Government of Tamilnadu

Department of Employment and Training

Course : TNPSC Group I Mains Material

Subject : Environment, Biodiversity and Disaster Management

Topic : Environmental consequences of climate change and mitigation measures

Commissioner,

Department of Employment and Training.

ENVIRONMENTAL CONSEQUENCES OF CLIMATE CHANGE AND MITIGATION MEASURES

ENVIRONMENTAL CONSEQUENCES OF CLIMATE CHANGE AND MITIGATION MEASURES:

Reasons for Climate Change

Burning fossil fuels emits gases into the atmosphere. Burning fossil fuel to provide energy, coupled with the effects of major transportation and deforestation causes a rapid increase in global temperatures. This can change the climate of a place.

Effects of climate change

Scientists had predicted in the past that the result from global climate change are now occurring, loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

1. Temperatures will continue to rise -Experts agree that greenhouse gases which trap heat and prevent it from leaving the earth's atmosphere are mostly responsible for the temperature spike.

2. Frost- free season (and growing season) will lengthen -It could actually have detrimental effects on the crops we grow. Warmer weather helps pests survive longer which can destroy crops. Rising temperatures are also expected to contribute to a shift in areas which are agriculturally most productive and the crops that grow there.

3. Changes in precipitation patterns - The contrast between wet and dry areas will increase globally. In other words, the wet areas will get wetter and the dry areas will get drier.

4. More droughts and heat waves – With rising temperatures and shifting rainfall patterns, heat waves and droughts are increasing infrequency and intensity.

5. Sea level rise – Scientists have determined that global sea level has been steadily rising since 1900 at a rate of at least 0.1 to 0.25 cm per year. Sea level can rise by two different mechanisms with respect to climate change.

6. Arctic likely to become ice-free - The Arctic Ocean is expected to become essentially ice free in summer before mid-century.

ENVIRONMENTAL CONSEQUENCES OF CLIMATE CHANGE:

1.Agriculture and Food Security

i. Climate Change can affect crop yield as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.

ii. Rise in temperatures caused by increasing greenhouse gases is likely to affect crops differently from region to region. For example, moderate warming (increase of 1 to 3°C in mean temperature) is expected to benefit crop.

iii. Yields in temperate regions, while in lower latitudes especially seasonally dry tropics, even moderate temperature increases (1 to 2°C) are likely to have negative impacts for major cereal crops. Warming of more than 3°C is expected to have negative effect on production in all regions.

iv. As a result of thawing of snow, the amount of arable land in high-latitude region is likely to increase by reduction of the amount of frozen lands. At the same time arable land along the coast lines are bound to be reduced as a result of rising sea level.

v. Erosion, submergence of shorelines, salinity of the water table due to the increased sea levels, could mainly affect agriculture through inundation of low-lying lands.

vi. If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity will be manifold.

Impacts on Indian Agriculture

1. A large part of the arable land in India is rain-fed, the productivity of agriculture depends on the rainfall and its pattern. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall but also by shifts in the timing of the rainfall.

2. Any change in rainfall patterns poses a serious threat to agriculture, and therefore to the economy and food security. Summer rainfall accounts for almost 70 per cent of the total annual rainfall over India and is crucial to Indian agriculture. Increased frequencies of droughts, floods, storms and cyclones are likely to increase agricultural production variability.

3. Semiarid regions of western India are expected to receive higher than normal rainfall as temperatures soar, while central India will experience a decrease of between 10 and 20 per cent in winter rainfall by the 2050's.

4. Productivity of most crops may decrease due to increase in temperature and decrease in water availability, especially in Indo-Gangetic plains. There would be a decline in the productivity of Rabi as compared to kharif season crops. Rising temperature would increase fertilizer requirement for the same production targets and result in higher GHG emissions, ammonia volatilization and cost of crop production.

2.Water Stress and Water insecurity

i. Lack of access to water is a perturbing issue, particularly in developing countries. Climate change is expected to exacerbate current stresses on water resources. By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change. Spreading water scarcity is contributing to food insecurity and heightened competitions for water both within and between countries.

ii. Warming has resulted in decline in mountain glaciers and snow cover in both hemispheres and this is projected to accelerate throughout the 21st century. This will in turn lead to reducing water availability, hydropower potential, and would

change the seasonal flow of rivers in regions supplied by melt water from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes).By 2050 freshwater availability in Central, South, East and South-East Asia, particularly in large river basins is projected to decrease. The frequency of severe floods in large river basins has increased during the 20th century. Increasing floods poses challenges to society, physical infrastructure and water quality.

iii. Rising temperatures will further affect the physical, chemical and biological properties of fresh water lakes and rivers, with predominantly adverse impacts on many individual fresh water species, community composition and water quality. In coastal areas, sea level rise will exacerbate water resource constraints due to increased salinization of groundwater supplies.

Impacts on Water Situation in India

1. Water resources will come under increasing pressure in the Indian subcontinent due to the changing climate.

2. The Himalayan glaciers are a source of fresh water for perennial rivers, in particular the Indus, Ganga, and Brahmaputra river systems. In recent decades, the Himalayan region seems to have undergone substantial changes as a result of extensive land use (e.g. deforestation, agricultural practices and urbanization), leading to frequent hydrological disasters, enhanced sedimentation and pollution of lakes.

3. Glacial melt is expected to increase under changed climate conditions, which would lead to increased summer flows in some river systems for a few decades, followed by a reduction in flow as the glaciers disappear.

4. As a result of increase in temperature significant changes in rainfall pattern have been observed during the 20th century in India.

5. The food production has to be increased to the tune of 300 MT by 2020 in order to feed India's ever-growing population, which is likely to reach 1.30 billion by the year 2020.The total food-grain production has to be increased by 50 per cent by

2020 to meet the requirement. The falling groundwater levels in various parts of the country have threatened the sustainability of the groundwater resources.

3.Rise in Sea Levels

i. Sea level rise is both due to thermal expansion as well as melting of ice sheets.

ii. Satellite observations available since the early 1990sshow that since 1993, sea level has been rising at a rate per year, significantly higher than the average during the previous half-century. IPCC predicts that sea levels could rise rapidly with accelerated ice sheet disintegration.

iii. Global temperature increases of 3–4°C could result in330 million people being permanently or temporarily displaced through flooding. Warming seas will also fuel more intense tropical storms.

Impacts on Coastal States in India

1. The coastal states of Maharashtra, Goa and Gujarat face a grave risk from the sea level rise, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property.
2. Goa will be the worst hit, losing a large percentage of its total land area, including many of its famous beaches and tourist infrastructure.
3. Flooding will displace a large number of people from the coasts putting a greater pressure on the civic amenities and rapid urbanisation. Sea water percolation due to inundations can diminish freshwater supplies making water scarcer.
4. The states along the coasts like Orissa will experience worse cyclones. Many species living along the coastline are also threatened.
5. The coral reefs that India has in its biosphere reserves are also saline sensitive and thus the rising sea level threatens their existence too, not only the coral reefs but the phytoplankton, the fish stocks and the human lives that are dependent on it are also in grave danger.

4.Ecosystems and Bio-Diversity

i. Climate Change has the potential to cause immense biodiversity loss, affecting both individual species and their ecosystems that support economic growth and human well-being. The projected extinctions of flora and fauna in the future will be human driven i.e. due to adverse impact of human activities.

ii. Many species may be unable to move to new are as quickly enough to survive changes that rising temperatures will bring to their historic habitats. WWF asserted that one-fifth of the world's most vulnerable natural areas may be facing a "catastrophic" loss of species.

iii. It has catastrophic impact on the marine ecosystems. They will be affected not only by an increase in sea temperature and changes in ocean circulation, but also by ocean acidification, as the concentration of dissolved carbon dioxide (carbonic acid) rises.

Impacts on India's Biodiversity

1. India is a land of mega-biodiversity, encompassing features from glaciers to deserts. However, climate change is posing grave threat to its ecosystems. Temperature increases and human activities are causing fragmentation and degradation of mountain biodiversity.
2. The Himalayan Ecosystem is considered as the lifeline not only to India but also to our neighbouring countries such as China, Pakistan, Nepal, owing to the perennial rivers that arise out of the melting glaciers.
3. It is home to the largest number of glaciers after the North and the South Poles. However, climate change is threatening this life giver drastically.
4. It is also predicted that there will be an increase in the phenomenon of Glacial Lake Outburst Floods (GLOFs)in the eastern and the central Himalayas, causing catastrophic flooding downstream, with serious damage to 'life, property, forests, farms, and infrastructure'.

5. The melting glaciers of the Himalayas have a serious impact given the fact that they give rise to the perennial rivers that further flourishes the agriculture.

5.Climate Change and Health

i. Climate change poses a host of threats to the survival of mankind. A warmer and more variable climate would result in higher levels of some air pollutants, increased transmission of diseases through unclean water and through contaminated food.

ii. Climate change has a direct impact on human health. It is anticipated that there will be an increase in the number of deaths due to greater frequency and severity of heat waves and other extreme weather events. Climate change and the resulting higher global temperatures are causing increasing frequency of floods and droughts leading to the risk of disease infections.

iii. Lack of freshwater during droughts and contamination of freshwater supplies during floods compromise hygiene, thus increasing rates of diarrhoeal disease. Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in hydrological cycle. Flooding also creates opportunities for breeding of disease carrying insects such as mosquitoes.

Response to Climate Change

There are two main responses to climate change.

1. Mitigation - Which addresses the root causes of climate change, by reducing greenhouse gas emissions.

2.Adaptation - Seeks to lower the risks posed by the consequences of climatic changes. Both approaches will be necessary to deal with the global changes that have already been set in motion.

MITIGATION STRATEGIES

Mitigation measures:

It is important that we learn how to reduce climate change, and put them into practice now, before it is too late.

1. Cleaner alternative energy sources: One important way to fight climate change is to reduce our reliance on and usage of fossil fuels, and depend on alternative renewable and greener sources of energy such as wind energy, solar energy, water or hydropower, biomass, and geothermal energy.

2. Energy saving tips - we can adopt energy saving tips by investing in more expensive energy-saving appliances like the compact fluorescent light (CFL) bulbs, Air conditioners, refrigerators etc. Switching off our electrical appliances when not in use.

3. Green driving tips - The best strategy to reduce toxic gas emissions is definitely to reduce the use of automobiles. Use public transport, carpooling, use of electricity powered cars or two wheelers can be an alternative.

4. Reduce - Reuse - Recycle practices –Reducing, reusing and recycling helps us conserve resources and energy, and reduce pollution and greenhouse gas emissions produced thereby.

5. Re-forestation - The cleanest and most efficient remover of carbon dioxide from our atmosphere actually is nothing but green plants and trees. The rate at which we are cutting down our trees and forests to make way for human developments has greatly reduced the earth's ability to remove carbon dioxide from the atmosphere.

6. Organic farming - Soils are an important sink for atmospheric carbon dioxide. Nevertheless, deforestation making way for conventional agriculture is increasingly depleting this sink. Sustainable and organic agriculture helps to counteract climate change by restoring soil organic matter content as well as reduce soil erosion and improve soil physical structure. Organic farming uses natural fertilizers and helps maintain crop yields.

7.Carbon Sequestration:

Carbon capture and storage, also known as CCS or carbon sequestration, describes the technologies designed to tackle global warming by capturing CO2 at power stations, industrial sites or even directly from the air and permanently storing it underground. Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate defer global warming. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Sinks

Carbon sequestration may be carried out by pumping carbon into 'carbon sinks'— an area that absorbs carbon.

1. Natural sinks - Oceans, forests, soil etc.
2. Artificial sinks - Depleted oil reserves, un mineable, mines, etc.

There are three main steps to carbon capture and storage (CCS) –

1. trapping and separating the CO_2 from other gases,
2. transporting this captured CO_2 to a storage location,
3. storing that CO_2 far away from the atmosphere (underground or deep in the ocean).

Types of Sequestration:

There are number of technologies under investigation for sequestering carbon from the atmosphere. These can be discussed under three main categories:

1. Ocean Sequestration: Carbon stored in oceans through direct injection or fertilization.
2. Geologic Sequestration: Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.
3. Terrestrial Sequestration: A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks. Increasing carbon fixation through photo-synthesis, slowing down or reducing decomposition of organic

matter, and changing land use practices can enhance carbon uptake in these natural sinks.

4. Geologic Sequestration is thought to have the largest potential for near-term application.

8.Carbon sink

Unlike black and brown carbon that contribute to atmospheric greenhouse gases, green and blue carbon sequestrate the atmosphere greenhouse gases

Green Carbon

Green carbon is carbon removed by photosynthesis and stored in the plants and soil of natural ecosystems and is a vital part of the global carbon cycle.

Many plants and most crops, have short lives and release much of their carbon at the end of each season, but forest biomass accumulates carbon over decades and centuries.

Afforestation and reforestation are measures that can be taken to enhance biological carbon sequestration.

Blue Carbon

Blue Carbon refers to coastal, aquatic and marine carbon sinks held by the indicative vegetation, marine organism and sediments. In particular, coastal ecosystems such as tidal marshes, mangroves, and seagrasses remove carbon from the atmosphere and ocean, storing it in plants and depositing it in the sediment below them by natural processes.

Why is Blue Carbon Ecosystem Important?

1. Preventing degradation and destruction and promoting restoration of coastal ecosystems is a significant tool to mitigate climate change.

2. The coastal ecosystems of mangroves, tidal marshes, and seagrasses are some of the most rapidly disappearing natural systems on Earth.

3. When lost they not only stop sequestering carbon but also release their stores of carbon and become new sources of climate change causing carbon emissions which can last for centuries.

The Blue Carbon Initiative

The Blue Carbon Initiative is the first integrated program with a comprehensive and coordinated global agenda focused on mitigating climate change through the conservation and restoration of coastal marine ecosystems.

9.carbon credit:

A carbon credit is a tradeable certificate or permit representing the right to emit one tonnes of carbon or carbon-dioxide equivalent (tCO_2e). One carbon credit is equal to one ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases.

How does one earn a carbon credit?

An organization which produces one tonnes less of carbon or carbon dioxide equivalent than the standard level of carbon emission allowed for its outfit or activity, earns a carbon credit.

How does it help?

Countries which are signatories to the Kyoto Protocol under the UNFCCC have laid down gas emission norms for their companies to be met by 2012. In such cases, a company has two ways to reduce emissions.

(i) It can reduce the GHG (greenhouse gases) by adopting new technology or improving upon the existing technology to attain the new norms for emission of gases.

(ii) It can tie up with developing nations and help them set up new technology that is eco-friendly, thereby helping developing country or its companies 'earn' credits.

This credit becomes a permit for the company to emit GHGs in its own country. However, only a portion of carbon credits of the company in developing country can be transferred to the company in developed country.

10.carbon offsetting:

Carbon offsets are credits for reductions in greenhouse gas emissions made at another location, such as wind farms which create renewable energy and reduce the need for fossil-fuel powered energy. Carbon offsets are quantified and sold in metric tonnes of carbon dioxide equivalent (CO2e). For a carbon offset to be credible it must meet essential quality criteria, including proof that it is additional (the reduction in emissions would not have occurred without the carbon finance), that it will be retired from the carbon market so it cannot be double counted, and that it addresses issues such as permanence (it delivers the reductions it stated) and leakage.

Example:

Business A1 is unable to reduce 100 tonnes of its CO_2 emissions in the short term. There is a project somewhere else in the world which could save 100 tonnes easily, but they need a cash injection. For example, a community in India could swap from carbon intensive kerosene as an energy source to solar panels – but they can't afford the solar panels. Through the purchase of carbon offsets, you provide the financial assistance to subsidize the cost of getting solar panels onto housing, and through that means you have enabled a saving of 100 tonnes of CO_2. Business A1 has therefore reduced global net CO_2 emissions by 100 tonnes. The added benefit is that Business A1 has helped facilitate a step change in local technology in a developing market.

11.carbon tax:

Carbon tax is the potential alternative to the 'cap and trade' method currently used by the protocol. This tax is based on the amount of carbon contained in a fuel such as coal, etc. The aim of this tax is to cause less fossil fuel use and hopefully cause an incentive to use other sources of energy. If the carbon tax was implemented it would be gradual and start at a low amount and increase over time to allow better industry and technology to be developed.

India's Position on carbon tax:

India will bring a WTO challenge against any "carbon taxes" that rich countries impose on Indian imports. "If they impose such a tax, we will take them to the WTO dispute

settlement forum," "We will deal through hard negotiations. Such barriers are not going to be WTO-compatible and we will fight it." – the minister, MoEF. Both United States and European Union have discussed the possibility of imposing tariffs or other forms of "border carbon adjustment" on goods imported from countries with tax regulations on greenhouse gas emissions.

12.Geo-engineering:

Geo-engineering primarily aims at modifying and cooling Earth's environment, defeating the environmental damage and ensuing climate changes to make the planet more inhabitable. Geoengineering, at this point, is still only a theoretical Concept. Hoisting parasols, placing mirrors in space, whitening the stratosphere with sulfate aerosols, whitewashing building roofs to reflect sunlight or flinging iron filings into the ocean to promote carbon-gulping algae are some of the modes.

How Geoengineering Works: Big Plans to Stop Global Warming

1. Copy a Volcano

A volcanic eruption can bellow many million tons of sulfur-dioxide gas into the atmosphere, creating a cloud that blocks some of the sun's radiation. By injecting the atmosphere with sulfur, some scientists believe they could likewise block solar radiation and potentially cool the planet. Those droplets are particularly good at scattering the sun's light back out into space. And because Sulphur doesn't heat the stratosphere as much as other aerosols, it wouldn't work against the cooling effect. Hydrogen sulfide is an even better candidate for atmospheric seeding than sulfur dioxide.

2. Shoot Mirrors into Space

In order to deflect enough sunlight to bring the Earth's climate back to its pre-industrial level, geoengineers plan to launch a mirror, the size of Greenland and strategically position it between the planet and the sun.

3. Seed the Sea with Iron

Scientist suggests iron will be the key to turn things around. Phytoplankton, which dwell near the surface, prefer iron. They are also adapted at pulling carbon out of the

atmosphere during photosynthesis. When they die after about 60 days, the carbon the organisms have consumed falls to the bottom of the ocean. By pumping iron into the sea and stimulating phytoplanktonto grow like crazy, scientist believe, global warming could be reversed.

4. Whiten the Clouds with Wind-Powered Ships

Scientist hopes, like the volcanic eruption, the tops of clouds also reflect solar radiation. Spraying a lot of seawater into the sky by wind powered remotely activated ships to whiten the clouds and thus it will reflect solar radiation.

5. Build Fake Trees

"Artificial tree," a scaled-down version of an earlier prototype capable of capturing a ton of carbon in the atmosphere per day. Panels covering the surface of the tree--which would need to be about 50 square meters--will be made of an absorbent resin that reacts with carbon dioxide in the air to form a solid. It can be compared to a furnace filter, capable of pulling particles out of the air. The panels, or "boxes," can be removed and exposed to 113 F steam, which effectively cleans the filter. The chemical reaction with the steam causes the solid to release the carbon it has captured, which can then seize as liquid CO_2. But pulling carbon dioxide from the atmosphere is only half the battle--afterwards it must be sequestered, or permanently trapped.

How sequestrated CO2 can be commercials used?

Horticulturists need CO_2 in greenhouses for plants to use during photosynthesis, for dry ice production, and for developing new kinds of plastic and concrete that can be made with CO_2.

Drawbacks

1. Scientists have no idea whether they could shut down some of these geoengineering projects once they start.
2. Geoengineering treats the symptoms of global warming, and could very well undermine efforts to address the root cause.

3. people may feel as though they don't need to reduce their personal carbon emissions and companies may continue to conduct business as usual, expecting researchers to clean up the mess.
4. The cost, maintenance for geoengineering projects are too high.

Question:

1. Explain environmental consequence and its mitigation strategies.