

Introduction to climate change

2016

INTRODUCTION

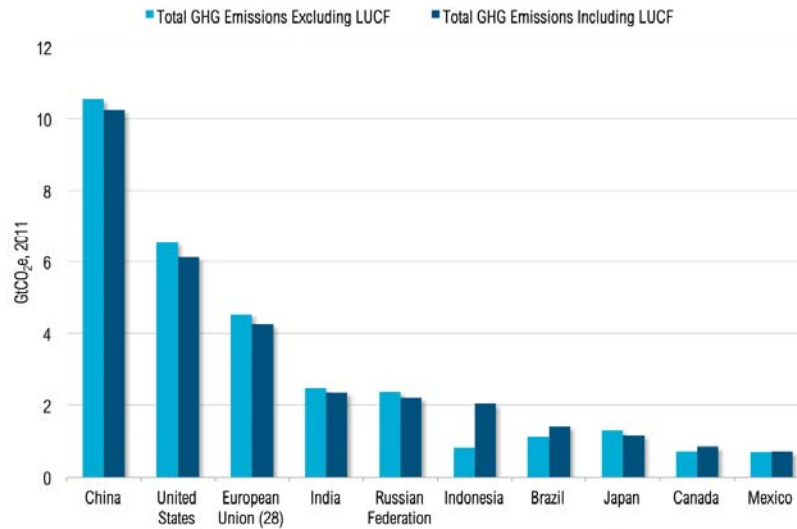
- Climate change is the alteration of world's climate caused by human activities through fossil burning, deforestation and other practices that increase the concentration of greenhouse gases in the atmosphere.
- Environmental impacts at the local level: air pollution from burning of fossil fuels; indoor air pollution, hydropower.
- Regional environmental impacts: trajectories of air pollution, acid rain, environmental impacts of nuclear power.
- Global environmental impacts: ozone depletion, climate change.

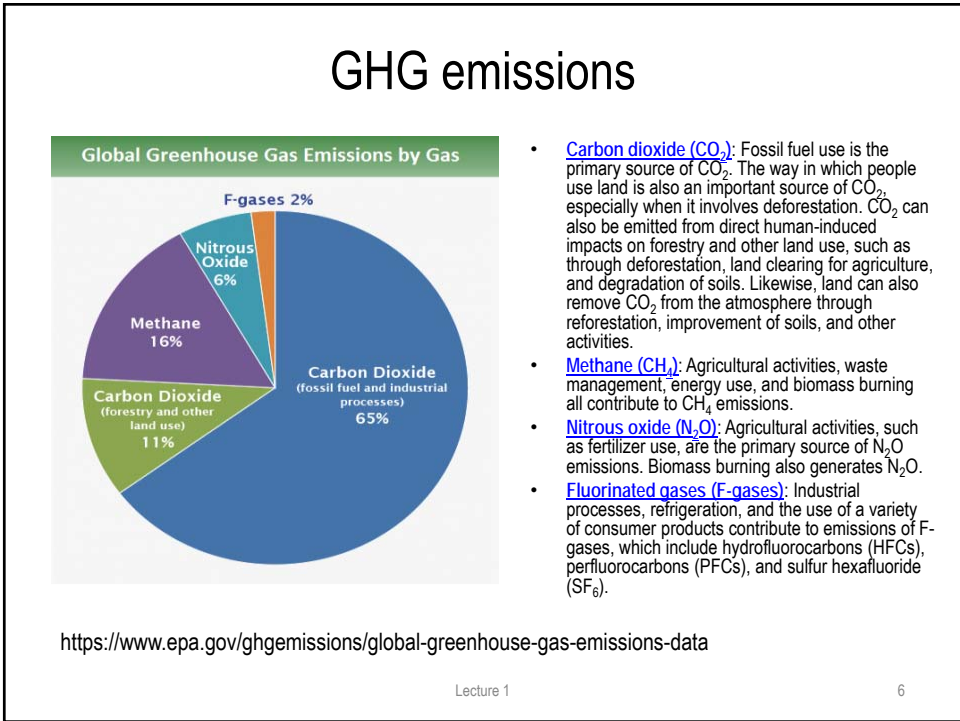
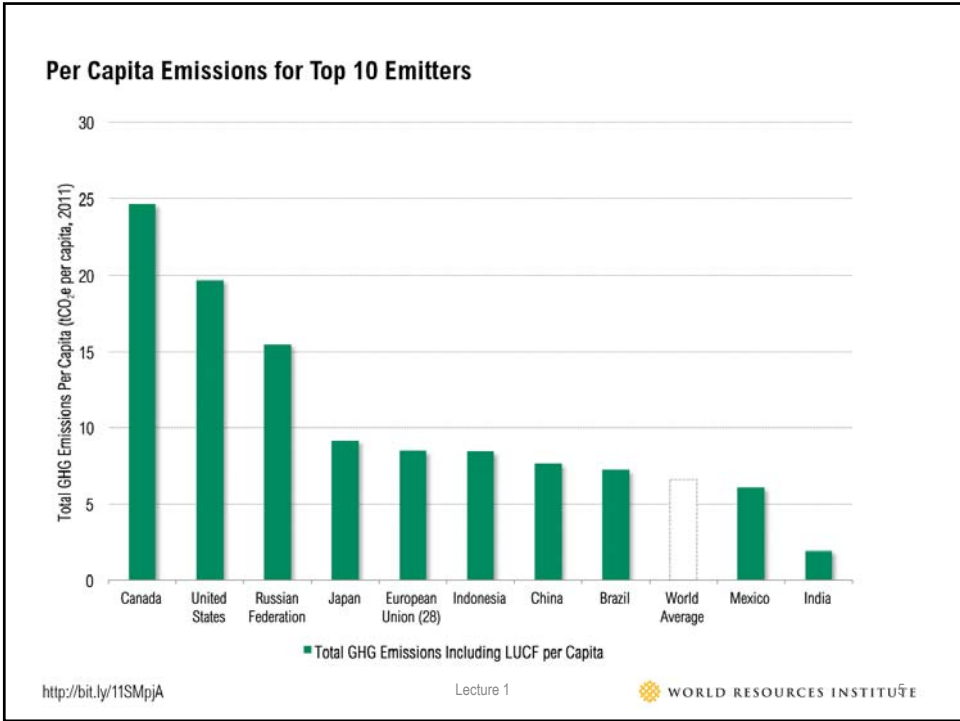
Approx length and time scale for selected environment effects of energy production and utilization

Level	Distance	Examples	Effects
Local	0.001 -10 km	Air pollutants	<ul style="list-style-type: none"> • Acute respiratory episodes: <1 day • Lung cancer: 10 - 50 years • Mutagenicity: 1 - 5 generations
Regional	100 – 500 km	<ul style="list-style-type: none"> • Acid rain • Particulate pollution 	Forest and aquifer damage: 1- 20 years
Global	5,000 – 25,000 km	Climate modification	<ul style="list-style-type: none"> • Sea-level rise: 30 – 100 years or more • Desertification: 30 – 100 years more

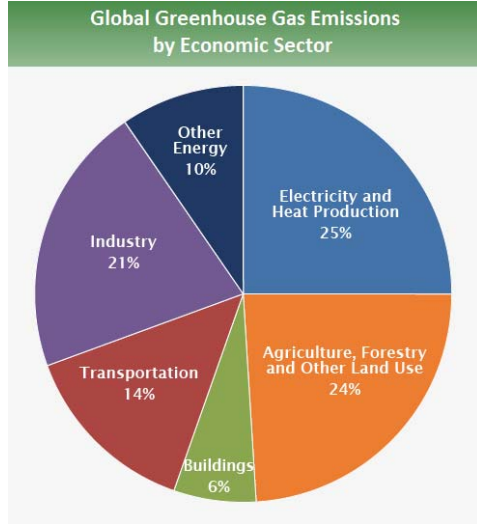
Top 10 Emitters

LUCF – land use change and forestry





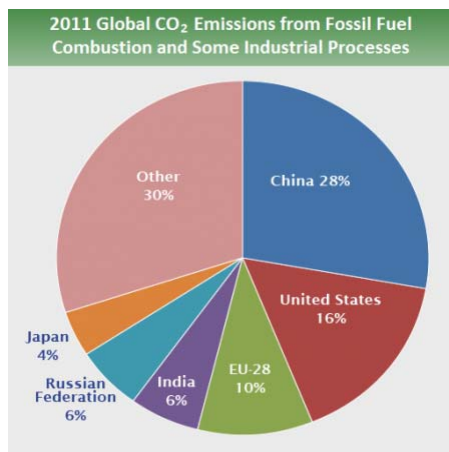
GHG emissions by economic sector



- Electricity and heat production: combustion of fossil fuels (coal, oil and NG)
- Agriculture, forestry and other land use: cultivation of crops, livestock and deforestation.
- Industry: fossil fuels burned on site at facilities for energy.
- Transportation: fossil fuels burned for road, rail, air, and marine transportation.
- Buildings: onsite energy generation and burning fuels for heat in buildings or cooking in homes.
- Others: GHG emissions from such as fuel extraction, refining, processing, and transportation

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

Emissions by country



- In 2011, the top carbon dioxide (CO₂) emitters were China, the United States, the European Union, India, the Russian Federation, Japan, and Canada.
- These data include CO₂ emissions from fossil fuel combustion, as well as cement manufacturing and gas flaring. Together, these sources represent a large proportion of total global CO₂ emissions.

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

OBSERVATIONS

- Increase in air and ocean temperature
 - Global temperature has increased by 0.74°C since 1850. It is annually increasing by 0.06%. [1.8 - 4°C]
- Melting of snow and ice
 - Melting of snow and ice from many mountains and in the polar regions
- Rising of sea level
 - Global sea level has risen by 17 cm [18 – 59 cm]

Source: IPCC Fourth Assessment Report

(Global Warming & Climate Change)

CO₂

Air pollution

Indoor air pollution

Ice on Kilimanjaro

Kilimanjaro 2000

(a) Global average temperature

(b) Global average sea level

(c) Northern Hemisphere snow cover

Drought

Flash Rain & Flood

Sea level rise

Arctic ice melting

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Observed Climate Changes (Intergovernmental Panel on Climate Change, 2007)

- The global surface temperature rose by 0.74 ° C between 1906 and 2005.
- Eleven of the last 12 years have been the warmest since records were kept.
- The increase in temperature during the last 50 years was twice as high as during the last 100 years. The warming of the Arctic has been twice as fast.
- The temperatures of the last 50 years have probably been higher than at any time in the last 1300 years.
- Glaciers are shrinking worldwide, as are the ice sheets on Greenland and Antarctica.
- Since 1993 the sea level has risen an average of 3.1 mm per year; during the 20th century this amounted to a total of 17 cm. More than half of this is due to the thermal expansion of the oceans, about 25% to the melting of mountain glaciers and around 15% to the melting of the arctic ice sheets.
- The frequency of heavy precipitation has increased.
- The frequency and intensity of droughts has increased since the 1970s.
- The frequency of extreme temperatures has increased.
- Tropical cyclones have become much more intense since the 1970s.

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Examples of Major Natural Catastrophes

- Winter 1990: The storms Daria, Herta, Vivian and Wiebke kill 272 people in Europe and cause 12.8 billion euros in damage.
- 29 April 1991: A storm tide resulting from the tropical cyclone Gorky hits Bangladesh. 138 000 people die. The material damage at 3 billion Euros is comparatively low in this poor country.
- 12 December 1999: Storm Lothar devastates large areas of Europe. 110 people died. The damage amounts to 11.5 billion euros.
- August 2002: Unusually heavy rainfall with up to 400 litres per square metre causes major flooding. In Germany, Dresden is one of the cities overcome by floods. In Europe overall 230 people lose their lives and the damage is 18.5 billion Euros.
- August 2003: Europe 's most extreme heat wave in recorded history takes 70 000 lives and causes damage close to 13 billion Euros.
- August 2005: Hurricane Katrina wreaks havoc in the USA and destroys the city of New Orleans. 1322 people die as a result. The most expensive storm of all time causes US\$125 billion (around 100 billion Euros) worth of damage.
- September 2005: Four weeks after Katrina, Hurricane Rita causes around 13 billion Euros worth of damage. About 3 million people are evacuated to protect the population.
- 18 January 2007: The storm Kyrill moves across Europe. The German railway halts all train travel in Germany for the first time in history.

Examples of Major Natural Catastrophes

- 2 May 2008: Myanmar was hit by a category 4 cyclone named Nargis. The damage caused by Nargis was extreme, both because the cyclone was so powerful and because Myanmar was not well prepared to handle it. After Nargis hit, the international community offered to assist Myanmar with its recovery, but because of its government, this assistance was not easily received.
- 11 March 2011: A magnitude-9.0 earthquake hit northeastern Japan and caused a savage tsunami that engulfed everything in its pathway. About 20,000 people were killed. The quake lifted the seafloor by 30 feet and the tsunami debris were found on US shorelines two years later. The twin disaster caused a meltdown at the Fukushima Daiichi nuclear plant which developed into the world's worst nuclear crisis.
- 2012: Hurricane Sandy (also known as Superstorm Sandy) was the most destructive hurricane of the 2012 Atlantic hurricane season. Sandy made landfall in southern New Jersey and became incredible in its size and power. It was a large storm with violent gusts and storm surges that caused major flooding and left millions of people along the East Coast without power.
- In Australia, between August and November 2013, over 100 wildfires have raged across the state of New South Wales with unprecedented levels of scale and severity. Australia has just experienced its hottest 12 months on record.
- Extreme weather events are becoming increasingly common in Russia, and the 2012 drought – following hard on the severe drought of 2010 – confirmed this trend. During 2012, 22 regions suffered crop losses, with a state of emergency declared in 20 of these.

5 natural disasters that beg for climate action

- **Australia wildfires:** In Australia, between August and November 2013, over 100 wildfires have raged across the state of New South Wales with unprecedented levels of scale and severity. Australia has just experienced its hottest 12 months on record.
- **Russia drought:** Extreme weather events are becoming increasingly common in Russia, and the 2012 drought – following hard on the severe drought of 2010 – confirmed this trend. During 2012, 22 regions suffered crop losses, with a state of emergency declared in 20 of these.
- **Guatemala coffee rust:** In Central America, a fungal disease on coffee plants called la Roya (coffee rust) is attacking Arabica coffee plants across Guatemala, Honduras, El Salvador and Nicaragua at ever higher altitudes as the climate warms. Guatemala, Honduras and Costa Rica have declared national emergencies with up to 70% of this year's crop in Guatemala affected.
- **Pakistan floods:** In August 2013 floodwaters inundated up to one fifth of Pakistan and affected an estimated 20 million people. Research has shown that Pakistan is suffering from a global phenomenon of more frequent and intense weather patterns that put many communities' lives and livelihoods at risk.
- **Phillipines typhoon:** Typhoon Haiyan is the strongest tropical cyclone to make landfall in history. 11.3 million people are affected and over 700,000 people have been displaced.

OBSERVATION IN NEPAL

- The average temperature has risen by 1.2°C from 19.3°C to 20.5°C for 1975-2005.
- Rainfall shows irregular pattern:
 - Intense rainfall during rainy season and longer dry periods during winter
 - Uncertain but higher annual rainfall but less rainfall during winter and spring
- Glacier melting causing a risk of bursting glacier lakes, flooding downstream due to increase in water volume of many rivers.

Heavy snowfall in October 2014

- Members of an alpine club were caught in heavy snowfall in Nepal during an October, 2014 ascent from Tilicho Lake to their base camp near Annapurna Massif.
- Snowstorms were more likely in Nepal last year because of human-induced climate change, according to a global team of scientists.



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IMPACTS OF CLIMATE CHANGE IN NEPAL



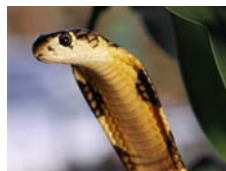
Rhododendron flowers are blooming in the month of Jan. in 2010 in Dadeldhura.



Glacier melting



Winter droughts



Poisonous snake in Kath.



Mosquito and diseases

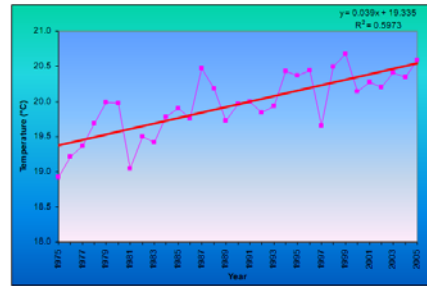


Flooding during rainy season

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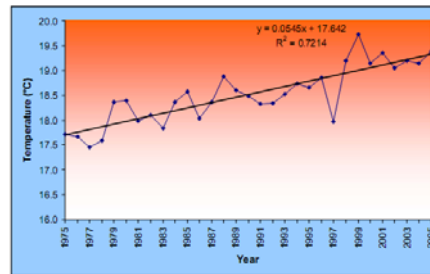
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The mean temperature of the country (1975-2005) is increasing steadily at the linear rate of $0.04^{\circ}\text{C}/\text{year}$. This rate is much higher than the mean global rate.



Annual mean all Nepal temperature trend.

The temperature in Katmandu, the capital city is increasing at the linear rate of $0.05^{\circ}\text{C}/\text{year}$, higher than the all Nepal rate.



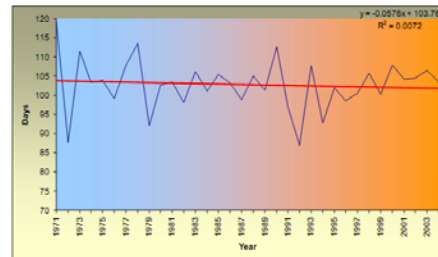
Annual mean temperature trend in Kathmandu Airport.

Source: Baidya et. al., 2007

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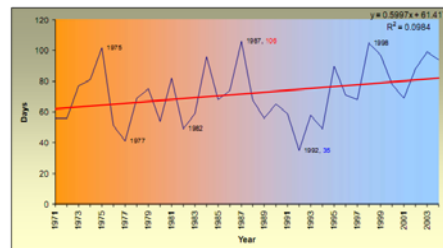
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The trend of monsoon rainfall is slightly positive, while the number of rainy days are in slight decreasing trend.



Trend of number of rainy days (≥ 1 mm/day)

The heavy rainfall events (≥ 100 mm/day) are observed to be in increasing trend. This implies that floods and landslides will be more common in future.



Trend of heavy precipitation events (≥ 100 mm/day)

Source: Baidya et.al, 2007

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CAUSES OF CLIMATE CHANGE

- Increase in GHG in the atmosphere.
- The greenhouse effect is itself natural, and without it the earth surface would have been very cold. About 34°C colder than it is now, in fact (-19°C instead of 15°C).
- Global warming is caused by enhancing this greenhouse effect, via the emission of carbon dioxide, methane, and other "greenhouse gasses".
- These are mostly emitted through the combustion of fossil fuels, deforestation, forest fires, animal farming and rice cultivation etc..

IMPACTS

- Extreme weather (glacier melting, flooding, irregular rainfall pattern, death due to heat wave and cold wave)
- Deforestation (unplanned land use due to increase in population)
- Agriculture change (decrease in winter and spring crop production)
- Migration and Loss of species (change and extinction of some species and habitats)
- Economic effects (increase in food price, insurance cost etc.)
- Diseases (spreading of diseases like malaria, asthma, etc.)
- Fresh water scarcity (Less water in perennial rivers in winter, water pollution)

BARRIERS

Information	<ul style="list-style-type: none"> • Limited awareness campaign on climate change • Limited data on climate change • Lack of database on climate change at national level
Financial	<ul style="list-style-type: none"> • Limited funding for R & D on climate change • No funding for developing a program on climate change
Technical	<ul style="list-style-type: none"> • Lack of technology transfer for adaptive measures • Lack of research infra-structure
Human resource	<ul style="list-style-type: none"> • Lack of trained manpower • Lack of career opportunity
Policy/ Institutional	<ul style="list-style-type: none"> • Lack of specific policies on climate change • Inadequate coordination among stakeholders on climate change
Social	<ul style="list-style-type: none"> • Lack of awareness on climate change

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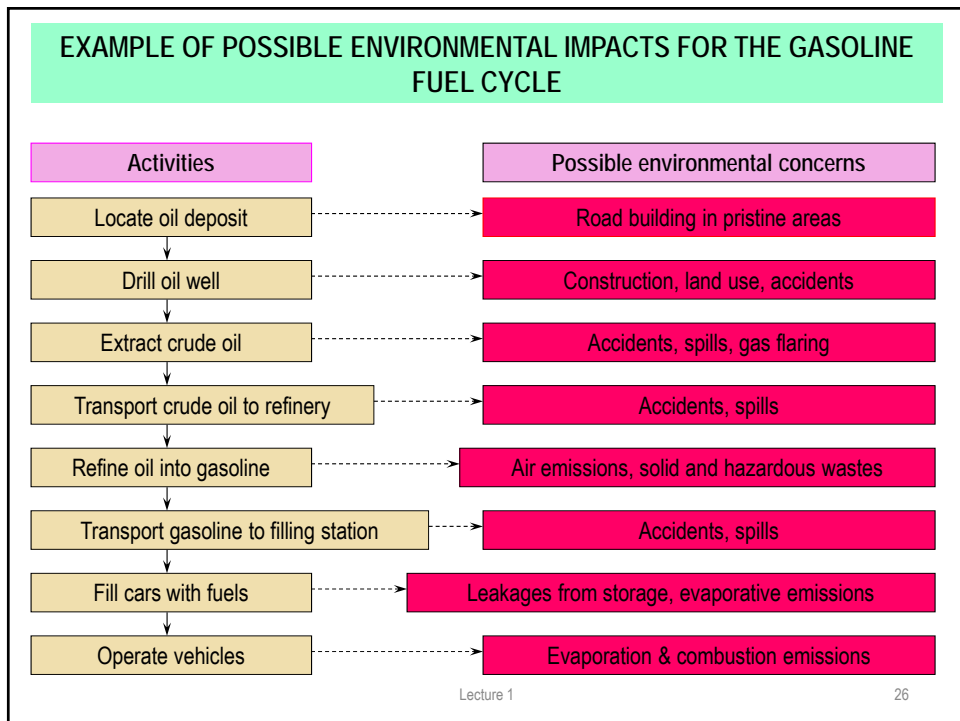
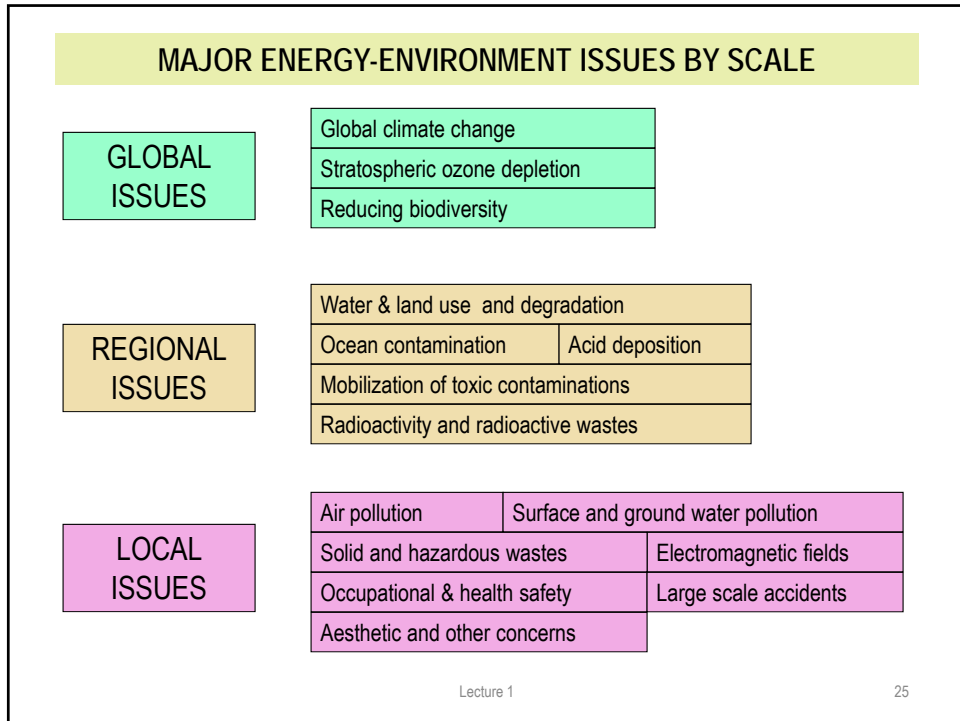
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CAPACITY BUILDING

Awareness campaign	<p>What: climate change, its impact & vulnerability, adaptation & mitigation measures</p> <p>How: school curricula, seminar, workshop, use of mass media</p> <p>Who: institutions/schools, NGOs, INGOs, local government</p>
Human resource development	<p>Institutionalized trainings</p> <p>On the job training</p> <p>Field visits</p>
Database centers	<p>Data collection network (e.g.; for easy access to climate risk information)</p> <p>Manpower (training centres, institutions)</p> <p>Environmental aspect</p> <p>Institutions involved in R & D</p>
Research and development	<p>Institutionalised R & D for adaptation and mitigation</p>
Research infra-structure	<p>Testing labs; demonstration lab; training centers (with availability of relevant equipment/instruments)</p>

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References

- <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>
- <http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters>
- <http://www.wri.org/our-work/topics/climate>

Homework

- Prepare the report on temperature rise, sea level rise and Arctic ice melting as per AR5 report. Also explain its deviation from AR4.
- Show the global trend of GHG emissions from 1980 to 2016.
- Reading materials.