Climate Change and Crop Production

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Definitions

- **Weather**: a daily condition of atmospheric events (i.e.: rain showers, wind direction, fog, snow amounts, etc.)
- **Climate**: long term (years) condition of atmospheric events.
- **Global warming**: the change in the yearly average of the world's temperature.
- **Climate change**: the long term (years) changes in atmospheric conditions, of which global warming is a part.

What is Climate Change?

- Climate is the average weather over a long period (typically 30 years).
- We expect the weather to change a lot from day to day, but we expect the climate to remain relatively constant.
- If the climate doesn't remain constant, we call it climate change.
- The key question is what is a significant change – and this depends upon the underlying level of climate variability

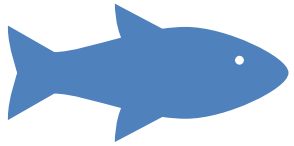
Climate Change History

- Earth's climate has always been changing
  - Ice age (2 million years ago), glacial periods, polar ice caps
  - 18,000 years ago: cold spell & continental glaciers
- Last 100 years, surface has warmed about 0.6°C
- In past 10,000 years, global temp. has never varied more than 1.5°C

Climate Change

Temperature Change

Precipitation Change



Sea Level Rise

Past Climate Change

The Earth's climate has changed numerous times in the geologic past, and 5 times it caused mass extinctions. Climate change in the past has been influenced by several different events:

- Changes in the sun's output
- Changes in the earth's orbit
- Meteors impacting the Earth
- Natural changes in greenhouse gases levels

Currently there is another event that causes climate change:

HUMAN ACTIVITY

Causes of Climate change

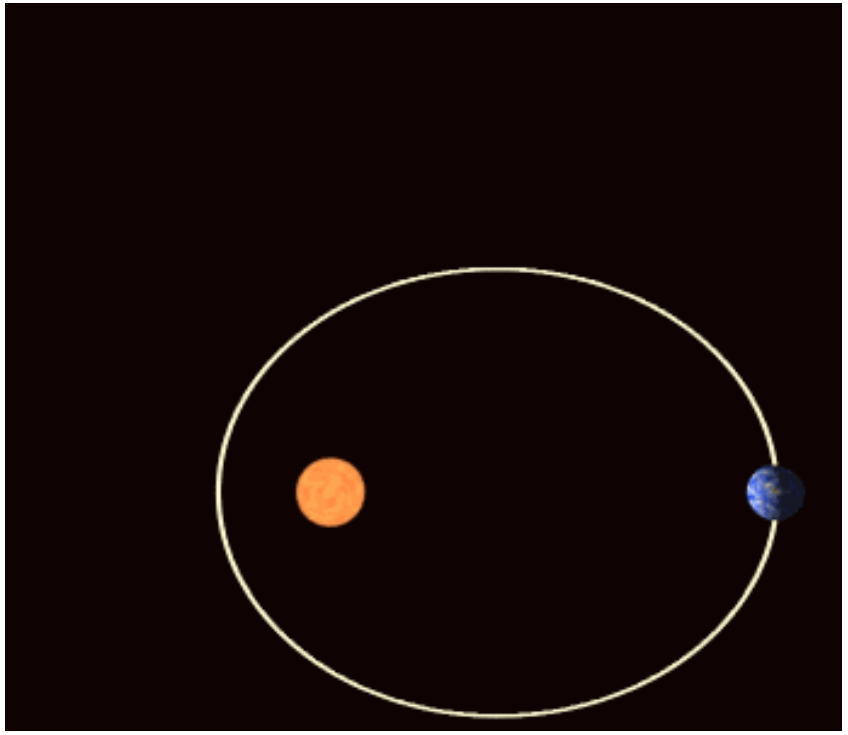
Natural

- Explosions on the sun ("sun spots")
- Volcanic eruptions on a massive scale
- Changes in earth orbit
- Changes in earth's orientation toward the sun
- Explosions caused by large meteors hitting the earth

Man made

- Greenhouse effect

Variations in the Earth's Orbit

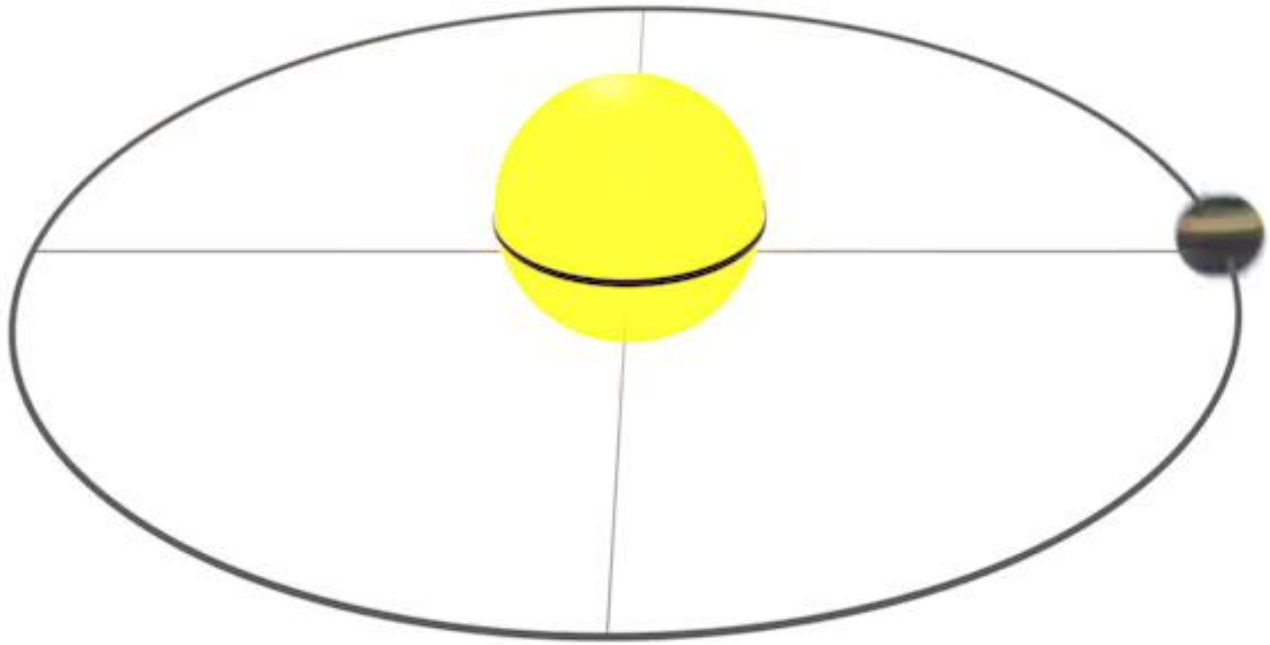


Changes in the energy output of the Sun, and the Earth's orbit around the Sun, do have an effect on the Earth's climate.

Ice ages have come and gone in regular cycles for nearly three million years. There is strong evidence that these are linked to regular variations in the Earth's orbit around the Sun, the so-called Milankovitch cycles. These cycles change the amount of the Sun's energy received by different places on the Earth's surface.

Changes in Eccentricity (Orbit Shape)

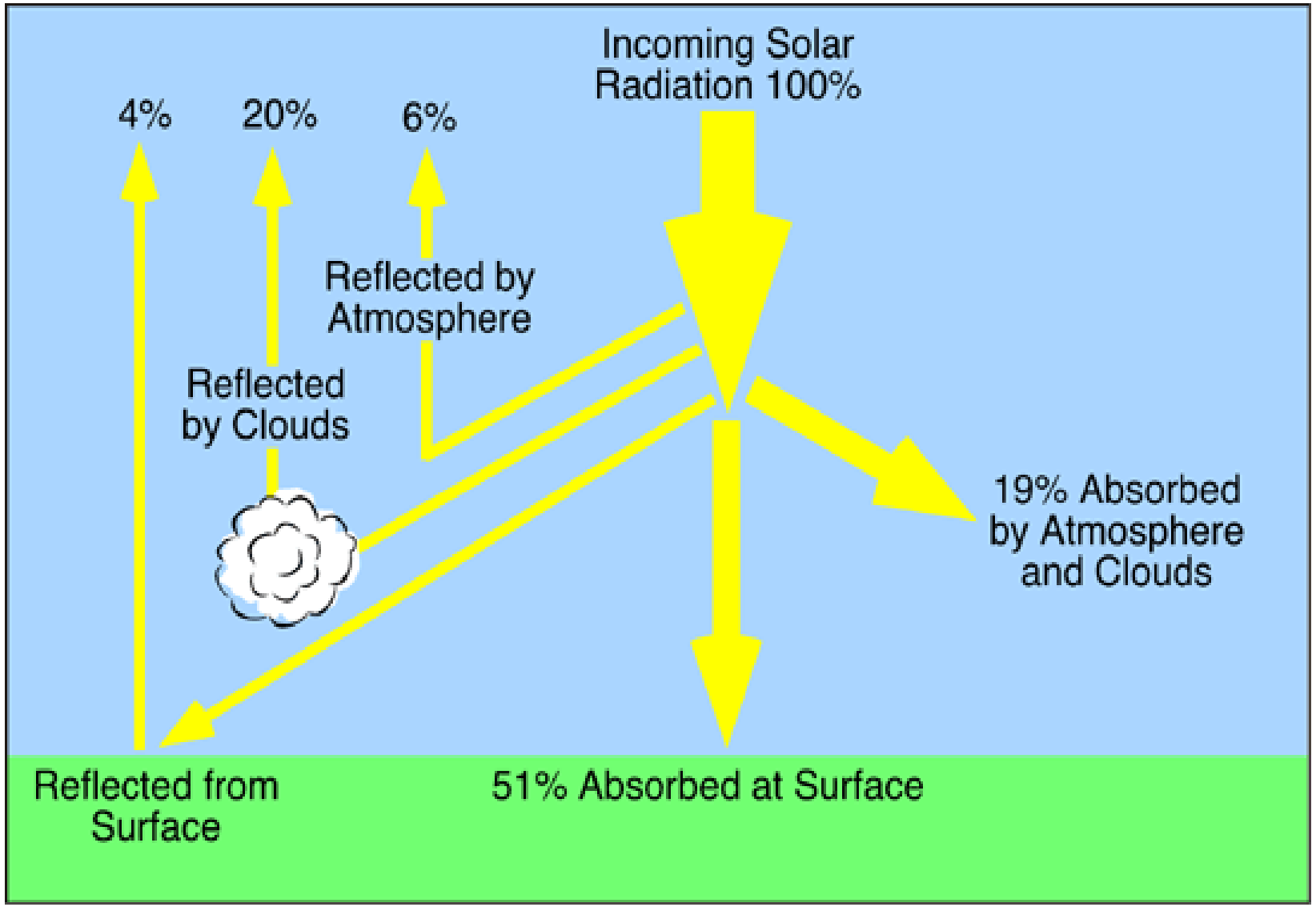
100,000-year cycles



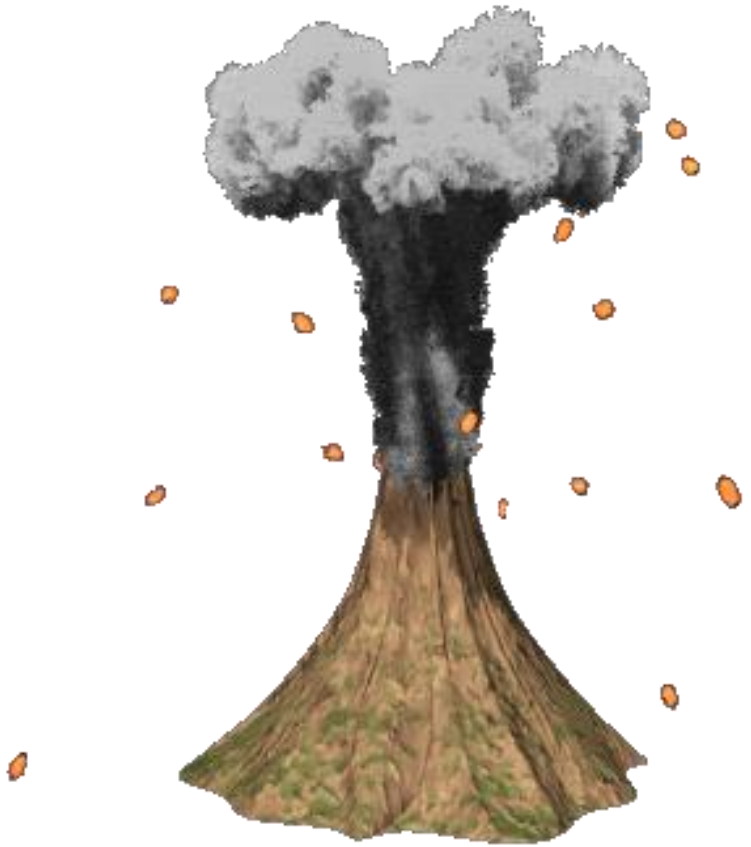
*Changes in eccentricity exaggerated so the effect can be seen. Earth's orbit shape varies between 0.0034 (almost a perfect circle) to 0.058 (slightly elliptical).

climate.nasa.gov

Changes in the amount of energy coming from the Sun



Volcanic emissions



There were 3 volcanic eruptions big enough to affect the climate in the 20th century – Agung in Indonesia (1963), El Chichon in Mexico (1982) and Pinatubo in the Philippines (1991).

Material (particles) from violent volcanic eruptions can be projected far above the highest cloud, and into the stratosphere where they can significantly increase how much incoming solar energy is reflected. Major volcanic eruptions can reduce average global surface temperature by about 0.5°C for months or even years.

Collisions with comets or meteorites

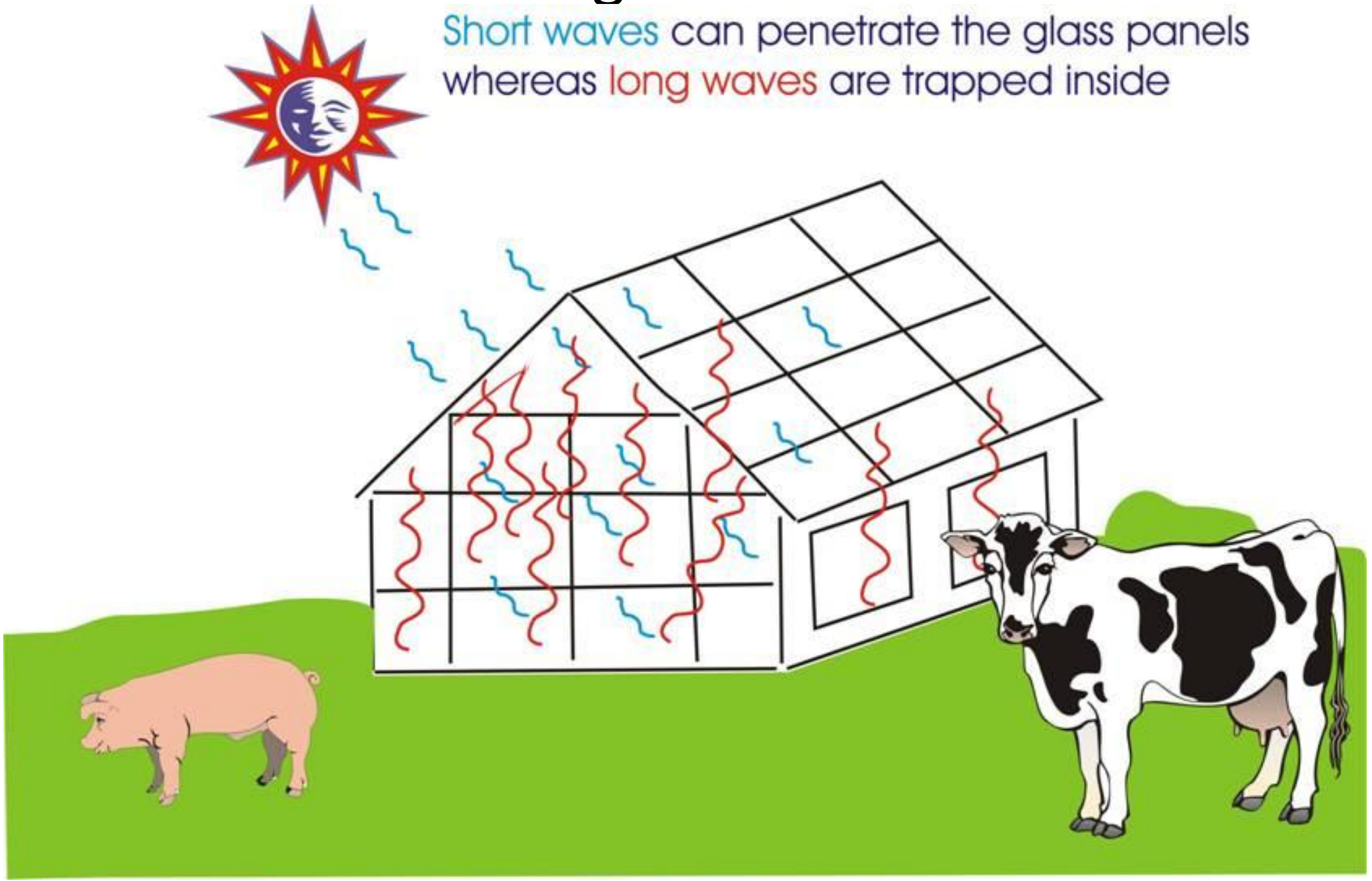
- The Earth's atmosphere protects us from the impacts of comets and meteorites, by vaporizing all or most of the incoming material before reaching the Earth's surface. Scientists believe however, that every once in a while a celestial body of significant size collides with the Earth, causing untold destruction and an ensuing global climate change.
- The comet/meteorite impact theory of climate change has been considered to account for the extinction of the dinosaurs 65 million years ago.


Sun
Greenhouse Effect

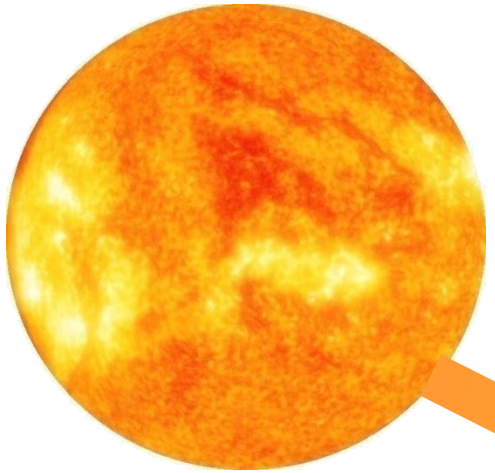
Definition of Greenhouse Effect

The greenhouse effect is the natural warming of the lower atmosphere (troposphere) because of the presence of **certain gases (Greenhouse gases)** by trapping more heat energy.

The real greenhouse



Example of the Greenhouse Effect



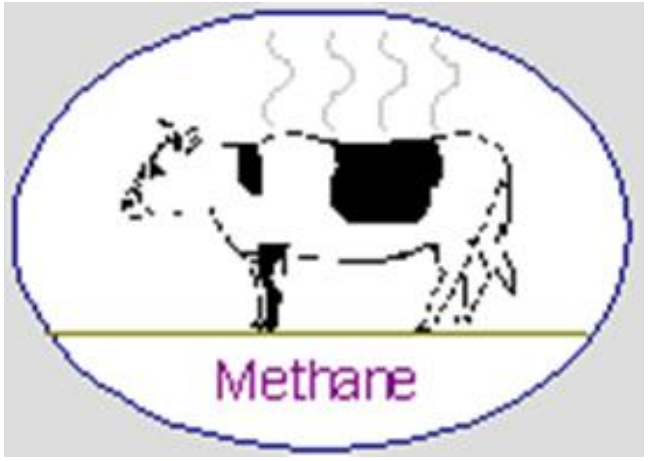
The Sun's energy passes through the car's windshield.

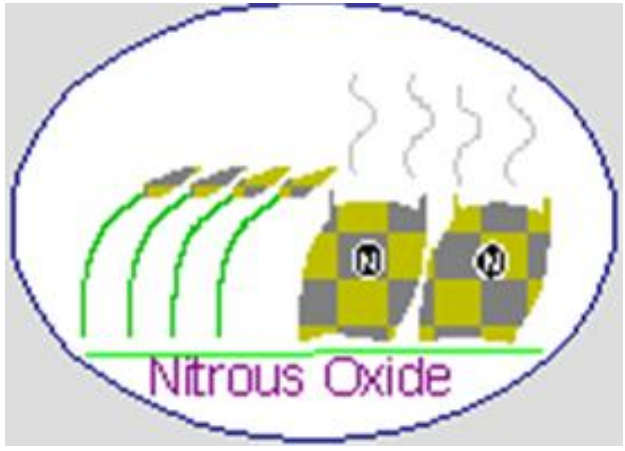
This energy (heat) is trapped inside the car and cannot pass back through the windshield, causing the inside of the car to warm up.

The Greenhouse Effect

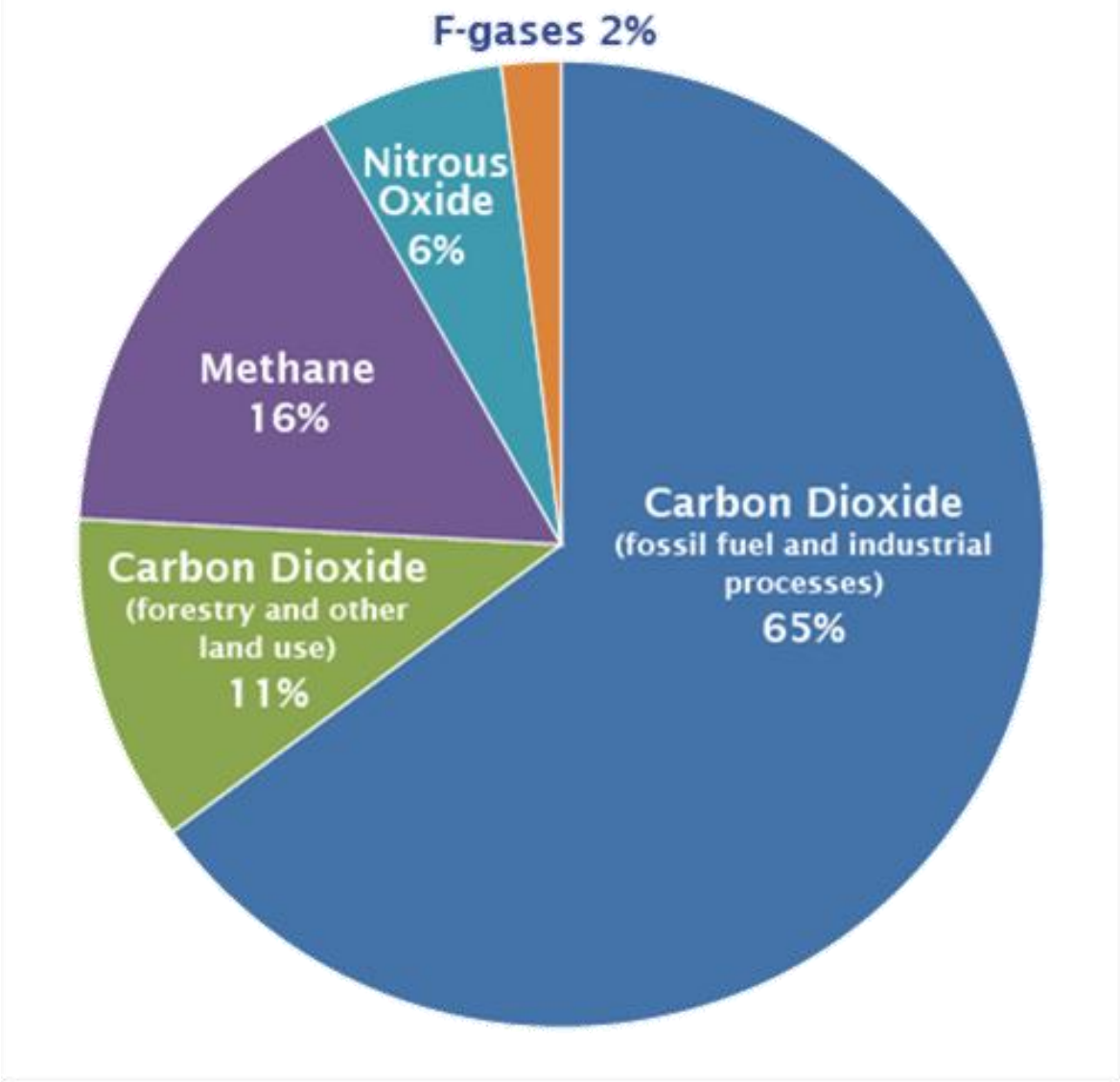
Increasing greenhouse gases trap more heat

Greenhouse gases

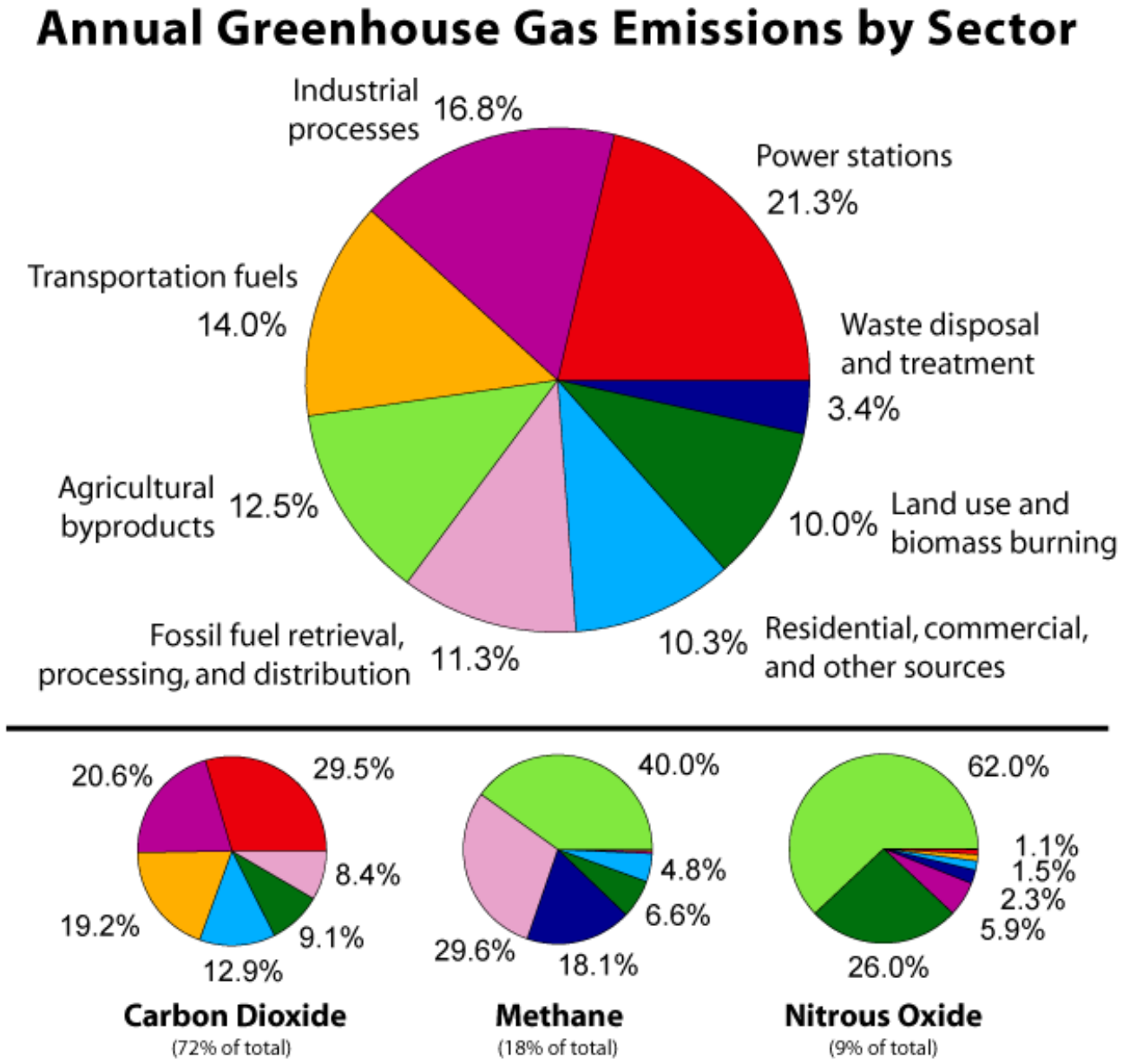




Relative proportion of anthropogenic greenhouse gases

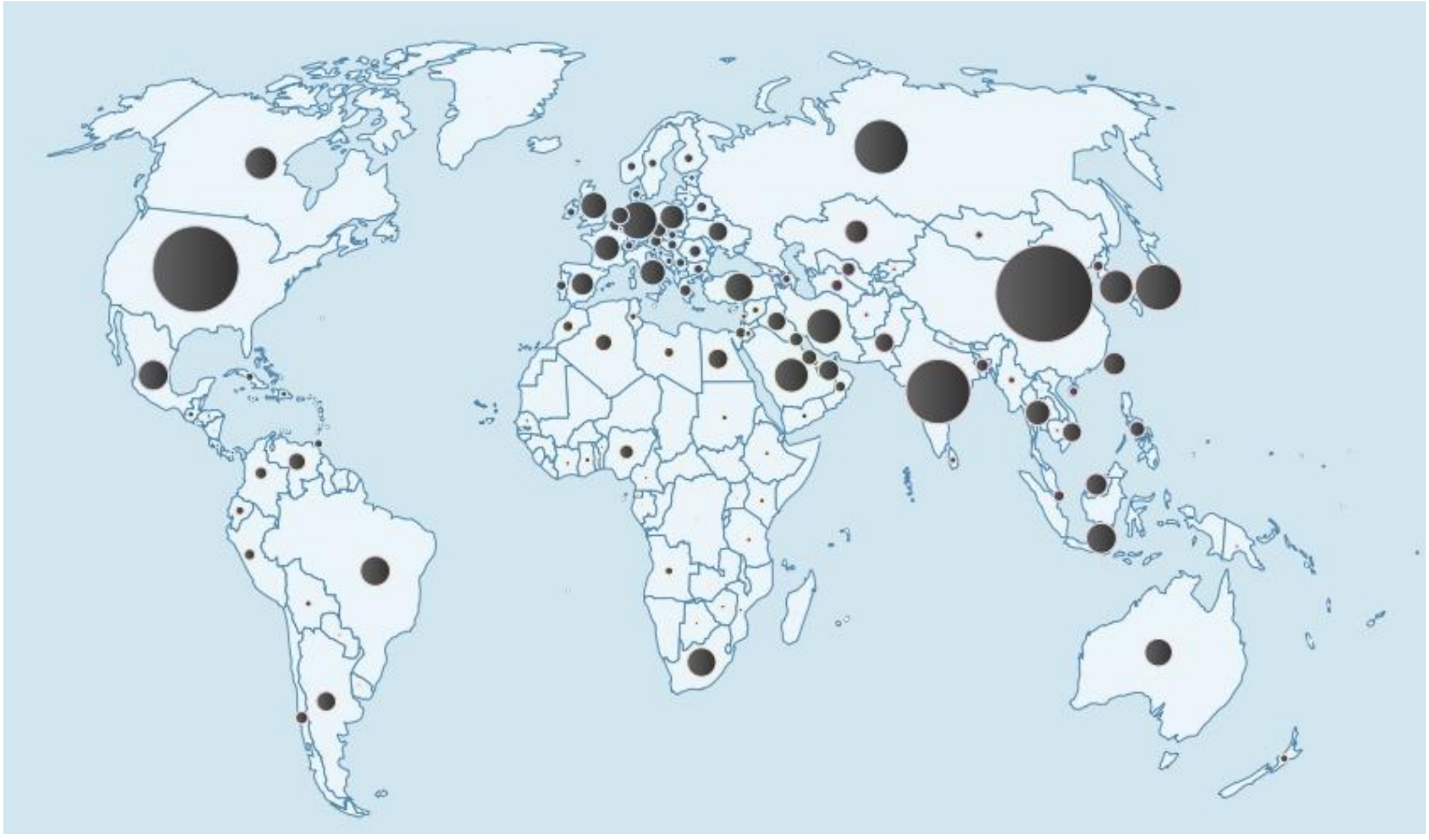


GHGs emission by sector



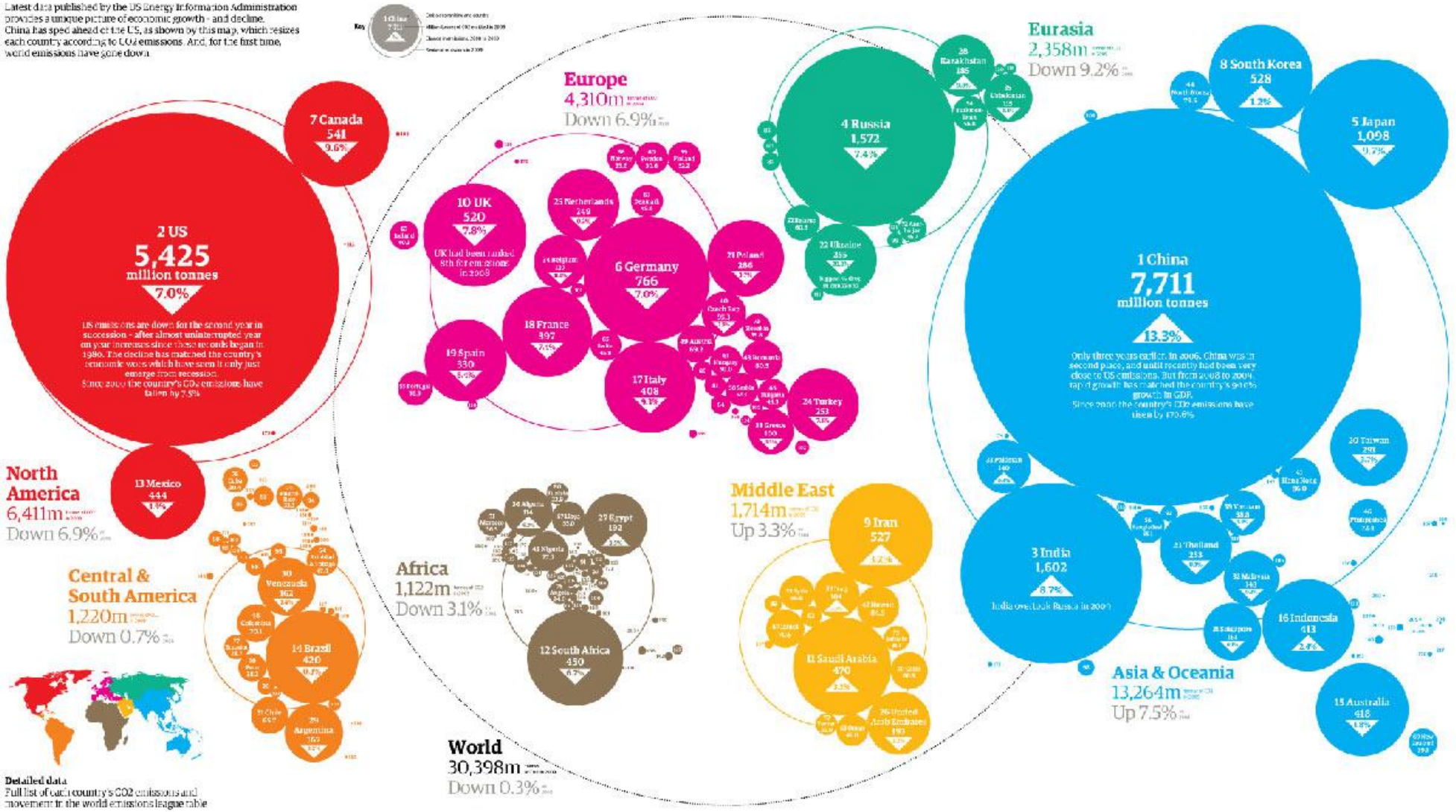
CO_2 is vital

CO_2 Territorial Emission



An atlas of pollution: the world in carbon dioxide emissions

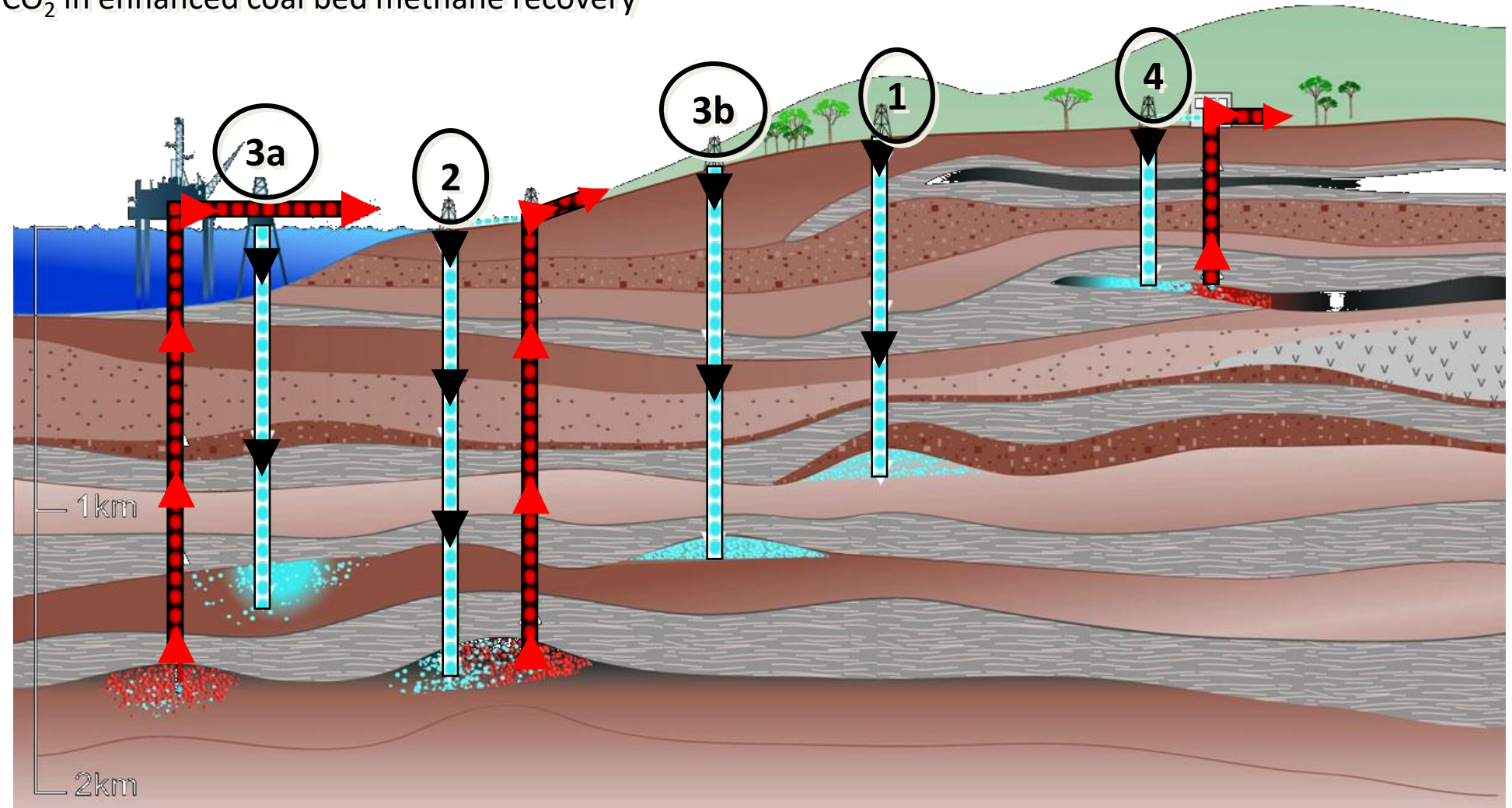
Latest data published by the US Energy Information Administration provides a unique picture of economic growth – and decline. China has sped ahead of the US, as shown by this map, which resizes each country according to CO_2 emissions. And, for the first time, world emissions have gone down



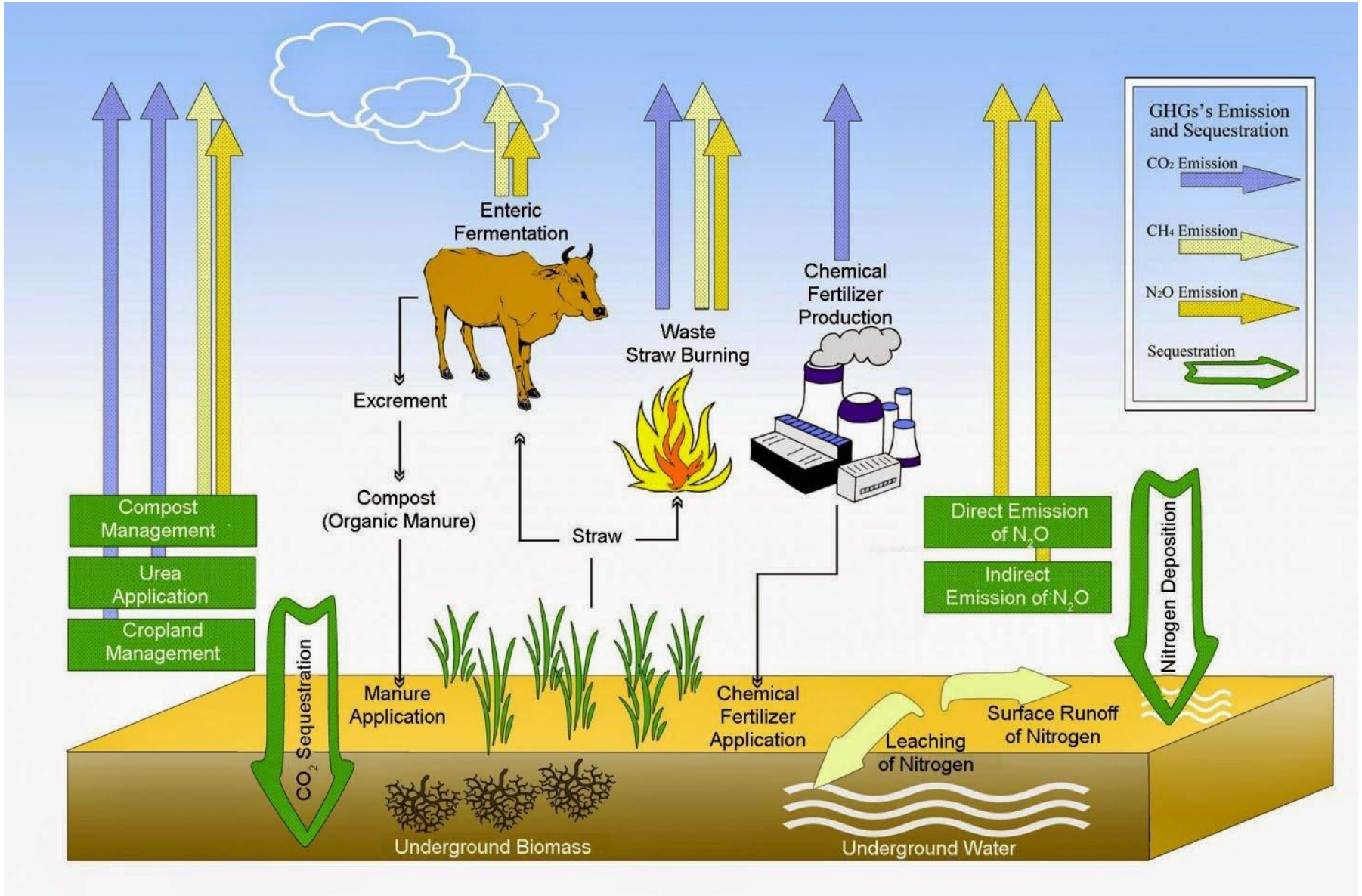
Detailed data
Full list of each country's CO_2 emissions and movement in the world emissions league table

Storage of CO_2 in Geological Formations

1. Depleted oil and gas reservoirs
2. CO_2 in enhanced oil and gas recovery
3. Deep saline formations – (a) offshore (b) onshore
4. CO_2 in enhanced coal bed methane recovery



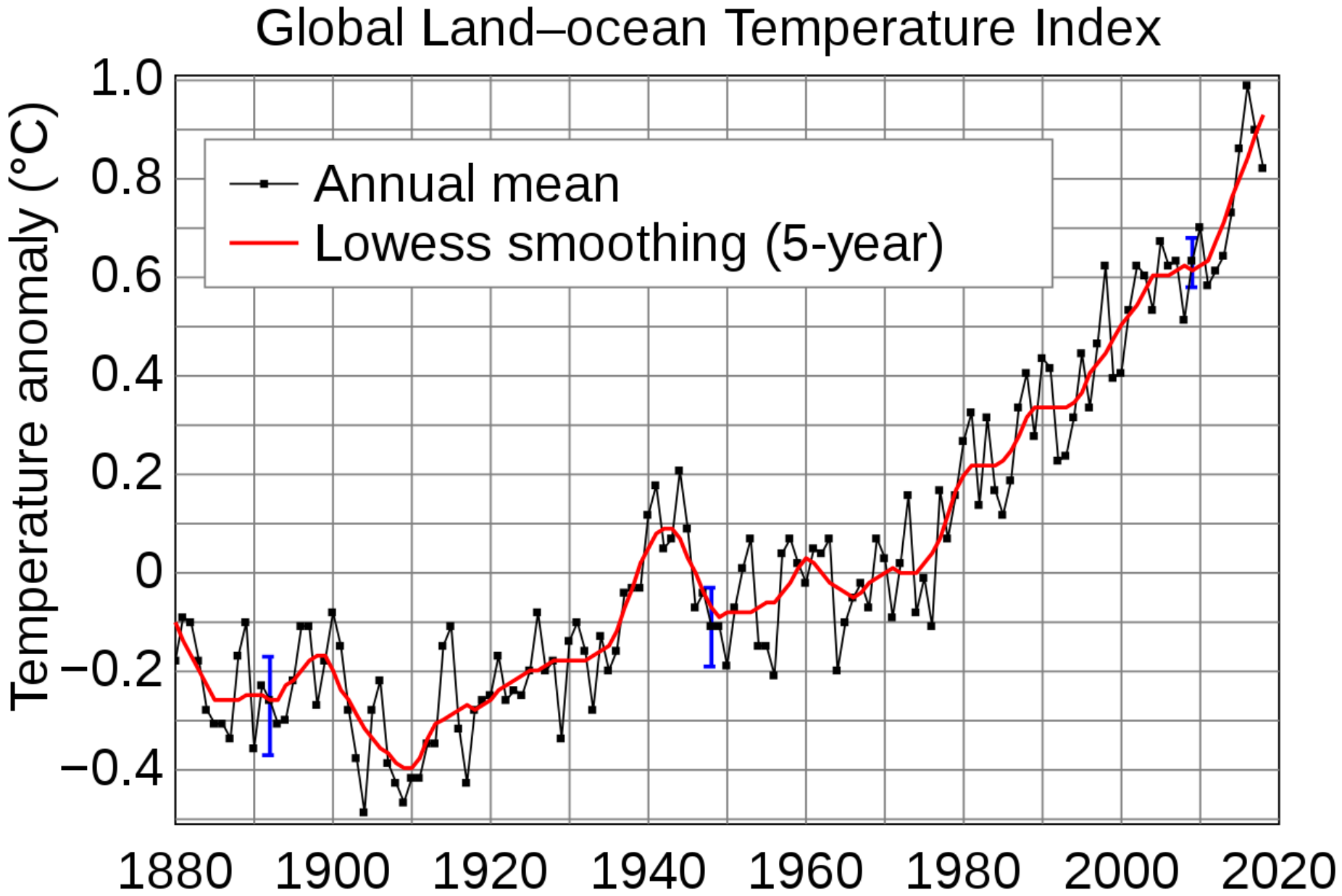
GHG emission and sequestration



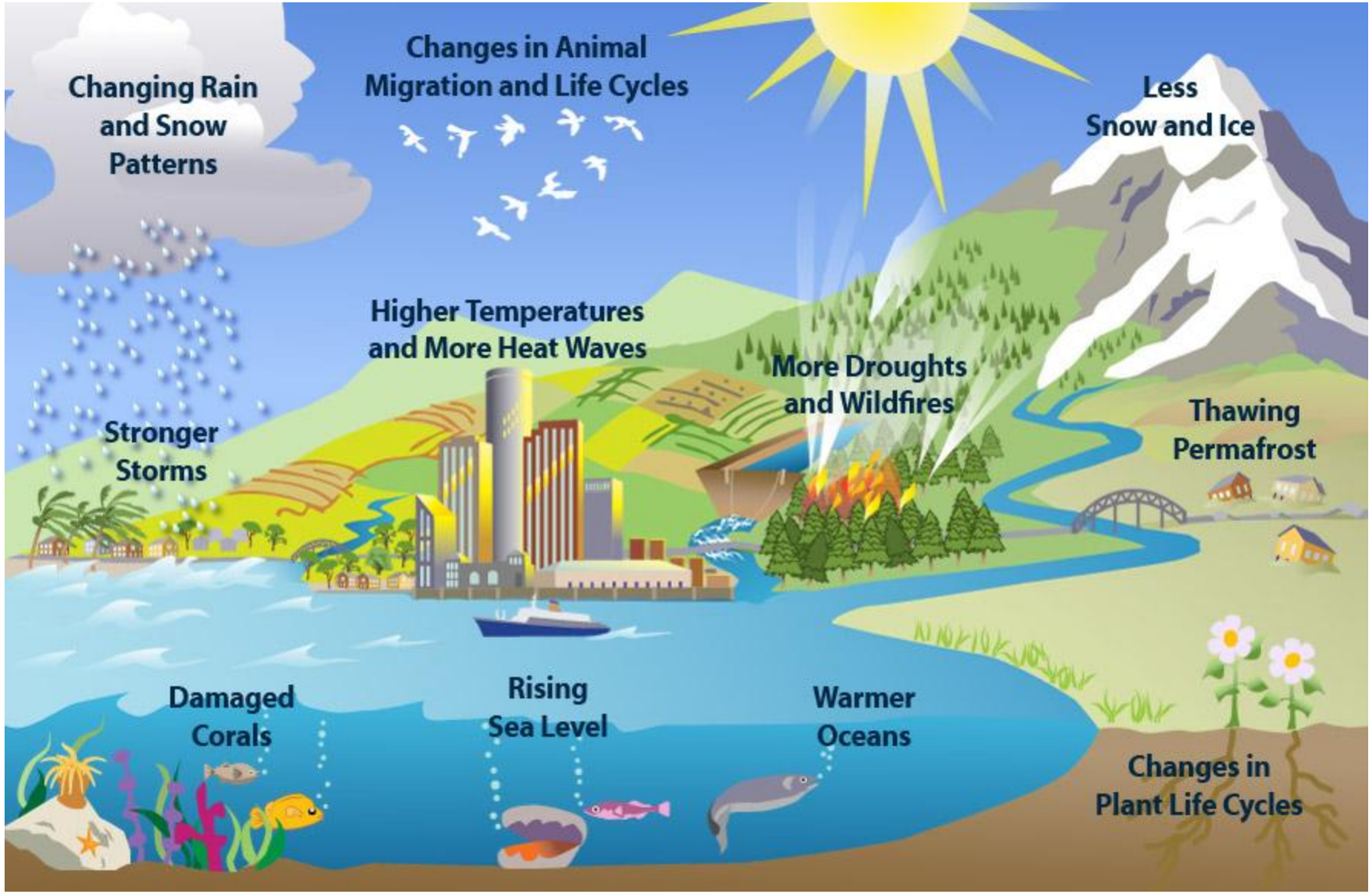
- *"With the possible exception of another world war, a giant asteroid, or an incurable plague, global warming may be the single largest threat to our planet."*

  - John Weier, NASA's Earth Observatory.

Global mean temperatures are rising faster with time



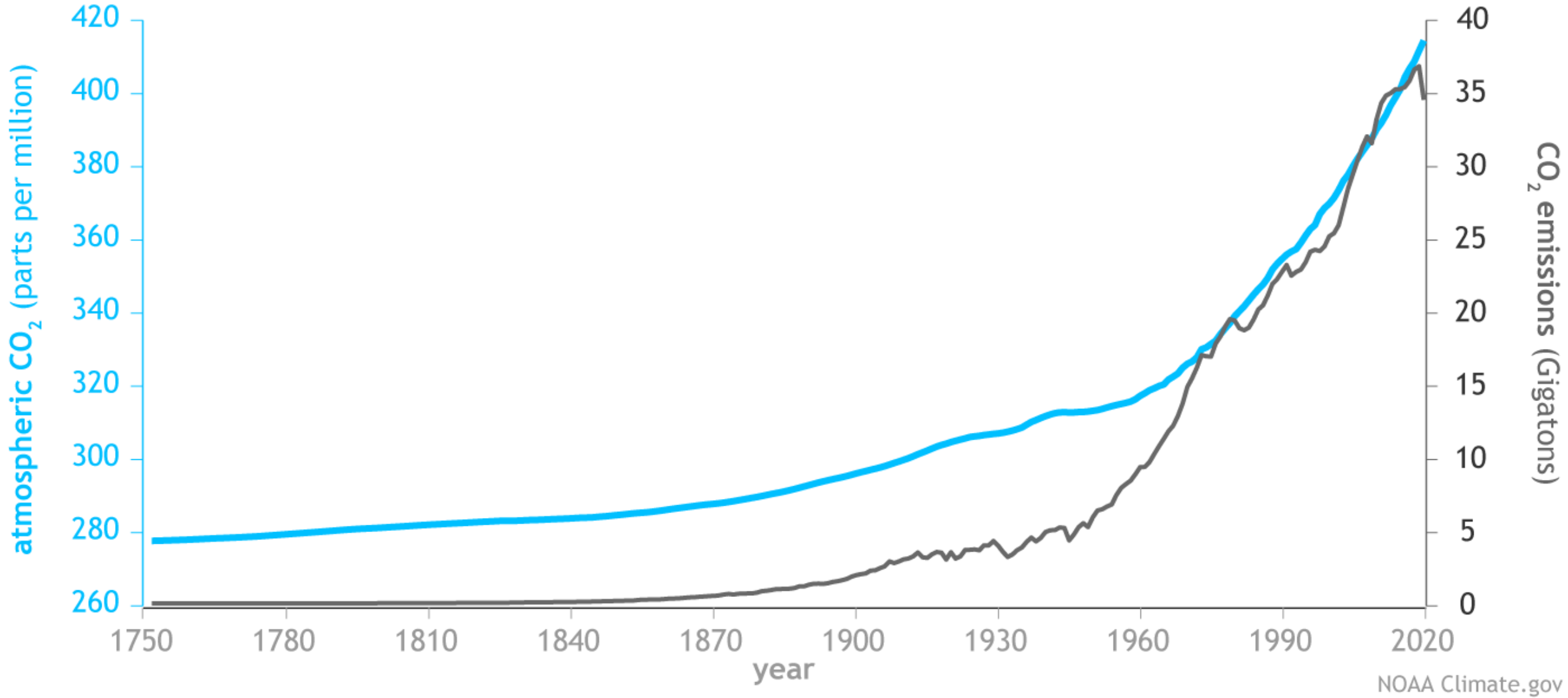
Major effects of global warming



Temperature Increase

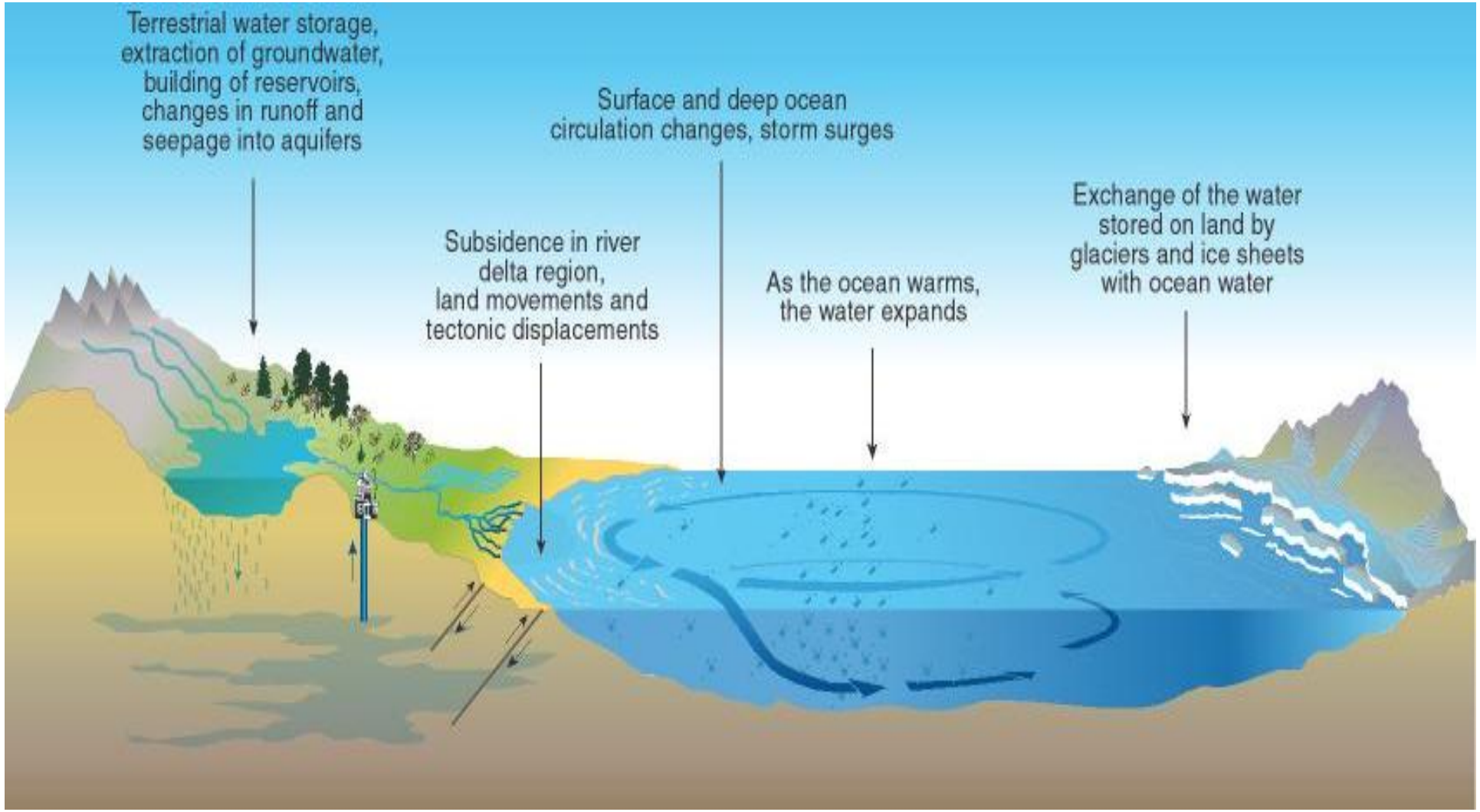
- Most of the increase occurred in the last few decades
- 1995-2006 were among the warmest on record
- The number of heat waves have increased
- A temperature increase of 0.2ºC is expected per decade if there is no control of emissions
- IPCC predicts that by 2100 temperature will rise 1.8-4ºC depending on the emission scenario

Carbon dioxide emissions and atmospheric concentration (1750–2020)



NOAA Climate.gov
Data: NOAA, ETHZ, Our World in Data

What causes sea level to change?



climate.org

Evidence of Global warming

- More warm days
- Melting of snow and ice
- Sea level rise (high confidence)
- Changes in precipitation patterns
- Carbon dioxide increasing in atmosphere
- More frequent extreme weather
- Disappearing Glaciers

Major effects

Rise in temperature

Rising Sea Level

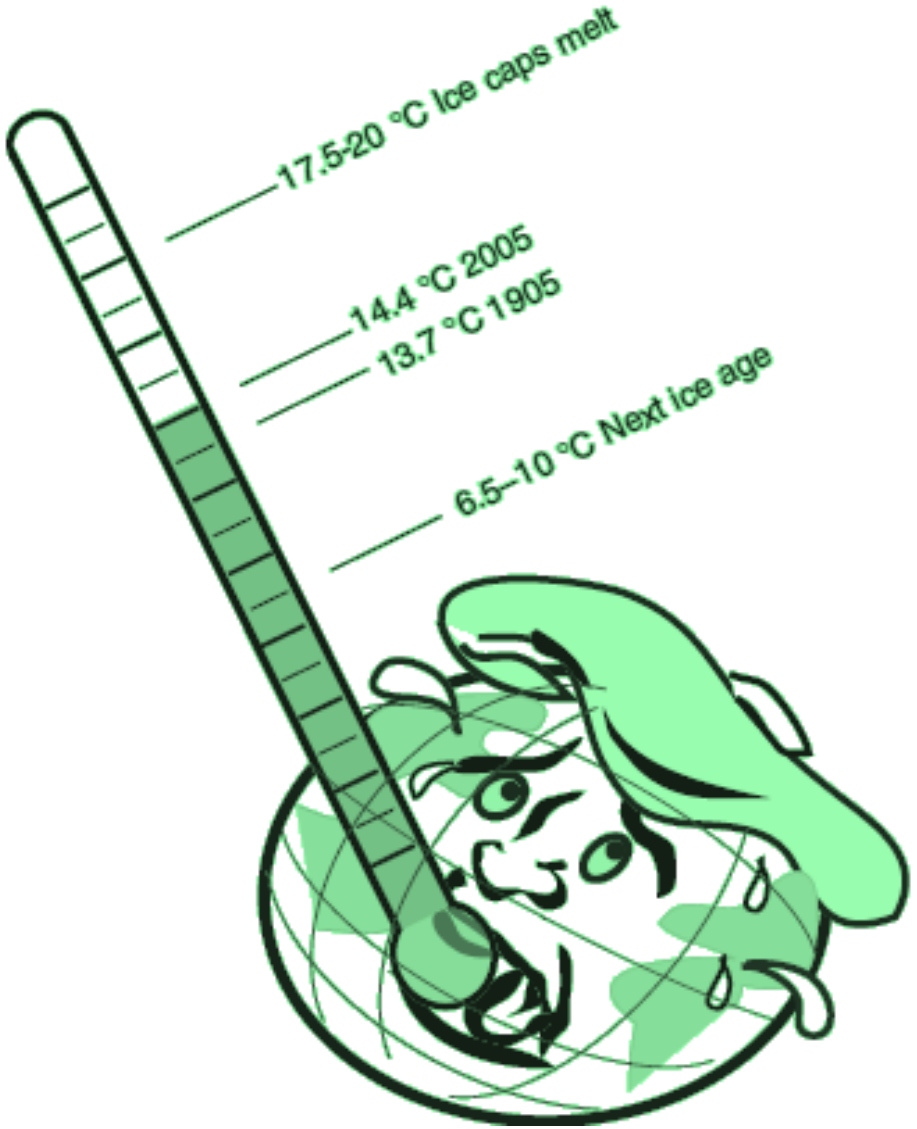
Habitat Damage

Food and Water Supply

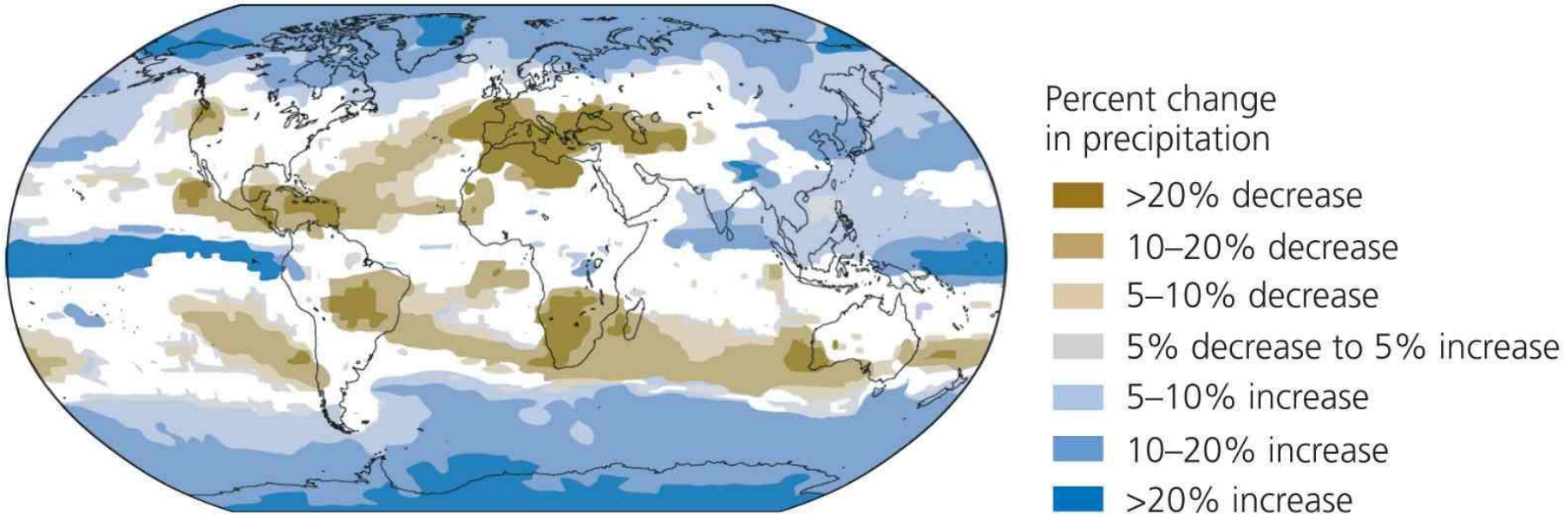
Increased temperature

- Models indicate that global average surface temperatures will rise by 1.5-4.5 ^{o}C over the next 100 years.
- Increases will be smallest at the equator and greatest at the poles
- Night temperatures have increased more than day temperatures

So, the earth is suffering from fever…



Changes in Precipitation



- It is predicted to increase at high latitudes and decrease at low and middle
- Will worsen water shortages near the tropics
- Away from the tropics heavy precipitation will become more frequent increasing chances of flooding
- Droughts will become more severe and frequent

Drought

Drought and high temperature episodes more often

– rice could be pushed out of some parts of Asia
– some semi-arid areas will become unable to support crop production

Storm

Flash Flood →

bdnews24.com
Bangladesh's First Internet Newspaper

‘সহস্র বছরের’ সর্বোচ্চ বৃষ্টিতে চীনে জলাবদ্ধতা, ১২ মৃত্যু

নিউজ ডেস্ক, বিডিনিউজ টোয়েন্টিফোর ডটকম
Published: 21 Jul 2021 10:30 AM BdST | **Updated:** 21 Jul 2021 10:58 AM BdST

চীনের হেনান প্রদেশে প্রবল বৃষ্টিপাতে রাজধানী ঝাংঝৌসহ বিস্তৃত এলাকা পানিতে তলিয়ে গেছে, মৃত্যু হয়েছে অন্তত ১২ জনের এবং প্রায় এক লাখ লোককে নিরাপদ স্থানে সরিয়ে নেওয়া হয়েছে।

শনিবার সন্ধ্যা থেকে মঙ্গলবার রাত পর্যন্ত ৬১৭ দশমিক এক মিলিমিটার বৃষ্টিপাত হয়েছে যাকে আবহাওয়াবিদরা এক হাজার বছরের মধ্যে সর্বোচ্চ বৃষ্টিপাত বলে অভিহিত করেছেন, স্থানীয় গণমাধ্যমের বরাতে জানিয়েছে বার্তা সংস্থা রয়টার্স।

এ পরিমাণ বৃষ্টি ওই অঞ্চলের বার্ষিক গড় বৃষ্টিপাত ৬৪০ দশমিক আট মিলিমিটারের প্রায় সমান।

এতে বুধবার প্রদেশটির বিশাল এলাকা তলিয়ে যায়। হুয়াং হি নদীর তীরবর্তী এক কোটি ২০ লাখ বাসিন্দার শহর ঝাংজৌতে সবচেয়ে কঠিন পরিস্থিতি সৃষ্টি হয়। সেখান থেকে এ পর্যন্ত ১২ জনের মৃত্যুর খবর পাওয়া গেছে ও প্রায় এক লাখ বাসিন্দাকে নিরাপদ স্থানে সরিয়ে নিতে হয়েছে বলে চীনের রাষ্ট্রায়ত্ত বার্তা সংস্থা সিনহুয়া স্থানীয় সরকারকে উদ্ধৃত করে জানিয়েছে।

এবার চীনের মধ্যাঞ্চলে অস্বাভাবিকরকম সক্রিয় বর্ষকাল দেখা যাচ্ছে। এতে হুয়াং হি নদীর অববাহিকার অনেকগুলো নদীর পানি দ্রুত বৃদ্ধি পেয়েছে। শনিবার থেকে শুরু হওয়া টানা বৃষ্টিতে হেনান প্রদেশের লাখ লাখ মানুষের জীবন ওলটপালট হয়ে গেছে।

Melting Ice and Snow

- Risks of sudden floods
- Ice dams burst
- Reduction of summertime water supply
- Artic/Antarctic ice surface is decreasing
  - Resulting in larger darker ocean surfaces which capture heat and melt the ice faster
  - More dark surfaces on Earth reduces the *albedo* effect (light reflection)
  - As a result Earth's surface increases in temperature
  - Positive: new shipping lanes and possible sites for oil and gas exploration

Sea Level Rise

- Most models predict a sea level rise of about 50 cm by 2100
- This will lead to the loss of agricultural land due to flooding by sea water and salinization in areas that are newly coastal
- River deltas are some of the most productive agricultural lands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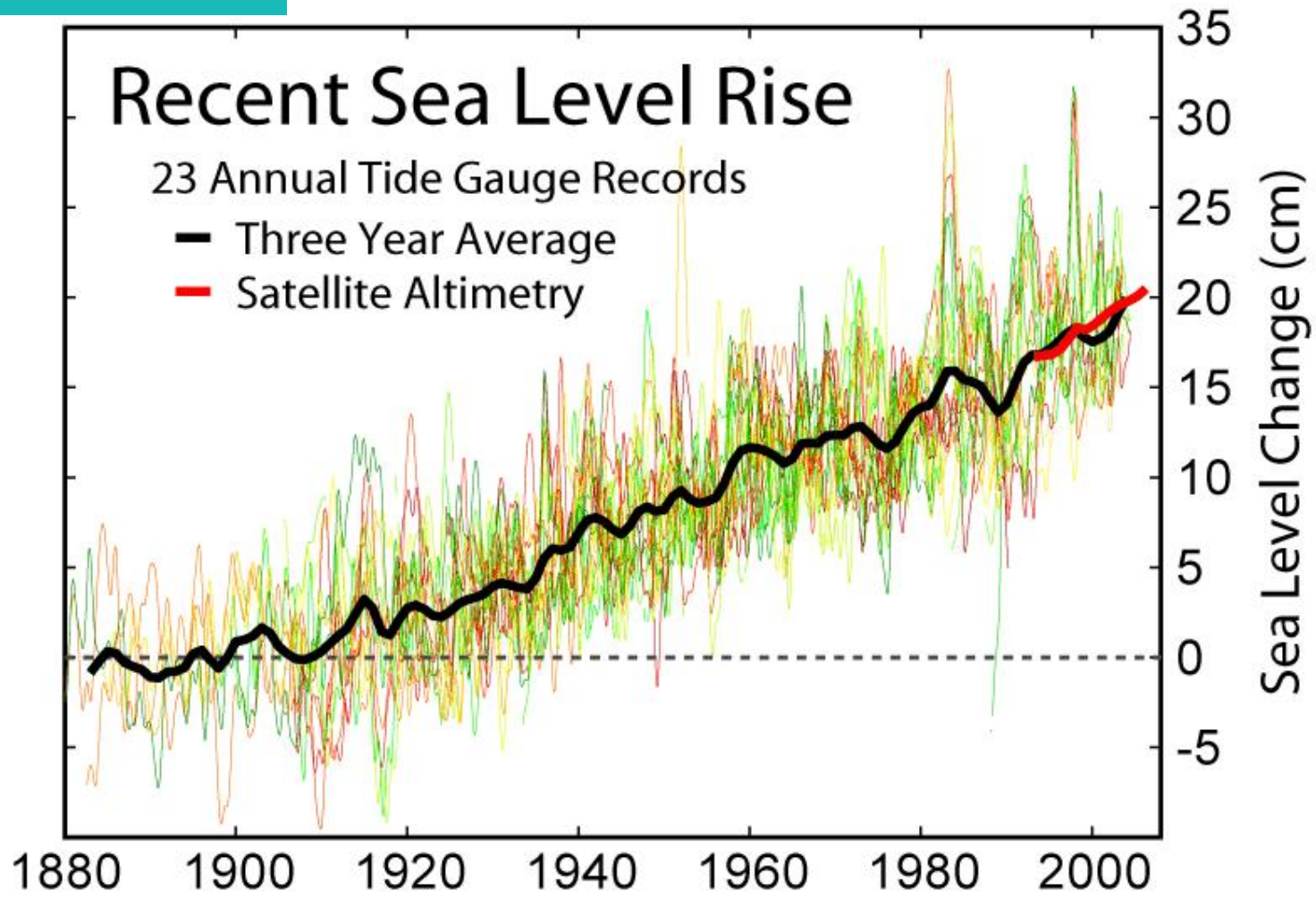

Recent Sea Level Rise
23 Annual Tide Gauge Records
Three Year Average
Satellite Altimetry
35
30
25
20
15
10
5
0
-5
Sea Level Change (cm)
1880
1900
1920
1940
1960
1980
2000

Problems with Rising Sea Levels

- Beach erosion
  - Florida, Washington, California, Texas, etc.

- Intrusion of salt water into aquifers
- Loss of wetlands (mangroves)
- Loss of coral reefs
  - Bangladesh, Maldives
- Possible evacuations and migration of people
  - Island nations of Maldives

Relationship of Climate Change with agriculture

Temperature Rise
-Increasing drought

→

-Crop failure
- Increasing fresh water demand

Precipitation change
-Increase in annual rainfall
- Occurrence of short duration heavy rainfall
-Rainfall at unexpected time

→

- Crop failure
-Erosion of soil
- Floods

Relationship of Climate Change with agriculture

Sea Level Rise
- Salinity intrusion
- River bank erosion
- Coastal erosion

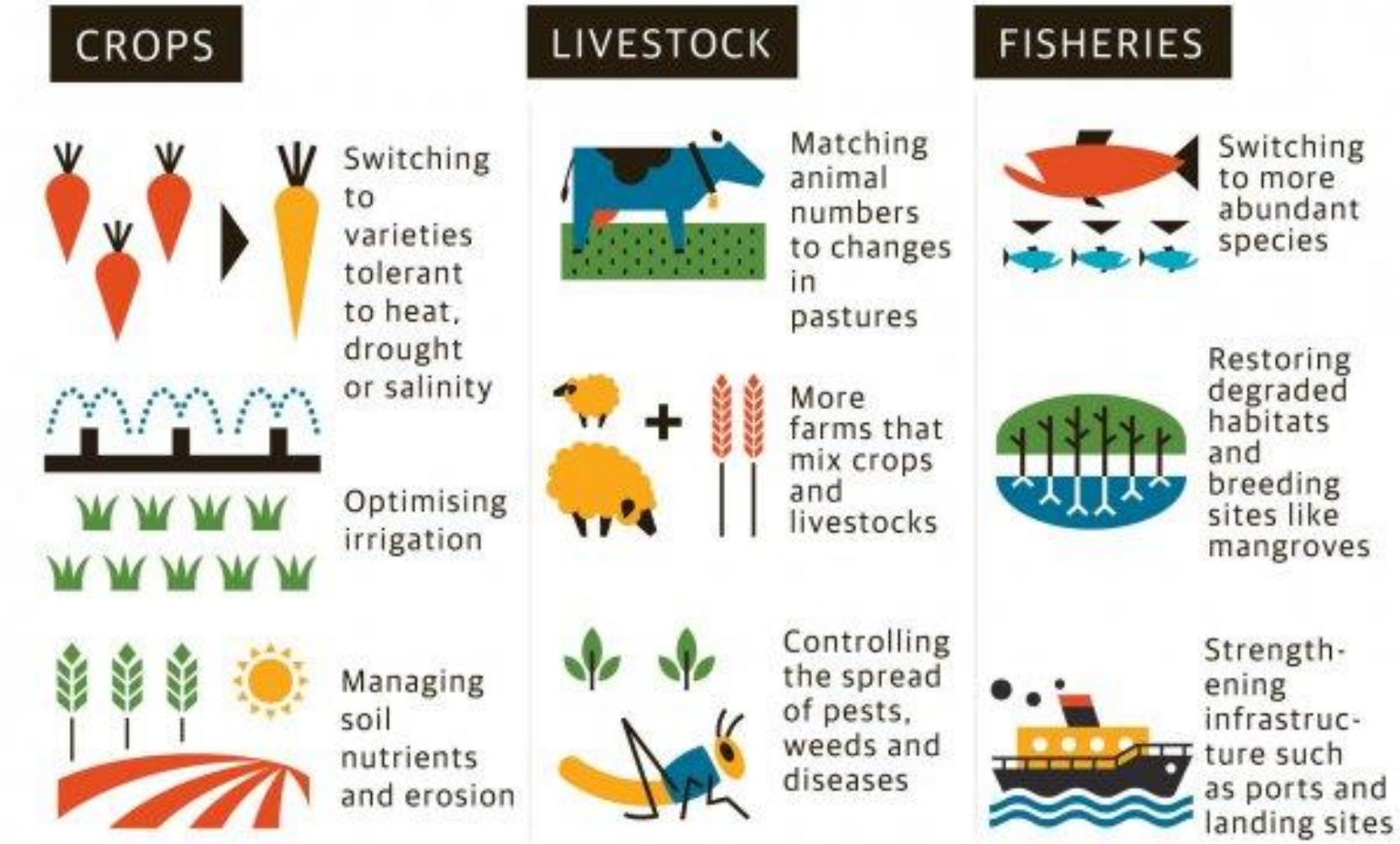
→ - Decreasing fresh water supply
- Degradation of Agricultural land

Mega Events
- Extreme temperatures

→ 

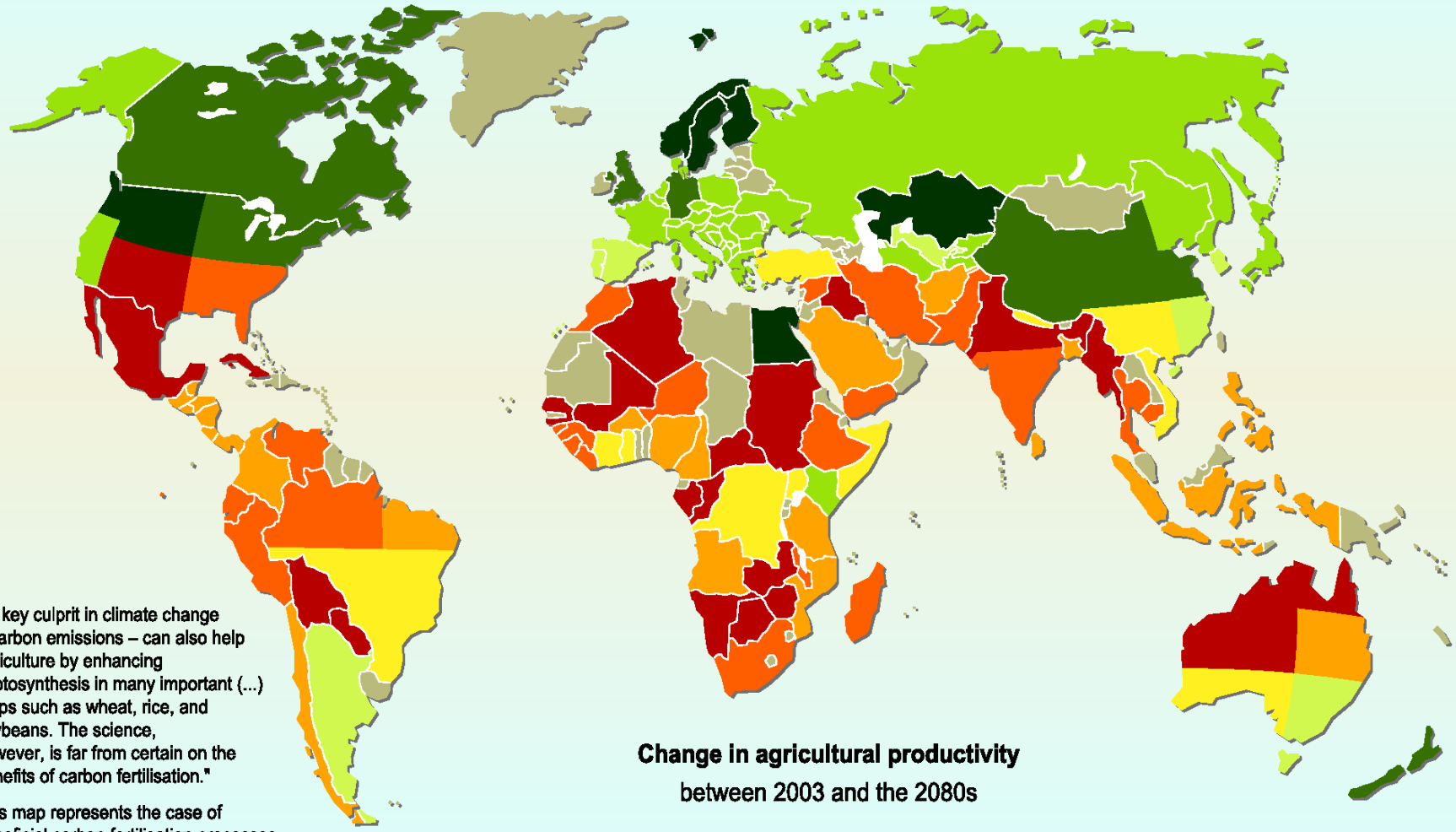
Crop failure

Climate change and farming: what you need to know about the IPCC report



Heat stress and crop failure

Projected impact of climate change on agricultural yields



" A key culprit in climate change – carbon emissions – can also help agriculture by enhancing photosynthesis in many important (...) crops such as wheat, rice, and soybeans. The science, however, is far from certain on the benefits of carbon fertilisation."

This map represents the case of beneficial carbon fertilisation processes.

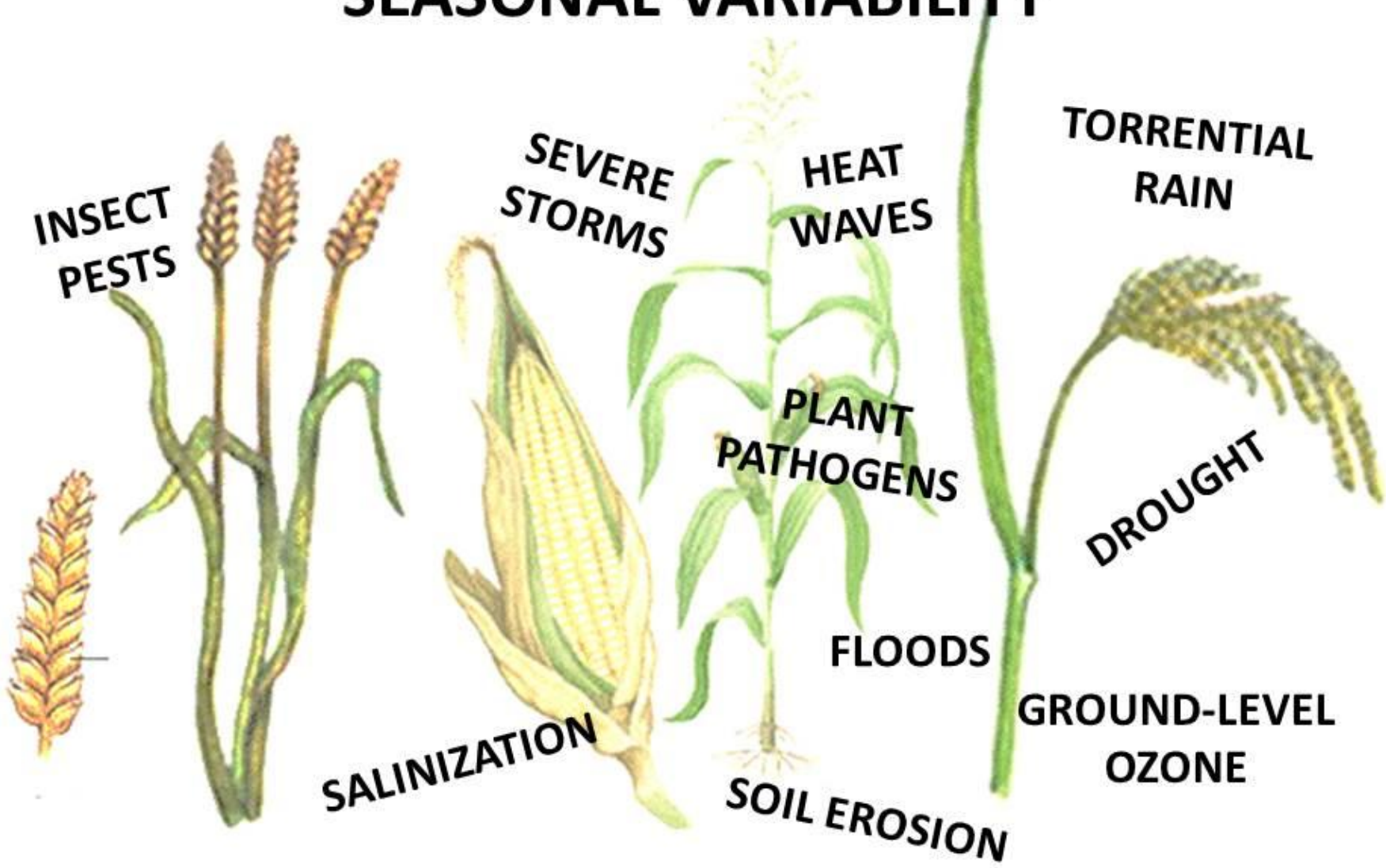
Source: Cline W., 2007, *Global Warming and Agriculture.*

Changes in Crop Quality

- In general, the higher levels of carbon (CO_2) will lead to crops (seeds or, in the case of forages, leaves and stems) that are higher in carbon and lower in protein.

- On the other hand, material with higher sugar contents will make better silage.

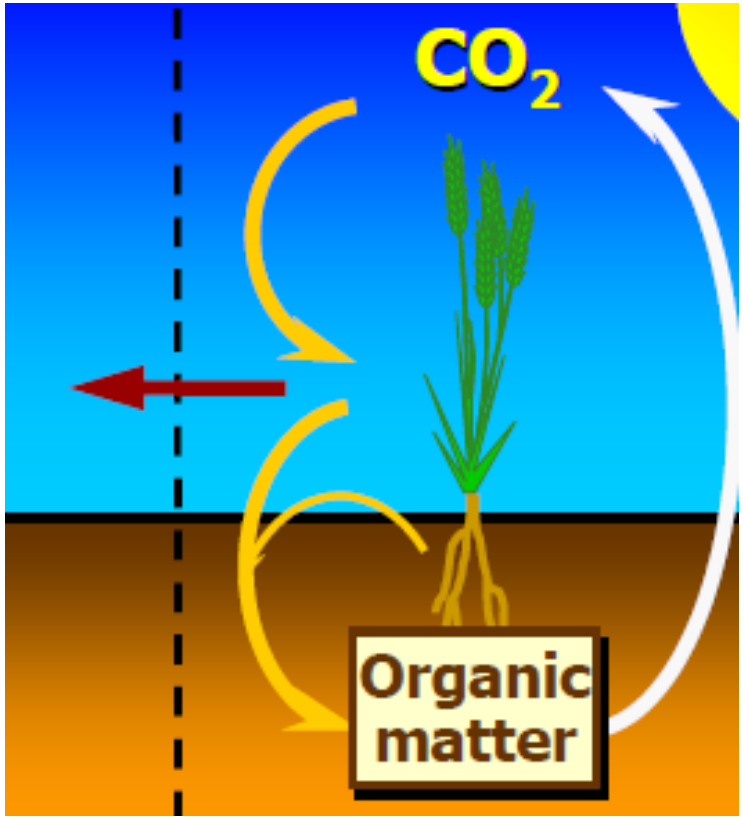
SEASONAL VARIABILITY



Changes in Soil Organic Matter

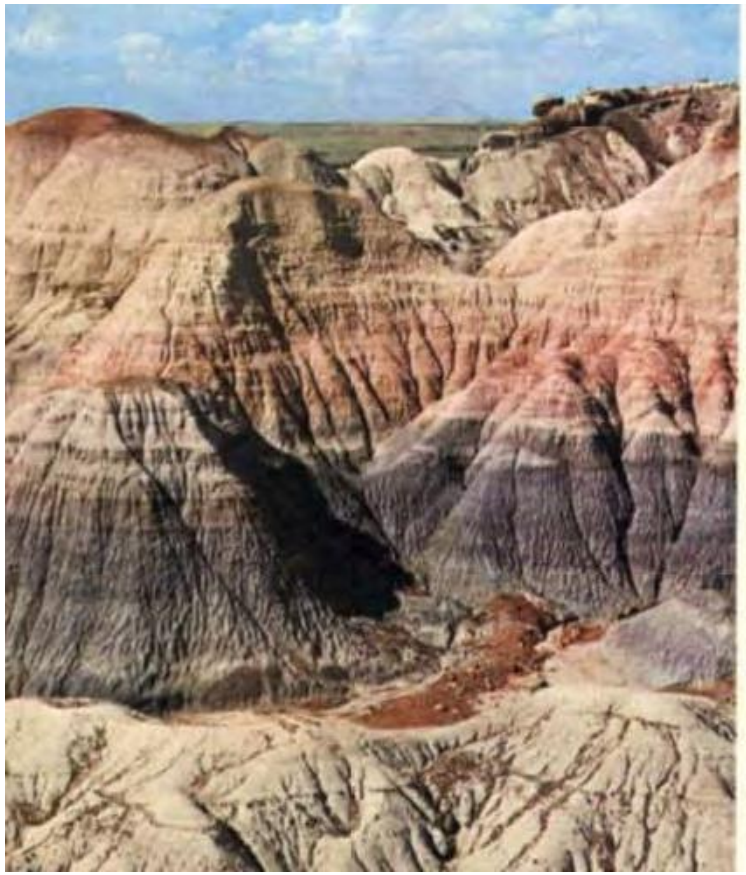
- Higher temperatures and, higher rainfall levels, will accelerate soil organic matter break down

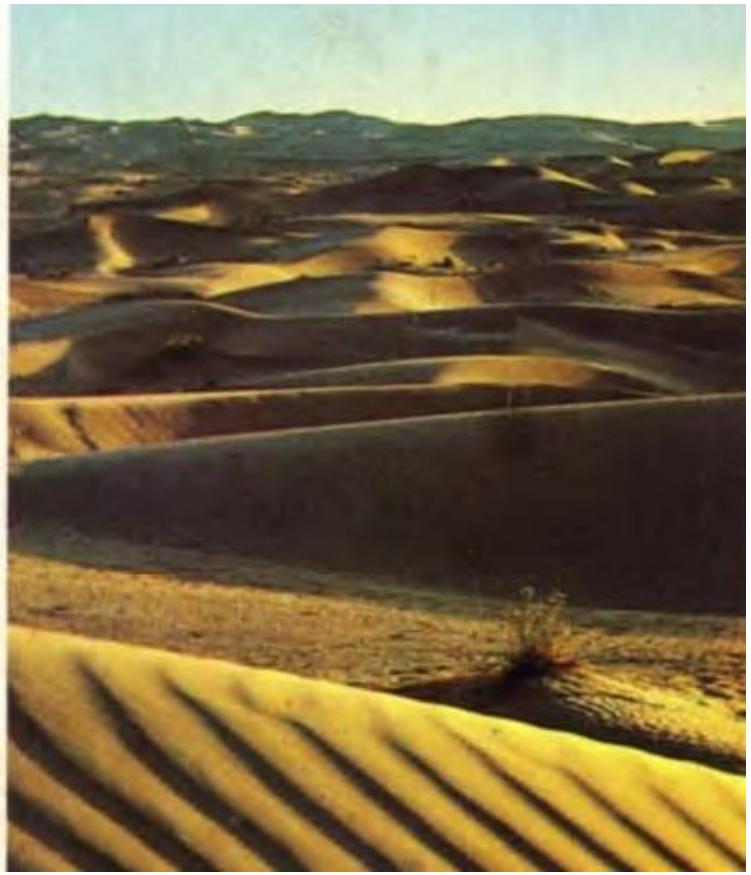
- Low organic matter soils hold few nutrients and are more susceptible to drought



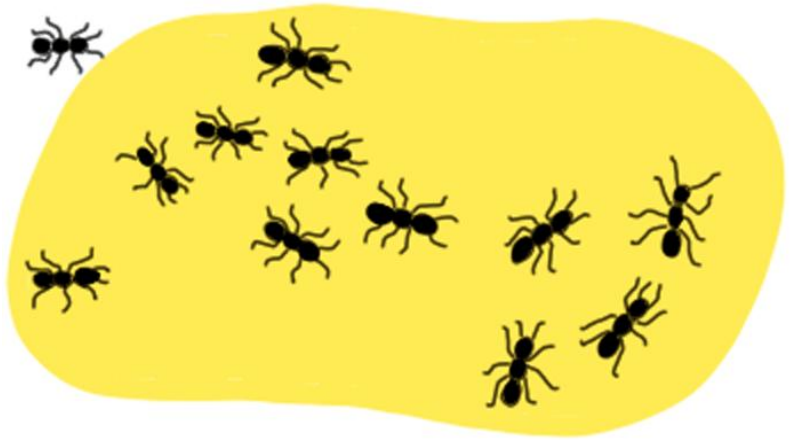
Soil Erosion

- In many areas soils will be drier
- Increased equator-to-pole heat flux will mean greater average wind speeds





Pests resurgence



- Weeds, diseases, insects will spread from warmer areas into formerly cooler ones.
- Warmer winters allow overwintering of larvae in areas where this was not possible.
- Increased number of generations possible.
- Longer time for development and feeding and a wider range of pests.

Changes of Grassland Species

- Where dry hot areas become more so there will be a shift from C_3 to C_4 species
- In temperate-moist areas increasing CO_2 will favor C_3 over C_4 species.

Consequences for Poultry and Fish

- Changes in temperature and precipitation could cut breeding populations of ducks and other poultries.
- Cold water fish habitat may be reduced and lost
- Migration/breeding cycles may be disrupted for species that depend on temperature signals

Consequences for Livestock production

- Changes in temperature decrease the forage production.
- Heat stress for livestock
- Habitat for livestock will be declined

জলবায়ু পরিবর্তনে ঝুঁকির মুখে বাংলাদেশের ১৩ কোটি মানুষ: বিশ্ব ব্যাংক

মঈনুল হক চৌধুরী,
Published: 2018-06-30 01:26:53.0 BdST **Updated:** 2018-06-30 01:37:35.0 BdST

২০১৭ সালের মে মাসে বাংলাদেশ উপকূলে আঘাত হানে ঘূর্ণিঝড় 'মোরা'

পৃথিবীর জলবায়ু যেভাবে বদলে যাচ্ছে, সেই ধারা অব্যাহত থাকলে এবং দ্রুত ক্ষতি কমিয়ে আনার পদক্ষেপ নেওয়া না হলে ২০৫০ সাল নাগাদ বাংলাদেশে ঝুঁকির মধ্যে থাকা এলাকাগুলোতে মাথাপিছু জিডিপি এখনকার তুলনায় ১৪.৪

Ecosystem Impacts

- Coral death from exposure to 3-4 ºC higher seasonal maximum sea-surface temperatures for 6 months or more
- Extensive reduction in Arctic summer sea-ice extent with benefits for shipping but adverse effects on sea-ice dependent animals (e.g. polar bears, seals, walrus)
- Coastal wetland loss from sea level rise (up to 10% globally for 20 cm rise, higher percentages in some areas)
- Increased disturbances of ecosystems by fire and insect pests
- Increase net primary productivity of many mid- and high-latitude forests
- Extinction of some critically-endangered and endangered species

Climatic Change
DOI 10.1007/s10584-017-2018-9

LETTER

The impacts of rising temperatures on aircraft takeoff performance

Ethan D. Coffel[1,2] · Terence R. Thompson[3] · Radley M. Horton[2,4]

Received: 6 April 2017 / Accepted: 19 June 2017

Predicted effects of climate change on agriculture over the next 50 years

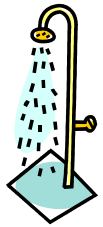
Climatic element	Expected changes by 2050's	Confidence in prediction	Effects on agriculture
CO_2	Increase from 360 ppm to 450 - 600 ppm (2005 levels now at 379 ppm)	Very high	Good for crops: increased photosynthesis; reduced water use
Sea level rise	Rise by 10 -15 cm Increased in south and offset in north by natural subsistence/rebound	Very high	Loss of land, coastal erosion, flooding, salinisation of groundwater
Temperature	Rise by 1-2^{o}C. Winters warming more than summers. Increased frequency of heat waves	High	Faster, shorter, earlier growing seasons, range moving north and to higher altitudes, heat stress risk, increased evapotranspiration
Precipitation	Seasonal changes by ± 10%	Low	Impacts on drought risk' soil workability, water logging irrigation supply, transpiration
Storminess	Increased wind speeds, especially in north. More intense rainfall events.	Very low	Lodging, soil erosion, reduced infiltration of rainfall
Variability	Increases across most climatic variables. Predictions uncertain	Very low	Changing risk of damaging events (heat waves, frost, droughts floods) which effect crops and timing of farm operations

Potential positive effects

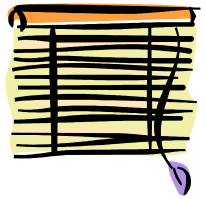
- Higher temperatures and higher CO_2 concentrations is improving ecosystems productivity
- Increase photosynthesis for some crop plants
- Melting of Arctic ice is opening the Northwest Passage in summer
- Increase in temperature due to global warming, is favorable condition for algae
- Rise in the dense forestation
- Formation of oil reserves

At personal level

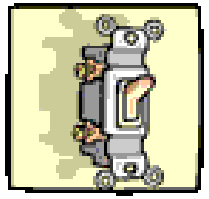
Turn off your computer or the TV when you're not using it.



Take shorter showers. Heating water uses energy.

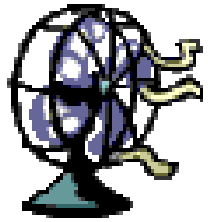


Keep rooms cool by closing the blinds, shades, or curtains.

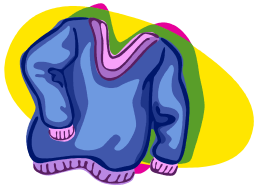


Turn off the lights when you leave a room.

Use compact fluorescent bulbs.



Dress lightly when it’s hot instead of turning off the air conditioner or use a fan.



Dress warmly when it’s cold instead of turning up the heat.

Offer to help your parents keep the air filters on your AC and furnace clean.

Walk short distances instead of asking for a ride in the car.

Plant a tree

Recycle.


And a majority are willing to make changes to their own habits:
give up plastic straws 70%
drive less 62%
BUS
recycle more 87%
use efficient light bulbs 86%
LED
travel less 58%
give up plastic bags 77%
But 69% aren't willing to give up eating meat.
The Guardian

At National and International level

- International agreement to fight global warming, although signatories are committed to reduce green house gas emission.

Human development:

- Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures;
- Reduced gender inequality & marginalization in other forms.

Poverty alleviation

- Improved access to & control of local resources;
- Land tenure;
- Disaster risk reduction;
- Social safety nets & social protection;
- Insurance schemes.

Livelihood security:

- Income, asset & livelihood diversification;
- Improved infrastructure;
- Access to technology;
- Increased decision-making power;
- Changed cropping, livestock & aquaculture practices;
- Reliance on social networks.

Disaster risk management

- Early warning systems;
- Hazard & vulnerability mapping;
- Diversifying water resources;
- Improved drainage;
- Flood & cyclone shelters;
- Building codes & practices;
- Storm & wastewater management;
- Transport & road infrastructure improvements.

Ecosystem management

- Maintaining wetlands & urban green spaces;
- Coastal afforestation; Watershed & reservoir management;
- Reduction of other stressors on ecosystems & of habitat fragmentation;
- Maintenance of genetic diversity;
- Manipulation of disturbance regimes; Community-based natural resource management.

Spatial or land-use planning

- Provisioning of adequate housing, infrastructure & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.

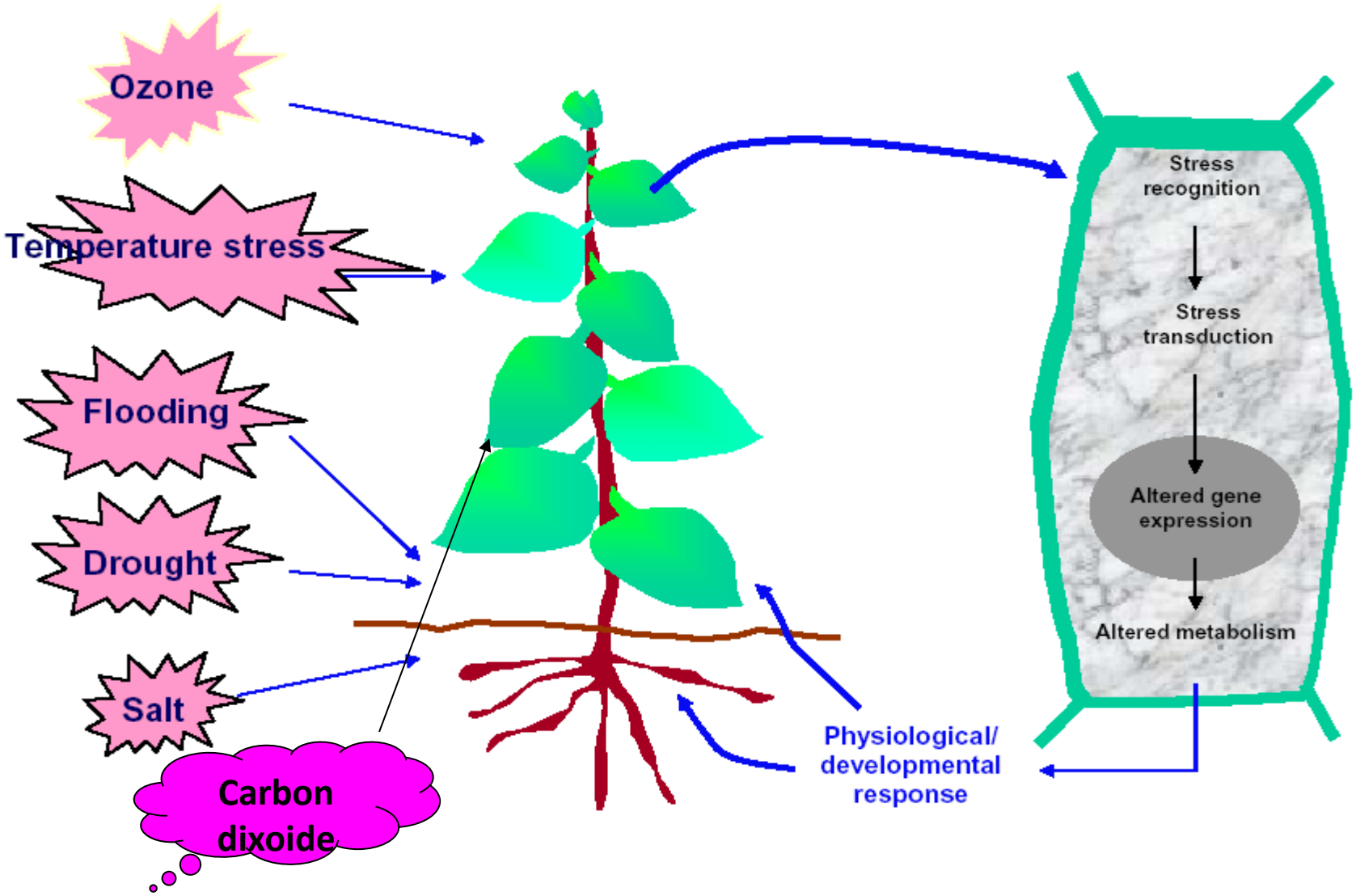
Institutional

- ***Economic options:*** Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
- ***Laws & regulations:*** Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
- ***National & government policies & programs:*** National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.

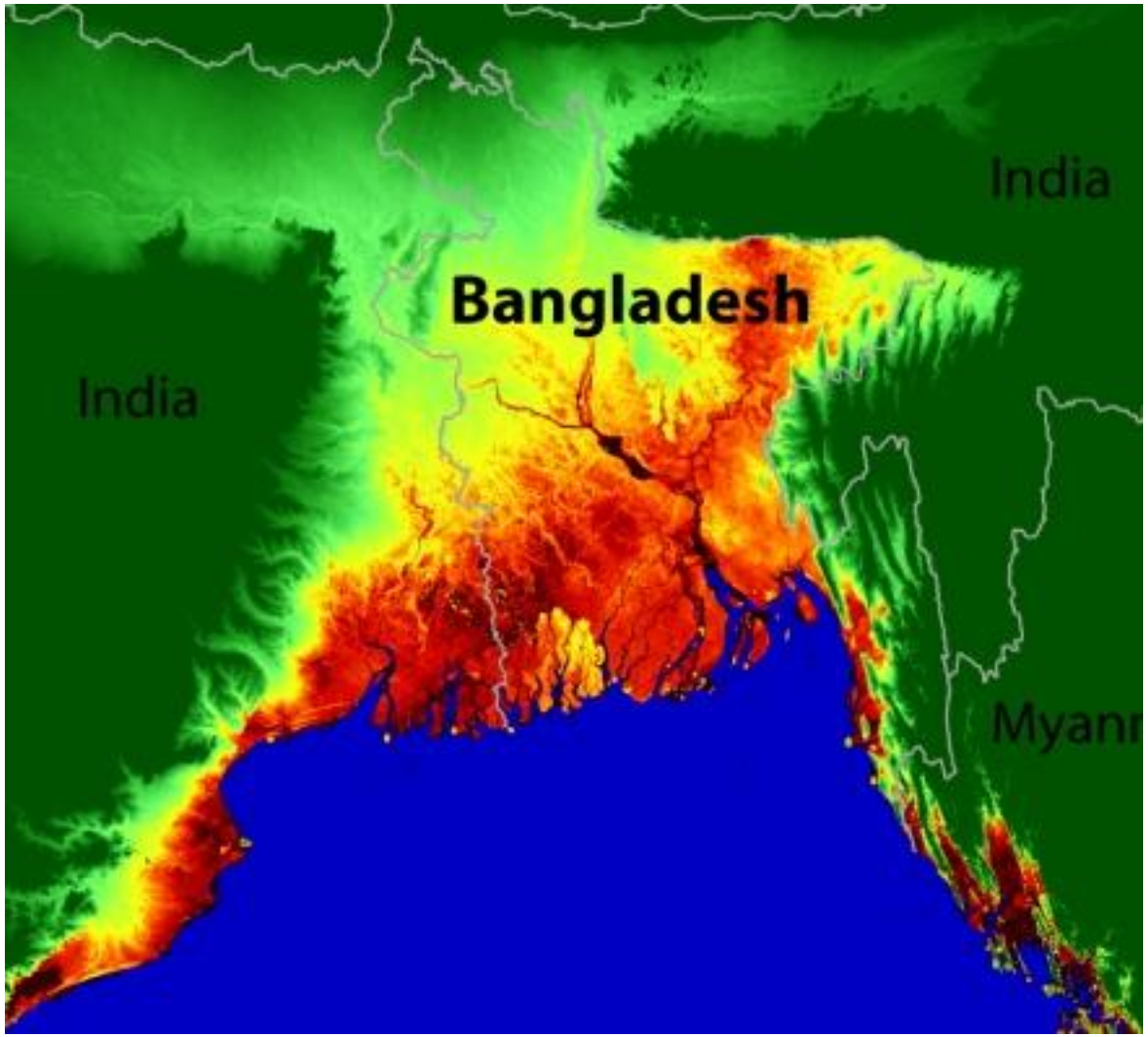
Social

- ***Educational options:*** Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
- ***Informational options:*** Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
- ***Behavioural options:*** Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock & aquaculture practices; Reliance on social networks.

Multi-stress response and tolerance research should be increased



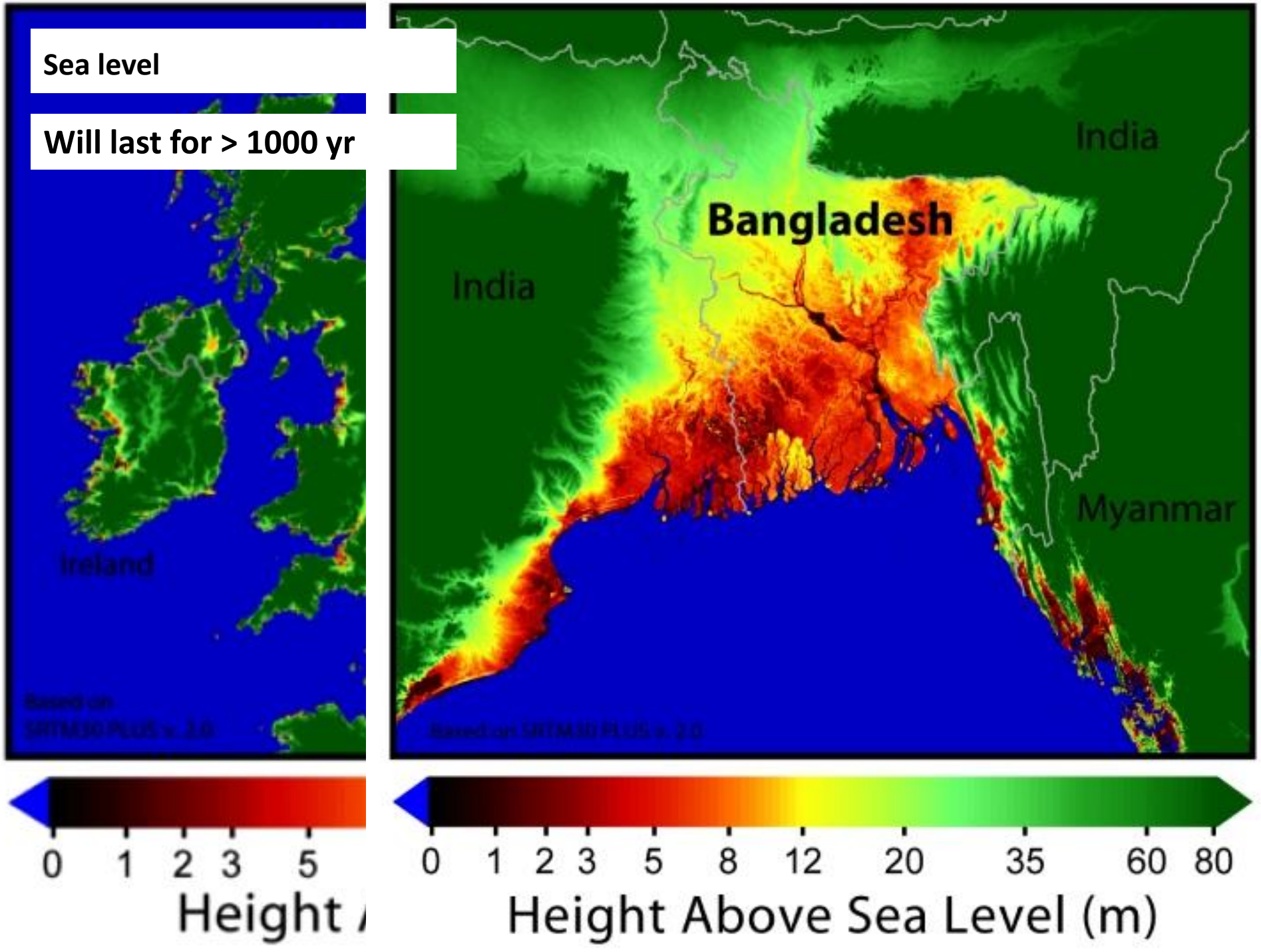
Climate Change and Bangladesh



Bangladesh the worst sufferer

Bangladesh-most vulnerable countries of the world.

Negligible gas emissions - worst victim.


Sea level
Will last for > 1000 yr
India
Bangladesh
India
Myanmar
Ireland
0 1 2 3 5
0 1 2 3 5 8 12 20 35 60 80
Height Above Sea Level (m)

Drought

Cyclone

Storm surge, salinity

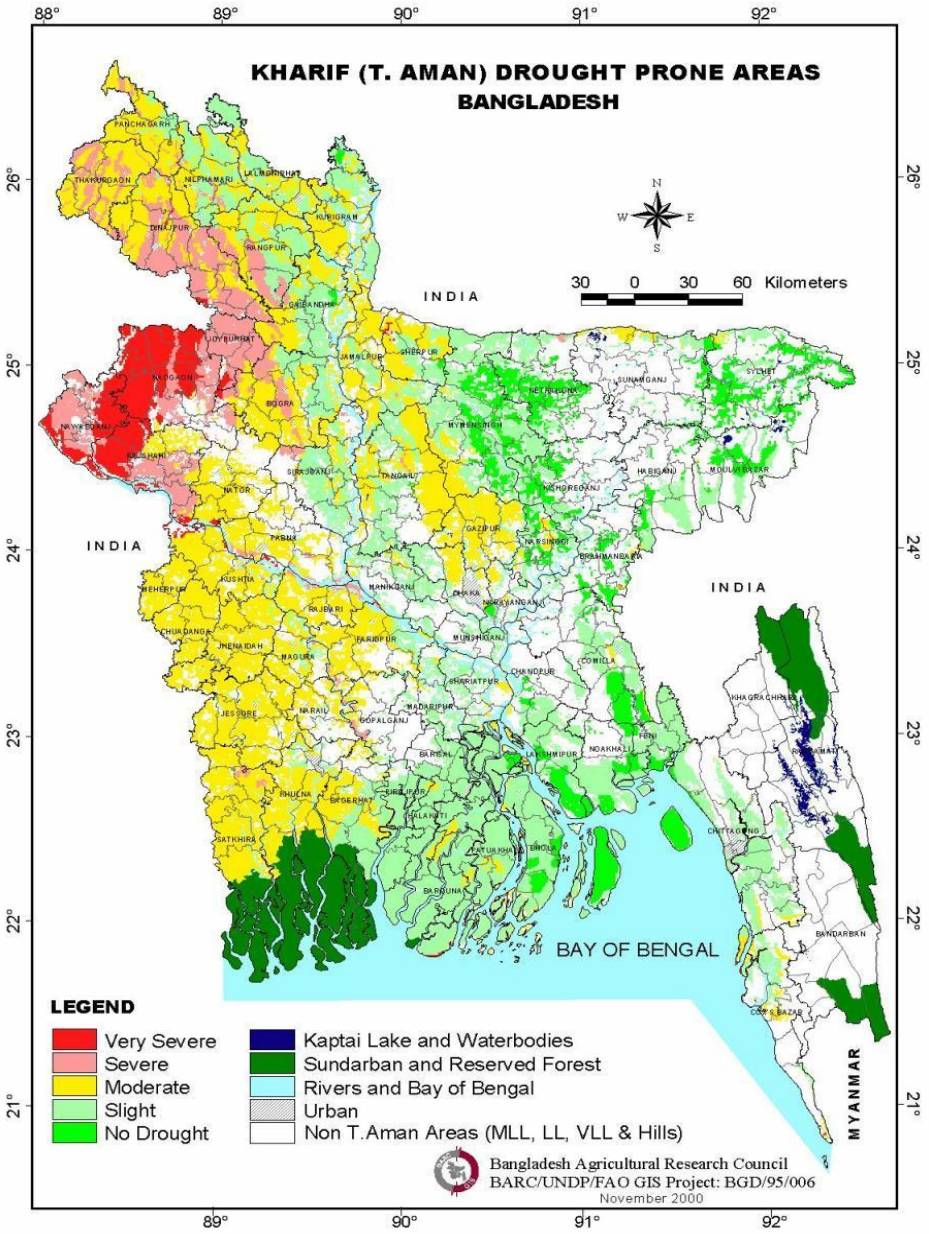
Hazards Bangladesh faces

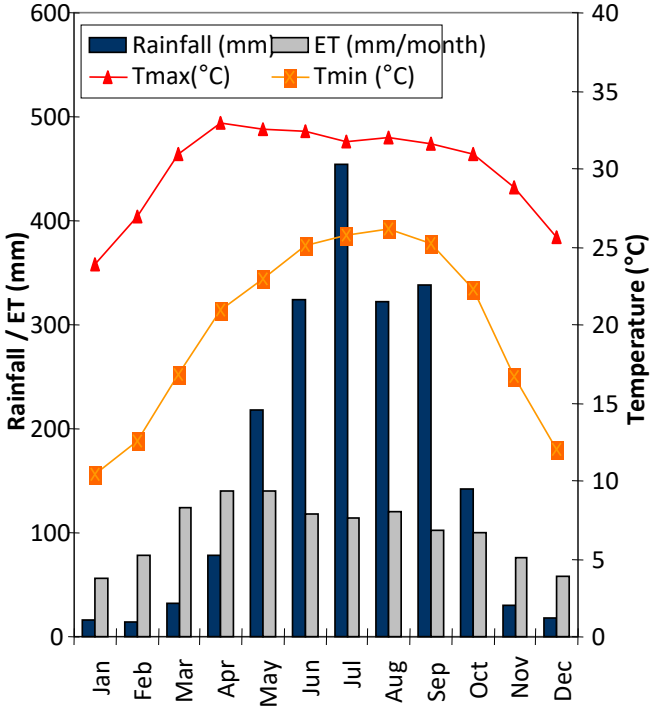
Flood

Water logging

Bank Erosion

Drought Prone Areas in Bangladesh





Recent Experiences

- **Cyclone –SIDR'2007**
- **Cyclone – AILA'2009**
- **Recurring Floods**
- **Desertification of North, North-west and South-west of Bangladesh**
- **Intrusion of saline water**

Health, Nutritional & Agricultural Challenges

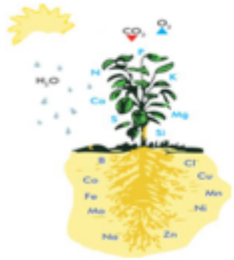
- Arsenic contamination poses major threat to health;
- Increased malnutrition among the poor contribute to the spread of communicable and non-communicable diseases

- Increased incidence of different degenerative diseases due to salinity intrusion;
- Country is now largely food secure – but limits of rice cultivation has been reached in dry period with ground water irrigation;

CROPS

Switching to varieties lolerant to heat, drought or salinity

Optimising Irrigation



Managing Soil nutrients and erosion

LIVESTOCK

Matching animal number to changes in pastures

More farms that mix crops and livestock

Controlling that spread of pests, weeds and diseases

FISHERIES

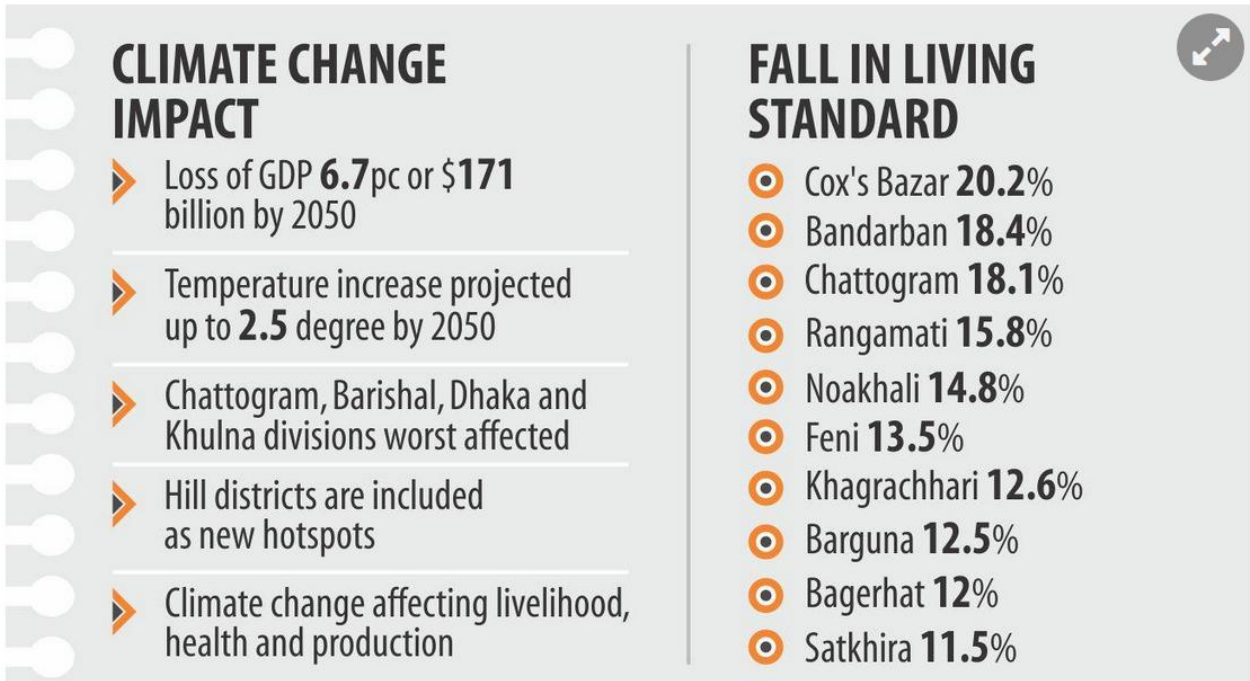
Switching to more abundant species

Restoring degraded habitats and breeding sites like mangroves

Strengthening infrastructure such as ports and landing sites

Climate Change Fallout: 13.4cr people to be hit hard

WB report depicts grim picture

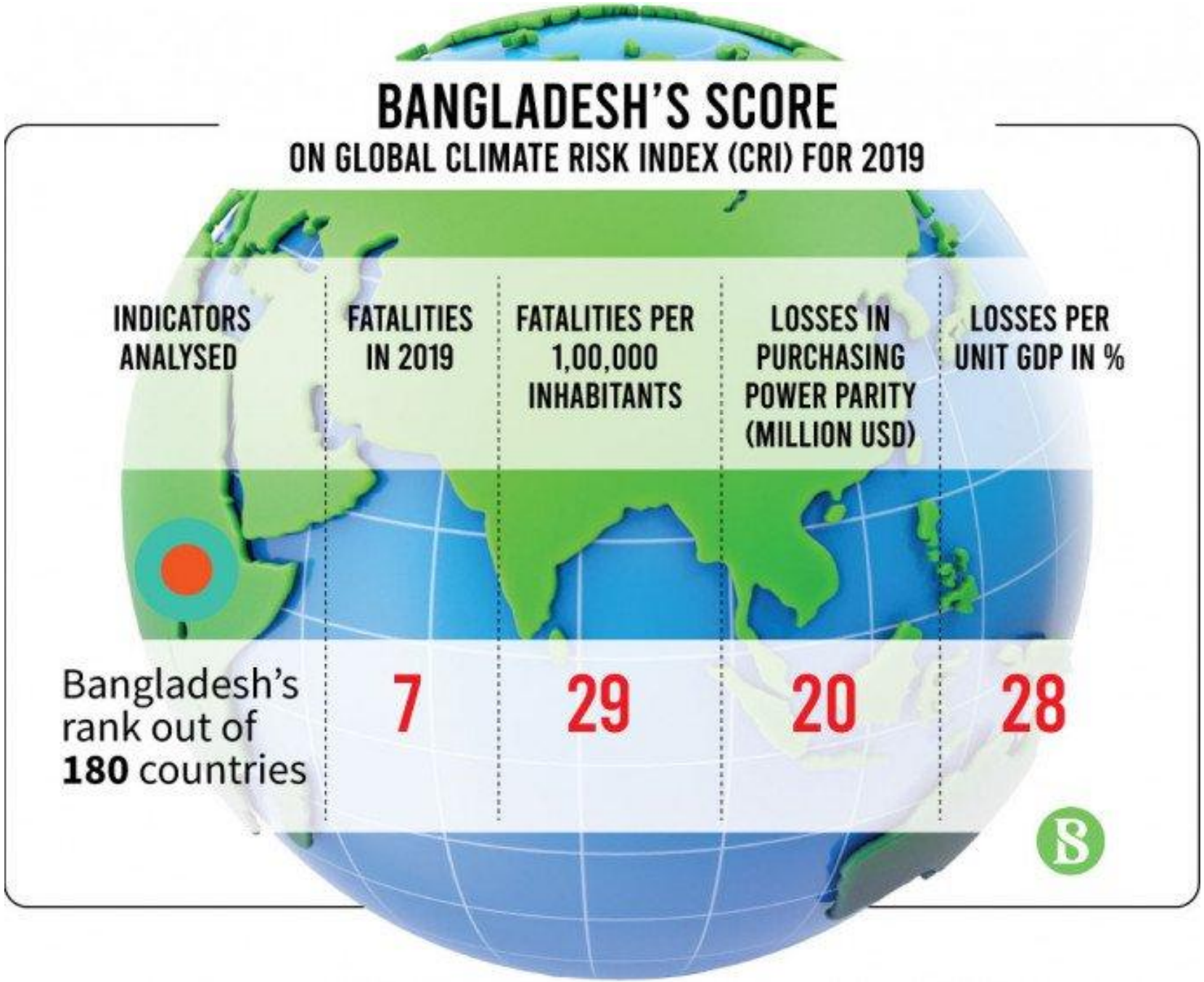


TOP NEWS

- Shakib falls after valiant 66
- 'June was hottest month ever recor on Earth'
- Reconsider gas tariff hike: 14-party govt
- PM places proposal for making any Pacific initiative a success
- Don't cheat people in name of hajj business: President
- 14 Russian sailors killed in sub fire:

BANGLADESH'S SCORE

ON GLOBAL CLIMATE RISK INDEX (CRI) FOR 2019



Why Bangladesh is vulnerable?

Bangladesh is one of the most vulnerable countries because of its

- geographic location;
- flat and low-lying topography;
- high population density;
- reliance of many livelihoods on climate sensitive sectors, particularly agriculture and fisheries;
- corruption?

Recent Success

- Bangladesh has already developed salinity tolerant, flood tolerant and shorter maturity varieties of rice. This will help in the short run.

- Extensive agricultural extension services are needed to make these varieties available to the farmers.

- But this is only the beginning: more varieties and appropriate ecosystem-based agricultural system need to be developed and popularized;

- There is no country that is not experiencing the drastic effects of climate change. Greenhouse gas emissions are more than 50 percent higher than in 1990.
- The annual average economic losses from climate-related disasters are in the hundreds of billions of dollars.
- This is not to mention the human impact of geo-physical disasters, which are 91 percent climate-related, and which between 1998 and 2017 killed 1.3 million people, and left 4.4 billion injured.
- The goal aims to mobilize US$100 billion annually by 2020 to address the needs of developing countries to both adapt to climate change and invest in low-carbon development.

Facts and Figures

+1°C

As of 2017 humans are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels.

+20cm

Sea levels have risen by about 20 cm (8 inches) since 1880 and are projected to rise another 30–122 cm (1 to 4 feet) by 2100.

2050

To limit warming to 1.5C, global net CO2 emissions must drop by 45% between 2010 and 2030, and reach net zero around 2050.

1/3

Climate pledges under The Paris Agreement cover only one third of the emissions reductions needed to keep the world below 2°C.

$26 trillion

Bold climate action could trigger at least US$26 trillion in economic benefits by 2030.

18 million

The energy sector alone will create around 18 million more jobs by 2030, focused specifically on sustainable energy.

Balancing the act

MITIGATION + ADAPTATION ≠

MITIGATION

ADAPTATION

Typology of adaptation options

1. Agronomic management
2. Water harvesting and exploitation
3. Water Use efficiency
4. Crop intensification
5. Alternative crop enterprises
6. Post harvest practices