

This handout contains discussion on-

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1. CLIMATE CHANGE- MECHANISMS UNDER THE KYOTO PROTOCOL

Countries with commitments under the Kyoto Protocol to limit or reduce greenhouse gas emissions must meet their targets primarily through national measures. As an additional means of meeting these targets, the Kyoto Protocol introduced three market-based mechanisms, thereby creating what is now known as the carbon market. Thus, a new commodity was created – emission reductions. Because carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity

The Kyoto mechanisms are:

Clean development mechanism (CDM)- The CDM allows emission-reduction (or emission removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO₂. These CERs can be traded and sold, and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction limitation targets.

Joint implementation (JI)- Through the JI mechanism, a country with an emission-reduction limitation commitment under the Kyoto Protocol may take part in an emission-reduction (or emission removal) project in any other country with a commitment under the Protocol, and count the resulting emission units towards meeting its Kyoto target. JI projects earn emission reduction units (ERUs), each equivalent to one tonne of CO₂. As with the CDM, all emission reductions must be real, measurable, verifiable and additional to what would have occurred without the project.

Basically, CDM and JI are the two project-based mechanisms which feed the carbon market. The CDM involves investment in emission reduction or removal enhancement projects in developing countries that contribute to their sustainable development, while JI enables developed countries to carry out emission reduction or removal enhancement projects in other developed countries.

Emissions trading (ET)- Parties with commitments under the Kyoto Protocol (Annex B Parties) have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or assigned amounts, at over the 2008-2012 commitment period. The allowed emissions are divided into assigned amount units (AAUs).

Emissions trading allows countries that have emission units to spare – emissions permitted them but not “used” – to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity. This is known as the “carbon market.”

2. CLIMATE FINANCE UNDER UNFCCC

“Climate finance” refers to money – both from public and private sources – which is used to help reduce emissions and increase resilience against the negative impacts of climate change.

It is defined as “finance that aims at reducing emissions, and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts.”

This definition represents finance for climate change in its broadest form whether mitigation or adaptation, anywhere in the world.

While climate finance has been a central element of the negotiations in one form or another since 1992, it is now most often associated with the target figure of mobilising US\$ 100 billion a year by 2020 by developed countries for developing countries. This target was first agreed in the Copenhagen Accord in 2009 and expanded upon in the Cancun Agreements in 2010 where the Green Climate Fund (GCF) was established to act as a key delivery mechanism. In the Paris Agreement in 2015 this target was further reinforced, with a goal to raise the target after 2025 and that this funding would come from a “wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance.”

What is the financial mechanism? What are the other funds?

To facilitate the provision of climate finance, the Convention established a financial mechanism to provide financial resources to developing country Parties. The financial mechanism also serves the Kyoto Protocol and the Paris Agreement.

The Convention states that the operation of the financial mechanism can be entrusted to one or more existing international entities. The Global Environment Facility (GEF) has served as an operating entity of the financial mechanism since the Convention’s entry into force in 1994.

The Global Environment Facility - was established on the eve of the 1992 Rio Earth Summit to help tackle our planet’s most pressing environmental problems. Today, the GEF is an international partnership of 183 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues.

Green Climate Fund (GCF) -At COP 16, in 2010, Parties established the Green Climate Fund (GCF) and in 2011 also designated it as an operating entity of the financial mechanism. The financial mechanism is accountable to the COP, which decides on its policies, programme priorities and eligibility criteria for funding. It supports the efforts of developing countries to respond to the challenge of climate change. It was set up by the 194 countries who are parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, as part of the Convention's financial mechanism. It aims to deliver equal amounts of funding to mitigation and adaptation, while being guided by the Convention's principles and provisions.

In addition to providing guidance to the GEF and the GCF, Parties have established two special funds—the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), both managed by the GEF—and the Adaptation Fund (AF) established under the Kyoto Protocol in 2001.

The Special Climate Change Fund (SCCF) -was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. This fund should complement other funding mechanisms for the implementation of the Convention.

The Adaptation Fund (AF)- was established in 2001 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. The Adaptation Fund is financed with a share of proceeds from the clean development mechanism (CDM)project activities and other sources of funding. The share of proceeds amounts to 2 percent of certified emission reductions (CERs) issued for a CDM project activity.

Some Random Facts about Climate Change Conferences

1. To limit global warming to no more than 2 degree Celsius above pre-industrial levels was formalised under Cancun Agreement of CoP 16- 2010.
2. Pre-industrial levels are taken as 1850-1900 by the IPCC.
3. The IPCC's 1.5 degree Celsius Special Report was formally requested by countries at CoP 21- Paris in 2015.
4. Finalisation of Paris Rulebook (operating manual for implementation of Paris Agreement) was the agenda of CoP 24- Katowice, 2018.
5. Carbon Offsetting and Reduction Scheme for International Aviation (CORSA) is a trading scheme set up for civil aviation emissions. It is implemented by International Civil Aviation Organization- UN's aviation body. Aim is to address any annual increase in total CO2 emissions from international civil aviation (i.e. civil aviation flights that depart in one country and arrive in a different country) above the 2020 levels.
6. Talanoa Dialogue- was launched in CoP 23. COP 21's Paris Agreement decided to convene a facilitative dialogue among Parties in 2018 to take stock of the collective efforts of Parties in relation to their progress. The Paris Agreement provides for progress assessments ("stocktakes") every five years in order to ensure that Parties

turn commitment into action and continue to regularly increase their ambition. The first full global stocktake will occur in 2023 in order to prepare for a new round of climate commitments, known as [Nationally Determined Contributions](#) (NDCs), by 2025. However, Parties felt it was important to initiate this cycle prior to the agreement's anticipated entry into force in 2020, and so a process called the Talanoa Dialogue (initially called a facilitative dialogue) has been established for 2018 to serve as an initial stocktaking exercise. The Dialogue is a mandated process requested by Parties to take stock of collective efforts to reduce emissions. Talanoa is a traditional word used in Fiji and across the Pacific to reflect a process of inclusive, participatory and transparent dialogue.

3. CLIMATE CHANGE- INDIA'S NATIONALLY DETERMINED CONTRIBUTIONS (NDCs) UNDER PARIS AGREEMENT

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
4. To achieve about 40 percent cumulative electric power installed capacity from nonfossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
5. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
7. To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

To achieve the above contributions, India is determined to continue with its on-going interventions, enhance the existing policies as detailed in previous sections and launch new initiatives in the following priority areas:

- 1) Introducing new, more efficient and cleaner technologies in thermal power generation.
- 2) Promoting renewable energy generation and increasing the share of alternative fuels in overall fuel mix.

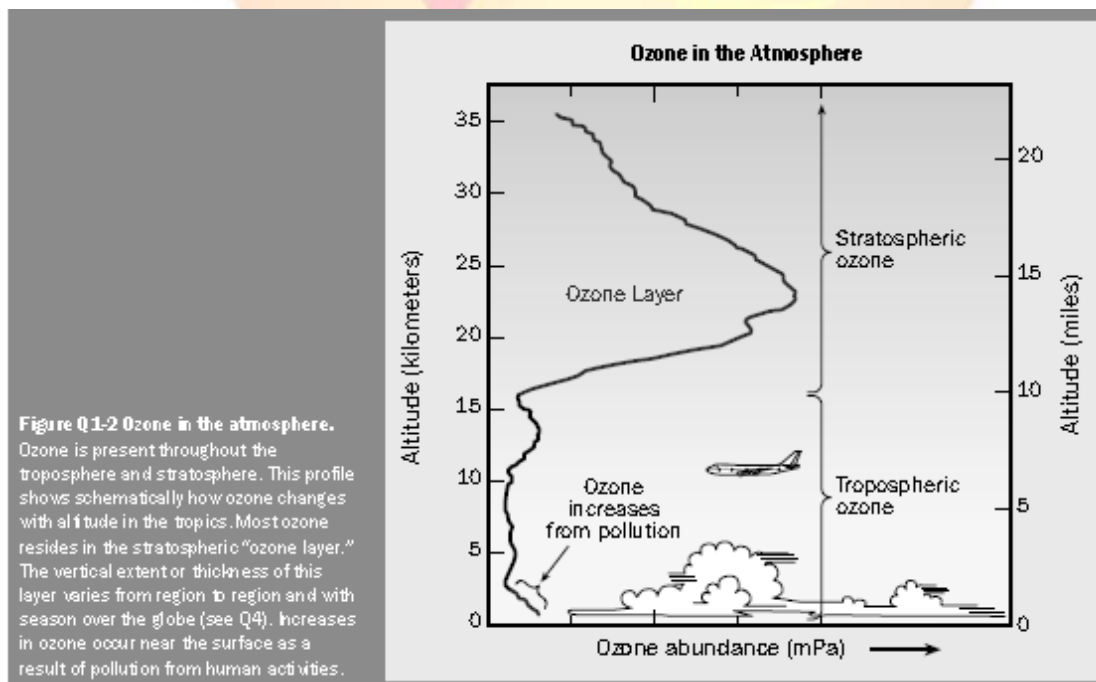
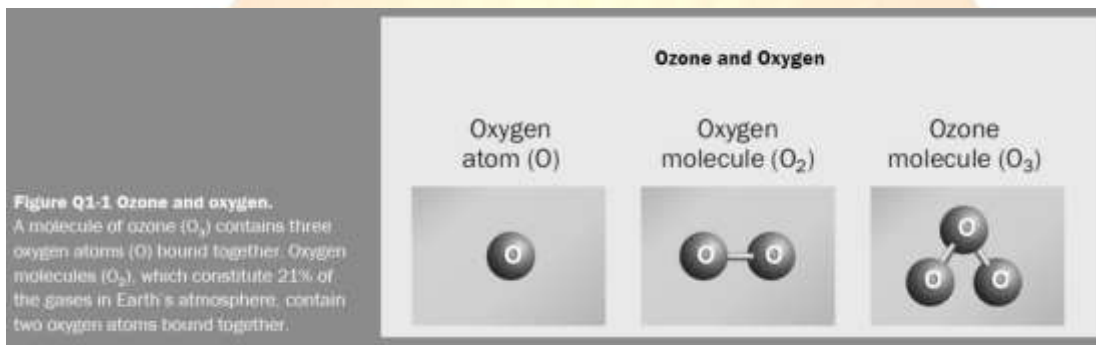
- 3) Reducing emissions from transportation sector.
- 4) Promoting energy efficiency in the economy, notably in industry, transportation, buildings and appliances.
- 5) Reducing emissions from waste.
- 6) Developing climate resilient infrastructure.
- 7) Full implementation of Green India Mission and other programmes of afforestation.
- 8) Planning and implementation of actions to enhance climate resilience and reduce vulnerability to climate change. India has also revisited the National Missions under the NAPCC in the light of new scientific information and technological advances and identified new missions or programs on wind energy, health, waste to energy, and coastal areas. It is also redesigning the National Water Mission and National Mission on Sustainable Agriculture.

It is clarified that India's INDC do not bind it to any sector specific mitigation obligation or action, including in agriculture sector. India's goal is to reduce overall emission intensity and improve energy efficiency of its economy over time and at the same time protecting the vulnerable sectors of economy and segments of our society. The successful implementation of INDC is contingent upon an ambitious global agreement including additional means of implementation to be provided by developed country parties, technology transfer and capacity building.

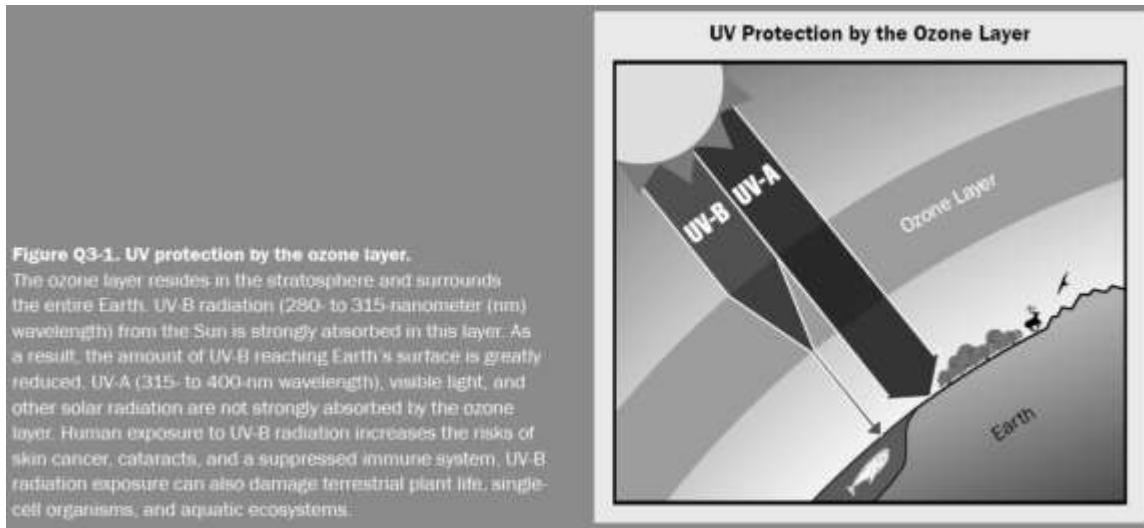
4. OZONE DEPLETION

The ozone layer sits in the lower region of the stratosphere from about 20-30 kilometers above the surface of the earth. The thickness of the ozone layer is about 3 to 5 mm, but it pretty much fluctuates depending on the season and geography. The concentration of ozone in the ozone layer is usually under 10 parts per million while the average concentration of ozone in the atmosphere is about 0.3 parts per million. The thickness of the ozone layer differs as per season and geography. The highest concentrations of ozone occur at altitudes from 26 to 28 km in the tropics and from 12 to 20 km towards the poles. The ozone layer was discovered in 1913 by the French physicists Charles Fabry and Henri Buisson.

Ozone molecules have a low relative abundance in the atmosphere. In the stratosphere near the peak concentration of the ozone layer, there are typically a few thousand ozone molecules for every *billion* air molecules (1 billion = 1,000 million). Most air molecules are either oxygen (O₂) or nitrogen (N₂). In the troposphere near Earth's surface, ozone is even less abundant, with a typical range of 20 to 100 ozone molecules for each billion air molecules. The highest surface values result when ozone is formed in air polluted by human activities.



Stratospheric ozone is considered good for humans and other life forms because it absorbs ultraviolet-B (UV-B) radiation from the Sun. If not absorbed, UV-B radiation would reach Earth's surface in amounts that are harmful to a variety of life forms. In humans, increased exposure to UV-B radiation increases the risks of skin cancer, cataracts, and a suppressed immune system. UV-B radiation exposure before adulthood and cumulative exposure are both important health risk factors. Excessive UV-B exposure also can damage terrestrial plant life, single-cell organisms, and aquatic ecosystems. Other UV radiation, UV-A, which is not absorbed significantly by ozone, causes premature aging of the skin.



Ozone near Earth's surface in excess of natural amounts is considered bad ozone. It is formed by reactions involving human-made pollutant gases. Increasing surface ozone above natural levels is harmful to humans, plants, and other living systems because ozone reacts strongly to destroy or alter many biological molecules. High ozone exposure caused by air pollution reduces crop yields and forest growth. In humans, exposure to high levels of ozone can reduce lung capacity; cause chest pains, throat irritation, and coughing; and worsen pre-existing health conditions related to the heart and lungs. In addition, increases in tropospheric ozone lead to a warming of Earth's surface because ozone is a greenhouse gas. The negative effects of excess tropospheric ozone contrast sharply with the protection from harmful UV-B radiation afforded by an abundance of stratospheric ozone.

In the absence of human activities, ozone would still be present near Earth's surface and throughout the troposphere and stratosphere because ozone is a natural component of the clean atmosphere. Ozone plays important roles in the atmosphere beyond absorbing UV radiation. For example, ozone initiates the chemical removal of many pollutants, such as carbon monoxide (CO) and nitrogen oxides (NO_x), as well as some greenhouse gases, such as methane (CH₄).

Scientists have established records spanning several decades that detail normal ozone levels during natural cycles. Ozone concentrations in the atmosphere vary naturally with sunspots, seasons, and latitude. These processes are well understood and predictable. Each natural reduction in ozone levels has been followed by a recovery. Beginning in the 1970s, however, scientific evidence showed that the ozone shield was being depleted well beyond natural processes.

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.

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. The chief ozone-depleting substances include chlorofluorocarbons (CFCs), carbon tetrachloride, hydrochlorofluorocarbons (HCFCs) and methyl chloroform. Halons, sometimes known as brominated fluorocarbons, also contribute mightily to ozone depletion. Although ODS are emitted at the Earth's surface, they are eventually carried into the stratosphere in a process that can take as long as two to five years.

Such deterioration of ozone allows large amounts of ultraviolet B rays to reach Earth, which can cause skin cancer and cataracts in humans and harm animals as well.

Extra ultraviolet B radiation reaching Earth also inhibits the reproductive cycle of phytoplankton, single-celled organisms such as algae that make up the bottom rung of the food chain. Biologists fear that reductions in phytoplankton populations will in turn lower the populations of other animals. Researchers also have documented changes in the reproductive rates of young fish, shrimp, and crabs as well as frogs and salamanders exposed to excess ultraviolet B.

Chlorofluorocarbons (CFCs), chemicals found mainly in spray aerosols heavily used by industrialized nations for much of the past 50 years, are the primary culprits in ozone layer breakdown. When CFCs reach the upper atmosphere, they are exposed to ultraviolet rays, which cause them to break down into substances that include chlorine. The chlorine reacts with the oxygen atoms in ozone and rips apart the ozone molecule. One atom of chlorine can destroy more than a hundred thousand ozone molecules, according to the the U.S. Environmental Protection Agency.

The ozone layer above the Antarctic has been particularly impacted by pollution since the mid-1980s. This region's low temperatures speed up the conversion of CFCs to chlorine. In the southern spring and summer, when the sun shines for long periods of the day, chlorine reacts with ultraviolet rays, destroying ozone on a massive scale, up to 65 percent. This is what some people erroneously refer to as the "ozone hole." In other regions, the ozone layer has deteriorated by about 20 percent. Significant depletion of ozone has been observed in the Arctic stratosphere in recent decades but still it is less severe than over Antarctic.

(Also know that- natural causes of depletion of ozone layer also exist. Ozone layer has been found to be affected by certain natural phenomena such as Sun-spots and stratospheric winds. But this has been found to cause not more than 1-2% depletion of the ozone layer and the effects are also thought to be only temporary. It is also believed that the major volcanic eruptions (mainly El Chichon in 1983 and and Mt. Pinatubo in 1991) has also contributed towards ozone depletion.)

Protection of Ozone Layer

International Day for the Preservation of the Ozone Layer is on 16 September every year.

Vienna Convention for the Protection of the Ozone Layer- The scientific confirmation of the depletion of the ozone layer prompted the international community to establish a mechanism for cooperation to take action to protect the ozone layer. This was formalized in the Vienna Convention for the Protection of the Ozone Layer, which was adopted and signed by 28 countries, on 22 March 1985. In September 1987, this led to the drafting of The Montreal Protocol on Substances that Deplete the Ozone Layer.

Montreal Protocol- In response to growing concern, the *Montreal Protocol on Substances that Deplete the Ozone Layer* was signed in 1987 and, following sufficient country ratification, entered into force in 1989. The Protocol has been successful in establishing legally binding controls for developed and developing nations on the production and consumption of halogen source gases known to cause ozone depletion. Halogen source gases containing chlorine and bromine controlled under the Montreal Protocol are referred to as ozone-depleting substances (ODSs). National consumption of an ODS is defined as the amount that production and imports of the substance exceed its export to other nations. The Protocol provisions are structured for developed countries to act first and for developing countries to follow with some financial assistance. In 2009, the Montreal Protocol became the first international treaty to achieve universal ratification by all 196 United Nations members.

The principal aim of the Montreal Protocol is to protect the ozone layer by taking measures to control total global production and consumption of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge and technological information.

The Montreal Protocol is structured around several groups of ozone-depleting substances. The Montreal Protocol requires the control of nearly 100 chemicals, in several categories.

There are a few exceptions for essential uses where no acceptable substitutes have been found, for example, in metered dose inhalers (MDI) commonly used to treat asthma and other respiratory problems or halon fire-suppression systems used in submarines and aircraft.

In 1994, the United Nations General Assembly proclaimed 16 September the International Day for the Preservation of the Ozone Layer, commemorating the date of the signing, in 1987, of the Montreal Protocol on Substances that Deplete the Ozone Layer (resolution 49/114).

Implementation of the Montreal Protocol- Implementation of the Montreal Protocol progressed well in developed and developing countries. All phase-out schedules were adhered to in most cases, some even ahead of schedule. In view of the steady progress made under the Protocol, already in 2003, former United Nations Secretary-General Kofi Annan stated “Perhaps the single most successful international agreement to date has been the Montreal Protocol”. His views are shared widely in the international community.

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Attention focused initially on chemicals with higher ozone-depletion potentials including CFCs and halons. The phase-out schedule for HCFCs was more relaxed due to their lower ozone-depletion potentials and because they have also been used as transitional substitutes for CFCs.

The HCFC phase-out schedule was introduced in 1992 for developed and developing countries, the latter with a freeze in 2015, and final phase-out by 2030 in developed countries and 2040 in developing countries.

In 2007, Parties to the Montreal Protocol decided to accelerate the HCFC phase-out schedule for both developed and developing countries.

Universal ratification:

On 16th September 2009, the Vienna Convention and the Montreal Protocol became the first treaties in the history of the United Nations to achieve universal ratification.

Kigali Amendment

The Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer reached agreement at their 28th Meeting of the Parties on 15 October 2016 in Kigali, Rwanda to phase-down hydrofluorocarbons (HFCs). The notable thing about the Kigali Amendment is that 197 countries came together and signed the first legally binding climate treaty of the 21st century.

HFCs are refrigerants used in air conditioning and refrigeration systems. They are potent Green House Gases (GHGs) with a thousand times more global warming potential (GWP) than carbon-di-oxide. The Montreal Protocol was signed in early 1990s to eliminate the use of chemicals that caused the Ozone hole. However, the replacement for the ozone-depleting chemicals was HFCs, which caused global warming. At the Kigali Meeting, the world agreed to reduce the use of HFCs and move to refrigerants that neither cause global warming nor create an ozone hole.

Under the agreement, developed countries will start reducing the use of HFCs first. They will be followed by China, along with many other developing countries. Finally, India, Pakistan and 8 other countries of West Asia will follow the suit.

Currently, 65% of all HFCs are consumed by developed countries with the USA alone accounting for 37% of global consumption. China accounts for 60% of global HFC production & 25% of global consumption. India accounts for less than 3% of the global production & consumption. This agreement, therefore, a most differentiated climate agreement and is a reflection of the responsibility and capability of countries to solve climate change issues.

Overall, the agreement is expected to reduce HFC use by 85% by 2045. This will result in a reduction of HFC emissions equivalent to about 70 billion tonnes of carbon-di-oxide globally.

It is important to note that unlike the Kigali Amendment to the Montreal Protocol, the historic Paris Agreement is neither legally binding nor are there mandatory emission reduction targets in it for countries.

Polar stratospheric clouds

One of the major factors producing the special chemistry that occurs in the stratosphere there is the cold temperatures present during the Antarctic winter. The air in the stratosphere is completely in the dark during the austral winter. Antarctica is also totally surrounded by water (as contrasted with the north pole which has landed geographic features on many sides around it) and therefore meteorologically isolated from air at higher latitudes during the winter. This physical condition forms an isolated air mass swirling over Antarctica called the south **polar vortex**. In the air of the polar vortex, the temperatures drop to very low levels in the stratosphere, below 80 degrees below zero C. At these temperatures, chemicals present in the stratosphere freeze out and form polar stratospheric clouds (**PSCs**). It is the chemical reactions that occur on the PSCs that result in the large decrease in ozone during each austral spring over Antarctica that we called the Antarctic ozone hole.

Despite two decades of research, the climatology of PSCs is not well described, and this impacts on the accuracy of ozone depletion models. The timing and duration of PSC events, their geographic extent and vertical distributions, and their annual variability are not well understood.

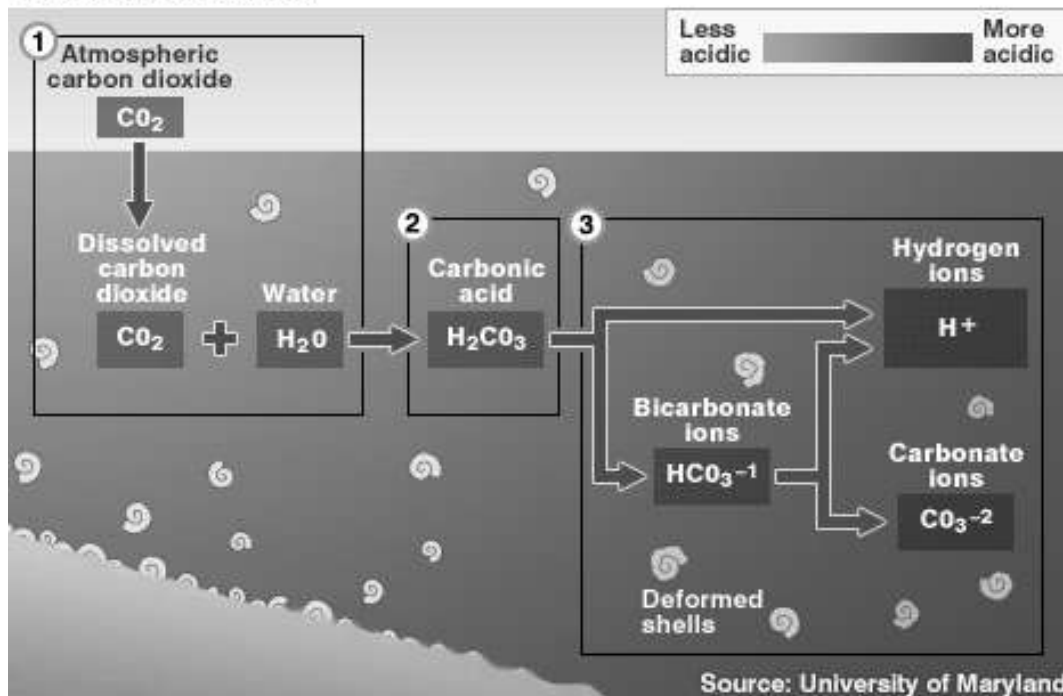
5. WHAT IS OCEAN ACIDIFICATION?

*Ocean acidification, or "OA" for short, is the term given to the chemical changes in the ocean as a result of carbon dioxide emissions. Ocean acidification refers to a **reduction in the pH of the ocean** over an extended period of time, caused primarily by uptake of carbon dioxide (CO₂) from the atmosphere.*

A pH unit is a measure of acidity ranging from 0-14. The lower the value, the more acidic the environment. Becoming more acidic is a relative shift in pH to a lower value.

When carbon dioxide (CO₂) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals. These chemical reactions are termed "ocean acidification" or "OA" for short. Calcium carbonate minerals are the building blocks for the skeletons and shells of many marine organisms. In areas where most life now congregates in the ocean, the seawater is supersaturated with respect to calcium carbonate minerals. This means there are abundant building blocks for calcifying organisms to build their skeletons and shells. However, continued ocean acidification is causing many parts of the ocean to become undersaturated with these minerals, which is likely to affect the ability of some organisms to produce and maintain their shells.

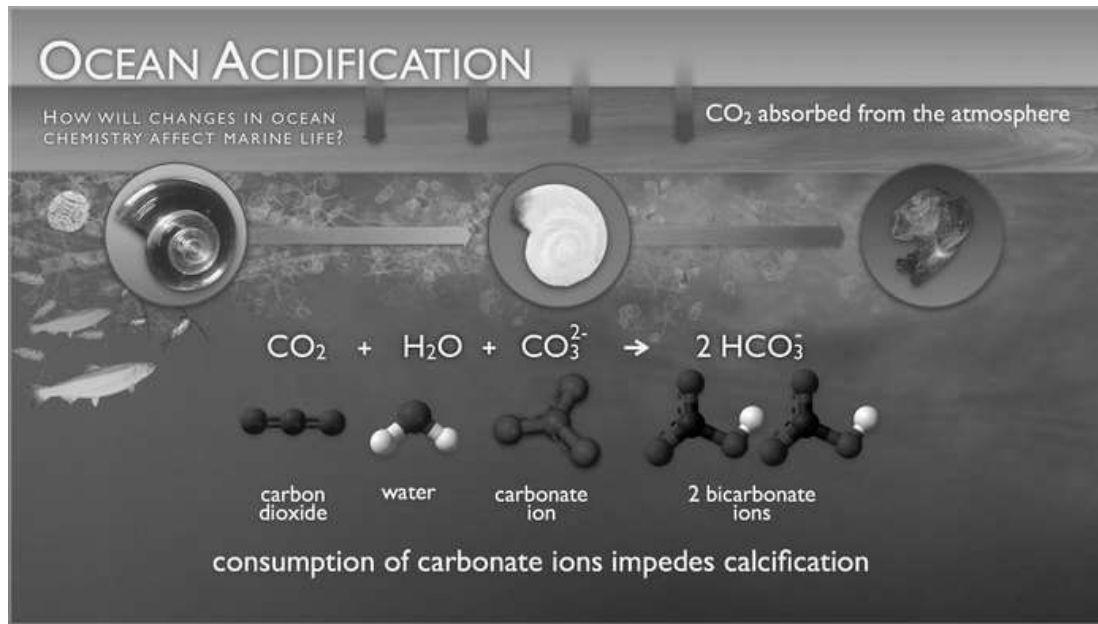
OCEAN ACIDIFICATION



1. Up to one half of the carbon dioxide (CO_2) released by burning fossil fuels over the past 200 years has been absorbed by the world's oceans
2. Absorbed CO_2 in seawater (H_2O) forms carbonic acid (H_2CO_3), lowering the water's pH level and making it more acidic
3. This raises the hydrogen ion concentration in the water, and limits organisms' access to carbonate ions, which are needed to form hard parts

Since the beginning of the Industrial Revolution, the pH of surface ocean waters has fallen by 0.1 pH units. Since the pH scale, like the Richter scale, is logarithmic, this change represents approximately a 30 percent increase in acidity. Future predictions indicate that the oceans will continue to absorb carbon dioxide and become even more acidic. Estimates of future carbon dioxide levels, based on business as usual emission scenarios, indicate that by the end of this century the surface waters of the ocean could be nearly 150 percent more acidic, resulting in a pH that the oceans haven't experienced for more than 20 million years.

The Biological Impacts- Ocean acidification is expected to impact ocean species to varying degrees. Photosynthetic algae and seagrasses may benefit from higher CO_2 conditions in the ocean, as they require CO_2 to live just like plants on land. On the other hand, studies have shown that a more acidic environment has a dramatic effect on some calcifying species, including oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton. When shelled organisms are at risk, the entire food web may also be at risk.



CARBONIC ACID- When carbon dioxide dissolves in this ocean, carbonic acid is formed. This leads to higher acidity, mainly near the surface, which has been proven to inhibit shell growth in marine animals and is suspected as a cause of reproductive disorders in some fish.

On the pH scale, which runs from 0 to 14, solutions with low numbers are considered acidic and those with higher numbers are basic. Seven is neutral. Over the past 300 million years, ocean pH has been slightly basic, averaging about 8.2. Today, it is around 8.1, a drop of 0.1 pH units, representing a 25-percent increase in acidity over the past two centuries.

CARBON STOREHOUSE- The oceans currently absorb about a third of human-created CO₂ emissions, roughly 22 million tons a day. Projections based on these numbers show that by the end of this century, continued emissions could reduce ocean pH by another 0.5 units. Shell-forming animals including corals, oysters, shrimp, lobster, many planktonic organisms, and even some fish species could be gravely affected. Equally worrisome is the fact that as the oceans continue to absorb more CO₂, their capacity as a carbon storehouse could diminish. That means more of the carbon dioxide we emit will remain in the atmosphere, further aggravating global climate change.

Impacts of ocean acidification on the Reef- In the long-term, ocean acidification is likely to be the most significant impact of a changing climate on the Great Barrier Reef ecosystem.

The oceans absorb carbon dioxide (CO₂) from the atmosphere and are estimated to have absorbed about half the excess CO₂ released by human activities in the past 200 years.

About half of this anthropogenic CO₂ (carbon dioxide in the atmosphere resulting from human activities, such as the burning of fossil fuels, rather than natural processes) is in the

upper 10 per cent of oceans (less than 1000 metres depth) due to slow ocean mixing processes.

This absorbed CO₂ is resulting in chemical changes in the ocean, and is estimated to have caused a decrease in oceanic pH of 0.1. This is referred to as ocean acidification as the oceans are becoming more acidic (though technically they are still alkaline).

As carbon dioxide (CO₂) is absorbed from the atmosphere it bonds with sea water forming carbonic acid. This acid then releases a bicarbonate ion and a hydrogen ion. The hydrogen ion bonds with free carbonate ions in the water forming another bicarbonate ion.

That carbonate would otherwise be available to marine animals for making calcium carbonate shells and skeletons. So the more dissolved carbon dioxide in the ocean, the less free carbonate ions available for making calcium carbonate.

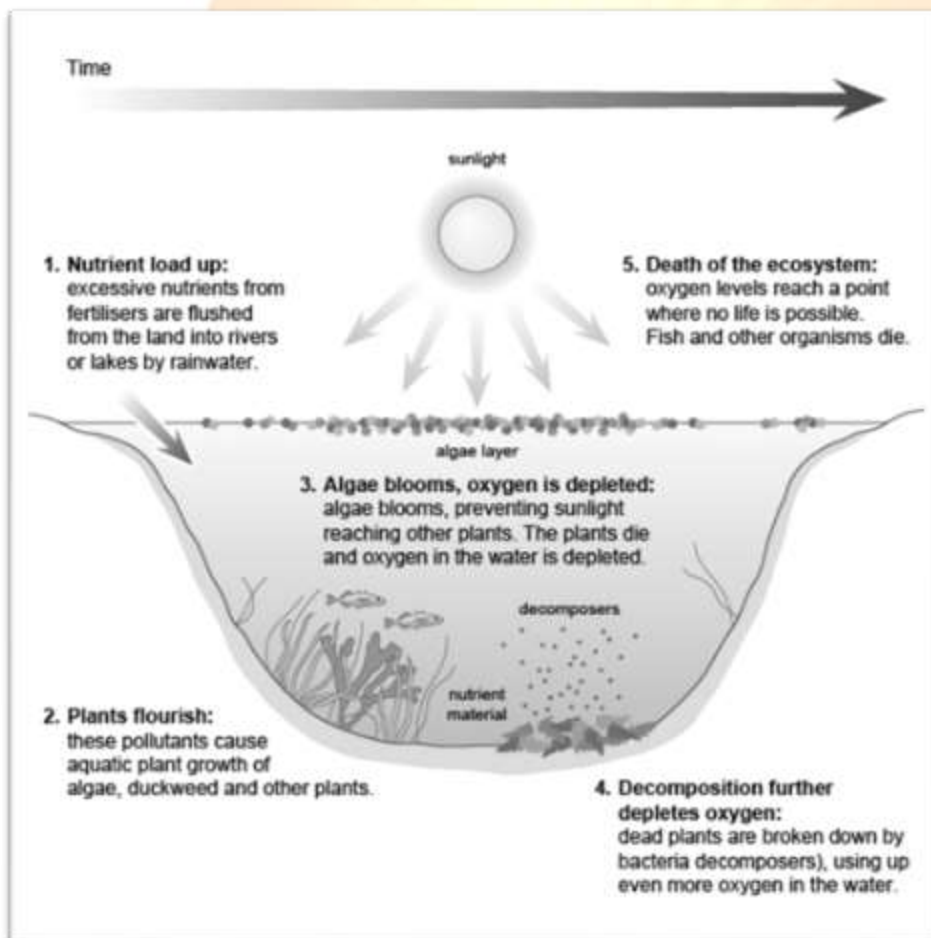
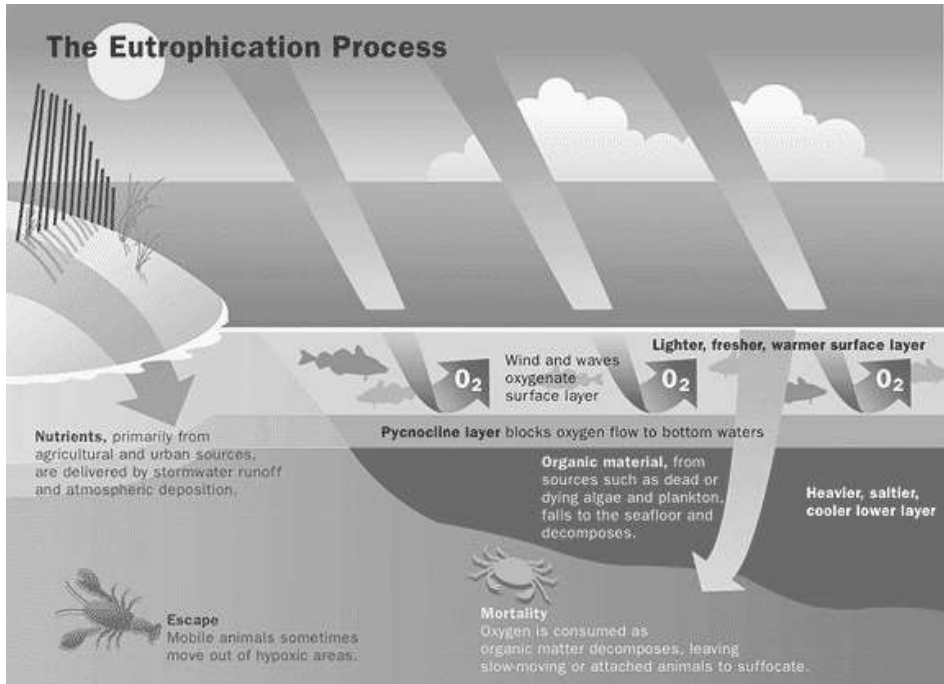
From a current pH of 8.2 (alkaline), it is predicted that the ocean's pH could fall to about 7.8 (still slightly alkaline) by 2100.

Although the chemistry of ocean acidification is simple and well understood, its effect on marine life is much less well-known as the process has only been recognised for less than a decade. Even relatively small increases in ocean acidity decrease the capacity of corals to build skeletons, which in turn decreases their capacity to create habitat for the Reef's marine life.

6. EUTROPHICATION & BIO-REMEDIATION

WHAT IS EUTROPHICATION?

Within the past 50 years, eutrophication---the over-enrichment of water by nutrients such as nitrogen phosphorus---has emerged as one of the leading causes of water quality impairment. The two most acute symptoms of eutrophication are hypoxia (or oxygen depletion) and harmful algal blooms, which among other things can destroy aquatic life in affected areas. Eutrophication is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis, such as sunlight, carbon dioxide, and nutrient fertilizers. Eutrophication occurs naturally over centuries as lakes age and are filled in with sediments. However, human activities have accelerated the rate and extent of eutrophication through both point-source discharges and non-point loadings of limiting nutrients, such as nitrogen and phosphorus, into aquatic ecosystems (i.e., **cultural eutrophication**), with dramatic consequences for drinking water sources, fisheries, and recreational water bodies. For example, aquaculture scientists and pond managers often intentionally eutrophy water bodies by adding fertilizers to enhance primary productivity and increase the density and biomass of recreationally and economically important fishes via bottom-up effects on higher trophic levels. However, during the 1960s and 1970s, scientists linked algal blooms to nutrient enrichment resulting from anthropogenic activities such as agriculture, industry, and sewage disposal. The known consequences of cultural eutrophication include blooms of blue-green algae (i.e., cyanobacteria), tainted drinking water supplies, degradation of recreational opportunities, and hypoxia.



Consequences-

Excess nutrients in coastal waters can cause excessive growth of phytoplankton, microalgae (i.e. epiphytes and microphytes), and macroalgae (i.e. seaweed).

In turn, the increase in phytoplankton and algae can lead to more severe secondary impacts such as:

- Loss of subaquatic vegetation as excessive phytoplankton, microalgae and macroalgae growth reduce light penetration.
- Change in species composition and biomass of the benthic (bottom-dwelling) aquatic community, eventually leading to reduced species diversity and the dominance of gelatinous organisms such as jellyfish.
- Coral reef damage as increased nutrient levels favor algae growth over coral larvae. Coral growth is inhibited because the algae outcompetes coral larvae for available surfaces to grow.
- A shift in phytoplankton species composition, creating favorable conditions for the development of nuisance, toxic, or otherwise harmful algal blooms.
- Low dissolved oxygen and formation of hypoxic or “dead” zones (oxygen-depleted waters), which in turn can lead to ecosystem collapse.

The scientific community is increasing its knowledge of how eutrophication affects coastal ecosystems, yet the long-term implications of increased nutrient fluxes in our coastal waters are currently not entirely known or understood. We do know that eutrophication diminishes the ability of coastal ecosystems to provide valuable ecosystem services such as tourism, recreation, the provision of fish and shellfish for local communities, sportfishing, and commercial fisheries. In addition, eutrophication can lead to reductions in local and regional biodiversity.

Red tides are nutrient-fueled blooms of phytoplankton that discolor water with their pigments. Several species are known to have toxic effects on marine life and pose a risk to human health through the consumption of exposed fish.

Harmful Algal Blooms- Harmful algal blooms can cause fish kills, human illness through shellfish poisoning, and death of marine mammals and shore birds. Harmful algal blooms are often referred to as “red tides” or “brown tides” because of the appearance of the water when these blooms occur.

Hypoxia- Hypoxia, considered to be the most severe symptom of eutrophication. Hypoxia occurs when algae and other organisms die, sink to the bottom, and are decomposed by bacteria, using the available dissolved oxygen. Salinity and temperature differences between surface and subsurface waters lead to stratification, limiting oxygen replenishment from surface waters and creating conditions that can lead to the formation of a hypoxic or “dead” zone. The formation of dead zones can lead to fish kills and benthic mortality. Because

benthic organisms are bottom dwelling and cannot easily flee low-oxygen zones, they are often the most severely impacted.

The most conspicuous effect of cultural eutrophication is the creation of dense blooms of noxious, foul-smelling phytoplankton that reduce water clarity and harm water quality. Algal blooms limit light penetration, reducing growth and causing die-offs of plants in littoral zones while also lowering the success of predators that need light to pursue and catch prey. Furthermore, high rates of photosynthesis associated with eutrophication can deplete dissolved inorganic carbon and raise pH to extreme levels during the day. Elevated pH can in turn 'blind' organisms that rely on perception of dissolved chemical cues for their survival by impairing their chemosensory abilities. When these dense algal blooms eventually die, microbial decomposition severely depletes dissolved oxygen, creating a hypoxic or **anoxic** 'dead zone' lacking sufficient oxygen to support most organisms. Furthermore, such hypoxic events are particularly common in marine coastal environments surrounding large, nutrient-rich rivers (e.g., Mississippi River and the Gulf of Mexico; Susquehanna River and the Chesapeake Bay) and have been shown to affect more than 245,000 square kilometers in over 400 near-shore. Hypoxia and anoxia as a result of eutrophication continue to threaten lucrative commercial and recreational fisheries worldwide.

Some algal blooms pose an additional threat because they produce noxious toxins (e.g., microcystin and anatoxin). Over the past century, harmful algal blooms (**HABs**) have been linked with (1) degradation of water quality (2) destruction of economically important fisheries and (3) public health risks. Within freshwater ecosystems, cyanobacteria are the most important phytoplankton associated with HABs. Toxigenic cyanobacteria, including *Anabaena*, *Cylindrospermopsis*, *Microcystis*, and *Oscillatoria (Planktothrix)*, tend to dominate nutrient-rich, freshwater systems due to their superior competitive abilities under high nutrient concentrations, low nitrogen-to-phosphorus ratios, low light levels, reduced mixing, and high temperatures.

Controls- Given the widespread extent of water quality degradation associated with nutrient enrichment, eutrophication has and continues to pose a serious threat to potable drinking water sources, fisheries, and recreational water bodies.

A variety of strategies are in place to minimize the effects of cultural eutrophication, including (1) diversion of excess nutrients, (2) altering nutrient ratios, (3) physical mixing, and (4) application of potent algaecides and herbicides. In general, these strategies have proven to be ineffective, costly, and/or impractical, especially for large, complex ecosystems. Water quality can often be improved by reducing nitrogen and/or phosphorus inputs into aquatic systems, and there are several well-known examples where bottom-up control of nutrients has greatly improved water clarity. However, nutrient reduction can be difficult (and expensive) to control, especially in agricultural areas where the algal nutrients come from nonpoint sources. The use of algaecides, such as copper sulfate, is also effective at reducing HABs temporally. However, algaecides are expensive to apply, do not control the primary cause of the problem (i.e., abundant resources for primary producers) and pose risks to humans, livestock, and wildlife, in addition to harming a variety of non-target aquatic organisms.

WHAT IS BIOREMEDIATION?

Bioremediation is a “treatment that uses naturally occurring organisms to break down hazardous substances into less toxic or non toxic substances.”

Bioremediation is a process that uses living organisms, mostly microorganisms and plants, to degrade and reduce or detoxify waste products and pollutants.

Bioremediation is the process of using organisms to neutralize or remove contamination from waste. It is very important to understand that this form of waste remediation uses no toxic chemicals, although it may use an organism that can be harmful under certain circumstances.

At sites filled with waste organic material, bacteria, fungi, protists, and other microorganisms keep on breaking down organic matter to decompose the waste. If such environment is filled with oil spill, some organisms would die while some would survive. Bioremediation works by providing these organisms with different materials like fertilizer, oxygen and other conditions to survive. This would help to break the organic pollutant at a faster rate. In other words, bioremediation can help to clean up oil spills.

Bioremediation is important for two reasons.

1. It uses no chemicals – One of the issues with using man-made chemicals in the treatment and removal of contamination is that the chemicals eventually make it into the water supply. There were many chemicals used at the beginning of the [waste management](#) era that we now know were very harmful to [plant, animal](#) and human life once they reached the water supply.

2. It can allow waste to be recycled – Another major reason that bioremediation is preferred is that once the waste is treated and the contamination neutralized or removed, the waste itself can then be recycled. When chemical remediation types are used, the waste is still contaminated just with a less toxic substance and in general, cannot then enter into the recycle process. Bioremediation allows for more waste to be recycled while chemical methods still create waste that cannot be used and has to be stored somewhere.

There are two classes of bioremediation used. (Don't confuse the class type with the actual types of bioremediation available, the classes describe the general application of the organisms.) The two classes are:

- **In-situ** – In situ refers to when contaminated waste is treated right at its point of origin. For example, there may be soil that is contaminated. Rather than remove the soil from its point of origin, it is treated right where it is. The benefit to in situ treatment is that it prevents the spread of contamination during the displacement and transport of the contaminated material.
- **Ex-situ** – Ex situ refers to treatment that occurs after the contaminated waste has been removed to a treatment area. To use soil as the example again, the soil may be removed and transported to an area where the bioremediation may be applied. The main advantage to this is it helps to contain and control the bioremediation products, as well as making the area that was contaminated available for use.

There are far more than 9 types of bioremediation, but the following are the most common ways in which it is used.

1. **Phytoremediation** – use of plants to remove contaminants. The plants are able to draw the contaminants into their structures and hold on to them, effectively removing them from soil or water.
2. **Bioventing** – blowing air through soil to increase oxygen rates in the waste. This is an effective way to neutralize certain oxygen sensitive metals or chemicals.
3. **Bioleaching** – removing metals from soil using living organisms. Certain types of organisms are drawn to heavy metals and other contaminants and absorb them. One new approach was discovered when fish bones were found to attract and hold heavy metals such as lead and cadmium.
4. **Bioaugmentation** – adding microbes and organisms to strengthen the same in waste to allow them to take over and decontaminate the area

There are some types of contamination that are very difficult to use bioremediation for. The two biggest concerns are:

1. Cadmium
2. Lead

Both of these are classified as heavy metals and are difficult to remove using microorganisms. But a recent discovery about the absorption rate of fish bone has proved successful. In fact, bone seems to hold the clue for removing heavy metal contamination. Char is used to remove small amounts of zinc, lead and cadmium; and it is thought that the calcium in the fish bone is what makes it effective.

7. GOVERNMENT OF INDIA NOTIFIES PLASTIC WASTE MANAGEMENT RULES, 2016

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011. The Plastic Waste Management Rules, 2016 aim to:

- Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste,
- Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also;
- To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility;
- To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system;
- To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers.

An eco-friendly product, which is a complete substitute of the plastic in all uses, has not been found till date. In the absence of a suitable alternative, it is impractical and undesirable to impose a blanket ban on the use of plastic all over the country. The real challenge is to improve plastic waste management systems.

VAJIRAM & RAVI

8. ENVIRONMENT POLLUTION- AIR POLLUTION IN INDIA

Air Pollution

Environment & Ecology Handout 1: GS PCM Batch 2019- 2020

According to W.H.O data released in May 2016 air pollution is the 5th largest killer in India. Among the world's 20 most polluted cities 13 are in India. India is in the group of countries which have the highest particulate matter (PM) levels. Its cities have highest levels of PM 10 and PM 2.5 (particles with diameter of 10 and 2.5 microns) and high concentration of carcinogenic substances like Sulphur Dioxide and Nitrogen Oxide. Gwalior, Allahabad, Patna, Raipur are in the top 10 polluted cities, Delhi at 11.

Action Plan:

- Environment Pollution (Prevention & Control) Authority (EPCA) is the nodal authority for tackling pollution in Delhi.
- Graded Response Action Plan (GRAP) has already kicked off to handle air pollution. It was notified by Union Environment Ministry in January 2017. It was approved by the Supreme Court to tackle air pollution in Delhi and adjoining areas.

GRAP classification of air pollution	PM 2.5 ($\mu\text{g}/\text{m}^3$)	PM 10 ($\mu\text{g}/\text{m}^3$)
Moderate to poor	61-90	101-250
Very poor	121-250	351-430
Severe	>250	>430
Severe to emergency	>300	>500

- Main objective of GRAP is to institutionalize measures to tackle air pollution emergencies.
- Steps undertaken under GRAP:
 - Badarpur power plant shut down in winters.
 - State Pollution Control Boards of UP and HR are monitoring pollution.
 - Movements of trucks are restricted.
- Universalisation of BS IV by 2017 leapfrogging from BS IV to BS VI fuel standards by 1st April 2020. An important strategy is to scale up public transport system and improve last mile connectivity (private vehicles constitute 90% of all vehicles in India).
- On Oct 27, 2017 the Supreme Court directed Environment Ministry to notify Comprehensive Action Plan to improve air quality.
- EPCA under the direction of the Supreme Court prepared first ever comprehensive plan with short term, medium term and long term measures for key sources of air pollution in Delhi and NCR.

GRAP is an emergency response but this region cannot remain on emergency mode always.

Supreme Court Bans Use Of Heavy Metals In Firecrackers To Prevent Air Pollution

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- Five harmful heavy metals like lithium, antimony, mercury, arsenic and lead in the manufacturing of firecrackers as they cause air and noise pollution.
- The Supreme Court maintained that it is the responsibility of the Petroleum and Explosives Safety Organisation (PESO) to ensure compliance of ban order to ensure compliance of ban order

India Becoming World Top Sulphur Dioxide Emitter: Study

- India's emissions of the air pollutant sulphur dioxide increased by 50 per cent since 2007, while Chinas fell by 75 per cent.
- Sulphur dioxide is an air pollutant that causes acid rain, haze and many health-related problems. It is produced predominantly when coal is burned to generate electricity.
- China and India are the world's top consumers of coal, which typically contains up to three per cent sulphur. Most of the two countries sulphur dioxide emissions come from coal-fired power plants and coal-burning factories.

BS-VI fuel norms from April 1, 2018 in Delhi instead of 2020

- BS-VI fuel will bring down sulphur by 5 times from the current BS-IV levels—a whopping 80 per cent reduction that makes this fuel extremely clean
- This will improve emissions from the existing fleet, even from the older vehicles on road, while allowing more advanced emissions control systems to be fitted in BS-VI vehicles when they begin to roll
- Full advantage of this move will be possible only when vehicle technology moves to BS-VI

Delhi will be the first city in our country to have fuel that is BS VI complaint. India currently operates on Bharat Stage IV emission norms for two-, three- and four-wheelers. In a bid to bring down pollution levels and having cleaner [cars](#) on the road, the Government has decided to skip directly to BS VI norms by 2020. This brings India closer to the world as Euro VI emission standards have been in place since 2014 across Europe.

What are emission norms? - Let's say this together: Vehicle pollution caused by the burning of fossil fuels has played a big role in global warming. The need to cut down the emission levels is what led to the formation of such norms that limit vehicular emissions across the globe, with Europe's Euro 1 coming into force in 1992 with the objective of having all vehicles comply by 1993. Europe has moved at a brisk pace by putting in place more stringent norms every 3-5 years and is currently operating at Euro VI emission standards. The Bharat emission norms that came into force in 1991 for petrol and '92 for diesel were basic and primarily governed carbon monoxide output from vehicles. India introduced Euro I emission standards in 2000, by which time Europe was already operating at Euro III norms. We have been slower to implement change, primarily due to the costs involved and the quality of fuel available. With India moving on to Euro VI/ BS VI standards, we will finally be at par with Europe and that is quite a feat. For BS VI, the stipulated CO emissions for

diesel vehicles is 0.50 g/km and for petrol is 1.0 g/km, NO_x is regulated at 0.080 g/km for diesel and 0.060 g/km for petrol, while particulate matter (PM) is set at 0.005 g/km for both. We should see a substantial drop in air pollutants, especially for diesel vehicles, as current BS IV figures are 0.25 g/km NO_x for and 0.025 g/km PM.

What are car companies doing about BS VI?- Vehicle manufacturers are investing in the tech to deliver according to the new guidelines, but they're unlikely to release cars before the deadline, because new engines mean new costs. Mercedes-Benz India has introduced their S-Class with BS VI-compliant made-in-India engines two years prior to deadline.

What is the implication of cleaner fuel?- The sulphur content in BS VI fuel is substantially lower than that of BS IV fuel. Currently the sulphur content in our fuel is at 50 parts per million (PPM) while BS VI fuel has a sulphur content of 10 ppm.

Ban on Polluting Fuels

Recently, Supreme Court banned the use of furnace oil and pet-coke in Haryana, Rajasthan and Uttar Pradesh. Later, however, it eased its ban on use of petcoke for cement manufacturing, lime industries and on furnace oil for power generation.

Pet coke and other polluting fuels such as furnace oil are widely used by cement factories, dyeing units, paper mills, brick kilns and ceramics businesses. Petroleum coke or pet coke, is a solid carbon rich (90% carbon and 3% to 6% sulfur) material derived from oil refining. It is a dirtier alternative to coal and emits 11% more greenhouse gases than coal and has higher sulphur than other fossil fuels. India is the world's biggest consumer of petroleum coke. India is becoming a dumping ground of petcoke from the US, which has banned its internal use because of pollution.

Furnace Oil is a dark viscous residual fuel obtained by blending mainly heavier components from crude distillation unit, short residue and clarified oil from catalytic cracker unit. It is one of the cheapest fuels available and used to generate power in industries to run boilers, turbines etc.

Reason for increased use of Pet-coke and furnace oil

- Per-unit delivered energy for petcoke is much cheaper compared to coal making it attractive for buyers.
- Favourable tax regime: Though both these fuels are taxed at 18% under GST but the industries, which use these fuels for manufacturing, get entire tax on the fuels credited back. On the other hand, on natural gas, which is not included in GST, the VAT is as high as 26 per cent in certain states.
- Clean energy cess of Rs. 400 per tonne levied on coal, further promotes shift to pet-coke.
- Zero Ash Content.
- It is an approved fuel in many states such as Andhra Pradesh, Telangana, Gujarat and Karnataka.

At present, India produces 12-13 million tonnes of pet coke. But what is most alarming is that our imports are soaring. Last fiscal year till November, we had already imported 10 million tonnes of pet coke, which is equal to the total imports of the previous year. At this rate we could end up with some 30 million tonnes of pet coke by year end, which is roughly equal to what China was using at its peak in 2014.

So, what is the way ahead? First, we should ensure that we utilise our domestic pet coke and do not end up dumping it on others like the US does. But this also means we should stop the import of cheap pet coke. Second, we should use the domestic pet coke only in the industries where emissions can be controlled. For instance, in the cement industry's clinker plants. But all other uses should be stopped.

9. ENVIRONMENTAL POLLUTION- SOLID WASTE GENERATION & SOLID WASTE MANAGEMENT RULES, 2016

With rapid urbanisation, the country is facing massive waste management challenge. Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centres clean. However, almost all municipal authorities deposit solid waste at a dumpyard within or outside the city haphazardly. Experts believe that India is following a flawed system of waste disposal and management.

As per CPCB Report- In 2016, India produced 50 MT of waste. With ineffective solid waste management, cities are drowning in piles of refuse; waste also contaminates groundwater and puts out toxic emissions of dust into atmosphere. According to CPCB- over 90% of Indian cities with a functional collection system, dispose off their waste in landfills.

Solid Waste Management- collection+treatment+dispersal of solid wastes generated in an environmentally acceptable manner. The key to efficient waste management is to ensure proper segregation of waste at source and to ensure that the waste goes through different streams of recycling and resource recovery. Then reduced final residue is then deposited scientifically in sanitary landfills. Sanitary landfills are the ultimate means of disposal for unutilised municipal solid waste from waste processing facilities and other types of inorganic waste that cannot be reused or recycled.

Government notified Municipal Solid Waste Management Rules in 2016- thereby making it mandatory for all ULBs to manage solid waste.

‘Solid Waste Management Rules Revised After 16 Years; Rules Now Extend to Urban and Industrial Areas’

Some of the salient features of SWM Rules, 2016 include:-

1. The Rules are now applicable beyond Municipal areas and extend to urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, airbase, Port and harbour, defence establishments, special economic zones, State and Central government organizations, places of pilgrims, religious & historical importance.
2. The source segregation of waste has been mandated to channelize the waste to wealth by recovery, reuse and recycle.
3. Responsibilities of Generators have been introduced to segregate waste in to three streams, Wet (Biodegradable), Dry (Plastic, Paper, metal, wood, etc.) and domestic hazardous wastes (diapers, napkins, empty containers of cleaning agents, mosquito repellents, etc.) and handover segregated wastes to authorized rag-pickers or waste collectors or local bodies.
4. Integration of waste pickers/ ragpickers and waste dealers/ Kabadiwalas in the formal system should be done by State Governments, and Self Help Group, or any other group to be formed.
5. No person should throw, burn, or bury the solid waste generated by him, on streets, open public spaces outside his premises, or in the drain, or water bodies.
6. Generator will have to pay 'User Fee' to waste collector and for 'Spot Fine' for Littering and Non-segregation.
7. Used sanitary waste like diapers, sanitary pads should be wrapped securely in pouches provided by manufacturers or brand owners of these products or in a suitable wrapping material and shall place the same in the bin meant for dry waste / non- bio-degradable waste.
8. The concept of partnership in Swachh Bharat has been introduced. Bulk and institutional generators, market associations, event organizers and hotels and restaurants have been made directly responsible for segregation and sorting the waste and manage in partnership with local bodies.
9. All Resident Welfare and market Associations, Gated communities and institution with an area >5,000 sq. m should segregate waste at source- in to valuable dry waste like plastic, tin, glass, paper, etc. and handover recyclable material to either the authorized waste pickers or the authorized recyclers, or to the urban local body.
10. The bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local authority.
11. Every street vendor should keep suitable containers for storage of waste generated during the course of his activity such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruits etc. and deposit such waste at waste storage depot or container or vehicle as notified by the local authority.
12. Special provision for management of solid waste in hilly areas:- Construction of landfill on the hill shall be avoided. A transfer station at a suitable enclosed location shall be setup to collect residual waste from the processing facility and inert waste. Suitable land shall be identified in the plain areas, down the hill, within 25 kilometers for setting up sanitary landfill. The residual waste from the transfer station shall be disposed off at this sanitary landfill.
13. In case of non-availability of such land, efforts shall be made to set up regional sanitary landfill for the inert and residual waste.

If implemented well, SWMR have the potential to transform waste management system in India.