CHAPTER - 21

MITIGATION STRATEGIES

21.1. CARBON SEQUESTRATION:

- Carbon capture and storage, also known as CCS or carbon sequestration, describes the technologies designed to tackle global warming by capturing CO_2 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 or 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.
  - Natural sinks - Oceans, forests, soil etc.
  - Artificial sinks - Depleted oil reserves, unmineable mines, etc.
- Carbon capture has actually been in use for years. The oil and gas industries have used carbon capture for decades as a way to enhance oil and gas recovery. Only recently have we started thinking about capturing carbon for environmental reasons.

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

- trapping and separating the CO_2 from other gases,
- transporting this captured CO_2 to a storage location, and
- 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:
- Ocean Sequestration: Carbon stored in oceans through direct injection or fertilization.
- Geologic Sequestration: Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.
- Terrestrial Sequestration: A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks. Increasing carbon fixation through photosynthesis, slowing down or reducing decomposition of organic matter, and changing land use practices can enhance carbon uptake in these natural sinks.
- Geologic Sequestration is thought to have the largest potential for near-term application.

Geologic Sequestration Trapping Mechanisms

- Hydrodynamic Trapping: Carbon dioxide can be trapped as a gas under low-permeability cap rock (much like natural gas is stored in gas reservoirs).
- Solubility Trapping: Carbon dioxide can be dissolved into a liquid, such as water or oil.
- Mineral Carbonation: Carbon dioxide can react with the minerals, fluids, and organic matter in a geologic formation to form stable compounds/minerals; largely calcium, iron, and magnesium carbonates.
- Carbon dioxide can be effectively stored in the earth's subsurface by hydrodynamic trapping and solubility trapping - usually a combination of the two is most effective.

Do you know?

Asian golden cat prefer forest habitats interspersed with rocky areas, and are found in dry deciduous, subtropical evergreen and tropical rainforests. In India it is distribution in assam& arunachal Pradesh. IUCN Status – near threatened.

21.2. CARBON SINK

- Unlike black and brown carbon that contribute to atmospheric green house gases, green and blue carbon sequestrate the atmosphere green house 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.
- Furthermore, forests can accumulate large amounts of CO_2 in relatively short periods, typically several decades.
- 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.
- These coastal ecosystems are very efficient at sequestering and storing carbon - each square mile of these systems can remove carbon from the atmosphere and oceans at rates higher than each square mile of mature tropical forests.
- Furthermore, coastal ecosystems have been found to store huge quantities of carbon in organic rich sediments - up to 5 times more carbon than many temperate and tropical forests.
- These ecosystems are found in all continents, except Antarctica.

Why is Blue Carbon Ecosystem Important?

- Preventing degradation and destruction and promoting restoration of coastal ecosystems is a significant tool to mitigate climate change.
- The coastal ecosystems of mangroves, tidal marshes, and seagrasses are some of the most rapidly disappearing natural systems on Earth.
- 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.

International Cooperation

- Conservation International (CI), the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanic Commission (IOC) of UNESCO is collaborating with governments, research institutions, non-governmental and international organizations, and communities around the world to
- Develop management approaches, financial incentives and policy mechanisms for ensuring conservation and restoration of coastal Blue Carbon ecosystems;
- Engage local, national, and international governments to ensure policies and regulations support coastal Blue Carbon conservation, management and financing;
- Develop comprehensive methods for coastal carbon accounting;
- Develop incentive mechanisms such as carbon payment schemes for Blue Carbon projects; and
- Implement projects around the world that demonstrate the feasibility of coastal Blue Carbon accounting, management, and incentive agreements;
- Support scientific research into the role and importance of coastal Blue Carbon ecosystems for climate change mitigation.

Do you know?

The seeds of Phytelephas macrocarpa, in the family Arecaceae, commonly called "ivory nut" or "tagua palm tree," is the chief source of vegetable ivory. It is extensively used as a substitute for true ivory. It can be carved and used in the manufacture of buttons, chess pieces, poker chips, dice, knobs, inlays, billiard balls, toys, etc. Metroxylon amicarum, in the Arecaceae family, can likewise be used for these purposes

21.3. CARBON CREDIT:

- A carbon credit is a tradeable certificate or permit representing the right to emit one tonne of carbon or carbon dioxide equivalent (tCO2e).
- 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 organisation which produces one tonne 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.

Developing countries

- Developing countries like India and China are likely to emerge as the biggest sellers and Europe is going to be the biggest buyers of carbon credits.
- Last year global carbon credit trading was estimated at $5 billion, with India's contribution at around $1 billion.
- China is currently the largest seller of carbon credits controlling about 70% of the market share.
- Carbon, like any other commodity, has begun to be traded on India's Multi Commodity Exchange.
- MCX has become first exchange in Asia to trade carbon credits.

Do you know?

Several species of nitrogen-fixing bacteria of Rhizobium, live inside the root nodules of leguminous trees. Similarly, Frankia, a nitrogen-fixing mycelial bacterium, is associated symbiotically with the root nodules of several non-legume plants, including Alnus, Casuarina, Coriaria, Myrica and Rubus. Both Rhizobium and Frankia are capable of fixing atmospheric nitrogen.

21.4. 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 (CO_2e).
- Buying one tonne of carbon offsets means there will be one less tonne of carbon dioxide in the atmosphere than there would otherwise have been.
- Carbon offsetting is often the fastest way to achieve the deepest reductions within businesses and it also often delivers added benefits at the project site, such as employment opportunities, community development programmes and training and education.
- 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 (the emission reduction in one area doesn't cause an increase in emissions somewhere else)

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 subsidise 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.

21.5. 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.
- Five primary reasons why a carbon tax could prove more beneficial than the 'cap and trade' system.

1. Predictability – the tax could help predict energy prices which might also help investments in energy efficiency and alternate fuels.
2. Implementation - a carbon tax could be put into use much quicker compared to the legalities that go along with the 'cap and trade' method.
3. Understandable – the carbon tax is simpler to understand and may therefore be embraced more by everyday people
4. Lack of Manipulation – special interest groups have less of a chance to manipulate a carbon tax because of its simplicity.
5. Rebates – like other forms of taxes, the carbon tax could be open for rebates to the public

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 [with this] 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.

Do you know?

Generally, softwood tracheids are preferred over hardwood fibers for papermaking because the tracheids of conifers are longer (about 2-4 mm) than are hardwood fibers (0.5-1.5 mm).

21.6. 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: 5 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 sulfur 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 adapt 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 phytoplankton to 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

> **Do you know?**
>
> Mugger crocodile is a freshwater species, which primarily occupies Indian lakes, rivers and marshes. It prefers slow-moving, shallower bodies of water and may be found in man-made reservoirs and irrigation canals.

- "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 CO_2 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

- Scientists have no idea whether they could shut down some of these geoengineering projects once they start.
- Geoengineering treats the symptoms of global warming, and could very well undermine efforts to address the root cause.
- 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.
- The cost, maintenance for geoengineering projects are too high.