

 **PART-III-CLIMATE CHANGE** 

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## CLIMATE CHANGE

- The long-term average of a region's weather events.
- The phrase 'climate change' represents a change in the long-term weather patterns
- The measurable effects of the continual warming trend.
- Usually measured in major shifts in temperature, rainfall, snow, and wind patterns lasting decades or more

### GLOBAL WARMING

- ✓ An average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns

### GREENHOUSE EFFECT

- ✓ The greenhouse effect is a naturally occurring phenomenon that blankets the earth lower atmosphere and warms it, maintaining the temperature suitable for living things to survive.
- ✓ water vapor and green house gases warms the Earth.

### Incoming Energy

- ✓ The Sun emits energy that is transmitted to Earth.
- ✓ Because the Sun is very hot, the energy is emitted in high-energy short wavelengths that penetrate the Earth's atmosphere.

### Absorption

- ✓ About 30% of the Sun's energy is reflected directly back into space by the atmosphere, clouds, and surface of the Earth.
- ✓ The rest of the Sun's energy is absorbed into the Earth's system (70%)

### Emission

- ✓ The Earth re-emits energy back into the atmosphere.
- ✓ Because the Earth is cooler than the Sun, the energy is emitted in the form of infrared radiation, at wavelengths longer than the incoming solar energy.

### Role of Greenhouse Gases

- ✓ Greenhouse gases in the atmosphere absorb much of the long-wave energy (infrared radiation) emitted from the Earth's surface,
- ✓ The greenhouse gases then re-emit this energy in all directions, warming the Earth's surface and lower atmosphere.

### GREEN HOUSE GASES



- ✓ Greenhouse gases" means those gaseous constituents of the atmosphere, both natural and anthropogenic, those absorb and re-emit infrared radiation.

#### 1. WATER VAPOUR

- ✓ the biggest overall contributor to the greenhouse effect and humans are not directly responsible for emitting this gas in quantities sufficient to change its concentration in the atmosphere.
- ✓ CO<sub>2</sub> and other greenhouse gases is increasing the amount of water vapour in the air by boosting the rate of evaporation.

#### 2. CARBON DIOXIDE

- The main sources
  - i. The combustion of fossil fuels to generate electricity.
  - ii. The combustion of fossil fuels such as gasoline and diesel used for transportation

- iii. Many industrial processes emit CO<sub>2</sub> through fossil fuel combustion.
- iv. Several processes also produce CO<sub>2</sub> emissions through chemical reactions that do not involve combustion.

- **Reducing Carbon Dioxide Emissions** - The most effective way to reduce carbon dioxide (CO<sub>2</sub>) emissions is to reduce fossil fuel consumption.
- Other strategies include Energy Efficiency, Energy Conservation, Carbon Capture and Sequestration.

### 3. METHANE

- (CH<sub>4</sub>) is emitted by natural sources such as wetlands, as well as human activities such as leakage from natural gas systems and the raising of livestock.
- Natural processes in soil and chemical reactions in the atmosphere help remove CH<sub>4</sub> from the atmosphere

#### Human induced:

- **Agriculture: Domestic livestock such as cattle, buffalo, sheep, goats, and camels produce large amounts of CH<sub>4</sub> as part of their normal digestive process.**
- **Globally, the Agriculture sector is the primary source of CH<sub>4</sub> emissions**
- Methane is the primary component of natural gas.
- Some amount of, CH<sub>4</sub> is emitted to the atmosphere during the production, processing, storage, transmission, and distribution of crude oil & natural gas.

### 4. NITROUS OXIDE

- (N<sub>2</sub>O) is naturally present in the atmosphere as part of the Earth's nitrogen cycle, and has a variety of natural sources.
- **Natural emissions of N<sub>2</sub>O are mainly from bacteria breaking down nitrogen in soils and the oceans.**
- emitted when people add nitrogen to the soil through the use of synthetic fertilizers.
- also emitted during the breakdown of nitrogen in livestock manure and urine, which contributed to 6% of N<sub>2</sub>O emissions in 2010
- emitted when transportation fuels are burned
- generated as a byproduct during the production of nitric acid, which is used to make synthetic commercial fertilizer, and in the production of adipic acid, which is used to make fibers, like nylon, and other synthetic products.
- **removed from the atmosphere when it is absorbed by certain types of bacteria or destroyed by ultraviolet radiation or chemical reactions.**

### 5. FLUORINATED GASES

- They are emitted through a variety of industrial processes such as aluminum and semiconductor manufacturing & Substitution for Ozone-Depleting Substances.
  - very high global warming potentials (GWPs) relative to other greenhouse gases.
  - well-mixed in the atmosphere, spreading around the world after they're emitted.
  - removed from the atmosphere only when they are destroyed by sunlight in the far upper atmosphere.
  - the most potent and longest lasting type of greenhouse gases emitted by human activities.
1. **hydrofluorocarbons (HFCs),**
  2. **perfluorocarbons (PFCs), and**
  3. **sulfur hexafluoride (SF<sub>6</sub>).**

- Hydrofluorocarbons are used as refrigerants, aerosol propellants, solvents, and fire retardants. These chemicals were developed as a replacement for chlorofluorocarbons (CFCs) and hydro chlorofluoro carbons (HCFCs) because they do not deplete the stratospheric ozone layer.
- Unfortunately, HFCs are potent greenhouse gases with long atmospheric lifetimes and high GWPs,
- Perfluorocarbons are compounds produced as a by-product of various industrial processes associated with aluminum production and the manufacturing of semiconductors.
- Like HFCs, PFCs generally have long atmospheric lifetimes and high GWPs.
- Sulfur hexafluoride is used in magnesium processing and semiconductor manufacturing, as well as a tracer gas for leak detection. Sulfur hexafluoride is used in electrical transmission equipment, including circuit breakers.

## **BLACK CARBON**

- commonly known as soot, is a form of particulate air pollutant, produced from incomplete combustion.
- consists of pure carbon in several linked forms.
- a solid particle or aerosol, (though not a gas) contributes to warming of the atmosphere.
- biomass burning, cooking with solid fuels, diesel exhaust, etc
- warms the Earth by absorbing heat in the atmosphere and by reducing albedo, (the ability to reflect sunlight) when deposited on snow and ice.
- the strongest absorber of sunlight and heats the air directly.
- it darkens snow packs and glaciers through deposition and leads to melting of ice and snow.
- disrupts cloudiness and monsoon rainfall and accelerates melting of mountain glaciers such as the Hindu Kush-Himalayan glaciers


## **Government Measures**

- Project Surya has been launched to reduce black carbon in atmosphere by introducing efficient stove technologies, solar cookers, solar lamps and biogas plants

## **Brown Carbon**

- a ubiquitous and unidentified component of organic aerosol which has recently come into the forefront of atmospheric research.
- Light-absorbing organic matter (other than soot) in atmospheric aerosols of various origins, e.g., soil humics, humic-like substances (HLTLIS), tarry materials from combustion, bio aerosols.

## **CLIMATE FORCINGS**

- are factors in the climate system that either increase or decrease the effects to the climate system.
- Positive forcings such as excess greenhouse gases warm the earth 
- negative forcings, such as the effects of most aerosols and volcanic eruptions, actually cool the earth.

## **Natural Forcing's**

- include changes in the amount of energy emitted by the Sun, very slow variations in Earth's orbit, and volcanic eruptions

## **Human-Induced Forcing's**

- Activities include greenhouse gas and aerosol emissions from burning fossil fuels and modifications of the land surface, such as deforestation.

- Greenhouse gases are a positive climate forcing; that is, they have a warming effect.
- Carbon dioxide emitted from the burning of fossil fuel is presently the largest single climate forcing agent, accounting for more than half of the total positive forcing since 1750
- Burning fossil fuels adds aerosols to the atmosphere.
- Aerosols are tiny particles in the atmosphere composed of many things, including water, ice, ash, mineral dust, or acidic droplets.
- Aerosols can deflect the Sun's energy and impact the formation and lifetime of clouds. Aerosols are a negative forcing; that is, they have a cooling effect.

### **Estimate the effect of each gas (three main factors)**

1. How much of these gases are in the atmosphere
2. How long do they stay in the atmosphere
3. How strongly do they impact global temperatures

### **GLOBAL WARMING POTENTIAL**

- ✓ The Global Warming Potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.
- ✓ Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP, and thus contribute more to warming Earth.
- ✓ Methane (CH<sub>4</sub>) has a GWP more than 20 times higher than CO<sub>2</sub> for a 100-year time scale
- ✓ Nitrous Oxide (N<sub>2</sub>O) has a GWP 300 times that of CO<sub>2</sub> for a 100-year timescale
- ✓ Chloro fluoro carbons (CFCs), hydro fluoro carbons (HFCs), hydro chloro fluoro carbons (HCFCs), perfluoro carbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>) are called high-GWP.

### **GLOBAL EMISSIONS BY SOURCE**

- **Energy Supply (26%)**
- **Industry (19%)**
- **Land Use, Land-Use Change, and Forestry (17%)**
- **Agriculture (14%)**
- **Transportation (13%)**
- **Waste and Wastewater (3%)**

### **ACIDIFICATION**

- the rainfall that has been acidified.
- formed when oxides of sulfur and nitrogen react with the moisture in the atmosphere.
- rain with a pH of less than 5.6.

### **TYPES OF ACID DEPOSITION**

- ✓ "Acid rain" is a broad term referring to a mixture of wet and dry deposition (form of deposition material) from the atmosphere

### **Sources of compounds causing acid rain**

#### **(a) Sulphur**

- 1) Natural sources: - seas and oceans, volcanic eruptions,
  - ✓ Biological processes in the soil e.g.,
  - ✓ Decomposition of organic matter.

## 2) Man-made sources:

- ✓ burning of coal (60% of  $\text{SO}_2$ ) and
- ✓ petroleum products (30% of  $\text{SO}_2$ ), and
- ✓ The smelting of metal sulfide ores to obtain the pure metals.
- ✓ Industrial production of Sulfuric acid in metallurgical, chemical and fertilizer industries

### (b) Nitrogen

- ✓ Natural sources: lightening, volcanic eruption, and Biological activity.
- ✓ Anthropogenic sources: Forest fires Combustion of oil, coal, and gas

### (c) Formic acid

- ✓ Biomass burning due to forest fires causes emission of formic acid ( $\text{HCOOH}$ ) and formaldehyde ( $\text{HCHO}$ ) into the atmosphere.
- ✓ Large fraction formaldehyde gets photo - oxidation and forms formic acid in the atmosphere.
- ✓ These are three main compounds that cause acidification of rain in the atmosphere

### (d) Other Acids:

- ✓ Chlorine, Phosphoric acid, Hydrochloric acid (smokestacks), Carbon monoxide and carbon dioxide (automobiles). These become carbonic acid.
- ✓ Lichgns serve as good bio-indicators for air pollution
- ✓ Acid rain containing ions of sulfate, nitrate, ammonium and hydrogen falls as wet deposition.

## Impact Of Acid Rain

### (a) Soil

- ✓ The exchange. between hydrogen ions and the nutrient cations like potassium and magnesium in the soil cause leaching Of the nutrients, making soil infertile.
- ✓ Increase in ammonia in the soil due to a decrease in other nutrients decrease the rate of decomposition.
- ✓ The impact of acid rain on soil is less India; because Indian soils are mostly alkaline, with good buffering ability.

### Micro organisms

- ✓ pH determines the proliferation of any microbial species in a particular environment and the rate at which it can produce.
- ✓ The optimum pH of most bacteria and protozoa is near neutrality; most fungi-prefer an acidic environment,
- ✓ most blue-green bacteria prefer an alkaline environment.
- ✓ after a long run of acid rain, microbial species in the soil and water shift from bacteria-bound to fungi-bound
- ✓ cause an imbalance in the microflora.
- ✓ causes a delay in the decomposition of soil organic material, and an increase in fungal disease in aquatic life and forests.

### Acid rain affects human health is a number of ways.

- ✓ The obvious ones are bad smells, reduced visibility; irritation of the skin, eyes and the respiratory tract
- ✓ Some direct effects include chronic bronchitis, pulmonary emphysema and cancer

### Acid rain damage on Materials

- ✓ Metals, stone, Paints , Paper, Photographic Micro material , Leather—by sulphur oxide mainly and some other gas oxides .
- ✓ Rubber- ozone gas
- ✓ Textiles- nitrogen oxide
- ✓ Ceramic and Surface glass- Acid gases, fluoride-containing

### **Trigger Effect of Acid Rain on Pollutants:**

#### **1. Mercury**

- ✓ Methyl mercury and related short chain alkyl, mercurial compounds are most dangerous to humans, as they accumulate in edible fish tissue.
- ✓ Although acid deposition may not increase the production of methyl mercury, it may increase the partitioning of methyl mercury into the water column.
- ✓ The use of lime has helped in reducing the mercury levels in fish.

#### **2. Aluminium:**

- ✓ Acidified waters are known to leach substantial amounts of aluminum from watersheds.
- ✓ Even at relatively low levels, aluminum has been implicated in dialysis dementia, a disorder of the central nervous system, which may be toxic to individuals with impaired kidney function

#### **3. Cadmium:**

- ✓ Cadmium can enter the drinking water supply through corrosion of galvanized pipe or from the copper-zinc through corrosion of galvanized piper or from the copper-zinc solder used in the distribution systems.
- ✓ A decrease in water pH from 6.5 to 4.5 can result in a fivefold increase in cadmium and could cause renal tubular damage

#### **4. Lead:**

- ✓ Foetuses and infants are highly susceptible to drinking water lead contamination.
- ✓ High blood lead levels in children (>30 mug/ Ml) are believed to induce biochemical and neurophysiological dysfunction.
- ✓ However, lower than normal blood levels of lead can cause mental deficiencies and behavioral problems

### **OCEAN ACIDIFICATION**

- ✓ the change in ocean chemistry - lowering of ocean pH (i.e. increase in concentration of hydrogen ions) driven by the uptake of carbon compounds by the ocean from the atmosphere.
- ✓ As the uptake of atmospheric carbon dioxide by the ocean increases, the concentration of hydrogen, ions in the ocean increases, the concentration of carbonate ions decreases, the pH of the oceans decreases and the oceans become less alkaline — this process is know as ocean acidification.
- ✓ The ocean currently has a pH around 8.0 and is therefore 'basic'

### **Forms of calcium carbonate**

1- **Calcite** is the mineral form found in the shells of planktonic algae, amoeboid protists, some corals, echinoderms, and some molluscs (e.g. oysters); it is relatively less soluble.

2 - **Aragonite** is a more soluble form of calcium carbonate; it is found in most corals, most mollusks (small planktonic snails), as well as some species

## Effect of ocean acidification

- ✓ Seawater absorbs  $\text{CO}_2$  to produce carbonic acid ( $\text{H}_2\text{CO}_3$ ), bicarbonate ( $\text{HCO}_3^-$ ) and carbonate ions ( $\text{CO}_3^{2-}$ ).
- ✓ These carbonate ions are essential to the calcification process that allows certain marine organisms to build their calcium carbonate shells and skeletons.
- ✓ increases in atmospheric  $\text{CO}_2$  levels lead to decrease in pH level, increase in the concentration of carbonic acid and bicarbonate ions, causing a decrease in the concentration of carbonate ions.
- ✓ Thus carbonate ions are less available and calcification is therefore harder to achieve

## Saturation horizons

- ✓ Deep, cold ocean waters are naturally under saturated with carbonate ions causing the shells of most calcifying organisms to dissolve.
- ✓ Surface waters are oversaturated with carbonate ions and do not readily dissolve shells of calcifying organisms.
- ✓ The saturation horizon is the level below which calcium carbonate minerals undergo dissolution
- ✓ The saturation horizon of calcite occurs at a greater ocean depth than that for aragonite, but both horizons have moved closer to the surface presently when compared to the 1800s.
- ✓ lysocline, the depth at which dissolution strongly increases in the deep ocean.
- ✓ carbonate compensation depth (CCD), the depth at which all carbonate is dissolved

## OZONE HOLE

- ✓ It is found in two different layers of the atmosphere.
- ✓ Ozone in the troposphere is "bad" because it dirties the air and helps to form smog, which is not good to breathe.
- ✓ Ozone in the stratosphere is "good" because it protects life on Earth by absorbing some of the sun's harmful Ultra Violet (UV) rays
- ✓ decrease in the concentration of ozone in a particular region of the atmosphere - 'ozone hole'
- ✓ The best example of such an ozone hole is the atmosphere over the Antarctic which has only about 50 percent of the ozone that originally occurred there.

## Sources

### 1. Chlorofluorocarbons (CFCs):

- ✓ CFCs molecules are made up of chlorine, fluorine and carbon.
- ✓ They are used as refrigerants (66%) ; propellants in aerosol sprays, foaming agents in plastic manufacturing (30%) , fire extinguishing agents, solvents for cleaning electronic and metallic components, for freezing foods etc
- ✓ CFCs has a wide and varied application due to its properties like non-corrosiveness, non-inflammability, low toxicity and chemical stability, etc.
- ✓ the residence time of CFCs in the atmosphere estimated to be between 40 and 150 years

## The chemical reaction

- ✓ CFCs + UV radiation = freeing chlorine atoms.
- ✓ A free chlorine atom + ozone molecule to = chlorine monoxide (OO).
- ✓ chlorine monoxide + atom of oxygen.= (O2) and reformation of the free chlorine atom (Cl).
- ✓ The element that destroys O3 (i.e chlorine) is being reformed at the end of cycle.
- ✓ A single chlorine atom destroy thousands of ozone molecules before encountering reactive nitrogen or hydrogen compounds that eventually return chlorine to its reservoirs.

## Nitrogen Oxides:

- ✓ The chemical reaction- Nitric oxide (NO) catalytically destroys ozone.
- ✓ Nitric oxide + ozone =Nitrogen dioxide + O2
- ✓ Nitrogen dioxide + monoxide =Nitric oxide + Oxygen

## Bromine

- ✓ containing compounds called halons and HBFCs, i.e. hydrobromo fluorocarbons [both used in fire extinguishers and methyl bromide (a widely used pesticide)].



Each bromine atom destroys hundred times of more ozone molecules than what a chlorine atom does.

## Sulphuric acid particles:

- ✓ These particles free chlorine from molecular reservoirs, and convert reactive nitrogen into inert forms thus preventing, the formation of chlorine reservoirs.

## Role of polar stratospheric clouds in ozone depletion

- ✓ The ice particles of the cloud provided substrates for chemical reactions which freed chlorine from its reservoirs.
- ✓ the reaction between HCl and ClONO2 is very slow, but this reaction occurs at a faster rate in the presence of a suitable substrate which is provided by the stratospheric clouds at the poles.
- ✓ The PSCs not only activate chlorine, but they also absorb reactive nitrogen.
- ✓ If nitrogen, - oxides were present they would combine with chlorine monoxide to form a reservoir of chlorine nitrate, (ClONO2).
- ✓ Every spring, a hole as big as the USA develops in the ozone layer over Antarctica, in the South Pole.
- ✓ A smaller hole develops each year over the Arctic, at the North Pole.

## Why is the ozone hole predominant at the Antarctic?

- ✓ The Antarctic stratosphere is much colder. The low temperature enables the formation of Polar stratospheric Clouds (PSCs), below 20 km
- ✓ The vortex is a ring of rapidly circulating air that confines the ozone depletion in the Antarctic region.
- ✓ The longevity of the Antarctic vortex is another factor, enhancing favorable conditions for the depletion of ozone.
- ✓ The vortex remains, in fact, throughout the polar winter, well into midspring Whereas- the vortex in the Arctic disintegrates by the time the polar spring (March-April) arrives.

- ✓ The ozone measurement instruments and techniques are varied. Some of them are the Dobson spectrophotometer and the filter ozonometer called M83, and total ozone mapping spectrometer (TOMS) in the Nimbus-7 satellite.
- ✓ The Umheher technique- The most common measure of total ozone abundance is the Dobson unit (named after the pioneering atmospheric physical Gordon Dobson) which is the thickness of the ozone column (compressed at Standard Temperature and Pressure (STP)) in milli-centimeters.

## **IMPACT OF CLIMATE CHANGE**

### **AGRICULTURE AND FOOD SECURITY**

- ✓ The Third Assessment Report of the IPCC, 2001 concluded that climate change would hit the poorest countries severely in terms of reducing the agricultural products
- ✓ Crop yield would be reduced in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect/pest incidence.

### **Impacts on Indian agriculture**

- ✓ 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.
- ✓ Summer rainfall accounts for almost 70 per cent of the total annual rainfall over India and is crucial to Indian agriculture
- ✓ Semi arid 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 2050s
- ✓ there would be a decline in the productivity of rabi as compared to kharif season crops

### **WATER STRESS AND WATER INSECURITY**

- ✓ By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change
- ✓ By 2050s freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.

### **Impacts on water situation in India**

- ✓ Available records suggest that the Gangotri glacier is retreating about 28 m per year
- ✓ A serious environmental problem has also been witnessed in the Indo-Gangetic Plain Region (IGPR) in the past whereby different rivers (including Kosi, Ganga, Ghaghara, Son, Indus and its tributaries and Yamuna) changed their course a number of times.
- ✓ available statistics on water demand shows that the agriculture sector is the largest consumer of water in India

### **Impacts on Coastal States in India**

- ✓ 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.
- ✓ Goa will be the worst hit, losing a large percentage of its total land area, including many of its famous beaches and tourist infrastructure
- ✓ The states along the coasts like Orissa will experience worse cyclones. Many species living along the coastline are also threatened.
- ✓ 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.

## **ECOSYSTEMS AND BIO-DIVERSITY**

- ✓ International World Wildlife Fund (WWF) asserted that one-fifth of the world's most vulnerable natural areas may be facing a "catastrophic" loss of species

## **IMPACTS ON INDIA'S BIODIVERSITY**

- ✓ It is 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.

## **CLIMATE CHANGE AND HEALTH**

- ✓ The warmer the climate the likelihood of its impact on human health becomes worse.
- ✓ 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.
- ✓ The World Health Organization (WHO) in their studies have indicated that due to rising temperatures, malaria cases are now being reported for the first time from countries like Nepal and Bhutan.
- ✓ The projections by WHO and IPCC suggest that the negative effects of climate change on health are greater

## **MITIGATION STRATEGIES**

### **CARBON SEQUESTRATION:-**

- ✓ Carbon capture and storage, also known as CCS or carbon sequestration, describes the technologies designed to tackle global warming by capturing CO<sub>2</sub> 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
  - 'carbon sinks'— an area that absorbs carbon.
    - **Natural sinks** - Oceans, forests, soil etc.
    - **Artificial sinks** - Depleted oil reserves, unmineable mines, etc

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

- ✓ trapping and separating the CO<sub>2</sub> from other gases,
- ✓ transporting this captured CO<sub>2</sub> to a storage location, and
- ✓ storing that CO<sub>2</sub> far away from the atmosphere (underground or deep in the ocean).

**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
- ✓ 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

## **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.

### **Blue Carbon**

- ✓ Blue Carbon refers to coastal, aquatic and marine carbon sinks held by the indicative vegetation, marine organism and sediments
- ✓ 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.

### **CARBON CREDIT:**

- ✓ A carbon credit is a Tradable certificate or permit representing the right to emit one tonne of carbon or carbon dioxide equivalent (tCO<sub>2</sub>e).
- ✓ 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
- ✓ 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.
- ✓ 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.

### **CARBON OFFSETTING:**

- ✓ 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.
- ✓ are quantified and sold in metric tonnes of carbon dioxide equivalent (CO<sub>2</sub>e)
- ✓ 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
- ✓ 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)

### **CARBON TAX**

- ✓ the potential alternative to the 'cap and trade' method currently used by the protocol.
- ✓ The aim of this tax is to cause less fossil fuel use and hopefully cause an incentive to use other sources of energy.

### **India's Position on carbon tax:**

- ✓ India will bring a WTO challenge against any "carbon taxes" that rich countries impose on Indian imports.

## **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.
- ✓ Geo engineering, at this point, is still only a theoretical Concept
- ✓ Hydrogen sulfide is an even better candidate for atmospheric seeding than sulfur dioxide.

## **INDIA AND CLIMATE CHANGE**

### **INDIA'S POSITION ON CLIMATE CHANGE**

- ✓ India's per capita emission levels will never exceed that of the per capita emission levels of developed countries-PM India
- ✓ India cannot and will not take on emission reduction targets
- ✓ India will continue to be a low-carbon economy (World Bank study).
- ✓ India's primary focus is on "adaptation", with specific focus for "mitigation"
- ✓ India has already unveiled a comprehensive National Action Plan on Climate Change
- ✓ Only those Nationally Appropriate Mitigation Actions (NAMAs) can be subject to international monitoring, reporting and verification that are enabled and supported by international finance and technology transfer
- ✓ India wants a comprehensive approach to Reducing Emissions from Deforestation & Forest Degradation (REDD) and advocates REDD+ that includes conservation, afforestation and sustainable management of forests
- ✓ India advocates collaborative research in future low-carbon technology and access to intellectual Property Rights (IPRs) as global public goods.

### **CURRENT CARBON DIOXIDE EMISSIONS IN INDIA**

- ✓ India's CO<sub>2</sub> emissions per capita are well below the world's average.(1.02 metric ton)

### **OBSERVED CLIMATE AND WEATHER CHANGES IN INDIA**

- ✓ India's National Communication (NATCOM) to UNFCCC has consolidated some of the observed changes in climate parameters in India.
- 1. **Surface Temperature**
  - ✓ At the national level, increase of 0.4° C has been observed in surface air temperatures over the past century.
  - ✓ A warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India.
  - ✓ cooling trends have been observed in north-west India and parts of south India.
- 2. **Rainfall**
  - ✓ While the observed monsoon rainfall at the all-India level does not show any significant trend, regional monsoon variations have been recorded
  - ✓ A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh, and north-western India (+10% to +12% of the normal over the last 100 years)

- ✓ while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (-6% to --8% of the normal over the last 100 years).
- 3. **Extreme Weather Events**
  - ✓ the states of West Bengal and Gujarat have reported increasing trends, a decline has been observed in Orissa
- 4. **Rise in Sea Level**
  - ✓ Sea level rise was between 1.06-1.75 mm per year. These rates are consistent with 1-2 mm per year global sea level rise estimates of IPCC.
- 5. **Impacts on Himalayan Glaciers-**
  - ✓ recession of some glaciers, has occurred in some Himalayan regions in recent years, the trend is not consistent across the entire mountain chain.
  - ✓ It is accordingly, too early to establish long-term trends, or their causation, in respect of which there are several hypotheses.

### **CURRENT ACTIONS FOR ADAPTATION AND MITIGATION**

- ✓ Current Indian government expenditure on adaptation to climate variability, exceeds 2.6% of the GDP.
- 1. **AGRICULTURE**
  - ✓ Two risk-financing programmes support adaptation to climate impacts.
  - ✓ **The Crop Insurance Scheme-** supports the insurance of farmers against climate risks, and
  - ✓ **the Credit Support Mechanism-** facilitates the extension of credit to farmers, especially for crop failure due to climate variability.
- 2. **FORESTRY**
  - ✓ India has a strong and rapidly growing afforestation programme.
  - ✓ **Forest Conservation Act of 1980**, which aimed at stopping the clearing and degradation of forests through a strict, centralized control of the rights to use forest land and mandatory requirements of compensatory afforestation in case of any diversion of forest land for any non-forestry purpose.
  - ✓ an aggressive afforestation and sustainable forest management programme, resulted in annual reforestation of 1.78 mha during 1985-1997, and is currently 1.1 mha annually.
- 3. **WATER**
  - ✓ **The National Water Policy (2002)** stresses that non-conventional methods for utilization of water, including inter-basin transfers, artificial recharge of groundwater, and desalination of brackish or sea water, as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting, should be practised to increase the utilizable water resources.
- 4. **COASTAL REGIONS**
  - ✓ In coastal regions, restrictions have been imposed in the area between 200m and 500m of the Htl (high tide line)
  - ✓ **special restrictions** have been imposed in the area up to 200m to protect the sensitive coastal ecosystems and prevent their exploitation.
- 5. **HEALTH**
  - ✓ The prime objective present of health programmes is the surveillance and control of vector borne diseases such as Malaria, Kala-azar, Japanese Encephalitis, Filariasis and Dengue.

- ✓ Programmes also provide for emergency medical relief in the case of natural calamities, and to train and develop human resources for these tasks.

#### 6. DISASTER MANAGEMENT

- ✓ **The National Disaster Management programme** provides grants-in-aid to victims of weather related disasters, and manages disaster relief operations.
- ✓ It also supports proactive disaster prevention programmes, including dissemination of information and training of disaster-management staff.

### India's NATIONAL ACTION PLAN ON CLIMATE CHANGE

- ✓ The National Action Plan hinges on the development and use of new technologies.
- ✓ The implementation of the Plan would be through appropriate institutional mechanisms suited for effective delivery of each individual Mission's objectives and include public private partnerships and civil society action.

### Eight National Missions

#### 1. NATIONAL SOLAR MISSION

- The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge.
- ✓ To establish India as a global leader in solar energy
- ✓ The Mission will adopt a 3-phase approach
- ✓ remaining period of the 11<sup>th</sup> Plan and first year of the 12th Plan (up to 2012-13) as Phase 1,
- ✓ the remaining 4 years of the 12th Plan (2013-17) as Phase 2
- ✓ the 13th Plan (2017-22) as Phase 3.
- ✓ there will be an evaluation of progress, review of capacity and targets for subsequent phases,

#### **Mission targets are:**

1. To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
2. To ramp up capacity of grid-connected solar power generation to 1000 MW within three years —by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff.
3. To create favorable conditions for solar manufacturing capability, particularly solar **thermal** for indigenous production and market leadership.
4. To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022
5. To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022.
6. To deploy 20 million solar lighting systems for rural areas by 2022.

#### 2. THE NATIONAL MISSION FOR ENHANCED ENERGY EFFICIENCY (NMEEE):-

- ✓ To **strengthen the market** for energy efficiency by creating conducive regulatory and policy regime.

### **Mission Goals**

- ✓ Market-based approaches to unlock energy efficiency opportunities.

#### **Four New Initiatives to Enhance Energy Efficiency:**

- a) Perform Achieve and Trade (PAT)
- b) Market Transformation for Energy Efficiency
- c) Energy Efficiency Financing Platform (EEP)
- d) Framework for Energy Efficient Economic Development (FEEED)

### **3. NATIONAL MISSION ON SUSTAINABLE HABITAT**

- ✓ to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste, modal shift towards public transport and conservation through appropriate changes, in legal and regulatory framework.
- ✓ It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events.

### **4. NATIONAL WATERMISSION (NWM) MISSION OBJECTIVES**

- ✓ Ensuring integrated water resource management for conservation of water, minimization of wastage and equitable distribution both across and within states.
- ✓ Developing a framework for optimum water use through increase in water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing, taking the National Water Policy (NWP) into consideration.

### **5. NATIONAL MISSION FOR SUSTAINING THE HIMALAYAN ECOSYSTEM (NMSHE)**

- The most crucial and primary objective of the mission is to develop a sustainable National capacity to continuously assess the health status of the Himalayan Ecosystem and enable policy bodies in their policy-formulation functions and assist States in the Indian Himalayan Region with their implementation of actions selected for sustainable development

### **6. NATIONAL MISSION FOR A GREEN INDIA**

- Increased forest/tree cover on 5 million hectares (ha) of forest/non- forest -lands and
- improved quality of forest cover on another 5 million ha of non-forest/forest lands' (a total of 10 million ha)
- Improved ecosystem services including biodiversity, hydrological services, and carbon sequestration from the 10 million ha of forest/ non-forest lands mentioned above

### **7. NATIONAL MISSION FOR SUSTAINABLE AGRICULTURE (NMSA)**

- The NMSA has identified 10 key dimensions for adaptation and mitigation:

1. Improved Crop Seeds, Livestock and Fish Culture
2. Water Efficiency
3. Pest Management
4. Improved Farm Practices
5. Nutrient Management
6. Agricultural Insurance
7. Credit Support
8. Markets

9. Access to Information
10. Livelihood Diversification

### **The National Mission on Strategic Knowledge for Climate Change (NMSKCC) (not complete)**

- ✓ Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitating data sharing and exchange through a suitable policy framework and institutional support
- ✓ Establishment of global technology watch groups with institutional capacities to carry out research on risk minimised technology selection for developmental choices.
- ✓ Development of national capacity for modeling the regional impact of climate change
- ✓ Establishing research networks and encouraging research in the areas of climate change impacts on important socio-economic sectors
- ✓ Building alliances and partnerships through global collaboration in research & technology development

### **National Bio-Energy Mission**

- ✓ to boost power generation from biomass, a renewable energy source abundantly available in India
- ✓ launched during the 12th Five-Year Plan, will offer a policy and regulatory environment to facilitate large-scale capital investments in biomass-fired power stations.
- ✓ It will also encourage development of rural enterprises.
- ✓ It will also propose a GIS-based National Biomass Resource Atlas to map potential biomass regions in the country
- ✓ adopt a two phase approach, spanning the 12th Plan in Phase and the 13th Plan in Phase 2

### **INDIAN NETWORK ON CLIMATE CHANGE ASSESSMENT**

- ✓ (INCCA) was launched in October 2009 by the Ministry of Environment and Forests (MoEF) in an effort to promote domestic research on climate change, and build on the country's climate change expertise.
- ✓ Consists of over 120 institutions and over 250 scientist country wide is aimed at bringing in more science-based policy-making, based on measurement , monitoring and modelling.
- ✓ Reports prepared by the INCCA will form a part of India's National Communication (Nat Com) to the United. Nations framework Convention on Climate Change (UNFCCC)
- ✓ **INCCA — First Assessment** - INCCA prepared the Country's greenhouse gas (GHG) emission data "India: Greenhouse Gas Emissions 2007" in 2010 . which said the country's emissions grew by 58 per cent during 1994 to 2007
- ✓ **INCCA - Second Assessment 'Climate Change and India: A 4x4 Assessment'** (4 regions and 4 sector)
- ✓ A 4x4 Assessment' addresses the impact of climate change in 2030s to the natural resources and livelihoods of the people in the four climate sensitive regions of Himalayan region, North- East region, the Western Ghats and the Coastal plains for the 4 key sectors of Agriculture, Water, Health and Natural Ecosystems and Biodiversity
- ✓ using a regional climate model (PRECIS).

### **Impacts Agriculture**

- ✓ Up to 50% reduction in maize yields
- ✓ 4-35% reduction in rice yields (with some exceptions)
- ✓ Rise in coconut yields (with some exceptions);
- ✓ reduced apple production
- ✓ Forests and natural ecosystems    Increased net primary productivity

#### **NATIONAL COMMUNICATION (NATCOM)-**

- National Communication (NATCOM) to the UNFCCC has been initiated in 2002 funded by the Global Environment Facility under its enabling activities programme through the United Nations Development Programme, New Delhi.

#### **To communicate the following information to the Secretariat of the Conference of Parties:**

- ✓ A national inventory of anthropogenic emissions by sources and removal by sink of all GHGs not controlled by the Montreal protocol (what is montreal protocol)
- ✓ A general description of steps taken or envisaged by the Party to implement the Convention
- ✓ The Ministry of Environment and Forests (MoEF) is implementing and executing agency of the project
- ✓ base year 1994
- ✓ Creation of reliable and comprehensive database for all the outputs produced through the establishment of a Data Centre' (DC)
- ✓ The areas of energy, industrial processes, agriculture land use and land use change and forestry (LULUCF) and waste.
- ✓ The gases to be inventoried include carbon dioxide methane, nitrous oxide, hydro fluorocarbons, perfluorocarbon and sulphur hexafluoride released from various anthropogenic sources of the base year 1994.
- ✓ Strengthening of the ecology security is one of the goal of the MGNREGA. MGNREGA is designed to strengthen the ongoing effort for water harvesting, watershed management, and soil health care and enhancement.

#### **INDIA'S POLICY STRUCTURE RELEVANT TO GHG MITIGATION**

- ✓ **The Integrated Energy Policy was adopted in 2006-** Promotion of energy efficiency in all sectors, Emphasis on mass transport, Emphasis on renewables including biofuels plantations
- ✓ Accelerated development of nuclear and hydropower for clean energy
- ✓ Focused R&D on several clean energy related      technology

#### **The Rural Electrification Policy, 2006**

- It promotes renewable energy technology where grid connectivity is not possible or cost-effective.

#### **ENERGY CONSERVATION BUILDING CODE**

- ✓ was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the buildings' energy demand based on their location in different climatic zones
- ✓ Compliance with ECBC norms is voluntary at present but is expected to soon become mandatory.

#### **Green Building**

- ✓ Buildings are one of the major pollutants that affect urban air quality and contribute to climate change

- ✓ The aim of a green building design is to: 1) Minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources when in use, and Maximize reuse and recycling of available resources 2) Utilization of renewable resources.
- ✓ It costs a little more to design and construct a green building. However, it costs less to operate a green building
- ✓ Building system designed in a way to efficiently use HVAC (heating ventilation and air conditioning), lighting, electrical, and water heating.
- ✓ Integration of renewable energy sources to generate energy onsite.

### **Green Rating for Integrated Habitat Assessment (GRIHA)**

- ✓ GRIHA is a Sanskrit word meaning - 'Abode'.
- ✓ GRIHA has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India.
- ✓ The green building rating system devised by TERI and the MNRE is a voluntary scheme
- ✓ to help design green buildings and, in turn, help evaluate the 'greenness' of the buildings.
- ✓ GRIHA is a rating tool that helps people assess the performance of their building against certain nationally acceptable benchmarks and is suitable for all kinds of buildings in different climatic zones of the country
- ✓ building is assessed based on its predicted performance over its entire life cycle — inception through operation.
- ✓ **The stages of the life cycle that have been identified for evaluation are:-**
- ✓ Pre-construction stage, Building operation and maintenance stage

### **GRIHA rating system consists of 34 criteria categorized under 4 categories**

1. Site Selection and Site Planning,
2. Conservation and efficient utilization of resources,
3. Building operation and maintenance, and
4. Innovation points:
  - ✓ It means that a project intending to meet the criterion would qualify for the points.
  - ✓ Different levels of certification (one star to five stars) are awarded based on the number of points earned.
  - ✓ The minimum points required for certification is 50.

### **ENERGY AUDITS OF LARGE INDUSTRIAL CONSUMERS**

- ✓ In March 2007 the conduct of energy audits was made mandatory in large energy-consuming units in nine industrial sectors.
- ✓ These units, notified as "designated consumers" are also required to employ "certified energy managers", and report energy consumption and energy conservation data annually.

### **MASS TRANSPORT**

- ✓ The National Urban Transport Policy emphasizes extensive public transport facilities and non-motorized modes over personal vehicles.
- ✓ The expansion of the Metro Rail Transportation System in Delhi and other cities (Chennai, Bangalore, Jaipur, etc)

### **CLEAN AIR INITIATIVES**

- (i) introduction of compressed natural gas (CNG) in Delhi and other cities;

- (ii) Retiring old, polluting vehicles; and
- (iii) Strengthening of mass transportation.

- ✓ Some state governments provide subsidies for purchase and use of electric vehicles.
- ✓ For thermal power plant, the installation of electrostatic precipitators is mandatory.

#### **Promotion OF ENERGY SAVING DEVICES-**

- ✓ The bureau of Energy efficiency has introduced "The BaChat Lamp Yojana",
- ✓ a program under which households may exchange incandescent lamps for CFLs (compact fluorescent lamps) using clean development mechanism (CDM) Credits to equate purchase price.

#### **PROMOTION OF BIOFUELS**

- ✓ The Biodiesel Purchase Policy mandates biodiesel procurement by the petroleum industry.
- ✓ A mandate on Ethanol Blending of Gasoline requires 5% blending of ethanol with gasoline from 1st January, 2003, in 9 States and 4 Union Territories.

#### **INDIAN SOLAR LOAN PROGRAMME**

- ✓ In April 2003, the United Nations Environment Programme ("UNEP") initiated a, three-year Programme, credit facility in Southern India to help rural households finance the purchase of Solar Home Systems.
- ✓ Canara Bank and Syndicate bank, along with their eight associate Regional Rural Banks, partnered with LTNEP
- ✓ assistance with technical issues, vendor qualification and other activities to develop the institutional capacity for this type of finance.

#### **NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE (NICRA)**

- ✓ The ICAR has launched National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with an outlay of Rs.350 crores for the XI Plan.
- ✓ This initiative will primarily enhance the resilience of Indian Agriculture covering crops, livestock and fisheries

##### **The project is comprised of four components.**

- ❖ Strategic research on adaptation and mitigation
- ❖ Technology demonstration on farmers' fields to cope with current climate variability
- ❖ Sponsored and competitive research grants to fill critical research gaps
- ❖ Capacity building of different stake holders
- ✓ the project is focusing on crops like wheat, rice, maize, pigeonpea, groundnut, tomato, mango and banana;
- ✓ cattle, buffalo and small ruminants among livestock and both marine and freshwater fish species of economic importance

##### **The major research themes are:**

- **Vulnerability assessment** of major production zones
- **Linking weather based agro-advisories to contingency planning**
- **Assessing the impacts** and evolving varieties tolerant to key climatic stresses (drought, heat, frost, flooding, etc)

- ✓ Evolving adaptation and mitigation strategies
- ✓ Continuous monitoring of greenhouse gases
- ✓ Studying changes in pest dynamics
- ✓ Adaptation strategies in livestock

- ✓ Harnessing the beneficial effects of temperature in inland and marine fisheries
- Seven major research institutes of the ICAR will work in unison to evolve coping technologies with Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad as the lead centre.

### **BSE-GREENEX**

- ✓ The BSE-GREENEX Index is a veritable **first step in creating a credible market** based response mechanism in India, whereby both businesses and investors can rely upon purely quantitative and objective performance based signals, to assess "carbon performance"
- ✓ gTrade Carbon Ex Ratings Services Private Limited (gTrade) is a company based in India, which has co-developed the BSE-GREENV Index in close association with the BSE .
- ✓ includes the top 20 companies which are good in terms of Carbon Emissions, Free-Float Market Capitalization, and Turnover.
- ✓ Cap Weighted Free-Float Market Capitalization weighted Index comprising from the list of BSE-100 Index.
- ✓ 1st October, 2008 (Base Date) with the base index value of 1000.
- ✓ rebalanced on a bi-annual basis i.e. end of March and September quarters.
- ✓ The September quarter review will be based on the fresh set of carbon emission numbers and
- ✓ the March quarter review will be based on the existing carbon emission numbers but latest financial data.

## **CLIMATE CHANGE ORGANIZATIONS**

### **UNFCCC**

- ✓ UN Summit Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992 adopted, by consensus, the first multilateral legal instrument on Climate Change, the UN Framework Convention on Climate Change or the UNFCCC.
- ✓ There are now 195 Parties to the Convention.
- ✓ All subsequent multilateral negotiations on different aspects of climate change, including both adaptation and mitigation, are being held based on the principles and objectives set out by the UNFCCC

### **KYOTO PROTOCOL: COP-3.**

- ✓ to strengthen the global response to climate change.
- ✓ The Kyoto Protocol was adopted in Kyoto Japan,, on 11 December 1997. Due to a complex ratification process, it entered into force on '16 February 2005.
- ✓ Kyoto Protocol is what "operationalizes" the Convention.
- ✓ It commits industrialized countries to stabilize greenhouse gas emissions based on the principles of the Convention.
- ✓ The major distinction between the Protocol and the Convention is that while the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.
- ✓ sets binding emission reduction targets for 37 industrialized countries and the European community in its first commitment period.
- ✓ It only binds developed countries

- ✓ KP places a heavier burden on developed nations under its central principle: that of "common but differentiated responsibility"
- ✓ these targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012

#### **KP is made up of:**

- ❖ Reporting and verification procedures;
- ❖ Flexible market-based mechanisms, which in turn have their own governance procedures;
- ❖ A compliance system.

#### **So, two things make KP tick**

##### **1. Emissions Reduction Commitments**

- ✓ The first was binding emissions reduction commitments for developed country parties. This meant the space to pollute was limited.
- ✓ carbon dioxide, became a new commodity. KP now began to internalize what was now recognized as an unpriced externality.

##### **2. Flexible Market Mechanisms**

- Joint Implementation (JI)
- The Clean Development Mechanism (CDM)
- Emission Trading

#### **The objectives of Kyoto mechanisms:**

- ✓ Stimulate sustainable development through technology transfer and investment
- ✓ Help countries with Kyoto commitments to meet their targets by reducing emissions or removing carbon from the atmosphere in other countries in a cost-effective way
- ✓ Encourage the private sector and developing countries to contribute to emission reduction efforts

#### **Joint Implementation**

- ✓ allows a country with an emission reduction or limitation commitment under the Kyoto Protocol to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO<sub>2</sub>, which can be counted towards meeting its Kyoto target.
- ✓ Projects starting as from the year 2000 may be eligible as JI projects, ERU issued from 2008

#### **Clean Development mechanism:**

- ✓ Allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries.
- ✓ It is the first global, environmental investment and credit scheme of its kind,
- ✓ Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO<sub>2</sub>, which can be counted towards meeting Kyoto targets.

#### **Example**

- ✓ A CDM project activity might involve, for example, a rural electrification project using solar Panels or the installation of more energy-efficient boilers.
- ✓ The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

- ✓ Most of the CDM projects were implemented in China and India as climate in these countries is favorable for implementing projects for almost all the spheres

### **Carbon Trading:**

- ✓ the name given to the exchange of emission permits. This exchange may take place within the economy or may take the form of international transaction.

#### **Two types of Carbon trading:**

1. Emission trading- Emission permit is known alternatively as carbon credit
2. Offset trading-Another variant of carbon credit is to be earned by a country by investing some amount of money in such projects, known as carbon projects, which will emit lesser amount of green-house gas in the atmosphere.

### **Non-Compliance of Kyoto And Penalties**

- ✓ If a country does not meet the requirements for measurements and reporting said country loses the privilege of gaining credit through joint implementation projects.
- ✓ If a country goes above its emissions cap, and does not try to make up the difference through any of **the** mechanisms available, then said country must make up the difference plus an additional thirty percent during the next period.
- ✓ The country could also be banned from participating in the 'cap and trade' program.

### **BALI MEET:**

- ✓ Bali Meet was the meeting of 190 countries that are party to a UN treaty on climate change held in December 2007.
- ✓ to discuss what happens after 2012-what are countries expected to do after the first phase of Kyoto ends in 2012.

### **Bali Road Map includes**

- ✓ The Bali Action Plan (BAP)
- ✓ The Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol negotiations and their 2009 deadline,
- ✓ Launch of the Adaptation Fund,
- ✓ Decisions on technology transfer and
- ✓ On reducing emissions from deforestation.

### **Bali Action Plan (BAP)**

- ✓ A shared vision for long-term cooperative action, including a long-term global goal for emission reductions.
- ✓ Enhanced national/international action on mitigation of climate change.
- ✓ Enhanced action on adaptation.
- ✓ Enhanced action on technology development and transfer to support action on mitigation and adaptation.
- ✓ Enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation and technology cooperation

### **COP 15 COPENHAGEN SUMMIT**

- ✓ The summit concluded with the CoP taking a note of Copenhagen Accord ( a five nation accord- BASIC and US).
- ✓ The Copenhagen Accord is a non-binding agreement.

- ✓ Developed countries (Annex-I) agree to set targets for reductions in their greenhouse gas emissions by 2020.
- ✓ Developing countries agree to pursue nationally appropriate mitigation strategies to slow the growth of their emissions, but are not committed to reducing their carbon output.
- ✓ developed countries would raise funds of \$30 billion from 2010-2012 of new and additional resources
- ✓ Agrees a "goal" for the world to raise \$100 billion per year by 2020. New multilateral funding for adaptation will be delivered, with a governance structure.

#### **COP 16 CANCUN SUMMIT**

- ✓ all Parties to the Convention (including the developed and developing countries) have agreed to report their voluntary mitigation goals for implementation
- ✓ Decisions were taken at Cancun to set up a Green Climate Fund, a Technology Mechanism, and an Adaptation Committee at global level to support developing country actions for adaptation and mitigation
- ✓ process to design a 'Green Climate Fund'

#### **Mechanism of COP 16**

1. **Technology mechanism**-in 16th session of the COP in Cancun 2010. Facilitate the implementation of enhanced action-on technology development and transfer in Order to support action on mitigation and adaptation to climate change.
2. **Green climate fund**- will support projects, programme, policies and other activities in **developing** country Parties. **The Fund will** be governed by the GCF Board.
  - ✓ The World Bank was invited by to serve as the interim trustee
3. **The Adaptation Fund** was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.
  - ✓ financed from the share of proceeds on the clean development mechanism project activities.
4. **Adaptation committee**-
  - ✓ Providing technical support and guidance to the Parties
  - ✓ Sharing of relevant information, knowledge, experience and good practices
  - ✓ Promoting synergy and strengthening engagement with national, regional and international organizations, centers and networks.
  - ✓ Considering information communicated by Parties on their monitoring and review of adaptation actions, support provided and received

#### **COP 17 DURBAN SUMMIT**

- ✓ India had gone to Durban with two major demands — that the principle of equity remain intact in any new climate regime and that this new global deal be launched after 2020.

#### **Outcome**

- New deal to be finalized by 2015 and launched by 2020
- Second phase of Kyoto Protocol secured
- Green Climate Fund launched, though empty as yet Green tech development mechanism put in place

- Equity finds place back in future climate talks
- Adaptation mechanism
- Transparency mechanism
- India regains leadership of developing world, Wins on all its important non-negotiable Common but differentiated responsibility principle retained.
- India Secures 10 years of economic growth without carbon containment Intellectual Property Rights and technology not as well anchored in new deal Loopholes for developed world not fully blocked
- Agriculture brought in by developed nations under climate change

#### **REDD & REDD+**

- ✓ REDD (Reducing Emissions from Deforestation and Forest Degradation) is the global endeavor **to create an incentive for developing countries to protect, better** manage and save ,their forest resources, thus contributing to the global fight against climate change
- ✓ REDD+ goes beyond merely., Checking deforestation and forest degradation, and includes incentives for positive elements of conservation, sustainable management of forests and enhancement of forest carbon stocks.
- ✓ REDD+ conceptualizes flow of positive incentives' for demonstrated reduction in deforestation or for enhancing quality and expanse of forest cover.
- ✓ India has made a submission to UNFCCC on "REDD, Sustainable Management of Forest(SMF) and Afforestation and Reforestation, (A&R)" in December 2008

#### **THE GEF (Global Environment Facility)**

- ✓ to function under the guidance of the UNFCCC COP and be accountable to the COP
- ✓ established in 1991 by the World Bank in consultation with the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP), to provide funding to protect the global environment

#### **The GEF now has six focal areas:**

1. biological diversity;
2. climate change;
3. international waters;
4. land degradation, primarily desertification and deforestation;
5. ozone layer depletion; and
6. persistent organic pollutants.

#### **CLIMATE-SMART AGRICULTURE**

- ✓ While agriculture is the sector most vulnerable to climate change, it is also a major cause, directly accounting for about 14 percent of greenhouse gas emissions (IPCC 2007).
- ✓ **This is called the 'triple win':** interventions that Would increase yields (poverty reduction **and** food Security) , make yields more resilient in the **face extremes** (adaptation), and make **the farm** a solution to the climate change problem rather than part of the problem (mitigation).
- ✓ These triple wins are likely to require a package of interventions and be country- and locality specific in their application. This method of practicing agriculture is called 'Climate Smart Agriculture'

#### **INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)**

- ✓ established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the governments of the world with a clear scientific view of what is happening to the world's climate.
- ✓ headquarters in Geneva.

- ✓ Currently 195 countries are members of the IPCC
- ✓ The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change
- ✓ It does not conduct any research nor does it monitor climate related data or parameters

#### **Key AR5 cross-cutting themes will be:**

- ✓ Water and the Earth System: Change, Impacts and Responses;
- ✓ Carbon Cycle including Ocean Acidification;
- ✓ Ice Sheets and Sea-Level Rise;
- ✓ Mitigation, Adaptation and Sustainable Development; and
- ✓ Article 2 of the UNFCCC (see UNFCCC for definition).

#### **NATIONAL GREEN HOUSE GAS INVENTORIES PROGRAMME (NGGIP)**

- ✓ The IPCC established the NGGIP,
- ✓ TO provide methods for estimating-national inventories of greenhouse gas emissions to, and removals from, the atmosphere.

#### **GREEN ECONOMY**

- ✓ The 'Green Economy' can be considered synonymous to a 'sustainable' economy. However, the Green Economy concept often carries a more distinctive meaning
- ✓ Green economy focuses specifically on the fundamental changes that are required to ensure that economic systems are made more sustainable.
- ✓ Green Economy focuses on the ways to overcome the deeply rooted causes of unsustainable economic development.
- ✓ **A Green Economy is one** whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystems

#### **Three priorities in transition of economy to green economy are**

- decarbonizes the economy;
- commit the environmental community to justice and equity; and
- conserve the biosphere.