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Semester-IV

Self-Learning Material

Paper Code: GEO/DSE/EG/T-420

Paper: Environmental Geography- III: ENVIRONMENTAL ISSUES
(Special Paper)

DIRECTORATE OF OPEN AND DISTANCE LEARNING (DODL)

UNIVERSITY OF KALYANI

Kalyani, Nadia West
Bengal, India

GEO/DSE/EG/T-420	**Environmental Geography- IIi: ENVIRONMENTAL ISSUES (Special Paper)**
Units	**Compiled By**
Unit-1: Concept of the scale of environmental issues	Dr. Ayan Rudra
Unit-2: Contemporary global issues in environment: deforestation and biodiversity loss	Dr. Ayan Rudra
Unit-3: Contemporary global issues in environment: global warming and sea-level change	Dr. Ayan Rudra
Unit-4: Contemporary global issues in environment: wetland and wasteland	Dr. Ayan Rudra
Unit-5: Environmental migration and environmental refugee	Dr. Ayan Rudra
Unit-6: Social pathology: crime	Dr. Ayan Rudra
Unit-7: Social pathology: disease	Dr. Ayan Rudra
Unit-8: Global resource scarcity with special reference to freshwater	Dr. Ayan Rudra
Unit-9: Environmental pollution with reference to e-waste and other non-degradable waste products	Dr. Ayan Rudra
Unit-10: Ground water contamination: Arsenic	Dr. Ayan Rudra
Unit-11: Ground water contamination: Fluoride	Dr. Ayan Rudra
Unit-12: Noise pollution	Dr. Ayan Rudra

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Director's Message

Satisfying the varied needs of distance learners, overcoming the obstacle of distance and reaching the unreached students are the threefold functions catered by Open and Distance Learning (ODL) systems. The onus lies on writers, editors, production professionals and other personnel involved in the process to overcome the challenges inherent to curriculum design and production of relevant Self Learning Materials (SLMs). At the University of Kalyani a dedicated team under the able guidance of the Hon'ble Vice-Chancellor has invested its best efforts, professionally and in keeping with the demands of Post Graduate CBCS Programmes in Distance Mode to devise a self-sufficient curriculum for each course offered by the Directorate of Open and Distance Learning (DODL), University of Kalyani.

Development of printed SLMs for students admitted to the DODL within a limited time to cater to the academic requirements of the Course as per standards set by Distance Education Bureau of the University Grants Commission, New Delhi, India under Open and Distance Mode UGC Regulations, 2020 had been our endeavour. We are happy to have achieved our goal.

Utmost care and precision have been ensured in the development of the SLMs, making them useful to the learners, besides avoiding errors as far as practicable. Further suggestions from the stakeholders in this would be welcome.

During the production-process of the SLMs, the team continuously received positive stimulations and feedback from Professor (Dr.) Amalendu Bhunia, Hon'ble Vice- Chancellor, University of Kalyani, who kindly accorded directions, encouragements and suggestions, offered constructive criticism to develop it within proper requirements. We gracefully, acknowledge his inspiration and guidance.

Sincere gratitude is due to the respective chairpersons as well as each and every member of PGBOS (DODL), University of Kalyani. Heartfelt thanks is also due to the Course Writers-faculty members at the DODL, subject-experts serving at University Post Graduate departments and also to the authors and academicians whose academic contributions have enriched the SLMs. We humbly acknowledge their valuable academic contributions. I would especially like to convey gratitude to all other University dignitaries and personnel involved either at the conceptual or operational level of the DODL of University of Kalyani.

Their persistent and co-ordinated efforts have resulted in the compilation of comprehensive, learner-friendly, flexible texts that meet the curriculum requirements of the Post Graduate Programme through Distance Mode.

All the Self Learning Materials are self-writing and collected from e-book, journals and websites.

Director
Directorate of Open and Distance Learning
University of Kalyani

Syllabus

SEMESTER-IV						
Paper Code	**Paper**	**Theory/ Practical**	**Internal Assessment / Evaluation**	**Examination / Report/ Viva-Voce**	**Credit**	**Marks**
GEO/DSE/EG/ T-419	**Environmental Geography- II: ENVIRONMENTAL ISSUES (Special Paper)**	Theory	10	40 (Semester-end Examination)	4	50

Unit-1: Concept of the scale of environmental issues

Unit-2: Contemporary global issues in environment: deforestation and biodiversity loss

Unit-3: Contemporary global issues in environment: global warming and sea-level change

Unit-4: Contemporary global issues in environment: wetland and wasteland

Unit-5: Environmental migration and environmental refugee

Unit-6: Social pathology: crime

Unit-7: Social pathology: disease

Unit-8: Global resource scarcity with special reference to freshwater

Unit-9: Environmental pollution with reference to e-waste and other non-degradable waste products

Unit-10: Ground water contamination: Arsenic

Unit-11: Ground water contamination: Fluoride

Unit-12: Noise pollution

Mode of Internal Evaluation: Class test

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1.1 INTRODUCTION

Environmental issues are the set of challenges and problems facing Earth and its natural systems. From climate change and pollution to overpopulation and energy use, these issues are complex and interconnected. Environmental issues are the harmful effects of human activities on the environment. These include pollution, overpopulation, waste disposal, climate change, global warming, the greenhouse effect, etc. Various environment protection programs are being practised at the individual, organizational and government levels with the aim of establishing a balance between man and the environment.

The environmental issue may be posed in terms of a social issue based on the fact that it plays a significant role within opinion and public debate, that it is subject to an institutional context weighting and that it makes the positioning of collective initiatives inevitable, and also highlights the individual commitments regarding environmental issues. However, the environmental issue is also a social issue insofar as the given social context, in return, shapes part of the scope and characteristics of the environmental issue. The place, the time or the context, both social and political, in which the environmental issue is formulated, are not strangers to its main features.

Nevertheless, in this sense, as regards the social context, the environmental issue not only concerns physical processes, or hazards. It is also a product of historical facts and of society. Environmental issues were not a major concern of the United Nations in the period following its establishment in 1945. In 1949, the United Nations convened its first conference on the environment, the UN Scientific Conference on the Conservation and Utilization of Resources, to address the urgent issue of the improvident use of the earth's dwindling resources against the background of dramatic population growth and increasing resource demand

Some of the current environmental issues that require urgent attention are:

Climate Change: - Climate change is a great concern in today's scenario. This problem has surfaced in the last few decades. Greenhouse gases are the major cause of climate change. Environmental changes have several destructive impacts such as the melting of glaciers, change in seasons, epidemics, etc.

Global Warming: - The burning of fossil fuels, emissions from automobiles and chlorofluorocarbons add to the greenhouse gases in the atmosphere. This has led to an increase in the earth's temperature causing environmental changes. This increase in temperature across the globe is known as global warming.

Ozone Layer Depletion: - The ozone layer is a layer of concentrated ozone gas. It protects us from the sun's harmful ultraviolet rays. This very important layer is being destroyed by CFCs (chlorofluorocarbons), which are used in industries and everyday life (e.g. aerosol cans). The chlorine in these compounds destroys the ozone layer. The hole in the ozone layer leaves humans and wildlife exposed to harmful UV rays resulting in several skin diseases including cancer.

Water Pollution: - The introduction of harmful substances into rivers, oceans, lakes and ponds, which changes the physical, chemical or biological condition of the water is called water pollution. The polluted water lacks oxygen and therefore the organisms die. Water is the main source of life and therefore it is our prime duty to prevent it from any kind of pollution.

Air Pollution: - Air pollution is the result of emissions from industries, automobiles, and the increasing use of fossil fuels. The gaseous emissions have added to an increase in the temperature of the earth. Not only this, but it had also increased the risk of diseases among individuals.

Solid Waste Management Solid-waste management is defined as the discipline associated with the generation, storage, collection, transfer and transport, processing, and disposal of solid waste in a manner that it does not have a harmful effect on the environment.

Deforestation: - Deforestation is the depletion of trees and forests at an alarming rate. The trees provide us with oxygen and several raw materials and also maintain the temperature of the earth. Due to the depletion of trees for commercial purposes, there has been a drastic change in the earth's climate. Forests are an abode to a large number of wild animals and plants. Destruction of forests has led to the elimination of a large number of plants and animal species affecting biodiversity.

Overpopulation: - The earth's population is increasing drastically. It is estimated to be more than seven billion. The increasing population has led to a shortage of resources. If this continues, it will be very difficult to sustain such a huge population. The other environmental issues including pollution, waste management, deforestation, climate change and global warming are all associated with overpopulation.

1.2 LEARNING OBJECTIVES

The present section aims to introduce the following topics –

- Different types of scale related to environmental issues.
- Concept of deforestation and biodiversity loss.
- Concepts global warming and its challenges.
- The global change of sea level and its impact on environment.
- Understand the concept of Wetland and wasteland and its management.
- The key issues of environmental refugee and its link with environmental migration.
- Concept of disease and crime as social pathology.
- Issues and challenges of global resource scarcity and importance of freshwater.
- E-waste pollution and its impact on environment..
- Non-degradable waste product and its theame.
- Ground water contamination with special reference to arsenic and fluoride..
- Measuring and impact of noise pollution.

1.3 ASSESSMENT OF PRIOR KNOWLEDGE

Discussion about nature, scope and relevance of environmental geography is necessary. Discussion about recent trends in environmental research is necessary.

1.4 LEARNING ACTIVITIES

The preparation of short notes and essays on different topics will be discussed in Personal Contact programs (PCPs).

1.5 FEEDBACK OF LEARNING ACTIVITIES

Debate and discussion on various topics discussed in the class may be conducted. Class seminar on various topics may be arranged.

UNIT: - 1

Concept of the Scale of Environmental Issues

Introduction: - Environmental issues are disruptions in the usual function of ecosystems. Further, these issues can be caused by humans (human impact on the environment) or they can be natural. These issues are considered serious when the ecosystem cannot recover in the present situation, and catastrophic if the ecosystem is projected to certainly collapse. Environmental protection is the practice of protecting the natural environment on the individual, organizational or governmental levels, for the benefit of both the environment and humans. Environmentalism is a social and environmental movement that addresses environmental issues through advocacy, legislation education, and activism. Environmental issues result from a combination of natural causes and human impact. While the Earth's ecosystems are designed to handle certain amounts of natural disturbances (such as forest fires and floods), human activities can create circumstances in which they happen with greater frequency or intensity. Since the Industrial Revolution, the burning of fossil fuels and other activities has increased the number of greenhouse gas emissions in Earth's atmosphere, leading to an increase in global warming. The resulting climate change has accelerated disruption of the environment and vital natural processes. Land use practices, extraction of natural resources, waste disposal and other human behaviors also contribute to environmental issues.

What are the main types of environmental issues? - Each environmental issue contributes to a host of interconnected challenges facing the Earth and human beings. Here's a closer look at some of the main types of environmental issues (https://www.ibm.com/topics/environmental-issues): 1. Climate change, 2. Loss of biodiversity, 3. Air pollution, 4. Ocean health, 5.Water pollution, 6. Overpopulation, 7. Energy use, 8. Weather events

1. Climate change: - Climate change refers to the long-term changes in temperature, precipitation, and other weather patterns caused by human activities such as burning fossil fuels. These activities have increased the number of greenhouse gas emissions released; these emissions trap heat within Earth's atmosphere, leading to increasing global temperatures. According to NASA, the Earth's average surface temperature has risen by about 1°C since the late 19th century. The results include melting glaciers, rising sea levels, disrupted ecosystems and an increase in severe weather events such as droughts, floods, heat waves and wildfires.

2. Loss of biodiversity: - Biodiversity refers to the variety of life on Earth, including animals, plants, and microorganisms. From the Amazon to the tundra, biodiversity is essential to the ecological balance of the planet. A loss of biodiversity can lead to species extinction, put food and water supplies at risk and reduce carbon sequestration (the natural process of removing carbon dioxide from the atmosphere, which is essential to reducing climate change). Human activities, such as deforestation, agricultural expansion, land use changes and pollution, contribute to the overall loss of biodiversity. The use of pesticides can also

harm non-target species and disrupt ecosystems. According to the World Wildlife Fund, the Earth has lost 69% of its wildlife populations since 1970.

3. Air pollution: - Air pollution refers to the presence of harmful substances such as carbon dioxide, methane, and nitrogen dioxide in the air that people breathe. The burning of fossil fuels, industrial processes, transportation, and wildfires can have a negative impact on air quality. Exposure to fine particles, ground-level ozone, and other pollutants can cause respiratory problems, heart disease, cancer, and other health conditions. According to the World Health Organization, outdoor air pollution causes 4.2 million premature deaths every year.

4. Ocean health: - The Earth's oceans face several threats. Oceans absorb almost a third of the carbon dioxide that is released into the atmosphere; as global carbon emissions raise, so does the amount that is absorbed by oceans, leading to acidification. Ocean acidification can harm marine life, disrupt ecosystems, and impact global food security. Pollution also puts the oceans at risk: the United Nations estimates that 11 million metric tons of plastic enter the water each year. While wastewater, oil spills, chemicals, and other pollutants cause harm to living organisms and their habitats. Also, as global warming melts Earth's glaciers, sea levels rise, this can harm marine life and cause coastal flooding and erosion.

5. Water pollution: - Beyond the ocean, Earth's other water supplies are also facing challenges. Safe drinking water is critical for human health; however, industrial waste, pesticides, and agricultural processes can pollute water sources. The presence of the resulting bacteria and chemical concentrations in drinking water can cause digestive problems, neurological illnesses, skin infections and more. More than a billion people worldwide do not have access to clean water. As climate change and human actions shrink the available water supply, two-thirds of the world's population may face water shortages by 2025.

6. Overpopulation: - According to the United Nations, the world's population is expected to reach 9.7 billion by 2050. As the global population grows, so does demand for natural resources, as well as human impact on the environment. Without sustainable development, overpopulation can lead to shortages in food and water and other resource depletion. It can also exacerbate issues like waste disposal, pollution, and deforestation that can contribute to public health problems.

7. Energy use: - Overall energy use can have a major impact on the environment. Today, fossil fuels are the primary source of energy for most individuals, businesses, and industries. However, their combustion is a significant source of greenhouse gas emissions and may contribute to other environmental problems such as acid rain. Renewable energy sources such as solar, wind, and hydropower may offer ways to reduce carbon emissions but come with potential environmental impacts of their own.

8. Weather events: - Extreme weather events—such as hurricanes, floods, wildfires, droughts, and snowstorms—are becoming more frequent and severe due to climate change. These events pose a threat to both the environment and human populations, and can cause significant damage to infrastructure, homes and ways of life. Rising temperatures and rising

sea levels, among other factors, contribute to the increase in extreme weather conditions. According to the World Meteorological Organization, extreme weather and climate events were responsible for 2 million deaths and USD 4.3 trillion in economic losses between 1970 and 2021.

How are people and organizations addressing environmental issues? - Individuals, governments, organizations, and communities are attempting to address environmental issues in various ways:

a. Research and education: - Through scientific research and development, people are learning more about the causes of environmental issues and ways to limit or repair their negative consequences. New technologies, including advances in renewable energy sources and energy-efficient operations, can help reduce carbon emissions. Ecology and environmental science can offer a better understanding of how human activities affect Earth in complex ways. Public education efforts spread knowledge about the harmful impact of some behaviors and practices on the environment and can drive interest in environmental protection and sustainable development.

b. International cooperation: - Collaborative international efforts are attempting to find and implement solutions that mitigate environmental problems. Environment, health and safety (EHS) organizations focus on safeguarding the environment from pollution and degradation. They play a role in researching and advising on environmental management and protection measures to reduce the negative impact of human activities, emissions, and hazardous materials on ecosystems. Treaties, such as the Paris Agreement, are aimed at addressing climate change on an international scale. Sharing resources and best practices between countries can also lead to more effective environmental protection efforts.

c. Corporate responsibility: - More companies are adopting corporate social responsibility policies and operating with environmental challenges in mind. They seek to increase sustainability in business to minimize any contribution to environmental change. Their efforts might include reducing emissions and their carbon footprint, by using less water and energy, and minimizing waste and improving waste management. Transparency in reporting their environmental impact, by using environmental, social, and governance (ESG) reporting frameworks. And as mandated by directives like Europe's Corporate Sustainability Reporting Directive (CSRD), helps hold companies accountable and allows consumers to make informed choices. Many are following the recommendations set forth by the Task Force on Climate-related Financial Disclosures, or TCFD, to inform investors, shareholders, and the public of their climate-related financial risks. Efforts to address environmental impact might help businesses find cost-saving measures and build trust and loyalty from consumers and investors.

d. Economic incentives: - Some governments use economic incentives, such as taxes and subsidies to address environmental problems and foster environmentally friendly practices. For example, some used carbon taxes in an attempt to deter pollution-causing activities or used subsidies to help make electric cars or solar panels more affordable. Investments in

sustainable infrastructure, such as public transportation and energy-efficient buildings, can also provide long-term economic and social benefits while reducing environmental impact.

e. Individual action: - Some people are making lifestyle choices with the goal of reducing their environmental impact at an individual level. These choices may include reducing energy use, recycling, choosing sustainable products, or reducing water waste. Individuals can also advocate for environmental issues and support policies and businesses that prioritize sustainability.

Why is scaling such a difficult issue? - Scaling, that is, the idea that processes in nature and society have their characteristic spatial and temporal domains, presents us with a paradox. When we think about it, the need to be explicit about scale seems self-evident: various processes take such-and-such a time and extend so far but not further, and short-term, spatially restricted events seldom add up to long-term, spatially extended processes in a smooth, linear fashion. In fact, both theoretical considerations and empirical evidence suggest that linear scaling is a rare exception and non-linearity is the rule. On the other hand, however, when we do not consciously think about scaling, this self-evidence evaporates and we lapse into scale-free consideration. My aim in this introductory essay is to come to terms with this paradox. The paradox arises because the idea of non-linear scaling hits against one of the basic certainties in western thinking: that an unambiguous and universal standard can be found against which all phenomena in nature and society can be reflected. The world is ordered and can be depicted by an ultimate representation, similar to a map. Scaling in research would then be similar to making different reproductions of the ultimate map in a broader or finer scale as the need be, just as one takes different prints of a topographic map for different purposes (Haila, 2002).

One could also say that scale-free thinking is ingrained in the 'metaphysics', that is, the presuppositions underlying modern scientific thinking. A preliminary understanding of metaphysics can be derived from R.G. Collingwood's An Essay on Meta-physics (Collingwood, 1998). According to this conception, metaphysics comprises such presuppositions about the nature of reality which have to be accepted in order that systematic scientific study of nature is possible at all. The notion of 'presupposition' is essential. The necessity of presuppositions in science is analogous with their necessity in language. Collingwood aimed at identifying the critical presuppositions of modern science and tracing their history. To make a long story short, as particularly important presuppositions he identified absolute space, absolute time, and one-to-one causality in a uniform and unified world. This metaphysics looms large behind our problems with scaling: if absolute space, absolute time, and uniform causality are presupposed, scaling is reduced to a technical operation. All processes of nature take ultimately place in an ordered world in which every-thing has its place, time and ultimate cause. Large versus small entities, and slow versus fast processes, of course, differ from each other, but an external reference is always available for assessing the distinction. This is analogous to the Galilean relativity principle that the movement of ships relative to each other can be reliably assessed using the shore as a reference (Haila, 2002).

Scale of Environmental issues: - There are three types of environmental issues, like; - 1. Global environmental issues, 2. National environmental issues and 3. Regional environmental issues.

1. Global Environmental Issues: - Environment is the foundation and support of human existence and survival and the guarantee of sustainable human development; environmental protection has undoubtedly become a common understanding and development strategy of all countries of the world. Now humankind is striving into the historical process of postindustrial society and is trying to reach rebalance with environment in later stage of development. All countries need to perform respective duties and obligations in environment governance, in joint efforts to plan economic development, social progresses and environment protection to realize mutual wins and sustainable development of the world and to create an Earth homeland for harmonious co-existence of humankind and environment (Jianping et al. 2013).

Global environmental issues present a comprehensive and stimulating introduction to the key environmental issues presently threatening our global environment. As early as 1896, the Swedish scientist Svante Arrhenius had predicted that human activities would interfere with the way the sun interacts with the earth, resulting in global warming and climate change. His prediction has become true and climate change is now disrupting global environmental stability. The last few decades have seen many treaties, conventions, and protocols for the cause of global environmental protection. Few examples of environmental issues of global significance are:

- Ozone layer depletion
- Global warming
- Loss of biodiversity

One of the most important characteristics of this environmental degradation is that it affects all mankind on a global scale without regard to any particular country, region, or race. The whole world is a stakeholder and this raises issues on who should do what to combat environmental degradation. With the help of many surveys and a lot of research, it has been found that more than 50% of people across the globe believe that abrupt climate change is the biggest global concern. It is seriously impacting the health of our planet and is the reason behind so many other problems, for example more droughts, more floods and many other extreme events. The good news is that most people are ready to change their lifestyle to fix it and save the environment. Apart from climate change, there are other environmental problems as well, and if we're going to save the planet we better know what we're up against (https://www.ecobin.com.au/blogs/blog/top-10-global-environmental-problems).

2. National Environmental Issues: - The entire south Asian region is threatened by climate change. Changes in average weather conditions are likely to create hotspots across the region and have negative impacts on living standards and gross domestic product (GDP). India is at the core of this trend: it ranks 14th in the last United Nations global climate risk index and in 2017 it was the second most-affected country in terms of casualties related to extreme weather. Air quality in Indian cities is quickly deteriorating and it is today worse than the

situation in China: in the 2018 World Health Organization (WHO) global ambient air quality database, 11 of the 12 cities with the highest levels of small particulate – PM2.5 – are located in India. Air pollution goes hand in hand with poverty: in 2016 an estimated 790 million people (almost 60 % of the Indian population), still relied on biomass for cooking. Deforestation, water pollution, clean water shortages, and waste management are further issues of concern. The Indian authorities have taken several initiatives to tackle these issues. In 2008, the first national plan on climate change (NAPCC) outlined eight 'national missions' running up to 2017. India is a leader in the implementation of the Paris Agreement on climate change. It is a founding member of the International Solar Alliance and has ambitious targets in terms of solar power energy. It has launched a national clean air program (NCAP) to combat air pollution. The EU supports Delhi's efforts on tackling its environment challenges. At their March 2016 summit, the EU and India agreed on two joint declarations: on an India-EU water partnership and on a clean energy and climate partnership. The joint declaration on partnership for smart and sustainable urban development signed at the India-EU Summit in October 2017 is the framework for EU support for India's urbanization challenges.

3. Regional or Local Environmental Issues: - Regional environmental issues transcend local boundaries, impacting broader geographical areas (https://www.adda247.com/teaching-jobs-exam/environmental-issues/).

Water scarcity: -

- Water scarcity is a significant regional challenge, often caused by factors such as droughts, overconsumption, or inadequate water management practices.
- Regions experiencing water scarcity face difficulties in meeting the needs of their populations, sustaining agriculture, and supporting ecosystems that rely on adequate water availability.

Land degradation: -

- Land degradation is another regional environmental issue with severe consequences.
- Unsustainable agricultural practices, overgrazing, and land mismanagement can lead to soil erosion, desertification, and the loss of fertile land.
- Regional land degradation compromises food security, exacerbates the effects of climate change, and contributes to the loss of biodiversity

Loss of Biodiversity: -

- The loss of biodiversity is a regional concern resulting from habitat destruction, invasive species, and pollution.
- When regional ecosystems lose their diversity of species, it disrupts the balance and functioning of these ecosystems.
- This loss of biodiversity affects ecosystem services, such as pollination, nutrient cycling, and pest control, ultimately impacting food production, water quality, and the resilience of regional ecosystems.

Acid Rain: -

- Acid rain is a regional environmental issue caused by emissions of pollutants like sulfur dioxide and nitrogen oxides from industrial activities.
- These pollutants combine with atmospheric moisture to form acids that fall back to the Earth's surface as acid rain.
- Acid rain can damage forests, lakes, and infrastructure, particularly in regions downwind of industrial areas where emissions are concentrated.

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UNIT: - 2

Contemporary global issues in environment: deforestation and biodiversity loss

Introduction: - Over the last few decades, unprecedented global population growth has led to increased demand for food and shelter. At the same time, extraction of natural resources beyond the Earth's resilience capacity has had a devastating effect on ecosystems and environmental health. Furthermore, climate change is having a significant impact in a number of areas, including the global hydrological cycle, ecosystem functioning, coastal vulnerability, forest ecology, food security, and agricultural sustainability. According to the Intergovernmental Panel on Climate Change (IPCC), only immediate and sustained action will prevent climate change causing irreversible and potentially catastrophic damage to our environment. This book presents various scientific views and concepts, research, reviews, and case studies on contemporary environmental issues in changing climate scenarios and highlights different adaptation measures. Increasing awareness of modern-day patterns of climate change, it addresses questions often raised by environmental scientists, researchers, policymakers and general readers (Singh et al. 2020).

Deforestation: - Deforestation and degradation of forests create ecological problems in every part of the world. Deforestation is occurring at a rapid pace, especially in tropical regions where millions of acres are clear cut every year. Remaining forests also suffer from pollution and selective logging operations that degrade the integrity of local ecosystems. Destruction of forests also affects the soil and water quality in the immediate area and can have an adverse effect on biodiversity over a range of connected. Forest degradation is a process in which the biological wealth of a forest area is permanently diminished by some factor or by a combination of factors. "This does not involve a reduction of the forest area, but rather a quality decrease in its condition. "The forest is still there, but with less number of trees, or less species of trees, plants or animals, or some of them affected by plagues. This degradation makes the forest less valuable and may lead to deforestation. Forest degradation is a type of the more general issue of land degradation (Ansari, 2018).

Deforestation leads to habitat loss while preservation and conservation of the natural forest increase biological diversity. Through the biological diversity of the natural forest the basis for life on earth provided, including human existence and it is a sure means of securing the abundance of the earth for people of the future. In essence, by conserving the forest, we do not just guarantee the survival of several other habitats but also the survival of the human environment. In the long run, we can have food security, improved agriculture, recreational pursuits and other derive benefits through different the varieties of life that the forest houses by conserving the different characteristic elements and the biological diversity of the forest (Meyer et al. 2003). Biological diversity is the assurance we need for healthy living presently and in the future as the entire scope of the uncommonly rich and assorted biological legacy of the tropical areas is presently in danger. The reasons why the issue of deforestation and habitat loss should be seen as global concern and given urgent attention are so many; some of which are the exploding human population, the continuous scientific advancement of new uses for biological diversity and currently the extinction or the gradual disappearance of some

rare plants and animals. Despite these alarming circumstances, some countries of the world are still destroying the forest in their surroundings, especially the ones with high income. The poor countries of the world have relatively low rates of deforestation because their available income is limited in carrying out large scale exploitation in their environment; and as the incomes of these countries rises, more lands are being deforested for the purposes of development.

Conceptual Clarifications:

A. Deforestation: - Deforestation can be defined comprehensively to incorporate the change or conversion of a natural forest to a non-forest for purposes of agricultural services and development (Gimah & Bodo, 2019). In a nutshell, we can conclude that deforestation simply means the permanent transition from forest to all other land uses. About half (47 percent) of Earth's forest front of over 8,000 years have gone into extinction as a result of human action. Despite the above unfortunate incident, above 25 percent of the earth surface is still covered with forest or 3.5 million hectares (ha). 55 percent are situated in developing nations, fundamentally in the tropical world. According to Angelsen (2001), from 1980 to 1995, the developing nations lost around 200 million ha (10%) of their forested areas, while developed nations extended their forested areas to around 20 million ha.

1. Forest Degradation: - Forest degradation is a process which negatively affects the structural and functional characteristics of a forest. Forest degradation usually results from human activities, which are greatly influenced by the variety of macroeconomic, demographic, technological, institutional and political factors. The degradation of the forest do not happen suddenly (like an earthquake) but a gradual process, that may take a long period before it is visibly ascertained, implying that the forest degrades over time. The gradual degradation of the forest can also occur due to increased disturbance resulting in loss of forest products or the reduction of forest quality - the thickness and structure of the trees, the biological administrations that provided the biomass of plants and animals, the species variety and the hereditary variety. When the quality of the forest drops, the forest's biotic components may also be affected leading to reduction of the quality of the soil and water, and interactions between the individual components, ultimately affecting forest functioning and diminishing the provision of ecosystem goods and services. Man is solely responsible for forest degradation because of his unsustainable exploitation through excessive harvesting of forest products, overgrazing, wildfires, and the spread of invasive species or pests.

2. Forest Fragmentation: - Forest fragmentation is the breaking of enormous, ad-joining, forested regions into more modest bits of forest; ordinarily these pieces are isolated by streets, farming activities, utility passageways, regions, or other human developmental projects. It ordinarily happens steadily, starting with clearing few portions of the forested lands for temporary or permanent human activity. After some time, those non-forested patches gradually extend into deeper part of the forest and continue to grow until most parts of the forest are affected, leading to the reduction in the quality, function and value of the remaining forest.

3. Afforestation: - Afforestation is the transformation from other land uses into forest, or the expansion of the shelter cover over the 10% threshold. Afforestation is the converse of deforestation and incorporates territories that are effectively changed over from other land uses into forest through conscious human effort. For instance, consciously planting trees in an abandoned agricultural field will over time, transform such area to a forest. Afforestation also entails the natural transitions of non-forest areas into forest.

4. Reforestation: - Reforestation is the re-enforcement of forest formations especially with a noticeable reduction in the number of individual trees, quality and value of the forest below 10% canopy cover due to the activities of the humans or natural disturbances. According to Tejaswi (2007), "the definition of forest clearly states that forests under regeneration are considered as forests even if the canopy cover is temporarily below 10 per cent". Thus, reforestation can be said to be planting more trees in places in the forest where the richness of the forest is seen to be depreciating or generally restoring a dying forest.

5. Forest Improvement: - Forest improvement is simply increasing the richness (number of trees) or stocking within a forest to restore the forest to its full or former capacity and increase sustain-able usage. Forest improvement can also be defined as the increase of canopy cover and/or stocking of the forest through growth. Generally, forest improvement is the long-term increase of the overall potential supply of benefits from the forest, which incorporates biodiversity and every other product or services.

B. Habitat Loss: - Habitat loss is the process by which a natural habitat becomes incapable of supporting its native species there-by leading to total or partial loss of the richness or bio-diversity. Basically, three major types of habitat loss can be identified: habitat destruction, habitat degradation, and habitat fragmentation.

1. Habitat Destruction: - Habitat destruction is the cycle in which natural habitat is harmed or wrecked so much that it is no longer capable of supporting the species and biological networks that normally happen there. This scenario brings about the elimination of species and, subsequently, the deficiency of biodiversity. Most habitats are greatly destroyed directly by the numerous human activities, where a large portion land is usually cleared for farming, mining, logging, hydroelectric dams, and developmental structures (Bodo & Gimah, 2019). Very unfortunately, it is reported that humans are currently destroying natural habitats at a rate and spatial extent that exceed the level of at which most species and communities can survive. Aside from the human induced factors, habitat destruction can also be caused by natural circumstances like floods, volcanic eruptions, seismic tremors, and atmosphere variances. Despite the fact that habitat destruction fundamentally causes species eradications, it can likewise open up new living space that may give a climate wherein new species can develop, in this manner exhibiting the versatility of life on Earth.

2. Habitat Degradation: - Habitat degradation is another outcome of human activities. The continual quest of humans to develop the environment has led to habitat degradation. The resultant effects of this human developmental agenda are environ-mental contamination, climate change, and the introduction of obtrusive species, and general reduction in the quality

of the environment, making it hard for local plants and creatures to flourish. Of the factors that are aiding habitat degradation is urbanization. On the rise, small villages are the turned into towns and cities; leading to an increase in human population and also the demand for land. This scenario will lead to a bigger reality where habitat degradation not only affects native species and communities but human populations as well. Human's survival depends on healthy lands, because degraded lands are frequently lost to erosion, desertification, and nutrient depletion.

3. Habitat Fragmentation: - Habitat fragmentation is often defined as a process during which a large expanse of habitat is transformed into a number of patches of a smaller total area, separated from each other and different from the original pattern. In simple term, forest fragmentation is the breaking of large, contiguous, forested areas into smaller pieces of forest; typically these pieces are separated by roads, agriculture, utility corridors, subdivisions, or other human development. It usually occurs incrementally, beginning with cleared patches scattered within the area. Over time, those non-forest patches tend to multiply and expand until eventually the forest is reduced to scattered, disconnected forest islands. Fragmentation is caused by both natural and anthropogenic processes in terrestrial and aquatic systems.

World Deforestation

According to Professor Norman Myers, one of the foremost authorities on rates of deforestation in tropical forests, "the annual destruction rates seems set to accelerate further and could well double in another decade" (Myers, 1992). Mostly deforestation has occurred in the temperate and sub-tropical areas. Deforestation is no longer significant in the developed temperate countries now and in fact many temperate countries now are recording increases in forest area (Anon., 1990a; 2010). In most instances developed nations are located in temperate domains and developing nations in tropical domains. However deforestation was significantly less in tropical moist deciduous forest in 1990-2000 than 1980-1990 but using satellite imagery it was found that FAO overestimated deforestation of tropical rainforests by 23 per cent (Anon., 2001a; b). However the definition of what is and what is not forest remains controversial. The tropical rainforests capture most attention but 60 per cent of the deforestation that occurred in tropical forests during 1990-2010 was in moist deciduous and dry forests.

However extensive tropical deforestation is a relatively modern event that gained momentum in the 20th century and particularly in the last half of the 20th century. The FAO FRA 2001 and 2010 reports indicate considerable deforestation in the world during 1990-2010 but this was almost entirely confined to tropical regions (Anon., 2001a; 2010). A summary of deforestation during the decades 1990-2010 is given in tables 1 and 2. These tables show there was considerable deforestation in the world during 1990-2010 but this was almost entirely confined to tropical regions. Rowe et al. (1992) estimated that 15 per cent of the world's forest was converted to other land uses between 1850 and 1980. Deforestation occurred at the rate of 9.2 million hectares per annum from 1980-1990, 16 million hectares per annum from 1990-2000 and decreased to 13 million hectares per annum from 2000-2010.

The net change in forest area during the last decade was estimated at -5.2 million hectares per year, the loss area equivalent to the size of Costa Rica or 140 km2 of forest per day, was however lesser than that reported during 1990-2000 which was 8.3 million hectares per year equivalent to a loss of 0.20 per cent of the remaining forest area each year. The current annual net loss is 37 per cent lower than that in the 1990s and equals a loss of 0.13 per cent of the remaining forest area each year during this period. By contrast some smaller countries have very high losses per year and they are in risk of virtually losing all their forests within the next decade if current rates of deforestation are maintained. Indeed some 31 countries do not even make the list because they have already removed most of their forests and even if that remain are seriously fragmented and degraded.

Table: Annual change in forest area by region and sub-region, 1990-2010

Region/sub-region	**1990-2000**		**2000-2010**	
	1 000 ha/year	**%**	**1 000 ha/year**	**%**
Eastern and Southern Africa	-1841	-0.62	-1839	-0.66
Northern Africa	-590	-0.72	-41	-0.05
Western and Central Africa	-1637	-0.46	-1535	-0.46
Total Africa	**-4067**	**-0.56**	**-3414**	**-0.49**
East Asia	1762	0.81	2781	1.16
South and Southeast Asia	-2428	-0.77	-677	-0.23
Western and Central Asia	72	0.17	131	0.31
Total Asia	**-595**	**-0.10**	**2235**	**0.39**
Russian Federation (RF)	32	n.s.	-18	n.s.
Europe excluding RF	845	0.46	694	0.36
Total Europe	**877**	**0.09**	**676**	**0.07**
Caribbean	53	0.87	50	0.75
Central America	-374	-1.56	-248	-1.19
North America	32	n.s.	188	0.03
Total North and Central America	**-289**	**-0.04**	**-10**	**0.00**
Total Oceania	**-41**	**-0.02**	**-700**	**-0.36**
Total South America	**-4213**	**-0.45**	**-3997**	**-0.45**
World	**-8327**	**-0.20**	**-5211**	**-0.13**

Source: - (Anon, 2010)

South America with about four million hectares per year suffered the largest net loss of forests during the last decade followed by Africa with 3.4 million hectares annually and the least Oceania with seven lakh hectares annually. Oceania suffered mainly due to Australia where severe drought and forest fires from 2000 AD had exacerbated their loss. Both Brazil and Indonesia had the highest net loss of forest during the decade of 1990 but has significantly reduced their rate of loss after this decade. Brazil and Indonesia dominate accounting for almost 40 per cent of net forest loss over the decade of 1990s. Even though Brazil was the top deforesting country by area, the forests in Brazil are so extensive that this represents a loss of 0.4 per cent per year. The forest area in North and Central America remained stable during the past decade. The forest area in Europe continued to expand although at a slower rate of seven lakh hectare per year during the last decade than in the 1990s with nine lakh hectares per year. Asia loosed some six lakh hectares annually during 1990s but gained more than 2.2 million hectares per year during the last decade. The ten

countries with the largest net loss per year in the period 1990-2000 AD had a combined net loss of forest area of 7.9 million hectares per year. In the period 2000-2010 AD this was reduced to six million hectares per year as a result of reductions in Indonesia, Sudan, Brazil and Australia.

The causes of Deforestation: - As Myers pointed out, "we still have half of all tropical forests that ever existed" (Myers, 1992). The struggle to save the world's rainforests and other forests continues and there is a growing worldwide concern about the issue. In order to save forests, we need to know why they are being destroyed. Distinguishing between the agents of deforestation and its causes is very important in order to understand the major determinants of deforestation. The agents of deforestation are those slash and burn farmers, commercial farmers, ranchers, loggers, firewood collectors, infra-structure developers and others who are cutting down the forests. Causes of deforestation are the forces that motivate the agents to clear the forests. However, most of the existing literature typically distinguishes between two levels of specific factors: direct and indirect causes of deforestation. Direct agents and causes of deforestation, also typically referred to as sources of deforestation, first level or proximate causes are relatively easy to identify but the indirect causes which are usually the main divers of deforestation are the ones that cause most disagreement and the ones that are hardest to quantify.

A. Direct Causes:

1. Expansion of farming land: - About 60 per cent of the clearing of tropical moist forests is for agricultural settlement with logging and other reasons like roads, urbanization and Fuel wood accounting for the rest (Anon., 1994b). Tropical forests are one of the last frontiers in the search for subsistence land for the most vulnerable people worldwide (Myers, 1992). Millions of people live on the tropical forest with less than a dollar a day where a third of a billion are estimated to be foreign settlers. However, as the land degrades people are forced to migrate, exploring new forest frontiers increasing deforestation. Deforestation is proxies by the expansion of agricultural land. This is because agricultural land expansion is generally viewed as the main source of deforestation contributing around 60 per cent of total tropical deforestation. Shifting agriculture also called slash and burn agriculture is the clearing of forested land for raising or growing the crops until the soil is exhausted of nutrients and/or the site is overtaken by weeds and then moving on to clear more forest. It is been often reported as the main agent of deforestation. Smallholder production in deforestation and the growing number of such producers notably shifting cultivators were the main cause of. Mostly all reports indicate shifting agriculture as responsible for about one half of tropical deforestation and some put it up to two-thirds. Shifting agriculture was greatest in Asia (about 30 per cent) but only about 15 per cent over the whole tropical world. It appears that the proportion of direct conversion of forest to agriculture is increasing and the proportion of shifting agriculture is decreasing with time (Myers, 1994).

2. Forest and other plantations: - Plantations are a positive benefit and should assist in reducing the rate of deforestation. The fact that plantations remove the timber pressure on natural forests does not translate eventually into less, but rather into more deforestation.

Indeed, it is feared that agricultural expansion which is the main cause of deforestation in the tropics might replace forestry in the remaining natural forests. The impact of timber plantations could thus turn out to be quite detrimental to tropical forest ecosystems. Tree crops and rubber in particular plays a more important role in deforestation in Indonesia than subsistence-oriented shifting cultivation. Unfortunately about one-half of the plantations in the tropics are established on native forest cleared for the purpose. Moreover plantations can promote deforestation by constructing roads that improve access of the shifting cultivators and others to the forest frontier (Chomitz and Griffiths, 1996).

3. Logging and fuel wood: - Logging does not necessarily cause deforestation. However, logging can seriously degrade forests. Logging in Southeast Asia is more intensive and can be quite destructive. However, logging provides access roads to follow-on settlers and log scales can help finance the cost of clearing remaining trees and preparing land for planting of crops or pasture. Logging thus catalyzes deforestation (Chomitz et al., 2007)

4. Overgrazing: - Overgrazing is more common in drier areas of the tropics where pastures degraded by overgrazing are subject to soil erosion. Stripping trees to provide fodder for grazing animals can also be a problem in some dry areas of the tropics but is probably not a major cause of deforestation. Clear cutting and overgrazing have turned large areas of Qinghai province in China into a desert. Overgrazing are causing large areas of grasslands north of Beijing and in Inner Mongolia and Qinghai province to turn into a desert.

5. Fires: - Fires are a major tool used in clearing the forest for shifting and permanent agriculture and for developing pastures. Fire is a good servant but has a poor master. Fire used responsibly can be a valuable tool in agricultural and forest management but if abused it can be a significant cause of deforestation (Repetto, 1988; Rowe et al., 1992). Based on the data available from 118 countries representing 65 per cent of the global forest area, an average of 19.8 million hectares or one per cent of all forests were reported to be significantly affected each year by forest fires. Deforestation due to road pavements in Brazil had also lead to higher incidences of forest fires.

6. Mining: - Mining is very intensive and very destructive (Mather, 1991; Sands, 2005). The area of land involved is quite small and it is not seen as a major cause of primary deforestation. Mining is a lucrative activity promoting development booms which may attract population growth with consequent deforestation. The deforestation rate due to mining activities in Guyana from 2000 to 2008 increased 2.77 times according to an assessment by the World Wildlife Fund-Guianas (Staff, 2010). Similarly, in the Philippines, mining, along with logging, has been among the forces behind the country's loss of forest cover: from 17 million hectares in 1934 to just three million in 2003 or an 82 per cent decline (Docena, 2010). Nearly 2,000 hectares of tropical forest in the Municipality of Coahuayana in the State of Michoacán (south-western Mexico) will completely be destroyed by mining iron minerals planned by the Italo-Argentine mining company TERNIUM.

7. Urbanization/industrialization and infra-structure: - Expanding cities and towns require land to establish the infrastructures necessary to support growing population which is

done by clearing the forests. Tropical forests are a major target of infra-structure developments for oil exploitation, logging concessions or hydropower dam construction which inevitably conveys the expansion of the road network and the construction of roads in pristine areas (Kaimowitz and Angelsen, 1998). The construction of roads, railways, bridges, and airports opens up the land to development and brings increasing numbers of people to the forest frontier.

8. Air pollution: - Air pollution is associated with degradation of some European and North American forests. The syndrome is called "Waldsterben" or forest death. In 1982, eight per cent of all West German trees exhibited damage that rose to about 52 per cent by 1987 (Raloff, 1989) and half of the trees reported dying of Waldsterben in the Alps (Lean, 1990). High elevation forests show the earliest damage including forests in the north-east and central United States.

9. Wars and role of the military: - It is well established that military operations caused deforestation during the Vietnam War and elsewhere (Mather, 1991; Sands, 2005). More recently, linkages have been documented between the civil war in Myanmar and the timber trade between Myanmar and Thailand. Myanmar regime sells timber to the Thais to finance its civil war against the Karen hill tribe. Forest destruction in El Salvador has resulted from war. Apart from military involvements in wars, the role of military in deforestation has been documented in Southeast Asia and South America (Mather, 1991; Sands, 2005). The authors also observed that role of powerful military in Brazilian politics are a major cause of Amazonian forest destruction.

10. Tourism: - National parks and sanctuaries beyond doubt protect the forests, but uncautioned and improper opening of these areas to the public for tourism is damaging. Unfortunately, the national governments of tropical and sub-tropical countries adopt tourism for easy way of making money sacrificing the stringent management strategies. Further, many companies and resorts who advertise themselves as eco-tourist establishments are in fact exploiting the forests for profit. In Cape Tribulation, Australia, for example, the rain forest is being threatened by excessive tourism. Similarly, in the Terai Duars of eastern India foothill Himalaya, eco-tourism is encouraged and we fear this is being done without developing adequate management plans. For instance, the Chilapatta Reserve Forest in this area is opened for eco-tourism for its ancient ruins deep in the forest and a tree species Myristica longifolia that exudes a blood like sap when injured. The site has become a popular eco-tourist destination because of the ruins and for this blood exuding tree.

B. Indirect Causes:

The World Rainforest Movement's 'Emergency Call to Action for the forests and their Peoples' asserts that "deforestation is the inevitable result of the current social and economic policies being carried out in the name of development" (Anon., 1990d). It is in the name of development that irrational and unscrupulous logging, cash crops, cattle ranching, large dams, colonization schemes, the dispossession of peasants and indigenous peoples and promotion of tourism is carried out. Harrison Ngau, an indigenous tribesman from Sarawak,

Malaysia and winner of the Goldman Environment Award in 1990 puts the cause of tropical deforestation like this, "the roots of the problem of deforestation and waste of resources are located in the industrialized countries where most of our resources such as tropical timber end up.

1. Colonialism: - Erstwhile colonies of the colonial powers like Britain, France, Spain or Portugal are now the Third World Countries or the developing nations mostly have the tropical rainforests except Australia and Hawaii were exploited for their natural resources and their indigenous people's rights destroyed by the colonial powers. All these countries have indigenous populations who had their own system of land management and/or ownership in place for thousands of years before the intervention of colonists from rich industrialized nations. Colonialism turned previously self-sufficient economies into zones of agriculture export production. This process continues even today in different form of exploitation and the situation is worsening (Colchester and Lohmann, 1993).

2. Exploitation by industrialized countries: - Wealthy countries or the erstwhile colonial powers having deficit of their own natural resources are mainly sustaining on the resources of the financially poorer countries those are generally natural resource rich. Twenty per cent of the world's population is using 80 per cent of the world's resources. Unfortunately also the governments of these poor resource rich countries had generally adopted the same growth-syndrome as their western neighbours or their erstwhile colonial master giving emphasis on maximizing exports, revenues and exploiting their rich natural resources unsustainably for short-term gains.

3. The debt burden: - Pursuing the guided development agenda, the financially poorer countries are on a heavy international debt and now feeling the urgency of repaying these huge debts due to escalating interest rates. Such a situation compels these debt ridden poorer countries to exploit their rich natural resources including their forests partly to earn foreign exchange for servicing their debts. For instance, construction of roads for logging operations in some South-east Asian countries was funded by Japanese aid which allowed the Japanese timber companies to exploit the forests of these countries.

4. Overpopulation and poverty: - The role of population in deforestation is a contentious issue (Mather, 1991; Colchester and Lohmann, 1993; Cropper and Griffiths, 1994; Ehrhardt-Martinez, 1998; Sands, 2005). The impact of population density on deforestation has been a subject of controversy. Poverty and overpopulation are believed to be the main causes of forest loss according to the international agencies such as FAO and intergovernmental bodies. It is generally believed by these organizations that they can solve the problem by encouraging development and trying to reduce population growth. Conversely, the World Rainforest Movement and many other NGOs hold unrestrained development and the excessive consumption habits of rich industrialized countries directly responsible for most forest loss. However there is good evidence that rapid population growth is a major indirect and over-arching cause of deforestation. More people require more food and space which requires more land for agriculture and habitation. This in turn results in more clearing of forests. Arguably increasing population is the biggest challenge of all to achieve sustainable

management of human life support systems and controlling population growth is perhaps the best single thing that can be done to promote sustainability.

5. Transmigration and colonization schemes: - Transmigration of people to the forest frontier whether forced or voluntary due to development policy or dislocation from war is the major indirect cause of deforestation (Mather, 1991; Colchester and Lohmann, 1993; Sands, 2005). Moreover, governments and international aid agencies earlier believed that by encouraging colonisation and transmigration schemes into rainforest areas could alleviate poverty of the areas in the financially poorer countries. Such schemes have miserably failed but hurted the indigenous people and the environment. In Indonesia, the Trans-migrasion Program of 1974 had caused annual deforestation of two lakh hectares.

6. Land rights, land tenure and inequitable land distribution and resources: - Cultivators at the forest frontier often do not hold titles to land (absence of property rights) and are displaced by others who gain tenure over the land they occupy (Mather, 1991; Deacon, 1999; Sands, 2005). This means they have to clear more forest to survive. Poorly defined tenure is generally bad for people and forests (Chomitz et al., 2007). In many countries government have nominal control of forests but are too weak to effectively regulate their use. This can lead to a tragedy of the commons where forest resources are degraded. In frontier areas deforestation is a common practice and legalized way of declaring claim to land and securing tenure.

7. Undervaluing the forest: - Forests gain value only when they are cleared for obtaining legal title through 'improvement' (Mather, 1991; Sands, 2005). The extraction of non-wood forest products has been suggested as a way to add value to the forest but it is not economical when compared to clearing options. If some means could be devised where those who benefit from the environmental values could pay the forest owners or agents of deforestation for them, then the option to not clear would become more competitive. Alternatively, if the national governments value the environmental benefits, it could apply a tax or disincentives to clear. However, even though maintenance of the environmental services is essential for sustained economic development, deforesting nations usually have more immediate goals and are unprepared to take this step.

8. Corruption and political cause: - The FAO identified forest crime and corruption as one of the main causes of deforestation in its 2001 report and warned that immediate attention has to be given to illegal activities and corruption in the world's forests in many countries (Anon., 2001b). Illegal forest practices may include the approval of illegal contracts with private enterprises by forestry officers, illegal sale of harvesting permits, under-declaring volumes cut in public forest, underpricing of wood in concessions, harvesting of protected trees by commercial corporations, smuggling of forest products across borders and allowing illegal logging, processing forest raw materials without a license.

Consequences of Deforestation and Habitat Loss:

1. Loss of Biodiversity: - The most pronounced consequence of deforestation is the destruction of biodiversity. The forests house some of the most veritable hubs of biodiversity,

covering mammals, birds, insects, amphibians or plants, the forest shelters many rare and fragile species. When humans engage in deforestation, they put the entire ecosystems in danger, creating natural imbalances, and putting their own lives at risk. The forest is a huge support system or a web of connectivity. For instance, the trees provide shade and colder temperatures for animals and smaller trees or vegetation which may not survive with the heat of direct sunlight. Besides, trees also feeding animals with their fruits while providing them with food and shelter they need to survive.

2. Soil Erosion: - Deforestation usually reduces the quality of the soil. The soil in the forest is very rich in organic matter and also very resistant to erosion, bad weather, and extreme weather events. On the other hand, deforestation simply exposes the soil making it increasingly fragile, leaving it more vulnerable to natural disasters such as landslides and floods. Deforestation will also pose a serious erosion problem to the environment. These eroded soils can lead to disastrous mudslides. Large amounts of soil can wash into local streams and rivers, clogging waterways and causing damage to hydroelectric structures and irrigation infrastructure. In certain areas, soil erosion issues caused by deforestation lead to farming problems and loss of reliable electric power.

3. Climate Change: - Deforestation is a big contributor to climate change Trees, on a daily basis specialises in trapping and absorbing excess carbon dioxide (CO2) from the atmosphere which could have been harmful to man. The fact remains that when we cut down trees, we are releasing the already trapped CO2 back into the atmosphere. Very unfortunately, these trees are cut down for the purposes of agriculture; as records show that food and agriculture account for 24% of greenhouse gas emissions, while deforestation is estimated to be responsible for 10-15% of all anthropogenic CO2 emissions.

4. Water Cycle Disruption: - The trees also aid in the distribution of water on the earth. Water from Earth's oceans as well as from the surface of trees evaporates and condenses into clouds. Trees extract water from under the ground and release the same water into the atmosphere through a process called photosynthesis. Subsequently, this water in the atmosphere forms clouds that produce rain, which falls back on the earth forming run-offs on the surface, with some percolating downwards to produce groundwater and eventually ocean water again. Deforestation simply implies that there will be no tree to extract, store and release into the atmosphere. This means that cleared forests, which once had moist, fertile soil and plenty of rain become barren and dry.

5. Environmental Refugees: - The long term effects of deforestation are environment tal deterioration. People live around forested areas and depend on the forest resources for their survival. Deforestation of such forest can have adverse consequence on the people living around the forest. Most often people may be forced to migrate leaving them as "environmental refugees"—people who are forced to move away from their ancestral homes due to environmental degradation, which could be deforestation, sea-level rise, expanding deserts, and drastic changes in weather. It has been reported that in recent time, people are more displaced by environmental disasters than by war.

6. Outbreak of New Diseases: - The invasion of the forest by human for food or for games has led to the emergence of tropical diseases and outbreaks of new diseases, including deadly hemorrhagic fevers like ebola and lassa fever, which are consequences of deforestation. These exploiters, who are pushing deeper into the thick forest, usually encounter dangerous microorganisms that they can transmit to those outside the forest on their return. Unfortunately, this bad practise forest and invasion and destruction could lead to a massive epidemic that could kill many innocents on our planet.

7. Destruction of Renewable Resources: - Valuable renewable resources are destroyed yearly through deforestation leaving behind barren lands. The forests are the source of renewable resources that can significantly contribute to the economic growth of a country on a continuing basis. When practised properly, logging can be a sustainable activity, generating huge source of revenue without diminishing the resource base. According to World Bank, an estimate of about US$5 billion in revenues is being lost annually as a result of illegal logging. Ecotourism of a nation also suffers from deforestation as no tourists, will want to travel in order to see polluted rivers, stumps of former forests, barren wasteland, animal carcasses, and abandoned settlement of former inhibiters.

8. Human-Wildlife Conflict: - Most animals are forced out their natural habitat by hunters and other forest invaders. In the quest to escape from their hunters or in search for safer accommodation, some of these animals move into areas populated by humans which often resulted into fatal encounters with wild animals like tigers, lions and venomous snakes. When the conflict between humans and forest animals is beyond bearable limits, many farmers simply kill the offending animals.

Biodiversity Loss:

Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes, and their relative abundance. biodiversity is the variability among living organisms or the number of species found in an area, particularly, flora (plants) and fauna (animals). In other words, it is all life on the Earth in the form of plants, animals, and microorganisms as well as the variety of genetic material they contain. It also includes the relative abundance and genetic diversity of organisms from all habitats which includes terrestrial, marine and other aquatic systems. The term ‘biological diversity’ or ‘biodiversity’ was first used by wildlife scientist and conservationist Raymond F. Dasmann in 1968 in his book titled “A Different Kind of Country”. Biodiversity can also be defined in several ways. Heywood (1995) defined biodiversity as “the total variability of life on the Earth”. Therefore, it can be said that biological diversity means variety within the living natural world, and is commonly used to explain the variety in terms of number and variability of living organisms.

Factors affecting loss of biodiversity: - Important biological causes of the loss of biological diversity include the loss of habitats, the introduction of exotic species, over-harvesting of biodiversity resources, and homogenization of species in agriculture. The common factor of all these elements is that they are human-driven. This paper analyzes the economic and social root causes behind biodiversity loss. In the last few decades, more than natural factors, human activities have caused the majority of biodiversity loss.

The biodiversity habitats are threatened by reckless industrial activities and pollution problems. Excessive use of chemicals in agriculture and the incidences of oil spills in sea are some of the examples. The continuous release of pollutants from urban and agricultural sources combined with more and more developmental activities will lead to multiplication of dead zones in the near future. The dead zones are those areas where other forms of life cannot survive. These zones have negative impacts on the biodiversity for their development and survival. Garbage dumped into the water, chemical runoff, pollution from vehicles all have negative effects on biodiversity. Dumping of non-biodegradable materials has become so common in the sea that lead to increasing mortality among birds, fishes and oceanic mammal populations. Habitats are the home of flora and fauna. When they are forced to leave their homes may be naturally or due to human activities, it leads to their loss or sometimes extinction. The habitats of plants and animals are increasingly being harmed by exploitation for personal and economic gains and changes in the land use. The land use changes include deforestation and takeover of land for agriculture, industries, and human settlements. Due to the continuous expansion of human settlements, many habitats are reduced in extent and become fragmented. When we cut down trees to use its lumber, or claim the land for agricultural purposes, we are destroying the unique ecosystems that can't exist anymore else. The fragmentation of habitats divides the species into smaller populations which cannot survive for longer time. Fragmentation also creates physical barrier for biodiversity to move, disperse and colonise new areas. One of the estimates says that 67 per cent of all endangered, vulnerable and rare species are being threatened by habitat degradation and fragmentation.

1. Pollution and Associated Impacts: - The biodiversity habitats are threatened by reckless industrial activities and pollution problems. Excessive use of chemicals in agriculture and the incidences of oil spills in sea are some of the examples. The continuous release of pollutants from urban and agricultural sources combined with more and more developmental activities will lead to multiplication of dead zones in the near future. The dead zones are those areas where other forms of life cannot survive. These zones have negative impacts on the biodiversity for their development and survival. Garbage dumped into the water, chemical runoff, pollution from vehicles all has negative effects on biodiversity. Dumping of non-biodegradable materials has become so common in the sea that lead to increasing mortality among birds, fishes and oceanic mammal populations.

2. Over Exploitation and Illegal Trade: - The last few decades have seen the over exploitation of plants and animals by various human activities. Unethical and illegal trade of animals is a major threat to biodiversity. Over-exploitation of fishes, known as overfishing, has reduced some commercial fish stocks by more than 90 per cent. It is really difficult to put a number on overfishing because most of the ocean is still unexplored, but it's estimated that

anywhere from 60 to 90 per cent of the ocean has been overfished and reaching to a state of collapse. Commercial hunting and trading is the major destroyer of wildlife. Illegal trade of endangered species of plants and animals is now a business of billion dollars. Rhinoceros, elephant, tiger, leopard, and mahogany trees are some of the animals and plants which are under the threat of illegal trade.

3. Environmental Degradation and Climate Change: - Changes in the climate can occur naturally over millions of years. But the present day climate change has been attributed to the human interventions and the anthropogenic causes. It is happening so quickly that the species of plants and animals are not adapting to these faster rates of change and are slowly becoming vulnerable to the process of dying out and extinction. Due to the changes in the environmental and climatic conditions, temperature is rising, seas are warming up and sea level is increasing, frequency of extreme events and disasters had increased and many other impacts are now clearly visible. There are alterations to the local climate, rivers and watersheds are drying up, and consequently, there is increased erosion of top soil. Furthermore, the increasing deforestation causes increase in levels of greenhouse gases such as CO2. According to Myers (1989), over the period of 1979-1989, there was a 41 per cent increase in the release of carbon as a result of deforestation. Further, climate changes have led to visible changes in timing of agricultural practices, flowering seasons, migration patterns and so on. These changes have the capacity to change food chains and food webs in the ecosystems. Because of all these reasons, many species are affected. There are critical data for decline of birds. Over 1200 bird species are likely to become extinct and about 128 species have vanished over the last 500 years and 103 since 1800 Since 2006, it is estimated that millions of honeybees have been dying known as 'Colony Collapse', which are causing a great concern. Mass deaths of whales at various places are also attributed to the fact of climate change.

4. Invasive Species: - In some areas, exotic species of plants, animals and other organisms are accidently or intentionally introduced to get benefits. Outside the natural geographical areas, these introduced invasive species often damage the native species. They can compete for food, sometime eating native species, helps in spreading diseases and sometimes bringing genetic change due to inter-breeding process. All these processes have the capability to disturb the local ecosystem and the overall physical environment. Species introduced in an area where they have no natural predators can destroy the whole ecosystem. An example of this is the pythons in the Florida Everglades, and Lionfish in the Gulf of Mexico. Most of these invasive species are linked directly to human intentions.

5. Forest Fires: - Frequent fires in the forest areas are caused by higher temperature during summer and dry season. In tropical forests, fires occur in every dry season. These wildfires cause the displacement of territorial birds and mammals, which affect the local balance. Ultimate result of this is in the form of wildlife loss, since displaced individuals have nowhere to go. For example, in the severe fires of 1998 in Russian Federation led to increased water temperatures and high carbon dioxide levels in lakes and water ways. This has adversely affected salmon spawning in the area. In 2019, the fires rage across Australia for several days have brought global attention to wildfires in forest management. In recent

years India is also combating with wild fires which causes extensive damage, for example the fire at Bandipur Tiger Reserve in Karnataka (2018). According to the India State of Forest Report 2019, over 30,000 incidents of forest fires were reported in India in 2019.

6. Volcanic Eruption: - Volcanic eruption also has led to the damage to the habitats of biodiversity in its surrounding areas. The impact of eruption is so vast that it clears all the flora and fauna in the nearby areas. For example, volcanic eruption of Mount St. Helens which is located in the state of Washington (United States) is a good example of it. In May 1980, a major volcanic eruption occurred from Mount St. Helens and thick ash accumulation downwind of the volcano damaged many agricultural crops such as wheat, apples, potatoes and alfalfa to a large extent. This has led to the killing of as many as 1,500 elk and 5,000 deer, and an estimated 12 million salmon were also killed. Therefore, volcanic eruption can do huge loss to the biodiversity of the particular area.

7. Recreation and Hunting: - Human beings are always thrilled by recreational activities. Hunting while travelling to forest is one of them. Recently, hunting for money-making is another interest of human beings. Collections of skin, tusk, meat, fur taken for monetary or aesthetic value or hunting with no purpose are killing the animals and creating the situation of extinction for some particular species. For example, in the last decade, over one-third of African elephants have been killed by hunters and poachers to fuel the ivory trade in African continent. It is found that, in the semi-arid rural area of Southern Cochabamba (Bolivia) about 132 inventoried plants are used by the local people for traditional medicinal purposes. Out of the total, at present 10 plants are now under threat because of their excessive collection.

8. Traditional Knowledge-Based Medicinal Demand: - Traditional knowledge about medicines from specific plants and animals are worldwide known. These medicines are in significant demand for which animals and plant material are compromised. These are collected and obtained by killing animals. For example, Rhino horn is highly priced in the culture of Asian countries for its claimed medicinal properties. Therefore, Rhino poaching is now pushing Rhino populations to the brink of extinction. Another example of aesthetic medicinal plant i.e. red sandal wood, in which centre part of the trunk is used for treating digestive track problems, cough and blood purification. It is also used as a flavouring in alcoholic beverages. It is one of the threatened species recognized by International Union for Conservation of Nature (IUCN). Red sandal wood mostly grows in forest tracts of Eastern Ghats of Andhra Pradesh state in India. Since it is a lucrative business, some people try to smuggle these trees illegally to other countries for making goods and medicinal purpose.

Impact of Biodiversity Loss: The factors causing biodiversity loss have a huge impact on the natural ecosystem functioning as well as on various human activities. Some of the major impacts are discussed below:

1. Food chain and ecosystem functioning: - Biodiversity is the important part of life and any reductions in their quantity can disturb the food chain of ecosystem. Some species appear to be the most important part in supporting the entire ecosystems. When these species

disappear, the whole network of life gets disturb and the mutual benefits are lost. Further, the disappearance also leads to the poor functioning of the ecosystems.

2. Ecosystem services: - Biodiversity are the source of various ecosystem services. For example, forest provide fresh air, humus content to soil, helps in bringing rain, provide shelters to various birds and animals, hold water and soil which are invaluable. If the processes of deforestation continue, all these services will be no longer available. Further, it has been said that a square kilometre of coastal ecosystem like mangrove forest can store up to five times more carbon than the equivalent area of mature rainforest. Bacteria break down organic material and helps in building and fertilising the soil. Wetlands filter pollutants from drinking water. Insects pollinate many of our crop species. If humankind has to artificially duplicate these services, the cost would total trillions of dollars annually, and very likely surpass the value of all the world's economies combined.

3. Human health: - The health of human beings depends especially upon ecosystem products and outputs such as availability of food, freshwater and energy sources. Traditional medicine continues to play an important role in health sector, especially in primary health care. Medicinal plants like neem have immense medicinal value. Many communities rely on natural products collected from ecosystems for medicinal and cultural purposes along with food.

4. Agriculture: - Biodiversity plays a crucial role in human nutrition. Micro-organisms in the soil provide basic nutrient for different crops. Nutritional composition between varieties of the same food can differ dramatically which can affect micronutrient availability in the diet. Healthy diet with adequate average levels of nutrients intake maintains high biodiversity levels.

5. Religious and cultural attributes: - Most indigenous population in various countries are closely linked with the biodiversity resources of their areas. Biodiversity of an area shows a very positive link with the cultural heritage of the areas. Various plants and flowers form the significant part of day-to-day religious activities in Hindu religion. The other religions across the world are also spiritually and culturally associated with biodiversity.

6. Commercial activities: - Many business and industrial activities are based on various biodiversity products, for example, timber, rubber and variety of forest produce etc. The economy of some of the countries also totally depends on timber like Malaysia. Therefore, biodiversity loss has the capability to affect the economy of a country in the long run.

7. Tourism: - Ecotourism is a large and pollution-free business. It is estimated that the Great Barrier Reef, on the eastern coast of Australia is estimated to contribute nearly $6 billion to the country's economy due to its tourism-related potential and other recreational activities. Besides, various natural scenery, bird sanctuaries, forest areas are the special destinations for nature lovers. If this natural scenery is lost, there will be huge impact on the economic front as well as the maintenance of the ecological balance of the surroundings. All these impacts of biodiversity loss, sooner or later, will affect the sustainability of the Earth's surface. There

will be depletion of natural resource which will lead to the loss of biodiversity and put the survival of humankind at stake

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UNIT – 3

Contemporary global issues in environment: global warming and sea-level change

Introduction: - Our environment is constantly changing, and as our environment changes so does the need to become increasingly aware of the environmental issues that are causing these changes. With a massive increase in natural disasters, warming and cooling periods, and different types of weather patterns, people need to be a lot more cautious with the way they lead their lives in conjunction with the types of environmental issues our planet is facing. Environmental issues are the harmful effects of human activities on the environment. These include pollution, overpopulation, waste disposal, climate change, global warming, the greenhouse effect, etc. Various environment protection programs are being practiced at the individual, organizational and government levels with the aim of establishing a balance between man and the environment.

It is high time for human beings to take the 'right' action towards saving the earth from major environmental issues. If ignored today, these ill effects are sure to curb human existence in the near future. Our planet earth has a natural environment, known as 'Ecosystem' which includes all humans, plant life, mountains, glaciers, atmosphere, rocks, galaxy, massive oceans and seas. It also includes natural resources such as water, electric charge, fire, magnetism, air and climate. (Smith, 1984). Technological developments are resulting in resource depletion and environmental destruction. Modern technologies used in the engineering and manufacturing industry have a major impact on our life in past few years. Due to the rapid changes in the engineering and manufacturing industry have been drastic changes in the environment (Harris, 2017). Engineering and manufacturing industry have increased the use of materials like metals, plastic, oil and rubber. These are used in the production of numerous end products which can be associated with different industries such as Car production units, shipping industries, Cotton mills, plastics industries, Coal mining, heavy machineries and etc. which are causing numerous arduous effects and are considered to be non-environment friendly.

Global Warming: - The continuous rise in temperature of the planet is really upsetting. The root cause for this is global warming. Global warming begins when sunlight reaches the Earth. The clouds, atmospheric particles, reflective ground surfaces and surface of oceans then sends back about 30 % of sunlight back into the space, whilst the remaining is absorbed by oceans, air and land. This consequently heats up the surface of the planet and atmosphere, making life feasible. As the Earth warms up, this solar energy is radiated by thermal radiation and infrared rays, propagating directly out to space thereby cooling the Earth. However, some of the outgoing radiation is re-absorbed by carbon dioxide, water vapours, ozone, methane and other gases in the atmosphere and is radiated back to the surface of Earth. These gases are commonly known as greenhouse gases due to their heat-trapping capacity. It must be noted that this re-absorption process is actually good as the Earth's average surface temperature would be very cold if there was no existence of greenhouse gases. The dilemma began when the concentration of greenhouse gases in the atmosphere was artificially increased by humankind at an alarming rate since the past two

centuries. As of 2004, over 8 billion tons of carbon dioxide was pumped thermal radiation is further hindered by increased levels of greenhouse gases resulting in a phenomenon known as human enhanced global warming effect. Recent observations regarding global warming have substantiated the theory that it is indeed a human enhanced greenhouse effect that is causing the planet to heat up. The planet has experienced the largest increase in surface temperature over the last 100 years. Between 1906 and 2006, the Earth's average surface temperature augmented between 0.6 to 0.9 degrees Celsius, however out per year. Millions of pounds of methane gas are generated in landfills and agricultural decomposition of biomass and animal manure. Nitrous oxide is released into the atmosphere by various nitrogen-based fertilizers including urea and diammonium phosphate and other soil management utilizations. Once released, these greenhouse gases stay in the atmosphere for decades or even longer. According to Intergovernmental Panel on Climate Change (IPCC), carbon dioxide and methane levels have increased by 35 % and 148 % since the industrial revolution of 1750 (Shahzad, 2015).

Why does a global temperature increase of 1.5°C matter? - Global warming of 1°C or 1.5°C represents an average across the planet – many places will warm faster, and see far greater temperature increases. For example, the Arctic is warming 2-3 times faster than any other place on Earth. The effects of global heating are far-reaching, including rising sea levels, glacier retreat, changes in the timing of seasonal events (plants flowering, migration patterns), and a rise in the frequency and severity of extreme weather events. These categories of impacts have direct and indirect consequences on people and wildlife. Direct consequences include displacement of people and communities due to sea level rise and extreme weather events, whereas indirect consequences may include disruptions to economic development, food production, escalation in water crises, and increased public health risks. The impacts of climate change will not be evenly felt around the world – people living in the poorest countries and in geographically vulnerable regions (such as small-island states) will be first and most significantly impacted. This is because communities living in poverty are more likely to be exposed to environmental hazards, are often more dependent on natural resource-based livelihoods such as agriculture, and have fewer resources to cope with climate impacts. Each fractional degree of warming also results in outsized impacts on biodiversity and species extinction, and disturbances in natural ecosystems. Even if carbon emissions in the atmosphere can be absorbed and stabilized over a long period of time, many of the impacts on wildlife, land, water, and people will be irreversible once they occur, which makes halting the release of greenhouse gas emissions, and limiting global warming as much as possible, the first priority.

How Does Global Warming Drive Climate Change? - Heat is energy and when you add energy to any system changes occur. Because all systems in the global climate system are connected, adding heat energy causes the global climate as a whole to change. Much of the world is covered with ocean which heats up. When the ocean heats up, more water evaporates into clouds. Where storms like hurricanes and typhoons are forming, the result is more energy-intensive storms. A warmer atmosphere makes glaciers and mountain snow packs, the Polar ice cap, and the great ice shield jutting off of Antarctica melt raising sea levels. Picture

(Source: US Environmental Protection Agency) Changes in temperature change the great patterns of wind that bring the monsoons in Asia and rain and snow around the world, making drought and unpredictable weather more common. This is why scientists have stopped focusing just on global warming and now focus on the larger topic of climate change.

Green House Effect: When sunlight reaches Earth's surface some is absorbed and warms the earth and most of the rest is radiated back to the atmosphere at a longer wavelength than the sun light. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this long wave radiant energy warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. The reflecting back of heat energy by the atmosphere is called the "greenhouse effect". The major natural greenhouse gases are water vapor, which causes about 36-70% of the greenhouse effect on Earth (not including clouds); carbon dioxide CO2, which causes 9-26%; methane, which causes 4-9%, and ozone, which causes 3-7%. It is not possible to state that a certain gas causes a certain percentage of the greenhouse effect, because the influences of the various gases are not additive. Other greenhouse gases include, but are not limited to, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons and chlorofluorocarbons. Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO2), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect.

Causes of Global Warming: - In 1988, The Intergovernmental Panel on Climate Change (IPCC) was established to assess climate change and provide policymakers with updates. In 2022, the IPCC released its sixth assessment report examining the impacts of global warming on ecosystems, biodiversity, and humans. The findings were grim. It found that climate change will increase all over the world. Even with 1.5°C, heat waves, longer warm seasons, shorter cold seasons, and extreme weather events will increase. The report also found that we can still turn things around by cutting emissions to net-zero. How? What's causing global warming? It's the burning of fossil fuels. When fossil fuels burn, they release a series of greenhouse gases such as methane, carbon dioxide, and nitrous oxide. Global emissions can be categorized into different sectors: electricity and heat production, industry, agriculture, buildings, and transportation. In this article, we'll dig into these areas in a bit more depth and expose ten main causes of global warming.

1. Power plants: - In a study published in Environmental Research Letters, 5% of the 29,000 power plants surveyed were responsible for 73% of the global electricity generation industry's C02 emissions. These "hyper-polluting" power plants, as the study calls them, are found in places like East Asia, India, and Europe. Inefficiency is a big reason. Coal plants in particular are a problem. There are around 8,500 coal power plants in operation globally, but they produce ⅕ of total greenhouse gases. This makes them the largest single source. Smithsonian Magazine names a 27-year-old power plant in Poland, which produces 20% of Poland's electricity using brown coal, an especially "dirty" form of coal. Globally, coal plants generate over ⅓ of all electricity, so we need to turn to other sources quickly.

2. Agriculture: - According to The World Bank, agriculture is a big driver of climate change. It produces between 19-29% of total greenhouse gas emissions. Emissions are likely to rise due to the demand for more food production to feed the world's growing population. Where are the problems originating from? Methane is a big concern since it is 26 times stronger than carbon dioxide. Methane is released from livestock and rice production. About ⅓ of agriculture's global methane emissions come from livestock. Rice grown in rice paddies also produces a lot – about 11% of agriculture's emissions. Nitrous oxide – which is 300 times stronger than CO2 – is also a problem! 60% of human-caused N2O emissions come from agriculture. It's produced after croplands are fertilized and after crop residues get burned.

3. Vehicles and transport: - According to the Center for Biological Diversity, transportation is responsible for around ⅓ of the United States' greenhouse gas emissions. Transport includes more than cars. At 9%, airplanes make up the third-largest source of emissions in the United States. Globally, the aviation industry will likely produce around 43 metric gigatons of CO2 through 2050. Globally, ships release almost 3% of the world's carbon dioxide emissions. With expanding international trade, it's expected that ship and boat emissions could increase 250% by 2050. To reduce emissions from vehicles and other transport, the world needs solutions like increased technology efficiency, changes in how people travel and move goods, and lower-carbon fuel sources.

4. Landfills: - Landfills present serious risks to the environment and human health. Our old friend methane is a big reason why. As organic waste (like food waste) sits in landfills, the decomposition process releases methane gas. Since 2016, NASA's Jet Propulsion Laboratory and Scientific Aviation, a leak-detection firm, have performed flyovers over landfills in California. Commissioned by air-quality regulators, the years-long survey revealed that "super-emitters" landfills were responsible for 43% of measured methane emissions. This puts landfills above fossil-fuel and agricultural sectors in the state. Results also showed that the ten biggest culprits were averaging 2.27% over the federal estimates of methane emission. This is just one example of the impact landfills have on global warming. Considering how many landfills there are in the world, they deserve more attention.

5. Offshore drilling: - Offshore drilling is the extraction of petroleum in rock formations beneath the seabed. Companies drill wellbores. Measuring the impact of offshore drilling is extremely important because of how many offshore platforms there are. For a while, offshore drilling was considered efficient with limited methane leakage. However, a study by scientists from Princeton University found that extracting oil and natural gas in the North Sea released a lot more methane than previously estimated. The survey found that on average, methane leakage during normal operations was more than double the reported emissions. Offshore drilling also threatens ocean health and human health with spills and pollution. Burning the fuels extracted through offshore drilling increases greenhouse gas emissions, as well.

6. Fracking: - Fracking is the process of shooting high-pressure liquid into rocks and boreholes deep beneath the ground. This opens fissures for the extraction of oil or gas. There are many risks. If oil or gas wells aren't sturdy, they can leak into groundwater. The fracking

fluids are also toxic. What about fracking's connection to global warming? Fracking could be responsible for an increase in methane emissions. It's possible to draw this conclusion thanks to how quickly the atmosphere responds to methane. A 2019 Cornell University report found "chemical fingerprints" linking increased methane to shale oil and gas. These chemical fingerprints also helped the research pinpoint fracking as the cause of methane release and not livestock. This is essential to understand because stopping methane emissions has an immediate effect. It fades away quickly (compared to CO2), so it's arguably an easy way to combat global warming.

7. Deforestation: - It's difficult to overestimate the importance of forests. They're home to countless plant and animal species, they produce medicine and food, and they support millions of jobs. They're also essential in combating global warming. When trees perform photosynthesis, they drink carbon dioxide from the air, store it, and release oxygen. Wood is made almost completely from carbon. When forests are destroyed, all that carbon is released. As of 2021, deforestation is responsible for less than 10% of the global warming pollution. This represents a decrease as people work to save forests, but it's also because burning fossil fuels has increased, which cuts down on deforestation's impact. There are many reasons why forests get destroyed, including agriculture, housing, and logging. Tropical deforestation is linked to the production of wood products, beef, soybeans, and palm oil. The loss of forests doesn't only release greenhouse gases, it also affects biodiversity, soil erosion, and water cycles.

8. Overfishing:- Overfishing is a major issue affecting ocean health. As the fish species become depleted, fleets have begun moving deeper and deeper into the ocean, disrupting the ocean's systems. Overfishing and global warming have a close relationship. A 2022 article in Frontiers in Marine Science analyzed ocean warming, overfishing, and mercury pollution in European waters. Referencing previous studies, the authors name several connections between overfishing and global warming. Overfishing increases the risk of ocean warming because it affects the resilience of marine species. In turn, ocean warming harms biodiversity. The more fish and marine life there are, the more carbon emissions are stored, which reduces global warming. To protect the oceans and their ability to store carbon, overfishing needs to stop.

9. Melting permafrost: - Permafrost is soil that's been at or below freezing for at least two years. This frozen ground covers about 9 million square miles of the northern part of the planet. In parts of the Northern Hemisphere, there's twice as much carbon stored in permafrost than what's in the Earth's atmosphere. According to the National Snow & Ice Data Center, if 10% of the carbon believed to be stored in permafrost was released, it would equal about 1 billion metric tons per year. Permafrost thaw is an insidious cycle. As global warming increases due to greenhouse emissions, permafrost softens and melts. As permafrost melts, ancient stores of methane and carbon dioxide are released and the cycle is set off again. Plant and animal life, humans, and infrastructure are threatened. Permafrost thaw can't be reversed, so we must reduce emissions and stop the process.

10. Consumerism: - Consumerism simply means buying stuff. What do shopping trips have to do with global warming? In 2015, a study revealed the production and use of household services and goods drove 60% of global greenhouse gas emissions. Wealthy countries have the biggest impact because they make and buy the most stuff. While each individual purchase doesn't make a big difference, it adds up quickly when everyone is in denial about consumerism's impact on global warming. The biggest culprits – big corporations – are also motivated by economic growth and what they know people will buy. As reported in the New Republic, a 2019 report from C40 Cities reads: "Individual consumers cannot change the way the global economy operates on their own, but many of the interventions proposed in this report rely on individual action." This isn't to say that individual action is only a matter of motivation. Most people would probably love to change their lifestyles to benefit the planet, but factors like finances and access to climate-friendly products and services play a huge role. People cannot take individual action when there are too many barriers. Consumers alone can't be blamed for consumerism.

Solutions for Global Warming: - In order to eradicate the problem of Global Warming, we need to take the necessary steps. Some of these steps are as easy as changing our daily habits. Given below are some solutions to solve the issue of global warming (https://static.mygov.in/indiancc/2022/12/mygov-9999999992062473942.pdf),

• **Switch to Public Transport: -** The greatest strategy to reduce carbon dioxide emissions is to switch to an electric or hybrid vehicle. As a citizen, it is preferable to switch to a hybrid vehicle and take public transportation. Pollution and traffic congestion will be reduced as a result of this.

• **Reduce, Reuse, Repair and Recycle: -** You can also make a huge contribution by reducing your use of plastic. Plastic is the biggest source of global warming, and recycling it takes years. Since it takes years for plastic or any metal to decompose, it is an advantageous decision to reuse and repair them rather than just throwing them away after one use or once they break just because it stops serving our purpose.

• **Afforestation: -** More tree planting should be encouraged in order to green the environment. Industrialization should adhere to specific guidelines. In order to protect plants and species, industries should not be built in green zones. Such industries that contribute to global warming should face severe fines.

• **Use of Electric Vehicles: -** Since burning fuels like petrol and diesel emit large amounts of carbon dioxide and methane which contributes majorly to global warming, switching to electric vehicles would significantly reduce the number of carbon emissions into the atmosphere and also decrease the pollution levels along with the temperature.

• Individuals cannot be held responsible for global warming; nevertheless, it can be addressed and prevented from worsening at the individual level. Industries and multinational companies, of course, emit more carbon than the typical citizen. Still, the only viable ways to control the growing status of Global Warming are activism and communal effort.

• Additionally, world leaders must develop real strategies and step programs at the state or government level to ensure that the environment is not harmed any further. Despite the fact that we are running out of time to limit the rate of global warming, it is critical to find the correct solution. Everyone, from individuals to governments, must work to find a solution to Global Warming. Pollution control, population control, and natural resource utilization are just a few of the variables to consider. Together we will be able to put an end to this for sure.

Effects of Global Warming:

Increasing global temperatures are causing a broad range of changes. Sea levels are rising due to thermal expansion of the ocean, in addition to melting of land ice. Amounts and patterns of precipitation are changing. The total annual power of hurricanes has already increased markedly since 1975 because their average intensity and average duration have increased (in addition, there has been a high correlation of hurricane power with tropical sea-surface temperature). Changes in temperature and precipitation patterns increase the frequency, duration, and intensity of other extreme weather events, such as floods, droughts, heat waves, and tornadoes. Other effects of global warming include higher or lower agricultural yields, further glacial retreat, reduced summer stream flows, species extinctions. As a further effect of global warming, diseases like malaria are returning into areas where they have been extinguished earlier. Although global warming is affecting the number and magnitude of these events, it is difficult to connect specific events to global warming. Although most studies focus on the period up to 2100, warming is expected to continue past then because carbon dioxide (chemical symbol CO2) has an estimated atmospheric lifetime of 50 to 200 years.

Effects on weather: Increasing temperature is likely to lead to increasing precipitation but the effects on storms are less clear. Extra tropical storms partly depend on the temperature gradient, which is predicted to weaken in the northern hemisphere as the polar region warms more than the rest of the hemisphere. Regional effects of global warming vary in nature. Some are the result of a generalized global change, such as rising temperature, resulting in local effects, such as melting ice. In other cases, a change may be related to a change in a particular ocean current or weather system. In such cases, the regional effect may be disproportionate and will not necessarily follow the global trend. There are three major ways in which global warming will make changes to regional climate: melting or forming ice, changing the hydrological cycle (of evaporation) and changing currents in the oceans and air flows in the atmosphere. The coast can also be considered a region, and will suffer severe impacts from sea level rise.

Glacier retreat and disappearance: Mountain glaciers and snow cover had decreased in both the northern and southern hemispheres. This widespread decrease in glaciers and ice caps has contributed to observed sea level rise. Predictions relating to future changes in glaciers.

- Mountainous areas in Europe will face glacier retreat

- In Latin America, changes in precipitation patterns and the disappearance of glaciers will significantly affect water availability for human consumption, agriculture, and energy production
- In Polar regions, there will be reductions in glacier extent and the thickness of glaciers.

Oceans: The role of the oceans in global warming is a complex one. The oceans serve as a sink for carbon dioxide, taking up much that would otherwise remain in the atmosphere, but increased levels of CO2 have led to ocean acidification. Furthermore, as the temperature of the oceans increases, they become less able to absorb excess CO2. Global warming is projected to have a number of effects on the oceans. Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification. Other possible effects include large-scale changes in ocean circulation.

Health: Human beings are exposed to climate change through changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events) and indirectly through changes in water, air and food quality and changes in ecosystems, agriculture, industry and settlements and the economy. The effects of climate change to date have been small, but are projected to progressively increase in all countries and regions. It is concluded that climate change had altered the seasonal distribution of some allergenic pollen species. With medium confidence, they concluded that climate change had altered the distribution of some infectious disease vectors and increased heat waverelated deaths.

Sea Level Change:

The sea level changes that affect coastal systems involve more than just expanding oceans, however, because the Earth's continents can also rise and fall relative to the oceans. Land can rise through processes such as sediment accumulation (the process that built the Mississippi River delta) and geological uplift (for example, as glaciers melt and the land below is no longer weighed down by heavy ice). In other areas, land can sink because of erosion, sediment compaction, natural subsidence (sinking due to geologic changes), groundwater withdrawal, or engineering projects that prevent rivers from naturally depositing sediments along their banks. Changes in ocean currents such as the Gulf Stream can also affect sea levels by pushing more water against some coastlines and pulling it away from others, raising or lowering sea levels accordingly. Scientists account for these types of changes by measuring sea level change in two different ways. Relative sea level change refers to how the height of the ocean rises or falls relative to the land at a particular location. In contrast, absolute sea level change refers to the height of the ocean surface above the center of the earth, without regard to whether nearby land is rising or falling (https://climatechange.chicago.gov/sites/production/files/2016-08/documents/print_sea-level-2016.pdf).

How much is sea level changing? - Regular recordings of tide gauges in ports across the world have allowed measurements of global sea level spanning at least 150 years. Through

time the accuracy of such measurements has improved, and they have been supplemented in the past decades by precise measurements of the world's oceans from satellites. The data show that since the mid nineteenth century sea level has risen by ~20 cm. The rate of sea-level rise has grown over this time to ~3.2 mm each year since the new millennium. In recent research, through better analysis of old data, the rate of twentieth century sea-level rise has been revised down from ~1.75 to ~1.2 mm per year, meaning that the rate of sea-level change today compared with the last century is ~20% greater than thought previously (Siegert, 2015).

Why does sea level change? - There are four main processes that lead to sea-level rise. Thermal expansion of water as a consequence of ocean warming; melting of the world's major ice sheets; melting of smaller glaciers; and human-induced changes to the volume of terrestrial water, in particular from the extraction of groundwater and in reservoir development. Thermal expansion accounts for around half of the observed change, with the melting of thousands of small glaciers providing nearly as much. Since the mid eighteenth century, the ice sheets in Antarctica and Greenland have contributed relatively little to sea level. How much could sea level rise? Under climate warming, the contributions of ocean thermal expansion and glacier melting will continue. The total contribution to sea level possible from melting of the planet's remaining glaciers is ~ 50 cm. For ocean thermal expansion, the contribution is likely to be dependent on the continued warming of sea water. The largest potential contribution to sea level comes from the world's large ice sheets in Greenland, West Antarctica and East Antarctica, which, if melted completely over many centuries would raise the level of the ocean globally by ~7 m, ~5 m and ~53 m, respectively (Siegert, 2015).

How can ice sheets contribute to sea level? - The ice sheets of West and East Antarctica and Greenland are distinct, and react to climate warming differently. For Greenland, much of the potential ice loss comes from direct climate warming, leading to surface melting and run-off of water to the ocean (in addition to iceberg release). In West Antarctica, the ice is grounded on a bed over 2 km below present sea level in places, making it known as a 'marine' ice sheet. As the ocean is in direct contact with the ice-sheet edge, the warmth of the oceanwater next to the ice is the dominant influence on its rate of melting. Additionally, in a number of locations, West Antarctic ice-sheet retreat would cause the ice edge to migrate across deepening terrain, leading to further enhanced loss – known as 'marine ice-sheet instability'. In East Antarctica, while some regions have 'marine' ice-sheet characteristics, the bulk of the ice rests on land above sea level. While the intense cold of East Antarctica has likely led to its persistence over as much as 14 million years, its size means that even small ice loss changes here can have significant global sea level effects (Siegert, 2015).

How will sea level change in the future? - Given the observed trends in sea level, and in global warming, it is virtually certain that sea level will continue to rise over the coming decades due to increased loss of mass from glaciers and ice sheets, and thermal expansion of ocean water. The fourth assessment report of the IPCC in 2007 was uncertain about the contribution of ice sheets to future sea level change. To remedy this, a recent EU-funded project, named Ice2sea, quantified the cryosphere's 'likely' contribution to sea level under a

range of atmospheric carbon emission scenarios. Under a ‘business as usual’ emissions scenario, ice sheets are likely to contribute between 3.5 and 36.8 cm by 2100. However, as unstable behaviour in ice sheets is difficult to predict and model, Ice2sea also indicated, via an ‘expert elicitation’ exercise, that there was a less than 1 in 20 risk of ice sheets contributing up to 84 cm to sea level by 2100. These values must be added to other components of sea level change, to produce an overall likely increase in sea level. The 5th assessment report of the IPCC in 2013 did this and concluded that, under climate scenario RCP8.5 (emissions continuing as now throughout the next century), sea level will likely increase by between ~0.5 and ~1 m by 2100. The rate of change of sea level rise is also likely to increase, with the IPCC concluding that the RP8.5 scenario will lead to an increase in the rate of change to between ~0.7 and ~1.6 cm per year by 2100; values reminiscent of sea-level rise during the end of the last Ice Age.

Causes of Sea-level Change: - While mean sea-levels change naturally in the normal evolution of the Earth, anthropogenic global warming since the industrial revolution is probably the major cause of the accelerated sea-level change observed in the 20th century. Two primary physical processes are involved: (i) expansion of water volume in the global ocean when heated up; and (ii) transfer of water stored on land to the ocean due to increased melting of glaciers, ice caps and ice sheets. The tide gauge stations at North Point and Quarry Bay were built on reclaimed land where land subsidence was substantial during the first couple of decades of operation (Wong et al 2003). Civil Engineering and Development Department (CEDD) of the HKSAR government has conducted precision leveling measurement of the tide gauges at half yearly intervals to determine the rate of land subsidence. Tidal records were corrected for land subsidence before the mean sea-level was computed.

Changes in sea level occur for many reasons on different time and space scales Tide gauges measure sea level variations in relation to a fixed benchmark and thus record "relative sea level" change due both to vertical land movements and to real (eustatic) changes in the ocean level Vertical land movements result from various natural isostatic movements, sedimentation, tectonic processes and even anthropogenic activities (e g , groundwater and oil extraction) In parts of Scandinavia, for instance, relative sea level is decreasing by as much as lm per century due to isostatic "rebound" following the last major glaciation In attempting to identify a globally-coherent, secular trend in MSL, the vertical land movements contaminate tide gauge records and have to be removed Eustatic sea level is also affected by many 1 actors Differences in atmospheric pressure, winds, ocean cuncnts and density of seawater all cause spatial and temporal variations in sea level in relation to the geoid (the surface of constant gravitational potential corresponding to the surface which the ocean would assume if ocean temperature and salinity were everywhere 0°C and 35 o/oo, respectively, and surface air pressure was everywheie constant) Changes in the geoid itself, due to re-distribution of mass within the Earth, are irrelevant on the decadalcentury timescales under consideration Over these timescales, the most important climate-related factors are likely to be thermal expansion of the oceans and melting ol land ice (but not floating ice shelves or sea ice) (https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc_far_wg_I_chapter_09.pdf).

Possible Contributing Factors to Past and Future Sea Level Rise: - There are four major climate-related factors that could possibly explain a rise in global MSL on the 100-year time scale These are 1) thermal expansion of the oceans, 2) glaciers and small ice caps, 3) the Greenland ice sheet, and 4) the Antarctic ice sheet (including the special case of the West Antarctic ice sheet) In this section, we examine the sensitivity of each factor to changes in climate (particularly temperature), and estimate its possible contribution to past sea level change In the subsequent section, attention is then turned to future sea level change.

1. Thermal Expansion of The Oceans: - At constant mass, the volume of the oceans, and thus sea level, will vary with changes in the density of sea-water Density is inversely related to temperature Thus as the oceans warm, density decreases and the oceans expand – a steric rise in sea level Marked regional variations in sea water density and volume can also result from changes in salinity, but this effect is relatively minor at the global scale. In order to estimate oceanic expansion (past or future) changes in the interior temperature, salinity and density of the oceans have to be considered, either empirically or by models. Unfortunately, observational data are scant, both in time and space (Barnett, 1985) A few recent analyses have been carried out on the limited time-series data For instance, Roemmich (1985) examined the 1955 1981 Panuhns series of deep hydrographic stations off Bermuda and Thomson and Tabata (1987) examined the Station PAPA (northeast Pacific Ocean) steric height anomalies for a similar 27-year record. The latter study found that open ocean steric heights are increasing linearly at 0. 93mm/year However, in this and other studies the large inter-annual variability creates too much noise to be confident of the estimate derived from such a short time-series. Moreover the limited geographical coverage makes inference to the global scale problematic In a few decades current efforts such as the World Ocean Circulation Experiment (WOCE) will be begin to fill the data gaps and overcome these problems.

2. Land Ice: - A distinction is made between glaciers and small ice caps, the Greenland ice sheet and Antarctic ice sheet, since different climatic characteristics and different response times are involved. A large uncertainty exists regarding the volume of glaciers and small ice caps. Although the total area is relatively well known, the mean thickness is not. Although the positive and negative contributions to the mass budget of the Greenland and Antarctic ice sheets noted sum up to zero, it is actually unknown how close the ice sheets are to equilibrium.

3. Glaciers and small ice caps: - The majority of valley glaciers have been retreating over the last hundred years. Although long records of glacier length are only available for some glaciers in the European North Atlantic region, geomorphological investigations have made it clear that the trend of glacier retreat has generally been world-wide since the little ice age.

4. The Greenland Ice Sheet: - Estimates of the mass budget of the Greenland ice sheet have been hampered by a pronounced lack of data. Accumulation measurements have been done on a few traverses only. Systematic ablation measurements in the marginal zone have been carried out in several places, but all located in the southwestern part of Greenland. The only profile from the ice margins to the region well above equilibrium line is the EGIG profile

(Expedition Glaciologique International au Greenland, West Greenland, at about 70 degree North).

5. The Antarctic Ice Sheet: - The question of balance of the Antarctic ice sheet proves to be a very difficult one From a physical point of view regarding the very long time scale introduced by geodynamics and thermo mechanical coupling in the ice sheet, it seems unlikely that the present ice sheet has adjusted completely to the last glacial-interglacial transition A detailed modeling study by Huybrechts (1990), in which a glacial cycle of the Antarctic ice sheet is simulated on a 40km grid suggests that the large scale imbalance will not be more than a few percent of the annual mass turnover (corresponding to a rate of sea level change of less than 0.1 mm/year) This does not exclude the possibility however that climate fluctuations with a shorter time scale have pushed the ice sheet out of balance Also there is increasing evidence that marine ice sheets like the West Antarctic could exhibit pulsating mass discharge which is not climate related but may have important consequences for sea level.

6. Possible Instability of the West Antarctic Ice Sheet: - Most of the early attention to the issue of sea level use and greenhouse warming was related to the stability of the West Antarctic ice sheet Parts of this ice sheet are grounded far below sea level and may be very sensitive to small changes in sea level or melting rates at the base of adjacent ice shelves (e g Meicei 1978 Thomas el al 1979, Van dei Veen 1986) In case of a climatic warming such melting rates could increase and lead to disappearance of ice rises (places where the floating ice shelf runs aground).

7. Other Possible Contributions: - Sea level could also have been affected by net increases or decreases in surface and groundwater storage In particular, groundwater depletion (through pumping) and drainage of swamps, soils and wetlands would contribute to a MSL rise On the other hand, increases in surface storage capacity - especially large dams but also the combined effects of many small reservoirs and farm ponds - would detract from sea level Decreases in groundwater levels are commonly reported from all over the world from many different environments This suggests that total groundwater storage volumes have been diminishing, particularly during the last 50 years Data are meager, however One rough estimate (Meier, 1983, also see Robin, 1986) is that, globally, net depletion has amounted to about 2000km3 (equivalent to 0 55cm in sea level) during this century Land drainage, particularly in Northwest Europe and North America over the last 100 years, has reduced soil and shallow groundwater storage over wide areas, but the actual amounts of water are difficult to estimate.

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UNIT: 4

Contemporary global issues in environment: wetland and wasteland

Introduction: - Land is the most precious resource on this planet earth which supports life. Land is the natural home of most of species of plants, animals, microbes etc. The primary sources of food for the lives on land come from the plants growing naturally of specifically grown for the purpose. With advancement humans and technology, domestication of plants in the form of agriculture started. The agriculture products now provide the raw materials for most of the human needs. The land available on the earth is not uniform and differs geologically, geographically, environmentally, climatically etc. The different land masses on the different parts of the earth have been created through different geological processes and differ in their physical, chemical, geological composition etc. Depending on the soil composition, fertility, availability of water, climatic and edaphic conditions, specific adaptations, different land forms support different type of vegetation. However, all the land forms do not naturally support vegetation or life (productive) due to climatic and edaphic conditions. But many landforms which were naturally productive have become unproductive due to various anthropogenic activities. The unproductive lands weather natural or anthropogenic are in general called wastelands. Such unproductive land or wastelands formed due to anthropogenic activities are of particular concern as the decreasing productive land area decreases the agricultural and vegetative productivity. Further, the ever increasing human population adds woes to their survival due to decrease in productive land forms. Hence, it is necessary to manage and reclaim the wastelands to productive land forms (https://ebooks.inflibnet.ac.in/esp03/chapter/wasteland/).

Water is the most critical substance for the existence of life on the Earth. The highly uneven surface of the Earth has many areas where the land is saturated with or is submerged under the water that flows or remains standing for different duration - from days to centuries before it returns to the oceans and the atmosphere. These watery areas were inhabited by a large diversity of plants and animals. The foundations of human civilization were laid on these lands. Fish were harvested long before the humans learned to grow food on the floodplain of Tigris and Euphrates rivers in the Middle East, and discovered rice and domesticated it in Eastern Asia. Many plants (such as lotus and Euryale ferox) and animals such as turtles, crocodiles and swans became an integral part of the socio-cultural ethos of the people in South Asia. Jute was domesticated for fiber in India whereas in Egypt the giant sedge, Cyperus papyrus, led to the discovery of paper and was used to build boats that could be sailed across the ocean. In Europe, the reeds (Phragmites australis) were extensively used for thatching. In Asia, humans were not only attracted by the serene beauty of these watery areas that is reflected in their art, but developed such compassion for the wildlife that many species were bestowed with divinity, associated with gods. Lotus became a symbol of sacredness and purity in both Hinduism and Buddhism. In India, these watery vegetated habitats were called Anup (incomparable). Similar habitats elsewhere in the world were given many local names of which the most common in English were marsh, swamp, bog and mire which differed greatly in their characteristics and biota.

Life is sustained on planet Earth by various kinds of natural resources. With the growing or flourishing economy, the vital natural resources are excessively used which causes the depletion of natural resources. It is increasingly being realized that the planet Earth is facing grave environmental problems, with fast depleting natural resources threatening the very existence of many ecosystems. Wetlands are considered one of the most important threatened ecosystems.

What is a Wetland? - A wetland is an area where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and land species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants and promotes the development of characteristic wetland soils. Wetlands vary widely because of regional and local differences in soils, topography, climate, water, vegetation and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica. Two general categories of wetlands are recognized: coastal wetlands and inland wetlands. Although wetlands are often wet, a wetland might not be wet year-round. In fact, some of the most important wetlands are only seasonally wet. Wetlands are the link between the land and the water. They are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation—making these areas very important features of a watershed. Using a watershed-based approach to wetland protection ensures that the whole system, including land, air, and water resources, is protected. Often called "nurseries of life," wetlands provide habitat for thousands of species of aquatic and terrestrial plants and animals. Although wetlands are best known for being home to water lilies, turtles, frogs, snakes, alligators, and crocodiles, they also provide important habitat for waterfowl, fish, and mammals. Migrating birds use wetlands to rest and feed during their cross-continental journeys and as nesting sites when they are at home. As a result, wetland loss has a serious impact on these species. Habitat ruin since the 1970s has been a leading cause of species extinction. Wetlands do more than provide habitat for plants and animals in the watershed. When streams and rivers overflow, wetlands help to absorb and slow floodwaters. This ability to control floods can alleviate property damage and loss and can even save lives. Wetlands also absorb excess nutrients, sediment, and other pollutants before they reach rivers, lakes, and other water bodies. They are great spots for fishing, canoeing, hiking, and bird-watching, and they make wonderful outdoor classrooms for people of all ages.

Types of Wetlands: - Each wetland differs due to variations in soils, landscape, climate, water, vegetation, and human disturbance. Wetlands found in the United States include: marshes, swamps, bogs, fens, vernal pools, and prairie potholes, to name a few.

Marshes are wetlands dominated by soft-stemmed vegetation. They are sometimes saturated, flooded, or ponded with water and characterized by grasses adapted to wet soil conditions. Marshes are further characterized as tidal marshes and non-tidal marshes.

Tidal (coastal) marshes occur along coastlines and are influenced by tides and often by freshwater from runoff, rivers, or ground water. Salt marshes are the most common types of tidal marshes and are characterized by salt tolerant plants. Salt marshes have one of the highest rates of productivity among wetland ecosystems because of the inflow of nutrients from surface and/or tidal water. Tidal freshwater marshes are located upstream of estuaries. Tides influence water levels but the water is fresh. The lack of salt stress allows a greater diversity of plants to thrive. Cattail, wild rice, pickerelweed, and arrowhead are common and help support a large and diverse range of bird and fish species, among other wildlife.

Non-tidal (inland) marshes are also dominated by soft-stemmed low plants and frequently occur in poorly drained depressions, floodplains, and shallow water areas along the edges of lakes and rivers. These freshwater marshes are characterized by periodic or permanent shallow water. They typically derive most of their water from surface waters, including floodwater and runoff, but do receive ground water inputs. Major regions of the United States that support inland marshes include the Great Lakes coastal marshes, the prairie pothole region, and the Florida Everglades.

Swamps are wetlands dominated by trees and other woody plants. Swamps occur in either freshwater or saltwater floodplains. They are characterized by very wet soils during the growing season and standing water during certain times of the year. Well-known swamps include Georgia's Okefenokee Swamp and Virginia's Great Dismal Swamp. Swamps are classified as forested, shrub, or mangrove. Forested swamps are found in broad floodplains of the northeast, southeast, and south-central United States and receive floodwater from nearby rivers and streams. Common deciduous trees found in these areas include bald cypress, swamp white oak, and red maple. Shrub swamps are similar to forested swamps except that shrubby species like buttonbush and swamp rose dominate. Mangrove swamps are coastal wetlands characterized by salt-tolerant trees, shrubs, and other plants growing in brackish to saline tidal waters.

Bogs are freshwater wetlands characterized by spongy peat deposits, evergreen trees and shrubs, and a floor covered by a thick carpet of sphagnum moss. These systems, whose only water source is rainwater, are usually found in glaciated areas, often in old glacial lakes, of the northern United States.

Fens are freshwater peat-forming wetlands covered mostly by grasses, sedges, reeds, and wildflowers. Like bogs, most fens formed when glaciers retreated. Unlike bogs, fens receive water from streams and groundwater in addition to precipitation. With an increased rate of water exchange, fens are less acidic than bogs and thus more nutrient-rich. Fens are often near bogs and over time will likely become bogs.

Vernal Pools, also called **Vernal Ponds**, are temporary woodland pools that provide habitat for distinctive plants and animals. Vernal ponds themselves are generally less than 40 yards in diameter and no more than 4 feet deep, although they receive water from a larger surrounding landscape. Named from vernalis, the Latin word for spring, vernal ponds are formed seasonally in shallow ground depressions from spring snowmelt, precipitation, and

rising water tables. Vernal pools have either bedrock or a hard clay layer in the soil that helps hold water in the depression. Generally drying up in late summer, these ponds are only temporary woodland reservoirs. They are slightly harder to identify during the summer and fall months; however, there are several clues to look for. Blackened, compressed leaf litter; gray soil; watermarks on surrounding tree trunks; and the presence of moisture-tolerant vegetation all suggest an area that collects water part of the year. Red maple, high bush blueberry, and buttonbush are all common at these locations.

The seasonal nature of vernal ponds means that they are uninhabited by fish. This makes them the perfect habitat for a variety of amphibians and invertebrates to breed and develop with less chance of predation. Species like mole salamanders, wood frogs, and fairy shrimp depend exclusively on vernal ponds for part of their life cycles. Often a pond is the ancestral home of an amphibian community that resides nearby in the forest each winter, then migrates to the same pond each spring to lay its eggs. Spring peepers, American toads, spadefoot toads, gray tree frogs, green frogs, and red-spotted newt are among the many creatures that may come to breed. By the end of the breeding season, ponds are filled with egg clusters that appear as jellylike masses containing small, round eggs. As activity inside the pond increases each spring, it attracts other animals to the vernal community. Some turtle species visit the ponds to feed on egg masses, while snakes and raccoons may feed on tadpoles and frogs. Birds like the green heron a nd red-shouldered hawk also visit ponds to feed.

Prairie Potholes are found in the grasslands of North Dakota and South Dakota. Prairie potholes develop when snowmelt, rain and groundwater fill the pockmarks left on the landscape by glaciers. Some prairie pothole marshes are temporary, while others may be essentially permanent. Here a pattern of rough concentric circles develops. Submerged and floating aquatic plants take over the deeper water in the middle of the pothole while bulrushes and cattails grow closer to shore. Wet, sedge-rich marshes lie next to the upland. The Upper Midwest, because of its numerous shallow lakes and marshes, rich soils, and warm summers, is described as being one of the most important wetland regions in the world. The area is home to more than 50 percent of North American migratory waterfowl, with many species dependent on the prairie potholes for breeding and feeding. In addition to supporting waterfowl hunting and birding, prairie potholes also absorb surges of rain, snow melt, and floodwaters thereby reducing the risk and severity of downstream flooding. Many of these important and highly productive communities have been altered or destroyed due to increased agricultural and commercial development. As a result, only an estimated 40 to 50 percent of the region's original prairie pothole wetlands remain undrained today.

Functions of a Wetland: - Long regarded as wastelands, wetlands are now recognized as important features in the landscape that provide numerous beneficial services for people and for fish and wildlife. For example, wetlands naturally protect and improve water quality, provide fish and wildlife habitats, store floodwaters, and maintain surface water flow during dry periods. These beneficial services, considered valuable to societies worldwide, are the result of the inherent and unique natural characteristics of wetlands. Wetland functions include:

- Absorption and storage of flood waters and ground water recharge in dry periods
- Protection of coastlines from high energy open ocean waves
- Slowing of water velocity so sediments may settle out thereby improving water quality
- Filtering and removal of excess nutrients and toxins by wetland soils and plants
- Providing nurseries for juveniles of many aquatic species including most commercially harvested fish
- Providing habitat for many upland species such as raccoons and deer as well as habitat for sensitive wetland dependent species like salamanders
- Stop-over and resting sites for migratory birds as well as waterfowl habitat. In fact, up to one-half of North American bird species nest or feed in wetlands.

Importance of Wetlands: - The major importance's of Wetlands are (https://www.drishtiias.com/pdf/1644907382.pdf) -

- Wetlands are highly productive ecosystems that provide the world with nearly two-thirds of its fish harvest.
- Wetlands play an integral role in the ecology of the watershed. The combination of shallow water, high levels of nutrients is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, shellfish and insects.
- Wetlands' microbes, plants and wildlife are part of global cycles for water, nitrogen and sulphur. Wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide.
- Wetlands function as natural barriers that trap and slowly release surface water, rain, snowmelt, groundwater and flood waters. Wetland vegetation also slow the speed of flood waters lowering flood heights and reduces soil erosion.
- Wetlands are critical to human and planet life. More than one billion people depend on them for a living and 40% of the world's species live and breed in wetlands.
- Wetlands are a vital source for food, raw materials, genetic resources for medicines, and hydropower.
- They play an important role in transport, tourism and the cultural and spiritual well-being of people.
- They provide habitat for animals and plants and many contain a wide diversity of life, supporting plants and animals that are found nowhere else.
- Many wetlands are areas of natural beauty and promote tourism and many are important to Aboriginal people.
- Wetlands also provide important benefits for industry. For example, they form nurseries for fish and other freshwater and marine life and are critical to commercial and recreational fishing industries.

Wetland values to humans: - Wetlands provide tremendous economic benefits, for example: water supply (quantity and quality); fisheries (over two thirds of the world's fish harvest is linked to the health of coastal and inland wetland areas); agriculture, through the maintenance

of water tables and nutrient retention in floodplains; timber production; energy resources, such as peat and plant matter; wildlife resources; transport; and recreation and tourism opportunities. In addition, wetlands have special attributes as part of the cultural heritage of humanity: they are related to religious and cosmological beliefs, constitute a source of aesthetic inspiration, provide wildlife sanctuaries, and form the basis of important local traditions. These functions, values and attributes can only be maintained if the ecological processes of wetlands are allowed to continue functioning. Unfortunately, and in spite of important progress made in recent decades, wetlands continue to be among the world's most threatened ecosystems, owing mainly to ongoing drainage, conversion, pollution, and over-exploitation of their resources (Amenu & Mamo, 2018).

Alternately, the value of a wetland is an estimate of the importance or worth of one or more of its functions to society. For example, a value can be determined by the revenue generated from the sale of fish that depend on the wetland, by the tourist dollars associated with the wetland, or by public support for protecting fish and wildlife. Although large-scale benefits of functions can be valued, determining the value of individual wetlands is difficult because they differ widely and do not all perform the same functions or perform functions equally well. Wetlands improve water quality in nearby rivers and streams, and thus have considerable value as filters for future drinking water. When water enters a wetland, it slows down and moves around wetland plants. Much of the suspended sediment drops out and settles to the wetland floor. Plant roots in the soil absorb excess nutrients in the water from fertilizers, manure, leaking septic tanks, and municipal sewage. While a certain level of nutrients is necessary in water ecosystems, excess nutrients can cause algae growth that's harmful to fish and other aquatic life. A wetland's natural filtration process can remove excess nutrients before water leaves a wetland, making it healthier for drinking, swimming and supporting plants and animals. Some types of wetlands are so good at this filtration function that environmental managers construct similar artificial wetlands to treat storm water and wastewater. Wetlands can play a role in reducing the frequency and intensity of floods by acting as natural buffers, soaking up and storing a significant amount of floodwater. A wetland can typically store about three-acre feet of water, or one million gallons. An acre-foot is one acre of land, about three-quarters the size of a football field, covered one foot deep in water. Three acre-feet describes the same area of land covered by three feet of water.

Coastal wetlands serve as storm surge protectors when hurricanes or tropical storms come ashore. In the Gulf coast area, barrier islands, shoals, marshes, forested wetlands and other features of the coastal landscape can provide a significant and potentially sustainable buffer from wind wave action and storm surge generated by tropical storms and hurricanes. After peak flood flows have passed, wetlands slowly release the stored waters, reducing property damage downstream or inland. One reason floods have become more costly is that over half of the wetlands in the United States have been drained or filled.

The loss of more than 64 million acres of wetlands in the Upper Mississippi Basin since the 1780's contributed to high floodwaters during the Great Flood of 1993 that caused billions of dollars in damage. Wetlands contribute to the national and local economies by producing resources including foods like cranberries and rice and commercially harvested fish, by

enabling recreational activities such birdwatching which generates over $100 billion per year, and by providing other benefits, such as pollution control and flood protection. While it can be difficult to calculate the economic value provided by a single wetland, it is possible to evaluate the range of services provided by all wetlands and assign a dollar value. These amounts can be impressive. According to one assessment of natural ecosystems, the dollar value of wetlands worldwide was estimated to be $14.9 trillion (https://lancasterconservation.org/wp-content/uploads/ED-MS-WETLANDS.pdf).

What are the Threats to Wetlands? -

Urbanization: Wetlands near urban centers are under increasing developmental pressure for residential, industrial and commercial facilities. Urban wetlands are essential for preserving public water supplies.

Agriculture: Vast stretches of wetlands have been converted to paddy fields. Construction of a large number of reservoirs, canals and dams to provide for irrigation significantly altered the hydrology of the associated wetlands.

Pollution: Wetlands act as natural water filters. However, they can only clean up the fertilizers and pesticides from agricultural runoff but not mercury from industrial sources and other types of pollution. There is growing concern about the effect of industrial pollution on drinking water supplies and the biological diversity of wetlands.

Climate Change: Increased air temperature; shifts in precipitation; increased frequency of storms, droughts, and floods; increased atmospheric carbon dioxide concentration; and sea level rise could also affect wetlands.

Dredging: The removal of material from a wetland or river bed. Dredging of streams lowers the surrounding water table and dries up adjacent wetlands.

Draining: Water is drained from wetlands by cutting ditches into the ground which collect and transport water out of the wetland. This lowers the water table and dries out the wetland.

Introduced Species: Indian wetlands are threatened by exotic introduced plant species such as water hyacinth and salvinia. They clog waterways and compete with native vegetation.

Salinization: Over withdrawal of groundwater has led to salinization.

Why conserve wetlands? - Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic material. Rice, for example, which is a common wetland plant, is the staple diet of more than half of humanity. The multiple roles of wetland ecosystems and their value to humanity have been increasingly understood and documented in recent years. This has led to large expenditures to restore lost or degraded hydrological and biological functions of wetlands. But it's not enough – the race is on to

improve practices on a significant global scale as the world's leaders try to cope with the accelerating water crisis and the effects of climate change. And this at a time when the world's population is likely to increase by 70 million every year for the next 20 years. Global freshwater consumption rose sixfold between 1900 and 1995 – more than double the rate of population growth. One third of the world's population today lives in countries already experiencing moderate to high water stress. By 2025, two out of every three people on Earth may well face life in water stressed conditions. The ability of wetlands to adapt to changing conditions, and to accelerating rates of change, will be crucial to human communities and wildlife everywhere as the full impact of climate change on our ecosystem lifelines is felt. Small wonder that there is a worldwide focus on wetlands and their services to us. In addition, wetlands are important, and sometimes essential, for the health, welfare and safety of people who live in or near them. They are amongst the world's most productive environments and provide a wide array of benefits (https://www.ramsar.org/sites/default/files/documents/library/info2007-01-e.pdf).

Ramsar Convention: - The Ramsar Convention encourages the designation of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated, these sites are added to the Convention's List of Wetlands of International Importance and become known as Ramsar sites. In designating a wetland as a Ramsar site, countries agree to establish and oversee a management framework aimed at conserving the wetland and ensuring its wise use. Wise use under the Convention is broadly defined as maintaining the ecological character of a wetland. Wetlands can be included on the List of Wetlands of International Importance because of their ecological, botanical, zoological, limnological or hydrological importance.

Ramsar Convention is a convention on wetlands that was signed in 1971 in the Iranian city of Ramsar. The negotiations for the convention started in the 1960s by the different countries and NGOs for the protection of wetlands and their resources. Finally, it came into force in 1975. There are 75 Ramsar Sites in India listed under the Ramsar Convention.

What is the purpose of the Ramsar Convention? - The convention works on three pillars that define the purpose of the Ramsar Convention:

a. Wise Use – To work towards the wise use of all wetlands

b. List of Wetlands of International Importance – Designate suitable wetlands under the Ramsar List to effectively manage those

c. International Cooperation – To bring cooperation internationally over the trans boundary wetlands, shared wetland systems and shared species.

Important Facts about the Ramsar Convention: -

1. It is the only international treaty that addresses a specific ecosystem (wetland.)

2. Originally, the treaty focussed on the conservation of the habitats for waterbirds.

3. The official name of the treaty is The Convention on Wetlands of International Importance, especially as Waterfowl Habitat.

4. With time, the treaty has broadened its horizon and covers all aspects of wetland conservation.

5. The Ramsar Conventions contains three important subjects:

- The contracting parties which are now 171 in numbers have to designate suitable wetlands in their territory under the Ramsar List of Wetlands of International Importance.
- The designated wetlands have to be wisely used and taken care of.
- Shared wetland systems over the territories of more than one contracting party have to be used wisely by the parties concerned after due consultation

6. As of June 2021, there are 2422 wetlands in the list of wetlands of international importance.

7. Ramsar Convention is not a regulatory regime.

8. Ramsar Convention was modified by the Paris Protocol in 1982 and by the Regina Amendments in 1987.

9. Montreux Record – It is a mechanism that was launched in 1990 and is associated with the Ramsar Advisory Mission. It is a register of the list of those Ramsar Sites that need urgent attention. One can read more about Montreux Record at the linked article.

10. World Wetlands Day – It was first celebrated in 1997. It is celebrated each year on 2nd February to mark the anniversary of the Ramsar Convention and promote its mission.

11. A conference of the contracting parties (COP) to the convention meets every three years.

12. The Ramsar Convention has six international organization partners:

- Birdlife International
- IUCN
- Wetlands International
- WWF
- International Water Management Institute
- Wildfowl and Wetlands Trust

13. The convention comes with a six-year strategic plan. The latest one is the 4th Ramsar Convention Strategic Plan 2016-2024 which was approved at COP12 of the convention.

14. Ramsar Convention’s Standing Committee has 18 members that are elected at COP till the next COP elects new members.

15. The Convention works in three languages – English, Spanish and French.

Wasteland: - About one fourth of the earth's surface is covered by land in many instances; the biological and physical makeup of the land contributes to how it is used. Some land areas which contain rich soils are the most suitable zones for farming. At the sametime some land areas which are prone to be affected by floods are less suitable for any activity including settlement land is valuable natural resources. It is the home for all life. The needs of human population are met by the land for Food, Fiber, Medicine, howling and settlement, energy supply, water supply. Land is the most important ingredient for any ecological and economic development in the world. When it is good. A land can be used for several activities including. Cultivation, construction, grazing and for all other development work land is a terrestrial bio-productive ecosystem. It comprises of Soil, Water, Plant and Other biota.

Based on the Ecological conditions, land system are classified into various types as : (a) Cropland (b) Barren land (c) Wet land (d) Arid dry land (e) Range land (f) Grass land (g) Snowy land and h) Wastelands.

A land becomes a valuable resource, when the environmental conditions are conducive for human use. A land many be declared as a wasteland due to some limiting factors in the environment. These limiting factors may be natural or anthropogenic improper land use is a major anthropogenic factor affecting a land system factor affecting a land system. Due to increase in population, the demand of land for cultivation and other activities has also increased.

The types of wastelands, created due to these limiting factors are, many in the world, wasteland may also be valuable lands, some of the world, some of the also be valuable lands, some of the serious categories are:- (a) Degraded land (b) Solemnized soil (c) Water lagging (d) Desertification and (e) Soil erosion

These have drastically decreased the per capita cultivable land besides ecological imbalances. According to a report of the FAO, the global land area without major soil fertility constraints is about 31.8 million sq. km and the total potential, arable land is about 41.4 million sq. km. India shares 16% of the world population. While its total geographic area of the world. Naturally; the pressure on the land is often beyond its carrying capacity. Therefore, the productive land especially the farmlands in the India are in the constant process of various degrees of degradation and are fact turning into wasteland at present, approximately 68.35 million hectare area of the lands is lying as wastelands in India.

What is a Wasteland? - In general, the barren or degraded lands which do not fulfill their life sustaining potential. Some of agricultural fields degraded or unfit for profitable cultivation are also often considered as wastelands. The most commonly used definition of wastelands is “any type of land which because of neglect, overuse or degradation by climatic and / or anthropogenic factors is not being used to its fullest potential” The National Wasteland Development Board, Govt. of India defines wasteland as “land which is presently degraded and is lying unutilized except current fallow due to different constrains”.

Types of Wasteland: - The wastelands can be mainly divided into 2 types and then subdivided into several subtype. These are:

A. Culturable Wastelands: These are the wastelands which can be cultured easily or without much difficulty. No special measures are required for their reclaimation. These may reclaim at their own naturally with time.

B. Non culturable Wastelands: These cannot be reclaimed easily and natural reclamation of is not possible. These can either be reclaimed with extreme difficulty or cannot be reclaimed at all.

A. Culturable Wastelands

1. Gullied or Ravinous Wasteland: This type of land is formed as a result of concentrated run off flowing at very high speed. This runoff erode soil and forms gullies. Fertility of these soils is very low and nearly at zero level.

2. Steep Sloping Area/Undulating Uplands: Lands having slope from 3 to 10 degrees. These are unsuitable for cultivation due to high degree of slope which hinders in agricultural operations. These are characterized by accelerated water and wind erosion. The common vegetation present is weeds, grasses and bushes cover.

3. Water Logged or Marshy Lands: These lands remain submerged in water practically for whole of the year. These lands may develop due to seepage of water from rivers, canals or water reservoirs. These lands are formed near coastal and in other low lying areas.

4. Salt Effected Lands: These lands have deposition of salts on the upper layers of soil. The depth of layer depends on the quantity of salts deposited. The salts deposited may be soluble or exchangeable. When there is excess of soluble salts and pH 8.5, soil is known as saline. When there is exchangeable Na, pH is from 8 to 10 soil is known as alkaline. These soils are usually fine textured, light with good porous space but low water holding capacity. Due to deposition of salts, colors of upper crust vary from white to grayish white.

5. Degraded Forest Land: Due to removal of forests for fuel and firewood the tree canopy has been reduced and trees almost look like bushes or merely skeleton and they are not able to grow further. The soil of this area is good for planting crops provided used with care.

6. Shifting Cultivation Area: The land areas are cleared by burning or cutting mostly by tribal people. This type of cultivation is also called Jhumming cultivation. The land is exposed to natural conditions of weathering till plant or crop sowing. The cultivation is done for few years, and then these tribal people move to another place and again clear other forest area for next cultivation and so on. This practice may lead to the formation of wastelands.

7. Degraded Pastures/Grazing Lands: These are the areas under permanent grasses where cattle or animals graze. These lands are initially degraded due to over grazing by animals. Further, trampling of land by the animals loosen the upper soil layers which promote soil erosion by water or wind. These lands should be used with care as these are fertile and good in texture.

8. Mining/Industrial Wasteland: The land becomes barren to large extent due to excavations and movement of heavy machinery. This area is left exposed to natural weathering processes and it may lead to soil erosion due to wind and water. The remains of rocks and excavated waste material comes down with rains and wind to low laying area and gets deposited there, creating more wastelands. These lands are mostly found in Jharkhand, Chattisgarh, Bihar, Orissa, Madhya Pradesh, Karnataka etc.

9. Land with or without Scrub Vegetation: Scrub vegetation is generally used for vegetation dominated by stunted trees or bushes and the crown cover less than 10% of land area. These plants are neither eaten by animals nor used by man. Scrub vegetation degrades soil quality. The barren land which does not have any capability to grow vegetation or the fallow land covered with grass is called land without scrub. These lands are productive and can be used for agricultural purposes if managed properly.

10. Degraded Land under Plantation Crops: The plantation crops are grown for commercial purposes. The monoculture agriculture makes the soils deficient in specific nutrients which lowers the soil fertility. The continuous monoculturing degrades the soil and the fertile land becomes a wasteland.

B. Non Culturable Wasteland: These cannot be reclaimed easily. Natural reclamation of such wastelands is not possible. It can either be reclaimed with extreme difficulty or cannot be reclaimed at all. It can further be subdivided into following types:

1. Barren Rocky Area: Presence of big and small rocks hinders agricultural operations. Small rocks can be removed easily and the land can be used for raising crops. Where removal of big rocks is not possible trees can be planted.

2. Sandy Area: Found in desert, coastal areas, near river beds and sea shores. Sand deposits may found in a layer of 10-15cm on the surface of soil or the area can be totally sandy. High wind currents form sand dunes which hinders cultivation.

3. Snow Covered or Glacial Areas: Area remains practically under snow cover for whole of the year. Usually found in mountains with slope which may be too much for correction. Not suitable for agriculture.

Wasteland Reclamation: - It is the process of turning barren, sterile land into fertile land suitable for agriculture or vegetation and cultivation. Reclamation means recovering physical structure of land to rebuild the ecosystem. These lands can be reclaimed by three methods (Aber, 2012) :

A. Topography and Soil Management

B. Water Management

C. Crop Management

A. Soil Management: The soil management can be done with following:

1. Filling of Gullies and Leveling: This can be done by filling stones in gullies, followed by compacting after placing soil over it. The leveling of land should be done to reduce water erosion. Further changing course of water or small check dams are also useful for the purpose. Planting grasses and bushes along the water course also help to stop soil erosion.

2. Terracing: In this the earth is shaped in the form of small leveled terraces to hold soil and water. The terraces are given inward slope to increase infiltration of water. The banks of terraces are made firm and compact by placing stones and planting grasses over the sides.

3. Scraping: This technique is used for soils covered with 2-3 cm thick layer of salts over it. This layer can be removed by scraping using spade. This is possible only at small scale and may not be possible at large scale.

4. Flushing: The method is used for lands where water soluble salts accumulate over land surface due to evaporation of water. To remove these salts, the area is first filled with water and allowed to remain there for few days. The water is checked for its conductivity so as to find that how much salts have dissolved. The water is then flushed off. Water should not be made to stand for long as salts can leach down to the sub soil.

5. Deep Ploughing: Fallow lands i.e. land that is normally used for farming but that is left with no crops for long time become hard due to trampling by animals, settling of soil particles and lack of vegetation. To recover such lands, ploughing should be done deep so that soil is opened to absorb moisture from rain. This also removes weeds, stones and pebbles etc.

6. Drainage: Waterlogged soils are improved by this method. There are 2 types of drainage systems, Sub-surface drainage and Underground drainage.

7. Addition of Green Manure and Soil Amendments: The method is used to reclaim the soils low in organic matter, nutrients and alkaline or acidic in nature. In this method legume crops or nitrogen fixing plants are cropped on the land and ploughed down in the soil when they are soft and without flowers. They fix atmospheric nitrogen and add organic matter to soil. The chemicals like calcium carbonate, gypsum, fly ash and farm yard manure are added to the soil to increase the nutrient level and lime is added to reduce the soil acidity.

8. Wind Breaks: The method is used in areas having loose dry sandy soil and high intensity of speedy winds leading to movement of soil with wind. To reduce soil erosion due to high speed wind, row of fast growing trees are plated on boundaries of wastelands and banks of water courses. The trees species commonly used as wind breaks are Poplar, Neem, Shesham Bamboo and some fruit trees like, Ber, Jamun Mango etc.

9. Silt Trapping Dams: When the water flowing from uplands cause soil erosion and siltation, to check the movement of eroded soil, big or small dams of reasonable height can be constructed against the course of water flow. Water is made to stand near these traps for a while and silt particles settle down thus reducing soil erosion.

10. Contour Furrowing and Bunding: The method is adopted for sloppy wasteland. The contours or furrows are made to allow water to remain in contour or to move at a slow speed and hence reduce soil erosion by water. This increases Infiltration of water leading to water conservation.

11. Mulching: The method is used to conserve soil moisture during droughts and when there are no rains. Mulches of dry grass, polythene, chemical mulch etc. are used to cover the soil surface. Mulching also check soil erosion and suppresses emergence of weeds.

B. Water Management: Consists of three options:

1. Addition of water-Irrigation: The addition of water to agriculture of vegetation is called irrigation. Irrigation or soil moisture is most important to provide water to the plants and maintain land productivity. Various methods are used for irrigation depending on the soil type, crop/vegetation type, water availability etc. Mainly following techniques are used for irrigation.

2. Furrow or channel- Used where land is leveled and water is in plenty. Flooding-Water is allowed to flow over the field. It is used where water is in plenty. Sprinkler – Used where less but frequent water is required. It is very useful as no soil erosion, no loss of nutrients and water saving. Ring or basin method-Used for irrigating fruit and other trees, individual tree is given water at a time. No loss of nutrients, no soil erosion but time consuming and laborious method.

3. Drip irrigation/Trickle irrigation method- This is relatively modern irrigation technology. In this, water is made to trickle down near root zone. Trickling of water drops is slow, underground and continues. There is no run-off of water, evaporation loss, no leaching down of water. Conservation of soil Moisture: It includes all the policies, strategies and activities to sustainably manage and conserve the soil moisture. It can be conserved by already discussed methods of terracing, mulching, wind barriers, silt trapping dams etc.

Some other methods used for the purpose are:

Graded bunds: These are simple earthen embankments constructed across the slope/ contour of the area are called contour bunds. When these are constructed at pre-determined longitudinal grade, they are known as graded bunds. These are constructed where rainfall is more than 600 mm per year. The run-off from upper bund is retained in the lower bund and again the surplus water passed on to the next bund and in this way water is conserved in the soil.

Water Storage in Ditch: During rainy season, water is collected in ditches made at regular intervals depending upon soil type and amount of water to be handled. The water stored in ditches and can be used during water scarcity. Evaporation losses are overcome by covering the top of ditches.

Drainage: This is the method of removal of excess of water from soil/sub soil. The most common method used is pumping out the water with mechanical methods. On sloppy lands channels are laid down and water flows down by gravity.

C. Crop Management: Growing suitable crops and their management is another approach to reclaim wasteland. Those crops selected for wastelands should have characteristics like drought tolerant, minimum rate of transpiration, less nutrient requirement etc. Growing leguminous crops and ploughing them young in the soil. Multiple cropping mixed cropping and crop rotation is done.

Aonla and Jatropha Plantations: The Aonla commonly called Amla is a minor sub-tropical deciduous tree. It can withstand drought conditions and can grow in neglected regions owing to its hardy nature. The fruit of the tree is in high demand due to its nutritional values. Similarly, another plant preferred to reclaim waste lands is Jatropha. It can grow on degraded soil and can resist drought conditions. The Seeds have high oil content which can be used for bio diesel production.

Fuel Wood Plantations on Wastelands: The land which cannot use for agricultural purposes can be planted with fast growing species of trees having rotation cycle of 4-7 years .It can provide fuel wood and fodder for cattle. Hence, it reduces excessive pressure on pasture lands.

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UNIT: - 5

Environmental migration and environmental refugee

Introduction: - The consequences of climate change on migration present humanity with an unprecedented challenge. The numbers of storms, droughts and floods have increased threefold over the last 30 years with devastating effects on vulnerable communities, particularly in the developing world. In 2008, 20 million persons have been displaced by extreme weather events, compared to 4.6 million internally displaced by conflict and violence over the same period. How many people will be affected by climate change by 2050? Forecasts vary from 25 million to 1 billion people with a figure of 200 million being the most widely cited estimate. Extreme environmental events such as cyclones, hurricanes, tsunamis and tornadoes tend to capture the media headlines, but it is gradual changes in the environment that are likely to have a much greater impact on the movement people in the future. For example, over the last 30 years, twice as many people have been affected by droughts as by storms (1.6 billion compared with approximately 718 million).

It is important, however, not to view migration as simply the failure of communities to adapt to climate change. Migration has always been one of the ways in which people have chosen to adapt to changing environments. Migration can also help those left behind in environmentally degraded areas. Studies in Côte d'Ivoire, for example, have shown that migrants who moved from Burkina Faso regularly sent home remittances which were invested in schools and hospitals and in water and irrigation systems. Moreover, migrants are often the first to provide assistance when natural disasters occur. Research in countries such as El Salvador, Jamaica, Botswana and the Philippines has shown that migrant remittances increase significantly when disasters occur providing essential relief assistance to affected communities.

Over the last few years there has been an upsurge of interest in the likely impact of climate change on population movements. Estimates have suggested that between 25 million to one billion people could be displaced by climate change over the next 40 years. For the most part these figures represent the number of people exposed to the risk of climate change in certain parts of the world and do not take account of the measures that could be taken to adapt to these changes. Although experts have dismissed such figures as, at best, "guesswork" these statistics have helped to focus policy makers' attention on the likely implications of climate change on migration. Despite the lack of precise figures, there is now little doubt that parts of the earth are becoming less habitable due to factors such as climate change, deterioration of agricultural lands, desertification, and water pollution. The number of natural disasters has more than doubled over the last two decades, and more than 20 million people were displaced by sudden-onset climate-related natural disasters in 2008 (OCHA-IDMC, 2009). Further climate change, with global temperatures expected to rise between 2 and 5 degrees centigrade by the end of this century, could have a major impact on the movement of people. Policy makers are therefore asking the research community and other experts to provide them with guidance in regards to a number of key questions (Laczko & Aghazarm, 2009).

The Complexity of Environmental Migration: - To address environmentally induced migration comprehensively under international law is a complex task because it requires a diversity of different approaches depending on the different types of factors that induces migration in different parts of the world. Some situations may require permanent international displacement, as will be the case of for example submerging states due to rising sea levels, or some cases of desertification or drought. In other situations temporary international protection might suffice, as could be the case of occasional storms or tropical cyclones. In such cases, even internal displacement might sufficiently respond to the needs of the people concerned, especially if the environmental impact is limited to only a portion of an affected state. Three main categories of climate change effects are expected to contribute most to migration flows: Namely, submerging island states due to rising sea levels, an increasing quantity and intensity of storms, and drought, desertification, and water shortages (Bush, 2012; Docherty & Giannini, 2009). In the upcoming section, these events will be divided into subsections of sea level rise and migration, rapid onset events and migration, and slow onset events and migration.

1. Sea level rise and migration: - Sea level rise may be characterized as a slow onset gradual environmental change as well as a rapid onset climate event because it is also a contributor to the impact of flooding and storms. This specific aspect is therefore allocated its own section. Further, given the possible disappearance of island states, and consequently the effective statelessness of inhabitants of the islands in question, sea level rise might be regarded as the most dramatic manifestation of climate change. There is a genuine risk of complete submergence for small island states that will exacerbate the effects of environmentally induced disruptions because of their large coastal areas and low elevation (Kraler et al., 2011). The Maldives, for example, could see portions of its capital flooded by 2025, and half of the island is estimated to be flooded by 2100. Further, the islands of Kiribati and Tuvalu, the Marshall Islands, and several Caribbean islands, are urgently threatened and will eventually end up completely submerged. In such cases of complete submergence of states, the island residents are effectively rendered stateless and can consequently neither be displaced internally nor enjoy any other protection of their respective governments. While some states may cease to exist, others might lose portions of territory, which would in turn spur migration. Especially in regions of Asia major disruptions loom for certain low lying shoreline areas. For example, Bangladesh consist to eighty percent of a delta, and IPCC calculations indicate that a rise in sea levels of 45 centimeters would displace 5.5 million people and submerge over 10 percent of Bangladesh. Increased levels of migration are thus unavoidable.

2. Rapid onset climate events and migration: - There has been much publicity about rising sea levels and potentially submerging states.23 However, extreme weather events such as storms, floods, earthquakes, volcanic eruptions, and tropical cyclones are examples of rapid onset climate events that equally cause inhabitants to migrate (Kraler et al., 2011). Often, this kind of migration occurs in an even more urgent manner as the populations have not been able to anticipate and prepare themselves for such events. Such events have nevertheless not received as much attention in the discussion concerning environmental migration. Yet, the

number of these kinds of extreme weather events are predicted to grow as a result of environmental changes (Change, 2014), and people are thus increasingly displaced to avoid physical harm or loss of life, and because homes and livelihoods such as crops and productive assets are destroyed. The occurrence of migration related to rapid onset events is probably the easiest to identify because the impacts of the environmental events are relatively observable. People migrating due to rapid onset climate events should accordingly be less difficult to encompass under international law. However, rapid onset events rarely lead to long-term and long-distance migration but rather short-term internal displacements, unless social factors exacerbate the impact of the disaster, for instance if the affected society is highly dependent on the natural environment in order to support livelihood, and the natural environment is heavily damaged due to the extreme weather event in question. The extent of cross-border migration depends further on the frequency and as well as on the extent of damage, and also on the management of the disaster response (Tacoli, 2009).

As previously mentioned, the people that are cross-border migrating as a result of rapid onset climate events requires urgent protection responses by the international community. However, they habitually require only temporary protection as they will most likely be able and willing to return to their state of origin as soon as it is safe and the damage is repaired. The capacity to migrate over long distances is often also limited because of lack of the required resources. What is required of international law in order to provide adequate protection for people migrating due to rapid onset climate events is thus a reliable system that determines where the migrants are entitled at least temporary protection, the extent and content of which might vary depending on the specific needs and circumstances of each case.

3. Slow onset climate events and migration: - Drought, desertification and land degradation are the main slow onset events which are exacerbated by climate change and that contribute substantially to the number of environmental migrants. Globally, 10-20 percent of dry lands are already degraded. The more than 2 billion people who live in these degraded areas are particularly vulnerable to loss of essential resources such as water supply. Because water scarcity is anticipated to intensify as an effect of climate change, desertification will correspondingly be further exacerbated. The people living in those areas might be affected economically as it will eventually be more difficult to support livelihoods, for example because of decline in agricultural productivity. Consequently, desertification might cause mobility or at least be a contributing environmental push factor to migration, in addition to the often already existing social and economic factors that induce migration.

What are the links between migration, the environment and climate change? - The migration - environment nexus is not a new issue: the environment has always been one of the major drivers of migration. However, climate change significantly increases its current and future relevance.

In its First Assessment Report (1990) the Intergovernmental Panel on Climate Change (IPCC) posited that “the gravest effects of climate change may be those on human migration”. In its Fourth Assessment Report (2007) the IPCC notes population movements as a likely key consequence of climate change.

Climate change is likely to exacerbate (a) the frequency and intensity of extreme weather events (e.g. tropical storms, floods, heat waves) (b) gradual processes of environmental degradation (e.g. desertification, soil and coastal erosion).2 These effects of climate change as well as its adverse consequences for livelihoods, public health, food security, and water availability will have a major impact on human mobility, likely leading to a substantial rise in its scale.

In most cases, it is difficult to establish a simple and direct causal link between the movement of people and the environment: the environment, including climate change impacts, is usually one of multiple factors involved in a decision to move. Other factors, such as levels of human and economic development, conflict, gender, livelihood strategies, demographic trends, access to networks as well as the availability of alternatives to migration, have an impact on whether or not a person migrates and the nature of migration.

What do we know about the relationship between environmentally induced migration and conflict? - There are links between climate change, conflict and migration, but it is not a simple cause and effect relationship.

As highlighted in the UN Secretary General's 2009 report to the UN General Assembly on "Climate Change and its possible security implications", the linkages between climate change and conflict are complex and need to be analyzed in the context of pre-existing social, economic and environmental threats, or stresses. Climate change can be viewed as a "threat multiplier" which exacerbates existing sources of conflict and insecurity.

The adverse impacts of climate change may push a growing number of already fragile States to a point where political crisis, poverty and environmental strains, including natural disasters, combine to form "complex emergencies". Such complex emergencies can cause the displacement of populations who find themselves in conditions of exacerbated vulnerability.

However, there is little by way of solid empirical evidence to support that migration as a result of climate change leads to conflict, without any other factors shaping the situation. Furthermore, migration can also be seen to serve as a conflict management mechanism that allows population pressures to be adjusted in line with environmental pressures.

What legal frameworks apply to environmentally induced population movements? - All migrants are protected by international human rights law. In addition, persons displaced within their country due to natural or human made disasters are covered by provisions laid out in the Guiding Principles on Internal Displacement (a non-binding instrument). Those crossing international borders for environmental reasons would not normally qualify as refugees, who are entitled to international protection within the existing international framework, nor do they fall squarely within any one other particular category provided by the existing international legal framework.

Some States, however, have made some provisions for environmental migration: In Finland and Sweden, someone who left his or her country and is unable to return due to environmental disaster qualifies as a person in need of protection. The USA grants

"Temporary Protection Status" to persons already in the USA and unable to return home as a result of environmental disaster; this was applied, for example, after Hurricane Mitch in Honduras and Nicaragua in 1998. In the EU, the "Temporary Protection Directive" allows for temporary protection under certain circumstances, when people are suddenly displaced in large numbers and it is not feasible to deal with their cases on an individual basis. Lastly, after the 2004 Indian Ocean tsunami Canada, Switzerland and the UK temporarily suspended removal of nationals of affected countries (Warener, 2012).

Environmental Refugee: - In early 1999, there were almost 22 million traditional and 'internationally recognized' refugees (people fleeing political oppression, religious persecution and ethnic troubles). Their numbers had declined from a peak of 27 million in 1995 but remained higher than the 19 million of 1993 (Salgado, 2000). In addition, there were large numbers of people who could be characterized as environmental refugees, or people who could no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification, deforestation and other environmental problems, together with the associated problems of population pressures and profound poverty. Not all of them have fled their countries, many being internally displaced. In 1995, they were estimated to have totaled at least 25 million, and their numbers have been increasing (Myers, 1997).

Out of the 25 million environmental refugees in 1995, there were roughly five million in the African Sahel, where a full 10 million people had fled from recent droughts, only half returning home. Another four million, out of 11 million refugees of all types, were in the Horn of Africa including Sudan. In other parts of Sub-Saharan Africa, where 80 million people were considered to be semi starving due primarily to environmental factors (Myers & Kent, 2001) seven million people had been obliged to migrate in order to obtain relief food. In early 2000, Sudan had eight million people who were officially considered at risk of starvation, with another six million in Somalia and three million in Kenya, plus several million others in other countries. A large, though undocumented, proportion of these could be characterized as environmental refugees. Although Sub-Saharan Africa remains the prime locus of environmental refugees, there are sizeable numbers in other regions and countries. In China, with its 120 million internal migrants, at least six million deserve to be regarded as environmental refugees, having been obliged to abandon their farmlands due to shortages of agricultural plots in the wake of decades of population growth (Hu, 1993).

There is a new phenomenon in the global arena: environmental refugees. These are people who can no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification, deforestation and other environmental problems, together with associated problems of population pressures and profound poverty. In their desperation, these people feel they have no alternative but to seek sanctuary elsewhere, however hazardous the attempt. Not all of them have fled their countries, many being internally displaced. But all have abandoned their homelands on a semi-permanent if not permanent basis, with little hope of a foreseeable return.

As far back as 1995 (latest date for a comprehensive assessment), these environmental refugees totalled at least 25 million people, compared with 27 million traditional refugees

(people fleeing political oppression, religious persecution and ethnic troubles). The environmental refugees total could well double between 1995 and 2010. Moreover, it could increase steadily for a good while thereafter as growing numbers of impoverished people press ever harder on over-loaded environments. When global warming takes hold, there could be as many as 200 million people overtaken by disruptions of monsoon systems and other rainfall regimes, by droughts of unprecedented severity and duration, and by sea-level rise and coastal flooding.

Of the 25 million environmental refugees in 1995, there were roughly five million in the African Sahel, where a full ten million people had fled from recent droughts, only half returning home. Another four million, out of eleven million refugees of all types, were in the Horn of Africa including Sudan. In other parts of Sub-Saharan Africa, where 80 million people were considered to be semi-starving due primarily to environmental factors, seven million people had been obliged to migrate in order to obtain relief food. In early 2000 Sudan featured eight million people who were officially considered at risk of starvation, with another six million in Somalia and three million in Kenya, plus several million others in other countries. A sizeable though undocumented proportion of these could be characterized as environmental refugees (Myers, 2005).

Causes of Environmental Refugees: - Norman Myers put forth a slightly different definition of environmental refugees. In Myers' definition, he addressed some of the leading causes of the creation of environmental displacement. These causes include "environmental factors of unusual scope, notably drought, desertification, deforestation, soil erosion, water shortages and climate change, also natural disasters such as cyclones, storm surges, and floods" (Myers, 1995, p. 18-19). Some of the causes result from a combination of human and natural factors, such as drought, deforestation, soil erosion, and climate change. However, some of the causes result from natural influences, such as cyclones, volcanoes, and earthquakes. Both of these categories add to the growing number of environmental refugees, though the primary focus will be on causes that are both human and naturally induced.

Water, both in excess and in shortage, creates problems and has the potential to create environmental refugees. The problem of excess water comes in the form of sea-level rise, floods, and natural disasters such as hurricanes and cyclones. The reasons for sea-level rise are twofold: the melt from glaciers primarily in the polar regions of the world due to global warming, and the warming of ocean waters, causing them to expand and rise (Mann & Kump, 2008). These issues will be thoroughly investigated in later portions of this paper when the issue of the Maldives is discussed. Water shortages affect all aspects of a society, especially the economic sector.

Floods, cyclones, and hurricanes are a result of too much water in a given area. When these natural disasters occur, people are often forced to leave their residence because the land is no longer suitable for habitation. Flooding of the Mississippi River in 1993 spread to the city of Kaskaskia, Illinois, and created a massive disaster (Mann & Kump, 2008). This city was an island that was protected by a levee that broke during the Great Flood of 1993 (History.com). The entire town was under water and all of the residents were forced to leave and find a new

home (History.com). In October, 2010, Myanmar was hit with a huge tropical cyclone that left around 70,000 people homeless (CNN Wire Staff, 2010). This cyclone led to homelessness, damage to infrastructure, 27 deaths, and communication problems (CNN Wire Staff, 2010).

These are just two examples of ways in which extreme amounts of water can create environmental refugees by making peoples' location unlivable. Worldwide, there has been an overall deficit of water, which creates major issues as the demand for water has tripled within the past half-century. Water is the most important natural resource in the world. It is necessary to support nearly every industry, from processing and manufacturing to agriculture. Shortages of water especially impact the agricultural industry, affecting irrigation and leading to potential harvest issues. In terms of irrigation, two water sources are available: underground water and surface water. Underground water is found in aquifers, most of which are replenished by rainfall, while surface water is found primarily behind dams. The current problem with both underground and surface water is that the water is being used at a faster rate than it is being replenished. As this occurs, the available amount of water for irrigation decreases, which directly correlates with the amount of harvest available for any given population. Forty percent of the world's grain harvest comes from irrigated lands, so these decreasing water supplies are clearly an issue of concern (Brown, 2011).

Deforestation has been an intense environmental problem, especially in the tropical regions of the world. Deliberate removal of forests has been occurring for centuries as there has been a constant demand for lumber. Forests are cleared for various reasons, such as agricultural expansion, fuel needs for domestic and industrial processes, and firewood for local populations for their everyday needs. The results of deforestation are reduced biological diversity including species extinctions; changes in local and regional environments such as soil degradation, change in water flow, and increased sedimentation in rivers, reservoirs, etc.; and changes to the global environment in regards to the carbon dioxide released into the environment (Goudie, 2000).

Case Studies:

a. Case Study: Haiti: - Haiti is a small country located in the Caribbean Sea on the island of Hispaniola. With a GDP of only $1,200, Haiti economically ranks 205 out of 229 countries worldwide, and Haiti is the poorest country in the Western Hemisphere. Eighty percent of the population lives under the poverty line, and 54% of the population lives in abject poverty (Central Intelligence Agency, 2011a). This type of extreme poverty corresponds with the poor environment in Haiti. While only one-third of the land is suitable for agriculture, three fifths of the land is being cultivated because of population demands. As a result, the soils are especially prone to erosion and much of the soil is so overworked that it is not reclaimable (Myers, 2002). The poor environmental conditions have historically resulted in the migration of many Haitians. Estimates show that about 1.3 million Haitians have left their homelands, with 300,000 of them migrating to the United States. Refugees realize that their lives in Haiti contain little hope, and so they desire to start a new life elsewhere. Since the primary factor causing Haitians to migrate is poor environmental conditions, it is logical to call these

individuals environmental refugees. In the United States, and Florida in particular, $250 million have been paid per year in the past to meet the needs of Haitian environmental refugees (Myers, 2002).

Deforestation is a huge contributor to environmental degradation in Haiti. Only 2% of the original forest remains, creating extremely degraded land (Keese, 2011). This extreme deforestation occurred for a couple of reasons. First, French colonizers were desperate to make room for coffee and sugar plantations, so they cleared a large portion of forest land for farming. Additionally, during the 19th and 20th century, the timber industry played a large role in deforesting Haitian land. One of the last major reasons for deforestation in Haiti is for the needs of the Haitian population. The lumber from the forests provided fuel for subsistence farmers and as fuel for the capital of Port-auPrince. The intensive deforestation led to additional soil erosion, decreased harvest, and increasing severity of floods. As these negative effects of deforestation worsened, massive amounts of people left the country-side and headed to Port-auPrince (Interlandi, 2010).

b. Case Study: The Maldives: - The Maldives are located in the central Indian Ocean, and are comprised for 1200 small, individual islands (Morner, Tooley, & Possnert, 2004). With the highest point at 2.4 meters, these islands are at a high risk of the effects of sea-level rise. Depending on the rate of sea-level rise, these islands could be completely submerged at some point within the next couple centuries. With a population of about 400,000, this would have a huge effect on the surrounding areas such as India, the rest of Asia, and Australia, as these environmental refugees would have to migrate to other regions (Central Intelligence Agency, 2011b). Sea level rise occurs for two reasons. First, as water warms, it expands. Secondly, melting ice contributes to sea level rise. The melting of ice is an interesting factor because it is primarily the continental ice sheets that would cause sea level rise, rather than the sea-ice (Mann & Kump, 2008). Continental and mountain glaciers have the most potential boosting sea level rise, as their complete melting would result in a sea level rise of seventy meters. Even though complete glacial melting is unlikely at any point in the near future, sea level rise is still likely to continue. Based on current data, there is a projected sea level rise of .5 to 1.2 meters by the year 2100. Since, as previously stated, the highest point of the Maldives is at 2.4 meters; this sea level would clearly affect the islands.

When those living in low-lying island states must migrate, many stateless individuals result. When this occurs, the question arises of where these individuals can find statehood. As sea-level rises, the entire population of the Maldives may eventually be externally displaced. As the population migrates, they will be completely dependent upon the government where they migrate to. It has yet to be determined what should occur when states completely cease to exist, which would occur if sea levels completely engulfed the Maldives, but it is clear that problems will arise both for the migrating population and the population of the host country. The International Law Commission has stated that “when a state disappears by dissolution, its nationality also disappears”. Therefore, if forced to completely abandon their country, the Maldives’ population would be without a place of residence and without nationality. The tragedy of sea-level rise is that everyone, in some small way, contributes to sea level rise; but

it is only those who live in lowlying coastlines and islands and regions that are directly affected by it (UNHCR, 2009).

c. Case Study: Sub-Saharan Africa: - Africa, particularly sub-Saharan Africa, is an extremely impoverished region, both in terms of the people and the environment. A correlation exists between these two factors where a poor environment helps increase the levels of poverty. In a region that is extremely prone to drought and food resources are scarce, the people constantly struggle to make ends meet (Brown, 2011). Sub-Sahahran Africa is the fastest growing region in the world, and this increase in population is only going to make environmental problems worse (Rowntree, Lewis, Price, & Wyckoff, 2009). Recent data shows that in sub-Saharan Africa, 80 million people are under nourished due to environmental conditions, with about seven million people migrating in order to find food (Myers, 2002). Sub-Saharan Africa has become the main producer of environmental refugees because of reasons such as food scarcity and drought which force people to migrate and search elsewhere for resources and living habitats (Myers, 2002).

Desertification plays a huge role in sub-Saharan Africa and particularly in the Sahel region in Africa. In 2006, a UN conference estimated that by the year 2020, approximately 60 million people could migrate to North Africa and Europe from sub-Saharan Africa due to desertification (Brown, 2011). People in this region are constantly affected by water shortages, often leading to drought and harvest reduction. The amount of cropland available is constantly decreasing, which leads to a decrease in harvest and an increase in malnutrition (Myers, 1997). As desertification, water shortages, drought, and harvest reduction occur; people are more likely to migrate in search for a better environment that will sustain their life. Additionally, as global temperatures rise, North Africa is expected to experience more intense, more frequent, and longer lasting heat waves (Mann & Kump, 2009). As this occurs, individuals are likely to migrate in search of regions primarily in Africa and Europe where water is available.

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UNIT: - 6

Social Pathology: crime

Introduction: - In the late 19th and early 20th century sociologists grouped together under the heading of social pathology those human actions which ran contrary to ideals of residential stability, property ownership, sobriety, thrift, habituation to work, small business enterprise, sexual discretion, family solidarity, neighborliness and discipline of the will. In effect social problems were considered to be any forms of behavior violating the mores from which these ideals were projected. The concept of disorganization was developed by Thomas and Zananiecki in their famous book 'The Polish Peasant in Europe and America'. According to them the term social disorganization refers to the decrease in the influence of the existing social rules of behavior upon individual members. As a result of this there develops individuation and lack of cohesion in society. It was explained by them as a process which will automatically and inevitably create social problems.

The concept of social pathology seems to pose a dilemma for social philosophers. On the one hand, social philosophers are easily repelled by the transfer of a medical or biological vocabulary to issues regarded as social or cultural. Biological, medical and naturalistic analogies seem not only reductionist but also suspiciously amenable to being used as a means of domination (Lu¨demann, 2004). The step from a social-critical usage of a pathology diagnostic vocabulary to a racist or sexist discourse of labeling sexual, linguistic, ethnic or religious minorities as unhealthy deviations might be not only shorter than sober social critics would like to think (Honneth, 2014b: 683–4), but also the more radical claim could be raised that it is precisely the task of social criticism to denaturalize social phenomena so as to reveal how something that took the shape of a natural event was in fact a social construction.

Now if this were the only problem that social philosophers have with the naturalistic vocabulary of ‘societal organism’, ‘social life’ and ‘social pathology’, the solution to hand would be simply to drop it. Social criticism could instead be directed by metaphysically more innocent-looking concepts such as ‘moral injustice’ or ‘political illegitimacy’, etc. But the difficulties with the notion of social pathology become more complicated once its concrete role in social-philosophical criticism is taken into account: Social philosophers often use a naturalistic vocabulary, in which the concept of social pathology is to exert an evaluative authority, in order to establish social philosophy as a discipline in its own right and to claim critical power for a social criticism, which does not rely on narrowly moral or political standards of validity; the use of the concept of social philosophy is, then, motivated by the ambition to establish an evaluative approach to social reality not reducible to the perspectives of moral and political philosophy (Dewey, 1973; Honneth, 2007). According to an influential contemporary commentator, social philosophy is oriented toward a ‘deeper’ layer of reality, a ‘higher’ order of wrongs (Honneth, 2014a: 86) or ‘society itself’ (Honneth, 2014b: 684). Following such intuitions, social philosophers often subscribe to the idea that social practices or perhaps even society itself might suffer from evils at a higher or deeper level, which marks the jurisdiction of a distinctively social philosophy. This level would, moreover, not be reached by the vocabularies of moral and political philosophy, and its characteristic evils

would in some relevant sense resemble or even be 'illnesses', 'diseases' or 'pathologies'. From this perspective, then, the very faith of social philosophy as a discipline in its own right looks tied to a naturalistic vocabulary.

Immanent social criticisms are characterized by the attempt not to rely on prior moral or political standards (Honneth, 2000). Sometimes this rejection of prior or external standards for critique is tied to the view of social philosophy as taking a more extensive view of things than moral or political philosophy. For example, Max Horkheimer distinguishes 'critical' social theory by virtue of its claim to grasp 'the life of society as whole' (1972: 203) from 'traditional' practical philosophies engaged in mere 'isolated consideration of particular... branches of activity' (1972: 199). Following Horkheimer, then, social-philosophical inquiry is practiced on a conceptual level, which does not allow reduction to any subtending disciplines of practical philosophy. Furthermore, this level is characterized as the 'life of society'. So even for a seemingly anti-naturalistic social philosopher like Horkheimer, the faith of social philosophy is tied to its naturalistic vocabulary.

This claim seems to be implicit also in the contemporary debate about social pathologies. There are four variations of the concept of social pathology in that debate. In what follows, we will try to sort out the diverging ontological commitments, metaphysical implications and evaluative aspirations of those four conceptions. All these conceptions of social pathology are committed to a picture of social philosophy as somehow more inclusive a project than 'mere' moral or political philosophy. Moreover, in all of them, 'social pathology' or some equivalent is made the very negative subject-matter defining social philosophy. Therefore, the use of the concept of social pathology says a lot about how social philosophy is understood. In a certain sense, each of the four conceptions also paints a specific picture of social philosophy. It is, however, important to sort out the diverging assumptions of these conceptions, not least because one can often find two or more of these incompatible conceptions used by one and the same author. While each approach tries to remain true to one horn of the dilemma (social kinds should not be reduced to natural kinds), they differ in whether they think it is nonetheless possible or important to retain the naturalistic or medical connotations of the concept of social pathology.

Four Conceptions of Social pathology:

1. Social pathology as an umbrella term for social wrongs: - The first approach regards 'social pathology' as a replaceable umbrella term for what is socially criticizable (Piotrowski, 2006: x). In this approach, 'social pathology' is more or less synonymous with social evils, social wrongs, criticizable social arrangements. (The distinction between first- and second-order wrongs is not relevant to this approach, see discussion below.) The approach can be called 'anti-theoretical' in the sense in which Gadamer's hermeneutics, Wittgenstein's or McDowell's philosophy of language, Aristotle's ethics or Michael Walzer's and Charles Taylor's views about social criticism are 'anti-theoretical' (Wittgenstein, 1953; Walzer, 1987; Taylor, 1991; Aristotle, 2004; Gadamer, 2004). The best we can do is to have good exemplars of what is socially criticizable, and somehow learn to go on from there, case by case. The cases include ideological worldviews, misrecognition, mal-distribution,

invisibilization, rationality distortions, reification or institutionalized self-realization, thus, to anticipate a list of social wrongs that the second approach will discuss as well. The first approach assumes that there need not be any inner logic or shared structure for these social wrongs – the list is open-ended; and can include any significant topics of social criticism. It seems thus very unambitious theoretically speaking, or anti-theoretical.

There are, however, good theoretical reasons for the anti-theoretical approach: according to this view, it would be a distortion to force the phenomena into the straitjacket of a unified structure, unless the phenomena already contain that structure. If the phenomena indeed constitute a cluster with no common denominator, we have strong theoretical reasons to remain anti-theoretical: the forced structure would be a distortion. A family resemblance may be the best we can have. It would be a mistake to think that 'the social' and 'social pathologies' have some universal or essential structure. The only universalistic truth is that the social is historically malleable, and new kinds of wrongs can emerge in new historical settings – they can be social wrongs without sharing any structure. Assuming shared structure smacks of essentialism to the followers of Gadamer, Aristotle and Walzer. It will just blind us, and lead us to focus on familiar cases; like the drunkard who was looking for their lost keys under the lamppost; not because that was where the keys were lost but because it would be easier to find them there. Arguably, this anti-theoretical option, even if non-informative theoretically, is the fall-back option if other construal fail.

Does this approach enable us to see the task of social philosophy in terms of the diagnosis of social pathologies? It may, if it has a story about how social wrongs differ from moral or political ones. On this approach, something is a social pathology, if it is somehow 'social', and wrong. How moral, political and social phenomena differ from one another is a contested issue, but at least a negative characterization is readily available for the first approach: socio-ethical questions are not limited to morality in a narrow sense (that concerns how individuals ought to act), and social problems are not limited to political questions of democracy or legitimacy of governance – there are social wrongs or evils of social practices, institutions, structures and processes in addition to narrowly moral and political ones. There are, for example, Charles Taylor's three 'malaises': loss of meaning, eclipse of ends in face of rampant instrumental reason, and loss of freedom or powerlessness under 'soft despotism' (Taylor, 1991).

The proponents of this first approach may even think there is no real reason to use the term 'social pathology' instead of its synonyms, but it is acceptable to use it out of courtesy as it were, when one's interlocutors use it; it is just another word for social wrongs. And it may be that the metaphor of 'pathology' has useful connotations, suggesting that we can analyze, diagnose, provide an etiology and suggest a cure or therapy, just as in medical cases (Honneth, 2007); and in successful cases, healing (Dewey, 2015). If something is experienced as a social suffering, then it makes sense to articulate it through a vocabulary of pathology or, for example, as 'malaises of modernity' (Taylor, 1991). So maybe there is, on this view, a rhetorical gesture, albeit not a theoretical reason, behind sticking to the term 'pathology'. It may of course be that these reasons do not override the weighty practical reasons not to use the vocabulary of 'social pathology', as in its naive usage it may have essential zing,

naturalizing, biologizing, universalizing, medicalizing, organicistic, vitalistic, and uncritical overtones that critical thought should avoid.

2. Social pathologies as non-natural but sharing a structure: second-order disorders and more encompassing views: - The second family of approaches tries to show that there is more to what social pathologies share, there is an illuminating theoretical account to be given after all.6 Social pathologies are all alike in sharing a structure, but (as opposed to the third and fourth approaches), the structure can be analysed in anti-naturalist terms. One prominent exemplar of this approach is Christopher Zurn's (2011) interpretation of the tradition of critical theory. Zurn suggests that social pathologies of all sorts, as discussed in the tradition of critical theory and by Honneth in particular, can be conceived of as 'second-order disorders'. These include pathologies of ideological recognition, maldistribution, invisibilization, rationality distortions, reification and institutionalized self-realization. What is at stake, in his view, are 'constitutive disconnects between first-order contents and second-order reflexive comprehension of those contents, where those disconnects are pervasive and socially caused'.

Think of the myth of personal responsibility for poverty. This myth is ideological in that it fails to note the causes of poverty in social arrangements, and misattributes it to personal failures. The myth also makes the systematic arrangements between the rich and the poor seem natural and legitimate – it produces a failure to critically question whether some other, more egalitarian arrangement should prevail. There is thus a disconnect between what is really going on, and what is comprehended – second-order critical questioning is blocked. And this blockage is socially caused and pervasive.

3. Social pathology as disease of the social organism: revitalized social organisms: - One of our guiding questions has been: is something 'pathological' because it is wrong or is it wrong because it is pathological? Whereas the first two of our four conceptions use the concept of social pathology to denote some social failures that are wrong in some specified way, the last two conceptions do the opposite: they use the concept of pathology in order to diagnose social life, to identify social wrongs. If the proponents of the first two conceptions use the concept in a predominantly metaphorical way – they translate the concept of pathology into a 'normative' vocabulary – the following two perspectives, on the contrary, use a contentful notion of pathology in order to find out what is wrong with the social organism or with social life. In the tradition of social philosophy, naturalistic terminology has also been put to use in a more literal, self-conscious way, and so the concept of social pathology has been used to deliberately produce medical and biological connotations or to articulate the kind of life that social practices present.

The third option prevalent in contemporary social ontology is to conceive of social pathology on the model of the ill organism. Here, social pathologies present deviations from the reproductive values and ends of society. In the broad tradition of social philosophy, this use of diagnostic pathology concepts is, of course, familiar from Durkheim's diagnosis of anomie (Durkheim, 1895). Its roots, however, reach back to Plato's Republic and have been modernized by Auguste Comte's Cours de philosophie positive. Although Hegel arguably

does not directly endorse an organicistic view of society (see below), he does in the Philosophy of Right treat the state as an organism, which has been the source of a predominantly right-Hegelian line of organicistic social theory. Similarly, in the French tradition, the likes of Louis de Bonald and Joseph de Maistre utilized an organicistic social ontology to criticize abstract principles of liberalism in political philosophy.

One evident advantage of this organicistic conception is that it makes sense of the concept of social pathology as a critical tool in its own right by delimiting it from other social-philosophical projects such as the critique of ideology or the critique of reification, on the one hand, but also from the more narrowly normative undertakings of moral and political philosophy. In the above two approaches, the choice of the name 'social pathology' to denote the wrongs criticized was arbitrary in the sense that the criticized phenomena could just as well be brought under the labels 'social evil', 'reflexive disorder', or 'higher-order wrong'. Here, on the contrary, the transference of the word 'pathology' from the sphere of organic life and medicine to that of social life and criticism becomes the critical point of the concept's use. It is the idea of pathology that will help the social theorists to diagnose the peculiar wrongs in the social world.10 The critical force of the concept lies in the supposition that societal reproduction can fail by analogy to the way in which the self-maintenance of a living organism is disrupted when it falls ill. Therefore, there is, on this conception, no longer any distance between the critical claim and the naturalistic vocabulary of the social pathologist.

4. Social pathology as degeneration of social life: naturalism of growth and stagnation: - This brings us to the fourth and last conception, which, as it happens, is defended, among others, by just these metaphysicians of growth and intensity: Nietzsche, Dewey and Whitehead. Dewey, whose social-theoretical works exhibit a rich naturalistic vocabulary of social pathology (Sa¨rkela¨, 2017b), objects to the organicist conception in his 'The public and its problems': What is characteristic of human societies, Dewey implies, is that they are not geared to ends of the organic kind. On the contrary, they relate to their ends as 'ends-in-view' in the sense that they need to be 'esteemed and sought for'. In this way, Dewey's social ontology, while still being naturalistic in regarding the social as a life-process, takes societal values as mutable social kinds and the social organization as transformable already at the outset. The important thing to note, however, is that Dewey explicitly rejects the organicistic social ontology, while remaining a social pathologist of the naturalist genus. This gives reason to speculate that the idea of a diagnosis of social pathology, which locates its evaluative authority and invests its critical force in its naturalistic connotations, might not, after all, be dependent on 'rehabilitating [the] organic conception', as Honneth (2014b: 702) fears. Dewey namely drops the organism analogy, while sticking firmly to diagnosing social pathologies. Whereas Dewey is far from constructing the object of social ontology in terms of the Aristotelian organism, he, first of all, is clearly convinced that the social constitutes a life process, which he calls 'associated life' (Dewey, 1973: 90–8), and, second, he proposes a conception of the social philosopher as a 'physician who attempts by acting upon what he knows to produce health in place of disease'.

Crime:

We have made the claim that, aside from being an interesting intellectual exercise, there are important practical reasons for trying to understand human behavior in an integrated fashion. In this chapter we will test the utility of the human ecological approach on one of the most intractable internal social problems in culturally diverse societies—crime. In subsequent chapters, we also will test our approach on more group-level problems such as the conservation of public resources and war. Crime is a particularly interesting problem because it is in many respects the obverse (i.e., the 'flip side') of altruism. This is especially true if we define crime broadly as behavior in which individuals obtain resources from others via force, fraud, or stealth. Think about this. We've discussed the apparent importance of altruism for large-scale social interactions between unrelated people. In order for people to reap the full benefits of group cooperation and division of labor, they sometimes must subordinate their personal interests to those of others—occasionally in dramatic fashion. Altruistic acts cost an individual more than he or she gains. Criminal acts do just the opposite. People who commit these acts intentionally harm others for their own gain.

Definition of Crime: - A normative definition views crime as deviant behavior that violates prevailing norms – cultural standards prescribing how humans ought to behave normally. This approach considers the complex realities surrounding the concept of crime and seeks to understand how changing social, political, psychological, and economic conditions may affect changing definitions of crime and the form of the legal, law-enforcement, and penal responses made by society. In other words "Crime is the breach of rules or laws for which some governing authority (via mechanisms such as legal systems) can ultimately prescribe a conviction. Individual human societies may each define crime and crimes differently. While every crime violates the law, not every violation of the law counts as a crime; for example: breaches of contract and of other civil law may rank as "offences" or as "infractions". Modern societies generally regard crimes as offences against the public or the state, distinguished from torts (offences against private parties that can give rise to a civil cause of action).

According to C. Darrow, "Crime is an act forbidden by the law of the land and for which penalty is prescribed ".This constitutes a definition of a crime from the social viewpoint. From the legal viewpoint, violation of law constitutes crime. In other words of Branes and Teeters," The term "Crime " technically means a form of anti-social behaviour that has violated public sentiment to such an extent as to be forbidden by statue". Garofalo developed a concept of the "natural crime" and defined it as a violation of the prevailing sentiments of pity and probity. Radcliff Brown defined crime as the violation of usage which gives rise to the exercise of a sanction. The crime any act which causes harm to man's social interests. The criminal is a person who commits crime. According to law a criminal is one who has intentionally violated a criminal law. Sometimes a criminal is not treated as such until his criminal acts are proved in court.

Short historical background of crime and punishment: - Normally there is no society without the problem of crime and criminals. The concept of crime is essentially concerned

with the society order. It is well known that man's interests are best protected as a member of the community. Everyone owes certain duties to his fellow men and at the same time has certain rights and privileges which he expects others to ensure for him. This sense of mutual respect and trust for the right of others regulates the conduct of the members of society inter se. Although most people believe in live and let live policy yet there are few who for some reason or the other, deviate from this obviously imposes an obligation on the state to maintain normalcy in society. This arduors task of protecting the law binding citizens and punishing the law breakers this reason led Salmond to define law as the "rule of action" regulating the conduct of individual in the society. The conduct which are prohibited by the law are known as wrongful acts and the conduct which are permissible under the law are known as lawful acts.

The Early Concept of Crime: - Historically, the concept of crime seems to have always been changing with the variation in the social conditions during the evolutionary stages of human society. This can be explained to the fact that during the early English society in 12 and 13 centuries it includes only those acts which were committed against the state or the religion. Treason, rape and blasphemy were treated as crime where murder was not 3 .The early societies failed to differentiate between the law of crime and the law of torts they only knew the law of wrongs. This is due to the fact that the bond of family was far stronger than that of the community, the injured party and his kindred could avenge the wrong by private vengeance and self-redress. During this time the recourse to legal remedied was considered merely an optional alternative to self-redress. So the wrongdoer was supposed to offer compensation to the person wronged, the compensation depend on the extent of the wrong caused and the status of the sufferer. The compensation paid was known as „bot" it washes away the guilt of wrongdoer and put him to the position as if he had done no wrong.

Eighteenth and Nineteenth Century: - The concept of crime is closely related to the social policy of a given time. The earlier emphasis on crime, the idea that crime was the result of divine displeasure, the superstition and myth. But during the 18 and 19 century in European countries especially in Italy and France we witnessed a new era of miraculous reorientation in criminological thinking. The early ideas were abandoned and the study of crime and criminal was started basing on scientific bases. Due to that changes it once established that no one else than the offender himself could be attributed criminal responsibility for his crime. This seems that when it happen those were there are ideological changes in the society the concept of crime also change.

Twentieth Century up to Day: - It happen those now days there has been considerable increase in crime rate in all over the world. But some of the countries the rate of crime is not higher this was due to the variation of social condition in those countries for example in India. The factors such as greater control of family over the ward and respect of morality and religion have acted as effective instrument to reduce the rate of crime in those countries. The development of science and technology which led to the discovery of computers increase the rate of crime like cyber-crime.

Types of Crime: - Generally there are three types of crime this include

a) Crime against the person

b) Crime against the property

c) Crime against the state

Crime against person These kind of crime include all wrong person can commit against another person. Underviolent personal criminal behavior, clinard and quinney listed homicide, assault and forciblerapes. These crimes have one thing in common, also it include crime like assault and battery

Crime against property This group of crime include all types of theft or stealing such as shoplifting, palfrey, breaking and entering, theft or motor vehicles or spare parts and accessories, forgery, and othercrime like this are violence against property. Crimes committed against property, much morethan crimes of violence, have shown a remarkable increase and there are much prevented inurban area than in rural area

Causes of Crime: - Crime can be defined in many different ways. Different societies may also choose to define crimes differently. However, in general, crime can simply be defined as the breach of laws that are laid down by the ruling authority of the land. There can be many different causes of crime and many studies are conducted all around the world to understand and bring down criminal activities. It is a constant endeavor of governments and policing organizations all around the world to bring down crime rates so that the world becomes a safer place to live in. The fight against crime is not a new one in humanity and it has, since the establishment of society, tried to bring crimes down. Let us now attempt to look at some of the causes of crimes. Crime is an intentional act or omission in violation of criminal law can be caused by different factors which we can categorize it into three: economic, social and political cause.

Economic factor like Poverty: Economic deprivation or simply poverty is a major cause of crime all around the world. People are often driven to great lengths of desperation by poverty and this is a major cause of crime all around the world. The fact that such frustration is created is in itself a very dangerous thing for society on the whole as global inflation has risen significantly over the last few years. Although it does seem that in our world today, the rich get richer and the poor get poorer.

Social factor whereby under this situation there is overpopulation, racism, social classes, family condition, drugs.

Religion: - Religion has also been one of the causes of crime in the world. This does not mean that religion itself encouraged crimes but the encouragement has come from the different sects who originated in the differences of opinion between people on matters of religion and in the hatred for other religions. In a general way, of course, communal riot and crimes such as looting, murder and so on, perpetrated in order to increase the number of one's own religion and to injure another religion have always been happening in many different area.

Politics factor is often a cause of crime. It is seen that many political associations allaround the world have their own mafias running which they use to manipulate and subjugate people. Political power is often misused to take advantage of weaker groups and people and the dissidence that rises out of such situations often force the victims to resort to crimes. Politics is more related to crime on a much larger and a much heinous level than anything else.

Concept of Criminology: - The word criminology is composite of two words criminal + ology . Literallyit means a systematic study of the criminals, that is, persons who break or offend the social or group law. However, since the offences committed by criminals are crimes, and as crimes occur in society, the term criminology fully means a study of crimes as well as criminals in relation to society. It also tries to determine the causes of these and also thereby recommend preventive measures. The science of criminology is a scientific and systematic study of a social phenomenon. Various scientific techniques and methods are employed for the study of this phenomenon. As criminology views man as a social animal, it tries to study social interactions and phenomena to place its subject matter in a proper perspective. The science of criminology also investigates the structure and function of social laws, rules and regulations. In order to understand the nature of criminology, it is essential to examine closely the definitions given by learned sociologists and eminent criminologists. According to Elliott M.A. and Merrill, F. E . "Criminology may be defined as the scientific study of crime and its treatment. 10 " The definition, emphasizing the scientific investigation into the nature and etiology of crime, stresses the practical or utilitarian nature of this body of knowledge, namely, devising ways and means to prevent or reduce the incidence of crime and to rehabilitate criminals as normal members of the society. According to D.R. Taft. "Criminology is the study which includes all the subject matter necessary to the understanding and prevention of crimes together with the punishment and treatment of delinquents and criminals." The definition is comprehensive and it describes theoretical as well as practical aspects of the study. It brings out clearly the fact, which may get over looked usually, that criminology is concerned not with the offences committed by adults only but also with juvenile offences

When an act is considered as crime? - There are seven interrelated but over lapping criteria to call an act as a crime. Ideally behavior would not be a crime unless all the seven conditions are present.

1. Harm: - Before a behavior can be called crime there must be certain external consequences or ‘harm’. A crime has a harmful impact on social interests.

2. Illegal: - The harm must be legally forbidden, must have been prescribed in penal law. Anti-social behavior is not crime unless it is prohibited by law.

3. Malafide Intention: - There must be the criminal conduct i.e.: there must be an intentional or reckless action or inaction which brings about the harmful consequences e.g.: Doctor‘s negligence.

4. Criminal Intention: - Criminal intent must be present. Hall suggests that legal scholars have confused between intention and motive. The motives for a crime may be good but the

intention is criminal. Thus if a man kills his starving children his motive is good but killing is legally forbidden and so his intention is criminal.

5. Concurrence of Intention and Conduct: - There must be a concurrence of criminal intention and conduct.e.g: if a policeman, who goes into a house to make an arrest goes into a house to make an arrest is not a trespasser from the beginning.

6. Casual Relationship: - There must be a casual relationship between the legally forbidden harm and the voluntary misconduct. e.g: if a man dies of suffocation after being shot at, the relationship between conduct and the harm is not clear cut.

7. Prescription of Punishment: - There must be legally prescribed punishment. The voluntary misconduct must be punishable by law.

Classification of Crime: - There are a variety of crimes that can be committed by individuals Some crimes

Felonies, Misdemeanors, and Petty Offenses

Perhaps the most common way to classify crimes is according to their punishment. Crimes can be broken into three major categories: felonies, misdemeanors, and petty offenses.

i. Felonies:

• Serious crime

• Punishable by more than a year of imprisonment or death

• Sentences usually served in prison

Examples: homicide, rape, robbery, possession or distribution of illegal narcotics, arson

At common law, felonies were the most serious class of criminal offense and were uniformly punishable by death. All other offenses were considered misdemeanors and thus were not punishable by death. The modern definition of a felony is any serious crime that is punishable by more than a year of imprisonment or by death. Felonies include, but are not limited to, various degrees of homicide, rape, robbery, possession or distribution of illegal narcotics, and arson. It is important to understand that a crime does not have to be violent or even be perpetrated against a specific individual victim to constitute a felony. For example, white-collar crime, a term that covers several types of felonies relating to dishonesty in commercial matters, is generally nonviolent. Both federal and state legislatures have enacted laws that criminalize other nonviolent acts as well, such as drug crimes. The majority of modern jurisdictions divide felonies into various categories or degrees, in order to treat some offenses as more serious than others. This can be seen in homicide cases, where a person may be charged with first-degree murder, second-degree murder, voluntary manslaughter, or involuntary manslaughter in jurisdictions that make these distinctions. One reason for these distinctions is the level of punishment: First-degree murder can be punishable by death, while other levels of homicide usually are not.

ii. Misdemeanors:

• Less serious than felonies

• Punishable by fines, penalties, or incarceration of less than one year

• Sentences usually served in local or county jail or alternative programs

Examples: shoplifting, disorderly conduct

The common law classified all crimes that were not felonies as misdemeanors. Similarly, modern law defines a misdemeanor as a crime that is less serious than a felony and is usually punishable by fines, penalties, or incarceration of less than one year. Examples of misdemeanors include shoplifting and disorderly conduct. A person who is convicted of a misdemeanor and incarcerated usually serves his or her sentence in a local or county jail. In contrast, a convicted felon serves his or her sentence in a state penitentiary, and the term will exceed one year. Misdemeanor punishment may also include forms of incarceration other than jail, such as boot camps and in-patient drug treatment programs. In modern law, the line between felonies and misdemeanors can be quite unclear. In fact, many jurisdictions have enacted laws that allow certain offenses to be prosecuted as either felonies or misdemeanors (wobblers), depending on the circumstances. Some factors that a prosecutor may consider in deciding whether to charge an offense as a felony or a misdemeanor include: • Prior offenses. • Seriousness of the offense. • Number of victims. • Age of the perpetrator. In plea bargaining, a defense attorney will often attempt to reduce a felony to a misdemeanor when this option exists.

iii. Petty Offenses:

• Insignificant crime involving minor misconduct

• Punishable by fines and community service

Examples: traffic violations and other infractions

A petty offense is any insignificant crime involving very minor misconduct. Petty offenses often consist of violations that protect the public welfare. In fact, they are usually called violations or infractions rather than crimes; a common example of a petty offense is a traffic violation. Petty offenses are usually not punishable by incarceration, but by monetary fines or community service requirements. The stigma attached to a conviction for a petty offense is usually minimal; one possible exception occurs when a person commits enough traffic violations to have his or her license suspended or revoked. Although petty offenses may be technically offenses classified under criminal codes, the MPC classifies them as noncriminal. It limits the sentence for a petty offense to a fi ne, fi ne and forfeiture, or other civil penalty such as the cancellation or suspension of a license. Many citizens have experienced petty offense convictions, such as for speeding or jaywalking. The position of the MPC and the states that follow this approach is that penal sanctions are justified only for conduct warranting the moral condemnation implicit in the concept of a crime. Note that

constitutional protections that are accorded persons charged with crimes often do not apply to those facing noncriminal charges.

Cognizable Offence: - The expression "cognizable offence" has been defined under Section 2I Cr.P.C as follows:- "I "Cognizable offence" means an offence for which and "cognizable case" means a case in which, a police officer may, in accordance with the First Schedule or under any other law for the time being in force, arrest without warrant." When a complaint alleging the commission of a cognizable offence is lodged before the officer-in-charge of a police station (i.e. Station House Officer-S.H.O) he has to mandatorily register an FIR in view of the statutory compulsion under Section 154 (1) Cr.P.C. There is, however, the Judge-made law that the S.H.O, before registering an FIR, can conduct a preliminary inquiry in the following cases:-

i. To ascertain whether the information received discloses a cognizable offence.

ii. In matrimonial disputes/family disputes.

iii. In commercial offences.

iv. In medical negligence cases.

v. In corruption cases, and

vi. In cases where there is abnormal delay/laches in lodging the complaint.

When once the S.H.O registers an FIR, the offence being a "cognizable offence", the S.H.O has the authority under Section 156(1) Cr.P.C to conduct investigation of such offence without the order of a Magistrate. If he has reason to suspect the commission of a "cognizable offence" he can enter on investigation into the offence in view of Section 157 Cr.P.C. Here the S.H.O has no freedom to consider whether the information given regarding the cognizable offence is true or credible.

Non-cognizable Offence: - The expression "non-cognizable offence" has been defined under Section 2(l) Cr.P.C as follows:- "(l) "non-cognizable offence" means an offence for which, and "noncognizable case" means a case in which a police officer has no authority to arrest without warrant." In the case of a "non-cognizable offence", apart from the fact that a police officer has no authority to arrest the offender without a warrant, he cannot also register an FIR or conduct investigation without the order of the Jurisdictional Magistrate in view of subsection (2) of Section 155 Cr.P.C. The said Section reads as follows:-

i. When information is given to an officer in charge of a police station of the commission within the limits of such station of a non-cognizable offence, he shall enter or cause to be entered the substance of the information in a book to be kept by such officer in such form as the State Government may prescribe in this behalf, and refer, the informant to the Magistrate.

ii. No police officer shall investigate a non-cognizable case without the order of a Magistrate having power to try such case or commit the case for trial.

iii. Any police officer receiving such order may exercise the same powers in respect of the investigation (except the power to arrest without warrant) as an officer in charge of a police station may exercise in a cognizable case.

iv. Where a case relates to two or more offences of which at least one is cognizable, the case shall be deemed to be a cognizable case, notwithstanding that the other offences are non-cognizable.

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UNIT: - 7

Social Pathology: disease

Introduction: - Social pathology is a concept developed in modern social science to refer both to aspects of social structures and to the behaviors and values attributed to particular social categories. Definitions of social pathology are particular to specific times and reflect the dominant moral concerns of the era. This concept fits within the ideas of anthropologist Mary Douglas. In Purity and Danger (1966) she examines the universality of cultural explanations of things considered "out of order" as polluting and dangerous. These cultural constructions emerge in specific contexts. Regarding social pathology, prior to the Enlightenment in Europe, social transgressions (pathologies) were attributed to supernatural forces exerted by spirits (e.g., possession) or evil humans (witchcraft). As the Enlightenment focused on human reason and scientific understanding of the natural world, early social scientists began to objectify what they defined as natural laws of "society" that explained undesirable human behaviors as transgressions of natural law.

Modern social science developed during a period of rapid social change produced by expanding industrial capitalism and colonialism. Such processes created increased migration and a growing wealth gap between, on the one hand, colonial nations and colonized territories, and on the other, wealthy industrialist/financiers and European working classes. These social changes produced dislocations and inequalities that led to fears among established groups of moral and social danger. In the nineteenth century, following parallel developments in the advancing science of biology, social theory often used either biology (e.g., racial types) or biological analogies to the physical body and biological processes to explain the social system.

Émile Durkheim, a French sociologist, created the foundation for the modern sociological study of society by focusing on social facts, structures, and systems rather than individuals. His profound ideas generated many concepts and laid the basis for many fields of study. Like other foundational social theorists confronting rapid change, he privileged solidarity and cohesion as normal. Durkheim introduced two analogies for a smoothly functioning social order characterized by solidarity: the machine (mechanical) and the body (organic). He envisioned society as a system seeking equilibrium with norms for behavior. Anomie was a pathological condition of moral breakdown at the societal level.

Throughout the early twentieth century, this emphasis on social equilibrium or structural functionalism, further developed by such thinkers as Talcott Parsons, dominated U.S. social theory. In defining equilibrium and stasis (status quo) as desirable, it was implied that change and disorder were abnormal and threatening. These pathologies were not attributed to the differential nature and value of individuals but rather to aspects of structure. Nonetheless, such ideas emphasized the value of returning to the status quo over change.

The idea of declaring the behavior of individual's in particular social categories as socially pathological followed a different trajectory. In the post-Darwin nineteenth century, Darwin's theories of evolutionary change were applied loosely in ways that misinterpreted his theory.

Particular social categories or populations were seen as having an essential, innate, and immutable behavioral inferiority leading to criminal and dangerous behaviors. While Darwin saw natural selection occurring in a random, purposeless way with no implied hierarchy of worth, Social Darwinism saw different classes and races as arrayed in terms of inferiority and superiority. Social science critiques of the culture of poverty examine ways to represent poor people as varied individuals with competence and awareness who cannot be categorized in terms of innate biology or culture. Particular behaviors of the poor can be analyzed in terms of the extremely constrained options of disadvantaged social positions, as rational strategies, or as political opposition rather than social pathology.

Moreover, in the second half of the twentieth century U.S. sociologists such as C. Wright Mills and William Ryan began to point out the role that dominant elite interests play in defining normalcy and pathology as the status quo as well as the way this masks the relationship between structural relations of power and the social production of inequality. Blaming the victims (stigmatized and disadvantaged groups such as the poor) was shown to not only hide the effects of power and privilege but also to stifle recognition of a need to address social problems through sociopolitical change. Late-twentieth-century European social theories developed by such thinkers as Michel Foucault, Pierre Bourdieu, and others have brought issues of differential power and inequality to the fore. After continued world wars and the cold war as well as social movements advocating anticolonial independence, socialism, feminism, and civil and human rights, these ideas have emerged and have led to reexamining the ideological uses of social pathology as a way of reinforcing current inequalities in the social order.

Disease: - A disease is a particular abnormal condition that adversely affects the structure or function of all or part of an organism and is not immediately due to any external injury. Diseases are often known to be medical conditions that are associated with specific signs and symptoms. A disease may be caused by external factors such as pathogens or by internal dysfunctions. For example, internal dysfunctions of the immune system can produce a variety of different diseases, including various forms of immunodeficiency, hypersensitivity, allergies, and autoimmune disorders.

The term disease broadly refers to any condition that impairs the normal functioning of the body. For this reason, diseases are associated with the dysfunction of the body's normal homeostatic processes. Commonly, the term is used to refer specifically to infectious diseases, which are clinically evident diseases that result from the presence of pathogenic microbial agents, including viruses, bacteria, fungi, protozoa, multicellular organisms, and aberrant proteins known as prions. An infection or colonization that does not and will not produce clinically evident impairment of normal functioning, such as the presence of the normal bacteria and yeasts in the gut, or of a passenger virus, is not considered a disease. By contrast, an infection that is asymptomatic during its incubation period, but expected to produce symptoms later, is usually considered a disease. Non-infectious diseases are all other diseases, including most forms of cancer, heart disease, and genetic disease.

Over the last several decades, epidemiological studies have been enormously successful in identifying risk factors for major diseases. However, most of this research has focused attention on risk factors that are relatively proximal causes of disease such as diet, cholesterol level, exercise and the like. We question the emphasis on such individually-based risk factors and argue that greater attention must be paid to basic social conditions if health reform is to have its maximum effect in the time ahead. There are two reasons for this claim. First we argue that individually-based risk factors must be contextualized, by examining what puts people at risk of risks, if we are to craft effective interventions and improve the nation's health. Second, we argue that social factors such as socioeconomic status and social support are likely "fundamental causes" of disease that, because they embody access to important resources, affect multiple disease outcomes through multiple mechanisms, and consequently maintain an association with disease even when intervening mechanisms change. Without careful attention to these possibilities, we run the risk of imposing individually-based intervention strategies that are ineffective and of missing opportunities to adopt broad-based societal interventions that could produce substantial health benefits for our citizens (Link & Phelan, 1995).

Health and illness are not strictly random or natural states of affairs. They do not depend solely on biological issues, the environment, individual behavioral factors or medical treatment. The distribution of disease is almost always a function of one’s socio-professional status or social class. As a rule, those at the top of the social pyramid enjoy better health than those directly below them, who are themselves in better health than those just below them … and so on down the pyramid. In other words, the higher you go up the social hierarchy, the better your health. This is what is commonly known as the social gradient in health. The reality covered by this term can be identified both within countries and internationally.

From social inequalities to health vulnerabilities: - What follows is an attempt to demonstrate that social inequalities reinforce health vulnerabilities, prolong pandemics and fuel inequalities in the length and quality of life on an international scale. This was clearly demonstrated by the COVID-19 pandemic.

The same is true of HIV, TB and malaria. Here too, the social gradient in health has a significant explanatory power. Diseases are more prevalent at the bottom of the social ladder and diminish the higher up the ladder you go. In the opinion of the two Executive Directors of both the Global Fund and UNAIDS, “in the fight to put an end to disease, inequality is often the main obstacle”. Inequalities aggravate pandemics and feed on them (bidirectional causation). They uncover gaps in our societies and exacerbate them. In short, they make diseases and pandemics longer-lasting, more deadly and more damaging for developing countries, including many African countries which, incidentally, bear the heaviest burden of certain diseases.

While it is true that research into and access to antiretroviral drugs (ARVs) has increased the life expectancy of people living with HIV worldwide, it is still close to the average for each country. For example, while the life expectancy of a man living with HIV and on treatment is 53 years and is 54.2 years for an HIV-negative person born in 2019 in Chad, it is 69.4 years

for someone on treatment and 82 years for an HIV-negative person born in 2019 in Canada. The 16- and 28-year gap between the two categories in the countries cited cannot be attributed solely to the natural lottery of life or to religious determinism of the "it was his day" type (understood here as: the day on which he was bound to die). While it is true that other factors (gender, age, biological make-up, skin color, disability, etc.) play a part in the distribution of health vulnerabilities, it can nonetheless be said that socio-economic factors (income inequalities, social insecurity, inadequate state resources, a weak health system, etc.) account for the low age that Chadians living with HIV can expect to reach compared with Canadians.

On an international scale, there is generally a factual, empirical correlation between income or gross domestic product (GDP) levels and vulnerability to disease and pandemics. Living standards subordinate, determine and structure these vulnerabilities in a central and decisive way. Having a higher social status, a more stable job, being richer and better educated not only guarantees a better social situation, greater financial ease and more favourable living conditions, it also leads to a longer and healthier life. In fact, as Didier Fassin points out, there is a major difference between life expectancy in terms of duration and life expectancy in terms of quality of life (https://aidspan.org/the-social-causes-of-disease/).

Prevention is better than cure: - Social inequalities are not a matter of chance or fate. They are the result of political and economic choices that can be corrected. What is socially constructed can be socially deconstructed. To overcome diseases, we need to act on the root cause of the problem, i.e., resolutely tackle the social inequalities that feed and exacerbate them. To get back on track and put an end once and for all to HIV, tuberculosis and malaria as global health threats, we need "above all an ironclad commitment to fight the inequalities that fuel them. This is a challenge we can and must take up", rightly state Peter Sands and Winnie Byanyima. Given that such a prospect inevitably involves reform of the global economic system and better redistribution of collective wealth, it will not be without its share of obstacles and misgivings.

These must be considered while also taking into account the tension towards an ideal of social equity. The effectiveness of such an ideal would make it possible to broaden and revitalize the range of social determinants of health. For, let us repeat, reducing social inequalities on a global scale is the main viaticum or "Last Rite" against health vulnerabilities and the related inequality of lives. The appeal of this approach lies in the fact that it treats the pain rather than the illness. It is fundamentally more preventive than curative. Better still, it suggests prioritizing systemic and sustainable solutions rather than relying on circumstances. It is not charity that provides lasting solutions to problems, but social justice/equity. In any case, there is a pragmatic and ethical precedence for justice/equity over charity. And as a Baham (Cameroon) proverb says: "If you want to help your neighbor who is hungry, give him seeds rather than roasted maize". The more countries are divided by social inequalities, the less effective they will be in combating disease and pandemics. A global community characterized by great disparities cannot remain healthy.

Evidence Linking Social Conditions to Disease: - We begin with a brief review of the evidence concerning the connection between social conditions and illness. For the purposes of this paper, we define social conditions as factors that involve a person's relationships to other people. These include everything from relationships with intimates to positions occupied within the social and economic structures of society. Thus, in addition to factors like race, socioeconomic status, and gender, we include stressful life events of a social nature (e.g., the death of a loved one, loss of a job, or crime victimization), as well as stress-process variables such as social support.

Forty years of medical sociology have uncovered numerous examples of the social patterning of disease. Most obvious is the ubiquitous and often strong association between health and socioeconomic status. Lower SES is associated with lower life expectancy, higher overall mortality rates and higher rates of infant and perinatal mortality (Buck 1981; Dutton 1986; Illsley and Mullen 1985). Moreover, low SES is associated with each of the 14 major cause-of-death categories in the International Classification of Diseases (Illsley and Mullen 1985), as well as many other health outcomes, including major mental disorders (Dohrenwend et al. 1980; Kessler et al. 1994). Other examples of the social patterning of disease are plentiful. Males have higher mortality rates at all ages (Walsh and Feldman 1981), as well as higher rates of coronary heart disease, chronic respiratory diseases (Colley 1985) and ulcers. There are pronounced gender differences in rates of various forms of cancer (Prout, Colton, and Smith 1987) and mental disorder. African Americans have higher rates of overall mortality and infant mortality, renal failure (Challah and Wing 1985), and stroke than do Whites, but lower rates of coronary heart disease (Pedoe 1982); cancer rates also differ by race and ethnicity (Prout et al. 1987). Both physical and mental disorders vary with marital status and population density (Benenson 1987; Robins et al. 1984), and certain religious groups such as Mormons and Seventh Day Adventists have lower risks of some types of cancer (Saracci 1985).

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UNIT: - 8

Global resource scarcity with special reference to freshwater

Introduction: - Scarcity is an economics concept rooted in one of the most basic facts of life: We live in a world of limited resources that requires choices about how they are allocated. In that sense, every product down to a pack of gum or a book of matches is scarce, since someone expended resources that could have been deployed elsewhere to produce it. Scarcity is so fundamental to economics that scarce goods are also known as economic goods. In economics, scarce goods are those for which demand would exceed supply at a price of zero. Some natural resources that may appear to be free because they are easily and widely accessible eventually prove scarce as they are depleted from overuse in a tragedy of the commons. Economists increasingly view clean air and a climate compatible with human welfare as scarce goods because of the significant cost of protecting them, and may place a price on them for the purposes of a cost-benefit analysis.

Scarcity is one of the key concepts of economics. It means that the demand for a good or service is greater than the availability of the good or service. Therefore, scarcity can limit the choices available to the consumers who ultimately make up the economy. Scarcity is important for understanding how goods and services are valued. Things that are scarce, like gold, diamonds, or certain kinds of knowledge, are more valuable for being scarce because sellers of these goods and services can set higher prices. These sellers know that because more people want their good or service than there are goods and services available, they can find buyers at a higher cost. Scarcity of goods and services is an important variable for economic models because it can affect the decisions made by consumers. For some people, the scarcity of a good or service means they cannot afford it. The economy of any place is made up of these choices by individuals and companies about what they can produce and afford.

The goods and services of any country are limited, which can lead to scarcity. Countries have different resources available to produce goods and services. These resources can be workers, government and private company investment, or raw materials (like trees or coal). Certain limits of scarcity can be balanced by taking resources from one area and using them somewhere else. Sellers like private companies or governments decide how the available resources are spread out. This is done by trying to strike a balance between what consumers need or want, what the government needs, and what will be an efficient use of resources to maximize profits. Countries also import resources from other countries, and export resources from their own (https://education.nationalgeographic.org/resource/scarcity/).

Resource scarcity is essentially about current demand for a resource exceeding available supply. But what matters is that this scarcity has potentially huge implications for how we lead our lives and the economic prosperity of communities, countries and regions. Resource scarcity occurs when demand for a natural resource is greater than the available supply – leading to a decline in the stock of available resources. This can lead to unsustainable growth and a rise in inequality as prices rise making the resource less affordable for those who are

least well-off. Students introducing themselves to economics will become familiar with the different types of factor inputs available to produce (supply) goods and services. These are summarized in this graphic. At the heart of many economic issues is this point: The economic problem involves decisions about how to make the best use of limited (scarce) resources when not all wants/needs can be fully satisfied (https://www.tutor2u.net/economics/reference/resource-scarcity).

Natural Resource Scarcity: - Even abundant common resources long consumed at zero apparent cost often prove neither free nor limitless eventually. Climate isn't a tangible asset and its value is hard to calculate, but the costs of climate change for companies as well as the society are all too real. Air is free, but clean air has a cost in terms of the economic activity discouraged to prevent pollution, as well as value for health and quality of life. To preserve the benefits associated with these resources, governments may require manufacturers and utilities to invest in pollution control equipment, or to adopt cleaner power sources. Governments and the regulated industries eventually pass on these costs to taxpayers and consumers. Breathing freely, in other words, is not really free.

Defining Water Scarcity: - One of the core characteristics of the Earth's freshwater resources is the great variability in its distribution in space and time. The hydrologic cycle moves water between stocks such as the oceans, icecaps, glaciers, and groundwater in flows such as evaporation, transpiration, rainfall, and river runoff. These movements vary through natural fluctuations driven by complex climatic factors. As a result, parts of the planet are naturally dry, some are naturally wet, and all experience dynamic changes in water availability. Natural ecosystems have evolved and adapted to this natural variability. Scarcity in the context of human social, economic, and health needs arises in particular places or at particular times when human demand for water may exceed the stocks or flows of water on which those demands depend. Water supplies are affected by both natural hydrologic variability and a wide range of human activities that modify the hydrologic cycle, such as contamination of stocks, the construction and operation of water infrastructure, and human-caused climate change.

Human demands for water also change over time, driven by population growth, economic activities, and social priorities and preferences. Globally, the total stock of water is hundreds of thousands of times larger than even the largest estimates of human water demands. However, not all the water in those stocks is accessible, and there are great disparities in when and where humans require fresh water to satisfy demands. In this sense, the following discussion of water scarcity focuses on the human and natural drivers that lead to mismatches between supply and demand. Most discussions about water scarcity are actually discussions about regions that are approaching peak renewable water limits, where the effective capture and use of fresh water is near the total renewable supply. Major river systems such as the Colorado River, the Nile, the Huang He, and the Jordan, among others, are all reaching peak water limits beyond which no additional withdrawals are possible.

When peak renewable water limits are reached in a watershed where demand is thought to be increasing, scarcity ensues and either additional water sources must be found through

transfers from other basins, desalination, or reuse or existing water use must be made more efficient to permit increased production of desired goods and services within the limits of available supply. Not all water resources are considered renewable, however. When a stock of water is used faster than it is naturally recharged, such as in regions where groundwater is over drafted, peak nonrenewable water limits occur, and the resource becomes physically or economically more costly to obtain over time. At this point, extraction begins to decline, conditions of scarcity increase, and substitutes must be found (Gleick & Cooley, 2021).

Freshwater Scarcity: - It is becoming increasingly important to put freshwater issues in a global context. Local water depletion and pollution are often closely tied to the structure of the global economy. With increasing trade between nations and continents, water is more frequently used to produce exported goods. International trade in commodities implies long-distance transfers of water in virtual form, where virtual water is understood as the volume of water that has been used to produce a commodity and that is thus virtually embedded in it. Knowledge about the virtual water flows entering and leaving a country can cast a completely new light on the actual water scarcity of a country. For example, Jordan imports about 5 to 7 billion m3 of virtual water per year, which is in sharp contrast with the 1 billion m3 of water withdrawn annually from domestic water sources. This means that people in Jordan apparently survive owing to the import of water-intensive commodities from elsewhere, for example the USA.

The recent past has shown a growing interest from both trade and water experts in the relation between international trade and freshwater scarcity. Until the recent past, it has not been very common for water sector specialists to look at the relation between water use in a region and import into or export from this region. Traditionally, in their view, water demand in an area is simply a function of the amount and sort of water users in that area. At the same time, economists do generally not bother much about the implications of international trade for the water sector. The reason is that water inputs usually hardly contribute to the overall price of traded commodities. This seems to justify the conclusion that water cannot be a significant factor influencing production and trade patterns. The fact that water inputs are often heavily subsidized by national governments is hereby ignored. Trade specialists also tend to forget that external effects of water use can be very significant, but are never included in the price of water and that no country charges a scarcity rent for water inputs even though water is sometimes very scarce. When merely looking at the prices of traded commodities one will indeed get the impression that water scarcity cannot be a driving force of or limiting factor to international trade (Hoekstra, 2010).

Water is usually not regarded as a global resource. Whereas in most countries the energy sector has an obvious international component, this is different for the water sector. The international component of water is recognized in the case of trans-boundary rivers, but the relation between international trade and water management is generally not something that water sector officials think about. The reason is probably because water itself is not traded internationally, due to its bulky properties. Besides, there is no private ownership of water so that it even cannot be traded as in a market (Savenije, 2002). Water sector specialists forget, however, that water is traded in virtual form, i.e. in the form of agricultural and industrial

commodities (Hoekstra and Hung, 2005; Chapagain and Hoekstra, 2008). Although invisible, import of 'virtual water' can be an effective means for water-scarce countries to preserve their domestic water resources (Allan, 2001a).

What is special about freshwater?

a. Freshwater is a scarce resource: - Freshwater is a scarce resource because its annual availability is limited and demand is growing. It is impossible to 'produce' water; one can only deviate or temporarily store natural flows in order to have access to it at another location or point in time. There are, however, sincere limitations to this, since water transfer and storage are due to different sorts of constraints. First of all, because water is bulky, transferring or storing is quite costly, requiring large infrastructure. Second, taking water out of its natural flow and returning it elsewhere or at another point in time will influence ecosystems that are adapted to the natural flow. Significant changes to natural flows generally have undesired consequences for both downstream ecosystems and downstream users.

b. Freshwater is a renewable but finite resource: - Water is a renewable resource, but that does not mean that its availability is unlimited. In a certain period precipitation is always limited to a certain amount. The same holds for the amount of water that recharges groundwater reserves and that flows through a river. Rainwater can be used in agricultural production and water in rivers and aquifers can be used for irrigation or industrial or domestic purposes. But in a certain period one cannot use more water than is available. One cannot take more from a river than what flows in it and in the long term one cannot take more water from lakes and groundwater reservoirs than the rate with which they are recharged. Water is a basic resource; one cannot 'make' it, but will have to rely on what is naturally available.

c. Freshwater can be 'overexploited': - There are many spots in the world where serious water depletion or pollution takes place: rivers running dry, dropping lake and groundwater levels and endangered species because of contaminated water. 'Available' does not mean that water can always be fully consumed without undesired consequences.

d. Freshwater is a public resource: - Everywhere in the world, freshwater is a public resource. People can own the land but not the freshwater that stays or flows on or underneath it. Freshwater is neither privately owned nor traded. When the term 'water privatization' is used, one generally refers to the privatization of water supply, which means that the services of collecting, purifying and distributing and/or the services of wastewater collection and treatment are privatized. The term does not mean that the water itself is privatized.

e. Freshwater availability strongly varies in time: - Many regions in the world face both water scarcity and flooding. Scarcity happens in the dry period, flooding in the wet period of the year. The competition for and economic value of the water fluctuates accordingly throughout the year. This is a very specific property of freshwater, a property that one cannot find for other resources or commodities.

f. Freshwater availability strongly varies in space: - The amount of fresh water varies strongly over space as well. In this respect, freshwater is just like oil. Some countries have a

lot of it, while others don't. Freshwater is a geopolitical resource in a similar way as oil (Hoekstra and Chapagain, 2008). Abundance of oil or freshwater gives a comparative economic advantage in goods that require a lot of energy or freshwater respectively, but also constitutes a form of political power (Allan, 2001).

g. Freshwater productivity strongly varies: - Water productivities – defined as the output per unit of water volume consumed – vary strongly from place to place. This is not just a matter of available technology or available human, social or institutional capital. Water productivity is also related to climate. From a climate and soil perspective, the water of the Nile can be made more productive for making crops in the highlands of Ethiopia than for making the same crops downstream in the desert of Egypt. In this particular case, however, the actual water productivity in Egypt reaches close to its potential, while in Ethiopia, the actual productivity is far below its potential, so that Egypt's actual water productivity is still higher. The fact that different countries have different water productivities creates a comparative advantage for those countries that have relatively high water productivity in producing particular water-intensive crops. This is, however, theoretical rather than practical, because real economic costs of water inputs are never fully charged to the water users, so that water will not be a decisive factor in production, unless in cases where water shortages will simply hamper production.

h. Freshwater is generally priced far below its economic value: - Most governments subsidies water supply on a huge scale by investing in infrastructure like dams, canals, water purification, distribution systems, desalination plants and wastewater treatment. These costs are often not charged to the water users. As a result, there is insufficient economic incentive for water users to save water. Besides, due to the public character of water, water scarcity is generally not translated into an additional component in the price of goods and services that are produced with the water, as happens naturally in the case of private goods. Finally, water users generally do not pay for the negative impacts that they cause on downstream people or ecosystems. As a result, water inputs do not form a substantial component of the total price of even the most water-intensive products. Consequently, the production of and trade in goods – even though various sorts of goods require a lot of scarce water inputs – is not or hardly governed by water scarcity. The only constraint on production is absolute water scarcity: when the river is dry there will be no further use. As Yang et al. (2003) have shown, absolute water scarcity indeed hampers production and necessitates imports of water-intensive goods like cereals in the most waterscarce regions of the world.

i. Water is not being traded: - When people speak about 'water markets' or 'water trading' they refer to the trade of water use rights, also briefly called water rights or water entitlements. Only a few countries or states – like Chile and California – do have such 'water markets' but most countries don't have that. In water markets, the water is not really traded as in the case of other physical commodities. It are the water use rights that are traded. In the field, this means that one farmer can irrigate his field with a certain amount of water, and not another farmer, when the first one holds the water use right. Or one industry can withdraw some volume of water and not another one that lives along the same river or above the same aquifer. The only form of water trade occurs in the form of trade in bottled water (Gleick,

2004) and beverages. This sort of trade, however, concerns relatively small volumes. People drink no more than a few litres of water per day, while the total water use per capita – for producing all goods and services consumed – amounts to at least a few thousands of litres per day.

j. International real and virtual water transfers: - International trade in bottled drinking water and beverages does exist but is very small from a volume perspective. From a hydrological point of view it is irrelevant. Bulky international water trade does hardly exist. Freshwater crosses international borders in the case of Trans Boundary Rivers like the Nile, Mekong or Danube, but otherwise there are only rare instances of international water transfers. A recent example was in spring 2008 when the Spanish city of Barcelona had to ship in freshwater from France. Various islands, including Aruba, Nauru, Tonga and the Canary Islands have at times received freshwater by tanker from elsewhere (Gleick et al., 2002).

Drivers of Freshwater Scarcity: - Many factors drive water scarcity, including the basic hydrology of a region, demographics and economics, the level and type of water infrastructure and institutions built to satisfy human demands, and the nature of those demands themselves.

A. Hydrology: - Central to the concept of scarcity is the mismatch between supply and demand. The natural variability of the hydrological cycle creates such mismatches, but in the absence of the human component of water demand, such natural variability simply drives variability in ecosystem type, from rainforest to desert systems. As noted above, the natural hydrologic cycle is highly variable in space and time. Although estimates of global average stocks and flows of water are available, these averages hide the dynamic fluctuations that can also influence human perceptions of scarcity.

There are many different definitions of drought, including hydrological, meteorological, agricultural, and economic (Mann & Gleick, 2015; Wilhite & Glantz, 1985). Hydrological and meteorological drought, for example, may be defined as a shortfall of runoff, groundwater, precipitation, or another water-related metric compared to the amount of water expected on average. Agricultural drought may be a shortage of water during a particularly critical time required for the successful production of a crop. A social or economic drought can be defined in the context of a specific social or economic demand for water when that demand cannot be fully met. Ecological drought is a deficit in naturally available water supplies that create stresses across ecosystems. A simple definition of drought is “the mismatch between the amounts of water nature provides and the amounts of water that humans and the environment demand” (Mann & Gleick, 2015). The impacts of drought result from the interplay between natural events, the demands people place on water supply, and the fact that human activities can influence both supply and demand.

B. Demographic and Economic Factors: - In the simplest sense, the role of population- and economic-driven demands is straightforward. With very modest exceptions, water is neither created nor lost on Earth, but simply shifts from one stock to another over time, so the natural

availability of water resources over time is fixed. As populations increase, therefore, the amount of water available per capita declines. The simple metric—per capita water availability (water per unit population)—is a common way to measure water scarcity, and numerous indices have been created with variants of it. With population and economic growth, the demand for water has traditionally increased as well, creating measurable and significant new contributors to scarcity and supply/demand imbalances. Economic factors can also drive perceived scarcity when for reasons of poverty people are unable to pay for the water services they need and are deprived of access to those services (Molle & Mollinga, 2003). It is vital to note that in regions considered water scarce, there are often populations—typically wealthier and socially privileged communities—who do not lack access to adequate basic water services. Conversely, in regions with abundant water, there are communities that do not have access to safe, affordable water—typically poor and marginalized communities (Meehan et al., 2020). This issue of water poverty requires far more attention, because it transcends the issue of physical water availability or scarcity and encompasses issues of economic ability to pay for water (Feitelson & Chenoweth, 2002); questions about public versus private control of water systems; differences in access to water technologies and built water systems; and entrenched social, political, religious, and racial discrimination (Schreiner & Koppen, 2003).

C. Infrastructure and Institutions: - Even when physical or economic availability of water is not a problem, water scarcity can still occur if inadequate infrastructure exists or problems with institutions and water management systems keep desired water services from reaching the point of demand. Is water scarce when a nearby watershed, spring, or river has abundant water but a community must walk two miles to get it, or when the quality is unsafe? In such cases, the problem may be institutional or infrastructure scarcity, not physical scarcity, and it is addressed not by finding new sources of supply or modifying demand, but by improving the management and infrastructure required to satisfy water demands. Another aspect of institutional scarcity is when water policy limits the amounts of water that can be used, for example, when efforts to protect and restore ecosystems lead to commitments of water for the environment that might previously have been used by humans. By acknowledging that ecosystems have a right to water left instream, local conditions of scarcity as perceived by humans may worsen. In 1992, the US Congress passed the Central Valley Project Improvement Act, a multipurpose water law that, among other things, mandated that a billion cubic meters of water be dedicated to ecosystem restoration, including improving the health of anadromous fish populations. This law was perceived as creating additional water scarcity challenges for farmers in the region and worsening groundwater overdraft by shifting agricultural water use from surface sources to aquifers, and it has been a contentious issue in California water politics for nearly three decades (Fischhendler & Zilberman, 2005).

D. Climate Change: - Human-induced climate changes are accelerating. Among the now unavoidable consequences are fundamental changes in the hydrologic cycle, including increases in evapotranspiration rates as temperatures rise, regional shifts in stocks and flows of water and ice, alterations in the intensity and severity of extreme events such as droughts and floods, shifts in the freshwater balances of coastal aquifers and estuaries as sea levels

rise, and more (Field et al., 2014). Climate changes will also have direct and indirect impacts on water scarcity by changing both the supply and demand of fresh water. Although climate models continue to improve, uncertainties about the detailed long-term implications of climate change for regional and local hydrology remain. Nevertheless, in recent years, the fingerprint of climate changes has been seen in a growing number of water-related areas, including the amount of water delivered by tropical cyclones (Risser & Wehner, 2017), the depth and severity of droughts, alterations of river flows due to melting snow and ice, and evaporation losses from reservoirs . As climate changes worsen, the risks of water scarcity for hundreds of millions of people are expected to increase, barring major efforts to reduce scarcity risks (Gampe et al., 2016).

Solutions for Addressing Water Shortages: - While some human activities have exacerbated the water crisis, humans have also developed technologies to better acquire or conserve freshwater. Solutions to addressing water shortages include dams and reservoirs, rainwater harvesting, aqueducts, desalination, water reuse, and water conservation.

1. Dams and Reservoirs: - Reservoirs (artificial lakes) that form behind dams in rivers can collect water during wet times and store it for use during dry spells (figure 1). They also can be used for urban water supplies. Other benefits of dams and reservoirs are hydroelectricity, flood control, and recreation. Some of the drawbacks are evaporative loss of water in arid climates and downstream river channel erosion. Additionally, dams reduce water flow downstream, which could lead to political conflicts when rivers span states or countries. The negative ecosystem impacts of dams are another major drawback. For example, dams change a river to a lake habitat and interfere with migration and spawning of fish. Furthermore, warming of the surface water in the reservoir influences the temperature of the water downstream, impacting the fish and aquatic invertebrates that are adapted to colder water. Dams also trap sediments that would otherwise continue to flow down the river, creating habitat and supplying nutrients downstream.

Fig: - 1 The Hoover Dam on the Colorado River in Nevada. Behind the dam is Lake Mead, the largest reservoir in the United States.

(Source: - Kelo, 2009)

2. Rainwater harvesting: - Rainwater harvesting involves catching and storing rainwater before it reaches the ground. Figure 2 shows a complex rainwater harvesting system (rain water capture system) proposed for federal buildings, but smaller, simpler systems (sometimes called rain barrels) can be used by individual homeowners (figure 3).

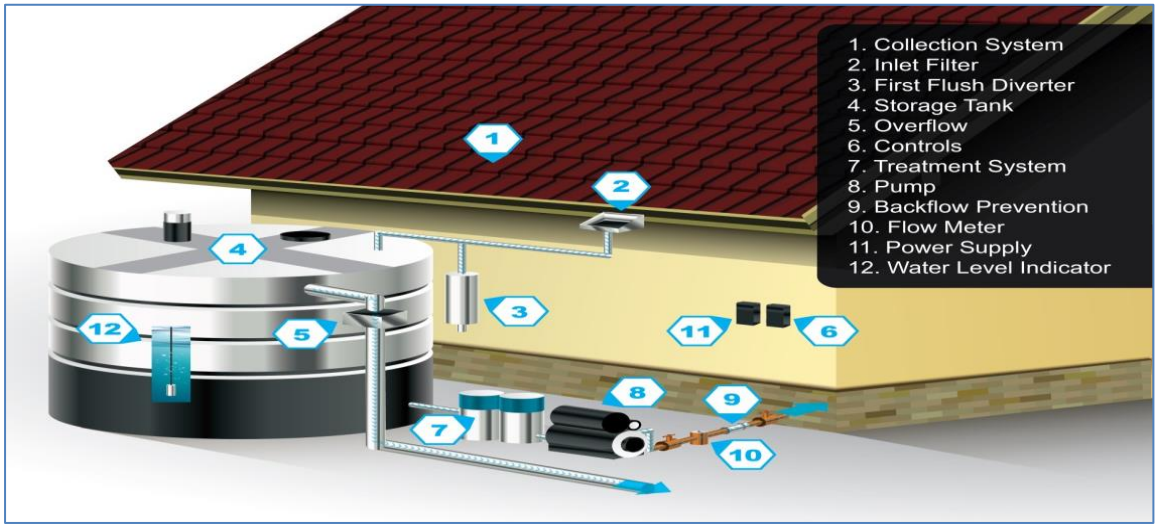

Figure: - 2 : The components of a rainwater harvesting system include (1) the collection system consisting of the roof surface and gutters that capture rain water and send it to (2) the inlet filter, a screen that catches large debris. (3) The first flush diverter removes debris not captured by the inlet filter from the initial stream of rainwater. (4) The storage tank is composed of food-grade polyester resin material approved by the U.S. Food and Drug Administration (FDA), which is green in color and helps to reduce bacterial growth. (5) The overflow is a drainage spout that releases excess water if the storage tank is full. The (6) control system monitors the water level and filtration system, and the (7) treatment system is responsible for filtration and disinfection, treating water until it is potable (safe to drink). The (8) pump moves water through the system to where it will be used, and the (9) backflow preventer ensures that water cannot flow backwards through the system in cases of low water pressure (when the storage tank is low). (10) The flow meter (with data logger) measure water production. The (11) power supply may rely on conventional energy sources or solar energy, and the (12) water level indicator monitors the water level in the storage tank. Caption modified from and image from Office of Energy Efficiency and Renewable Energy, Department of Energy (public domain).

Figure 3: - A rain barrel is a simple rainwater harvesting system. Homeowners commonly use the stored water to irrigate their gardens. Image by Walton LaVonda, USFWS (public domain).

3. Aqueducts: - Aqueducts can move water from where it is plentiful to where it is needed. Aqueducts can be controversial and politically difficult especially if the water transfer distances are large. One drawback is the water diversion can cause drought in the area from where the water is drawn. For example, Owens Lake and Mono Lake in central California began to disappear after their river flow was diverted to the Los Angeles aqueduct. Without water supply, Owens Lake dried and became a major source of particulate matter, polluting the air during dust storms. Owens Lake remains almost completely dry, but Mono Lake has recovered more significantly due to legal intervention.

4. Desalination: - One method that can actually increase the amount of freshwater on Earth is desalination, which involves removing dissolved salt and minerals from seawater or saline groundwater. An advantage of this approach is that there is a virtually unlimited supply of saltwater. There are several ways to desalinate seawater including boiling, filtration, electro dialysis (applying an electric current to remove the ions which comprise salts), and reverse osmosis. All of these procedures are moderately to very expensive and require considerable energy input, making the water produced much more expensive than freshwater from conventional sources. In addition, the process creates highly saline wastewater, which must be disposed of and creates significant environmental impact. Desalination is most common in the Middle East, where energy from oil is abundant but water is scarce.

5. Water Reuse: - (Water Recycling) Water recycling refers to reusing water for appropriate purposes such as agriculture, municipal water supply, industrial processes, and environmental restoration. This could occur at the scale of a single household, for example, installing plumbing that reroutes water drained from the sink to flush the toilet. Water recycling can also occur at large scales. For example, wastewater from the sewage system is regularly treated to an extent, but it can be treated further to produce potable water (which is safe to drink) and then pumped into depleted aquifers. This approach limits saltwater intrusion of aquifers near the coast and reduces dependence on precipitation and subsequent infiltration to recharge aquifers. Orange County Water District in California employed this system following an information campaign to explain the purification process and ensure public confidence in the safety of the treated wastewater.

6. Water Conservation: - Water conservation refers to using less water and using it more efficiently. Around the home, conservation can involve both water-saving technologies and behavioral decisions. Examples of water-saving technologies include high-efficiency clothes washers and low-flow showers and toilets. Water-conserving behaviors include turning off the water while you brush your teeth, taking shorter showers and showers instead of baths, and fixing leaky faucets. A dishwasher uses less water than washing dishes by hand; particularly the dishwasher is only run when it is full. Similarly, running fewer, larger loads of laundry conserves water relative to more frequent, smaller loads. Choosing foods with a low water footprint (like eggs) over those with a high water footprint (like beef) can also conserve water. Gardening offers several water-saving opportunities. If you live in a dry climate, consider growing only native, drought-tolerant vegetation, which requires little irrigation. When you do irrigate your garden, do so only as needed and early in the morning, when less water will be lost to evaporation. Drip systems assist in delivering only the needed

amount of water in a way that minimizes evaporation. These strategies can also be applied at large scales in agriculture, which is extremely important considering the high agricultural demands on our water supply relative to municipal use. Water conservation strategies in agriculture include growing crops in areas where the natural rainfall can support them, more efficient irrigation systems such as drip systems, and no-till farming, which reduces evaporative losses by covering the soil.

Bottled water is not a sustainable solution to the water crisis. Bottled water is not necessarily any safer than the U.S. public water supply, it costs on average about 700 times more than U.S. tap water, and every year it uses approximately 200 billion plastic and glass bottles that have a relatively low rate of recycling. Compared to tap water, it uses much more energy, mainly in bottle manufacturing and long-distance transportation. (Purchasing a water filter is a more sustainable solution than bottled water if you do not like the taste of tap water.)

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UNIT: - 9

Environmental pollution with reference to e-waste and other non-degradable waste products

Introduction: - Human activities directly or indirectly affect the environment adversely. A stone crusher adds a lot of suspended particulate matter and noise into the atmosphere. Automobiles emit from their tail pipes oxides of nitrogen, sulphur dioxide, carbon dioxide, carbon monoxide and a complex mixture of unburnt hydrocarbons and black soot which pollute the atmosphere. Domestic sewage and run off from agricultural fields, laden with pesticides and fertilizers, pollute water bodies. Effluents from tanneries contain many harmful chemicals and emit foul smell. These are only a few examples which show how human activities pollute the environment. Pollution may be defined as addition of undesirable material into the environment as a result of human activities. The agents which cause environmental pollution are called pollutants. Pollutants may be defined as a physical, chemical or biological substance unintentionally released into the environment which is directly or indirectly harmful to humans and other living organisms.

The pressing need to clean up the environment and save the earth has been recognized internationally but how far the human being realized and aware of the important of maintaining stability in every activity that involved with nature of their materialistic needs. Human activities are contributing towards pollution at tremendous speed tor the world development. Therefore necessary measures need to be taken in order to control and reduce the level of pollutions. The economic growths of every state in Malaysia are accumulations of different sectors that related to the total National Development. These sectors (industrials, housing, commercial, agricultural etc.) are among the major contributors to the environmental pollution, many of which have the great potential to cause damage to the environment. A well understanding of the consequences on how pollutions get started practically and theoretically may help us to identify the appropriate remedies to these problems especially for the National Development but not to forget the whole universe.

By definition, pollution is harmful—too much of something in the wrong place. In appropriate quantities, some erstwhile pollutants are beneficial. Phosphates and other plant nutrients are essential to aquatic life; too much of these nutrients, however, and eutrophication results. Carbon dioxide in the atmosphere helps keep Earth warm enough to be habitable, but the buildup of vast quantities of excess carbon dioxide from fossil fuel use and other sources now threatens to alter the planet's climate. Other pollutants, like dioxin and P.C.B.s, are so toxic that even the minutest amounts pose health hazards, such as cancer and reproductive impairment. Releases of pollutants to the environment are most often the casual by-product of some useful activity, such as generating electricity or raising cows. Pollution of this type is a form of waste disposal. It occurs when the economic costs of eliminating the pollution exceed the economic benefits, at least the benefits to the polluter—a calculation historically skewed in favor of pollution since the atmosphere and waterways have been treated as free disposal sites. But releases of pollutants can also be purposeful, as with

pesticides, where biocidal substances are released into the environment to reap economic rewards, or accidental, as in oil spills, where the polluters themselves suffer loss.

Pollution is traditionally categorized in several ways—by receiving media, sources, types of pollutants, and effects. Perhaps the most customary pollution categories are those that focus on the receiving media: air (emissions), water (effluents), and land (dumps and disposals). A slightly more sophisticated breakdown would distinguish between inland and marine waters, surface and groundwater, troposphere and stratosphere, and perhaps we should now add outer space as well, given the satellite and other debris accumulating out there. Most discussion and regulation of pollution is built around these categories, but concern is shifting increasingly to inter-media effects, such as the acidification of lakes and streams caused by air pollution or the disposal on land or in the ocean of sludge and other residuals from air- and water-pollution control measures.

Causes of environmental pollution: The major causes are as follows (Ukaogo, 2020):

A. Urbanization and industrialization: - Since the era of industrial revolution, man has continued to introduce hazardous materials into the environment at an alarming rate. Industrialization, urbanization, economic development, and the environment are connected by a combination of positive and negative impacts. Generally, in many countries, urbanization and rapid economic growth occur where movement of populations from villages to cities and towns has been observed. Environmental degradation is one of the consequences of uncontrolled urbanization in developing nations. This occurs very rapidly, resulting in a myriad of other problems such as excessive air pollution, water contamination, increased waste disposal challenges, and infertile farmlands. Most likely, industrialization, modernization, and rapid increase in urbanization contribute to environmental pollution across the globe, but the impact is more in developing nations.

Water resources are beginning to diminish, and with an increase in population, there is a possibility of further reduction or even drying up due to indifference to water conservation and wasteful consumption of water. Also, pollution leads to contamination of water bodies, making them non-potable. Moreover, waste discharges into land and water bodies because of industrialization are overwhelming. With rapid urbanization and industrialization, huge quantities of wastewater, heavy metals, toxic sludge, and solvents enter streams and rivers, thereby polluting them. Urbanization has multiplied the growth in automobiles and motor vehicles, which is a serious concern for air pollution. Finally, industrialization is championing drastic habitat destruction through the cutting of trees for their lumber, construction of roads, and building of houses, which all contribute to the destruction of ecosystems and the extinction of some animal and plant species.

B. Mining and exploration: - The process of mining and exploration generates varying degrees of pollution affecting the quality of air, water, and land. The degree of pollution depends on the phase and magnitude of work being carried out at the site. Excavation of the mine site alone may produce waste material, form sinkholes, and result in a loss of habitat. In the process of mining a particular valuable material such as gold ore, other toxic elements

such as lead (Pb) could erupt and cause both soil and water pollution. Though mineral exploration may bring about slight pollution, the different stages of large-scale exploration may result in more intense soil, water, and air pollution. The pollution is even greater when it emanates from a large-scale exploitation of rocks, petroleum, and limestone used in different construction works. In most oil-producing states in African countries, vandals have taken to illegal bursting of oil pipelines, and siphoning oil for refining in illegal refineries.

Most often, these illegal refineries are burnt down by security agencies with the intension of putting a stop to bunkering. However, this burning activity produces enormous amounts of carbon compounds, sulfur compounds, organic pollutants, and toxic metals that pose severe consequences not only to the environment but also to both terrestrial and aquatic lives. For example, acid rain is observed, intensity of heat increases due to the presence of greenhouse gases, and death of fishes and other aquatic animals in surface waters occurs. Cement factories and mining operations in limestone quarry sites may release large volumes of dust into the air, which further exacerbate environmental pollution.

C. Agricultural activities: - Agriculture serves as a source of economic development for any country and sustains the livelihoods of the populace. Despite these important roles of agriculture, pollution still emanates from agricultural activities resulting in a number of health and environmental risks. Agricultural pollution may be triggered by certain farming activities that tend to damage, contaminate, and degrade the environment and ecosystem. A source of pollution in farming is the burning of waste materials from agricultural activities such as land clearance, applying excessive fertilizer more than the plants' requirement, and use of certain pest control chemicals that are non-biodegradable. The aftermath of these processes includes the introduction of certain chemical substances into the food web, generation of smoke and PM, and destabilization of habitats.

Furthermore, nitrates from agricultural processes are known chemical pollutants in groundwater aquifers. Eutrophication that occurs due to excess nutrients in water bodies is commonly related to fertilizers that are applied at a higher dose than they are required for the plants' uptake. Excess nitrogen and phosphates can leach into surface water or groundwater through runoffs. Apart from pollution arising from cultivation of farmlands, rearing of terrestrial or aquatic animals also pollutes the environment. For instance, uneaten animal feeds or animal excreta may produce pungent odors with possible ill-health effects. More so, the quest for increased production of agricultural products for the sustenance of an ever-increasing population has encouraged the use of antifouling agents, antibiotics, and fungicides in farming, which in turn exacerbate the pollution of the ecosystem. Although agriculture is a basic necessity for human beings and is required to feed the human population, pollution resulting from agricultural activities should be of utmost concern.

D. Burning of fossil fuels: - Fossil fuels may emit harmful air pollutants long before they're burned. When fossil fuels are burned, a number of air pollutants are emitted, which cause environmental pollution and concomitant destruction of the ecosystem. In meeting our energy needs, we burn oil, coal, and gas, and these drive the current global warming crisis. A variety of primary and secondary pollutants are emitted due to burning of fossil fuels including

airborne particles, SO2, CO2, CO, hydrocarbons, organic compounds, chemicals, and nitrogen oxides (NOx). Fossil fuel emissions contain the major greenhouse gases, including carbon dioxide, methane (CH4), nitrous oxide, and fluorinated gases. Therefore air pollution from these activities does not only present a menace for the air quality, but also is partly responsible for climate change and global warming.

E. Particulate matter: - PM is an important constituent of the atmosphere. The sources of PM can be natural or manmade sources. There are a number of natural sources that inject millions of tons of PM into the atmosphere. They include volcanic eruption, wind and dust storms, forest fire, salt spray, rock debris, reactions between gaseous emissions, and soil erosion. Man-made activities such as fuel combustion, industrial processes, steel industry, petroleum foundries, cement, glass manufacturing industry, smelting and mining operations, fly-ash emissions from power plant, burning of coal, and agricultural refuse also contribute to PM in the atmosphere.

F. Plastics: - People are beginning to understand the extent to which plastics have contributed to environmental pollution. Some types of plastics that are found in the natural environment include polypropylene, polyethylene, polystyrene, polyamides, and polyesters. In most developing countries, plastic bags are primarily used in shopping and storing of food items because of their strength and cost. Also, most drinks that were sold in glass bottles are now packaged in plastic bottles. However, in some places, drinks in these plastic bottles are consumed and the bottles are indiscriminately discarded adding to the large number of plastics in the environment. Plastics are largely non-biodegradable but can be reduced to macro- or micro plastics. It was reported that between 1960 and 2013 the growth of municipal solid waste generation in the United States was 188%, whereas the generation of plastics was 8238% (Tsiamis et al., 2018).

However, the growth of plastic generation coincided with a reduction in waste generation from glass and metal. Primarily, micro plastics (MPs) are found in consumer products such as paints, cosmetics, and fibers in washed synthetic clothes, while secondary MPs result from the breakdown of larger plastic debris (Auta et al., 2017). Most surface plastics are MPs (0.33-4.75 mm). MPs pollution has been identified as a threat to coastal marine environments. However, research is still ongoing to elucidate the environmental implications of MPs distributions, concentrations, and characteristics.

E-waste pollution: - The discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste). The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; in water due to recycling process, if not carried out properly, can cause damage to human being through inhalation of gases during recycling, contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process.

"E-waste" is a popular, informal name for electronic products nearing the end of their "useful life." E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. Discarded computers, televisions, VCRs, stereos, copiers, fax machines, electric lamps, cell phones, audio equipment and batteries if improperly disposed can leach lead and other substances into soil and groundwater. Many of these products can be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem. This paper highlights the hazards of e-wastes, the need for its appropriate management and options that can be implemented (Devi et al., 2004).

Industrial revolution followed by the advances in information technology during the last century has radically changed people's lifestyle. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution. The technical prowess acquired during the last century has posed a new challenge in the management of wastes. For example, personal computers (PCs) contain certain components, which are highly toxic, such as chlorinated and brominated substances, toxic gases, toxic metals, biologically active materials, acids, plastics and plastic additives. The hazardous content of these materials pose an environmental and health threat (Jain, 2009).

Electronic waste, or e-waste, refers to all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use (Step Initiative 2014). E-waste is also referred to as WEEE (Waste Electrical and Electronic Equipment), electronic waste or e-scrap in different regions and under different circumstances in the world. It includes a wide range of products – almost any household or business item with circuitry or electrical components with power or battery supply. In this methodology, defined by the Partnership on Measuring ICT for Development (Baldé et al., 2015a), the definition of e-waste is very broad. It covers six waste categories:

1. Temperature exchange equipment, more commonly referred to as cooling and freezing equipment. Typical equipment includes refrigerators, freezers, air conditioners, heat pumps.

2. Screens, monitors. Typical equipment includes televisions, monitors, laptops, notebooks, and tablets.

3. Lamps. Typical equipment includes fluorescent lamps, high intensity discharge lamps, and LED lamps.

4. Large equipment. Typical equipment includes washing machines, clothes dryers, dish-washing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels.

5. Small equipment. Typical equipment includes vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments.

6. Small IT and telecommunication equipment. Typical equipment includes mobile phones, Global Positioning Systems (GPS), pocket calculators, routers, personal computers, printers, telephones.

Each product of the six e-waste categories has a different lifetime profile, which means that each category has different waste quantities, economic values, as well as potential environmental and health impacts, if recycled inappropriately. Consequently, the collection and logistical processes and recycling technology differ for each category, in the same way as the consumers' attitudes when disposing of the electrical and electronic equipment also vary.

E-waste Concerns and Challenges:

a) Accurate figures not available for rapidly increasing e-waste volumes— generated domestically and by imports.

b) Low level of awareness among manufacturers and consumers of the hazards of incorrect e-waste disposal.

c) No accurate estimates of the quantity of e-waste generated and recycled available in India.

d) Major portion of e-waste is processed by the informal (unorganized)sector using rudimentary techniques such as acid leaching and open-air burning, whichresults in severe environmental damage.

e) E-waste workers have little or no knowledge of toxins in e-waste and are exposed to health hazards.

f) Cherry-picking by recyclers who recover precious metals (gold, platinum, silver, copper, etc) and improperly dispose of the rest, posing environmental hazards.

g) No specific legislation for dealing.

h) High-risk backyard recycling operations impact vulnerable social groups like women, children and immigrant labourers.

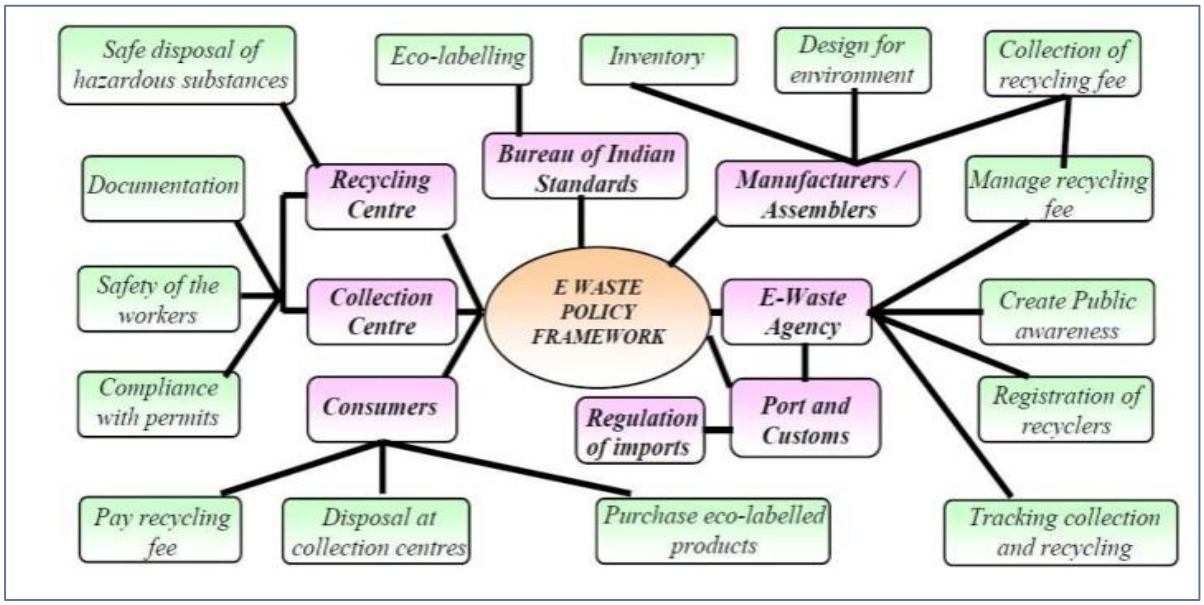
i) Inefficient recycling processes result in substantial losses of material value and resources.

E-waste in India: - As there is no separate collection of e-waste in India, there is no clear data on the quantity generated and disposed of each year and the resulting extent of environmental risk. The preferred practice to get rid of obsolete electronic items in India is to get them in exchange from retailers when purchasing a new item. The business sector is estimated to account for 78% of all installed computers in India (Kristina et al., 2002).Obsolete computers from the business sector are sold by auctions. Sometimes educational institutes or charitable institutions receive old computers for reuse. It is estimated that the total number of obsolete personal computers emanating each year from business and individual households in India will be around 1.38 million. According to a report of confederation of Indian Industries, the total waste generated by obsolete or broken down electronic and electrical equipment in India has been estimated to be 1,46,000 tons per year.

The results of a field survey conducted in metropolitan city of India to assess the average usage and life of the personal computers (PCs), television (TV) and mobile phone showed that the average household usage of the PC ranges from 0.39 to 1.70 depending on the income class . In the case of TV it varied from 1.07 to 1.78 and for mobile phones it varied from 0.88 to 1.70. The low-income households use the PC for 5.94 years, TV for 8.16 years and the mobile phones for 2.34 years while, the upper income class uses the PC for 3.21 years, TV for 5.13years and mobile phones for 1.63 years. Although the per-capita waste production in India is still relatively small, the total absolute volume of wastes generated will be huge. Further, it is growing at a faster rate. The growth rate of the mobile phones (80%) is very high compared to that of PC (20%) and TV (18%). The public awareness on e-wastes and the willingness of the public to pay for e-waste management as assessed during the study based on an organized questionnaire revealed that about 50% of the public are aware of environmental and health impacts of the electronic items. The willingness of public to pay for e-waste management ranges from 3.57% to 5.92% of the product cost for PC, 3.94 % to 5.95 % for TV and 3.4 % to 5 % for the mobile phones. However, no confirmed figures available on how substantial are these trans boundary e-waste streams, as most of such trade in e-waste is camouflaged and conducted under the pretext of obtaining 'reusable' equipment or 'donations' from developed nations (Rao, 2014).

Present E-waste Status in India: - In India most of activities like collection, transportation, segregation, dismantling, etc., is done by unorganized sectors manually. Being a rich source of reusable and precious material, E waste is also a good source of revenue generation for many people in India. The big portion (rag pickers) of the Indian population earned their livelihood by collecting and selling the inorganic waste-like plastics, polythene bags, glass bottles, cardboards paper, other ferrous metals, etc. In India, most of the operations related to E-waste such a collections, segregation, dismantling, recycling, and disposals are performed manually. In absence of the adequate technologies and equipment, most of the techniques used for the recycling/treatments of E-waste are very raw and dangerous. Figure A reveals the trend in growth of E-waste in India that is continuously rising over the years. In 2007 E-waste generation is 332979, but in2009 it is 69926 MT. more than previous record. In 2011 the production of E-waste is 487515, and it is84610 more than 2009. So we conclude that the E-waste rising over the year with a healthy pace and it is an alarming signal for Indian environmentalist, planners and administrates.

Figure A: - Elements of E-waste management system for India



Source: - Rao, 2014

Environmental and Health Issues:

Management of hazardous municipal waste is a challenge in itself. Added to this burden is the management of huge and growing quantities of electrical and electronic waste emerging as one of the most important environmental problems of developing countries, especially India. Approximately 2 lakh tonnes of e-waste was generated in the country in 2007. E-waste has become more of a problem than all other wastes because of the very significant health and environment hazards associated with it. The e-waste contains a number of toxic components that can cause serious damage to environment and human and animal health if not properly discarded in an environmentally sound manner.

Effects of some of the chemicals found in e-waste on human health are given below:

Brominated flame retardants: Brominated flame retardants (BFRs) have routinely been added to consumer products for several decades in a successful effort to reduce fire-related injury and property damage. Recently, concern for this emerging class of chemicals has risen because of the occurrence of several classes of BFRs in the environment and in human biota. The widespread production and use of BFRs; strong evidence of increasing contamination of the environment, wildlife, and people; and limited knowledge of potential effects heighten the importance of identifying emerging issues associated with the use of BFRs. These do not decompose easily in the environment, and long term exposure can cause impaired memory function and learning. Pregnant women exposed to brominated flame retardants have been shown to give birth to babies with behavioral problems as it interferes with estrogen and thyroid functioning.

Lead: Lead is a naturally-occurring element that can be harmful to humans when ingested or inhaled, particularly to children under the age of six. Found in most computer monitors and

televisions, lead exposure leads to intellectual impairment in children and serious damages to human reproductive systems, the nervous system and blood. Lead poisoning can cause a number of adverse human health effects, but is particularly detrimental to the neurological development of children.

Cadmium: The kidney is the critical target organ for the general population as well as for occupationally exposed populations. Cadmium is known to accumulate in the human kidney for a relatively long time, from 20 to 30 years, and, at high doses, is also known to produce health effects on the respiratory system and has been associated with bone disease. Found in rechargeable batteries for laptop computer and other electronic devices, can cause damage to kidneys and bones. Cadmium can be bio-accumulate in the environment and is extremely toxic to human, in particular adversely affecting kidneys and bones.

Mercury: Elemental and methyl mercury are toxic to the central and peripheral nervous systems. The inhalation of mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal. The inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested. Neurological and behavioral disorders may be observed after inhalation, ingestion or dermal exposure of different mercury compounds. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction. Kidney effects have been reported, ranging from increased protein in the urine to kidney failure. Mercury (Hg), which is used in lightening devices in flat screen monitors and televisions, can cause damage to the breast milk.

Hexavalent Chromium Compounds: Hexavalent chromium is a toxic form of the element chromium. Hexavalent chromium compounds are man-made and widely used in many different industries. A known carcinogen, these are used in the creation of metal housing which are typical of many electronic products. It can cause lung cancer, irritation or damage to the nose, throat, and lung (respiratory tract), irritation or damage to the eyes and skin etc.

Plastic compounds: Poly vinyl chloride (PVC) cabling is used for printed circuit boards, connectors, plastic covers and cables. When burnt or land-filled, these PVCs release dioxins that have harmful effects on human reproductive and immune systems.

Treatment and Disposal

Because of the complex composition of valuable and hazardous substances, specialized, often "high-tech" methods are required to process e-waste in ways that maximize resource recovery and minimize potential harm to humans or the environment. Unfortunately, the use of these specialized methods is rare, with much of the world's e-waste traveling great distances, mostly to developing countries, where crude techniques are often used to extract precious materials or recycle parts for further use. This also leads to localized pollution of environment and is health hazards for advanced life forms. The methods followed in general of which some are not recommended are (Kumari and Baby, 2016):

1. Land filling: It is widely used methods for disposal of e-waste. In this method, trenches are made on the flat surfaces by removing soil from the trenches and waste material is buried in it, which is covered by a thick layer of soil. Secure landfill is made using modern technique. Here they are provided with some facilities like, impervious liner made up of plastic or clay, leachate collection basin that collects and transfer the leachate to wastewater treatment plant. The degradation processes in landfills are very complicated and run over a wide time span and can be many years.

2. Incineration: In this controlled and complete combustion process, the waste material is burned in specially designed incinerators at a high temperature (900-1000oC). Advantage of incineration of e-waste is the reduction of waste volume and the Utilization of the energy content of combustible materials. In this method some environmentally hazardous organic substances are converted into less hazardous compounds.

3. Recycling of e-waste: Fridge, Washing machines, TVs, Monitors & CRT, keyboards, laptops, modems, telephones, hard drives, floppy drives, Compact disks, mobiles, fax machines, printers, CPUs, memory chips, connecting wires & cables can be recycled. Recycling involves dismantling i.e. removal of different parts of e-waste containing dangerous substances like PCB, Hg, separation of plastic, removal of CRT, segregation of ferrous and nonferrous metals and printed circuit boards. Strong acids are used to remove precious metals such as copper, gold, palladium. The value of recycling from the element could be much higher if appropriate technologies are used.

4. Re-use: It constitutes direct second hand use or use after slight modifications to the original functioning equipment. It is commonly used for electronic equipment like computers, cell phones etc. Inkjet cartridge is also used after refilling. Old working computers can be donated to schools or organization working in the field of education. Computers beyond repairs can be returned back to the manufacturers. This method also reduces the volume of e-waste generation. The better option is to avoid its generation. To achieve this, buy back of old electronic equipment shall be made mandatory. This can considerably reduce the volume of e- waste generation.

Other non-degradable waste products:

A pollutant that is not broken down by natural processes is a non-degradable pollutant. As we become more technologically advanced, we produce materials that can withstand extreme temperatures, are durable and easy to use. Plastic bags, synthetics, plastic bottles, tin cans, and computer hardware are some of the things that make life easy. DDT, plastics, polythene, insecticides, pesticides, synthetic fibers, glass objects, mercury, lead, arsenic, metal articles like aluminum cans, iron products and silver foils are products do not break down into simpler, harmless substances naturally. They are not biodegradable. These things stay on earth for thousands and thousands of years. When we dispose of them in a garbage pile, the air, moisture, climate, or soil cannot break them down naturally to be dissolved with the surrounding land. However natural waste and products made from nature break down easily when they are disposed of as waste. But as more and more non-degradable materials pile up,

there is increased the threat to the environment. The contribution of Thermoplastics is about 80% and Thermoset constitutes approximately 20% of the total plastics waste generated. There are so many polymeric products which are not utilized or digested by any living system as they don't have digestive enzymes for such polymers. It is roughly estimated that it will take some 3 lac years for the degradation of plastic, therefore, it is called Non-biodegradable but we can re-utilize these things.

Degradation related research shows that a banana peel degrades in two months, while notebook paper will break down in three months. Harder substances take longer time. Sodacans can take up to 350 years, while the plastic rings that hold together a six-pack of those cans can take up to 450 years. Glass bottles and Styrofoam products might never biodegrade. The danger is that products that do not biodegrade will continue to pile up over time, requiring more and more land devoted to holding waste. A study shows that low doses of Bisphenol a chemical used in water bottles, food containers, and hard plastics leach into foods and water over time and are carcinogenic, cause insulin resistance and interfere with conception. Constant exposure to heat melts plastic, emitting gasses into the atmosphere in a process known as outgassing. According to the conservation reports, incinerating plastic causes toxic fumes to be released into the atmosphere. The same problem happens with plastics exposed to constant sunlight. One of the most common household wastes is polyethene- mostly used as polythene bags for shopping and carrying light things. Since they are cheap, they are used by almost everyone. The hazard that polythene causes to the environment is very serious (Jain et al., 2017).

Non-degradable pollutants create problems because they are toxic and persistent in the environment. We need to deal non-degradable pollutants to reduce the quantity released into the environment either by recycling them for reuses before they are disposed of or by curtailing their production. Biodegradable plastic is Bio plastic, whose components are derived from renewable raw materials and plastics made from petrochemicals containing biodegradable additives which enhance biodegradation. Scientists have been able to develop new types of bacteria, that do not exist in nature, but that will degrade plastics. Biodegradable plastics are plastics that decompose by the action living organisms, usually bacteria.

Waste Management Initiatives in India: - During the recent past, the management of solid waste has received considerable attention from the Central and State Governments and local (municipal) authorities in India. A number of partnerships/alliances are found to exist in the field of solid waste management in Indian cities. These alliances are public-private, community-public and private-private arrangements. To identify the status of existing alliances in the study area, it is first necessary to identify the various actors working in the field of waste management. These actors can be grouped as under:

1. Public sector: this comprises of local authority and local public departments at city level;

2. Private-formal sector: this constitutes large and small registered enterprises doing collection, transport, treatment, and disposal and recycling;

3. Private-informal sector: this constitutes the small-scale, no recognized private sector and comprises of waste-pickers, dump pickers, itinerant-waste buyers, traders and non-registered small-scale enterprises; and

4. Community representatives in the form of NGOs, etc.

These actors enter into partnerships for providing various activities related to solid waste management. These partnerships can be as follows:

a. public-private (Local Authority and private enterprises);

b. public-community (Local Authority and NGOs); etc

c. private-private (waste-pickers, itinerant-waste buyers, waste traders and dealers, wholesalers, small scale and large scale recycling enterprises); and

d. Public-private-community (Local Authority, private enterprises and NGOs).

National Solid Waste Association of India (NSWAI) is the only leading professional non-profit organization in the field of Solid Waste Management including Toxic and Hazardous Waste and also Biomedical Waste in India. It was formed on January 25, 1996. NSWAI helps the Ministry of Environment and Forest (MoEF), New Delhi in various fields of solid waste management makes policies and action plans and is entrusted the responsibility of collecting information and various data related to solid waste management from the municipalities of Urban Class-I cities (population more than 1Lakh) and Urban Class-II cities(population above 50,000), collate and disseminate the information to website which is linked to national and international organizations. The association is a member of the International Solid Waste Association (ISWA), Copenhagen, Denmark and provides forum for exchange of information and expertise in the field of Solid Waste Management at the national and international level (Agarwal et al., 2015).

Differences between Biodegradable And Non-biodegradable Pollutants:

Biodegradable Waste	Non-biodegradable Waste
Degradation process is rapid	Degradation process is slow
It is decomposed and degraded by microbes	It cannot be decomposed
It disappears in a short time.	It often accumulates
It becomes part of biogeochemical cycle	It does not become part of the cycle. Instead turns toxic
Useful. Can be used to produce biogas, manure, etc.	It can be separated and recycled, but the process is expensive.

Disadvantages of Non-biodegradable Waste:

- One of the side effects of modern technological advancements is the inability of nature to decompose substances that humans create.

- For example, the polythene used in shopping bags is non-biodegradable, meaning it does not break down naturally in landfills.
- The non-biodegradable waste can last for hundreds of years and cause severe environmental problems.
- They can sit as litter in forests, parks, rivers, or streams.
- The piling of throwaway plastic and other materials has taken a toll on the ecosystem.
- It has led to heaps of non-biodegradable waste forming in many areas of major cities.

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UNIT: -10

Ground water contamination: Arsenic

Introduction: - Ground water contamination is nearly always the result of human activity. In areas where population density is high and human use of the land is intensive, ground water is especially vulnerable. Virtually any activity whereby chemicals or wastes may be released to the environment, either intentionally or accidentally, has the potential to pollute ground water. When ground water becomes contaminated, it is difficult and expensive to clean up. To begin to address pollution prevention or remediation, we must understand how surface waters and ground waters interrelate. Ground water and surface water are interconnected and can be fully understood and intelligently managed only when that fact is acknowledged. If there is a water supply well near a source of contamination, that well runs the risk of becoming contaminated. If there is a nearby river or stream, that water body may also become polluted by the ground water.

Groundwater quality comprises the physical, chemical, and biological qualities of ground water. Temperature, turbidity, color, taste, and odor make up the list of physical water quality parameters. Since most ground water is colourless, odorless, and without specific taste, we are typically most concerned with its chemical and biological qualities. Although spring water or groundwater products are often sold as “pure,” their water quality is different from that of pure water. Naturally, ground water contains mineral ions. These ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. They are referred to as dissolved solids. Some dissolved solids may have originated in the precipitation water or river water that recharges the aquifer (Harter, 2003).

Water is essential for life and for all economic activities. It is used for domestic, industrial and agricultural purposes. Having sufficient water in sufficient quantity and quality contributes to maintaining health. The availability of water of good quality is essential to prevent diseases and to improve the quality of life. The use of water increased due to increasing in human population and activities (Al-Sudani, 2018). Groundwater is one of the important components in development of any area. It is the major potable, agricultural and industrial source of water. In 2003, it was estimated that groundwater holds nearly 50% of the drinking water supply,40% of the demand for industrial water, and 20% of the water used for irrigation (Foster & Chilton, 2003). Globally, more than a third of water used by humans comes from groundwater. In rural areas, the ratio is higher: more than half of all drinking water worldwide is supplied from groundwater. In the past, it was thought that groundwater is protected from pollution by layers of rocks and soil that act as filters. But we now know that groundwater is vulnerable to pollution. Groundwater pollutants can enter landfills and lakes used to store waste, chemical spills, underground storage tanks, and improper management of hazardous waste sites. Groundwater pollution can also result from innumerable common practices, such as the use of fertilizers and pesticides as well as disposal of human, animal and agricultural waste (US EPA 1993).

What is groundwater? - Groundwater is fresh water (from rain or melting ice and snow) that soaks into the soil and is stored in the tiny spaces (pores) between rocks and particles of soil. Groundwater accounts for nearly 95 percent of the nation's fresh water resources. It can stay underground for hundreds of thousands of years, or it can come to the surface and help fill rivers, streams, lakes, ponds, and wetlands. Groundwater can also come to the surface as a spring or be pumped from a well. Both of these are common ways we get groundwater to drink. About 50 percent of our municipal, domestic, and agricultural water supply is groundwater.

How does the ground store water? - Groundwater is stored in the tiny open spaces between rock and sand, soil, and gravel. How well loosely arranged rock (such as sand and gravel) holds water depends on the size of the rock particles. Layers of loosely arranged particles of uniform size (such as sand) tend to hold more water than layers of rock with materials of different sizes. This is because smaller rock materials settle in the spaces between larger rock materials, decreasing the amount of open space that can hold water. Porosity (how well rock material holds water) is also affected by the shape of rock particles. Round particles will pack more tightly than particles with sharp edges. Material with angular-shaped edges has more open space and can hold more water. Groundwater is found in two zones. The unsaturated zone, immediately below the land surface, contains water and air in the open spaces, or pores. The saturated zone, a zone in which all the pores and rock fractures are filled with water, underlies the unsaturated zone. The top of the saturated zone is called the water table. The water table may be just below or hundreds of feet below the land surface.

Sources of Ground Water Contamination: - Ground water can become contaminated from natural sources or numerous types of human activities. Residential, municipal, commercial, industrial, and agricultural activities can all affect ground water quality. Contaminants may reach ground water from activities on the land surface, such as releases or spills from stored industrial wastes; from sources below the land surface but above the water table, such as septic systems or leaking underground petroleum storage systems; from structures beneath the water table, such as wells; or from contaminated recharge water.

1. Natural Sources: - Some substances found naturally in rocks or soils, such as iron, manganese, arsenic, chlorides, fluorides, sulfates, or radionuclides, can become dissolved in ground water. Other naturally occurring substances, such as decaying organic matter, can move in ground water as particles. Whether any of these substances appears in ground water depends on local conditions. Some substances may pose a health threat if consumed in excessive quantities; others may produce an undesirable odor, taste, or color. Ground water that contains unacceptable concentrations of these substances is not used for drinking water or other domestic water uses unless it is treated to remove these contaminants.

2. Septic Systems: - One of the main causes of ground water contamination in the United States is the effluent (out-flow) from septic tanks, cesspools, and privies. Approximately one-fourth of all homes in the United States rely on septic systems to dispose of their human wastes. Although each individual system releases a relatively small amount of waste into the ground, the large number and widespread use of these systems makes them a serious

contamination source. Septic systems that are improperly sited, designed, constructed, or maintained can contaminate ground water with bacteria, viruses, nitrates, detergents, oils, and chemicals. Along with these contaminants are the commercially available septic system cleaners containing synhetic organic chemicals. These cleaners can contaminate water supply wells and interfere with natural decomposition processes in septic systems. Most, if not all, state and local regulations require specific separation distances between septic systems and drinking water wells. In addition, computer models have been developed to calculate suitable distances and densities.

3. Improper Disposal of Hazardous Waste: - Hazardous waste should always be disposed of properly, that is to say, by a licensed hazardous waste handler or through municipal hazardous waste collection days. Many chemicals should not be disposed of in household septic systems, including oils (e.g., cooking, motor), lawn and garden chemicals, paints and paint thinners, disinfectants, medicines, photographic chemicals, and swimming pool chemicals. Similarly, many substances used in industrial processes should not be disposed of in drains at the workplace because they could contaminate a drinking water source. Companies should train employees in the proper use and disposal of all chemicals used on site. The many different types and the large quantities of chemicals used at industrial locations make proper disposal of wastes especially important for ground water protection.

4. Releases and Spills from Stored Chemicals and Petroleum Products: - Underground and aboveground storage tanks are commonly used to store petroleum products and other chemical substances. For example, many homes have underground heating oil tanks. Many businesses and municipal highway departments also store gasoline, diesel fuel, fuel oil, or chemicals in on-site tanks. Industries use storage tanks to hold chemicals used in industrial processes or to store hazardous wastes for pickup by a licensed hauler. Approximately 4 million underground storage tanks exist in the United States and, over the years, the contents of many of these tanks have leaked and spilled into the environment. If an underground storage tank develops a leak, which commonly occurs as the tank ages and corrodes, its contents can migrate through the soil and reach the ground water. Tanks that meet federal/state standards for new and upgraded systems are less likely to fail, but they are not fool proof. Abandoned underground tanks pose another problem because their location is often unknown. Aboveground storage tanks can also pose a threat to ground water if a spill or leak occurs and adequate barriers are not in place. Improper chemical storage, sloppy materials handling, and poor-quality containers can be major threats to ground water. Tanker trucks and train cars pose another chemical storage hazard. Each year, approximately 16,000 chemical spills occur from trucks, trains, and storage tanks, often when materials are being transferred. At the site of an accidental spill, the chemicals are often diluted with water and then washed into the soil, increasing the possibility of ground water contamination.

5. Landfills: - Solid waste is disposed of in thousands of municipal and industrial landfills throughout the country. Chemicals that should be disposed of in hazardous waste landfills sometimes end up in municipal landfills. In addition, the disposal of many household wastes is not regulated. Once in the landfill, chemicals can leach into the ground water by means of precipitation and surface runoff. New landfills are required to have clay or synthetic liners

and leachate (liquid from a landfill containing contaminants) collection systems to protect ground water. Most older landfills, however, do not have these safeguards. Older landfills were often sited over aquifers or close to surface waters and in permeable soils with shallow water tables, enhancing the potential for leachate to contaminate ground water. Closed landfills can continue to pose a ground water contamination threat if they are not capped with an impermeable material (such as clay) before closure to prevent the leaching of contaminants by precipitation.

6. Surface Impoundments: - Surface impoundments are relatively shallow ponds or lagoons used by industries and municipalities to store, treat, and dispose of liquid wastes. As many as 180,000 surface impoundments exist in the United States. Like landfills, new surface impoundment facilities are required to have liners, but even these liners sometimes leak.

7. Sewers and Other Pipelines: - Sewer pipes carrying wastes sometimes leak fluids into the surrounding soil and ground water. Sewage consists of organic matter, inorganic salts, heavy metals, bacteria, viruses, and nitrogen. Other pipelines carrying industrial chemicals and oil brine have also been known to leak, especially when the materials transported through the pipes are corrosive.

8. Pesticide and Fertilizer Use: - Millions of tons of fertilizers and pesticides (e.g., herbicides, insecticides, rodenticides, fungicides, avicides) are used annually in the United States for crop production. In addition to farmers, homeowners, businesses (e.g., golf courses), utilities, and municipalities use these chemicals. A number of these pesticides and fertilizers (some highly toxic) have entered and contaminated ground water following normal, registered use. Some pesticides remain in soil and water for many months to many years. Another potential source of ground water contamination is animal wastes that percolate into the ground from farm feedlots. Feedlots should be properly sited and wastes should be removed at regular intervals.

Between 1985 and 1992, EPA's Office of Pesticides and Toxic Substances and Office of Water conducted a National Pesticide Survey to determine the number of drinking water wells nationwide that contain pesticides and nitrates and the concentration of these substances. The survey also analyzed the factors associated with contamination of drinking water wells by pesticides and nitrates. The survey, which included samples from more than 1,300 public community and rural domestic water supply wells, found that approximately 3.6 percent of the wells contained concentrations of nitrates above the federal maximum contaminant level, and that over half of the wells contained nitrates above the survey's minimum reporting limit for nitrate (0.15 mg/L). The survey also reported that approximately 0.8 percent of the wells tested contained pesticides at levels higher than federal maximum contaminant levels or health advisory levels. Only 10 percent of the wells classified as rural were actually located on farms. There is a higher incidence of contamination by agricultural chemicals in farm wells used for drinking water. After further analysis, EPA estimated that for the wells that contain pesticides, a significant percentage probably contain chemical concentrations that exceed the federal health-based limits (e.g., maximum contaminant levels or health advisory levels). Approximately 14.6 percent of the wells tested contained levels of

one or more pesticides above the minimum reporting limit set in the survey. The most common pesticides found were atrazine and metabolites (breakdown products) of dimethyl tetrachloroterephthalate (DCPA, commonly known as Dacthal), which is used in many utilities easement weed-control programs and for lawn care.

9. Drainage Wells: - Drainage wells are used in wet areas to help drain water and transport it to deeper soils. These wells may contain agricultural chemicals and bacteria.

10. Injection Wells/Floor Drains: - Injection wells are used to collect storm water runoff, collect spilled liquids, dispose of wastewater, and dispose of industrial, commercial, and utility wastes. These wells are regulated by the U.S. EPA's Underground Injection Control Program. In New England, these wells may not be used to inject hazardous wastes from industrial, commercial, and utility operations. The injection wells used in this region are typically shallow and include sumps and dry wells used to handle storm water. Floor drains were historically used by businesses to handle spills. Today, if a business operates or handles waste fluids that drain to a septic system, dry well, or floor drain, it is required to submit information regarding its operation to the U.S. EPA or its state environmental protection agency. Disposal wells that pose threats to drinking water supplies are prohibited and must be closed, connected to a public sewage system, or connected to a storage tank.

11. Improperly Constructed Wells: - Problems associated with improperly constructed wells can result in ground water contamination when contaminated surface or ground water is introduced into the well.

12. Improperly Abandoned Wells: - These wells can act as a conduit through which contaminants can reach an aquifer if the well casing has been removed, as is often done, or if the casing is corroded. In addition, some people use abandoned wells to dispose of wastes such as used motor oil. These wells may reach into an aquifer that serves drinking supply wells. Abandoned exploratory wells (e.g., for gas, oil, or coal) or test hole wells are usually uncovered and are also a potential conduit for contaminants.

13. Active Drinking Water Supply Wells: - Poorly constructed wells can result in ground water contamination. Construction problems, such as faulty casings, inadequate covers, or lack of concrete pads, allow outside water and any accompanying contaminants to flow into the well. Sources of such contaminants can be surface runoff or wastes from farm animals or septic systems. Contaminated fill packed around a well can also degrade well water quality. Well construction problems are more likely to occur in older wells that were in place prior to the establishment of well construction standards and in domestic and livestock wells.

14. Poorly Constructed Irrigation Wells: - These wells can allow contaminants to enter ground water. Often pesticides and fertilizers are applied in the immediate vicinity of wells on agricultural land.

15. Mining Activities: - Active and abandoned mines can contribute to ground water contamination. Precipitation can leach soluble minerals from the mine wastes (known as spoils or tailings) into the ground water below. These wastes often contain metals, acid,

minerals, and sulfides. Abandoned mines are often used as wells and waste pits, sometimes simultaneously. In addition, mines are sometimes pumped to keep them dry; the pumping can cause an upward migration of contaminated ground water, which may be intercepted by a well.

Consequences of Groundwater Contamination: - Groundwater contamination can impact human health, environmental quality, and socioeconomic development. For example, many studies have shown that high levels of fluoride, nitrate, metals, and persistent organic pollutants are a health risk for human populations (Wu et al. 2020). This is especially critical for infants and children who are more susceptible to the effects of these contaminants than adults (He et al. 2020; Karunanidhi et al. 2020). For example, "blue baby syndrome," also known as infant methemoglobinemia, is caused by excessive nitrate concentrations in the drinking water used to make baby formulas. Human health also can be affected by the groundwater contamination through effects on the food production system. Irrigation with groundwater contaminated by heavy metals and wastewater containing persistent contaminants can result in the accumulation of toxic elements in cereals and vegetables, causing health risks to humans.

The consequences of contaminated ground water or degraded surface water are often serious. For example, estuaries that have been impacted by high nitrogen from ground water sources have lost critical shellfish habitats. In terms of water supply, in some instances, ground water contamination is so severe that the water supply must be abandoned as a source of drinking water. In other cases, the ground water can be cleaned up and used again, if the contamination is not too severe and if the municipality is willing to spend a good deal of money. Follow-up water quality monitoring is often required for many years.

Groundwater contamination also can negatively affect the quality of lands and forests. Contaminated groundwater can lead to soil contamination and degradation of land quality. For example, in many agricultural areas in arid regions, high groundwater salinity is one of the major factors influencing soil salinization (Wu et al. 2014). The soluble salts and other contaminants, such as toxic metals, can accumulate in the root zone, affecting vegetation growth. Groundwater contaminants also can be transported by surface water-groundwater interactions, leading to deterioration of surface water quality (Teng et al. 2018).

Sustainable economic development requires a balance between the rate of renewal of natural resources and human demand. Freshwater is probably the most valuable of the natural resources. However, chronic groundwater contamination may reduce the availability of freshwater, breaking the balance between water supply and demand and leading to socioeconomic crises and even wars. Water shortages induced by contamination may become a factor causing conflicts among citizens in the future (Schillinger et al. 2020), possibly delaying the socioeconomic development of a nation. Groundwater contamination is not only an environmental issue but also a social issue, demanding collaboration between both natural scientists and social scientists.

Arsenic contamination in Groundwater: - Arsenic contamination of groundwater in different parts of the world is an outcome of natural and/or anthropogenic sources, leading to adverse effects on human health and ecosystem. Millions of people from different countries are heavily dependent on groundwater containing elevated level of As for drinking purposes. As contamination of groundwater, poses a serious risk to human health. Excessive and prolonged exposure of inorganic as with drinking water is causing arsenicosis, a deteriorating and disabling disease characterized by skin lesions and pigmentation of the skin, patches on palm of the hands and soles of the feet. Arsenic poisoning culminates into potentially fatal diseases like skin and internal cancers.

In terrestrial environment, the inorganic forms of As (such as trivalent arsenite (AsIII) and pentavalent arsenate (AsV)) are more prevalent and toxic than the organic forms in general. As exerts detrimental effects on general protein metabolism with high toxicity by reacting with sulfhydryl groups existing in cysteine residues.

Toxicity of Arsenic: - For a detailed analysis of toxicology and wider aspects of the effects of As on human health, the reader is referred to the recent volume edited by States (2016). There is a common perception that inorganic AsIII is more toxic than inorganic AsV. Forhumans, the situation is more complex. Most inorganic arsenic ingested is excreted in urine as the mono- and di-methylated form, with minor amounts excreted unchanged (Thomas 2016; refs therein). For many years, methylation and excretion was viewed as a detoxification system. It is now recognised that these methylated forms are probably the more damaging forms of As in respect of human metabolism. Long-term ingestion of water containing more than the recommended amount of As can give rise to a variety of cancers e.g. of the skin, bladder, or kidneys, and diseases of the heart and lungs i.e. chronic As-poisoning. The display of symptoms lags ingestion by months to years, depending on the As concentrations in ingested foodand water. The ill-effects are, to some degree, specific to individuals, with anecdotal evidence that well-nourished individuals suffer less than those on poor diets. No certain cures are known for chronic As-poisoning (as opposed to the acute form; Hughes 2016); avoidance of As in drinking water and in food (e.g. in local rice grown with As-rich irrigated water) can be recommended, but practicalities of life amongst the rural poor often precludes such action. Such avoidance strategies appear to ameliorate skin conditions but do not appear to ameliorate the long-term risks of contracting cancer.

Mechanism of As-Pollution of Groundwater:

Anthropogenic Mechanisms: - Human activity can add As to groundwater. Amongst the many potential sources are leaching from ash deposited from the smoke-plumes of brick-kilns, leaching of residues of arsenical pesticides and herbicides that are applied to crops; leaching of arsenical tick-control solutions from ponds used for dipping livestock; release of As from soils by application of phosphate fertilizer which promotes competitive exchange of PO4 with As; the oxidation of gangue sulphides in mine-waste, in which rates of oxidation and weathering greatly exceed those that occur naturally in situ, and poor disposal practices at factories that manufacture As-pesticides.

In the areas under discussion, these human impacts are not significant contributors to As-pollution of groundwater, except for one instance of industrial pollution in Kolkata (formerly Calcutta) by arsenical waste-products from manufacture of Paris Green, an As-rich pesticide (Chatterjee et al. 1993). That apart, invocation of some of these mechanisms results from misunderstanding. For example, it is well documented that arsenical pesticides and herbicides accumulate in soils– they sorb to soil particles, especially the iron oxyhydroxide component. This is typically not a problem until phosphate fertiliser is applied to those soils, usually when a new type of crop is grown (e.g. rice after cotton). The PO4 in the fertiliser displaces much of the As that is sorbed on mineral surfaces and soil water becomes rich in As. The effect on crops can be devastating e.g. a rice-crop with straight head disease and no rice yield. This experience has been extrapolated, incorrectly, to suggest that, because As-polluted groundwater often contains 1–5 mg/L of PO4, the As has been put into solution by competitive exchange with PO4. In reality, because exchange is an equilibrium process, this amount of PO4 could not liberate more thana few μg/L of As and cannot be responsible for the occurrence of groundwater containing tens to hundreds of μg/L as is commonly seen in alluvial and deltaic aquifers (Ravenscroft et al. 2001; Kent and Fox 2004).

Migration of As-rich soil water downwards into aquifers is also unlikely to occur except in the most unusual of circumstances because sorption, dilution and dispersion, prevent it happening. As an end-member example, almost no migration of As away from a cattle-dip site was noted by Kimber et al. (2002), despite the soils of such sites being heavily polluted by As from its use as a tickicide at concentrations of around 1000 mg/L over many years.

Natural Mechanisms: - Arsenic finds its way into groundwater by five natural routes. These are:

1. From hydrothermal activity e.g. hot springs and geysers in volcanic areas(e.g. Yellowstone National Park, USA);

2. by oxidation of arsenic-bearing pyrite in fractured crystalline rocks and, rarely, in sediments;

3. By desorption from mineral surfaces in response to rising pH to values much above 8, the rise being driven by processes unconnected to As;

4. By microbially-mediated reductive dissolution of sedimentary iron oxyhydroxides, which strongly sorb As and PO4 and liberate both to solution when destroyed; and

5. Evaporative concentration.

Reduction of iron oxyhydroxides occurs only in anoxic groundwater lacking both dissolved oxygen and dissolved nitrate i.e. anoxic groundwater (Gulens et al. 1979; Nickson et al. 2000). Anoxia tends to occur in stagnant or slowly moving ground-water. Such groundwater is found in low-lying, flat terrain – deltas and the alluvial plains of large rivers. Release of As to groundwater is accompanied by release of Fe, and usually by release of PO4, which also strongly sorbs to sedimentary iron oxides. In groundwater where reductive dissolution occurs, positive relationships are usually seen between As, Fe and PO4, although they are often

weak. The reason they are often weak is that during and after dissolution of sedimentary iron oxides, several secondary processes differentially affect As, Fe and PO4, thereby degrading the strong positive relationships that would otherwise be seen. In the early stages of reduction, the liberated As will resort to unreacted Fe-oxyhydroxides, as demonstrated by modelling (Welch et al. 2000) and visualised by McArthur et al. (2004). In anoxic groundwater, reduction of SO4 can generate H2S, which reacts with dissolved Fe and As (and undissolved Fe-oxides) to form, ultimately, pyrite containing hundreds to thousands of ppm of As, so removing both Fe and As from ground water in a ratio different from that in groundwater (Kresse and Fazio 2003; Kirk et al.2004). Formation of mixed-valence hydroxycarbonates (brown and green rusts) may remove Fe alone, whilst Fe and PO4, but not appreciable As, may be removed into vivianite, an hydrated FeII-phosphate. Arsenic may be found in concentrations of several hundred ppm in siderite (Mumford et al. 2012) but is not clear that the phase was pure and did not contain admixed Fe-oxyhydroxides, so its role in sequestering As in the study areas has yet to be defined. Finally, both Fe and As may be removed by sorption onto freshly precipitated Fe-oxyhydroxides as a result of anoxic oxidation of Fe (II) by NO3 (Smith et al. 2017).

Regions affected by arsenic contamination in India: - The various sources of arsenic that contaminate water across the subcontinent affect the lives of millions of people directly and indirectly. India is badly affected by consumption of groundwater contaminated by arsenic. In response to a question in parliament, the Government of India acknowledged that 1.47 crore (14.7 million) people are at the frontlines of arsenic contamination of potable water across 16,889 areas (Hindustan times, 2019). As per information entered by different States of India in the Integrated Management Information System (IMIS) of this Ministry as on 31.03.2019, there are 60,365 habitations affected by various chemical contaminants. Numbers of habitations affected by different chemical contaminants are given below in Table 1 (Jalshkti, 2019).

Table: Numbers of habitations affected by different chemical contaminants

Fluoride	Iron	Arsenic	Salinity	Nitrate	Heavy Metals
9,001	15,813	18,600	1,446	2,162	60,365

Source: - Tiwari et al., 2021

The first incidences of detection of As in groundwater in India can be traced back to the Bengal region in the last two-three decades of concluded millennia. Bengal Basin, which is formed by the delta of Ganga-Brahmputra rivers, is the hotbed of the As contamination of potable water. The reason for this has been attributed to the large volumes of the arsenic rich sediments brought down by these rivers during the Pleistocene and Holocene periods. Within India west Bengal has 78 blocks in 9 districts with arsenic permissible limit of 0.05mg/lt. One of the flashiest areas of concern is the eastern side of Bhagirati river in Malda. Also the regions of north and south of Parganas are greatly affected. Some of the western side of Hooghly and Howrah are arsenic contaminated. Mainly arsenic is evident up to the depth of 80m. The deeper you go the lesser is water affected by arsenic. Arsenic has also been detected in the state of Uttar Pradesh, Bihar, Assam, Chhattisgarh, Jharkhand and Karnataka.

In Bihar, West Bengal and Uttar Pradesh mostly it is seen in alluvial soil while in Chhattisgarh the arsenic contamination is mostly visible in volcanic rocks (Jalshkti, 2019).

Health Effect of Arsenic Contamination in India: - Arsenic is very fatal cancerous and harmful contaminant of drinking water. It occurs in both organic and inorganic forms. Organic As is less dangerous while inorganic As is very much harmful as well as carcinogenic. This has been extensively emphasized in very well-known studies. Studies prove that it actually affects the gene proliferation process. It also deforms the signal transduction pathway. It also damages the cell repairing, cycling and differentiating power of the DNA. Some of the transduction process that it hinders are protein 53 signaling thoroughfare, Nrf2- mediated thoroughfare, MAPK thoroughfare. Not only carcinogenic but it causes other diseases like dermal, cardiovascular, hypertension. Sometimes it also causes diabetes. When the concentration increases to 0.05 mg/kg/day or more than this, then it stems many digestive system issues like stomach ache, vomiting etc. It is so much harmful in this case that it may lead to even death and coma. Continuous poisoning for 6 months with arsenic causes lung disease, skin lesion and hyperpigmentation. It was 2011 that USEPA changed the 50mg/lt. old standard to 10mg/l while India still uses the same old standard. After many years of this still we could witness the skin lesions. Arsenic contamination is also transmitted through rice which is grown in Bengal basin is also a matter of debate.

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UNIT: - 11

Ground water contamination: Fluoride

Introduction: - Water is a resource that is required for all life, including human life. In 2010, the UN General Assembly explicitly recognized the human right to water and sanitation. For water to be useful for drinking and irrigation, it must not be polluted beyond certain thresholds. According to the World Health Organization, 2 billion people lived in water-stressed communities without safely managed drinking-water services in 2020. At the same time, over 1.7 billion people still did not have basic sanitation services, which is defined as having access to a public sewage system, septic tank, or even a simple pit latrine. Each year approximately 1.7 million people die from diarrheal diseases associated with unsafe drinking water, inadequate sanitation, and poor hygiene. Almost all of these deaths are in developing countries, and around 90% of them occur among children under the age of 5. Compounding the water crisis is the issue of social justice; poor people more commonly lack clean water and sanitation than wealthy people in similar areas. Globally, improving water safety, sanitation, and hygiene could prevent up to 9% of all disease and 6% of all deaths.

Groundwater contamination (also called groundwater pollution) occurs when pollutants are released to the ground and make their way down into groundwater. This type of water pollution can also occur naturally due to the presence of a minor and unwanted constituent, contaminant, or impurity in the groundwater, in which case it is more likely referred to as contamination rather than pollution.

How Does Groundwater Become Contaminated? - Water pollution is the contamination of water by an excess amount of a substance that can cause harm to human beings and/or the ecosystem. The level of water pollution depends on the abundance of the pollutant, the ecological impact of the pollutant, and the use of the water. Pollutants are derived from biological, chemical, or physical processes. Although natural processes such as volcanic eruptions or evaporation sometimes can cause water pollution, most pollution is derived from human, land-based activities. Water pollutants can move through different water reservoirs as the water carrying them progresses through stages of the water cycle. Pollutants enter water supplies from point sources, which are readily identifiable and relatively small locations, or nonpoint sources, which are large and more diffuse areas. Point sources of pollution include animal factory farms that raise a large number and high density of livestock such as cows, pigs, and chickens. Also included are pipes from factories or sewage treatment plants. Combined sewer systems that have a single set of underground pipes to collect both sewage and storm water runoff from streets for wastewater treatment can be major point sources of pollutants. During heavy rain, storm water runoff may exceed sewer capacity, causing it to back up and spilling untreated sewage directly into surface waters.

The Concept of Groundwater Quality: - In the past, aquifer water level was the main quantitative factor that determined the level of groundwater exploitation. The growth of studies about aquifer behavior, the threat or the reality of contamination episodes in most groundwater masses, and concern that groundwater resource shows a very long renewal time,

have led, in recent decades, to the concept of groundwater quality assuming the same importance as quantity, and the need to preserve them both in an integrated management system. Quality aspects usually decide whether groundwater is suitable for a definite use or, if it is necessary to treat the water or dilute with other water from other sources. In the case of a natural aquifer, without anthropogenic influence, the natural composition of the groundwater depends basically on the following factors:

- The geological characteristics of the aquifer,
- The speed of circulation across the aquifer,
- The initial composition of infiltration water,
- Mixing with other waters, and
- The movement rules of the transported substances in aqueous media, as well as the hydrodynamic factors.

In most cases, this natural quality has been permanently changed by anthropic actions like over-abstraction, industrial spills, modifications in the recharge water quality, with no or only very long-term possibility of remediation. In such cases, the term initial concentration, to define the actual quality state of the aquifers, could be more appropriate than the natural one.

Fluoride contamination in Groundwater: - Fluoride is an ion of the chemical element fluorine which belongs to the halogen group. Fluoride has a significant mitigating effect against dental caries if the concentration is approximately 1 mg/l. However, continuing consumption of higher concentrations can cause dental fluorosis and in extreme cases even skeletal fluorosis. High fluoride concentrations are especially critical in developing countries, largely because of lack of suitable infrastructure for treatment (http://www.wateraid.org). Groundwater fluoride contamination has gained the wide attention of researchers in the recent era due to its toxicity, persistent nature, and bioaccumulation. Several pathways input fluoride into water and its enhancing concentration makes water unfit and undesirable for drinking purposes. The availability of fluoride in groundwater is due to fluoride-bearing aquifers, geological factors, ion exchange reaction, and rate of weathering and leaching of subsurface contaminants.

Source of Fluoride in the Environment: - The fluoride-containing minerals and rocks naturally introduce fluoride and are also considered the largest fluoride reserve.

A. Natural Sources:

1. Rocks and Minerals: - One of the most abundant trace elements present in the Earth's crust is fluoride, having 625mg/kg average concentration in different kinds of rock (Edmunds and Smedley 2005). The rocks containing fluoride-rich minerals are the largest fluoride reserve. According to some studies, the highest fluoride concentrations are combined with quartz, felsic, gneisses, syenites, granites, and alkaline volcanic (Robinson Jr and Kapo 2003; Ozsvath, 2006). Rocks found in the Coimbatore district of Tamil Nadu contain 180–2600mg/kg fluoride. Among various fluoride-rich minerals, some of them are fluorite (CaF2), micas, amphiboles, villiaumite (NaF), and topaz (Al2[SiO4]F2). These chemicals are abundantly found minerals in sediments and rocks (Saxena and Ahmed 2003).

2. Groundwater: - There are several factors affecting the fluoride presence like granite, gneissic rocks, and volcanic as well as mountainous area sediments of marine origin. The above-mentioned rocks are rich in fluoride and are often found beneath the Earth's surface, ultimately leading to groundwater contamination. Alarming high fluoride ion concentrations together with various other toxic and infectious substances present in the groundwater of South and Southeastern Asia are of utmost concern (Ghosh et al. 2013).

B. Anthropogenic Sources: - In many developing countries as well as developed countries, the fluoride concentration present in the environment has been majorly altered by industrial discharge. The main sources of fluoride input into the environment via anthropogenic activities are the aluminum and zinc industry, coal-burning, brick/clay burning, steel production, oil refining, chemical production, uranium trifluoride, magnesium smelting, ceramic glass and uranium hexafluoride production, enamel manufacturing, and fluoride-containing fertilizers or pesticide industries (Sujatha, 2003). Discharge from industries heavily pollutes the soil and water, as well as vegetation cover around the industry and far away from it. Other than industrial emissions, agriculture runoffs having fluoride-containing fumigants, fertilizers, and pesticides are some of the other predominant causes of fluoride pollution (Kundu and Mandal, 2009). Industries involving coal burning pollute the atmosphere in a small area, and the extent of the pollution depends on the origin and type of coal. It has been estimated that burning of biomass releases 76Gg fluoride into the air annually (Jayarathne et al. 2014).

Effects of Fluoride on Human Health: - The effect of fluoride contamination on human health has been studied by researchers from all over the world for more than a century. Fluoride causes both good and bad effects on the human body depending on the level of exposure. According to the study of Ozsvath (2009), ingestion of a moderate amount of fluoride can actively decrease the risk of occurrence of dental caries as well as promote the growth of strong bones under certain conditions. Chronic exposure to fluoride can cause various ill effects on human health such as dental fluorosis and skeletal fluorosis; it can also increase the rate of urolithiasis, and decrease natality and IQ level of children. In some cases, chronic exposure might also lead to a number of defects such as genetic mutations, birth defects, and Alzheimer's disease; the scientific data at present are inconclusive (Ozsvath, 2009). According to the World Health Organization (WHO), the maximum intake of fluoride in drinking water is recommended as 1.5mg/L. Among various other adverse health impacts on the body, fluorosis remains the major problem in affected populations and is categorized as dental fluorosis and skeletal fluorosis.

1. Dental Fluorosis: - Dental fluorosis is a developmental disturbance of tooth enamel or tooth surface that occurs due to systemic overexposure of fluoride during enamel formation (Kanduti et al. 2016). During the first six years of life, the development of enamel occurs over the tooth and increased mineralization is accompanied by reduction of matrix protein. Exposure to fluoride causes dose relationship disruption in the process of amelogenesis and dentinogenesis that ultimately results in deformity in the crystalline structure of teeth (Swarup and Dwivedi, 2002). Dental fluorosis is characterized by yellow to brownish mottling of enamel with narrow white horizontal striations. The dental fluorosis severity

depends upon the degree of exposure of fluoride on humans. In India, 70% of adolescents consuming fluoride-contaminated drinking water with more than the recommended value of the World Health Organization are affected by dental fluorosis (Chaudhry et al. 2017). Enamel opacities also occur due to malnutrition and deficiency of Vitamin A and D as well as due to low protein-energy intake. Therefore, fluoride is not the only cause of dental enamel defects (Zohoori and Duckworth 2017).

2. Skeletal Fluorosis: - Skeletal fluorosis is a somewhat more severe adverse health impact, characterized by increased bone mass and bone density (osteosclerosis) that occurs due to a prolonged period of exposure to fluoride at the time of bone modeling and/or remodeling. Fluoride exposure of more than 4mg/L concentration may lead to skeletal fluorosis; the exposure may be either direct (ingestion) or indirect (inhalation) (Yadav et al. 2019). Skeletal fluorosis occurs in three stages: initial, intermediate, and final:

i. The initial stage – The initial stage shows various mild symptoms like joint pain, stiffness of bones and joints, muscle weakness, periodic pain, and chronic fatigue.

ii. The intermediate stage – The intermediate stage is characterized by calcification of bone followed by hardening and stiffening of joints as well as calcification of ligaments in the body. Patients may develop a "Poker back" situation in severe cases of skeletal fluorosis. Poker back- a condition in which the whole spine becomes a fixed column due to increasing bone stiffness.

iii. The final stage (crippling skeletal fluorosis) – In this stage, joint movements become very limited and skeletal bone deformities, acute calcification of ligaments, muscle wasting, and neurological defects can be seen in patients (Itai et al. 2010).

According to some literature, it has been revealed that maximum ingestion fluoride ions can cause other health effects such as headache, deformities in red blood cells, rash over skin, gastrointestinal problems, depression, low haemoglobin levels, nausea, pain in abdomen, fingers and toes with tingling sensations, and reduced immunity, as well as neurological manifestations which are quite similar to pathological changes occurring in patients with Alzheimer's. These effects of fluoride have received less attention in comparison to the dental and skeletal fluorosis typical of high fluoride-contaminated areas (Thole 2013).

3. Other effects: - Other health disorders that occur due to consumption of high fluoride in drinking water to be muscle fibre degeneration, low haemoglobin levels, deformities in RBCs, excessive thirst, headache, skin rashes, nervousness, neurological manifestations, depression, gastrointestinal problems, urinary tract malfunctioning, nausea, abdominal pain, tingling sensation in fingers and toes, reduced immunity, repeated abortions or still births, male sterility, etc (Meenakshi and Maheshwari, 2006). As fluoride is excreted in urine through the kidneys, they affect the effective functioning of the kidneys. They facilitate in the formation of kidney stones. Li et al. (1988) reported that fluoride might have genotoxical effects. Several studies also reported these effects on humans and animals. Consumption of drinking water with high fluoride by children may affect their intelligence. Tang et al. (2008) who studied this phenomenon however could not come out with a mechanism by which the

IQ of children is lowered. Guan et al. (1999) suggested that when phospholipids and ubiquinone contents gets altered in the brain of rats affected by chronic fluorosis, changes in their membrane lipids may be the cause of this problem. Several other studies carried also comply with this fact (Ge et al., 2010). The presence of excessive fluoride in groundwater has its impact not only on humans but also on soil fertility and plant and animal growth.

Fluoride contamination in India: - Of the 85 million tons of fluor ide deposits on the earth's crust, 12 million are found in India (Teotia and Teotia, 1994). Hence it is natural that fluoride contamination is widespread, intensive and alarming in India. Endemic fluorosis is prevalent in India since 1937 (Shortt et al., 1937). It has been estimated that the total population consuming drinking water containing elevated levels of fluoride is over 66 million (FRRDF, 1999). Different parts of India where elevated concentration fluoride in groundwater as reported in literature are shown in Figure 3 and adetailed list of concentration of fluoride in ground water and their sources in different places are given in Table 1.

Table: 1 - Concentration of fluoride in groundwater in India and its sources based on literature

State, district/place (in alphabetical order)	Source	General range of fluoride concentration in groundwater
Andhra Pradesh, Kurmapalli watershed	Fluoride rich rocks	Up to 21.0 mg/l
Andhra Pradesh, Nalgonda	Fluoride rich granite rocks	0.4 to 20 mg/1
Andhra Pradesh, part of Nalgonda district	Fluoride rich granitic rocks	0.1 to 8.8 mg/l
Andhra Pradesh, Visakhapatnam	Granitic rocks	0.6 to 2.1 mg/l
Andhra Pradhesh and Jharkhand	Coal ash	0.1 to >4 mg/l
Assam, Guwahati	Granite	0.18 to 6.88 mg/l
Delhi	Irrigation water and brick industries	0.1-16.5 mg/l
Gujarat, Mehsana	Granite, gneiss and pegmatite	0.94 to 2.81 mg/l
Gujarat, Mehsana	Calcite and dissolution of dolomite	1.5 to 5.6 mg /l
Haryana, Bhiwani	Rock	0.14 to 86 mg/l
Karnataka, Bellary	Apatite, hornblende and biotite	0.33 to 7.8 mg/l
Keral, Palghat	Hornblende and biotitegneiss	0.2 to 5.75 mg/l
Maharashtra, Yavatmal	Amphibole, biotite and fluoroapatite	0.30 to 13.41mg/l
Rajasthan, Hanumangarh	Fluoride bearing host rocks	1.01 to 4.42 mg/l
Tamil Nadu, Erode	Host rocks and weathering of fluorite	0.5 and 8.2 mg/l
West Bengal, Hooghly	Super phosphate fertilizer	0.01to 1.18 mg/l

Source: - Brindha, K., & Elango, 2011

Some regions in north western and southern India are heavily affected with fluorosis (Agarwal et al., 1997; Yadav et al., 1999). About 50% of the groundwater in Delhi exceeds the maximum permissible limit for fluoride in drinking water (Datta et al., 1996). Jacks et al. (2005) observed that high fluoride in groundwater in many parts of India was due to evapotranspiration of groundwater with residual alkalinity. Fluoride content was higher in deeper aquifers of Maharashtra (Madhnure et al., 2007) which was due to long residence time than shallow groundwater.

The rocks in southern India are rich with fluoride which forms the major reason for fluoride contamination in groundwater. It is a well-established fact that groundwater in Nalgonda district, Andhra Pradesh, has high fluoride due to the inherent fluoride rich granitic rocks. The granitic rocks in Nalgonda district contain fluoride from 325 to 3200 mg/kg with a mean of 1440 mg/kg. The mean fluoride content in Hyderabad granites is 910 mg/. The Nalgonda granties contain much higher fluoride than the world average fluoride concentration of 810 mg/kg. In Kurmapalli watershed, rocks are enriched in fluoride from 460 to 1706 mg/kg (Mondal et al., 2009). Calcretes act as a sink for fluoride. Co-precipitation and/or adsorption of fluoride by calcrete deposits in Wailapalli watershed had resulted in high fluoride in groundwater.

Brindha et al. (2011) found that when groundwater fluctuation was within 4.5 m belowground level, fluoride concentration was high when the water level was low and the fluoride concentration decreases with the rise in water table. This was due to direct evaporation of groundwater from these wells. If groundwater fluctuation was beyond 4.5 m below ground level the concentration of fluoride measured in groundwater after the monsoonal rains were higher than the preceding months. This was because evaporation resulted in the precipitation of fluoride rich salts on the soil which reached the groundwater along with percolating rainwater. The fluoride rich rocks form the main source for high fluoride groundwater in India. Also, agriculture is intensively practiced in most parts of India. Hence it is possible that the fertilisers also add upto the sources of fluoride contamination in groundwater. Thus, treatment of groundwater especially for fluoride before using it for drinking purpose is very essential in India.

Mitigation Measures: - Everybody needs clean water. When high fluoride in the drinking water source has been identified, it is better to avoid that source and look for other sources. But this is not a long-lasting solution. In-situ and ex-situ methods are available to treat groundwater with high fluoride and bring it to the usable form.

1. In-situ treatment methods: - In-situ method aims at directly diluting the concentration of fluoride (in groundwater) in the aquifer. This can be achieved by artificial recharge. Construction of check dams in Anantapur district, India has helped widely to reduce fluor ide concentration in groundwater (Bhagavan and Raghu, 2005). Rainfall recharge also called as rainwater harvesting can be adopted using percolation tanks and recharge pits which may prove helpful. Recharge of rainwater after filtration through the existing wells can also be planned to improve the groundwater quality.

2. Ex-situ treatment methods: - Numerous ex-situ methods are available for de fluoridation of water either at household or community level. Adsorption method involves the passage of water through a contact bed where fluoride is adsorbed on the matrix. Activated charcoal and activated alumina are the widely used adsorbents (Chidambaram et al., 2003). Brick, bone char, fly ash, serpentine, red mud, waste mud, rice husk, kaolinite, bentonite, charfines, ceramic etc. are some of the other absorbents capable of effectively removing fluoride from groundwater (Srimurali et al.). The effective removal of fluoride by these absorbents depends on the initial concentration of fluoride, pH, contact time, type of absorbent and its size.

In ion exchange process, when water passes through a column containing ion exchange resin, the fluoride ions replace calcium ions in the resin. Once the resin is saturated with fluoride ions, it is backwashed with solution containing chloride such as sodium chloride. The chloride ions thus again replace the fluoride ions in the resin and is ready for reuse. But the backwash is rich in fluoride and hence care should be taken in disposing this solution. Similarly in precipitation methods, the disposal of sludge with concentrated fluoride is a great problem. Precipitation involves addition of chemicals such as calcium which results in the precipitation of fluoride as fluorite. Aluminum salts are also used for this process. Nalgonda technique which is a well-known technique uses alum, lime and bleaching powder followed by rapid mixing, flocculation, sedimentation and filtration. This was developed in India by National Environmental Engineering Research Institute to serve at community and household levels. The resulting sludge from this process contains high amount of aluminium and fluoride, the disposal of which is yet another problem. These above-mentioned ex-situ methods are simple and cost effective.

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UNIT: - 12

Noise pollution

Introduction: - With the fast development of the world, particularly with developing counties urbanization has become quite phenomenon. Added to it, growth in the GDP with urban areas has become relatively high compared to rural areas. Migrations have grown in multiple folds to urban and semi-urban towns and cities overcrowding them in recent few years. Consequently, the vehicular traffic, both goods and passenger has become unmanageable as there is no proportional widening of roads or alternative modern systems. With people looking for personal comforts and giving top priority for status, started looking at personal transportation needs instead of much desired public transportation. This has further aggravated the urban traffic congestion problems touching the new peaks. The change in attitude of the people and the challenging needs of the traffic congestions, several new and innovative type of horns have found to play a significant role creating nuisance, in the name of "noise pollution". It has different type of impacts on different type of people working on different jobs and professions.

It is obvious that noise affects human health. Resistance to noise is different among people of different age and sex. A survey shows that 84% of people report effect on hearing in which 83% are from male group and 81% are from female group. 90% of people suffer from sleep disturbance in which 96% are from female group and 85% are from male group. It is found that majority of male population feels the adverse effect of noise on hearing, efficiency, inter personal communication. But in other parameters like (annoyance, disturbances in sleep) the female population feels the higher impact than the male population. However, in terms of deafness there is no marked difference between male and female groups, survey on noise pollution (Mishra et al., 2009).

The Concept of Noise:

Sound versus Noise: - Have you ever imagined, how we, human being hear sound from various sources such as voice, violin media, player? Basically, all these sources produce vibrations in form of sound waves, which causes pressure variations, that on reaching the ear causes the sensation of hearing through nerves and thus, the sound produced is heard by our sensory organ, ear. Sound is form of energy which the human ear can detect. Some of sounds produced by vibrating bodies can be heard which other cannot be heard. Those, which can be heard by Human ear is called audible. Physically there is no distinction between sound and noise. Noise is derived from the Latin word “nausea” implying ‘unwanted sound’ or ‘sound that is loud, unpleasant or unexpected’. In fact, any unwanted noise arising in the environment, which has adverse effects on the health of the organism, is noise pollution. It is a type of energy pollution which have distracting, irritating, or damaging effects on wellbeing of human and other wildlife. The contaminants of noise pollution are not physical particles, but rather waves that interfere with naturally-occurring waves of a similar type in the same environment. The noise as pollution has often been neglected as the effects of noise are not lethal. Although, Environmental Pollution Act in 1986 have defined “noise” an important

environmental pollution. Much before this, most of acts and laws associated with occupational health or factories/industries have identified noise as nuisance and harmful to human beings.

A noise problem generally consists of three inter-related elements- the source, the transmission path and the receiver. The source can be one or any number of mechanical devices that radiate noise or vibratory energy such as appliances or machines. The transmission path is the way by which noise travels between the source and the receiver. The path is usually the atmosphere through which the sound is propagated, but can include the structural materials of any building containing the receiver. Depending on this, noises can be classified as airborne noise or structure borne noise. Noise can travel from one point to another via any one path or a combination of several paths. The receiver can be a single person/worker or a group of people.

Sources of Noise Pollution: - Noise pollution is classified into two major categories depending on source of origin and human interventions: 1) Natural 2) Anthropogenic Sources.

A. Natural Sources: - Although Nature itself is not considered to be a creator of noise pollution, however living organisms such as insects, birds, animals can create excessive noise which causes negative reactions in people and animals in that environment. The chirping of rickets, Cicada and other bugs are examples of insects that can create a lot of noise. Birds and animals usually chirp, moo, bark, squeal, squawk, quack and wail. The individual form of these natural source of noises is not harmful, however when these natural noises are combined together, then it can affect the other severely. Natural calamities such as thundering and lightening of clouds, strong winds and storms can block out all other noise and affect the people mentally and psychologically.

B. Anthropogenic Sources: - All the manmade activities which produces noise are termed as Anthropogenic sources of noise pollution. The broad categories of anthropogenic sources are Transportation (Road traffic, Railways, Aircraft, Vessels), Industries, Construction activities, Commercial places, Social Events, Public address system etc. Let us understand each one of these in more elaborate way.

1. Transportation systems: - The most important modes of transportation are Road traffic, Railways and Aircraft. The marine ships and vessels are often neglected, yet important source of noise. However, amongst all, the road traffic noise is probably the most widespread and invasive cause of environmental pollution as the extent of population exposed to road traffic far exceeds than that of rail and aircraft sources combined. Let us understand each of transport sources one by one.

i. Road traffic noise is a function of traffic volume, composition, speed, road characteristics (surface and gradient). More specifically, it is a combination of noise resulting from the propulsion system of a vehicle (engine noise) and noise due to the interaction between the tyres of the vehicle and the road surface (tyre/road noise or rolling noise). The speed of vehicle also influences the contribution of each source mechanism, such as at low speeds,

engine noise dominates, while at higher speeds, tyre/road noise dominates. The speed at which rolling noise begins to dominate over engine noise is call the crossover speed. Heavy vehicles have a higher crossover speed compared to light vehicles, while electric vehicles (with minimal engine noise) have a very low crossover speed. The knowledge of crossover speed can help determine the most appropriate type of noise mitigation measure for a particular scenario. For example, a low-noise road surface (which reduces rolling noise) would have little impact in an area where engine noise is dominant. The impact of road traffic noise on the community depends on various factors such as road location and design, land use planning measures, building design, vehicle standards and even on driving style of the driver.

ii. Railway noise is generated by a number of different sources such as propulsion systems (engine noise) or, the vibration of the wheels and rails generated by their rolling contact (rolling noise). Like road traffic noise, the source mechanism is dependent on the speed of the train. Aerodynamic noise becomes a significant source in the case of high-speed trains. The other transient noise impacts includes at starting and stopping points and crossings, wheel or flange squeal on curves, braking and audible warning devices.

iii. Aircraft noise can be divided intwo major sources:air noise and ground noise. Air noise from aircraft depends on elements such as engine thrust, elevation or atmospheric conditions.Ground noise are the noise generated during operation of airport infrastructure, or airport-related infrastructure other than aircraft which are either in flight, taking off or landing. Ground noise can be a significant issue for people living or working close to both the airport and the surface access routes. Aircraft noise affects a much smaller proportion of the population comparedto road and traffic noise.

2. Industrial noise: - The four main categories of industrial activity, which cause noise pollution are product fabrication, product assembly, power generation and processing of product. Examples for noise emitting industries are steel making plants, coal fired power stations, car assembly plants, furniture making workshops, train depots or the loading and unloading of trucks at a distribution centre. Mineral extraction sites also are intense area of noise pollution. Industrial noise can vary from one site to the next and, in practice, each source onsite must be measured to obtain the noise emission value required to produce an accurate noise impact assessment. Industrial area mostly produces intermittent and impulsive noise, and sometimes generate audible tones and low-frequency noise also. The industrial workers are most affected people than those of people living near to industrial area as they face more noise intensity and that too, for longer period of exposure.

3. Construction noise: - The characteristics of construction varies with respect to its activities such as demolition, excavation works and highly impulsive piling works. The impact of construction noise on the local community depends upon the location of the site, hours of operation, the existing/background ambient levels in the area and of course and the characteristics of the noise itself. The movements of heavy vehicles, breaking up concrete, cutting steel, ground excavation, drilling, pumping, welding, etc. are few other sources of noise associated with a construction site.

4. Household Sources: - Domestic gadgets like the mixer-grinders, pressure cookers, desert coolers, air- conditioners, exhaust fans, vacuum cleaners, sewing and washing machines and dryer are all indoor household sources of noise pollution. The entertainment equipment such as radio, record-players, television and loud speakers of sound systems are other most common sources of noise.

5. Commercial places: - Open markets, shopping malls, Offices and other commercial buildings having Generator set, air conditioning systems, parking areas together all create a combined noise pollution.

6. Social Events: - Public Address System being used in anyevent such as a religious function, birth, death, marriage, elections, demonstration, or commercial advertising is inevitable source of noise pollution. Indoor functions such as Discotheque, loud music, DJ and open air theatersetc are few other sources of noise.

7. Defence Equipment: - Artillery, tanks, launch of rockets, explosions, exercise of military airplanes and shooting practices other high impact sources of noise. Such noises, in extreme cases, have been known to shatter the window panes and old dilapidated buildings. In addition to above, there could be numerous sources for noise pollution, which affect the wellbeing of an individual.

Impacts of Noise Pollution: - The impact of noise on surrounding community varies with respect to many factors. Such as,

i. firstly, the characteristics of noise sources (instantaneous, intermittent, or continuous in nature). The steady noise is not as annoying as one that is continuously varying in loudness.

ii. secondly, the time of day at which noise occurs, for example, high noise levels at night in residential areas are not acceptable because of sleep disturbance.

iii. thirdly, the location of the noise source, with respect to noise-sensitive area particularly the loudness and period of exposure.

The overall impact on health due to high noise may be broadly classified into auditory effects and non-auditory effects. Auditory effects include hearing impairment resulting from excessive noise exposure such as those related to occupational noise exposure. The non-auditory effects include stress, related physiological and behavioural effects, and safety concerns.

A. Auditory /Hearing Effects: - Constant exposure to loud levels of noise result in the damage of ear drums and loss of hearing. It also reduces sensitivity to sounds that ears pick up unconsciously to regulate body's rhythm. The major effects of noise exposure on hearing can be summarized as following condition:

i. Acoustic trauma -an immediate and permanent effect due to sudden and acute exposure of loud noise such as an explosion.

ii. Tinnitus: ringing or buzzing in the ear due to noise.

iii. Temporary hearing loss (or temporary shift) in hearing threshold level is an immediate effect after an acute exposure of high noise that could be reverted in case affected person spends time in a quiet place, and complete recovery may take several hours.

iv. Permanent hearing loss (or permanent shift) of hearing threshold level is a permanent effect caused by chronic exposure, which continues for longer period year after year. Such noise-induced hearing damage cannot be cured by medical treatment and worsens with continued noise exposure.

Noise-induced hearing loss (NIHL) is a type of sensorineural hearing loss which is related to both the level of noise as well as exposure time. This condition become severe, if the affected person also suffers from age induced hearing loss. The noise exposure damages the hair cells of the cochlea in the inner ear. In general, the amount of noise required to cause permanent damage from chronic exposure is equivalent to 10 years or more at a level of 85 dB for more than 8 hours a day.

B. **Non-auditory health Effects: -** The non-auditory health impacts of noise pollution include many physical/physiological, psychological and psychiatric disorders. Some of these conditions are described below:

i. Sleeping Disorders: - Sleep is a physiological mind state and needs its integrality to allow for recuperation of the organism. Noise oftens interrupt sleep and it causes both primary and secondary sleep disturbances. The primary effects include difficulty in falling asleep, differences of sleep patterns, and awakenings. Secondary effects include interrupted sleep due to fatigue, decreased well-being and performance. Further, the noise exposure during sleep is accompanied by several physiological effects such as an increase in high blood pressure, finger pulse amplitude and heart rate. These abnormal cardiac rhythms, changes in breathing patterns, and increased body movements affect period of time when the body is attempting to rest and restore itself. The sleep can be disturbed by a continuous noise greater than 30 dB or an intermittent noise that increases the amounts of awakenings per night.

ii. Cardiovascular Disturbances: - The high noise is associated with cardiovascular disturbances, such as elevated blood pressure, heart rate, and peripheral resistance by the release of hormones such as norepinephrine, epinephrine, and cortisol with chronic daily levels of noise greater than 65 dB or acute exposure to levels above 80 to 85 db. Epidemiological investigations have shown the direct connection between vehicular traffic and/or aircraft noise and cardiovascular effects on adults and children.

iii. Endocrine Response: Aggression, Depression, Migraines: - The exposure to high sound pressure levels increases the level of hormones and neurotransmitters such as adrenaline, cortisol and noradrenaline hormones in body. These hormones are associated with depression and aggression. Increased availability of norepinephrine in the brain could generate impulsive and/or aggressive responses. Many antidepressant drugs (those for treatment of depression/migraines) usually act on the production or reuptake of norepinephrine or serotonin. The deficit of serotonins associated with depression, anxiety, eating disorders, pain, aggressive behaviour and migraines also. The interferences between

neurotransmission and neuroregulation could cause behavioural disorders as well. Studies have demonstrated that depression is associated with an increased risk of progression among people with episodic migraineto chronic migraine. Thus, sensitivity to noise enhances the vulnerability of an individual to a wide range of stressors.

iv. Cognitive Disability: - Impairment of Task Performance There are many potential detrimental effects of noise pollution on task performance involving both children and adults. Cognitive task performance at school and at work has been well documented in several studies. Children exposed to noise in the home or at school have difficulty with learning, cognitive and language development, and problem solving. Studies have shown that high aircraft noise showed an association with increased annoyance and poorer reading comprehension. The strongest effect of noise is on reading attention, problem solving, and memory. At workplace, noise may impair concentration, decrease motivation, increase rates of errors and often lead to preventable accidents. In addition, communication may be affected leading to misinterpretation of instructions further reducing a person's effectiveness and accuracy.

v. Negative Social Behaviour and Annoyance Reactions: - Noise levels have been associated with increased negative reactions such as increased agitation, exhaustion, dissatisfaction, anger, and distraction. In general, exposure to levels above 80 dB are associated with increase aggressiveness when combined with alcohol, provocation or existing anger and hostility. Annoyance is described as feelings of displeasure when individuals believe an agent or condition has and adverse effect on them. The level of annoyance is dependent on the type of noise, the time and the activity interrupted by the noise. In addition, individual sensitivity to the exposure also plays a role in annoyance levels. People who have a lack of a sense of control over noise have higher levels of annoyance especially when the noise is accompanied by low frequency components, loud impulse noises, or a crescendo noise effect. Negative social behaviours and annoyance reactions to noise cause significant declines to one's sense of well-being. The affected person may also feel restlessness, disquietude, depression or helplessness, as well as discomfort, distrust, frustration or wear and tear.

vi. Mental Health: - It is speculated that latent mental illness are exacerbated and intensified by noise pollution. In one study, children who were exposed to noise levels above 55 dB had decreased attention, difficulty with social adaptation, and increased oppositional behavior to others compared to children not exposed to these noise levels. Other studies have shown an increase in the use of sleeping pills and mental-hospital admission rates with those exposed to unwanted noise. However, the relationship of mental illness and noise pollution are still inconclusive because of the many possible confounding factors affecting the mental health. Again, children and the elderly are more vulnerable to the mental effects of noise pollution.

vii. Alteration to Ecosystems: - Most animals use acoustic signals to orientate, hunt, defend themselves and communicate. Most species have some degree of susceptibility and response to acoustic stimulation and often suffer adverse consequences to environmental noise. Some birds are sensitive to high noise levels, during the breeding season. Songbirds are particularly

sensitive to noise, on other hand, urban bird species can adapt to intense levels of continuous noise. Each species has its own emission and hearing abilities according to its natural ambience in order to success on feeding, reproducing and defending itself and its breeding. Such adaptive potential to environmental changes helps in preventing long-term ecosystem alterations due to anthropogenic activities.

viii. Marine ecosystems: - Background noise in the ocean such as noise of ships and other industrial activity, can interfere with marine mammals' use of sound for hunting, navigating, and communicating. This is called masking. Noise trauma is another impact that results in declined hearing ability in marine mammals. Sudden and long or repeated exposure to high frequency sounds can cause permanent hearing loss. Blast trauma, is another injury that marine mammals suffer due to single exposure to a sound that has an explosive shock wave. The shock wave has a compressive wave phase carrying much energy through the water quickly. The pressure rises much higher than normal for a few seconds, and then drops quickly to levels below normal. This feeling is just like the humans have during the ascent and descent of airplane and it ultimately damage the ears of marine mammals.

Control of Noise Pollution: - The Government of India have published guidelines of National Building code (2016), which emphasized on two important aspect of noise control: by considering the location and layout of building to reduce the harmful effects of noise. The areas that are particularly noisy should be segregated from quiet areas by buffer zones, that can tolerate intermediate noise levels. Further, machines, processes and work areas which are equally noisy should be located together. Another method of noise reduction is by layout, which means the office space in a factory should be located very far or preferably in a separate building. If it is unavoidable, then a thick wall with sound absorbing material should be used to separate with the production area. You will understand about such materials in subsequent section. In previous sections, you have read that noise is originated from a source, it travels through a medium or transmission path and finally, it is heard by a receiver. The control of noise pollution can be achieved at each of three basic elements of noise i.e. source, transmission path and receiver through various interventions. Let us understand them in more detail in following subsection:

A. Noise Control – at Source: - The engineering-based improvement in acoustic design criteria such as machine surface, internal and external design changes, operations can reduce the noise at level of source. The following are few key modifications suggested to reduce the noise at source: Reduce Impact Factors: Many machines and items of equipment are designed with parts that strike forcefully against other parts, producing noise. Some of design modifications are as follows:

• Reduce the weight, size, or height of fall of the impacting mass.

• Cushion the impact by inserting a layer of shock-absorbing material between the impacting surfaces.

• Use of non-metallic material to reduce resonance.

• Substitute the application of a small impact force over a long time period for a large force over a short period to achieve the same result.

• Smooth out acceleration of moving parts by applying accelerating forces gradually.

i. Reduce Speeds and Pressures: - Reducing the speed of rotating moving parts in machines and mechanical systems results in smoother operation and lower noise output. Likewise, reducing pressure and flow velocities in air, gas, and liquid circulation systems lessens turbulence, resulting in decreased noise radiation. For example, fans, rotors, turbines, and blowers operated at the lowest blade tip speeds reduces noise. Similarly, use of centrifugal, squirrelcage type fans are less noisy than vane, axial, or propeller type fans. Studies have shown that a 50% reduction in the speed of the air flow may lower the noise output by 10–20 dB, or roughly one-quarter to one-half of the original loudness.

ii. Reduce Frictional Resistance: - The friction between rotating, sliding, or moving parts in mechanical systems frequently results in smoother operation and lower noise output. This can be achieved by proper alignment, routine cleaning, polishing and properly balanced rotating, moving, or contacting parts of machines.

iii. Reduce Radiation Area: - The effective radiating surface areas of the mechanical parts can be reduced to control noise without impeding their operation or structural strength. This can be done by making parts smaller, removing excess material, or cutting openings, slots, or perforations in the parts. For example, if the area is halved, the noise intensity will be reduced by 3 dB and the reduction will be much greater at low frequencies.

iv. Reduce Noise Leakage: - In many cases, machine cabinets can be made into effective soundproof enclosures through simple design changes and the application of some sound-absorbing treatment.

v. Use of Damping Materials: - The application of any material that reduces or restrains the vibrational motion of that body will decrease its noise output. Some examples of damping materials which can be bonded with vibrating surface include rubber pads, felt, plastic foam, leaded vinyls, adhesive tapes, or fibrous blankets, metal viscoelastic laminates or composites etc.

vi. Acoustic filters: - The acoustical filters such as mufflers and silencers are used when fluid flow noise is to be reduced. There are two types of acoustic filters: adsorptive mufflers and reactive mufflers. The adsorptive type generally absorbs/ attenuates the high-frequency noises while their active type does not absorb energy but either transmits or reflects it back to the source depending on the frequency of sound. The reactive silencers used in industrial application are basically high-pass filters that alternate low-frequency noise only.

B. Noise Control in Transmission Path: - This method set up devices in the transmission path to block or reduce the flow of sound energy before it reaches to ears. This can be done in several ways: firstly by absorbing the sound along the path, secondly by deflecting the sound in some other direction by placing a reflecting barrier in its path and thirdly placing the source inside a sound-insulating box or enclosure.

i. Separation: - The air absorbs high-frequency sounds more effectively than low-frequency sounds. This absorptive capacity of the atmosphere is most economical method of reducing the noise level. Thus, when the distance from the point source is doubled, then the sound pressure level will be lowered by 6 dB.

ii. Sound Absorbing Materials: - Noise have wave properties, which will bounce from one hard surface to another and ultimately will vanish, when the noise from source is stopped. This is called reverberation in noise control work. The reverberation time (T60) is the time taken in seconds for the average sound energy level in a room to decrease to one millionth of its originally steady level after the source has stopped, i.e., time taken to decrease 60 dB. It is usually related to frequency bands as it varies with frequency. T60 is the common criterion, where the values of 0.60 seconds or shorter are required for noise reduction. The best way to reduce excess reverberation is by applying the appropriate amount of sound-absorbing surface materials inside noisy room on the ceilings, walls or floors.

A sound absorber is designed to dampen sound within a room, to eliminate the reverberation of sound and to reduce the build-up of sound within an enclosed space. Sound absorbing materials are rated by their Sabine absorption coefficients (αSAB), which is defined as a unit of absorption comprising the sum of the products of absorption coefficients and areas of the materials of a room. It is the arithmetic mean of the sound absorption coefficients at 250, 500, 1000, 2000 and 4000 Hz rounded off to the nearest multiple of 0.05. Sound absorbing materials such as acoustic tile, carpets, and drapes placed on ceilings, floors, or wall surfaces can reduce the noise level in most rooms by about 5–10 dB for high-frequency sounds, but only by 3 or 3 dB for low-frequency. The effectiveness of reducing the reverberation is measured by the "Noise Reduction Coefficient" (NRC) of materials used in building. The NRC expresses the effectiveness of an absorptive material or surface as compared to a theoretically perfect absorber. The higher the NRC number, the better is the absorption. It has relatively little effect upon the transmission of sound into an adjoining area. Example: NRC values are in range of 0.80 to 0.90 for ceilings of a room for acoustic control.

iii. Vibration isolators: - A vibrating source does not usually contain a large radiating surface but the vibration conducted along mechanically rigid paths to surfaces that can act as effective radiator. If the rigid connecting paths are interrupted by resilient materials, the transmission of vibration and consequently the noise radiated may be greatly reduced. The reduction depends on the ratio of the driving (forcing) frequency of the source to the natural frequency of the resilient system. The higher the ratio between the two frequencies, the lesser is the transmissibility. Thus, the transmissibility can be defined as ratio of the force transmitted through the resilient isolator to the exciting force applied to it.

C. Noise Control- at Receiver level: - This includes protection of the receiver by altering the work schedule or provision of personal protection devices such as ear plugs for operating noisy machinery.

i. Alter work schedule: - The amount of continuous exposure to high noise levels should be limited. The intensely noisy operation can be scheduled for a short interval of time each day

over a period of several days rather than a continuous 8-h run for a day or two. The noisy operations such as street repair, municipal trash collection, factory operation, and aircraft traffic should be curtailed at night and early morning hours to avoid disturbing the sleep of the community.

ii. Ear protection: - Moulded and pliable earplugs, cup type protectors, and helmets are commercially available as hearing protectors. Such devices may provide noise reductions ranging from 15 to 35 dB. Earplugs are effective only if they are properly fitted by medical personnel. These devices should be used as a last resort after all other methods have failed to lower the noise level to acceptable limits.

D. Green Belts and Landscaping: - Vegetation are natural material to reduce noise energy outdoors. Belts of trees and bushes situated between the noise source and the receiver can reduce the noise level perceived by the receiver. They act as noise filters, purify air and sequester carbon. Onder and Kocbeker, 2012 have summarized following principles which are needed to be successful in establish of a noise belt area:

• The planting area should be a total width of 5m to at least up to 30m.

• The plants which are subjected to use should be selected from natural flora or the appropriate varieties which are compatible with the natural flora should be used

• The "evergreen" plants should be used primarily.

• The plants should be planted uprightly to the noise direction.

• The plants should plant closely as possible as to each other and the distance between two plants should be appropriate with growing conditions.

• The plants which are longer, bigger, hard textured, intensive leaf-branch and apical tissue which is reaching to the ground should be preferred.

• The plant groups which are consisted from different heights of trees, shrubs and bushes should be used. -The longer plants should be planted to the back side of shorter plants, and the distance between to plants should be increase as much as possible. The plants consisted from bushes and coniferous which are more than 5m are able to more blocking to the noise.

• The green belt should close to the source of the noise and as much as far to the area which is wanted to be protected.

• It is more efficient that putting the plant belts together with noise barrier wall and soil wall to blocking the noise.

The creation of green belt is particularly advisable on the perimeter of aerodromes, along railway lines and arterial roads, through or past built-up areas and adjoining noisy industrial zones. The implementation of noise pollution control measures essentially requires a strategic noise abatement planning with enforcement of proposed ambient standards, exercising control limits on all the noisy sources and formulation of noise abatement goal.

E. Awareness: - It is envisaged that awareness among general public in maintaining a 'noisefree community' is a necessary step for its abatement. The participation of NGOs and social websites are important in creating awareness and educating people about noise and associated health hazards apart from school and college curriculum. The noise grievances cell as a part of State Pollution Control Boards should be proactive in receiving, analysing and taking appropriate action on complaints. Educative and innovative programmes such as organizing 'Noise Awareness Campaigns' and integrating 'Noise Pollution Control Mission' as a part of 'Swachh Bharat Mission' introduced by the Government of India shall be indispensable in controlling noise pollution in India.

References:

- Mishra, R. K., Rangnekar, S., & Parida, M. (2009). Survey on noise pollution and its management. Journal of IPHE, India, 4, 30-33.

1.7 Self-Assessment Test: -

- What are the main types of environmental issues? Explain it.
- How are people and organizations addressing environmental issues?
- Why is environmental scaling such a difficult issue?
- What are the causes and consequences of deforestation?
- What are the factors affecting the loss of biodiversity?
- What are the impacts of biodiversity loss?
- What do you mean by global warming?
- Why does a global temperature increase of 1.5°C matter?
- How Does Global Warming Drive Climate Change?
- What are the causes and consequences of global warming?
- What are the causes and consequences of sea level change?
- What is wetland and what are the types of wetlands?
- What are the threats to wetlands?
- What are the reasons for conserving wetlands?
- Discuss about the complexity of environmental migration.
- What do we know about the relationship between environmentally induced migration and conflict?
- Discuss different case student of environmental refugees.
- Bring out the four different conceptions of social pathology.
- Define crime and explain the linkages of crime with economy.
- What is disease? Find out the association between disease and society.
- What are the causes and consequences of fresh water depletion.
- What are the solutions for addressing water shortages?
- Explains the E-waste concerns and challenges.
- What are the consequences of groundwater contamination with special reference to arsenic and fluoride?
- What is noise pollution and what are the process to control it?

1.8 Summaries and Key points: -

The entire volume may be summaries with emphasizing some important key points:

- Environmental issues
- Environmental scaling
- Deforestation
- Biodiversity loss
- Global warming and sea-level rise
- Wetland and wasteland
- Social pathology as crime and disease
- Resource depletion

- Freshwater depletion
- E-waste management
- Non-degradable waste
- Groundwater contamination
- Noise pollution

Disclaimer: This self-learning material is based on different books, journals and web-sources.