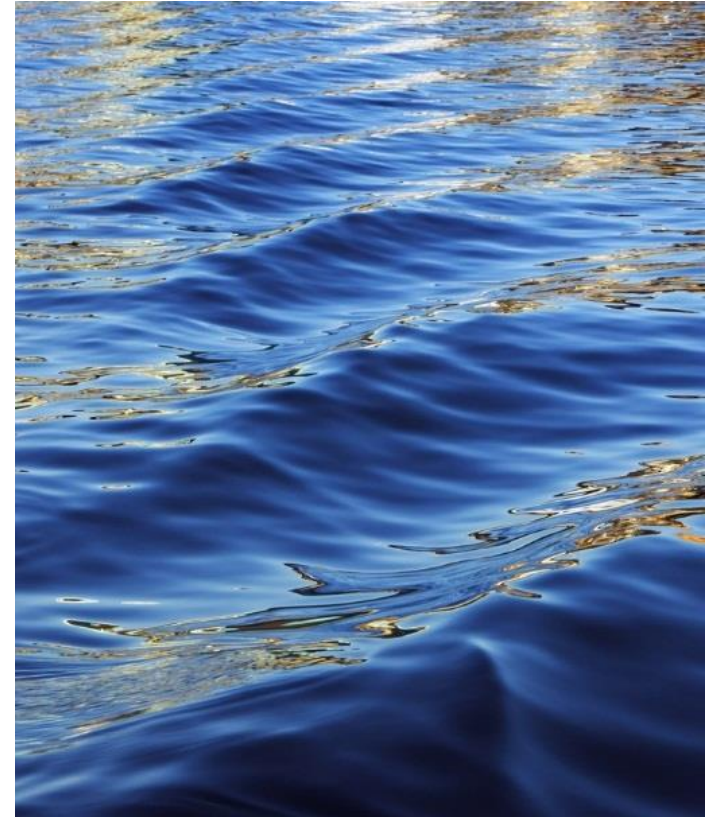




# Global Warming & Climate Change

Lecture 01



# About me

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Central University of Gujarat (Gandhinagar)
- Master's Project at Space Applications Centre (ISRO).
- Presently working as a Project Associate in Dept. of Computer Science (Gujarat Univ.)

# Why study Environmental Sciences?

- To help the society in controlling pollution.
- Apply environmental procedures and adhere to policies in daily life.
- Build communities for conservation of environment.
- Increase the use of renewable sources of energy.
- Identify procedures to reduce carbon footprint in computing.

# Introduction

- **Weather:** Weather refers to atmospheric condition that occur locally over short period of time – from min to hours or days.

Example: Snow, Rain, Clouds, Winds etc.

- **Climate:** Refers to long term regional or even global average of temperature, humidity and rainfall patterns over seasons – from years to decades.

# Global Warming

- It is the long term heating of Earth's Climate system observed since the pre-industrial period due to human activities.

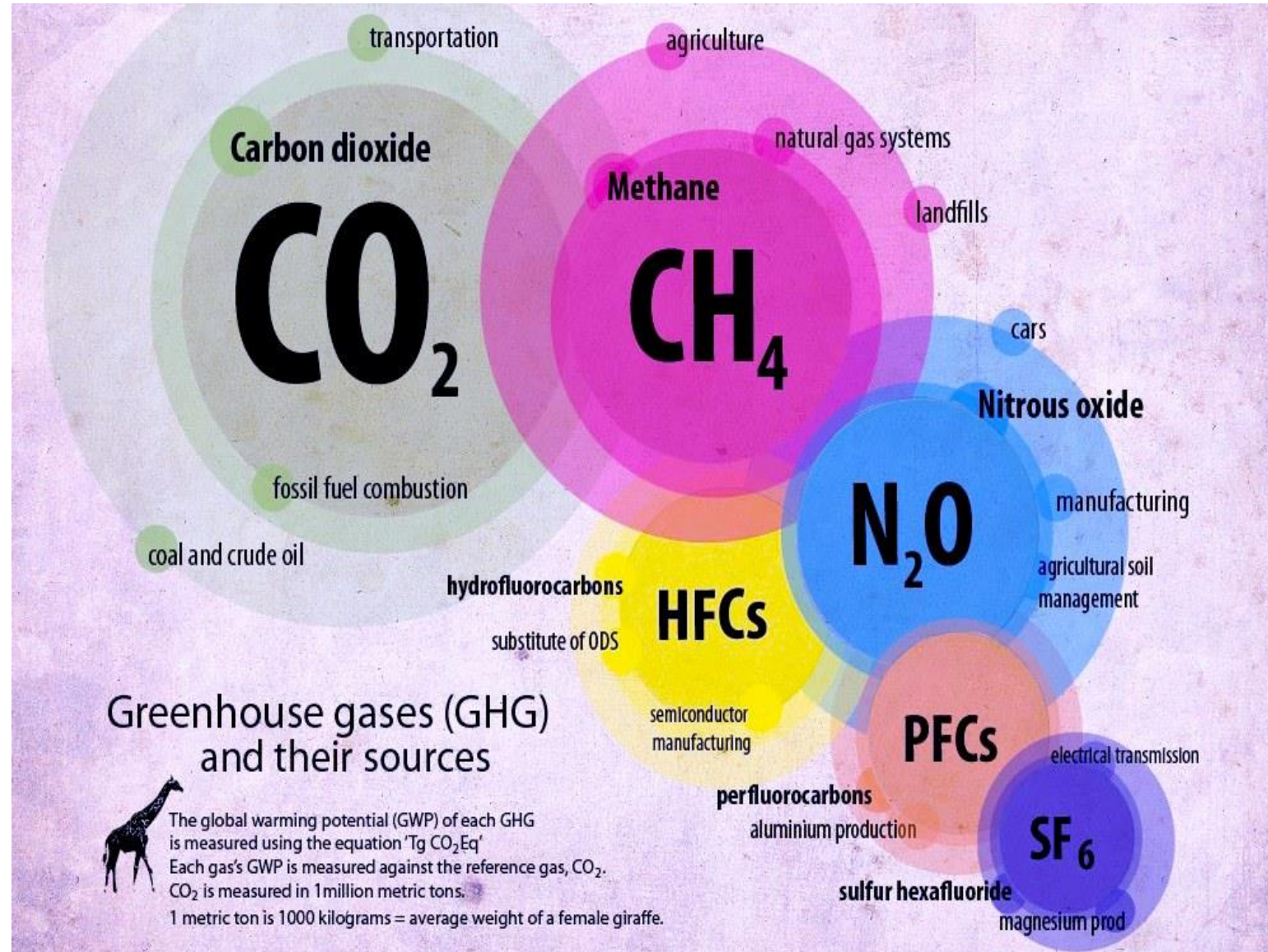
## Causes of Global warming

- The major cause of global warming is the greenhouse gases. They include carbon dioxide, methane, nitrous oxides and in some cases chlorine and bromine containing compounds.
- The build-up of these gases in the atmosphere changes the radiative equilibrium in the atmosphere. Their overall effect is to warm the Earth's surface and the lower atmosphere because greenhouse gases absorb some of the outgoing radiation of Earth and re-radiate it back towards the surface.
- Since the pre-industrial period, human activities are estimated to have increased Earth's global temperature by  $1^{\circ}\text{C}$  (this number is currently increasing at the rate  $0.2^{\circ}$  per decade).



# What are GHGs?

- GHG stands for Green House Gases.
- Naturally occurring green house gases are as follows:
- **Example:** Water vapour, carbon dioxide, nitrous oxide, methane etc.
- Some greenhouse gases are synthetic, human-made. These include for example chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>), Tropospheric ozone
- These gases are responsible for trapping the energy that comes from the sun.



# Green house gases(GHG) and their sources

- **1) water vapour**
- **2) Carbon dioxide**
  - Naturally produced when people and animals breathe.
  - Releases from burning of fossil fuels, solid waste, trees and wood products.
- **3) Methane**
  - Natural wetlands
  - Paddy rice fields
  - Anaerobic decomposition of organic waste in landfills
  - Comes from grazing animals as they digest their food
- **4) Chlorofluorocarbons (CFCs)**

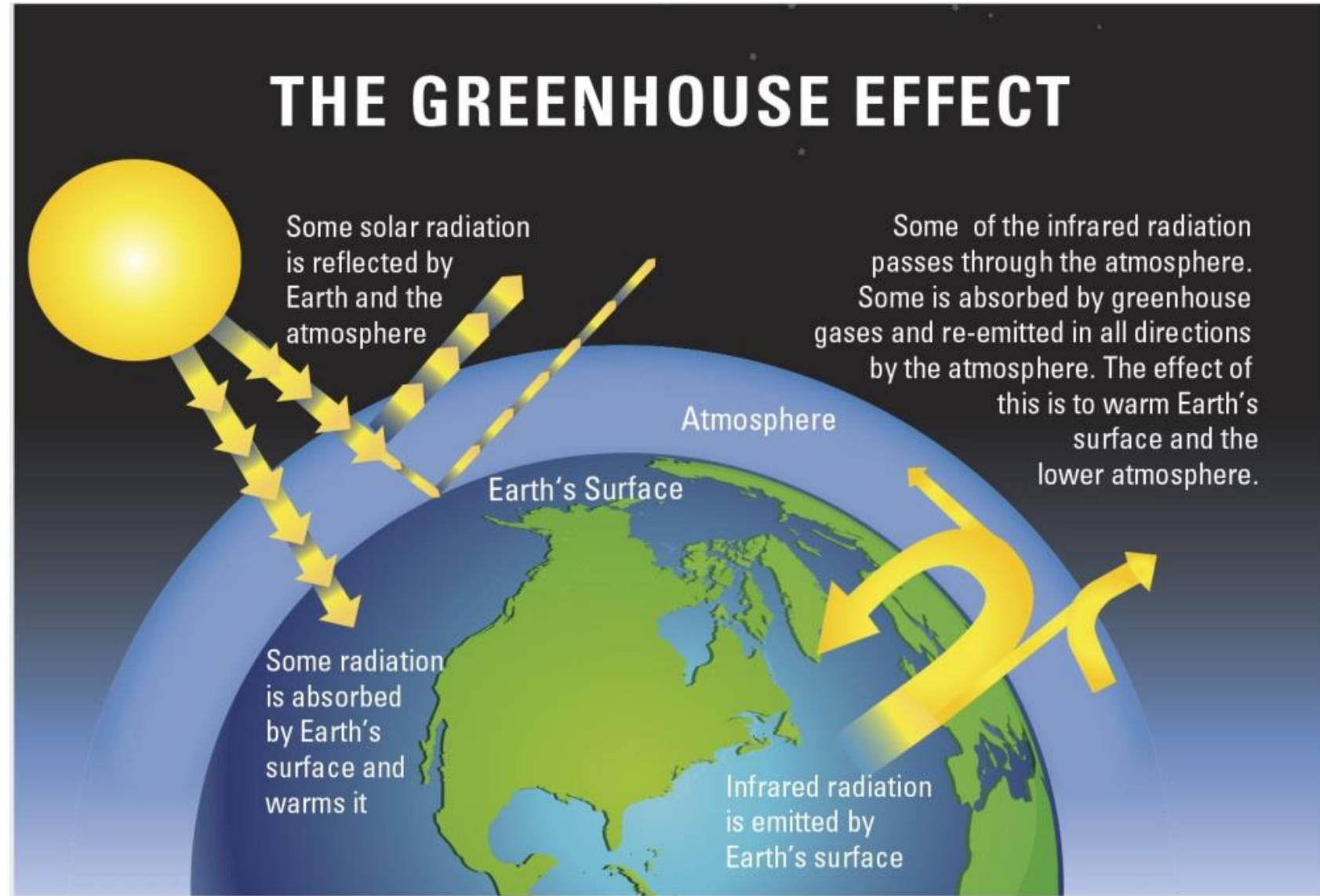
# Green house gases(GHG) and their sources(continued...)

- CFCs were widely used as coolant in refrigeration and air conditioners.
- Gases containing CFCs were used for a long time as components in aerosol cans and propellant liquids



# Green house effect

- The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat.
- This process makes Earth much warmer than it would be without an atmosphere. The greenhouse effect is one of the things that makes Earth a comfortable place to live.
- This is completely a natural process and without these gases, all the heat would escape back into the space causing Earth's average temp to become  $\sim 255 \text{ K } (-18^{\circ}\text{C})$



# Green house effect (cont..)

- **So what's the Problem?**

- If we say that the greenhouse effect has been in play for centuries and is in fact a necessity for human existence, then the question remains, why is it a cause for concern over the past few years.
- The rise in the burning of fossil fuels and an increase in the carbon footprint across the globe is leading to an excess of carbon dioxide in the atmosphere. This exponential increase in atmospheric CO<sub>2</sub> is creating a temperature imbalance. The logic is simple. As the amount of CO<sub>2</sub> is increasing so is its power to entrap solar radiation and direct it to the earth's surface. This is contributing to an incremental rise in the earth's temperature, which is now touching dangerous levels.
- Additionally, the greenhouse effect is causing rapid climate change with global warming, melting glaciers, erratic temperate conditions, etc.
- It is the human interference that has ruined the balance between the incoming and outgoing radiation, due to increased CO<sub>2</sub> which is problematic.

# Effects of Global Warming

Global warming produces many negative effects some of which are described here.

- When the weather turns warmer, evaporation process from both land and sea rises. This leads to drought in the regions where increased evaporation process is not compensated by increased precipitation.
- In some areas of the world, this will result in crop failure and famine particularly in areas where the temperatures are already high.
- The warmer climate will likely cause more heat waves, more violent rainfall and also amplification in the severity of hailstorms and thunderstorms.
- Rising of sea levels is the most deadly affect of global warming, the rise in temperature is causing the ice and glaciers to melt rapidly. This will lead to rise of water levels in oceans, rivers and lakes that can pilot devastation in the form of floods.

# Effects of Global Warming (continued...)

## Effects on Living Beings

- Global warming can severely affect the health of living beings.
- Excess heat can cause stress which may lead to blood pressure and heart diseases.
- Crop failures and famines, which are a direct consequence of heating up of earth, can cause a decline in human body resistance to viruses and infections.
- Global warming may also transfer various diseases to other regions as people will shift from regions of higher temperatures to regions of comparatively lower temperatures.
- Warmer oceans and other surface waters may lead to severe cholera outbreaks and harmful infections in some types of sea food
- Dry soil and wind can carry spores that spread the virus. Hotter and drier climates are projected to increase the amount of dusting carrying this disease.

# Climate Change

- It is a long term change in the average weather patterns that have come to define earth's local, regional and global climates.
- Changes observed in earth's climate since the early 20<sup>th</sup> century are primarily driven by human activities particularly fossil fuel burning, which increases heat trapping greenhouse gas levels in earth's atmosphere, raising earth's average surface temp.
- These human produced temp increases are commonly referred to as global warming.
- Natural processes can also contribute to climate change including internal variability (cyclical ocean pattern like El-Nino, La-Nina etc) and external forcing (Volcanic activity, changes in the Sun's energy output etc)

Some of the news you may have heard

**Polar bears** are losing their habitats

**Sea level** is rising

**Hurricanes** are getting bigger and stronger

**Glaciers** are melting fast

**Temperatures** are going up

# What is ozone and ozone layer?

- Ozone is a gas composed of three atoms of oxygen.
- Nearly 90% of the ozone is found in the stratosphere and referred to as the ozone layer.
- Discovered in 1913 by the French physicist Charles Fabry and Henri Buisson
- This layer contains high concentration of ozone( $O_3$ ) relative to the other parts of the atmosphere.
- It absorbs a portion of the radiation from the sun, preventing it from reaching the earth's surface. Most importantly, it absorbs the portion of UV light called UV-B



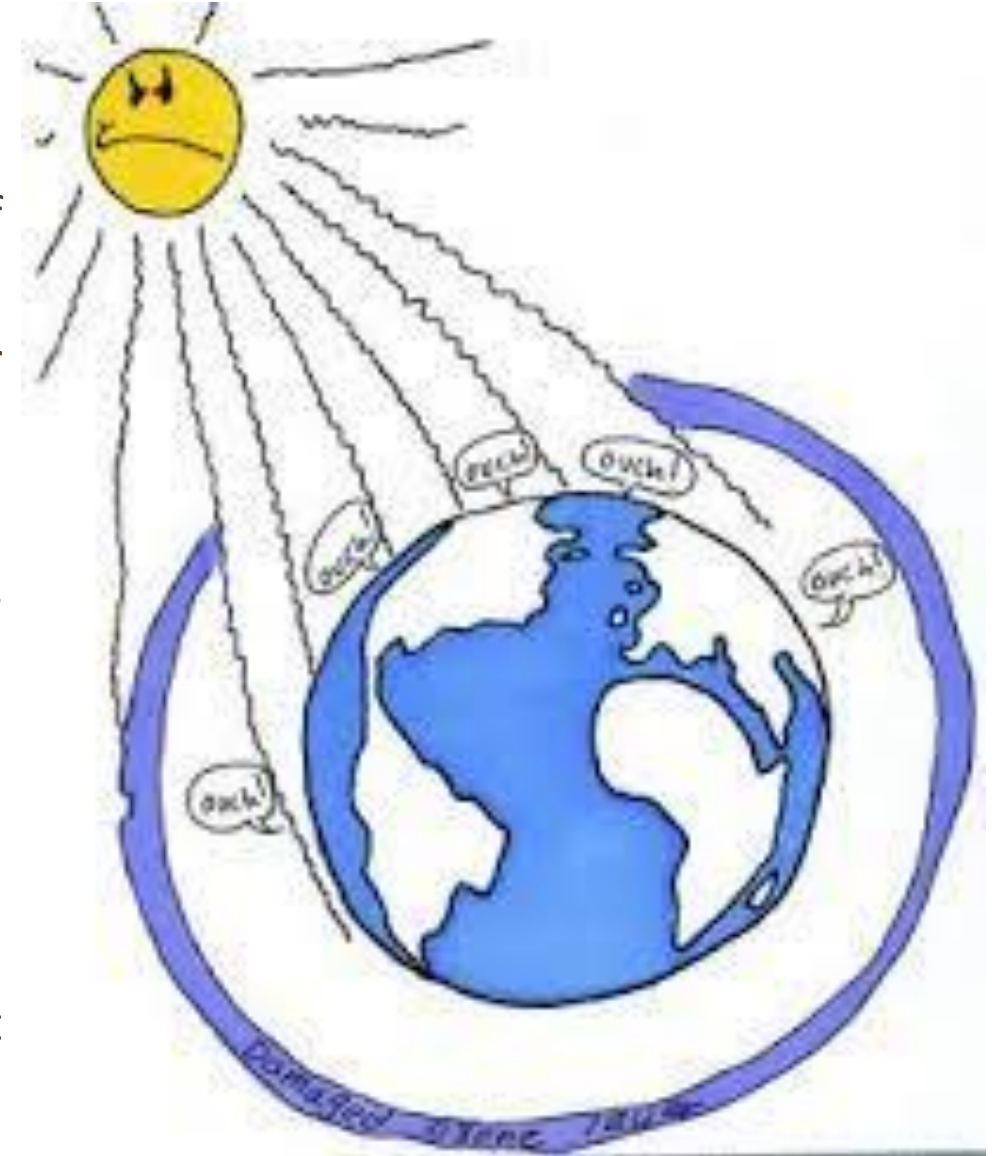


# Ozone Layer Depletion

- Ozone layer depletion is the reduction of amount of ozone in the stratosphere or thinning of ozone layer .
- Scientists discovered in the 1970s that the ozone layer was being depleted.

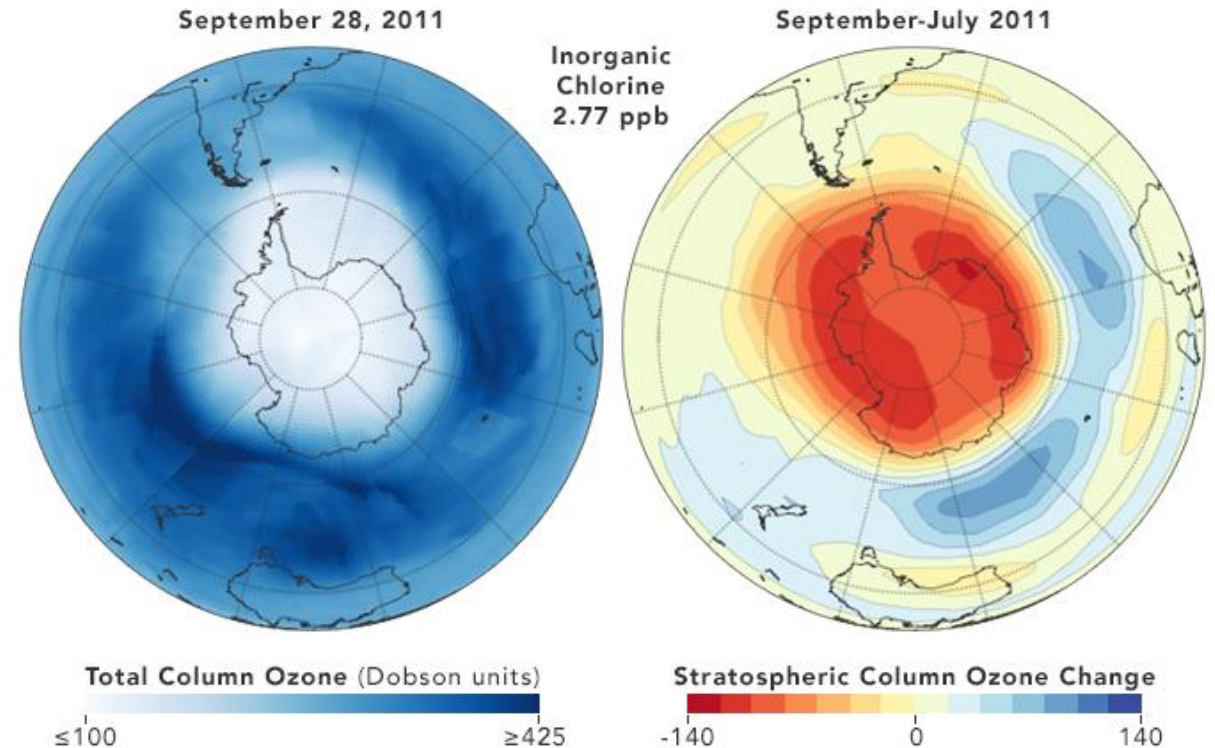
## Cause of ozone depletion

- The main cause of ozone depletion and the ozone hole is manufactured chemicals, especially manufactured halocarbon refrigerants, solvents, propellants, and foam- blowing agents (chlorofluorocarbons (CFCs), HCFCs, halons).
- Since the early 1970's, scientists observed reduction in stratospheric ozone and it was found more prominent in Polar Regions. ODS substances have a lifetime of about 100 years.



# Ozone layer Depletion (continued..)

- Some compounds release chlorine or bromine when they are exposed to intense UV light in the stratosphere. These compounds contribute to ozone depletion, and are called ozone-depleting substances (ODS).
- When chlorine and bromine atoms come into contact with ozone in the stratosphere, they destroy ozone molecules. One chlorine atom can destroy over 100,000 ozone molecules before it is removed from the stratosphere. Ozone can be destroyed more quickly than it is naturally created.



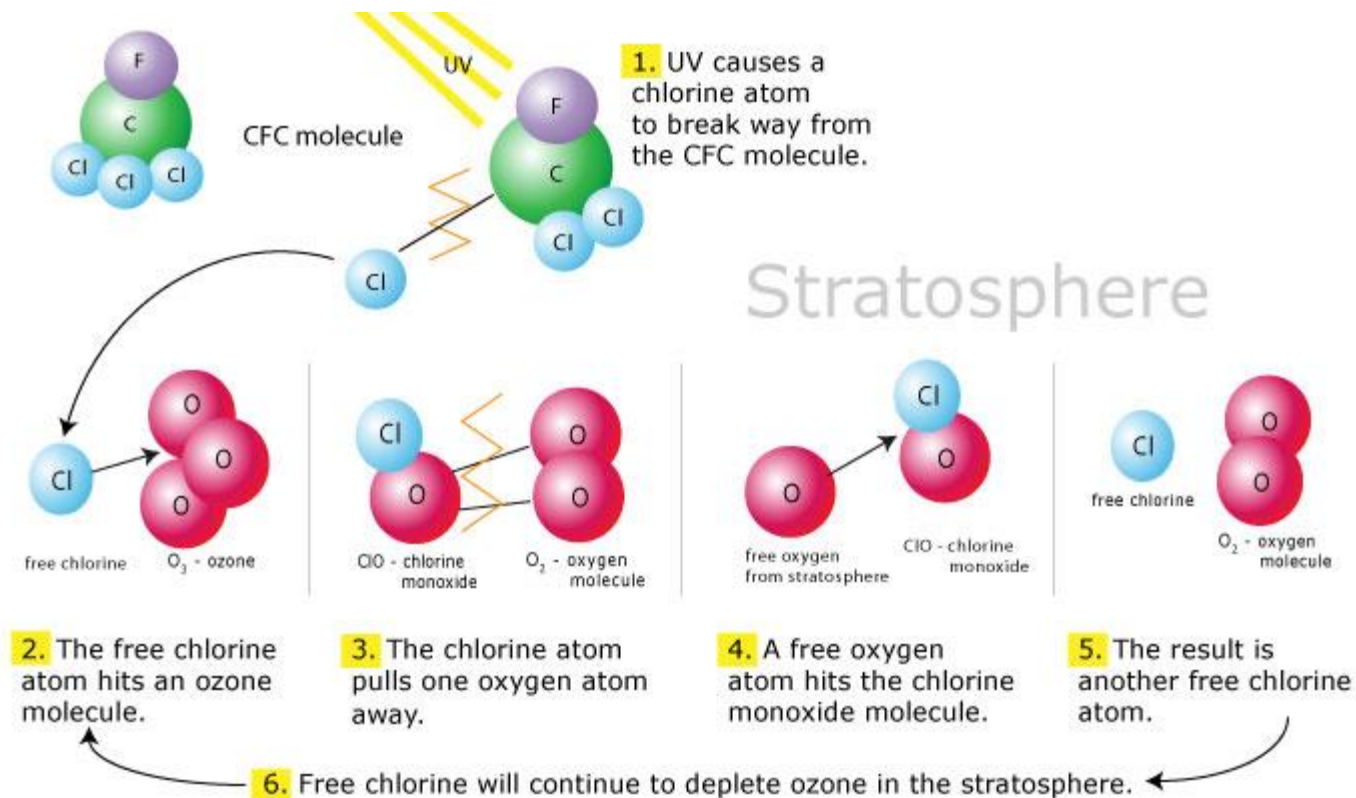
# Chemistry of Ozone Depletion

- CFC molecules are made up of chlorine, fluorine and carbon atoms and are extremely stable.
- This extreme stability allows CFC's to slowly make their way into the stratosphere (most molecules decompose before they can cross into the stratosphere from the troposphere).
- When the CFC's come into contact with high energy photons present in stratosphere, their individual components are freed from the whole. The following reaction displays how Cl atoms have an ozone destroying cycle:



# Chemistry of Ozone Depletion (Continued)

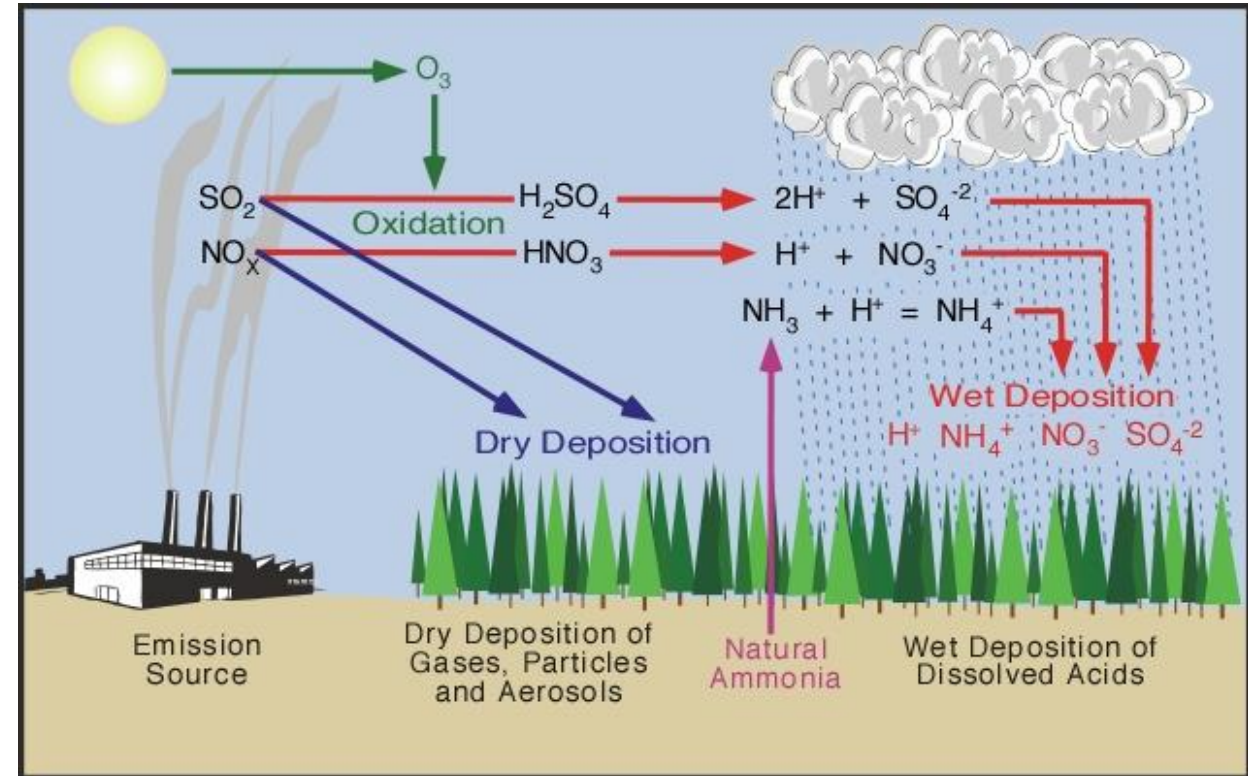
- Chlorine is able to destroy so much of the ozone because it acts as a catalyst. Chlorine initiates the breakdown of ozone and combines with a freed oxygen to create two oxygen molecules. After each reaction, chlorine begins the destructive cycle again with another ozone molecule. One chlorine atom can thereby destroy thousands of ozone molecules. Because ozone molecules are being broken down they are unable to absorb any ultraviolet light so we experience more intense UV radiation at the earth's surface.





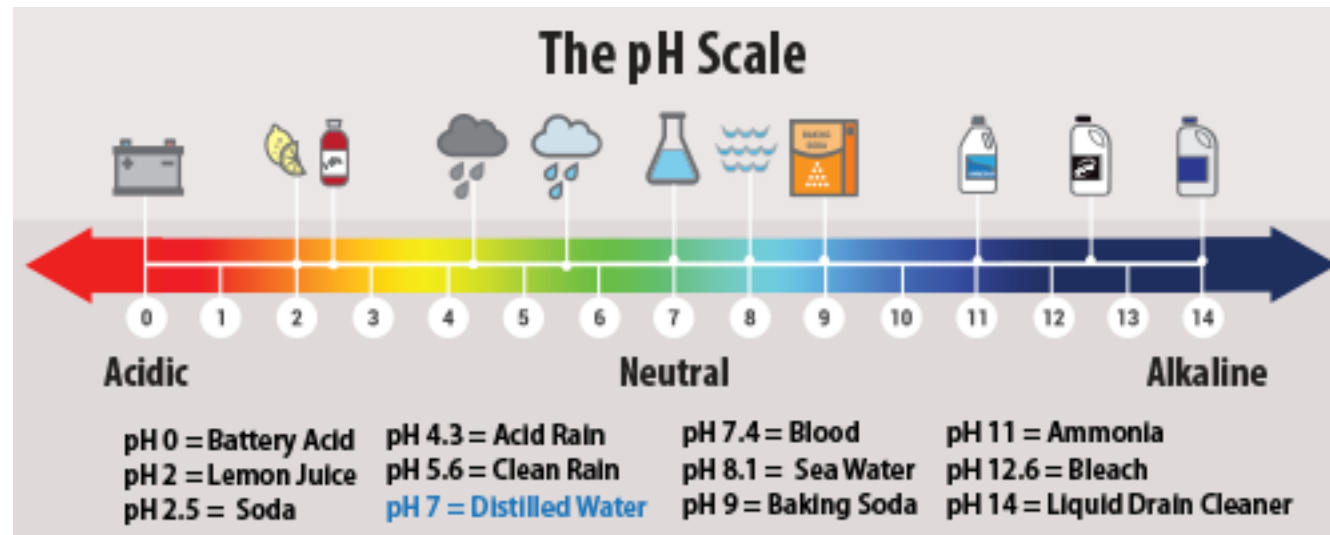
# ACID RAIN

- Acid rain is the rain that has been acidified, with a pH less than 5.6.
- The term “acid rain” was coined in 1872 by Robert Angus Smith.
- Acid rain is also called acid deposition. It is two types of deposition:
  1. Wet deposition
  2. Dry deposition
- The type of acid rain that contains water is called wet deposition.
- Acid rain formed with dust or gasses is called dry deposition.



# Measuring Acid Rain

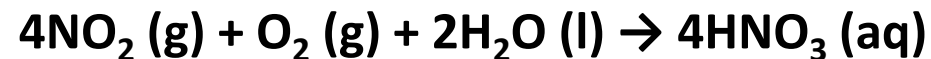
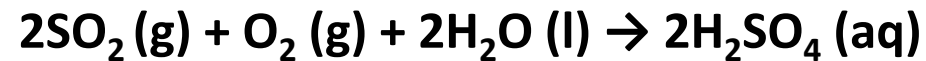
- Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is.
- Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide ( $\text{CO}_2$ ) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4.





# CAUSES OF ACID RAIN

- The causes of acid rain are ***Sulphur and Nitrogen particles which get mixed with the wet components of rain*** and result in precipitation that is highly acidic. These pollutants react with water vapours present in the atmosphere to form sulfuric acid and nitric acid respectively.
- Sulphur dioxide and [nitrogen dioxide](#) undergo oxidation, and then they react with water resulting in the formation of sulphuric acid and nitric acid, respectively. The following reaction will clarify the acid formation reaction:



- sulfur and Nitrogen particles may be released in the atmosphere due to anthropogenic causes or by natural causes.
- Anthropogenic causes include industrial emissions, burning of fossil fuels such as diesel and coal, incineration of garbage, production of paper.
- Natural causes could be release of sulfur during volcanic eruptions or nitrogen ions released in the atmosphere during a lightning strike. The chemical reaction occurs in the presence of lightning to form the nitric oxide. This further reacts with oxygen to form nitrogen dioxide.

# Impacts of Acid Rain

## Impact on humans

- Acid rain does not harm humans immediately. The sulfur dioxide creates various health problems. It can cause lung inflammation including asthma, bronchitis and emphysema.
- It cause damage to marble building by formation of  $\text{CaSO}_4$  which is more soluble and thus leaves a pitted appearance on marble. Example: Acid rains have turned the Taj Mahal's marble yellow.
- $\text{CaCO}_3(\text{insoluble}) + \text{H}_2\text{SO}_4 \longrightarrow \text{CaSO}_4(\text{soluble}) + \text{H}_2\text{O} + \text{CO}_2$
- Weakens the fabric.
- Causes discolouration of paint.
- Acid rain also causes the corrosion of water pipes, which further results in leaching of heavy [metals](#) such as iron, lead and copper into drinking water.
- Causes lake acidification and kills marine life

# Acid Rain: Impacts on Agriculture

- Impact on Agriculture
- Acid rain has been found to be very hard on trees. It weakens them by washing away the protective film on leaves, and it stunts growth.
- It cause leaf injury and discolouration
- Damages fine root hairs and destroy beneficial microbes. Some microbes in the soil cannot tolerate changes to low pH and get killed. The enzymes of these microbes are denatured by the acid.
- Reduces the availability of  $K^+$ ,  $Mg^{2+}$ ,  $Ca^{2+}$  into the soil, thus soil becomes poor in nutrient.



1908



Present



June 2008

February 2011



Of course, we can't forget the acid rain

Original color of Taj Mahal

Taj Mahal after the  
constant effect of acid rain



# Nature Reserves

- Nature reserve is a part of the territory where the preservation of the fauna, flora, soil, water, mineral and fossil deposits or other special interests that play an important role in maintaining ecosystem and ecological biodiversity.
- No artificial intervention likely to degrade such a territory should be allowed in it.
- They are often protected and conserved to prevent them from extinction and also to provide study, research and nature appreciation opportunities.

## Protected Areas of the world



Source: IUCN and UNEP-WCMC (2016). The World Database on Protected Areas (WDPA) [On-line], April 2016, Cambridge, UK: UNEP-WCMC. Available at [www.protectedplanet.net](http://www.protectedplanet.net)



Terrestrial protected areas Marine and coastal protected areas



# Types of Nature Reserves/Protected areas (International Union For Conservation of Nature)

- **Category Ia** :Strict Nature Reserve
- **Category Ib**:Wilderness Area
- **Category II** :National Park
- **Category VI**:Protected Area with sustainable use of natural resources
- **Category V** : Protected Landscape/ Seascape
- **Category IV**: Habitat or Species Management Area
- **Category III** :Natural Monument Or Feature



# Types of Nature Reserves/Protected areas

## Category Ia – Strict Nature Reserve

- A strict nature reserve (IUCN Category Ia) is an area which is protected from all but light human use in order to protect its biodiversity and also possibly its geological/geomorphical features.
- These areas are often home to dense native ecosystems where all human disturbance except scientific study, environmental monitoring and education is prohibited.

## Category Ib – Wilderness Area

- The Serengeti National Park, Tanzania is a designated Wilderness Area
- A wilderness area (IUCN Category Ib) is similar to a strict nature reserve, but generally larger and protected in a slightly less stringent manner.

## Category II – National Park

- A national park (IUCN Category II) is similar to a wilderness area in its size and its main objective of protecting functioning ecosystems. However, national parks tend to be more lenient with human visitation and its supporting infrastructure.

# Types of Nature Reserves/Protected areas

## Category III – Natural Monument Or Feature

- A natural monument or feature (IUCN Category III) is a comparatively smaller area that is specifically allocated to protect a natural monument and its surrounding habitats.

## Category IV – Habitat or Species Management Area

- The Galápagos, Ecuador, is managed under category IV to preserve the islands' native flora and fauna
- A habitat or species management area (IUCN Category IV) is similar to a natural monument or feature, but focuses on more specific areas of conservation (though size is not necessarily a distinguishing feature), like an identifiable species or habitat that requires continuous protection rather than that of a natural feature.

## Category V – Protected Landscape or Seascape

- A protected landscape or protected seascape (IUCN Category V) covers an entire body of land or ocean with an explicit natural conservation plan, but usually also accommodates a range of for-profit activities.

# Types of Nature Reserves/Protected areas

## **Category VI – protected area with sustainable use of natural resources**

- Great Barrier Reef Marine Park, Australia
- Though human involvement is a large factor in the management of these protected areas, developments are not intended to allow for widescale industrial production. The IUCN recommends that a proportion of the land mass remain in its natural condition—a decision to be made on a national level, usually with specificity to each protected area.

# Resource sustainability

## (The Concept Of Sustainable Use Of Earth's Resources)

### WHAT IS SUSTAINABLE DEVELOPMENT???

- The main aim of sustainable development is to provide resources for present generations without compromising the needs of future generations.
- Judicious use of resources
- Use of resources as per needs of future generation
- Balance between economic development and environment protection

### NEED FOR SUSTAINIBILITY

- Developing society
- Increased use of toxic and chemical substances

- Emerging industries
- Overpopulation
- Ozone layer depletion
- Depleting conditions of environment

### FEATURES

- Inter-generational equity
- Environmental protection
- Use & conservation
- Precautionary principle:
- Polluter pay principle: The Polluter Pays Principle imposes liability on a person who pollutes the environment to compensate for the damage caused and return the environment to its original state regardless of the intent
- Maintain balance

# Resource sustainability

## ECONOMIC DEVELOPMENT & ENVIRONMENT PROTECTION

- Developing countries
- Industrial revolution
- Exploitation of resources
- Maintain balance
- State & Society

## GUIDELINES TO SUSTAINABILITY

- System thinking
- Temporal & spatial scales
- Precautionary principle
- Engagement & integration
- Equity & disparity
- efficiency

# Environmental Laws and Policies

## Act

- An **Act** is passed by the legislative branch, whereas **Law** is the set of rules and regulations that the government enforces or The term 'Act' refers to a bill which has been passed through various legislative steps to become an enforced law.

## Law

- A **Law** is described as a collection of mandatory rules and regulations that must be followed

## Policy

- A **Policy** outlines what a government hopes to achieve and the methods and the principles it will use to achieve them.
- Policies can lead to new laws.
- Tend to evolve and adapt over time under various review processes.

## Policies to protect environment in India

- Environment Protection Act, 1986
- National Conservation Strategy and Policy Statement on Environment and Development, 1992
- Policy Statement for the Abatement of Pollution, 1992
- National Environment Policy, 2006



# Environmental Laws and Policies

- The **Vienna Convention** for the Protection of the Ozone Layer was signed in 1985 under which UN member countries recognized the importance of curbing damage to the ozone layer.
  - ❑ As per the Convention's provisions, countries agreed to adopt the Montreal Protocol to further the goals of the Vienna Convention.
- The **Montreal Protocol** was signed in 1987 and entered into force in January 1989.
  - ❑ The protocol gives provisions to reduce the production and consumption of ODSs in order to protect the ozone layer.
- **The Water (Prevention and Control of Pollution) Act, 1974**
  - ❑ Objective: To provide prevention and control of water pollution. Maintaining or restoring of wholesomeness and purity of water in the various sources of water.
- **The Air (prevention and control of pollution) act, 1981**
  - ❑ The act targets to control and prevent air pollution in India and its main objectives are:
    - ❑ To provide for prevention, control, and abatement of air pollution.

# Environmental laws and policies

- **The Stockholm Convention:**

- ☐ It is a **global treaty** to protect **human health and the environment** from POPs.
- ☐ It was opened for signature in 2001 in Stockholm (Sweden) and became effective in **2004**.

- **The Kyoto Protocol**

- ☐ was adopted on 11 December 1997. It entered into force on 16 February 2005. Currently, there are 192 Parties to the Kyoto Protocol.
- ☐ In short, the Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets.
- ☐ Important features:
  - a) Common but differentiated responsibilities.
  - b) Commitment for developed countries.
  - c) Countries should decrease the emission levels by 5.2 % of the average of 1990 levels (before the year 2012).

# Environmental laws and policies

- **Paris Agreement**, in full **Paris Agreement Under the United Nations Framework Convention on Climate Change**,
  - ❑ also called **Paris Climate Agreement** or **COP21**, international treaty, named for the city of Paris, France, in which it was adopted in December 2015, which aimed to reduce the emission of gases that contribute to global warming.
  - ❑ The Paris Agreement set out to improve upon and replace the Kyoto Protocol, an earlier international treaty designed to curb the release of greenhouse gases. It entered into force on November 4, 2016, and has been signed by 195 countries and ratified by 190 as of January 2021.

# Principles of environmental law

## Principles of environmental law

- The design and application of modern environmental law have been shaped by a set of principles and concepts outlined in publications such as *Our Common Future* (1987), published by the World Commission on Environment and Development, and the Earth Summit's Rio Declaration (1992).

### 1. The precautionary principle

- It states that if an action or policy has a suspected risk of causing harm to the public or to the environment if there is a strong suspicion that a certain activity may have environmentally harmful consequences, it is better to control that activity now rather than to wait for incontrovertible scientific evidence.
- This principle is expressed in the Rio Declaration, which stipulates that, where there are “threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

### 2. The prevention principle:

- It is the fundamental notion behind laws regulating the generation, transportation, treatment, storage, and disposal of hazardous waste and laws regulating the use of pesticides. The principle was the foundation of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), which sought to minimize the production of hazardous waste and to combat illegal dumping.

# Principles of environmental law

## 3. The “polluter pays” principle

- The 'polluter pays' principle is the commonly accepted practice that **those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment.**

## 4. The integration principle

- Environmental protection requires that due consideration be given to the potential consequences of environmentally fateful decisions.

## 5. The public participation principle

- Decisions about environmental protection often formally integrate the views of the public and the public has been given the opportunity to influence the decision through written comments or hearings.
- In many countries citizens may challenge in court or before administrative bodies government decisions affecting the environment. These citizen lawsuits have become an important component of environmental decision making at both the national and the international level

# Principles of environmental law

## 6. Sustainable development

- Sustainable development is an approach to economic planning that attempts to foster economic growth while preserving the quality of the environment for future generations.

## 7. The public participation and perception

- Decisions about environmental protection often formally integrate the views of the public.
- In many countries citizens may challenge in court or before administrative bodies government decisions affecting the environment. These citizen lawsuits have become an important component of environmental decision making at both the national and the international level.



# Public Participation and Perception

## Perception:

- It is an internal reaction based on the impression, assessment, opinion, feeling, and interpretation of information one has obtained.
- The notion is that by perception a human can interact with his or her surroundings, for instance between humans and their environment, or humans with each other's. By sensing the nature conservation policy, people are expected to take on a social behavior in protecting the environment, and so contribute to awareness in the management of forest products as a preservation process.

## Public participation

- It can generally be defined as allowing people to influence the outcome of plans and working processes that constitute the operations of governance (CIS 2003). It can be practiced in different phases of integrated river basin management, but the public's environmental understanding forms one basis for participation.

# Public Participation and Perception [Cont..]

- On 25 June 1998, Ministers from European countries signed a Convention in the town of Aarhus, Denmark. The Convention is now known as the Aarhus Convention and it gives the public the right to obtain information on the environment, the right to justice in environmental matters and the right to participate in decisions that affect the environment. It entered into force on 30 October 2001.

## The Right to Information

- It sets out a general right of access to information on the environment where information can only be withheld in certain circumstances.

## The Right to Justice

- If rights are to be effective, the public must have a way of seeking justice when those rights are accidentally, or deliberately, denied

## The Right to Participate

- The **Aarhus Convention** gives the public a right to participate in making these decisions. The right covers decisions on whether to allow specific activities. It is only by working with the public that decisions will be made which provide a good environment and meet the needs of local communities for a better quality of life.

# Public Participation and Perception

## Importance of public participation

- It is also a moral duty. Public authorities work for the public. To do so in a way that the public want and to ensure that they know what the public needs, they must involve the public when they make decisions. Each person has a stake in protecting and enhancing the Environment
- Public participation can lead to better decisions. That is, decisions that better meet the needs of more people, decisions that last longer and decisions that have more validity.
- In the longer term, public participation can improve democracy. Regular public participation shows people that they are valued and that their views are important.

## Objectives of public participation

- To encourage maximum participation of citizens to improve decision making process to create awareness of environmental issues and to help increase acceptance and commitment towards intended plans.

# Public Participation and Perception

## Objectives of public participation

- Participation is beneficial in environmental decision making for a *number of reasons*:
- It can enhance the democratic legitimacy of environmental decisions and thus facilitate smoother implementation and enforcement;
- It can manage social conflict by minimizing the conflicts that arise during a project, and lead to greater accountability and effectiveness in decision making;
- It is an effective means (or sometimes the only means) through which local concerns, values, and *traditional knowledge* are raised.
- It helps to produce more accurate results that better suit the needs of the community and economy, and that better manage the environment and natural resources.

THANK YOU



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