ENVIRONMENT

in 21st Century

(Volume II)

Editor

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Bahona College, Jorhat,
Assam, India.

Kripa Drishti Publications, Pune.

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1. Environment and COVID-19

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1.1 Introduction:

The COVID-19 pandemic has influenced different aspects of our life. It has affected numerous sectors worldwide. While the COVID-19 pandemic has had an unprecedented effect on society and the economy, to the contrary, it has helped to restore some environmental damage (Chakraborty and Maity, 2020). Impact of COVID on the environment has been mixed. Although the pandemic resulted in enhanced environmental conditions, there have been other harmful effects. In short, the positive effects have been reduced GHG (greenhouse gas) emissions, improved water quality, reduced noise pollution, improved air quality and in some cases, wildlife restoration. Negative effects have been increased medical waste, haphazard disposal of PPE, increased municipal waste and reduced recycling efforts.

Worldwide spread of COVID-19 has brought a dramatic decrease in industrial activities, productivity, tourism, road traffic, classroom teaching etc. Inadequate human interaction with nature during this crisis time has appeared as a blessing for nature and environment. Worldwide reports are indicating that after the occurrence of COVID-19, environmental conditions including water quality in rivers, air quality are getting better and wildlife is blossoming. The consequences of lockdowns have been remarkable, as pollution levels have dropped significantly; for instance, greenhouse gas emissions, nitrogen dioxide, black carbon and water pollution have decreased significantly.

It has been seen for a long time that India has always been a core of pollution with vast population, heavy traffics and polluting industries. But after announcement of lockdown due to COVID-19, quality of air has started to improve and all other environmental parameters such as water quality in rivers, air, wildlife, climate etc. have improving which is an excellent for our environment. In this chapter, the impacts of COVID-19 on water resources of India, especially on the **river water quality, air quality and impact on wildlife are discussed.**

- **COVID-19 and River Water Quality:** In India, more than 38,000 million liters of untreated sewage are discharged daily into the rivers. Due to the limited sewage treatment capacity, which can treat only 38% of the sewage generated (CPCB, 2015). Many industries in India, whether it is large or small were closed from March 2020, to September 2020, as a result of nationwide lockdown imposed for COVID-19. During this period, the water quality and quantity in many rivers have consequently improved in a short span of time, especially in river Ganga, as we know Ganga is longest river of our country which covers many states of our country.

In river Ganga, the dissolved oxygen levels have increased, biological oxygen demand, and nitrate concentration have decreased which leads to improvement in the overall water quality (Dutta et al., 2020).

According to Central Pollution Control Board (CPCB, 2020) report, improvements in water quality have also been observed in India. It is indicating slight decreases in nitrates and improvements in dissolved oxygen in the river Ganga, and similar improvements in the biological, chemical and oxygen demand indicators in the river Yamuna.

The changes were predominantly attributable to the lack of industrial and agricultural activity although unabated domestic waste discharge led to there not being a significant fall in the biological oxygen demand in the river Ganga (CPCB, 2020).

However, such analyses can be extended to other major rivers of India. In the same way, the Krishna and Cauvery rivers and their tributaries in Karnataka (in the central and southern part of India) also regained their decades-old status in terms of water quality (KSPCB, 2020). On the contrary, the rivers that have more urban catchment areas, such as Yamuna River in Delhi, reported no major decline in water quality since domestic sewage makes up about 80% of the pollution, while the rest is from the industries (India Water Portal, 2020).

- **COVID-19 and Air Quality:** Air pollution caused serious health issues, and a large number of people die due to the air pollution. In 2017 alone, air pollution caused 4.9 million deaths globally, with low-income economies suffering the most (Global Burden of Disease Collaborative Network, 2018).

Air pollution has been a widespread and visible concern, which has increased significantly over the last decade across many parts of India with several studies tracking the severe consequences for health and well-being (Spear et.al). Disability Adjusted Life Years (DALYs) suggest that deaths of around 1.24 million could be due to air pollution in the year 2017 for India (Balakrishnan, 2017).

Early estimates suggest that reduced air pollution during lockdowns and restrictions in the economy could have prevented up to 0.65 million annual deaths for India (Sharma at.al), 11 thousand avoided deaths in Europe (Myllyvirta et.al) and saved many lives in China (Isaifan et.al). Due to the drop in fossil fuel consumption, air pollution has dropped in several countries, such as China, Italy, the USA, and India (Paital, 2020). Dantas et al. (2020) reported that carbon monoxide (CO) and NO2 decreased significantly during the global shutdown, while ozone (O3) increased due to reduction in NO2.

Air pollutants such as NO2 levels in major Indian cities such as Ahmedabad, Mumbai, and Pune decreased between 40 and 50% at the time of lockdown (Wright, 2020). NO2 and carbon dioxide (CO2) emissions dropped significantly due to the shutdown in industrial and vehicle operations worldwide (Paital, 2020). Indian residents can now see the towering peaks of the Himalayas from Punjab for the first time in 30 years, after a massive drop in pollution caused by the country's corona virus lockdown. The lockdown, implemented on March 22, has resulted in a "significant improvement in air quality in the country", as revealed by data analysis from India's Central Pollution Control Board.

The report showed air quality in 85 cities had improved significantly as most vehicles remained off roads and non-essential businesses closed. The report said:

Data shows that on average, Indian cities had an AQI (Air Quality Index) of 115 between March 16 and 24. The air quality started showing improvements from the first day of the 21-day lockdown. The average AQI fell to 75 in the first three days of the lockdown.

Dozens of residents from the Jalandhar district in Punjab took to social media to share crystal-clear views of the snow-capped mountains, thanking the improved air quality for the awe-inspiring snaps. The mountain range is the world's highest with elevations of more than 8,000 metres, and includes the world's tallest peak, Mount Everest. (See Figure 1.1).

Figure 1.1: Mount Everest

India has a population of around 1.3 billion people, with one of the world's most polluted cities, according to IQ Air pollution researchers. Ghaziabad, an area close to New Delhi in northern Uttar Pradesh state, had been ranked as the world's most polluted, with an average PM 2.5 concentration measurements of 110.2 in 2019. NASA and the European Space Agency's pollution monitoring satellites detected a significant decline in the amount of nitrogen dioxide (NO2) over China since the lockdown.

- **Covid-19 and Impact on Wildlife:** The COVID-19 pandemic has resulted in a global shutdown. Cities which are large or small both have effected almost equally. Reduced motorized traffic, shuttered businesses, restricted travel and trade and closed parks and beaches has the potential to significantly impact wildlife. It has been seen that, in the absence of people, nature was improved and became more perfect. But some new research showed that the true effect of suddenly removing people from different aspect of environment has turned out to be much more complex.

Cities that kept natural spaces unlock during the shutdown may unintentionally have contributed to harmful impacts on wildlife if more people visited these sites than usual. According to Kowarik (2011) environmental variation within cities, including urban noise, vehicular traffic, air and noise pollution, have long been known to be associated with shifts in wildlife behaviour, dispersal, and survival. In countries like India, monkeys and a number of other wildlife species are very much adapted to urban environments and are very much dependent on human generated food waste to stay alive. People feed monkeys for religious sentiments also which condition them to associate human presence with food and complicate the matter further.

Where no one to feed, animals that have grown dependent on humans for food has been forced to fend for them. This condition also has the potential to generate further problems including man-animal conflict situations. Thailand, known for the urban macaque monkey population that relies on food provided by the numerous tourists, has seen gangs of macaques surrounding open stores and fighting in the streets over dwindling food resources. Some urban dwellers like monkeys, gulls and rats struggled to find enough food in the absence of tourists and restaurant scraps. The idea that wildlife population will reclaim urban environments during this lockdown period seems quite far-fetched as animals have always been part of our surroundings. Another immense impact of the corona virus occurrence is the decline in wildlife trade which comes as a much needed silver lining in these dark times. When Lockdowns began and humans reduced their activities, reports of unusual wild animal encounters and behaviours began appearing on social and regular media. The shy predatory species like cougars were unexpectedly recorded in cities in the Americas. It has been seen Jackals ventured into the city part in broad daylight in Tel Aviv, Israel. Among all above mentioned environmental factor there are many other environmental aspects which has influenced by covid-19 lockdown. As we see there are various researches and studies which are showing that our environment has improved and became more suitable for living creature but there are also some negative impacts of this. But in short, it can be said that positive impacts is more noticeable as compare to negative impacts.

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2. Environmental Degradation: Basis, Impacts and Possible Alleviation

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Abstract:

Environmental degradation means the disintegration or deterioration of the environment and its components affecting through the consumption or destruction of the valuable assets of the earth due to scarcity of resources, accelerated soil erosion, landslides, droughts, floods, declines of forest cover, decline in agricultural yields, siltation problem, shrinking of bio-diversity etc. These results in the destruction of environment along with the abolition of wildlife and then environment become unsupportive to its living components. The major causes behind the environmental degradation are urbanization, industrialization, over-population, deforestation etc. Environmental pollution refers to the degradation of both the quality and quantity of natural resources.

Some undesirable and detrimental human activities are responsible for the environmental degradation producing different types of degrading particles and substances in the environment. The exposure of these degrading particles and substances affect air, water and soil throughout the world making the earth environment unsuitable for the living species.

Deterioration of the agricultural land is being affected by the quality of soil and climate change and these factors are facilitating this incident. The overall impacts of environmental degradation are forcing to destabilize the ecosystem as well as the global climate. Environmental degradation can be prevented by framing effective relevant policies related to the use of renewable sources of energy instead of non-renewable sources, protection of species from their extinction, conservation of water resources from the polluted materials and chemicals from industries, factories, formulation of energy saving plan for community.

Though the government has launched many programmes and policies but still there are more needs for drastic interventions from national and international levels as well as individual awareness which are necessary to maintain and continue the ecological balance and sustainability.

Keywords: Environmental degradation, Deterioration of natural resources, Environmental pollution, Ecological balance and sustainability.

2.1 Introduction:

Over the last few decades, environmental degradation has come to be a "common concern" for humankind. Excessive consumerism and economic growth have started to exhibit malicious effects on our Mother Nature. Environmental degradation is the result of past and present generations using up or degrading natural resources more rapidly than nature can reinstate them. The interaction between human health and the environment has been extensively studied by the environmental researchers. Environmental risks significantly affect human health, either directly by exposing people to harmful agents, or indirectly, by disrupting life-sustaining ecosystems (Tyagi et al, 2014).

Environmental degradation is the disintegration or deterioration of the environment through consumption of assets, like, air, water and soil due to human intervention and it is considered as one of the most significant threats for the mankind. Environmental degradation might be a consequence of socio-economical, innovative and institutional mal-exercises.

Degradation happens when Earth's normal resources are exhausted. These resources comprise water, air, soil, wildlife, plants, animals, micro-organisms. During the last decades, deforestation, rapid urbanization, industrialization, massive agricultural expansion etc. are responsible for the rapid changes and disruptions in our environment.

Environment also degrades due to the attempts of the developing countries to achieve their sustained economic growth for poverty reduction (Rani, 2016) as well as for the high energy use by the developed countries for the maintenance of their affluent lifestyle.

2.2 Causes of Environmental Degradation:

The causes of environmental degradation and habitat eradication could be desertification, deforestation, population explosion, pollution, climate change etc. The primary explanation behind the environmental degradation is manmade disturbance or mal practices of humans. The degree of the impact varies with the effect on habitats of the plants and animals that inhabit into it. Here we will emphasize our discussion on some related significant factors.

2.2.1 Desertification:

Desertification is the loss of biological productivity of land due to natural processes such as climate change (particularly due to the global warming) or by human activities. It is important to distinguish between anthropologically created ecosystem stress affecting the components of environment and natural disturbances (environmental factors beyond the reach of ecosystem evolutionary history) as drought, flood, fire and wind storms that produce desertification.

Grazing and overgrazing of livestock decreases coverage of vegetation and stimulates the unwanted changes on the bio-geophysical ecosystem and weather patterns of the arid and semi-arid regions. The rise in the size of bare soil patches resulting from overgrazing contributes to an increase in albedo. A higher range of albedo, reflected from the earth's crust increases the soil radiation and has an effect on ambient temperatures and humidity.

Human operations which alter the atmospheric conditions by changing the chemical compositions of air, soil and water have significant effects on desertification. Dust, storms and airborne dust particles mainly coming from wind driven salt particles affect the ground's surface and release into the airway fine particles (Okine et al., 2006).

Dust emissions from arid and semi-arid areas can be transported worldwide by wind. The effect of dust on light dispersion and light absorption produce atmospheric dust or mineral aerosols that impact on the global environment. Erosion by wind of any of the land degradation will increase the risk of wind erosion in dry-lands.

The growth of biosphere around water sources exposes land to wind erosion, including the areas with fair grass cover. The clearance of areas for urban and urban development opens wind erosion to the soils and exposes urban residents to atmospheric pollution. Sand dunes are also a wind-erosion type of land (Mirzabaev et al., 2019).

The relationship between the biodiversity in habitats and their long term behaviour is one of the main biological challenges in the 21st century. There are four hypotheses about this relationship, namely the hypothesis of diversity and consistency, the hypothesis of riveting, the hypothesis of redundancy and the hypothesis of an idiosyncratic response (Johnson et al., 1996). The hypothesis of diversity and consistency predicts that the productivity of ecosystems and their potential will increase with growing species number within the system (Mirzabaev et al., 2019).

2.2.2 Environmental Pollution:

Environmental pollution refers to the degradation of the standard and quantity of environmental natural resources. Different sorts of human activities are the most reasons for environmental degradation. The key reasons of environmental pollution are the expansion of human population and agriculture modernization (Maurya and Malik: 2016, Maurya et al., 2019) as well as industrialization, unplanned urbanization (Olorodeet et al., 2015).

Various pollutants from natural and man-made sources enter the atmosphere continuously and these create disturbances in the dynamic equilibrium of the atmosphere which leads to air pollution producing hazards to living and non-living components of environment. Industries and automobiles are the first and secondary contributing factors of pollution worldwide. The car and industries increase the amount of poisonous gases like SOx, NOx, CO, and smoke within the atmosphere.

Automobiles use gallons of fuel, then CO2, carbon monoxides, sulphide, dioxide and particulate matters are produced resulting in rising heat (Alexander and Kannanr, 1995; Maurya et al., 2020). Burning fuel wood, agriwaste and biomass cake releases annually over 165 million plenty of combustion products into the indoor and outdoor air of India. These biomass-based household ovens in India also are a number one cause for global climate change and greenhouse emissions (Chopra, 2016; Das, 2020). In case of water pollution, microbial contamination of groundwater due to sewage outfalls and high concentration of these in marine and river water due to agricultural runoff are among the most serious threats.

Unsafe drinking or bathing water can impose serious health risks (both acute and delayed) to human health. Toxic pollutants, fertilizers and pesticides used in agriculture have been found in rivers, lakes and ground water. The decomposers generally use solvent oxygen (O2) as they decrease breathes for the necessity of biologic oxygen demand (BOD). Flora and wildlife within the rivers are evolving and reduced by suffocation induced death (Maurya and Malik, 2016).

The high incidence of oil leaks and incidents within the environment is gigantic and a failure to preserve pipeline integrity causes environmental contamination. After discovery of oil at Olobiri within the eastern Niger Delta of Nigeria by Shell British Petroleum, oil mining began in 1958 (NNPC, 2016). Nine oil-producing states and 185 local authorities currently exist in Nigeria.

There are over 800 Niger Delta oil-producing villages, with over 900 oil wells and lots of associated facilities (Osuji & Onojake, 2004). It is approximately a network of 7,000 km of oil and gas pipelines (Anifowose, 2008; Onuoha, 2007) which are causes of oil pollution. The destruction of a greater area of the terrestrial ecosystem is important to watch the pipeline beginning with the clearing of seismic lines for oil investigations to the development of pipelines those are laid within the mangrove and rainforest regions.

The poor growth of the seedlings was thanks to the suffocation of plants due to the exclusion of air from oil which affected the soil water relationships of the plants. This will flow from to the unregulated and unsustainable gas flaring during oil extraction that has adversely affected the region's terrestrial ecosystem.

Ukaybou and Okeke (1987) stated that the air / soil temperature of the gas flaring, contributed to a 20% decreased microbial load by 61% soil (Chukwuka et al., 2020). The geographical position of the individual delta and its watershed gives rise to different spatial patterns for distribution of the hydrological and ecological indicators for every delta, but the principal biophysical degradation processes altogether deltas are identical and have an equal effect on the dynasty of the ecosystem and therefore the organic phenomenon (Chen, 2019).

Soil salination is additionally a crucial cause for land loss that the majority countries have with an area of roughly 1 billion hectors (FAO, 2015) and land salination creates drought (Tewari and Arora, 2013).

The key explanation for salinization of land is unskilled agriculture with inappropriate irrigation process. Inadequate water irrigation contributes to the deposition of salt in soils, and therefore the improper water drainage exacerbates the scenario (Drew et al., 1999; Mishra et al. 2018).

The abundance, diversity and function of beneficial soils microbes also are impeded by salt poisoning. Within the current situation over 50 percent land would become salty by 2050 if it persists at the present pace (Bartels et al., 2005). From the figure-2.1, the distribution is shown salt affected degradation of soils assessment in dry-lands of various regions of the planet (FAO, 2013).

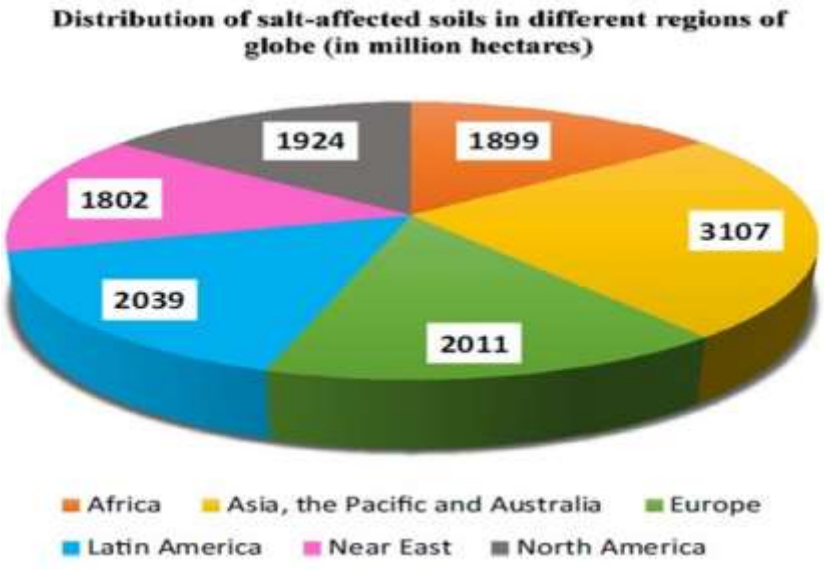


Figure 2.1: Distribution of Salt-Affected Soil in different Regions of Globe

2.2.3 Acid Rain:

Acid rain is another cause of environmental degradation and occurs when nitrogen oxides (NOx) and sulphur oxides (SOx) etc from coal plant and industrial emissions combine or react with water droplets or moisture present in the air. Rain fall cause this acidic precipitation. Acid rain decreases the pH and pollutes the water of lakes and streams. It causes similar effects to the soil also resulting environmental degradation.

2.2.4 Ozone Layer Depletion:

In the stratosphere, the second layer of the atmosphere, ozone is present in small quantities as a protective shield for the earth. Ozone strongly absorbs ultraviolet radiation from the sun (295–320 nm) which is injurious to the life on earth. The most important reason for ozonosphere depletion is that the production and emission of chlorofluorocarbons (CFCs) which consume ozone and reduce its concentration which results in almost 80 percent of the entire ozonosphere depletion resulting penetration of ultraviolate rays to the earth causing environmental degradation. There are many other substances that cause ozonosphere depletion like hydro chlorofluorocarbons (HCFCs) and volatile organic compounds (VOCs) (Das, 2020).

2.2.5 Landfills:

Landfills degrade the environment by the massive amount of waste that gets generated by households, industries, factories and hospitals. Landfills pose risk factors to environment and therefore affect the people that live there. Landfills produce foul smell when burned and sometimes cause leaching of toxic substances leading groundwater pollution creating huge environmental risks.

2.2.6 Deforestation:

Farming, mining, and grazing of livestock account for a major cause of deforestation. Wildfires, forestry practices and urbanization contribute the rest. About 80% of land animals and plants of earth live in forests, and deforestation intimidates species including the Sumatran tiger, orang-utan, and many bird species. Regional and perhaps the global water cycles are influenced by the South American rainforest. In relation to climate change, deforestation both adds CO2 to the air and eliminates the chances to absorb existing carbon dioxide. According to the World Resources Institute, tropical deforestation would rank third in carbon dioxide-equivalent emissions, behind China and the U.S. (Nunez, 2017). Deforestation costs between $2 trillion and $4.5 trillion each year through the loss of biodiversity (Sukhdev, 2010). Deforestation causes environmental degradation by raising rates of soil erosion and also increases river sediment and leads to droughts. The reduction in forest size brings carbon back to the atmosphere results in heating (Maurya et al., 2020).

2.2.7 Climate Change:

Climate change is any long-standing noteworthy changes within the climate over time, created naturally or human activities. Global climate change can't be expressed in separation from environmental degradation as both are very closely interrelated. Anthropogenic activities like industrialization, urban growth, deforestation, new agricultural practices, shifting patterns of land use are the main causes of earth global climate change (Mahato, 2014). In terms of variables including pre-capitation, winds and temperature, global climate change usually refers to vary over time (Parry et al., 2007). According to the fourth Assessment report of the UN Intergovernmental Panel on global climate change (IPCC), global agricultural land is believed to be deteriorated dramatically (Arora, 2018).

Climate change could also be an enormous factor for land loss, land clearing and deforestation, soil nutrients degradation by poor agriculture overgrazing and over grafting activities. The rising population dynamics and subsequent demand for food, energy and housing, land use policies have changed drastically and thus the climate in south Asian countries are seriously damaged. The world is facing a couple of noticeable changes - arbitrary droughts, unanticipated weather arrays and unexpected rainfall and snowfall. There's endless temperature fluctuation leading to disasters and therefore the weather is not any longer foreseeable enough.

In late 2019, lockdown thanks to a completely unique communicable disease, COVID-19 has some encouraging effect on natural environment. NASA (National Aeronautics and Space Administration) and ESA (European Space Agency) acknowledged that in some epicentres (Wuhan, Italy, Spain and USA etc.) of COVID-19 infection environmental pollution in has decreased up to 30% (Mohammad et al., 2020).

2.2.8 Population Explosion:

In the developing world, rapid increase displayed a critical global crisis. Environmental degradation during a country mainly is attributed to fast growth of population, which unfavorably upsets the natural resources and environment.

Sustainable development of a rustic is challenged by the insurgence of population and therefore the consequent environmental degradation (Kutting & Rose, 2006). The presence or the nonexistence of favorable natural resources can promote or impede the method of socio-economic development (Ray and Ray, 2011).

The three elementary demographic factors - birth and mortality and human migration and immigration create modifications in population and increase can upraise many grave environmental consequences including land degradation, forests, habitat obliteration and impairment of biodiversity. The ultimate results of those are pollution, heating, climatic change, and water shortage pollution.

Deforestation, desalination, desertification, and erosion all are resultant of population explosion. FAO estimate the use of biomass for daily energy consumption by about 2 billion peoples is gigantic (Kumar et al., 2020). The rising population (Akbulut et al., 2014) and subsequent demand of food, energy and housing, the land-use policies also are changing dramatically (Maurya et al., 2020; Chopra, 2016; Das, 2020).

So, the results of high increase rates are increasing population density, increasing number of individuals below poverty level and pressure on natural resources which contributes to environmental degradation through over exploitation of natural resources (Ray and Ray, 2011; Richmond et al., 2019).

2.2.9 Poverty:

Poverty is claimed to be the cause and effect of environmental degradation. Inequality may foster unsustainability because the poor, who believe natural resources are quite a budget, deplete natural resources faster as they have no real prospects of gaining access to other kinds of resources. Moreover, the degraded environment can accelerate the tactic of impoverishment again because the poor depend directly on natural assets.

2.2.10 Technology:

The application of technology has unavoidable environmental impacts. The many technologies aim to take advantage of, control, or otherwise "improve" upon nature for the perceived advantage of humanity while at an equivalent time the myriad of processes in nature are optimized and are continually adjusted by evolution, and any disturbance of those natural processes by technology is probably going to end in negative environmental consequences.

2.2.11 Natural Causes:

Natural calamities like avalanches, tremors, tsunami, floods, and fires will completely crush adjacent biodiversity and groups of animals and plants to the degree of survival. This will be accomplished by physically demolishing a specific catastrophe or by long-term asset depletion by the presentation to the planet of an obturator's species (Maurya et al., 2020; Das, 2020). Things like landslides, earthquakes, tsunamis, hurricanes, and wildfires can destroy local plant and animal communities to the purpose where they will not function.

This will either happen through physical destruction via natural disaster or by the future degradation of resources by the introduction of an invasive alien species to a replacement habitat. The latter often occurs after hurricanes, when lizards and insects are washed across small stretches of water to foreign environments.

2.3 Impact of Environmental Degradation:

Environmental degradation affects human quality of life by showing symptom of biotic indigence. Food availability depends on environmental conditions and is an elementary determinant of quality of life.

In 2020, worldwide 149 million children under 5 were assessed to be stunted (too short for age), 45 million were evaluated to be wasted (too thin for height), and 38.9 million were overweight or obese (WHO, 2021).

Even with unequivocal legal requirements that industries publicize information on their toxic emissions, globally many people still have dearth of both information and the decision-making power that control the quality of their lives. Environmental degradation obstructs many basic human rights, including the rights to health, livelihood, property, culture and privacy (Chu and Karr, 2013).

2.3.1 Impact on Socio-Economic Status:

Societies everywhere are closely and intricately interconnected to the natural environment in which they are belonging to. Environmental degradation which includes diminution of renewable and non-renewable resources and air, water and soil pollution can create a substantial stress upon societies.

It can affect social integration indirectly, through putting constraints on productive activities, and it can also exhibit direct social impacts.

Environmental deterioration may persuade changes in settlement patterns and thus interrupt established social relations. It may enhance social stratification or stimulate social solidarity and motivate collective action. (UNRISD, 1994).

2.3.2 Impact on Human Health:

Environmental degradation effects on the health of individuals and populations. Areas exposed to toxic air pollutants can cause respiratory problems like pneumonia, lung diseases, and asthma. According to the World Health Organization (WHO), air pollution kills an estimated seven million people worldwide every year.

Within the last ten years, the pollution level in Indian cities has risen alarmingly with strongest pollutants contamination like residual suspended particulate matters(RSPM), suspended particulate matter(SPM), nitrogen dioxides (NO2), carbon monoxide gas (CO), lead, etc (Chopra, 2016).

Table 2.1: Table shows the urban Air Pollution Concentration-Response Coefficients (Pope et al., 2002; Ostro, 2004) for the mortality coefficients.

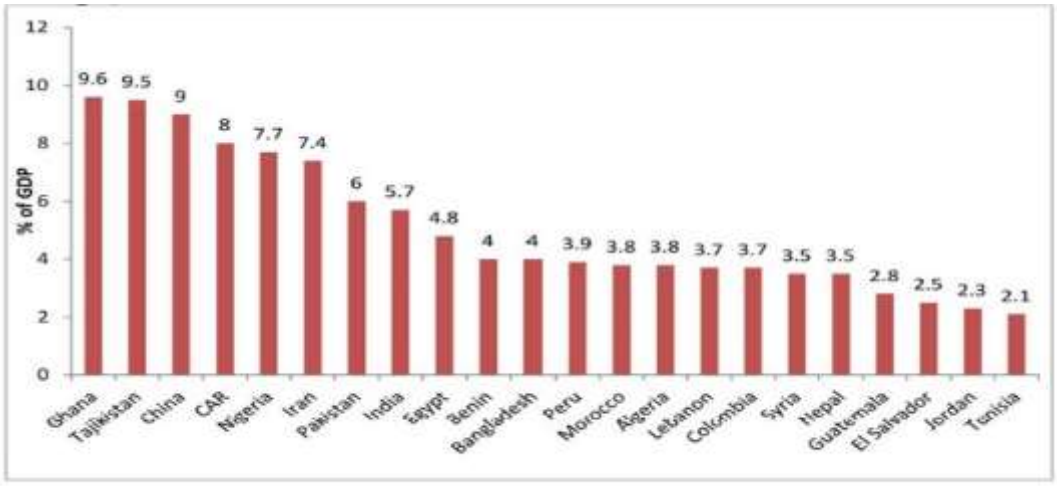
Annual Health Effect	Concentration-response Coefficient	Per 1 ug/m^3 annual average ambient concentration of
Long term mortality (% change in cardiopulmonary and lung cancer mortality)	0.8% *	PM 2.5
Acute mortality children under five (% change in ARI death)	0.166%	PM10
Chronic bronchitis (% change in annual incidence)	0.9%	PM10
Respiratory hospital admissions (% per 100,000 population)	1.2%	PM10
Emergency room visits (per 100,000 population)	24	PM10
Restricted activity day (% change in annual incidence)	0.475%	PM10
Lower respiratory illness in children (per 100,000 children)	169	PM10
Respiratory symptoms (per 100,000 adults)	18,300	PM10

It is estimated that about 2 million premature deaths in developing countries result from indoor air pollution (Srinivasan, 2013), where almost half of these deaths are due to pneumonia in children below 5 years of age and from contaminated drinking water mainly in developing countries (Afroza et al., 2015). Water pollution also provokes the process of transformation of heavy toxic metals through the food chain and deposit these in plants tissues when they absorb it. These plants and animals are in turn consumed by man and hence their health became affected (Afroza et al., 2015; Jeevanantham et al., 2019). These heavy metals commonly affect human heart (carcinogenic and teratogenic impacts), kidneys, nervous system, liver, pancreas, skin, and reproductive system (Jeevanantham et al., 2019). Diseases such as typhoid, cholera, vomiting, skin lesions, and nervous system problems can spread as a result of consumption of polluted water include (Afroza et al., 2015; Ghafoor et al. (1994).

2.3.3 On the Economic Growth and Development:

The hostile effects of environmental degradation on the environment and economic growth include loss of biodiversity and diminished food and agricultural production levels. In some cases, for instance, Nigeria that are usually challenged with oil spillage, lost their occupation such as fishing, canoe carving, and forestry, which account for about 70% of the total employment in the region; this often leads to dropping out of school by children of most families who can no longer pay their wards' school fees (Ipingbemi, 2009).

In comparison with other countries, India has approximately equivalent costs for environmental degradation with others. According figure-2.2, it shows that price of increased morbidity, mortality and natural resources degradation typically costs 4 to 10 per cent of GDP, compared to 7 percent of GDP in India (World Bank and MOEF, 2013).



Source: Bank (2012): Green Growth: Path to Sustainable Development.

Figure 2.2: Cost of Environmental Degradation (Health and Natural Resources Damages)

2.3.4 On Ecology, Biodiversity and Environmental Resources:

The frequent penetration of the environmental pollutants into the soil or lithosphere affects the organisms living therein. Environmental degradation is helping to boost the accumulation of these noxious pollutants in the food chain and thereby destroying the ecosystem stability. A large range of contaminants are released annually within the atmosphere by pollution from industry. There are over 1,40,000 new chemicals and pesticides that have been synthesized since 1950 (Landrigan et al.; 2017) and only a couple of them such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), hydro chlorofluorocarbons (HCFCs), and chlorofluorocarbons carbons (CFCs) are tested clinically for toxicity. The role of CFCs within the depletion of the ozonosphere is extremely reported and fortunately, the CFCs that caused ozonosphere trouble were expelled by the protocol of Montreal (https:/www.nasa.gov) in 2018. There are many other substances such as hydro chlorofluorocarbons (HCFCs) and volatile organic compounds (VOCs) that lead to ozone layer depletion (Arora et al., 2018).

Biodiversity is vital for maintaining a balance of the ecosystem within the sort of combating pollution, restoring nutrients, protecting water sources, and stabilizing climate. The most explanation for loss of biodiversity are deforestation, overpopulation, global warming and pollution are a few of the main causes for loss of biodiversity. Actually, the citizens have deeply altered the environment, and have modified the territory, exploiting the species directly, for instance by fishing and hunting, changing the biogeochemical cycles, and transferring species from one area to a different. (Chopra, 2016).

One major component of environmental degradation is the depletion of the resource of fresh water on earth. Water scarcity is an increasing problem due to many foreseen issues in the future, including population growth, increased urbanization, higher standards of living, and climate change. The deterioration of the environment can be a huge setback for the tourism industry that relies on tourists for their daily livelihood. Environmental damage in the form of loss of green cover, loss of biodiversity, losing earth's beauty, huge landfills, increased air and water pollution can be a big turn off for most of the tourists.

2.4 Mitigation Measures:

In the SDG report (UN, 2018) which projects the agenda for 2030, it is clear that the major cities have problems of extreme air, soil, and water contamination and problems need to be discussed very urgently. There is a need for swift action from nations, international organizations, and even individual levels in order to execute ecological solutions and policies. There are considerable bad effects to anthropogenic activities, so and we need to turn to the earth and thus turns towards green alternatives to heal the habitats and get them back to normalcy. Biological instruments and bodies, such as microorganisms and plants, may play an important role in the regeneration of contaminated habitats and in mitigating the effects of global warming and climate change. These must, however, be enforced at the global level (Maurya et al., 2020; Chukwuka et al., 2020; Chopra, 2016). In terms of solving its environmental concerns and improving the environmental standard, it is estimated that, between 1994 and 2010 India also made one of the world's fastest advancements. However, India still has a long way to go to achieve environmental quality close to that of advanced economies.

General and environmental education and climate training is a crucial tool in preserving the environment. Training increases one's ability to acquire, decode and comprehend information and the effects on learning and changes in behaviour. Education has been seen in recent years as a tool of sustainable development and hence of pollution control (Akbulut, 2014; Maurya et al., 2020). Education is ‘a continuous learning mechanism that helps to educate people whose purpose is the development of knowledge, soft skills and experience and good manners”. Maurya et al. (2020) reported how human interaction with the environment is influenced by education strategy (Figure- 2.3).

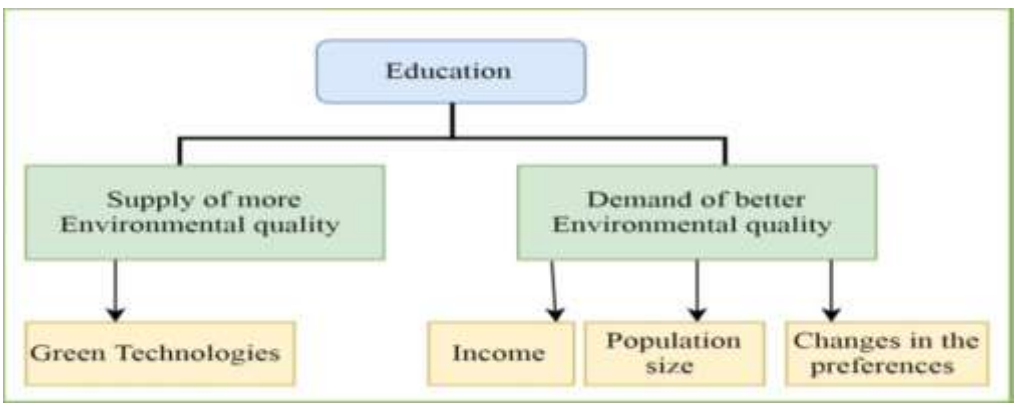


Figure 2.3: Impact of Education on Environmental Quality. (Maurya et al., 2020)

There are many ways which can help to decrease environment degradation. Some of these include:

- Recyclable goods should be bought and used.
- Frequent water quality monitoring as the issue of river pollution is rising. Sustainable development would not be feasible without a sufficient amount and quality of freshwater which has limited sources with limited amount left. So, it is necessary to preserve them for agriculture, industry and to nourish and flourish human lives.
- Demand for drinking water preservation should be raised.
- By improving the standard of potable water quality and its appropriate use alongside enhancing accessibility and domestic supply.
- Waste products should be dumped in a specific and suitable place, far from the human habitats, or should be destroyed accordingly.
- Awareness should be promoted in the community by making small groups to arouse consciousness about the consequences of environmental degradation and limited nonrenewable sources of energy.
- Lack of 'environmental values' has encouraged us to extensive use of ‘free’ natural resources abundantly. So, these thoughts need to be changed and here the educational and awareness campaigns can help.
- The overproduction of use and throw items that are commercially cheap also has led to allow people to voluntarily discard them after a single use in the ecosystem and this ongoing cycle is creating harmful impacts in the ecosystem and should be regulated.
- Institutional productivity needs to be directed to check and control the economic productivity and for engineering involvements with mandatory environment educations.
- Plastic wastes are serious physical hazards to the environment that leads to significant plastic pollution and the degradation of our planet. Usage of disposable plastic bags, cups, plates, containers, cutlery, etc. should be refrained.
- In order to mitigate the adverse effects of environmental degradation, deforestation needs to be stopped. It is crucial for a healthy and sustainable ecosystem and also the environment. We should not cut or burn trees down as trees are providing us oxygen by replacing or absorbing greenhouse gases for the healthy living of the natural habitats, animals, and plants that may become endangered if these forests are destroyed.
- Conservation of natural resources needs to be done by direct action such as declaration of reserved forests, biosphere, wetlands, mangroves, and protection of endangered species.
- There should be strict legal actions for illegal dumping to reduce the adverse ecological consequences.
- Environmental Impact Assessment Studies should be done and monitored.
- The Environment (Protection) Act has been established in 1986 to protect the environment. The Forest (Conservation) Act 1980 and the Act on Wildlife (Protection), 1972 are both significant legislation within the region.
- Authorities not only in politics but also authorities for the implementation and evaluation of progress should be moved properly in order to achieve the long-term national environmental objective contributing to sustainable growth. (Maurya et al., 2020).

- To promote forestation the government should use the economic incentive and penalty scheme.
- People should be aware by proper programme about the consequences of environmental degradation.

The UN-2018 SDG Study, projects the agendas up to 2030 during which 17 goals of the UN have been report and therefore the 2030 is that the target, out of which 13 are specifically aimed toward the sustainable environment and must be accomplished through biological or natural alternatives for food production as well as for the protection of green fuel, sustainable management of water resources and treatment of contaminated water, renewable and green energy, sustainable economic development and job opportunities, and sustainable industries (Arora et al., 2018). Maurya et al. (2020) proposed the flow chart for the mitigation strategies and remediation of soil for the development of quality of soil shown in Figure: 2.4.

Figure 2.4: Strategies of Mitigation and Remediation for Slightly and Heavily Contaminated Soil (Maurya et al., 2020)

Maurya et al. (2020), also explained the sustainability components of human environment (Figure- 2.5).

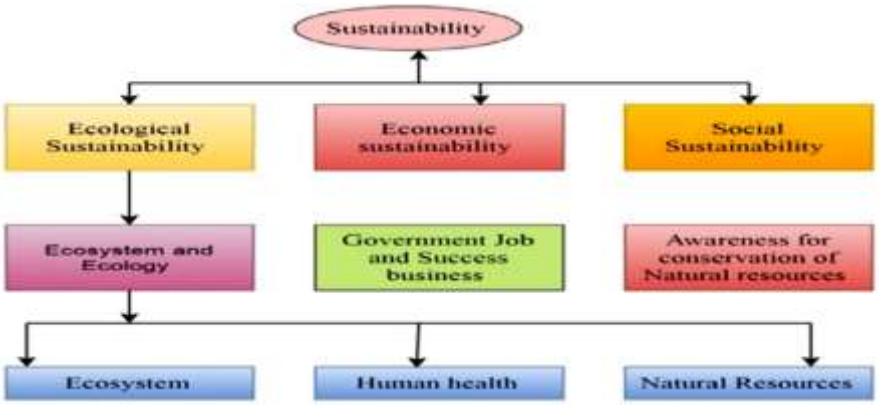


Figure 2.5: Sustainability Components of Human Environment (Maurya et al., 2020)

2.5 Conclusion:

Environmental degradation is one of the most challenging environmental issues in 21st century. The main causes of environmental degradation are attributed to the rapid growth of population, excessive use of natural resources along with land degradation, deforestation, soil erosion, habitat destruction, and loss of biodiversity.

Besides these, air, water, and noise pollution together with water scarcity enhance the environmental issues in combination with environmental degradation.

As a result, the plants and animals inhabiting in this earth are going to be in trouble. So city planners, industry, and resource managers must consider the future effects of unplanned and harmful so-called development in the environment. With appropriate planning, increase in public awareness, and community supports, environmental degradation may be get prevented in future. It is the responsibility of every individual to become conscious about the environment ethically or morally. Thus it is very much essential to improve the quality of the environment by increasing our awareness through large-scale participation of people for the development of the environment.

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3. A Review Note on Shifting Cultivation in Meghalaya

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3.1 Chapter-I: Introduction:

The state of Meghalaya is situated in the north-eastern region of India. It is a land locked territory lying between the latitudes of $25^0$47' N and $26^0$10' N and longitudes of $89^0$45' E and $92^0$47' E. The state is made up of three hills namely, Khasi Hills, Jaintia Hills and Garo Hills. The altitude of the state varies between 100 to 1900 m from mean sea level. Meghalaya is bounded in the south and west by Bangladesh. The state of Assam surrounds the state in north and east. The Meghalaya plateau is highly dissected and has irregular terrain in the western and northern sides. With an area of 22,429 sq km, it is predominantly inhabited by tribal people who account for eighty nine percent of the total population. The state has 11 districts and thirty eight blocks.

Meghalaya is an agricultural state of our country where more than 85 per cent of the people live in village and depend on agriculture for their livelihood. Although agriculture occupies an important place in the economy of the state, only a little more than 8 per cent of the total geographical area is available for cultivation and only 13 per cent of the cultivated land produces more than one crop. The rainfall in the state is sufficient for agriculture but due to rugged topography and less productive soil it has been able to give satisfactory result, except in valleys and border areas which are a part of Brahmaputra valley.

Objective of Study:

- To study about the concept of shifting cultivation.
- To study about the impact of shifting cultivation on environment and economy.
- Efforts to overcome the problems and suggestions.

A. Cultivation Practices:

The ethnic communities of Meghalaya follow two major types of agricultural practices such as shifting cultivation or slash and burn agriculture, and terrace or bun cultivation. Shifting cultivation is practiced in and around forests, and terrace cropping is practiced in valleys and foothills, and inside plantation forests.

These traditional systems of cultivation practices are well adapted to the environmental conditions and the traditional knowledge of indigenous communities growing cereals and other agricultural crops have enabled them to maintain an ecological balance.

Enormous increases in human population have led to massive coverage of land under shifting cultivation. Besides shifting cultivation and bun agriculture, there are some other potential indigenous farming systems in northeast India developed by the tribal farmers using their ingenuity and skill.

These techniques and systems have a sustainable agriculture base and are practiced since centuries in some isolated pockets of Meghalaya and other northeastern states. These farming systems make use of locally available resources and there is need of an in-depth study to know the secrets of their success.

B. Terrace or Bun Cultivation:

Bun cultivation on hill slopes and valleys is a settled cultivation system being practiced for last three decades, to provide improved production system, to conserve soil moisture and also to prevent land degradation and soil erosion. In this system, bench terraces are constructed on hill slopes running across the slopes. The space between two buns is leveled using cut and hill method.

The vertical interval between the terraces is not usually more than one metre. Such measures help to prevent soil erosion and retaining maximum rainwater within the slopes and safely disposing off the excess runoff from the slopes to the foothills.

C. Shifting Cultivation:

Shifting cultivation or slash and burn agriculture is the most prevalent form of agricultural practice of the ethnic people and is commonly called Jhum or Swidden cultivation, which is one of the most ancient systems of farming believed to have originated in the Neolithic period around 7000 BC.

This system is a primitive cultivation technique and is transition between food gathering and hunting to food production. The system of farming is still in vogue in Meghalaya as well as whole northeast Himalayan region. About 350,000 people practice shifting cultivation on about 4,160 km² of un-surveyed land.

Shifting cultivation is a very wide term covering a number of very different forms of land use, it's essential feature beings that the land is cleared and agricultural crops are grown for a limited period, which may range from one to over ten years, after which the cultivation is moved to a new site. The cultivators may or may not intend to return to the old site after the fertility of the soil has recovered.

Shifting cultivation, though a rudimentary technique of land and forest resource utilization, represents an intricate relationship between ecology, economy and society (Kerkhoff & Sharma, 2006).

Shifting cultivation is identified as a way of life for the societies practicing it. In fact, it is found that the jhum fields surrounded by forests and nature offer two alternative sources of livelihoods to the population practicing shifting cultivation.

In case, the jhum crops are not good or fail due to external vulnerabilities like fire and landslides, the surrounding forest resources support the shifting cultivators by augmenting their food supplies.

Moreover, these shifting cultivators, who practice piggery and keep swine, use vegetable wastes and inferior grains from the shifting cultivation fields as their feed.

Shifting cultivation implies the systems involving a few years of cultivation alternating with several years of fallow to regenerate soil fertility.

This primitive form of agriculture is known by different nomenclatures in different parts of the globe. Among the Khasis, this system is known as *Thang shyrti* or Thang bun and among the Garos, this system is known as Jhum *Kheti* or *aba-oa*.

Shifting cultivation is widely practiced food production system in Meghalaya over 407.32 sq km involving more than 2, 64, 960 number of families residing in 3, 610 villages.

Shifting cultivation is the oldest form of agriculture and is as old as the agriculture itself. The prehistoric shifting cultivation used fire, stone, axes and hoes, while in the present day shifting cultivation, stone tools have been replaced by iron digging sticks, iron tools, dao, hoe and knives etc.

The system in brief consists of the set of operations. The first and foremost operation is the clearance of the vegetative cover of the piece of land and drying of the slash thereafter at the spot and later set on fire.

The ash so collected is then spread over the entire patch before the onset of rains and that works as manure in the jhumland. Having prepared the land in this manner, seeds are dibbed in the soil with the help of pointed bamboo sticks or other primitive implements.

The crops in the jhumland are raised for one to three years and later that soil is abandoned to recoup naturally.

Cultivation is then shifted to another plot and the "*jhumias*" returns to the original plot after the completion of the cycle during which all the favourable plots are cultivated from one year to three years.

Thus under jhumming, the cultivation moves in a cycles, around the settlement which forms a permanent nucleus.

Steps Involved in Shifting Cultivation:

Figure 3.1: Selection of Sites on Hilly Slopes

Figure 3.4: Burning of Jungle

Figure 3.2: Jungle Cutting in Dec/Jan

Figure 3.5: Jungle Cutting in Dec/Jan

Figure 3.3: Creation of Fire Line

Figure 3.6: Sowing of Various Crops

3.2 Chapter-II: Magnitude of the Problem:

Shifting cultivation has been trapped in a low-level and unstable equilibrium owing to two equally unviable paradigms that operate at the policy and institutional levels. The dominant perspective is that shifting cultivation is a wasteful and ecologically dysfunctional system, detrimental to forests and soil, and hence needs to be eradicated by inducing cultivators to adopt other forms of livelihood.

When such efforts meet with failure, the other paradigm comes into play, according to which shifting cultivation is a legitimate practice that ensures the survival of people living on marginal lands and hence should be allowed to carry on as it is without external influence. As a result, shifting cultivators fall through the crack between marginalization and traditionalism. Almost the entire state has been or is being influenced under shifting cultivation, except for some pockets of valley bottomlands, and reserve forests. Shifting cultivation destroys the protective and productive vegetation in preference to a very brief period of immediate crop production and this result in soil loss and other consequential damages.

It has been reported that soil erosion from the hill slopes of 60-70% is as follows:

1st year of Jhum - 146.6 tonnes/ha/yr

2nd year of Jhum - 170.2 tonnes/ha/yr

Abandoned Jhum - 30.2 tonnes/ha/yr

(1st year)

Bamboo forest - 8.2 tonnes/ha/yr

Thus from the erosion point of view, the second of year of Jhumming cycle is more hazardous than the first year.

No reliable and adequate information is available on the coverage of jhum cultivation in statistical publications of the Directorates of Economics and Statistics. The last and the so far latest available estimates are based on the study conducted by the Task Force on shifting cultivation by the state Government to study the problems shifting cultivation:

Sr. No	Name of the District	Annual Area under Jhum in km^2
1	East Khasi Hills	4.90
2	West Khasi Hills	44.60
3	Ri-Bhoi	47.86

Sr. No	Name of the District	Annual Area under Jhum in km^2
4.	Jaintia Hills	10.25
5.	East Garo Hills	92.61
6	West Garo Hills	144.69
7	South Garo Hills	62.41
Total		407.32

Shifting cultivation has continued for thousands of years and stood the test of time. This practice has an in-built mechanism of sustenance and conservation. However, due to anthropogenic pressure on land use for shifting cultivation adversely affecting eco-restoration and ecological process of forests. This leads to degradation of land causing soil erosion and finally converting forests into wastelands. The shifting cultivation practice has socio-economic relevance for production of agricultural crops in Meghalaya. There is no other alternative means of livelihood for the ethnic peoples of the area because of their poor economic condition and this compels them to still practice this system and they are bound to reduce *Jhum* cycle for their need. The people who follow the *Jhum* cultivation are called *Jhummias*, the district wise Jhummia families of Meghalaya are listed in the following Table3.2.

Table 3.2: (Year - 2001) District-Wise Jhummia Families of Meghalaya

Name of District	Total Population (Rural)	Jhummia Families Dependent on jhum	Jhummia Population Dependent on jhum	Percentage of the Jhummia Population from the total Rural Population	Annual Area under Jhum in Sq. Km.	Percentage of Annual Jhum Area from the total Geographical Area
East Khasi Hills	383027	721	3605	0.94	6.20	0.23
Ri-Bhoi	179630	4351	21755	12.11	27.40	1.53
West Khasi Hills	260595	5374	26870	10.31	46.19	0.88
Jaintia Hills	270669	1366	6830	2.52	11.74	0.31
East Garo Hills	211652	13630	68150	32.20	117.15	4.50
West Garo Hills	457422	18086	90430	19.77	155.45	4.19

Name of District	Total Population (Rural)	Jhummia Families Dependent on jhum	Jhummia Population Dependent on jhum	Percentage of the Jhummia Population from the total Rural Population	Annual Area under Jhum in Sq. Km.	Percentage of Annual Jhum Area from the total Geographical Area
South Garo Hills	90462	7900	39500	43.66	67.87	3.67
Total	**1853457**	**51428**	**257140**	**13.87**	**442.00**	**1.97**

3.2.1 Jhum Cycle:

The period before a family returns to the same plot for cultivation or the interval between one phases of cultivation to another phase of cultivation on the same plot of land is called jhum cycle. The cycle normally depends upon the availability of land with particular community and population in village. The practice of shifting cultivation is short and has a variable fallow period. After a piece of land is selected, trees or bushes are cut down partially or fully, left to dry and then burnt in situ. In the cleared land, seeds of crops are dibbled into holes or broadcast, without using ploughs or animal power. When the crop yield begins to decrease after some years, the cultivator moves to a new patch of forest to repeat the process, and allows the abandoned land to recuperate. After a period varying from 2-20 yrs., they return to the same land for cultivation. The cultivation cycle in shifting cultivation is very important and varies considerably. The longer cycle is better for restoring soil fertility and it also stops soil erosion. At present Jhum cycle has reduced to 4-6 yrs., inadequate to provide recuperation to the site and repair the ecological damage. Shifting cultivation on short cycles decreases soil productivity due to excessive loss of soil nutrients and imbalance in the socio-economic set up of the village communities. Earlier, a cycle of fifty years or more was adequate to maintain ecological balance. Initially, the duration of cycle was as long as 30 to 40 years mainly due to better fertility of the soil and limited population dependent on jhumming. At present the duration of the jhum cycle in Meghalaya varies from 3 to 5 years, this may be due to overwhelming pressure on land. Shifting cultivation is mostly practiced in community forests of Meghalaya. In the state, the village council commonly called Dorbar Shnong owns the land, and allots the forestland for cultivation. The main interest of the cultivators is to produce almost everything that they need to fulfill their requirement.

- **Crops of Shifting Cultivation:**

So far as the cropping pattern goes, the shifting cultivators in the State have been found to have adopted mixed cropping with respect to growing different crops, but it varies from tribe to tribe. In mixed cropping, soil exhausting crops like rice, maize, millets and cotton are grown along with the soil enriching crops like legumes. Since the soil exhausting crops and soil enriching crops have different harvest periods, these crops supply food to the tribal communities almost throughout the year.

Even when the fields are abandoned for the next cycle, intermittently, they provide residual crops to the farmers, thereby taking care of the nutritional aspect of the tribal communities. The shifting cultivators across the State are mostly found to grow food grains and vegetables, and on rare occasions, some cash crops are also grown. Among food grains, the coarse varieties of rice, maize, job tears and small millets are the principal crops grown. Ginger, turmeric, cabbage, linseed, rapeseeds, sesame, oranges, pineapple and jute are the important cash crops grown in the shifting cultivation fields. Among vegetables, soya-bean, potato, pumpkins, cucumbers, yams, tapioca, chilies, beans, onion and arum are mostly cultivated.

The choice of crops among the shifting cultivators is mostly consumption oriented. Meghalaya produces a variety of agricultural crops such as food grains, commercial crops, horticultural crops, etc. Of the total agricultural land in Meghalaya, 62% is used for food grains, 25% for cash crops, 9% for horticultural crops and the rest 4% is used for raising miscellaneous crops.

Rice (*Oryza sativa* Linn.), the most important food crop occupies about 44 % of the total agricultural land. About 40 % of rice is cultivated from the *Jhum* fields. Sung valley of the *Jaintia Hills* is considered as the fertile paddy fields of Meghalaya. Meghalaya produces three cropping seasons for rice, autumn rice, winter rice, and spring rice. Winter cropping covers 67 % of the total production. Maize (*Zea mays* Linn.) is the next important agricultural food crop of Meghalaya.

It is grown in about 8 % of the cropped area and cultivated mainly in the plains of *Garo* hills, Mairang (West *Khasi* hills), Mawphlang (West *Khasi* hills) and Laskein block of *Jaintia* hills. Wheat (*Triticum aestivum* Linn.) is confined in some pockets of the lower elevation of *Garo* hills of Meghalaya. Pulses (gram, tur and few others) are less important in the agricultural economy of the state. Pulses occupy 1.3 % of the cropped area and are confined only in some pockets of remote areas of the Garo hills.

Potato (*Solanum tuberosum* Linn.), the most important commercial agricultural crop, covers about 7 % of the total agricultural area of the state. It was introduced in *Khasi* hills by David Scott in the early part of the 19th century and grown mainly in the terrace fields of the high altitudes of *Khasi* hills. Oil seeds are grown mostly in the plain areas of the *Jhum* fields of *Garo* hills. Among the oil seeds, mustard (*Brassica nigra* Koch), rape (*Brassica campestris* Hook. f.), castor (*Ricinus communis* Linn.), sesamum (*Sesamum indicum* Linn.) and soyabean (*Glycine max* Merrill) are grown. Fibre crops, cotton (*Gossypium* sp.) and jute (*Hibiscus cannabinus* Linn.) are grown in the *Garo* hills. Ginger (*Zingiber officinale* Rosc.) is mainly grown in *Jaintia* hills and some pockets of *Khasi* hills. Sugarcane (*Saccharum officinarum* Linn.) is confined only in plain areas of the state and grown in *Jhum* fields.

The soils and climatic conditions are suitable for the production of horticultural crops. Pineapple (*Ananas comosus* Merrill), litchi (*Litchi chinensis* Sonn.), guava (*Psidium guajava* Linn.), mango (*Mangifera indica* Linn.), banana (*Musa paradisiaca* Linn.) and jackfruit (*Artocarpus heterophyllus* Lam) are grown at low altitudes, and orange (*Citrus reticulata* Blanco), plums (*Prunus domestica* Linn.), peaches (*Prunus persica* Batsch) and pears (*Pyrus communis* Linn.) are the major horticultural crops of high altitude.

Tapioca (*Manihot esculenta* Crants) is one of the subsidiary food crops and is grown in western part of Khasi hills. Turmeric (*Curcuma domestica* Valeton) is famous for its quality and has a great demand. It is widely grown in the *Jhum* and Terrace field of *Jaintia* hills.

Rice (*Oryza sativa* Linn.) and maize (*Zea mays* Linn.) are the major food crops. Important fruits grown are orange (*Citrus reticulata* Blanco), pineapple (*Ananas comosus* Merrill), lemon (*Citrus Limon* Burm. f.), guava (*Psidium guajava* Linn.), jack fruit (*Artocarpus heterophyllus* Lam.) and bananas (*Musa* sp.). Potato (*Solanum tuberosum* Linn.*)*, jute (*Hibiscus cannabinus* Linn.), cotton (*Gossypium* sp.), arecanut (*Areca catechu* Linn.), ginger (*Zingiber officinale* Rosc.), turmeric (*Curcuma domestica* Valeton), betel leaf (*Piper betle* Linn.) and black pepper (*Piper nigrum* Linn.) are the chief commercial crops.

3.2.2 Causes of Jhuming:

Shifting cultivation is recognized as a catalytic force for community life across the State. The social organization of the tribes living in the hills is mostly built around community ownership, participation and responsibility. Shifting cultivation is deep rooted in the way of life of the tribal of the region and it forces one to investigate the social and economic compulsions involved in continuance of this system. The system came to be pursued in a natural environment which is inhospitable and rather hostile in many instances and inhabited by simple and backward communities. Land given shifting cultivation is by and large confined to rainy low land areas, dense rain forests, hills and other infertile tracts. The physical environment in such areas favours quick and luxuriant growth of vegetation. Thus, hardly any pocket of land devoid of dense vegetative cover is available for cultivation. The hill sides contrary to the plain tracts are thinly covered by forest and can be easily cleared. Cleared trees and bushes after being burnt with fire got converted into ash are obviously rich in organic matter and can support some crops for 1 to 3 years without being regularly manured.

Therefore, such regions inhabited by primitive tribes that lack innovative devices and orthodox outlook towards live, have to be infested with this type of agricultural system. The specific reasons, other than the one explained above, responsible for the system, may be summed ups as follows:

- History stands as witness that in many parts of the world, the original inhabitants i.e. aboriginals are inhabited in an inaccessible forest and mountainous areas. Being ignorant, these people who are already the victims of poverty and socio-economic backwardness are obviously reluctant to shun traditions and learn better methods.
- Many tribal communities have socio-cultural ties with the land and because of these socio-religious bonds, they dare not to disturb or break the prevalent system.
- In these sub-mountainous, ravine infested, and rainforest areas, there has been an utter lack of alternative means of employment. On the other hand a fairly high capital investment is needed for cattle, implements, manure and reclamation/ terracing of land etc. The agricultural economy being in the traditional stage cannot turnout capital required for having and maintaining settled cultivation. Thus, the tribals are compelled by the vicious circle that originates from their inhospitable surroundings and ignorance, to pursue shifting cultivation.

3.3 Chapter-III: Impact on Environment:

Various scholars have described the several merits in the system that wisely regulated jhumming could be carried on indefinably without causing deterioration to the soil and land erosion. The relevance of jhum, however, has to be seen with reference to time frame and larger developmental perspective. In good old days, when jhum cycle was 30 years or more, it used to allow vegetation and help preservation of forests and soil erosion etc. But, when the jhum cycle has just reduced to two years with least production levels, there should be no doubt for calling jhum cultivation as one the greatest obstacles in the development of agriculture in the state. The evil effects of jhumming can be briefly summarized as follows:

a. The shifting cultivation has led to destruction of forests in Meghalaya.

Sr. No	Name of the District	Annual area affected by jhum (Km^2)
1	East Khasi Hills	24.50
2	West Khasi Hills	223.50
3	Ri-Bhoi	239.30
4.	Jaintia Hills	51.25
5.	East Garo Hills	463.05
6	West Garo Hills	723.45
7	South Garo Hills	312.05
Total		2036.60 Km^2

b. Further, the destruction of forests as a result of shifting cultivation coupled with high rainfall in the region, has led to heavy soil erosion and siltation in major rivers of the region which in turn have been responsible for floods in the lower reaches of the main river systems

c. Loss of soil from jhum plot is much more in some of the areas where clean cultivation is practiced involving de-weeding of slopes two to three times in a season, contributes about 22% of the total soil loss in a year.

d. Although vegetation grows quickly after the jhum plot is abandoned, the successive growth deteriorates from large tress to shrubs and bamboos, and ultimately to coarse grass, resulting finally to the exposure of inert material in the form of rocks and gravel on the slopes, thus making such areas unfit for cultivation.

e. Besides, loss of top soil, loss of inherent fertility due to burning of weed cover contributes to decline in production because burning has been found to cause substantial reduction in organic matter content.

f. Removal of forest and resultant soil erosion drastically reduce the water balance of the sub soil and underground water balance of the sub-soil and underground water. Consequently, the springs and the wells located at the foot-hills go dry. In areas where the streams are not snow fed, the drying up of springs in summer acute shortage of even drinking water. The case of Cherrapunjee is a classic case of this kind.

One of the most important negative environmental impacts of shifting cultivation is the damage that it causes to the soil system. It accelerates the soil erosion manifolds. Besides causing air pollution due to burning, shifting cultivation is responsible for loss of soil nutrients and useful fauna and microbes. Burning of slash lowers soil acidity, organic matter and total nitrogen but enhances phosphorous. Most shifting cultivation practices are subsistence level farming system having very low output/ input. The clearing of forest areas at regular and frequent intervals for shifting cultivation results in the loss of primary forests and formation secondary forests. This causes to substantial loss to trees diversity and associated vegetation. Due to shortening of jhum cycle, quite often, the secondary forests do not get adequate time to regenerate. The repeated use of land with short jhum cycle finally converts the jhum fallows into degraded wastelands. Therefore shifting cultivation is considered to be the single most important factor causing deforestation.

3.4 Chapter-IV: Controlling Shifting Cultivation: The Initiatives and Strategies:

Clandestinely, shifting cultivation is being practiced on the Revenue, Reserve Forests and protected forests. Although shifting cultivation is a non-viable resource-utilization practice, tribals are still clinging to this primitive practice to sustain themselves and their families mainly due to non-availability of timely employment avenues. The major initiative was started only in 1975 when the Indian Council of Agricultural Research (ICAR) established an Agricultural Research Complex for NE hills region at Shillong with the subsequent set up of its centre in the states of NER as well as its major objectives to study the shifting cultivation system in details and suggest various alternatives to replace the age-old practice. Some of the schemes of jhum control programmes are:

- Soil conservation and land reclamation for permanent agriculture in hills
- Setting jhummias on wet terraced land or valley (WTRC)
- Allotment of dry/wet terraced land along with some sloppy land for growing horticulture crops
- Engaging cultivators as wage earners in the cash crop plantations and setting them on forest land on small pockets with some provision of basic amenities like schools, sale depots etc. and watershed management schemes with integrated programmes of agriculture, forestry and animal husbandry.
- Providing variety of post rehabilitation incentives as assistance for purchasing power tiller and so on.

Various attempts have been made by the Government to settle the tribal people involved in shifting cultivation. Arable land is provided to the tribal for carrying out agriculture and also to settle in the area; a few schemes are being implemented under integrated tribal development programme in some parts of Meghalaya. These schemes have however, not yielded the desired results perhaps because of the ignorance of the authorities about the socio-economic and agro-ecological conditions of shifting cultivation and also due to minimal involvement of Forest Department officials, who are more informed about the above factors, in implementation of the scheme. Failure of the scheme led the National Commission of Agriculture to reformulate the schemes only after considering the impact of the forest management.

3.4.1 The Strategies:

a. Providing employment opportunities and income generation on a regular basis through proper utilization of the land resources, i.e. by equitable distribution of waste land among the tribals. But, the various schemes of the Government, under the tribal plan, will have to pump in sufficient resources for proper reclamation and development of the wasteland through agro-forestry and silvi-pasture practices.

b. By encouraging cooperative efforts for carrying out forest-based activities, i.e. basket making, rope making, cane furniture processing of minor forest produce, honey collection, etc. have to be made commercially viable by providing proper marketing facilities. This will not only discourage tribals from practicing shifting cultivation but will also help them monetarily.

c. By forming Village Forest Committees for the protection and development of the degraded forests. These committees by providing suitable incentives to the tribals, after the time of harvest can divert some of the tribals away from the shifting cultivation. Generating employment opportunities during the lean season of forestry operations will also prevent tribals from shifting to other areas. Employing the tribals in the various rural employment schemes is also the need of the hour.

d. By ensuring implementation of total literacy campaign, which due to remoteness and un-supportive attitude of the tribal people, has not been successful. For educating tribal women and children, services of various non-Governmental organizations and voluntary agencies, besides the regular Government machinery, are on required sustainable basis rather than with a targeted approach.

3.5 Chapter-V: Conclusion:

Shifting cultivation practices are linked with the ecological, socio-economic, and cultural life of the people and are closely connected to their rituals and festivals. Shifting cultivation in Meghalaya is not only the way to earn livelihood of rural tribes but also it contributes to the state domestic product substantially. But due its evil effects on environment and ecological balance in the region, the time comes to think about the alternative of this traditional system. Thus, to control jhumming completely, it will require huge investment and many years. Under this situation, short term measures should be undertaken to improve productivity and also to check soil erosion. ICAR has already suggested in this line. Considering the physiographic characters of land, climate conditions, social customs, food habits etc. alternative system of farming like diversified farming should be introduced. This would require a system which includes agriculture, horticulture along with animal husbandry, fishery and poultry farming etc. success of this alternative farming depends upon the gaining of confidence of jhummias over this alternative system through persuasion, demonstration and applied fundamental research to be conducted very slowly without any haste.

The problem of shifting cultivation needs a holistic approach for its solution and for such approach adequate data base in the form of time series is necessary.

The jhum cultivation has been subject to review and the governments both at the center and state have tried various schemes to wean away jhummias in the last 30 years, mainly through the introduction of schemes on soil conservation, afforestation, water management projects, land development and terracing projects to assist jhummias for alternate settled cultivation, introduction of plantation crops such as rubber, coffee, tea, black pepper, cashew nut etc. These have met with potential success. However, no schemes can really be effective unless food security is assured and the question of alternate livelihood is incorporated with full involvement of the people.

- Less success towards shifting the jhummias for cultivation due to:
- New settlement cut into their socio-cultural life abruptly.
- Farmers are not used to cultivation on terrace/ using bullocks/implements.
- Low production on newly built terraces during first years.
- Lack of viable production technology for terrace cultivation; and
- Lack of dedicated workers to serve rural areas.
- Lack of coordination.
- Testing of schemes as pilot projects is necessary before its large scale implementation.
- Popularization of high value cash crops.

Considering the high cost, labour and energy input involved in terrace cultivation, and in absence of other viable alternatives to shifting cultivation, the majority of the population of Meghalaya depend on shifting cultivation for their subsistence livelihood. Due to limited arable land and increasing population growth, the farming on ecological fragile and marginal mountain slopes will continue. If shifting cultivation is allowed to continue, land degradation and the resources are bound to worsen with time. Considering the adverse impacts of the shifting cultivation such as loss of precious top soil, nutrients and forest biodiversity, destabilization of slopes and its low productivity, sustainable farming alternatives need to be developed and implemented.

3.5.1 Suggestions and Remedial Measures:

Traditional land practices exacerbated by poverty and associated with a lack of technical knowledge is the main cause for the continuation of unsustainable shifting cultivation. Population pressure, inadequate land for cultivation, low education levels, policy planning and implementation without local participation are all factors that influence farmers' decision to continue shifting cultivation. Considering the evil and deleterious effects of shifting cultivation, it is quite important to adopt a broad based strategy for changing the status of such cultivation in the mind of the tribal people as well as to motivate this tribal people from their nomadic agricultural practices into a settle and permanent agricultural practice. The following measures are to be helpful to control shifting cultivation in the region:

- In controlling of shifting cultivation, a successful way is to settle the jhum on an irrigated terrace by channelling water from mountain streams. This type of cultivation is known as terrace cultivation which is very much popular in Khasi, Jaintia hills of Meghalaya. Thus, adequate steps must be taken to introduce irrigated terrace cultivation in the other parts of the region.

- Solution to the problem of shifting cultivation requires the settlement of tribal families on permanently settled agriculture. This will require development of land for regular cultivation which again requires a huge investment and many years. Considering the physiographic characters of land, climatic conditions, social conditions, food habits etc., alternative system of farming like diversified farming should be introduced. This would require a system which includes agriculture, horticulture along with animal husbandry, fishery, poultry farming etc.
- The State as well as Union Governments and promotional agencies should come forward with forefront initiative to take up intensive and extensive cultivation of plantation crops (tea, coffee, rubber, pineapple etc.) and for the development of non-forest wasteland in the region. Recently, in Assam the Government has decided that a large area of the non-forest wasteland would be brought under 'rubber block planting' scheme where more than 65% of the total investment would be contributed by Rubber Board of India and the rest would be financed by the state government. This type of scheme should be implemented for other plantation crops in the all states in the region so that it increases the employment opportunity in the hill region.
- To reduce the population pressure on cultivable land in hill areas, Government should make adequate legal provisions to keep in check the flood of infiltration from other parts of India and the neighbouring countries. So that the benefit of controlling measures of shifting cultivation and employment opportunity will be enjoyed by the local people. Besides, the degraded jhum land should be developed into Special Agricultural Zones (SAZ).
- Under the present context, the concept of 'Sustainable Agricultural Development' can be an effective strategy for ensuring adequate supply of food, Fibre, fuel and other amenities to the growing tribal population in the region. This strategy will pave the way for improving the living standard of the tribal people and also create a sense of security in their life as well.

  This concept of sustainable development of agriculture will also give due recognition to the geophysical and environmental factors of the region for developing a sound agricultural pattern for the people of this hilly region. Scientific studies suggest that mixed land use system is quite suitable for hilly areas from the point of view of production as well as conservation.

  In this context, the latest and most effective land and water management techniques, popularly known as 'Watershed Management programme' along with land development, soil conservation, agriculture, horticulture, plantation crop, forestry, animal husbandry and fishery can safely be considered as most vital and important strategy.

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4. Impact of Climate Change on Agricultural Productivity and Food Security

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4.1 Introduction:

Climate is a weather condition prevailing in an area over a long period of time. The climate of an area includes seasonal temperature and rainfall averages, and wind patterns. Different places have different climates. A desert, for example, is referred to as an arid climate because little water falls, as rain or snow, during the year. Other types of climate include tropical climates, which are hot and humid, and temperate climates, which have warm summers and cooler winters. Climate change is a change in the statistical properties of the climate system that persists for several decades or longer. It is a significant change in the average values of meteorological elements, such as precipitation and temperature, for which averages have been computed over a long period. Climate change may be due to natural processes, such as changes in the Sun's radiation, volcanoes or internal variability in the climate system, or due to anthropogenic causes such as deforestation, land use, anthropogenic wastes that cause changes in the composition of the atmosphere, land and water. Anthropogenic activities lead to the emission of greenhouse gas such as CO2, methane, and nitrous oxide, as well as other substances that lead to ozone depletion in the atmosphere [1]. The past few decades indicate that significant changes in climate at a global level were the result of enhanced human activities that altered the composition of the global atmosphere [2]. The average global temperature is expected to rise by 2°C by 2100 and 4.2°C by 2400, as predicted by probabilistic computations of the IPCC's range of climate sensitivity. So this rising global temperature affects the world many ways. In the recent time there has been a lot of discussion on climate change. So it is evident that impact of climate change is will be felt cross the world in different sectors ranging from water resources to industries to social arenas. It is not like that those people who contributed most to climate change will be affected more but everyone will be affected irrespective of their contribution to global warming and climate change. Though climate change poses a variety of challenges, the present paper would specifically focus on the issues viz. impact of climate change on agriculture and food security which have immense impacts all over the world but particularly in some developing countries like India where still agriculture contributes a significant portion in GDP of the country.

The increasing world population is putting stress on rising demands for crop production. By 2050, global agricultural production may need to be doubled to meet increasing demands [3]. Evidence comes from agricultural science research as well as an analysis of crop production data that climate variability matters as much to crop production as the mean values of climate variables during the crop season [4]. Crop productivity in world faces weather adversities, especially extreme events that jeopardize socioeconomic demands [5]. Climate change not only increases the average global temperature but may also lead to some other effects like stronger storm system, increases frequencies of heavy precipitation events and extended dry periods. These changes have implication for overall food production, food security as well as food safety.

4.2 Climate Change and Crop Production:

Crop production is extremely susceptible to climate change as it can effects the microbial population of the macro-environment (soil, air and water) and population of pest or other vectors. Thus act as a contributing factor to the occurrence of biotic diseases caused by different organisms like fungi, bacteria, viruses and insects.

Abiotic factors such as nutrient deficiencies, air pollutants and temperature or moisture extent can also affect the plant health and productivity which is happening due to climate change. It has been estimated that climate change are likely to reduce the yield of crops in the 21th century [6]. While the impact of biotic and abiotic factors on crop production and food securities are more obvious, it is important to note that these factors may also have significant impacts on safety of food crops. The prevalence of environmental contaminants and chemical residues in food chain is a chief impact of climate change.

The changing climate may also negatively affect the crop production by altering plant-microbes interactions and soil ecology specifically in the rhizosphere region. It is well known that plants and associated microbial interactions are critical factors affecting the growth, survival, yield, and nutritional quality of agricultural crops [7]. Apart from this the changing climate condition may also affect the plant pathogen interaction by altering the pathogen life cycle, expression of host resistance, disease epidemiology and severity of disease epidemics, development of new races or pathotypes, virulence, overwintering or over summering of the pathogen, and so forth [8]. In addition, the warming climate can alter the mobility, leaching, bioavailability, volatilization, and global transport of chemical pollutants in agro-ecosystems [9]. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Pests management become less effective, meaning that higher rates of pesticides will be necessary to achieve the same levels of control but it will negatively impacts human beings as well as environment.

This changing climatic conditions coupled with subsequent changes in biotic and abiotic stress have drastically affected the quantity and quality of agricultural products [10]. Heat waves can cause extreme heat stress in crops, which can limit yields if they occur during certain times of the plants' life-cycle (pollination, pod or fruit set) are changes. Extreme periods of high temperature are particularly harmful for crop production if they occur when the plants are flowering – if this single, critical stage is disrupted, there may be no seeds at all.

Also, heat waves can result in wilted plants (due to elevated transpiration rates) which can cause yield loss if not counteracted by irrigation. In global level global warming have already doubled the chance of "killer" heat waves like the one that scorched Europe in July–August 2003 [11]. Strong evidence indicates that the summer was the hottest in Europe in at least the past 500 years [12]. All-time high temperature records were broken in many countries. High temperatures at night can be particularly damaging to agriculture. Some crops require cool night temperatures. The heat and associated drought and wildfires cost European economies over $14.7 billion (13 billion Euros) in losses in the agriculture, forestry, and electric power sectors [13]. Specific damages included a 60% reduction in fodder production in France, an 18% decrease for wine in Italy, an 11% fall in grain production for Europe as a whole [14].

Due to the climate change rainfall pattern also have changed. Heavy rainfall may often results in flooding that can also be detrimental to crops and to soil structure. Most plants cannot survive in prolonged waterlogged conditions because the roots don't get proper aeration for survive. According to the available data, a significant increase in the intensity of precipitation events occurred over the second half of the 20th century. This increase is consistent with the predicted effects of global warming, since higher temperatures speed up evaporation from the land, vegetation and oceans. This increase in the amount of moisture in the warmer atmosphere in the form of water vapour leads to heavier downpours.

Heavier rainfall in turn increases the risk of flooding [15]. One of many extreme flooding events that may have been exacerbated by global warming occurred in December 1999, when Venezuela experienced its highest monthly rainfall in 100 years [16].

Another impact of climate change that affects the crop productivity is drought. Droughts are also expected to be more frequent and severe. Higher temperatures tend to increase the rate of evaporation; if precipitation doesn't soon replenish the lost moisture, soils grow drier. In drier soils, less solar energy is used up in evaporating water, meaning more energy is available to raise the temperature of the soil and the overlying air, leading to even more desiccating conditions; this kind of self-amplifying cycle can lead to a lengthy and severe drought [17]. Warmer ocean temperatures due to global warming may also increase the severity of droughts. The Indian Ocean and the western Pacific were exceptionally warm between 1998 and 2002, in part because of the overall warming trend in the world's oceans. In the same period, unusually persistent atmospheric flow patterns resulted in below normal precipitation, high temperatures, and drought conditions across wide swaths of North America, southern Europe, and southern and central Asia [18]. Drought is also associated with another severe environmental condition like forest fire and nature have witnesses this type of natural disaster at many instances. Desiccating heat and lack of precipitation create ideal conditions for major wildfires. In addition, longer warm seasons often translate into longer fire seasons. Warmer temperatures also promote outbreaks of insects that feed on trees, killing many of the hosts and creating large amounts of dry fuel for forest fires. Warmer temperatures also promote outbreaks of insects that feed on trees, killing many of the hosts. In south-central Alaska in the 1990s, the world's largest recorded outbreak of spruce bark beetles damaged more than 4 million acres (1.6 million hectares) of forest, an area nearly the size of the state of New Jersey. Since 1994, Canada has been afflicted with its largest and most northerly spruce bark beetle outbreak ever, affecting 750,000 acres (300,000 hectares) in the Yukon that severely affects crop production [19].

In 1998, Mexico experienced its worst fire season ever, when 1.25 million acres (506,000 hectares) burned during a severe drought. Smoke reaching Texas triggered a statewide health alert [20]. If wildfires continue to increase in frequency and intensity, the amount of carbon dioxide released into the atmosphere from burning vegetation and soil organic matter could outstrip the amount absorbed by remaining forest and thus strengthening the greenhouse effect and global warming and possibly leading to even more fires in a worsening cycle which again effects on crop production.

The loss of crop yields can increase food prices, and can have an absurd effect on agriculture welfare globally, with a 0.3% annual loss of future GDP globally by 2100 [21]. However, it has been found that climate change has limited influence on the world food supply, but the developing countries will face severe negative consequences [22]. In India, the temperature is predicted rise between 2.33°C and 4.78°C along with a doubling of CO2 concentration and longevity of heat waves, which could have a detrimental effect on the agriculture sector [23]. Although the detrimental impact of climate change will be enormous in developing countries tropical regions but it will also depend on the region's climate scenario. The drier region of Sri Lanka (north and east) will experience huge losses in agriculture compared to the cooler central highland region, the output of which is expected to remain the same or even increase with rising temperatures [24]. In the arid region of Rawalpindi, Pakistan, an annual loss of INR 4180/acre is to be borne by farmers by 2100 with a 1°C increase in temperature, while the net revenue can be increased by INR 377.4 and INR 649.21 with an increase in rainfall of 8% and 14%, respectively [25]. The yield losses in rice, maize, and wheat are projected to worsen by 10 to 25% with a 1°C increase in mean surface temperature globally. In sub-Saharan Africa, the average crop yield is projected to be reduced by 6–24% due to climate change [26].

The change in climate or weather pattern of an area is predicted to increase a crop's susceptibility to various pests, diseases, and weeds. There are projections of a 10–25% increase in losses due to insect pest infestation with an increased temperature of one degree [27]. Climate change has the potential to increase the pest population and its migration, which can have an adverse impact on agricultural yields and even viability, as the pest population depends mainly on abiotic factors such as humidity and temperature. In Brazil, the infestation of coffee nematodes and leaf miners is expected to increase due to an increase in the number of generations in a month compared to the climatic conditions of 1961–1990 [28]. Climate change is projected to have a favorable influence on the weeds of wheat crops, which are very vital to world food security [29]. In the wake of climate change, new geographical horizons are being opened up for weeds, and their management can only be possible if new management practices are being planned while considering climate change. Pest infestations of various crops is predicted to worsen with climate change, as warmer and humid conditions are more favorable to pest proliferation. Pest infestation thereby has led to huge pesticides costs for pest management.

The increasing average temperature of earth could lead to changes in the range of latitudes at which certain fungi are able to compete. Since 2003, frequent hot and dry summers in Italy have resulted in increased occurrence of *Aspergillus flavus*, the most xerophilic of the *Aspergillus* genus, with consequent unexpected and serious outbreak of aflatoxin contamination, uncommon in Europe, even in the southern regions. Also in United States serious outbreaks of A. Flavus have been reported for similar reasons.

Generally moist, humid conditions favour mould growth. Moist conditions following periods of heavy precipitation or floods would be expected to favour mould growth with the expectation of greater production of mycotoxins. There are reports that periods of higher than average temperatures and reduced annual rainfall in Kerman Province in Iran has been linked to nut deformity and increased levels of aflatoxin contamination [30]. Mycotoxins can diffuse into the grain and can be found in all ground fractions and, due to their thermo-resistance properties, also in products subject to thermal processing [31]. Such products make a serious threat to the consumers health and some of the toxins are enumerated among carcinogenic compounds for humans and animals. Aflatoxin that belongs to human carcinogens induces liver tumors, and ochratoxin A has nephrotoxic effects. Trichothecenes, and deoxynivalenol (DON) among them present a wide range of toxic influence on human beings and animals resulting in their lack of appetite, nausea, diarrhea, hemorrhages and anemia. Loss of food commodities due to pest infestations is a major reason of food crisis particularly in tropical countries [32].

Mycotoxins contamination in cereals intended for human and animal consumption, is a serious food safety issue regarding productions from all over the world. In particular, cereals and by-products could be contaminated by different class of mycotoxins including one of the most dangerous to human health and animal found in nature, aflatoxin B1. Mycotoxins occurring in food commodities are secondary metabolites of filamentous fungi, which can contaminate many types of food crops throughout the food chain. Although hundreds of fungal toxins are known, a limited number of toxins are generally considered to play important roles in food safety. Around a quarter century back itself, the World Health Organization estimated that approximately 25% of the world's grains were contaminated by mycotoxins. This has most certainly grown since then due to an increase in global import and export of grains and cereals and the changing environmental and weather patterns which is an effect of climate change. Climate change may make production of certain crops difficult in some areas thus posing an obvious food security problem. Climate change impacts not only on primary production but some conditions like increasing average temperature could increase hygiene risks associated with storage and distribution of food commodities. Reduced availability and quality of water in food handling and processing operations will also give rise to a new challenge to hygiene management. It is anticipated that these risk management measures and adaptation strategies will pose greatest challenge for developing countries. Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting increases in food prices after extreme events are expected to be more frequent in the future. Internationally, these effects of climate change on agriculture and food supply are likely to be similar to those seen in the United States. However, other stressors such as population growth may magnify the effects of climate change on food security. In developing countries, adaptation options like changes in crop-management or ranching practices, or improvements to irrigation are more limited than in the United States and other industrialized nations. Any climate-related disturbance to food distribution and transport, internationally or domestically, may have significant impacts not only on safety and quality but also on food access.

4.3 Impact of Climate Change on Agricultural System of India:

Food production in India is sensitive to climate changes such as variability in monsoon rainfall and temperature changes within a season. Studies by Indian Agricultural Research Institute (IARI) and others indicate greater expected loss in the Rabi crop. Pathogens and insect populations are strongly dependent upon temperature and humidity, and changes in these parameters may change their population dynamics. Indian climate is dominated by the southwest monsoon, which brings most of the region‘s precipitation. It is critical for the availability of drinking water and irrigation for agriculture. Agricultural productivity is sensitive to two broad classes of climate-induced effects:

a. Direct effects from changes in temperature, precipitation or CO2 concentration and
b. Indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases.

Rice and wheat yields could decline considerably with climatic changes [33]. However, the vulnerability of agricultural production to climate change depends not only on the physiological response of the affected plant, but also on the ability of the affected socio-economic systems of production to cope with changes in yield, as well as with changes in the frequency of droughts or floods. The adaptability of farmers in India is severely restricted by the heavy reliance on natural factors and the lack of complementary inputs and institutional support systems. Agriculture in the coastal regions of Gujarat, Maharashtra, and Karnataka is found to be the most negatively affected. Small losses are also indicated for the major food-grain producing regions of Punjab, Haryana, and western Uttar Pradesh. On the other hand, West Bengal, Orissa, and Andhra Pradesh are predicted to benefit to a small extent from warming. In a recent study, the International Commission for Snow and Ice (ICSE) reported that Himalayan glaciers – that are the principal dry-season water sources of Asia’s biggest rivers - Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow – are shrinking quicker than anywhere else and that if current trends continue they could disappear altogether by 2035 [34]. Agriculture is not provided the food only but also the primary source of livelihood for 38.6 percent of the world’s total workforce [35]. If agricultural production in developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and food insecurity will be highly vulnerable. India will also begin to experience more seasonal variation in temperature with more warming in the winters than summers [36, 37]. All the models of climate predict that there will be more extreme weather conditions, with more droughts, heavy rainfall and storms in agricultural production regions. Such extreme weather events will heavily imposing severe risks and potential crop failure. With rapidly increasing population, climate change has been become a more threat to developing countries like India. The tropical climate of India could become warmer under conditions of increased atmospheric carbon dioxide.

Wheat yields are predicted to fall by 5-10% with every increase of 1°C and overall crop yields could decrease up to 30% in South Asia by the mid-21st century [38]. India could experience a 40% decline in agricultural productivity by the 2080s [39]. Rise in temperatures will affect wheat growing regions, placing hundreds of millions of people at the brink of chronic hunger.

4.3.1 Impact of Climate Change on Agricultural System of North Eastern Region:

North eastern states primarily based on agriculture, so agriculture is considered as the driving force in these states. Nestled in the Himalayas, the North Eastern Region of India comprises the 'Seven Sister States' of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, plus the 'Brother' state of Sikkim. Climate change affects directly and indirectly in the production of agricultural crops. This can take place through changes in average temperatures, rainfall, and climate extremes; changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods. The region is a global biodiversity hotspot, as well as being home to many different ethnic groups with a rich cultural heritage and traditional knowledge of the environment. Climate change has dramatic impacts on natural resources, economic activities, food security, health and physical infrastructure. Wherever, livelihoods of people are particularly dependent on natural resources.

In these vulnerable areas, climate adaptation measures are of central importance for the protection of rural livelihoods and for ensuring sustainable development. The impact of climate change is more likely to have an adverse effect in the developing countries due to high dependency on climate sensitive livelihood like rain-fed agriculture, water, and forestry [40]. Climate Change will reduce access to drinking water, affects the health of the poor, will pose a threat to food security.

Additionally, poor people in developing countries tend to be more vulnerable due to limited opportunities and choices, small land holdings and lack of access to market. Tea yields in the North East are expected to decline by up to 40 % by 2050 (Tea Board of India). In NE 2006, 2008, 2014, 2015, 2016, 2020 is considered as the warmest year.

Besides, the growing human population and livestock pressure gradually widening the gap between demand and supply of natural resources. These impacts will cut across multiple dimensions of day to day life affecting not just the environment but the communities as well. Climate change thus could impose a variety of stress on sustainable livelihood of the poor inhabitants of Northeast India through stresses on ecosystem function. The major concerns are irregular rainfall patterns, longer dry spells, and implications on agriculture calendar, productivity, new pests; food security; health and disasters like flash floods. It is presumed that there would be a change in distribution, abundance of species, more particularly wild, endemic species, crop plants, pests and vectors. Due to change in habitat condition, displacement both human and other wilderness would take place. Apart from these, the food security, mitigation of hazards and addressing the epidemics like malaria, encephalitis etc is other issues of major concerns for the region. Under such circumstances, there is possibility of conflicts over reduced natural resources causing strained social relations taking toll on to the cultural and spiritual services provided by ecosystems. The gap in information and lack of scientific comprehensive data base on climate change and its implications has become a hindrance for taking up appropriate site specific adaptation and mitigation strategies and action plan. The overall interpretation of regional forest statistics suggest the drivers of loss of forest cover in terms of threats and pressures being enhanced by erratic changes in local climatic factors due to global change.

Timing and magnitude of climate changes still remain uncertain, it is clear that climate change would affect many ecosystems particularly the terrestrial forest ecosystems and human activities in the remote eco-region of North East India at the foot hills of Himalayas. One of the major factors affecting forest cover is the growth of human populations throughout the Northeast India and the forests are the best place to accommodate the growing pressure of additional people [41].

4.3.2 Impacts of Climate Change in the Agriculture System of Assam:

Climate change and environment directly influences the livelihoods of the people of Assam. The geographic proximity to the delta region and poor socio-economic conditions makes Assam to be extremely vulnerable to climate change. This vulnerability is reflected in the exposure, sensitivity and adaptive capacity of the local population to climate induced extreme events such as floods. Human activity like coal mining, deforestation, overgrazing etc causes climate change drastically. The state is characterized by high rainfall and a subtropical climate. It gets annual floods and frequent droughts, both of whose severity has risen due to adverse climatic conditions. As a result of flood and erosion, there has been a decline in the agricultural land, and beside these thousands of hectares of fertile agricultural land in different parts of Assam has become waste land as a result of deposition of sand brought by the flood over the fertile land. However, like most developing regions, climate change issues have received short shrift in the state, and efforts are more focused on recovery than creation of adaptive capacity. The poor are more vulnerable to extreme climate events and the drastic climate change projections are particularly worrisome for Assam as almost 32% of its population lives below the poverty line. Further, a majority of this population is dependent for its income on agriculture, which in turn is highly dependent on climatic factors such as precipitation and weather, and is frequently disrupted due to damage from floods and droughts. The state's low adaptive capacity further exacerbates the situation and makes the populace dependent on agriculture highly. Frequent droughts have affected the produce of the bountiful state and have often led to economic consequences. Drought causes lower the agricultural production. According to the State Action Plan for Climate Change, the annual mean temperature in the state has increased by 0.59 degrees Celsius over the last 60 years (1951 to 2010), and is likely to increase by 1.7-2.2 degree Celsius by 2050. Climate projections in the state action plan also predict that extreme rainfall events will increase by 38%. Drought conditions lower the production of agricultural commodities, which in turn push their prices up. One can easily imagine the result of low incomes and high prices in the face of events such as droughts and floods. In 2006, 15 district of Assam had below normal (nearly 40%) rainfall in the region. More than 75% of the 26 million people associated with livelihoods related to agricultures were affected. State suffered a loss of more than 100 cores due to crop failure and other peripheral affects [42].

4.4 Case Study Regardinte Changes and Economic Loss of our State:

a. Assam, in North-east India, produces one of the finest, and most expensive, types of silk in the world. Produced by the semi-domesticated silkworm Antheraea assamensis, which is only found in the Brahmaputra Valley, this silk is called Muga – Assamese for “yellow” or “amber” – and is often called golden silk.

This silk has been produced in the region from as far back as 321 BC, and is an inextricable part of the life and culture of Assam. Unfortunately silkworms are highly sensitive to climatic conditions since they are grown outdoors. Recently unpredictable rainfall patterns, a rise in temperature and persistent floods have endangered Muga cocoon production across the state. Due to the long history of sericulture, Muga silk occupies a special place in the lives of the indigenous people, inextricably linked to their cultural life. Moreover Muga silk is one of the most expensive silks in the world due its durability and beauty. The luster of the fabric increases with each wash, making it a product that is treasured – and which lasts – throughout the lifetime of its owner. In 2007, Assam received the Geographical Indication (GI) tag for Muga silk. A GI tag is given to products that are produced in a particular area, and boosts the reputation of the product [43].

b. Another example of the adverse impact of climate change on the economically marginalized communities is that of Majuli, the largest riverine island in the Brahmaputra River. Majuli has a very high poverty rate at around 21.47% (according to Jorhat district administration). Climate change has resulted in continuous shifts in rainfall pattern as well as an increase in temperatures of the island. It has also lost visibly large tracts of land due to erosion over the last century. The already low income of island's population is further declining due to lower farm productivity caused by frequent floods, erosion, and siltation. The loss of livelihood due to climate induced events has resulted in forced migration to neighboring urban centers such as Jorhat.
c. This deeply troubling economic implication of climate extremes resulting in the loss of livelihood options is reflected in other parts of the state. A 2012 study by the Centre for Environment, Social and Policy Research (CESPR), in collaboration with the Indian Network on Ethics and Climate Change, noted the widespread loss of livelihood options for thousands of people across Assam due to climate disasters, particularly floods and erosion. Climate change is even endangering the abundant tea plantations that are synonymous with Assam, as several modeling results have pointed towards decreasing tea yields in the region. Tea production in July 2014 in Assam down by 3.22 % compared to the same period in 2013 [44]. 35 years from now, the suitability of these regions would reduce drastically across all the tea growing regions and shifting of tea would be observed in comparatively higher altitude areas of Karbi Anglong, Dima Hasao and Tinsukia district. In 2011 early onset of winter resulted in loss 15 million KG of tea. In that time upper Assam estates in the South Bank of the Brahmaputra experienced severe drought condition, net estimated loss of tea production is 60% of normal (about 26 million on KGs). In the year 2014 abnormally below normal per monsoon rainfall during Feb-April (less 30% of normal) badly affected tea production in Upper Assam.
d. Apart from the economic loss, the effect of climate distortion on the population's health and wellbeing is also overlooked, further weakening the region's human resource base. While previously unheard of, heat strokes are becoming commonplace in Assam as summer temperatures are touching 40 degrees Celsius. There is a dearth of data on climate change induced rise in diseases in the region, but it shouldn't be surprising if such a study does indeed establish a correlation between spread of diseases, particularly communicable diseases.
e. Climate change has the potential to modify host physiology and resistance and to alter stages and rates of development of the pathogen. The most likely impacts would be shifts in the geographical distribution of host and pathogen, changes in the physiology

of host-pathogen interactions and changes in crop loss. Another important impact may be through changes in the efficacy of control strategies. Increases in temperature can modify host physiology and resistance. Agricultural crops and plants in natural communities may harbor pathogens as symptomless carriers, and disease may develop if plants are stressed in a warmer climate. Host stress is an especially important factor in decline of various forest species.

4.5 Conclusion:

It is evident that impact of climate change is will be felt cross the world in different sectors ranging from water resources to industries to social arenas. It is not like that those people who contributed most to climate change will be affected more but everyone will be affected irrespective of their contribution to global warming and climate change. As a consequence of climate change the occurrence of floods and droughts, heat and cold waves are of common occurrence across the world. Their adverse impact on livelihood of farmers is tremendous especially in the people of developing countries like India where economy is still more dependent on Agricultural sectors. Interestingly, weather extremes of opposite in nature like cold and heat waves and floods and droughts are noticed within the same year over the same region or in different regions of our country and likely to increase which will lead to more crop losses due to climate change. The whole climate change is associated with increasing greenhouse gases and human induced aerosols and the imbalance between them may lead to uncertainty even in year-to-year monsoon behaviour over India. 2020 was eighth warmest year on record since 1901 with annual mean land surface air temperature + 0.29°C. The last decade (2011-2020) was also the warmest decade on record.

Average annual mean temperature during 1901-2020 showed an increasing trend of 0.62°C in 100 years. Recently in 24th May 2021 Guwahati witness highest temperature in last 10 years which is 37.9°C almost 6 degree higher above the normal temperature. Nationwide, reductions to agricultural productivity or sudden losses of crops or livestock will likely have ripple effects, including increased food prices and greater food insecurity.

Therefore, there should be a determined effort from developed and developing countries to make industrialization environment friendly by reducing greenhouse gases pumping into the atmosphere. In the same fashion, awareness programmes on climate change and its effects on various sectors viz., agriculture, health, infrastructure, water, forestry, fisheries, land and ocean biodiversity and sea level and the role played by human interventions in climate change need to be taken up on priority basis. There is an urgent need for coordinated efforts to strengthen the research to assess the impact of climate change on agriculture, forests, animal husbandry, aquatic life and other living beings.

Two major international agreements namely the Paris Agreement and the 2030 Agenda for Sustainable Development were adopted with the objective of manually reinforcing and codependent the risk of climate change to economic development and successful low carbon transition depends on social economic and environmental development. So various climate change mitigation policies has been developed by different policy makers specially to motivate the developing countries for climate action where basic development objectives often outweigh the importance of climate objective [45].

Every nation should reduce their per capita carbon pollution by implementing different policies like a type of carbon tax, negotiated industrial agreements and domestic emission trading scheme etc. More accurate climate policy evaluations can give inform on the analysis of national and global carbon budget, which form the basis of actionable goals for climate stabilization.

From the agriculture point of view, effects of extreme weather events on crops are to be documented on regional scale so that it will be handy to planners in such re-occurrence events for mitigating the ill effects. Also, there is need to guide farmers on projected impact climate change and sensitize them on probable mitigation and adaptation options to minimize the risk in Agricultural sector. We have to introduce stress resistant verity which can survive in extreme environmental conditions. We should improve our irrigation system so that in the winter also people will not suffer water crisis in their production of agricultural crops also introducing water harvesting systems in the rural areas. Our state's economy will increased if we focus on agricultural productions. Development of agriculture in the form of science-based farming practices, that can buffer farmers from climate damage and help make their operations more resilient and sustainable for the long term.

But farmers face many obstacles to changing practices, so it's critical that policymakers shift federal agriculture investments to support and accelerate this transition. We should try to control the climate change because global warming causes extreme hot weather in these climatic conditions farmers are not able to work and their productivity directly or indirectly affected so we should plant more trees and make our mother earth green.

Extension system has to focus more on diversifying the livelihood options, changing suitable cropping patterns to adjust to the change which is occurring in the particular location, planting more drought tolerant crops, promoting increased share of non-agricultural activities and Agro-forestry practices, identifying the traditional coping strategies, improved on - farm soil & water conservation, promoting mixed cropping pattern and making provision for access to various information sources related to weather and other advisories of climate change would minimize the risks and certainty of farmers related to climate change.

Institutional interventions, either by strengthening the existing ones or initiating new ones, relating to seed 25 bank, fodder bank, custom hiring center, collective marketing, and introduction of weather index based insurance and climate literacy through a village level weather station. Farmers should visit the district agricultural office as well as KVK (Krishi Vigyan Kendra) to discuss their issues.

Mitigation comprises measures to reduce the emissions of greenhouse gases that cause climate change in the first place, e.g. by switching to renewable sources of energy such as solar energy or wind energy or nuclear energy instead of burning fossil fuel in thermal power stations. Scientific diagnosis and assessment of the impact of climate change on the agricultural sector is essential for formulating the vision of future agriculture and the direction of agricultural administration. Specifically, it can provide useful information for formulating the long-term agricultural development plan for each region and the adaptive measures for farming households.

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5. Challenges on Environmental Degradation and Mitigation Measures

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5.1 Introduction:

The word "environment" can be defined as the physical surrounding on which his or her activities like physiological functioning, production, and consumption depends. It is deteriorating for the last two centuries and almost every part of the planet has been touched by destruction in one way or the other. The major cause of environmental degradation is human disturbance led by urbanization and industrialization. The industrial revolution has begun in the 19th century which increased the production and manufacturing of goods. It also introduced the use of machines and other heavy equipment - which in turn, used fuels as a source of energy and releases waste materials to the environment that causes pollution of air, water, and land [1].

The deterioration of the environment has led to numerous adverse impacts. First, living organisms like humans are at risk of suffering from dangerous health conditions like asthma and pneumonia due to pollution.

Another adverse effect is the loss of biodiversity and natural resources. To overcome this critical situation, we need to make calculative use and management of resources and sustainable development. The path of mitigation will not be that smooth rather be full of challenges as degradation of the environment is not a problem to be tackled in a day or two. Environmental education and policy-making regarding environmental conservation and protection will be useful for the natural environment. The world is making impressive steps to minimize the damage to the environment.

5.2 Overview:

Environmental degradation is a serious problem which is being faced mostly nowadays. It means the deterioration of the surroundings or the environment. Several factors contribute to environmental degradation like deforestation, natural disasters, global warming, climate change, mining, waste discharge, etc. The main contributors are urbanization, industrialization, and pollution which are mostly interlinked in either direct ways or indirect ways. The beginning of the 19th century was also the beginning of which means the setup of new industries that employ many people [1]. Urbanization meant the conversation of small villages into towns or can also be defined as the migration of people from small towns to cities in search of livelihood. Industrialization and urbanization meant the availability of various facilities such as hospitals, schools, primary healthcare centres, colleges, etc.

At this time technology also came to play and led to the invention of various tools and machines that ultimately is the workload of the individual in different sectors such as agriculture, industries, communication, and transport.

With the beginning of this new era of urbanization, industrialization and technology have also increased the level of pollution due to the use of various machines and tools. As the establishment off knew cities led to different types of environmental pollution in several sectors such as air, water, land, noise, etc. Industrial pollution is the main cause of the pollution occurring today. The untreated waste materials from the industries are directly dumped into the water bodies which as a result cause water pollution as the chemicals get accumulated. The waste from those industries can be classified into two types as Process wastes (produced during processing and manufacturing) and Chemical wastes (produced as untreated effluent and by-product after the products formed).

There are several factors on which environmental degradation depends such as overpopulation and overexploitation of natural resources, Intensification of agriculture, Climate change, Illegal dumping, Mining, etc. Environmental degradation has several different effects on both living and non-living environments such as acid rain, neutral calamities, loss of livelihood, etc. The solution of this degradation that is needed to be imposed to decrease the rate of awareness, education, fines, and taxes, avoiding the use of plastics, conserve and use, etc. There are some initiative measures such are 5R's are REFUSE, REDUCE, REUSE, REPURPOSE, RECYCLE) and 3M's (MAN, MATERIAL, MACHINERY [19].

Some of the challenges that are faced due to environmental degradation are loss of biodiversity and natural resources, climate change, polluted water bodies, loss of capital, degrading the quality of air, water, and soil [3]. Sustainable development is a process method of meeting the human developmental goals and also simultaneously conserving the natural resources and ecosystem on which our society and economy depend. They have also set up some goals according to which every nation works. Mitigation is the method or process through which we can decrease the adverse and harmful effects of environmental degradation.[1] Some measures that lead to mitigation are controlling at the point of source, selecting the proper industrial site, treatment of industrial wastewater, afforestation, strict application of government actions and rules. Government and non-governmental organizations play important role in spreading the awareness and measures of environmental degradation by conducting several programs in several communication sectors such as radio television and the internet. Some of the government initiatives to safeguard the environment are Swachh Bharat Mission, Green Skill Development Programme, and National Mission for Green India, Conservation of Natural Resources and Ecosystems and some of the rules are The Environmental Protection Act, The Wildlife Protection Act, The Forest Conservation Act, etc. [6]

5.3 Environment and Its Degradation:

Environment means our surroundings. It can be defined as a collection of all the elements, processes, and conditions around an organism, that influence the lifestyle. There are 2 components of the environment such as living (Biotic- humans, plants, animals, etc) and non-living (Abiotic-sunlight, soil, air, water, land, etc.)

The process of creating the` environment has been classified into two categories such as;

a. Natural environment: It includes all the living and non-living things that occur naturally. The creation of these components has been done by nature and not through humans. It includes the chemical constituents, living space, climate, etc.
b. Human-made environment: this is the type of environment that is made by human beings according to their need and comfort.

The process of degradation of natural resources present in the environment is known as environmental degradation. The main concern is to ensure the amount of stress and pressure we are imposing on the limited surrounding and due to its over-exploitation, the capacity of replenishing decreases. It has been cautioned as one of the 10 threats by the High-level Panel on Threats, Challenges, and Change of the United Nations. [1] For the past two centuries, almost every sphere is deteriorating. We are being cautioned about the deterioration in the environment and its consequences which is directly or indirectly linked with our lifestyle. There is an urgent need to take all possible steps to check environmental degradation along with the degree of degradation with its cause.

5.3.1 Causes of Environmental Degradation:

Major causes of environmental Degradation are:

a. Urbanization: is referred to as the increase in the population living in urban areas. It can also be defined as the process of forming towns and trading centres because people are preferring to move from rural areas in search of work [13]. Factors that contribute to urbanization are mainly: industrialization, modernization, and rationalization that results from sociological processes. It majorly involves the replacement of old cultural ways to a dominating urban culture [26].

b. Industrialization: is referred to the change in social and economic activities of people involving a shift in manufacturing, innovating and replacing minor activities such as farming [8]. Around 1760 in Britain, the beginning of industrialization occurred. This period marked the growth in population and employment. It can be said that urbanization led to industrialization. Industrial Revolution played the major cause behind the positive change for the industrial world. Natural resource depletion, carbon emission and pollution occurred directly due to the industrial revolution.

Table No.5.1: Gives a brief idea about the advantages of industrialization and urbanization

Advantages of Industrialization	Advantages of Urbanization
1. Created jobs for poor peasants	1. Dependable job sand increased earnings
2. Short, effective & reliable production	2. Efficient & reliable healthcare
3. More industries developed	3. More cities developed

Advantages of Industrialization	Advantages of Urbanization
4. Products were cheaper	4. Quality education
5. GDP of the industrialized nations grew	5. Improved lifestyle

- **Pollution and its Types:** Pollution is the process of an undesirable change in the various characteristics of air, water, and land which adversely affects the lifestyle. There is a wide range of pollutants that occur either naturally or through human activities and further can classify into degradable (domestic wastes, sewage, etc.) and non-degradable (heavy metals, plastics, etc.).

Different natural disasters such as volcanic eruptions, landslides, runoff water, etc causing natural pollutants which are less effective and persistent than man-made pollutants which are more drastic and long-lasting. The major problem arises with the increasing population as it leads to deforestation, rapid and unplanned industrialization which results in environmental pollution. Environmental pollution causes several health problems. [23].

Water Pollution: is caused by organic and inorganic industrial wastes and affluents that are directly discharged into water bodies without any treatment. There are several industrial contributors such as paper, pulp, chemical, textile and dyeing, petroleum refineries, tanneries, and electroplating release many harmful chemicals such as lead, mercury, synthetic chemicals, organic and inorganic compounds into the water bodies [4].

Land Pollution: Increasing population in the urban areas due to urbanization, the industrialization that results in the disposal of different types of wastes into vast open land areas. The land gets polluted by solids and liquid waste from the industries. The use of fertilizers, pesticides, herbicides, and insecticides for enhancing agricultural productivity contributes to land pollution and decreases its fertility. Concrete used in the building process creates land pollution [24].

Air Pollution: is the type of pollution that is caused by the presence of undesirable substances such as nitrogen oxides, carbon oxides, etc. these undesirable substances are present in different forms such as solid, liquid, vapour, gas.

Smoke is emitted by different industries and fuels that are burnt in factories as raw materials and toxic gas leaks can be very hazardous with long-term effects [5]. Air pollution adversely affects human health, animals, plants, buildings and the atmosphere as a whole.

Industrial Pollution: it is the type of pollution that is generally occurred by the waste produced by the industries [15]. This release of waste leads to contamination of water, land, and air pollution.

The nature of industrial waste depends upon the industrial process in which these originate and the raw materials they use. Broadly the industrial wastes may be divided into two groups:

A. Process Waste: The industrial waste generated during the washing and processing of raw materials is known as process waste. It may be organic or inorganic depending upon the raw materials used and the nature of the industry [15].

B. Chemical Wastes: The chemical substance generated as a by-product during the preparation of a product is known as a chemical waste. It includes heavy metal ions, detergents, acids, alkalies, and various other toxic substances [15].

Table No.5.2: Shows the type of industrial waste is released from the industries along with the pollution caused.

Sr. No.	Industry	Waste Produced	Types of Pollution
1.	Caustic Soda	Mercury, Chlorine Gas	Air, Water and Land
2.	Cement Dust, Smoke	Particular matter	
3.	Distillery	Organic waste	Land and Water
4.	Fertilizer	Ammonia, Cyanide, Oxides of Nitrogen, Oxides of Sulfur	Air and Water
5.	Dye	Inorganic Waste Pigment	Land and Water
6.	Iron and Steel	Smoke, Gases, Coal, Dust, Fly ash, Fluorine	Air, Water and Land
7.	Pesticides	Organic and inorganic Waste	Water and Land
8.	Oil Refineries	Smoke, Toxic Gases, Organic Waste	Air and Water
9.	Paper and Pulp	Smoke, Organic Waste	Air and Water
10.	Sugar	Organic, Waste, Molasses	Land and Water
11.	Textiles	Smoke, Particulate Matter	Land and Water
12.	Tanneries	Organic Waste	Water
13.	Thermal Power	Fly ash, SO_2 Gas	Air and Water
14.	Nuclear Power Station	Radioactive Wastes	Water and Land
15.	Food Processing	Alkalis, Phenols Chromates, Organic Waste	Water and Land

Prevention and Control of Pollution:

The main approach of pollution control is to erase or eliminate the release of different pollutants to the surrounding.

Various governmental and non-governmental agencies regulate policies to limit the discharge of a pollutant into the atmosphere. Production of pollutants can be prevented by following:

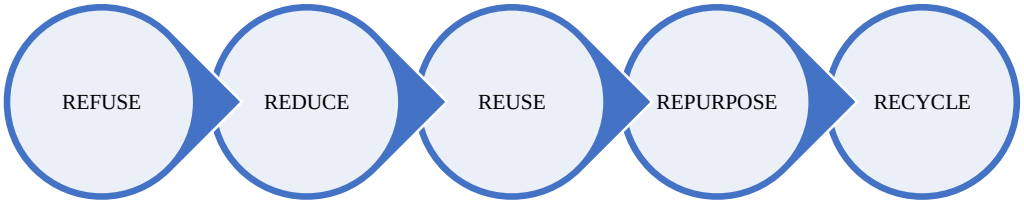

Figure 5.1: These are the 5R's which needs to be implemented so that production of waste materials can be minimized so that environmental degradation can be controlled [19].

5.3.2 Factors of Environmental Degradation:

There are several different factors on which degradation of the environment depends and most of them are interlinked [4]

- **Population Growth and Exploitation of Resources:** As the population is increasing the basic needs are also increasing which means more land for settlement and farming which results in deforestation ultimately leading to environmental degradation. As a result a lot of pressure is applied on the utilization of natural resources leading to over-exploitation of the natural resources, and leads to environmental erosion. Decreasing forest cover increases the level of carbon in the atmosphere and causes global warming.
- **Intensification of Agriculture:** it decreases the quality of the land as natural environment for example forest and grasslands are being converted into agricultural land. Severe agricultural practices decrease the fertility due to the accumulation of toxic substances like organic compounds. Runoffs of agricultural wastes and chemical fertilizers and pesticides into water bodies also deteriorate the quality of wild life habitats, natural water resources, wetlands and aquatic life.
- **Atmospheric Changes:** Many natural activities release of a lot of ash and smoke to atmosphere that harm our environment and also lead to acid rain and skin diseases among living organisms. Ozone depletion alone is responsible for 300,000 additional cases of skin cancer a year and 1.7 million cases of cataracts. Global warming increases the risk of climatic natural disasters.
- **Littering and illegal Dumping:** Illegal dumping can lead to several kinds of pollution. By dumping those wastes into water bodies leads to severe pollution which in turs become unsuitable for many aquatic dwellers. Littering is a practice that occurs mostly. Additionally, the unburnt cigarette buds are one of the main causes for wildfires which also leads to significant ecological degradation. The waste littered in an open area rather than proper disposal gets washed off and mix in the water bodies that directly or indirectly reaches the water table and affect the groundwater.
- **Mining:** Mining can lead to serious degradation of the environment as large areas of land is used. The method mining is done by cleaning the area due to which there is a loss of natural habitat.

5.3.3 Effects of Environmental Degradation:

There are a lot of adverse effects which takes place due to environmental degradation. These effects cannot be visible in a day or two, rather it takes years [5, 6].

- **Acid Rain:** significant amounts of air pollution from the industrial processes & components that gets accumulated in the environment cause acid rain [21].
- **Biodiversity Loss:** Land and soil degradation can harm many plants. Since plants and animals are usually quite sensitive to their natural living conditions and their contamination with harmful substances leads to their death. Loss of biodiversity leads to endangerment or extinction of species [22].
- **Natural Disasters:** it can happen more frequently due to human interventions with nature. Due to global warming, air and sea temperature increases which lead to a higher probability of severe storms and floods. Industrial production processes, electricity generation and the daily use of our cars contribute to climate change since most of these processes involve the combustion of fossil fuels which leads to the emission of enormous amounts of greenhouse gases such as oxides of nitrogen, sulphur, carbon, etc into the atmosphere. Several kinds of natural disaster occur such as Global warming, Famine, Flood, landslides, etc.
- **Public Health Problems:** In many countries, due to deforestation, mining or other practices caused by human interactions with nature, the probability of floods or other natural disasters increases with due course of time. The effects of those natural disasters are unpredictable. Many people lose their homes and suffer from quite poor hygienic conditions due to the destruction of important infrastructure.
- **Loss in Tourism:** Many poor countries rely on tourism as their most important source of income. If the degradation continues then their income will be zero as the number of visitor's decreases.
- **Economic Effects:** Apart from the detrimental effects there are severe adverse economic effects related to the issue.
- **Bad Effects of Technology on Environment:** Nowadays we are fascinated by using new and improved technologies which ultimately decrease our effort of doing the work. In recent years, the improvement of technology led to the production of more machines, weapons, and automobiles. Mismanagement of technology and lack of control measures results in environmental degradation [7]. The increased rate of consumption of improved facilities triggers the demand of supply of required technology that are major effectors of industrialization led by urbanization. The adverse effect of pollution of the environment due to increased production in the manufacturing and processing industries, weapons testing, and high usage of automobiles such as cars, bikes, buses, etc. Air, water, and noise pollution are the key components of the environment that has been continually being polluted. The emission of a large number of gases such as CO2 in the air by large manufacturing industries has degraded the environment immensely. Disposal of waste materials into the water systems by industries and other institutions is an environmental hazard through water pollution. A lot of noise pollution occurs while the weapons testing and usage, industries in their routine production processes, and automobiles are causative of environmental destruction. Environmental degradation is a growing concern as continued industrialization is being witnessed mostly in developed countries.

Environmental degradation is a growing concern as continued industrialization is being witnessed mostly in developed countries. An increase in the use of technology leads to climate change in various ways such as global warming, use of electronic devices.

5.3.4 Solutions for Environmental Degradation:

The loss that the environment faces while environmental degradation can be regained by obtaining the following solutions on daily basis [5, 6]:

- **Stop Deforestation:** in order to restore the fertile land, we need to stop deforestation as the trees produce oxygen and store greenhouse gases.
- **High Fines for illegal Dumping:** high fines must be charged from the people who dump their domestic wastes in an illegal way rather than of dumping in specific sites or trash bins, also the industries must be fined for not dumping their waste properly.
- **Stricter Government Regulations:** when it comes to environmental degradation the government must set some rules and regulations which every person or industry must follow.
- **Reduce Consumption Levels and Waste Production:** these are few points which we can incorporate in our lifestyle so that we can check our need of consuming that will ultimately control the amount of waste production. We must reuse the old stuff rather than dumping it.
- **Refrain from Plastic Packaging and Disposable Cups:** disposal of plastic bags is becoming a threat for our planet as it leads to soil pollution, water pollution, etc. when an animal swallows, it causes severe health issues and sometimes leads to their death.
- **Education:** it can be used as a strong weapon on people for protecting our mother earth. Several NGO's have started many campaigns in joint hands with the government to educate people about the importance of our environment and its sustainability.

Sometimes it becomes a tough task to make people understand the harm that we are doing to the environment by our day-to-day activities and how we can conserve it for our future generations to use.

5.4 Challenges in Environmental Degradation:

The challenges that are faced due to environmental degradation by different sectors of living and non-living units. [3, 12]

- Deep decarbonization and climate neutrality.
- Dynamics of the economic ecological system.
- Risk, uncertainty, and resilience.
- Disruptive development and path dependencies.
- Behavioural environmental economics.
- Institutional analysis of environmental policy.
- Equitable use of the environment.
- Loss of biodiversity and natural capital.
- Valuing and paying for ecosystem services.

5.4.1 Challenges in Attaining SDGs for India:

The four major challenges for attaining SDGs in India are discussed below [3]:

a. **Defining the Key Indicators:** to devise the suitable indicators for effective assessment of their progress. The key definitions are different for different areas, such as poverty, hunger, safe drinking water, education need to be revised in order to implement the SDGs.
b. **Financing Sustainable Development Goals:** India has the highest number of people living below the poverty line even after so many efforts. At today's level of investment, there is a huge funding shortfall that hinders the progress of attaining SDGs.
c. **Monitoring & Ownership of Implementation Process:** Although NITI (National Institution for Transforming India) Aayog plays an important role in taking ownership for the implementation process and the members of the Aayog have expressed their concerns on time and limited manpower they have to handle such a task.
d. **Measuring the Progress:** Incomplete coverage of administrative data is one of the factors that has hampered the measurement of progress for even the Millennial Development Goals (MDGs) that were the precursor to SDGs.

5.4.2 Challenges Faced in the 21st Century:

a. **Public Health:** This is one area that faces most of the challenges all over the world which is led by many other concerns such as pollution, overpopulation and water scarcity. According to WHO, one death out of every four is due to an unhealthy environment? This problem is occurring in both developed and developing countries [20].
b. **Water-Related Challenges:** According to the UNICEF 2017 report 2.1 billion people lack to have the access to safe drinking water. In many countries, people lack to have water for daily activities. And on the other side people are wasting the water without thinking. Nowadays the water bodies are getting polluted due to the mixing of untreated wastes from different sectors such as industries, household wastes, hospital wastes, agricultural runoffs. This leads to water pollution which adversely affects the living organisms.
c. **Overpopulation:** Increase in population is putting strain on the natural resources that are limited and results in the degradation of the environment. Birth rate and Death rate are the two factors that define the population. Recently the death rate has gone down due to the availability of better medical services and hospitality. More population means more food, more shelter and more resources and this ultimately leads to deforestation, loss of natural resources, etc.
d. **Ecosystems & Endangered Species:** As the list of different types of environmental degradation happening in this world is increasing, both the ecosystem and the species are in danger of vanishing. Habitat loss is the main concern for living organisms due to a shortage of food and shelter. As the ecosystems are decreasing day by day many animals, birds and aquatic animals are preferring to migrate and some others are preferring to adapt themselves to survive in harsh condition with the help of evolution.
e. **Climate Change:** The rising temperature gives rise to many harmful problems such as melting of glaciers, forest fires, drought, etc.

The melting of ice and glaciers present in the Himalayas, Arctic and Antarctica region causes a problem for the wild animals to survive and increases the water level which leads to flooding in some areas. Forest fires that took place in some parts of the country for example Australian bush fire, Amazon rainforest fire, Similipal forest fire, etc cause huge loss to the wild animals and plants. Climate change leads to water scarcity, loss of agricultural practices, rain cycle changes and many more [25].

f. **Effects of Industrialization and Globalization:** These two words have both positive and negative effects, but more negative as it leads to the loss of natural resources through mining activities in need of raw materials, pollution of air due to release of harmful and poisonous gases, pollution of water as the industrial wastes are directly released to the water bodies without any prior treatment which makes the water unfit for the survival [26].

5.5 Mitigation:

Mitigation is defined as a method by which we can decrease the adverse or harmful effect of environmental degradation. The process of mitigation is not a task of a few days or months, rather it will take ages to replenish.

There are numerous ways that will decrease environmental degradation. Some of these include [1]:

- Purchase recycled products
- Conserve and energy
- Do not litter or throw waste into inappropriate places
- Join an awareness group
- Talk with others about the impacts of environmental degradation

The harm that we are causing today is negligible for us but those upcoming future generations will suffer. Now they don't come in the count for cost of socio-economic terms. This negligence is allowing us to overexploit the free natural resources and overproduction of cheap goods.

The cycle of production, buying and discarding go on and on affecting the environment adversely. We need to change this way of human interaction with the environment.

5.5.1 Some Important Control Measures:

The ultimate object behind the measures is to control pollution and maintain the safety of Man, Material and Machinery (Three Ms) [18]. There are some measures that are based on the principle of recovery or recycling of pollutants. Those measures are considered to be an integral part that leads to the mitigation of environmental degradation [15]. These are:

- **Control at Source Point:** Raw materials used need to be checked and controlled at the source point. This step will ensure the proper use of the raw materials.
- **Selection of Industry Site:** The site for industry must be examined properly so that the living organisms should not be affected along with their lifestyle.

- **Treatment of Waste Released:** The industrial wastes should be subjected to proper treatment before their discharge.
- **Afforestation:** Intensive plantation in the region will considerably reduce the dust, smoke and other pollutants.
- **Government Action:** Government should take immediate action against the industries which release a higher number of pollutants into the environment as per the guidelines prescribed by the Pollution Control Board.
- **Assessment of the Environmental Impacts:** Environmental impact assessment should be done at regular interval which intends to identify and evaluate the potential of harmful impacts of the industries on the natural eco-system.
- **Strict Implementation of Environmental Protection Act:** Environment Protection Act should be strictly followed and the destroyer of the environment should be strictly punished.

5.5.2 Genetically Engineered Bacteria:

As the environmental pollution is increasing so because of the pollutants. So, with the tactic of biotechnology, the trendy biotechnologists have come up with the answer of genetically engineered bacteria to degrade the pollutants [32].

The invention of an enormous number of the gene which was introduced within the bacteria with good adaptability resulted in the production of engineered bacteria.

This bacterium is capable to treat heavy metals and other refractory environmental pollutants. The event of recent industry results in the appearance of latest pollutants ultimately ends up in the invention of latest strains of bacteria.

5.6 Role of Government:

The cooperation of every citizen of the country is essential for safeguarding the environment.

Government and its rules and regulation play an important role in helping to find solutions to the problems.

The government has taken various steps for the protection of the environment [11, 30]. Some of them are listed below:

a. Swachh Bharat Mission
b. Compensatory Afforestation Fund Act (CAMPA)
c. National River Conservation Programme
d. Conservation of Natural Resources & Eco-systems
e. The National Green Tribunal Act, 2010
f. The Air (Prevention and Control of Pollution) Act, 1981
g. The Environment Protection Act, 1986
h. The Hazardous Waste Management Regulations, etc.

5.6.1 The ACTS:

There is a big set of acts which are made by the government that are implemented on the people, such as [30].

- **The Environmental Protection Act:** This Act was enacted in 1986, and it aims to establish a sufficient protection system. This act delivers powers to the Central Government to regulate all forms of waste. It is one of the primary sectors to protect the environment and regulation of waste produced.
- **The Wildlife Protection Act, 1972:** this act was enacted to effectively protect the wildlife and also control numerous activities such as poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was passed in January 2003 and as a result, the punishment and penalty for offences under this Act have been made more stringent. The Ministry has proposed further amendments in this law by introducing more rigid measures to strengthen the Act. The major objective of this act is to protect the listed endangered flora and fauna and ecologically important protected areas.
- **The Forest Conservation Act, 1980:** was enacted to help conserve the country's forests. It particularly restricts and regulates the de-reservation of forests areas or use of forest land for non-forestal purposes without any prior approval of Central Government.
- **The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006:** recognizes the rights of forest-dweller Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according an equivalent.
- **The Indian Forest Act, 1927:** consolidates the law relating to forests, the transit of forest produces and the duty livable on timber and other forest produce.
- **Public Liability Insurance Act, 1991:** was enacted to provide required liabilities to the victims of the incident that occurred due to the handling of hazardous substances. The Act applies to all or any owners related to the assembly or handling of any hazardous chemicals.)
- **The Biological Diversity Act, 2002:** The Act aims at the conservation of biological resources and associated knowledge also as sustainably facilitating access to them.

5.6.2 The Guidelines:

Rules by the government to check waste management system that mainly leads to degradation:

- **The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008:** controlling the release of these hazardous waste is not easy. For the management, certain guidelines combine and form a set of regulations that are responsible for their conversion from hazardous waste to safe waste [3].
- **E-Waste (Management and Handling) Rules, 2011:** this rule was set up to check and control the use of hazardous substances released from the industries of electronic equipment and to channelize the e-waste. This rule is meant to be followed by producer, consumer, collection centre, dismantler, involved in manufacturing and processing of electrical equipment industries and domestic users.

- **Batteries (Management & Handling) Rules, 2001:** this rule deals with the waste materials released from batteries and their industries. The waste materials contain lead which is harmful and gets easily accumulated [11].
- **Biomedical Waste (Management and Handling) Rules, 1998,** were formulated for proper disposal, segregation, transport, etc, of infectious wastes that are disposed of mainly by hospitals and primary healthcare centres.
- **Municipal Solid Wastes (Management and Handling) Rules, 2000,** aims at the proper disposal of municipal solid waste and domestic wastes which are released from houses daily.

5.6.3 Suggestion to Overcome the Problem of Environmental Degradation:

- **Social Awareness:** this is much needed to spread awareness about the consequences of environmental degradation and also how each individual is responding and contributing to stopping it from increasing.
- **Population Control:** if environmental degradation is to be stopped then it is essential to check population growth.
- **Application of Environment Act:** Its objective was to check the deterioration in the quality of the environment and to check the conservation of flora and fauna.
- **Control over Industrial and Agricultural Pollution:** It is necessary to check the air and water pollution that are caused by industrial development should be controlled properly. The use of pesticides and chemical fertilizers should be minimized to protect restore the quality of land and water.
- **Afforestation Campaign:** Extensive afforestation campaign should be launched to build interest among the population to protect the planet earth.
- **Water Management:** different water bodies should be made clean. There must be a supply of clean drinking water to every corner of the rural and urban areas.
- **Management of Solid Waste:** Planned management of solid waste is very essential. The domestic solid wastes can be reused as compost.

5.7 Conclusion:

Environmental degradation is a serious problem for both living and non-living organisms. If we continue our consumption and daily life behaviour, as we did it for the last decades then our future generations will suffer from enormous adverse consequences. Industrial pollution is not the problem of any particular country or locality rather the entire world is responsible for causing its harmful effects. Hence, the world together needs to find out a solution to control pollution and degradation of the environment. Those governmental and non-governmental organizations are taking many necessary steps to treat it. Waste disposal and recycling are the two essential steps that will make a lot of difference in controlling. Advanced technologies are being developed for waste disposal and recycling so that industries can minimize waste creation as much as possible. Looking at the damage some of them cannot be replenished such as natural resources, water level, loss of flora and fauna, atmosphere, etc. To minimize the damage, proper planning must be made and executed. Every person dwelling on this planet must be educated with the pro and cons of technology, the harmful effects of environmental pollution and the laws and rules which were made by the government.

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6. Impact of Covid 19 on Environment

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Abstract:

The novel Coronavirus pandemic (COVID-19) hit the world severely in the first half of 2020 which forced several nations to impose severe restrictions on all sorts of activities involving human population. Environmental health across indicators in India is rapidly declining, and the state's failure to regulate sources of, and causes for, environmental degradation has never been more apparent.

The reasons for this failure are numerous and complex: conflicting interests in limited resources; inadequate regulatory capacity to design and enforce the law effectively; lack of interagency coordination; and environmental issues not being politically salient enough to trump competing policy interests and priorities. As the country grapples with an increasing array of environmental problems, it is an important moment in time to reflect on the nature and quality of the environmental regulation that is in place.

Keywords: Pandemic, degradation, environment, coronavirus, health.

6.1 Introduction:

The current outbreak of coronavirus disease (COVID-19) got reported first from Wuhan, China, on 31 December 2019. A novel coronavirus disease 2019 (COVID-19) outbreak is a global dramatic pandemic that is immeasurably impacting our communities. Considering massive health and economic burden of the COVID-19 pandemic, any means by which to improve the condition of patients to accelerate recovery and to reduce the risk of deterioration and death would be considered of significant clinical and economic importance. People were mainly advised to remain home quarantined to curb the virus spread. Industrial and vehicular movements were ceased as a result of lockdown, and therefore the rate of pollutants entering the ecosystem was also reduced in many places.

Water and air pollution remained a major concern in the last few decades as these were gradually deteriorating in many spheres including the hydrosphere and atmosphere. As the nation-wide lockdown period in India completed more than two months, this study attempted to analyze the impact of lockdown on water and air quality to understand the short-term environmental changes. With substantially less vehicular movement, air quality has improved by leaps and bounds. Numerous sources have covered how air quality indices of the globe's largest metropolitan areas have improved extensively since strict coronavirus lockdowns were issued.

Even NASA satellites from outer-space show the significant reductions in air pollutants, which support Eco Watch's observation that the novel coronavirus pandemic has delivered the silver lining of decreased air pollution. Today, the World is a 'global village' due to the use of Information and Communication Technology and we are living there and deriving all the benefits from Nature. When we are deriving the benefits, we must have to bear some responsibilities. We have to develop environment centric approach to utilize the natural resources in such a manner so that we can achieve the inclusive and sustainable development with coexistence of all other species of organisms of the globe. The lockdown therefore provided us an opportunity to shift our ideology from anthropocentric or human centric worldview to eco-centric worldview. The former worldview puts the human beings in the centre giving them the highest status, considers man to be the most capable for managing the planet earth, realizes that man is the planet's most important species and is the in-charge of the rest of nature. It emphasizes that earth has unlimited resources for humans only and a healthy environment depends upon a healthy economy. The later worldview states that the earth resources are limited and belong to all the species that exist in nature [1]. Though humans have right to draw their requirements from the environment but certainly not the extent that degrades the environment and harms other species and living beings. This eco-centric worldview is therefore based on earth-wisdom and urges us to live on this earth as a part of it, like any other creature of nature and live sustainably. It realizes that healthy economy depends upon a healthy environment (healthy environment does not depend upon a healthy economy). Due to lockdown, a large number of birds including vultures are clearly started to appear [2].

6.2 SARS-CoV-2 Impact on Environment:

The “oral-feces” transmission of COVID-19 is threat to environment. Detection of SARS-CoV-2 in the human feces is an alarming threat where it can spread to whole compartments of environment through the sewage sludge and waste water. There are various countries having more population below the poverty lines and they can’t afford toilets. The detection of SARS-CoV-2 in the human feces and transmission may cause the drastic consequences for the counties having larger slum areas. The bigger problem with slum areas is to maintenance of social distancing where area are overcrowded and five or more persons are staying in singe room[3]. If virus is not eradicated on early stage it may cause the drastic results. If virus spread on large scale, whole compartments of environments to be rebooted which is impossible task. The environment compartments like surface and ground water, sewage sludge, animals, solids and sediments, waste water, and crops will be effected where depth screening to be required on the transmission of virus to total environment. Improper disposal of hospital waste may spread SARS-CoV-2 so waste management including hospital waste and sewage sludge will be the hot area of future research. There are few well-known approaches to clean the environmental compartments including waste management. Techniques like nitrifying-enriched activated sludge (NAS) approach, micro-organisms based approach and conventional activated sludge (CAS) approaches are most effective to clean the environment. Nitrifying-enriched activated sludge (NAS) approach is considered as best technique for treatment of wastewater and sludge. NAS approach is 2.5 times better than conventional activated sludge (CAS) [1]. NAS approach increase the lifetime (two times) of membrane bioreactors. As wastewater contain low carbon/nitrogen ratio so NAS approach decrease the foul smell and enriched nitrifiers population in membrane bioreactors[2].

6.2.1 Effect of Climatic Conditions on SARS-CoV-2:

Environmental conditions like temperature pH and humidity are the major factors to access the efficiency of the microorganisms. Under variable climatic conditions, mutation of microorganisms is the other threat. Virus mutagenic capability depends upon several factors, including the fidelity of viral enzymes that replicate nucleic acids. RNA viruses are known for higher mutation rate, up to million times higher than their hosts. As, SARS-CoV-2 is a RNA virus mutate through RNA dependent polymerase (RdRp). Pachetti et al., (2020) has found 8 mutations of SARS-CoV-2 where 5 mutations were found in Europe and 3 mutations were observed in North America. In England (UK), RdRp based mutations were found with median of 3 points mutations (range 2–5 at p value < 0.001). An amino acid composition changing mutation in RdRp were noticed in Italy (Lombardy) with median of 1 point's mutations (range 0–3 at p value < 0.001). They has suggest that the virus is evolving and European, North American and Asian strains might coexist, each of them characterized by a different mutation pattern[4]. Some positive and negative environmental and socio-economic aspects of COVID-19. There are few positive aspects of COVID-19 where environment is becoming pure day by days. Due to lockdown, air quality and noise pollution is decreased consequently total environment is improving. Rivers and sea beaches are becoming neat and clean due to lockdown conditions. The emission of green-house gases was found significantly low after the time of World War II which is due the effects of lockdowns. It has been reported that the air quality was improved where 55 % particulate matter decreased in India during first lockdown period of 21 days. The other positive aspect learned from COVID-19 was that every country is trying its best to uplift the healthcare services. Various countries have opened new hospitals especially dedicated to the COVID-19. Various countries have strengthened their traditional medicine system to fight against COVID-19. Work from home culture was adopted by various companies which is entirely new culture and new lesson learned from COVID-19. The major negative aspect of COVID-19 is the social distancing, which may leads to anxiety and frustration. The psychosomatic traits like anxiety and frustration can disturb the immune and COVID- 19 has been noticed in patients with weak immune system. In the era of 21st century everyone was living fast life and they enjoy their weekends with friends which is curtailed due to lockdowns and social distancing. Unsocial behavior of human is also observed during the outbreak where a rat race for N95 masks was observed. Black marketing was noticed due to excess demand of personal protection care equipment was noticed. *Climate Change Effects on Environmental Functionality* is a timely reference to better understand environmental changes amid the COVID-19 pandemic and the associated lockdowns [5].

6.3 COVID-19 in the Environment:

Impact, Concerns, and Management of Coronavirus highlights the research and technology addressing COVID-19 in the environment, including the fate, transport, and disposal. It examines the impacts of the virus at local, national, and global levels, including both positive and negative environmental impacts and techniques for assessing and managing them. Utilizing case studies, it also presents examples of various issues around handling these impacts, as well as policies and strategies being developed as a result. P-1Environmental change is one of the biggest challenges of the 21st century. In spite of all their efforts to restore the nature during the last few decades, humans could only move a few steps forward, not up to the commendable extent.

But during the last few months, consequences of the COVID-19 pandemic have successfully recovered the environment to a large extent that should definitely set positive impact on global climate change. It of course changes the daily behaviour of humans and the surrounding ecological system. The present review article deals with the multiple positive effects of lockdown on environment and society including biodiversity [6].

In humans, several corona viruses are known to cause respiratory infections ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). In December 2019, a new infectious respiratory disease emerged in Wuhan, Hubei province, China and was named by the World Health Organization as COVID-19 (coronavirus disease 2019). It is caused by recently discovered a class of corona virus, known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). It is basically a single stranded RNA virus. The SARS-CoV-2 viral particles are spherical and have mushroom shaped protein called spikes protruding from their surface, giving the particle a crown like appearance. The spikes bind to the human cells and allowing virus to gain entry. The spike protein of novel corona virus shares 98% sequence identity with the spike protein of bat coronavirus. The researchers found that spike protein of SARS-CoV-2 binds to the cellular receptor called angiotensin converting enzyme 2, which is entry point into human cells. It has 10 to 20-fold higher binding affinity than SARS. The higher binding affinity causes higher human to human transmission [1, 2].

COVID-19 is a zoonotic disease with intermediate host. Although the intermediate source of origin and transfer to humans is not clearly known. Intermediate host for SARS-CoV is palm civet and camel while the possible intermediate host for SARS-CoV-2 is pangolin or snakes. The reserve host for all the three is bat. Bat carries so many viruses and around 200 corona viruses without getting sick. So the primary mode of transmission is from bats to intermediate host to humans. The transmission of COVID-19 can be direct in the form of droplets produced during sneezing, coughing, speaking and accidently inhaling the droplets in a closed proximity of an infected person. Droplets are water holding entities of diameter more than 5μm and these can be caught by a healthy person within a certain range of 1 m approximately. The indirect transmission is when virus is deposited on a dead surface like door bells, lift buttons, stairs, vegetables, fruits etc. which may come in contact with rest healthy persons frequently. From here the virus reaches to eyes, nose and mouth and finally leads to a new corona patient. Even fecal matter of infected person is found to be the transmitting source hence it can spread 585\through fecal-oral transmission. Studies showed that WHO has published guidance on adjusting public health and social measures for the next phase of the COVID-19 responses. Some governments have suggested that the detection of antibodies to the SARS-CoV-2, the virus that causes COVID-19, could serve as the basis for an 'immunity passport' or 'risk-free certificate' that would enable individuals to travel or to return to work assuming that they are protected against re- infection.

There is currently no evidence that people who have recovered from COVID - 19 and have antibodies are protected from a second infection. WHO continues to review the evidence on antibody responses to SARS-CoV-2 infection? Most of these studies show that people who have recovered from infection have antibodies against virus. However, some of these people have very low level of neutralizing antibodies in their blood, suggesting that cellular immunity may also be critical for recovery.

At this point in the pandemic, there is not enough evidence about the effectiveness of antibody-mediated immunity to guarantee the accuracy of an immunity passport or risk-free certificate. People who assume that they are immune to a second infection because they have received a positive test result may ignore public health advice. The use of such certificates may therefore increase the risks of continued transmission [7].

6.4 COVID-19 and Global Warming:

From the beginning of civilization, human beings gradually started manipulating the nature as per its own benefit. In order to satisfy the demand of increasing population; industrialization and urbanization became inevitable, and the obvious significance was proved to be detrimental on the global climatic changes. The desire to drive the nature as per their own whims and desire, human beings started to destroy the nature in numerous ways by anthropogenic activities without caring for sustainable development. As an inevitable consequence, environmental pollution has become a big issue of the present day. It is obvious that environmental pollution will change the distribution and burden of various vector borne infectious diseases including bacterial and viral diseases [8].

But, due to the unusual outbreak of COVID-19, almost every big and small cities and villages in the affected countries is under partial or total lockdown for a long period of time ranging from a few weeks up to a few months. All local and central administrations instructed to close the academic institutions and imposed a ban on free movement of their citizens outside their home and non-essential businesses in order to avoid community transmission.

The various religious, cultural, social, scientific, sport, and political mass gathering events like Hajj, Olympics etc. are cancelled. Various industries are not functioning and all types of travels like airplanes, rails, buses and private vehicles are restricted or cancelled[5].

Meanwhile, efforts to restrict transmission of the SARS-CoV-2, by restricting the movement have had an outstanding environmental effect. Due to non-functioning and closure of industries, industrial waste emission has decreased to a large extent. Vehicles are hardly found on the roads leading almost zero emission of green-house gases and toxic tiny suspended particles to the environment. Minimal activity from industrial sites, factories and construction sectors improving the air quality. As such, aviation emissions, which accounted for 2.4% of global CO2 emissions in 2018, according to the Environmental and Energy Study Institute (EESI) have dropped significantly [6].

China has witnessed a drastic reduction in emission of NOx, CO2 and various hydrocarbons during the coronavirus lockdown (2020) as compared to the values last year (2019). The areas of Eastern and Central China showed a significant reduction (10-30%) in NO2 levels. According to, there is significant reduction in the air pollution in major cities of United State of America due to lockdown. The lockdown is a highly sustainable approach to reduce the noise and injection of tropospheric and stratospheric pollutants. That means the coronavirus crisis is so far “trigger the largest ever annual fall in CO2 emissions in 2020, more than during any previous economic crisis or period of war.” While this is encouraging news, experts say it still may not be adequate for meeting Paris Agreement [7].

Due to lesser demand of power in industries, use of fossil fuels or conventional energy sources have been lowered considerably. Ecosystems are being greatly recovered. In many big cities the inhabitants are experiencing a clear sky and clear river water for the first time in their lives. Due to Covid-19 lockdown, a variety of birds are seen in the localities. The pollution level in tourist spots such as forests, sea beaches, hill areas etc. is also shrinking largely. Ozone layer may also be healing. The pandemic has displayed its contrasting consequence on human civilization, in the sense that, on one hand it has executed worldwide destruction, but created a very positive impact on the world environment on the other hand. Thus the lockdown acts as a healing dose for climate change, ozone depletion, human health, brown haze etc. Insect pollinators have appeared in abundance on crops and other plants. All these are good indication for ecological balance and biodiversity. Almost total lockdown due to COVID-19 outbreak has minimized the anthropogenic activities including overexploitation of natural resources. The major human population is bound to live in their homes, automatically prevented to cause various types of pollution. The surrounding environment is reflecting clean and green. We all are observing a clean environment where almost all animals including birds etc. have stated to flourish. Almost all humans are feeling healthy without any major clinical problems. Authors observed that during present lockdown period, the water of Rapti, Saryu, Ganga and Yamuna rivers in cities also became clear and transparent due less deposition of domestic and industrial effluents. During lockdown it was not possible to estimate the water quality parameters but the transparent condition of water of these holy rivers clearly indicate that pollution level definitely reduced to a great extent. These reductions in pollution level help in flourishing the aquatic organisms including fishes [8].

In a rare but substantial global achievement, the efforts of all the countries to stop the damage to the Ozone layer seem to be paying off as the damage to the Ozone layer above Antarctica has recovered, Science Alert reported citing a study. The development has the potential to clog the wheel of many disastrous chain of events that was taking place in the atmosphere of the Southern Hemisphere.

A new study has highlighted the positive role played by the Montreal Protocol which was agreed to by major world powers in 1987. Under the Montreal Protocol, developing as well as developed countries took substantial steps to stop the emission of Ozone Depleting Substances (ODS) that included refrigerators and Air Conditioners that relied heavily on Chlorofluorocarbons (CFCs). According to the new study, depletion of the life-saving Ozone layer had altered the path of Jet streams further from the South Pole. The development had led to magnanimous impact on the rainfall patterns of the planet along with ocean currents, Science Alert reported. Jet Streams are ultra-fast air currents that move towards the poles of our planet at high altitude. The study has highlighted that one decade after the Montreal Protocol came into being, the alteration in the Jet patterns stopped [9].

“The lockdown due to COVID-19 pandemic has resulted in improved air quality and water quality in rivers and lakes. The lockdown experience demonstrated that nature heals itself in a short period.” The lockdown, while having a positive result on the environment, has damaged the economies around the world. And so, we are again faced with the question of balancing out the economic activities with preservation of nature. This is also the agenda for the World Economic Forum 2021, which highlights the importance of taking steps in this direction.

6.5 Sustainability and Rejuvenation of Earth System:

The lockdown is a highly sustainable approach. Now, the flights are grounded resulting in reduction of noise and injection of tropospheric and stratospheric pollutants. Ozone layer is also reported to be healing. The road transport and factories are also closed and hence, the emissions of air pollutants are reduced. After the lockdown, a variety of birds are seen in the localities. People have realized that their survival needs are very less but for status in the society they were wasting the resources. I would say that the lockdown is teaching us the practical lessons how to achieve the Sustainable Development Goals (SDGs). The global shutdown is allowing the planet to heal and rejuvenate itself against the torture of Homo sapiens of twentieth century [7]. Spiritual Environmental Aspect During the lockdown, staying at home and working from home has forced us to opt all the alternate methods for keeping engaged. One of the best methods is meditation and Yoga that give peace and good health. We are not able to go to parks for physical exercise. Performing yoga, meditation and prayers regularly rejuvenates our body in terms of enhancing our immunity system, concentration of mind and confidence levels. Spiritual development is essential for humanity and positive personality development. There are a number of online yoga classes given by the experts, which is proving the utilization of lockdown time fruitfully. I guess a more positive behavior of public after the lockdown. If it happens, that will be a relief to the governments. A peaceful nation can make significant growth due to savings in no-war and no-crime state [8]. In a way the spread of COVID-19 has forced the globe to halt all outdoor human activities for the longest period in the memories of the present population of this planet. This lockdown will probably be marked in history forever. Nevertheless, this shutdown is a rejuvenation of the Earth, environment and human health systems. Despite the sudden changes to the daily behaviour of humans, our surrounding ecological systems are enjoying holistic and positive changes. This is a kind of Holistic treatment of ecological system as the shutdown has multiple positive effects. The implications and outcomes of the prohibition of outside activities is different for different aspects of the environment, as described below A. Physical Environmental Aspect Halting outside movements has stopped all types of transportation (aircrafts buses, cars, trucks etc.) which has controlled emissions of pollutants. China has witnessed a drastic reduction in NOx during the Coronavirus lockdown (2020) as compared to the values last year (2019). Eastern and central China areas showed a significant reduction (10 – 30%) in NO2 levels.1 CBCB data showed more than 50% reduction in PM10 and PM2.5 levels.2-3 According to reports in the United States of America, Coronavirus shutdown has resulted in a huge decline in pollution over major cities such as Los Angeles, Seattle, New York, Chicago and Atlanta etc. On average, a Jumbo Boeing 747 consumes around 150,000 litres fuel in a 10 hrs flight. Cumulatively around 400 billion litres of fuel is consumed annually by the commercial flights. Additionally, aircrafts fly at 8-13 km height from ground kevel emitting huge amount of NOx, CO2 and various hydrocarbons. These emissions affect radioactive forcing and stratospheric ozone [4, 6].

6.6 Conclusion:

The corona has proved that although humans are a superpower and have weapons that are capable to destroy the whole world but still if humans are creating mess with nature then even now nature is itself powerful to destroy humans with this small virus which is having very common symptoms like cold and cough.

The best way to prevent and hamper transmission is to protect yourself and others from infection by frequent washing of hands or using an alcohol based - rub frequently, not touching the face and follow social distancing norms. Use of mask is beneficial if anyone has to go out of home due to an urgent work. During the lockdown, staying at home and working from home should be followed. Yoga is the best methods for good health which rejuvenates our body in terms of enhancing our immunity system, concentration of mind and confidence levels. Spiritual development is essential for immunity, humanity and positive personality development. There are a number of online yoga classes given by the experts, which is proving the utilization of lockdown time fruitfully. No need to worry about the future because time heals everything. If there are negative impacts, we have various positive things to learn from this. Due to lock down, the resources are being consumed in a limited manner. The COVID-19 has proved that Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, humans should respect and nurture her. Indiscriminate development and overexploitation of natural resources should be minimized at the level of sustainability.

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7. Use of Nanotechnology in Remediation of Environmental Pollutants

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7.1 Introduction:

Environmental pollution is one of the highly concerned global issues as affected the whole planet. Although numerous laws are made to control environmental pollution, but there is no improvement has been seen in recent years. The quality of air degraded day by day and it became toxic several part of the earth. Specifically air pollution causes severe illness, even snatch away the lives of people. Environmental pollution not only destroyed our environment but also cause serious health problems in humans. Heavy metals, particulate matter, pesticides, herbicides, fertilizers, oil spills, toxic gases, industrial effluents, sewage and organic compounds are some of the contaminants that polluted our environment. Intensive agriculture, industrialization and various land activities contaminate water, soil and air as well as with toxic pollutant. Waste discharge from pulp, dyeing, petrochemical and textile industries and the partial degradation of phenoxy contaminants in various remediation processes produce phenolic components. These may have deleterious consequences on the health and well-being of plant and animal biota. So there is an urgent need to control environmental pollution to restore the health of the environment. During recent years various technologies have been used to eliminate pollutants from the environment. New technologies are constantly explored for the remediation of the air, water and soil contaminants. Salvaging basic resources, along with remediating toxic pollutants and contaminants, by adopting latest technologies is a challenging priority. So nanotechnology is emerging to provide a state of art solution to these problems.

Nanotechnology involves the creation and manipulation of materials at the nanometer scale, either by scaling up from single groups of atoms or by refining or reducing bulk materials. This technology has gained a lot of attention in the past decades due to the unique physical properties of nanoscale materials or nanoparticles. Nanoparticles are wide the class of materials that include particulate substances, which have one dimension less than 100 nm at least. Nanoparticles possess unique physical and chemical properties due to their high surface area and nanoscale size. Their size, shape and structure determine their reactivity, toughness and other properties. Due to these properties nanoparticles can be used in various domestic and commercial applications that include catalysis, imaging, and medical application as well as environmental applications. It was found that nanomaterials have enhanced reactivity and better effectiveness than their bulkier counterparts.

Various types of materials can be employed in environmental remediation. Since environmental pollutants are the mixture of different compounds of high volatility, and low reactivity, it is challenging to the capture and degrades these pollutants.

Due these complexities, recent studies have focused on the use of nanomaterials for the development of new environmental remediation technologies. As compared to traditional approaches nanomaterials or nanoparticles has more potential due to their unique surface chemistry, because they can functionalized or grafted with functional groups that can target specific molecules of interest for efficient remediation. Moreover, due to their specific physical properties and chemical composition, they provide additional advantageous characteristics that directly affect the material for contaminant or pollutant remediation. The rich surface modification chemistry along with the unique physical parameters of the nanoparticles offers significant advantages over traditional methods for controlling environmental contamination.

The larger exposed area of nanoparticles reflects in higher number of atoms being stationed at the surface and these are readily available for several reactions including catalysis. Nanoparticles can detect and treat existing environmental contaminants and prevent new pollution. They can be used in the treatment of various contaminated media by chemically transforming contaminants or they act as super adsorbent. Nanoparticles also play vital role in the development of environmental sensor which can detect pollutant at molecular level. Nanoparticles can be used to improve water quality. Bioactive nanoparticles, Nano adsorbents and nanostructured catalytic membranes have enormous application in water purification. They serve as high capacity ligands for the toxic metal ions, organic and inorganic solutes and remove them from contaminated water. Soil pollution is also major problem that faced by our over growing population. Due to growing population the amount of solid and plastic waste has increased and it affects adversely the soil health and fertility. In this case, nanotechnology solution can be used for bioremediation and phytoremediation to remove contaminants.

7.2 Nanobioremediation:

It is estimated that around 10 million tons of toxic compounds are released by industry. These toxic chemical compounds further react to form chemicals like polychlorinated dibenzo-p-dioxine which is a by-product of certain chemical processes involving chlorine. These compounds have variable physical and chemical property. They have cytotoxic effects and their interaction with biotic and abiotic environmental components have complicated the remediation processes. So to overcome such problems nanoparticles can be useful tool. The use of nanoparticles in remediation processes can help to avoiding process intermediate and increases the speed of degradation. Apart from physical and chemical remediation technologies, biological treatment of pollutant have become relevant because of its low cost and wide range of application. Bioremediation involves the process of bioaccumulation, biotransformation and biostabilization. In recent years, nanoparticles have been integrated with biological processes to accelerate and enhance the removal of toxic compounds from the environment. The term nanobioremediation was first used by Cechin and his co-workers for the processes where nanoparticles, microorganisms and plants are used to remove contaminants. Further El-Ramady and his colleagues named these types of practices according to the nature of organisms utilized for the remediation. Thus the processes like phyto-nanoremediation, microbial nanoremediation and zoo-nanoremediation are named after the organisms used in the remediation process. There is a proper interaction between nanoparticles and living organism in case of nanobioremediation, which help to eradicate contaminants from environment.

According to some researcher the physical and chemical interaction between nanoparticles, biota and contaminants depends on various parameters which includes the size of nanoparticles, its shape, surface coating, chemical nature of the nanoparticles and contaminant, the type of the organisms, media, pH as well as temperature. For example pH and temperature of media play an important role in the proper development of living organisms or microorganisms.

In turn these parameters also influence the stability of nanoparticles and contaminants. For example gold nanoparticles are stable in milio water and buffer, but they lose their stability at pH of 4, 7, 8 and 10. It is also proved that different synthetic methods influenced the thermal stability of copper nanoparticles.

For remediation of contaminants, specific temperature and pH has synergistic effect on nanoparticles and living organisms in nanobioremediation. Sorption is an essential part of nanobioremediation. This process involves adsorption and absorption. In adsorption, the interaction between the pollutant and the sorbent occurs at a surface level. In the second one, the pollutant penetrates deeper layers of the sorbent to form a solution. In case of adsorption a chemical reaction occurs whereas in absorption only physical forces are involved.

In sorption process, the contaminants can be immobilized, sequenced and concentrated. Numerous study and research has been conducted to understand the nature of the adsorption process using nanomaterials or nanoparticels. So mechanistic, thermodynamic as well as kinetic studies are needed for describing the nanomaterial when this material enters into contact with the contaminants.

The degradation of contaminants occurred by photocatalytic process that depends on the nature of nanoparticles or nanomaterials. The product that is produced after degradation further bio transformed by the biotic system and reduce the concentration of pollutant or contaminant in the media. In addition to this, some enzymes produced by living organisms may degrade a variety of pollutant or contaminants. Nanoparticles are able to enter contaminated zones due to their small size, where entry of other particle is not possible.

That's why nanobioremediation technologies can be used in different field. This aspect represents an advantage over other remediation techniques. But the standardization of protocols is necessary to evaluate the toxicity of nanoparticles and nanoparticles in soil and water, elucidation of their interactions with biotic and abiotic elements. A regulatory frame is also required where these materials could be applied.

By extension, methods that are developed as a combination of several different materials (hybrids/composites), gathering specific desired properties from each of its components, are potentially more efficient, selective, and stable than methods based upon a single Nano platform. For instance, adhering nanoparticles to a scaffold can be an alternative way to increase the stability of the material when compared to the use of nanoparticles alone.

Functionalizing material with specific chemicals responsible for targeting contaminant molecules of interest can help increase the selectivity and efficiency of the material.

7.3 Commonly Used Nanoparticles in Remediation of Contaminats:

Different metal-based nanomaterials or nanoparticles have been described for the remediation of numerous contaminants. Metal and metal oxide nanomaterials are highly efficient adsorbents exhibiting advantages such as fast kinetics and high adsorption capacity.

7.3.1 Silver Nanoparticles (Ag NPs):

These are well known for their significant antibacterial, antifungal, and antiviral activity, and thus applied as water disinfectants. For instance, Ag NPs of less than 10 nm in diameter were found to be highly toxic to Escherichia coli and Pseudomonas aeruginosa. They can also prevent viruses from binding to host cells by preferentially binding to the virus' glycoproteins.

Slightly larger particle sizes (i.e., 11–23 nm) afford lower bactericidal activity. In addition, triangular Ag NPs exhibited better antibacterial effects than Ag nanorods and Ag Nano spheres, emphasizing the importance of not only size, but Ag NPs have been coupled with several other materials such as metal oxides and polymers with the goal of improving the overall efficiency of the resulting nanocomposite.

7.3.2 Titanium Oxide Nanoparticles (TiO2 NPs):

Another frequently investigated metal-based material for environmental remediation is titanium oxides. TiO2 NPs have been extensively studied for waste treatment, air purification, self-cleaning of surfaces, and as a photocatalyst in water treatment application due to their characterized low-cost, nontoxicity, semiconducting, photocatalytic, electronic, gas sensing, and energy converting properties. TiO2 NPs are activated by light, and thus frequently studied for their ability to remove organic contaminants from various media. TiO2 NPs are capable of producing highly reactive oxidants like hydroxyl radicals that serve as a disinfectant for microorganisms such as fungi, bacteria, viruses, and algae. Since TiO2 exhibits a rather limited photocatalytic capability, the material is typically doped with another transition metal ion to increase performance. Therefore, several studies have investigated metal-doped TiO2 NPs. The synthesis of TiO2 nanofibers (control) and Ag-doped TiO2 Nano fibers can be performed by a sol–gel electrospinning technique. These materials were as photocatalyst for the photocatalytic degradation of 2-chlorophenol under UV irradiation. Ag-doped TiO2 nanofibers presented increased photodegradation when compared to the TiO2 nanofibers.

The increase was attributed to four possible factors, including, adequate amount of Ag on the surface that effectively captured photo induced electrons and holes, quick transfer of photo induced electrons to the adsorbed oxygen present on the surface of the nanofibers, increased amount of surface hydroxyl groups, and expanded response range to light to the visible region. In addition to titanium oxide materials, titanates (i.e., inorganic compounds of titanium oxide) have also been reported for the removal of contaminants. The fabrication of basic, acidic, and neutral titanate nanotubes (TNTs) by a hydrothermal method, and these materials were evaluated for the catalytic reduction of NO with ammonia.

Manganese oxides were loaded to the three TNT formulations to yield Mn-doped titanate nanosheets, titanate nanorods, and titanate nanotubes (i.e., Mn/TNTs) in the case of basic, acidic, and neutral pH media, respectively.

7.3.3 Mixed Oxide Material Nanoparticles:

Moreover, mixed oxide materials have also been investigated. TiO2 SiO2 binary mixed oxide materials using bamboo as a silica source and titanium isopropoxide or titanium butoxide. The materials were evaluated for the photocatalytic degradation of methylene blue dye. The results showed a significant photo activity as indicated by the degradation rate of methylene blue at varied treatment times. The composite may have potential applications in smaller-scale industrial wastewater treatment systems. These mixed oxide materials have enhanced abilities to remove a wide variety of pollutants. Despite the fact that these binary mixed oxides show better activity than pure TiO2 materials in most instances, their utilization is limited for the mineralization of selected pollutant.

7.4 Silica Nanomaterials:

Due to their versatility, mesoporous silica materials have gained attention for various applications, such as adsorption and catalysis. Mesoporous silica materials possess a number of beneficial features for environmental remediation applications including: high surface area, facile surface modification, large pore volumes, and tunable pore size. Due to their exquisite performance as adsorbents, a variety of studies have reported the use of these materials for contaminant remediation in the gas phase. Furthermore, different surface modifications of mesoporous silica materials have been reported in many publications.

7.4.1 Carbon-Based Nanomaterials:

The structural composition of elemental carbon and its mutable hybridization states account for the unique physical, chemical, and electronic properties of carbonaceous materials compared to metal-based nanomaterials. Mutable hybridization states can yield different structural configurations such as fullerene C60, fullerene C540, single-walled nanotubes, multi-walled nanotubes, and graphene.

In a variety of investigations determining the suitability of carbon nanotubes and graphene for environmental remediation applications, it has been reported that surface treatments, activation, or functionalization of the pristine carbon material is first required. Multi-walled and single walled carbon nanotubes (MWCNTs and SWCNTs) have been the subject of many studies. The adsorption properties of these materials make them particularly useful for the removal of organic and inorganic pollutants from air and from large volumes of aqueous solution.

Carbon based nanomaterials are also employed to remediate contaminants through photocatalytic approaches. Under UV irradiation, photons of energy greater than or equal to the band gap of the nanotubes promote the generation of valence band holes (h+) and conduction band electrons. The holes are responsible for the formation of hydroxyl radicals that take part in the oxidation of chlorinated organic compounds.

The electrons form superoxide radicals that take part in the reduction of heavy metal contaminants. Several studies have been reported that describe the use of graphene to fabricate photocatalytic nanocomposites. Graphene composites containing TiO2 NPs show increased photocatalytic activity when compared to bare TiO2- NPs due to an increase in conductivity.

7.4.2 Carbon Nanotubes (CNTs):

Most notably, efforts have been undertaken to open the closed ends of pristine CNTs in order to enhance their adsorption properties. Generally, single walled carbon nanotubes (SWCNTs) are arranged in a hexagonal configuration (i.e., one nanotube surrounded by six others), thus forming bundles of aligned tubes with a heterogeneous, porous structure. For a typical open-ended CNT bundle, adsorption can take place in four different available sites, which are of two types: those with lower adsorption energy, localized on external surfaces of the external CNTs composing the bundle; and those of higher adsorption energy, localized either in between two neighboring tubes or within an individual tube. Adsorption on external sites reaches equilibrium much faster than adsorption on internal sites due to the direct exposure of the external sites to the adsorbing material. Multi walled carbon nanotubes (MWCNTs) do not usually exist as bundles, except when specific methods of preparation are used to create such configurations.

Many researcher have demonstrated in their nitrogen adsorption studies that different types of pores (i.e., inner and aggregated) create a multi-stage adsorption process. Aggregated pores were shown to be more significantly responsible for the adsorption properties of these materials than the less accessible inner pores.

7.4.3 Polymer-Based Nanoparticles:

Although the large surface area-to-volume ratio of nanomaterials contributes to higher reactivity with concomitant improved performance, the occurrence of aggregation, non-specificity, and low stability can limit the use of these nanotechnologies due to the lack of functionality. An alternative to enhance stability of nanoscale materials is to employ the use of a host material, the purpose of which is to serve as a matrix or support to other types of materials. Polymers are mostly used for the detection and removal of contaminant chemicals (e.g., manganese, nitrate, iron, arsenic, heavy metals, etc.), gases (e.g., CO, SO2, NOx), organic pollutants (e.g., aliphatic and aromatic hydrocarbons, pharmaceuticals, or VOCs) and a wide array of biologics (e.g., bacteria, parasites, viruses, etc.). Polymeric hosts (e.g., surfactants, emulsifiers, stabilizing agents, and surface functionalized ligands) are often employed to enhance stability and overcome some of the limitations of pristine nanoparticles as well as to impart other desirable properties such as enhanced mechanical strength, thermal stability, durability, and recyclability of the material in question. Amphiphilic polyurethane (APU) NPs have been developed for the remediation of polynuclear aromatic hydrocarbons (PAHs) from soils, thus validating the hypothesis that organic NPs can be engineered with desired properties. The hydrophilic surface of the nanoparticles promotes mobility in the soil, while the hydrophobic interior of the material confers affinity for the hydrophobic organic contaminants. APU NPs removed phenanthrene from contaminated aquifer sand (i.e., 80% recovery).

An analysis of different formulations indicated that the APU nanoparticle affinity for phenanthrene increased when the size of the hydrophobic backbone was also increased. Furthermore, increasing the number of ionic groups on the precursor chain contributed to a reduction in APU particle aggregation in the presence of polyvalent cations. While the application of these materials in the environment could be beneficial for contaminant remediation, there is no report on the biodegradability of such materials, which contributes to concerns regarding their fate after application. Poly (amidoamine) or dendrimers (PAMAM) have been utilized in wastewater remediation for water samples contaminated with metal ions such as Cu2+. Those dendritic nanopolymers contain functional groups such as primary amines, carboxylates, and hydroxamates which are able to encapsulate a broad range of solutes in water, including cations (e.g., Cu2+, Ag+, Au+ etc). They are used as chelating agents and ultrafilters to bind with metal ions thus facilitating water purification. These materials have also been used as antibacterial/antivirus agents. The key feature of the dendritic nanopolymers is that they have a lower tendency to pass through the pores of ultrafiltration membranes compared to linear polymers of similar molecular weight polymers due to their lower polydispersity and globular shape. Therefore, they have been employed to improve ultrafiltration (UF) and microfiltration (MF) processes for the recovery of dissolved ions from aqueous solutions. First, a solution of functionalized dendritic nanopolymers is mixed with contaminated water and then the bound nanopolymer-contaminants are transferred to UF or MF units to recover the clean water. They can be separated from each other by changing the acidity (pH) of the solution and then the recovered concentrated solution of contaminants is collected for disposal and the nanopolymers may be recycled.

7.4.4 Biological Response during the use of Nanoparticles in Bioremediation:

The bacteria and plants which are used in bioremediation are capable of immobilizing metals and transforming both organic as well as inorganic contaminants. It is reported in recent years that the combine use of nanoparticels and bioremediation technologies showed promising results to eliminate contaminants or pollutant from the environment. The combination of nanopartilcles with electrokinetic remediation, chemical oxidation and bioremediation has significant effects in the removal of contaminants from heavily polluted sites. Toxic compounds like polychlorinated byphenils (PCBs) which create a global environmental problem due to their persistence, long range atmospheric transport and slow degradation as well as biocculation.

These compounds are used in electrical capacitors, transformers, hydraulic fluids as wells lubricants. Although these compounds have various uses in preparing numerous useful products but they are very harmful to our environment. To degrade these toxic compounds nanoparticles can be used along with bioremediation.

Researchers have developed a nano/bio treatment for these compounds by using the bimetallic nanoparticles Pd/nFe and *Burkholderia xenovorans* LB400, bacteria. It is also reported that by using carbon nanotubes and *Anthrobacter* sp. PCBs can be degraded. Studies also showed that using of magnetic nanoparticles along with *Rhodococcus rhodochrous* bacteria can degrade compounds like chlorophenal. Likewise the combined effect of phyto and nanoparticles are also provided evidence of successful removal of contaminant from soil and water.

Bometallic nanoparticles along with plants like tobacco are used to degrade compounds such as hexabromocyclododecane (HBCD). This compound is act as a flame retardant additive for preparing thermoplastic polymers and used in insulation, textiles, and electronics. But it has toxic effect to the environment and carcinogenic in nature.

The nanobioremediation technology thus helps to eliminate the toxic effect of hexabromocyclododecane from the environment. So it is found that nanoparticles along with microorganisms and plant gives a significant result in degrading toxic compounds and helps to eliminate the harmful effects of these compounds from the environment.

7.5 Conclusion:

As we are facing the global problem of environmental pollution, new technologies are emerging to control it and help in removing the toxic effect of pollutant. Nanotechnology is one the modern technology which shows promising results in controlling pollution. Use of nanoparticles in nanotechnology helps to remove contaminants from soil and water. Combination of nanoparticles with microorganisms and plants provides significant effect in pollutants eradication. The physical properties and chemical nature of nanoparticels or nanomaterial enables them to remove tough molecules of pollutant from the environment. Thus nanotechnology would help us to restore our environment by removing toxic compounds.

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8. Enforcement of Environmental Laws and Policies-Judicial Trends in India

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8.1 Introduction:

The roots of the word, 'environment' means "that which environs us." Being "environed" is being encircled or surrounded. Broadly speaking, the environment should be understood as the overall physical and emotional context in which we are located. It is very important, therefore, to recognize that environments are different from place-to-place and from time-to- time, depending upon who we are and where we are. India is among the bottom five countries on the Environmental Performance Index 2018, ``plummeting 36 points from 141 in 2016, according to a biennial report by Yale and Columbia Universities along with the World Economic Forum[1]. Its overall low ranking that is 177 among 180 countries was linked to poor performance in the environment health policy and deaths due to air pollution categories.[2] Switzerland leads the world in sustainability, followed by France, Denmark, Malta and Sweden in the EPI, which found that air quality is the leading environmental threat to public health. India's low scores are influenced by poor performance in in the Environmental Health policy objective. In 2016, the Institute for Health Metrics and Evaluation estimated that diseases related to airborne pollutants contributed to two-thirds of all life-years lost to environmentally related deaths and disabilities.

The Constitution of India and Clean Environment, In the realm of the fundamental rights the most essential right is the 'right of life' guaranteed by Article 21 of the Indian Constitution, which the article says that cannot be taken away accept according to procedure established by law. To safeguard this right and other fundamental rights we do have a very special feature in the Constitution of India known as right to constitutional remedies[3].

Article 32 of the constitution empowers the supreme court in an appropriate proceeding to issue not only writ of mandamus, certiorari, prohibition or quo warrant but also any other direction, order or writ for the enforcement of fundamental rights. The same power is vested in the High Courts under Article 226 of the Constitution. It is upon the exercise of this power of judicial review the Courts are called upon to decide whether any instrumentality, agency or organs of the 2 state has transgressed or exceeded the limits of power conferred upon it and to ensure that the state and the public officials fulfill the obligation of the Constitution and the law under which they exist and function. In addition to Chapter on Fundamental Rights, the Constitution of India contains a Chapter on Directive Principles of State Policy, which emphasize in amplification of the preamble, that the goal of Indian polity is not laissez faire, but welfare state, where the state has positive duty to ensure to its citizens social and economic justice and dignity of the individual. According to Article 48A of the Directive Principles "the State should strive to protect and improve the environment and to safeguard forests and wildlife.

And Article 51A (g) of part IV-A of Fundamental Duties states that it shall be the duty of every citizen of Indian to protect and improve the natural environment. Life means to live with human dignity but if one cannot breathe clean air, have safe drinking water or health food, the all human rights civil, political, social or economic are meaningless[4]. Due to appalling scenario of the environmental pollution in our country the Supreme Court sharpened its tools and strategies during mid-80's and 90's by keeping aside all technical rules of procedure and liberalized the rule of 'locus standi' in order to alleviate the sufferings of the victims of environmental pollution under the banner of Public Interest Litigation (PIL). The courts have given expanded interpretation to Article 21 concerning the right to life to include all those rights which are essential and basic for the enjoyment of the quality of life free from environmental pollution and other health and consumer hazards."

8.2 Environment Laws in India:

The Ministry of Environment and Forests has been putting sincere efforts to eliminate all the ordeals and are following the main objectives laid down by the ministry of environment:

- Conservation & survey of flora, fauna, forests and wildlife.
- Prevention and control of pollution.
- Afforestation & regeneration of degraded areas.
- Protection of environment.
- Ensuring the Welfare of Animals[5]

A. Environmental Legislations:

- Wild Life (Protection Act), 1972
- The Indian Forest Act, 1927
- The Water (Prevention and Control of Pollution) Act, 1974
- Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- The Noise Pollution (Regulation and Control) Rules, 2000

The environmental regulatory authorities (that is, the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCB) have been ordered by the National Green Tribunal (NGT) to strictly enforce and take into account the Comprehensive Environmental Pollution Index (CEPI). CEPI allocates weightages to various pollutants, ambient pollutant concentrations, receptors (the number of people affected) and additional high-risk elements. The original CEPI assessment was undertaken in 2009, but the CEPI criteria were updated in 2016 and the final report on CEPI was issued in 2018. The NGT[6] in 2019 then directly supervised the enforcement of the CEPI criteria by the regulatory authorities. Industrial clusters are categorized under the CEPI as Polluted Industrial Areas (PIAs), which are each ranked as one of the following:

- A critically polluted area (CPA).
- A severely polluted area (SPA).
- Other polluted areas (OPA).

The CPCB and SPCB will now be focused on remediating these CEPI areas and seeking compensation from polluting industries; and any expansion or development of new sites in these areas will be rejected.

B. Environmental Permits:

The main environmental laws, including under which various key environmental permits (or consents) are being issued in India, include the:

- Water (Prevention and Control of Pollution) Act 1974 (Water Act), which also initially identified the powers, functions and hierarchy of the environmental agencies, the CPCB and the SPCB.
- Air (Prevention and Control of Pollution) Act 1981 (Air Act).
- Environment Protection Act 1986 (EP Act). This umbrella law enables the central government to take measures it deems necessary to protect and improve the environment, and to prevent, control and abate environmental pollution. A wide range of rules and notifications have been adopted under it, such as the:

a. E-Waste (Management) Rules 2016, as amended in 2018 (E-Waste Rules);
b. Bio-Medical Waste Management Rules 2016;
c. Plastic Waste Management Rules 2016;
d. Solid Waste Management Rules, 2016;
e. Construction and Demolition Waste Management Rules 2016;
f. Hazardous and Other Waste (Management and Trans-boundary Movement) Rules 2016, as amended in 2019 (HW Rules);
g. Manufacture, Storage and Import of Hazardous Chemicals Rules 1989 (MSIHC Rules); viii. Coastal Regulation Zone Notification 2019; and
h. Environment Impact Assessment Notification 2006.

- Wild Life (Protection) Act 1972.
- Forest (Conservation) Act 1980.
- Public Liability Insurance Act 1991.
- Biological Diversity Act 2002.
- National Green Tribunal Act 2010.

The Key Regulatory authorities are the Ministry of Environment, Forests and Climate Change (MoEFCC).

The Central Pollution Control Board (CPCB) the State Pollution Control Board (SPCB) and the District Level Authorities (that is, municipal corporations).

8.3 Landmark Judgments:

The Indian State has also enshrined it in the Constitution which requires both the State and the Citizen to "protect and improve the environment". The landmark judgments for environmental jurisprudence are as follows:

A. The 42nd Amendment to the Constitution of India which added **Article 48A and 51A (g)** these comes under the Directive Principle of State Policy and the Fundamental Duties respectively. The Supreme Court of India in **Sachidanand Pandey v/s. State of West Bengal** [7] stated that the Court is bound to bear in mind the above said articles whenever a case related to Environmental problem is brought to the Court.

- The Article 48A states: "The State shall endeavor to protect and improve the environment and to safeguard the forest and wildlife of the country."
- The Article 51A (g) imposes a duty upon every citizen of India to protect and improve the natural environment and confers right to come before the Court for appropriate relief.

Thus the court believed that State is the legal, the actual owner of the natural resources as a trustee of the people and although it is empowered to distribute the same[8], the process of distribution must be guided by the constitutional principles including the doctrine of equality and larger public good which is a prior goal for the guardian of a nation.

B. Article 21 of the Indian Constitution i.e. Right to personal Right and Liberty:

The Apex Court in **Damodar Rao v/s. S.O. Municipal Corporation[9]** held that the environmental pollution and spoliation which is slowly poisoning and polluting the atmosphere should also be regarded as amounting to violation of **Article 21 of the Constitution.**

The High Courts have also accorded recognition to this environmental dimension of Article 21 such as judgment by the Andhra Pradesh High Court in T. Damodar Rao v/s Special Officer Municipal Corporation, Hyderabad 40 explicitly recognized an environmental dimension to Article 21 while considering a writ petition to enjoin the Life Insurance Corporation and Income Tax Department from building residential houses in a recreation zone, held: It would be reasonable to hold that the enjoyment of life and its attainment and fulfillment guaranteed by Article 21 of the Constitution embraces the protection and preservation of nature's gifts without which life cannot be enjoyed. There can be no reason why practice of violent extinguishment of life alone should be regarded as violation of Article 21 of the Constitution[10]. The slow poisoning by the polluted atmosphere caused by environmental pollution and spoliation should also be regarded as violation of Article 21 of the Constitution. The Court held that the attempt of the respondents to build houses in this area is contrary to law and also contrary to Article 21 of the Constitution.

C. Public Liability and Public Nuisance: "M.C. Mehta and Anr. etc vs. Union of India and Ors. etc [11]" discusses the concept of Public Liability. This case is also known as Oleum Leakage Case. It is a landmark judgment in which the principle of Absolute Liability was laid down by the Supreme Court of India.

On the midnight of 2/3-12, 1984; there was a leakage of poisonous gas (methyl isocyanate) from Union Carbide Corporation India Limited, located at Bhopal, Madhya Pradesh. This disaster was described as "World's worst industrial disaster" as it claimed the lives of 2260 people and caused serious injuries with a variety of complications to about 6 lakhs of people.

When the matter was pending before the Supreme Court, another gas disaster took place from Shri Ram Foods and Fertilizer Industries (belonging to Delhi Textile Mills Ltd.), Delhi on 4th and 6th December 1985. One advocate died and several others injured. MC Mehta, filed a "public interest litigation" petition under Article 32 of the Constitution. The Supreme Court through P.N. Bhagwati, C.J., keeping in mind the one-year-old great gas disaster of Bhopal, evolved a new rule, "Absolute Liability" in preference to 1868 rule of Strict Liability.

The Issues Raised were: Whether the plant can be allowed to continue or not? If not, what measures are required to be taken to prevent the leakages, explosions, air and water pollution? To find out the number of safety devices exists in the plant and others though necessary is not installed in the plant. Court held that the "absolute liability" of a hazardous chemical manufacturer to give compensation to all those affected by an accident was introduced in this case and it was the first time compensation was paid to victims. The court directed the Central Government to set up an Environmental Court consisting of a Judge and two experts (Ecological Sciences Research Experts) as members to assist the judge in deciding the environmental cases. Pursuant upon the recommendation, the Government of India passed the National Environment Tribunal Act, 1995 to deal with the cases of environmental pollution.

D. Municipal Corporation, Ratlam vs. Vardhichand[12]: it was held that the **plea of lack of fund will be poor alibi when people in misery cry for justice**. The office in charge and even the elected representatives will have to face a penalty if they violate the constitutional and other statutory directives. Ratlam. a city in the State of Madhya Pradesh had some of the residents of the municipality filing a complaint before the Sub-Divisional Magistrate alleging that the municipality is not constructing proper drains and there is stench and stink caused by the exertion by nearby slum-dwellers and that there was nuisance to the petitioners. The Sub Divisional Magistrate of Ratlam district instructed the municipality to prepare a proper development plan within 6 months of the complaint submitted by the residents of Ratlam city (approved by High Court). Afterwards the municipality came in appeal before the apex court of India and alleged that they do not have proper financial support as well as proper funds to comply with the direction given by the sub divisional magistrate of Ratlam city. Respondents argued that the Municipality of Ratlam city had failed to meet its obligations given by the sub divisional magistrate to provide for public health including by failing to abate pollution and other hazardous waste from impacting their homes.

Respondents focused to stop pollution caused by a runoff from a nearby alcohol plant resulting in form of malaria. The Supreme Court instructed the Municipal Council of Ratlam to immediately follow order given by the Sub Divisional Magistrate of Ratlam city to protect the area from pollution caused by alcohol plant flowing into the neighboring areas of the resident. Supreme court also ordered the municipal to take necessary steps to fulfill their obligation by providing adequate number of public laterals for specifically men and women separately along with to provide water supply and scavenging service in morning as well as in evening to ensure proper sanitation. The court also ordered that these obligations to be fulfilled within six months of court order. The problem was due to private polluters and haphazard town planning, it was held by Supreme Court that pollution free environment is an integral part of right to life under Article 21.

The Court Further held that in case municipality feel the need of resources then it will raise its demand from State government by elitist projects, request loans from the State Government from the savings account of public health expenditure to fulfill the resource requirement for the implementation of courts order.

E. Sustainable Development: The Bench of Justices PN Bhagwati and Ranganath Mishra in "**Rural Litigation and Entitlement Kendra, Dehradun vs. State of Uttar Pradesh**"[13] introduced the concept of "Sustainable Development". An NGO named RLEK filed a case against limestone quarrying in the valley in 1987. It was stated that the permanent assets of mankind are not to be exhausted in one generation. The natural resources should be used with requisite attention and care so that ecology and environment may not be affected in any serious way. This case is also known as the '**Dehradun Valley Litigation**'. In Mussoorie hill range of Himalayas, the activity of quarrying was being carried out. Limestone was extracted by blasting out the hills with dynamite. This practice has also resulted in cave-ins and slumping because the mines dug deep into the hillsides, which is an illegal practice per se. Due to lack of vegetation many landslides occurred, which killed villagers, and destroyed their homes, cattle and agricultural land. It was contended by the mining operators that the case should be dismissed by the court and the issue should be left to the administrative authorities under the Environment Protection but the Court rejected the miners' arguments the ground that the litigation had already commenced and significant orders had been issued by the court before the adoption of the Environment Protection Act. Later a monitoring committee was made. Monitoring Committee directed the company in certain way but the lessee continued to quarry limestone in an unscientific manner and in disregard of the directions issued by the Monitoring committee. In an application filed by the committee, the court held that the mining activity secretly carried on by Vijay Shree Mines had caused immense damage to the area and directed the firm to pay Rs. 3 lakhs to the fund of the Monitoring committee.

After years, the Supreme Court of India has held that pollution caused by quarries adversely affects the health and safety of people and hence, the same should be stopped. The right to wholesome environment is a part of right to life and personal liberty guaranteed under Article 21 of the Constitution. This case was the first requiring the Supreme Court to balance environment and ecological integrity against industrial demands on the forest resources.

F. Environmental Impact Assessment Justice Jeevan Reddy in the landmark judgment of "**Indian Council for Enviro-Legal Action vs. Union of India**[14]" held that the financial costs of preventing or remedying damage caused by pollution should lie with the undertakings which cause the pollution by adopting the "**Polluter Pays Principle**". It is an irrational interpretation of the polluter as somebody who results in harm to, not anyone, but perhaps the environment.

As the environment cannot really be actually recompensed, this allows for a justification to levy taxes upon guilty entities along with the assurance that the sum will be utilized to reverse the harm done. But in practice, these "polluter penalties" mainly help to boost the earnings of the government officials, advisors, and attorneys, most of whom profit from the method. As presently interpreted, the polluter pays concept actually winds up as just a mechanism for transferring money from polluters to non-victims who are politically very well connected.

As per the Indian scenario, legislation with respect to the imposition of criminal liability against defaulting corporations is still not found. Some even have commented that the principle of 'polluter pays' has now degenerated into the concept of 'pay and pollute', as a result of delay and insufficiency in providing executive action in such cases. [15]The punishment given to industries ought to be such as to reimburse the victims as well as repair the damaged environment and somehow also discourage the polluters from performing such an act again.

G. Water Pollution Ganga Pollution Case: The writ petition filed by the activist advocate M.C. Mehta in the Supreme Court highlighted the pollution of the Ganga River by the hazardous industries located on its banks. Justice E.S. Venkataramiah gave a historic judgement in "M.C. Mehta vs. Union of India[16]" ordering the closure of a number of polluting tanneries near Kanpur. In this judgment it was observed that just like an industry which cannot pay minimum wages to its workers cannot be allowed to exist, a tannery which cannot setup a primary treatment plant cannot be permitted to continue to be in existence. In 1985, M.C. Mehta filed a writ petition in the nature of mandamus to prevent these leather tanneries from disposing of the domestic and industrial waste and effluents in the Ganga River.

In this petition, the petitioner requested the court to request the Supreme Court to restrain the respondents from releasing effluents into the Ganga river till the time they incorporate certain treatment plants for the treatment of toxic effluents to arrest water pollution.

The Court highlighted the importance of certain provisions in our constitutional framework, which enshrine the significance and the need for protecting our environment. Article 48-A provides that the State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country. Article 51-A of the Constitution of India imposes a fundamental duty on every citizen to protect and improve the natural environment, including forests, lakes, rivers, and wildlife.

The Court stated the importance of the Water (Prevention and Control of Pollution) Act, 1974 (the Water Act). This act was passed to prevent and control water pollution and maintaining water quality. This act established central and stated boards and conferred them with power and functions relating to the control and prevention of water pollution. The question was raised that what is Trade Effluent and it was explained as any substance in the form of solid, liquid, or gaseous state which is discharged from any establishment used for carrying out any trade or industrial activity, other than domestic sewage. It was noted that the leather industry is one of the significant industries besides paper and textiles consuming large quantities of water. Most of the water used is discharged as wastewater. The wastewater contains toxic substances that deplete the Oxygen content of the clean river water in which they are discharged. This results in the death of aquatic life and emanates foul odor. The Court held the despite provisions in the Water (Prevention and Control of Pollution) Act, 1974 Act no effective steps were taken by the State Board to prevent the discharge of effluents into the river Ganga. Also, despite the provisions in the Environment Protection Act, no effective steps were taken by the Central Government to prevent the public nuisance caused by the tanneries at Kanpur. The Court ordered the tanneries to establish primary treatment plants, if not Secondary treatment plants. That is the minimum which the tanneries should do in the circumstances of the case.

H. Animal Welfare the Jallikattu Judgment: The Hon'ble Supreme Court prohibited Jallikattu and other animal races and fights. It was observed that the Bulls cannot be performing animals in the case of "Animal Welfare Board of India vs. A. Nagaraj and Ors. [17]". The court in the case considered the rights of animals as a "Constitutional Rights". The Court also brought into the aspect of Article 51-A (g) & (h) [18], which are Fundamental Duties on the part of the citizens. The impact was the case was tremendous on the States, especially those of Tamil Nadu and Maharashtra. The States revenue decreased since large number of spectators does come to attend the Jallikattu every year. The message is loud and clear, individuals can't dispense agony and enduring on a panicked and be fuddled animal all for the sake of safeguarding social legacy. The court held that it is indeed a 'dangerous sport', both for the bulls and the people watching it. The question whether the law or a custom which has been prevailing for hundreds of years must prevail or not which was the issue in this case.

Considering the fact that thousands of people are injured and that lives are lost and moreover the fact that brutal cruelty and harassment are shown to these voiceless creatures of the earth, the decision of the court can be justified to ban the much renounced "Jallikattu and Bullock Cart racing" and shows that Definitely the law must prevail.

I. Air Pollution: The pride of India and one of the wonders of the world i.e., Taj Mahal, was facing threat due to high toxic emissions from Mathura Refineries, Iron Foundries, Glass and other chemical industries. The acid rain was a serious threat to the Taj Mahal and 255 other historic monuments within the Taj Trapezium. The Apex Court in "M.C. Mehta vs. Union of India (Taj Trapezium Case) AIR 1987[19]" delivered its historic judgment in 1996 giving various directions including banning the use of coal and cake and directing the industries to Compressed Natural Gas (CNG).

J. Environmental Awareness and Education Case: The Supreme Court in "M.C. Mehta vs. Union of India[20]" ordered the Cinema theatres all over the country to exhibit two slides free of cost on environment in each show. Their licenses will be cancelled if they fail to do so. Environment has become a compulsory subject up to 12th standard from academic session 1992.

K. Wildlife and Forest Protection Case: The livelihood of forest dwellers in the Nilgiri region of Tamil Nadu was affected by the destruction of forests. The Supreme Court in "**TN Godavarman Thirumulpad vs. Union of India and Ors**." passed a series of directions since 1995, till the final judgment in 2014. The Apex Court decided to set up a Compensatory Afforestation Funds Management and Planning Authority (CAMPA) to monitor the afforestation efforts, to oversee the compensation who suffered on account of deforestation, and to accelerate activities for preservation of natural forests. The court held that- Environmental law is an instrument to protect and improve the environment and to control or prevent any act or omission polluting or likely to pollute the environment. In view of the enormous challenges thrown by the industrial revolutions, the legislatures throw out the world are busy in this exercise. In a number of cases, sentences of imprisonment have been imposed. Apart from the direct cost to business of complying with the stricter regulatory controls, the potential liabilities for non-compliance are also increasing. In the present case the Forest Advisory Committee under the Conservation Act on 11/07/2001 examined the renewal proposal in respect of the Company's mining lease.

The Ministry of Environment and Forests deferred a formal decision on the said recommendation as the matter was pending before this court. Taking note of factual background, it is proper to accept the time period fixed by the Forest Advisory Committee constituted under Section 3 of the Conservation Act. That means mining should be allowed till the end of 2005 by which the time the weathered secondary ore available in the already broken area should be exhausted. This is, however, subject to fulfillment of the recommendations made by the Committee on ecological aspects. However the concern was that the State and Central Government were not very consistent.

L. Public Trust and Right to Life: The Bench of Justices Kuldip Singh and Sagir Ahmed held that the Government violated the Doctrine of Public Trust in **M.C. Mehta vs. Kamal Nath and Ors.**[21]". The Himachal Pradesh State Government had leased out a protected forest area on the bank of river Beas to motels, for commercial purposes. In 1996, the Supreme Court passed a judgment that would hold the State more responsible for maintaining natural resources.

The Indian Express published an article reporting that a private company, Span Motels Private Ltd. ('the Motel Company'), owner of Span Resorts, had floated an ambitious project called Span Club. Kamal Nath who was the Minister of Environment and Forests had direct links with this company. The company encroached upon land which also included forest land. The land was regularized and subsequently leased out to the company on 11th April 1994.

The question was whether the court has wrongly inducted Mr. Kamal Nath as a Respondent in the present petition? Whether the construction activity carried out by the Motel Company justified? The Supreme Court rejected this contention and held that the forest lands which have been given on lease to the Motel by the State Governments are situated at the bank of the river Beas. The Beas is a young and dynamic river and it changes its course very often. The right bank of the river is where the Motel is located comes under forest. The area is ecologically fragile and therefore it should not be converted into private ownership. The Supreme Court applied the '**Doctrine of Public Trust**' to the present case.

Doctrine of Pubic trust is an ancient legal doctrine which states that certain common properties such as rivers, seashore, forests and the air were held by Government in trusteeship for the free and unimpeded use of the general public. Public Trust Doctrine primarily rests on the principle that certain resources like air, sea, water and the forests have such a great importance to the people as a whole that it would be unjustified to make them a subject of private ownership.

Therefore The Court quashed the lease deed by which forested land was leased to the Motel Company and held that the construction activity carried out by the Motel Company was not justified. The Motel was ordered to pay compensation by way of cost for the restitution of the environmental and ecology of the area.

The Motel was ordered to construct a boundary wall at a distance of not more than 4 meters for the building of the motel beyond which they were not allowed to use the land of the river basin. The Court also restricted the Motel from discharging untreated effluent into the river.

M. Vellore Citizens Welfare Forum v. Union of India; Supreme Court of India:[22]

The petition was filed against the excessive pollution caused by River Palar due to the release of pollutants by the tanneries and other industries in the State of Tamil Nadu. Palar River is the main source of drinking and bathing water for the surrounding people. Later, the Tamil Nadu Agricultural University Research Centre, Vellore discovered that approximately 35,000 hectares of agricultural land have turned either entirely or partially unsuitable for cultivation. This is one of the landmark cases whereby the Supreme Court critically analyzed the relationship between environment and industrial development. The question which emerged for thought under the steady gaze of the Supreme Court was whether the tanneries ought to be permitted to keep on working at the expense of lives of lakhs of individuals. It was presented by the petitioner that the whole surface and sub-soil water of river Palar has been intoxicated and has resulted in the non-accessibility of consumable water to the inhabitants of the region. The Supreme Court analyzing the report conveyed its judgment putting forth all attempts to keep up a concordance among condition and improvement. The Court conceded that these Tanneries in India are the major foreign exchange earner and furthermore gives work to a large number of individuals. In any case, at the equivalent time, it wrecks nature and represents a well-being danger to everybody. The court conveying its judgment in favor of the petitioner guided all the Tanneries to submit a whole of Rs. 10,000 as fine in the Collector's office. The Court additionally coordinated the State of Tamil Nadu to grant Mr. M. C. Mehta with an entirety of Rs. 50,000 as gratefulness towards his endeavors for the security of the Environment.

N. A.P. Pollution Control Board v. Prof. M.V. Nayudu (Retd.) & Ors:[23] In this case the respondent industry is ought to be establishing a new factory for the production of vegetable oils in the State of Andhra Pradesh. Respondent industry purchased a piece of land in Indore village named Peddashpur. Within the range of the village the reservoirs that provides drinking water for the 5 million of people around the area. The Issues raised were:

- The validity of the orders passed by the A.P.Pollution Control Board?
- The correctness of the orders of the Appellate Authority under section 28 of the Water Act, 1974?
- The validity of exemption granted for the operation of the 10 k.m. rule?
- In what ways that the technological aspects of the environmental law cases ought to be adjudicated?

In the impugned judgment, the Supreme Court relied on the judicial doctrine of the **Precautionary Principle**. The Precautionary Principle as it is very name suggests needs the authorities in charge to anticipate, prevent and attack the reason behind environmental pollution. This rule is based on the salutary theory that it is better to err on the side of caution and safety than in the wrong way wherever environmental damage, once done, is also irreversible. In other words, one ought to take measures in anticipation of environmental damage, instead of to hunt cure when the damage is inflicted. It would be better to stay safe earlier then be sorry later. Hindrance is healthier than cure. The Court in the present judgment directed that the authority to be appointed under Section 3(3) of the Environment (Protection) Act, 1986 that shall implement the Precautionary Principle and also the Polluter Pays Principle.

Further, it had been discovered that the new conception envisages that when a risk of great or irreversible damage to the environment is perceived, the burden of proof lies on the one that is proposing to undertake the activity in question.

O. M.C. Mehta v. Union of India- Vehicular Pollution Case[24]: This writ petition was filed by Mr. M.C. Mehta requesting the court to pass appropriate orders for the reduction of Vehicular Pollution in Delhi. Supreme Court in this case held that Indian constitution recognizes the importance of protection of environment, life, flora and fauna by the virtue of Article 51-A and Directive principles of state policy. Therefore, it is the duty of the state to protect the environment and all the persons using automobiles should have a fair idea of the harmful effects on the environment due to emissions caused by their vehicles. A committee was setup to look in to the problem and decide on what can be done. The committee was setup with the following objectives:

- To make an assessment of the technologies available for vehicular pollution control in the world; To make an assessment of the current status of technology available in India for controlling vehicular pollution;
- To look at the low cost alternatives for operating vehicles at reduced pollution levels in the metropolitan cities of India.
- To examine the feasibility of measures to reduce/eliminate pollution from motor vehicles both on short term and long term basis and make appropriate recommendations in this regard;
- To make specific recommendations on the administrative/legal regulations required for implementing the recommendations.

The committee was ordered to give reports in two months and also mention the steps taken. This was a landmark judgment with respect to Vehicular pollution in India. Later the Supreme Court also passed orders for the provision of Lead free petrol in the country and for the use of natural gas and other mode of fuels for use in the vehicles. Lead free petrol was introduced in four metropolitan cities in 1995. All cars manufactured after 1995 were fitted with catalytic convertors to reduce emissions. CNG outlets have been setup to provide CNG gas to vehicles. As a result of this case Delhi became the first city in the world to have a complete public transport running on Compressed Natural Gas.

P. Subhash Kumar v. State of Bihar & Ors[25]: The petition was filed by the way of Public Interest Litigation by Subhash Kumar for preventing the pollution of the water of the river Bokaro from the discharge of sludge/slurry from the Tata Iron & Steel Co. Ltd. The Petitioner alleged that the Parliament enacted Water (Prevention and Control of Pollution) Act, 1978 for maintaining the wholesomeness of water and for the prevention of water pollution. The State Pollution Control Board failed to take actions against the Company and permitted the pollution of the water and the State of Bihar instead of taking actions, it is granting a lease on the payment of royalty for collection of slurry to various persons. Issue raised was whether the water of the river Bokaro is polluted by the discharge of the slurry from the Company? The apex court held that the right to get pollution free water and air is a fundamental right under Article 21. Following this, the right to pollution free environment was incorporated under the head of right to life and all the laws courts within the Indian Territory were bound to follow.

Public health and ecology were held to be the priorities under Article 21 and the constitution of a green bench was also ordered by the Supreme Court. The Tata Iron & Steel Co. has been granted sanction from the Board for discharging effluents from their outlets under Sections 25 and 26 of the Water Prevention and Control of Pollution Act, 1974. Before granting the discharge of the effluents to the Bokaro River, the Board has analyzed and monitored that the effluents generated did not pollute the river. It was clear from the facts that and pleadings on behalf of the Respondent that there was no good reason to accept Petitioner's contentions that the water of Bokaro River was polluted by the discharge of slurry/sludge from the respondent Company, on the other hand, the bench found that effective steps were taken by State Pollution Control Board to check pollution. Therefore, the petition was dismissed.

Q. Samir Mehta v. Union of India & Ors; National Green Tribunal Judgment[26]: In this case, an environmentalist filed an application regarding the damage caused by the sinking of a ship which was carrying coal, fuel oil and diesel. Due to the sinking, a thick oil layer was formed on the surface of the sea which caused damage to the marine ecosystem. This case was held to involve questions of public importance and significance of environmental jurisprudence. The tribunal noticed the negligence. The sinking of the ship was the result of the negligence of the Respondents and upholding the principle of Polluter Pay. The Tribunal has further held that it has power to grant compensation for the costs incurred by the Central Government to clean the wrecks which may pose hazards to navigation and to marine environment. The Court thereby reaffirmed the "Precautionary Principle" and "Polluter Pays Principle" and also recognized Right to clean environment as a fundamental right under Article 21 of the Constitution of India which guarantees protection of life and personal liberty. The Tribunal held that the ship sinking accident is said to have led to the pollution of the marine environment on three counts: (a) Dumping of the cargo on the ship, i.e., coal in to the sea; (b) Release of the Fuel oil stored on board and the resultant oil spill caused by it and (c) wreckage of the ship itself, which contained the materials. In the present case, the ship used in the transport is unseaworthy and the respondents should have never used the ship for transport purpose. Therefore, in the present case, sinking of the ship is held equivalent to dumping. Environmental compensation of Rs. 100 crores was imposed. This is one of the biggest compensation ever made by private entity to government.

R. Ms. Betty C. Alvares v. The State of Goa and Ors.; National Green Tribunal Judgment[27]: A complaint regarding various instances of illegal construction in the Coastal Regulation Zone of Candolim, Goa was made by a personal of foreign nationality. Her name was Betta Alvarez. The first objection was that Betty Alvarez had no locus standi in the matter because she was not an Indian citizen and thus legally incompetent to file the petition under Article 21 because as a non-citizen, she has not been guaranteed any right under the Indian Constitution. The second objection was that the matter was barred by the law of limitation and should be dismissed. The case was initiated in the Honorable High Court of Bombay Bench at Goa in the form of a PIL but by an order dated Oct 23, 2012, the Writ Petition was transferred to the National Green Tribunal. Therefore The Tribunal in bold terms stated that even assuming that the Applicant – Betty Alvarez is not a citizen of India, the Application is still maintainable as she had filed several other writ petitions and contempt applications before she filed the present application, in which she had asserted that the Respondents had raised some illegal constructions by way of which they were encroaching the sea beaches along with governmental properties.

The Court laid down in very bold terms that once it is found that any person can file a proceeding related to the environmental dispute, Ms. Betty's application is maintainable without regards to the question of her nationality.

S. Art of Living Case on Yamuna Flood Plain; National Green Tribunal Judgment: The National Green Tribunal (NGT) held the Art of Living Foundation of Sri Sri Ravi Shankar responsible for the alleged damage caused to the Yamuna floodplains due to the World Cultural Festival organized in March 2016[28]. NGT Panel found that the organizers of the Art of Living Festival violated the environmental norms and it has severely damaged the food plane area at the bank of Yamuna River in Delhi. Earlier, the Government of Delhi and Delhi Development Authority (DDA) has permitted the Art of living festival organizers but it was an under some conditions.

The NGT panel imposed a penalty of Rs. 5 Crore on Art of Living Foundation as environmental compensation after coming down heavily on the foundation for not disclosing its full plans. The panel also warned AOL Foundation that in case of failure to pay the penalized amount the grant of Rs.2.5 crore which the ministry of culture is supposed to pay AOL will be attached. While reacting with dismay to the verdict, the Art of Living Foundation expressed disappointment and claimed that it had complied with all environment laws and norms and its' submissions were not considered by NGT. The Art of Living Foundation said in a statement that- "We will appeal to Supreme Court. We are confident that we will get justice."

T. Save Mon Region Federation and Ors. v. Union of India and Ors.[29]; National Green Tribunal: The Save Mon Region Federation, on behalf of the Monpa indigenous community, challenged the environmental clearance granted for the construction of a hydroelectric dam on the Naymjang Chhu River. The Federation pointed to faults in the environmental impact assessment (EIA) procedure and a lack of close scrutiny of the project by the expert appraisal committee (EAC). The National Green Tribunal concluded: "It is true that hydel power project provides eco-friendly renewable source of energy and its development is necessary, however, we are of the considered view that such development should be 'sustainable development' without there being any irretrievable loss to environment.

We are also of the view that studies done should be open for public consultation in order to offer an opportunity to affected persons having plausible stake in environment to express their concerns following such studies. This would facilitate objective decision by the EAC on all environmental issues and open a way for sustainable development of the region." Therefore, the project was close to a wintering site for a bird Black-necked Crane, which is included under Schedule I species under the Wildlife Protection Act of 1972.

It also comes under the 'Threatened Birds of India' literature by the appellants in this case. It also had other endangered species such as the red panda, snow leopard, etc. The tribunal gave orders to suspend the clearance for the project. It also directed the EAC to make a new proposal for environmental clearance. The tribunal also directed the Ministry of Environment and Forest in the country to prepare a study on the protection of the bird involved in the case.

U. Almitra H. Patel & Ors. v. Union of India and Ors.[30]; National Green Tribunal Judgment: This case has been the biggest case dealing with the solid waste in India. In this case, Mrs. Almitra Patel and another had filed a PIL under Article 32 of the Constitution of India before the Apex Court whereby the Petitioner sought the immediate and urgent improvement in the practices that are presently adopted for the way Municipal Solid Waste or garbage is treated in India. The Tribunal found that the magnitude of the problem was gigantic because over a lakh tonnes of raw garbage is dumped every day and there is no proper treatment of this raw garbage which is dumped just outside the city limits on land, along highway, lakes. The Tribunal noted the requirement of conversion of this waste into a source of power and fuel to be used for society's benefit, taking into consideration the Principles of Circular Economy. The tribunal considered it one of the major problems faced by India over the last few years as lakh tonnes of garbage go without proper treatment and just dumped outside the city in the outskirts. The tribunal noted the requirement to solve this problem and make it a source of power for the benefit of society. After hearing the case the tribunal issued over 25 directions. The tribunal asked all the states and UTs to strictly follow and implement the Solid Management Rules, 2016. A complete prohibition on open burning of waste on lands was made after the case.

Absolute segregation has been made mandatory in waste to energy plants and landfills should be used for depositing inert waste only and are subject to bio-stabilization within 6 months. The most important direction of the Tribunal was a complete prohibition on open burning of waste on lands, including at landfills.

8.4 The National Green Tribunal (NGT) Act, 2010[32]:

The NGT provided for the establishment of a National Green Tribunal for the effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.[33] It follows a very simple procedure to file an application seeking compensation for environmental damage or an appeal against an order or decision of the Government. A claim for Compensation can be made for:

- Relief/compensation to the victims of pollution and other environmental damage including accidents involving hazardous substances;
- Restitution of property damaged;
- Restitution of the environment for such areas as determined by the NGT.

8.4.1 Principles of Justice Adopted by NGT:

The NGT is not bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of natural justice. Further, it is also not bound by the rules of evidence as enshrined in the Indian Evidence Act, 1872. Thus, it will be relatively easier (as opposed to approaching a court) for conservation groups to present facts and issues before the NGT, including pointing out technical flaws in a project, or proposing alternatives that could minimize environmental damage but which have not been considered.

While passing Orders/decisions/awards, the NGT will apply the **principles of sustainable development, the precautionary principle and the polluter pays principles**.

However, if a claim is false, it can impose costs including lost benefits due to any interim injunction.

If a project proponent or any authority does not comply with the directions contained in an NGT order, the **penalty can be imprisonment for three years or fine extending to 10 crores or both**. Continued failure will attract a fine of twenty five thousand rupees per day.

The Tribunal has the power to hear all civil cases relating to environmental issues and questions that are linked to the implementation of laws listed in Schedule I of the NGT Act 2010. These include the following:

- The Water (Prevention and Control of Pollution) Act, 1974;
- The Water (Prevention and Control of Pollution) Cess Act, 1977;
- The Forest (Conservation) Act, 1980;
- The Air (Prevention and Control of Pollution) Act, 1981;
- The Environment (Protection) Act, 1986;
- The Public Liability Insurance Act, 1991;
- The Biological Diversity Act, 2002.

This means that any violations pertaining only to these laws, or any order / decision taken by the Government under these laws can be challenged before the NGT. The Tribunal has not been vested with powers to hear any matter relating to the following:

- Wildlife (Protection) Act, 1972,
- The Indian Forest Act, 1927 and
- Various laws enacted by States relating to forests, tree preservation etc.

Therefore, specific and substantial issues related to these laws cannot be raised before the NGT and one has to approach the State High Court or the Supreme Court through a Writ Petition (PIL) or file an Original Suit before an appropriate Civil Judge of the taluk where the project is located.

Thus to conclude the following are covered:

- Permanent/temporary disability or other injury or sickness.
- Medical expenses incurred for treatment of injuries or sickness.
- Damages to private property.
- Loss and destruction of any property other than private property.
- Expenses incurred by the government or a local authority in providing relief, air and rehabilitation to the affected persons, or compensation for environmental degradation and restoration of the quality of the environment.
- Claims including cost of restoration on account of any harm or damage to the environment, including pollution of soil, air, water, land and ecosystems.

- Claims on account of any harm, damage or destruction to fauna and aquatic fauna and flora, crops, vegetables, trees and orchards.
- Loss of business or employment, or both.
- Any other claim arising out of or connected with any activity of handling hazardous substances.

The Act also provides that anyone who fails to comply with any order or award of the NGT Act is punishable with imprisonment for a term up to three years, or a fine up to INR100 million, or both. If the failure or breach continues, an additional fine can be imposed up to INR25, 000 per day. The penalty under the NGT Act is even stricter for companies. If a company fails to comply with an order or award of the NGT, it is liable to a fine up to INR250 million, and an additional fine up to INR100, 000 for each day the breach continues.

8.5 Conclusion:

With the problem of environmental degradation becoming globally accepted as a matter of serious and grave concern, legal solutions to environmental problems lie not in temporary legal remedies but in fundamental ideological changes in the role and use of law. The development of Indian environmental jurisprudence shows how, within a modern constitutional law framework, such a comprehensive approach can be maintained and used.

The legal development for the protection of the environment in India is firmly based on a constitutional rationale. This constitutional rationale seeks to establish a new public law regime in India. The Preamble, the Fundamental Rights, the Directive Principles of State Policy and the incorporation of the Fundamental Duties in 1976, brought about distinguishable changes to the ideology and rationale of Indian constitutionalism. These vital parts of the Constitution have, even if this was not initially obvious, laid the foundations for a new public law regime.

From an era when India hardly cared about environmental costs, it has graduated to a stage where the regulators are making it mandatory for companies to report as to how they fare on environmental, social and governance ("ESG") parameters. The projects and policies are also streamlined to meet the sustainable development goals ("SDGs").

The Judiciary has ensured that environmental compliance is no longer a matter of choice but a compulsion. It has ensured that the regulators discharge their statutory duties properly and make sure that the industries comply with the environmental regulations in letter and spirit. [33]Thus the judiciary over the last few decades has done an excellent job to interpret and provide clarity to the environmental laws. As India gained independence and the economy started growing, there was a need to enact legislation's which were meant to protect the natural environment and its various components, be it air, water, forests, wildlife, biodiversity etc. More importantly, since India had started becoming a signatory to various international environmental conventions, it was obligatory that it protected its environment back home. It is now being proposed that the Environment Protection Act, Air Act and Water Act be consolidated into a single environmental management law to prevent overlaps and conflicts, incorporate provisions relating to environmental compensation and tools like emissions trading scheme, extended producer responsibility etc.

While consolidation and streamlining are important and so is the need to make the laws stricter by incorporating provisions relating to environmental compensation as well as the Criminal liability. The Ministry of Environment, Forests and Climate Change (MoEFCC) has adopted a new method from 2016 of classifying the industries it regulates and introduced a new category of "white industries". These white industries are non-polluting industries that no longer need a consent to operate (CTO) or an Environmental Clearance (EC) under the Environmental Impact Assessment (EIA) Notification.

Instead, they merely need to notify the relevant SPCB. Whereas the earlier industry categories (red, orange and green) were essentially determined based on the size of industries, this new method is based on a Pollution Index (PI) for emissions (air pollutants), effluents (water pollutants) and hazardous waste generated apart from the consumption of resources. A PI score is allocated to each industrial sector as follows:

- Red category: PI score of 60 and above. For example: asbestos, nuclear power plants, shipbreaking, oil and gas extraction, and so on.
- Orange category: PI score of 41 to 59. For example: food and food processing, printing ink manufacturing, paint blending and mixing, and pharmaceutical formulations.
- Green category: PI score of 21 to 40. For example: saw mills, tyres/rube retreating, polythene and plastic products.
- White category: PI score up to 20. For example: solar power generation through solar photovoltaic cells, wind power, and mini hydro-electric power less than 25 megawatts.

The Supreme Court and the State high courts can and do impose exemplary damages for damage to the environment. For instance, in the Sterlites Industries Judgment 8 August 2013, one of the largest copper smelter plants in India was found to be operating without a valid renewal of its environmental consent to operate. When assessing the company's liability to pay damages (that is, for damage caused to the environment during the 15 years it operated without a valid environmental permit), it reviewed the company's annual report, and determined that 10% of the profit before depreciation, interest and taxes had to be paid as compensation, which amounted to INR1 billion. The Water Act, Air Act and EP Act all contain specific provisions for offences committed by companies. Under these Acts, every person who is in charge when an offence is committed, and is responsible to the company for the conduct of its business, is guilty of the offence and liable to be prosecuted and punished accordingly unless he proves that the offence was committed without his knowledge, or that he exercised all due diligence to prevent the offence. Thus importantly, the National Green Tribunal Act, 2010 (NGT Act) contains penalty provisions which are considerably higher compared to previously adopted environmental laws. Strengthening our institutions and ensuring strict implementation of our existing environmental laws is the key.

Thus to conclude Self-certification will definitely help improve accountability and India already has laws where this is being provided for. Change is the only constant though it may not be imminent in so far as our environmental law statutory framework is concerned. The key is not really consolidation but an effective and transparent implementation and interpretation of the existing laws to ensure that they serve the purpose for which they were originally enacted.[34]

It has often been suggested that humans exercise a different relationship with their environment than other animals. "Humans," are said to "modify their environment to suit themselves; while other animals accept their environment as it is." Ignoring the fact that this is not true in detail and accepting the degree to which it is true, it is the possession of technology of which we speak. In this regard, technology is one of the chief features of our relationship with what environs us. **Philosophy of technology** is, thus, a significant subordinate to any adequate philosophy of the environment. In this sense, an ethical (wise) relationship to environments ought to be mainly expressed as a general conception of good (wise) technological behavior, a definition of appropriate behavior to which technology is responsive. When we construct things in the world, we need to consider the destiny of the world. Thus, the focus of environmental ethics, then, is not merely the idea of treating the environing world with respect or obligation but, more basically, returning to an understanding of dependence and reciprocity in the world. The Declaration of the United Nations Conference on the Human Environment held in Stockholm in 1972[35] stated that – "Man is both creature and molder of his environment which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth.

Sooner or later, we will have to recognise that the Earth has rights, too, to live without pollution. What mankind must know is that human beings cannot live without Mother Earth, but the planet can live without humans.

-Evo Morales

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9. Covid-19: It's Positive and Negative Impacts on the Environment

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9.1 Introduction:

The world has changed in the last few months due to the rare disaster known as COVID-19 pandemic. This is an ongoing global pandemic of corona virus disease 2019 (COVID-19), caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). The virus was first identified in December 2019 in Wuhan, China. The World Health Organization declared a Public Health Emergency of International Concern regarding COVID-19 on 30 January 2020, and later declared a pandemic on 11 March 2020. So far, COVID-19 has caused the deaths of more than 3 million people worldwide. As of 13 June 2021, more than 175 million cases have been confirmed, with more than 3.79 million confirmed deaths attributed to COVID-19, making it one of the deadliest pandemics in the history.

COVID-19 is affecting people's health in different ways. Most infected people develop mild to moderate illness and recover without hospitalization. Most common symptoms of this disease include fever, dry cough and tiredness. Among less common symptoms include aches and pains, sore throat, diarrhea, conjunctivitis, headache, loss of taste or smell, a rash on skin or discoloration of fingers or toes. Severe cases can lead to cardiac injury, respiratory failure, acute respiratory distress syndrome and even death.

The pandemic has resulted in significant global, social and economic disruption. It has led to widespread supply shortages exacerbated by panic buying, agricultural disruption and food shortages. However, there have also been decreased emissions of pollutants and greenhouse gases. Numerous educational institutions and public areas have been partially or fully closed and many events have been cancelled or postponed. Misinformation has circulated through social media and mass media, and political tensions have been exacerbated. The pandemic has raised issues of racial and geographic discrimination, health equity and the balance between public health imperatives and individual rights.

India is one of the most affected countries from corona virus pandemic in all sectors. Healthcare is the epicenter during this unprecedented global pandemic. In the first quarter of the fiscal year 2021, India's Gross Domestic Product collapsed by 23.9% amid the corona virus lockdown. The pandemic has led to an unprecedented shutdown of business, industries and services. This has wreaked havoc on the job landscape in India. According to the Centre for Monitoring Indian Economy (CMIE) about 21 million salaries employees lost their jobs during April-August. According to an analysis by Scroll, during the first two months of the lockdown, India's vulnerable section lost incomes amounting to as much as Rs 4 lakh crores, or nearly 2% of the country's annual GDP.

The ongoing pandemic has also affected people's mental health majorly. According to the report compiled by a group of researchers at Jindal Global School of Law during the period of March 19 till May 2, suicide was the leading cause of over 300 non-corona virus deaths in India due to the distress triggered by the nationwide lockdown.

Indian travel and tourism industry is one of the worst-impacted sectors by the corona virus pandemic. The pandemic has also disrupted the education sector as people are forced to stay at home. The schools and colleges remain closed ever since the nationwide lockdown was imposed. Many children are struggling to keep up with the challenges of online classes. Students and teachers in cities, towns and villages scramble to cope with the demands of the times. On the other hand, livelihoods of street vendors which depend on being in public places have been hit hard by the unprecedented lockdown. With the absence of people, the city's vendors lost their source of income. Many were unable to feed their families, which led to starvation and deprivation. Even after the lockdown restrictions were lifted, many street vendors reported a drastic decrease in income as compared to the times before the pandemic outbreak.

Changes came into our life due to the lockdown already commenced impacting our environment in myriad ways. Both the positive and negative effects of Covid-19 are reflected on the environment and the climate. Doctors and researchers are noticing some curious and unexpectedly positive side effects of the abrupt shifts in human behavior in response to the covid-19 pandemic. Skies are bluer, fewer cars are crashing, crime is falling and some other infectious diseases are fading from hospital emergency departments. In these circumstances, this study intended to explore the positive and negative environmental consequences of the COVID-19 pandemic and propose possible strategies as future guideline for environmental sustainability.

9.2 Environmental Impacts of COVID-19:

The global disruption caused by the COVID-19 has brought about several effects on the environment and climate. Both positive and negative environmental impacts are discussed below:

9.2.1 Positive Effects of COVID-19 on the Environment:

A. Air Quality and Climate:

Air comprises the immediate environment of human beings, which is vital for their survival. With 91% of the global population living in places where the air quality is poor, with Air Quality Index (AQI) exceeding the permissible limits, the possible health effects of the degraded air quality had the largest footprints attributable to the pervasive, pernicious, prolonged, and constant exposure to pollution. The World Health Organization (WHO) estimated that the outdoor air pollution kills 7 million people each year worldwide and more than 80% urban population is exposed to unhealthy air. It is shocking that millions of people die every year because of polluted air, smog and soot which are considered to be slow killers. The locking down of cities has significantly improved the environmental quality with a sharp drop in air pollution levels across several countries.

As industries, transportation and companies have closed down, it has brought a sudden drop of greenhouse gases (GHGs) emissions. It is assumed that, vehicles and aviation are key contributors of emissions and contribute almost 72% and 11% of the transport sector's GHGs emission respectively. The measures taken globally for the containment of the virus are having a dramatic impact on the aviation sector. Many countries restricted international travelers from entry and departure. Due to the decreased passengers and restrictions, worldwide flights are being cancelled by commercial aircraft companies.

The reduced consumption of fossil fuels during lockdown lessens the GHGs emission, which helps to combat against global climate change. Besides, global coal consumption is also reduced because of less energy demand during this period. Due to corona virus lockdown the emission of carbon dioxide has decreased worldwide which is responsible for the climate change. The experts are predicting this to be the biggest decline in anthropogenic carbon dioxide emissions after World War-II. Scientists estimated that this reduction have saved many million lives.

The Ongoing COVID-19 lockdown across the world is showing a direct relation between air pollution levels and economic activities such as industrial activities, transportation and energy production along with the small-scale interferences at city levels. This suggests that clean energy-based system has to be adopted as the corona outbreak ends.

B. Water Quality and Aquatic Life:

Water pollution is a common phenomenon of a developing country like India and Bangladesh, where domestic and industrial wastes are dumped into rivers without treatment. Reports are indicating that COVID-19-induced lockdown not only improved the air quality but water quality in rivers and water bodies are also improved. Lockdown has been able to achieve what the governments could not for decades. The stoppage of discharging industrial effluents and other wastes into water bodies led to an apparent positive effect on water quality. India’s holiest river Ganga has been one of the most polluted rivers in the world. Waste from domestic and industrial setups along the banks of this river cost the government in millions without any success. But during lockdown, a 40–50% improvement has been observed in the water quality of the Ganga River and the water has become fit for drinking after decades. Similarly, its sister river the Yamuna has been improved as well.

The improvement of water quality at Haridwar and Rishikesh was ascribed to the sudden drop of the number of visitors and 50% reduction of sewage and industrial effluents. In Venice, the water are looking clearer after the two months of COVID-19 lockdown and aquatic life is now visible which hasn’t been seen for many years in the cities.

Clean rivers and other water bodies have a significant positive effect on the aquatic life. Many species are returning to their natural habitats since induction of the lockdown. With many cruisers suspended, the tourism subdued while all other marine activities being suspended, consequently, the aquatic species are taking controls in their hands. Commercial fishing industries have been hit hard due to the closure of main buyers, the restaurants and hotels. The indigestion and entanglement due to the plastic and marine debris which are the leading causes of injuries to sea creatures will be wiped out during this lockdown.

Not just the oceans but even the rivers and other water bodies are clearing out indicating lesser toxic and harmful materials entrance to these water bodies. There have been visible positive signs of this lockdown but few weeks or months of lockdown will not be enough to eradicate or reverse the damage caused during many years. The lockdown gives us hope that there is a possibility of minimizing the unnecessary human interferences and letting these wonderful creatures back in their space and habitats. Data gathered by several studies can be utilized for devising better environmental policies. If the governments construct sewage treatment plants in the right manner and make strong regulations for the companies and industries to treat their wastes accordingly, then the lockdown induced ecofriendly impact on aquatic life can be long lasting.

C. Reduction of Noise Pollution:

Environmental noise pollution is well-defined as an undesirable sound generated by various anthropogenic, transports, industrial and commercial activities and is the major source of discomfort for the environment and human health. Prolonged exposure to noise pollution has been shown to cause a range of health problems such as stress, tinnitus, cognitive impairment, cardiovascular disease, and hearing loss, lack of sleep, fatigue, and poor concentration, difficulties in communication and productivity losses from working places. It is reported that, globally around 360 million people are prone to hearing loss due to noise pollution. Moreover, anthropogenic noise pollution has adverse impacts on wildlife through the changing balance in predator and prey detection and avoidance. Unwanted noise also negatively affects the invertebrates that help to control environmental processes which are vital for the balance of the ecosystem. The worldwide imposition of quarantine measures by governments has confined the people to their homes which has not only decreased the use of private and public transportation but has also led to a significant dropdown in commercial activities. All these changes have caused a considerable drop in the noise level in most cities in the world. For instance, noise level of Delhi the capital of India, is reduced drastically around 40-50% in the recent lockdown period. As a result, city dwellers are now enjoying the chirping of birds, which usually ranges from 40-50 dB. Due to travel restrictions, the number of flights and vehicular movements has drastically reduced around the world which has ultimately reduced the level of noise pollution. With cruises temporarily being on hold, oceans are more in a state of calm. This calmness and decrease in ocean noise is likely to reduce the stress of aquatic creatures. Similarly, the noise pollution from shipping and powerful blasts from the seismic air gun tests, used to locate the deposits of gas and oil in the deep oceans, must be traumatizing for marine life. Noise levels from shipping traffic are generally 20-200 Hz and disturb the aquatic life which is decreased by six decibels with a significant reduction below 150 Hz.

Though the current reduction seems to be a short-term phenomenon, proper and a long-term strategy is needed to ensure and maintain the environmental noise level within the WHO's permissible limits.

D. Ecological Restoration and Assimilation of Tourist Spots:

Over the past few years, tourism sector has witnessed a remarkable growth because of technological advancements and transport networks which contribute significantly to global gross domestic product.

The places of natural beauty such as beaches, islands, national park, mountains, desert and mangroves are usually attracting the tourists and make a huge harsh. In coastal areas, beaches function as important natural capital assets and provide essential services such as tourism, recreation, sand, land, and source of livelihood to coastal communities. Besides providing valuable and intrinsic values, the sandy beaches and dunes are sentinel, shielding the heavy impacts of waves and preventing the furious winds from destroying crops, homes and other livestock. However, the non-responsible and improper use by people has caused these places to present pollution problems, which impair natural beauty and create ecological imbalance. It is estimated that the tourism industry is responsible for 8% of global GHGs emission. To facilitate and accommodate them, lots of hotels, motel, restaurant, bar and market are built, which consume lots of energy and other natural resources. Due to the outbreak of COVID-19 and local restrictions, the number of tourists has reduced in the tourist spots around the world. Nature gets a time to assimilate human annoyance and due to recent reduction of pollution, returning of dolphins was reported in the coast of Bay of Bengal of Bangladesh and canals, waterways and ports of Venice of Italy after a long decade. The beaches of Salinas (Ecuador), Barcelona (Spain) and Acapulco (Mexico) now look cleaner and with clear waters. The effect of Covid-19 lockdown on the surface water quality found that the water quality of Vembanad Lake of Kerala, increased significantly.

All these studies suggest that the virus crisis has brought with it the unintended benefits for the environment and mankind.

E. Slow Moving Life:

Mobility has been stopped all over the world during COVID-19 lockdown. All modes of mobility like public transport, micro-mobility and individual auto commuting have seen a melodramatic diminution across the globe. COVID-19 Community Mobility Reports, which use anonymous, aggregated geolocation data from mobile phones to chart movement trends over several weeks, provide perceptions into changes in mobility patterns. These reports illustrated the trends in movements in most busy places including workplaces, markets, parks, places of residence, entertaining venues and pharmacies etc.

The data collected from the mobile phones of people by this community depicts that people have reduced their movement after the COVID-19 pandemic. Decreased mobility has been observed across the globe especially in countries such as Italy, USA, Germany, UK, Canada, China, India and Saudi Arabia.

According to data from TomTom Traffic Index (TTTI), which provides detailed insights on live and historic road crowding levels in cities around the world, traffic levels have greatly been reduced in this ongoing pandemic.

In India, according to All India Motor Transport Congress (AIMTC) daily movement of trucks has been reduced to less than 10% of normal levels. Reduced road transport and fewer air travels across the globe considerably decreased fuel consumption. However, this pandemic is a great opportunity for us to learn that how urban traffic and transportation can be monitored to reduce the expenditure of fuel, its consumption and maintain a healthy environment.

F. Animals on Street:

The environmental changes brought by the corona virus were first visible from space. Then, as the disease and the lockdown spread, they could be sensed in the sky above our heads, the air in our lungs and even the ground below our feet. While humans are restricted to their homes, the wild animals all over the planet seem to have come to reclaim their territory. The emergence of wild animals in urban areas is mostly because of peace and calm, which attracts them to the residential areas.

G. Feathers Flock Together:

While the home confinement rules and social distancing has stopped the movement of peoples outside, at the same time, this global lockdown has allowed birds and wildlife to flourish and enjoy all the freedom of nature. Reports confirmed that a growing flock of thousands of flamingos beating their black and pink-lined wings has been seen splashing over the glistening water of Nartan Lagoon of the Adriatic coast. According to park authorities, since January 2020, the number of these birds has been found to increase by 3-fold up to some 3,000. Similarly, the wildlife seems to have regained all their absolute rights and is enjoying the freedom of nature. Similar cases were found in the Indian beaches with flocks of flamingos flying to these beaches with the number increasing by more than 25% compared with previous years.

H. The Vegetation is Growing Better:

Healthy plant growth is observed with improved air quality. Due to less human interference, plants are exposed to better air quality and clean water. The amount of oxygen and other nutrients required for their growth are not polluted and hence allow plants to grow and harvest healthy produce which is essential for improving the food cycle of the planet.

9.2.2 Negative Effects of Covid-19 on the Environment:

A. Covid-19 and the Global Economy:

Although the territorial colonization ended long ago, this existing global health crisis can serve as a reminder that the colonization of economics, medicine and politics are still alive. In addition to its immediate effects on the lives and health outcomes, it is now clear that the corona virus outbreak is likely to have long-lasting effects on the global economy. Loss of lives by any sort of pandemic causes irretrievable damage to the society; however, the Covid-19 pandemic apart from taking a huge toll on the global lives has severely demobilized the global economy. To limit further transmission, governments at local, regional, national and global levels have decided to undergo complete lockdown. Owing to the complete lockdown and cross-border closure, all the flights, railway services, trucks, buses and all other types of vehicular transports are suspended. Nearly all the Covid-19-traumatized nations, industries, and entire commercial, educational, religious and sports institutions are closed. All these restrictions are negatively affecting global economies. Moreover, increased prices, lost income and overburdened social safety nets will further push the more vulnerable groups into poverty and increase the financial barriers.

With the production level gone down, the economy of many so-called powerful countries is facing the threat of high inflation. Especially, the gross domestic product (GDP) projections have already been revised downwards in most of the developed countries amid the disruption in production. Most business sectors especially those in tourism, aviation, and hospitality industries are facing serious challenges with a real threat of significant declines in insolvencies, revenue and job losses.

B. Effect of Covid-19 on Energy Resources:

In the global energy systems, coal stands one of the major fuels accounting for up to 40% of the electricity generation. The global coal production was estimated to have increased by 2.7% in 2018 with the annual production of 8.1 billion tons in 2019. The increase was mainly driven by three major coal-producing countries such as China, India, and Australia, which together accounts for 70% of global production. Owing to the corona virus lockdown and other government policies during the on-going Covid-19 pandemic, the global coal market is likely to fall from $816.5 billion in 2019 to $722.8 billion in 2020. This significant decline in the global output is mainly because of the economic slowdown across the countries caused by the global lockdown to stem the spreading of the Covid-19 pandemic. Similarly, the global oil demand was strongly hit, showing a decline of 5% in the first quarter of 2020. This drastic reduction was mainly because of the curtailments in mobility and aviation which alone accounts for more than 60% of the global oil demand. Likewise, the electricity demand has also shown a significant reduction (>20%) due to lockdown measures, with knock-on effects on the power mix.

C. Impacts on Biodiversity:

Although affecting all the sectors of human life, the Covid-19 pandemic propagates exponentially and impacts other global resources at an accelerating pace. Reports suggest that there is reduced human pressure on natural ecosystems and wildlife. The protected areas have witnessed a significant decline in the number of visitors, caused mainly by the travel ban and park closure, reducing the stress on the wildlife. Besides some of the positive effects (all though temporary), it is quite unclear how the conservation biology will fare in the pandemic aftermath. At present, most of the protected areas appear to be safe and biodiversity seems to be benefitting from the reduced human activities. However, threats persist especially in the areas where the enforcement has weakened. Although greenhouse gas emissions, environmental pollution and many other anthropogenic impacts on the wild nature will ricochet, the support and funding for conservation purposes have to compete with a wide range of priorities for financial resources. The forest sector is the main contributor to the development of society and for social and economic recovery in the aftermath of any crisis. Forests by-products function as essential sources and support the livelihood during the crisis, by delivering necessary products, such as hygiene and sanitary items, respirator papers, ethanol for sanitizer, biomass for heating and papers for parcel packaging. The negative effects of the Covid-19 pandemic on production and trade of forest and forest by-products will put many of the key livelihoods and industrial sectors at risk. Moreover, the forest sector has high rural to urban migration; however, the Covid-19 pandemic is leading to reverse migration, which has the potential to spread the disease to the remote, distant and unprepared areas.

Furthermore, the effect of this global pandemic on forest-based industries will have instant consequences for forest owners and traders arising primarily from the persistent decline in product runoff and sales.

D. Increase of Biomedical Waste Generation:

The biomedical waste (BMW) generation from COVID-19 patients is increasing throughout the world since the outbreak of COVID-19 which is a major threat to public health and environment. For sample collection of the suspected COVID-19 patients, diagnosis, treatment of huge number of patients and disinfection purpose lots of infectious and biomedical wastes are generated from hospitals. India is producing approximately 550 tons of biomedical waste per annum.

During epidemic in Wuhan, China, the city produced 240 tons of medical waste per day. Such a sudden rise of hazardous waste and their proper management has become a significant challenge to the local waste management authorities.

According to the recent report, the SARS-CoV-2 virus can exist a day on cardboard and up to 3 days on plastics and stainless steel. So, waste generated from the hospitals should be managed properly to reduce further infection and environmental pollution, which is now a matter of concern globally.

Dedicated vehicles must be employed to collect COVID-19 ward waste and its sanitization. The proper monitoring is quite essential while disposing of COVID-19 waste so the workers should not get infected by it. For discarding the BMW properly, it is important to know the composition so that its proper disposal can be ensured.

Some of the promising ways to get rid of BMW is incineration at high temperatures between 800°C and 1200 °C, which kills the pathogens and also reduces organic matter up to 90%. High temperature pyrolysis and medium temperature microwave technique are two primary alternative thermal technologies that are available to deal with biomedical waste. Chemical disinfection may also be used to pre-treat COVID-19 waste before mechanical shredding.

E. Municipal Solid Waste Generation and Reduction of Recycling:

Increase of municipal organic and inorganic waste generation has direct and indirect effects on environment. Due to the pandemic, quarantine policies established in many countries have led to an increase in the demand of online shopping for home delivery, which ultimately increase the amount of household wastes from shipped package materials.

However, waste recycling is an effective way to prevent pollution, save energy and conserve natural resources. But many countries postponed the waste recycling activities to reduce the transmission of viral infection. For instance, USA, UK, Italy and other European countries restricted recycling programs in many cities.

As a result of disruption of routine municipal waste management, waste recovery and recycling activities increases the land filling and environmental pollutants worldwide.

F. Impact on Soil and Water Ecosystems:

The components of the ecosystem are intertwined with each other. With every person washing hands more regularly with soap, mass disinfection by government and local bodies and production of single-use plastics containing bisphenol A (BPA) are destined to have negative impacts on soil and water quality. Alcohol containing products spilled in the water are toxic to aquatic fauna and spill in soil may also pollute the groundwater. Discharged detergents cause foam in water bodies. Soaps can reduce re-aeration by 40%. These substances form a protective surface film which acts as an obstacle at the air-water interface. Soap can prevent the growth and development of algae and aquatic plants. Accumulation of harmful pollutants in soil as a result of extensive use of soaps may deteriorate the quality of the soil.

The increase in soapy discharge over a short period of time, increase the amount of pollutants and alter the chemistry of grey-water. Such domestic effluent will pollute the river, lakes and oceans. This unwelcoming chain of events is going to be a serious issue in the near future.

G. Ecological Perspectives of Covid 19:

Amidst corona pandemic, particularly during the lockdown phase, some positive effects were observed in the wildlife. The wildlife was at peace with less flow of humans and tourists. However, a significant increase in poaching of wild animals in some areas was observed during the lockdown period, especially in the areas which were not protected or not marked to any specific wildlife area. If left unregulated, the poaching of ungulates and small animals may lead to a depletion of the prey base for predators. This might in turn, result in increase in human-animal conflicts.

Along with humans, animals such as dogs, cats, rabbits, mink and even tigers and lions are getting infected with corona virus which is an indicative of the fact that corona virus can transfer from human to animals. Further, stray animals like dogs and cats are amongst the sufferers owing to the absence of waste food due to restaurants and shops being closed. Also, they are being abandoned by their owners due to unfounded fears that they may spread COVID-19. The worst possibility is that the stray animals might eat disposed masks and gloves, which can become lethal.

H. Safety Equipment Use and Haphazard Disposal:

To protect from the viral infection, presently peoples are using face mask, hand gloves and other safety equipment, which increase the amount of healthcare waste. Since the outbreak of COVID-19, the production and use of plastic based PPE is increased worldwide. However, due to lack of knowledge about infectious waste management, most people dump these in open places and in some cases with household wastes. Such haphazard dumping of these trashes creates clogging in water ways and worsens environmental pollution. Though, experts and responsible authorities suggest for the proper disposal and segregation of household organic waste and plastic based protective equipment, but mixing up these wastes increases the risk of disease transmission and exposure to the virus of waste workers.

I. Other Effects on the Environment:

Recently, huge amount of disinfectants is applied into roads, commercial and residential areas to exterminate SARS-CoV-2 virus. Such extensive use of disinfectants may kill non-targeted beneficial species which may create ecological imbalance. Moreover, the virus was detected in the COVID-19 patient's faces and also from municipal wastewater in many countries including Australia, India, Sweden, Netherlands and USA. So, additional measures in wastewater treatment are essential, which is challenging for developing countries. China has already strengthened the disinfection process by increasing use of chlorine to prevent SARS-CoV-2 virus spreading through the wastewater. But, the excessive use of chlorine in water could generate harmful by-product.

9.3 Conclusion:

COVID-19 pandemic is a global health emergency with severe consequences on health and economy, but it has also brought some positive environmental effects that may serve as an example and inspiration for future behavioral changes that would help to bring positive changes in environment. Environmental changes are arguably the most vital and severe challenge of the twenty-first century. The current global pandemic has forced people to introspect and imagine a different world. The lockdowns show that a world with cleaner air is possible. The ongoing pandemic across the world is showing a direct relation between pollution levels and bigger economic activities such as industrial activities, transportation and energy production along with the small-scale interferences at city levels. This indicates that clean energy-based system has to be adopted as the corona outbreak ends. Without pollution control, the waste products from consumption, heating, agriculture, mining, manufacturing, transportation and other human activities will degrade the environment. Therefore, proper strategies should be adopted to control environmental degradation.

The lockdown gives us hope that there is a possibility of minimizing the unnecessary human interferences in environment. To bring positive changes in the environment, governments and individuals should adopt the strategies like inspection and maintenance of vehicles, efficient public transport system, improving traffic managements, using eco-friendly products, minimizing the use of Chlorofluorocarbons (CFCs), adopting renewable energy sources, promoting reusing and recycling of wastes, decreasing the use of pesticides, using minimum required amount of water, plantation of trees, avoiding deforestation, treatment of sewage and removing solid, suspended and inorganic materials from it, before it enters the environment and use of Ecosan toilets where no water is required and human excreta is converted into natural fertilizers. Like the previous catastrophes on the planet Earth, the humans will win over this pandemic in due course of time. However, people should know the limits to which they can thrust nature before it is too late. Despite the continuous efforts by governmental and non-governmental organizations to restore and repair nature, humans can only move a few steps forward and yet there are enormous challenges. However, being a blessing in disguise, the Covid-19 pandemic has successfully recovered the environment to a much larger extent and has improved the mutually effective link between nature and humans. While at the same time the lockdown and social distancing have contributed positively toward the environment, though, it is essential to take into account the negative effects such as mortality, impacts on social aspects and the dramatic economic effects as well.

At present, it is important to control the disease, reduce the transmission, and proactively save lives. Although the positive impacts on the environment may be temporary, the governmental, non-governmental organizations and the individuals should be united and propose time-oriented effort that can strengthen environmental sustainability and save the earth from the effects of global climate change.

To tackle the ongoing and future impacts of COVID-19, there is need to frame policy guidelines and implement them at International and National levels for proper management of waste and waste water treatment, to develop safety guidelines and ensure their implementation for doctors, sanitary workers and hospital staff to keep them healthy and to avoid any viral spread; to drive awareness programs and campaigns at various levels including schools, colleges, villages etc. to avoid spread of wrong information and misconceptions and to guarantee proper implementation of various guidelines; to understand environmental and ecological impacts of COVID-19 with intensive research efforts so that in future such adversities may be tackled in a more effective way; to develop database of elderly people who might require more care, proper and timely treatment due to COVID-19 and to ensure their health and care in future; to understand the mental stress and psychology of children who had been forced to live in locked conditions in home and to develop environment and safe conditions for their outing, games and sports activities.

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10. Environment and Human Population

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Abstract:

One of the key issues of the twenty-first century is environmental change. Despite all of their efforts over the previous few decades to repair the ecosystem, humans may only budge a few steps ahead, not up to an admirable extent. The COVID-19 plague is measured as the mortal disease of the century and the utmost dispute that mankind faced ever.

The spread of COVID-19 has enforced the world to stop the progress of all outdoor human actions on the peak phase in the reminiscences of the current population of this globe. This lockdown will perhaps be distinct in history eternally.

Nonetheless, this shutdown is a renewal of the Earth, atmosphere, and human health systems. But throughout the last few months, consequences of the COVID-19 plague have effectively improved the surroundings to a great coverage that ought to undeniably set an optimistic impact on universal atmosphere evolution. It will definitely change the actions of humans and the contiguous environmental system daily.

Keywords: Environment, Pandemic, Greenhouse gas, Economy, Water based epidemiology.

10.1 Introduction:

As the COVID-19 pandemic augmented exponentially across the globe threatening lives and uprooting the economy of cities and nations, it also had a major impact on the environment.

Here this chapter gives you a broad spectrum of views over the indirect effect impacts the COVID-19 pandemic has brought to the ecology system.

The unbidden new coronavirus (SARS-CoV2) has generated an unprecedented impact all over the world. COVID-19 is being viewed as a symptom of bias and a lack of social advancement, in addition to flattering the largest threat to inclusive community health of the century.

The ‘CO' in COVID-19 refers for ‘corona,' as the name implies. 'VI' stands for 'virus,' 'D' stands for 'disease,' and '19' stands for the year of its occurrence.

The World Health Organization called COVID-19, a new infectious respiratory disease that arose in Wuhan, Hubei zone, China, in December 2019. (Coronavirus disease 2019).

COVID-19 is a single-stranded RNA virus that measures 80 to 120 nanometers in diameter. COVID-19 belongs to a large diverse family of viruses.

They are lined up into four genera namely, α-, β-, γ-, and δ. All the coronaviruses responsible for the worldwide spread of the pandemic, namely SARS, MERS-CoV, and SARS-CoV-2 are β- coronaviruses.

The spike protein of the novel coronavirus shares 98% sequence identity with the spike protein of bat coronavirus.

The novel coronavirus has four stages of transmission namely stage-1 (imported cases), stage-2 (local transmission), stage-3 (community transmission), and stage-4 (transmission out of control).

The spread of disease between humans, from one infected person to another uninfected person, both through direct contact and indirect contact such as surface contamination.

The COVID-19 pandemic has had an impact on many aspects of human existence as well as the global economy.

The global response to the COVID-19 pandemic has resulted in erratic drops in economic activity and financial prices.

According to a statement released by the World Health Organization (WHO) on June 24, 2021, there have been 179,686,071 confirmed cases of COVID-19 worldwide, with 3,899,172 deaths.

It has hurriedly multiply around the globe, causing huge health, monetary, ecological, and community challenges to the complete human inhabitants.

Clinically approved antiviral drugs or vaccines that are helpful against COVID-19 are being continuously produced across the countries.

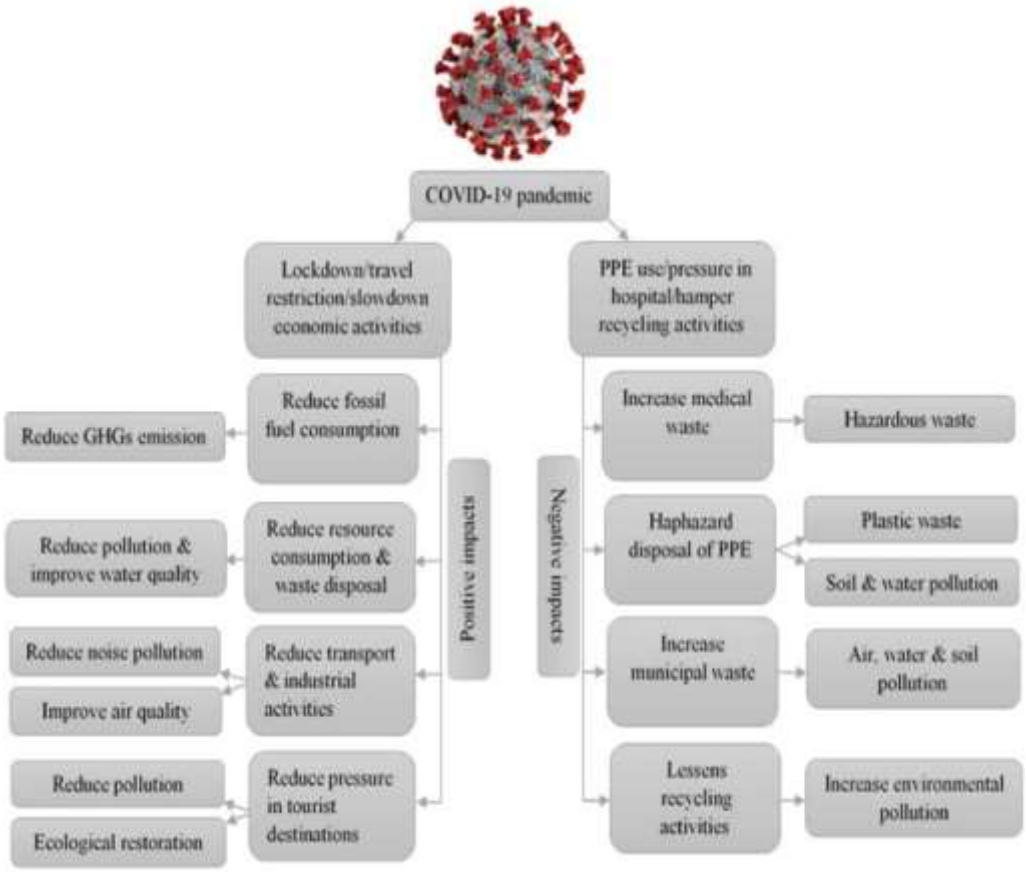

Figure 1.1: The Positive and Negative Indirect Effects on COVID-19 Pandemic

10.2 COVID-1 Impact on Air Quality:

In the case of air quality improvement COVID-19 is a stock of luck for this entire world. Global temperatures have risen considerably above ground level, making it harder to ignore. Temperatures have risen as a result of increased greenhouse gas emissions, indicating global warming (GHGs). GHGs and air pollution are inextricably linked, with severe repercussions for human welfare.

According to the report, air travel fallen by 96% due to COVID-19, truncated in 75 years. Recent coronavirus prevention measures have resulted in a 40% reduction in typical levels of nitric dioxide pollution (NO2), and a 10% reduction in particulate matter pollution has resulted in a reduction of 11.000 deaths due to air pollution. Moreover, not only the transport sector but also the industrial and manufacturing sector is greatly affected by a deadly disease. This boom is the result of a 37% decline in coal production and a 1/3 drop in oil use.

NASA satellites and of the Copernicus Atmosphere Monitoring Service of the European Space Agency (ESA) have predicated considerable fall in air pollution in major cities across the world.

Particulate matter (PM2.5 and PM10) is an additional pointer of air quality and it originates from different emission sources like industries, power plants, refuses burning and road dust re-suspension, etc. As lockdown limited all these activities in the whole country, its direct impact on PM concentration is inexorable.

When people are exposed to PM on a regular basis (especially the elderly), their respiratory systems are more likely to be damaged by the virus. The satellite views evidently show how the concentration of PM2.5 and PM10 has condensed in the span of one month particularly in the Northern and eastern states including the capital New Delhi.

The COVID-19 emergency has resulted in a large reduction in motor vehicle traffic, resulting in lower greenhouse gas emissions and particle pollutants, as well as a significant reduction in traffic clatter and road surface tire wear.

Short- and mid-term airline travels are both on the decline, resulting in lower greenhouse gas emissions, particularly CO2.

Furthermore, the reduction of contrails may result in a wider temperature range on a regular basis. Due to the reduced greenhouse effect, the reduction of contrails will almost certainly result in a drop in air temperature.

Despite the fact that the COVID-19 disaster has caused widespread human suffering around the world, air pollution is decreasing as a result of ongoing virus-fighting efforts, demonstrating what is achievable if we shift to clean energy.

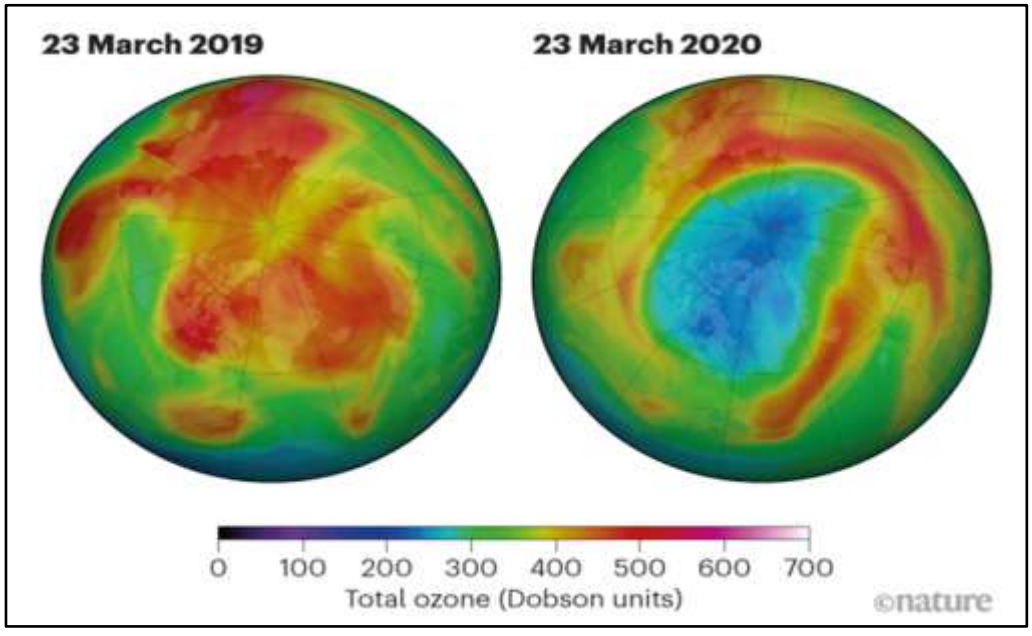

Figure 1.2: ARCTIC OPENING: A rare and record ozone hole has formed over the Arctic. An opening in the ozone layer appears each spring over the Antarctic, but the last time this phenomenon was seen in the north was in 2011

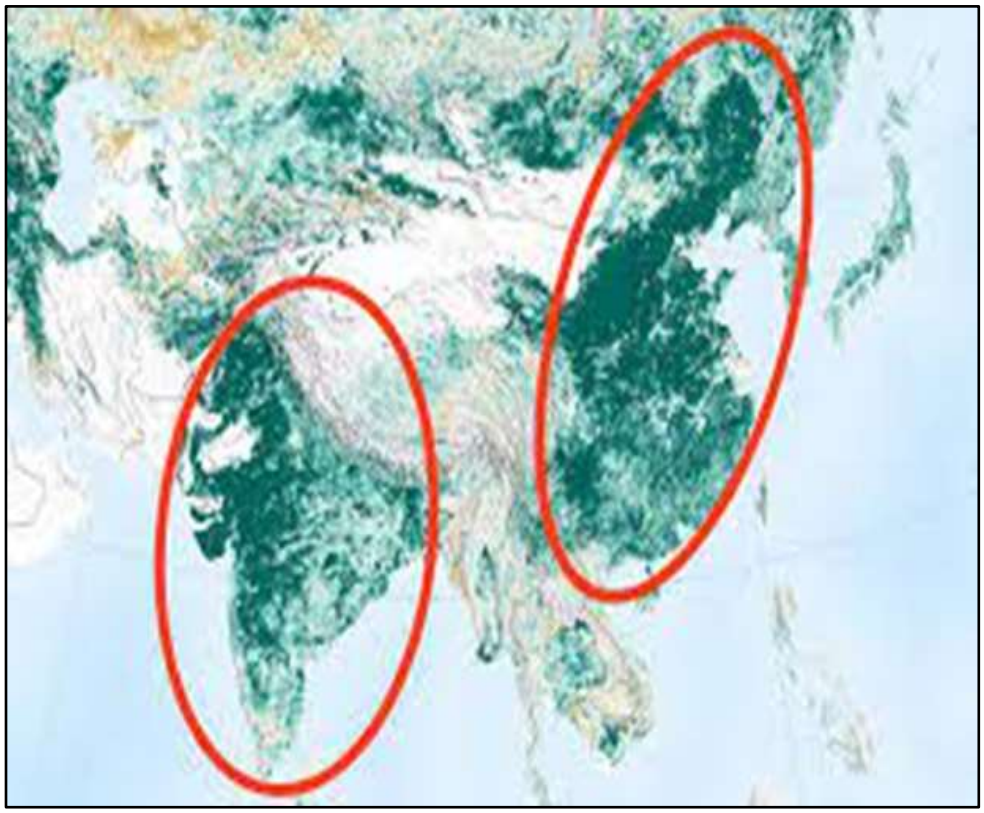

Figure 1.3: NASA Says Earth is Greener Today than 20 Years Ago Thanks to China, India

10.2.1 COVID 19 - Water:

The immediate impact of the COVID-19 pandemic on water resources is minimal, but monthly and annual perspectives may exaggerate water quality and resources. The presence of SARS-CoV-2 in sewage was first discovered, and it was suggested as a sensitive way to track the virus's spread. While viral RNA has been found in wastewater, this does not necessarily mean that the public or the environment is at risk. Corona viruses die swiftly in wastewater and inactivate faster in warm water (i.e., 10 days in 23°C water and >100 days in warm water at 4°C). Until now, sewage or drinking water has not been claimed as a means of infection for this virus. But recently it has been proposed that this virus can live on surfaces for hours or days suggests that it is a potential pathogen competent of being infectious through untreated wastewater, untreated waste, and soil, or its access into other forms of life allowing its circulation into the environment and under its control to change its characteristics.

Wastewater-based epidemiology (WBE) is a well-organized approach with enormous potential for early caution of infectious disease transmission and outbreaks, which aim to draw the source of the virus, recognize the locations of possible carriers, and offer early cautions effectively. Also, if associated to an effective response system, WBE can be helpful for pandemic surveillance.

The WBE trial biochemical signatures in wastewater, such as fragment biomarkers for Corona virus Severe Acute Respiratory Syndrome 2 (SARS-CoV-2), just by applying the type of medical diagnostic test (designed for individuals) to the signature joint of complete communities.

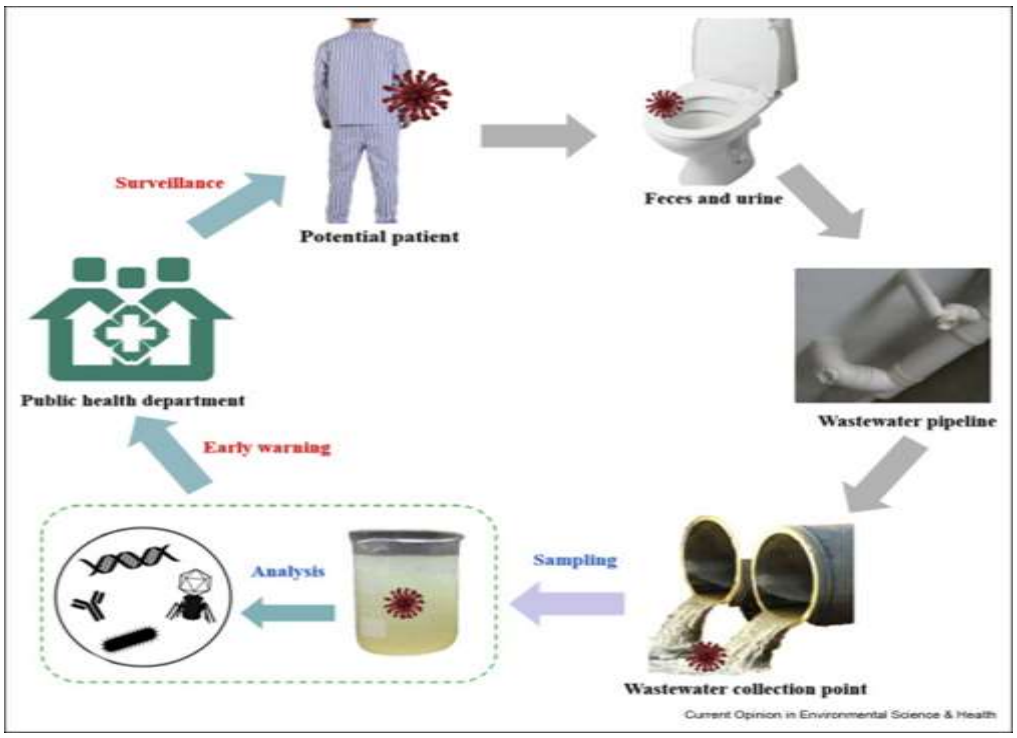

Figure 1.4: The Potential of Waste Water-Based Epidemiology as Surveillance and an Early Warning of Infectious Disease Outbreak

10.2.2 COVID 19 - Aquatic Resources:

Among the changes in the atmosphere due to the occurrence of the SARS-CoV-2 virus in the world, it is experiential that the water of rivers, coasts, and seas are clearer and clean given the fall in the number of tourists, of the use of motorboats and decreased sediment agitation, while the company of water pollutants has also been reduced accordingly.

Many fishing fleets have suspended or decreased activities as a result of the drop in demand, which has resulted in lower prices for fish and fish products in some situations. Due to insufficient demand and a lack of storage for a perishable product, quotas have not been filled in some circumstances.

Export-oriented fleets are more likely to be affected than fleets serving domestic markets. Sanitary measures (physical distance between crew members at sea, faces, masks, etc.) and a lack of appropriate equipment (e.g. masks and gloves) make fishing difficult (and in some circumstances deadly) and may result in the cessation of operations. Input supply constraints (e.g. ice, gear, bait).

The effects on catches have varied around the world, with many nations experiencing dramatic declines in productivity in the early weeks of the crisis, followed by improvements as the sector reacted. Due to the risk of the virus spreading, governments have abandoned their recycling and waste management programmers, potentially causing negative health and environmental consequences.

The quality of a number of Indian rivers, including the Ganga, Cauvery, Sutlej, and Yamuna, has improved, according to articles and reports published in newspapers and on social media. The lack of industrial effluents inflowing into rivers as a result of the epidemic's lockdown is the primary cause. A decline in irrigation water demand, above-average rainfall, and human-made factors such as reduced religious activities such as puja and cremations on the river's banks have all helped to improving the river's quality.

Excess water extraction can be reduced by reusing treated sewage water in non-production operations such as toilet flushing and road cleaning. Both industrial and municipal trash should be recycled and utilized to alleviate the burden of wastes and ecological affluence.

As a result, globular economy or circularity systems should be implemented in the manufacturing process to reduce raw material consumption.

Furthermore, WHO guidelines for the management of hazardous and infectious restorative waste should be followed. It is now clear that the vast majority of people (particularly in poor nations) are unaware of waste segregation and disposal difficulties. As a result, the government should launch a social media campaign to raise awareness about proper waste segregation, recycling, and disposal. Former to COVID-19, the worldwide water sector was impacted by five main trends:

a. Global warming, which has led to an augment in extreme floods and droughts, challenging the resilience of water and sanitation systems.
b. Increasing population facing water stress (currently 2 billion), which increases supply vulnerabilities.
c. Hurried urbanization, which strains existing water resources and ecosystems
d. The emergence of metro cities, which adds the challenge of extending water and sanitation services to about 1 billion people living in casual settlements not served by water grids.
e. Growing infrastructure, which has amplified the pressure to accelerate investments in more highly developed markets. The aquaculture production sector is tremendously diverse, both freshwater and marine, but it however, relies greatly on labor, inputs, financing, and markets, which have been and will continue to be impacted during and after the COVID-19 epidemic.

10.2.3 COVID19 - Education:

The COVID-19 outbreak has wreaked havoc on educational systems around the world, causing schools, colleges, universities, and other educational institutions to close. School closures in reaction to the pandemic have overstated the number of students by nearly 1.268 billion.

According to UNICEF monitoring, 177 nations have implemented nationwide shutdowns and 13 have implemented local halts, affecting roughly 73.5 percent of the world's student population.

Several universities offered online classes and reading material through emails and other media.

In a nutshell, for high school students, the usual classroom education is turned into an e-class room education system.

This is an international turning point for adopting this new 'e-education system and `Work from Home' tradition which is being approved by institutions and individuals.

The e-education will have a bang on research and its procedures one cannot gather practical experience of real laboratory work like handling of instruments etc.

COVID-19 is the greatest challenge that the national education systems have ever faced. Almost every government has ordered institutions to instruct, teach and guide students virtually.

The COVID-19 plague has disrupted the lives of students in unusual ways, depending on their level and course of study. In different ways, the main concern is to reassure students and parents-with embattled communication.

The most significant modification, for those used to teach in real-time, is to take benefit of asynchronous culture. For most, there is no need for simultaneous communication for the learners.

One of the major advantages of Asynchronous learning is teachers' flexibility in preparing materials and enables students to fit in the demands of home and study. Asynchronous education works best in digital formats.

Teachers do not need to distribute the material at a fixed time. Students can access those notes using various e-platform according to their schedules.

One of the opportunities in the crisis is the virtual internships, which are allowing the students to go beyond their prospectus and gain knowledge about the realism of their professions.

A further value-added advantage is that the way universities are approaching students to examine the present situation and value the need to mechanize.

This will upgrade them in their fields shortly and also preparing them to face any kind of situation. This follow will encourage more self-confidence than disarray or dread.

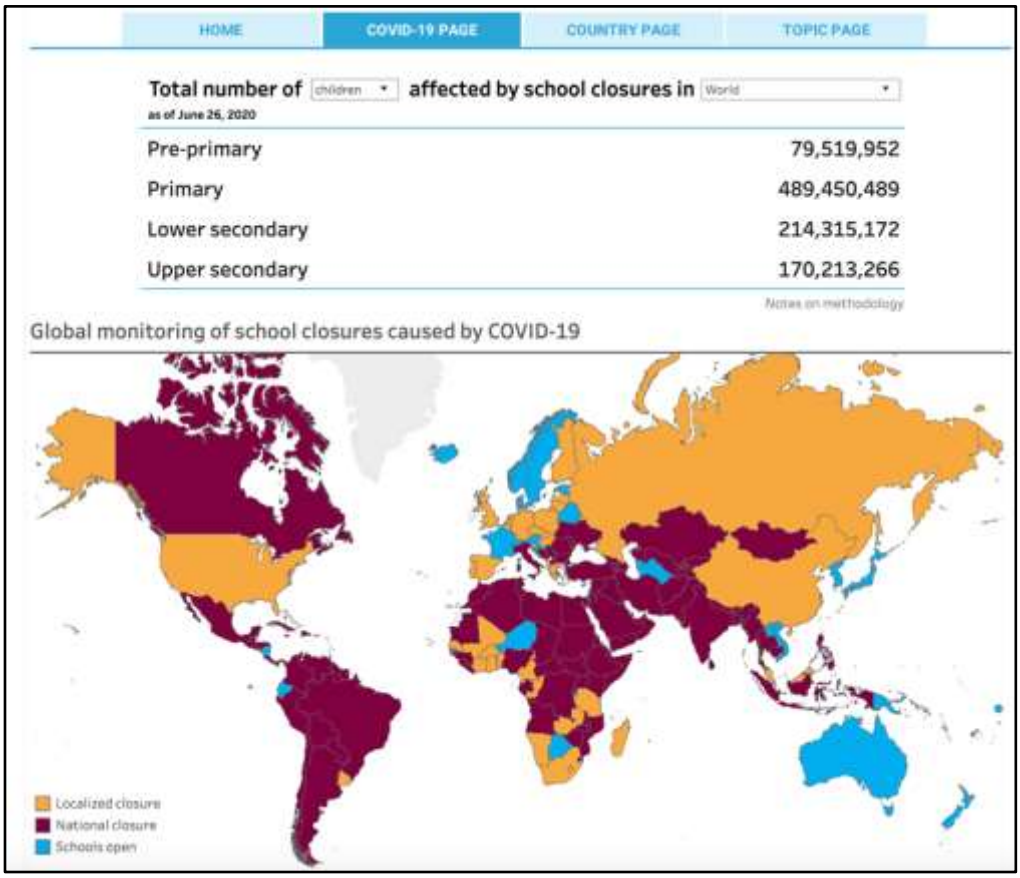

Figure 1.5: UNICEF: Global Monitoring of School Closures Caused by COVID-19

10.2.4 COVID 19 - Employment:

The COVID-19 endemic is having a tragic effect on employment and earnings globally. The International Labor Organization (ILO) the report shows that the COVID-19 catastrophe is probably to wipe out 6.7% of working hours globally comparable to 195 million full-time workers in the 2nd Quarter of 2020.

ILO claimed that about 40 lakh students post-graduated in India every year, but in the current situation, it's not that easy to get a job for each passed out student. Almost 3.3 billion are presently exaggerated by full or partial workplace closures.

Due to the COVID-19 shutdown, there was an of temporary factory closures which has shown its impact on the manufacturing sector. Because they specialized in areas that are more likely to be forcedly closed, the countries that are hardest struck by the epidemic are more likely to face the harshest employment implications of the confinement.

The COVID situation is so severe that it will not only have a significant impact on labor markets in the near and medium term, but it will also have a significant impact on how the government operates.

10.2.5 COVID19 - Global Health:

At the beginning stage of civilization, the human beings started to influence the natural resources for their own benefit. The increasing population needs to satisfy their demand of urbanization and industrialization it become necessary and the axiomatic significance to prove the detrimental on global climatic changes. The humans desire to drive the nature as per their tendency, without the affectionate for sustainable development they started to destroy the nature in many ways by anthropogenic activities.

After the COVID-19 issue it affected a major public health issue and it bring large global outbreak in all over the countries. The scientist report that virus is extremely infectious it transmitted through close contact and droplets. Being a respiratory disease, it damage the lung tissues rather than it affect the other organs of tissue.

Beyond viral shedding in plasma/serum is demotic in respiratory tract infections, through the insertion of labile blood products, there is a possibility of transmission of corona virus .In the world's population, COVID-19 become major public health concern, particularly for old and middle age people leading to cause of hospitalization and death, in the affected countries.

Climate specialists, on the other hand, believe that greenhouse gas (GHG) emissions might be decreased to levels not seen since World War II. The environment become a zero emission of GHG and without the suspended of tiny particles because of vehicles are rarely found on the road sides. Due to closing and minimal activities of factories, industrial sites and construction sectors the waste produced from these sectors had reduced large extent and improving the air quality.

Due to COVID-19 lockdown, in many cities inhabitants are experiencing a clear river water and clear sky for their first time in their lives. Variety of birds are seen in their localities. Ecosystem are being greatly recovered. The main sources of discomfort for the population is due to the environmental noise because of unwanted sound created by industrial or commercial activities, the transit of engine vehicles etc., it cause health problems and the natural condition of ecosystem. Environmental noise had been reduced in this pandemic situation. Protection against health emergencies necessitates urgent modification as well. Despite a greater emphasis on global health security, COVID-19 has revealed a crucial need for multi-sect oral health emergency surge capacity and well-coordinated preparedness at all levels and across all countries. It was necessary to maintain and develop early warning systems in order to move and control public health over the world.

10.2.6 COVID 19 - Social Changes:

According to the reports specify that Covid-19 is not affecting every person the same way in terms of Social and demographic factors. To fully figure out that why contagious pandemics influence different socioeconomic groups differently is pretty difficult. Irrespective of some socioeconomic indicators like education, rural or urban area, population, etc., regrettably, Covid-19 has a significant impact on the impoverished community.

Work from home can bind social relationships with new individuals, but it is more advantageous for better socio-economic jobs, with only a portion of a group benefiting from this circumstance. WHO has published health advisories that people smokers are in danger to a great extent since and Covid-19 both aim at lungs. Inhabitant areas with fewer socioeconomic provision, such as India, Pakistan, and Bangladesh, are at greater danger due to a lack of healthcare services. Patients with COVID-19 (or, for that matter, anyone suffering from a contagious condition that necessitates protective isolation in a healthcare setting) frequently experience feelings of isolation and depression.

Although various patients perceive and cope with physical, social, and psychological confinement in different ways, the isolation is genuine. Modern electronic communication methods have provided much-needed mental respite and may help with physical and social recovery sooner rather than later. COVID-19 sufferers are also subjected to the disease's social stigma, which presents in many ways depending on the patient's or caregiver's position. During the infected stage, this makes the patient hesitant to return to the community. This could be due to genuine anxiety about infecting other family members, or it could be owing to society's indifference to people who have been afflicted.

10.2.7 COVID 19 - Economy:

A supply chain suggests is a system of organizations that work mutually to design, produce, and deliver a product to a market, extending from the extraction of raw materials to the division of finished products or services. It plays an essential role in the automobile, IT sectors but due to the Covid-19 pandemic, all the automobile, manufacturing, and IT sectors had to be shut down which exaggerated the supply chain worldwide.

The negative and large effects of COVID-19 will drag the economy several years back and government needs to take measures for this in a hostile way. The government will have to consider current as well as future policies for handling this situation. It is going to slow down both, business and economy. On the set of a viral outbreak already dampening the oil demand, this oil-price war is predicted to have grave implications for the global economy. In more usual times, low-priced oil may have functioned as an advantage for economies.

Countries around the world have forced several defending actions to hold the exponentially escalating spread. Which includes social distancing, avoiding needless travel, and a ban on congregations. Shutdown limitations drastically condensed the manufacture of goods from factories, while quarantine policies decreased utilization, demand and utilization of products and services. Due to the outbreak of COVID-19, the tourism sector is hardly affected, with great impacts on both travel and supply. The world of travel and tourism has announced that 50 million occupations in the global tourism and travel sector at a risky stage. COVID-19 has created a lot of uncertainty in the real estate business. Individually, social distancing caution lowered house views; it's a big part of the selling process, and it's forcing both buyers and sellers to rethink their plans. Sellers are gradually waiting for assurances about the health of potential purchasers who come to inspect properties. Recently evidence reports that both low-income and high-income countries, economically reduced to proportion, with a limited capacity of the health system, are liable to suffer contagion mortality rates. The evidence that exists reveals majorly on macroeconomic data and the disease spread based on the assumption of forecast potential modeling of future scenarios.

The socioeconomic treaty of this outbreak and the policies implemented by the government slow the spread of the virus at household, adult, and child levels.

The global pandemic situation brings a penetrating challenge to individuals and strikes a balance between the economically to manage the spread of the virus and health benefits.

This situation brings that politically difficult in high-income countries. To summaries, socioeconomic demographics are at the heart of the Covid-19 epidemic, which is why densely populated places have greater infection and mortality rates. Economists are nonetheless worried about a potential economic loss.

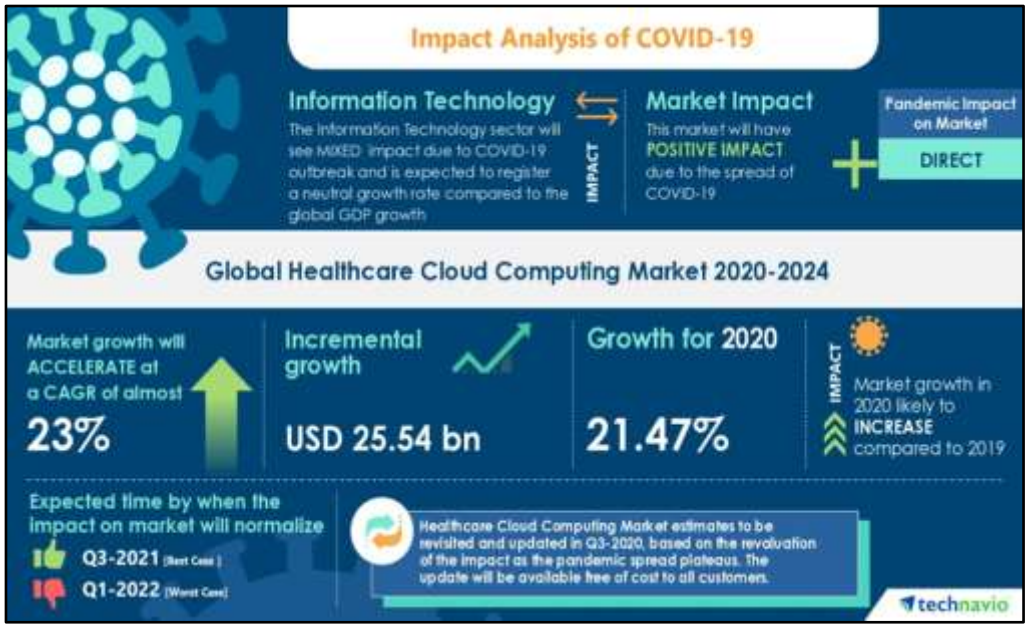

Figure 1.6: COVID-19 Impact and Recovery Analysis- Global Healthcare Cloud Computing Market 2020-2024

10.3 Conclusion:

Finally, COVID-19 will have both positive and negative indirect effects on the environment, but the overall result will be better. Short-term reductions in GHG concentrations are not a long-term solution for environmental sanitation.

Furthermore, if countries ignore the viral threat, it will result in other environmental issues that will continue longer and be more difficult to control. Some countries' reductions in GHG emissions are just temporary. When the pandemic is over, countries' economy will most likely recover, and GHG emissions will resume their upward trajectory.

This positive influence on the environment may be temporary, but governments and individuals should be taught how to reduce pollution on a long-term basis as a result of this lockout.

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11. Air-Pollution: Indian and Assam Scenario, Impact on Human Health and its Control-A Brief Account

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Abstract:

Air pollution is one of the most important threats to the health and wellbeing of mankind. Human beings need clean air in order to sustain healthy lives. Due to industrialization, there has been increase in the release of gaseous emissions and particulate matter (PM). Air pollution is found to be one of the top ten killers in the world. Globally, around 3% of cardiopulmonary and 5% of lung cancer deaths has been attributed to particulate matter. According to 'India State-Level Disease Burden Initiative Air Pollution Collaborators' India has been estimated to have some of the worst levels of pollutions globally. Thirteen cities of India including Delhi, Patna, Gwalior, Raipur as the top four, have been listed among the top twenty most polluted cities in the world. Various initiatives have been taken by the government of India in order to control air pollution in the country. The improvement in the air quality has been found to have an immediate impact. Thus improving the quality of air can go a long way in improving the health of the general population.

11.1 Introduction:

Air pollution is considered to be one of the largest environmental threat to human health throughout the world (Pandey, A., Brauer, M., Cropper, M. L., et al. 2021). One of the main users of the various resources of the Earth is mankind; thus human beings are either knowingly or unknowingly responsible for environmental pollution (Sarma 2013). Various kinds of anthropogenic emissions are being released into the atmosphere. Such emissions are termed as primary pollutants. The primary pollutants undergo chemical reactions in the atmosphere and lead to the formation of new pollutants. These new pollutants are termed as secondary pollutants. The Air (Prevention and Control of Pollution) Act, 1981 states that 'air pollutant means any solid, liquid or gaseous substance, including noise, present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment' (The Air- Prevention and Control of Pollution Act, 1981).

According to this statement noise pollution is also an important part of air pollution. The World Health Organization estimated that throughout the world around seven million people have died due to the exposure to air pollution. Such deaths were due to exposure to toxic pollutants both indoors as well as outdoors (Ghosh & Parida 2015). Major air pollutants have been categorized into two groups: Outdoor pollutants and Indoor pollutants. Outdoor air pollution refers to the exposure that takes place outside of the built environment.

These include the remains of fossil fuel, carbon particles and metallic particles in the atmosphere from industrial and automobile emissions, toxic gases like nitrogen dioxide, carbon monoxide, sulfur dioxide etc. and ozone, tobacco smoke etc. Indoor air pollution refers to exposures to particulates, carbon oxides, and other pollutants carried by indoor air or dust. Such pollutants include toxic gases produced from kitchen fuels, building materials that is asbestos, lead etc and tobacco smoke etc. (Anon. 2019).

11.2 Indian Scenario:

According to 'India State-Level Disease Burden Initiative Air Pollution Collaborators' India has been estimated to have some of the worst levels of pollutions globally (Balakrishnan K et al. 2018). It has been estimated that thirteen cities of India have been listed among the top twenty most polluted cities in the world; these include Delhi, Patna, Gwalior, Raipur as the top four (Chainey 2015). The population-weighted mean PM2.5 exposure to particulate matter in India was found to be one of the highest in the world (89.9 µg/m3 per annum) in the year 2017. It was also found that within India in 2017 Delhi (209.0 µg/m3 per annum) was leading with the highest population-weighted mean PM2.5 followed by Uttar Pradesh, Bihar and Haryana in North India (range 125.7-174.7 µg/m3 per annum) and then Rajasthan, Jharkhand and West Bengal with a range of 81.4-93.4 µg/m3 per annum (Balakrishnan K et al. 2018). In May 2014 World Health Organization (WHO) found New Delhi to be the most polluted city in the world for PM2.5 particles (Sedghi 2015).This is due to increase in automobile exhaust as well as coal fueled factories in the cities(Ghosh & Parida 2015).

Assam is one of the eight states of North-Eastern India. The North-Eastern part of India is generally considered to be an environmental friendly state with plentiful greenery. But at present with the increase in the population, increase in number of automobiles as well as industries the air quality of the region has degraded with increase in the amount of toxic pollutants in the atmosphere.

In a study done in five different places of Assam viz. Guwahati, Dibrugarh, Golaghat, Tezpur and Bongaigaon it was found that the concentration of NO2 andSO2 was below the prescribed maximum level by the National Ambient Air Quality Standard (NAAQS) of Central Pollution Control Board (CPCB 2011); however the annual average values of respirable particulate matter (RSPM) and suspended particulate matter (SPM) was found to be either high or in critical condition (Barman 2013). This could be due to dryness during the winters, increase in the number of vehicles as well as industries and various other human activities. The three wheeled tempos which run in the roads of the state have been found to release huge amount of toxic air pollutants (Barman 2013).

In the Noonmati area of Guwahati one of the important health hazards is the emissions from the Guwahati Refinery. Even though measures have been taken by the industries under the direction of Guwahati Municipal Corporation, however the general public still continues to suffer from the effects of the pollution (Sarma 2013). Another contributor to the burden of pollution in the city of Guwahati is the Barchala bil which is situated in the heart of the city. The bil has now become the reservoir of sulphurited hydrogen gas due to which the atmosphere of the nearby area gets polluted (Sarma 2013).

11.3 Impact of Air Pollution on Health:

Air pollution is found to be one of the top ten killers in the world (Chandola 2013). Globally, around 3% of cardiopulmonary and 5% of lung cancer deaths has been attributed to particulate matter. Studies have found that air pollution is the sixth most deadly killer in South East Asia and the fifth largest killer in India (Iyengar 2014). It has been estimated that in the year 2017 around 1.24 million (12.5%) deaths in India were attributable to air pollution which increased to 1.67 million deaths in the year 2019 (Balakrishnan K et al. 2018; Pandey, A., Brauer, M., Cropper, M. L., et al. 2021). Around 0.67 million deaths in India in 2017 were attributed to ambient particulate matter pollution while 0.48 million deaths were attributed to household air pollution. An increase of 1.7 years life expectancy would have been possible in India if the pollution levels had been lower than the minimum levels associated with health loss (Balakrishnan K et al. 2018).

Exposure to air pollution has been found to be associated with various health problems including cardiovascular disorders, hypertension, bronchitis, respiratory distress, dermatitis etc. (Chainey 2015). Very small particles (less than 2.5 micrometer in diameter) are capable of entering into the respiratory system and causing fatal physiological consequences (Chandola 2013).

It has been estimated that particulate air pollution account for 19% of all cardiovascular deaths, 23% of all ischemic heart disease deaths, and 21% of all stroke deaths (Hadley, Baumgartner & Vedanthan 2018). Strong association have been found between particulate air pollution and increased risk of cardiovascular disease mortality, myocardial infarction, stroke, and hospital admission for congestive heart failure (Brook et al. 2004).According to a study very small sized particulate matter in the respiratory air is responsible for hypertension(Iyengar 2014).A 26-city US survey revealed that a 10 μg/m3 increase in PM2.5 in a 2-day period was associated with an approximately 2% increase in myocardial infarctions and hospital admissions for heart failure (Zanobetti et al. 2009).According to Sorensen et al air pollution as well as traffic noise may be linked with higher levels of cholesterol (Sorensen et al. 2015).In India, 38% of the disease burden on account of air pollution is due to cardiovascular diseases and diabetes.

Various studies have found that air pollution is associated with type 2 diabetes mellitus (Eze et al. 2015). Among both diabetic as well as non-diabetic individuals, exposure to PM2.5 and NO2 has been found to be linked with the prevalence of diabetes and increase in the glycosylated hemoglobin levels (Honda et al. 2017). Higher morbidity as well as mortality due to air pollution has been found among individuals with diabetes (Raaschou-Nielsen et al.2013; Schraufnagel et al. 2019). Dendup et al in the year 2018 revealed that higher levels of NO2, PM2.5 and noise are associated with increased risk of developing type 2 diabetes mellitus (Dendup et al. 2018).

It has been estimated that ambient air pollution is the major cause behind the death of more than 800,000 individuals from COPD and 280,000 individuals from lung cancer (Cohen et al. 2017). Death of more than 750,000 individuals from COPD and 300,000 individuals from lung cancer have been attributed to indoor air pollution (Gordon et al. 2014; WHO 2018). Delhi has been marked as the asthma capital of India (Dubey 2009).

Increase in air pollution has also been associated with the increase in the prevalence of hepatic steatosis (Li et al. 2017). Study conducted among 23,820 individuals for a median of 16.9 years revealed the association of exposure to PM2.5 with an increased risk of hepatocellular cancer (Pan et al. 2016).

Studies have found that due to air pollution allergic reactions among sensitized persons can aggravate. Air pollution is found to be linked with enhancement of allergic sensitization among young children and also with the increase in IgE levels in the very young (Majkowska-Wojciechowska et al. 2007; Patel et al 2011).

Air pollution is found to affect a lot of biologic parameters which in turn influence the quality of one's skin. These include changes in the composition and excretion rate of sebum, carbonylated protein level in the stratum corneum, and a higher erythematous index on the face of highly exposed subjects (Lefebvre et al. 2015).

Such changes may result in an increase in the occurrence of acne among individuals exposed to air pollution (Liu et al. 2018). Air pollution is found to be linked with high frequency of atopic and urticarial skin disease, dermographism, and seborrhea (but a lower frequency of dandruff) (Lefebvre et al. 2015).

11.3.1 Air Pollution Control in India:

Various initiatives have been taken by the government of India in order to control air pollution in the country. Such initiatives include reduction in the emission of particulate matter by coal power plants as well as reduction in consumption of energy by industries by the Ministry of Power, standard for emission have been set for industries of brick manufacture as well as reduction in stubble burning in agriculture by Ministry of Environment, regulation of emissions by vehicles by Ministry of Road Transport and Highways and Ministry of Petroleum and Natural Gas and improving the availability of public transport by Ministry of Urban Development (Balakrishnan K et al. 2018). The Government has banned the running of vehicles which are more than 15 years old on the roads of Delhi (Ghosh & Parida 2015). The government has also taken up various steps in order to reduce the number of vehicles that use diesel on the roads of Delhi (Sedghi 2015). In order to reduce the emission of particulate matter into the environment electrostatic precipitators have been added to the chimneys of the industries (Ghosh & Parida 2015). The Prime Minister of India in the year 2016 initiated the scheme 'The Pradhan Mantri Ujjwala Yojana' in order to reduce solid fuel use among households.

According to this scheme 50 million low-income households were planned to be provided with clean and safe cooking fuel (liquefied petroleum gas) by the month of March, 2019. However, the original target of the scheme was met in the month of August, 2018 and thus the government has now increased the target to reach 8 crores with budgetary allocation of Rs 12,800 crore (Press Information Bureau, 2018). Clean Air for Delhi Campaign was launched in the year 2018. This campaign later led to the initiation of the National Clean Air Program. The aim of the National Clean Air Program is 'to sensitize the public and enhance coordination between the implementing agencies for control of air pollution across the country' (Balakrishnan K et al. 2018).

Similar initiatives include 'The Intended Nationally Determined Contributions'. This initiative targets 'to reduce particulate matter emission intensity by 33–35% by 2030, promotion of electric public transport fleets, and upgrading vehicles to Bharat Stage VI (which is equivalent to Euro-VI standard) vehicle emission standards' (Ministry of Petroleum and Natural Gas, 2014; Press Information Bureau, 2015; Press Information Bureau, 2016).

11.4 Conclusion:

The World Health Organization has termed air pollution as 'Silent Killer'. Various studies continue to reveal the harmful effects of air pollution on public health. However, it is possible to address the problem of air pollution and improve the air quality. The findings of such studies must be taken into account for the development of strategies to mitigate the harmful effects of toxic pollutants. Numerous steps have been taken by the government of India in order to tackle this problem in various parts of the country in the form of schemes, laws etc. Alternative and renewable sources of energy must be considered in order to reduce pollution. The improvement in the air quality has been found to have an immediate impact. Thus improving the quality of air can go a long way in improving the health of the general population. Also short term measures such as use of respiratory mask must be encouraged among individuals who are regularly exposed to toxic air pollutants.

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12. भारत में पर्यावरण पर जनसंख्या का प्रभाव

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प्रस्तावना :

भू–वैज्ञानिकों तथा खगोल शास्त्रियों का कहना हैं कि पृथ्वी के 70ः भाग पर पानी हैं तथा 30ः भाग ही स्थल (भू–भाग) हैं। जिस पर प्राकृतिक संसाधनों (भूमि, हवा, मिट्टी, पेड़–पौधे) से लेकर विभिन्न प्रकार की गैसें (नाइट्रोजन, कार्बन डाय आक्सॉइड, कार्बन मोनो ऑक्साइड) जलवायु या जलवायु परिवर्तन आदि का एक समूह विद्यमान हैं, जिसे हम पर्यावरण कहते हैं। इस पर्यावरण में मानव, विभिन्न प्रकार के जानवर व जीव–जन्तु पाये जाते हैं। पर्यावरण इनकी (मानव, जीव–जन्तु, जानवर) दृष्टि से महत्वपूर्ण हैं, क्योंकि इनको अपने जीविकोपार्जन हेतु जिन आवश्यक वस्तुओं या संसाधनों (भोजन) की जरूरत होती हैं, वह उसे इसी से प्राप्त होती हैं, परन्तु मानव ने अपने स्वार्थ एवं लालच के कारण इस पर्यावरण को हानि या नुकसान पहुॅचाना आरंभ कर दिया हैं।

पर्यावरण को हानि पहुॅचाने में जिस कारक का सबसे अधिक योगदान रहा हैं, तो वह जनसंख्या हैं, जो कि दिन–प्रतिदिन बढ़ती जा रही हैं। यदि हम वैश्विक दृष्टि से जनसंख्या का मूल्यॉकन करें तो यह प्राप्त होता हैं कि **वर्तमान में कुल वैश्विक जनसंख्या लगभग 7.6 बिलियन हैं और यह प्रतिदिन बढ़ती जा रही हैं।**[1] वैज्ञानिकों एवं जनसॉख्यिकीय विदो का कहना हैं कि यदि इसी तरह से जनसंख्या बढ़ती गयी तो यह **वर्ष 2025 तक 8 बिलियन, 2040 तक 9 बिलियन तथा 2100 तक 11 बिलियन पहुॅच जायेगा,**[2] जो कि पर्यावरण की दृष्टि से घातक हैं, क्योंकि बढ़ती हुयी जनसंख्या कई दृष्टियों जैसेः– ईधन हेतु वनों का विनाश, भोजन और वाहनों हेतु जीवश्म ईधन का उपयोग करना, मनुष्य द्वारा वाहनों के अत्यधिक उपयोग करने से वातावरण में अनावश्यक कार्बन की मात्रा का उत्सर्जन करना, जिससे वायु–प्रदूषण उत्पन्न होता हैं, मानव द्वारा अपने आर्थिक विकास हेतु पृथ्वी के भू–गर्भ से प्राकृतिक संसाधनों को निकालना इत्यादि कारणों से पर्यावरण को क्षति पहुॅच रही हैं।

भारत के संदर्भ में यह कहा जाता हैं कि यह दुनियॉ का दूसरा सबसे अधिक आबादी वाला देश हैं, जो कि दुनिया की कुल आबादी का **1.271 बिलियन अर्थात 17.5% का हिस्सा हैं।**[3] यह हिस्सा बहुत अधिक हैं, हालॉकि भारत की जनसंख्या एक समान रूप से नहीं बढ़ी हैं, वर्ष

1991 तक जनसंख्या अधिक थी, लेकिन 1991 के बाद वार्षिक वृद्धि दर में थोड़ी कमी दर्ज की गयी थी, लेकिन इसके बाद भारत की जनसंख्या बढ़ती गयी और **20वीं शताब्दी की शुरूआत तक यह बढ़कर 234.8 बिलियन के आसपास पहुँच गयी हैं।**[4] भारत के संदर्भ में दिलचस्प बात यह हैं कि 20वीं सदी से पूर्व अगले 50 वर्षों में यह केवल डेढ़ गुना बढ़ी हैं, जबकि 20वीं सदी के बाद शेष 50वर्षों में इसमें 3 गुना वृद्धि हुयी हैं। यह ऑकड़े चौकाने वाले हैं, क्योंकि वर्तमान में जनसंख्या जिस गति से बढ़ रही हैं, उसे ध्यान में रखते हुये यह कहा जा सकता हैं कि भारत में जनसंख्या पर्यावरण को कही अधिक तेजी से हानि पहुँचा रही हैं तथा जिससे प्राकृतिक संसाधनों भूमि, पानी, पेड़–पौधे, हवा आदि का क्षरण हो रहा हैं अर्थात शुद्ध दवा के स्थान पर दूषित हवा प्राप्त हो रही हैं, जो कि मानव स्वास्थ्य की दृष्टि से उचित नहीं हैं, क्योंकि प्रदूषित हवा मानव के लिये कई बीमारियों (श्वसन, सॉस संबंधी) का कारण बनती हैं, इसलिये पर्यावरण को बचाना या सुरक्षित बनाये रखना हम लोगों का महत्वपूर्ण कर्तव्य हैं।

अध्ययन के उद्देश्य : मैने भारत में पर्यावरण पर जनसंख्या का प्रभाव नामक शोध पत्र के लिये निम्नलिखित उद्देश्यों का चयन किया हैं।

- **भारत में जनसंख्या वृद्धि का पर्यावरण पर पड़ने वाले नकारात्मक प्रभाव को समझना।**
- **भारत में प्राकृतिक संसाधनों का अत्यधिक दोहन के कारण पर्यावरण पर पड़ने वाले प्रभावों को समझना।**
- **भारत में शहरीकरण के विकास के कारण पर्यावरण पर पड़ने वाले प्रभाव को समझना।**

अध्ययन की सामग्री : यह शोध पत्र पूर्ण रूप से द्वितीयक समंको पर आधारित हैं, जिसे पूर्ण करने के लिये मैने विभिन्न शोध पत्र, पत्रिकाओं, विभिन्न समाचार पत्रों तथा इंटरनेट पर उपलब्ध विभिन्न वेबसाईटों से समंक एकत्रित करके किया हैं।

उपलब्ध साहित्य का अध्ययन : भारत में विशेष रूप से उत्तर–पूर्वी भारत में पर्यावरण, जनसंख्या तथा गरीबी पर बहुत अधिक संख्या में साहित्य उपलब्ध हैं, इसका कारण भारत के पड़ोसी देशों जैसेः– नेपाल तथा बंग्लादेश से बहुत बड़े पैमाने पर अपनी आजीविका व रोजगार हेतु जनसंख्या का आवागमन रहा हैं।

बी.के. जोशी (1990) ने अपने लेख ''गरीबी, असमानता और सामाजिक संरचना'' के तहत उत्तर–पूर्व भारत का अध्ययन किया और तर्क दिया कि : ''मेघालय जैसे राज्य में गरीबी और जनसंख्या वृद्धि ने राज्य की अर्थव्यवस्था के विकास एवं वृद्धि को प्रभावित किया हैं, क्योंकि इस राज्य में जनसंख्या वृद्धि की दर 2% प्रतिवर्ष से अधिक रही हैं, जिसके कारण राज्य की आर्थिक विकास की दर तथा लोगों का जीवन स्तर निम्न हैं अर्थात अभी तक सुधार नहीं हो सका हैं।''[5]

एम बैनर्जी (1994) ने अपने लेख मेघालय राज्य की जनसांख्यिकीय प्रोफाइल में तर्क दिया हैं कि : ''सम्पूर्ण विश्व की जनसंख्या में तीव्र वृद्धि तथा खाद्य आपूर्ति पर इसका प्रभाव, मानव जाति के लिये एक गंभीर खतरा हैं। यह भारत में भी बढ़ती हुयी जनसंख्या के कारण गरीबी, अल्प रोजगार व बेरोजगारी आदि मूल समस्याऐं हैं।''[6]

ए.के. सैन (1994) ने ''जनसंख्या और शोध : भोजन, उर्वरता तथा आर्थिक विकास'' नामक लेख में उल्लेख किया हैं कि : ''बढ़ती हुयी जनसंख्या कई समस्याऐं जैसे : लोगों का निम्न जीवन स्तर, भोजन संबंधी समस्या, मानव की खुशी आदि को जन्म देती हैं।''[7]

पी. दासगुप्ता, सी. फोल्क और के. जी. मेलर (Dasgupta. P, C. Folke and K.G. Maler, 1994) में अपले लेख ''पर्यावरण संसाधन और मानव कल्याण'' में उल्लेख किया हैं कि : ''पर्यावरण को प्रभावित करने वाले वनों के क्षरण और आर्थिक विकास के पीछे उपलब्ध संसाधनों की पहचान की और बताया कि वनों के क्षरण का मुख्य कारण गरीबी तथा फैशन हैं। उन्होंने तर्क दिया कि जब जनसंख्या का आकार उपलब्ध संसाधनों से अधिक हो जाता हैं तो जनसंख्या को नियंत्रित करने की आवश्यकता अधिक होती हैं।''[8]

के. सैनगुप्ता (1994) ने मेद्यालय राज्य का जनसंख्या और पर्यावरण के संबंध में अध्ययन किया तथा वर्णन किया कि : ''यदि मेद्यालय राज्य की जनसंख्या में वृद्धि होती हैं तो खाद्यान्न की समस्या हो सकती हैं, जिसे यह राज्य अन्य राज्यों से खाद्यान्न प्राप्त करके समस्या का हल निकाल सकता हैं। इसके अलावा मेद्यालय राज्य में बढ़ती हुयी जनसंख्या आर्थिक विकास और लोगों के जीवन स्तर को न्यूनतम कर सकता हैं। यह न्यूनतम जीवन स्तर लोगों की मुश्किले बढ़ा सकता हैं अर्थात लोगों को दैनिक जीवन के हर क्षेत्र में चुनौतियों का सामना करना पड़ता हैं।''[9]

एस. बाय पाटिल (2000) ने भारत के संदर्भ में विकासशील देशों में पर्यावरण तथा आर्थिक विकास के तहत अध्ययन करके यह प्रस्तुत किया कि : ''प्राकृतिक संसाधन न केवल वनो के प्रभावी संरक्षण के लिये आवश्यक हैं, बल्कि मानव की सुरक्षा तथा सुधार व राष्ट्रीय कल्याण के लिये भी महत्वपूर्ण हें।''[10]

एन. राजलक्ष्मी (2000) ने उल्लेख किया हैं कि : ''पर्यावरण और गरीबी पारस्परिक रूप से मजबूत प्रभावों से जनसंख्या वृद्धि की दर तेज हो सकती हैं। गरीब लोग पीड़ित तथा पर्यावरण क्षति के ऐजेंट हैं। प्रौद्योगिकी तथा संसाधनों की कमी के कारण, भूखे किसान, कटाव–प्रवण पहाड़ी किनारों पर खेती करने और उष्णकंटिबंधीय वन क्षेत्रों में जाने का सहारा लेते हैं, जहॉ साफ किये गये खेतों में फसल की पैदाबार आमतौर पर कुछ ही वर्षों के बाद तेजी से गिरती हैं।''[11]

उपरोक्त साहित्य का अध्ययन करने के बाद यह प्राप्त होता हैं कि विभिन्न लेखकों ने पर्यावरण हानि या क्षरण के लिये निम्न कारकों जैसे : जनसंख्या वृद्धि, गरीबी, आर्थिक विकास, प्राकृतिक संसाधनों का दोहन आदि को जिम्मेदार माना हैं। इससे यह स्पष्ट होता हैं कि दिन–प्रतिदिन इन कारकों में होने वाली वृद्धि ही पर्यावरण क्षरण का मुख्य कारण हैं, जब तक इन कारकों पर नियंत्रण नहीं किया जाता, तब तक पर्यावरण को नुकसान या हानि होती रहेगी।

भारत में जनसंख्या वृद्धि का पर्यावरण पर पड़ने वाला प्रभाव : सम्पूर्ण विश्व में समय–समय पर आयोजित होने वाले संगोष्टियों, सम्मेलनों तथा सेमिनारो में इस विषय (जनसंख्या) पर विभिन्न लेखकों, सामाजिक–आर्थिक दार्शनिकों एवं अर्थशास्त्रियों के बीच बहस होती रही हैं कि किसी भी देश में होने वाली जनसंख्या वृद्धि किस प्रकार मानव जीवन के गुणवत्ता पूर्ण

जीवन स्तर, गरीबी और पर्यावरण को गंभीर रूप से प्रभावित कर रही हैं। जनसंख्या वृद्धि ने पृथ्वी पर अनावश्यक भार तो बढ़ाया ही हैं, इसके साथ–साथ उस देश के आर्थिक विकास को भी प्रभावित किया हैं। दिन–प्रतिदिन जैसे–जैसे जनसंख्या बढ़ती जा रही हैं, वैसे–वैसे कई समस्याऐं उत्पन्न होती जा रही हैं, जैसे–भोजन सबंधी समस्या, ईधन हेतु वनो का विनाश, दो पहिया या चार पहिया वाहनो के कारण उत्पन्न होने वाला कार्बन उत्सर्जन, जनसंख्या की अधिकता के कारण कृषि भूमि हेतु वनो का विनाश आदि। इसमें से जिस कारक ने सबसे अधिक पर्यावरण को नुकसान पहुॅचाया हैं, वह नयी कृषि भूमि हेतु जंगलों (वनो) को नष्ट करना रहा हैं। **सम्पूर्ण दुनियॉ में वनो की कटाई के लगभग 80% के लिये कृषि भूमि जिम्मेदार हैं।**[12] इसका केवल और केवल एक ही कारण हैं और वह हैं जनसंख्या वृद्धि, यह वृद्धि वैश्विक स्तर पर **वर्ष 2015 में 7.3 बिलियन से अधिक थी**[13] और यह अनुमान लगाया जा रहा हैं कि भविष्य में और अधिक बढ़ सकती हैं। **संयुक्त राष्ट्र का अनुमान हैं कि वर्ष 2050 तक विश्व की कुल आबादी 9.2 अरब तक पहुॅच जायेगी।**[14] इतनी अधिक जनसंख्या के लिये भोजन, पानी, भूमि (आवास हेतु) वायु, जीवाश्म ईधन और खनिजों जैसे संसाधनों की अधिक मात्रा में आवश्यकता होगी और इसकी पूर्ति हेतु कार्य भी किया जा रहा हैं, जिसका घातक प्रभाव पर्यावरण पर दृष्टिगोचर हो रहा हैं, हालॉकि पर्यावरण पर होने वाले हानिकारक प्रभावो को लेकर मानव चिंतित हैं। वह इस पर विचार विमर्श भी कर रहा हैं कि बढ़ती हुयी आबादी पर्यावरण से लेकर पारिस्थितिकी तंत्र तक के लिये तबाही का कारण भी बन सकती हैं, परन्तु आश्चर्य की बात यह हैं कि अभी तक हमने इस जनसंख्या वृद्धि को रोकने का सफल प्रयास नहीं किया हैं, हॉ यह जरूर हैं कि हमने इसके लिये कानूनों का निर्धारण कर रखा हैं, लेकिन उचित क्रियान्वयन के अभाव में अभी भी सफलता काफी दूर हैं। यह जनसंख्या वृद्धि विकसित एवं विकासशील दोनों देशों की समस्याऐं बनी हुयी हैं। हॉ, एक अन्तर जरूर हैं और वह हैं विकसित देशों की तुलना में विकासशील देशों में जनसंख्या की वृद्धि कही अधिक तेजी से बढ़ना तथा ऐसी स्थिति एशिया महाद्वीप में स्थित भारत में सर्वाधिक हैं। भारत के संदर्भ में यह कहा जाता हैं कि इसके लिये यहॉ कई कारक जिम्मेदार हैं, जैसेः– गर्म जलवायु का पाया जाना, जो तीव्र गति से प्रजनन क्षमता को बढ़ाती हैं, अशिक्षा, परिवार नियोजन संबंधी कानूनों का कड़ाई से पालन न करना, अंध–विश्वास व रूढ़ियॉ, प्रथाऐं आदि हमारे देश मे यह ऐसे कारक रहे हैं, जो प्राचीन काल से आज तक विद्यमान हैं, हालॉकि वर्तमान में शिक्षा का विस्तार व प्रचार–प्रसार होने के कारण जनसंख्या वृद्धि की दर में थोड़ी बहुत गिरावट दर्ज की हैं, परन्तु फिर भी उस गति से कम नहीं हुयी हैं, जिसकी भारत को सख्त आवश्यकता हैं।

भारत में बढ़ती हुयी जनसंख्या ने पर्यावरण पर अनावश्यक भार बढ़ाकर उसकी प्रभावशीलता को कम कर दिया हैं अर्थात पर्यावरण के स्तर में गिरावट की स्थिति उत्पन्न कर दी हैं। **जैसा कि शॉ (1989), जोधा (1990), हर्टे (2007) ने स्पष्ट किया हैं कि –** "भारत जैसे विकासशील देश में बढ़ती हुयी आबादी और विकासात्मक गतिविधियों के कारण पर्यावरण की गिरावट तथा प्राकृतिक संसाधनों की कमी उक्त दोनों ही समस्याऐं उत्पन्न की हैं।"[15,16,17] देश में जैसे–जैसे जनसंख्या में वृद्धि हुयी वैसे–वैसे भोजन, भूमि (आवास, कृषि), ईधन (जीवाश्म ईधन), प्राकृतिक संसाधनो (खनिज, तेल, पानी) की अधिक मात्रा में आवश्यकता महसूस हुयी, जिसके परिणामस्वरूप लोगों ने अधिक मात्रा में निकालना शुरू कर दिया, जिससे पर्यावरण पर अनावश्यक भार के कारण क्षरण होने लगा। इस क्षरण के पीछे एक और कारक हैं और वह हैं मानव की विकासात्मक गतिविधियॉ, जिसके तहत उसने (मानव) तकनीकी एवं वैज्ञानिक

कौशल की मदद से उद्योग, परिवहन तथा अन्य व्यवसायों के लिये पृथ्वी के भू–गर्भ से अधिक मात्रा में प्राकृतिक संसाधनों को निकालना आरंभ कर दिया। यही ऐसे कारण हैं, जिससे पर्यावरण में असंतुलन की स्थितियॉ निर्मित होने से उसका क्षरण होना आरंभ हो गया हैं। यदि इसी प्रकार की प्रक्रिया चलती रही तो भविष्य में कई प्रकार के मानव से संबंधित घातक परिणाम दृष्टिगोचर होगें। **जैसा कि अलका गौतम (2007) ने स्पष्ट किया हैं कि –** "इस तरह से प्राकृतिक संसाधनों का उपयोग करने से पर्यावरणीय क्षय, गरीबी और इससे अधिक प्रदूषित दुनिया का हमें सामना करना पड़ सकता हैं।"[18] इसी प्रकार ग्लोबल 2000 की रिपोर्ट ने भी स्पष्ट किया हैं कि – **बढ़ती हुयी जनसंख्या के कारण पृथ्वी पर भीड़–भाड़ हो जायेगी, अभी हम जिस दुनियॉ में रह रहे हैं, वह कहीं अधिक प्रदूषित, पारिस्थितिकी तंत्र की दृष्टि से अधिक अशॉत एवं असुरक्षित हो जायेगी।"**[19]

पर्यावरण क्षरण की समस्याऐं भिन्न–भिन्न देशों में अलग–अलग रही हैं, जैसे **: अफ्रीका में पर्यावरणीय गिरावट का प्रमुख कारण प्राकृतिक संसाधनों की कमी रही हैं, इसीलिये वहॉ गरीबी का स्तर हैं,**[20] जबकि एशिया प्रशॉत क्षेत्र में तेजी से जनसंख्या वृद्धि और निरंतर आर्थिक विकास दोनो ंही पर्यावरण गिरावट के प्रमुख कारण माने जाते हैं।[21] इसी प्रकार संयुक्त राज्य अमेरिका की स्थिति हैं, जहॉ पर्यावरण के गिरावट का मुख्य कारण प्राकृतिक संसाधनों की प्रतिव्यक्ति खपत का अधिक होना और अत्यधिक उच्च कार्बन का उत्सर्जन होना हैं,[22] जबकि भारत जैसा विकासशील राष्ट्र अपनी जनसंख्या वृद्धि के कारण गरीबी, बेरोजगारी और पर्यावरणीय गिरावट जैसी गंभीर स्थितियों का सामना कर रहा हैं। भारत में इस प्रकार की स्थिति के लिये एक और कारक जिम्मेदार हैं तथा वह हैं, जनसंख्या घनत्व एक समान न होना अर्थात देश के विभिन्न क्षेत्रों एवं राज्यों में आर्थिक विकास एवं जनसंख्या वृद्धि में एक समान रूप से कमी न होना, जिससे भारत में क्षेत्रीय असमानता की स्थिति उत्पन्न हो गयी हैं। यहॉ क्षेत्रीय असमानता का मतलब हैं, देश के विभिन्न क्षेत्रो ंमें विकास एवं आबादी का एक समान मात्रा में न पाया जाना रहा हैं, जिसके कारण पर्यावरण असंतुलन की स्थिति उत्पन्न हो गयी हैं। इसके लिये स्वंय भारतीय जिम्मेदार हैं, क्योंकि हम अपने तथा देश के आर्थिक विकास में इतना अधिक व्यस्त हो चुके हैं कि हमने पर्यावरण की स्थिति पर कोई ध्यान नहीं दिया। वर्तमान मे ंतो हम उच्च स्तर की प्रौद्योगिकी का उपयोग करने के कारण व्यक्ति एकाकी जीवन यापन कर रहा हैं अर्थात एकाकी का मतलब स्वयं तथा स्वयं के परिवार के सदस्यों के साथ अपना जीवन व्यतीत करना हैं। उदाहरण के लियेः– वर्तमान में व्यक्ति सूचना व संचार प्रौद्योगिकी का तीव्र विकास होने से वह मोबाइल फोन, जो कि इंटरनेट आधारित प्रणाली से संचालित होता हैं, में इतना अधिक व्यस्त हो गया हैं कि उसे किसी और से लेना–देना नहीं हैं।

भारत के कुछ क्षेत्र व राज्य तो ऐसे हैं, जहॉ अधिक आबादी के कारण गरीबी का उच्च स्तर बना हुआ हैं। ऐसी स्थिति भारत के मध्य–पूर्वी और उत्तर–पूर्वी क्षेत्रों में बनी हुयी हैं। **आर स्कॉट के अनुसार –** "भारत में मध्य पूर्वी क्षेत्रों में 40% तथा पूर्वी क्षेत्रों में 35% गरीबी का स्तर पाया जाता हैं, जिससे पानी, जंगल एवं भूमि (कृषि भूमि) जैसे प्राकृतिक संसाधनों का अधिक इस्तेमाल होने लगा हैं।"[23] इसके अलावा प्राकृतिक संसाधनों के संरक्षण की समस्या, अत्यधिक आबादी के कारण जीवन स्तर की गुणवत्ता संबंधी समस्या और सामाजिक–आर्थिक विकास का अपर्याप्त स्तर इत्यादि समस्याऐं भारत के लिये मुख्य चुनौतियॉ हैं।

भारत में पर्यावरणीय क्षरण के लिये अत्यधिक आबादी और गरीबी ही जिम्मेदार नहीं हैं, बल्कि आय के आधार पर निर्धारित किये गये लोगों का वर्ग भी जिम्मेदार हैं। हमारे देश में लोगों को आय अर्जन के आधार पर तीन वर्गो जैसे : गरीबी, मध्यम, उच्च आदि में बॉटा गया हैं। इसमें जो गरीब वर्ग हैं, उसके संबंध में ये कहा जाता हैं कि इनके पास पर्याप्त आय के अभाव में ये लोग सीधे जंगलों से लकड़ी एकत्रित करके खाना पकाना, वनों की भूमि का उपयोग अत्यधिक फसल हेतु कृषि कार्य में करना इत्यादि के कारण पर्यावरण का क्षय होता हैं और इसके लिये इस वर्ग को सबसे ज्यादा जिम्मेदार माना जाता हैं, जो कि पूर्णतया गलत हैं। वैज्ञानिकों तथा लेखकों ने यह स्पष्ट कर दिया हैं कि गरीब वर्ग की तुलना में मध्यम एवं उच्च वर्ग कही अधिक मात्रा में पर्यावरण के गिरावट के लिये जिम्मेदार हैं। उन्होंने यह बात इस प्रकार सिद्ध किया कि दो पहिया एवं चार पहियॉ वाहन सबसे अधिक इन (मध्यम, उच्च) वर्गो के पास हैं, जब वाहन अधिक होगें तो जीवाश्म ईधन अधिक इस्तेमाल होगा, जिससे पर्यावरण में कार्बन उत्सर्जन की मात्रा अधिक होगी, जो आगे पर्यावरण प्रदूषण को बढ़ायेगी। **के गणेश, जी मल्होत्रा और एस दासमिश्रा (2007) ने स्पष्ट किया हैं कि –** "भारत में मध्यम एवं उच्च वर्ग ने उपभोक्त वस्तुओं का व्यापक अधिग्रहण किया हैं।"[24] जिसके कारण पर्यावरण का क्षय हुआ हैं।

भारत के पास कुल वैश्विक भूमि का केवल 2.4% हिस्सा हैं, परन्तु कुल वैश्विक आबादी का 16.7% भाग हैं,[25] अर्थात भूमि की तुलना में जनसंख्या अधिक हैं, जिसके कारण पर्यावरण गिरावट की समस्या उत्पन्न हो रही हैं। इसके अलावा जनसंख्या घनत्व भी देश के विभिन्न राज्यों एवं हिस्सों में अलग–अलग हैं। वर्ष 2011 में जनसंख्या घनत्व उत्तर–पूर्वी क्षेत्रों को छोड़कर शेष सभी क्षेत्रों में औसत 366 हैं, जबकि भारत का उत्तरी क्षेत्र, जिसमें देश की राजधानी नयी दिल्ली भी शामिल हैं, अन्य क्षेत्रों की तुलना मं जनसंख्या घनत्व सर्वाधिक हैं। भारत के पूर्वी क्षेत्र, जो पहले से ही पिछड़े हुये हैं, समग्र जनसंख्या दवाब कही अधिक तीव्र हैं। दक्षिणी एवं पश्चिमी भाग भी अधिक जनसंख्या घनत्व को प्रलेखित करता हैं, लेकिन इसका स्थान पूर्वी क्षेत्र के बाद दूसरा हैं। पर्यावरण की दृष्टि से जनसंख्या घनत्व का ऑकलन इसलिये किया जाता हैं कि **कार्बन उत्सर्जन तथा संसाधन खपत में निरंतर रूप से वृद्धि होना जारी रहता हैं,**[26] और जनसंख्या भी सघनता के कारण प्रदूषण (वायु, जल, शोर) का स्तर कही अधिक घातक हो जाता हैं, जो मानव के स्वास्थ्य को तो प्रभावित करता ही हैं, इसके साथ–साथ यह पर्यावरण के स्तर को भी गिरा देता हैं।

इस प्रकार यह कहा जा सकता हैं कि भारत में जो दिन–प्रतिदिन पर्यावरण का स्तर गिर रहा हैं, उसके लिये केवल बढ़ती हुयी जनसंख्या जिम्मेदार हैं, हालॉकि वर्तमान में सरकार के साथ–साथ शिक्षा का स्तर बढ़ने से लोगों में भी जागरूकता उत्पन्न हुयी हैं अर्थात अब अधिकॉश लोग यह समझने लगे हैं कि बढ़ती हुयी जनसंख्या न केवल देश के आर्थिक विकास में बाधा उत्पन्न कर रही हैं, बल्कि विभिन्न प्रकार की पर्यावरणीय समस्याऐं जैसे – वायु, जल, शोर प्रदूषण और घातक गैसे, जहॉ तक कि ग्रीन हाउस गैसे जैसी समस्याऐं भी उत्पन्न कर सकती हैं, इसलिये हमें जनसंख्या को नियंत्रित करने का प्रयास करना चाहिये, तभी हम भविष्य की पीढ़ी के लिये एक स्वच्छ पर्यावरण दे पायेंगे।

प्राकृतिक संसाधनों का अत्यधिक दोहन : एक मानव के लिये अपने जीवन स्तर को उच्च बनाये रखने तथा गुणवत्तापूर्ण जीवनयापन हेतु विकास, जिसमें सामाजिक–आर्थिक, दोनों

शामिल हैं, एक प्रमुख आवश्यकता हैं। आज के संदर्भ में हम देखते हैं कि सम्पूर्ण विश्व (विकसित, विकासशील) इस ओर सक्रिय रूप से संलग्न हैं और इसके लिये हमने एक नयी आर्थिक प्रणाली अर्थात वैश्विक अर्थव्यवस्था भी संचालित कर रखी हैं, जो आज सतत रूप से आर्थिक विकास के कार्यो में संलग्न हैं और इसके लिये हम दिन–प्रतिदिन प्राकृतिक संसाधनों का अधिक से अधिक दोहन कर रहे हैं, यह विकास निश्चित रूप से मानव और उसके जीवन यापन हेतु अत्यंत उपयोगी हैं, परन्तु जब हम इन प्राकृतिक संसाधनों को पर्यावरण की दृष्टि से देखते हैं तो यह बिल्कुल भी उचित नहीं हैं क्योंकि इसके कारण दिन–प्रतिदिन पर्यावरण का क्षरण हो रहा हैं। इसके लिये केवल विकास ही जिम्मेदार नहीं हैं, बल्कि जनसंख्या भी हैं। आज जिस तरह से जनसंख्या बढ़ रही हैं, उससे बड़े–बड़े शहरों का निर्माण हो रहा हैं, औद्योगिक विकास भी चरम स्तर पर हैं, कहीं–कहीं तो नवीन उद्योग व व्यावसायिक संगठन भी स्थापित हो रहे हैं, वैश्वीकरण के कारण भारत में आज अनेक बहु–राष्ट्रीय निगम स्थापित हैं, जो प्रतिदिन इन प्राकृतिक संसाधनों के दोहन में सतत रूप से संलग्न हैं। संक्षेप में यह कहा जा सकता हैं कि अत्यधिक जनसंख्या, शहरीकरण व औद्योगिकरण में वृद्धि अत्यधिक प्राकृतिक संसाधनों के दोहन के लिये जिम्मेदार हैं। **जैसा कि लक्ष्मण और गणेश ने (2007) ने स्पष्ट किया हैं कि –** "प्राकृतिक संसाधनों के अत्यधिक दोहन के लिये शहरीकरण तथा जनसंख्या वृद्धि पूर्ण रूप से जिम्मेदार हैं, जिसके परिणामस्वरूप दुर्लभ संसाधनों और पर्यावरण प्रदूषण की समस्याऐं उत्पन्न हो गयी हैं।"[27,28]

अतः हम यह समझने का प्रयास करेंगे कि प्राकृतिक संसाधनों का सर्वाधिक दोहन मानव क्यों कर रहा हैं? इसके पीछे कौन–कौन से कारण हैं और ये कारण किस प्रकार पर्यावरण के गिरावट के लिये जिम्मेदार हैं।

- **यातायात :** जैसे–जैसे मानव प्रगति करता जा रहा हैं, वैसे–वैसे उसके रहन–सहन का स्तर तथा जीवनयापन का तरीका बदलता जा रहा हैं, इसलिये वह पैदल चलने के स्थान पर आज दो पहिया या चार पहिया वाहन का इस्तेमाल कर रहा हैं। इसके पीछे एक और अन्य कारण धन समृद्धि भी हैं। जिसकी वजह से आज प्रत्येक व्यक्ति इन वाहनों का उपयोग करने में सक्षम हैं। इसने मनुष्य के इस व्यवहार को यात्रा व्यवहार में बदल दिया हैं। **रॉय चौधरी (2013) के अनुसार –** "यात्रा की मॉग में वृद्धि तथा यात्रा व्यवहार में परिवर्तन के कारण शहरी जनसंख्या तथा भौतिक आकार के मामलें बढ़ रहे हैं।"[29]

वर्ष 2001 के बाद भारतीय शहरों एवं महानगरों में 1000 लोगों पर वाहनों की संख्या में अधिक दर में वृद्धि हुयी हैं। दुपहिया एवं चार पहिया वाहन, जिनके धारक अधिकांशत व्यक्ति स्वयं हैं, 9.6% व 10.3% की दर से प्रतिवर्ष वृद्धि हुयी हैं। **के शर्मा एवं सैन (2011) के अनुसार –** "वर्ष 2011 की जनगणना के तहत भारत के 22 शहर ऐसे हैं, जहॉ पॅजीकृत वाहनों की संख्या में 8.7% की दर से वृद्धि हुयी हैं, जो कि देश के कुल वाहनों का लगभग 28% की हिस्सेदारी व्यक्त करती हैं।"[30] यही कारण हैं कि भारतीय सड़कों पर अनावश्यक कार्बन उत्सर्जन की मात्रा मे वृद्धि हो रही हैं, जिसने वायु प्रदूषण जैसी समस्या को उत्पन्न करके मानव स्वास्थ्य के स्तर को गंभीर रूप से प्रभावित किया हैं।

- **पानी की गुणवत्ता पर प्रभाव :** जब देश में जनसंख्या की वृद्धि का स्तर बढ़ जाता हैं, तो उनके लिये स्वच्छ पानी की व्यवस्था करना एक अहम समस्या उत्पन्न होती हैं। यही

स्थिति भारत की हैं। यहॉ स्वच्छ पानी की तुलना में अपशिष्ट जल का स्तर अधिक हैं। ऐसी स्थिति में इस जल को स्वच्छ एवं साफ जल के रूप में बदलकर जनता की प्यास संबंधी समस्या पूर्ण की जाती हैं, परन्तु फिर भी पानी की मॉग पूर्ण नहीं हो पाती हैं और जल–प्रदूषण का स्तर बढ़ जाता हैं। हमारे देश में कुल अपशिष्ट जल 116 एल.पी.सी.डी. तथा 7007 एम.एल.डी. की दर से बढ़ गया हैं और ऐसा अनुमान लगाया जा रहा हैं कि भविष्य में इसका स्तर और भी बढ़ सकता हैं। **आर एम भारद्वाज (2005) ने यह अनुमान लगाया हैं कि वर्ष 2051 तक भारत में सकल अपशिष्ट जल का स्तर बढ़कर 120000 एम.एल.डी. हो जायेगा।**[31]

भारत में जब–प्रदूषण एक प्रमुख समस्या बनी हुयी हैं। हमारे यहॉ अत्यधिक जल का केवल 10% ही स्वच्छ करके लोगों तक पहुॅचाया जाता हैं। शेष जल (90%) नदियों में बहा दिया जाता हैं। जिसके परिणामस्वरूप **पृथ्वी के भू–जल से लेकर नदियॉ, तालाबों मे अपशिष्ट जल बहा दिया जाता हैं, जिससे ये जल निकाय प्रदूषित हो रहे हैं।**[32]

- **कचरा :** ऐसा माना जाता हैं कि जनसंख्या वृद्धि की दर अधिक होती हैं तो यह निश्चित हैं कि कचरा की मात्रा अधिक होगी। यह कचरा मानव द्वारा प्रतिदिन उपयोग की गयी वस्तुओं के इस्तेमाल से उत्पन्न होता हैं। जिसे एकत्रित करके उस क्षेत्र की नगर पालिका शहर से बाहर फेंक देती हैं। जिससे पर्यावरण प्रदूषण की समस्या उत्पन्न हो जाती हैं। एक अनुमान के अनुसार भारत में कचरे का उत्पादन 375 ग्राम/दिन और 14.9 मीट्रिक टन/वर्ष बढ़ गया हैं और भविष्य में इसमें कितनी वृद्धि होगी, यह कहना संभव नहीं हैं, क्योंकि जनसंख्या दिन–प्रतिदिन बढ़ रही हैं। **डी. विज और कुमार के अनुसार –** "भारत में स्थित महानगरों/शहरों के बाहर अनियंत्रित रूप से कचरे की मात्रा में वृद्धि हो रही हैं, जिससे शहर के बाहरी क्षेत्रों में उसे नष्ट करने में समस्या हो रही हैं और गंभीर वायु प्रदूषण सृजित हो रहा हैं।"[33]
- **कृषि भूमि :** किसी भी देश में जैसे–जैसे जनसंख्या, महानगरों का विस्तार, औद्योगिकरण इत्यादि में वृद्धि होती रहती हैं, तो हमें एक नये बुनियादी ढॉचे की आवश्यकता महसूस होती हैं। भारत की भी ऐसी ही स्थिति हैं। यहॉ कृषि कार्य हेतु जितनी भी भूमि उपलब्ध हैं, उसे लोगों के आवास हेतु इस्तेमाल किया जा रहा हैं। **एस. फजल के अनुसार –** "अधिकॉश भारतीय शहरों में कृषि भूमि को लोगों के आवास हेतु उपभोग करने से पर्यावरण में असंतुलित वातावरण तथा अस्थिरता की स्थिति उत्पन्न हो गयी हैं।"[34]

इस प्रकार कहा जा सकता हैं कि प्राकृतिक संसाधनों का अधिक उपयोग पर्यावरण क्षरण का कारण बनता हैं।

शहरीकरण का विकास : औद्योगिकरण, रोजगार की तलाश, फैंशन, रहन–सहन का उच्च स्तर तथा विलासिता पूर्ण वस्तुओं का उपयोग करने की इच्छा रखने वाले व्यक्ति आदि ऐसे कारण हैं, जिसकी वजह से लोगों ने शहरों में रहना आरंभ किया था। ये सब कारण न केवल विकसित देशों में बल्कि विकासशील देशों में भी शहरीकरण के लिये जिम्मेदार रहे हैं।

यदि हम वैश्विक स्तर पर शहरीकरण की आबादी का मूल्यॉकन करें तो हमें प्राप्त होता हैं कि **वर्ष 1960 तक एक तिहायी से भी कम आबादी शहरों में रहती थी।**[13] लेकिन जैसे–जैसे शहरों का विकास हुआ वैसे–वैसे यह आबादी बढ़ने लगी थी और **वर्ष 2014 तक यह ऑकड़ा पहुॅचकर 54% हो गया था।**[13] भविष्य में यह अनुमान लगाया जा रहा हैं कि वर्ष 2050 तक

यह आबादी बढ़कर 66% तक पहुॅच जायेगी। अतः स्पष्ट हैं कि शहरी क्षेत्रों में आबादी बढ़ने से पर्यावरणीय गिरावट की समस्याऐं सृजित हो रही हैं।

भारत के संदर्भ में शहरीकरण की आबादी के बारे मे ंयह कहा जाता हैं कि शहरीकरण का विकास अचानक नहीं हुआ बल्कि पारम्परिक ग्रामीण आधारित अर्थव्यवस्था से शहरी या औद्योगिक आधारित अर्थव्यवस्था के विकास के परिणामस्वरूप हुआ था अर्थात औद्योगिक, व्यावसायिक, व्यापारिक गतिविधियों में बदलाव के कारण ग्रामीण लोगों का पलायन शहरीकरण की ओर हुआ था। **के डेविस (1965) ने शहरीकरण को परम्परागत आधारित अर्थव्यवस्था से आधुनिक औद्योगिक अर्थव्यवस्था में परिवर्तन की प्रक्रिया के रूप में स्वीकार किया हैं,**[35] जबकि कुछ सामाजिक–आर्थिक दार्शनिक, लेखक एवं इतिहासकार शहरीकरण के विकास को फैशन, शहर के प्रति आकर्षण, जीवनयापन की उच्च शैली इत्यादि कारको को जिम्मेदार मानते हैं। उनका कहना हैं कि जब कोई ग्रामीण शहर में घूमने के लिये आता हैं, तो वह शहर की चकाचौद से प्रभावित हो जाता हैं और शहर की ओर अपना रूख कर देता हैं। शहरीकरण के संबंध में मेरा मानना यह हैं कि शहरो के विकास का एकमात्र कारण आर्थिक हैं, लोग ग्रामीण क्षेत्रों से काम धंधे या रोजगार की तलाश में आते हैं, क्योंकि शहरों में बहुत बड़े पैमाने पर उद्योग, व्यवसाय तथा व्यापारिक गतिविधियॉ संचालित रहती हैं, जिसे निरंतर रूप से चलायमान रखने हेतु व्यापक स्तर पर लोगों या श्रमिकों की आवश्यकता होती हैं इसीलिये ग्रामीण लोग शहरों की ओर अपना रूख करते हैं। **सन 1901 के ऑकड़ों के अनुसार – भारत में शहरी क्षेत्रों में निवासरत जनसंख्या का प्रतिशत 11.4 था, जो कि 2001 और 2011 में बढ़कर क्रमशः 28.53% एवं 30% तक पहुॅच गयी हैं।**[36] भारत में बढ़ती हुयी शहरी जनसंख्या के संबंध में विश्व बैंक का कहना हैं कि वर्ष 2050 तक भारत, इंडोनेशिया, चीन, नाइजीरिया तथा संयुक्त राज्य अमेरिका आदि ऐसे देश हैं, जो दुनिया को शहरी आबादी में सबसे अधिक योगदान देंगे।

भारतीय शहरों में यह आबादी एक साथ नहीं बढ़ी हैं बल्कि धीरे–धीरे शहरों के विकास के परिणामस्वरूप बढ़ी हैं। भारतीय जनगणना के ऑकड़ों से यह पता चलता हैं कि भारत में उदारीकरण के बाद शहरों में बहुत बड़े पैमाने पर ग्रामीणवासियों का प्रवाह देखा गया, जिससे ग्रामीण क्षेत्रों में कृषि पर तो असर हुआ ही इसके साथ–साथ शहरों में जनसंख्या बढ़ने से पर्यावरण से संबंधित समस्याऐं जैसे वायु, जल प्रदूषण, जनसंख्या की सघनता अर्थात एक किमी. के दायरे में अधिक से अधिक जनसंख्या का एक साथ निवास करना जिससे स्वच्छ हवा की समस्या उत्पन्न हो जाती हैं, क्योंकि जनसंख्या की सघनता की वजह से प्रत्येक व्यक्ति तक स्वच्छ वायु नहीं पहुॅच पाती हैं। इसका सबसे अच्छा उदाहरण हम मलिन बस्तियों को ले सकते हैं, जहॉ पर एक किमी के दायरे में कई लोग रहते हैं। इस प्रकार की अधिकॉश मलिन बस्तियॉ मुम्बई में स्थित धारावी हैं, जिसे एशिया की सबसे बड़ी झोपड़ पट्टी कहते हैं। इसका निर्माण मुम्बई शहर के आर्थिक विकास के परिणामस्वरूप हुआ हैं।

भारतीय शहरों में आज हम जिस गति से जनसंख्या वृद्धि को देख रहे हैं, वह सब ग्रामीण जनता का पलायन हैं, जो कि रोजगार की तलाश में शहरों की ओर रूख करते हैं। इसमें एक बड़ा हिस्सा उन लोगों का भी हैं, जो ग्रामीण क्षेत्रों में वर्षों से गरीबी का जीवन यापन कर रहे हैं। **सैनगुप्ता (2005) के अनुसार –** "भारत के अधिकॉश गरीब लोग ग्रामीण क्षेत्रों में रहते हैं और कृषि कार्य मे ंसंलग्न हैं,"[37] हालॉकि भारत सरकार ने गरीबी उन्मूलन योजनायें संचालित की हैं, परन्तु फिर भी गरीबी का अनुपात कम नहीं हुआ और ग्रामीण इलाकों में

दिन–प्रतिदिन बढ़ता गया। ऐसी स्थिति में इन लोगों ने शहरों की ओर पलायन किया और पर्यावरण प्रदूषण से लेकर मलिक बस्तियों के विस्तार में योगदान दिया।

भारत मे तेजी से बढ़ते हुये शहरीकरण, औद्योगिकरण के कारण कई समस्याओं को जन्म दिया। वायु, जल तथा शोर प्रदूषण शहरीकरण की ही देन हैं। शहरों में स्थित उद्योग या व्यावसायिक संगठन चिमनी के माध्यम से एक प्रकार का जहरीला धुँआ छोड़ते हैं, जो वातावरण में मिलकर अत्यधिक कार्बन, नाइट्रोजन ऑक्साईड, कार्बन मोनो ऑक्साईड तथा अन्य खतरनाक गैसों को जन्म देते हैं, जो मानव स्वास्थ्य को गंभीर रूप से प्रभावित करते हैं। मानव स्वास्थ्य को प्रभावित करने में वायु–प्रदूषण सबसे उच्च स्थान पर हैं, इसके कारण श्वसन या सॉस संबंधी बीमारी का खतरा बना रहता हैं। आज यह भारत की एक प्रमुख समस्या बन गयी हैं। जिसका ज्वलंत उदाहरण भारत की राजधानी कहा जाने वाला शहर/प्रदेश दिल्ली हैं।

भारत के शहरों में जो जनसंख्या वृद्धि हो रही हैं, वह मुख्य रूप से प्राकृतिक संसाधनों के अत्यधिक दोहन का कारण बनती हैं, जिसके परिणामस्वरूप पर्यावरण में प्राकृतिक संसाधनों की कमी, जिसे हम दुर्लभ संसाधन भी कहते हैं, उत्पन्न हो जाती हैं और पर्यावरण का स्तर गिर जाता हैं, हालॉकि यह सत्य हैं कि मानव विकास हेतु आर्थिक विकास की प्रक्रिया सतत रूप से संचालित रहना चाहिये, जो कि शहरीकरण की एक प्रमुख विशेषता हैं, परन्तु इसका मतलब यह नहीं हैं कि हम पर्यावरण पर ध्यान दिये बगैर प्राकृतिक संसाधनों का उपयोग करते जाये, क्योंकि ऐसा करने से **कार्बन डाय–ऑक्साईड, कार्बन उत्सर्जन और ग्लोबल वॉर्मिंग की समस्या उत्पन्न हो जाती हैं।**[38]

अतः आवश्यकता हैं कि पर्यावरण को बचाने तथा संरक्षित बनाये रखने के लिये जनसंख्या को नियंत्रित करना अति आवश्यक हैं, क्योंकि पर्यावरणीय गिरावट या क्षरण के लिये केवल और केवल बढ़ती हुयी जनसंख्या ही जिम्मेदार हैं।

निष्कर्ष : विश्व के विभिन्न दार्शनिको तथा अर्थशास्त्रियों के बीच यह बहस का मुददा बना रहा हैं कि किसी भी देश मे बढ़ती हुयी जनसंख्या किस प्रकार उस देश की अर्थव्यवस्था को लेकर पर्यावरणीय मुददों तक को गंभीर रूप से प्रभावित कर देती हैं। यह बेरोजगारी, आय की असमानता, गरीबी जैसे आर्थिक मुददों के लिये तो जिम्मेदार होती ही हैं, इसके अलावा आज यह पर्यावरण से संबंधित अनेक मुददों या समस्याओं के लिये जिम्मेदार बनी हुयी हैं। वायु प्रदूषण से लेकर जल, शोर प्रदूषण तक जनसंख्या ही जिम्मेदार हैं। इसके अतिरिक्त पर्यावरण प्रदूषण से संबंधित एक और मुददा उभरकार आया हैं और वह हैं प्लास्टिक कचरा या अपशिष्ट, जो कि वर्तमान की एक मुख्य समस्या बनी हुयी हैं, क्योंकि ये अपशिष्ट (प्लास्टिक) इसलिये भी खतरनाक हैं कि इसे नष्ट करना मुश्किल हैं। आज यह कचरा नालियों में एकत्रित होकर उसे जाम कर रहा हैं, जिससे गंदा पानी नालियों के ऊपर आकर मानव को विभिन्न प्रकार की बीमारियों से ग्रसित कर रहा हैं, यह सब बढ़ती हुयी आबादी एवं विकास प्रक्रिया का परिणाम हैं, अतः आवश्यकता हैं कि किसी भी तरह से बढ़ती हुयी आबादी को रोका जाये, तभी पर्यावरण हमारे और हमारे भविष्य के लिये सुरक्षित बच पायेगा।

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ABOUT THE BOOK

The environment is all that is present surrounding us. All living organisms on this earth live naturally in the environment. But in the current global scenario, it has been observed that human beings and their certain activities are continuously affecting mother nature in a negative way. As such, in the 21st century our environment is facing lots of problems like climate change, depletion of natural resources, ozone layer depletion, pollution, population explosion, different diseases including COVID-19, extinction of species due to exploitation mostly by human, etc. It is high time to rescue our environment and to help it maintain in a sustainable way for our next generations. The various chapters included in this book are from different areas of environment studies like Human population and environment, the impact of COVID-19 on the environment, environmental degradation and challenges faced during the 21st century, waste management, pollution, environmental laws, etc. I sincerely hope that this book will be of great help and support to all the teachers, students, researchers, foresters, other activists who are directly and indirectly associated with environmental studies and its protection.

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