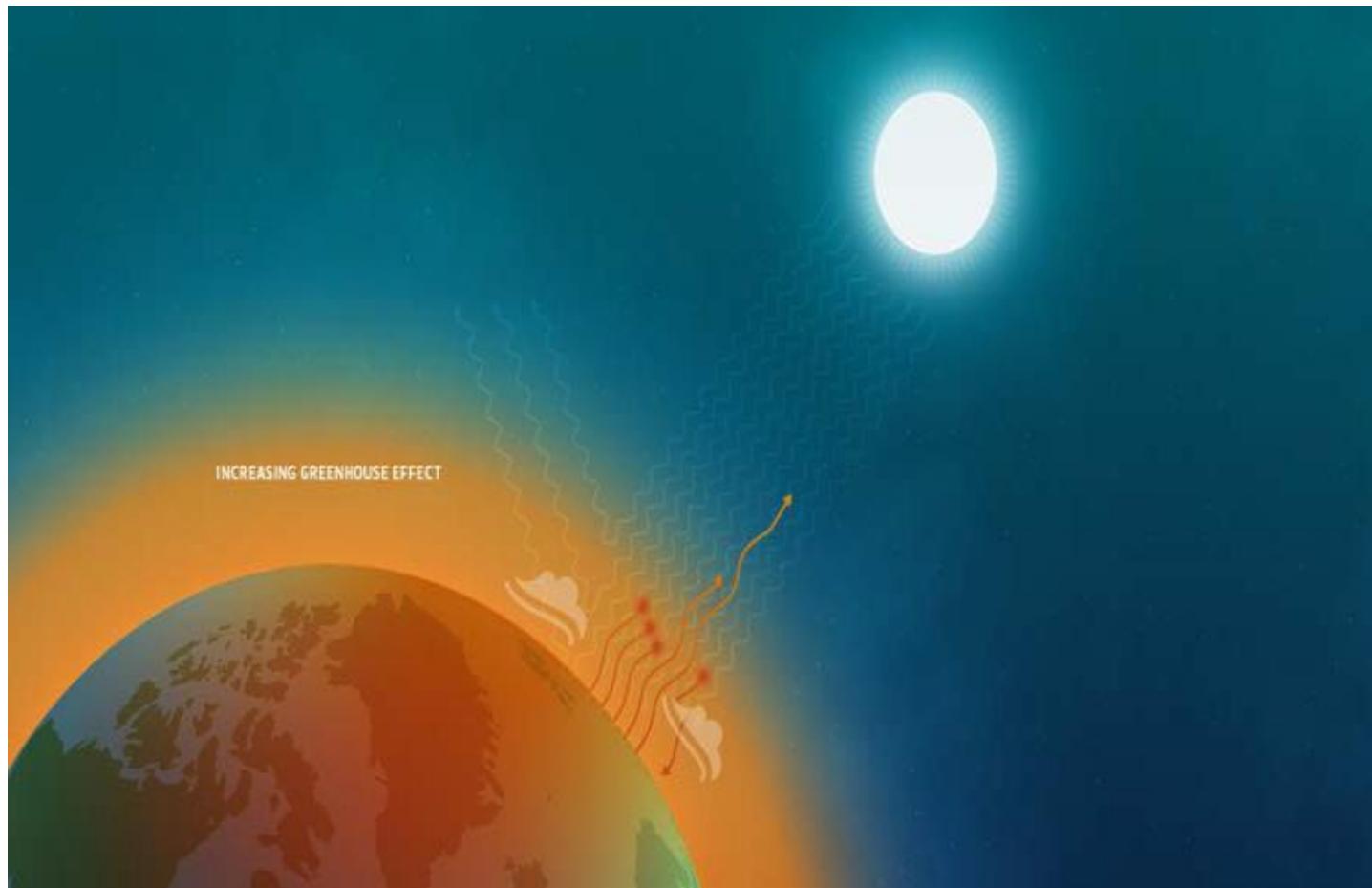
EPA

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

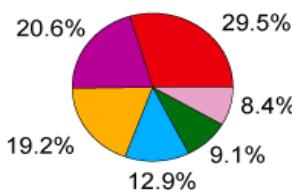
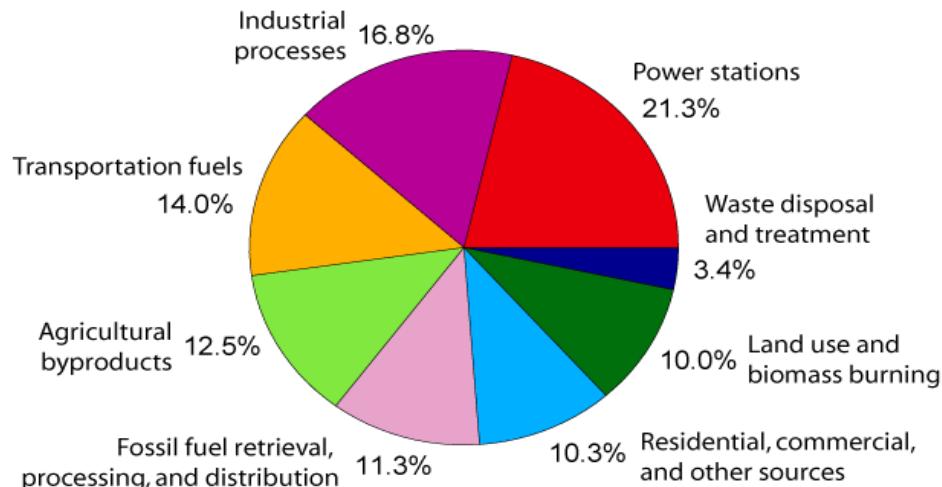
Land Use Changes

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

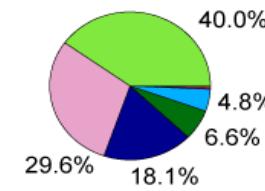
Fossil Fuel Burning

- Power stations
- Industry
- Transport
- Buildings
- Agriculture

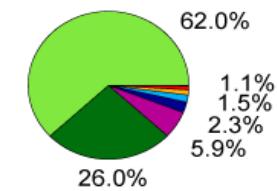
Annual Greenhouse Gas Emissions by Sector



Carbon Dioxide
(72% of total)



Methane
(18% of total)



Nitrous Oxide
(9% of total)

Climate Change Effects and Impacts

Changes in means

Temperature



Rainfall



Sea level rise

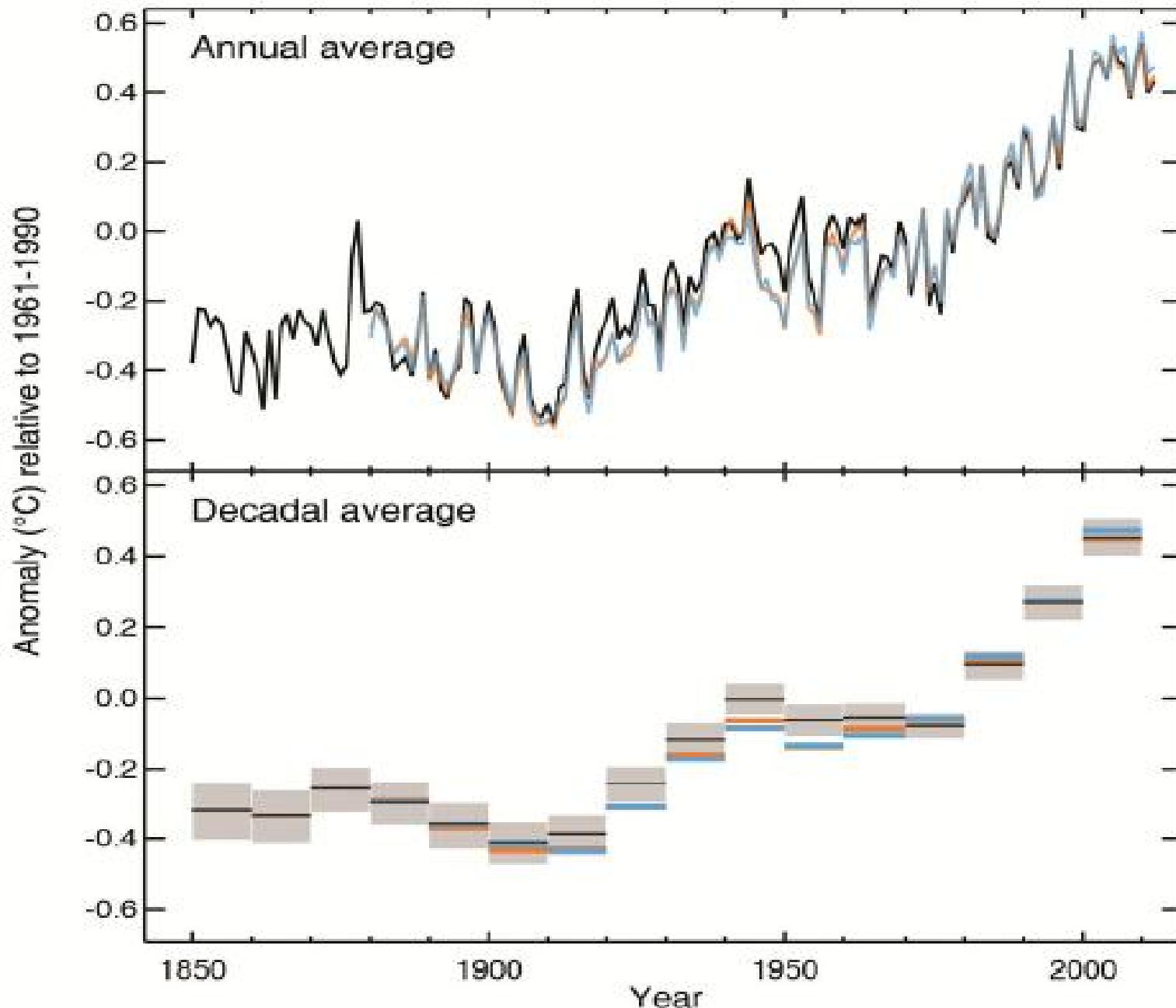


Global Temperature

Change

Observed globally averaged combined land and ocean
surface temperature anomaly 1850–2012

(a)



Annual temperature trends: 1976 to 1999

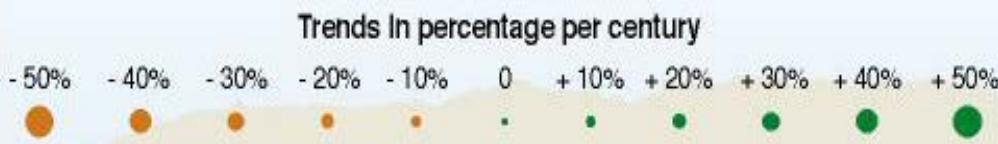
The Land and Oceans have Warmed

Trends in °C per decade

-1 -0.8 -0.6 -0.4 -0.2 0 +0.2 +0.4 +0.6 +0.8 +1

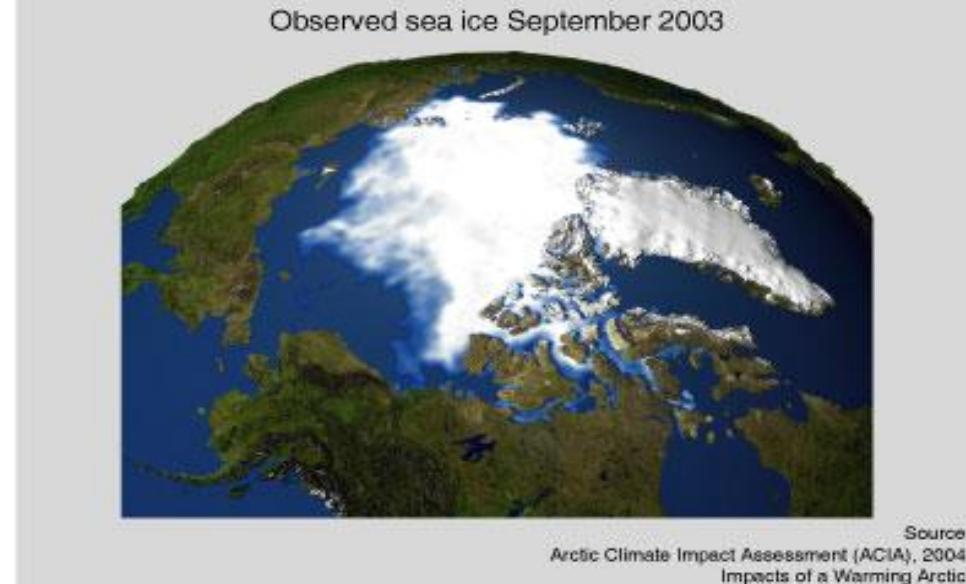
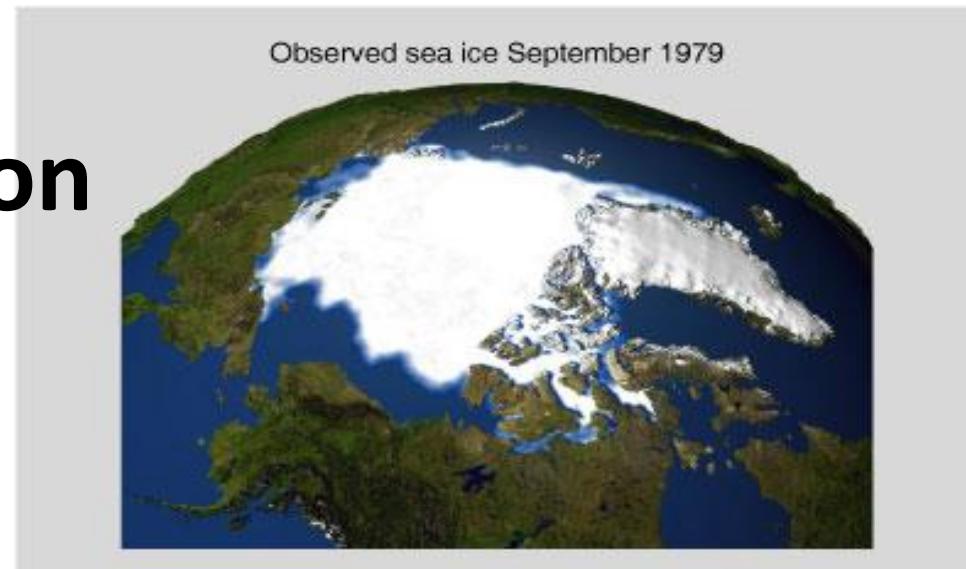
Annual precipitation trends: 1900 to 2000

Precipitation Patterns have Changed



North Polar cap

25% reduction

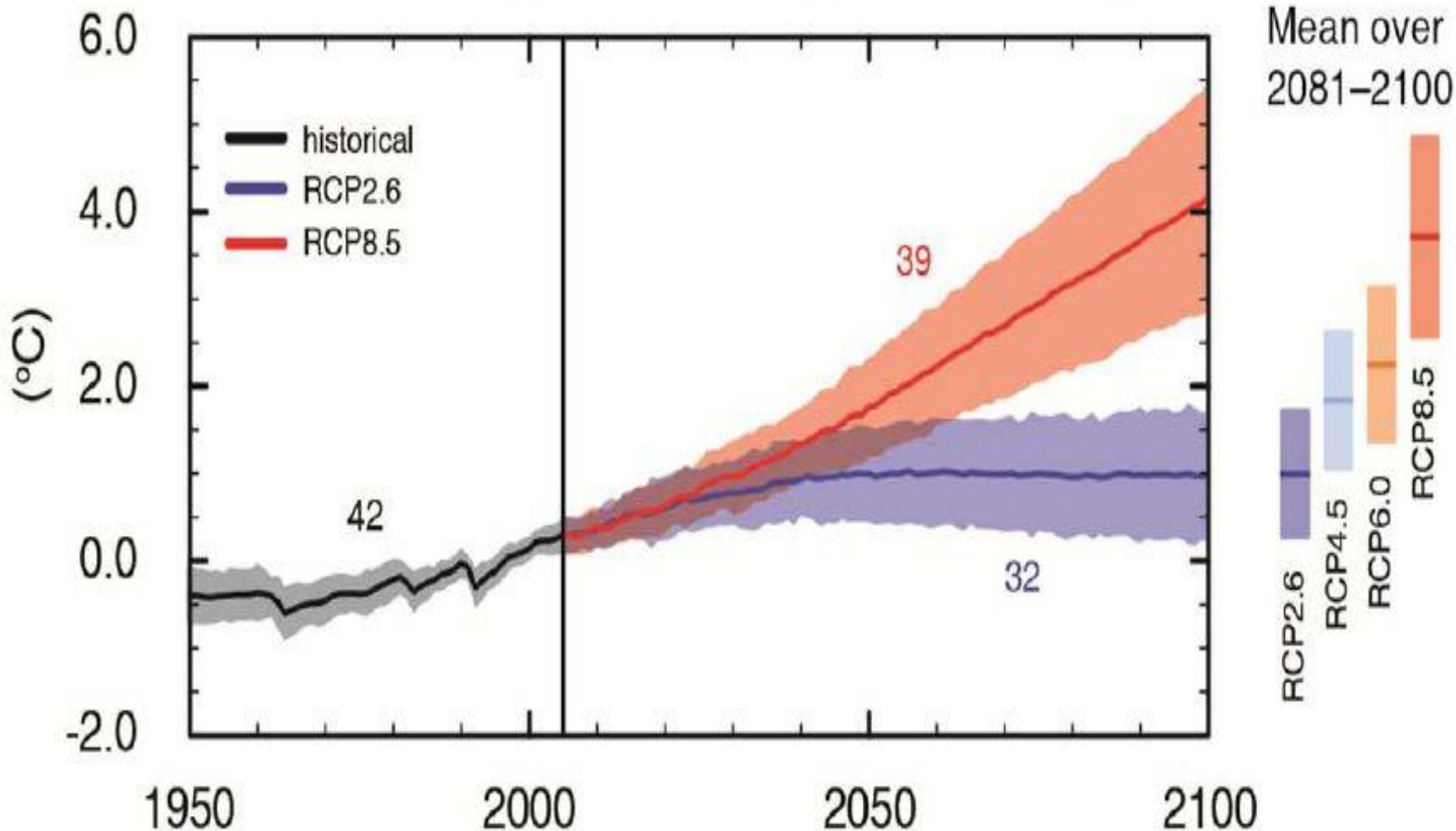


in **25** years

Source:
Arctic Climate Impact Assessment (ACIA), 2004.
Impacts of a Warming Arctic.

a)

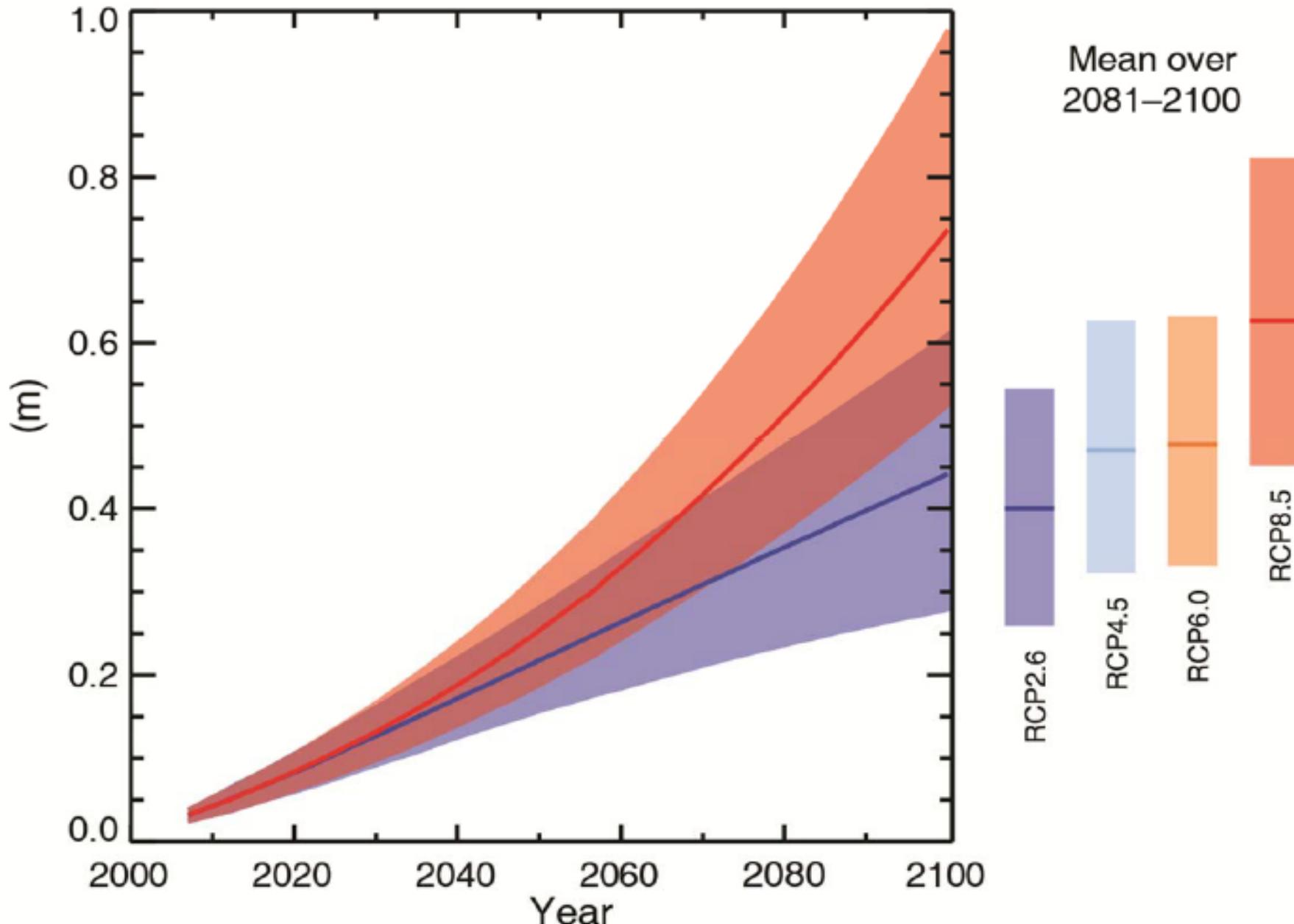
Global average surface temperature change



Source: IPCC

RCPs: Representative Concentration Pathways

Global mean sea level rise



Ten Indicators of a Warming World



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



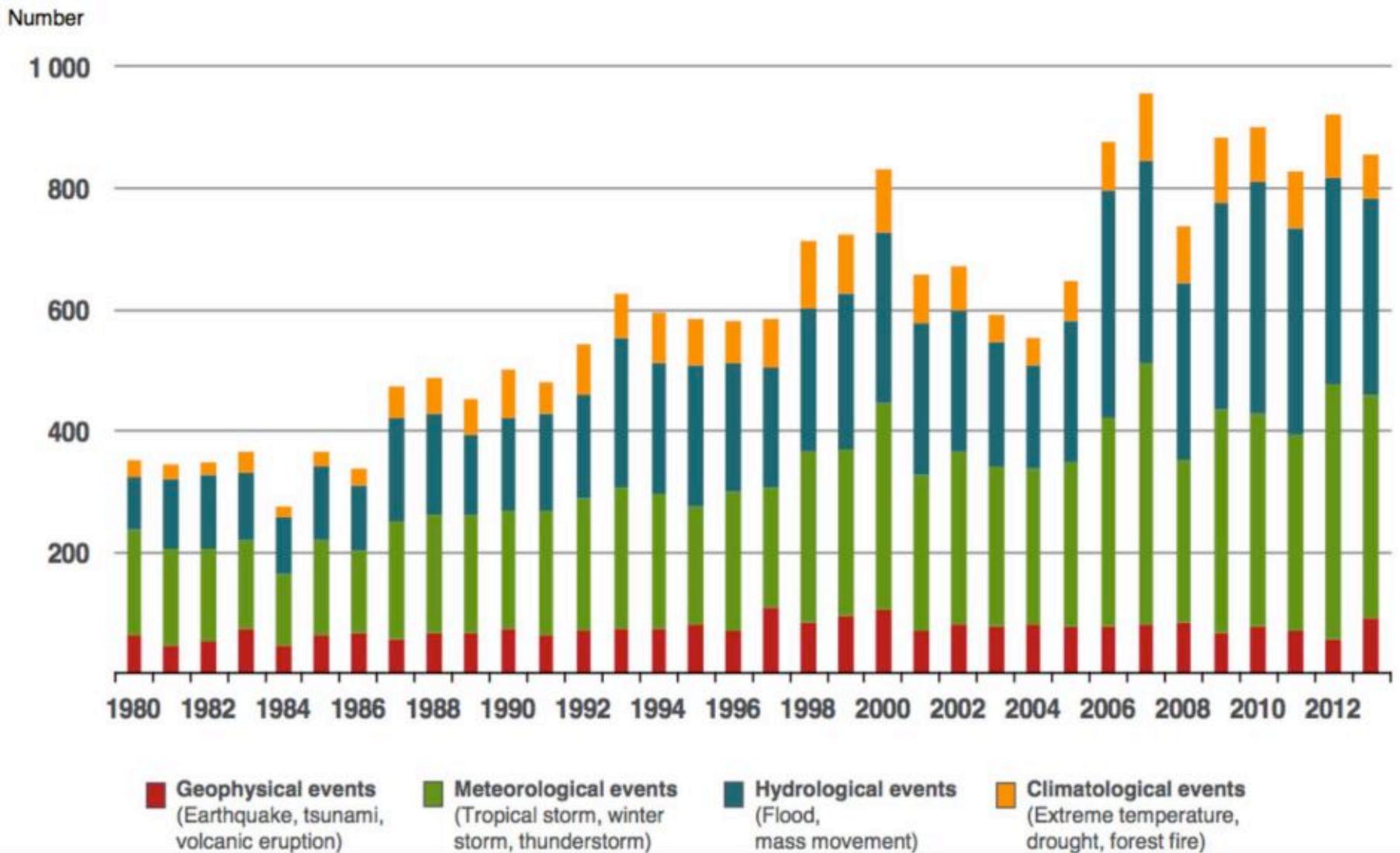








Climate Induced Disasters

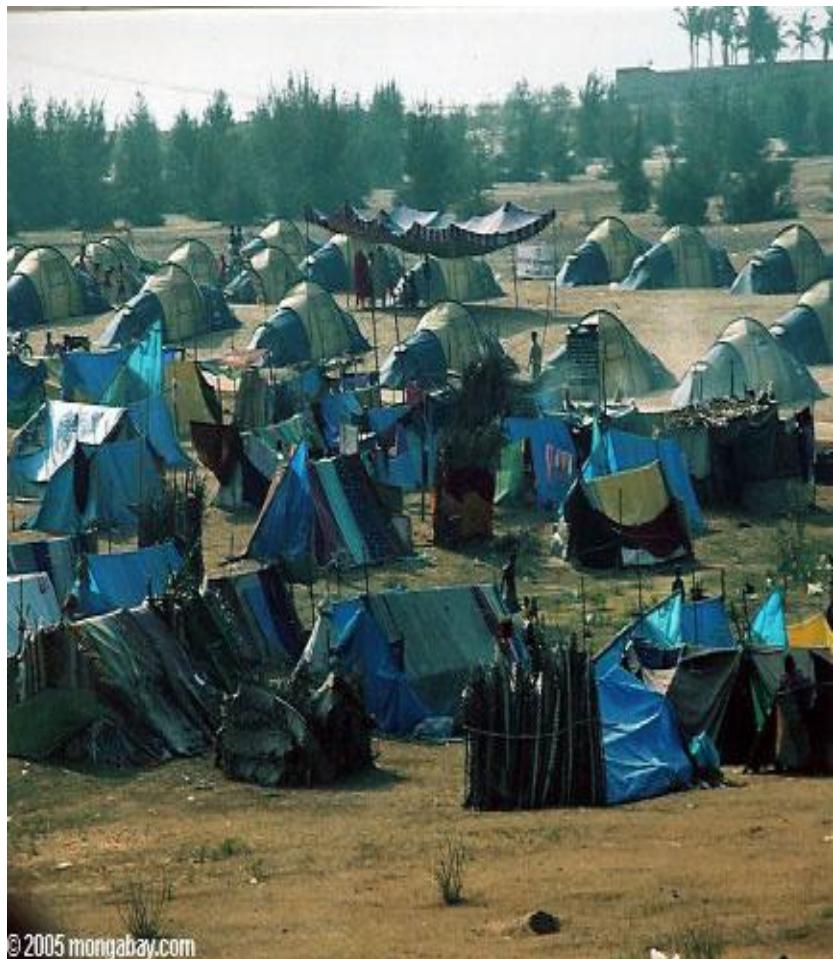


IMPACTS of Climate Change



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

Indirect IMPACTS of Climate Change

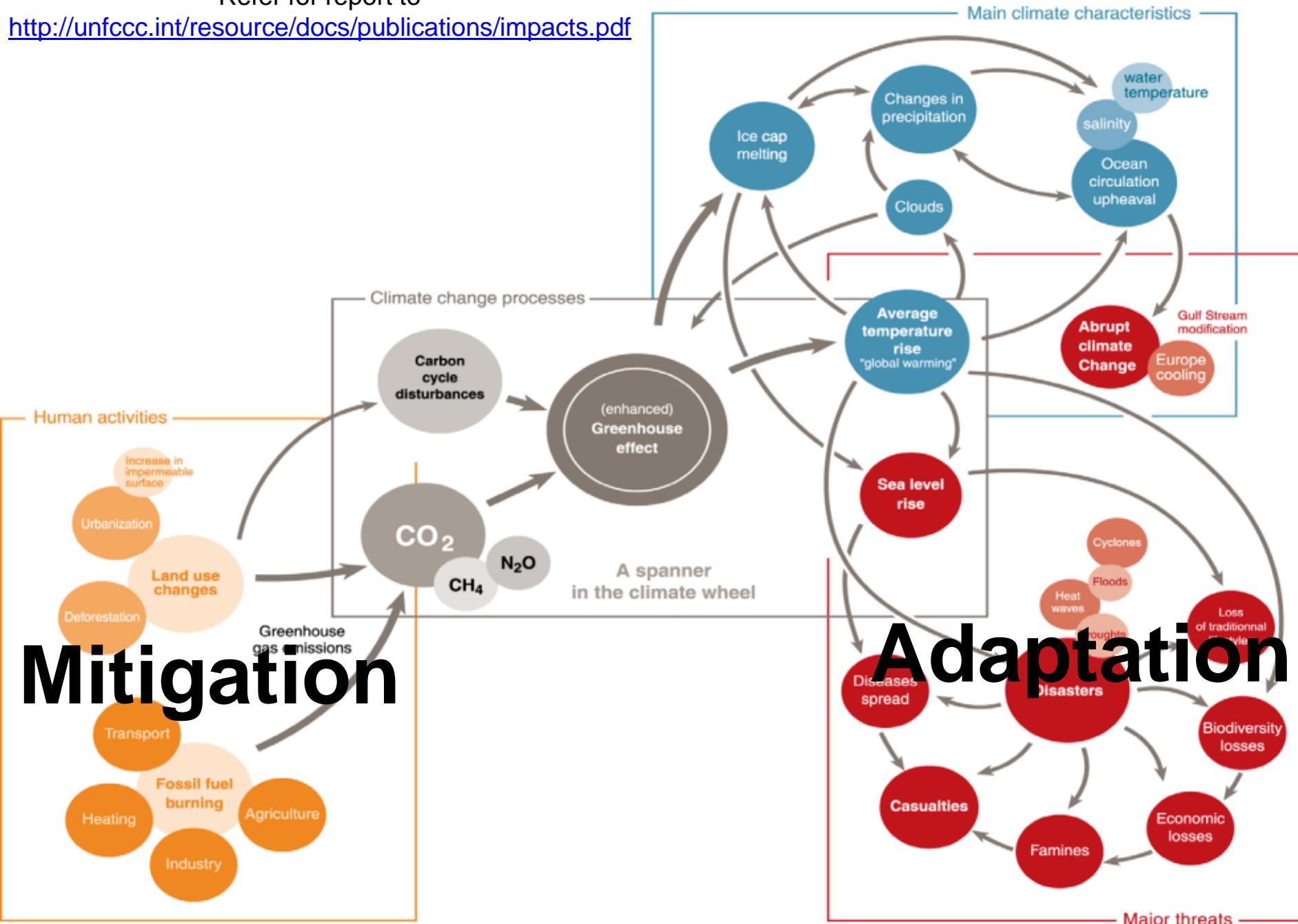


- Environmental refugees
- Accelerated urbanization
- Epidemics, worsening public health
- High energy demand for cooling

Source: UNEP / GRID-Arendal, 2007

Refer for report to

<http://unfccc.int/resource/docs/publications/impacts.pdf>

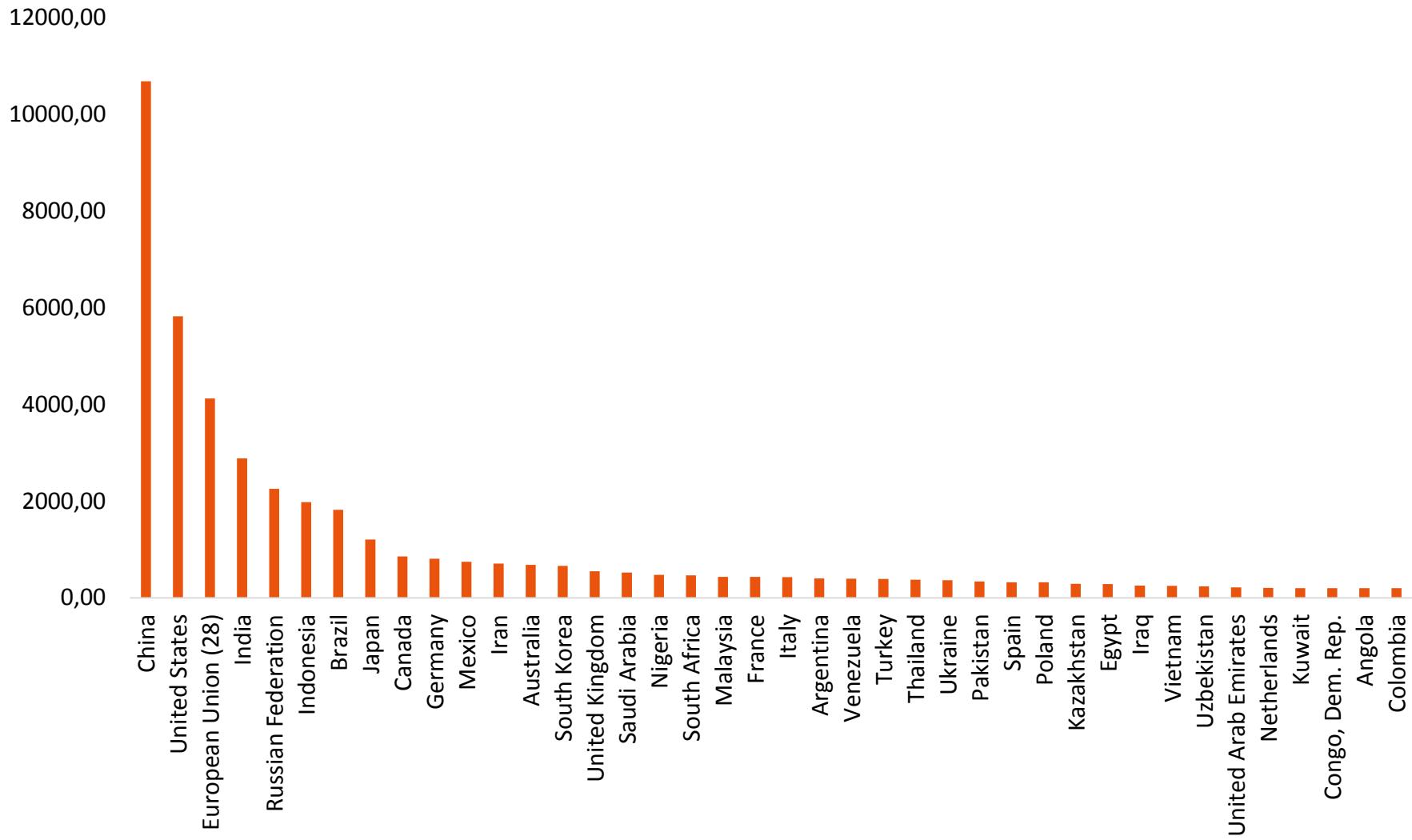


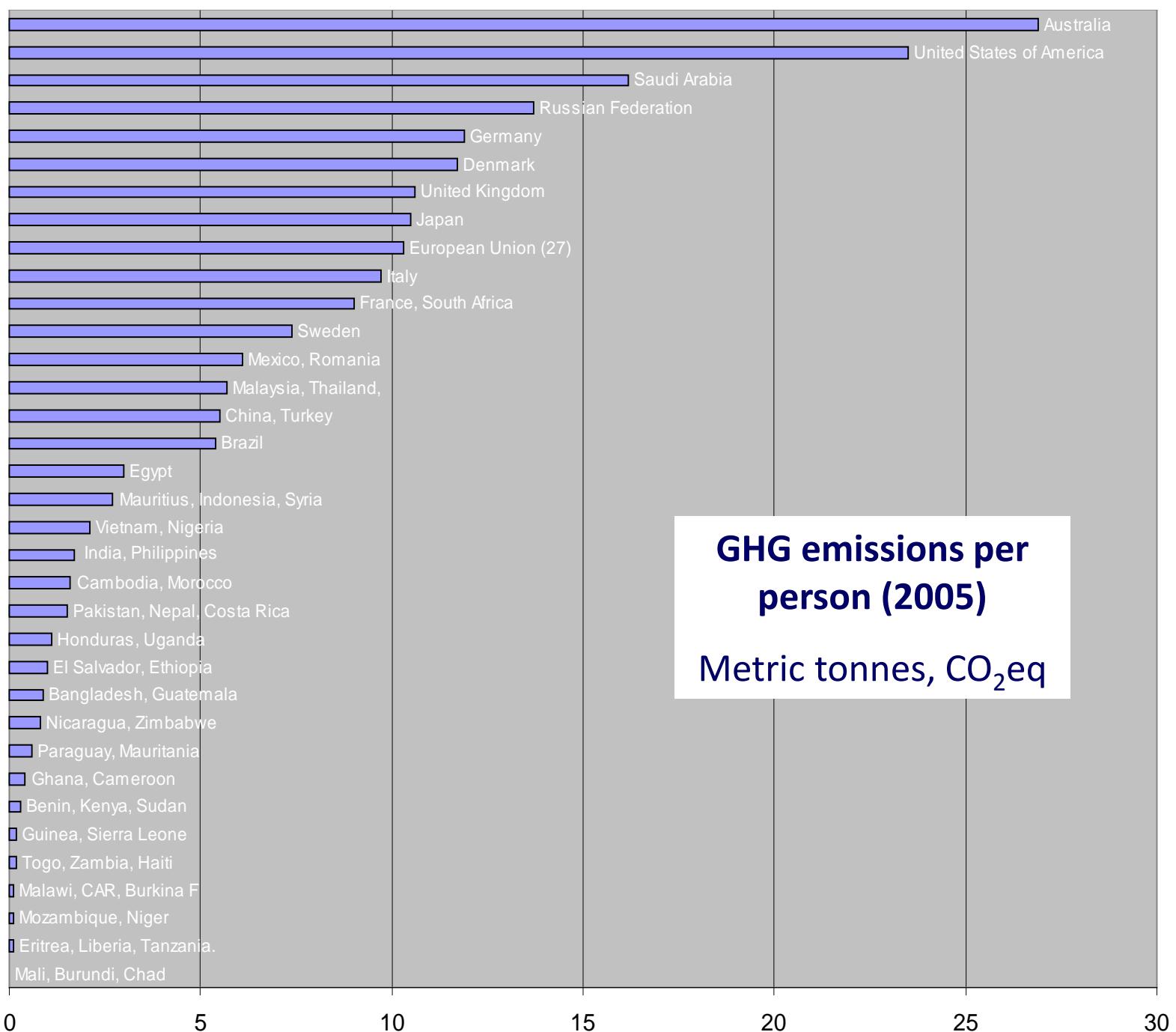
What is driving climate change?

How are humans and cities drive climate change?

Country GHG emissions

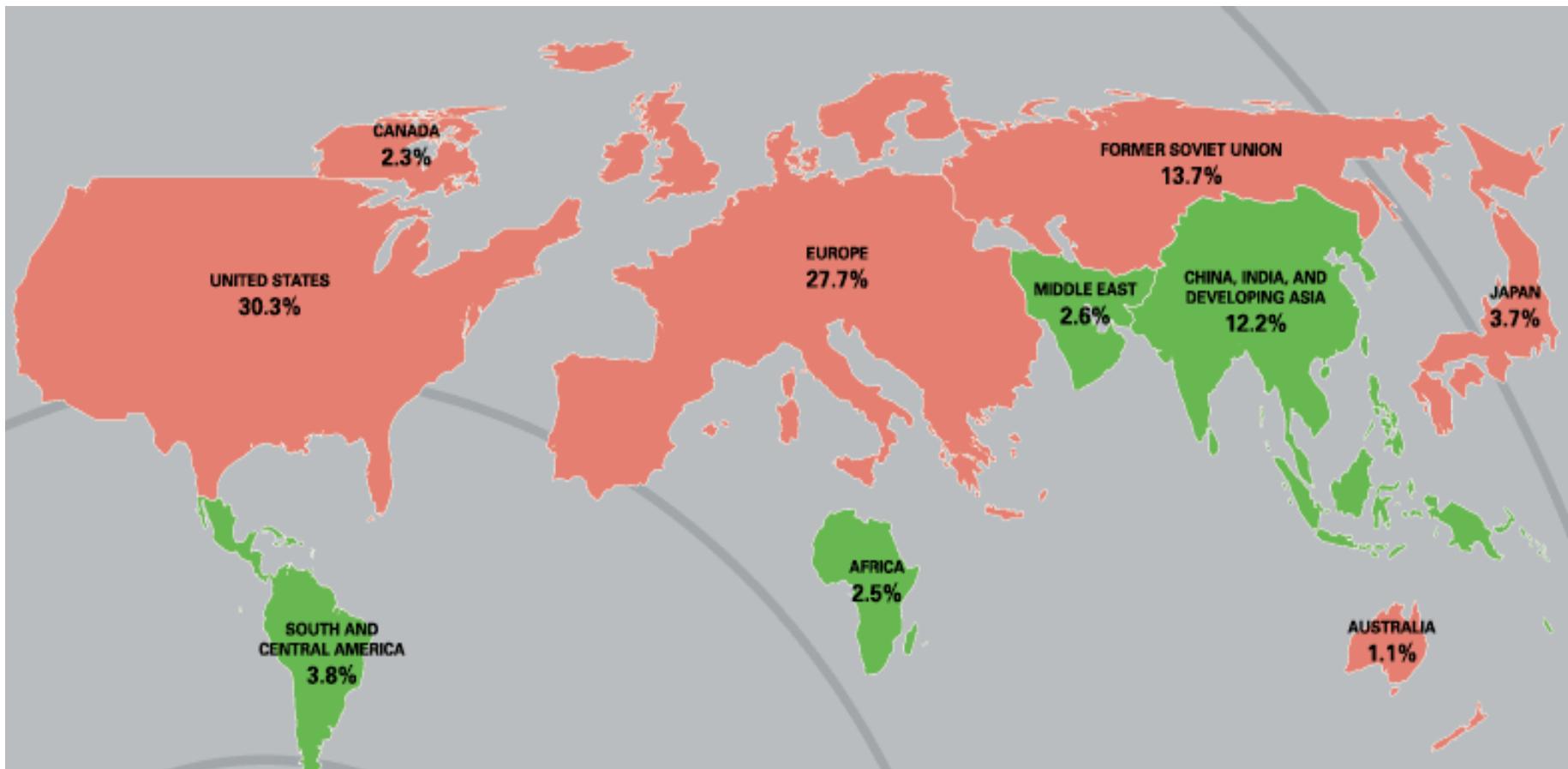
Total GHG Emissions (MtCO₂e)





Industrialized countries have emitted the most anthropogenic CO₂

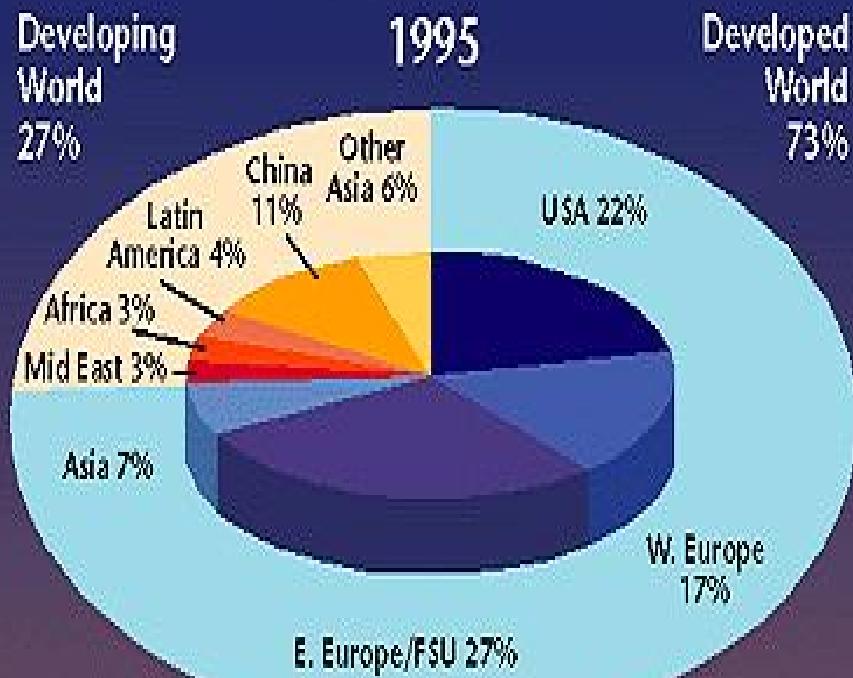
(Area proportional to historical CO₂ emissions from fossil fuel combustion, 1900-1999)



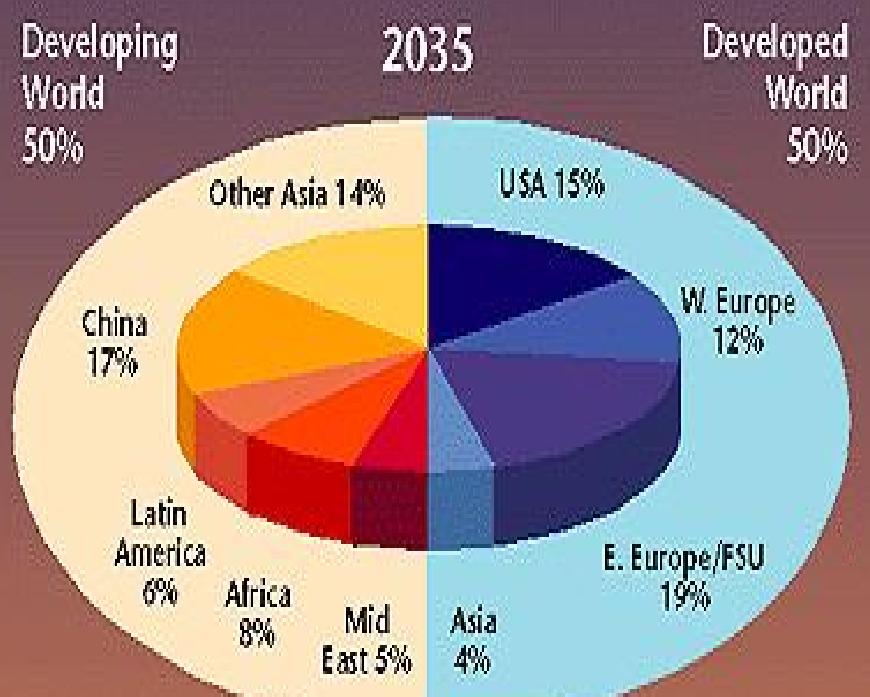
Source: WRI

Share of global GHG emissions

**1995 total emissions:
6.46 billion tons of carbon**

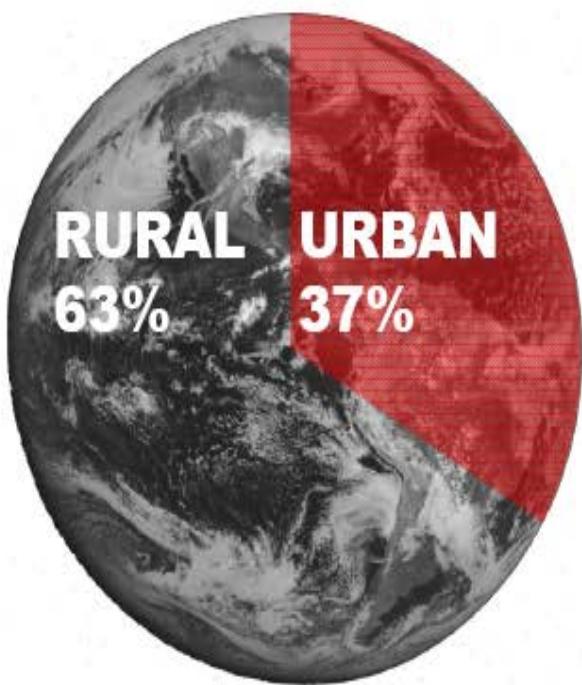


**2035 total emission estimate:
11.71 billion tons of carbon**

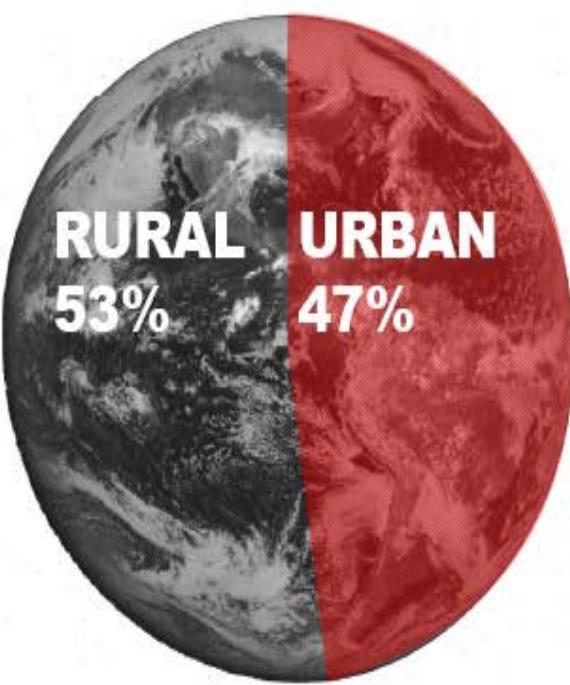


Source: OSTP

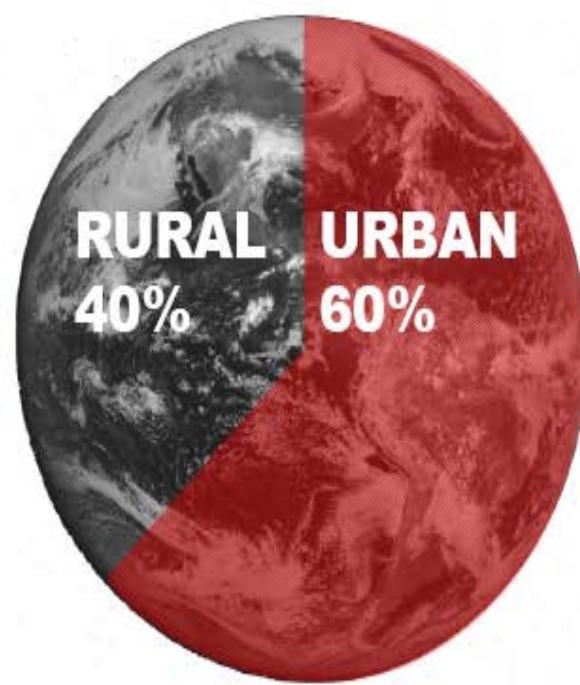
Global Population: Rural / Urban



1970

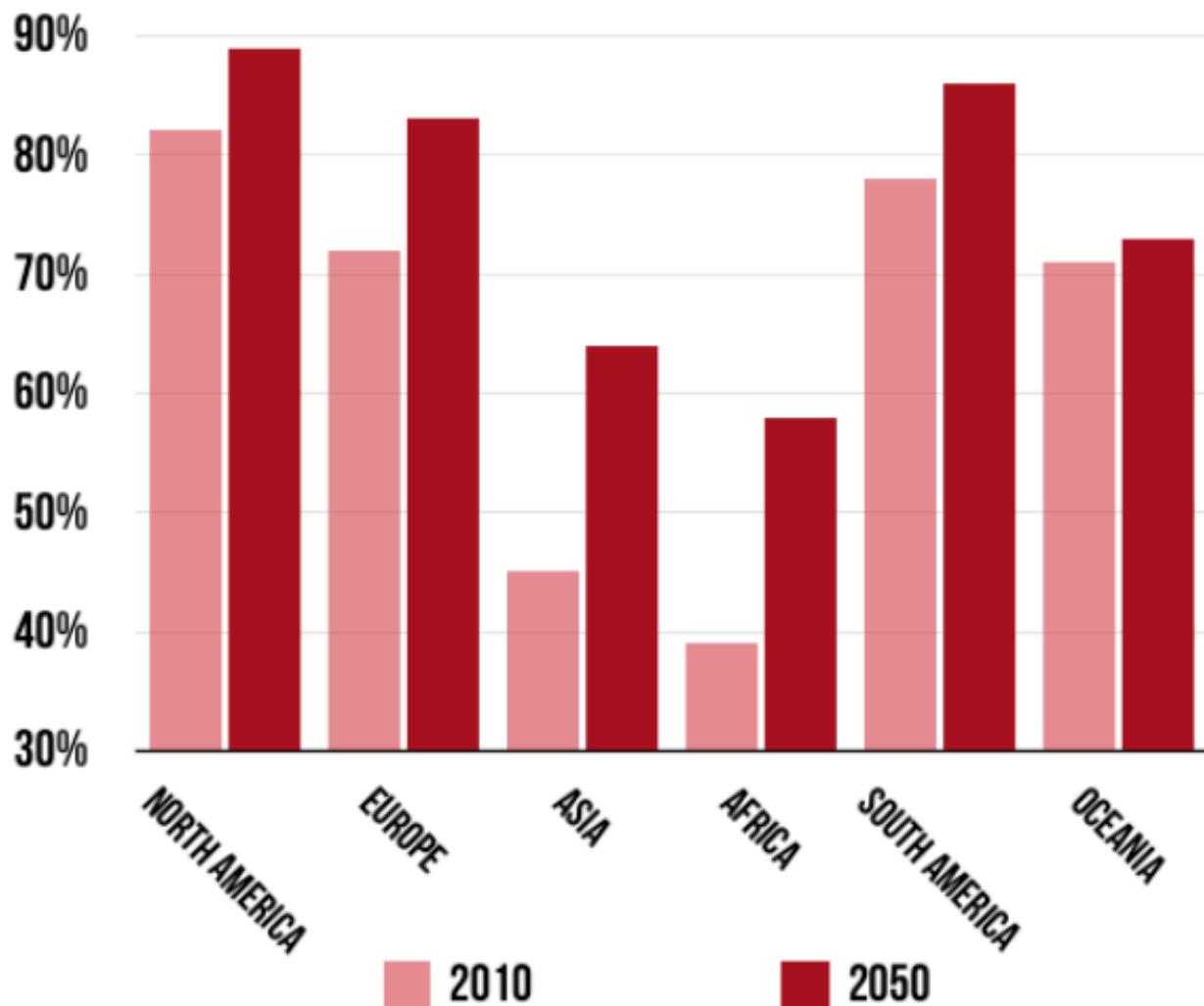


2000

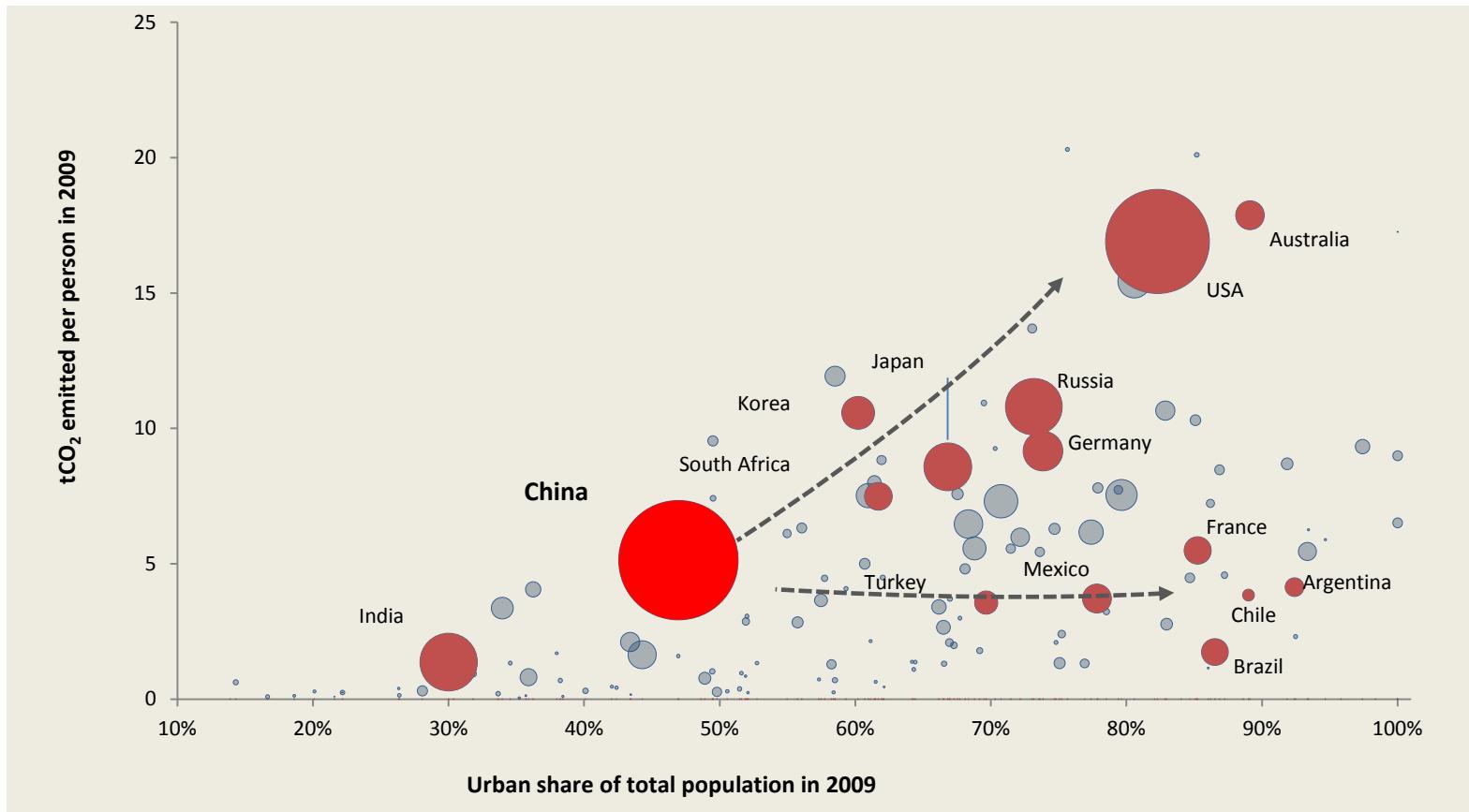


2030

% OF POPULATION LIVING IN URBAN CENTRES



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



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

Source: World Development Indicators

“Our struggle for global sustainability will be won or lost in cities”
(Ban Ki-Moon,
UN Secretary
-General)



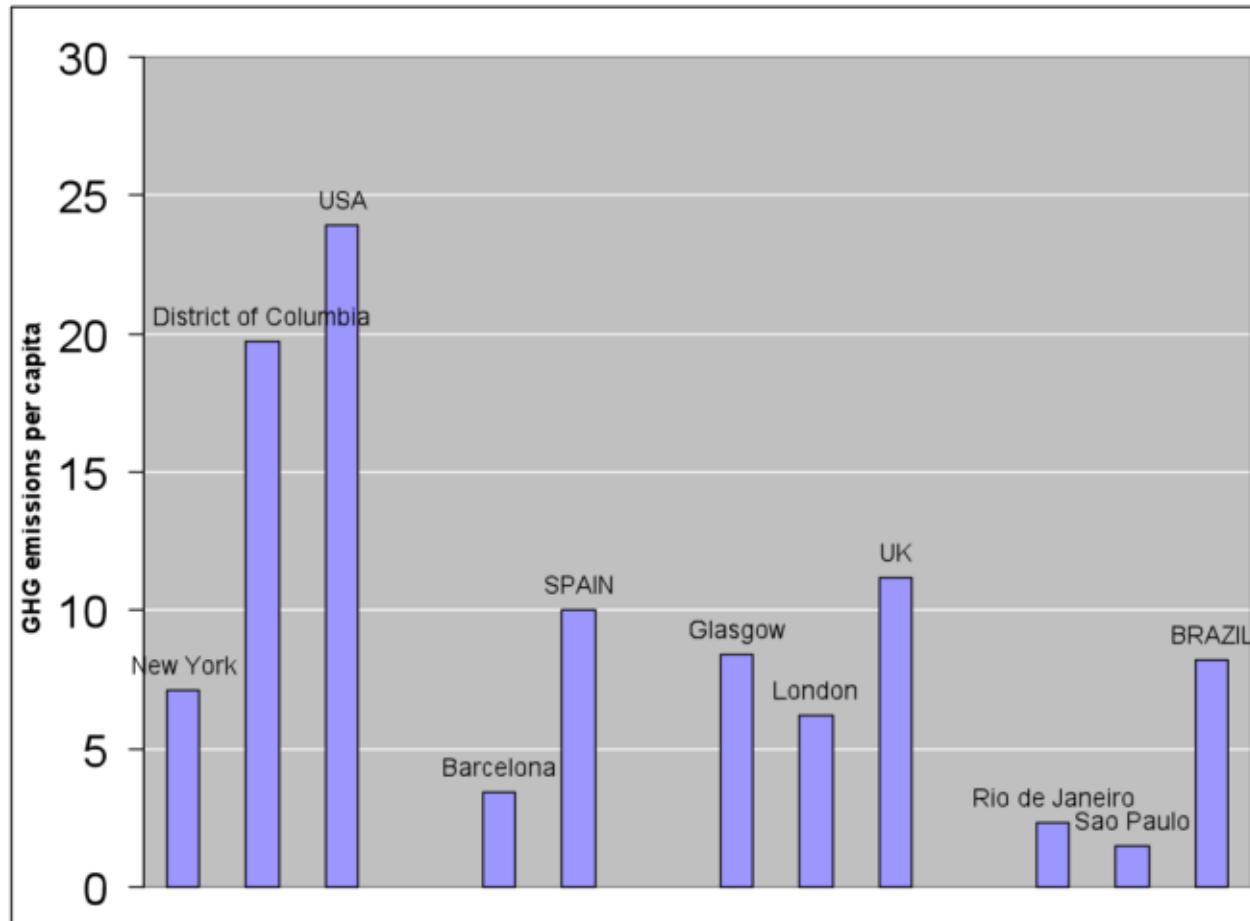
Cities cover about 3% of
the earth's surface but
are disproportionately
responsible for causing
climate change

60-80%

Source: UN Habitat, 2011

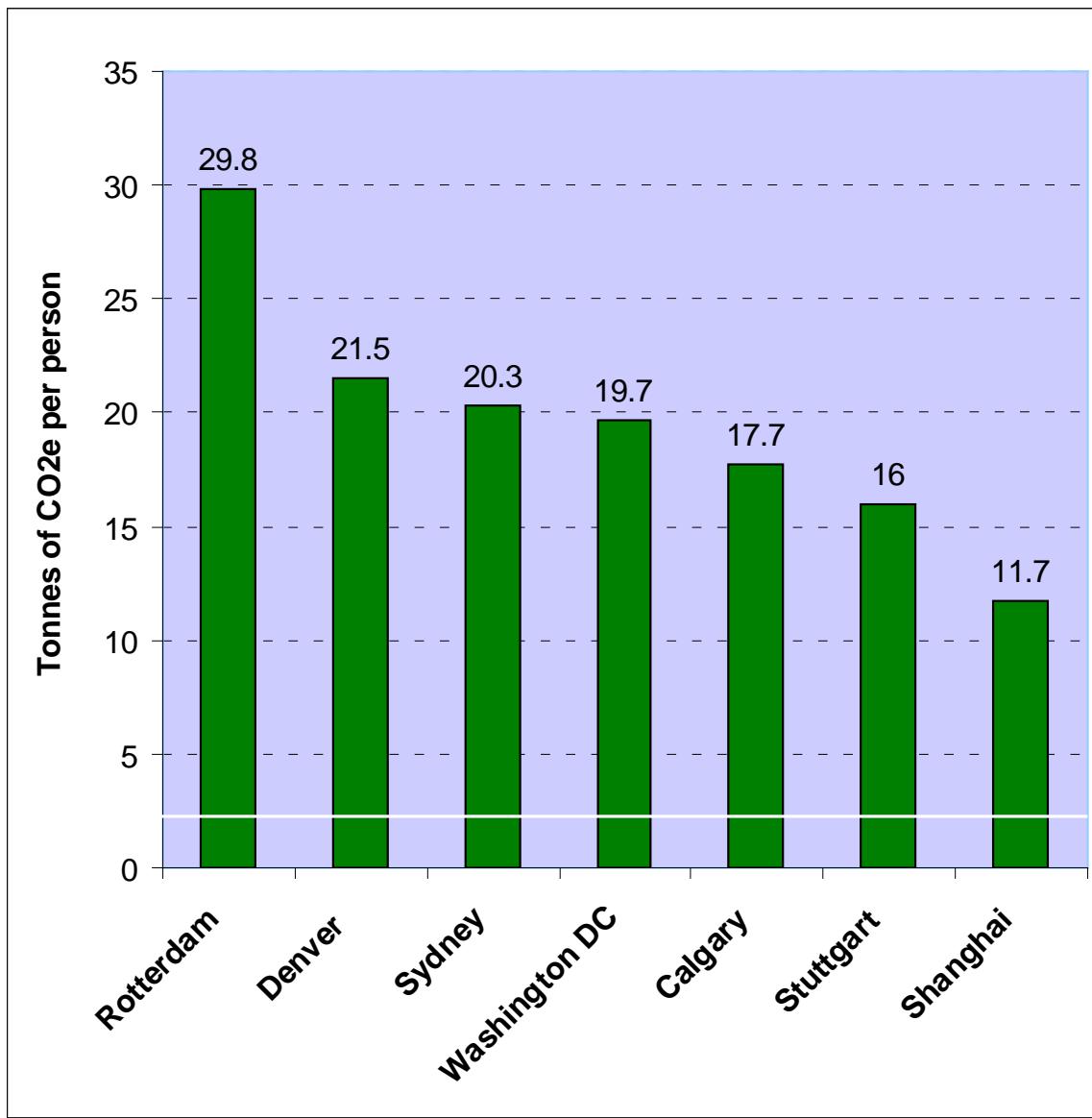
Per person GHG emissions: Cities vs Nations

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

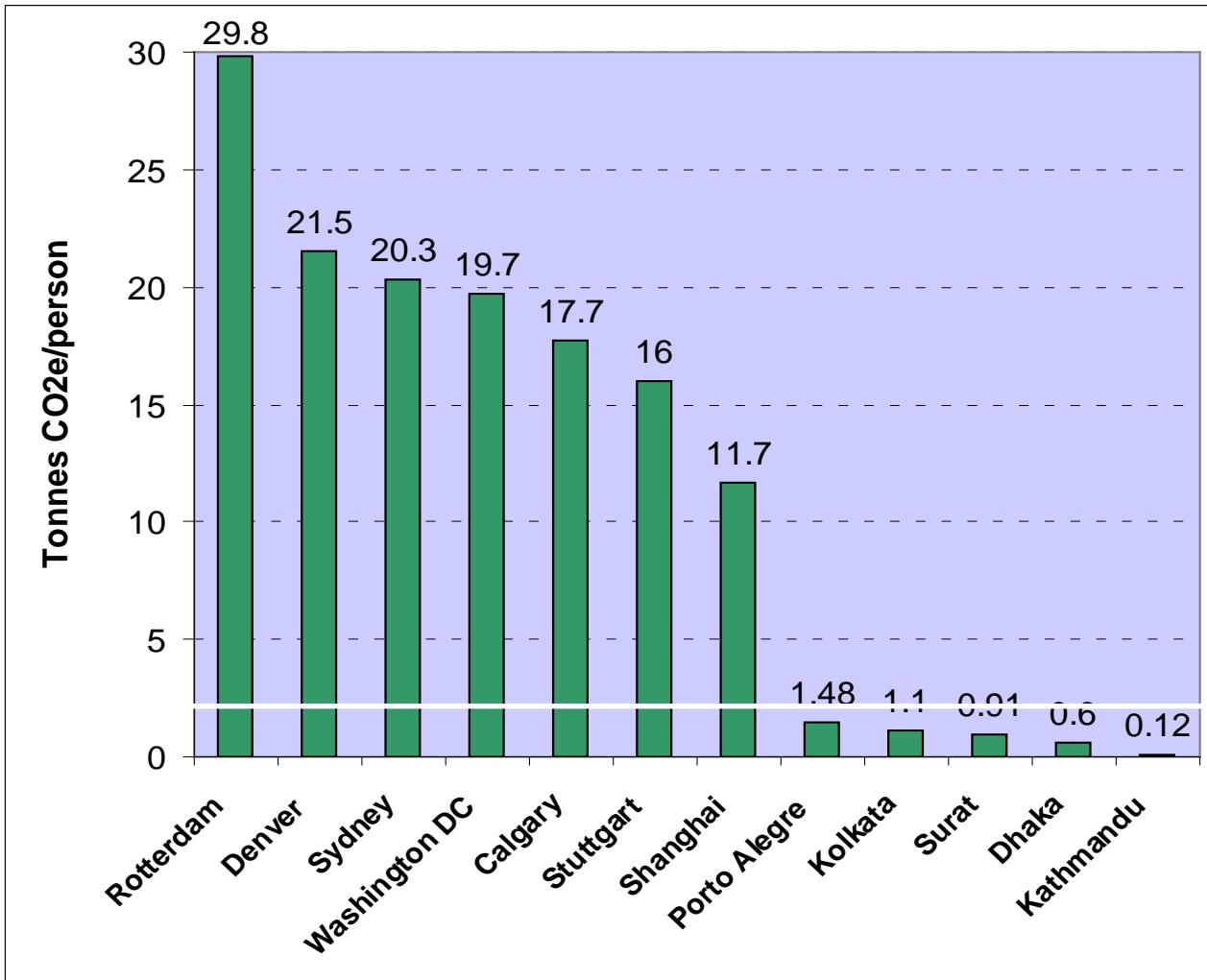


Source: Dodman 2009. NB Care should be taken in comparing figures for the cities in different nations, due to differences in methodologies for counting and assigning greenhouse gas emissions.

GHG emissions/person/year



GHG emissions/person/year



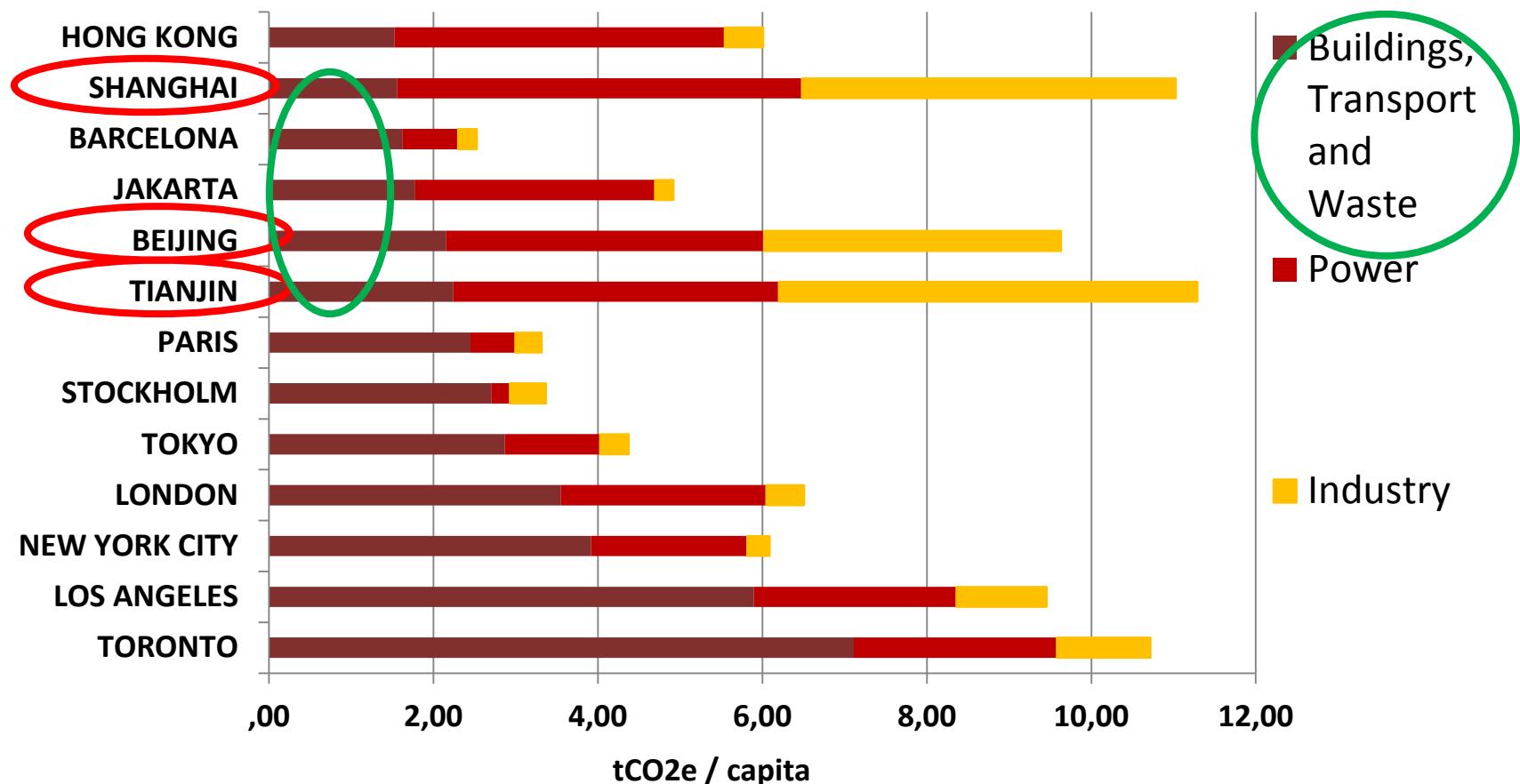
'Fair-share'
global
average

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



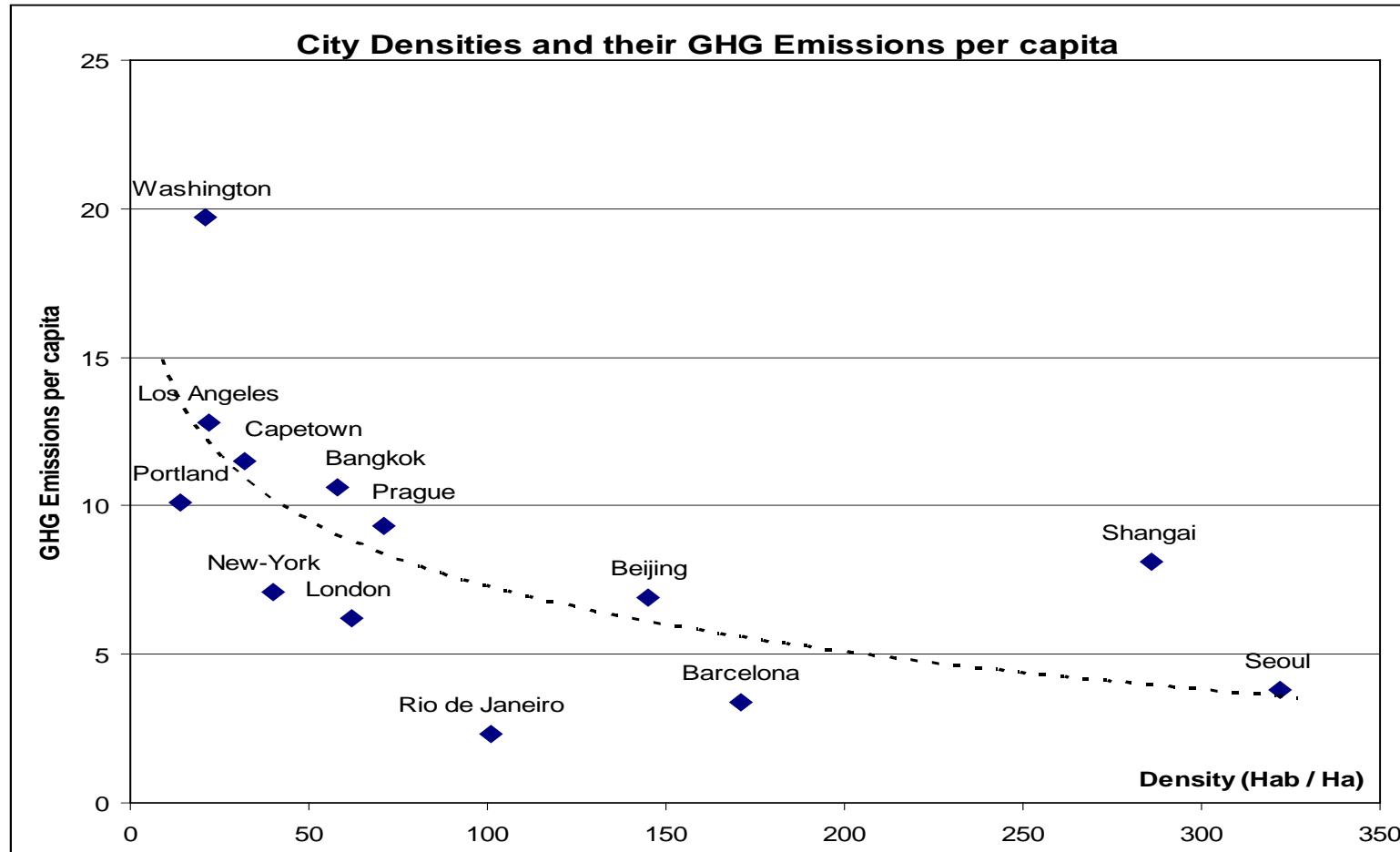
Consumption vs production based approaches

- **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 CO₂e/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



Atlanta and Barcelona have similar populations but very different carbon productivity

Atlanta

Barcelona

Built-up area



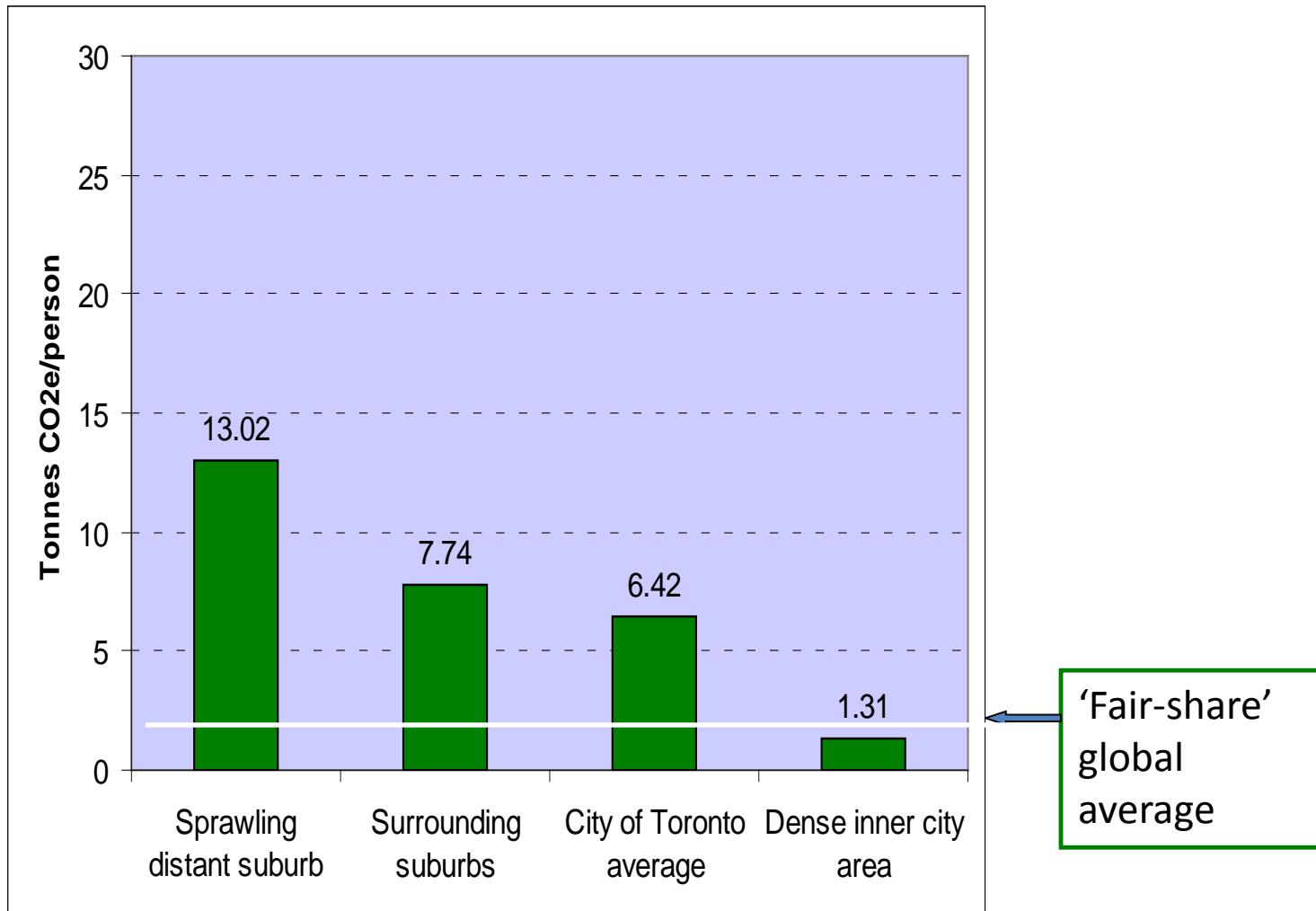
Built-up area



Population	Urban area	Transport carbon emissions	Population	Urban area	Transport carbon emissions
2.5 million	4,280 km ²	7.5 tonnes CO ₂ /person (public + private transport)	2.8 million	162 km ²	0.7 tonnes CO ₂ /person (public + private transport)

(Source: New Climate Economy report, 2014)

GHG emissions/person/year, Toronto



(Source: Van de Weghe and Kennedy, 2007)

Land-Use and CO₂

Suburban
8 DU/acre
0.25 FAR



Urban
40 DU/acre
2.5 FAR



CO₂ Lbs/Yr/Household

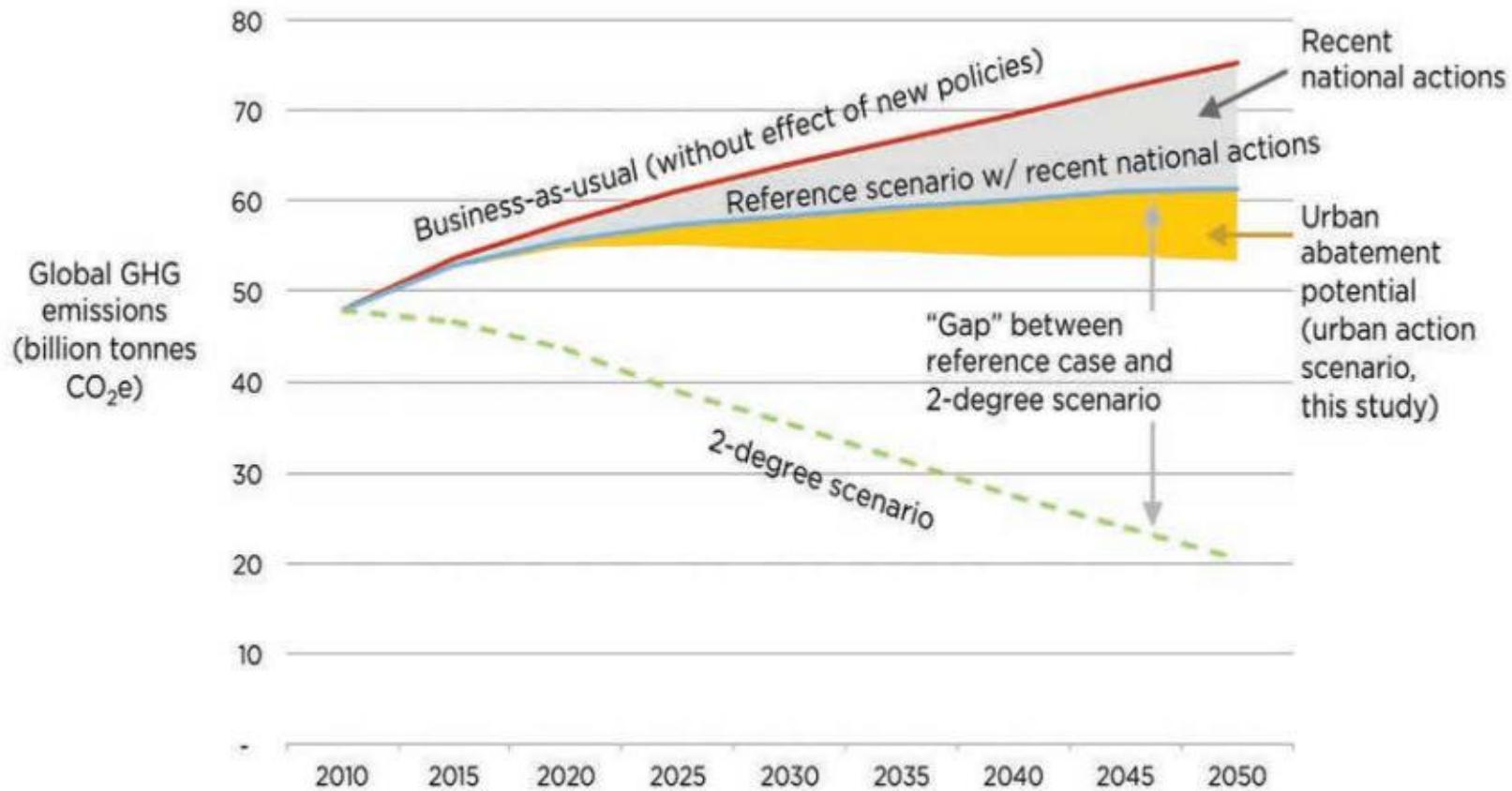
Buildings	25,000	10,000
Transportation	<u>24,000</u>	<u>9,000</u>
Total	49,000	19,000

Source: Eliot Allen, "Cool Spots"

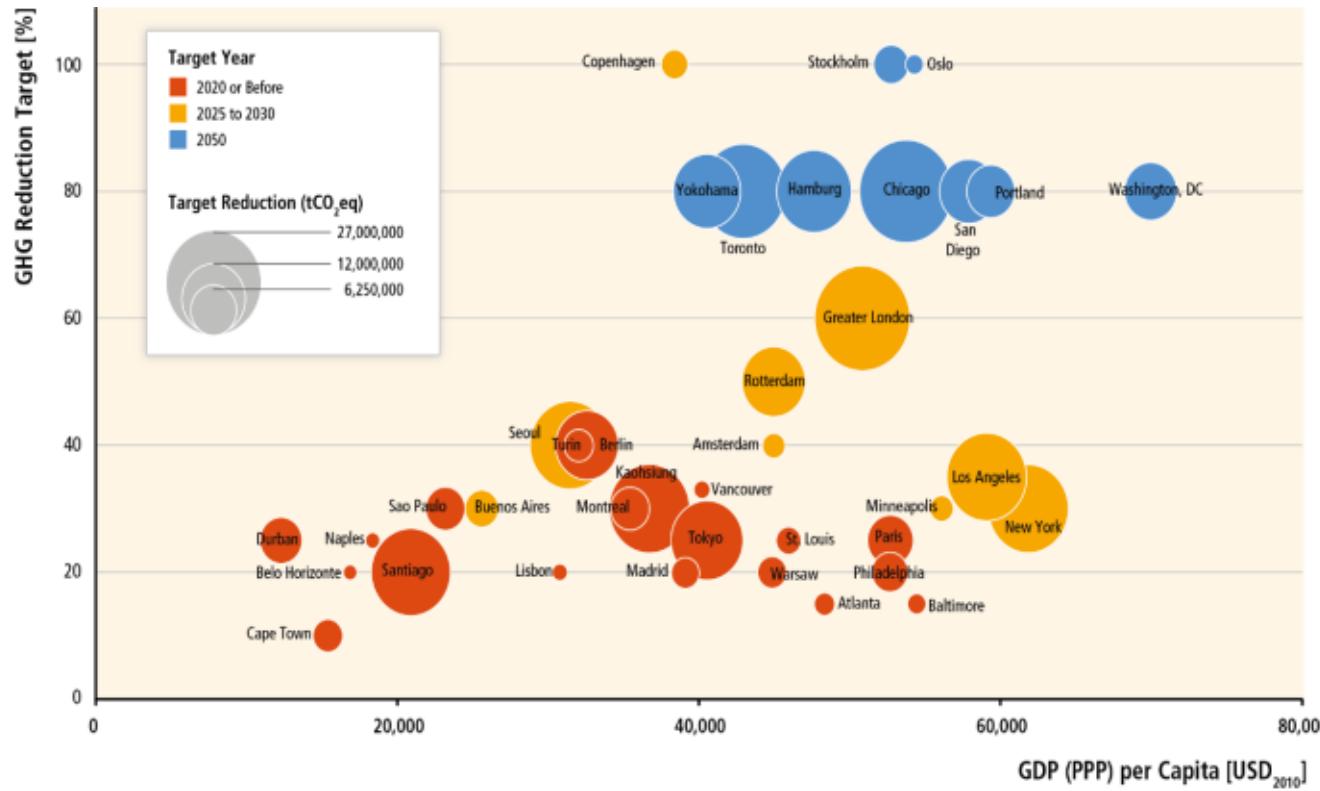
Low carbon cities and quality of life

- 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 CO₂ 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



Thousands of cities are undertaking Climate Action Plans and Mitigation commitments

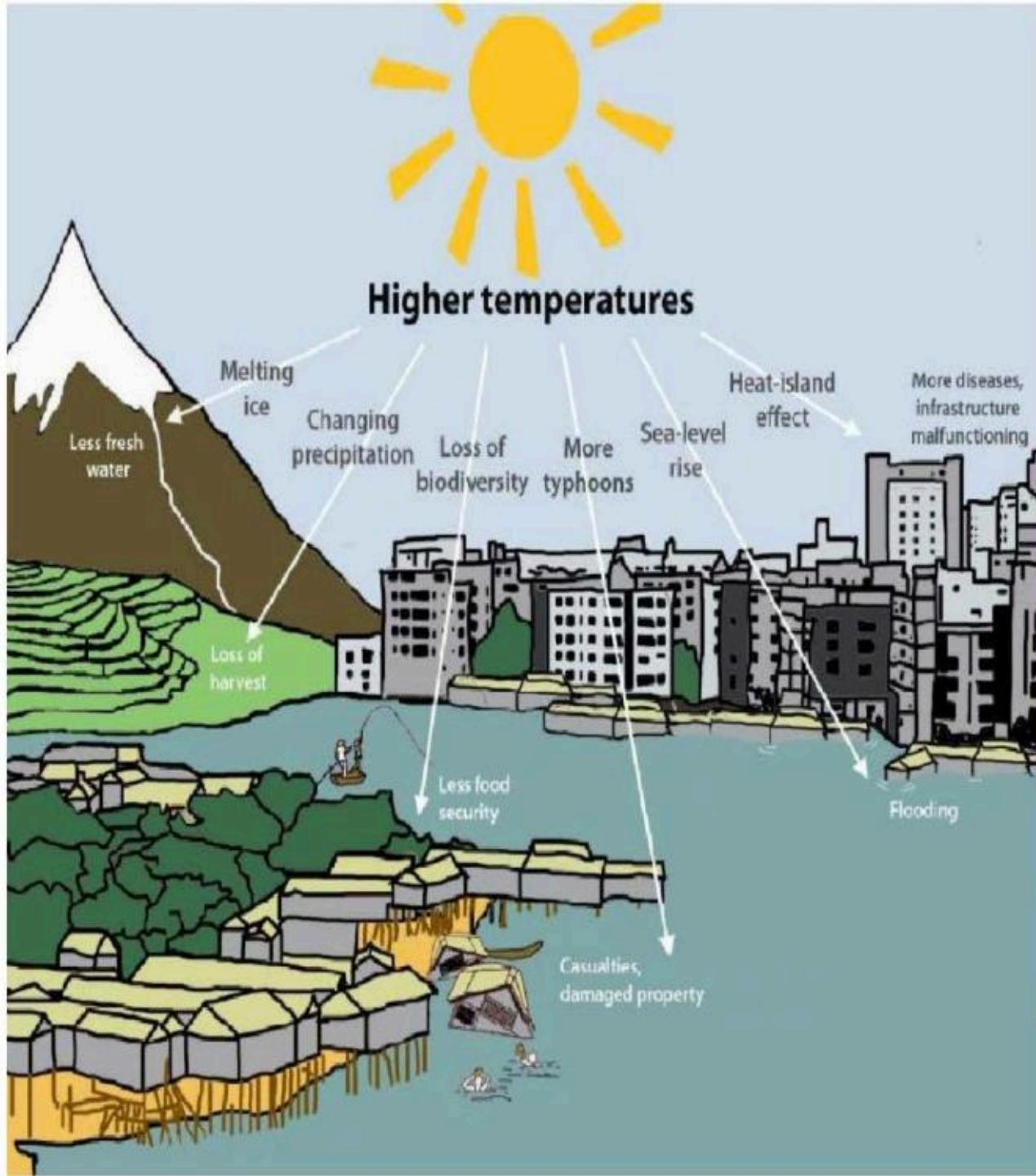


Yet, their aggregate impact on urban emissions is uncertain

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

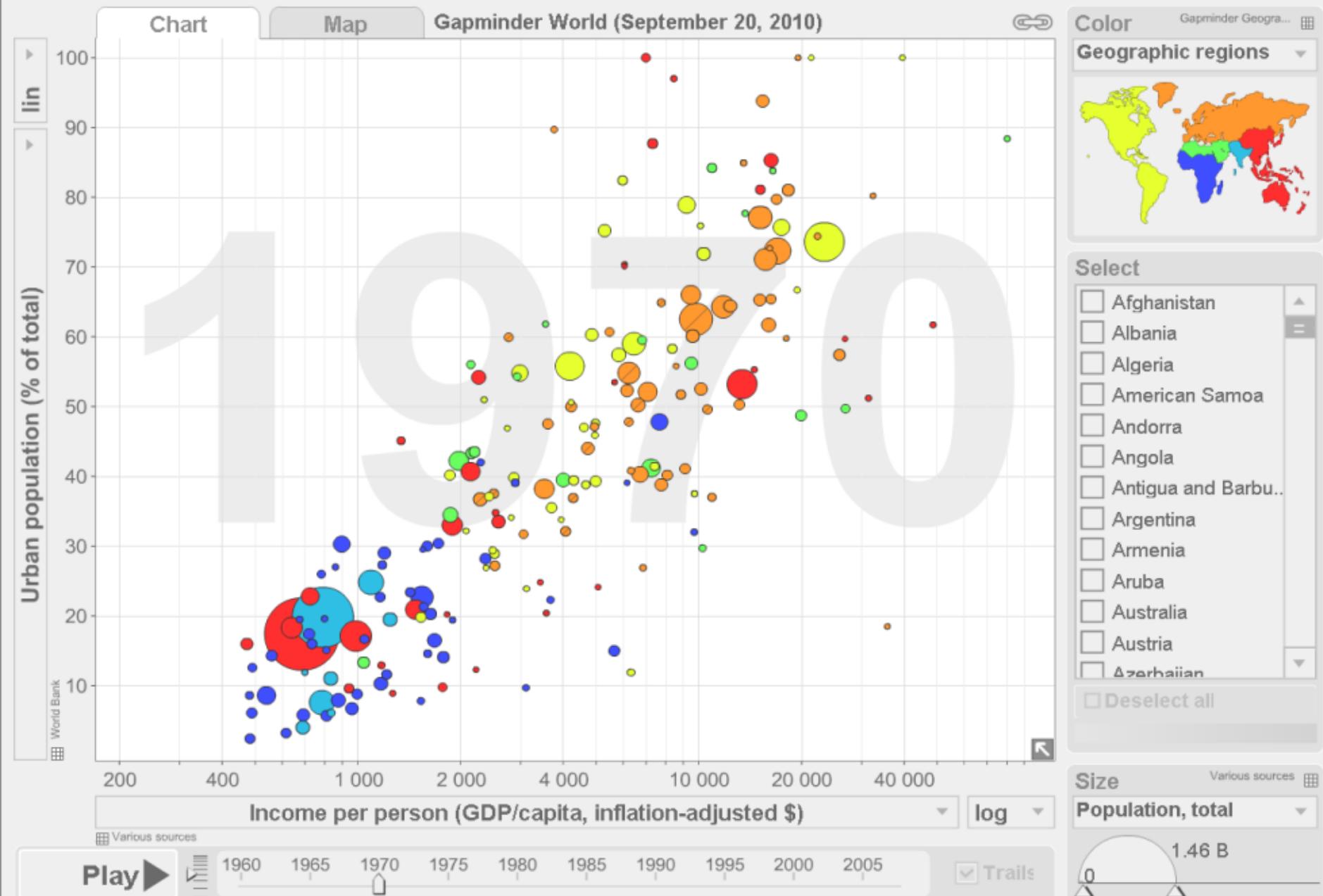
Climate change impacts, cities and Urbanization



TED talk on Urban CC vulnerability and adaptation

[http://www.ted.com/talks/vicki arroyo let s p
repare for our new climate.html](http://www.ted.com/talks/vicki_arroyo_lets_prepare_for_our_new_climate.html)

[New example] +



[New example] +

Chart

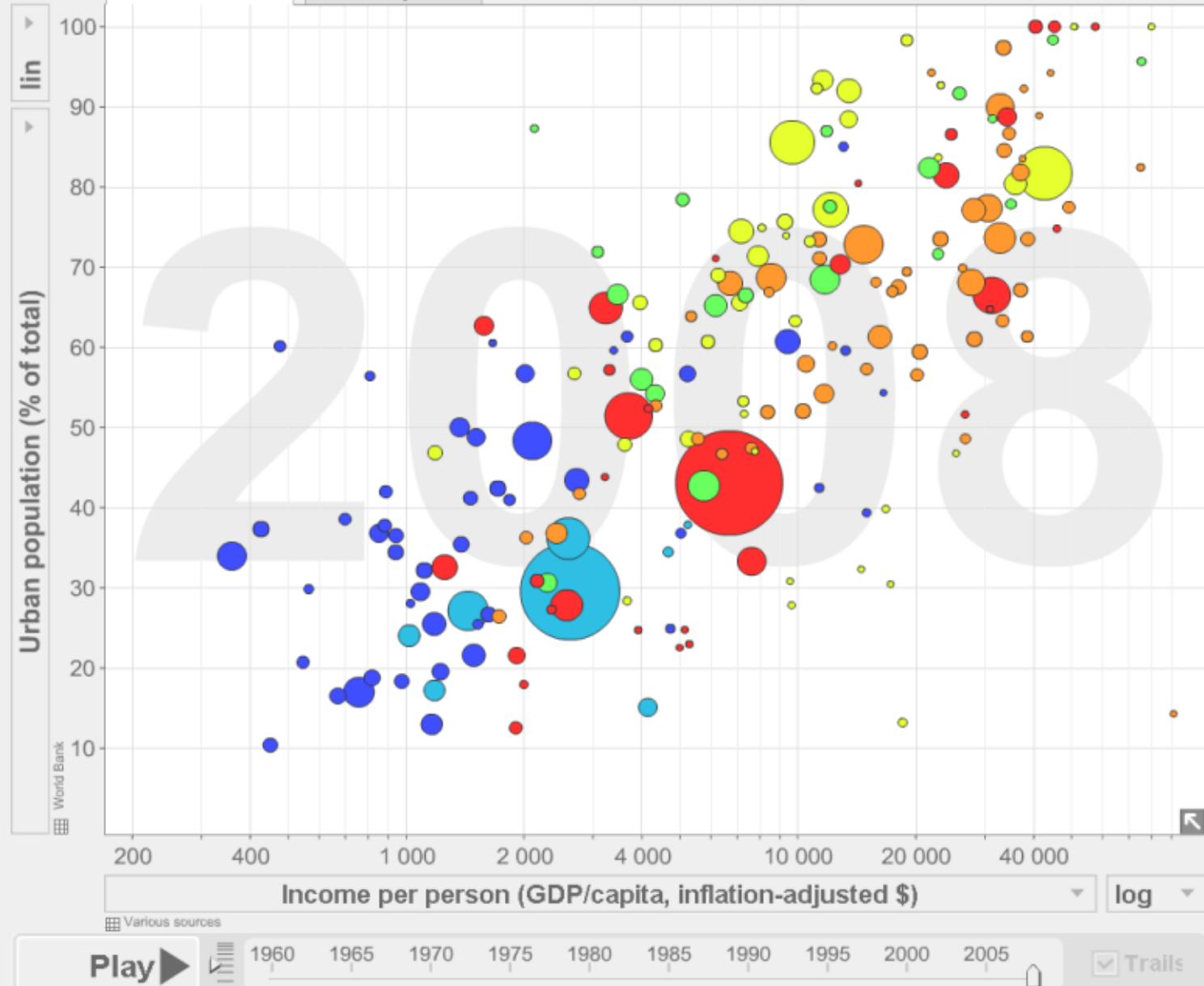
Map

Gapminder World (September 20, 2010)



Color

Gapminder Geogra...



Color Gapminder Geogra... 



Select

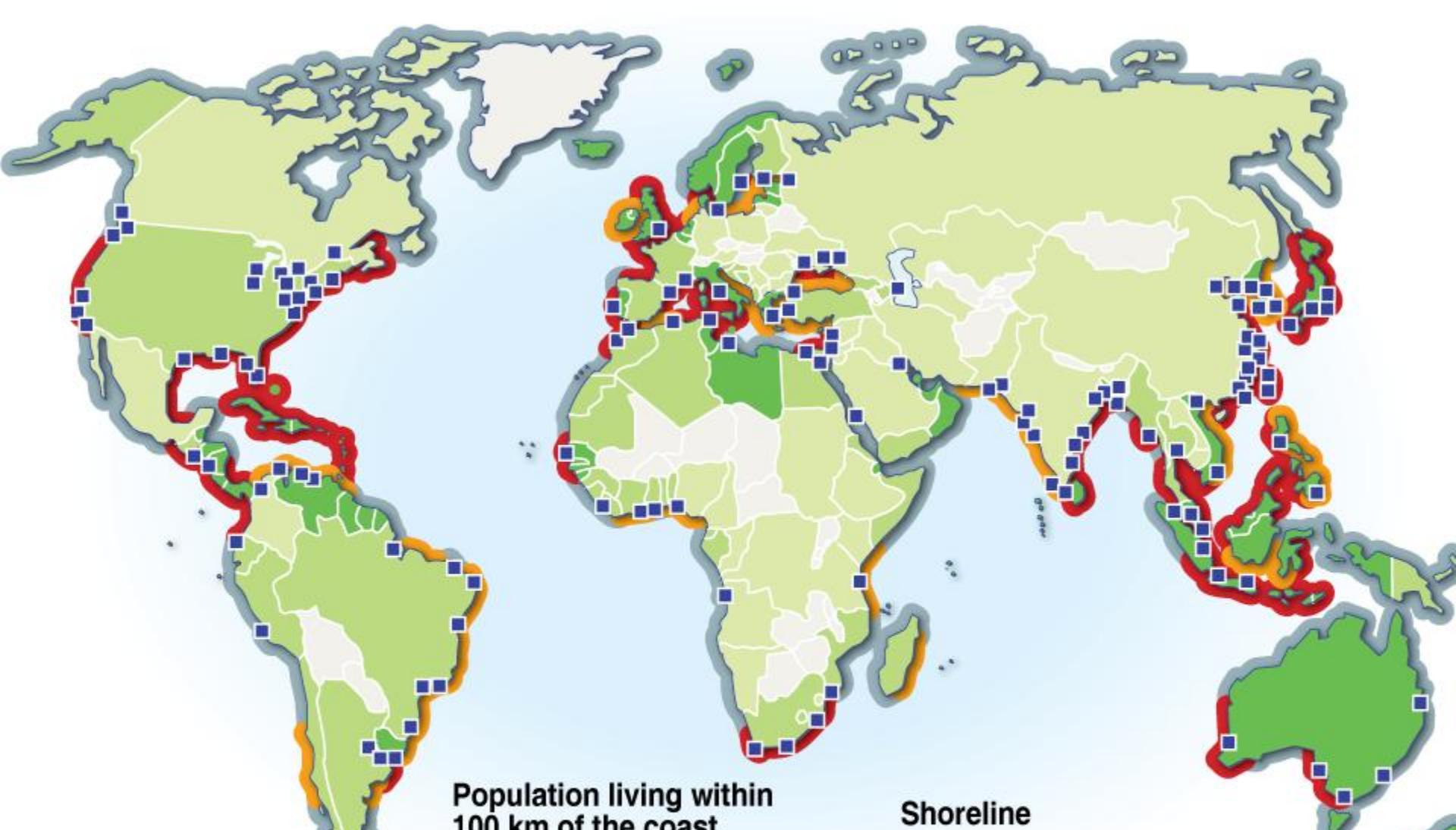
- Afghanistan
 - Albania
 - Algeria
 - American Samoa
 - Andorra
 - Angola
 - Antigua and Barbuda
 - Argentina
 - Armenia
 - Aruba
 - Australia
 - Austria
 - Azerbaijan

Size

Various sources

Population, total





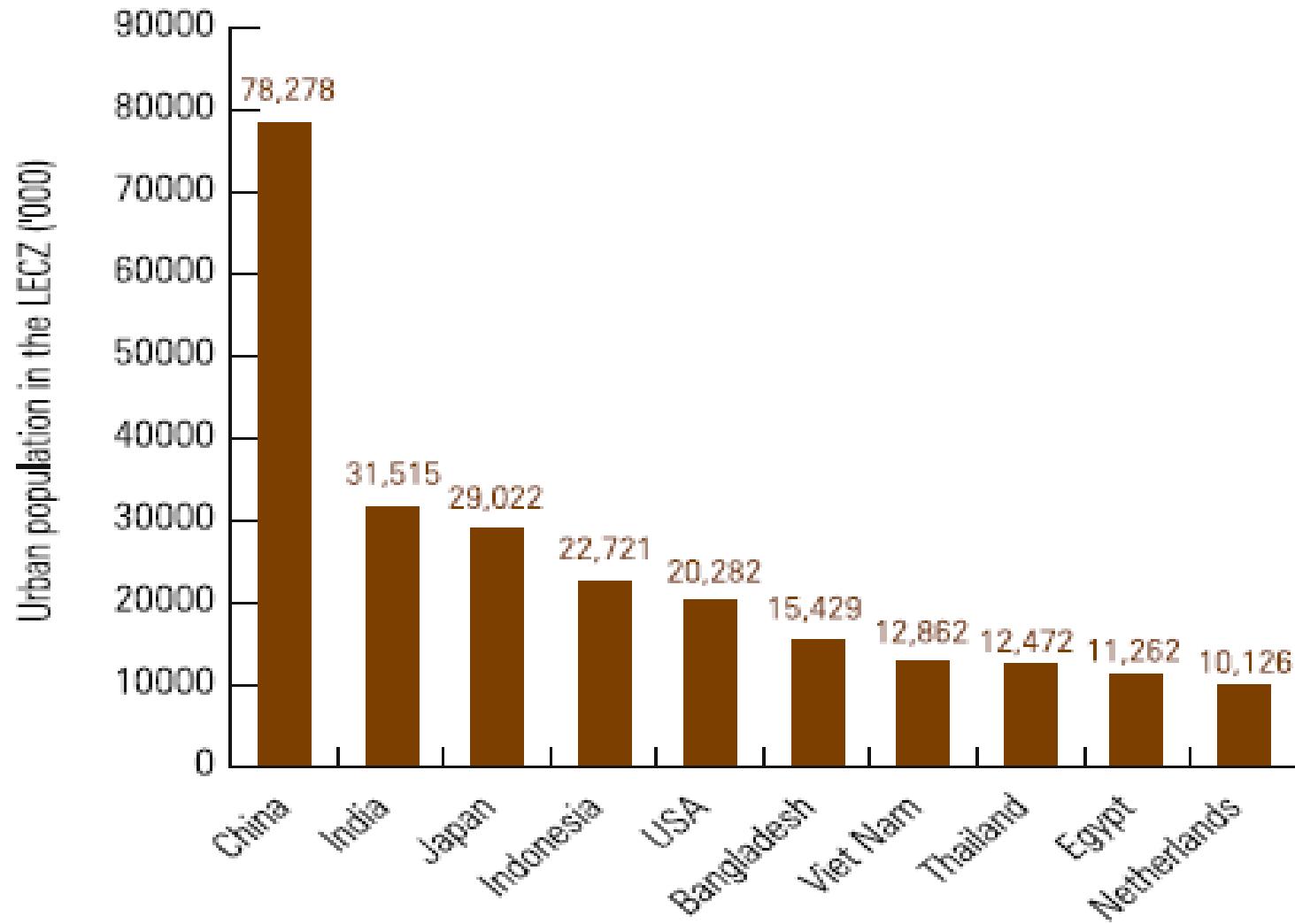
Population living within
100 km of the coast



Shoreline

- Most altered (red line)
- Altered (orange line)
- Least Altered (grey line)
- Selected coastal cities of more than one million people (blue squares)

Urban Population in Low Elevation Coastal Zones for Selected Countries



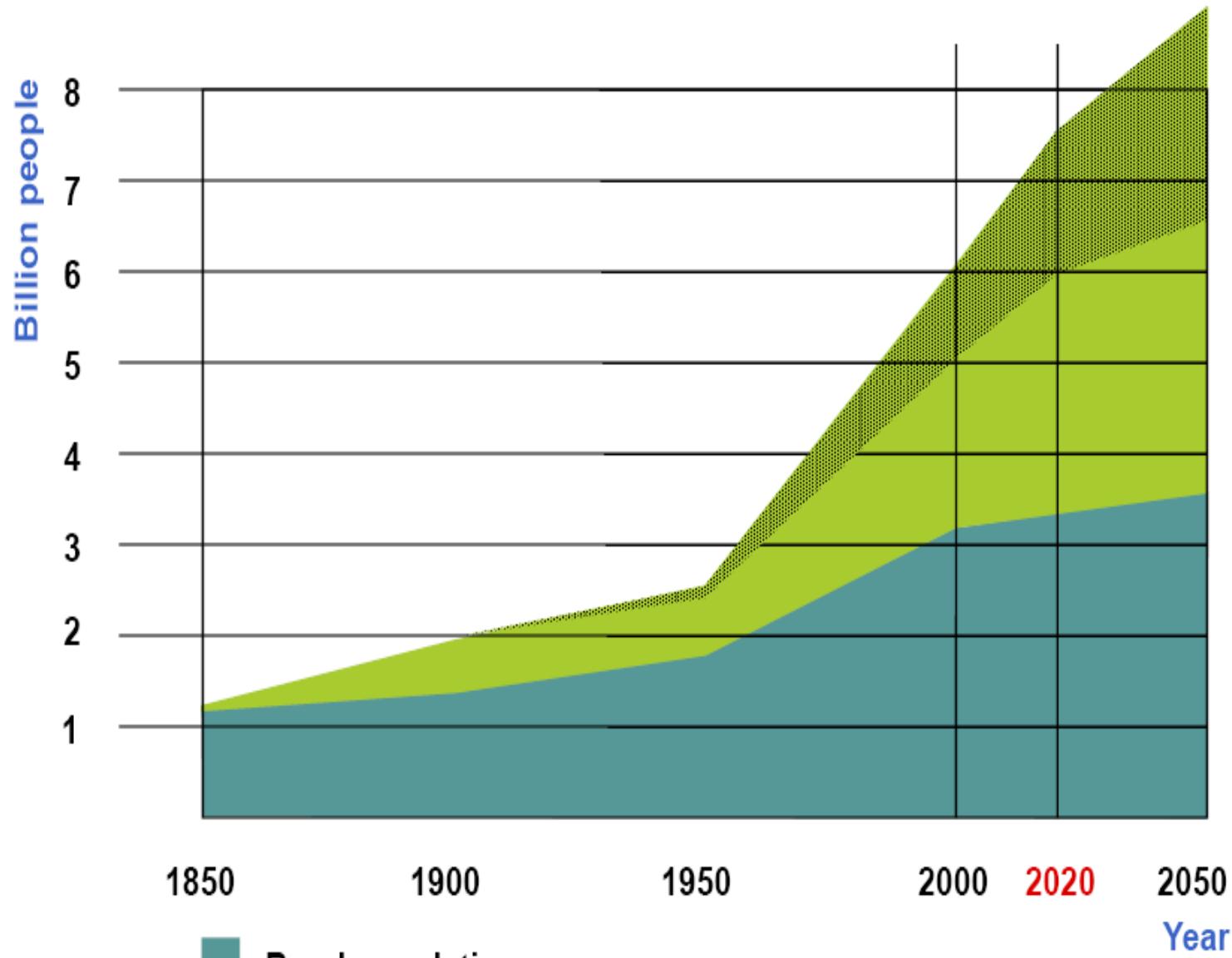
Climate impacts in cities

Cities face the **greatest risks**

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



Population of the World



 Rural population
 Urban population
 Urban slum population

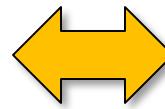
Reference: UN-HABITAT, Global Urban Observatory

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)

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**

Thank You



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Literature

- UN –Habitat, 2011, Global Report on Human Settlements 2011: Cities and Climate Change, ch. 1: Urbanization and the challenge of climate change, Earthscan, London, UK, 1 – 16, (15 pages).
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- Dodman, D., (2009), Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories, *Environment and Development*, vol. 21 (1), 185-201
- Chakravarty et al., (2009) Sharing global CO2 emission reductions among one billion high emitters, *PNAS*, vol. 106, no. 29