Lecture 8 – Impacts of climate change-1

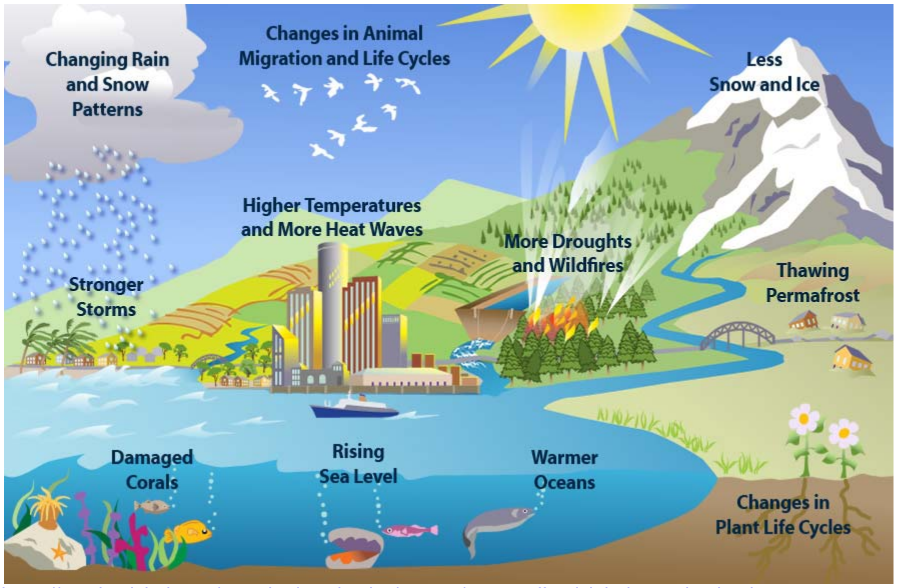
Effect and impact

- Global warming – a process of a constant increase of the annual temperature across the whole planet.

- Effect – result or outcome of an action or a phenomenon
  - Effects of global warming are environmental and social changes like the retreat of glaciers, changing in timing of seasonal events, changes in agricultural productivity etc.

- Impact – overall net result or powerful effect. Impact refers to negative effects
  - Global warming has a major impact on all human and animal life on earth such as food and water shortages, increased poverty, increased displacement of people, coastal flooding etc.

Effects of global warming

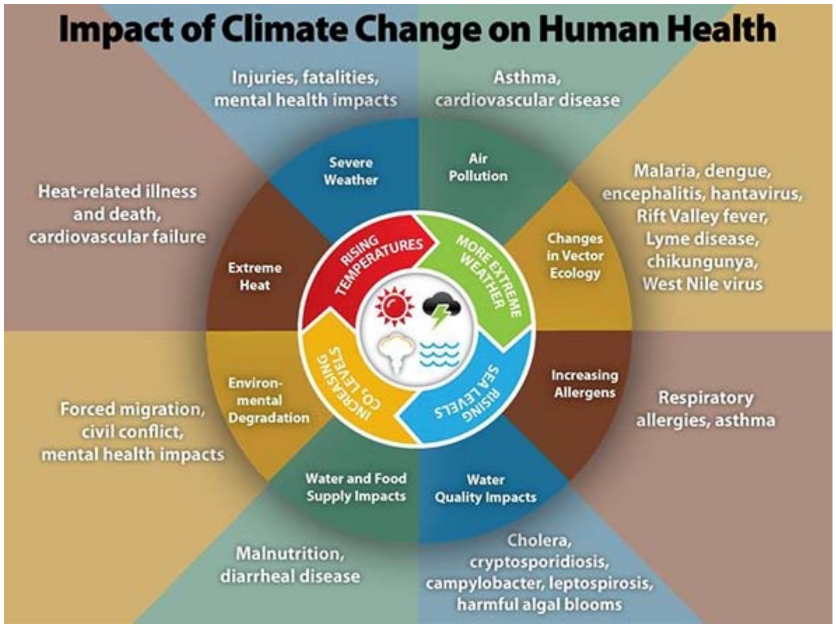


https://academichelp.net/samples/academics/essays/cause-effect/global-warming.html

Climate impacts

- People: health, food, water use, costs
- Freshwater: extreme wet ,extreme dry, land ice
- Oceans: seal level, sea ice, ocean chemistry (acidic oceans threatening sea life)
- Ecosystems: lakes and rivers, land, salt water
- Temperature: air, ocean, water and ground

http://www.climatehotmap.org/global-warming-effects/



http://www.hercampus.com/school/eckerd/could-climate-change-impact-our-health

Impacts of climate change

- Sea level rise
- Impacts on coastal areas
- Impacts of climate change on fresh water resources
- Impacts on agriculture and food supply
- Impact on ecosystem
- Impact on human health
- Adaptation to climate change
- Costing the total impacts

Refer chapter 7 on ebook “Global warming”.

The emission scenarios of the Special Report on Emission Scenarios (SRES)

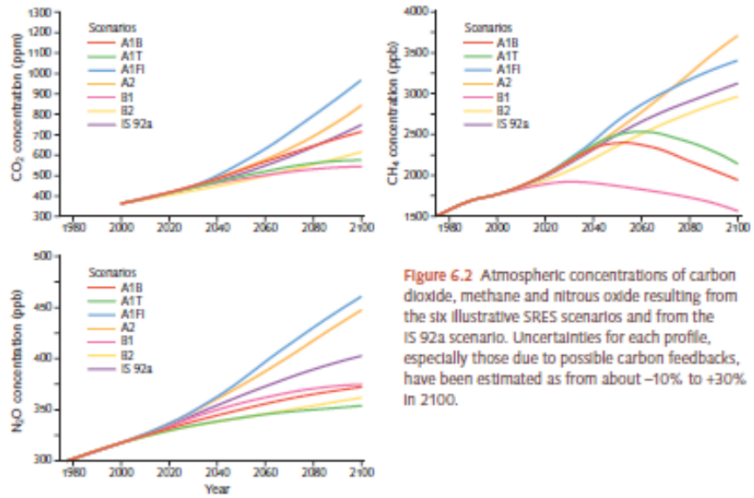


Figure 6.2 Atmospheric concentrations of carbon dioxide, methane and nitrous oxide resulting from the six illustrative SRES scenarios and from the IS 92a scenario. Uncertainties for each profile, especially those due to possible carbon feedbacks, have been estimated as from about −10% to +30% in 2100.

From the total set of 35 scenarios, an illustrative scenario was chosen for each of the six scenario groups A1B, A1FI, A1T, A2, B1 and B2. All should be considered equally sound.

A1 storyline

- The A1 storyline and scenario family describes a future world of **very rapid economic growth**, a global population that peaks in mid century and declines thereafter, and the rapid introduction of new and more efficient technologies.
- Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income.
- The A1 scenario family develops into **three** groups which describe alternative directions of technological change in the energy system. The three groups are distinguished by their technological emphasis:
- **fossil fuel intensive** (A1FI), **non-fossil fuel energy sources** (A1T) or a **balance across all sources** (A1B) – where balance is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy-supply and end-use technologies.

A2 storyline

- The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is **self reliance and preservation of local identities.** Fertility patterns across regions converge very slowly, which results in a continuously increasing population.
- Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1 storyline

- The B1 storyline and scenario family describes a convergent world, with the same global population that peaks in mid century and declines thereafter as in the A1 storyline, but with **rapid change in economic structures towards a service and information economy**, with reductions in material intensity and the introduction of clean and resource-efficient technologies.
- The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate-related initiatives.

B2 storyline

- The B2 storyline and scenario family describes a world in which the emphasis is on **local solutions** to economic, social and environmental sustainability.
- It is a world with a continuously increasing global population, at a rate lower than in A2, intermediate levels of economic development and less rapid and more diverse technological change than in the B1 and A1 storylines.
- While the storyline is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

Table 6.1 Radiative forcing (W m^{-2}) globally averaged, for greenhouse gases and aerosols from the year 1750 to 2005 and from SRES scenarios to 2050 and 2100

Greenhouse gas	Year	Radioactive forcing (W m^{-2})	A1B	A1T	A1FI	A2	B1	B2	IS 92a
CO_2	2005	1.66							
	2050		3.36	3.08	3.70	3.36	2.92	2.83	3.12
	2100		4.94	3.85	6.61	5.88	3.52	4.19	4.94
CH_4	2005	0.48							
	2050		0.70	0.73	0.78	0.75	0.52	0.68	0.73
	2100		0.56	0.62	0.99	1.07	0.41	0.87	0.91
N_2O	2005	0.16							
	2050		0.25	0.23	0.33	0.32	0.27	0.23	0.29
	2100		0.31	0.26	0.55	0.51	0.32	0.29	0.40
O_3(trop)	2005	0.35							
	2050		0.59	0.72	1.01	0.78	0.39	0.63	0.67
	2100		0.50	0.46	1.24	1.22	0.19	0.78	0.90
Halocarbons	2005	0.34							
Total aerosols	2005	−1.2[a]							

[a] Including both direct and indirect effects.

Impacts of global warming

- Positive impacts of global warming
  - Growing season will lengthen in northern Siberia, Scandinavia, northern Canada with possibilities of growing greater varieties of crops
  - There will lower mortality and lower heating requirements
  - Increased CO2 will aid the growth of some types of plants leading to increased crop yields
- Negative impacts of global warming
  - Sea level rise
  - Melting of glaciers and ice sheets in Arctic and Antarctic
  - Changes in ecosystem etc.

Definitions

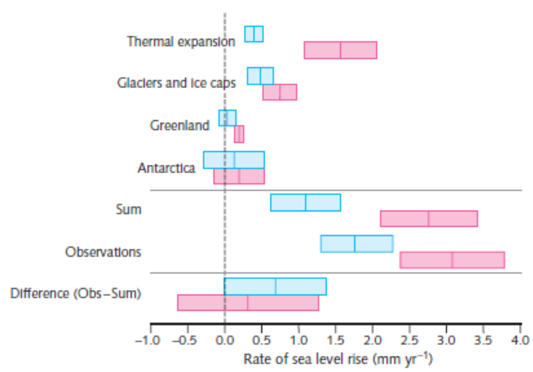
- *Sensitivity* is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.
- *Adaptive capacity* is the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities or to cope with the consequences.
- *Vulnerability* is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Changes in Sea level

- During the twentieth century observations show that the average sea level rose by about 20 cm. The contributors are
  – Thermal expansion of ocean water: as the oceans warm the water expands and the sea level rises
  – Melting of glaciers
  – Melting of ice caps of Greenland and Antarctica (though very little)
- Changes in terrestrial storage of water, for instance from the growth of reservoirs or irrigation

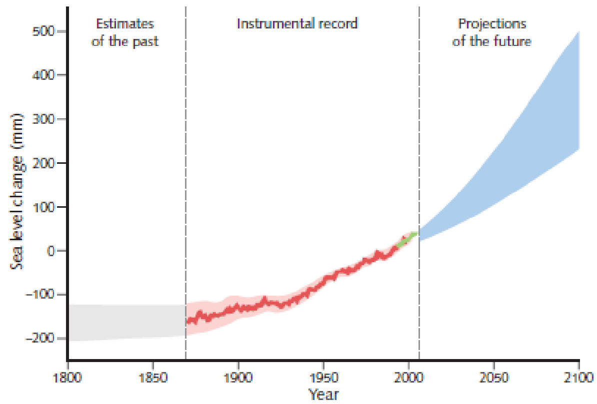
Thermal expansion of the oceans

Figure 7.1 Estimates for 1961–2003 (blue) and 1993–2003 (pink) of contributions to global mean sea level change (upper four entries), the sum of these contributions and the observed rate of rise (middle two) and the difference between the observed rate and the estimates (lower). The bars represent a range of uncertainty of 90% probability. Errors of the separate terms have been combined in quadrature to obtain the error on their sum.



For cold water the expansion for a given change of temperature is small. The maximum density of sea water occurs at temperatures close to 0°C; for a small temperature rise at a temperature close to 0°C, therefore, the expansion is negligible. At 5°C (a typical temperature at high latitudes), a rise of 1°C causes an increase of water volume of about 1 part in 10,000 and at 25°C (typical of tropical latitudes) the same temperature rise of 1°C increases the volume by about 3 parts in 10,000. For instance, if the top 100 m of ocean (which is approximately the depth of what is called the mixed layer) was at 25°C, a rise to 26°C would increase its depth by about 3 cm.

Figure 7.2 Global mean sea level in the past and as projected for the future. From 1870 is a reconstruction of the global mean from tide gauges; the green line is global mean sea level as observed from satellite altimetry. Beyond 2004 is the range of model projections (the 5% to 95% uncertainty range) for the SRES A1B scenario for the twenty-first century relative to the 1980–99 mean from the sum of estimates of the different contributions (major ones identified in Figure 7.1).



For the twenty-first century, the IPCC AR4 2007 projects that Antarctica will continue close to balance but that for Greenland, ablation (erosion by melting) will be greater than accumulation leading to a net loss amounting to less than 0.1 m by the end of the century.

Four indications of this, the first two suggested by P. Christoffersen and M. J. Hambrey and the last two by J. Hansen and his co-authors, are:

1. Observations from satellite radar altimeters show that the total ice-mass loss from the Greenland ice cap rose from 90 km^3 in 1996 to 140 km^3 in 2000 and 220 km^3 in 2005. Similar losses have been observed from the West Antarctic ice-sheet. A loss of 400 km^3 per year transfers into a global sea level rise of about 1 mm per year or 0.1 m per century.
2. Observations of acceleration in the movement of coastal outlet glaciers to now more than 10 km per year. Similar losses and movement are occurring with the West Antarctic ice-sheet.
3. Observations of increased melt water, from the operation of the ice-albedo feedback (see Chapter 5 , page 114), penetrating to the bed of the ice-sheet and through its lubrication enhancing ice motion and instabilities near the ice-sheet base.
4. Palaeo evidence of periods of rapid melting with associated global sea level rise of up to several metres per century occurring for instance during the recovery from the last ice age about 14,000 years ago.

Impacts on coastal area

- Vulnerable river deltas: e.g.; Bangladesh
  - Densely populated country (150 million live in delta regions)
  - 10% of the country's habitable land (with about 6 million population) would be lost with half a metre of sea level rise and about 20% (with about 15 million population) would be lost with a 1-m rise. Loss of land is serious issue for densely populated country.
  - Bangladesh is extremely prone to damage from storm surges. Every year, on average, at least one major cyclone attacks Bangladesh.
  - There is a further effect of sea level rise on the productivity of agricultural land; that is, the intrusion of salt water into fresh groundwater resources.
  - Similar situation can arise in Egypt (Nile delta region) and in Eastern Coastline of China.
- Low land close to sea: Netherlands
- Small low lying islands in the Pacific and other oceans
- Wetlands and mangrove swamp

Endangered coastal areas

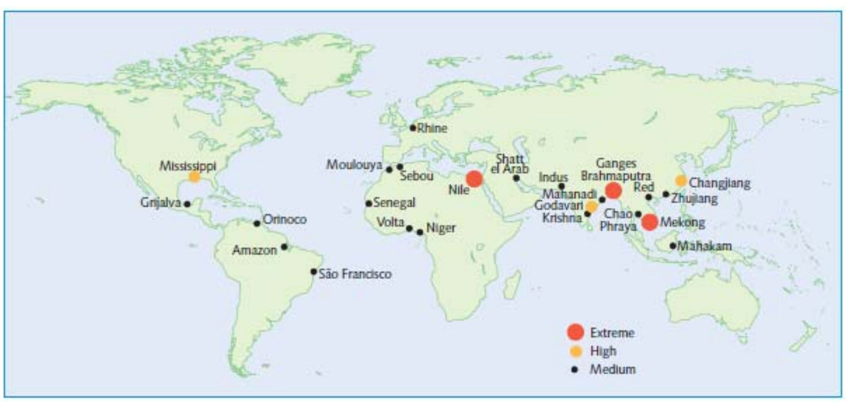


Figure 7.3 Relative vulnerability of coastal deltas as indicated by estimates of the population potentially displaced by current sea level trends to 2050 (extreme, >1 million; high, 1 million to 50000; medium, 50000 to 5000). Climate change would exacerbate these impacts.

Figure 7.4 Land affected in Bangladesh by various amounts of sea level rise. The 1, 2, 3 and 5 m contours are shown.

Note:

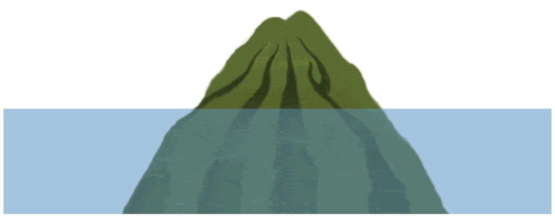
- Substantial amount of agricultural land will be lost.
- This is serious: half the country's economy comes from agriculture and 83% of the nation's population depends on agriculture for its livelihood.

Impacts on coastal area

- Vulnerable river deltas: e.g.; Bangladesh
- Low land close to sea: Netherlands
  - more than half of which consists of coastal lowlands, mainly below present sea level. It is one of the most densely populated areas in the world; 8 million of the 14 million inhabitants of the region live in large cities such as Rotterdam, The Hague and Amsterdam.
  - An elaborate system of about 400 km of dykes and coastal dunes (dune is a hill of sand built either by wind or water flow), built up over many years, protects it from the sea.
  - Dykes and sand dunes will need to be raised; additional pumping will also be necessary to combat the incursion of salt water into freshwater aquifers.
  - About $US12 000 million would be required for protection against a sea level rise of 1 m .
- Small low lying islands in the Pacific and other oceans
  - Half a million people live in archipelagos of small islands and coral atolls, such as the Maldives in the Indian Ocean, consisting of 1190 individual islands, and the Marshall Islands in the Pacific, which lie almost entirely within 3 m of sea level.

Impacts on coastal area

- Vulnerable river deltas: e.g.; Bangladesh
- Low land close to sea: Netherlands
- Small low lying islands in the Pacific and other oceans
  - Half a million people live in archipelagos of small islands and coral atolls, such as the Maldives in the Indian Ocean, consisting of 1190 individual islands, and the Marshall Islands in the Pacific, which lie almost entirely within 3 m of sea level.
  - Half a metre or more of sea level rise would reduce their areas substantially – some would have to be abandoned – and remove up to 50% of their groundwater. The cost of protection from the sea is far beyond the resources of these islands' populations.
- Wetland and mangrove swamp



This animation shows the dynamic process of how a coral atoll forms. Corals (represented in tan and purple) begin to settle and grow around an oceanic island forming a fringing reef. It can take as long as 10,000 years for a fringing reef to form. Over the next 100,000 years, if conditions are favorable, the reef will continue to expand. As the reef expands, the interior island usually begins to subside and the fringing reef turns into a barrier reef. When the island completely subsides beneath the water leaving a ring of growing coral with an open lagoon in its center, it is called an **atoll**. The process of atoll formation may take as long as 30,000,000 years to occur.

Impacts on coastal area

- Vulnerable river deltas: e.g.; Bangladesh
- Low land close to sea: Netherlands
- Small low lying islands in the Pacific and other oceans
- Wetland and mangrove swamp
  - The world's wetlands and mangrove swamps currently occupy an area of about 1 million square kilometres (the figure is not known very precisely), equal approximately to twice the area of France. They contain much biodiversity and their biological productivity equals or exceeds that of any other natural or agricultural system.
  - Over two thirds of the fish caught for human consumption, as well as many birds and animals, depend on coastal marshes and swamps for part of their life cycles, so they are vital to the total world ecology. Such areas can adjust to slow levels of sea level rise, but there is no evidence that they could keep pace with a rate of rise of greater than about 2 mm per year – 20 cm per century.
  - What will tend to occur, therefore, is that the area of wetlands will extend inland, sometimes with a loss of good agricultural land.

Falling water levels threaten Mississippi barges

- Mississippi River to Shut Down?
- Drought conditions in the Midwest have left the Mississippi River so dry, that shipping could grind a halt within days. CNBC's Sharon Epperson speaks to Mike Toohey, Waterways Council president and CEO for more insight.
- Date 1/4/13, Duration 4:39,

Shipping organizations say the low water levels have hurt commercial traffic along the Mississippi for months, in some cases doubling transit times, reducing the size of barge shipments and cancelling some orders. And they're looking for continued assistance from the federal government to keep those water levels up.
Source: http://money.msn.com/now/post.aspx?post=c0fcff8d-458c-48d0-82e2-ca608767d393

Conclusions

- Sea level may rise to ½ m or more due to global warming during 21st century.
- In delta regions sea level rise will lead to substantial loss of agricultural land and salt intrusion into freshwater resources.
- Possibility of increased intensity and frequency of disasters because of storm surges.
- Countries like the Netherlands and many cities in coastal regions will have to spend substantial sum on protection against the sea.
- Significant amounts of land will also be lost near the important wetland areas of the world.

What is the global ocean conveyor belt?

The global ocean conveyor belt is a constantly moving system of deep-ocean circulation driven by temperature and salinity.

- The ocean is not a still body of water. There is constant motion in the ocean in the form of a global ocean conveyor belt. This motion is caused by a combination of thermohaline currents (thermo = temperature; haline = salinity) in the deep ocean and wind-driven currents on the surface. Cold, salty water is dense and sinks to the bottom of the ocean while warm water is less dense and remains on the surface.
- The ocean conveyor gets its "start" in the Norwegian Sea, where warm water from the Gulf Stream heats the atmosphere in the cold northern latitudes. This loss of heat to the atmosphere makes the water cooler and denser, causing it to sink to the bottom of the ocean. As more warm water is transported north, the cooler water sinks and moves south to make room for the incoming warm water. This cold bottom water flows south of the equator all the way down to Antarctica. Eventually, the cold bottom waters return to the surface through mixing and wind-driven upwelling, continuing the conveyor belt that encircles the globe.

http://oceanservice.noaa.gov/facts/conveyor.html