CLIMATE CHANGE AND HUMAN ADAPTATION

Q: What do you know about the factors of climate change? Discuss the natural and anthropogenic factors of climate change.

Factors of Climate Change:

Climatic factors are some facts or causes that influences and consequences the occurrences of climate change. If climate change is the consequence than the causes might be recognized as the factors of climate change. In other words, factors of climate change can be considered as the catalyst or causes of the very occurrence of climate change (Brulle, 2012).

The factors of climate change can be of two types-

1. Anthropogenic factors
2. Natural factors

Anthropogenic factors are those activities, processes and actions conducted by human being either directly or indirectly through catalyzing actions, can influence the occurrence of climate change.

Natural factors are those activities, processes and actions take place by default in the nature and natural system of the earth considered either as a normal or an abnormal phenomena that can influence the occurrence of climate change.

1. Anthropogenic factors of climate change: The anthropogenic or humane factors of climate change includes-

- **Deforestation:** Deforestation is the cutting down of trees and plants to make way for any development activity. Vegetation absorbs carbon dioxide from the atmosphere during the process of photosynthesis, converting this to carbon which is stored within all plants. When vegetation is burned, this organic carbon is released into the atmosphere in the form of carbon dioxide, and in so doing becomes a carbon source rather than a carbon sink.
- **Burning Fossil Fuels:** Burning coal to generate electricity, burning oil to power vehicles and aircraft (vehicle emissions), or burning wood in fires used for cooking or to provide heat, etc. changes the state of stored organic carbon from a liquid (e.g. oil) or solid (e.g. coal/wood) into a gas (carbon dioxide) which is released into the atmosphere.
- **Landfills:** Landfills are those big chunks of garbage that stink and can be seen in so many places around the world. Most of the time that garbage is burnt which releases toxic gases including methane into the atmosphere. These enormous amounts of toxic greenhouse gases when go into the atmosphere make global warming worse.
- **Overpopulation:** Another cause of global warming is overpopulation. Since carbon dioxide contributes to global warming, the increase in population makes the problem worse because we breathe out more carbon dioxide in the atmosphere. More people means more demand for food, more carbon dioxide in the atmosphere, more demand for cars and more demand for homes. More demand for food will lead to more transportation since movement of goods and services is done by transportation sector.

More demand for cars means more pollution in the air and more traffic on the roads which means longer waiting time on the traffic lights and that will result in burning of more fuel. More demand for homes means cutting down of plants and trees to make way for homes, schools and colleges.

- **Mining:** Oil and coal are two main culprits in producing greenhouse gases. Methane, like carbon dioxide creates a thick shield over the atmosphere trapping the sun's rays. With the continued use of mining operations, these harmful gases will only increase.
- **Fertilizer Use:** The unique thing about fertilizer is that it produces nitrous oxide once it absorbs the soil. Nitrous oxide is 300 times more dangerous than carbon dioxide. The EPA strongly warns that the farming industry's use of fertilizer is one of the leading causes of global warming.
- **Emission of Harmful Gases:** Gases like CFC, CO, CO_2, NH_4, O_3, N_2O etc. from different humane sectors are responsible for the catalyzing of global warming and thus the influencing of climate change.

2. Natural Factors of Climate Change: The natural factors are-

Volcanic eruptions: The main effect volcanoes have on the climate is short-term cooling. Volcanic eruptions pump out clouds of dust and ash, which block out some sunlight. Because the ash particles are relatively heavy, they fall to the ground within about three months, so their cooling effect is very short-lived. But volcanic debris also includes sulfur dioxide. This gas combines with water vapor and dust in the atmosphere to form sulfate aerosols, which reflect sunlight away from the Earth's surface. These aerosols are lighter than ash particles and can remain in the atmosphere for a year or more.

Ocean currents: The oceans are a major component of the climate system. Ocean currents are located at the ocean surface and in deep water below 300 meters (984 feet). They can move water horizontally and vertically and occur on both local and global scales. The ocean has an interconnected current, or circulation, system powered by wind, tides, the Earth's rotation (Coriolis effect), the sun (solar energy), and water density differences. The topography and shape of ocean basins and nearby landmasses also influence ocean currents.

Earth orbital changes: Shifts and wobbles in the Earth's orbit can trigger changes in climate such as the beginning and end of ice ages. The last ice age ended about 12,000 years ago and the next cooling cycle may begin in about 30,000 years. But orbital changes are so gradual they're only noticeable over thousands of years – not decades or centuries. The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. Changes in the tilt of the earth can lead to small but climatically important changes in the strength of the seasons, more tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters. Slow changes in the Earth's orbit lead to small but climatically important changes in the strength of the seasons over tens of thousands of years. Climate feedbacks amplify these small changes, thereby producing ice ages.

Solar variations: The Sun is the source of energy for the Earth's climate system. Although the Sun's energy output appears constant from an everyday point of view, small changes over an extended period of time can lead to climate changes. Some scientists suspect that a portion of the warming in the first half of the 20th century was due to an increase in the output of solar energy. As the sun is the fundamental source of energy that is instrumental in our climate system it would be reasonable to assume that changes in the sun's energy output would cause the climate to change.

Internal variability: Some changes in climate have no external trigger. These changes are instead caused by interactions within the climate system itself, often involving positive feedbacks. One example is the El Niño–La Niña cycle, which can cause temporary warming and cooling. Both phenomena affect atmospheric circulation patterns and influence global climate. While El Niño increases global temperature, La Niña decreases it. This cycle repeats itself on a timescale of about five years. But these changes are short-term, only lasting a few years. Another example of internal variability is the Arctic oscillation (AO), which is associated with changing patterns of air pressure in the northern hemisphere. This phenomenon brings warmer weather to parts of Europe and North America, leaving the Arctic colder than usual. The other phase of the AO brings the opposite conditions, resulting in a warmer-than-usual Arctic and colder weather in the sub-polar regions. Because of this seesaw effect, the AO has little effect on global temperatures, but can significantly influence local and regional weather.

Other: Organic decoy, forest fires, vegetational temperature variation etc.

Q: What are the climate extreme events? Do you believe that climate extreme events are on rise due to climate change? Explain.

Climatic Extemere Events:

According to Vose et al. (2013) climatic extreme event is the state of the weather that falls outside the normal weather patterns, and it should be defined based in meteorological standards rather than physical destructiveness.

According to WMO, Climatic extreme event is the occurrence of a value of a weather variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. In many cases, a weather event with high impact is also deemed as extreme event.

According to Radovic and Iglesias (2019), the climatic extreme events are-

Thunderstorm: Storms characterized by the presence of lightning and thunder. They produce strong winds, heavy rain, and sometimes snow, sleet, and hail.

- **Cyclones:** They are storm systems that rotate around a low-pressure center. Cyclones can be classified in extratropical and tropical cyclones. Extratropical cyclones are largescale (synoptic) low-pressure middle latitude weather systems that can produce from cloudiness and mild showers to heavy gales, thunderstorms, blizzards, and tornadoes. Tropical cyclones are also known as hurricanes, typhoons, tropical storms,

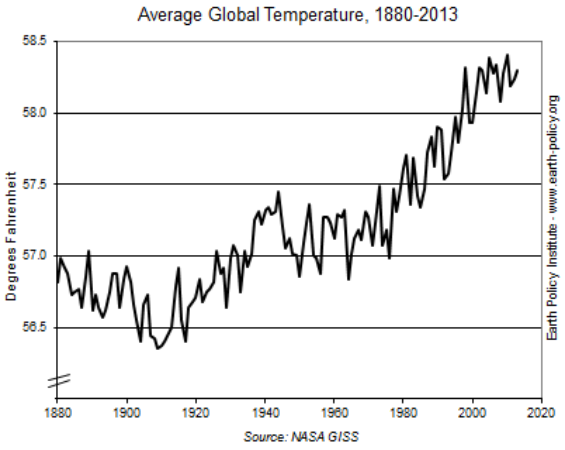
cyclonic storms, or tropical depressions, and this classification depends on their location and associated wind strength.

- **Floods**: Floods can be defined as the effect of covering by water areas that are not normally underwater. It can be several types: flash flood, urban flood, river flood, coastal flood etc.
- **Drought:** It is a period of below-average precipitation in a given region. It is normally defined on the basis of the degree of dryness. It can be either agrological (lack of precipitation) or hydrological drought (lack of river flow).
- **Cold waves or cold spells:** They are weather phenomena that produce a decrease in the temperatures. A cold wave has associated several extremely cold days or a succession of frost days with minimum temperatures below a certain value.
- **Fog**: It is a low-lying cloud generated locally that reduces visibility to less than 1 km. It has major impacts on various sectors such as aviation and road transport.
- **Other**: Extreme heat, extreme precipitation, wildfires etc.

Do you believe that climate extreme events are on rise due to climate change?

Based on the recent data and environmental impact of climate change, it is safe to that, yes, climatic extreme events are on the rise. It can be proven with two simultaneous points of view-

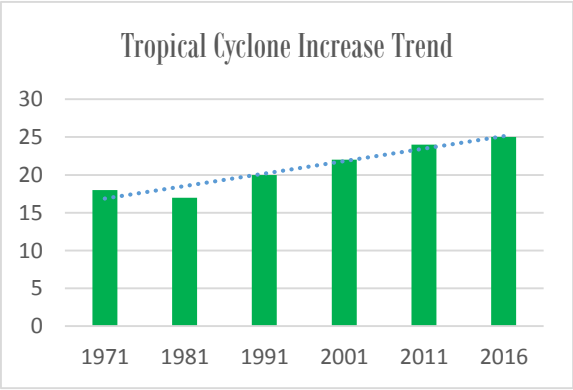
a. The rise of temperature
b. The rise of the number of extreme events



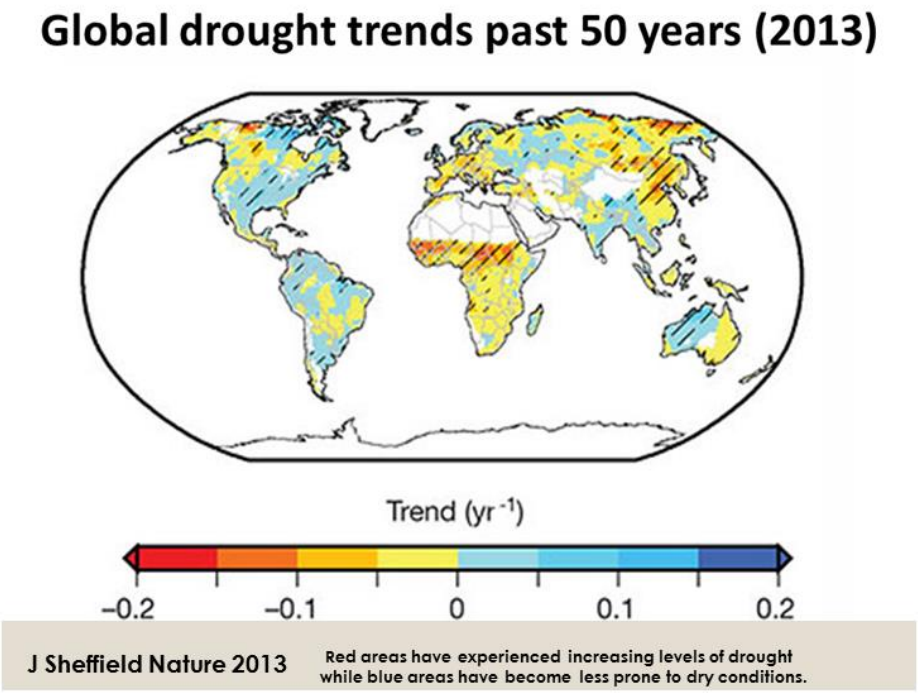
a. The rise of temperature: GISS data show global average temperatures in 2017 rose 1.62 degrees Fahrenheit (0.9 degrees Celsius) above the 1951-1980 mean. According to GISS, the global mean surface air temperature for that period was estimated to be 57 F (14 C). That would put the planet's average surface temperature in 2017 at 58.62 F (14.9 C). NOAA's data indicated that the change of temperature is 1.4 F on average.

b. The rise of the number of extreme events: it is as following-

1. **Rise in the number of cyclone**: The number of cyclone in the tropical areas seem to be increased. The average number of cyclone was 15-18 in 1970s which turned into 24-26 in 2016, according to NOAA.
2. **Rise in the number of typhoon:** The number of typhoon in Atlantic Ocean has also increased. The number of 40-45 in 1950s which is 85-90 in 2010s.



3. **Increasing flood:** The number of flood have been increasing over the years. According to recent studies, average yearly floods in South Asia has been increased from 10-12 to 20-22 according to Dutta. The most suffered region in Asia, is China but the vulnerability is most severe in Bangladesh and India.
4. **Increasing drought:** Especially with the featured El Nino and La Nina, the drought number has been much increased than the past. According to FAO (2010), drought loss has been measured per climate change affected country with the case study of Turkey as 2.5 Billion USD which was 1.3 in the 1990s.
5. **Heat and cold wave:** There would 250 thousand dead per year due to heat stress within the next 30 years as WHO (2018) predicted based on the increasing number and intensity of heat wave. Also cold wave can be fatal in many cases. Both of these occurrences are taking place severely than past.



So, combining the both information, it can be well presumed that the correlation between climate change and extreme event is strongly positive which refers to the answer- yes, I indeed believe that the climate extreme events are on the rise due to climate change.

Q: What do you know about climate change and sea level rising? Discuss the drivers of climate change. Discuss climate change according IPCC's latest report.

Climate Change:

According to IPCC, Climate change is a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of

its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

According to UCDAVIS (University of California, Davis), Climate change refers to significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer.

According to Nampoothiri (2018), Climate change refers primarily to a gradual increase in the average temperature of the Earth's atmosphere and its oceans, a change that is believed to be permanently changing the Earth's climate.

According to, Changes in sea level, globally or locally, due to (i) changes in the shape of the ocean basins, (ii) changes in the total mass and distribution of water and land ice, (iii) changes in water density, and (iv) changes in ocean circulation.

The mean sea level change is 16-21 cm since 1900-2016 and 7.5 cm since 1993-2017.

Drivers of Climate Change:

The drivers of climate change are some phenomena that influences climate change. It can be of the following-

A. Concentration of Gases as drivers
B. Physical process of earth as drivers
C. Natural drivers
D. Anthropogenic drivers

A. Emission and concentration of Gases:

Greenhouse gases: These are emitted from fossil fuel combustion for transportation and energy, landfills, wastewater treatment facilities, and livestock. The major greenhouse gases are carbon dioxide (CO_2), methane, nitrous oxide (N_2O) and Ozone (O_3). Water Vapor (H_2O) acts as magnifying the energy of GHGs.

Black Carbon concentration: Black carbon is a "short-lived climate pollutant". Unlike CO2, it does not persist for long in the atmosphere. It is also a powerful global warming agent. Black carbon is the second most important contributor to global warming after CO2.

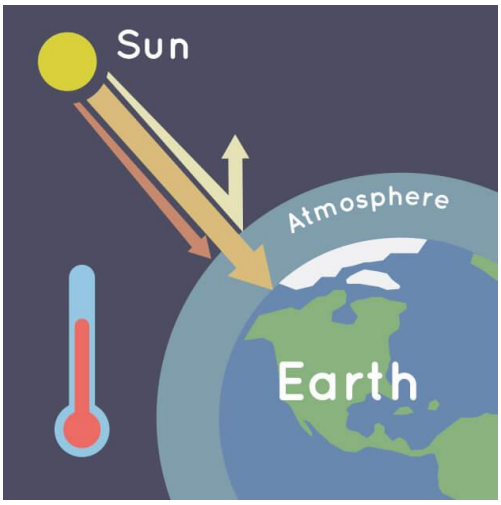
CO_2 concentrations: Atmospheric concentrations of CO2 continue to increase. CO2 accounts for 85 percent of greenhouse gas emissions in the world, and transportation is its largest source, accounting for over a third of the total emissions in 2015.

Aerosol: Aerosols caused by human activity play a profound and complex role in the climate system through radiative effects in the atmosphere and on snow and ice surfaces and through effects on cloud formation and properties.

B. Physical processes of earth as drivers:

Earth's energy budget: The amount of radiation and infrared falls on the earth, the amount of radiation is reflected or absorbed etc. are responsible for the climate change since the confined solar energy in earth's atmosphere raises the temperature on earth.

Greenhouse effect: The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without this atmosphere. Radiatively active gases in a planet's atmosphere radiate energy in all directions. The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without this atmosphere. Radiatively active gases in a planet's atmosphere radiate energy in all directions.



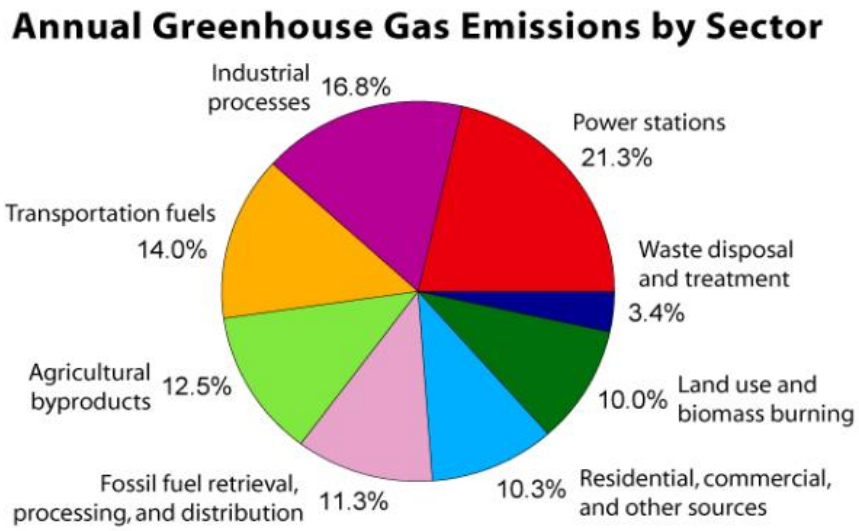
Industrial Era and Earth's Climate: Climate drivers of significance over the industrial era include both those associated with anthropogenic activity and, to a lesser extent, those of natural origin.

Natural drivers: There are-

- Solar radiation
- Volcanic eruption
- Ocean current
- El Nino and La Nina
- Earth's orbital change
- Decoying organism

Anthropogenic drivers: They are-

▪ Deforestation ▪ Burning Fossil Fuels ▪ Landfills ▪ Overpopulation ▪ Mining ▪ Fertilizer Use ▪ Transportation ▪ Industrialization	▪ Agricultural byproduct ▪ Waste disposal ▪ Biomass burning ▪ Power stations ▪ Others ▪ Oil extraction



Greenhouse Gas	Natural sources	Man - made sources
Carbon Dioxide	Organic decay, Forest fires, Volcanoes	Burning fossil fuels-car and factory emissions, electricity generation
Methane	Wetlands, Organic decay, Termites	Natural gas and oil, extraction, biomass burning, Rice cultivation, Cattle, Refuse landfills
Nitrous Oxide	Forest, Grasslands, Oceans, Soils, Soil cultivation; Fertilizers	Biomass burning; Burning of fossil
Chlorofluorocarbons (CFCs)	None	Refrigerators; Aerosol spray propellants; Cleaning solvents

(Source: Eucekutlu, 2017)

Climate change according IPCC's latest report:

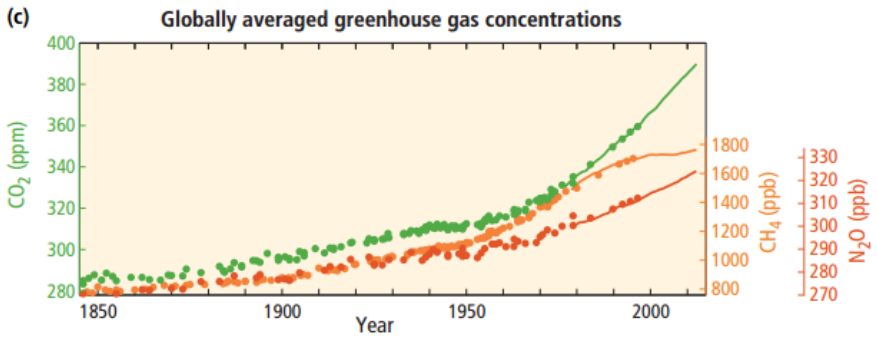
According to the climate change Synthesis report 2014, the following issues of the climate change has been the following-

- **Observed Climate Change:** Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.
  Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was likely the warmest 30-year period of the last 1400 years in the Northern Hemisphere, where such

assessment is possible (medium confidence). The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C 2 over the period 1880 to 2012, when multiple independently produced datasets exist.

- **Causes of Climate Change:** Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.
- **Impacts of climate change:** In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.
- **Climate extreme events:** Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions.
- **Future Climate Changes, Risks and Impacts**: Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.
- **Key drivers of future climate:** Cumulative emissions of CO 2 largely determine global mean surface warming by the late 21st century and beyond. Projections of greenhouse gas emissions vary over a wide range, depending on both socio-economic development and climate policy.
- **Projected changes in the climate system**: Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise.
- **Future Adaptation:** Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term and contribute to climate-resilient pathways for sustainable development.

- **Adaptation and Mitigation:** Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives.



Climate Change impacts according to NASA-

i. Temperatures Will Continue to Rise
ii. Frost-free Season (and Growing Season) will Lengthen
iii. Changes in Precipitation Patterns
iv. More Droughts and Heat Waves
v. Hurricanes Will Become Stronger and More Intense
vi. Sea Level Will Rise 1-4 feet by 2100
vii. Arctic Likely to Become Ice-Free

Q: What do you know about the vulnerability and adaptation framework? Explain different methods and approaches of vulnerability and adaptation framework.

Vulnerability: According to IPCC, vulnerability refers to the state of propensity or predisposition to be adversely affected.

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (IPCC).

The Adaptation framework: The adaptation framework, provides the overarching structure of better practice actions, tools and outputs involved in a comprehensive response to adaptation. This framework consists of two main stages: climate risk and vulnerability assessment and climate adaptation planning.

Vulnerability & adaptation framework: According to Islam (2007), Vulnerability & adaptation framework refers to the structure of the practices, actions, plans, strategies, approaches and action plans for reducing the effect of climate change and surviving in the changed and adverse climatic condition through assessing the ongoing and possible vulnerabilities of a particular region.

Approaches to vulnerability and adaptation:

According to Yamin, Rahman & Huq (2005), the approaches to vulnerability & adaptation are-

i. Natural hazard & disaster approach
ii. Social vulnerability approach
iii. Integrative approaches to vulnerability

Natural hazards and disasters approaches focus on hazards and the dose-exposure of affected communities to identify impacts and hazard-related vulnerabilities. This view focuses on factors such as the frequency (or probability), intensity and nature of the physical hazard as key components of vulnerability and the exposure of communities to such hazards. Less attention is paid to existing vulnerabilities and the role of socio-economic conditions and power relations in structuring such vulnerabilities in particular distributive configurations. A merit of this approach is the clear significance attached to infrequent but extreme events and the focus on delineating hazard-specific vulnerabilities.

Social vulnerability approach, starts by assessing vulnerabilities already embedded in the social and political order. Vulnerabilities therefore exist prior to and independently of hazards. People's coping strategies and socio-economic structures are put centre stage. Social vulnerability approaches tend to treat the vulnerability environment as "given." But this underplays the role of hazards, particularly infrequent ones, in generating and perpetuating vulnerabilities. One implication is the shift in policy attention away from macro level causes of hazards, shock and stresses – that might be reduced at the macro level through disaster mitigation, preparedness and risk reduction – towards more micro level processes. Another is that people are labelled as "vulnerable" and seen as "victims", forever trying to cope with problems.

Integrative approaches to vulnerability come from climate change research which sees vulnerability as a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC 2001: 995; for a discussion of the internal consistency of this definition see Füssel and Klein 2002). The state of the art integrative approach to vulnerability comes from the disaster community and is set out in the Hyogo Framework 2005–2015 adopted by the UN in 2005. Vulnerability is defined as 'the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.' Hazards are defined as 'a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.' Hazards can include latent conditions that may represent future threats and can have natural origins or be induced by human processes. The Hyogo definition of "resilience" refers to 'the capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to

increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures.' This incorporates the concept of "coping" which usually connotes temporary measures designed to maintain or return to the status quo and the concept of "adaptation" which refers to learning from the past to make improvements from changing circumstances.

Methods of vulnerability assessment:

- Sector specific top-down tool
- Climate data analysis
- Bottom-up tool for vulnerability assessment
- Indicator base method
- Staging of assessment-
    - Defining the purpose of vulnerability assessment
    - Planning for vulnerability assessment
    - Assessing current vulnerability
    - Assessing future vulnerability

Methods for adaptation:

- Local adaptation efforts
- Enhancing adaptive capacity
- Agricultural production (Reforestation, More spending on irrigation)
- Weather control
- Damming glacial lakes
- Geoengineering
- Migration
- Insurance

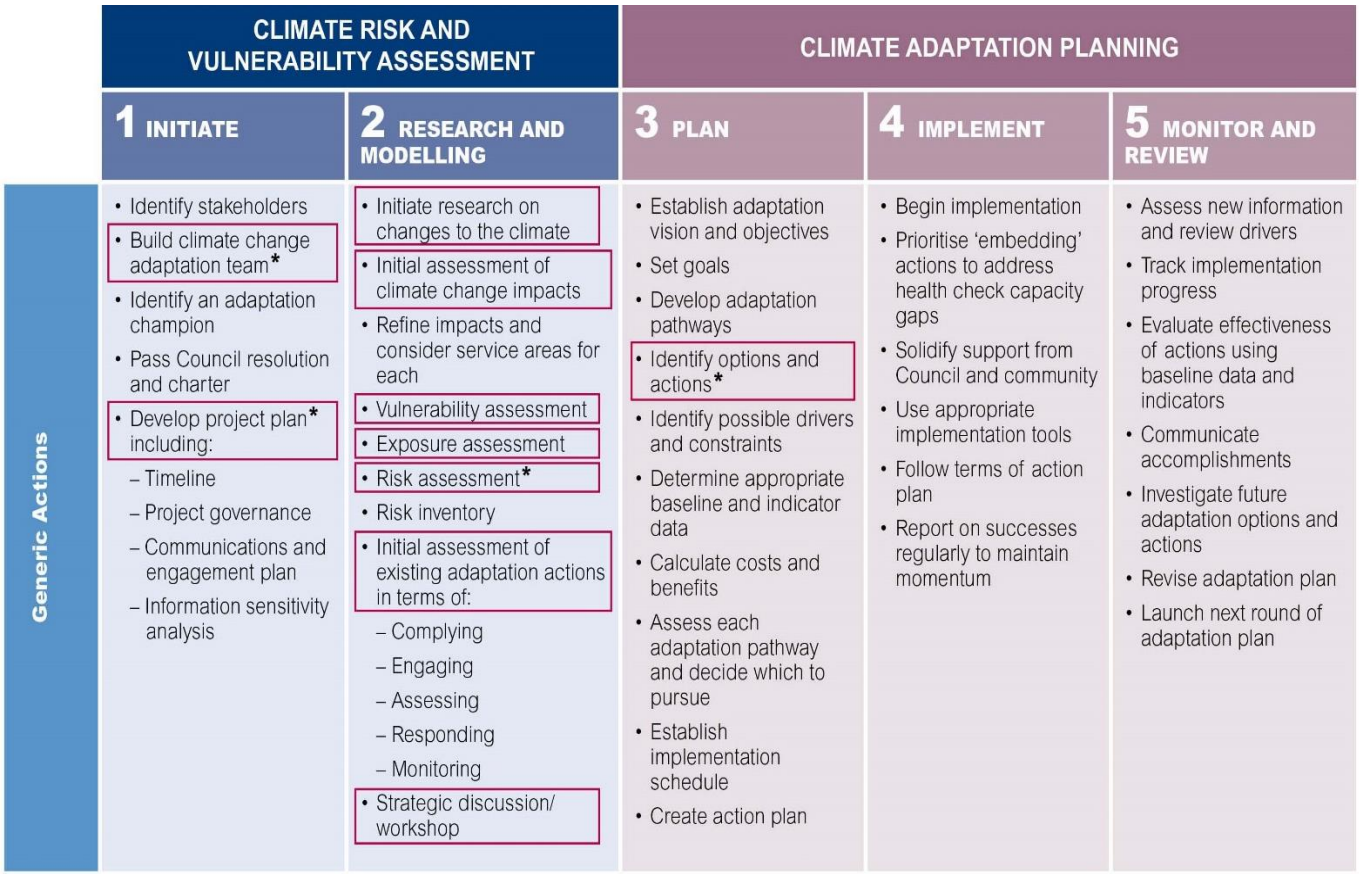
Integral Method for Vulnerability & Adaptation Framework:

The whole process of vulnerability & adaptation framework has the following flow-

- Initiate
- Research and modeling
- Plan
- Implement
- Monitor and review

The first two methods are climatic risk and vulnerability assessment.

The last three methods are climate adaptation planning.



Q: What are the main approaches to climate change mitigation? Explain sectoral and cross sectoral mitigation pathways and measures.

Climate change mitigation: It refers to a set of actions to limit the magnitude or rate of long term global warming and its related effects (Fisher et al., 2007).

Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC).

Approaches to climate change mitigation: Climate change mitigation approaches are as the following-

A. Behavioral & technological approach
B. Engineering & geoengineering approach
C. Sectoral & cross sectoral approach

A. **Behavioral & technological approach**

1. Technological approach: In this approach, mitigation is considered to accomplish by using new technologies and renewable energies, making older equipment more energy efficient to reduce or prevent emission of greenhouse gases.

2. Behavioral approach: In this approach, mitigation is considered to accomplish by hanging management practices or consumer behavior to reduce or prevent emission of greenhouse gases.

B. **Climate Engineering & Climate geoengineering approach**

1. Engineering approach: In this approach, mitigation is considered to accomplish by engineering activities which are building up anti GHG emitting infrastructures and daily commodities and produce alternatives that can be used to reduce or prevent emission of greenhouse gases.

2. Geoengineering approach: Reducing GHGs through climate geoengineering that refers to large-scale schemes for intervention in the earth's oceans, soils and atmosphere.

C. **Sectoral & cross sectoral approach**

1. **Sectoral Approach:** A sectoral approach consists of a combination of policies and measures, developed to enhance efficient, sector-by-sector, greenhouse gas mitigation, within the UN Framework Convention on Climate Change (UNFCCC).

2. **Cross sectoral Approach:** Cross-sectoral interactions are the effects that an adaptation or mitigation measure in one sector has on another sector, but the measure does not affect adaptation or mitigation in that other impacted sector.

Sectoral Mitigation Pathways:

A sectoral approach consists of a combination of policies and measures, developed to enhance efficient, sector-by-sector, greenhouse gas mitigation, within the UN Framework Convention on Climate Change (UNFCCC). The sectoral mitigations mentioned in IPCC are-

- Agriculture
- Biodiversity
- Coast
- Water resource management
- Others:
    - Transport
    - Urban Planning
    - Societal Control & population

The IPCC mentioned sectors-

Sector	Actor's adaptation objective	Adaptation option
Agriculture	Enhance drought and pest resistance; enhance yields	Biotechnology and genetically modified crops
	Provide financial safety net for farmers to ensure continuation of farming enterprises	Subsidized drought assistance; crop insurance
	Maintain or enhance crop yields; suppress opportunistic agricultural pests and invasive species	Increased use of chemical fertilizer and pesticides
Biodiversity	Enhance capacity for natural adaptation and migration to changing climatic conditions	Migration corridors; expansion of conservation areas
	Enhance regulatory protections for species potentially at risk due to climate and non-climatic changes	Protection of critical habitat for vulnerable species
	Facilitate conservation of valued species by shifting populations to alternative areas as the climate changes	Assisted migration
Coasts	Provide near-term protection to financial assets from inundation and/or erosion	Sea walls
	Allow natural coastal and ecological processes to proceed; reduce long-term risk to property and assets	Managed retreat
	Preserve public health and safety; minimize property damage and risk of stranded assets	Migration out of low-lying areas
Water resources management	Increase water resource reliability and drought resilience	Desalination
	Maximize efficiency of water management and use; increase flexibility	Water trading
	Enhance efficiency of available water resources	Water recycling/reuse

Others:

Transport:

- Modes of mass transportation such as bus, light rail (metro, subway, etc.), and long-distance rail are far and away the most energy-efficient means of motorized transportation for passengers, able to use in many cases over twenty times less energy per person-distance than a personal automobile.
- Modern energy-efficient technologies, such as electric vehicles and carbon-neutral synthetic gasoline and jet fuel may also help to reduce the consumption of petroleum, land use changes and emissions of carbon dioxide.

- Utilizing rail transport, especially electric rail, over the far less efficient air transport and truck transport significantly reduces emissions.
- With the use of electric trains and cars in transportation there is the opportunity to run them with low-carbon power, producing far fewer emissions.

Urban Planning:

- Effective urban planning to reduce sprawl aims to decrease Vehicle Miles Travelled (VMT), lowering emissions from transportation.
- Personal cars are extremely inefficient at moving passengers, while public transport and bicycles are many times more efficient (as is the simplest form of human transportation, walking). All of these are encouraged by urban/community planning and are an effective way to reduce greenhouse gas emissions.
- Inefficient land use development practices have increased infrastructure costs as well as the amount of energy needed for transportation, community services, and buildings.
- At the same time, a growing number of citizens and government officials have begun advocating a smarter approach to land use planning.

Societal Control:

- Another method being examined is to make carbon a new currency by introducing tradeable "personal carbon credits".
- The idea being it will encourage and motivate individuals to reduce their 'carbon footprint' by the way they live.
- Each citizen will receive a free annual quota of carbon that they can use to travel, buy food, and go about their business.
- It has been suggested that by using this concept it could actually solve two problems; pollution and poverty, old age pensioners will actually be better off because they fly less often, so they can cash in their quota at the end of the year to pay heating bills and so forth.

Population:

Less population means less CO_2 emission and less fossil fuel necessities.

Cross-sectoral Mitigation:

It as an option for mitigation that does not consider the individual sectors of mitigation but considers all the sectors integrally as a holistic approach to reduce the greenhouse effect and it considers all socioeconomic, technical and technological opportunities for mitigation. It can be described in following sectors-

A. Technological option
B. Geoengineering option
C. Cost benefit approach
D. Policy making option
E. Organizational integration option

A. **Technological Approach:**

- Usage of technology to offer alternatives of tools that produce GHGs.
- Usage of less GHG producing technological or mechanical tool.
- Using renewable energy.
- Reducing energy loss.
- Efficient use of energy.

B. **Geoengineering option:**

- Iron fertilization of ocean.
- Changing quality of the oceanic water.
- GHG reducing technologies implementation.
- Removing GHG producing sources from soil, water or air.

C. **Cost benefit approach:**

- **Cost:** One way of estimating the cost of reducing emissions is by considering the likely costs of potential technological and output changes. Policy makers can compare the marginal abatement costs of different methods to assess the cost and amount of possible abatement over time. The marginal abatement costs of the various measures will differ by country, by sector, and over time. Mitigation costs will vary according to how and when emissions are cut: early, well-planned action will minimise the costs.
- **Benefit:** Yohe et al. (2007) assessed the literature on sustainability and climate change. With high confidence, they suggested that up to the year 2050, an effort to cap greenhouse gas (GHG) emissions at 550 ppm would benefit developing countries significantly. This was judged to be especially the case when combined with enhanced adaptation. By 2100, however, it was still judged likely that there would be significant effects of global warming. This was judged to be the case even with aggressive mitigation and significantly enhanced adaptive capacity.
- **Sharing:** One of the aspects of mitigation is how to share the costs and benefits of mitigation policies. In terms of the politics of mitigation, the UNFCCC's ultimate objective is to stabilize concentrations of GHG in the atmosphere at a level that would prevent "dangerous" climate change (Rogner et al., 2007).

D. **Policy making option:**

- Making policy for GHG emission like *Personal Carbon Credit* concepts.
- Making policy for least carbon emission and other GHGs.
- Implementing fine for the over usage carbon user.

E. **Organizational integration option:**

- Many countries, both developing and developed, are aiming to use cleaner technologies (World Bank, 2010).
- Integration among the governments of many nations can make it possible to follow GHG avoiding actions together.

- Combined acts or treaties can be implemented for not violating the non GHG emitting agreement.
- More protocols like Kyoto protocols can be implemented.
- GO and NGO can work together to earn sustainability of environment in this case.

Q: What are the anthropogenic factors on global warming? What are the local and regional level contributory factors in Chittagong to cause to happen global warming. Critically evaluate whether sea level changes on Bangladesh coast due to global warming.

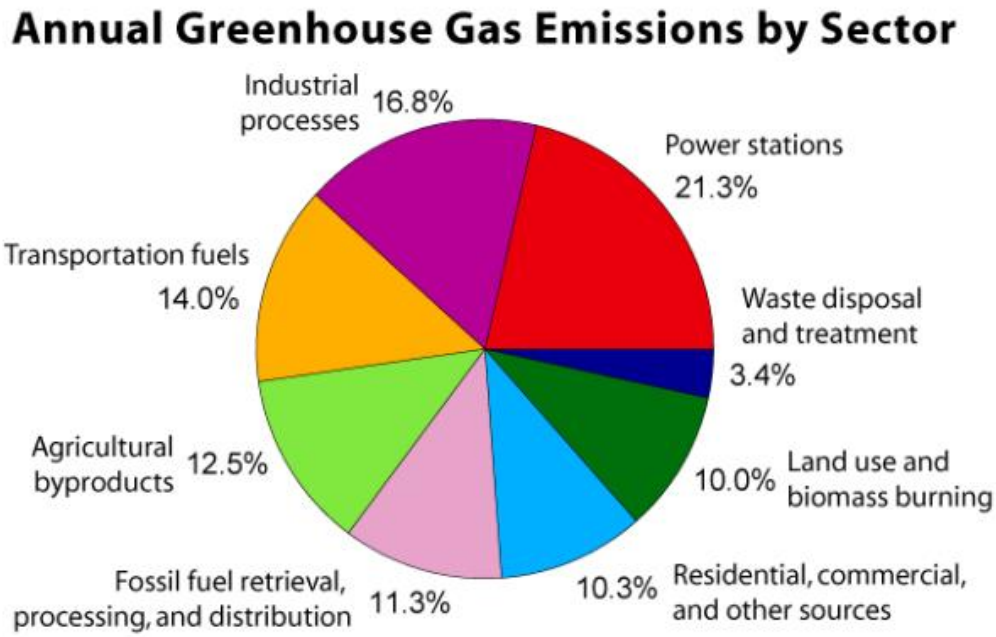
Global warming refers to arise in the temperature of the surface of the earth and increase in the concentration of greenhouse gases leads to an increase in the magnitude of the greenhouse effect.

Greenhouse gases are naturally occurring gases that pose no harm when they are in balance. However, when they are present in excess, the system becomes unbalanced and things start to go awry.

Anthropogenic Causes of Global Warming:

Scientists have concluded that most of the observed warming is very likely due to anthropogenic causes. The most important greenhouse gases are carbon dioxide, methane, nitrous oxide and water vapor. While all these gases occur naturally in the atmosphere, emissions from human sources has caused their levels to rise to a point that is no longer sustainable.

Let's take a look at the major human causes of global warming.



Deforestation: Deforestation is the cutting down of trees and plants to make way for any development activity. Vegetation absorbs carbon dioxide from the atmosphere during the process of photosynthesis, converting this to carbon which is stored within all plants (i.e it is a carbon sink). When vegetation is burned, this organic carbon is released into the atmosphere in the form of carbon dioxide, and in so doing becomes a carbon source rather than a carbon sink.

This means that it is very important to protect our trees to stop the greenhouse effect, and also so we can breathe and live.

Burning Fossil Fuels: burning coal to generate electricity, burning oil to power vehicles and aircraft (vehicle emissions), or burning wood in fires used for cooking or to provide heat, etc. changes the state of stored organic carbon from a liquid (e.g. oil) or solid (e.g. coal/wood) into a gas (carbon dioxide) which is released into the atmosphere.

Landfills: Landfills are those big chunks of garbage that stink and can be seen in so many places around the world. Most of the time that garbage is burnt which releases toxic gases including methane into the atmosphere. These enormous amounts of toxic greenhouse gases when go into the atmosphere make global warming worse.

Overpopulation: Another cause of global warming is overpopulation. Since carbon dioxide contributes to global warming, the increase in population makes the problem worse because we breathe out more carbon dioxide in the atmosphere. More people means more demand for food, more carbon dioxide in the atmosphere, more demand for cars and more demand for homes. More demand for food will lead to more transportation since movement of goods and services is done by transportation sector. More demand for cars means more pollution in the air and more traffic on the roads which means longer waiting time on the traffic lights and that will result in burning of more fuel. More demand for homes means cutting down of plants and trees to make way for homes, schools and colleges.

Mining: Oil and coal are two main culprits in producing greenhouse gases. Methane, like carbon dioxide creates a thick shield over the atmosphere trapping the sun's rays. With the continued use of mining operations, these harmful gases will only increase.

Fertilizer Use: The unique thing about fertilizer is that it produces nitrous oxide once it absorbs the soil. Nitrous oxide is 300 times more dangerous than carbon dioxide. The EPA strongly warns that the farming industry's use of fertilizer is one of the leading causes of global warming.

Local and regional level contributory factors in Chittagong to cause to happen global warming:

Deforestation in forest and hilly areas:

Destruction of forests has taken place due to industrialisation and population boom and was not compensated by reforestation. Its adverse impact on climate has been noticed. The forests in the Chittagong Hill Tracts have been over-exploited by the tribal people, mainly for jhum cultivation. In hill forest area, militarization, profit-making,

industrialization and development interventions in the form of Karnaphuli hydro-electricity project and Kaptai dam is the main underlying cause of hill deforestation.

Hill cutting: Among the topographical features of any region, hills are the most dominating one contributing to the delicate balance in the ecosystem. It is obvious that any sort of mishandling of the hills will make the ecosystem of this region complicated.

Table: Hill cutting area of Chittagong city

Thana	Existing hilly area In 1976 (km^2)	Cutted hills during 1976-2010		Remaining hills in 2010 (km^2)
		km^2	%	
Bayaizid	9.920	4.338	53.810	4.582
Khulshi	4.750	3.518	61.183	2.232
Panslaish	4.640	3.468	74.741	1.172
Kotowali	3.920	2.132	54.388	1.788
Pahartali	8.140	3.888	47.764	4.252
Total	32.370	18.344	57.76	14.026

Brick fields: In Bangladesh bricks are produced using coal or firewood as fuel. Brick manufacture is seasonal, taking place in the winter, and disseminated through the whole country, although there is a concentration of kilns around Chittagong. There is no data available on carbon dioxide emissions from these kilns.

Industries: Industry contributes greatly in global warming as Chittagong is an industrialized city. Main industrial sector contributing global warming are as follows:

Fertilizer: There are 10 fertilizer plants in Bangladesh of which seven produce Urea, one TSP and two DAP. 3 of these situated in Chittagong. The CO^2 generation from the process is very small and therefore their contribution to national emissions is negligible. In 2004, natural gas consumption in the fertilizer sector was 12821 million m3 (source BCIC).

Cement: Chittagong has some cement industries which are contributing in global warming. The main pollutants emitted from cement industries include Particulate Matter, Sulphur Dioxide (SO^2) and Nitrogen Dioxide (NO^2).

Chemical: Chittagong has some chemical industries. The pollutants found in the largest quantities at chemical manufacturing sites include pesticides and volatile organic compounds. However, other pollutants include arsenic, cadmium, cyanide, mercury, chromium and lead.

Textile: Textile industry is chemically intensive. Approximately 2000 different varieties of chemicals are used in textile industries right from dyes like desizing, prewashing, mercerizing, dyeing, printing etc to transfer agents.

Solid waste burning: Increased generation of methane (CH4) from municipal solid wastes (MSW) alarms the world to take proper initiative for the sustainable management of MSW, because it is 34 times stronger than carbon dioxide (CO2). MSW combustion principally

converts chemical energy stored into it to thermal energy through the combustion processes at high temperatures of 980 to 1090°C by which CO2 is emitted.

Commercial agriculture: Commercial agricultural practices in Chittagong is contributory to global warming as it involves in the production of greenhouse gases through following ways: manufacture and use of pesticides and fertilizers, fuel and oil for tractors, equipment, trucking and shipping, electricity for lighting, cooling, and heating, and emissions of carbon dioxide, methane, nitrous oxide and other greenhouse gases.

Fossil fuel burning: Fossil fuel burning is imposing significant threats through alternating parameters of different environmental components. It was found from a study which was conducted Nasirabaad industrial zone in Chittagong from January to December, 2014, most of the industries used to burn huge amount of different types fossil fuel and do not use any types of air pollution controller.

Critical evolution of sea level change on Bangladesh coast due to global warming:

From an estimation (WARPO, 2006), it is predicted that about 14, 32 and 88 cm sea-level rise will occur at 2030, 2050 and 2100, respectively which may inundate about 8, 10 and 16% of total land mass of Bangladesh. At base line situation i.e. 0 (zero) rise in the sea level a total of 1572085 ha land is inundated in 16 coastal districts due to monsoon flood. Further rise in sea-level will expand inundation areas where Patuakhali, Khulna and Barisal regions would be the most affected.

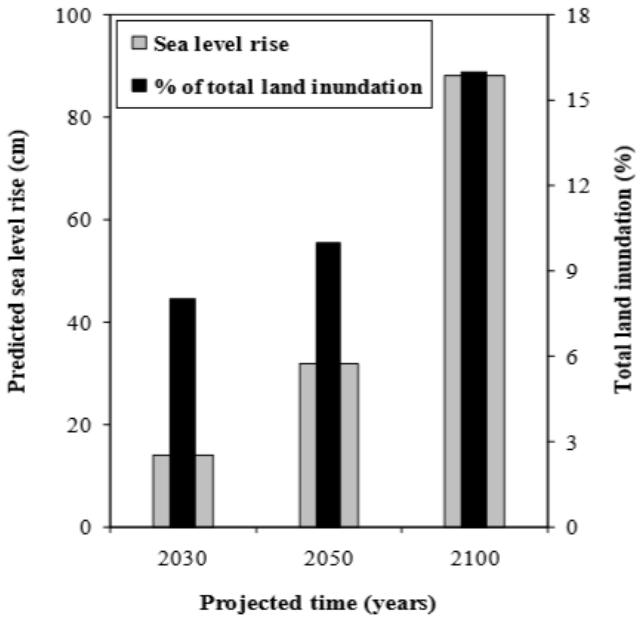


Figure: Land area inundation due to projected sea-level rise in Bangladesh. (WARPO, 2006)

Faster ocean warming due to climate change – One of the reasons of catastrophic sea level rising. Rising sea levels are driven by two things – (i) the thermal expansion of sea water,

and (ii) additional water from melting sources of ice. Both these processes are caused by global warming.

For example, the glaciers or ice sheet that cover Arctic region contains enough water to raise world ocean levels by seven meters, which would bury sea-level cities like Dhaka and Chittagong and also other coastal areas of the country.

Global heating effects are strong in melting of snow and ice, rising global mean sea level, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. The rate of rise in temperatures depends on if and how fast emissions are reduced and on possible adverse feedbacks in the climate system. Temperatures are sure to rise faster in the next decades as well.

From these discussions it can be say that global warming is the main contributory reasons of sea level change in Bangladesh coast.

Q: What is meant by approaches to climate change mitigation? Explain climate change adaptation pathways with example.

Approaches to climate change mitigation:

According to IPCC, climate change mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Approaches to climate change mitigation are some ways to achieve these GHG reducing goal. The approaches can be several considering the techniques, methods, implementation, concept and subject matter. They are-

A. Behavioral & technological approach
B. Engineering & geoengineering approach
C. Sectoral & cross sectoral approach

Climate change adaptation pathways:

According to IPCC, in human systems, **adaptation** is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.

According to South West Climate Portal, **adaptation pathways** is a planning approach addressing the uncertainty and challenges of climate change decision-making. It enables consideration of multiple possible futures, and allows analysis/exploration of the robustness and flexibility of various options across those multiple futures.

About adaptation pathway, IPCC has stated that- Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness.

Adaptation Pathways with example:

Adaptation pathway feature according to IPCC Synthesis Report 2014-

1. Prime goal of adaptation is to reduce vulnerability (High Confidence).
2. Climate change adaptation is place and context specific (High Confidence).
3. Adaptation should be occurred from individual to government level (High Confidence).
4. Adaptation initiatives rely on the social value, object and risk perception (High Confidence).
5. Political, economic, social and technological actions and decisions can enhance the adaptation (High Confidence).
6. Constrains can be produced while implementing adaptation (High Confidence).
7. Adaptation responses/activities can interact within themselves across the regions (Very High Confidence).
8. Poor or short term planning and implementation will be vulnerable (Medium Evidence, High Agreement).
9. Intense/high magnitude climate change can make adaptation steps ineffective (High Confidence).

Examples of Climate Change Adaptation:

- Local adaptation efforts (local engineering activities, greening)
- Enhancing adaptive capacity (removing poverty, economic development, educational, institutional, infrastructural improvement)
- Agricultural production (producing quality & quantity crop, reforestation, producing sustainable and withstanding crop)
- Weather control (controlling cloud, weather through technology, developed countries)
- Damming glacial lakes
- Geoengineering
- Migration
- Insurance

Q: Discuss the effect of climate change in Bangladesh & the pillars of climate change strategy and action plan 2009-2018.

Impact of Climate Change:

According to Denissen (2004), there can be of the following impacts-

a. Climatic impact
b. Sectoral impact

Climatic Impacts: Bangladesh experiences different types of Natural Disasters almost every year because of the Global Warming as well as Climate Change impacts, these are:

Floods / Flash Floods (Almost 80% of the total area of the country is prone to flooding).

Cyclones and Storm Surges (South and South-eastern Parts of the country were hit by Tropical Cyclones during the last few years).

Salinity Intrusion (Almost the whole Coastal Belt along the Bay of Bengal is experiencing Salinity problem).

Extreme Temperature and Drought (North and North-western regions of the country are suffering because of the Extreme Temperature problem).

Sea level rise Sea level rise in many areas.

River bank erosion

Tsunami

Extreme rainfall

Desertification

Ground water level deterioration

Sectoral Impacts:

The sectoral impacts are-

Agriculture and Fisheries:

As already mentioned earlier, the economy of Bangladesh is based on Agriculture mainly, with two thirds of the population engaged (directly or indirectly) on Agricultural activities; although the country is trying move towards industrialization slowly during the last one and a half decade almost. So, the overall impact of Climate Change on Agricultural production in Bangladesh would be wide spread and devastating for the country's economy. Beside this, other impacts of Climate Change such as - Extreme Temperature, Drought, and Salinity Intrusion etc. are also responsible for the declining crop yields in Bangladesh. Temperature and Rainfall changes have already affected crop production in many parts of the country and the area of arable land has decreased to a great extent. The Salinity intrusion in the coastal area is creating a serious implications for the coastal land that were traditionally used for rice production.The fisheries sector has also experienced an adverse effect because of the impacts of Climate Change. The fisheries sector contributes about 3.5% of the GDP in Bangladesh and people depend on fish products in order to meet up majority of their daily protein requirements. There are around 260 species of fish in the country and almost all the varieties are sensitive to specific salt and freshwater conditions.

Water Resources and Hydrology:

In a high density country like Bangladesh, the effects of Climate Change on the Surface and Ground water resources will be very severe and alarming. Changes to water resources and hydrology will have a significant impact on the country's economy, where people mostly depend on the Surface water for Irrigation, Fishery, Industrial production, Navigation and similar other activities.

Coastal Areas:

Almost one fourth of the total population of the country live in the coastal areas of Bangladesh, where majority of the population are somehow affected (directly or indirectly) by Coastal Floods / Tidal Surges, River-bank Erosion, Salinity, Tropical Cyclones etc. With the rise of Sea-level up to one meter only, Bangladesh could lose up to 15% of its land area under the Sea water and around 30 million people living in the coastal areas of Bangladesh could become Refugees because of Climate Change impacts. Agriculture, Industry, Infrastructure (School, Hospitals, Roads, Bridges and Culverts etc.), Livelihoods, Marine Resources, Forestry, Biodiversity, Human Health and other Utility services will suffer severely because of the same. Salinity Intrusion from the Bay of Bengal already penetrates 100 kilometers inside the country during the dry season and the Climate Change in its gradual process is likely to deteriorate the existing scenario to a great extent. Since most of the country is less than 10 meters above Sea level and almost 10% of the population of the country is living below 1 meter elevation - the whole coastal area is Highly Vulnerable to High Tides and Storm Surges. Moreover, the Bay of Bengal is located at the tip of the north Indian Ocean, where severe Cyclonic storms as well as long Tidal waves are frequently generated and hit the coast line with severe impacts because of the Shallow as well as Conical shape of the Bay near Bangladesh.

Forestry / Biodiversity:

Bangladesh has got a wide diversity of Ecosystems including Mangrove forests at the extreme south of the country. The "Sundarbans" a World Heritage, is the largest Mangrove Forest in the world, comprising 577,00 ha of land area along the Bay of Bengal. A total of 425 species have been identified there, the most significant is the famous Royal Bengal Tiger. Therefore, Climate Change impacts will have negative effects on the Ecosystem of the Forest recourses in Bangladesh while the Sundarbans is likely to suffer the most.

Urban areas:

Cities and Towns situated along the Coastal belt in Bangladesh are at the Front line of Climate Change related Disaster impacts and could experience a severe damage directly because of the Sea level Rise and Storm Surges at any time. Direct impacts may occur through the increased Floods, Drainage congestion and Water logging as well as Infrastructure Damage during extreme events. The important Urban sectors that suffered severely by the previous floods in Bangladesh include Urban Infrastructure, Industry, Trade, Commerce and Utility services etc. As consequence, it hampered usual productivity during and after major floods and hence increased the vulnerability of the urban poor by many folds. It should be mentioned here that, around 40 per cent of the urban population in Bangladesh lives in the Slum and Squatter settlements of the major cities which are highly prone to Disaster risk during Flooding further.

Vulnerable groups:

The Urban poor are therefore directly at the risk of Natural Disasters being enhanced by the impacts of Climate Change - especially in the absence / shortage of the necessary

Infrastructure as well as Employment opportunity for them in the major cities of the country. In Bangladesh, Women are especially Vulnerable because of the Gender inequalities in the Socio- economic and Political institutions. During the 1991Cyclone and Storm surge in Bangladesh, the death rate in case of women was almost five times higher than the men. Because men were able to communicate with each other in the public spaces, but the information did not reach most of the women timely.

The pillars of climate change strategy and action plan:

There are 6 pillars according to climate change strategy and action plan-

The Climate Change Action Plan is built on six pillars:

1

Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programmes focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.

2

Comprehensive disaster management to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.

3

Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well-maintained and fit-for-purpose and that urgently needed infrastructure (e.g. cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.

4

Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on science, and best practices of climate change management.

5

Mitigation and low carbon development to evolve low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases.

6

Capacity building and institutional strengthening to enhance the capacity of government ministries and agencies, civil society and the private sector to meet the challenge of climate change and mainstream them as part of development actions.

The needs of the poor and vulnerable, including women and children, will be prioritized in all activities implemented under the Action Plan. The Climate Change Action Plan comprises immediate, short, medium and long-term programmes.

Q: Global initiatives on sustainable development and environmental protections since 1992 earth summit. Key aspects of climate change mitigation outline in Kyoto Protocol.

Global initiatives on sustainable development and environmental protections since 1992 earth summit:

- **1992 Earth Summit:** UN Conference on Environment and Development (UNCED) is held in Rio de Janeiro. Agreements are reached on the action plan "Agenda 21," and on the Convention on Biological Diversity, the Framework Convention on Climate Change, and non-binding Forest Principles.
- **1994 Global Environment Facility:** Billions of aid dollars are restructured to give more decision-making power to developing countries.
- **1994 China's Agenda 21:** White paper on PRC's population, environment, and development is published. China sets an international example for country strategies for sustainable development.
- **1995 World Trade Organization (WTO)** established. Formal recognition of trade, environment and development linkages.
- **1995 Fourth World Conference on Women** held in Beijing. Negotiations recognize that the status of women has advanced but obstacles still remain to the realization of women's rights as human rights.
- **1996 ISO 14001** formally adopted as a voluntary international standard for corporate environmental management systems.
- **1999 Third World Trade Organization Ministerial Conference** held in Seattle, USA. Thousands of demonstrators take to the streets to protest the negative effects of globalization and growth of global corporations and, along with deep conflicts among WTO delegates, scuttle the negotiations. The first of many such anti-globalization protests, they signal a new era of confrontation between disaffected stakeholders and those in power.
- **2000 UN Millennium Summit and the MDGs**: The largest-ever gathering of world leaders agrees to a set of time-bound and measurable goals for combating poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. Now known as the Millennium Development Goals, they are to be achieved by 2015.
- **2005 Kyoto Protocol** enters into force, legally binding developed country parties to goals for greenhouse gas emission reductions, and establishing the Clean Development Mechanism for developing countries.
- **2007: IPCC 4h assessment report:** The Intergovernmental Panel on Climate Change publishes its fourth assessment report on climate change; the report posits that climate change policies are best addressed by integrating them within the broader framework of sustainable development strategies.
- **2012: The United Nations Conference on Sustainable Development** gathers in Rio de Janeiro to mark the 20th anniversary of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro and the 10th anniversary of the 2002

World Summit on Sustainable Development in Johannesburg; it focuses on two themes: a green economy in the context of sustainable development and poverty eradication, and the institutional framework for sustainable development.

Kyoto Protocol:

- ✓ The Kyoto Protocol is an international agreement that aimed to reduce carbon dioxide (CO2) emissions and the presence of greenhouse gases (GHG) in the atmosphere. The essential tenet of the Kyoto Protocol was that industrialized nations needed to lessen the amount of their CO2 emissions.
- ✓ The Protocol was adopted in Kyoto, Japan in 1997, when greenhouse gases were rapidly threatening our climate, life on the earth, and the planet, itself. Today, the Kyoto Protocol lives on in other forms and its issues are still being discussed.
- ✓ The main goal of the Kyoto Protocol is to control emissions of the main anthropogenic (human-emitted) greenhouse gases (GHGs) in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to make the reductions. The treaty follows the main principles agreed in the original 1992 UN Framework Convention

Here are some **key concepts** involved in the Kyoto Protocol:

- **Annex 1 and Non Annex Countries** – Governments are separated into two general categories: developed countries, referred to as Annex 1 countries (who have accepted greenhouse gas emission reduction obligations and must submit an annual greenhouse gas inventory) and developing countries, referred to as Non Annex 1 countries (who have no greenhouse gas emission reduction obligations but may participate in the Clean Development Mechanism).
- **Clean Development Mechanism (CDM)** – The CDM is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment (Annex 1 countries) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries.
- **Joint Implementation (JI)** – Joint implementation is a programme under the Kyoto Protocol that allows industrialized countries to meet part of their required cuts in greenhouse gas emissions by paying for projects that reduce emissions in other industrialized countries.
- **Carbon trading** – Carbon (or Emission) trading is a system that controls pollution by providing economic incentives for achieving emission reductions. To simplify it, emitters are given a cap on emissions, if that cap is exceeded they must buy credits and if they emit less than their allowance they can sell credits. In essence, the buyer is being fined for polluting and the seller is being rewarded.

SHORT NOTES

Climate Change and Food Security

Climate change will worsen the living conditions of farmers, fishers and forest-dependent people who are already vulnerable and food insecure. Hunger and malnutrition will increase. Rural communities, particularly those living in already fragile environments, face an immediate and ever-growing risk of increased crop failure, loss of livestock, and reduced availability of marine, aquaculture and forest products. More frequent and more intense extreme weather events will have adverse impacts on food availability, accessibility, stability and utilization, as well as on livelihood assets and opportunities in both rural and urban areas. Poor people will be at risk of food insecurity due to loss of assets and lack of adequate insurance coverage. Rural people's ability to cope with climate change impacts depends on the existing cultural and policy context, as well as on socio-economic factors like gender, household composition, age, and the distribution of household assets. According to FAO-

- Climate change will increase hunger and malnutrition
- New patterns of pests and disease will emerge
- Fishing and aquaculture are threatened by climate change
- Agriculture contributes to climate change, but is also part of the solution
- Sustainable livestock management can reduce GHG emissions

Global Warming & Dimming

Global warming refers to arise in the temperature of the surface of the earth and increase in the concentration of greenhouse gases leads to an increase in the magnitude of the greenhouse effect.

Greenhouse gases are naturally occurring gases that pose no harm when they are in balance. However, when they are present in excess, the system becomes unbalanced and things start to go awry.

Global dimming is defined as the decrease in the amounts of solar radiation reaching the surface of the Earth. The by-product of fossil fuels is tiny particles or pollutants which absorb solar energy and reflect back sunlight into space.

Global dimming is thought to have been caused by an increase in particulates such as sulfate aerosols in the atmosphere due to human action. It has interfered with the hydrological cycle by reducing evaporation and may have reduced rainfall in some areas. Global dimming also creates a cooling effect that may have partially counteracted the effect of greenhouse gases on global warming.

Climate Refugees

Climate refugees are people who are forced to leave their home region due to sudden or long-term changes to their local environment. These are changes which compromise their well-being or secure livelihood. Such changes are held to include increased droughts,

desertification, sea level rise, and disruption of seasonal weather patterns (i.e. monsoons). Climate refugees may choose to flee to or migrate to another country, or they may migrate internally within their own country.

They are of three types-

The International Organisation for Migration proposes three types of environmental migrants:

- Environmental emergency migrants: people who flee temporarily due to an environmental disaster or sudden environmental event. (Examples: someone forced to leave due to a hurricane, tsunami, earthquake, etc.)
- Environmental forced migrants: people who have to leave due to deteriorating environmental conditions. (Example: someone forced to leave due to a slow deterioration of their environment such as deforestation, coastal deterioration, etc.)
- Environmental motivated migrants also known as environmentally induced economic migrants: people who choose to leave to avoid possible future problems. (Example: someone who leaves due to declining crop productivity caused by desertification)

IPCC

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations that is dedicated to providing the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced climate change, its natural, political, and economic impacts and risks, and possible response options.

The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) and was later endorsed by the United Nations General Assembly. Membership is open to all members of the WMO and UN. The IPCC produces reports that contribute to the work of the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty on climate change.The objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system". The IPCC's Fifth Assessment Report was a critical scientific input into the UNFCCC's Paris Agreement in 2015.

It comprises with-

- Ipcc panel
- Chair
- Secretariat
- Bureau
- Working group
- Task force
- Executive committee