UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

4/6/18
(Dr. Santanu Paul)
Deputy Registrar

University of Calcutta

Under Graduate Curriculum under Choice Based Credit System (CBCS)

Syllabus forAbility Enhancement Compulsory Course-2 (AECC-2) in
Environmental Studies

Semester-2

Total Marks-100*(Credit -2)*
(50 Theory-MCQ type + 30 Project + 10 Internal Assessment + 10 Attendance)

[Marks obtained in this course will be taken to calculate SGPA & CGPA]

Theory

Unit 1 Introduction to environmental studies — 2 lectures

•Multidisciplinary nature of environmental studies;
•Scope and importance; Concept of sustainability and sustainable development.

Unit 2 Ecology and Ecosystems — 6 lectures

•Concept of ecology and ecosystem, Structure and function of ecosystem; Energy flow in an ecosystem; food chains, food webs; Basic concept of population and community ecology; ecological succession.
•Characteristic features of the following:
a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, wetlands, rivers, oceans, estuaries)

Unit 3 Natural Resources — 8 lectures

• Concept of Renewable and Non-renewable resources
• Land resources and landuse change; Land degradation, soil erosion and desertification.
•Deforestation: Causes, consequences and remedial measures
•Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
•Energy resources: Environmental impacts of energy generation, use of alternative and nonconventional energy sources, growing energy needs.

Unit 4 Biodiversity and Conservation — 8 lectures

•Levels of biological diversity: genetic, species and ecosystem diversity;
• Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
•India as a mega-biodiversity nation; Endangered and endemic species of India
•Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
•Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
•Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5 Environmental Pollution — 8 lectures

• Environmental pollution: concepts and types,
• Air, water, soil, noise and marine pollution- causes, effects and controls
• Concept of hazards waste and human health risks
• Solid waste management: Control measures of Municipal, biomedical and e-waste.

Unit 6	**Environmental Policies and Practices**	7 lectures
	•Climate change, global warming, ozone layer depletion, acid rain and their impacts on human communities and agriculture •Environment Laws: Wildlife Protection Act; Forest Conservation Act. Water (Prevention and control of Pollution) Act; Air (Prevention & Control of Pollution) Act; Environment Protection Act; Biodiversity Act. •International agreements: Montreal Protocol, Kyoto protocol and climate negotiations; Convention on Biological Diversity (CBD). •Protected area network, tribal populations and rights, and human wildlife conflicts in Indian context.	
Unit 7	**Human Communities and the Environment**	6 lectures
	•Human population growth: Impacts on environment, human health and welfare. •Case studieson Resettlement and rehabilitation. • Environmental Disaster: Natural Disasters-floods, earthquake, cyclones, tsunami and landslides; Manmade Disaster- Bhopal and Chernobyl. •Environmental movements: Bishnois.Chipko, Silent valley,Big dam movements. •Environmental ethics: Role of gender and cultures in environmental conservation. •Environmental education and public awareness	
Project/ Field work		Equal to 5 lectures
	•Visit to an area to document environmental assets: Natural resources/flora/fauna, etc. •Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. •Study of common plants, insects, fish, birds, mammals and basic principles of identification. •Study of ecosystems-pond, river,wetland, forest,estuary and agro ecosystem.	
	Total	50 Lectures

Suggested Reading:

Asthana, D. K. (2006).*Text Book of Environmental Studies*. S. Chand Publishing.

Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India

Basu, R. N., (Ed.) (2000). *Environment*. University of Calcutta, Kolkata

Bharucha, E. (2013). *Textbook of Environmental Studies for Undergraduate Courses*. Universities Press.

De, A.K., (2006).*Environmental Chemistry*, 6th Edition, New Age International, New Delhi.

Mahapatra, R., Jeevan, S.S., Das, S. (Eds) (2017). *Environment Reader for Universities*, Centre for Science and Environment, New Delhi.

Masters, G. M., &Ela, W. P. (1991).*Introduction to environmental engineering and science*. Englewood Cliffs, NJ: Prentice Hall.

Odum, E. P., Odum, H. T., & Andrews, J. (1971).*Fundamentals of ecology*. Philadelphia: Saunders.

Sharma, P. D., & Sharma, P. D. (2005).*Ecology and environment*.Rastogi Publications.

ENVS PROJECT
ON
CLIMATE CHANGE

College Roll No.: S-204
CU Registration No: 223-1113-0023-17

INTRODUCTION

Climate change is the current rapid warming of the Earth's climate caused by human activity. If left unchecked (and current responses are doing little to halt it) it poses an unprecedented threat to human civilisation and the ecosystems on this planet. Weather changes by the hour and naturally varies widely between years. We know the climate is changing because, averaged out over longer periods, the global mean temperature has been consistently rising, across land and sea. It is now about 0.8C above pre-industrial times.

People who study Earth see that Earth's climate is getting warmer. Earth's temperature has gone up about one degree Fahrenheit in the last 100 years. This may not seem like much. But small changes in Earth's temperature can have big effects.

Global warming is the long-term rise in the average temperature of the Earth's climate system. It is a major aspect of climate change, and has been demonstrated by direct temperature measurements and by measurements of various effects of the warming. Global warming and climate change are often used interchangeably.

Fossil fuels are being continuously used to produce electricity. The burning of these fuels produces gases like carbon dioxide, methane and nitrous oxides which lead to global warming. Deforestation is also leading to warmer temperatures. The hazard of global warming is continuously causing major damage to the Earth's environment. Most people are still unaware of global warming and do not consider it to be a big problem in years to come. What most people do not understand is that global warming is currently happening, and we are already experiencing some of its withering effects. It is and will severely affect ecosystems and disturb ecological balance. Because of the treacherous effects of global warming, some solutions must be devised.

Scientists attribute the global warming to the human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space. Certain gases in the atmosphere block heat from escaping. Long-lived gases that remain semi-permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change. Gases, such as water vapor, which respond physically or chemically to changes in temperature are seen as "feedbacks."

Earth receives energy from the Sun in the form of ultraviolet, visible, and near-infrared radiation. About 26% of the incoming solar energy is reflected to space by the atmosphere and clouds, and 19% is absorbed by the atmosphere and clouds. Most of the remaining energy is absorbed at the surface of Earth. Because the Earth's surface is colder than the Sun, it radiates at wavelengths that are much longer than the wavelengths that were absorbed. Most of this thermal radiation is absorbed by the atmosphere and warms it. The atmosphere also gains heat by sensible and latent heat fluxes from the surface. The atmosphere radiates energy both upwards and downwards; the part radiated downwards is absorbed by the surface of Earth. This leads to a higher equilibrium temperature than if the atmosphere did not radiate.

An ideal thermally conductive blackbody at the same distance from the Sun as Earth would have a temperature of about 5.3 °C (41.5 °F). However, because Earth reflects about 30% of the incoming sunlight, this idealized planet's effective temperature (the temperature of a blackbody that would emit the same amount of radiation) would be about −18 °C (0 °F). The surface temperature of this hypothetical planet is 33 °C (59 °F) below Earth's actual surface temperature of approximately 14 °C (57 °F). The greenhouse effect is the contribution of greenhouse gases to this difference.

GLOBAL WARMING

The basic mechanism can be qualified in a number of ways, none of which affect the fundamental process. The atmosphere near the surface is largely opaque to thermal radiation (with important exceptions for "window" bands), and most heat loss from the surface is by sensible heat and latent heat transport. Radiative energy losses become increasingly important higher in the atmosphere, largely because of the decreasing concentration of water vapor, an important greenhouse gas. It is more realistic to think of the greenhouse effect as applying to a layer in the mid-troposphere, which is effectively coupled to the surface by a lapse rate. The simple picture also assumes a steady state, but in the real world, the diurnal cycle as well as the seasonal cycle and weather disturbances complicate matters. Solar heating applies only during daytime. During the night, the atmosphere cools somewhat, but not greatly, because its emissivity is low. Diurnal temperature changes decrease with height in the atmosphere.

Within the region where radiative effects are important, the description given by the idealized greenhouse model becomes realistic. Earth's surface, warmed to a temperature around 255 K, radiates long-wavelength, infrared heat in the range of 4–100 μm. At these wavelengths, greenhouse gases that were largely transparent to incoming solar radiation are more absorbent. Each layer of atmosphere with greenhouse gases absorbs some of the heat being radiated upwards from lower layers. It reradiates in all directions, both upwards and downwards; in equilibrium (by definition) the same amount as it has absorbed. This results in more warmth below. Increasing the concentration of the gases increases the amount of absorption and reradiation, and thereby further warms the layers and ultimately the surface below.

Greenhouse gases—including most diatomic gases with two different atoms (such as carbon monoxide, CO) and all gases with three or more atoms—are able to absorb and emit infrared radiation. Though more than 99% of the dry atmosphere is IR transparent (because the main constituents—N_2, O_2, and Ar—are not able to directly absorb or emit infrared radiation), intermolecular collisions cause the energy absorbed and emitted by the greenhouse gases to be shared with the other, non-IR-active, gases.

By their percentage contribution to the greenhouse effect on Earth the four major gases are:

- water vapor, 36–70%
- carbon dioxide, 9–26%
- methane, 4–9%
- ozone, 3–7%

It is not possible to assign a specific percentage to each gas because the absorption and emission bands of the gases overlap (hence the ranges given above). Clouds also absorb and emit infrared radiation and thus affect the radiative properties of the atmosphere.

Strengthening of the greenhouse effect through human activities is known as the enhanced (or anthropogenic) greenhouse effect. This increase in radiative forcing from human activity is attributable mainly to increased atmospheric carbon dioxide levels. According to the latest Assessment Report from the Intergovernmental Panel on Climate Change, "atmospheric concentrations of carbon dioxide, methane and nitrous oxide are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century".

CO_2 is produced by fossil fuel burning and other activities such as cement production and tropical deforestation. Measurements of CO_2 from the Mauna Loa observatory show that concentrations have increased from about 313 parts per million (ppm) in 1960 to about 389 ppm in 2010. It reached the 400 ppm milestone on May 9, 2013. The current observed amount of CO_2 exceeds the geological record maxima (~300 ppm) from ice core data. The effect of combustion-produced carbon dioxide on the global climate, a special case of the greenhouse effect first described in 1896 by Svante Arrhenius, has also been called the Callendar effect.

Over the past 800,000 years, ice core data shows that carbon dioxide has varied from values as low as 180 ppm to the pre-industrial level of 270 ppm. Paleoclimatologists consider variations in carbon dioxide concentration to be a fundamental factor influencing climate variations over this time scale.

A stronger greenhouse effect will warm the oceans and partially melt glaciers and other ice, increasing sea level. Ocean water also will expand if it warms, contributing further to sea level rise.

Meanwhile, some crops and other plants may respond favorably to increased atmospheric CO_2, growing more vigorously and using water more efficiently. At the same time, higher temperatures and shifting climate patterns may change the areas where crops grow best and affect the makeup of natural plant communities.

OBJECTIVES:

A)To investigate into the reasons of climate change

The Earth's climate has been constantly evolving at varying rates since the very beginning, yet these fluctuations have been slow in comparison to the current one. It is important to consider the speed of this variation, the so-called "timescale" of the changes, in order to understand the different contributions of natural and anthropogenic activities to current climatic changes.

The average temperature is regulated by the balance between incoming and outgoing energy, which determines the Earth's energy balance. As such, any factor that causes a change to the amount of incoming or outgoing energy, which is sustained over a long period (decades or more) can lead to climate change. Some of these factors could be natural or "internal" to the climate system, such as changes in volcanic activity, solar output or the Earth's orbit around the Sun.

Other causes are "external" to the climate system and are referred to as 'climate forcers', evoking the idea that they force or push the climate towards a new long-term state. This may be warmer or cooler depending on the cause of the change.Different factors operate on different time scales, and not all of the factors that have been responsible for changes to the Earth's climate in the distant past are relevant to contemporary climate change.The two natural factors relevant to the timescales of contemporary climate change are changes in volcanic activity and solar radiation.

These factors primarily influence the amount of incoming energy. Large volcanic eruptions that emit enormous quantities of dust and sulphates cool the atmosphere, but this contribution is episodic and has relatively short-term effects on the climate (lasting from a few months to a few years). Changes in solar irradiance have contributed to climate trends over the past centuries, but since the industrial revolution the effect of increased greenhouse gas levels in the atmosphere has made approximately 10 times the contribution to "climate forcing" than the effect of variations in the Sun's output.

Variations in ocean currents or atmospheric circulation (e.g. the El Niño phenomenon), can also influence the climate for short periods of time. Although this is important due to its effect on human activities as it determines hotter years, harsher droughts or heavier precipitations, this natural internal climate variability doesn't contribute to the long-term trend which is instead regulated by the amount of anthropogenic climate forcers, mainly the greenhouse gases added to the atmosphere. Scientists believe that natural changes alone cannot explain the temperature changes of the last 50 years. Using computer models they reproduce the different climate forcers (both natural and anthropogenic), first ensuring that these models are able to reproduce the temperature changes observed in the recent past.

When the models only include natural climate drivers (such as sun intensity variation and volcanic eruptions), they cannot accurately reproduce the warming that has been observed over the past half century. When human-induced climate drivers (greenhouse gases) are also included in the models, they are then able to replicate the recent temperature increases in the atmosphere and in the oceans. When natural and human-induced climate drivers are compared to one another, the dramatic accumulation of carbon from human sources is by far the largest climate change driver in the past half century.

The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. These industries created jobs and over the years, people moved from rural areas to the cities. This trend is continuing even today. More and more land that was covered with vegetation has been cleared to make way for houses. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for material things) has increased by leaps and bounds, creating mountains of waste. Also, our population has increased to an incredible extent.

All this has contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles, generate electricity for industries, households, etc. The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides (NOx) and carbon monoxide (CO) which are not greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases.

Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use patterns, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide.

Methane is another important greenhouse gas in the atmosphere. About ¼ of all methane emissions are said to come from domesticated animals such as dairy cows, goats, pigs, buffaloes, camels, horses, and sheep. These animals produce methane during the cud-chewing process. Methane is also released from rice or paddy fields that are flooded during the sowing and maturing periods. When soil is covered with water it becomes anaerobic or lacking in oxygen.

Under such conditions, methane-producing bacteria and other organisms decompose organic matter in the soil to form methane. Nearly 90% of the paddy-growing area in the world is found in Asia, as rice is the staple food there. China and India, between them, have 80-90% of the world's rice-growing areas.

Methane is also emitted from landfills and other waste dumps. If the waste is put into an incinerator or burnt in the open, carbon dioxide is emitted. Methane is also emitted during the process of oil drilling, coal mining and also from leaking gas pipelines (due to accidents and poor maintenance of sites).

A large amount of nitrous oxide emission has been attributed to fertilizer application. This in turn depends on the type of fertilizer that is used, how and when it is used and the methods of tilling that are followed. Contributions are also made by leguminous plants, such as beans and pulses that add nitrogen to the soil.
All of us in our daily lives contribute our bit to this change in the climate.
Give these points a good, serious thought:

- Electricity is the main source of power in urban areas. All our gadgets run on electricity generated mainly from thermal power plants. These thermal power plants are run on fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants.

- Cars, buses, and trucks are the principal ways by which goods and people are transported in most of our cities. These are run mainly on petrol or diesel, both fossil fuels.

- We generate large quantities of waste in the form of plastics that remain in the environment for many years and cause damage.

- We use a huge quantity of paper in our work at schools and in offices. Have we ever thought about the number of trees that we use in a day?

- Timber is used in large quantities for construction of houses, which means that large areas of forest have to be cut down.

- A growing population has meant more and more mouths to feed. Because the land area available for agriculture is limited (and in fact, is actually shrinking as a result of ecological degradation!) high-yielding varieties of crops are being grown to increase the agricultural output from a given area of land. However, such high-yielding varieties of crops require large quantities of fertilizers; and more fertilizer means more emissions of nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it. Pollution also results from the run-off of fertilizer into water bodies.

B) To identify the key agreement related to climate change that is associated with Earth Summit (1992) and COP21(2015)

i) Earth Summit(1992)

From 3-14 June 1992, Rio de Janeiro hosted the United Nations Conference on Environment and Development (UNCED). The focus of this conference was the state of the global environment and the relationship between economics, science and the environment in a political context. The conference concluded with the Earth Summit, at which leaders of 105 nations gathered to demonstrate their commitment to sustainable development. This paper will summarize the goals of the Conference.

At UNCED, more than 130 nations signed a Convention on Climate Change and a Convention on Biodiversity. The delegates also reached agreement on Agenda 21, an action plan for developing the planet sustainably through the twenty-first century, and on a broad statement of principles for protecting forests. All nations present accepted without change the Rio Declaration, a non-binding statement of broad principles for environmental policy New international networks, both formal and informal, were set up to carry out and oversee implementation of the agreements.

The ultimate objective of this convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant position provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The discussions on climate change took place from February 1991 to May 1992 and concluded with a framework convention agreed to by more than 130 countries. The key elements of the convention are: new and additional financial resources to meet convention goals; promotion of transfer of technology to developing countries; and an institutional mechanism to enable the international community to manage the climate change problem over the long term, working with the Intergovernmental Panel on Climate Change.

Three major treaties were drawn up in subsequent international environmental conferences; these were

- The Rio Declaration on Environment and Development
- The Kyoto Protocol
- The Copenhagen Accord.

Five agreements were drawn up during the Earth summit;

1. The Convention on Biological Diversity,
2. The Framework Convention on Climate Change
3. Principles of Forest Management
4. Agenda 21
5. The Rio Declaration on Environment and Development.

The UNFCCC(United Nations Framework Convention on Climate Change) entered into force on 21 March 1994. Today, it has near-universal membership. The 197 countries that have ratified the Convention are called Parties to the Convention. The UNFCCC is a "Rio Convention", one of three adopted at the "Rio Earth Summit" in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification. The three are intrinsically linked. It is in this context that the Joint Liaison Group was set up to boost cooperation among the three Conventions, with the ultimate aim of developing synergies in their activities on issues of mutual concern. It now also incorporates the Ramsar Convention on Wetlands. Preventing "dangerous" human interference with the climate system is the ultimate aim of the UNFCCC.

First steps to a safer future: the Convention in summary
The Convention:

Recognized that there was a problem.

- This was remarkable for its time. Remember, in 1994, when the UNFCCC took effect, there was less scientific evidence than there is now. The UNFCCC borrowed a very important line from one of the most successful multilateral environmental treaties in history (the Montreal Protocol, in 1987): it bound member states to act in the interests of human safety even in the face of scientific uncertainty.

Sets a lofty but specific goal.

- The ultimate objective of the Convention is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."

Puts the onus on developed countries to lead the way.

- The idea is that, as they are the source of most past and current greenhouse gas emissions, industrialized countries are expected to do the most to cut emissions on home ground. They are called Annex I countries and belong to the Organization for Economic Cooperation and Development (OECD). They include 12 countries with "economies in transition" from Central and Eastern Europe. Annex I countries were expected by the year 2000 to reduce emissions to 1990 levels. Many of them have taken strong action to do so, and some have already succeeded. Directs new funds to climate change activities in developing countries.

- Industrialized nations agree under the Convention to support climate change activities in developing countries by providing financial support for action on climate change-- above and beyond any financial assistance they already provide to these countries. A system of grants and loans has been set up through the Convention and is managed by the Global Environment Facility. Industrialized countries also agree to share technology with less-advanced nations. Keeps tabs on the problem and what's being done about it.

- Industrialized countries (Annex I) have to report regularly on their climate change policies and measures, including issues governed by the Kyoto Protocol (for countries which have ratified it).

- They must also submit an annual inventory of their greenhouse gas emissions, including data for their base year (1990)and all the years since.

- Developing countries (Non-Annex I Parties) report in more general terms on their actions both to address climate change and to adapt to its impacts - but less regularly than Annex I Parties do, and their reporting is contingent on their getting funding for the preparation of the reports, particularly in the case of the Least Developed Countries. Charts the beginnings of a path to strike a delicate balance.

- Economic development is particularly vital to the world's poorer countries. Such progress is difficult to achieve even without the complications added by climate change. The Convention takes this into consideration by accepting that the share of greenhouse gas emissions produced by developing nations will grow in the coming years. Nonetheless, in the interests of fulfilling its ultimate goal, it seeks to help such countries limit emissions in ways that will not hinder their economic progress. One such win-win solution was to emerge later, when the Kyoto Protocol to the Convention was conceived. Kicks off formal consideration of adaptation to climate change.

- The Convention acknowledges the vulnerability of all countries to the effects of climate change and calls for special efforts to ease the consequences, especially in developing countries which lack the resources to do so on their own. In the early years of the Convention, adaptation received less attention than mitigation, as Parties wanted more certainty on impacts of and vulnerability to climate change. When IPCC's Third Assessment Report was released, adaptation gained traction, and Parties agreed on a process to address adverse effects and to establish funding arrangements for adaptation. Currently, work on adaptation takes place under different Convention bodies. The Adaptation Committee, which Parties agreed to set up under the Cancun Adaptation Framework as part of the Cancun Agreements, is a major step towards a cohesive, Convention-based approach to adaptation.

IN OUR HANDS
EARTH SUMMIT '92

Earth Summit '92

ii) 2015 United Nations Climate Change Conference

The 2015 United Nations Climate Change Conference, COP 21 or CMP 11 was held in Paris, France, from 30 November to 12 December 2015. The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change, the text of which represented a consensus of the representatives of the 196 attending parties. The agreement enters into force when joined by at least 55 countries which together represent at least 55 percent of global greenhouse gas emissions.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to increase the ability of countries to deal with the impacts of climate change, and at making finance flows consistent with a low GHG emissions and climate-resilient pathway.

To reach these ambitious goals, appropriate mobilization and provision of financial resources, a new technology framework and enhanced capacity-building is to be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The Paris Agreement came into effect on November 4th 2016, after the minimum threshold was met - 55 countries representing at least 55% of global emissions. For countries that join after this point, the Agreement comes into force 30 days after the country "deposits its instrument of ratification, acceptance, approval or accession with the Secretary-General."

The Paris Agreement addresses crucial areas necessary to combat climate change. Some of the key aspects of the Agreement are :

- **Long-term temperature goal** – The Paris Agreement, in seeking to strengthen the global response to climate change, reaffirms the goal of limiting global temperature increase to well below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees.

- **Global peaking and 'climate neutrality'**–To achieve this temperature goal, Parties aim to reach global peaking of greenhouse gas emissions (GHGs) as soon as possible, recognizing peaking will take longer for developing country Parties, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century.

- **Mitigation** – The Paris Agreement establishes binding commitments by all Parties to prepare, communicate and maintain a nationally determined contribution (NDC) and to pursue domestic measures to achieve them. It also prescribes that Parties shall communicate their NDCs every 5 years and provide information necessary for clarity and transparency. To set a firm foundation for higher ambition, each successive NDC will represent a progression beyond the previous one and reflect the highest possible ambition. Developed countries should continue to take the lead by undertaking absolute economy-wide reduction targets, while developing countries should continue enhancing their mitigation efforts, and are encouraged to move toward economy-wide targets over time in the light of different national circumstances.

- **Sinks and reservoirs** –The Paris Agreement also encourages Parties to conserve and enhance, as appropriate, sinks and reservoirs of GHGs including forests.

- **Voluntary cooperation/Market- and non-market-based approaches**–The Paris Agreement recognizes the possibility of voluntary cooperation among Parties to allow for higher ambition and sets out principles – including environmental integrity, transparency and robust accounting – for any cooperation that involves internationally transferal of mitigation outcomes. It establishes a mechanism to contribute to the mitigation of GHG emissions and support sustainable development, and defines a framework for non-market approaches to sustainable development.

- **Adaptation** – The Paris Agreement establishes a global goal on adaptation – of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. It aims to significantly strengthen national adaptation efforts, including through support and international cooperation. It recognizes that adaptation is a global challenge faced by all. All Parties should engage in adaptation, including by formulating and implementing National Adaptation Plans, and should submit and periodically update an adaptation communication describing their priorities, needs, plans and actions. The adaptation efforts of developing countries should be recognized

- **Loss and damage** – The Paris Agreement recognizes the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage. Parties are to enhance understanding, action and support, including through the Warsaw International Mechanism, on a cooperative and facilitative basis with respect to loss and damage associated with the adverse effects of climate change.

- **Finance, technology and capacity-building support**– The Paris Agreement reaffirms the obligations of developed countries to support the efforts of developing country Parties to build clean, climate-resilient futures, while for the first time encouraging voluntary contributions by other Parties. Provision of resources should also aim to achieve a balance between adaptation and mitigation. In addition to reporting on finance already provided, developed country Parties commit to submit indicative information on future support every two years, including projected levels of public finance. The agreement also provides that the Financial Mechanism of the Convention, including the Green Climate Fund (GCF), shall serve the Agreement. International cooperation on climate-safe technology development and transfer and building capacity in the developing world are also strengthened: a technology framework is established under the Agreement and capacity-building activities will be strengthened through, inter alia, enhanced support for capacity building actions in developing country Parties and appropriate institutional arrangements. Climate change education, training as well as public awareness, participation and access to information is also to be enhanced under the Agreement.

- Climate change education, training, public awareness, public participation and public access to information is also to be enhanced under the Agreement.

- **Transparency ,implementation and compliance**– The Paris Agreement relies on a robust transparency and accounting system to provide clarity on action and support by Parties, with flexibility for their differing capabilities of Parties. In addition to reporting information on mitigation, adaptation and support, the Agreement requires that the information submitted by each Party undergoes international technical expert review. The Agreement also includes a mechanism that will facilitate implementation and promote compliance in a non-adversarial and non-punitive manner, and will report annually to the CMA.

- **Global Stocktake**– A "global stocktake", to take place in 2023 and every 5 years thereafter, will assess collective progress toward achieving the purpose of the Agreement in a comprehensive and facilitative manner. It will be based on the best available science and its long-term global goal. Its outcome will inform Parties in updating and enhancing their actions and support and enhancing international cooperation on climate action.

- Decision 1/CP.21 also sets out a number of measures to enhance action prior to 2020, including strengthening the technical examination process, enhancement of provision of urgent finance, technology and support and measures to strengthen high-level engagement. For 2018 a facilitative dialogue is envisaged to take stock of collective progress towards the long-term emission reduction goal. The decision also welcomes the efforts of all non-Party stakeholders to address and respond to climate change, including those of civil society, the private sector, financial institutions, cities and other subnational authorities. These stakeholders are invited to scale up their efforts and showcase them via the Non-State Actor Zone for Climate Action platform .Parties also recognized the need to strengthen the knowledge, technologies, practices and efforts of local communities and indigenous peoples, as well as the important role of providing incentives through tools such as domestic policies and carbon pricing.

C) Major Functions of IPCC

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations that is dedicated to providing the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced climate change, its natural, political, and economic impacts and risks, and possible response options.

The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage.

IPCC

The IPCC work is shared among three Working Groups, a Task Force and a Task

Group. The activities of each Working Group and of the Task Force are coordinated and administered by a Technical Support Unit (TSU).

The IPCC Working Group I (WG I) assesses the physical scientific aspects of the climate system and climate change. The main topics assessed by WG I include: changes in greenhouse gases and aerosols in the atmosphere; observed changes in air, land and ocean temperatures, rainfall, glaciers and ice sheets, oceans and sea level; historical and paleoclimatic perspective on climate change; biogeochemistry, carbon cycle, gases and aerosols; satellite data and other data; climate models; climate projections, causes and attribution of climate change.

The IPCC Working Group II (WG II) assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. It also takes into consideration the inter-relationship between vulnerability, adaptation and sustainable development. The assessed information is considered by sectors (water resources; ecosystems; food & forests; coastal systems; industry; human health) and regions (Africa; Asia; Australia & New Zealand; Europe; Latin America; North America; Polar Regions; Small Islands).

The IPCC Working Group III (WG III) assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere. The main economic sectors are taken into account, both in a near-term and in a long-term perspective. The sectors include energy, transport, buildings, industry, agriculture, forestry, waste management. The WG analyses the costs and benefits of the different approaches to mitigation, considering also the available instruments and policy measures. The approach is more and more solution-oriented.

The Task Force on National Greenhouse Gas Inventories (TFI) was established by the IPCC to oversee the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP). The core activity is to develop and refine an internationally-agreed methodology and software for the calculation and reporting of national GHG emissions and removals and to encourage its use by countries participating in the IPCC and by parties of the United Nations Framework Convention on Climate Change (UNFCCC). The NGGIP also established and maintains an Emission Factor Database.

One of the main IPCC activities is the preparation of comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its causes, potential impacts and response strategies. The IPCC also produces Special Reports, which are an assessment on a specific issue and Methodology Reports, which provide practical guidelines for the preparation of greenhouse gas inventories.

The drafting and review of these reports follows clear procedures. Key elements of the IPCC process and procedures include:

Development of the scope of a report in consultation between experts and governments and decision on the outlines by the Panel

• This step should ensure that relevant scientific developments as well as the information needs of policymakers are reflected in the upcoming reports.

Author teams that reflect a wide range of expertise and views and work on a voluntary basis

• Author teams for the chapters of IPCC reports should represent a range of views and expertise as well as appropriate geographical representation. The IPCC also aims for gender balance. This is achieved through a wide nomination and selection process, as is currently ongoing for the Fifth Assessment Report (AR5).

• More than 450 Lead Authors and more than 800 Contributing Authors (CAs) have contributed to the Fourth Assessment Report (AR4). They were selected from around 2000 nominations.

• All experts contributing to the report work for the IPCC on a voluntary basis and are compensated by the IPCC only for their travel expenses to the necessary meetings, including that of the Chair of the IPCC and all of the elected leadership.

A writing process based as far as possible on peer-reviewed and internationally available literature

• The authors will work on the basis of peer reviewed and internationally available literature, including manuscripts that can be made available for IPCC review and selected non-peer reviewed literature as necessary.

• Materials relevant to IPCC Reports, in particular, information about the experiences and practices of the private sector in mitigation and adaptation activities, are also found in sources that have not been published or peer-reviewed (e.g., industry journals, internal organisational publications, non-peer reviewed reports or working papers of research institutions, proceedings of workshops, etc.). A lot of relevant information appears also in government reports and publications from international organizations. To make all references used in IPCC Reports easily accessible and to ensure that the IPCC process remains open and transparent, additional procedures have been agreed for the use of such sources, often referred to as "grey literature".

• Authors who wish to include information from a non-published/non-peer-reviewed source, are requested to critically assess and review the quality and validity of each source before incorporating results into an IPCC Report.

• The Co-chairs have to collect and index non-publicly available sources as well as the accompanying information received from authors about each source and make copies available to reviewers upon request during the review process.

• The IPCC uses also expert meetings and workshops to support the assessment process.

• Conclusions in IPCC reports are based on multiple lines of evidence and a wide range of scientific technical literature.

A multi stage and transparent review process involving experts and governments

• The IPCC Review entails multiple stages aimed at ensuring that the best possible scientific and technical advice be included, so that the IPCC Reports represent the latest scientific, technical and socio-economic findings, and are as comprehensive as possible. Draft reports are circulated among independent experts from all relevant fields of expertise and all regions, and in a second stage to government reviewers as well. Experts can send comments on the draft text. It is a process with a very wide circulation, which in principle any scientific expert can join.

• Normally two Review Editors per chapter ensure that all substantive expert and government review comments are afforded appropriate consideration so that IPCC Reports provide a balanced and complete assessment of current information.

• To ensure objectivity and transparency, review comments are made available to reviewers on request during the IPCC review process. On completion of a Report all review comments and responses by authors are retained in an open archive for a period of at least five years.

• In preparing the draft and final report, authors should clearly identify and describe different (possibly controversial) scientific, technical, and socio-economic views on a subject, together with the relevant arguments, particularly if they are relevant to the policy debate.

Approval, acceptance and adoption of IPCC reports and their summaries by the Panel

• The Summaries for Policy Makers (SPM), which summarize the key findings of each report, are prepared concurrently with the preparation of the main Reports and are subject to simultaneous review by both experts and governments. They are subject to a final line-by-line approval in a Plenary Session, which all IPCC member countries are invited to join. In case of a Report prepared by one or two Working Groups this will be done at a Working Group or joint Working Group Session or a Panel Session - in the case of reports being prepared by all WGs or the TFI.

• Approval of the Summary for Policymakers signifies that it is consistent with the factual material contained in the full scientific, technical and socioeconomic assessment. During the Session, Coordinating Lead Authors may be asked to provide technical assistance in ensuring that consistency.

• The Synthesis Report (SYR) synthesizes and integrates materials contained within the IPCC Reports (Assessment and Special Reports) and addresses a broad range of policy-relevant but policy-neutral questions. The SYR SPM is approved line-by-line and the longer report adopted section by section to ensure consistency with the SPM and the underlying Reports.

• The underlying Reports (of Assessment, Special and Methodology Reports) are accepted at a Session of the Working Group or Panel. While they are not subject to line-by-line discussion and agreement, approval by member countries signifies that the material presents a comprehensive, objective and balanced view of the subject matter.

• To assist Lead Authors of the Fourth Assessment Report in the consistent presentation of scientific uncertainties, uncertainty guidelines were prepared. They address approaches to developing expert judgments, evaluating uncertainties, and communicating uncertainty and confidence in findings that arise through the assessment process.

• Based on these guidelines, the AR4 authors assigned confidence levels to the major statements in the Summary for Policymakers. These range from very high to very low confidence.

• Authors also evaluated the likelihood, which refers to a probabilistic assessment of some well- defined outcome having occurred or occurring in the future, for certain outcomes in the Summary for Policymakers, with a range from virtually certain to very unlikely.

A budget based mainly on voluntary contributions from governments and in kind contributions from governments, research institutions and researchers

• The IPCC Budget is based on regular contributions from the two sponsoring organizations WMO and UNEP, which provide cash and one senior post in the IPCC Secretariat and regular contributions from the UNFCCC as agreed by the Parties. The largest share of contributions comes from governments on a voluntary basis.

D) Impacts of climate change we are experiencing and the ones we are likely to face.

The changing climate impacts society and ecosystems in a broad variety of ways. For example, climate change can alter rainfall, influence crop yields, affect human health, cause changes to forests and other ecosystems, and even impact our energy supply. Climate-related impacts are occurring across the country and over many sectors of our economy.
The direct consequences of man-made climate change include:

- rising maximum temperatures
- rising minimum temperatures
- rising sea levels
- higher ocean temperatures
- an increase in heavy precipitation (heavy rain and hail)
- shrinking glaciers

- thawing permafrost

The indirect consequences of climate change, which directly affect us humans and our environment, include:

- an increase in hunger and water crises, especially in developing countries
- health risks through rising air temperatures and heatwaves
- economic implications of dealing with secondary damage related to climate change
- increasing spread of pests and pathogens
- loss of biodiversity due to limited adaptability and adaptability speed of flora and fauna
- ocean acidification due to increased HCO3 concentrations in the water as a consequence of increased CO_2 concentrations

Interrelationships between the effects of climate change

In addition, these negative consequences feed each other back and increase their magnitudes; for example:

- Droughts frequently cause wildfires, which then destroy crops.
- The melting of glaciers, snow and ice causes sea level rise, which erodes the coast and involves the destruction of many economic means of subsistence.
- Droughts, rising sea levels, extreme natural phenomena and floods cause climate refugees

DROUGHT

Future effects of climate change are :

Temperature Will Rise: Climate models predict that Earth's global average temperature will rise in the future. For the next two decades, a warming of about 0.2° Celsius is projected. If we continue to emit as many, or more, greenhouse gases, this will cause more warming during the 21st Century than we saw in the 20th Century. During the 21st Century, various computer models predict that Earth's average temperature will rise between 1.8° and 4.0° Celsius (3.2° and 7.2° F). The amount of predicted warming differs depending on the model emissions scenario (how much greenhouse gas emissions it assumes for the future). The amount of predicted warming also differs between different climate models. Climate change is predicted to impact regions differently. For example, temperature increases are expected to be greater on land than over oceans and greater at high latitudes than in the tropics and mid-latitudes.

Changing Precipitation: Warmer average global temperature will cause a higher rate of evaporation, causing the water cycle to "speed up". More water vapor in the atmosphere will lead to more precipitation. According to models, global average precipitation will most likely increase by about 3-5% with a minimum increase of at least 1% and a maximum increase of about 8%. Yet, changes in precipitation will not be evenly distributed. Some locations will get more snow, others will see less rain. Some places will have wetter winters and drier summers.

Melting Snow and Ice: As the climate warms, snow and ice melt. The amount of summer melting of glaciers, ice sheets, and other snow and ice on land are predicted to be greater than the amount of winter precipitation. The amount of sea ice (frozen seawater) floating in the ocean in the Arctic and Antarctic is expected to decrease over the 21st Century too, although there is some uncertainty as to the amount of melt.

Rising Sea Level: A warmer climate causes sea level to rise via two mechanisms:
(**1**) melting glaciers and ice sheets (ice on land) add water to the oceans, raising sea level, and
(**2**) ocean water expands as it warms, increasing its volume and thus also raising sea level. During the 20th Century, sea level rose about 10 to 20 cm (4 to 8 inches). Thermal expansion and melting ice each contributed about half of the rise, though there is some uncertainty in the exact magnitude of the contribution from each source. By the year 2100, models predict sea level will rise between about 20 and 50 cm (8 to 20 inches) above late 20th Century levels. Thermal expansion of sea water is predicted to account for about 75% of future sea level rise according to most models.

Acidic Ocean Water: Earth's oceans are predicted to act as a buffer against climate change by taking up some of the excess heat and carbon dioxide from the atmosphere. This is good news in the short run, but more problematic in the long run. Carbon dioxide combined with seawater forms weak carbonic acid. Scientists believe this process has reduced the pH of the oceans by about 0.1 pH since pre-industrial times. Further acidification of 0.14 to 0.35 pH is expected by the year 2100. More acidic ocean water may cause problems for marine organisms.

Impacts on Ocean Currents: Large-scale ocean currents called thermohaline circulation, driven by differences in salinity and temperature, may also be disrupted as climate warms. Changes in precipitation patterns and the influx of fresh water into the oceans from melting ice can alter salinity. Changing salinity, along with rising water temperature, may disrupt the currents. In an extreme case, thermohaline circulation could be disrupted or even shut down in some parts of the ocean, which could have large effects on climate.

Changing Severe Weather: Some climate scientists believe that hurricanes, typhoons, and other tropical cyclones will (and may have begun to already) change as a result of global warming. Warm ocean surface waters provide the energy that drives these immense storms. Warmer oceans in the future are expected to cause intensification of such storms. Although there may not be more tropical cyclones worldwide in the future, some scientists believe there will be a higher proportion of the most powerful and destructive storms. Some scientists believe we are already seeing evidence for an upswing in the numbers of the most powerful storms; others are less convinced.

More Clouds: Clouds are a bit of a wild-card in global climate models. Warmer global temperatures produce faster overall evaporation rates, resulting in more water vapor in the atmosphere... and hence more clouds. Different types of clouds at different locations have different effects on climate. Some shade the Earth, cooling the climate. Others enhance the greenhouse effect with their heat-trapping water vapor and droplets. Scientists expect a warmer world to be a cloudier one, but are not yet certain how the increased cloudiness will feed back into the climate system. Modeling the influence of clouds in the climate system is an area of active scientific research.

Changes to Life and the Carbon Cycle: Climate change will alter many aspects of biological systems and the global carbon cycle. Temperature changes will alter the natural ranges of many types of plants and animals, both wild and domesticated. There will also be changes to the lengths of growing seasons, geographical ranges of plants, and frost dates.

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CU Registraton No : 223-1211-0291-20

AECC2 ENVS PROJECT

TOPIC NAME :–

<u>POLLUTION PREVENTION</u>

CONTENT

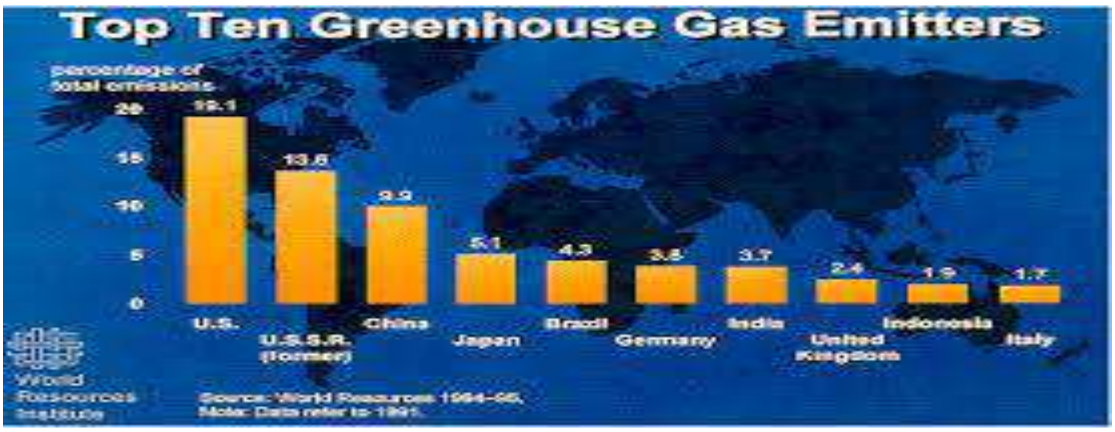
INTRODUCTION:-

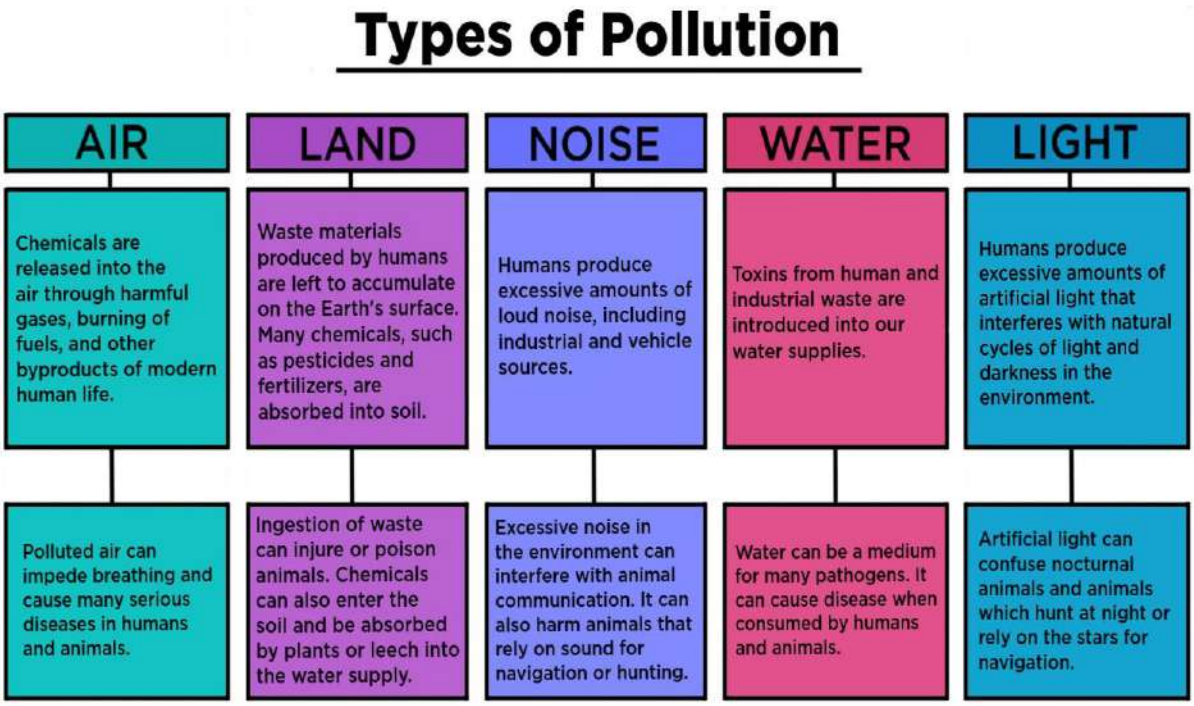
What is Pollution Prevention?

Pollution prevention (P2) is any practice that reduces, eliminates, or prevents pollution at its source. P2, also known as "source reduction," is the ounce-of-prevention approach to waste management. Reducing the amount of pollution produced means less waste to control, treat, or dispose of. Less pollution means less hazards posed to public health and the environment.

Pollution prevention reduces both financial costs (waste management and clean-up) and environmental costs (health problems and environmental damage). Pollution prevention protects the environment by conserving and protecting natural resources while strengthening economic growth through more efficient production in industry and less need for households, businesses and communities to handle waste.

Pollution prevention is any action that reduces the amount of contaminants released into the environment. Implementation of such processes reduces the severity and/or number of hazards posed to both public health and the environment. Prevention of pollution preserves natural resources and can also have significant financial benefits in large scale processes.[3] If companies produce less waste, they do not have to worry about proper disposal. Thus, P2 is also a proactive measure to reduce costs of waste disposal and elimination.





Air pollution is the main cause of climate change. Human activities such as burning fossil fuels and mass deforestation lead to the increase of carbon dioxide in the atmosphere, which traps heat inside the atmosphere through a process called the greenhouse effect. This impacts climate patterns and sea levels around the world.

Land pollution refers to the deterioration of the earth's land surfaces, at and below ground level. The cause is the accumulation of solid and liquid waste materials that contaminate groundwater and soil. These waste materials are often referred to as municipal solid waste (MSW), which includes both hazardous and non-hazardous waste.

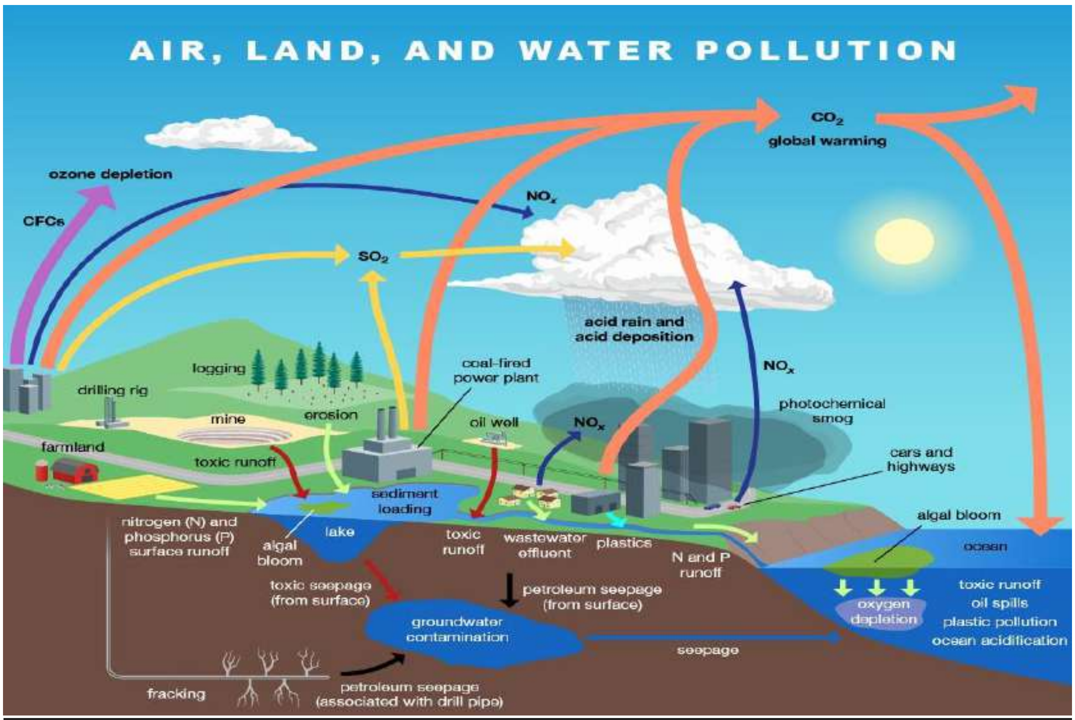
Noise pollution, also known as environmental noise or sound pollution, is the propagation of noise with ranging impacts on the activity of human or animal life, most of them harmful to a degree.

Water pollution (or aquatic pollution) is the contamination of water bodies, usually as a result of human activities. Water bodies include for example lakes, rivers, oceans, aquifers and groundwater.

Light pollution is the presence of unwanted, inappropriate, or excessive artificial lighting. The area affected by artificial illumination continues to increase. As a major side-effect of urbanization, light pollution is blamed for compromising health, disrupting ecosystems and spoiling aesthetic environments.

POLLUTION CAUSED DUE TO CLIMATE CHANGES: -

Although environmental pollution can be caused by natural events such as forest fires and active volcanoes, use of the word *pollution* generally implies that the contaminants have an anthropogenic source—that is, a source created by human activities. Pollution has accompanied humankind ever since groups of people first congregated and remained for a long time in any one place. Indeed, ancient human settlements are frequently recognized by their wastes—shell mounds and rubble heaps, for instance. Pollution was not a serious problem as long as there was enough space available for each individual or group. However, with the establishment of permanent settlements by great numbers of people, pollution became a problem, and it has remained one ever since.



Cities of ancient times were often noxious places, fouled by human wastes and debris. Beginning about 1000 CE, the use of coal for fuel caused considerable air pollution, and the conversion of coal to coke for iron smelting beginning in the 17th century exacerbated the problem. In Europe, from the Middle Ages well into the early modern era, unsanitary urban conditions favoured the outbreak of population-decimating epidemics of disease, from plague to cholera and typhoid fever. Through the 19th century, water and air pollution and the accumulation of solid wastes were largely problems of congested urban areas. But, with the rapid spread of industrialization and the growth of the human population to unprecedented levels, pollution became a universal problem.

POLLUTION PREVENTING PLAN AND TECHNICAL ASSISTANCE AND RESOURCE

An excellent way to get started with any P2 effort is to draw upon the many resources available through the Indiana Department of Environmental Management's (IDEM's) Office of Pollution Prevention and Technical Assistance (OPPTA). The following is a brief description of IDEM's assistance programs, incentive programs and industry partnerships:

Compliance and Technical Assistance Program: -

The Compliance and Technical Assistance Program (CTAP) is Indiana's business assistance program, statutorily authorized to operate under Indiana Code (IC) 13-28-1, 13-28-3, and 13-28-5-4. CTAP is a nonregulatory program that provides free, confidential compliance and technical assistance to regulated entities. CTAP was established to help Indiana businesses achieve compliance with environmental regulations. CTAP staff members provide guidance on air, water, and waste regulations, and they are knowledgeable about current environmental issues and new technologies. They are able to assess the environmental compliance of an entire facility or they can help address concerns about a particular process or regulation.

Governor's Awards for Environmental Excellence: -

The state of Indiana annually recognizes Indiana's leaders who have implemented outstanding environmental strategies into their operations and decision-making processes. By seeking out and utilizing innovative environmental practices, facilities/programs reduce waste, save money, and contribute greatly to Indiana's environmental protection efforts, as well as benefit the health and welfare of Indiana's communities and the state as a whole. The Governor's Awards are open to all Indiana facilities, state and local units of government, individuals, and technical assistance organizations that operate or support environmental protection efforts of outstanding quality. Eligible technical assistance organizations include, but are not limited to, public entities, educational groups, trade associations, individuals, and public interest, community and labour groups.

Indiana Partners for Pollution Prevention: -

Indiana Partners for Pollution Prevention is an organization comprised of Indiana industries and businesses that are interested in pollution prevention as well as the financial and environmental benefits P2 projects can bring. The Partners provide a forum where Indiana businesses can network and exchange ideas about P2 experiences and discuss how P2 fits into current and future IDEM programs. The Partners realize that pollution prevention is the arena where the environment and economics can meet on common ground. Consider becoming a Partner if you want to:

1. Network with other Indiana businesses regarding P2.

2. Have your organization be recognized as a pollution prevention leader in Indiana.

3. Hear how other businesses have implemented successful P2 technologies.

4. Learn how P2 can improve your business practices.

5. Stay up-to-date with pollution prevention technologies.

6. Become more aware of and involved in IDEM's efforts to integrate P2 into various programs.

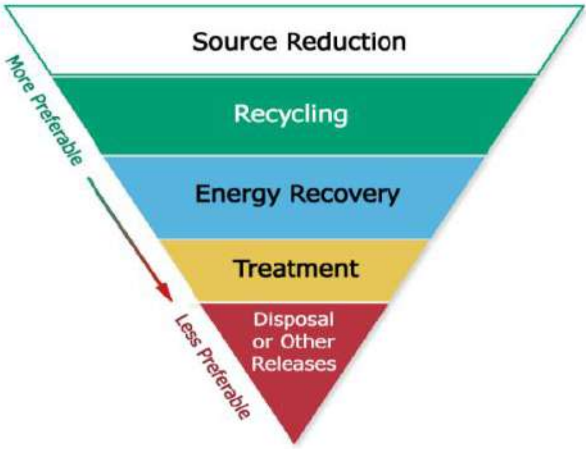
7. Partner with IDEM in a proactive setting.

The Indiana Partners for Pollution Prevention annually sponsor the Pollution Prevention Conference and Trade Show. This event provides a look at how award-winning companies have used pollution prevention to improve their businesses. Past topics have included new and emerging pollution prevention technologies and options for successful and profitable product substitutions.

MEASURES TO PREVENT POLLUTION:-

Prevention and control of pollution: Pollution control is an approach to eliminate the release of pollutants into the environment. It is regulated by various environmental agencies that establish limits for the discharge of pollutants into the air, water, and land. A wide variety of devices and systems have been developed to control air and water pollution and solid wastes. Pollution is prevented by using the below strategies:

- Recycling
- Reusing
- Reducing
- Mitigating



Noise pollution in India can be controlled by implementing following strategies:


- Control can be done by isolating noisy machines and also by using mufflers or noise reducers.
- Control of transmission by building enclosures and covering walls
- Protection from exposure by using ear plugs and ear muffs
- Legislation to restrict the use of loud speakers etc
- Education through films and newspapers about the hazards of noise pollution

- Use of noise barriers
- Limitation of vehicle speeds
- Alteration of roadway surface texture
- Limitation of heavy vehicles
- Use of traffic controls to reduce braking and acceleration and tire design
- Aircraft noise can be reduced to some extent by design of quieter jet engines
- Reconsideration of operations, such as altering flight paths and time of day runway use, has demonstrated benefits for residential populations.

Water pollution in India can be controlled by implementing following strategies:

- Water pollution can be controlled by using non-toxic soaps, detergents and cleaning products
- Avoid chemical fertilizers and pesticides on your lawn and gardens
- Dispose of paints, motor oil, gasoline, antifreeze and other harmful chemicals in accordance with your local laws and safety regulations

- Protect groundwater, which is critical for drinking water, irrigation systems and natural ecosystems
- Use chemicals in a proper way which may be harmful to the environment
- Use environment friendly washing powders, cleaning agents and toiletries to control water pollution
- Store chemicals in tightly sealed containers to avoid groundwater contamination
- Reduce the runoff that comes from your property
- Maintain your vehicle
- Replace your lawn and high maintenance plants with native plants
- Clean up pet waste
- Avoid using salt to de-ice walk ways
- Maintain your septic system

Air pollution in India can be controlled by implementing following strategies:


- Maintaining a healthy distance between the industrial and residential areas
- The chimneys should be constructed tall in size so that the emissions must be released higher up in the environment
- The sulphur must be removed after burning
- The gasoline must have anti knocking agents
- The railway track must be electrified

- The mining area should be planted with trees
- The coal fuel should be replaced with gas fuel to control the air pollution
- The automobiles must be designed with emission control system
- The wastes must be removed and recycled in the industrial plants and refineries
- Plants like pinus and ribes need to be planted to metabolize the nitrogen oxides and other pollutants
- Timely servicing of the car helps to keep it in a good condition, and also minimizes fuel exhaustion
- Using public transportation helps to prevent the air pollution
- Using alternative energy sources like solar energy, hydroelectric energy, and wind energy

Soil pollution in India can be controlled by implementing following strategies:

- Limit the use of fertilizers and pesticides
- Awareness about biological control methods and their implementation
- The grazing must be controlled and forest management should be done properly
- The afforestation and reforestation must take place
- Proper preventive methods like shields should be used in areas of wind erosion and wind breaks

- Remember to carry paper bags and minimize using plastic bags
- The soil binding grass must be planted and the large trees must be placed along the banks
- The industrial wastes must be dumped in the low lying areas
- There should be a definite technique of cropping which does not allow the weeds to settle on the fields
- The mining ways must be improved along with their transportation
- The area must not be left barren and dry

POLLUTION PREVENTION ACT 1990.

The Pollution Prevention Act of 1990 was enacted to increase interest in source reduction or pollution prevention and encourage adoption of cost effective source reduction practices.

According to the act, it is the policy of the United States that pollution should be prevented or reduced at the source. If pollution cannot be prevented it should be recycled in an environmentally safe manner. If pollution cannot be prevented or recycled it should be treated in an environmentally safe manner.

The Act defines source reduction as any practice which:

1. reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and
2. reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The act requires the Environmental Protection Agency (EPA) to establish an Office of Pollution Prevention, develop and coordinate a pollution prevention strategy, and develop source reduction models. The office of Pollution Prevention reviews and advises single medium program offices to promote an integrated, multi-media (i.e., air, land, and water) approach to source reduction. The EPA makes recommendations to Congress to eliminate barriers to source reduction. The EPA also conducts workshops and produces and disseminates guidance documents as part of a training program on source reduction opportunities for state and federal enforcement officers of environmental regulations. EPA's strategy, issued in 1991, identifies goals, tasks, target dates, resources required, organizational responsibilities, and criteria to evaluate program progress. In addition, the Act requires the EPA to promote source reduction practices in other federal agencies and to identify opportunities to use federal procurement to encourage source reduction.

To facilitate source reduction by industry, the EPA is required to:

- develop, test, and disseminate model source reduction auditing procedures to highlight opportunities;
- promote research and development of source reduction techniques and processes with broad applicability;
- establish an annual award program to recognize innovative programs;
- establish a program of state matching grants for programs to provide technical assistance to business; and
- disseminate information about source reduction techniques through a clearinghouse.

The act also includes provisions to improve data collection and public access to environmental data. The act requires EPA to develop improved methods of coordinating, streamlining and assuring access to data collected under all federal environmental statutes. An advisory panel of technical experts is established to advise the Administrator on ways to improve collection and dissemination of data.

Owners and operators of many industrial facilities must report annually on their releases of toxic chemicals to the environment. The reports should include the following information:

- the quantity of the toxic chemical entering any waste stream (or released to the environment) prior to recycling, treatment, or disposal;
- the quantity of toxic substance recycled (on- or off-site);
- the source reduction practices used;
- quantities of toxic chemical expected to enter waste streams and to be recycled in the two years following the year for which the report is prepared;
- ratio of production in the reporting year to production in the previous year;
- techniques used to identify opportunities for source reduction;

- amount of toxic chemical released in a catastrophic event, remedial action, or other one-time event; and
- amount of toxic chemical treated on- or off-site.

All collected information is available to the general public.

Citizens are given the authority to bring civil action for noncompliance against a facility, EPA, a governor, or a State Emergency Response Commission. Non compliance with mandatory provisions results in civil, administrative and criminal penalties.

Pollution control measures by the Government of India:

- Water prevention and pollution Act, 1974
- Air prevention and control of pollution Act, 1871
- Cess Act, 1977 and Environment Act, 1986
- Public Liability Insurance Act, 1981
- National Environment Tribunal Act, 1995
- National Environment Appellate Act, 1997

Central pollution control Board provides assistance to the central government on below issues:

- Coordinate the state board activities

- Provide technical assistance to the state boards and conduct research related activities to control pollution
- Collection, compilation and publication of the manuals and code of conduct
- To lay down the standards.

CONCLUSION:-

As a key environmental agency, EPA needs to support and maintain a strong research program. An evolving understanding of the complexity, magnitude,

and inter-relatedness of environmental problems leads us to conclude that a new balance of research programs may be helpful. This report describes a framework for conducting research in a way that will help alleviate the problems of the moment while providing a basis for solving tomorrow's problems.

In the past, pressing environmental issues have been addressed primarily through focused research efforts directed toward solving particular problems. Although this approach to environmental research can be effective, has often been necessary, and will surely continue, it also has limitations. In order to address the abundance of established, emerging, and as-yet-unknown environmental issues, an expanded understanding of the scientific principles underlying environmental systems is needed. Achieving this understanding will require innovative, interdisciplinary approaches.

To develop the knowledge needed to address current and emerging environmental issues, EPA should undertake both problem-driven research and core research. Problem-driven research is targeted at understanding and solving identified environmental problems, while core research aims to provide broader, more generic information that will help improve understanding of many problems now and in the future. Core research includes three components: (1) understanding the processes that drive and connect environmental systems;

(2) development of innovative tools and methods for understanding and managing environmental problems; and

(3) long-term collection and dissemination of accurate environmental data.

Research activities within problem-driven and core research programs may often overlap. Fundamental discoveries can be made during the search for a solution to a narrowly defined problem; likewise, as illustrated earlier in this report, breakthroughs in problem-solving often occur as a result of core research efforts. Both kinds of investigations are needed, and feedback between them will greatly enhance the overall environmental research endeavour

Because EPA's task of protecting the environment and human health is so vast and difficult, and because resources to undertake the necessary research are very limited, choices will have to be made among many worthwhile projects. The approaches for making these choices will be different in the core and problem-driven portions of the research program. The former should seek better understanding of fundamental phenomena and generate broadly relevant research tools and information. The latter will be more responsive to regulatory activities and other immediate needs and should be guided by the paradigm of risk reduction. Because there are so many specific issues of importance to the public, the Congress, and EPA's own program and regional offices, there is a temptation to include many problems for attention. It is important to resist this trend: it will inevitably lead either to the dilution of efforts to solve the most pressing problems or to the reduction of funding available for critical core research needs.

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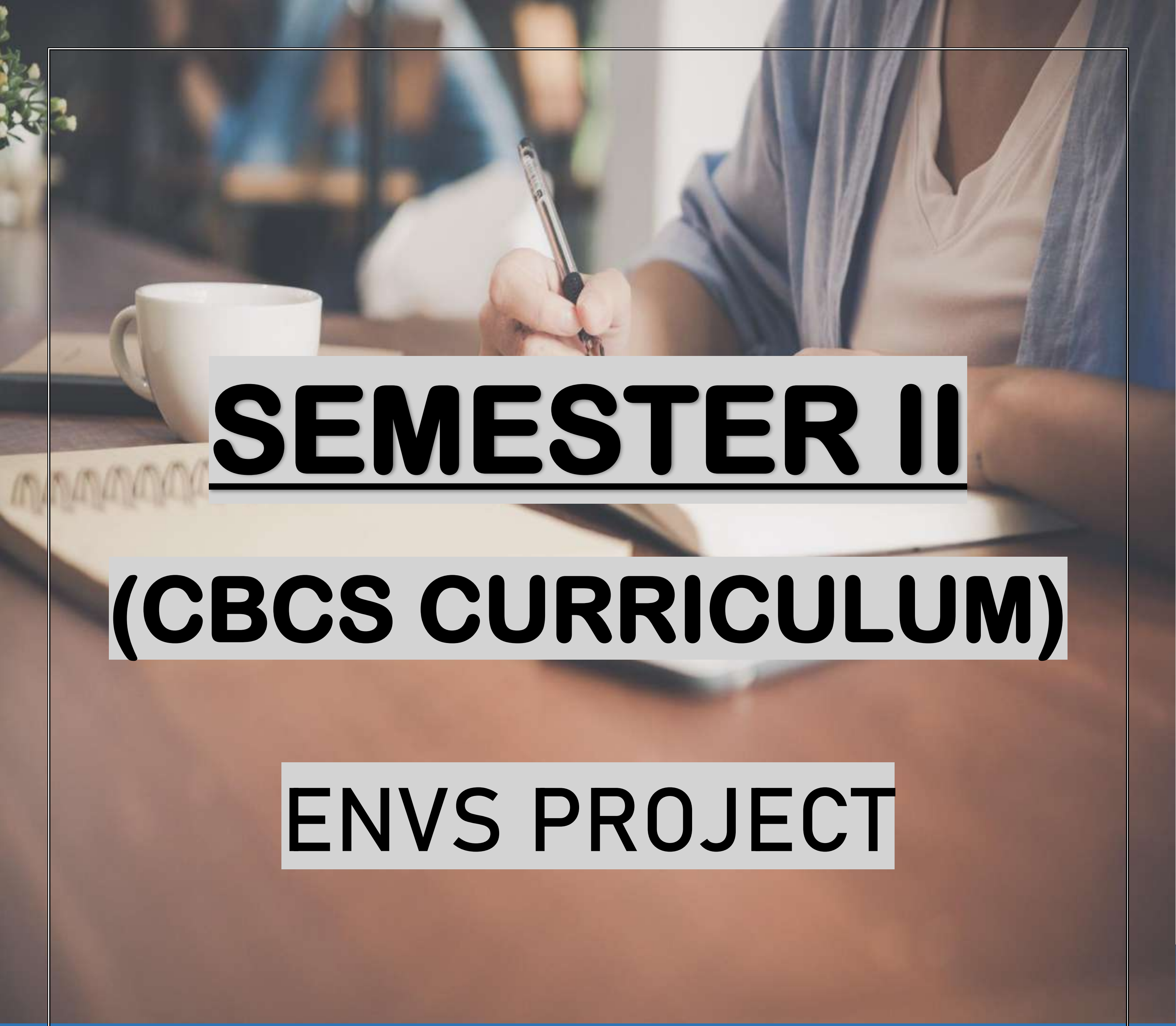


SEMESTER II

(CBCS CURRICULUM)

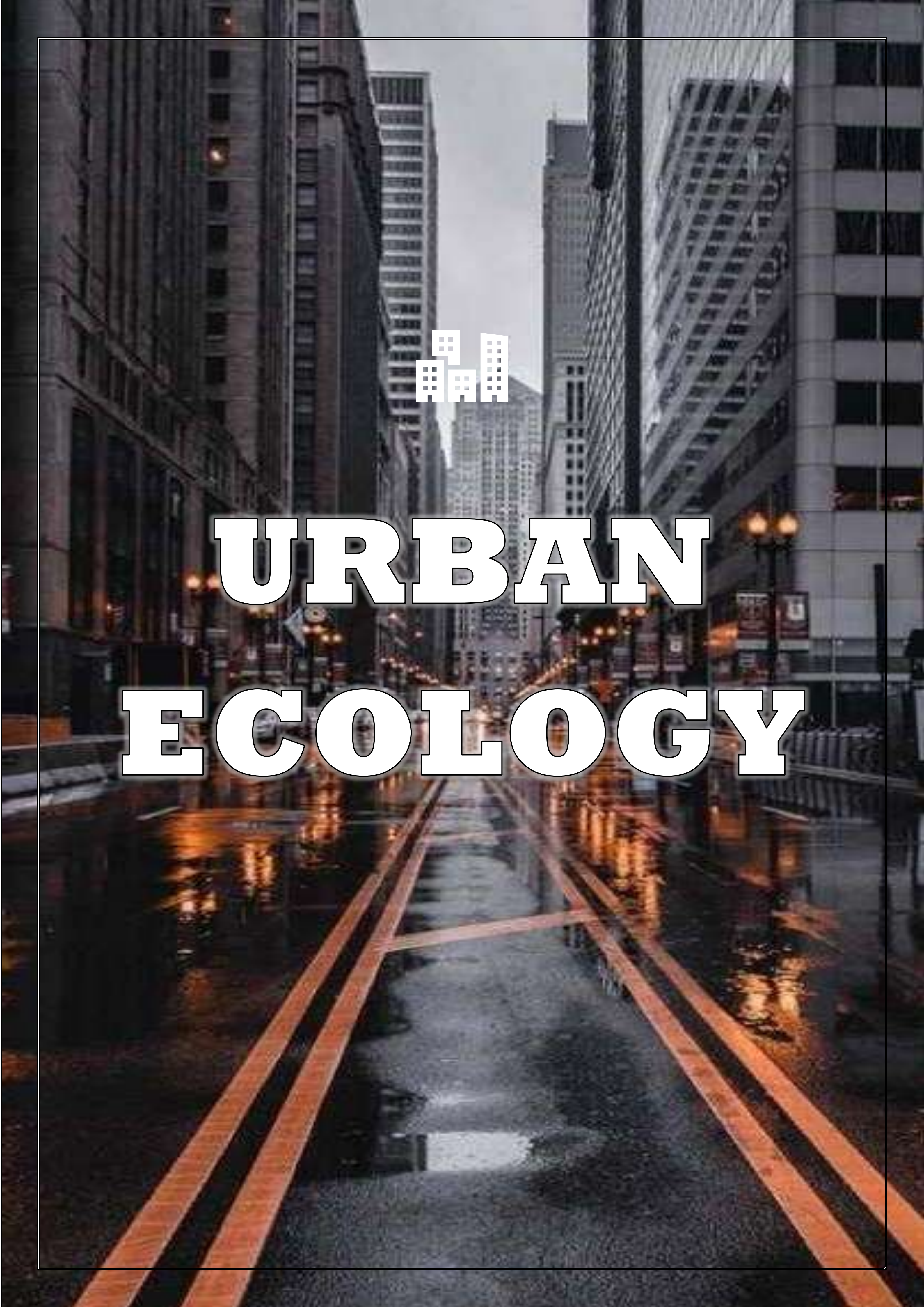
ENVS PROJECT

COLLEGE ROLL NO. – CMSA20F181

CU ROLL NO. – 203223-11-0054

CU REG. NO. – 223-1211-0376-20

URBAN ECOLOGY



CONTENTS

1. INTRODUCTION

The growing population of urban centres necessities the study of interaction between living organisms and urban environment, which is defined as the environment surrounded by man-made structures, such as residential and commercial buildings, paved surfaces, etc. Within this scope, urban ecology developed as a branch of ecology in the last few decades. According to United Nations, in forty years' time, two-third of the world's population will be living in growing urban centres, thus it is apparent that urban ecology is fairly important.

The study of urban ecology is vital if we would like to understand where and how human activity harms the urban environment or in which way we could improve the living conditions of humans without giving any damage to the urban environment.

2. URBAN ECOLOGY

Urban ecology studies the relations of mankind with each other and their surroundings including cities and urbanizing landscapes.This recent and interdisciplinary field tries to understand the coexistence of human and ecological processes in urban environment and help humans to build more sustainable living.It is a subfield of ecology and it has strong connections with many disciplines like sociology, geography, urban planning, landscape architecture, engineering, economics, anthropology, climatology and public health.Therefore, urban ecology is used to define the study of humans in urban environment, of nature in cities, and of the relationships between humans and nature.

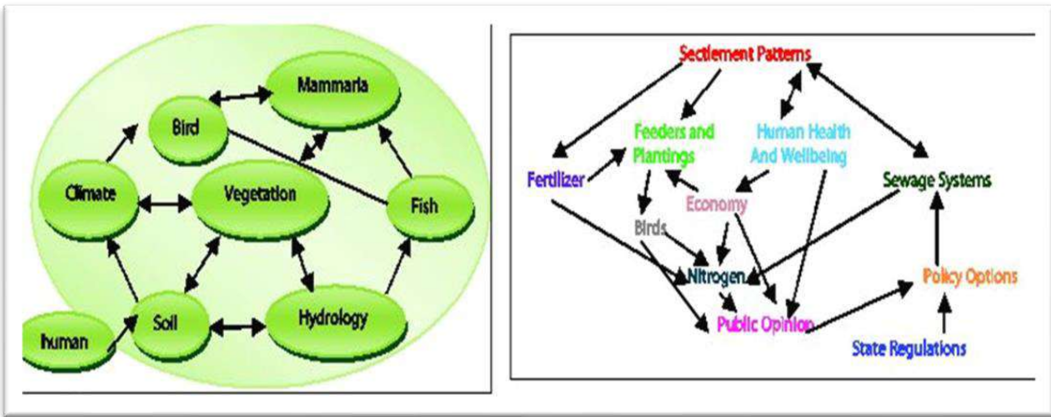


Figure 1.

Charts showing the relationships for the ecology in the city (left) and ecology of the city (right)

As seen in Fig. 1, urban ecology can be viewed as composing of ecology ‘in’ cities and ecology ‘of’ cities to functionalize the interdisciplinary nature of it. The former term deals with the questions asking the effect of urbanization on the ecology of living organisms as well as the differences between the ecological processes in cities and those in other environments. The latter one is associated with the interactions between ecological and social systems in an urban environment.

Jianguo (Jingle) Wu

Dean's Distinguished Professor of

Sustainability Science, Arizona State University

According to Wu, in order to investigate the relation between ecology and humans in urban habitats, the terms ‘science’ (ecology) and ‘art’ (the humanistic and holistic perspectives) should be taken into consideration for maintaining urban sustainability. Urban ecology basically concerns the relationship between the spatio-temporal patterns of urbanization and ecological processes.

Marzluff et al. pointed out that urban ecology can be viewed from three points: (1) ecology and evolution of living organisms residing in city boundaries; (2) biological, political, economic, and cultural ecology of humans in urban landscape; (3) cities resultant of the coupled relations of humans and natural processes. According to them, the third view in which human and nature are observed as interacting forces shaping the measurable patterns and processes should be followed by the field. Human factors and naturel systems with biotic and abiotic factors are coupled together since they both drive and are affected by the patterns and processes they create, see Fig. 2.

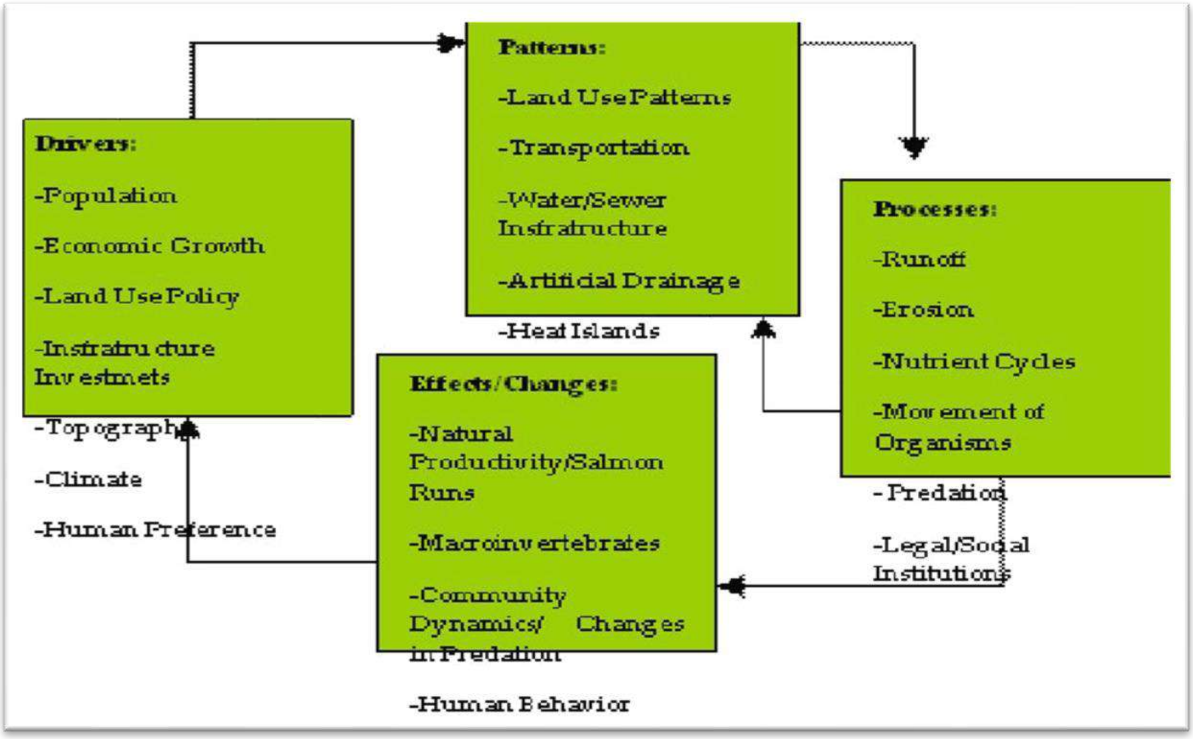
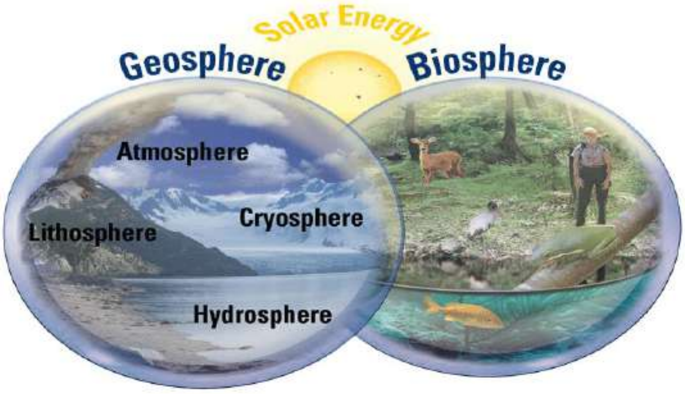


Figure 2.

A scheme of urban ecology showing the relationships between humans and natural drivers which are influenced by the patterns and processes of abiotic and biotic drivers

3. URBAN ECOSYSTEM

According to Moll and Petit, "a set of interacting species and their local environment working cooperatively to stay alive" is called as ecosystem. In urban environments, it could be difficult to distinguish different forms of ecosystems. In fact, one can define the whole city as a single ecosystem, while it is also possible to consider a city is a collection of many individual ecosystems, such as parks, lakes, urban forests, cultivated lands, wetlands, sea and streams. Here, the second approach is preferred which covers all natural green and blue areas in the city. Based on this definition, street and ponds should be considered as individual ecosystems, while actually, Bolund and Hunhammar states that they are very small and could only be defined as the elements of a larger ecosystem.



Regardless of the approaches mentioned above, the whole ecosystem in a city is called urban ecosystem which includes abiotic spheres (the atmosphere, hydrosphere, lithosphere, and soil or pedosphere) and biotic spheres (often viewed as an interacting biosphere of urban plants and animals plus the socio-economic world of people, the anthroposphere.

4, URBANIZATION

It is important to highlight the need for an international frame of thought regarding urbanization, which has recently been experienced as a massive, unplanned course of action in landscape change in the world. Urbanization offers a diversity of altered types of land covers in residential, commercial, and industrial areas; they are generally interconnected by roads and railways, on which special green spaces are allocated. This diversity and similar structures are common all around the world; yet; how they affect biodiversity and ecosystem processes has yet to be determined. What is more, international and comparative research attempts are essential in order to develop the understanding of ecological effects of urbanization.

Sustainability of future can be maintained only if an ecosystem oriented approach is adopted in terms of urban planning; this approach should include equitable access to ecosystem services and proper planning.

5. THE NECESSITY OF ECOLOGICAL AREAS IN THE URBAN LANDSCAPES

View of the English Garden in Munich-Germany (Original 2011).

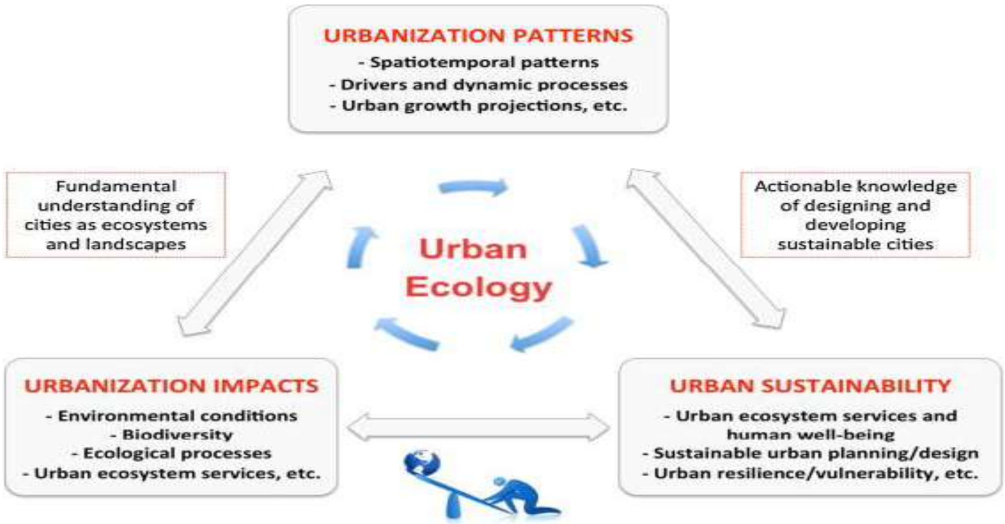
The presence of natural flora in the cities, the establishment of habitats suitable to the animals adapted to the urban conditions and ecological studies for the protection and development of ecosystems are considered as environmentally ethical studies, as they protect the natural resources. Meanwhile, these areas are places which are increasing the quality of life in the city and allowing the social interaction of the residents.

Ecological studies and designs are significantly important for the sustainability of the mankind and natural environment. The ecological studies carried out for the establishment of the sustainability in the urban areas as well as the for the protection of the resources involve not only the construction-scale efforts performed in the urban areas but also the works conducted in the rural areas. In the construction-scale, the studies comprise efforts such as taking precautions for the extensive use of solar energy, recycling of the domestic waste, etc.

6. DISCUSSION

It is important to highlight that urban ecosystems do have contributions to the well-being of urban life; however, urbanites depend on global ecosystems to survive. There are some services provided by urban ecosystems in order to improve the quality of life; accordingly, air quality, lower level noise were all provided, these could not be done from distant ecosystems. The causes of these problems have yet to be solved, but their effects have been reduced. Both should be the main aim.

of ecosystem services will be raised, which will help to maintain a more resource-efficient city structure and design. Only then urban ecosystems will be respected for their contributions to life in urban areas, and gained priority when the area faces exploitation.



The idea of significance of ecosystem services could result in protection of unexploited urban areas, even expanding them. One of the most important key objectives is that ecosystem services in urban areas and ecosystems are appreciated by political authorities as the cities grow in future.

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ENVIRONMENTAL STUDIES PROJECT

COLLEGE ROLL NO. : CMSA20F188

B.SC.(HONS.) SEMESTER 2 (UNDER CBCS)

CU ROLL NO. : 203223-11-0066

CU REGISTRATION NO. : 223-1211-0417-20

CLIMATE CHANGE

Climate change includes both **global warming** driven by human-induced emissions of greenhouse gases and the resulting large-scale shifts in weather patterns. Though there have been previous periods of climatic change, since the mid-20th century humans have had an unprecedented impact on Earth's climate system and caused change on a global scale.

Terminology

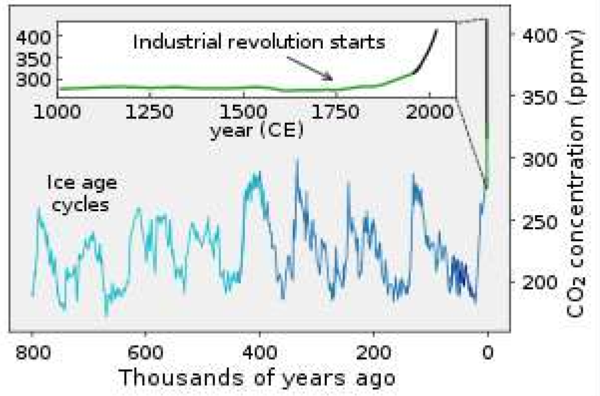
Before the 1980s, when it was unclear whether warming by greenhouse gases would dominate aerosol-induced cooling, scientists often used the term *inadvertent climate modification* to refer to humankind's impact on the climate. In the 1980s, the terms *global warming* and *climate change* were popularised, the former referring only to increased surface warming, the latter describing the full effect of greenhouse gases on the climate. Global warming became the most popular term after NASA climate scientist James Hansen used it in his 1988 testimony in the U.S. Senate. In the 2000s, the term *climate change* increased in popularity.

Global warming usually refers to human-induced warming of the Earth system, whereas climate change can refer to natural as well as anthropogenic change. The two terms are often used interchangeably.

Various scientists, politicians and media figures have adopted the terms *climate crisis* or *climate emergency* to talk about climate change, while using *global heating* instead of global warming. The policy editor-in-chief of *The Guardian* explained that they included this language in their editorial guidelines "to ensure that we are being scientifically precise, while also communicating clearly with readers on this very important issue".

CAUSES FOR CLIMATE CHANGE

GREENHOUSE GASES



CO_2 concentration over the last 800,000 years as measured from ice cores (blue/green) and directly (black)

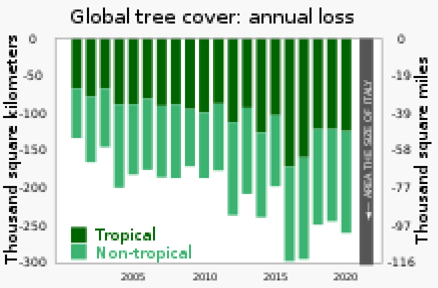
The Earth absorbs sunlight then radiates it as heat. Greenhouse gases in the atmosphere absorb and reemit infrared radiation, slowing the rate at which it can pass through the atmosphere and escape into space. Before the Industrial Revolution, naturally-occurring amounts of greenhouse gases caused the air near the surface to be about 33 °C (59 °F) warmer than it would have been in their absence. While water vapour (~50%) and clouds (~25%) are the biggest contributors to the greenhouse effect, they increase as a function of temperature and are therefore considered feedbacks. On the other hand, concentrations of gases such as CO_2 (~20%), tropospheric ozone, CFCs and nitrous oxide are not temperature-dependent, and are therefore considered external forcing.

Human activity since the Industrial Revolution, mainly extracting and burning fossil fuels (coal, oil, and natural gas) has increased the amount of greenhouse gases in the atmosphere, resulting in radiative imbalance. In 2018, the concentrations of CO_2 and methane had increased by about 45% and 160%, respectively, since 1750.These CO_2 levels are much higher than they have been at any time during the last 800,000 years, the period for which reliable data have been collected from air trapped in ice cores. Less direct geological evidence indicates that CO_2 values have not been this high for millions of years.

Global anthropogenic greenhouse gas emissions in 2018, excluding those from land use change, were equivalent to 52 billion tonnes of CO_2. Of these emissions, 72% was actual CO_2, 19% was methane, 6% was nitrous oxide, and 3% was fluorinated gases. CO_2 emissions primarily come from burning fossil fuels to provide energy for transport, manufacturing, heating, and electricity. Additional CO_2 emissions come from deforestation and industrial processes, which include the CO_2 released by the chemical reactions for making cement, steel, aluminium, and fertiliser. Methane emissions come from livestock, manure, rice cultivation, landfills, wastewater, coal mining, as well as oil and gas extraction. Nitrous oxide emissions largely come from the microbial decomposition of inorganic and organic fertiliser. From a production standpoint, the primary sources of global greenhouse gas emissions are estimated as: electricity and heat (25%), agriculture and forestry (24%), industry and manufacturing (21%), transport (14%), and buildings (6%).

Despite the contribution of deforestation to greenhouse gas emissions, the Earth's land surface, particularly its forests, remain a significant carbon sink for CO_2. Natural processes, such as carbon fixation in the soil and photosynthesis, more than offset the greenhouse gas contributions from deforestation. The land-surface sink is estimated to remove about 29% of annual global CO_2 emissions. The ocean also serves as a significant carbon sink via a two-step process. First, CO_2 dissolves in the surface water. Afterwards, the ocean's overturning circulation distributes it deep into the ocean's interior, where it accumulates over time as part of the carbon cycle. Over the last two decades, the world's oceans have absorbed 20 to 30% of emitted CO_2.

CHANGES OF THE LAND SURFACE



The rate of global tree cover loss has approximately doubled since 2001, to an annual loss approaching an area the size of Italy.

Humans change the Earth's surface mainly to create more agricultural land. Today, agriculture takes up 34% of Earth's land area, while 26% is forests, and 30% is uninhabitable (glaciers, deserts, etc.). The amount of forested land continues to decrease, largely due to conversion to cropland in the tropics. This deforestation is the most significant aspect of land surface change affecting global warming. The main causes of deforestation are: permanent land-use change from forest to agricultural land producing products such as beef and palm oil (27%), logging to produce forestry/forest products (26%), short term shifting cultivation (24%), and wildfires (23%).

In addition to affecting greenhouse gas concentrations, land-use changes affect global warming through a variety of other chemical and physical mechanisms. Changing the type of vegetation in a region affects the local temperature, by changing how much of the sunlight gets reflected back into space and how much heat is lost by evaporation. For instance, the change from a dark forest to grassland makes the surface lighter, causing it to reflect more sunlight. Deforestation can also contribute to changing temperatures by affecting the release of aerosols and other chemical compounds that influence clouds, and by changing wind patterns. In tropic and temperate areas the net effect is to produce significant warming, while at latitudes closer to the poles a gain of albedo (as forest is replaced by snow cover) leads to an overall cooling effect. Globally, these effects are estimated to have led to a slight cooling, dominated by an increase in surface albedo.

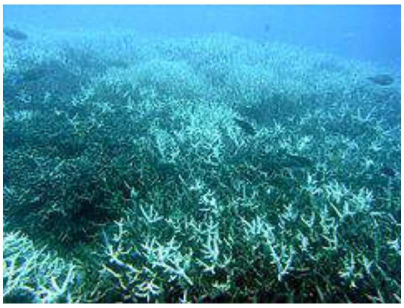
Deforestation

IMPACTS

PHYSICAL ENVIRONMENT

The environmental effects of climate change are broad and far-reaching, affecting oceans, ice, and weather. Changes may occur gradually or rapidly. Evidence for these effects comes from studying climate change in the past, from modelling, and from modern observations. Since the 1950s, droughts and heat waves have appeared simultaneously with increasing frequency. Extremely wet or dry events within the monsoon period have increased in India and East Asia. The maximum rainfall and wind speed from hurricanes and typhoons is likely increasing. Frequency of tropical cyclones has not increased as a result of climate change. While tornado and severe thunderstorm frequency has not increased as a result of climate change, the areas affected by such phenomena may be changing.

Climate change impacts on the environment:



Threaten reefs worldwide

Drought and high temperatures worsened bushfires

Global sea level is rising as a consequence of glacial melt, melt of the ice sheets in Greenland and Antarctica, and thermal expansion. Between 1993 and 2017, the rise increased over time, averaging 3.1 ± 0.3 mm per year. Over the 21st century, the IPCC projects that in a very high emissions scenario the sea level could rise by 61–110 cm. Increased ocean warmth is undermining and threatening to unplug Antarctic glacier outlets, risking a large melt of the ice sheet and the possibility of a 2-meter sea level rise by 2100 under high emissions.

Climate change has led to decades of shrinking and thinning of the Arctic sea ice, making it vulnerable to atmospheric anomalies. While ice-free summers are expected to be rare at 1.5 °C (2.7 °F) degrees of warming, they are set to occur once every three to ten years at a warming level of 2.0 °C (3.6 °F). Higher atmospheric CO_2 concentrations have led to changes in ocean chemistry. An increase in dissolved CO_2 is causing oceans to acidify. In addition, oxygen levels are decreasing as oxygen is less soluble in warmer water, with hypoxic dead zones expanding as a result of algal blooms stimulated by higher temperatures, higher CO_2 levels, ocean deoxygenation, and eutrophication.

NATURE AND WILDLIFE

Recent warming has driven many terrestrial and freshwater species pole ward and towards higher altitudes. Higher atmospheric CO_2 levels and an extended growing season have resulted in global greening, whereas heat waves and drought have reduced ecosystem productivity in some regions. The future balance of these opposing effects is unclear. Climate change has contributed to the expansion of drier climate zones, such as the expansion of deserts in the subtropics. The size and speed of global warming is making abrupt changes in ecosystems more likely. Overall, it is expected that climate change will result in the extinction of many species.

The oceans have heated more slowly than the land, but plants and animals in the ocean have migrated towards the colder poles faster than species on land. Just as on land, heat waves in the ocean occur more frequently due to climate change, with harmful effects found on a wide range of organisms such as corals, kelp, and seabirds. Ocean acidification is impacting organisms who produce shells and skeletons, such as mussels and barnacles, and coral reefs; coral reefs have seen extensive bleaching after heat waves. Harmful algae bloom enhanced by climate change and cause anoxia, disruption of food webs and massive large-scale mortality of marine life. Coastal ecosystems are under particular stress, with almost half of wetlands having disappeared as a consequence of climate change and other human impacts.

Habitat destruction. Many arctic animals rely on sea ice, disappearing.

Pest propagation. Kill large swaths of forest

HUMANS

The effects of climate change on humans, mostly due to warming and shifts in precipitation, have been detected worldwide. Regional impacts of climate change are now observable on all continents and across ocean regions, with low-latitude, less developed areas facing the greatest risk. Continued emission of greenhouse gases will lead to further warming and long-lasting changes in the climate system, with potentially “severe, pervasive and irreversible impacts” for both people and ecosystems. Climate change risks are unevenly distributed, but are generally greater for disadvantaged people in developing and developed countries.

Agricultural changes. Droughts

Tidal flooding. Sea-level rise increases

Food and health

Health impacts include both the direct effects of extreme weather, leading to injury and loss of life, as well as indirect effects, such as under nutrition brought on by crop failures. Various infectious diseases are more easily transmitted in a warmer climate, such as dengue fever, which affects children most severely, and malaria. Young children are the most vulnerable to food shortages, and together with older people, to extreme heat.[178] The World Health Organization (WHO) has estimated that between 2030 and 2050, climate change is expected to cause approximately 250,000 additional deaths per year from heat exposure in elderly people, increases in diarrheal disease, malaria, dengue, coastal flooding, and childhood under nutrition. Over 500,000 additional adult deaths are projected yearly by 2050 due to reductions in food availability and quality. Other major health risks associated with climate change include air and water quality. The WHO has classified human impacts from climate change as the greatest threat to global health in the 21st century.

Climate change is affecting food security and has caused reduction in global mean yields of maize, wheat, and soybeans between 1981 and 2010.Future warming could further reduce global yields of major crops. Crop production will probably be negatively affected in low-latitude countries, while effects at northern latitudes may be positive or negative. Up to an additional 183 million people worldwide, particularly those with lower incomes, are at risk of hunger as a consequence of these impacts. The effects of warming on the oceans impact fish stocks, with a global decline in the maximum catch potential. Only polar stocks are showing an increased potential. Regions dependent on glacier water, regions that are already dry, and small islands are at increased risk of water stress due to climate change.

Livelihoods

Economic damages due to climate change have been underestimated, and may be severe, with the probability of disastrous tail-risk events being nontrivial. Climate change has likely already increased global economic inequality, and is projected to continue doing so. Most of the severe impacts are expected in sub-Saharan Africa and South-East Asia, where existing poverty is already exacerbated. The World Bank estimates that climate change could drive over 120 million people into poverty by 2030. Current inequalities between men and women, between rich and poor, and between different ethnicities have been observed to worsen as a consequence of climate variability and climate change. An expert elicitation concluded that the role of climate change in armed conflict has been small compared to factors such as socio-economic inequality and state capabilities, but that future warming will bring increasing risks. Low-lying islands and coastal communities are threatened through hazards posed by sea level rise, such as flooding and permanent submergence. This could lead to statelessness for populations in island nations, such as the Maldives and Tuvalu. In some regions, rise in temperature and humidity may be too severe for humans to adapt to. With worst-case climate change, models project that almost one-third of humanity might live in extremely hot and uninhabitable climates, similar to the current climate found mainly in the Sahara. These factors, plus weather extremes, can drive environmental migration, both within and between countries. Displacement of people is expected to increase as a consequence of more frequent extreme weather, sea level rise, and conflict arising from increased competition over natural resources. Climate change may also increase vulnerabilities, leading to "trapped populations" in some areas who are not able to move due to a lack of resources.

Environmental changes can cause desertification

Environmental changes cause flooding

We can make a difference

You can take action. You can take steps at home, on the road, and in your office to reduce greenhouse gas emissions and the risks associated with climate change. Many of these steps can save you money; some, such as walking or biking to work, can even improve your health! You can also get involved on a local or state level to support energy efficiency.

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Environmental Studies Project

NEC TAMEN CONSUMEBATUR

Scottish Church College

Estd. 1830

College Roll No. : CMSA20F189

B.Sc.(Hons.) Semester 2 (Under CBCS)

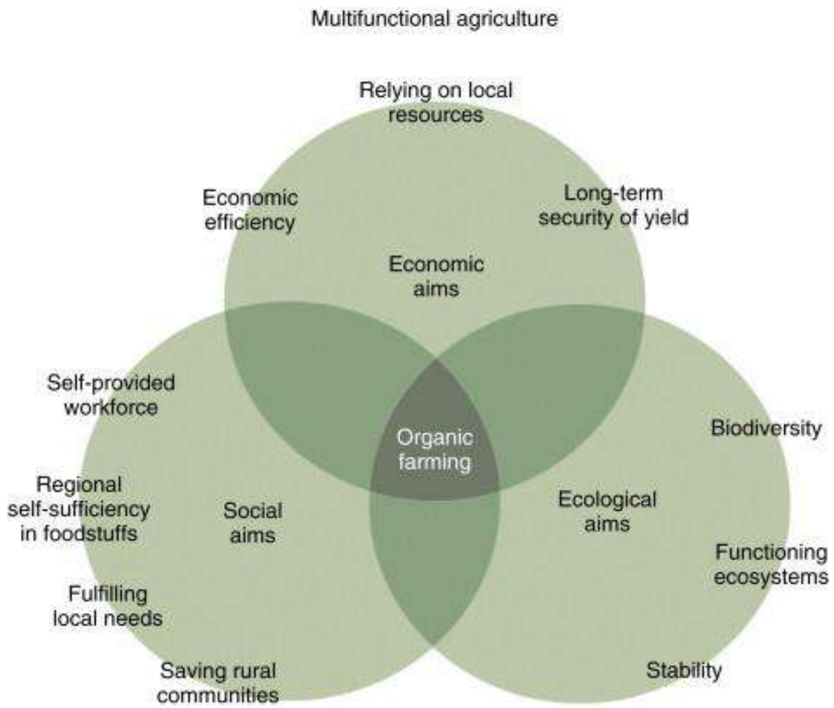
CU Roll No. : 203223-11-0070

CU Registration No. : 223-1211-0433-20


ORGANIC
FARMING

DEFINITION

Organic farming (OF) has developed as a reaction to negative effects of modern industrialized agriculture in the twentieth century. These effects, mostly caused by use of agrochemicals, are contamination of individual components of the environment, decrease in soil fertility, decrease in plant vitality and immunity, decrease in biodiversity, and lowered quality of food with negative effect on human health. Another reason for OF development was intensive animal industry which brought cruelty to animals, increased use of medicaments, use of low-quality feed, bad health condition of animals, and their reduced life span. Nowadays, OF is defined by law and government-issued trademarks for organic foodstuffs. OF is financially supported within rural development programs (Agro-environmental and food-quality programs) market are growing continuously.



ORIGIN

OF methods, as an alternative to conventional agricultural routines, were mostly developed by farmers themselves, then verified in practice and afterward proved by means of science and research.

The concepts of organic agriculture were developed in the early 1900s by Sir Albert Howard, F.H. King, Rudolf Steiner, and others who believed that the use of animal manures (often made into compost), cover crops, crop rotation, and biologically based pest controls resulted in a better farming system.

WHY WE NEED ORGANIC FARMING?

The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all.

The Green Revolution and its chemical-based technology are losing its appeal as dividends are falling and returns are unsustainable. Pollution and climate change are other negative externalities caused by the use of fossil fuel-based chemicals.

In spite of our diet choices, organic food is the best choice you'll ever make, and this means embracing organic farming methods. Here are the reasons why we need to take up organic farming methods:

To Accrue the Benefits of Nutrients

- Food from organic farms are loaded with nutrients because organic farms are managed and nourished using sustainable practices.

Stay Away From GMOs

- Statistics show that Genetically Modified Foods (GMOs) are contaminating natural foods sources at real scary pace, manifesting grave effects beyond our comprehension. So, sticking to organic foods sources from veritable sources is the only way to mitigate these grave effects of GMOs.

Natural and Better Taste

- Organically farmed foods have a natural and better taste. Organic farmers always prioritize quality over quantity.

Direct Support to Farming

- Subsidies and tax cuts from most governments over the past years has led to the proliferation of commercially produced foods that have increased dangerous diseases like cancer.

To Conserve Agricultural Diversity

- In the last century, it is approximated that 75 percent of the agricultural diversity of crops has been wiped out.

To Prevent Antibiotics, Drugs, and Hormones in Animal Products

- Commercial dairy and meat are highly susceptible to contamination by dangerous substances. A statistic in an American journal revealed that over 90% of chemicals the population consumes emanate from meat tissue and dairy products.

FEATURES OF ORGANIC FARMING

Protecting soil quality using organic material and encouraging biological activity

Indirect provision of crop nutrients using soil microorganisms

Nitrogen fixation in soils using legumes

Weed and pest control based on methods like crop rotation, biological diversity, natural predators, organic manures and suitable chemical, thermal and biological intervention

Rearing of livestock, taking care of housing, nutrition, health, rearing and breeding

Care for the larger environment and conservation of natural habitats and wildlife

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PRINCIPLES OF ORGANIC FARMING

The four principles of organic farming – health, fairness, ecology and care – provide a vision for agriculture that inspires environmentally friendly cultivation and production.

Organic farming aims to produce superior quality products, with high nutritional value and no chemicals, with the purpose of good health. It aims to create a sustainable system that conserves energy, soil and water; while at the same time providing general maintenance of the environment.

These principles provide a vision for agriculture that inspires environmentally friendly cultivation and production.

Health 

Fairness 

Ecological Balance 

Care 

1 Principle of Health

- *Organic agriculture must contribute to the health and well being of soil, plants, animals, humans and the earth. It is the sustenance of mental, physical, ecological and social well being. For instance, it provides pollution and chemical-free, nutritious food items for humans.*

2 Principle of Fairness

- *Fairness is evident in maintaining equity and justice of the shared planet both among humans and other living beings. Organic farming provides good quality of life and helps in reducing poverty. Natural resources must be judiciously used and preserved for future generations.*

3 Principle of Ecological Balance

- *Organic farming must be modeled on living ecological systems. Organic farming methods must fit the ecological balances and cycles in nature.*

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4 Principle of Care

- *Organic agriculture should be practiced in a careful and responsible manner to benefit the present and future generations and the environment.*

METHODS OF ORGANIC FARMING

- Crop Diversity
- Soil Management
- Weed Management
- Controlling other organisms
- Livestock
- Genetic Modification

Advantages

- Avoidance in soil pollution
- Easier pollination
- Better nutrition values
- Organic garbage can be composed and reused
- No use of GMOs

Disadvantages

- Significant costs
- Pest issues
- Small farmers can go out of business
- High variance in yield and quality
- Pest Issues

ORGANIC FARMING IN INDIA

Organic farming is in a nascent stage in India. About 2.78 million hectare of farmland was under organic cultivation as of March 2020, according to the Union Ministry of Agriculture and Farmers' Welfare. This is two per cent of the 140.1 million ha net sown area in the country.

A few states have taken the lead in improving organic farming coverage, as a major part of this area is concentrated only in a handful of states. Madhya Pradesh tops the list with 0.76 million ha of area under organic cultivation — that is over 27 per cent of India's total organic cultivation area.

The top three states — Madhya Pradesh, Rajasthan and Maharashtra — account for about half the area under organic cultivation. The top 10 states account for about 80 per cent of the total area under organic cultivation.

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POLLUTION PREVENTION

Pollution prevention is any practice that reduces, eliminates, or prevents pollution at its source. P2, also known as “source reduction,” is the ounce-of-prevention approach to waste management. Reducing the amount of pollution produced means less waste to control, treat, or dispose of. Less pollution means less hazards posed to public health and the environment. Pollution prevention includes: Source reduction, which is any practice that: Reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. Other practices that reduce or eliminate the creation of pollutants through: Increased efficiency in the use of raw materials, energy, water, or other resources, or Protection of natural resources by conservation. Equipment or technology modifications; process or procedure modifications; product reformulation or redesign; substitution of raw materials; or improvements in housekeeping, maintenance, training or inventory control. To consider in-process recycling a pollution prevention activity, it must serve a productive function with the making of the commercial product for which the original process was designed and must be an integral part of that process (i.e., the production process cannot function without the recycling process). Pollution prevention does NOT include: 1. Energy recovery. 2. Treatment of a waste stream. 3. Disposal.

Why is pollution prevention important?

Pollution prevention reduces both financial costs (waste management and clean-up) and environmental costs (health problems and environmental damage). Pollution prevention protects the environment by conserving and protecting natural resources while strengthening economic growth through more efficient production in industry and less need for households, businesses and communities to handle waste.

Pollution prevention (**P2**) is a strategy for reducing the amount of waste created and released into the environment, particularly by industrial facilities, agriculture, or consumers. Many large corporations view P2 as a method of improving the efficiency and profitability of production processes by waste reduction and technology advancements. Legislative bodies have enacted P2 measures, such as the Pollution Prevention Act of 1990 and the Clean Air Act Amendments of 1990 by the United States Congress. A facility that commits to an effective, ongoing P2 program that is dedicated to eliminating, reducing or reusing wastes can often: 1. Save money by reducing waste treatment and transportation costs. 2. Save money by reducing costs for energy, water and raw materials. 3. Minimize compliance issues and costs associated with regulated wastes. 4. Reduce future liability through reduced risks to workers, communities and the environment. 5. Avoid costs of accidents and spills. 6. Improve production times. 7. Enhance public image and community relations.

Significance

Pollution prevention is any action that reduces the number of contaminants released into the environment. Implementation of such processes reduces the severity and/or number of hazards posed to both public health and the environment. Prevention of pollution preserves natural resources and can also have significant financial benefits in large scale processes. If companies produce less waste, they do not have to worry about proper disposal. Thus, P2 is also a proactive measure to reduce costs of waste disposal and elimination.

Pollution Prevention

1. Recycling.

2.Any practice that alters a hazardous substance, pollutant or contaminant once it is generated.

3. A practice that is not necessary for production.

4. Practices that create new risks to human health or the environment

Health hazards

P2 strategies can mitigate many health hazards associated with pollution. Long-term exposure to certain pollutants can cause cancer, heart disease, asthma, birth defects, and premature death. Additionally, pollution of bodies of water can be detrimental to biodiversity.

SOURCE

Ships in port often have engines idling for days, releasing copious amounts of pollutants.

Shipping ports are a significant source of pollution due to the heavy cargo traffic that these areas receive. The impact of these ships is quite widespread, affecting coastal communities and ecosystems across the globe. Most major shipping ports are located near environmentally sensitive estuaries. These areas are particularly impacted by high levels of diesel exhaust, particulate matter, nitrogen oxides, ozone, and sulphur oxides. The solution for reducing port-related pollution is multi-fold, encompassing attainable alternatives and long-term reduction goals. Examples of simple steps include a restriction on engine idling for ships in the port and the use of cleaner grade diesel fuels. Some more expensive measures can be taken to mitigate the pollution of ships. Replacing older model ships with ships containing new engines allows the ships to meet modern emission standards. Exhaust systems can also be retrofitted in order to reduce exhaust emissions. Looking ahead into the future, there are a few technologies being developed. For example, plugging ships into "shore-side" power sources may eliminate the need for idling engines. Additionally, various sources of alternative fuel are being developed, the most significant of which is a fuel cell unit.

Due to increased trade, the emissions from ships are expected to become the second largest source of diesel particulate matter by 2020. One approach to reduction as set forth by the International Forum on Globalization (IFG) is to increase the amount of local trading, thereby reducing the number of miles that ships have to travel. Another approach regards the strategic placement of ports close to land transportation infrastructure (i.e., roads and railroads). Again, this reduces the number of miles that vehicles have to travel between the initial and final destinations. Railroads that reach all the way to ports are a significant way to produce less toxic pollutants, as this eliminates the need for less-efficient trucks to transport the goods from the coastal port to the inland railroad infrastructure.

In 2017, the biggest pollutants included carbon dioxide, nitrogen oxide, hydrocarbons, lead, and particulate matter according to Theilmann in the U.S. Clean Air Acts. These pollutants harm the environment as well as the citizens living in these areas. The pollutants contribute to climate change and can result in acid rain. Citizens living in car-dominant highly populated areas are at the risk of health issues caused by these pollutants, ranging from chronic cough to death. According to Singh, the groups of people most affected by air pollution include children, people suffering from an underlying chronic disease, the asthmatic, and elderly. These groups are faced with an increase in trips to the hospital, worsened cough, episodes of rhinitis, and asthma attacks. Theilman states that the Clean Air Act has done a successful job at assessing and limiting the pollutants that harm humans from stationary and mobile sources. With policies like the Clean Air Act, and replacement of trees removed by deforestation, humans can reduce their carbon footprint and improve the quality of air.

Pollution Prevention Act of 1990

To promote pollution prevention, the United States Congress passed the Pollution Prevention Act of 1990. Congress declared that pollution should be prevented and reduced wherever possible; in addition, any waste that must be released into the environment must be done in a responsible, environmentally-conscious manner. The law requires the United States Environmental Protection Agency (EPA) to:

- create effective policies
- establish a standard form of measurement of P2

- establish a network and advisory board among EPA offices to coordinate the prevention initiatives and data collection
- create a training program to be distributed to EPA offices
- identify aspects of policies that can be presented to and enforced by Congress
- create a model of source reduction that can be used to teach interested industries of P2 opportunities
- integrate a reward program to encourage companies to comply with regulations.

In order to enforce the points outlined in the act, EPA is directed to present a report to Congress biennially. The act requires that companies fill out a toxic chemical release form allowing EPA to collect information on the levels of pollution released into the environment.

Clean Air Act

The Clean Air Act Amendments of 1990 provided many P2 strategies, including governmental intervention, research and development programs, guidelines for efficient technologies, reduction of vehicle emissions, and a suggested Congressional status report.

2010–2014 Pollution Prevention Program Strategic Plan

The EPA *2010–2014 Pollution Prevention Program Strategic Plan* introduced a number of ways to reduce harmful industrial outputs (i.e., greenhouse gases, hazardous materials) while conserving natural resources

Strategies

P2 task force

In order to reduce costs of P2 techniques, many officials are turning to pollution elimination strategies, thereby eliminating any need for end-of-pipe solutions. A task force was created by the EPA in order to directly target reduction strategies. The P2 program task force has 5 main goals:

I. create feasible P2 objectives and corresponding time frames
II. provide training to the individuals involved in the effort
III. oversee the program's main tasks and measure progress
IV. evaluate the progress of the effort
V. maintain the program's goals long term

In industrial processes

Lumber is an example of a raw material that can be saved through implementation of pollution prevention processes.

The possibilities of P2 strategies in industrial processes are still being implemented at the corporate level, but benefits are already being realized by many companies. The view of P2 in industrial businesses has shifted from one of necessity to one of strategic advantage. If companies invest in P2 methods early in their development, they realize greater gains not too far down the road. Additionally, if companies do not produce waste, they do not have to worry about properly disposing of it. Thus, P2 is a proactive measure taken to reduce costs in the long run that would have been dedicated to disposal and elimination of waste.

There are two main ways to reduce waste through P2: increased efficiency and technology improvements. Waste reduction at the source implies the same amount of input raw materials with less waste and more output of the product. Technology improvements imply changes to the production process that reduce the amount of output waste, such as an improved recycling process. Companies are moving past simply complying with the minimum environmental requirements, and they are taking a more strategic, forward-thinking stance on tackling the issue.

One strategy is "in-process recycling". Though it is not the most efficient form of "reduction at the source", recycling is very profitable due to its ease of process. By engaging in recycling practices, industries not only cut down on the amount of material discarded as environmentally-hazardous waste, but they also increase profitability by reducing the amount of raw material purchased. The most widespread strategy is "reduction at the source", which is the idea that by products of production can be reduced through efficient and careful use of natural resources. This method reduces the number of dangerous pollutants present in waste before the waste is released. In turn, this creates a safer environment free of hazardous waste. This idea ties strongly into the benefits to corporations of investing in newer, more efficient technology.

Slowing the Population Growth

What can be done to slow the human population growth? "Experience shows that the most effective ways to slow human population growth are to encourage family planning, to reduce poverty, and to elevate the status of women (Miller & Spoolman, 2009, p. 133). Such plans and strategies can be converted into policies to ensure sustainability. "Action plans and strategies can be developed to increase public understanding of how rapid population growth limits chances for meeting basic... recycling or reuse.

As an environmental management strategy, pollution prevention shares many attributes with cleaner production, a term used more commonly outside the United States. Pollution prevention encompasses more specialized sub-disciplines including green chemistry and green design (also known as environmentally conscious design).

The US Environmental Protection Agency has a number of P2 programs that can assist individuals and organizations to implement P2.

Indiana Partners for Pollution Prevention

The Indiana Partners for Pollution Prevention is an organization comprised of Indiana industries and businesses that are interested in pollution prevention as well as the financial and environmental benefits P2 projects can bring. The Partners provide a forum where Indiana businesses can network and exchange ideas about P2 experiences and discuss how P2 fits into current and future IDEM programs. The Partners realize that pollution prevention is the arena where the environment and economics can meet on common ground. Consider becoming a Partner if you want to: 1. Network with other Indiana businesses regarding P2. 2. Have your organization be recognized as a pollution prevention leader in Indiana. 3. Hear how other businesses have implemented successful P2 technologies. 4. Learn how P2 can improve your business practices. 5. Stay up-to-date with pollution prevention technologies. 6. Become more aware of and involved in IDEM's efforts to integrate P2 into various programs. 7. Partner with IDEM in a proactive setting.

The Pollution Prevention Plan

To be effective, a pollution prevention plan should contain the following steps:

1. ***Get Organized***

   $ Get senior management's commitment.

   $ Make it a team effort (include employees and management at every level and department).

2. ***Analyse Your Process***

   $ Map out the steps in each process.

   $ Determine the amounts of raw materials used, releases to the environment and waste generated.

   $ Determine the full costs of raw materials use, releases to the environment and waste generation.

   $ Tour your facility and ask questions.

   $ Target processes for pollution prevention.

3. ***Identify P2 Alternatives***

   $ Determine the sources of releases and generated wastes.

$ Hold a brainstorming session.

$ Consider a range of pollution prevention techniques.

$ Encourage employee participation.

$ Seek outside help.

4. ***Evaluate Alternatives***

$ Determine what is feasible.

$ Analyse if production steps can be eliminated.

$ Select alternatives for implementation.

5. ***Implement Projects***

$ Schedule projects and set goals.

6. ***Measure Progress***

$ Account for production variations.

$ Measure the reduction of environmental releases for they may provide an opportunity for fewer regulatory requirements.

$ Publicize success stories.

<u>Eight Ways P2 Can Be Incorporated</u>

1. ***Cost Accounting***
2. ***Purchasing and Inventory Management***
3. ***Packaging, Shipping, and Containers***
4. ***Energy Usage and Efficiency***

5. ***Solvent Usage and Alternatives***
6. ***Water Usage***
7. ***Preventative Maintenance and Housekeeping***
8. ***Employee Training***

Voluntary approaches

Voluntary approaches to P2 are on the rise. Governmental organization often collaborate with businesses and regulatory agencies to create a structure of guidelines. There are four types of voluntary approach programs: public voluntary programs, negotiated agreements, unilateral commitments, and private agreements. Public voluntary agreements are the least restrictive. Environmental authorities collaborate and create specific guidelines. Companies are then invited to follow these procedures on a strictly voluntary basis. Negotiated agreements are created through collaboration between public authorities and industry authorities. The agreement establishes bargains that are beneficial to the industry. Unilateral commitments are established by industry authorities alone, and the guidelines they set are self-regulated. Private agreements are established between "polluters" and other affected parties. The regulations set forth create a compromise regarding a variety of pollution regulation strategies. The United States mainly follows the end-of-pipe prevention strategy. However, US President Richard Nixon created the Environmental Protection Agency (EPA) in 1970, and one of its principal missions was to regulate pollution. EPA's implementation of policies is almost entirely voluntary.

There are a few keys to a successful voluntary approach. First, the program needs a dependable source of funding (from the government, usually). The program also needs a dynamic relationship with the targeted industries. This creates a base of trust between all involved in the agreement. In terms of regulation, the program should be monitored by a reliable source. In order to assure that the program will establish itself long term, there should be visible benefits to the participants and obvious results to the greater community. The long-term establishment of the program also comes from setting attainable goals to measure progress.

Governmental approaches

EPA has published waste minimization guidelines that comprise 5 major steps:

1. organizing the primary task force
2. assessing the current pollution situation
3. evaluating the feasibility of different program options
4. reporting and planning the preparations based upon the analysis
5. implementing the program.

This framework mainly benefits smaller facilities.

Waste reduction algorithm

The EPA makes available software that employs the Waste Reduction Algorithm. They use the acronym WAR for this method and state "the goal of WAR is to reduce environmental and related human health impacts at the design stage". The WAR tracks pollutants through the entire production process in order to obtain accurate measurements.

Industrial efforts

By maximizing P2 opportunities, some companies choose to redesign their entire industrial process. Managers focus more on what enters and moves through the entire process, instead of only focusing on the output. Overall, the P2 strategies that financially benefit companies are the most likely to be implemented. However, since P2 has only recently been realized as a benefit, many corporations have not adopted significant measures to realize the potential gain.

Potential benefits

Pollution prevention can also be viewed as a form of environmental entrepreneurship, as companies see opportunities to reduce costs of waste treatment, storage, and disposal. For example, 3M has accrued a savings of over $750 million since 1973 due to their implementation of P2 incentives. If implemented correctly, P2 strategies can result in an increase in process yield. By reducing the amount of pollution released, companies can avoid some of the liability costs accrued when large amounts of pollution are released and contaminate the land on which the facility is located.

Individual efforts

Installing energy efficient lighting and appliances are a relatively cheap way to reduce pollution on a smaller scale.

According to EPA, there are some everyday steps that can be taken to prevent pollution:

- Use paper in limited quantities, and print double-sided. Also, look for paper that has been made with recycled materials.
- When shopping, buy in bulk in order to reduce the amount of packaging required to package the goods. Look for products made with recycled materials. Bring reusable bags in which to carry purchased goods in order to reduce the number of disposed paper/plastic bags.
- Use water sparingly by installing water-efficient shower heads and faucets, and install energy-efficient appliances. Make sure that sinks and hoses are not dripping. Do not excessively water plants.
- Use transportation efficiently, and utilize mass transportation when possible. Recycling used motor oil is also a way to eliminate the disposal of a hazardous material.

- Eating locally produced foods reduces the amount of fuel required for the food's transportation.

Additional examples of P2 include using energy efficient machinery, developing clean-burning fuel, reducing the amount of chemicals released into water sources, creating a production process that results in a reduced amount of waste, and utilizing water conservation techniques.

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Topic:

Organic Farming

Introduction

What is Organic Farming?

Organic farming is an agricultural system which originated early in the 20th century in reaction to rapidly changing farming practices. Organic farming works in harmony with nature rather than against it. This involves using techniques to achieve good crop yields without harming the natural environment or the people who live and work in it. It is defined by the use of fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. Biological pest control, mixed cropping and the fostering of insect predators are encouraged. Organic standards are designed to allow the use of naturally occurring substances while prohibiting or strictly limiting synthetic substances.

A modern approach to farming

Organic farming does not mean going 'back' to traditional methods. Many of the farming methods used in the past are still useful today. Organic farming takes the best of these and combines them with modern scientific knowledge.

Organic farmers do not leave their farms to be taken over by nature; they use all the knowledge, techniques and materials available to work with nature. In this way the farmer creates a healthy balance between nature and farming, where crops and animals can grow and thrive.

To be a successful organic farmer, the farmer must not see every insect as a pest, every plant out of place as a weed and the solution to every problem in an artificial chemical spray. The aim is not to eradicate all pests and weeds, but to keep them down to an acceptable level and make the most of the benefits that they may provide.

History of Organic Farming

The concepts of organic agriculture were developed in the early 1900s by Sir **Albert Howard, F.H. King, Rudolf Steiner,** and others who believed that the use of animal manures (often made into compost), cover crops, crop rotation, and biologically based pest controls resulted in a better farming system. Howard, having worked in India as an agricultural researcher, gained much inspiration from the traditional and sustainable farming practices he encountered there and advocated for their adoption in the West. Such practices were further promoted by various advocates—such as J.I. Rodale and his son Robert, in the 1940s and onward, who published *Organic Gardening and Farming* magazine and a number of texts on organic farming. The demand for organic food was stimulated in the 1960s by the publication of *Silent Spring*, by Rachel Carson, which documented the extent of environmental damage caused by insecticides.

Growth of demand of Organic Foods

Organic food sales increased steadily from the late 20th century. Greater environmental awareness, coupled with concerns over the health impacts of pesticide residues and consumption of genetically modified (GMO) crops, fostered the growth of the organic sector. In the United States, retail sales increased from $20.39 billion in 2008 to $47.9 billion in 2019, while sales in Europe reached more than $37 billion (€34.3 billion euros) in 2017.

The price of organic food is generally higher than that of conventionally grown food. Depending on the product, the season, and the vagaries of supply and demand, the price of organic food can be anywhere from less than 10 percent below to more than 100 percent above that of conventionally grown produce.

Needs and benefit of Organic Farming

Organic farming provides long-term benefits to people and the environment. Organic farming aims to:

• increase long-term soil fertility.

• control pests and diseases without harming the environment.

• ensure that water stays clean and safe.

• use resources which the farmer already has, so the farmer needs less money to buy farm inputs.

• produce nutritious food, feed for animals and high quality crops to sell at a good price.

Disadvantages of Artificial Farming

Modern, intensive agriculture causes many problems, including the following:

• Artificial fertilisers and herbicides are easily washed from the soil and pollute rivers, lakes and water courses.

• The prolonged use of artificial fertilisers results in soils with a low organic matter content which is easily eroded by wind and rain.

• Dependency on fertilisers. Greater amounts are needed every year to produce the same yields of crops.

• Artificial pesticides can stay in the soil for a long time and enter the food chain where they build up in the bodies of animals and humans, causing health problems.

• Artificial chemicals destroy soil micro-organisms resulting in poor soil structure and aeration and decreasing nutrient availability.

• Pests and diseases become more difficult to control as they become resistant to artificial pesticides. The numbers of natural enemies decrease because of pesticide use and habitat loss.

Methods of Organic Farming

Fertilizers

Since synthetic fertilizers are not used, building and maintaining a rich, living soil through the addition of organic matter is a priority for organic farmers. Organic matter can be applied through the application of manure, compost, and animal by-products, such as feather meal or blood meal.

Due to the potential for harbouring human pathogens, the USDA National Organic Standards mandate that raw manure must be applied no later than 90 or 120 days before harvest, depending on whether the harvested part of the crop is in contact with the ground. Composted manure that has been turned 5 times in 15 days and reached temperatures between 55–77.2 °C (131–171 °F) has no restrictions on application times.

Composting

Compost is organic matter (plant and animal residues) which has been rotted down by the action of bacteria and other organisms, over a period of time. Materials such as leaves, fruit skins and animal manures can be used to make compost. Compost is cheap, easy to make and is a very effective material that can be added to the soil, to improve soil and crop quality.

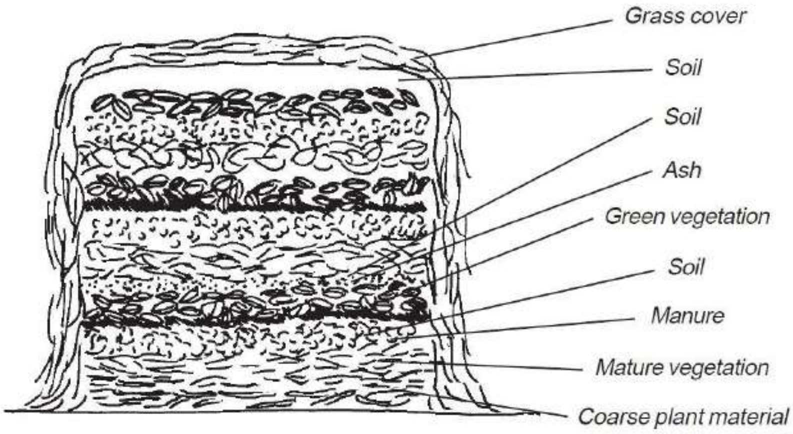
• Compost improves the structure of the soil. This allows more air into the soil, improves drainage and reduces erosion.

• Compost improves soil fertility by adding nutrients and by making it easier for plants to take up the nutrients already in the soil. This produces better yields.

• Compost improves the soil's ability to hold water. This stops the soil from drying out in times of drought.

• Compost can reduce pests and diseases in the soil and on the crop.

Compost has many advantages over chemical fertilisers. These provide nutrients for plants but do not improve soil structure. They usually only improve yields in the season in which they are applied. Because compost feeds soil life and improves soil structure, the beneficial effects are long lasting.



The layers of a compost heap

There are many ways to make compost depending on available materials and climate, for example:

- Indore method
- Bangalore method
- Heating process/Block method
- Chinese high temperature stack
- Pit composting
- Trench composting
- Basket composting
- Boma composting

Farmer managing a compost pile in France.

Mulching

Mulching means covering the ground with a layer of loose material such as Compost, manure, straw, dry grass, leaves or crop residues. Green vegetation is not normally used as it can take a long time to decompose and can attract pests and fungal diseases.

Mulches have several effects on the soil which help to improve plant growth:

• Decreasing water loss due to evaporation

• Reducing weed growth by reducing the amount of light reaching the soil

• Preventing soil erosion

• Increasing the number of micro-organisms in the top soil

• Adding nutrients to the soil and improving soil structure

• Adding organic matter to the soil

Green Manure

Green manures, often known as cover crops, are plants which are grown to improve the structure, organic matter content and nutrient content of the soil. They are a cheap alternative to artificial fertilisers and can be used to complement animal manures.

Growing a green manure is not the same as simply growing a legume crop, such as beans, in a rotation. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower. They are grown for their green leafy material which is high in nutrients and provides soil cover. They can be grown together with crops or alone.

Green manures:

• Increase and recycle plant nutrients and organic matter.

• Improve soil fertility.

• Improve soil structure.

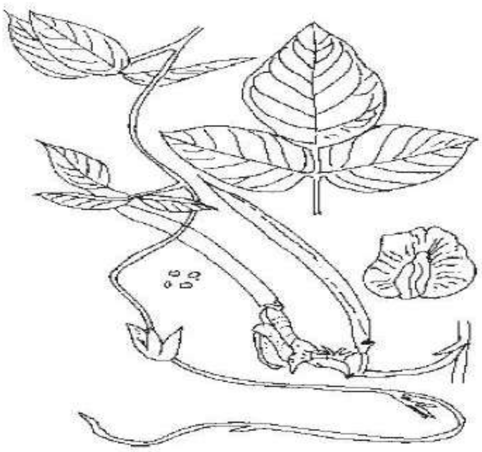
• Improve the ability of the soil to hold water.

• Control soil erosion.

• Prevent weed growth

• Stop nutrients being washed out of the

soil, for example, when the ground is not used between main crops



Centro (Centrosema pubescens), *a useful green manure*

Weed Control

In organic farming systems, the aim is not necessarily the elimination of weeds but their control. Weed control means reducing the effects of weeds on crop growth and yield. Organic farming avoids the use of herbicides which, like pesticides, leave harmful residues in the environment. Beneficial plant life such as host plants for useful insects may also be destroyed by herbicides.

On an organic farm, weeds are controlled using a number of methods:

• Crop rotation

• Hoeing

• Mulches, which cover the soil and stop weed seeds from germinating

• Hand-weeding or the use of mechanical weeders

• Planting crops close together within each bed, to prevent space for weeds to emerge

• Green manures or cover crops to outcompete weeds

• Soil cultivation carried out at repeated intervals and at the appropriate time, when the soil is moist. Care should be taken that cultivation does not cause soil erosion.

• Animals as weeders to graze on weeds

Weeds do have some useful purposes. They can provide protection from erosion, food for animals and beneficial insects and food for human use.

Weeds plants

Pest Control

Hazards of using chemical pesticides

There are a number of harmful effects that chemical pesticides can have on the environment:

• Chemical pesticides can kill useful insects which eat pests. Just one spray can upset the balance between pests and the useful predators which eat them.

• Artificial chemicals can stay in the environment and in the bodies of animals causing problems for many years.

• Insect pests can very quickly, over a few breeding cycles, become resistant to artificial products and are no longer controlled. This means that increased amounts or stronger chemicals are then needed creating further economic, health and environmental problems.

Natural Way of controlling pests by the Organic Farmers

There are many ways in which the organic farmer can control pests and diseases.

• Growing healthy crops that suffer less damage from pests and diseases.

• Choosing crops with a natural resistance to specific pests and diseases. Local varieties are better at resisting local pest and diseases than introduced varieties.

• Timely planting of crops to avoid the period when a pest does most damage.

• Companion planting with other crops that pests will avoid, such as onion or garlic.

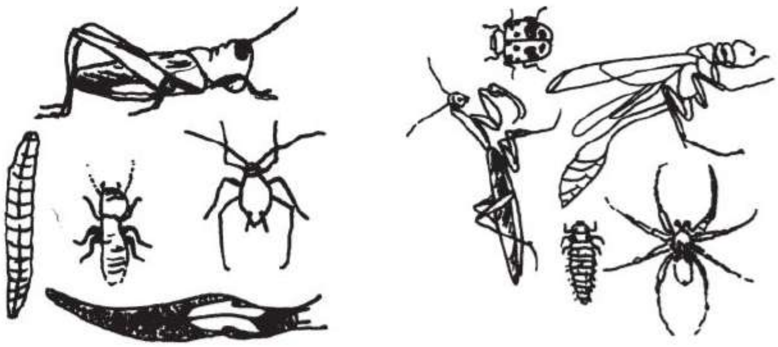
Companion Planting of Onion and Garlic

• Trapping or picking pests from the crop.

• Identifying pest and diseases correctly. This will prevent the farmer from wasting time or accidentally eliminating beneficial insects. It is therefore useful to know life cycles, breeding habits, preferred host plants and predators of pests.

• Using crop rotations to help break pest cycles and prevent a carry-over of pests to the next season.

• Providing natural habitats to encourage natural predators that control pests. To do this, the farmer should learn to recognise insects and other animals that eat and control pests.



Grasshoppers, slugs, termites, aphids and types of caterpillars are pests

Ladybirds, spiders, ground beetles, parasitic wasps and praying mantis are predators

Through careful planning and using all the other techniques available it should be possible to avoid the need for any crop spraying. If pests are still a problem natural products can be used to manage pests, including sprays made from chillies, onions, garlic or neem.

Careful use of water

In arid lands the careful use of water is as much a part of organic growing as is any other technique. Organic farmers should try to use water which is available locally, avoiding using water faster than it is replaced naturally.

There are many ways to use water carefully, including:

• The use of terracing, rain water basins or catchments and careful irrigation.

• The addition of organic matter to the soil to improve its ability to hold water.

• The use of mulches to hold water in the soil by stopping the soil surface from drying out or becoming too hot.

Terracing

Another important thing in Organic Farming is **Choice of Crop.**

Choice of Crops

Each crop and crop variety has its own specific needs. In some places it will grow well and others it will not.

Crops are affected by:

- soil type
- rainfall
- altitude
- temperature
- the type and amount of nutrients required
- the amount of water needed

These factors affect how a crop grows and yields. If a crop is grown in a climate to which it is not suited, it is likely to produce low yields and be more susceptible to pest and diseases. This then creates the need to use agrochemicals to fertilise the crop and control pest and diseases. The successful organic farmer learns to grow the crops and varieties which are suited to the local conditions. He should grow crops which are suited to his geography and climate. He should choose varieties which are suited to the local conditions such as local varieties.

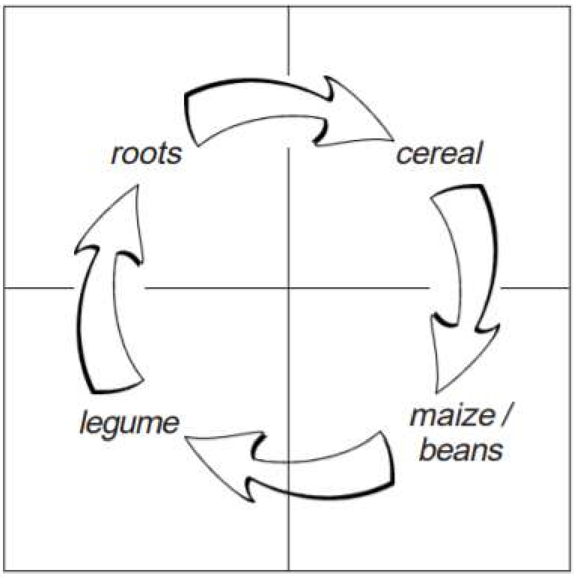
Crop Rotation

Growing the same crops in the same site year after year reduces soil fertility and can encourage a build-up of pests, diseases and weeds in the soil. Crops should be moved to a different area of land each year, and not returned to the original site for several years. For vegetables a 3 to 4 year rotation is usually recommended as a minimum. Crop rotation means having times where the fertility of the soil is being built up and times where crops are grown which remove nutrients. Crop rotation also helps a variety of natural predators to survive on the farm by providing diverse habitats and sources of food for them.

A typical 4 year rotation would include a cycle with maize and beans, a root crop and cereals with either of the following;

1. Grass or bush fallow (a fallow period where no crops are grown).

2. A legume crop where a green manure, which is a plant grown mainly for the benefit of the soil, is grown



A simple rotation that includes a legume

International Standards and Certification of Organic Food

The International Federation of Organic Agriculture Movements (IFOAM) has produced a set of international organic standards, laid down by people from many countries. These give guidelines about what organic farming is and how it should be practised on the farm.

International standards are also used to help countries set their own standards, which take into account different farming systems. Many countries have an organic standards authority which lays down national standards and awards a symbol to farms which have followed the standards. This symbol then allows farmers to market certified organic produce. This is important, as it ensures that people know that the food which they buy is organic.

The main principles of organic farming were laid down by IFOAM in 1992.

- To produce food of high nutritional quality in sufficient quantity.
- To interact in a constructive and life enhancing way with all natural systems and cycles.
- To encourage and enhance biological cycles within the farming system, involving micro-organisms, soil flora and fauna, plants and animals.
- To maintain and increase long term fertility of soils.
- To use, as far as possible, renewable resources in locally organised agricultural systems.
- To work, as far as possible, within a closed system with regard to organic matter and nutrient elements. This aims to reduce external inputs.
- To work, as far as possible, with materials and substances which can be reused or recycled, either on the farm or elsewhere
- To give all livestock living conditions which will allow them to perform the basic aspects of their innate behaviour.
- To minimise all forms of pollution that may result from agricultural practices.
- To maintain the genetic diversity of the agricultural system and its surroundings, including the protection of plant and wildlife habitats.

• To allow agricultural producers a living according to the UN human rights; to cover their basic needs and obtain an adequate return and satisfaction from their work, including a safe working environment.

• To consider the wider social and ecological impact of the farming system.

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3. https://www.epa.gov/agriculture/organic-farming

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CU REGISTRATION NO: 223-1111-0253-20

URBAN ECOLOGY

INDEX

SL NO.	CONTENTS	PAGE NO.

URBAN ECOLOGY

Urban ecology *is the scientific study of the relation of living organisms with each other and their surroundings in the context of an urban environment. The* ***urban environment*** *refers to environments dominated by high-density residential and commercial buildings, paved surfaces, and other urban-related factors that create a* ***unique landscape*** *dissimilar to most previously studied environments in the field of ecology. The goal of urban ecology is to achieve a* ***balance*** *between human culture and the natural environment.*

Central Park represents an ecosystem fragment within a larger urban environment

Urban ecology is a ***recent field of study*** *compared to ecology as a whole. The methods and studies of urban ecology are similar to and comprise a* ***subset of ecology****. The study of urban ecology carries increasing importance because more than 50% of the world's population today lives in urban areas. At the same time, it is estimated that within the next forty years, two-thirds of the world's population will be living in expanding urban centers. The ecological processes in the urban environment are comparable to those outside the urban context. However, the types of* ***urban habitats*** *and the species that inhabit them are poorly documented. Often, explanations for phenomena examined in the urban setting as well as predicting changes because of* ***urbanization*** *are the center for scientific research.*

Hyde Park in London represents the same, as Central Park in NYC...

HISTORY

*Ecology has historically focused on "pristine" natural environments, but by the 1970s many ecologists began to turn their interest towards ecological interactions taking place in, and caused by urban environments. Jean-Marie Pelt's 1977 book **"The Re- Naturalized Human"**, Brian Davis' 1978 publication **"Urbanization and the diversity of insects"**, and Sukopp et al.'s 1979 article **"The soil, flora and vegetation of Berlin's wastelands"** are some of the first publications to recognize the importance of urban ecology as adistinct form of ecology the same way one might see **landscape ecology** as different from **population ecology**. Forman and Godron's 1986 book **"Landscape Ecology"** first distinguished urban settings and landscapes from other landscapes by dividing all landscapes into five broad types. These types were divided by the intensity of human influence ranging from pristine **natural environments** to **urban centers**.*

The creation of an important stream water garden in Metz's centre during the early 70s was one of the materializations of Jean-Marie Pelt's works on urban ecology.

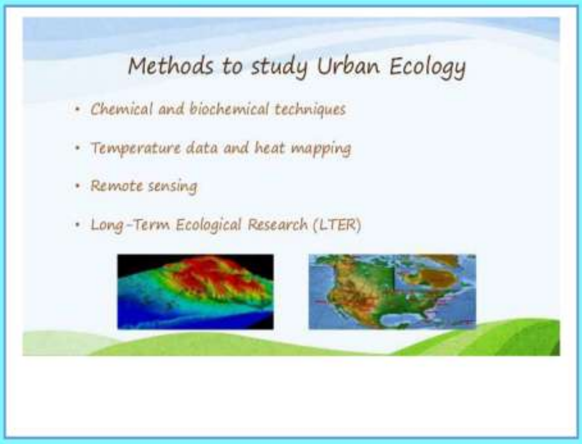
...

*Urban ecology is recognized as a diverse and complex concept which differs in application between North America and Europe. The European concept of urban ecology examines the **biota** of urban areas, the North American concept has traditionally examined the social sciences of the urban landscape, as well as the ecosystem fluxes and processes. The Latin American concept examines the effect of human activity on the biodiversity and fluxes of urban ecosystems. The world's first urban ecology labs were founded, for temperate ecosystems, in 1999 (**Urban Ecology Research Laboratory**, University of Washington), and for tropical ecosystems, in 2008 **Laboratory of Urban Ecology**, Universidad Estatal a Distancia of Costa Rica.*

Botanical Garden in homage to Jean-Marie Pelt

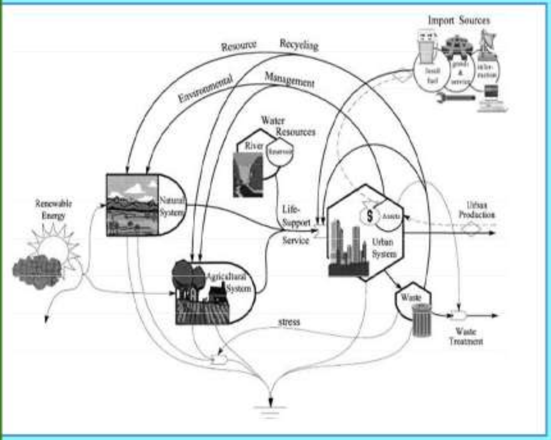
METHODS

Since urban ecology is a subfield of ecology, many of the techniques are similar to that of ecology. Ecological study techniques have been developed over centuries, but many of the techniques use for urban ecology are more recently developed. Methods used for studying urban ecology involve chemical and biochemical techniques, temperature recording, heat mapping remote sensing, and long-term ecological research sites.



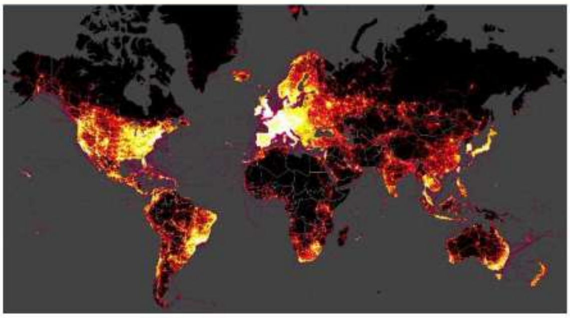
CHEMICAL AND BIOCHEMICAL TECHNIQUES

*Chemical techniques may be used to determine **pollutant concentrations** and their effects. Tests can be as simple as dipping a manufactured test strip, as in the case of pH testing, or be more complex, as in the case of examining the spatial and temporal variation of **heavymetal contamination** due to industrial runoff. Other chemical techniques include tests for **nitrates, phosphates, sulfates**, etc. which are commonly associated with **urban pollutants** such as **fertilizer** and industrial byproducts. These biochemical fluxes are studied in the atmosphere (e.g., **greenhouse gasses**), **aquatic ecosystems** and **soil vegetation**. Broad reaching effects of these biochemical fluxes can be seen in various aspects of both the urban and surrounding rural ecosystems.*



TEMPERATURE DATA AND HEAT MAPPING

Temperature data can be used for various kinds of studies. An important aspect of temperature data is the ability to correlate temperature with various factors that may be affecting or occurring in the environment. Oftentimes, temperature data is collected long-term by the Office of Oceanic and Atmospheric Research (OAR), and made available to the scientific community through the National Oceanic and Atmospheric Administration (NOAA). Heat maps can be used to view trends and distribution over time and space.



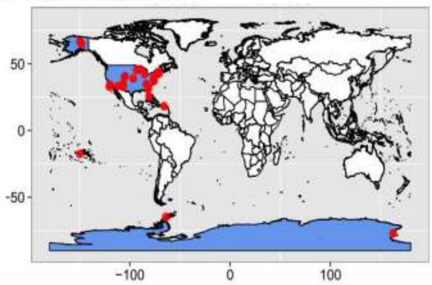
Heat map of the world

REMOTE SENSING & LTERS

Remote sensing of Boston

Remote sensing is the technique in which data is collected from distant locations through the use of satellite imaging, radar, and aerial photographs. In urban ecology, remote sensing is used to collect data about terrain, weather patterns, light, and vegetation. One application of remote sensing for urban ecology is to detect the productivity of an area by measuring the photosynthetic wavelengths of emitted light. Long-term ecological research (LTER) sites are research sites funded by the government that have collected reliable long-term data over an extended period oftime in order to identify long-term climatic or ecological trends. The main purpose of LTERs for urban ecologists

Global LTER sites



is the collection of vast amounts of data over long periods of time.

URBAN EFFECTS ON THE ENVIRONMENT

*Humans are the driving force behind urban ecology and influence the environment in a variety of ways, such as **modifying** land surfaces and waterways, introducing foreign species, and altering biogeochemical cycles. Some of these effects are more apparent, such as the reversal of the **Chicago River** to accommodate the growing pollution levels and trade on the river. Other effects can be more gradual such as the change in global climate due to urbanization.*

MODIFICATION OF LAND AND WATERWAYS

*Humans place high demand on land not only to build urban centers, but also to build surrounding suburban areas for housing. Land is also allocated for agriculture to sustain the **growing population** of the city. Key examples of this are **Deforestation in the United States** and**Europe**.*

Deforestation in Europe

*Along with manipulation of land to suit human needs, natural water resources such as rivers and streams are also modified in urban establishments. Modification can come in the form of dams, artificial canals, and even the reversal of rivers. Reversing the flow of the Chicago River is a major example. Urban areas in natural desert settings often bring in water from far areas to maintain the human population and will likely have effects on the local desert climate. Modification of **aquatic systems** in urban areas also results in decreased stream diversity and increased pollution.*

Reversing Chicago River took the city out of swamps and turned it into a bustling metropolis.

TRADE, SHIPPING & SPREAD OF INVASIVE SPECIES

Both local shipping and long-distance trade are required to meet the resource demands important in maintaining urban areas. ***Carbon dioxide emissions*** *from the transport of goods also contribute to accumulating* ***greenhouse gases*** *and nutrient deposits in the soil and air of urban environments. In addition, shipping facilitates the unintentional spread of living organisms,and introduces them to environments that they would not naturally inhabit.*

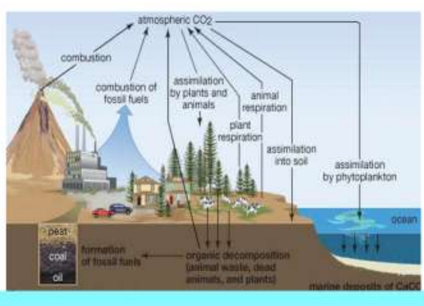
***Kudzu* unfurling in Lancaster County**

Alien species often have no natural predators and pose a substantial threat to the dynamics of existing ecological populations in the new environment where they are introduced. Such invasive species are numerous, and include ***European starlings, brown rats, Asian carp, Americanbullfrogs,*** *among others. In Australia, it has been found that removing Lantana (L.* ***camara****, an alien species) from* ***urban green spaces*** *can surprisingly have negative impacts on bird diversity.*

Invasive species on ships

HUMAN EFFECTS ON BIOGEOCHEMICAL PATHWAYS

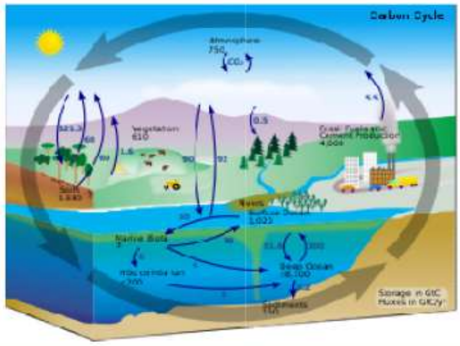
Biogeochemical Cycle



Urbanization results in a large demand for chemical use by industry, construction, agriculture, and energy providing services. Such demands have a substantial impact on **biogeochemical cycles**, resulting in phenomena such as **acid rain**, **eutrophication**, and **global warming**. Furthermore, natural biogeochemical cycles in the urban environment can be impeded due to impermeable surfaces that prevent nutrients from returning to the soil, water, and atmosphere.

Demand for **fertilizers** to meet agricultural needs exerted by expanding urban centers can alter chemical composition of soil. Such effects often result in abnormally high concentrations of compounds including sulfur, phosphorus, nitrogen, and heavy metals. In addition, nitrogen and phosphorus used in fertilizers have caused severe problems in the form of **agricultural runoff**, which alters the concentration ofthese compounds in local rivers and streams, often resulting in adverse effects on native species. A well-known effect of agricultural runoff is the phenomenon of eutrophication. When the fertilizer chemicals from agricultural runoff reach the ocean, an **algal bloom** results, then rapidly dies off. The dead algae biomass is decomposed by bacteria that also consume large quantities of oxygen, which they obtain from the water, creating a **"dead zone"** without oxygen for fish or other organisms. A classic example is the dead zone in the **Gulf of Mexico** due to agricultural runoff into the **Mississippi River**.

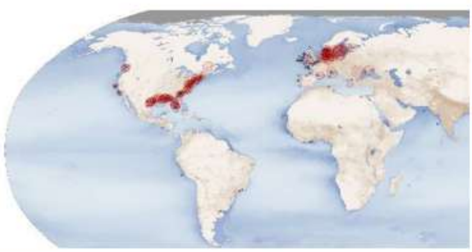
Carbon Cycle



Polluted agricultural runoffs

Just as pollutants and alterations in the biogeochemical cycle alter river and **ocean ecosystems**, they exert likewise effects in the air. Some stems from the accumulation of chemicals and pollution and often manifests in urban settings, which has a great impact on local plants and animals. Because urban centers are often considered point sources for pollution, unsurprisingly local plants have adapted to withstand such conditions.

Aquatic Dead Zones

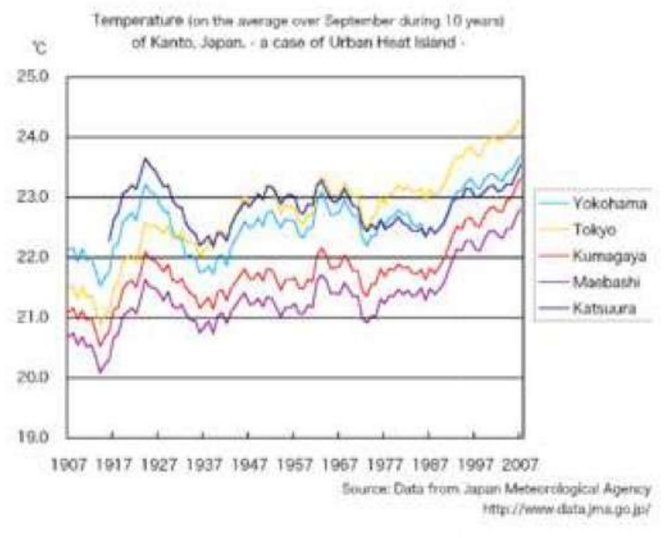


URBAN EFFECTS ON CLIMATE

*Urban environments and outlying areas have been found to exhibit unique local temperatures, **precipitation**, and other characteristic activity due to a variety of factors such as pollution and altered geochemical cycles. Some examples of the urban effects on climate are **urban heat island**, **oasis effect**, **greenhouse gases**, and **acid rain**. This further stirs the debate as to whether urban areas should be considered a unique **biome**. Despite common trends among all urban centers, the surrounding local environment heavily influences much of the climate. One such example of regional differences can be seen through the urban heat island and oasiseffect.*

URBAN HEAT ISLAND EFFECT

*The **urban heat island** is a phenomenon in which central regions of urban centers exhibit higher mean temperatures than surrounding urban areas. Much of this effect can be attributed to low city **albedo**, the reflecting power of a surface, and the increased surface area of buildings to absorb solarradiation. Concrete, cement, and metal surfaces in urban areas tend to absorbheat energy rather than reflect it, contributing to higher urban temperatures. Brazel et al. found that the urban heat island effect demonstrates a positive correlation with population density in the city of Baltimore. The heat island effect has corresponding ecological consequences on resident species. However, this effect has only been seen in temperate climates.*



Graphical representation of the rising temperature in Kanto, Japan due to urban heat island

WAYS TO IMPROVE URBAN ECOLOGY

*Cities should be **planned** and constructed in such a way that minimizes the urban effects on the surrounding environment (urban heat island, precipitation, etc.) as well as **optimizing ecological activity**. For example, increasing the **albedo**, or reflective power, of surfaces in urban areas, can minimize urban heat island, resulting in a lower magnitude of the urban heat island effect in urban areas. By minimizing these abnormal temperature trends and others, ecological activity would likely be improved in the urban setting.*

SPECIES REINTRODUCTION

*Reintroduction of species to urban settings can help improve the local **biodiversity** previously lost; however, the following guidelines should be followed in order to avoid undesired effects:*

- *No predators capable of killing children will be reintroduced to urbanareas.*
- *No introduction of species that significantly threaten human health, pets, crops or property.*
- *Reintroduction will not be done when it implies significant suffering to the organisms being reintroduced, for example stress from capture or captivity.*
- *Reintroduced organisms will receive food supplementation and veterinary assistance asneeded.*
- *Organisms that carry pathogens and whose genes threaten the genetic pool of other organisms in the urban area will not bereintroduced.*
- *Reintroduction will be done in both experimental and control areas to produce reliable assessments (monitoring must continue afterwards to trigger interventions ifnecessary).*
- *Reintroduction must be done in several places and repeated over several years to buffer for stochasticevents*

SUSTAINABILITY & GREEN INFRASTRUCTURE IMPLEMENTATION

With the ever-increasing ***demands forresources*** *necessitated by urbanization, recent campaigns to move toward sustainable energy and* ***resource consumption****, such as LEED* ***certification*** *of buildings,* ***Energy Star*** *certifiedappliances,and* ***zero emission*** *vehicles, have gained momentum.* ***Sustainability*** *reflects techniques and consumption ensuring reasonably low resource use as a component of urban ecology. Techniques such as carbon recapture may also be used to* ***sequester*** *carboncompounds produced in urban centers rather continually emitting more of the* ***greenhouse gas****.*

Biogas plant in Japan

Urban areas can be converted to areas that are more conducive to hosting wildlife through the application of ***green infrastructure****. Although the opportunities of green infrastructure (GI) to benefit human populations have been recognized, there are also opportunities to conserve wildlife diversity. GI can be defined as features that were engineered with natural elements or natural features. This natural constitution helps prevent wildlife exposure to man- made toxicants. In some cases, GI even preserved comparable measures of biodiversity to natural components.*

Green Infrastructure

URBAN GREEN SPACE

Eco Park, Newtown, Kolkata- An urban green space

Dallas Trinity Park-An urban green space

In land-use planning, urban green space is open-space areas reserved for parks and other "green spaces", including plant life, water features -also referred to as blue spaces- and other kinds of natural environment. Most urban open spaces are green spaces, but occasionally include other kinds of open areas. The landscape of urban open spaces can range from playing fields to highly maintained environments to relatively naturallandscapes. Generally considered open to the public, urban green spaces are sometimes privately owned,suchas higher education campuses, neighborhood/community parks/gardens, and institutional or corporate grounds. Areas outside city boundaries, are not considered urban open space. Urban greening policies are important for revitalizing communities, reducing financial burdens of healthcare and increasing quality of life.

The creation of an important stream water garden in Metz's centre during the early 70s was one of the materializations of Jean-Marie Pelt's works on urban ecology.

...

INCREASING WILDLIFE HABITAT CONNECTIVITY

Corridors made across European highways for increasing wildlife habitat connectivity

The implementation of wildlife corridors throughout urban areas (and in between wildlife areas) would promotewildlifehabitat ***connectivity****. Habitat connectivity is critical for ecosystem health and wildlife conservation yet is being compromisedbyincreasing* ***urbanization****. Urban green spaces that arelinkedby* ***ecosystem corridors*** *have higher ecosystem health. The usage of* ***green infrastructure*** *that is connected to natural habitats has been shown to reap greater biodiversity benefits than GI implemented in areas far from natural habitats. GI close to natural areas may also increase functional connectivity in natural environments.*

CONCLUSION

Urban ecosystems are expanding around the world as people migrate to cities and the human population continues to grow. What happens to other species as these urban ecosystems expand, and how species live and interact in established urban ecosystems, is the central focus of urban ecology.

Chicago-An urban ecological society

Urbanization results in a series of both local and far-reaching effectson ***biodiversity****,* ***biogeochemical cycles****,* ***hydrology****, and* ***climate****, among many other stresses. Many of these effects are not fully understood, as urban ecology has only recently emerged as a scientific discipline and much more research remains to be done. Research on cities outside the US and Europe remains limited. Observations on the impact of urbanization on biodiversity and species interactions are consistent across many studies but definitive mechanisms have yet to be established. Urban ecology constitutes an important and highly relevant subfield of ecology, and further study must be pursued to more fully understand the effects of human urban areas on the environment.*

Stockholm-Uncovering an urban ecological system

Urban Ecology – A modern necessity

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Firstly I want to thank my respected teachers and our principal for giving me this opportunity to do this wonderful project which helped me to learn a lot of new things.
Secondly I want to thank my parents for helping me complete this project on time.

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- https://www.slideshare.net/

Also I got help from the notes and ppt presentations provided by my envs teachers

ENVS: Remote Sensing & Geographic Information Systems

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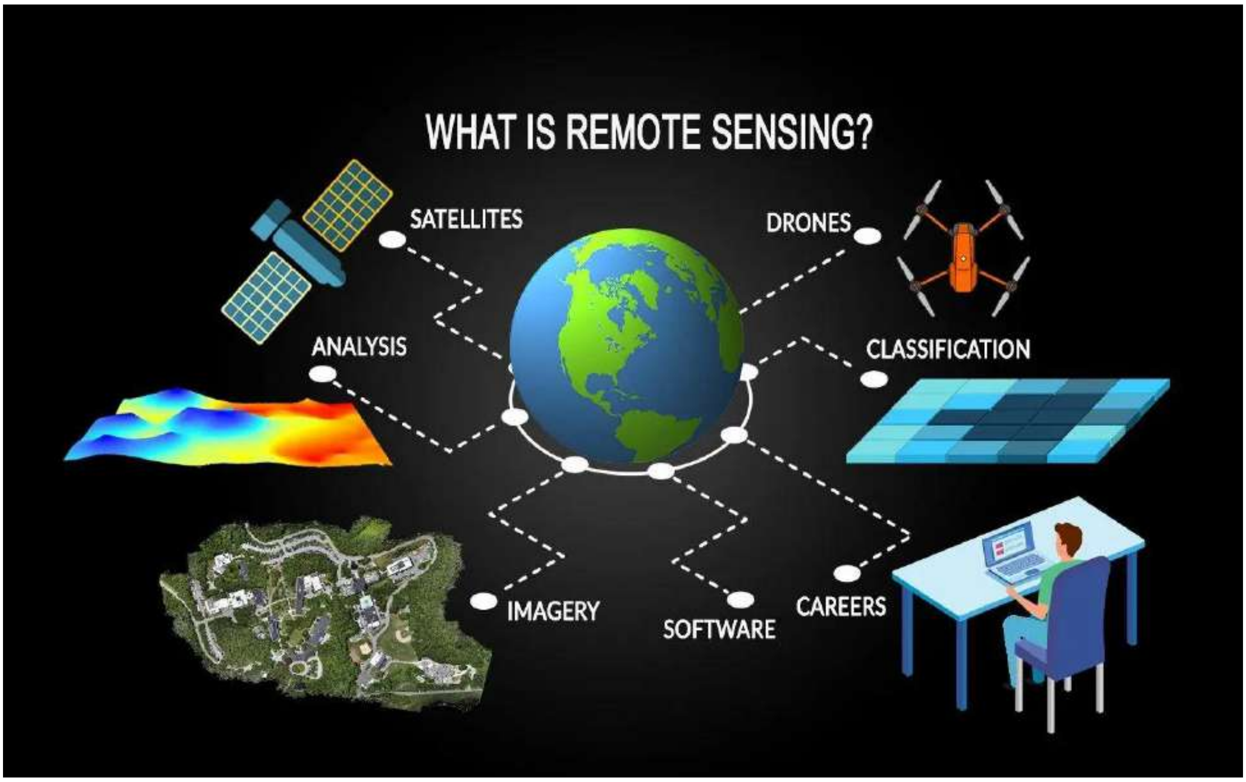
B.Sc.(Hons.) Semester 2

(Under CBCS)

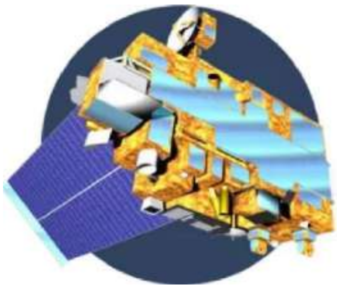
Remote Sensing and Geographic Information Systems



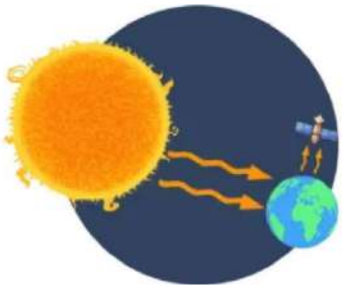
Remote sensing is the science of obtaining the physical properties of an area without being there.

It allows users to capture, visualize, and analyse objects and features on the Earth's surface.

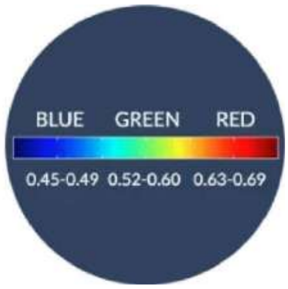
CONTENTS



Sensor Types



Types of Remote Sensing



Electromagnetic Spectrum

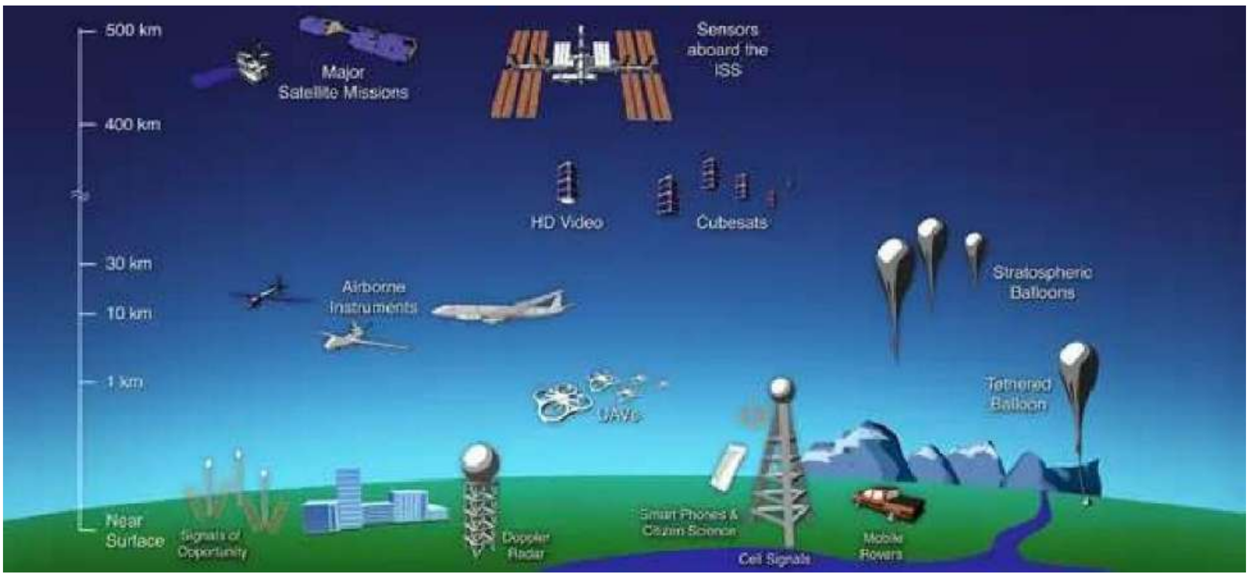
Image Classification

Uses and Applications

Sensor Types

Remote sensing uses a sensor to capture an image. For example, airplanes, satellites, and UAVs have specialized platforms that carry sensors.

The diagram below shows the major remote sensing technologies and their typical altitudes.



TYPES OF SENSORS

Each type of sensor has its own advantages and disadvantages. When you want to capture imagery, you must consider factors like flight restrictions, image resolution and coverage.

For example, satellites capture data on a global scale. But drones are a better fit for flying in small areas. Finally, airplanes and helicopters take the middle ground.

IMAGE RESOLUTION

For earth observation, you also must consider image resolution. Remote sensing divides image resolution into three different types:

- Spatial resolution
- Spectral resolution
- Temporal resolution

SPATIAL RESOLUTION

Spatial resolution is the detail in pixels of an image. High spatial resolution means more detail and smaller pixel size. Whereas lower spatial resolution means less detail and larger pixel size.

Typically, drones like DJI capture images with one of the highest spatial resolution. Even though satellites are highest in the atmosphere, they are capable of 50cm pixel size or greater.

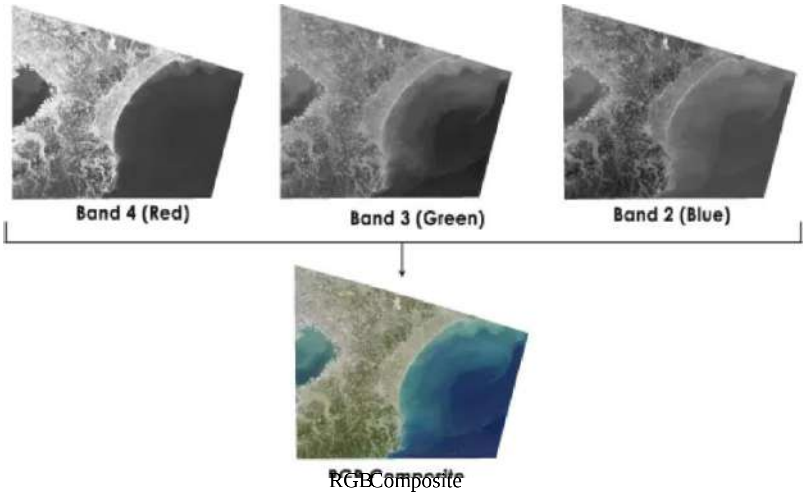
High Spatial Resolution

Medium Spatial Resolution

Low Spatial Resolution

SPECTRAL RESOLUTION

Spectral Resolution is the amount of spectral detail in a band. High spectral resolution means its bands are narrower. Whereas low spectral resolution has broader bands covering more of the spectrum.



TEMPORAL RESOLUTION

Temporal Resolution is the time it takes for a satellite to complete a full orbit. UAVs, airplanes, and helicopters are completely flexible. But satellites orbit the Earth in set paths.

Global position system satellites are in medium Earth orbit (MEO). Because they follow a continuous orbital path, revisit times are consistent. This means our GPS receiver can almost always achieve 3 satellites or greater for high accuracy.

TYPES OF ORBITS

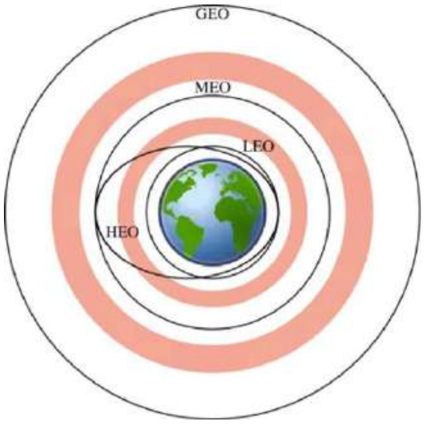
The three types of orbits are:

- Geostationary orbits match the Earth's rate of rotation.
- Sun synchronous orbits keep the angle of sunlight on the surface of the Earth as consistent as possible.
- Polar orbits passes above or nearly above both poles of Earth.

It is the satellite height above the Earth's surface that determines the time it takes for a complete orbit. If a satellite has a higher altitude, the orbital period increases. We categorize orbits by their altitude:

- Low Earth Orbit (LEO)
- Medium Earth Orbit (MEO)
- High Earth Orbit (HEO)

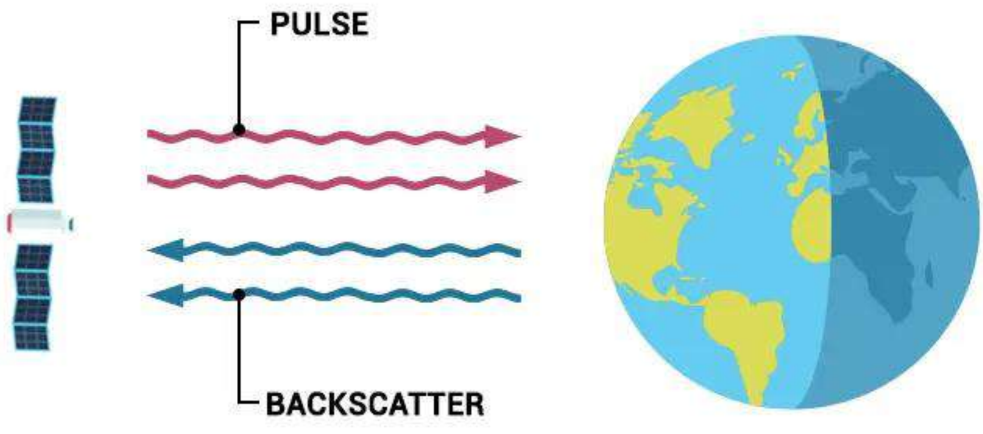
We often find the weather, communications, and surveillance satellites in high Earth orbit. But CubeSats, the ISS, and other satellites are often in low Earth orbit.



ACTIVE SENSORS

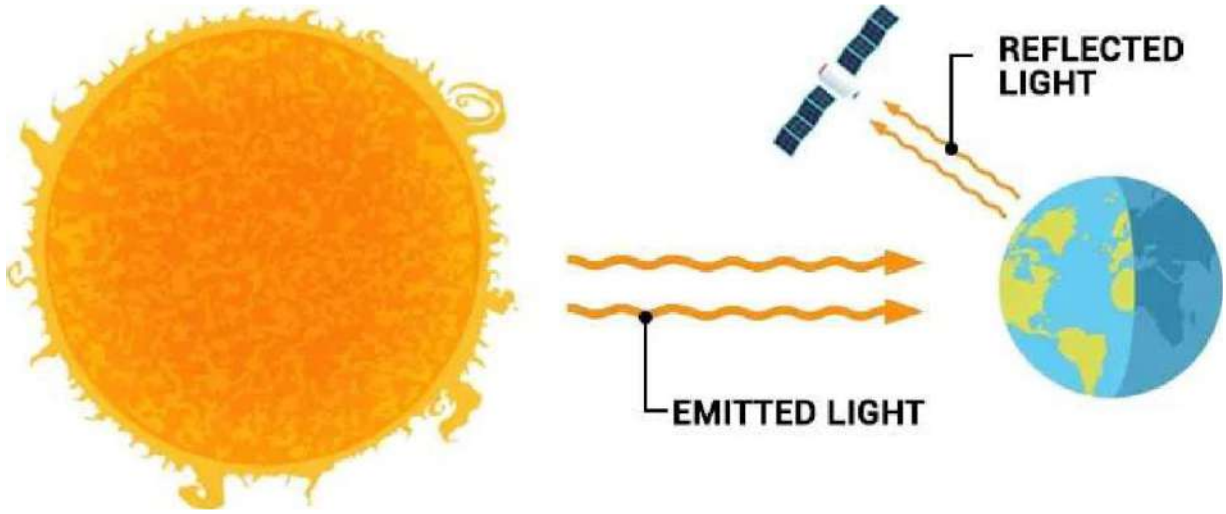
The main difference between active sensors is that this type of sensor illuminates its target. Then, active sensors measure the reflected light. For example, Radarsat-2 is an active sensor that uses synthetic aperture radar.

Imagine the flash of a camera. It brightens its target. Next, it captures the return light. This is the same principle of how active sensors work.



PASSIVE SENSORS

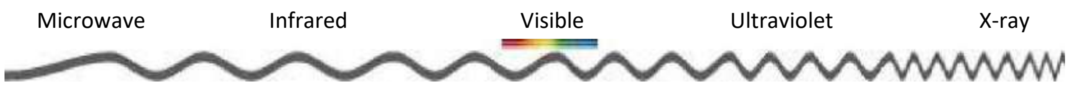
Passive sensors measure reflected light emitted from the sun. When sunlight reflects off Earth's surface, passive sensors capture that light.
For example, Landsat and Sentinel are passive sensors. They capture images by sensing reflected sunlight in the electromagnetic spectrum.



Passive remote sensing measures reflected energy emitted from the sun. Whereas active remote sensing illuminates its target and measures its backscatter.

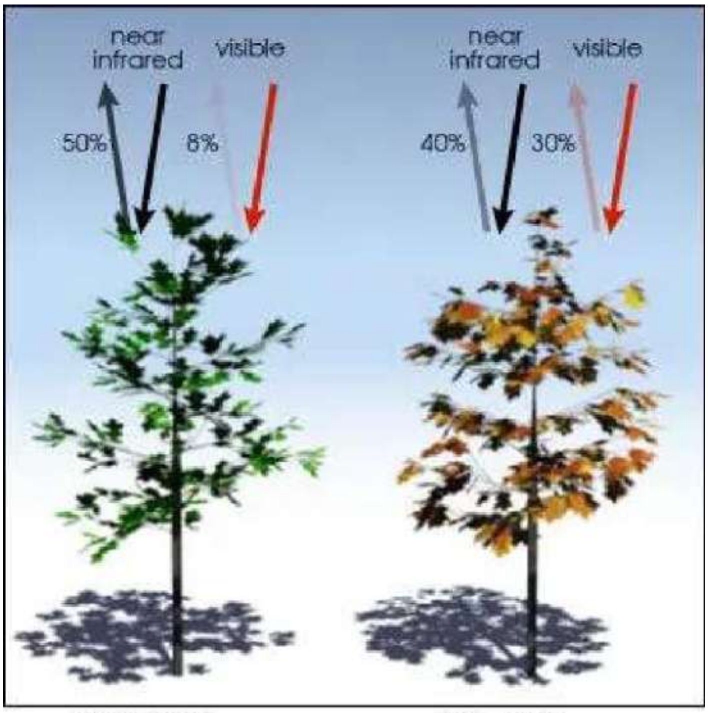
The Electromagnetic Spectrum

The electromagnetic spectrum ranges from short wavelengths (like X-rays) to long wavelengths (like radio waves).
Our eyes only see the visible range (red, green, and blue). But other types of sensors can see beyond human vision. Ultimately, therefore remote sensing is so powerful.



ELECTROMAGNETIC SPECTRUM

Our eyes are sensitive in the visible spectrum (390-700 nm). But engineers design sensors to capture beyond these wavelengths in the atmospheric window.
For example, near-infrared (NIR) is in the 700-1400 nm range. Vegetation reflects more green light because that is how our eyes see it. But it is even more sensitive to near infrared. That is why we use indexes like NDVI to classify vegetation.



$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72 \qquad \frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

SPECTRAL BANDS

Spectral bands are groups of wavelengths. For example, ultraviolet, visible, near-infrared, thermal infrared, and microwave are spectral bands.

We categorize each spectral region based on its frequency (v) or wavelength. There are two types of imagery for passive sensors:

- Multispectral imagery
- Hyperspectral imagery

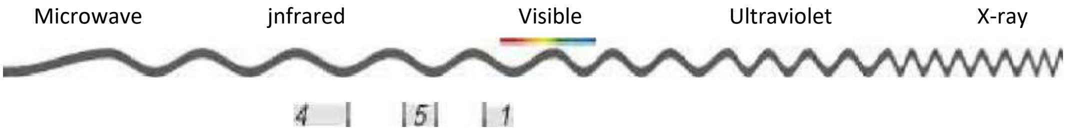
The main difference between multispectral and hyperspectral is the number of bands and how narrow the bands are. Hyperspectral images have hundreds of narrow bands, multispectral images consist of 3-10 wider bands.

MULTISPECTRAL

Multispectral imagery generally refers to 3 to 10 bands. For example, Landsat-8 produces 1 1 separate images for each scene.

- Coastal aerosol (0.43-0.45 um)
- Blue (0.45-0.51 um)
- Green (0.53-0.59 um)
- Red (0.64-0.67 um)
- Near infrared NIR (0.85-0.88 um)
- Short-wave infrared SWIR 1 (1.57-1.65 um)

- Short-wave infrared SWIR 2 (2.1 1-2.29 um)
- Panchromatic (0.50-0.68 um)
- Cirrus (1.36-1.38 um)
- Thermal infrared TIRS 1 (10.60-1 1.19 um)
- Thermal infrared TIRS 2 (1 1.50-12.51 um)



HYPERSPECTRAL

Hyperspectral imagery has much narrower bands (10-20 nm). A hyperspectral image has hundreds of thousands of bands.
For example, Hyperion (part of the EO-I satellite) produces 220 spectral bands (0.42.5 um).

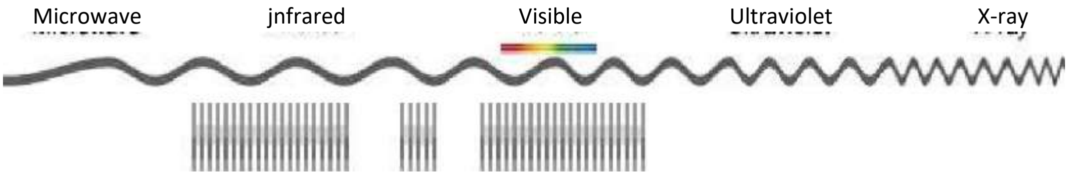


Image Classification

When you examine a photo and you try to pull out features and characteristics from it, this is the act of using image interpretation. We use image interpretation in forestry, military, and urban environments.
We can interpret features because all objects have their own unique chemical composition. In remote sensing, we distinguish these differences by obtaining their spectral signature.

SPECTRAL SIGNATURES

In the mining industry, there are over 4000 natural minerals on Earth. Each mineral has its own chemical composition that makes it different from others.

It is the objects' chemical composition that drives its spectral signature. You can classify each mineral because it has its own unique spectral signature. When you have more spectral bands, this gives greater potential in image classification. A spectral signature is the amount of energy reflected in a particular wavelength. Differences in spectral signatures are how we tell objects apart.

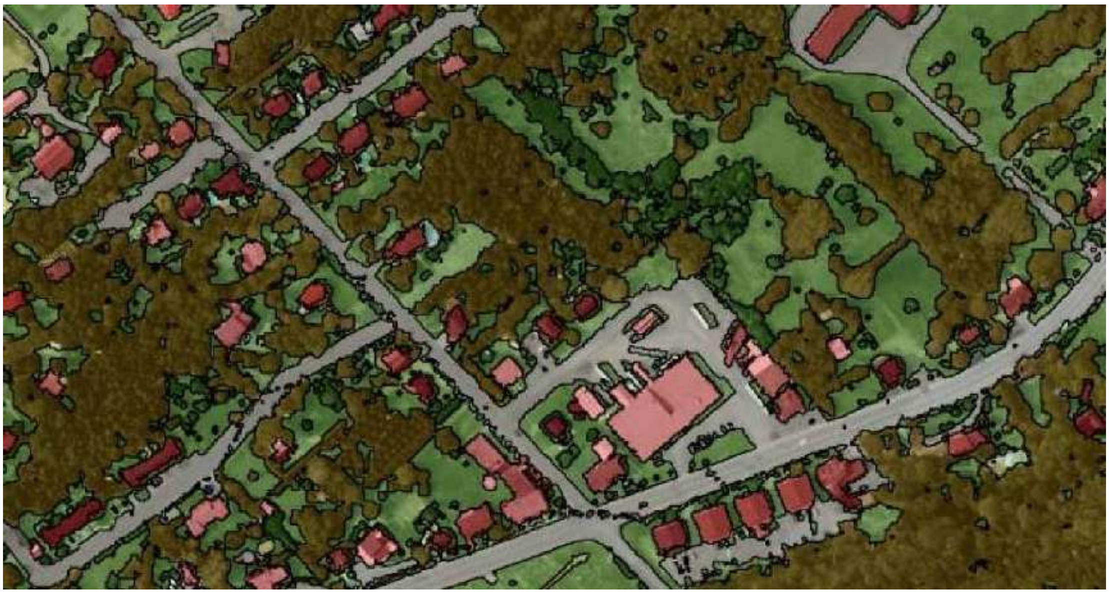
IMAGE CLASSIFICATION

When you assign classes to features on the ground, this is the process of image classification.

The three main methods to classify images are:

- Supervised classification
- Unsupervised classification
- Object-based image analysis

The goal of image classification is to produce land use/land cover. By using remote sensing software, this is how we classify water, wetlands, trees, and urban areas in land cover.



Applications and Uses

There are hundreds of applications of remote sensing. From weather forecasting to GPS, it is satellites in space that monitor, protect, and guide us in our daily lives.

LOCAL ISSUES

Commonly, we use UAVs, helicopters, and airplanes for local issues. But satellites can also be useful for local study areas as well.

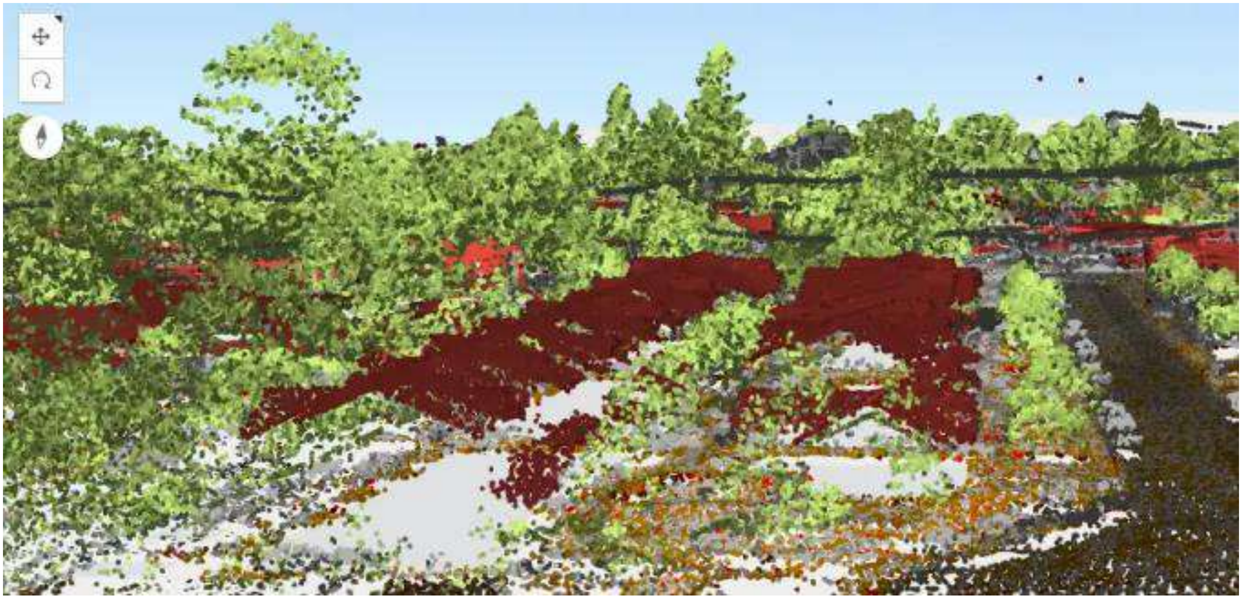
Here are some of the common sensor technologies:

- Light Detection and Ranging (LiDAR)
- Sound navigation ranging (Sonar)
- Radiometers and spectrometers

We use Light Detection and Ranging (LiDAR) and Sonar are ideal for building topographic models. But the main difference between the two is their use cases. While LiDAR is best suited for the ground, Sonar works better underwater.

By using these technologies, we build digital elevation models.

Using these topographic models, we can predict flooding risk, archaeological sites, and delineating watersheds (to name a few).



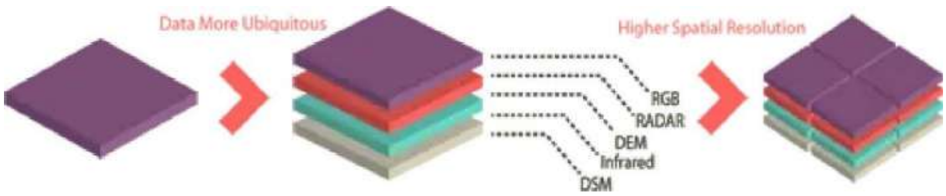
GLOBAL ISSUES

As the world becomes more globalized, we are just starting to see the proliferation of remote sensing. For example, satellites tackle issues including:

- Navigating with global positioning systems
- Climate change monitoring
- Arctic surveillance

Satellite information is fundamentally important if we are going to solve some of the major challenges of our time. All things considered; it is an expanding field reaching new heights.

For issues like climate change, natural resources, disaster management, and the environment, remote sensing provides a wealth of information on a global scale.



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AECC2 ENVS PROJECT

COLLAGE ROLL NO- CMSA20M173

CU ROLL NO- 203223-21-0036

CU REGISTRATION NUMBER – 223-1111-0269-20

TOPIC

CLIMATE CHANGE

INTRODUCTION

Physicians may be hesitant to talk about climate change because they aren't experts in climate science. In this section, you will find basic information about climate change — what it is, what causes it, and what we can do about it. But you don't need to be a climate scientist to talk about the risk's climate change poses to human health, or the health benefits of taking action on climate change. When physicians have a patient with a complex or rare illness, they often seek guidance from a sub-specialist with extensive training and education on that illness. Climate scientists are like sub-specialists — they are trained to understand climate patterns, and the sophisticated models that forecast those patterns in the future. If you were to consult with 100 climate scientists, you would find that:

97% of climate scientists agree:

- Climate change is happening now.
- It is being driven primarily by human activity.
- We can do something to reduce its impacts and progression.

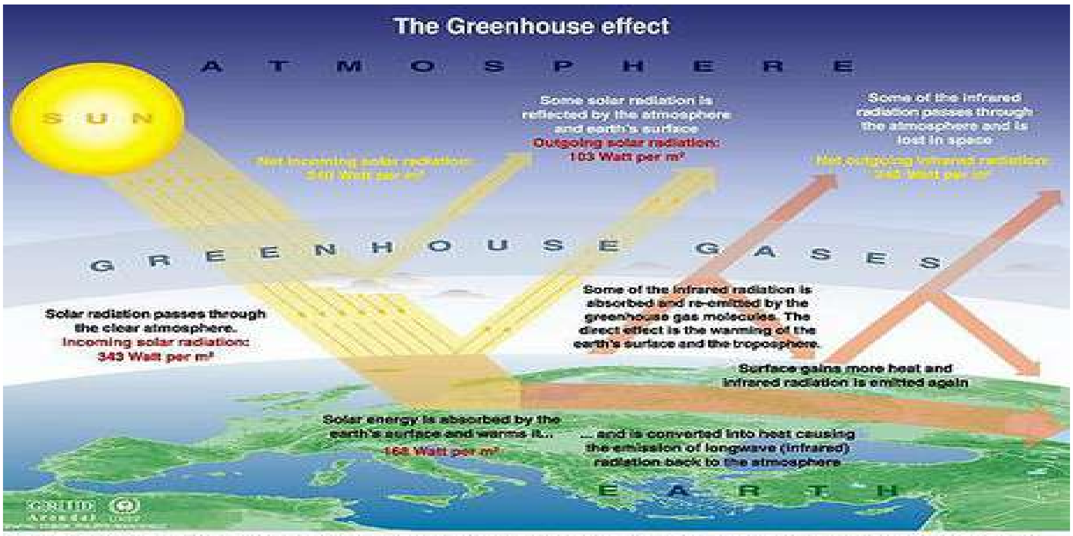
What's the difference between weather, climate, climate variability and climate change?

- Weather is the temperature, humidity, precipitation, cloudiness and wind that we experience in the atmosphere at a given time in a specific location.
- Climate is the average weather over a long time period (30 – 50 years) in a region.
- Climate variability refers to natural variation in climate that occurs over months to decades. El Niño, which changes temperature, rain and wind patterns in many regions over about 2 – 7 years, is a good example of natural climate variability, also called natural variability.

• Climate change is “a systematic change in the long-term state of the atmosphere over multiple decades or longer.” Scientists use statistical tests to determine the probability that changes in the climate are within the range of natural variability — similar to the statistical tests used in clinical trials to determine whether a positive response to treatment is likely to have occurred by chance. For example, there is a less than 1% chance that the warming of the atmosphere since 1950 could be the result of natural climate variability.

WHAT CAUSES CLIMATE CHANGE?

At its most basic, climate change is caused by a change in the earth’s energy balance — how much of the energy from the sun that enters the earth (and its atmosphere) is released back into space. The earth is gaining energy as we reduce the amount of solar energy that is reflected out to space — just like people gain weight if there is an imbalance between calories in and calories out. Since the Industrial Revolution started over 200 years ago, human activities have added very large quantities of greenhouse gases (GHG) into Earth’s atmosphere. These GHG act like a greenhouse (or a blanket or car windshield) to trap the sun’s energy and heat, rather than letting it reflect back into space. When the concentration of GHG is too high, too much heat is trapped, and the earth’s temperature rises outside the range of natural variability. There are many GHG, each with a different ability to trap heat (known as its “global warming potential”) and a different half-life in the atmosphere. GHG are sometimes called “climate active pollutants” because most have additional effects, most notably on human health.



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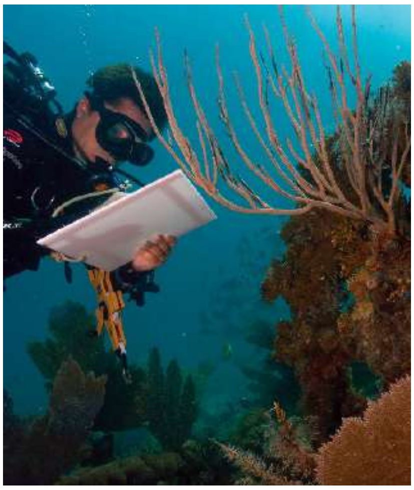
Summary Table of Greenhouse Gas Emissions:-

Name	% of U.S. GHG Emissions 2013	Sources	Lifetime in the Atmosphere	Global Warming Potential (GWP)
Carbon Dioxide (CO_2)	82%	Electricity production, transportation, numerous industrial processes.	Approximately 50-200 years. Poorly defined because CO_2 is not destroyed over time; it moves among different parts of the ocean–atmosphere–land system.	1
Methane (CH_4)	10%	Livestock manure, food decomposition; extraction, distribution and use of natural gas	12 years	25
Nitrous oxide (N_2O)	5%	Vehicles, power plant emissions	115 years	298
Black carbon (soot, PM)	>1%	Diesel engines, wildfires biomass in household cook stoves (developing countries)	Days to weeks	3,200
Fluorinated gases: PFCs, HFCs, NF_3, SF_6	>5%	No natural sources. These are synthetic pollutants found in coolants, aerosols, pesticides, solvents, fire extinguishers. Also used in the transmission electricity.	PFCs: 2600 – 50,000 years HFCs: 1-270 years NF_3: 740 years SF_6: 3200 years	PFCs: 7,000–12,000 HFCs: 12–14,000 NF_3: 17,2000 SF_6: 22,800

Why Short-Lived Climate Pollutants Matter

The greenhouse gases with a high global warming potential but a short lifetime in the atmosphere are called "short-lived climate pollutants" (SLCP). Key SLCP include methane, black carbon, and the fluorinated gases. Because of the combination of a short half-life and high GWP, the climate change impacts of the SLCP are front-loaded — more of the impacts occur sooner, while the full weight of impacts from CO_2 will be felt later.



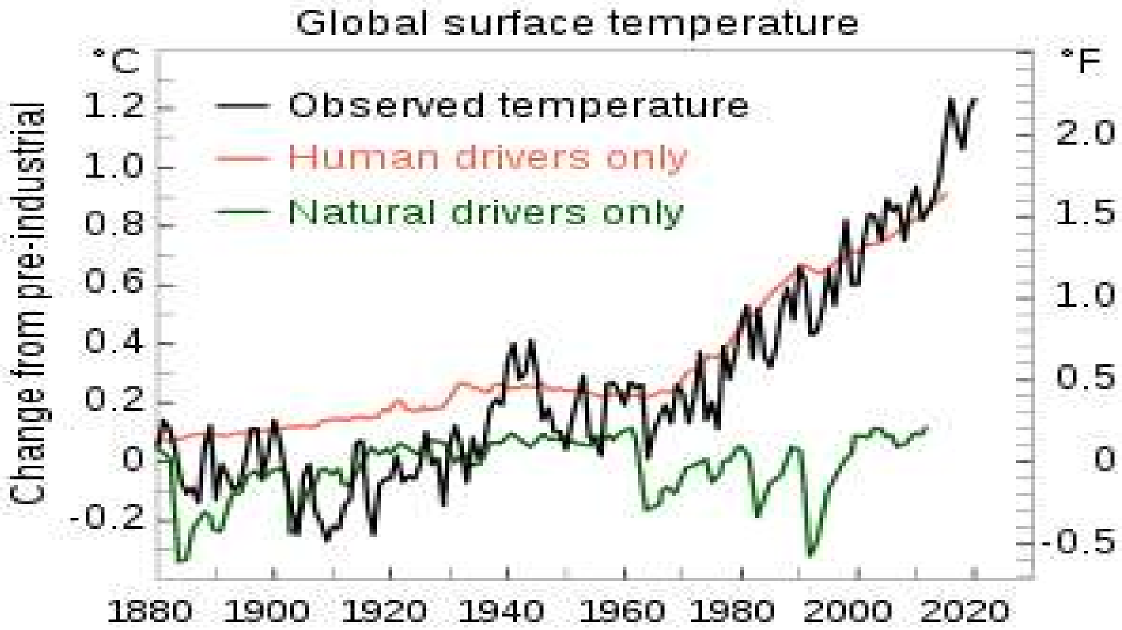
We must transition to carbon-free transportation and energy systems, because CO_2 remains the greatest contributor to climate change. But reducing emissions of short-lived climate pollutants may "buy time" while we make the transition.

Reducing global levels of SLCP significantly by 2030 will:

- Reduce the global rate of sea level rise by 20% by 2050
- Cut global warming in half, or 0.6° C, by 2050 and by 1.4° C by 2100
- Prevent 2.4 million premature deaths globally each year
- Improve health, especially for disadvantaged communities

CLIMATE CHANGE IS CAUSING FIVE CRITICAL GLOBAL ENVIRONMENTAL CHANGES:

WARMING TEMPERATURE OF THE EARTH'S SURFACE AND THE OCEANS: The earth has warmed at a rate of 0.13° C per decade since 1957, almost twice as fast as its rate of warming during the previous century.



Changes in the global water cycle ('hydrologic' cycle): Over the past century there have been distinct geographical changes in total annual precipitation, with some areas experiencing severe and long-term drought and others experiencing increased annual precipitation. Frequency and intensity of storms increases as the atmosphere warms and is able to hold more water vapor.

DECLINING GLACIERS AND SNOWPACK: Across the globe, nearly all glaciers are decreasing in area, volume and mass. One billion people living in river watersheds fed by glaciers and snowmelt are thus impacted.

SEA LEVEL RISE: Warmer water expands, so as oceans warm the increased volume of water is causing sea level rise. Melting glaciers and snowpack also contribute to rising.

OCEAN ACIDIFICATION: Oceans absorb about 25% of emitted CO_2 from the atmosphere, leading to acidification of seawater.

These global changes result in what we experience as changes in our local weather and climate:

Greater variability, with "wetter wets", "drier dries" and "hotter hots"

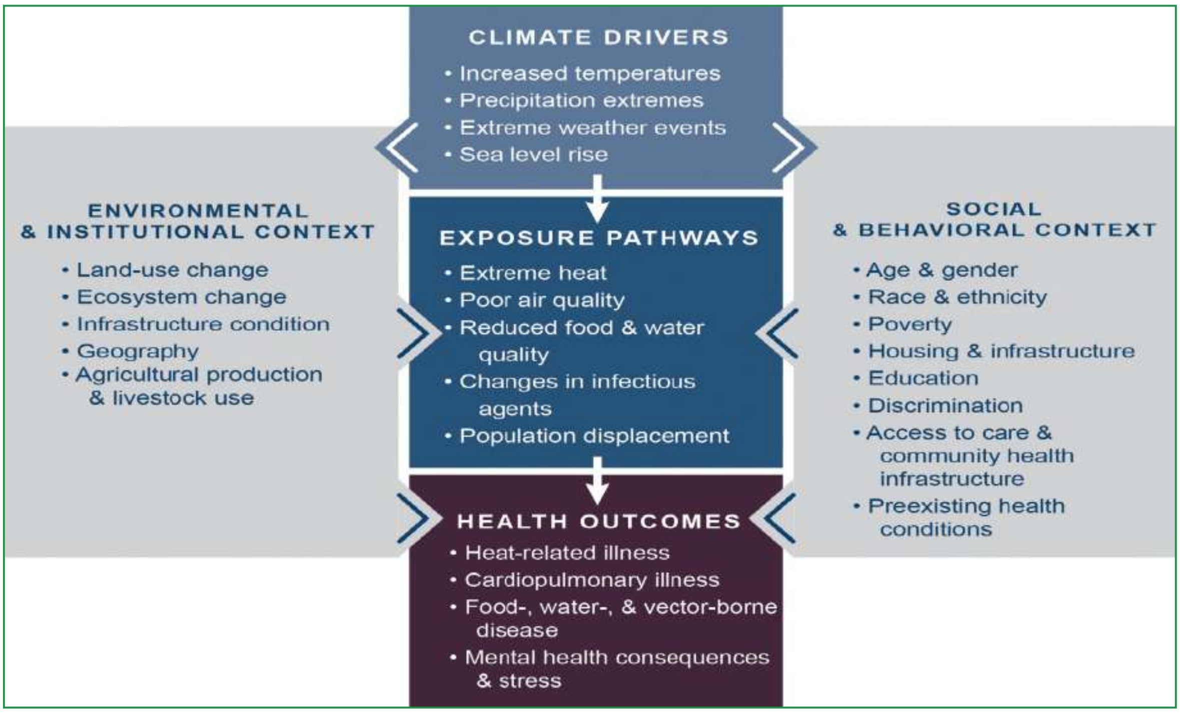
- More frequent and severe extreme heat events
- More severe droughts
- More intense precipitation, such as severe rains, winter storms and hurricanes

Higher average temperatures and longer frost-free seasons

Longer wildfire seasons and worse wildfires

Loss of snowpack and earlier spring runoff

Recurrent coastal flooding with high tides and storm surges



CLIMATE CHANGE AND INDIA:

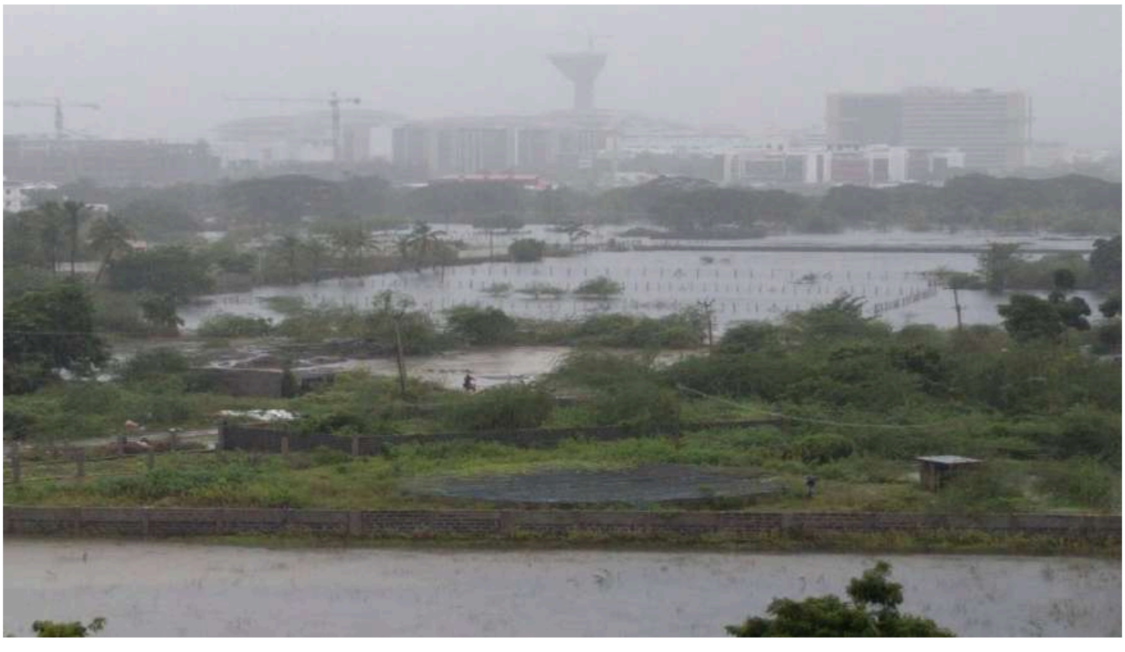
One of the major areas that will be impacted by climate change in its extremity in the near future is South Asia, especially India mainly because of its diverse terrain.12 Climate change is expected to have a serious impact in this region as the country is rapidly exhausting its natural resources thereby destroying its environment mostly due to “urbanizationindustrialization and economic growth.” 13 India faces an alarming environmental and socioeconomic challenge in its effort to protect its fast depleting natural resources. Water and air quality are worsening day by day due to increase of various pollutants in the atmosphere. In addition, the sectors that will be subjected to the highest exposure to climate change are the country’s coastal eco-systems, biodiversity and agricultural productivity.14 Besides, the region is already subject to natural hazards, such as the 2013 Uttarakhand floodslandslides, the 2015 Chennai flood and the 2016 drought. There is also an evidence of prominent increases in the intensity and/or frequency of many extreme weather events such as heat waves, extended dry spells and intense rainfall. The adverse impacts of such disasters range from hunger, vulnerability to diseases, loss of income and livelihoods.15 As per the World Bank, an increase of 2°C in the world’s average temperature in the next few decades will only make India’s monsoon more unpredictable. The shift in rain patterns across India is predicted to leave a number of areas under water and others without enough water even for drinking.16 “In India, more than 60% of the crop area is rain-fed, making it highly vulnerable to climate-induced changes in precipitation patterns. It is estimated that by the 2050s, with a temperature increase of 2°C-2.5°C compared to pre-industrial levels, water for agricultural production in the river basins of the Indus, Ganges and Brahmaputra will reduce further and may impact food adequacy for some 63 million people.” 17 A warmer climate is also expected to slow down the poverty reduction rate. Though climate change will affect everyone’s lives in the region, it is the poor who will be the most affected as they are the once largely dependent on rain-based agriculture and have no or minimal resources to sustain their livelihood. An increase of 2°C by the 2040s is going to hit crop production in South Asia too and will reduce the crop output by 12%, requiring more imports to meet demands at home. Also, decreasing food availability would give rise to considerable

UTTARAKHAND DISASTER 2013:

On 16 June 2013, the state of Uttarakhand witnessed one of the worst disasters in recent times that caused extensive damage and destruction to both life and property. The state was hit by very heavy rainfall and flash floods. Every district in the state was affected. The five worst hit districts of the state were Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi.20 The disaster took place in the peak tourist and pilgrimage season that led to an increase in the number of casualties and also affected the speed of the rescue and relief operations. The impact of the disaster was most evident in the Mandakini valley of the Rudraprayag district. 21 Torrential rains led to flooding at the Kedarnath Shrine and the adjacent areas. Several other pilgrimage centers in the state, including Gangotri, Yamunotri and Badrinath, which are also popular among thousands of devotees during the summer season, were affected.22 People were left stranded for days and had to take shelter in the mountains. Over one lakh people were stuck in various regions due to damaged roads, landslides and flash flood-induced debris. As per official reports of the State Government on 09 May 2014, a total of 169 people died and 4021 people were reported missing or presumed to be dead. Though the report did not directly say that climate change is the reason behind the floods but it certainly pointed in that direction. On the basis of statistical analysis, the report says that the high rainfall recorded in June 2013 was a century-scale event and that climate change can be held responsible for increased likelihood of such extreme events.

CHENNAI FLOODS 2015:

"The city of Chennai recorded multiple torrential rainfall events during November-December 2015 that inundated the coastal districts of Chennai, Kancheepuram and Tiruvallur, and affected more than 4 million people with economic damages that cost around US$3 billion."26 As per the Deputy Director General of the Delhi based Centre for Science and Environment, the Chennai floods were the direct outcome of the increasing global temperature breaking a 100 year old record with one day's rainfall covering a month's average.



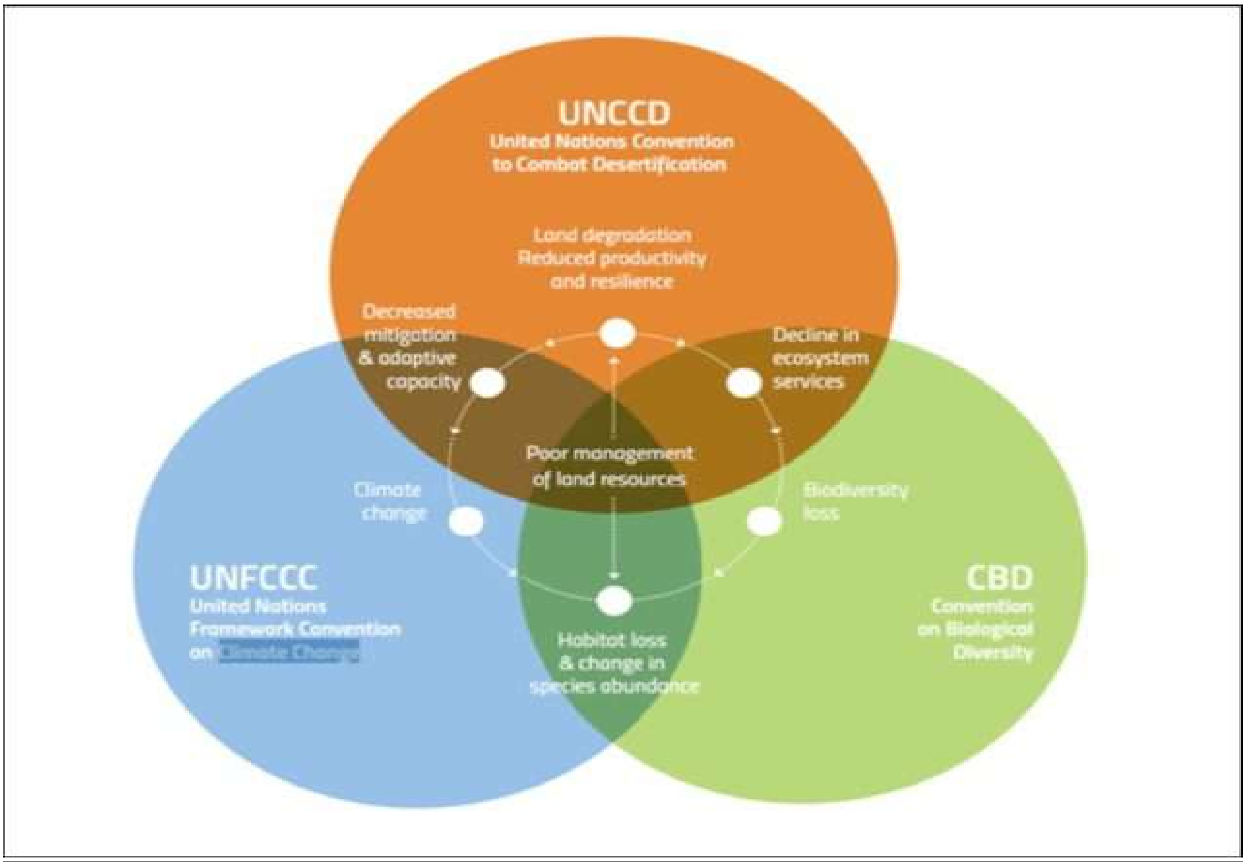
EXISTING LEGAL FRAMEWORK ON CLIMATE CHANGE IN INDIA:

In India, there is no specific legislation in place to combat the effects of climate change. Hence, in the absence of a specific legislation, the most crucial legislation that comes close to tackling the problem of climate change is the Air (Prevention and Control of Pollution) Act 198135 (hereinafter Air Act) enacted by the Parliament under Article 253 of the Constitution of India. The Air Act is important in the sense that, it provides for the prevention, control and abatement of air pollution as the presence of air pollutants in the atmosphere is injurious to human beings or other living creatures and plants. Thus, by talking of a direct link between air pollution and its effect on the whole environment, the Air Act addresses a key area related to climate change. Note that, the Air Act, however, does not mention the term ‘Climate Change’. The primary objective of the Air Act is to preserve the quality of air by controlling the emission of greenhouse gases that raises the air temperature and leads to global warming. The Air Act provides for the establishment of Central and State Control Boards to look into matters related with the improvement of air quality, monitoring activities and enforcement through fine and criminal prosecutions. State Governments can also designate particular areas as ‘air pollution control areas’ and every industrial operator within that area is required to obtain prior consent from the State board before establishing or operating any industrial plant in such area. The State boards in consultation with the Central boards can also lay down standards for emission of air pollutants from plants and automobiles. Further, under the Air Act, a Metropolitan Magistrate or Judicial Magistrate of First Class is empowered to restrain an air polluter from discharging emissions, after an application has been made by the Board and allows the Board to close down an industry, or withdraw its supply of power or water, if the directions of the Board are not followed. The parliament also passed the Water (Prevention and Control of Pollution) Act, 1974 (hereinafter Water Act) prior to the Air Act. The Water Act provides for the prevention and control of water pollution. Note that, both Water and Air Act have similar provisions with respect to achieving their said objectives.

INTERNATIONAL COMMUNITY AND CLIMATE CHANGE:

UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty adopted in 1992 by 197 countries. The treaty was set up to look into global warming and to prepare for its effects (e.g. temperature change and other climatic events). The UNFCCC sets out an agreement, which calls for international community to come together in the interest of human safety to tackle the challenges posed by climate change. Parties to the Convention recognize that the climate is a shared resource whose stability is of utmost importance and that it can be affected by emissions of carbon dioxide and other greenhouse gases. One of the achievements of the UNFCCC has been to “establish a reporting framework which provides information on greenhouse gases emissions and removals using common categorization and definitions.



This framework encourages reporting of data from most of the countries that are party to the Convention. This data provides essential input to:

1. Climate scientists (looking at the relationship of greenhouse gas emissions, temperature change and other environmental factors) in predicting whether climate change and the speed of climate change pose a significant risk to humans or the environment.

2. Track progress in historical emissions and removal trends.

3. Prioritize actions for emission reduction.

KYOTO PROTOCOL

It was the first legally binding international agreement to mandate countries to reduce greenhouse-gas emissions. Countries first agreed upon Kyoto Protocol in 1997 and it entered into force on 16 February 2005.60 The Kyoto Protocol extends the main objective of the UNFCCC i.e., “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” 61 In addition, the Protocol places the obligation upon developed countries to reduce emissions, since; they are historically responsible for the current levels of greenhouse gases in the atmosphere. Except the United States of America, all most every country has ratified the treaty.62 It is noteworthy that, under the treaty, developing countries, including China, India, Brazil and South Africa were not mandated to reduce emissions, given that these countries only contributed a relatively small share of the current emission of greenhouse gases.

CONCLUSION:

The paper has discussed the growing concerns faced by India with regard to climate change. There is an urgent need to enact specific enactments, which address climate change.70 Since, the existing legal framework in India lacks heavily when it comes to implementation, appropriate legislations need to be enacted by various State governments to minimize emissions of greenhouse gases and address climate change. It may also be useful to set longterm targets to reduce emissions of these harmful gases. There is also a growing need to deploy resources towards expanding domestic research capacity. This will help in gauging the impacts of climate change in different sectors. At present there is no conclusive research conducted on the impacts of climate change on India.71 Other initiatives may include increase in the usage of LED lighting, use of compressed natural gas as fuel, providing for stringent vehicle emission norms and usage of renewable sources of energy. There needs to be a strong national environmental policy which should include clear cut rules with regard to environmental pollution and waste management, while giving licenses to industrial houses. Since vehicles contribute to air pollution in a significant manner, a practical solution needs to be developed to curb this issue.72 The State must take initiative to encourage community participation in monitoring pollutions. As shown in the paper, India has ratified several international conventions relating to Climate Change. But none of the provisions in those international agreements can be implemented by the Indian State per se. India needs to frame new laws to incorporate those provisions in order to implement them to its letter and spirit. Apart from this, there must be strict penal sanctions to those who do not abide by the laws meant to safeguard the environment and tackle climate change. Where Public Interest Litigations are not filed, the Apex Court can suo moto take up issues of vital importance, which deal with climate change, environmental protection and the impact it has on the poor and the vulnerable. Where the State fails, the Apex Court in its judicial capacity can make laws, which will be binding on all. Only when the State, Judiciary and Civil society join hands, climate change can be tackled to a large extent and the impact it has on the people, especially the marginalized can be lessened to a minimum.

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Climate Change:

What Is Climate? How Is It Different From Weather?

You might know what weather is. Weather is the changes we see and feel outside from day to day. It might rain one day and be sunny the next. Sometimes it is cold. Sometimes it is hot. Weather also changes from place to place. People in one place might be wearing shorts and playing outside. At the same time, people far away might be shoveling snow.

Climate is the usual weather of a place. Climate can be different for different seasons. A place might be mostly warm and dry in the summer. The same place may be cool and wet in the winter. Different places can have different climates. You might live where it snows all the time. And some people live where it is always warm enough to swim outside! There's also Earth's climate. Earth's climate is what you get when you combine all the climates around the world together.

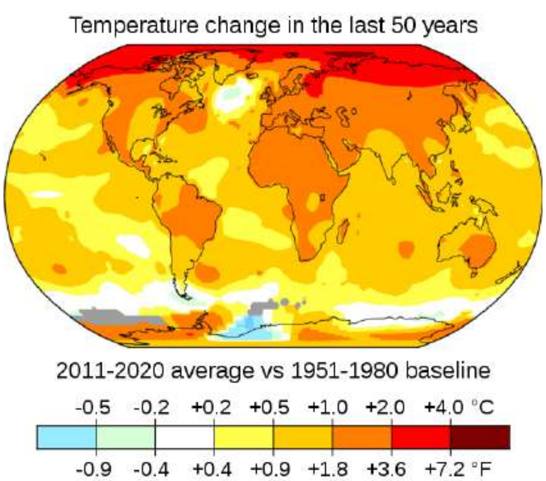
What Is Climate Change?

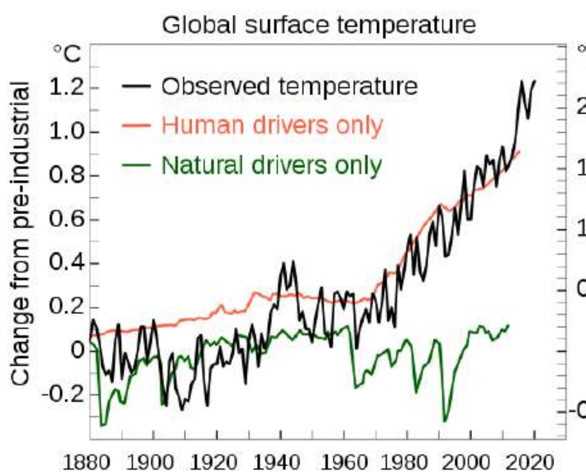
Climate change is a change in the usual weather found in a place. This could be a change in how much rain a place usually gets in a year. Or it could be a change in

a place's usual temperature for a month or season. Climate change is also a change in Earth's climate. This could be a change in Earth's usual temperature. Or it could be a change in where rain and snow usually fall on Earth.
Climate change is also a change in Earth's climate. This could be a change in Earth's usual temperature. Or it could be a change in where rain and snow usually fall on Earth. Weather can change in just a few hours. Climate takes hundreds or even millions of years to change.

Climate Change And Global Warming

Climate change includes both global warming driven by human-induced emissions of greenhouse gases and the resulting large-scale shifts in weather patterns. Though there have been previous periods of climatic change, humans have since the mid-20th century had an unprecedented impact on Earth's climate system and have caused change on a global scale.





The largest driver of warming is the emission of gases that create a greenhouse effect, of which more than 90% are carbon dioxide (CO2) and methane. Fossil fuel burning (coal, oil, and natural gas) for energy consumption is the main source of these emissions, with additional contributions from agriculture, deforestation, and manufacturing. The human cause of climate change is not disputed by any scientific body of national or international standing. Temperature rise is accelerated or tempered by climate feedbacks, such as loss of sunlight-reflecting snow and ice cover, increased water vapour (a greenhouse gas itself), and changes to land and ocean carbon sinks.

The Effects of Climate Change

Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted and trees are flowering sooner. Effects that scientists had predicted in the past would result from global climate change are now occurring: loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

"Taken as a whole, the range of published evidence indicates that the net damage costs of climate change

are likely to be significant and to increase over time."

- Intergovernmental Panel on Climate Change.

Scientists have high confidence that global temperatures will continue to rise for decades to come, largely due to greenhouse gases produced by human activities. The Intergovernmental Panel on Climate Change (IPCC), which includes more than 1,300 scientists from the United States and other countries, forecasts a temperature rise of 2.5 to 10 degrees Fahrenheit over the next century. According to the IPCC, the extent of climate change effects on individual regions will vary over time and with the ability of different societal and environmental systems to mitigate or adapt to change. The IPCC predicts that increases in global mean temperature of less than 1.8 to 5.4 degrees Fahrenheit (1 to 3 degrees Celsius) above 1990 levels will produce beneficial impacts in some regions and harmful ones in others. Net annual costs will increase over time as global temperatures increase.

Causes Behind Climate Change

Scientists attribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space

Gases:

Certain gases in the atmosphere block heat fromescaping. Long-lived gases that remain semi permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change. Gases, such as water vapor, which respond physically or chemically to changes in temperature are seen as "feedbacks."

Gases that contribute to the greenhouse effect include:

- **Water vapor:** The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate. Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.

- **Carbon dioxide (CO2):** A minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric CO2 concentration by 48% since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change.

- **Methane:** A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere.

- **Nitrous oxide:** A powerful greenhouse gas produced by soil cultivation practices,especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

- **Chlorofluorocarbons (CFCs):** Synthetic compounds entirely of industrial origin used in a number of applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also greenhouse gases.

Human Causes Of Climate Change:

Humans cause climate change by releasing carbon dioxide and other greenhouse gases into the air. Today, there is more carbon dioxide in theatmosphere than there ever has been in at least the past 800,000 years. During the 20th and 21st century, the level of carbon dioxide rose by 40%.

We produce greenhouse gases in lots of different ways:

- **Burning fossil fuels –** Fossil fuels such as oil, gas, and coal contain carbon dioxide that has been 'locked away' in the ground for thousands of years. When we take these out of the land and burn them, we release the stored carbon dioxide into the air.

- **Deforestation –** Forests remove and store carbon dioxide from the atmosphere. Cutting them down means that carbon dioxide builds
  up quicker since there are no trees to absorb it. Not only that, trees release the carbon they stored when we burn them.

- **Agriculture –** Planting crops and rearing animals releases many different types of greenhouse gases into the air. For example, animals produce methane, which is 30 times more powerful than carbon dioxide as a greenhouse gas. The nitrous oxide used for fertilisers is ten times worse and is nearly 300 times more potent than carbon dioxide!

- **Cement –** Producing cement is another contributor to climate change, causing 2% of our entire carbon dioxide emissions.

Natural changes to the climate:

The leading cause of climate change is human activity and the release of greenhouse gases. However, there are lots of natural causes that also lead to changes in the climate system.

Natural cycles can cause the climate to alternate between warming and cooling. There are also natural factors that force the climate to change, known as 'forcings'. Even though these natural causes contribute to climate change, we know that they are not the primary cause, based on scientific evidence.

Some of these natural cycles include:

- **Milankovitch cycles –** As Earth travels around the sun, its path and the tilt of its axis can change slightly. These changes, called Milankovitch cycles, affect the amount of sunlight that falls on Earth. This can cause the temperature of Earth to change. However, these cycles take place over tens or hundreds of thousands of years and are unlikely to be causing the changes to the climate that we areseeing today.

- **El Niño Southern Oscillation (ENSO) –** ENSO is a pattern of changing water temperatures in the Pacific Ocean. In an 'El Niño' year, the global temperature warms up, and in a 'La Niña' year, it cools down. These patterns can affect the global temperature for a short amount of time (months or years) but cannot explain the persistent warming that we see today.

Natural forcings that can contribute to climate change include:

- **Solar irradiance –** Changing energy from the sun has affected the temperature of Earth in the past. However, we have not seen anything strong enough to change our climate. Any increase in solar energy would make the entire atmosphere of Earth warm, but we can only see warming in the bottom layer.

- **Volcanic eruptions –** Volcanoes have a mixed effect on our climate. Eruptions produce aerosol particles that cool Earth, but they also release carbon dioxide, which warms it. Volcanoes produce 50 times less carbon dioxide than humans do, so we know they are not the leading cause of global warming. On top of this, cooling is the dominant effect of volcanic eruptions, not warming.

Is it too late to prevent climate change?

Humans have caused major climate changes to changes still. Even if we stopped emitting greenhouse gases today, global warming would continue to happen for at least several more decades, if not centuries. That's because it takes a while for the planet (for example, the oceans) to respond, and because carbon dioxide – the predominant heat-trapping gas – lingers in the atmosphere for hundreds of years. There is a time lag between what we do and when we feel it. In the absence of major action to reduce emissions, global temperature is on track to rise by 2.5°C to 4.5°C (4.5°F to 8°F) by 2100, according to the latest estimates. But it may not be too late to avoid or limit some of the worst effects of climate change.

1. **Switch to 100% green power:** Throughout the world, the use of energy represents by far the largest source of greenhouse gas emissions caused by human activity. Around two thirds of global greenhouse gas emissions are linked to burning fossil fuels for energy to be used for heating, electricity, transport and industry. Switching to renewables has a multiple positive impacts: **by converting to green electricity you support the phase-out of coal, do your bit to accelerate the move to renewable sources and directly reduce CO2 emissions.**

2. **Save energy:** It might sound like the most original-sounding tip around, but it's as relevant as ever. Saving energy not only saves you money – it also helps to cut emissions too.

3. **Optimise your diet:** Throughout the world, the global livestock industry produces more greenhouse gas emissions than all cars, planes, trains and ships combined. That doesn't mean that everyone has to become vegan or vegetarian - even a small shift in diets, with a reduction in meat and dairy products, and more plant-based foods instead, could reduce the pressure that agriculture places on the environment.

4. **Avoid plastic wherever you can:** Plastic is the all-round material par excellence and is therefore present in pretty much every aspect of our lives. But the durability of the material (which also makes it so popular) is of course also it's most drastic disadvantage: we're struggling to get rid of it. Plastic has found its way pretty much everywhere - on streets, in rivers, on the beach, in cosmetics, in waste water, in our clothing, even in the air we breathe. And there's also a close connection between climate change and our massive global plastic problem. Almost every plastic is produced from fossil fuels - and in every single phase of its life cycle, plastic emits greenhouse gas.

5. **Make Your Commute Green:** Millions of people drive to work every day. It is simply unavoidable in our modern-day society. However, the downside to this is that millions of cars emit greenhouse gases that destroy our atmosphere. Vehicle emissions are a close second when it comes to the top causes of climate change. There are always other options that you can utilize to make your commute to work eco-friendly. For starters, taking public transportation to work is a great way to cut out emissions. Riding your bike to work is also incredibly helpful to the environment and is a great method to get exercise.

6. **Protect our forests and plant more trees:** It has long been known how important forests are both for the microclimate in individual regions and for the global climate as a whole. They "feed" on CO_2 and convert the climate-damaging gas into oxygen, which is vital for our survival. A research team at ETH

Zurich has compiled some fascinating figures: Two thirds of man-made CO2 emissions could be removed from our atmosphere if we were to reforest 900 million hectares of forests worldwide. Forest restoration “isn’t just one of our climate change solutions, it is overwhelmingly the top one,” said the lead scientist, climate change ecologist Tom Crowther.

7. **Recycle:** Manufacturing plants emit a large number of greenhouse gasses per year. It is unavoidable in the production of goods that we use on a regular basis. However, a cleaner alternative would be to invest in recycling. Recycling is a cost-effective and eco-friendly process that eliminates waste and doesn’t emit greenhouse gasses into the environment. Be sure to collect your discarded paper, glass, plastic, and electronics to your local recycling center. The professionals will take these items to a processing plant where they will be remade into other recyclable materials again.

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AECC2 ENVS PROJECT

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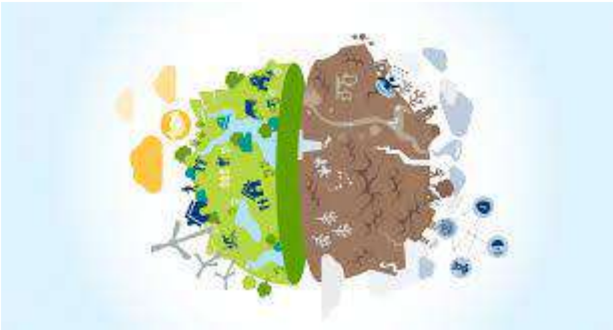
Climate change



Introduction

What is climate change?

Global warming is a term used for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Scientists are more than 95% certain that nearly all of global warming is caused by increasing concentrations of greenhouse gases (GHGs) and other human-caused emissions. Within the earth's atmosphere, accumulating greenhouse gases like water vapour, carbon dioxide, methane, nitrous oxide, and ozone are the gases within the atmosphere that absorb and emit heat radiation. Increasing or decreasing amounts of greenhouse gases within the atmosphere act to either hold in or release more of the heat from the sun.

How long carbon dioxide remains in our atmosphere

Carbon dioxide is currently the most important greenhouse gas related to global warming. For the longest time, our scientists believed that once in the atmosphere, carbon dioxide remains there for about 100 years. New research shows that is not true. 75% of that carbon will not disappear for thousands of years. The other 25% stays forever. We are creating a serious global warming crisis that will last far longer than we ever thought possible.

"The lifetime of fossil fuel CO2 in the atmosphere is a few centuries, plus 25 percent that lasts essentially forever. The next time you fill your tank, reflect upon this...[the climatic impacts of releasing fossil fuel CO2 to the atmosphere will last longer than Stonehenge… Longer than time capsules, longer than nuclear waste, far longer than the age of human civilization so far." —"Carbon is forever," Mason Inman

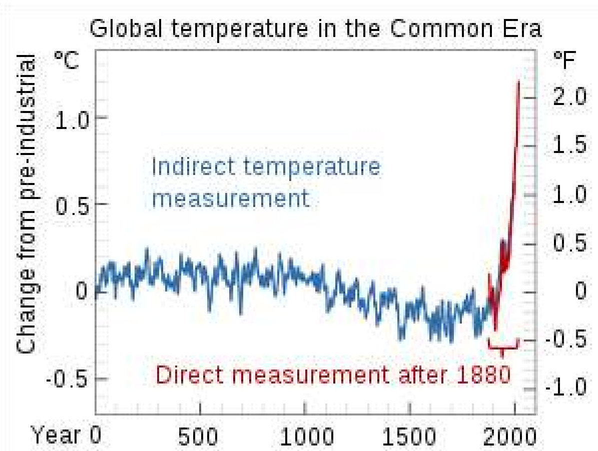
Atmospheric carbon from fossil fuel burning is the main human-caused factor in the escalating global warming we are experiencing now. The current level of carbon in our atmosphere is tracked using what is called the Keeling curve. The Keeling curve measures atmospheric carbon in parts per million (ppm).

Each year, many measurements are taken at Mauna Loa, Hawaii to determine the parts per million (ppm) of carbon in the atmosphere at that time. At the beginning of the Industrial Revolution around 1880, before we began fossil fuel burning, our atmospheric carbon ppm level was at about 270. Here is the current Keeling curve graph for where we are today:

Observed temperature rise

Multiple independently produced instrumental datasets show that the climate system is warming, with the 2009–2018 decade being 0.93 ± 0.07 °C (1.67 ± 0.13 °F) warmer than the pre-industrial baseline (1850–1900). Currently, surface temperatures are rising by about 0.2 °C (0.36 °F) per decade, with 2020 reaching a temperature of 1.2 °C (2.2 °F) above pre-industrial. Since 1950, the number of cold days and nights has decreased, and the number of warm days and nights has increased.

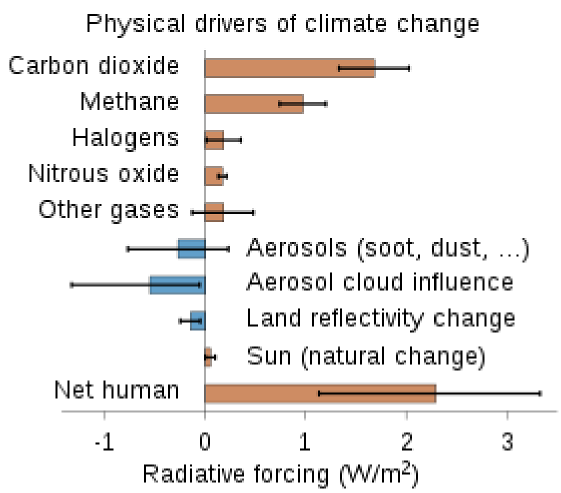
There was little net warming between the 18th century and the mid-19th century. Climate proxies, sources of climate information from natural archives such as trees and ice cores, show that natural variations offset the early effects of the Industrial Revolution. Thermometer records began to provide global coverage around 1850. Historical patterns of warming and cooling, like the Medieval Climate Anomaly and the Little Ice Age, did not occur at the same time across different regions, but temperatures may have reached as high as those of the late-20th century in a limited set of regions. There have been prehistorically episodes of global warming, such as the Palaeocene–Eocene Thermal Maximum. However, the modern observed rise in temperature and CO_2 concentrations has been so rapid that even abrupt geophysical events that took place in Earth's history do not approach current rates.



Drivers of recent temperature rise

The climate system experiences various cycles on its own which can last for years (such as the El Niño–Southern Oscillation), decades or even centuries. Other changes are caused by an imbalance of energy that is "external" to the climate system, but not always external to the Earth. Examples of external forcings include changes in the composition of the atmosphere (e.g. increased concentrations of greenhouse gases), solar luminosity, volcanic eruptions, and variations in the Earth's orbit around the Sun.

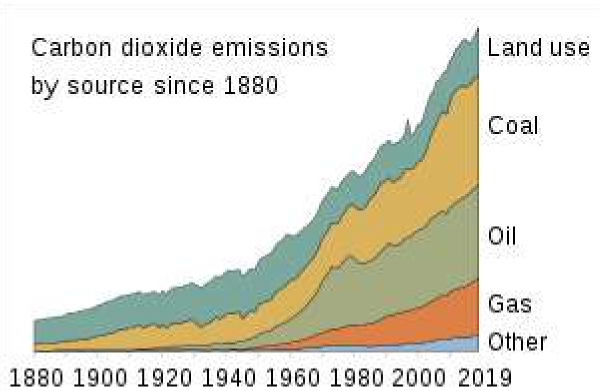
To determine the human contribution to climate change, known internal climate variability and natural external forcings need to be ruled out. A key approach is to determine unique "fingerprints" for all potential causes, then compare these fingerprints with observed patterns of climate change. For example, solar forcing can be ruled out as a major cause because its fingerprint is warming in the entire atmosphere, and only the lower atmosphere has warmed, as expected from greenhouse gases (which trap heat energy radiating from the surface). Attribution of recent climate change shows that the primary driver is elevated greenhouse gases, but that aerosols also have a strong effect.



Greenhouse gases

The Earth absorbs sunlight, then radiates it as heat. Greenhouse gases in the atmosphere absorb and reemit infrared radiation, slowing the rate at which it can pass through the atmosphere and escape into space. Before the Industrial Revolution, naturally-occurring amounts of greenhouse gases caused the air near the surface to be about 33 °C (59 °F) warmer than it would have been in their absence. While water vapour (~50%) and clouds (~25%) are the biggest contributors to the greenhouse effect, they increase as a function of temperature and are therefore considered feedbacks. On the other hand, concentrations of gases such as CO
2 (~20%), tropospheric ozone, CFCs and nitrous oxide are not temperature-dependent, and are therefore considered external forcings.

Human activity since the Industrial Revolution, mainly extracting and burning fossil fuels (coal, oil, and natural gas), has increased the amount of greenhouse gases in the atmosphere, resulting in a irradiative imbalance. In 2018, the concentrations of CO
2 and methane had increased by about 45% and 160%, respectively, since 1750. These CO
2 levels are much higher than they have been at any time during the last 800,000 years, the period for which reliable data have been collected from air trapped in ice cores. Less direct geological evidence indicates that CO
2 values have not been this high for millions of years.



Aerosols and clouds

Air pollution, in the form of aerosols, not only puts a large burden on human health, but also affects the climate on a large scale. From 1961 to 1990, a gradual reduction in the amount of sunlight reaching the Earth's surface was observed, a phenomenon popularly known as *global dimming*, typically attributed to aerosols from biofuel and fossil fuel burning. Aerosol removal by precipitation gives tropospheric aerosols an atmospheric lifetime of only about a week, while stratospheric aerosols can remain in the atmosphere for a few years. Globally, aerosols have been declining since 1990, meaning that they no longer mask greenhouse gas warming as much.

In addition to their direct effects (scattering and absorbing solar radiation), aerosols have indirect effects on the Earth's radiation budget. Sulfate aerosols act as cloud condensation nuclei and thus lead to clouds that have more and smaller cloud droplets. These clouds reflect solar radiation more efficiently than clouds with fewer and larger droplets. This effect also causes droplets to be more uniform in size, which reduces the growth of raindrops and makes clouds more reflective to incoming sunlight. Indirect effects of aerosols are the largest uncertainty in radioactive forcing.

While aerosols typically limit global warming by reflecting sunlight, black carbon in soot that falls on snow or ice can contribute to global warming. Not only does this increase the absorption of sunlight, it also increases melting and sea-level rise. Limiting new black carbon deposits in the Arctic could reduce global warming by 0.2 °C (0.36 °F) by 2050.

Humans change the Earth's surface mainly to create more agricultural land. Today, agriculture takes up 34% of Earth's land area, while 26% is forests, and 30% is uninhabitable (glaciers, deserts, etc. The amount of forested land continues to decrease, largely due to conversion to cropland in the tropics. This deforestation is the most significant aspect of land surface change affecting global warming. The main causes of deforestation are: permanent land-use change from forest to agricultural land producing products such as beef and palm oil (27%), logging to produce forestry/forest products (26%), short term shifting cultivation (24%), and wildfires (23%).

In addition to affecting greenhouse gas concentrations, land-use changes affect global warming through a variety of other chemical and physical mechanisms. Changing the type of vegetation in a region affects the local temperature, by changing how much of the sunlight gets reflected back into space (albedo), and how much heat is lost by evaporation. For instance, the change from a dark forest to grassland makes the surface lighter, causing it to reflect more sunlight. Deforestation can also contribute to changing temperatures by affecting the release of aerosols and other chemical compounds that influence clouds, and by changing wind patterns. In tropic and temperate areas the net effect is to produce significant warming, while at latitudes closer to the poles a gain of albedo (as forest is replaced by snow cover) leads to an overall cooling effect. Globally, these effects are estimated to have led to a slight cooling, dominated by an increase in surface

Climate change feedback

The response of the climate system to an initial forcing is modified by feedbacks: increased by self-reinforcing feedbacks and reduced by balancing feedbacks. The main reinforcing feedbacks are the water-vapour feedback, the ice–albedo feedback, and probably the net effect of clouds. The primary balancing feedback to global temperature change is radioactive cooling to space as infrared radiation in response to rising surface temperature. In addition to temperature feedbacks, there are feedbacks in the carbon cycle, such as the fertilizing effect of CO_2 on plant growth. Uncertainty over feedbacks is the major reason why different climate models project different magnitudes of warming for a given amount of emissions.

As air gets warmer, it can hold more moisture. After initial warming due to emissions of greenhouse gases, the atmosphere will hold more water. As water vapour is a potent greenhouse gas, this further heats the atmosphere. If cloud cover increases, more sunlight will be reflected back into space, cooling the planet. If clouds become more high and thin, they act as an insulator, reflecting heat from below back downwards and warming the planet. Overall, the net cloud feedback over the industrial era has probably exacerbated temperature rise. The reduction of snow cover and sea ice in the Arctic reduces the albedo of the Earth's surface. More of the Sun's energy is now absorbed in these regions, contributing to amplification of Arctic temperature changes. Arctic amplification is also melting permafrost, which releases methane and CO_2 into the atmosphere.

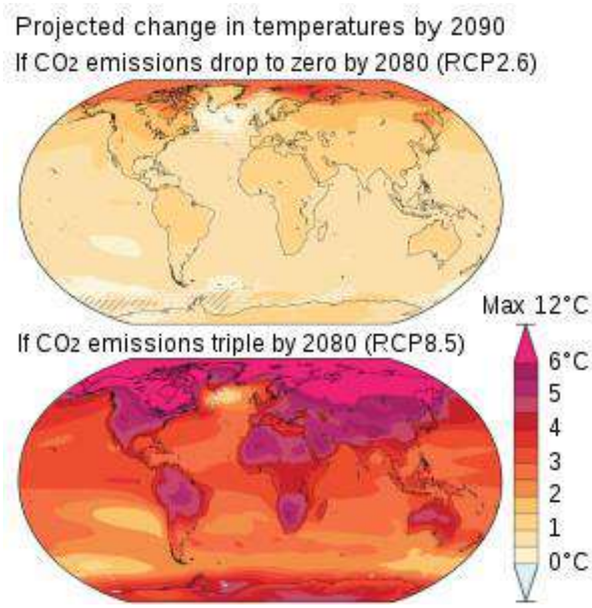
Around half of human-caused CO_2 emissions have been absorbed by land plants and by the oceans. On land, elevated CO_2 and an extended growing season have stimulated plant growth. Climate change increases droughts and heat waves that inhibit plant growth, which makes it uncertain whether this carbon sink will continue to grow in the future. Soils contain large quantities of carbon and may release some when they heat up. As more CO_2 and heat are absorbed by the ocean, it acidifies, its circulation changes and phytoplankton takes up less carbon, decreasing the rate at which the ocean absorbs atmospheric carbon. Climate change can increase methane emissions from wetlands, marine and freshwater systems, and permafrost.

Future warming and the carbon budget

Future warming depends on the strengths of climate feedbacks and on emissions of greenhouse gases. The former are often estimated using various climate models, developed by multiple scientific institutions. A climate model is a representation of the physical, chemical, and biological processes that affect the climate system. Models include changes in the Earth's orbit, historical changes in the Sun's activity, and volcanic forcing. Computer models attempt to reproduce and predict the circulation of the oceans, the annual cycle of the seasons, and the flows of carbon between the land surface and the atmosphere. Models project different future temperature rises for given emissions of greenhouse gases; they also do not fully agree on the strength of different feedbacks on climate sensitivity and magnitude of inertia of the climate system.

The physical realism of models is tested by examining their ability to simulate contemporary or past climates. Past models have underestimated the rate of Arctic shrinkage and underestimated the rate of precipitation increase. Sea level rise since 1990 was underestimated in older models, but more recent models agree well with observations. The 2017 United States-published National Climate Assessment notes that "climate models may still be underestimating or missing relevant feedback processes".

Various Representative Concentration Pathways (RCPs) can be used as input for climate models: "a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high [greenhouse gas] emissions (RCP8.5)". RCPs only look at concentrations of greenhouse gases, and so do not include the response of the carbon cycle. Climate model projections summarised in the IPCC Fifth Assessment Report indicate that, during the 21st century, the global surface temperature is likely to rise a further 0.3 to 1.7 °C (0.5 to 3.1 °F) in a moderate scenario, or as much as 2.6 to 4.8 °C (4.7 to 8.6 °F) in an extreme scenario, depending on the rate of future greenhouse gas emissions and on climate feedback effects.



Discovery

Explain why Earth's temperature was higher than expected considering only incoming solar radiation, Joseph Fourier proposed the existence of a greenhouse effect. Solar energy reaches the surface as the atmosphere is transparent to solar radiation. The warmed surface emits infrared radiation, but the atmosphere is relatively opaque to infrared and slows the emission of energy, warming the planet. Starting in 1859, John Tyndall established that nitrogen and oxygen (99% of dry air) are transparent to infrared, but water vapour and traces of some gases (significantly methane and carbon dioxide) both absorb infrared and, when warmed, emit infrared radiation. Changing concentrations of these gases could have caused "all the mutations of climate which the researches of geologists reveal" including ice ages.

Savant Arrhenius noted that water vapour in air continuously varied, but carbon dioxide (CO_2) was determined by long term geological processes. At the end of an ice age, warming from increased CO_2 would increase the amount of water vapour, amplifying its effect in a feedback process. In 1896, he published the first climate model of its kind, showing that halving of CO_2 could have produced the drop in temperature initiating the ice age. Arrhenius calculated the temperature increase expected from doubling CO_2 to be around 5–6 °C (9.0–10.8 °F). Other scientists were initially sceptical and believed the greenhouse effect to be saturated so that adding more CO_2 would make no difference. They thought climate would be self-regulating. From 1938 Guy Stewart Callendar published evidence that climate was warming and CO_2 levels increasing, but his calculations met the same objections.

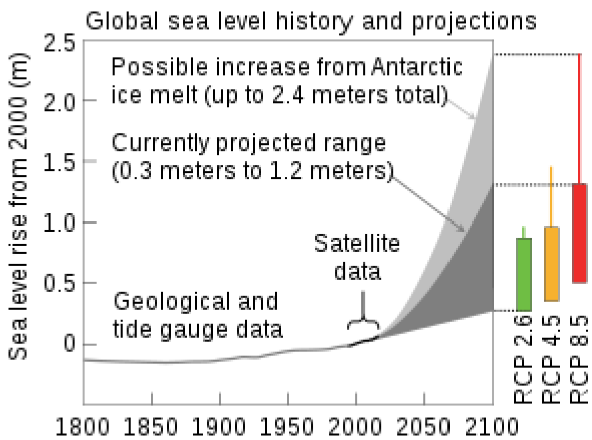
In the 1950s, Gilbert Plass created a detailed computer model that included different atmospheric layers and the infrared spectrum and found that increasing CO_2 levels would cause warming. In the same decade Hans Suess found evidence CO_2 levels had been rising, Roger Revelle showed the oceans would not absorb the increase, and together they helped Charles Keeling to begin a record of continued increase, the Keeling Curve. Scientists alerted the public, and the dangers were highlighted at James Hansen's 1988 Congressional testimony. The Intergovernmental Panel on Climate Change, set up in 1988 to provide formal advice to the world's governments, spurred interdisciplinary research.

Impacts

The environmental effects of climate change are broad and far-reaching, affecting oceans, ice, and weather. Changes may occur gradually or rapidly. Evidence for these effects comes from studying climate change in the past, from modelling, and from modern observations. Since the 1950s, droughts and heat waves have appeared simultaneously with increasing frequency. Extremely wet or dry events within the monsoon period have increased in India and East Asia. The maximum rainfall and wind speed from hurricanes and typhoons is likely increasing Frequency of tropical cyclones has not increased as a result of climate change. While tornado and severe thunderstorm frequency has not increased as a result of climate change, the areas affected by such phenomena may be changing.

Global sea level is rising as a consequence of glacial melt, melt of the ice sheets in Greenland and Antarctica, and thermal expansion. Between 1993 and 2017, the rise increased over time, averaging 3.1 ± 0.3 mm per year. Over the 21st century, the IPCC projects that in a very high emissions scenario the sea level could rise by 61–110 cm. Increased ocean warmth is undermining and threatening to unplug Antarctic glacier outlets, risking a large melt of the ice sheet and the possibility of a 2-meter sea level rise by 2100 under high emissions.

Climate change has led to decades of shrinking and thinning of the Arctic sea ice, making it vulnerable to atmospheric anomalies. While ice-free summers are expected to be rare at 1.5 °C (2.7 °F) degrees of warming, they are set to occur once every three to ten years at a warming level of 2.0 °C (3.6 °F).Higher atmospheric CO_2 concentrations have led to changes in ocean chemistry. An increase in dissolved CO_2 is causing oceans to acidify. In addition, oxygen levels are decreasing as oxygen is less soluble in warmer water, with hypoxic dead zones expanding as a result of algal blooms stimulated by higher temperatures, higher CO_2 levels, ocean deoxygenating, and eutrophication.



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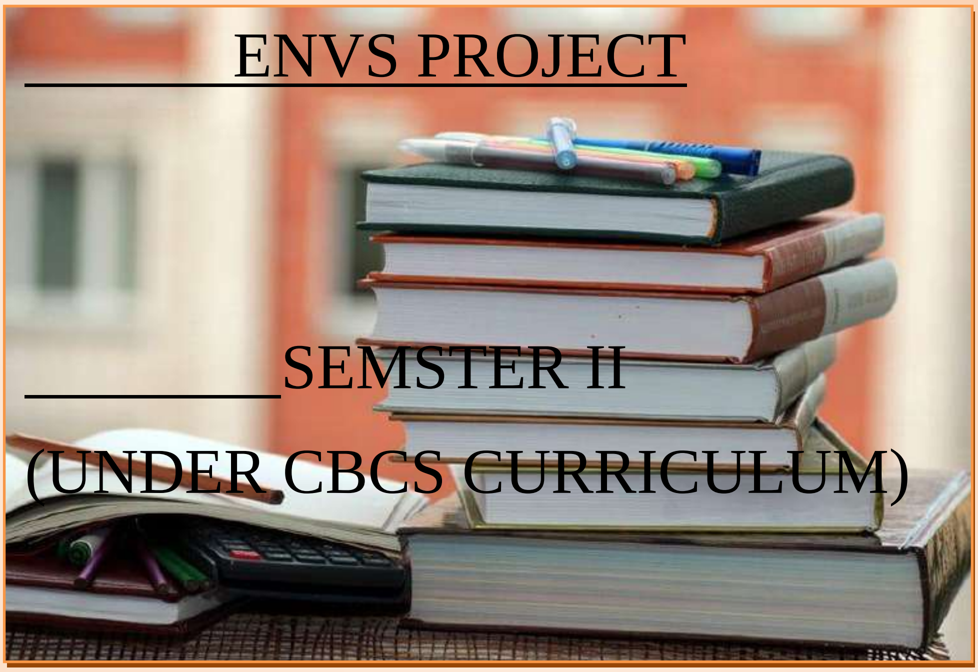

ENVS PROJECT

SEMSTER II

(UNDER CBCS CURRICULUM)

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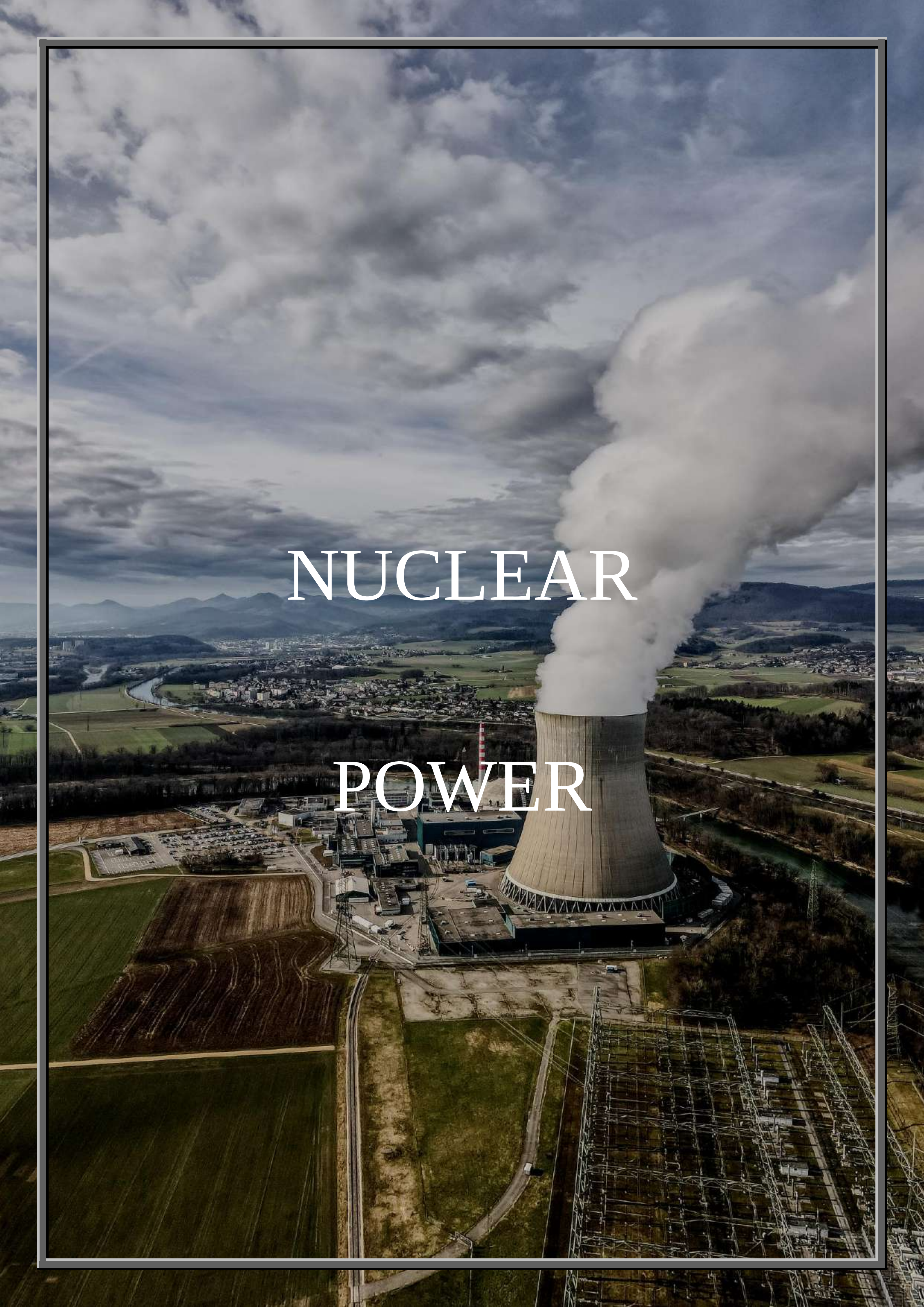

NUCLEAR
POWER

CONTENT

INTROCUCTION

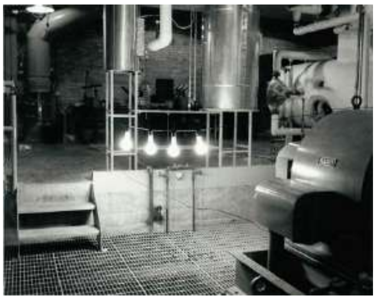
Nuclear power is the use of nuclear reactions to produce electricity. Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium in nuclear power plants. Nuclear decay processes are used in niche applications such as radioisotope thermoelectric generators in some space probes such as Voyager 2. Generating electricity from fusion power remains the focus of international research.

Civilian nuclear power supplied 2,586 terawatt hours (TWh) of electricity in 2019, equivalent to about 10% of global electricity generation, and was the second-largest low-carbon power source after hydroelectricity. As of January 2021, there are 442 civilian fission reactors in the world, with a combined electrical capacity of 392 gigawatt (GW). There are also 53 nuclear power reactors under construction and 98 reactors planned, with a combined capacity of 60 GW and 103 GW, respectively. The United States has the largest fleet of nuclear reactors, generating over 800 TWh zero-emissions electricity per year with an average capacity factor of 92%. Most reactors under construction are generation III reactors in Asia.

Nuclear power has one of the lowest levels of fatalities per unit of energy generated compared to other energy sources. Coal, petroleum, natural gas and hydroelectricity each have caused more fatalities per unit of energy due to air pollution and accidents. Since its commercialization in the 1970s, nuclear power has prevented about 1.84 million air pollution-related deaths and the emission of about 64 billion tonnes of carbon dioxide equivalent that would have otherwise resulted from the burning of fossil fuels. Accidents in nuclear power plants include the Chernobyl disaster in the Soviet Union in 1986, the Fukushima Daiichi nuclear disaster in Japan in 2011, and the more contained Three Mile Island accident in the United States in 1979.

HISTORY

Origins



The first light bulbs ever lit by electricity generated by nuclear power at EBR-1 at Argonne National Laboratory-West, December 20, 1951.

The discovery of nuclear fission occurred in 1938 following over four decades of work on the science of radioactivity and the elaboration of new nuclear physics that described the components of atoms. Soon after the discovery of the fission process, it was realized that a fissioning nucleus can induce further nucleus fissions, thus inducing a self-sustaining chain reaction. Once this was experimentally confirmed in 1939, scientists in many countries petitioned their governments for support of nuclear fission research, just on the cusp of World War II, for the development of a nuclear weapon.

In the United States, these research efforts led to the creation of the first man-made nuclear reactor, the Chicago Pile-1, which achieved criticality on December 2, 1942. The reactor's development was part of the Manhattan Project, the Allied effort to create atomic bombs during World War II. It led to the building of larger single-purpose production reactors for the production of weapons-grade plutonium for use in the first nuclear weapons. The United States tested the first nuclear weapon in July 1945, the Trinity test, with the atomic bombings of Hiroshima and Nagasaki taking place one month later.

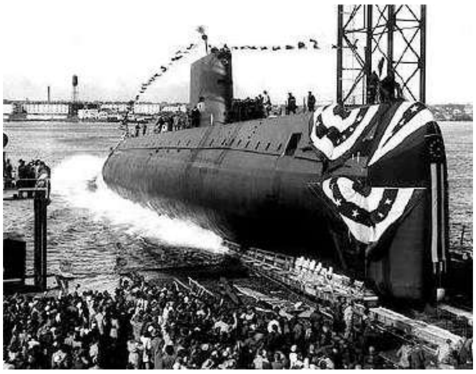
The launching ceremony of the USS Nautilus January 1954. In 1958 it would become the first vessel to reach the North Pole.

The Calder Hall nuclear power station in the United Kingdom, the world's first commercial nuclear power station.Despite the military nature of the first nuclear devices, the 1940s and 1950s were characterized by strong optimism for the potential of nuclear power to provide cheap and endless energy. Electricity was generated for the first time by a nuclear reactor on December 20, 1951, at the EBR-I experimental station near Arco, Idaho, which initially produced about 100 kW. In 1953, American President Dwight Eisenhower gave his "Atoms for Peace" speech at the United Nations, emphasizing the need to develop "peaceful" uses

of nuclear power quickly. This was followed by the Atomic Energy Act of 1954 which allowed rapid declassification of U.S. reactor technology and encouraged development by the private sector.

First power generation

The first organization to develop practical nuclear power was the U.S. Navy, with the S1W reactor for the purpose of propelling submarines and aircraft carriers. The first nuclear-powered submarine, USS Nautilus, was put to sea in January 1954. The S1W reactor was a Pressurized Water Reactor. This design was chosen because it was simpler, more compact, and easier to operate compared to alternative designs, thus more suitable to be used in submarines. This decision would result in the PWR being the reactor of choice also for power generation, thus having a lasting impact on the civilian electricity market in the years to come.



On June 27, 1954, the Obninsk Nuclear Power Plant in the USSR became the world's first nuclear power plant to generate electricity for a power grid, producing around 5 megawatts of electric power. The world's first commercial nuclear power station, Calder Hall at Windscale, England was connected to the national power grid on 27 August 1956. In common with a number of other generation I reactors, the plant had the dual purpose of producing electricity and plutonium-239, the latter for the nascent nuclear weapons program in Britain.

The first major accident at a nuclear reactor occurred in 1961 at the SL-1, a U.S. Army experimental nuclear power reactor at the Idaho National Laboratory. An uncontrolled chain reaction resulted in a steam explosion which killed the three crew members and caused a meltdown. Another serious accident happened in 1968, when one of the two liquid-metal-cooled reactors on board the Soviet submarine K-27 underwent a fuel element failure, with the emission of gaseous fission products into the surrounding air, resulting in 9 crew fatalities and 83 injuries.

Chernobyl and renaissance

The town of Pripyat abandoned since 1986, with the Chernobyl plant and the Chernobyl New Safe Confinement arch in the distance.

Olkiluoto 3 under construction in 2009. It was the first EPR, a modernized PWR design, to start construction.

During the 1980s one new nuclear reactor started up every 17 days on average. By the end of the decade, global installed nuclear capacity reached 300 GW. Since the late 1980s, new capacity additions slowed down significantly, with the installed nuclear capacity reaching 366 GW in 2005.

The 1986 Chernobyl disaster in the USSR, involving an RBMK reactor, altered the development of nuclear power and led to a greater focus on meeting international safety and regulatory standards. It is considered the worst nuclear disaster in history both in total casualties, with 56 direct deaths, and financially, with the cleanup and the cost estimated at 18 billion Soviet rubles (US$68 billion in 2019, adjusted for inflation). The international organization to promote safety awareness and the professional development of operators in nuclear facilities, the World Association of Nuclear Operators (WANO), was created as a direct outcome of the 1986 Chernobyl accident. The Chernobyl disaster played a major part in the reduction in the number of new plant constructions in the following years. Influenced by these events, Italy voted against nuclear power in a 1987 referendum, becoming the first country to completely phase out nuclear power in 1990.

In the early 2000s, nuclear energy was expecting a nuclear renaissance, an increase in the construction of new reactors, due to concerns about carbon dioxide emissions. During this period, newer generation III reactors, such as the EPR began construction, although encountering problems and delays, and going significantly over budget.

Fukushima and current prospects

Nuclear power generation (TWh) and operational nuclear reactors since 1997

Plans for a nuclear renaissance were ended by another nuclear accident. The 2011 Fukushima Daiichi nuclear accident was caused by a large tsunami triggered by the Tōhoku earthquake, one of the largest earthquakes ever recorded. The Fukushima Daiichi Nuclear Power Plant suffered three core meltdowns due to failure of the emergency cooling system for lack of electricity supply. This resulted in the most serious nuclear accident since the Chernobyl disaster. The accident prompted a re-examination of nuclear safety and nuclear energy policy in many countries.[43] Germany approved plans to close all its reactors by 2022, and many other countries reviewed their nuclear power programs. Following the disaster, Japan shut down all of its nuclear power reactors, some of them permanently, and in 2015 began a gradual process to restart the remaining 40 reactors, following safety checks and based on revised criteria for operations and public approval.

By 2015, the IAEA's outlook for nuclear energy had become more promising, recognizing the importance of low-carbon generation for mitigating climate change. As of 2015, the global trend was for new nuclear power stations coming online to be balanced by the number of old plants being retired. In 2016, the U.S. Energy Information Administration projected for its "base case" that world nuclear power generation would increase from 2,344 terawatt hours (TWh) in 2012 to 4,500 TWh in 2040. Most of the predicted increase was expected to be in Asia. As of 2018, there are over 150 nuclear reactors planned including 50 under construction. In January 2019, China had 45 reactors in operation, 13 under construction, and plans to build 43 more, which would make it the world's largest generator of nuclear electricity.

NUCLEAR POWER PLANT

Nuclear power plants are thermal power stations that generate electricity by harnessing the thermal energy released from nuclear fission. A fission nuclear power plant is generally composed of a nuclear reactor, in which the nuclear reactions generating heat take place; a cooling system, which removes the heat from inside the reactor; a steam turbine, which transforms the heat into mechanical energy; an electric generator, which transforms the mechanical energy into electrical energy.

When a neutron hits the nucleus of a uranium-235 or plutonium atom, it can split the nucleus into two smaller nuclei. The reaction is called nuclear fission. The fission reaction releases energy and neutrons. The released neutrons can hit other uranium or plutonium nuclei, causing new fission reactions, which release more energy and more neutrons. This is called a chain reaction. In most commercial reactors, the reaction rate is controlled by control rods that absorb excess neutrons. The controllability of nuclear reactors depends on the fact that a small fraction of neutrons resulting from fission are delayed. The time delay between the fission and the release of the neutrons slows down changes in reaction rates and gives time for moving the control rods to adjust the reaction rate.

Use in space

The Multi-mission radioisotope thermoelectric generator (MMRTG), used in several space missions such as the Curiosity Mars rover

The most common use of nuclear power in space is the use of radioisotope thermoelectric generators, which use radioactive decay to generate power. These power generators are relatively small scale (few kW), and they are mostly used to power space missions and experiments for long periods where solar power is not available in sufficient quantity, such as i n the Voyager 2 space probe. A few space vehicles have been launched using nuclear reactors: 34 reactors belong to the Soviet RORSAT series and one was the American SNAP-10A.

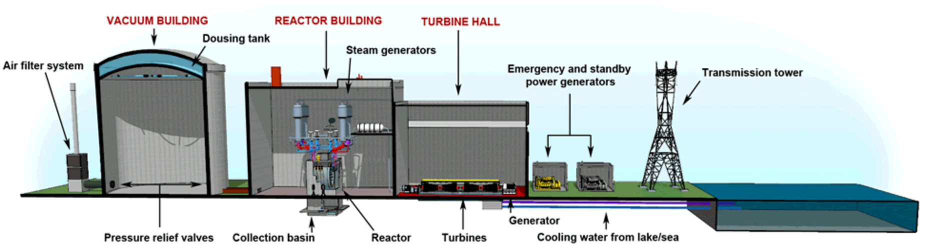
Both fission and fusion appear promising for space propulsion applications, generating higher mission velocities with less reaction mass.

Safety

Death rates from air pollution and accidents related to energy production, measured in deaths per terawatt hours (TWh)

Deaths per TWh per energy source in the European Union

Nuclear power plants have three unique characteristics that affect their safety, as compared to other power plants. Firstly, intensely radioactive materials are present in a nuclear reactor. Their release to the environment could be hazardous. Secondly, the fission products, which make up most of the intensely radioactive substances in the reactor, continue to generate a significant amount of decay heat even after the fission chain reaction has stopped. If the heat cannot be removed from the reactor, the fuel rods may overheat and release radioactive materials. Thirdly, a criticality accident (a rapid increase of the reactor power) is possible in certain reactor designs if the chain reaction cannot be controlled. These three characteristics have to be taken into account when designing nuclear reactors.



All modern reactors are designed so that an uncontrolled increase of the reactor power is prevented by natural feedback mechanisms, a concept known as negative void coefficient of reactivity. If the temperature or the amount of steam in the reactor increases, the fission rate inherently decreases. The chain reaction can also be manually stopped by inserting control rods into the reactor core. Emergency core cooling systems (ECCS) can remove the decay heat from the reactor if normal cooling systems fail. If the ECCS fails, multiple physical barriers limit the release of radioactive materials to the environment even in the case of an accident. The last physical barrier is the large containment building.

WASTAGE

The normal operation of nuclear power plants and facilities produce radioactive waste, or nuclear waste. This type of waste is also produced during plant decommissioning. There are two broad categories of nuclear waste: low-level waste and high-level waste. The first has low radioactivity and includes contaminated items such as clothing, which poses limited threat. High-level waste is mainly the spent fuel from nuclear reactors, which is very radioactive and must be cooled and then safely disposed of or reprocessed.

Activity of spent UOx fuel in comparison to the activity of natural uranium ore over time.

Dry cask storage vessels storing spent nuclear fuel assemblies

The most important waste stream from nuclear power reactors is spent nuclear fuel, which is considered high-level waste. For LWRs, spent fuel is typically composed of 95% uranium, 4% fission products, and about 1% transuranic actinides (mostly plutonium, neptunium and americium).[75] The plutonium and other transuranics are responsible for the bulk of the long-term radioactivity, whereas the fission products are responsible for the bulk of the short-term radioactivity.

High-level waste requires treatment, management, and isolation from the environment. These operations present considerable challenges due to the extremely long periods these materials remain potentially hazardous to living organisms. This is due to long-lived fission products (LLFP), such as technetium-99 (half-life 220,000 years) and iodine-129 (half-life 15.7 million years). LLFP dominate the waste stream in terms of radioactivity, after the more intensely radioactive short-lived fission products (SLFPs) have decayed into stable elements, which takes approximately 300 years. After about 500 years, the waste becomes less radioactive than natural uranium ore. Commonly suggested methods to isolate LLFP waste from the biosphere include separation and transmutation, synroc treatments, or deep geological storage.

SIDE EFFECTS

Accidents

Following the 2011 Fukushima Daiichi nuclear disaster, the world's worst nuclear accident since 1986, 50,000 households were displaced after radiation leaked into the air, soil and sea. Radiation checks led to bans of some shipments of vegetables and fish.

Reactor decay heat as a fraction of full power after the reactor shutdown, using two different correlations. To remove the decay heat, reactors need cooling after the shutdown of the fission reactions. A loss of the ability to remove decay heat caused the Fukushima accident.

See also: Energy accidents, Nuclear and radiation accidents and incidents, and Lists of nuclear disasters and radioactive incidents

Some serious nuclear and radiation accidents have occurred. The severity of nuclear accidents is generally classified using the International Nuclear Event Scale (INES) introduced by the International Atomic Energy Agency (IAEA). The scale ranks anomalous events or accidents on a scale from 0 (a deviation from normal operation that poses no safety risk) to 7 (a major accident with widespread effects). There have been 3 accidents of level 5 or higher in the civilian nuclear power industry, two of which, the Chernobyl accident and the Fukushima accident, are ranked at level 7.

The Chernobyl accident in 1986 caused approximately 50 deaths from direct and indirect effects, and some temporary serious injuries from acute radiation syndrome. The future predicted mortality from increases in cancer rates is estimated at about 4000 in the decades to come. The Fukushima Daiichi nuclear accident was caused by the 2011 Tohoku earthquake and tsunami. The accident has not caused any radiation-related deaths but resulted in radioactive contamination of surrounding areas. The difficult cleanup operation is expected to cost tens of billions of dollars over 40 or more years. The Three Mile Island accident in 1979 was a smaller scale accident, rated at INES level 5.

Attacks and sabotage

Main articles: Vulnerability of nuclear plants to attack, Nuclear terrorism, and Nuclear safety in the United States

Terrorists could target nuclear power plants in an attempt to release radioactive contamination into the community. The United States 9/11 Commission has said that nuclear power plants were potential targets originally considered for the September 11, 2001 attacks. An attack on a reactor's spent fuel pool could also be serious, as these pools are less protected than the reactor core. The release of radioactivity could lead to thousands of near-term deaths and greater numbers of long-term fatalities.

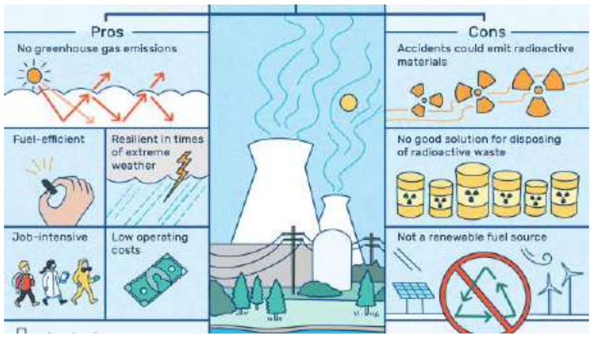
In the United States, the NRC carries out "Force on Force" (FOF) exercises at all nuclear power plant sites at least once every three years.[188] In the United States, plants are surrounded by a double row of tall fences which are electronically monitored. The plant grounds are patrolled by a sizeable force of armed guards.

Insider sabotage is also a threat because insiders can observe and work around security measures. Successful insider crimes depended on the perpetrators' observation and knowledge of security vulnerabilities. A fire caused 5–10 million dollars worth of damage to New York's Indian Point Energy Center in 1971.[191] The arsonist turned out to be a plant maintenance worker.

Drawbacks

There are many good reasons to oppose the use of nuclear energy. Nuclear power installations are vulnerable for accidents, incidents and attacks. Radioactive material can be disseminated. Radiation is harmfull and can, even in small quantities, be lethal. Contamination with radioactive material can make entire regions uninhabitable for thousands of years.

Even during 'normal operation' nuclear power stations (and other installations) disseminate radioactive materials. The nuclear fuel chain is complicated and in every step transport is needed. These transports are in itself vulnerable for accidents, incidents and theft. Radioactive material in the 'wrong hands' leads to a horror-scenario. The use of nuclear power leads to the production of large quantities of dangerous radioactive waste. Although the nuclear industry has been seeking for solutions for more than 6 decades now there is still no country in the world that has found a scientific sound way to deal with its radioactive waste.



Nuclear power plants are extremely expensive and hard to finance. Only when supported by public money a nuclear power station is build. In almost all countries risks and non-direct costs are passed on to the government (the public, the taxpayers); longterm management of the waste, security of the nuclear power plant, costs of transport for instance. It is impossible to insure your nuclear facility on the private market. So in all cases it is the government again who guarantees the compensation for accident-related costs - which is in itself again impossible. The Fukushima disaster in Japan is estimated to costs at least $143 billion. The nuclear disaster in Japan has tragically demonstrated how unsafe nuclear power can be. The chance that a major accident happens is maybe slim but the consequences are devastating.

A nuclear power station itself does not emit greenhouse gasses like CO2. Yet nuclear power contributes to climate change; with every step in the whole fuel chain, needed to in the end generate electricity, many energy is used. For instance, the extraction of uranium and the enrichment of uranium are extreme energy-intensive processes. Life-cycle analysis of the whole fuel chain clearly shows the contribution of nuclear power to climate change.

Weapons

Over 500 atmospheric nuclear weapons tests were conducted at various sites around the world from 1945 to 1980. Radioactive fallout from nuclear weapons testing was first drawn to public attention in 1954 when the Castle Bravo hydrogen bomb test at the Pacific Proving Grounds contaminated the crew and catch of the Japanese fishing boat Lucky Dragon. One of the fishermen died in Japan seven months

later, and the fear of contaminated tuna led to a temporary boycotting of the popular staple in Japan. The incident caused widespread concern around the world, especially regarding the effects of nuclear fallout and atmospheric nuclear testing, and "provided a decisive impetus for the emergence of the anti-nuclear weapons movement in many countries".

As public awareness and concern mounted over the possible health hazards associated with exposure to the nuclear fallout, various studies were done to assess the extent of the hazard. A Centers for Disease Control and Prevention/ National Cancer Institute study claims that fallout from atmospheric nuclear tests would lead to perhaps 11,000 excess deaths among people alive during atmospheric testing in the United States from all forms of cancer, including leukemia, from 1951 to well into the 21st century. As of March 2009, the U.S. is the only nation that compensates nuclear test victims. Since the Radiation Exposure Compensation Act of 1990, more than $1.38 billion in compensation has been approved. The money is going to people who took part in the tests, notably at the Nevada Test Site, and to others exposed to the radiation.

In addition, leakage of byproducts of nuclear weapon production into groundwater has been an ongoing issue, particularly at the Hanford site.

Effects of nuclear explosions

Some scientists estimate that a nuclear war with 100 Hiroshima-size nuclear explosions on cities could cost the lives of tens of millions of people from long-term climatic effects alone. The climatology hypothesis is that if each city firestorms, a great deal of soot could be thrown up into the atmosphere which could blanket the earth, cutting out sunlight for years on end, causing the disruption of food chains, in what is termed a nuclear winter.

Fallout exposure

Depending on if further afield individuals shelter in place or evacuate perpendicular to the direction of the wind, and therefore avoid contact with the fallout plume, and stay there for the days and weeks after the nuclear explosion, their exposure to fallout, and therefore their total do se, will vary. With those who do shelter in place, and or evacuate, experiencing a total dose that would be negligible in comparison to someone who just went about their life as normal.

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Nuclear Power ☢

***Nuclear power** is the use of nuclear reactions to produce electricity. Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium in nuclear power plants. Nuclear decay processes are used in niche applications such as radioisotope thermoelectric generators in some space probes such as Voyager 2. Generating electricity from fusion power remains the focus of international research. Civilian nuclear power supplied 2,586 terawatt hours (TWh) of electricity in 2019, equivalent to about 10% of global electricity generation, and was the second-largest low-carbon power source after hydroelectricity. As of January 2021, there are 442 civilian fission reactors in the world, with a combined electrical capacity of 392 gigawatt (GW). There are also 53 nuclear power reactors under construction and 98 reactors planned, with a combined capacity of 60 GW and 103 GW, respectively. The United States has the largest fleet of nuclear reactors, generating over 800 TWh zero-emissions electricity per year with an average capacity factor of 92%. Most reactors under construction are generation III reactors in Asia.*

[The 1200 MWe Leibstadt Nuclear Power Plant in Switzerland. The boiling water reactor (BWR), located inside the dome capped cylindrical structure, is dwarfed in size by its cooling tower. The station produces a yearly average of 25 million kilowatt-hours per day, sufficient to power a city the size of Boston].

ORIGINS

The discovery of nuclear fission occurred in 1938 following over four decades of work on the science of radioactivity and the elaboration of new nuclear physics that described the components of atoms. Soon after the discovery of the fission process, it was realized that a fissioning nucleus can induce further nucleus fissions, thus inducing a self-sustaining chain reaction.[3] Once this was experimentally confirmed in 1939, scientists in many countries petitioned their governments for support of nuclear fission research, just on the cusp of World War II, for the development of a nuclear weapon.[4]
In the United States, these research efforts led to the creation of the first man-made nuclear reactor, the Chicago Pile-1, which achieved criticality on December 2, 1942. The reactor's development was part of the Manhattan Project, the Allied effort to create atomic bombs during World War II. It led to the building of larger single-purpose production reactors for the production of weapons-grade plutonium for use in the first nuclear weapons. The United States tested the first nuclear weapon in July 1945, the Trinity test, with the atomic bombings of Hiroshima and Nagasaki taking place one month later.

The launching ceremony of the USS Nautilus January 1954. In 1958 it would become the first vessel to reach the North Pole.

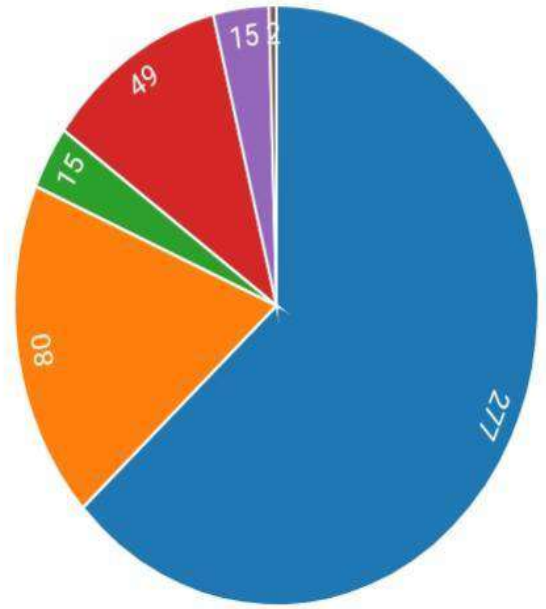
Despite the military nature of the first nuclear devices, the 1940s and 1950s were characterized by strong optimism for the potential of nuclear power to provide cheap and endless energy.[6] Electricity was generated for the first time by a nuclear reactor on December 20, 1951, at the EBR-I experimental station near Arco, Idaho, which initially produced about 100 kW.[7][8] In 1953, American President Dwight Eisenhower gave his "Atoms for Peace" speech at the United Nations, emphasizing the need to develop "peaceful" uses of nuclear power quickly. This was followed by the Atomic Energy Act of 1954 which allowed rapid declassification of U.S. reactor technology and encouraged development by the private sector.

First Power Generation

The first organization to develop practical nuclear power was the U.S. Navy, with the S1W reactor for the purpose of propelling submarines and aircraft carriers. The first nuclear-powered submarine, USS Nautilus, was put to sea in January 1954.[9][10] The S1W reactor was a Pressurized Water Reactor. This design was chosen because it was simpler, more compact, and easier to operate compared to alternative designs, thus more suitable to be used in submarines. This decision would result in the PWR being the reactor of choice also for power generation, thus having a lasting impact on the civilian electricity market in the years to come. On June 27, 1954, the Obninsk Nuclear Power Plant in the USSR became the world's first nuclear power plant to generate electricity for a power grid, producing around 5 megawatts of electric power.[12] The world's first commercial nuclear power station, Calder Hall at Windscale, England was connected to the national power grid on 27 August 1956. In common with a number of other generation I reactors, the plant had the dual purpose of producing electricity and plutonium-239, the latter for the nascent nuclear weapons program in Britain. The first major accident at a nuclear reactor occurred in 1961 at the SL-1, a U.S. Army experimental nuclear power reactor at the Idaho National Laboratory. An uncontrolled chain reaction resulted in a steam explosion which killed the three crew members and caused a meltdown.[14][15] Another serious accident happened in 1968, when one of the two liquid-metal-cooled reactors on board the Soviet submarine K-27 underwent a fuel element failure, with the emission of gaseous fission products into the surrounding air, resulting in 9 crew fatalities and 83 injuries

The Atomic Bomb [H-052-1] by the US Navy

NUCLEAR POWER PLANTS



Number of electricity generating civilian reactors by type as of 2014.[54]

Nuclear power plants are thermal power stations that generate electricity by harnessing the thermal energy released from nuclear fission. A fission nuclear power plant is generally composed of a nuclear reactor, in which the nuclear reactions generating heat take place; a cooling system, which removes the heat from inside the reactor; a steam turbine, which transforms the heat into mechanical energy; an electric generator, which transforms the mechanical energy into electrical energy. When a neutron hits the nucleus of a uranium-235 or plutonium atom, it can split the nucleus into two smaller nuclei. The reaction is called nuclear fission. The fission reaction releases energy and neutrons. The released neutrons can hit other uranium or plutonium nuclei, causing new fission reactions, which release more energy and more neutrons. This is called a chain reaction. In most commercial reactors, the reaction rate is controlled by control rods that absorb excess neutrons. The controllability of nuclear reactors depends on the fact that a small fraction of neutrons resulting from fission are delayed. The time delay between the fission and the release of the neutrons slows down changes in reaction rates and gives time for moving the control rods to adjust the reaction rate.

POSTITVES OF NUCLEAR POWER ⚡

Nuclear energy protects air quality by producing massive amounts of carbon-free electricity. It powers communities in 28 U.S. states and contributes to many non-electric applications, ranging from the medical field to space exploration. For others, nuclear is as bad if not worse than fossil fuels. They argue the potential of a nuclear meltdown like Chernobyl and Fukushima outweighs the positives of nuclear power, as do the excessive costs and difficulty in disposing of the nuclear waste produced.

- **Clean Energy Source:-** *Nuclear is the largest source of clean power in the United States. It generates nearly 800 billion kilowatt hours of electricity each year and produces more than half of the nation's emissions-free electricity. This avoids more than 470 million metric tons of carbon each year, which is the equivalent of removing 100 million cars off of the road.*

The thermal energy from nuclear reactors may also be used to decarbonize other energy-intensive sectors such as transportation – the largest contributor to carbon pollution

- **Reliable Energy Source:-** *Nuclear power plants run 24 hours a day, 7 days a week. They are designed to operate for longer stretches and refuel every 1.5 – 2 years. In 2019, nuclear plants operated at full power more than 92% of the time, making it the most reliable energy source on the grid today.*
- **Creates Jobs :-** *The nuclear industry supports nearly half a million jobs in the United States and contributes an estimated $60 billion to the U.S. gross domestic product each year. U.S. nuclear plants can employ up to 700 workers with salaries that are 30% higher than the local average. They also contribute billions of dollars annually to local economies through federal and state tax revenues.*

- **Supports National Security :-** *A strong civilian nuclear sector is essential to U.S. national security and energy diplomacy. The United States must maintain its global leadership in this arena to influence the peaceful use of nuclear technologies. The U.S. government works with countries in this capacity to build relationships and develop new opportunities for the nation's nuclear technologies.*

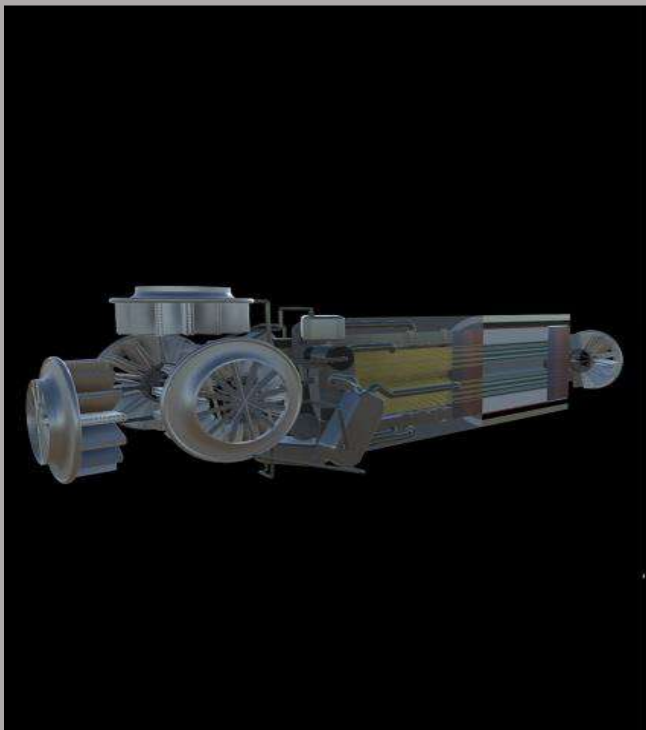
Challenges Faced Of Nuclear Energy

Apart from the positive sides, there are some side effects/negatives of the nuclear energy.

- **Public Awareness:-** *Commercial nuclear power is sometimes viewed by the general public as a dangerous or unstable process. This perception is often based on three global nuclear accidents, its false association with nuclear weapons, and how it is portrayed on popular television shows and films. DOE and its national labs are working with industry to develop new reactors and fuels that will increase the overall performance of these technologies and reduce the amount of nuclear waste that is produced.*

- **Storage And Disposal:-** *Many people view used fuel as a growing problem and are apprehensive about its transportation, storage, and disposal. DOE is responsible for the eventual disposal and associated transport of all commercial used fuel, which is currently securely stored at 76 reactor or storage sites in 34 states. For the foreseeable future, this fuel can safely remain at these facilities until a permanent disposal solution is determined by Congress.*

- **Constructing New Power Plants:-** *Building a nuclear power plant can be discouraging for stakeholders. Conventional reactor designs are* *considered multi-billion dollar infrastructure projects. High capital costs, licensing and regulation approvals, coupled with long lead times and construction delays, have also deterred public interest.*

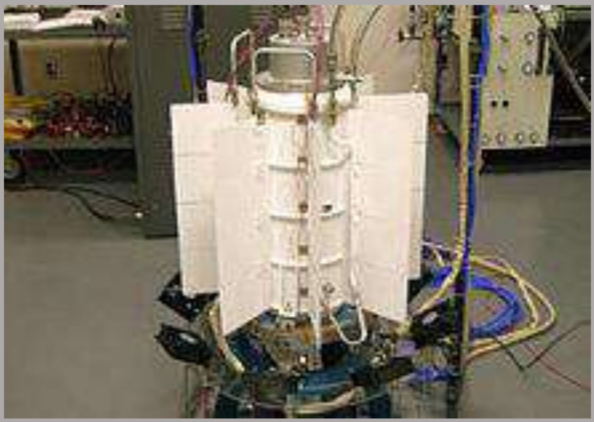


- **High Operating Costs:-** *Challenging market conditions have left the nuclear industry struggling to compete. Strict regulations on maintenance, staffing levels, operator training, and plant inspections have become a financial burden for the industry.*

- **Water intensive:-** *Nuclear power plants require a lot of water to produce energy. In 2015, the United States consumed 320 billion gallons of water to produce nuclear power. That's more water than what is used for coal processing. As water becomes more scarce, especially in the face of climate change, this enormous consumption of water could become unsustainable*

Applications Of Nuclear Energy

- **Use In Space:-** *The most common use of nuclear power in space is the use*



of radioisotope thermoelectric generators, which use radioactive decay to generate power. These power generators are relatively small scale (few kW), and they are mostly used to power space missions and experiments for long periods where solar power is not available in sufficient quantity, such as in the Voyager 2 space probe.[159] A few space vehicles have been launched using nuclear reactors: 34 reactors belong to the Soviet RORSAT series and one was the American SNAP-10A.[159]

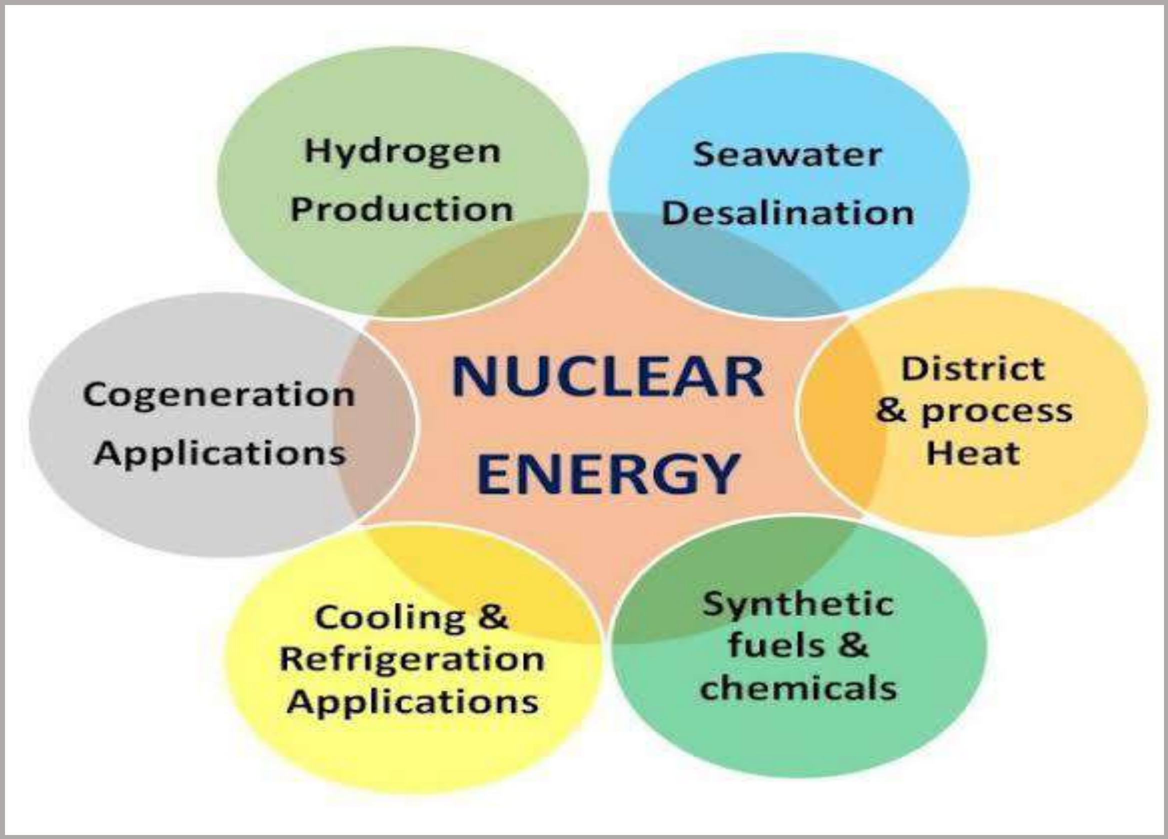
- **Both fission and fusion appear promising for space propulsion applications, generating higher mission velocities with less reaction mass.[159][160]**

- **Agriculture and Food:-** *In many parts of the world, agricultural workers use radiation to prevent harmful insects from reproducing. When insects cannot have offspring, there are fewer of them. Reducing the numbers of pests and bugs protects crops, providing the world with more food.*

Irradiation also kills bacteria and other harmful organisms in food. This type of sterilization occurs without making food radioactive or significantly affecting the nutritional value. In fact, irradiation is the only way to kill bacteria in raw and frozen foods effectively.

- **Medical:-** *Nuclear technologies provide images inside the human body and can help to treat disease. For example, nuclear research has allowed doctors to predict precisely the amount of radiation required to kill cancer tumors without damaging healthy cells.*

Hospitals sterilize medical equipment with gamma rays safely and inexpensively. Items sterilized by radiation include syringes, burn dressings, surgical gloves and heart valves.



- **Water Desalination:-** *Water desalination is the process of removing salt from saltwater to make the water drinkable. However, this process requires a lot of energy. Nuclear energy facilities can provide the large amount of energy that desalination plants need to provide fresh drinking water.*

Conclusion and Future of Nuclear Energy

While nuclear power cannot substitute fossil fuel entirely and become the sole sustainable energy resource, it can play a significant role in decarbonizing the production of electricity. Although we face significant challenges that are constraining the prospects for further development, nuclear power should be developed as a potential carbon-free energy resource in order to mitigate future problems of climate change and other environmental concerns. The future of nuclear power as a major source of energy will depend on whether it can overcome the challenges of operational safety, proliferation and waste management. While the third generation power plants are significantly safer than previous ones, their cost has to be driven down in order to be economically competitive. [6] New nuclear power plants operate at $1700-$3100/kW, which cannot compete against natural gas technology, especially when the gas infrastructure is already in place. However, the economics of nuclear energy can be competitive when coal or natural gas's infrastructure is not in place, since they have to be transported over long distances or through pipelines

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URBAN ECOLOGY

INDEX

INTRODUCTION

Central Park represents an ecosystem fragment within a larger urban environment

Urban ecology *is the scientific study of the relation of living organisms with each other and their surroundings in the context of an* ***urban environment****. The urban environment refers to environments dominated by* ***high-density*** *residential and commercial buildings,* ***paved surfaces****, and other urban-related factors that create a unique landscape dissimilar to most previously studied environments in the field of* ***ecology****. The goal of urban ecology is to achieve a balance between human culture and the natural environment.*

Urban ecology is a recent field of study compared to ecology as a whole. The methods and studies of urban ecology are similar to and comprise a subset of ecology. The study of urban ecology carries increasing importance because more than 50% of the world's population today lives in urban areas. At the same time, it is estimated that within the next forty years, two-thirds of the world's population will be living in expanding urban centers. The ecological processes in the urban environment are comparable to those outside the urban context. However, the types of ***urban habitats*** *and the species that inhabit them are poorly documented. Often, explanations for phenomena examined in the urban setting as well as predicting changes because of urbanization are the center for scientific research.*

HISTORY

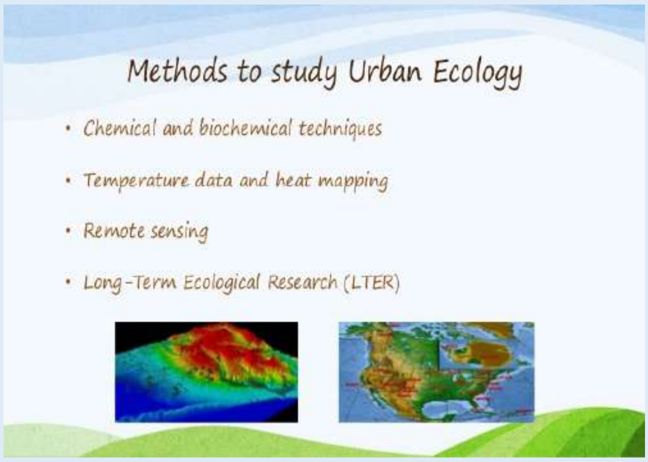
The creation of an important stream water garden in **Metz**'s centre during the early 70s was one of the materializations of **Jean-Marie Pelt**'s works on urban ecology

*Ecology has historically focused on "pristine" natural environments, but by the 1970s many ecologists began to turn their interest towards ecological interactions taking place in, and caused by urban environments. **Jean-Marie Pelt**'s 1977 book **The Re-Naturalized Human**, Brian Davis' 1978 publication **Urbanization and the diversity of insects**, and Sukopp et al.'s 1979 article "The soil, flora and vegetation of Berlin's wastelands" are some of the first publications to recognize the importance of urban ecology as a separate and distinct form of ecology the same way one might see **landscape ecology** as different from **population ecology**. Forman and Godron's 1986 book **Landscape Ecology** first distinguished urban settings and landscapes from other landscapes by dividing all landscapes into five broad types. These types were divided by the intensity of human influence ranging from pristine **natural environments** to **urban centers**.*

*Urban ecology is recognized as a diverse and complex concept which differs in application between North America and Europe. The European concept of urban ecology examines the **biota** of urban areas, the North American concept has traditionally examined the social sciences of the urban landscape, as well as the ecosystem fluxes and processes, and the Latin American concept examines the effect of human activity on the biodiversity and fluxes of urban ecosystems. The world's first urban ecology laboratories were founded, for temperate ecosystems, in 1999 (**Urban Ecology Research Laboratory**, University of Washington), and for tropical ecosystems, in 2008 (**Laboratory of Urban Ecology**, Universidad Estatal a Distancia of Costa Rica.*

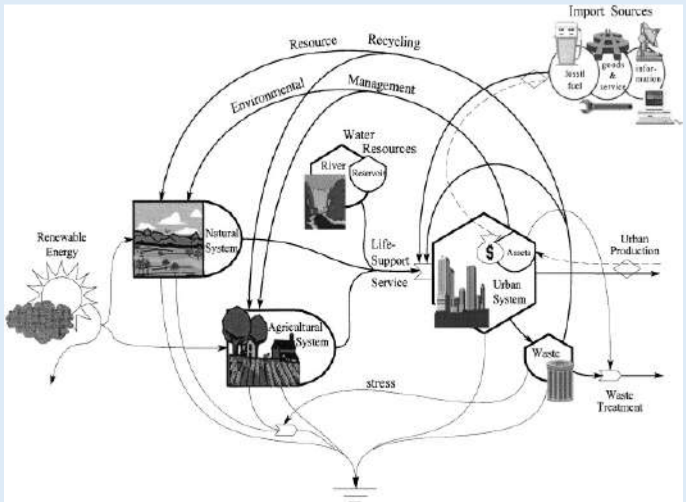
METHODS

Since urban ecology is a subfield of ecology, many of the techniques are similar to that of ecology. Ecological study techniques have been developed over centuries, but many of the techniques use for urban ecology are more recently developed. Methods used for studying urban ecology involve chemical and biochemical techniques, temperature recording, heat mapping remote sensing, and long-term ecological research sites.



Chemical and biochemical techniques

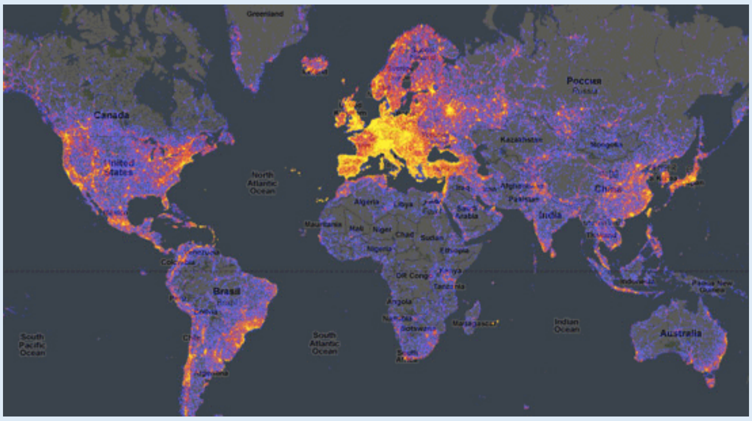
*Chemical techniques may be used to determine **pollutant concentrations** and their effects. Tests can be as simple as dipping a manufactured test strip, as in the case of pH testing, or be more complex, as in the case of examining the spatial and temporal variation of **heavy metal contamination** due to industrial runoff. In that particular study, livers of birds from many regions of the **North Sea** were ground up and **mercury** was extracted. Additionally, mercury bound in feathers was extracted from both live birds and from museum specimens to test for mercury levels across many decades. Through these two different measurements, researchers were able to make a complex picture of the spread of mercury due to industrial runoff both spatially and temporally.*



Conceptual Diagram of **Urban Ecological Economic System**

*Other chemical techniques include tests for **nitrates**, **phosphates**, **sulfates**, etc. which are commonly associated with **urban pollutants** such as **fertilizer** and industrial* *byproducts. These biochemical fluxes are studied in the atmosphere (e.g., **greenhouse gasses**), **aquatic ecosystems** and **soil vegetation**. Broad reaching effects of these biochemical fluxes can be seen in various aspects of both the urban and surrounding rural ecosystems.*

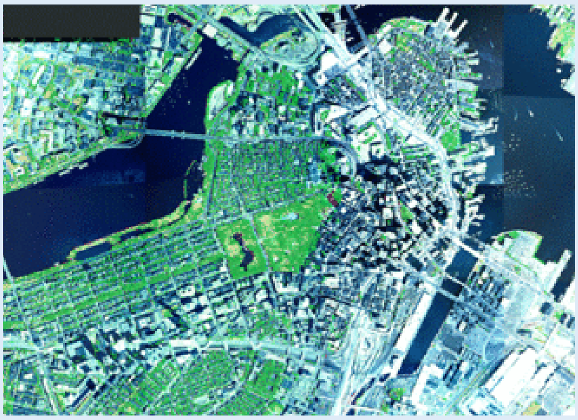
Temperature data and heat mapping



***Heat Maps** in GIS - GIS Lounge*

***Temperature** data can be used for various kinds of studies. An important aspect of temperature data is the ability to correlate temperature with various factors that may be affecting or occurring in the environment. Oftentimes, temperature data is collected long-term by the **Office of Oceanic and Atmospheric Research** (OAR), and made available to the scientific community through the **National Oceanic and Atmospheric Administration** (NOAA). Data can be overlaid with maps of terrain, urban features, and other spatial areas to create heat maps. These heat maps can be used to view trends and distribution over time and space.*

Remote sensing



***Remote sensing** allows collection of data using satellites. This map shows urban tree canopy in Boston*

***Remote sensing** is the technique in which data is collected from distant locations through the use of **satellite imaging**, **radar**, and **aerial photographs**. In urban ecology, remote sensing is used to collect data about terrain, weather patterns, light, and vegetation. One application of remote sensing for urban ecology is to detect the productivity of an area by measuring the photosynthetic wavelengths of emitted light. Satellite images can also be used to detect* *differences in temperature and landscape diversity to detect the effects of urbanization.*

LTERs and long-term data sets

Long-term ecological research *(LTER) sites are research sites funded by the government that have collected reliable long-term data over an extended period of time in order to identify long-term climatic or ecological trends. These sites provide long-term temporal and spatial data such as average temperature, rainfall and other ecological processes. The main purpose of LTERs for urban ecologists is the collection of vast amounts of data over long periods of time. These long-term data sets can then be analyzed to find trends relating to the effects of the urban environment on various ecological processes, such as species diversity and abundance over time. Another example is the examination of temperature trends that are accompanied with the growth of urban centers.*

URBAN EFFECTS ON THE ENVIRONMENT

*Humans are the driving force behind urban ecology and influence the environment in a variety of ways, such as modifying land surfaces and waterways, introducing foreign species, and altering biogeochemical cycles. Some of these effects are more apparent, such as the reversal of the **Chicago River** to accommodate the growing pollution levels and trade on the river. Other effects can be more gradual such as the change in global climate due to urbanization.*

Modification of land and waterways

*Humans place high demand on land not only to build urban centers, but also to build surrounding suburban areas for housing. Land is also allocated for agriculture to sustain the growing population of the city. Expanding cities and suburban areas necessitate corresponding deforestation to meet the land-use and resource requirements of urbanization. Key examples of this are **Deforestation in the United States** and **Europe**.*

Deforestation in Europe

Along with manipulation of land to suit human needs, natural water resources such as rivers and streams are also modified in urban establishments. Modification can come in the form of dams, artificial canals, and even the reversal of rivers. Reversing the flow of the Chicago River is a major example of urban environmental modification. Urban areas in natural desert settings often bring in water from far areas to maintain the human population and will likely have effects on the local desert climate. Modification of aquatic systems in urban areas also results in decreased stream diversity and increased pollution.

Trade, shipping, and spread of invasive species

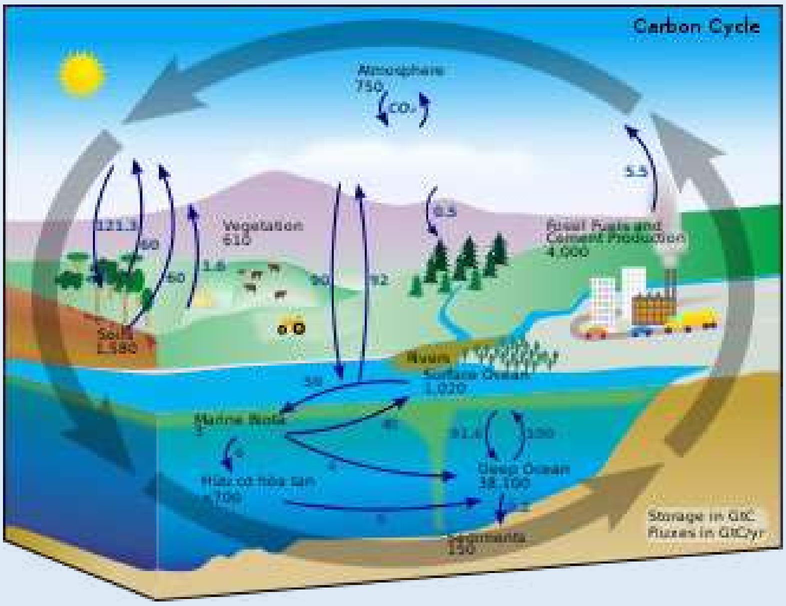
Invasive **kudzu vines** growing on trees in Atlanta, Georgia, USA

Both local shipping and long-distance trade are required to meet the resource demands important in maintaining urban areas. ***Carbon dioxide emissions*** *from the transport of goods also contribute to accumulating greenhouse gases and nutrient deposits in the soil and air of urban environments. In addition, shipping facilitates the unintentional spread of living organisms, and introduces them to environments that they would not naturally inhabit. Introduced or* ***alien species*** *are populations of organisms living in a range in which they did not naturally evolve due to intentional or inadvertent human activity. Increased transportation between urban centers furthers the incidental movement of animal and plant species. Alien species often have no natural predators and pose a substantial threat to the dynamics of existing ecological populations in the new environment where they are introduced. Such invasive species are numerous and include* ***house sparrows****,* ***ring-necked pheasants****,* ***European starlings****,* ***brown rats****,* ***Asian carp****,* ***American bullfrogs****,* ***emerald ash borer****,* ***kudzu vines****, and* ***zebra mussels*** *among numerous others, most notably domesticated animals. In Australia, it has been found that removing Lantana (****L. camara****, an alien species) from* ***urban green spaces*** *can surprisingly have negative impacts on bird diversity locally, as it provides refugia for species like the superb fairy (Malurus cyaneus) and silvereye (Zosterops lateralis), in the absence of native plant*

A ship navigates through the Firth of Clyde in Scotland, potentially carrying invasive species equivalents. Although, there seems to be a density threshold in which too much Lantana (thus homogeneity in vegetation cover) can lead to a decrease in bird species richness or abundance.

Human effects on biogeochemical pathways

Urbanization results in a large demand for chemical use by industry, construction, agriculture, and energy providing services. Such demands have a substantial impact on ***biogeochemical cycles****, resulting in phenomena such as* ***acid rain****,* ***eutrophication****, and* ***global warming****. Furthermore, natural biogeochemical cycles in the urban environment can be impeded due to impermeable surfaces that prevent nutrients from returning to the soil, water, and atmosphere.*



Graphical representation of the ***carbon cycle***

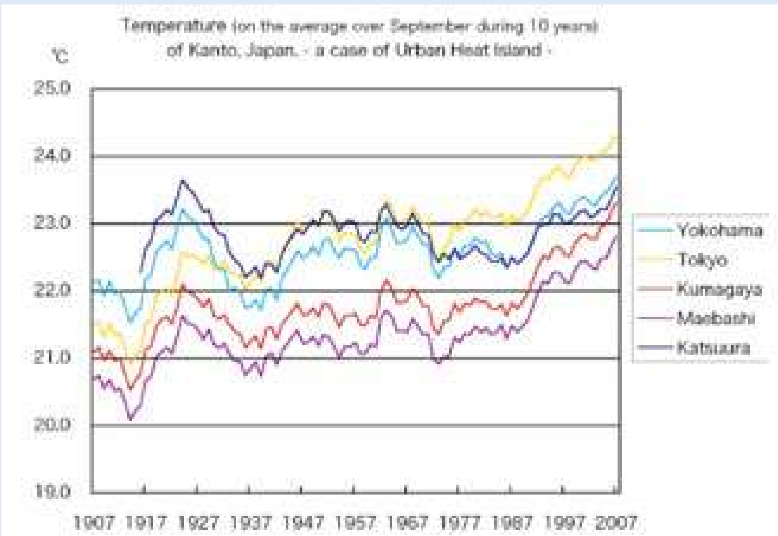
Demand for fertilizers to meet agricultural needs exerted by expanding urban centers can alter chemical composition of soil. Such effects often result in abnormally high concentrations of compounds including sulfur, phosphorus, nitrogen, and heavy metals. In addition, nitrogen and phosphorus used in fertilizers have caused severe problems in the form of agricultural runoff, which alters the concentration of these compounds in local rivers and streams, often resulting in adverse effects on native species. A well-known effect of agricultural runoff is the phenomenon of eutrophication. When the fertilizer chemicals from agricultural runoff reach the ocean, an ***algal bloom*** *results, then rapidly dies off. The dead algae biomass is decomposed by bacteria that also consume large quantities of oxygen, which they obtain from the water, creating a "dead zone" without oxygen for fish or other organisms. A classic example is the dead zone in the* ***Gulf of Mexico*** *due to agricultural runoff into the* ***Mississippi River****.*

URBAN EFFECTS ON CLIMATE

*Urban environments and outlying areas have been found to exhibit unique local temperatures, **precipitation**, and other characteristic activity due to a variety of factors such as pollution and altered geochemical cycles. Some examples of the urban effects on climate are **urban heat island**, **oasis effect**, **greenhouse gases**, and **acid rain**. This further stirs the debate as to whether urban areas should be considered a unique **biome**. Despite common trends among all urban centers, the surrounding local environment heavily influences much of the climate. One such example of regional differences can be seen through the urban heat island and oasis effect.*

Urban heat island effect

*The **urban heat island** is a phenomenon in which central regions of urban centers exhibit higher mean temperatures than surrounding urban areas. Much of this effect can be attributed to low city **albedo**, the reflecting power of a surface, and the increased surface area of buildings to absorb solar radiation. Concrete, cement, and metal surfaces in urban areas tend to absorb heat energy rather than reflect it, contributing to higher urban temperatures. Brazel et al. found that the urban heat island effect demonstrates a positive correlation with population density in the city of Baltimore. The heat island effect has corresponding ecological consequences on resident species. However, this effect has only been seen in temperate climates.*



*Graphical representation of the rising temperature in **Kanto**, **Japan** due to **urban heat island***

Greenhouse gases

*Greenhouse gas emissions include those of carbon dioxide and methane from the combustion of **fossil fuels** to supply energy needed by vast urban metropolises. Other greenhouse gases include water vapor, and **nitrous oxide**. Increases in **greenhouse gases** due to urban transport, construction, industry and other demands have been correlated strongly with increase in temperature. Sources of methane are agricultural dairy cows and landfills.*

Acid rain and pollution

*Processes related to urban areas result in the emission of numerous pollutants, which change corresponding **nutrient cycles** of carbon, sulfur, nitrogen, and other elements. Ecosystems in and around the urban center are especially influenced by these point sources of pollution. **High sulfur dioxide concentrations** resulting from the industrial demands of urbanization cause **rainwater to become more acidic**. Such an effect has been found to have a significant influence on locally affected populations, especially in aquatic environments. Wastes from urban centers, especially large urban centers in developed nations, can drive biogeochemical cycles on a global scale.*

Smokestacks from a wartime production plant releasing pollutants into the atmosphere

Urban environment as an anthropogenic biome

*The urban environment has been classified as an **anthropogenic biome**, which is characterized by the predominance of certain species and climate trends such as urban heat island across many urban areas. Examples of species characteristic of many urban environments include, cats, dogs, mosquitoes, rats, flies, and pigeons, which are all generalists. Many of these are dependent on human activity and have adapted accordingly to the niche created by urban centers.*

Ways to improve urban ecology

Cities should be planned and constructed in such a way that minimizes the urban effects on the surrounding environment (urban heat island, precipitation, etc.) as well as optimizing ecological activity. For example, increasing the ***albedo****, or reflective power, of surfaces in urban areas, can minimize urban heat island, resulting in a lower magnitude of the urban heat island effect in urban areas. By minimizing these abnormal temperature trends and others, ecological activity would likely be improved in the urban setting.*

Species reintroduction

Reintroduction of species to urban settings can help improve the local biodiversity previously lost; however, the following guidelines should be followed in order to avoid undesired effects.

- ✓ *No predators capable of killing children will be reintroduced to urban areas.*
- ✓ *There will be no introduction of species that significantly threaten human health, pets, crops or property.*
- ✓ *Reintroduction will not be done when it implies significant suffering to the organisms being reintroduced, for example stress from capture or captivity.*
- ✓ *Organisms that carry pathogens will not be reintroduced.*
- ✓ *Organisms whose genes threaten the genetic pool of other organisms in the urban area will not be reintroduced.*
- ✓ *Organisms will only be reintroduced when scientific data support a reasonable chance of long term survival (if funds are insufficient for the long term effort, reintroduction will not be attempted).*
- ✓ *Reintroduced organisms will receive food supplementation and veterinary assistance as needed.*

Random reintroduction of species

- ✓ *Reintroduction will be done in both experimental and control areas to produce reliable assessments (monitoring must continue afterwards to trigger interventions if necessary).*
- ✓ *Reintroduction must be done in several places and repeated over several years to buffer for stochastic events.*
- ✓ *People in the areas affected must participate in the decision process, and will receive education to make reintroduction sustainable (but final decisions must be based on objective information gathered according to scientific standards).*

Sustainability

*With the ever-increasing **demands for resources** necessitated by urbanization, recent campaigns to move toward sustainable energy and **resource consumption**, such as **LEED certification** of buildings, **Energy Star** certified appliances, and **zero emission** vehicles, have gained momentum. Sustainability reflects techniques and consumption ensuring reasonably low resource use as a component of urban ecology. Techniques such as carbon recapture may also be used to **sequester** carbon compounds produced in urban centers rather continually emitting more of the **greenhouse gas**.*

*Pipes carrying biogas produced by anaerobic digestion or fermentation of biodegradable materials as a form of **carbon sequestration***

Green Infrastructure Implementation

*Urban areas can be converted to areas that are more conducive to hosting wildlife through the application of **green infrastructure**. Although the opportunities of green infrastructure (GI) to benefit human populations have been recognized, there are also opportunities to conserve wildlife diversity. Green infrastructure has the potential to support wildlife robustness by providing a more suitable habitat than conventional, "grey" infrastructure as well as aid in stormwater management and air purification. GI can be defined as features that were engineered with natural elements or natural features. This natural constitution helps prevent wildlife exposure to man-made toxicants. Although research on the benefits of GI on biodiversity has increased exponentially in the last decade, these effects have rarely been quantified. In a study performed by Alessandro Filazzola (et. al.), 1,883 published manuscripts were examined and meta-analyzed in reference to 33 relevant studies in order to determine* *the effect of GI on wildlife. Although there was variability in the findings, it was determined that the implementation of GI improved* ***biodiversity*** *compared to conventional infrastructure. In some cases, GI even preserved comparable measures of biodiversity to natural components.*

Urban green space

In ***land-use planning***, ***urban green space*** *is* ***open-space*** *areas reserved for* ***parks*** *and other "green spaces", including plant life, water features -also referred to as* ***blue spaces***- *and other kinds of natural environment. Most urban open spaces are green spaces, but occasionally include other kinds of open areas. The landscape of urban open spaces can range from* ***playing fields*** *to highly maintained environments to relatively* ***natural landscapes***.

Forsyth Park *is a large urban open space area in the downtown district of* ***Savannah***, ***Georgia***

Generally considered open to the public, urban green spaces are sometimes privately owned, such as ***higher education campuses***, ***neighborhood/community parks/gardens***, *and institutional or corporate grounds. Areas outside city boundaries, such as* ***state*** *and* ***national parks*** *as well as open space in the countryside, are not considered urban open space. Streets, piazzas, plazas and urban squares are not always defined as urban open space in land use planning. Urban green spaces have wide reaching positive impacts on the health of individuals and communities near the green space.*

Urban greening policies are important for revitalizing communities, reducing financial burdens of healthcare and increasing quality of life. Most policies focus on community benefits, and reducing negative effects of urban development, such as ***surface runoff*** *and the* ***urban heat island*** *effect. Historically, access to green space has favored wealthier, and more privelaged communities, thus recent focus in urban greening has increasingly focused on* ***environmental justice*** *concerns, and community engagement in the greening process. In particular, in cities with economic decline, such as the* ***Rust Belt*** *in the United States, urban greening has broad community revitalization impacts.*

Increasing Wildlife Habitat Connectivity

The implementation of wildlife corridors throughout urban areas (and in between wildlife areas) would promote wildlife habitat ***connectivity****. Habitat connectivity is critical for ecosystem health and wildlife conservation yet is being compromised by increasing* ***urbanization****. Urban development has caused green spaces to become increasingly fragmented and has caused adverse effects in genetic variation within species, population abundance and species richness. Urban green spaces that are linked by* ***ecosystem corridors*** *have higher ecosystem health and resilience to global environmental change. Employment of corridors can form an ecosystem network that facilitates movement and dispersal. However, planning these networks requires a comprehensive spatial plan.*

Kupittaa Park (Kupittaanpuisto) is a large urban open space area in ***Turku****,* ***Southwest Finland****. At the same time, it is also the largest and oldest park in* ***Finland***

One approach is to target "shrinking" cities (such as ***Detroit****,* ***Michigan****, USA) that have an abundance of vacant lots and land that could be repurposed into greenways to provide ecosystem services (although even cities with growing populations typically have vacant land as well). However, even cities with high vacancy rates sometimes can present social and environmental challenges. For instance, vacant land that stands on* ***polluted soils*** *may contain heavy metals or* ***construction debris****; this must be addressed before the repurposing. Once land has been repurposed for ecosystem services, avenues must be pursued that could allow this land to contribute to structural or functional connectivity.*

Structural connectivity refers to parts of the landscape that are physically connected. Functional connectivity refers to species-specific tendencies that indicate interaction with other parts of the landscape. Throughout the City of Detroit, spatial patterns were detected that could promote structural connectivity. The research performed by Zhang "integrates ***landscape ecology*** *and* ***graph theory****,* ***spatial modeling****, and* ***landscape design*** *to develop a methodology for planning multifunctional green infrastructure that fosters social-ecological sustainability and resilience". Using a functional connectivity index, there was found to be a high correlation between these results (structural and functional connectivity), suggesting* *that the two metrics could be indicators of each other and could guide green space planning.*

Although urban wildlife corridors could serve as a potential mitigation tool, it is important that they are constructed so as to facilitate wildlife movement without restriction. As humans may be perceived as a threat, the success of the corridors is dependent on human population density proximity to roads. In a study performed by Tempe Adams (et. al.), remote-sensor camera traps and data from GPS collars were utilized to assess whether or not the African elephant would use narrow urban wildlife corridors. The study was performed in three different urban-dominated land use types (in ***Botswana*****,** ***South Africa****) over a span of two years.*

Asramam Maidan *in* ***Kollam*** *city,* ***India****. It is the largest open space available in any of the city limits in* ***Kerala*** *state*

The results of the study indicated that elephants tended to move through unprotected areas more quickly, spending less time in those areas. Using vehicular traffic as a measure of human activity, the study indicated that elephant presence was higher during times when human activity was at a minimum. It was determined that "formal protection and designation of urban corridors by the relevant governing bodies would facilitate coexistence between people and wildlife at small spatial scales." However, the only way this co-existence could be feasible is by creating structural connectivity (and thus promoting functional connectivity) by implementing proper wildlife corridors that facilitate easy movement between habitat patches. The usage of ***green infrastructure*** *that is connected to natural habitats has been shown to reap greater biodiversity benefits than GI implemented in areas far from natural habitats. GI close to natural areas may also increase functional connectivity in natural environments.*

SUMMARY

Urbanization results in a series of both local and far-reaching effects on ***biodiversity****,* ***biogeochemical cycles****,* ***hydrology****, and* ***climate****, among many other stresses. Many of these effects are not fully understood, as urban ecology has only recently emerged as a scientific discipline and much more research remains to be done. Research on cities outside the US and Europe remains limited. Observations on the impact of urbanization on biodiversity and species interactions are consistent across many studies but definitive mechanisms have yet to be established. Urban ecology constitutes an important and highly relevant subfield of ecology, and further study must be pursued to more fully understand the effects of human urban areas on the environment.*

ARTICLES & REFERENCES

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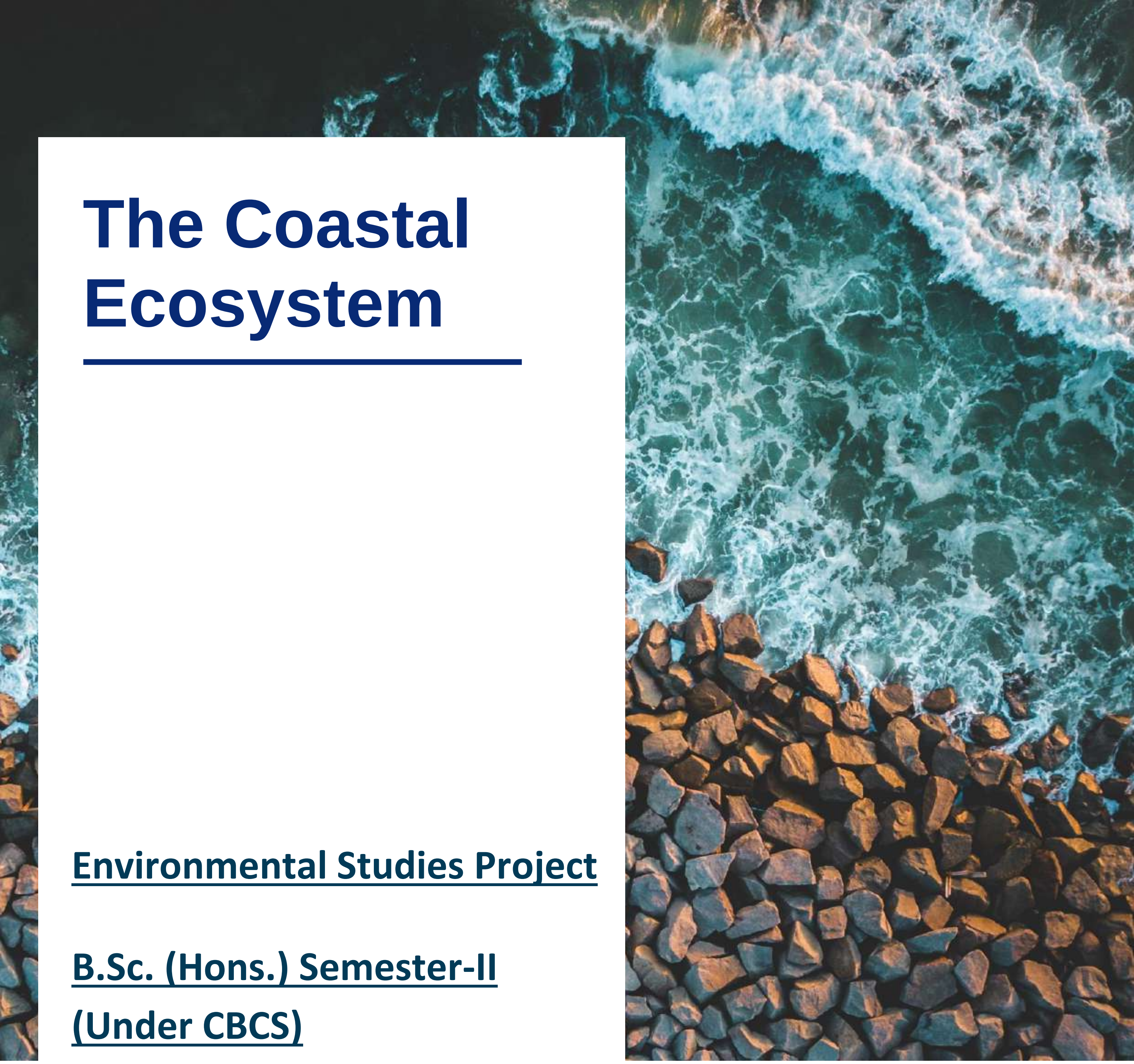

The Coastal Ecosystem

Environmental Studies Project

B.Sc. (Hons.) Semester-II (Under CBCS)

College Roll No. : CMSA20M185
CU Reg. No. : 223-1111-0404-20
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The Indian Coastline

Peninsular India is bounded by water on 3 sides: the Arabian Sea in the west, the Bay of Bengal in the East and the Indian Ocean in the South. The Indian coastline runs over a distance of 7500 km (5700 kms on mainland) distributed along nine coastal states, two groups of islands and four union territories. The coastal belt comprises of a wide range of ecosystems extending from sandy beaches and mangroves to coral reefs and rocky shores.

Fact file

- Seventh longest in the world
- 1/5 of the population live along the coast
- Gujarat has the longest coastline
- 3 of our metropolitan cities are on the coast.

India has a variety of natural coastal ecosystems. The Indian coastline can be divided into the Gujarat region, the west coast, the east coast and the Islands.

- The Western coastline has a wide continental shelf and is marked by backwaters and mud flats.
- The east coast is low-lying with lagoons, marshes, beaches and deltas rich in mangrove forests.
- Coral reefs are predominant on small islands in the Gulf of Kutch in Gujarat, Gulf of Mannar in Tamil Nadu and on Lakshadweep and Andaman and Nicobar groups of islands.

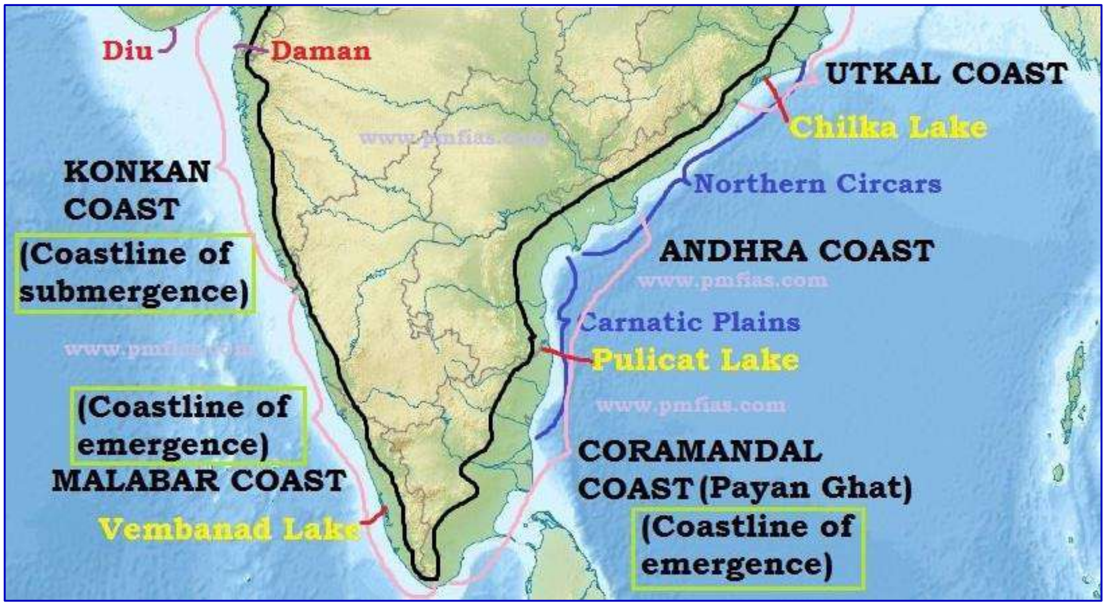

Fig: Indian Coastline

Living on the Coast

The narrow coastal stretches are under immense pressure today as a very large segment of the population want to live there. Living on the coast is highly attractive because of

- scenic beauty
- moderate weather
- plentiful and cheap seafood
- innumerable opportunities for employment in the fishing, shipping and leisure activities
- entertainment by way of sea sports like swimming, surfing, boating, etc.

Fig: Scenic beauty of coastal regions

Besides

- The most fertile agricultural lands are found beside the coast.
- Industries prefer to be located close to the coast for easy discharge of their effluents.
- Thermal and nuclear power plants are also located on the coast for easy access to plentiful water for cooling.
- Ports and harbours on the coast are an important source of employment and overseas trade.
- Tourism flourishes on the coast owing to all the water related sports and activities.

Seashores are classified into three main types, depending on their surface:

- rocky shores, including coral reefs
- muddy shores
- sandy shores

Fig: Fishing in coastal areas

Characteristic groups of organisms live on each type of shore.
The marine biodiversity of India is outstanding in the entire south Asian region. Species ranging from the tiny sea horse to the massive whale sharks have been documented by scientists in our coastal waters.

Fact file

- 26 species of fresh water turtles and tortoises and 5 species of marine turtles, which inhabit and feed in coastal waters and lay their eggs on suitable beaches are found in India. Over 200,000 Olive Ridley turtles come to Orissa to nest in the space of three or four nights. All the five species of sea turtles along with marine mammals are severely threatened and endangered.
- Highest tiger population is found in the Sunderbans along the east coast adjoining the Bay of Bengal.
- Dugongs occur in relatively large numbers in the Gulf of Mannar and Palk Bay. Today they are the most vulnerable in the region.
- Some species of whales like false killer whale, Balenoptera and humpbacked whales have been also reported.
- Of the 21730 species of fish found in the world, 2546 are found in India (11.7% in the World).

Mangroves: Sentinels of the Coast

Mangroves are generally found along the coastlines of tropical and subtropical regions, between 25°N and 25°S latitude, throughout the world. Mangroves are located all along estuarine areas, deltas, tidal creeks, mud flats and salt marshes.

India has some of the best mangroves in the world. About 380 km or 6% of the coastline of mainland India is covered by mangroves, while 40% of coasts (260 km) of Andaman and Nicobar are lined with mangroves. They are located in the alluvial deltas of rivers. The Sundarbans of West Bengal represent the largest stretch of mangroves in the country.

The mangrove is a specially adapted salt-tolerant tree. They are characterized by dark green foliage and a network of many stilt like roots that support them above water. The mangrove swamps are highly productive and are an important nursery ground for fish, crabs and prawn. They are an essential habitat for spawning and nursery bed of marine fishes, endangered migratory birds, estuarine crocodiles, dugongs, dolphins,

Royal Bengal Tiger, Olive Ridley turtles and sea otters. The east coast and Andaman & Nicobar Islands are richer in biodiversity than the west coast.
The wood, leaves and bark of mangroves are used mainly as fuelwood, thatch and for tanning leather respectively.

Role of mangrove ecosystem

- Act as a cost-free, self-repairing and static border security force, for protecting the coast from erosion by storms, cyclones and floods
- The thousands of stilt-like roots catch silt (mud deposits) at the mouths of streams, slow down the current and help the silt to settle
- Support a vast range of biodiversity
- Act as a natural sewage treatment plant
- Absorb pollution, including heavy metals

The principal reasons for degradation

- Dependence of coastal population on mangroves for domestic fuel needs
- Decreased freshwater discharge and increased salinity
- Unchecked expansion of salt pans and aquaculture along the coast

Fig: Tigers in Sunderban

Corals : An Underwater Jungle

Coral reefs have existed for close to 500 million years, making them one of the earth's oldest, largest and most diverse ecosystems. The number of species, representing nearly every group of organism, found on them rivals that of the tropical forests. Coral reefs are a fairy tale world of beautiful colours and changing patterns. They are also a very fragile ecosystem gravely endangered by our carelessness and ignorance. . Some 4,000 species of fish and 800 species of reef-building coral have been described to date, but the total number of species associated with reefs is probably more than 1 million. Coral reefs are a colony of tiny animals called coral polyps. When the animals die, they leave limestone "skeletons" that form the foundations of coral reefs. The creation of a reef can take centuries. Coral islands or atolls develop from reefs that grow up around volcanic islands.

In India, corals are found in

- Gulf of Kutch, off the western mainland coast
- Mandapam group of islands in Gulf of Mannar near Rameswaram
- Andaman and Nicobar islands
- Lakshadweep Islands

Fig: Coral Reef

Uses of coral reefs

- Remove and recycle CO_2 a greenhouse gas
- Protect the shore from erosion by storms and floods
- Are home to over 4,000 species of fish, 800 species of coral and thousands of other forms of plant and animal life, all of which will not survive without the reefs
- Account for 12% of the marine fish catch
- Could provide important medicines including anti-cancer drugs and a compound that blocks ultraviolet rays
- Coral skeletons are being used as bone substitutes in reconstructive bone surgery

Coral reefs are threatened

- Destructive fishing practices, such as dynamite or cyanide fishing and trawling in deeper waters, cause direct physical damage to corals.
- Widespread over fishing leads to very low levels of herbivorous fish, which check coral killing algae.

- Nutrient-laden sewage released near the shore causes algal blooms which block sunlight, stunting coral growth and interfering with reproduction.
- Shoreline construction disturbs sediments, which smother corals.
- Tourism and tourists cause physical damage to reefs by construction activities, trampling, boat abrasion and the removal of corals “souvenirs”.

Life on the reef

The most colourful and diverse groups of fishes are found on the reef. They are of bright colours with bold and distinctive patterns, which serve a purpose.
Red colours appear black under water, helping a fish to go unseen; stripes help a fish to merge with the coral; spotted patterns confuse its predator. They are also of unusual shapes and characteristics. Eels, angel fish, sea snakes, pufferfishes that swell up like a balloon, fierce looking lion fish with a poisonous sting, sharks and sea horses abound in the reef. The vast variety of species include

- Sponges
- Echinoderms like starfish, urchins, feather stars and sea cucumbers
- Sea worms
- Crustaceans like crabs
- Mollusks like snails, clams, oysters, octopus and sea slugs
- Shells
- Sharks and rays
- Reptiles like sea turtles and snakes.
- Marine mammals like dugongs or sea cows, dolphins and whales, seals and sea lions

Fig: Coastal tourism

Coastal Resources

Development of ports and harbours

India seems to be the first country of the Indian Ocean to possess a real navy, carrying on a flourishing trade with the Arab world. After the 16th Century, the Portuguese and the East India Trading Companies, became very active in trading with India. Today, India has many established ports along its coastline, that facilitate trade and tourism. Cargo ships dock in their harbours bringing valuable and necessary goods like oil, grains, coal, iron ore, etc. There are many natural harbours along the coast of Peninsular India, while Chennai has a man-made harbour. Ports are also useful in training and deploying our naval fleet.

Fig: Port of Chennai (INMAA)

Fishing industry

Fishing is an important livelihood of the people in India. Besides, seafood is a cheap and nutritional component of their diet. The total commercial marine catch for India has stabilized over the last ten years at between 1.4 and 1.6 million tonnes, with fish from the clupeoid group (e.g. sardines, Indian shad and whitebait) accounting for approximately 30% of all landings.

Fig: Coastal fishing in India

Coastal tourism

Our country has a long coastline along the mainland and numerous islands. It has achieved commendable success in Goa and Kovalam regarding beach tourism. Beach tourism involves water based activities like, bathing, diving, swimming, snorkeling, surfing, wind-surfing, sailing, sun bathing and beach football, etc.
Indian coastal areas are richly endowed with cultural heritage. They have sweeping golden beaches and roaring waves with temples, palaces, gardens, hills, wildlife sanctuaries and a variety of fairs and festivals.

Minerals from the sea

Coal, oil and natural gas can be obtained from under the seabed. Many minerals are also present in sea water. The most common one is salt. Seawater is evaporated to get salt.
India has large reserves of beach sand minerals, such as ilmenite, rutile, zircon, monazite, sillimanite and garnet. These deposits are mostly located in the coastal stretches of peninsular India. India is one of the leading producers of garnet in the world.

Tidal energy

In most of the shores, tides slowly rise and fall a few feet twice a day, and causes difference in water levels. The rise in water level is high tide and the fall in water level is low tide. The energy produced by the periodic rise and fall of ocean water, due to the gravitational force of the moon, sun and earth can be harnessed to produce electricity. Tidal energy could become an important source of energy in future, because it is a renewable resource. Tidal energy like solar energy and wind power is a relatively "Clean" source that does little damage to the environment.

Fig: Sihwa Lake Tidal Power Station, South Korea

Coastal Pollution

Pollution changes coastal habitats and destroys fish and other species. Most of the trash and pollutants produced by human activities end up in the world's oceans and remain in water near the coastal areas. They are directly drained or dumped into the ocean either on purpose or by accident (oil spills). Sewage and sedimentation from land-clearing and construction are the two most serious causes of coastal pollution. Rivers dump a lot of pollution into the sea, like sewage, industrial effluents, fertilizers and pesticides from farms and sediments.
There are six major types of pollution that affect the world's oceans and coasts: sewage, litter, petroleum, synthetic chemicals, toxic metals and radioactive materials.

Fig: Coastal pollution

Marine Protected Areas

Indian coasts have a large variety of sensitive eco-systems. Sand dunes, coral reefs, mangroves, seagrass beds and wetlands deserve special mention. They are the spawning grounds and nursery of a number of commercially important fish, gastropods and crustaceans.
Marine Protected Areas (MPAs) in India comprise national parks and wildlife sanctuaries declared in coastal wetlands, especially mangroves, coral reefs and

lagoons, under Wildlife (Protection) Act, 1972. There are a total of 26 Marine Protected Areas distributed in Gujarat, Maharashtra, Tamilnadu, Orissa, West Bengal, Lakshadweep and Andaman and Nicobar Islands. The total area of the MPAs in India is 5,318.9 sq. km, which is very small (3.4%) compared to total extent of the Protected Areas (586 PAs covering 15.64 million ha. area) in the country.

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Invasive species

An **invasive species** is an introduced organism that negatively alters its new environment. Although their spread can have beneficial aspects, invasive species adversely affect the invaded habitats and bioregions, causing ecological, environmental, and/or economic damage. Sometimes the term is used for native species that invade human habitats and become invasive pests. In the 21st century they have become a serious economic, social, and environmental threat.

"They may not sound very threatening, but these invaders, large and small, have devastating effects on wildlife."

Invasive species are among the leading threats to native wildlife. Approximately 42 percent of threatened or **endangered species** are at risk due to invasive species.

Human health and economies are also at risk from invasive species. The impacts of invasive species on our natural ecosystems and economy cost billions of dollars each year. Many of our commercial, agricultural, and recreational activities depend on healthy native ecosystems.

Terminology[3]

Alien or naturalized species are those species which are not native to an area but established, and those that are a threat to native species and biodiversity are often called invasive species. The term "invasive" is poorly defined and often very subjective, Invasive species may be plants, animals, fungi, and microbes; some also include native species that have invaded humane habitats such as farms and landscapes. Some broaden the term to include indigenous or "native" species that have colonized natural areas. The definition of "native" is also sometimes controversial. For example, the ancestors of *Equus ferus* (modern horses) evolved in North America and radiated to Eurasia before becoming locally extinct. Upon returning to North America in 1493, during their human-assisted migration, it is debatable as to whether they were native or exotic to the continent of their evolutionary ancestors.

While the study of invasive species can be done within many subfields of biology, the majority of research on invasive organisms has been within the field of ecology and geography where the issue of biological invasions is especially important. Much of the study of invasive species has been influenced by Charles Elton's 1958 book *The Ecology of Invasion by Animals and Plants* which drew upon the limited amount of research done within disparate fields to create a generalized picture of biological invasions. Studies on invasive species remained sparse until the 1990s when research in the field experienced a large amount of growth which continues to this day. This research, which has largely consisted of field observational studies, has disproportionately been concerned with terrestrial plants. The rapid growth of the field has driven a need to standardize the language used to describe invasive species and events. Despite this, little standard terminology exists within the study of invasive species which itself lacks any official designation but is commonly referred to as "invasion ecology" or more generally "invasion biology". This lack of standard terminology is a significant problem, and has largely arisen due to the interdisciplinary nature of the field which borrows terms from numerous disciplines such as agriculture, zoology, and pathology, as well as due to studies on invasive species being commonly performed in isolation of one another.

What Makes a Species "Invasive"?[1]

An invasive species can be any kind of living organism—an amphibian (like the cane toad), plant, insect, fish, fungus, bacteria, or even an organism's seeds or eggs—that is not native to an ecosystem and causes harm. They can harm the environment, the economy, or even human health. Species that grow and reproduce quickly, and spread aggressively, with potential to cause harm, are given the label "invasive."

An invasive species does not have to come from another country. For example, lake trout are native to the **Great Lakes**, but are considered to be an invasive species in Yellowstone Lake in Wyoming because they compete with native cutthroat trout for habitat.

Lionfish

Native to the Indo-Pacific oceanic region, lionfish are quickly spreading throughout the coasts and coral reefs of the East Coast of the United States. Lionfish are voracious eaters and their venomous dorsal spines have helped to protect them so far from any natural predation in the Atlantic.

How Invasive Species Spread [1]

Invasive species are primarily spread by human activities, often unintentionally. People, and the goods we use, travel around the world very quickly, and they often carry uninvited species with them. Ships can carry aquatic organisms in their **ballast water**, while smaller boats may carry them on their propellers. Insects can get into wood, shipping palettes, and crates that are shipped around the world. Some ornamental plants can escape into the wild and become invasive. And some invasive species are intentionally or accidentally released pets. For example, Burmese pythons are becoming a big problem in the Everglades.

In addition, higher average temperatures and changes in rain and snow patterns caused by climate change will enable some invasive plant species—such as garlic mustard, kudzu, and purple loosestrife—to move into new areas. Insect pest infestations will be more severe as pests such as mountain pine beetle are able to take advantage of drought-weakened plants.

Kudzu Attack

Kudzu is a plant native to Japan and southeast China. Introduced to North America in the 19th century, and has been nicknamed the "Vine that Ate the South.".This abandoned house in Helen, Georgia, has been almost completely overtaken by kudzu

Threats to Native Wildlife [1]

Invasive species cause harm to wildlife in many ways. When a new and aggressive species is introduced into an ecosystem, it may not have any natural predators or controls. It can breed and spread quickly, taking over an area. Native wildlife may not have evolved defenses against the invader, or they may not be able to compete with a species that has no predators.

The direct threats of invasive species include preying on native species, outcompeting native species for food or other resources, causing or carrying disease, and preventing native species from reproducing or killing a native species' young.

There are indirect threats of invasive species as well. Invasive species can change the food web in an ecosystem by destroying or replacing native food sources. The invasive species may provide little to no food value for wildlife. Invasive species can also alter the abundance or **diversity of species** that are important habitat for native wildlife. Aggressive plant species like kudzu can quickly replace a diverse ecosystem with a monoculture of just kudzu. Additionally, some invasive species are capable of changing the conditions in an ecosystem, such as changing soil chemistry or the intensity of wildfires.

Japanese Beetle

Japanese beetles are an invasive species in North America. They are native to the islands of Japan, where their population is naturally controlled by predators such as wasps. These wasps do not exist in North America, and Japanese beetles have become a major pest to farmers growing crops such as grapes.

Introduced Species[2]

Some species are brought to a new area on purpose. Often, these species are introduced as a form of pest control. Other times, introduced species are brought in as pets or decorative displays. People and businesses that import these species do not anticipate the consequences. Even scientists are not always sure how a species will adapt to a new environment.

Introduced species multiply too quickly and become invasive. For example, in 1949, five cats were brought to Marion Island, a part of South Africa in the southern Indian Ocean. The cats were introduced as pest control for mice. By 1977, about 3,400 cats were living on the island, endangering the local bird population.

Other invasive species descended from pets that escaped or were released into the wild. Many people have released pet Burmese pythons into the Everglades, a swampy area of south Florida. The huge snakes can grow to 6 meters (20 feet) long. Pythons, native to the jungles of southeast Asia, have few natural predators in the Everglades. They feast on many local species, including white ibis and limpkin, two types of wading birds.

Invasive Species and the Local Environment[2]

Many invasive species thrive because they outcompete native species for food. Bighead and silver carp are two large species of fish that escaped from fish farms in the 1990s and are now common in the Missouri River of North America. These fish feed on plankton, tiny organisms floating in the water. Many native fish species, such as paddlefish, also feed on plankton. The feeding cycle of the paddlefish is slower than that of the carp. There are now so many carp in the lower Missouri River that paddlefish do not have enough food.

Invasive species sometimes thrive because there are no predators that hunt them in the new location. Brown tree snakes were accidentally brought to Guam, an island in the South Pacific, in the late 1940s or early 1950s. No animals on Guam hunted the snakes, but the island was filled with birds, rodents, and other small animals that the snakes hunt. The snakes quickly multiplied, and they are responsible for the extinction of nine of the island's 11 forest-dwelling bird species.

Many invasive species destroy habitat, the places where other plants and animals naturally live. Nutria are large rodents native to South America. Ranchers brought them to North America in the 1900s, hoping to raise them for their fur. Some nutria were released into the wild when the ranchers failed. Today, they are a major pest in the Gulf Coast and Chesapeake Bay regions of the United States. Nutria eat tall grasses and rushes. These plants are vital to the regions' marshy wetlands. They provide food, nesting sites, and shelter for many organisms. They also help secure sediment and soil, preventing the erosion of land. Nutria destroy the area's food web and habitat by consuming the wetland grasses.

Some invasive species do great harm to the economy. Water hyacinth is a plant native to South America that has become an invasive species in many parts of the world. People often introduce the plant, which grows in the water, because of its pretty flowers. But the plant spreads quickly, often choking out native wildlife. In Lake Victoria, Uganda, water hyacinth grew so thickly that boats could not get through it. Some ports were closed. Water hyacinth prevented sunlight from reaching underwater. Plants and algae could not grow, preventing fish from feeding and reproducing. Lake Victoria's fishing industry declined.

Invasive species can also damage property. Small zebra mussels clog the cooling systems in boat engines, while larger ones have damaged water pipes at power plants throughout the Great Lakes region.

Eradicating Invasive Species[2]

Officials have used a variety of methods to try to eradicate, or get rid of, invasive species. The cats on Marion Island were infected with a virus, for instance.

Sometimes other species are introduced to help control an invasive species. In Australia, prickly pear cactus, which is native to the Americas, was growing out of control. The cactus was destroying rangeland, where ranchers raised livestock. The government brought in cactus moth caterpillars to eat the cactuses. The caterpillars are natural predators of the cactus.

Introducing insects can be dangerous, however. Sometimes, the insects also damage other plant species—they can become invasive species themselves. Chemicals have also been used to control invasive species, but they can sometimes harm noninvasive plants and animals.

Governments are working to educate the public about invasive species. For example, in the United States, international fishing vessels are warned to wash their boats before returning home. This prevents them from accidentally transporting zebra mussels or other species from one body of water to another.

Sometimes, communities approach invasive species like an invading army. Nutria in Chesapeake Bay destroy the natural habitat, as well as cost local governments and businesses millions of dollars each year. Environmental groups, business leaders, and government officials are concerned about the harm done by this invasive species.

Officials at the Blackwater National Wildlife Refuge, in the U.S. state of Maryland, worked with hunters to eradicate the 8,500 nutria in the refuge. Hunters waded into specific areas of the marsh during specific times of the year. They tracked nutria using global positioning system (GPS) equipment and set traps that would kill the rodents. The hunters moved across the refuge in a massive, coordinated, west-to-east movement. In winter, the ice on Chesapeake Bay prevented the nutria from swimming away. Hunters could shoot them on sight.

The operation took two years, but nutria were eradicated from Blackwater National Wildlife Refuge. The wetland is slowly recovering.

Curbing the Spread [1]

One way to **curb the spread of invasive species** is to plant native plants and remove any invasive plants in your garden. There are many good native plant alternatives to common exotic ornamental plants. In addition, learn to identify invasive species in your area, and report any sightings to your county extension agent or local land manager.

Regularly clean your boots, gear, boat, tires, and any other equipment you use outdoors to remove insects and plant parts that may spread invasive species to new places. When camping, buy firewood near your campsite (within 30 miles) instead of bringing your own from home, and leave any extra for the next campers. Invertebrates and plants can easily hitch a ride on firewood you haul to or from a campsite—you could inadvertently introduce an invasive to a new area.

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URBAN ECOLOGY

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INDEX

URBAN ECOLOGY

Urban ecology *is the scientific study of the relation of living organisms with each other and their surroundings in the context of an urban environment. The* ***urban environment*** *refers to environments dominated by high-density residential and commercial buildings, paved surfaces, and other urban-related factors that create a* ***unique landscape*** *dissimilar to most previously studied environments in the field of ecology. The goal of urban ecology is to achieve a* ***balance*** *between human culture and the natural environment.*

Central Park represents an ecosystem fragment within a larger urban environment

Urban ecology is a ***recent field of study*** *compared to ecology as a whole. The methods and studies of urban ecology are similar to and comprise a* ***subset of ecology****. The study of urban ecology carries increasing importance because more than 50% of the world's population today lives in urban areas. At the same time, it is estimated that within the next forty years, two-thirds of the world's population will be living in expanding urban centers. The ecological processes in the urban environment are comparable to those outside the urban context. However, the types of* ***urban habitats*** *and the species that inhabit them are poorly documented. Often, explanations for phenomena examined in the urban setting as well as predicting changes because of* ***urbanization*** *are the center for scientific research.*

Hyde Park in London represents the same, as Central Park in NYC…

History

*Ecology has historically focused on "pristine" natural environments, but by the 1970s many ecologists began to turn their interest towards ecological interactions taking place in, and caused by urban environments. **Jean-Marie Pelt**'s 1977 book **"The Re- Naturalized Human"**, Brian Davis' 1978 publication **"Urbanization and the diversity of insects"**, and Sukopp et al.'s 1979 article **"The soil, flora and vegetation of Berlin's wastelands"** are some of the first publications to recognize the importance of urban ecology as a distinct form of ecology the same way one might see **landscape ecology** as different from **population ecology**. Forman and Godron's 1986 book **"Landscape Ecology"** first distinguished urban settings and landscapes from other landscapes by dividing all landscapes into five broad types. These types were divided by the intensity of human influence ranging from pristine **natural environments** to **urban centers**.*

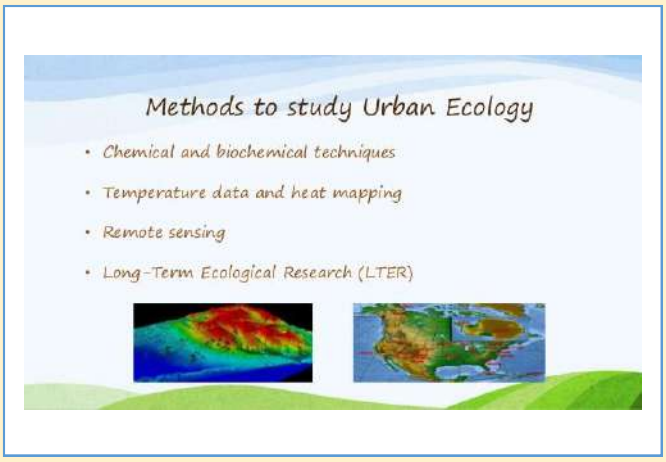
The creation of an important stream water garden in Metz's centre during the early 70s was one of the materializations of Jean-Marie Pelt's works on urban ecology.

*Urban ecology is recognized as a diverse and complex concept which differs in application between North America and Europe. The European concept of urban ecology examines the **biota** of urban areas, the North American concept has traditionally examined the social sciences of the urban landscape, as well as the ecosystem fluxes and processes. The Latin American concept examines the effect of human activity on the biodiversity and fluxes of urban ecosystems. The world's first urban ecology labs were founded, for temperate ecosystems, in 1999 (**Urban Ecology Research Laboratory**, University of Washington), and for tropical ecosystems, in 2008 **Laboratory of Urban Ecology**, Universidad Estatal a Distancia of Costa Rica.*

Botanical Garden in homage to Jean-Marie Pelt

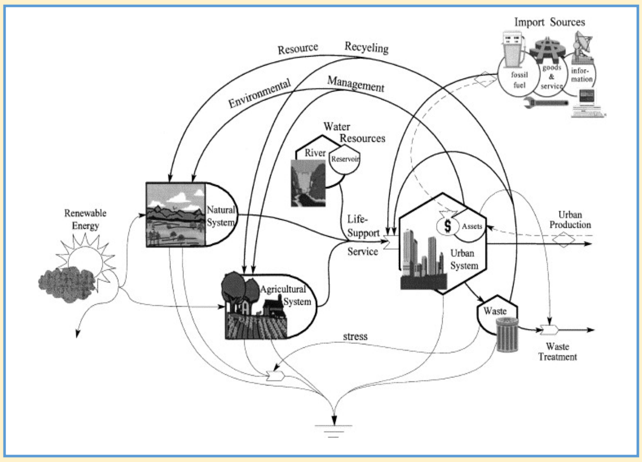
Methods

Since urban ecology is a subfield of ecology, many of the techniques are similar to that of ecology. Ecological study techniques have been developed over centuries, but many of the techniques use for urban ecology are more recently developed. Methods used for studying urban ecology involve chemical and biochemical techniques, temperature recording, heat mapping remote sensing, and long-term ecological research sites.



Chemical and biochemical techniques

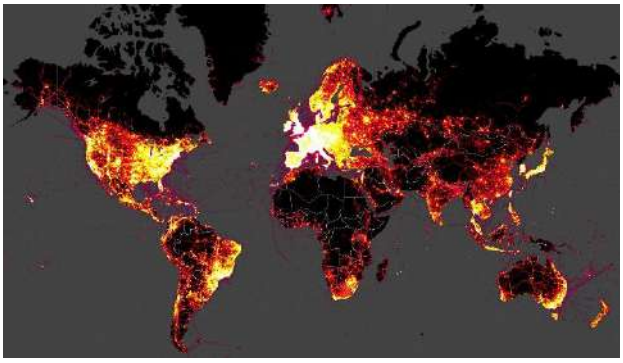
Chemical techniques may be used to determine ***pollutant concentrations*** *and their effects. Tests can be as simple as dipping a manufactured test strip, as in the case of pH testing, or be more complex, as in the case of examining the spatial and temporal variation of* ***heavy metal contamination*** *due to industrial runoff. Other chemical techniques include tests for* ***nitrates***, ***phosphates***, ***sulfates****, etc. which are commonly associated with* ***urban pollutants*** *such as* ***fertilizer*** *and industrial byproducts.*



These biochemical fluxes are studied in the atmosphere (e.g., ***greenhouse gasses****),* ***aquatic ecosystems*** *and* ***soil vegetation****. Broad reaching effects of these biochemical fluxes can be seen in various aspects of both the urban and surrounding rural ecosystems.*

Temperature data and heat mapping

***Temperature data** can be used for various kinds of studies. An important aspect of temperature data is the ability to correlate temperature with various factors that may be affecting or occurring in the environment. Oftentimes, temperature data is collected long-term by the **Office of Oceanic and Atmospheric Research** (OAR), and made available to the scientific community through the **National Oceanic and Atmospheric Administration** (NOAA). **Heat maps** can be used to view trends and distribution over time and space.*



Heat map of the world

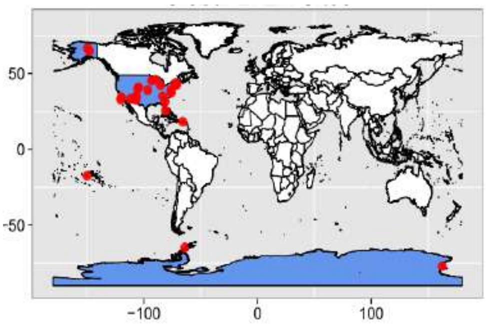
Remote Sensing & LTERs

***Remote sensing** is the technique in which data is collected from distant locations through the use of **satellite imaging**, **radar**, and **aerial photographs**. In urban ecology, remote sensing is used to collect data about terrain, weather patterns, light, and vegetation. One application of remote sensing for urban ecology is to detect the productivity of an area by measuring the **photosynthetic wavelengths of emitted light**.*

Remote sensing of Boston

***Long-term ecological research** (LTER) sites are research sites funded by the government that have collected reliable long-term data over an extended period oftime in order to identify long-term climatic or ecological trends. The main purpose of LTERs for urban ecologists is the collection of vast amounts of data over long periods of time.*

Global LTER sites



Urban Effects on the Environment

Humans are the driving force behind urban ecology and influence the environment in a variety of ways, such as ***modifying*** *land surfaces and waterways, introducing foreign species, and altering biogeochemical cycles. Some of these effects are more apparent, such as the reversal of the* ***Chicago River*** *to accommodate the growing pollution levels and trade on the river. Other effects can be more gradual such as the change in global climate due to urbanization.*

Modification of land and waterways

Humans place high demand on land not only to build urban centers, but also to build surrounding suburban areas for housing. Land is also allocated for agriculture to sustain the ***growing population*** *of the city. Key examples of this are* ***Deforestation in the United States*** *and* ***Europe****.*

Deforestation in Europe

Along with manipulation of land to suit human needs, natural water resources such as rivers and streams are also modified in urban establishments. Modification can come in the form of dams, artificial canals, and even the reversal of rivers. Reversing the flow of the Chicago River is a major example. Urban areas in natural desert settings often bring in water from far areas to maintain the human population and will likely have effects on the local desert climate. Modification of ***aquatic systems*** *in urban areas also results in decreased stream diversity and increased pollution.*

Reversing Chicago River took the city out of swamps and turned it into a bustling metropolis.

Trade, Shipping & spread of Invasive Species

Both local shipping and long-distance trade are required to meet the resource demands important in maintaining urban areas. ***Carbon dioxide emissions*** *from the transport of goods also contribute to accumulating* ***greenhouse gases*** *and nutrient deposits in the soil and air of urban environments. In addition, shipping facilitates the unintentional spread of living organisms, and introduces them to environments that they would not naturally inhabit.*

Kudzu unfurling in Lancaster County

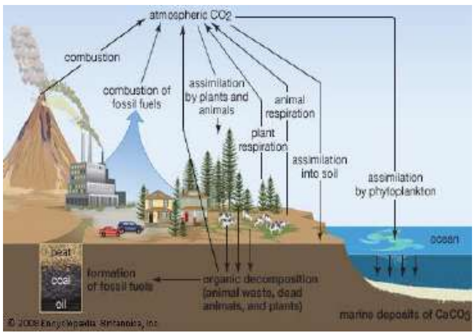
Alien species often have no natural predators and pose a substantial threat to the dynamics of existing ecological populations in the new environment where they are introduced. Such invasive species are numerous, and include ***European starlings***, ***brown rats***, ***Asian carp***, ***American bullfrogs***, *among others. In Australia, it has been found that removing Lantana (****L. camara****, an alien species) from* ***urban green spaces*** *can surprisingly have negative impacts on bird diversity.*

Invasive species on ships

Human effects on biogeochemical pathways

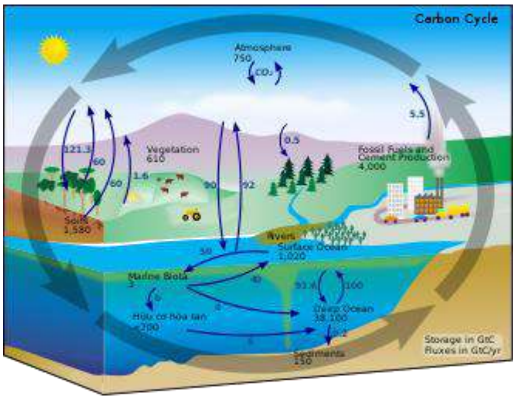
Urbanization results in a large demand for chemical use by industry, construction, agriculture, and energy providing services. Such demands have a substantial impact on ***biogeochemical cycles***, *resulting in phenomena such as* ***acid rain***, ***eutrophication***, *and* ***global warming***. *Furthermore, natural biogeochemical cycles in the urban environment can be impeded due to impermeable surfaces that prevent nutrients from returning to the soil, water, and atmosphere.*

Biogeochemical Cycle



*Demand for **fertilizers** to meet agricultural needs exerted by expanding urban centers can alter chemical composition of soil. Such effects often result in abnormally high concentrations of compounds including sulfur, phosphorus, nitrogen, and heavy metals. In addition, nitrogen and phosphorus used in fertilizers have caused severe problems in the form of **agricultural runoff**, which alters the concentration of these compounds in local rivers and streams, often resulting in adverse effects on native species. A well-known effect of agricultural runoff is the phenomenon of eutrophication. When the fertilizer chemicals from agricultural runoff reach the ocean, an **algal bloom** results, then rapidly dies off. The dead algae biomass is decomposed by bacteria that also consume large quantities of oxygen, which they obtain from the water, creating a **"dead zone"** without oxygen for fish or other organisms. A classic example is the dead zone in the **Gulf of Mexico** due to agricultural runoff into the **Mississippi River**.*

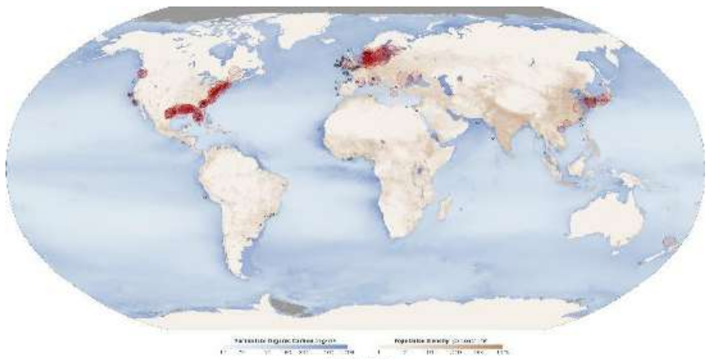
Carbon Cycle



Polluted agricultural runoffs

*Just as pollutants and alterations in the biogeochemical cycle alter river and **ocean ecosystems**, they exert likewise effects in the air. Some stems from the accumulation of chemicals and pollution and often manifests in urban settings, which has a great impact on local plants and animals. Because urban centers are often considered point sources for pollution, unsurprisingly local plants have adapted to withstand such conditions.*

Aquatic Dead Zones

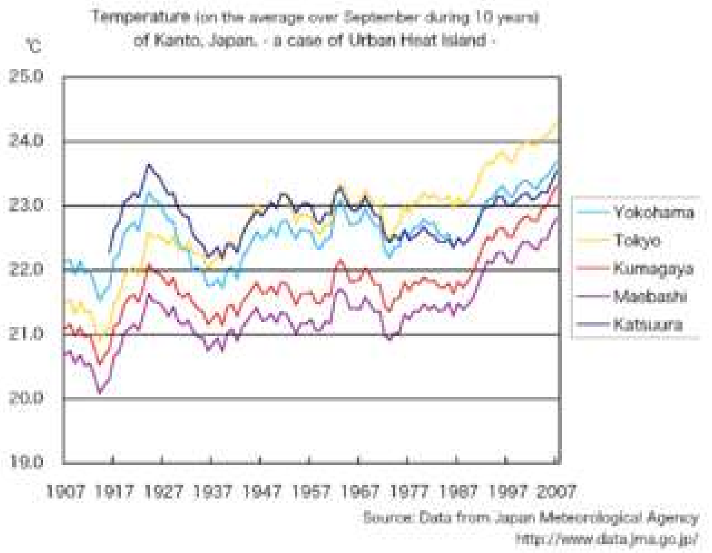


Urban Effects on Climate

Urban environments and outlying areas have been found to exhibit unique local temperatures, ***precipitation****, and other characteristic activity due to a variety of factors such as pollution and altered geochemical cycles. Some examples of the urban effects on climate are* ***urban heat island****,* ***oasis effect****,* ***greenhouse gases****, and* ***acid rain****. This further stirs the debate as to whether urban areas should be considered a unique* ***biome****. Despite common trends among all urban centers, the surrounding local environment heavily influences much of the climate. One such example of regional differences can be seen through the urban heat island and oasis effect.*

Urban heat island effect

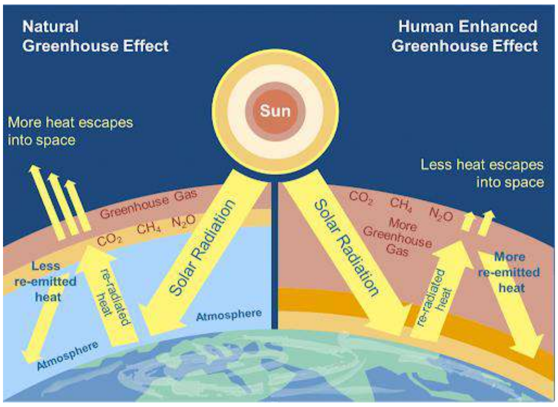
The ***urban heat island*** *is a phenomenon in which central regions of urban centers exhibit higher mean temperatures than surrounding urban areas. Much of this effect can be attributed to low city* ***albedo****, the reflecting power of a surface, and the increased surface area of buildings to absorb solar radiation. Concrete, cement, and metal surfaces in urban areas tend to absorb heat energy rather than reflect it, contributing to higher urban temperatures. Brazel et al. found that the urban heat island effect demonstrates a positive correlation with population density in the city of Baltimore. The heat island effect has corresponding ecological consequences on resident species. However, this effect has only been seen in temperate climates.*



Graphical representation of the rising temperature in Kanto, Japan due to urban heat island

Greenhouse gases

Greenhouse gas emissions include those of carbon dioxide and methane from the combustion of ***fossil fuels*** *to supply energy needed by vast urban metropolises. Other greenhouse gases include water vapor, and* ***nitrous oxide****. Increases in* ***greenhouse gases*** *due to urban transport, construction, industry and other demands have been correlated strongly with increase in temperature. Sources of methane are agricultural dairy cows and landfills.*



Effect of greenhouse gases

Acid rain & Pollution

Processes related to urban areas result in the emission of numerous pollutants, which change corresponding ***nutrient cycles*** *of carbon, sulfur, nitrogen, and other elements. Ecosystems in and around the urban center are especially influenced by these point sources of pollution.* ***High sulfur dioxide concentrations*** *resulting from the industrial demands of urbanization cause* ***rainwater to become more acidic****. Such an effect has been found to have a significant influence on locally affected populations, especially in* ***aquatic environments****. Wastes from urban centers, especially large* ***urban centers*** *in developed nations, can drive biogeochemical cycles on a global scale.*

Smokestacks from production plants releasing pollutants into the atmosphere

Effect of acid rain

Ways to improve Urban Ecology

Cities should be ***planned*** *and constructed in such a way that minimizes the urban effects on the surrounding environment (urban heat island, precipitation, etc.) as well as* ***optimizing ecological activity****. For example, increasing the* ***albedo****, or reflective power, of surfaces in urban areas, can minimize urban heat island, resulting in a lower magnitude of the urban heat island effect in urban areas. By minimizing these abnormal temperature trends and others, ecological activity would likely be improved in the urban setting.*

Species reintroduction

Reintroduction of species to urban settings can help improve the local ***biodiversity*** *previously lost; however, the following guidelines should be followed in order to avoid undesired effects:*

- *No predators capable of killing children will be reintroduced to urban areas.*
- *No introduction of species that significantly threaten human health, pets, crops or property.*
- *Reintroduction will not be done when it implies significant suffering to the organisms being reintroduced, for example stress from capture or captivity.*
- *Reintroduced organisms will receive food supplementation and veterinary assistance as needed.*
- *Organisms that carry pathogens and whose genes threaten the genetic pool of other organisms in the urban area will not be reintroduced.*
- *Reintroduction will be done in both experimental and control areas to produce reliable assessments (monitoring must continue afterwards to trigger interventions if necessary).*
- *Reintroduction must be done in several places and repeated over several years to buffer for stochastic events*

Sustainability & Green Infrastructure implementation

*With the ever-increasing **demands for resources** necessitated by urbanization, recent campaigns to move toward sustainable energy and **resource consumption**, such as **LEED certification** of buildings, **Energy Star** certified appliances, and **zero emission** vehicles, have gained momentum. **Sustainability** reflects techniques and consumption ensuring reasonably low resource use as a component of urban ecology.*

***Biogas** plant in Japan*

*Techniques such as carbon recapture may also be used to **sequester** carbon compounds produced in urban centers rather continually emitting more of the **greenhouse gas**.*

*Urban areas can be converted to areas that are more conducive to hosting wildlife through the application of **green infrastructure**. Although the opportunities of green infrastructure (GI) to benefit human populations have been recognized, there are also opportunities to conserve wildlife diversity. GI can be defined as features that were engineered with natural elements or natural features. This natural constitution helps prevent wildlife exposure to man- made toxicants. In some cases, GI even preserved comparable measures of biodiversity to natural components.*

Green Infrastructure

Urban Green Space

*In **land-use planning**, **urban green space** is **open-space** areas reserved for **parks** and other "green spaces", including plant life, water features -also referred to as **blue spaces-** and other kinds of natural environment. Most urban* open spaces are green spaces, but occasionally include other kinds of open areas. The landscape of urban open spaces can range from ***playing fields*** to highly maintained environments to relatively ***natural landscapes.*** Generally considered open to the public, urban green spaces are sometimes privately owned, such as ***higher education campuses***, ***neighborhood/community parks/gardens***, and institutional or corporate grounds. Areas outside city boundaries, are not considered urban open space. Urban greening policies are important for revitalizing communities, reducing financial burdens of healthcare and increasing quality of life.*

Eco Park, Newtown, Kolkata- An urban green space

Dallas Trinity Park-An urban green space

Increasing wildlife habitat connectivity

The implementation of wildlife corridors throughout urban areas (and in between wildlife areas) would promote wildlife habitat ***connectivity****. Habitat connectivity is critical for ecosystem health and wildlife conservation yet is being compromised by increasing* ***urbanization****. Urban green spaces that are linked by* ***ecosystem corridors*** *have higher ecosystem health. The usage of* ***green infrastructure*** *that is connected to natural habitats has been shown to reap greater biodiversity benefits than GI implemented in areas far from natural habitats. GI close to natural areas may also increase functional connectivity in natural environments.*

Corridors made across European highways for increasing wildlife habitat connectivity

Conclusion

Urban ecosystems are expanding around the world as people migrate to cities and the human population continues to grow. What happens to other species as these urban ecosystems expand, and how species live and interact in established urban ecosystems, is the central focus of urban ecology.

Urbanization results in a series of both local and far-reaching effects on ***biodiversity****,* ***biogeochemical cycles****,* ***hydrology****, and* ***climate****, among many other stresses. Many of these effects are not fully understood, as urban ecology has only recently emerged as a scientific discipline and much more research remains to be done. Research on cities outside the US and Europe remains limited. Observations on the impact of urbanization on biodiversity and species interactions are consistent across many studies but definitive mechanisms have yet to be established. Urban ecology constitutes an important and highly relevant subfield of ecology, and further study must be pursued to more fully understand the effects of human urban areas on the environment.*

Stockholm-Uncovering an urban ecological system

Chicago-An urban ecological society

Urban Ecology – A modern necessity

Acknowledgement

First of all I would like to thank Almighty God for helping me complete this project and my professors for giving me the opportunity to do this project and guiding me throughout. Last but not the least, I would like to thank my family and everyone around me…

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The end...

COLLEGE ROLL NO. – CMSA20M190

CU ROLL NO. – 203223-21-0117

CU REGISTRATION NO.

223-1111-0438-20

POLLUTION PREVENTION

BEFORE KNOWING ABOUT ANY TYPE OF PREVENTION WE HAVE TO KNOW ABOUT THE TOPIC IN DETAILS.

WHAT IS POLLUTION?

Pollution is the introduction of contaminants into the natural environment that cause adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat, or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution. In 2015, pollution killed 9 million people worldwide.

Major forms of pollution include air pollution, light pollution, litter, noise pollution, plastic pollution, soil contamination, radioactive contamination, thermal pollution, visual pollution, and water pollution.

URBAN POLLUTION

The burning of coal and wood, and the presence of many horses in concentrated areas made the cities the primary sources of pollution. The Industrial Revolution brought an infusion of untreated chemicals and wastes into local streams that served as the water supply. King Edward I of England banned the burning of sea-coal by proclamation in London in 1272, after its smoke became a problem; the fuel was so common in England that this earliest of names for it was acquired because it could be carted away from some shores by the wheelbarrow.

It was the Industrial Revolution that gave birth to environmental pollution as we know it today. London also recorded one of the earlier extreme cases of water quality problems with the Great Stink on the Thames of 1858, which led to construction of the London sewerage system soon afterward. Pollution issues escalated as population growth far exceeded viability of neighbourhoods to handle their waste problem. Reformers began to demand sewer systems and clean water.

Severe incidents of pollution helped increase consciousness. PCB dumping in the Hudson River resulted in a ban by the EPA on consumption of its fish in 1974. National news stories in the late 1970s – especially the long-term dioxin contamination at Love Canal starting in 1947 and uncontrolled dumping in Valley of the Drums – led to the Superfund legislation of 1980.

FORMS OF POLLUTION

- Air pollution: the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterized by their micrometre size PM_{10} to $PM_{2.5}$.
- Electromagnetic pollution: the overabundance of electromagnetic radiation in their non-ionizing form, like radio waves, etc., that people are constantly exposed at, especially in large cities. It's still unknown whether or not those types of radiation have any effects on human health, though.
- Light pollution: includes light trespass, over-illumination and astronomical interference.
- Littering: the criminal throwing of inappropriate man-made objects, unremoved, onto public and private properties.
- Noise pollution: which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.
- Plastic pollution: involves the accumulation of plastic products and microplastics in the environment that adversely affects wildlife, wildlife habitat, or humans.
- Soil contamination occurs when chemicals are released by spill or underground leakage. Among the most

significant soil contaminants are hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons.

- Radioactive contamination, resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment. (See alpha emitters and actinides in the environment.)
- Thermal pollution, is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.
- Visual pollution, which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash, municipal solid waste or space debris.
- Water pollution, by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides; also including human feces from open defecation – still a major problem in many developing countries); groundwater pollution from waste disposal and leaching into the ground, including from pit latrines and septic tanks; eutrophication and littering.


SOUND POLLUTION

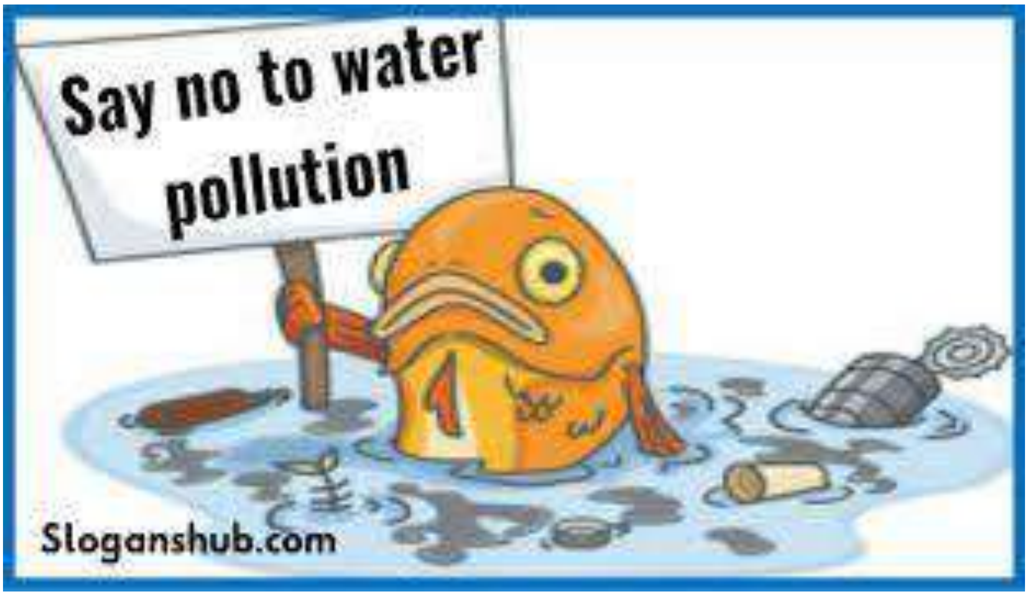
HOW WE CAN PREVENT THIS POLLUTION

1. AIR POLLUTION

2. Using public transports. ...
3. Turn off the lights when not in use. ...
4. Recycle and Reuse. ...
5. No to plastic bags. ...
6. Reduction of forest fires and smoking. ...
7. Use of fans instead of Air Conditioner. ...
8. Use filters for chimneys. ...
9. Avoid usage of crackers.

2. WATER POLLUTION

1. Keep out oils, fat, or grease from the sink.
2. Abstain from flushing contaminated liquids, pills, drugs, or medications down the drain.
3. Desist from using the toilet as a bin.
4. Ensure minimal use of bleach or detergents.
5. Reduce the use of herbicides, pesticides, and fertilizers.
6. Proper sewage treatment and management.
7. Dispose trash properly.
8. Avoid direct dumping into water systems.
9. Always conserve water.
10. Insist on using environmentally safe products.



3. LAND POLLUTION

1. Reduce toxic materials

2. Recycle waste materials.

3. Buy organics products, especially organic cleaners, pesticides, insecticides and fertilizers.

4. Avoid littering. Excessive littering is one of most common reasons for land pollution.

5. Organic wastes must be disposed off in areas that are far from human or animal habitation

6. Improve fertility of the land by reforesting.

4. SOUND POLLUTION

1. Turn off Appliances at Home and offices. ...
2. Shut the Door when using noisy Machines. ...
3. Use Earplugs. ...
4. Lower the volume. ...
5. Stay away from Noisy area. ...
6. Follow the Limits of Noise level. ...
7. Control Noise level near sensitive areas. ...
8. Go Green by planning trees.

References and Conclusion

1. GOOGLE
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CONCLUSION

I really enjoyed doing my project about Pollution Prevention. I have learned about many techniques in which waste are classified and how they are managed and what are its benefits. We all should contribute towards this idea and make our environment a cleaner place.

ENVIRONMENTAL STUDIES PROJECT

COLLEGE ROLL NO->**CMSA20M191**

B.Sc(Hons.) Semester 2(Under CBCS)

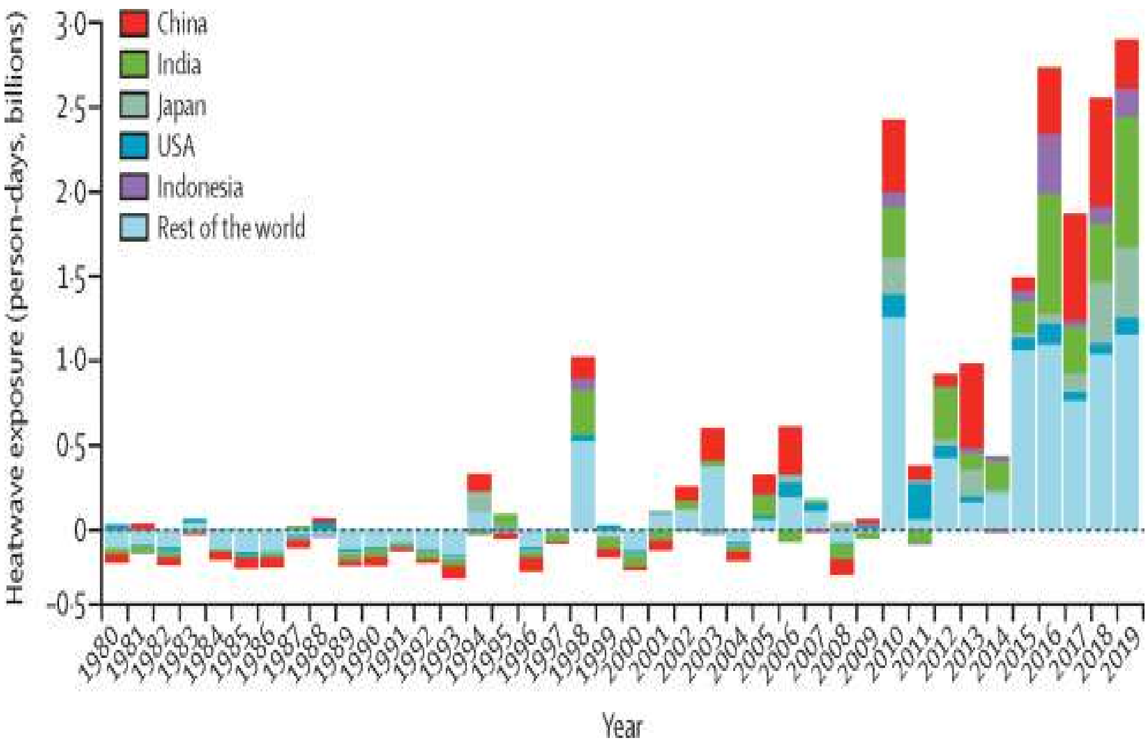
CU ROLL-> **203223-21-0118**

CU REGISTRATION-> **223-1111-0440-20**

TOPIC- **Climate Change**

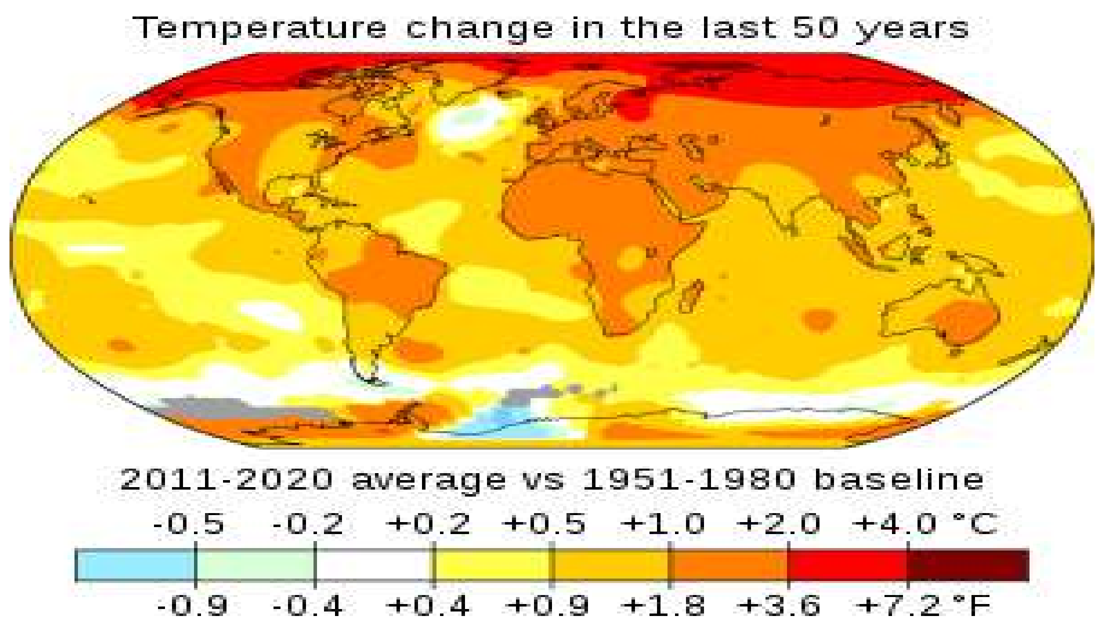
CONTENT

REPORT



The Assessment of Impacts and Adaptations to Climate Change (AIACC)1 study shows that climate is changing and has altered the micro-climates of the highland areas of East Africa. Analysis of time-series data from 1978 to 1999 reveals that the maximum and minimum temperatures have changed, with significant increases generally recorded at all sites. Analyses ofdata over the period 1961 to 2001 also reveal decreasing trends in rainfall. The temperature changes have been more pronounced at the higher altitudes than in the lowlands.2 The temperature in the Kabale district of Uganda has also shot up by 2ºC (3.6°F) in the last three decades.3 Development paths that are high carbon intensive contribute to global warming. Overall Africa's energy per capita consumption remains low and hence contribution to global climate change minimal. However localized impacts are evident especially where extraction of wood for fuel is high and surpasses reforestation rates. Africa suffers modern energy poverty, a hindrance to sustainable development. It is expected that current energy consumptions patterns will prevail though the share of renewable energy will gradually increase.

INTRODUCTION

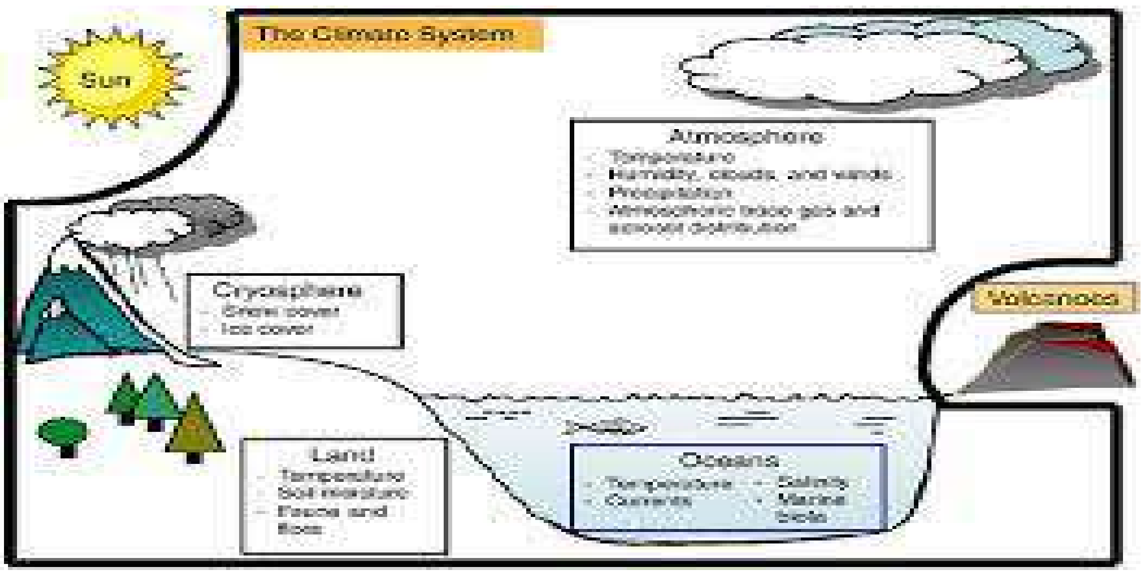


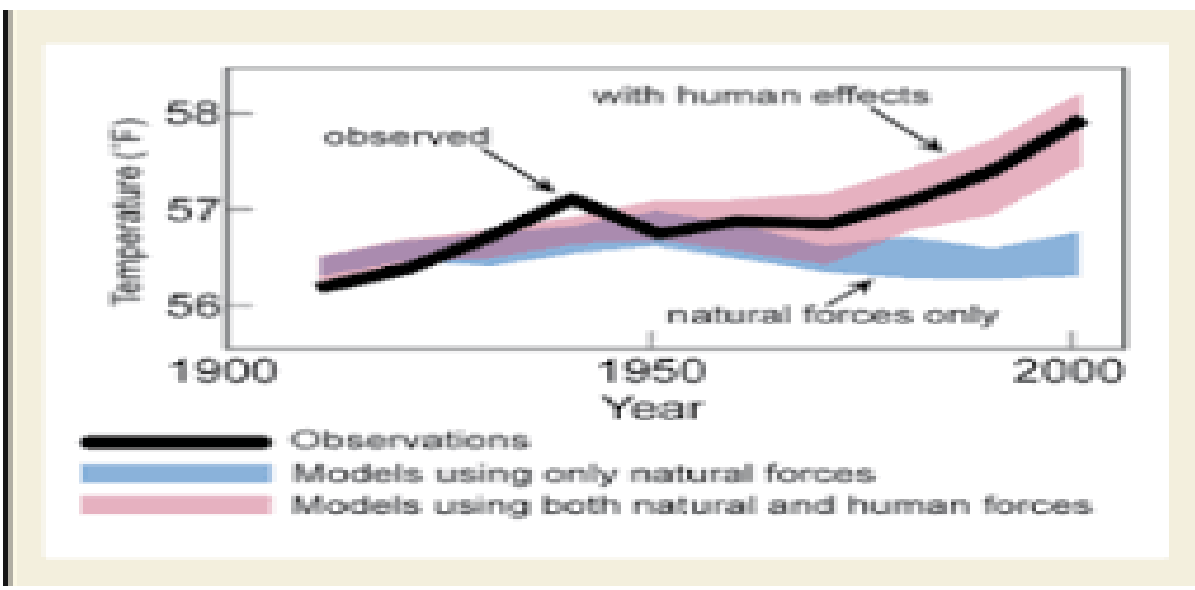
Climate change includes both **global warming** driven by human-induced emissions **of** greenhouse gases and the resulting large-scale shifts in weather patterns. Though there have been previous periods of climatic change, humans have since the mid-20th century had an unprecedented impact on Earth's climate system and have caused change on a global scale.

The largest driver of warming is the emission of gases that create a greenhouse effect, of which more than 90% are carbon dioxide (CO_2)

and methane. Fossil fuel burning (coal, oil, and natural gas) for energy consumption is the main source of these emissions, with additional contributions from agriculture, deforestation, and manufacturing. The human cause of climate change is not disputed by any scientific body of national or international standing. Temperature rise is accelerated or tempered by climate feedbacks, such as loss of sunlight-reflecting snow and ice cover, increased water vapour (a greenhouse gas itself), and changes to land and ocean carbon sinks. Temperature rise on land is about twice the global average increase, leading to desert expansion and more common heat waves and wildfires. Temperature rise is also amplified in the Arctic, where it has contributed to melting permafrost, glacial retreat and sea ice loss. Warmer temperatures are increasing rates of evaporation, causing more intense storms and weather extremes. Impacts on ecosystems include the relocation or extinction of many species as their environment changes, most immediately in coral reefs, mountains, and the Arctic .

TERMINOLOGY





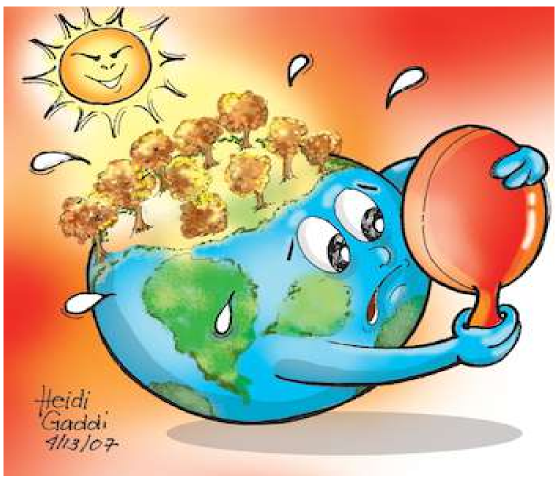
Before the 1980s, when it was unclear whether warming by greenhouse gases would dominate aerosol-induced cooling, scientists often used the term *inadvertent climate modification* to refer to humankind's impact on the climate. In the 1980s, the terms *global warming* and *climate change* were popularized, the former referring only to increased surface warming, while the latter describes the full effect of greenhouse gases on the climate. Global warming became the most popular term after NASA climate scientist James Hansen used it in his 1988 testimony in the U.S. Senate. In the 2000s, the term *climate change* increased in popularity. Global warming usually refers to human-induced warming of the Earth system, whereas climate change can refer to natural as well as anthropogenic change. The two terms are often used interchangeably.

CAUSES

  On Earth, human activities are changing the natural greenhouse. Over the last century the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO_2). This happens because the coal or oil burning process combines carbon with oxygen in the air to make CO_2. To a lesser extent, the clearing of land for agriculture, industry, and other human activities has increased concentrations of greenhouse gases. CO_2 produced by human activities is the largest contributor to global warming. By 2020, its concentration in the atmosphere had risen to 48% above its pre-industrial level (before 1750). Natural

causes, such as changes in solar radiation or volcanic activity are estimated to have contributed less than plus or minus 0.1°C to total warming between 1890 and 2010.

IMPACTS



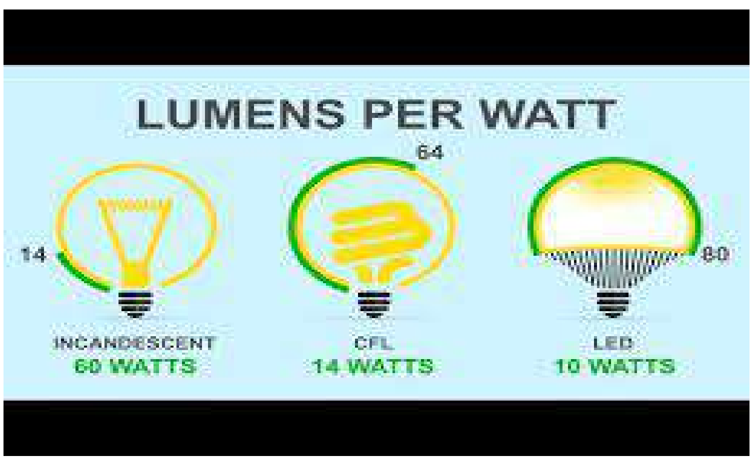
The environmental effects of climate change are broad and far-reaching, affecting oceans, ice, and weather. Changes may occur gradually or rapidly. Evidence for these effects comes from studying climate change in the past, from model, and from modern observations. Since the 1950s, droughts and heat waves have appeared simultaneously with increasing frequency. Extremely wet or dry events within the monsoon period have increased in India and East Asia. The maximum rainfall and wind speed from hurricanes and typhoons is likely increasing. Frequency of tropical cyclones has not increased as a result of climate change. While tornado and severe thunderstorm frequency has not increased as a result of climate change, the areas affected by such phenomena may be changing. Global sea level is rising as a consequence of glacial melt, melt of the ice sheets in Greenland and Antarctica, and thermal expansion. Over the 21st century, the IPCC projects that in a very high emissions scenario the sea level could rise by 61–110 cm. Increased ocean warmth is undermining and threatening to unplug Antarctic glacier outlets, risking a large melt of the ice sheet and the possibility of a 2-meter sea level rise by 2100 under high emissions.

PREVENTION

8 THINGS YOU CAN DO TO PREVENT CLIMATE CHANGE:-

1. **Add solar panels to your house.** With the plunging price of solar power, and an increasingly diverse group of companies tough decision may not be whether to install, but which style and color panels to place on your roof. The Energy Department has a good resource guide for homeowners, while Google's Project Sunroof helps calculate the potential benefits of home installation.

2. Change light bulbs to LEDs. Quality LED light bulbs can last 25 times longer, are more durable, and use at least 75 percent less energy than other bulbs. In the United States, widespread use of LEDs over the next 10 years could save the equivalent annual electrical output of 44 large power plants.



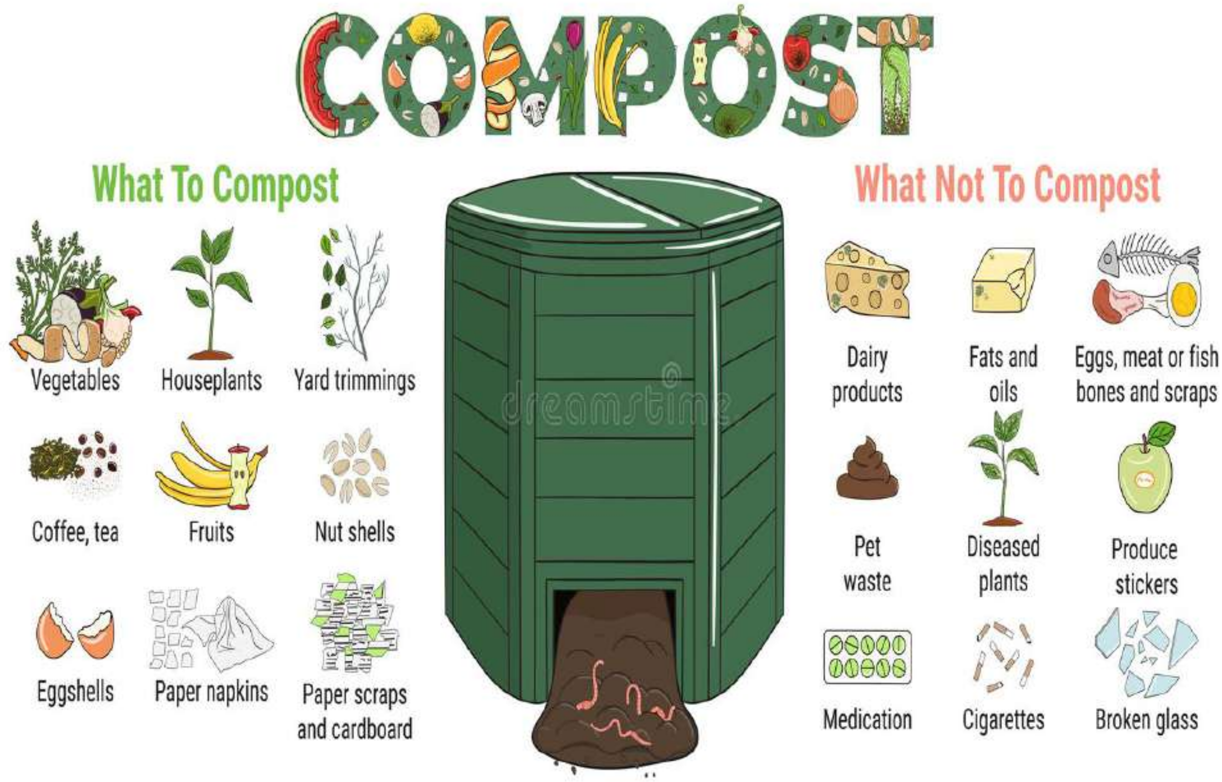
4. Buy furniture made with sustainably harvested wood. Deforestation is a serious problem, but buying sustainably sourced wood— look for the Forest Stewardship Council logo—ensures that your wood is coming from 380 million acres of FSC-certified forest and not an old-growth forest.

5. Plant a community garden. Rolling up your sleeves and digging in the soil offers a great way to meet neighbors and collaboratively add something to your neighborhood. To get you started, the American Community Gardening Association offers a set of resources and recommendations on how to manage and maintain a public patch.

6. Reduce food waste. Whether it's left on your plate or rotting in your fridge, wasted food is a big problem in the U.S.—to the tune of 38 million tons a year, according to the EPA. Luckily, small changes to your routine can make a big difference. Here's a great list of ideas for saving food, including ways to be thrifty and smarter about storage and preservation.

7. Don't drink bottled water. Landfills already contain more than 2 million tons of plastic bottles. And 1.5 million barrels of oil are used to manufacture water bottle every year. And those bottles take more than 1,000 years to biodegrade. Yeah, that reusable water bottle does sound like a good idea.

8. Start composting. Transforming food scraps and lawn clippings into fresh, nutrient-rich soil gives home gardens a boost (and if done right, doesn't create an olfactory offense). Roughly 20 to 30 percent of what we normally throw out can be composted. And the process offers huge benefits at the city level, too. New York City's composting program creates "black gold" in the form of rich soil, saves money on shipping organic waste to landfills, and even generates energy from methane.



CONCLUSION

In conclusion: we will need a mix of adaptation and mitigation measures to meet the challenge of climate change, but this is hampered by a lack of information on the costs and benefits of adaptation

Even the most stringent mitigation efforts cannot avoid some impacts of climate change over the next few decades. Indeed, we are beginning to see these impacts now. This makes adaptation essential, particularly in addressing near-term impacts. However, unmitigated climate change would, in the long term, be likely to exceed our capacity to adapt.

It is essential, then, to develop a portfolio or mix of strategies that includes mitigation, adaptation, technological development (to enhance both adaptation and mitigation) and research (on climate science, impacts, adaptation and mitigation). But analysis of the benefits of various mixes of strategy is severely restricted at present by lack of information on potential costs of impacts, by lack of comparable information on the damage that could be avoided by adaptation and, especially, by lack of understanding of how these impacts will vary under different socio-economic development pathways. It is important that these gaps in our knowledge are filled quickly.

END

ENVS Assignment

Topic: Coastal Ecosystem

College Roll.No.: CMSA20M192

CU Roll.No.: 203223-21-0142

CU Registration.No.: 223-1111-0486-20

What is "Coastal Ecosystem"?

A coastal ecosystem is an area where land and water come together. Coastal ecosystems provide habitat for a wide variety of marine plants and animals as well as provide resources and homes to humans around the world.

Coastal ecosystems have distinct and recognizable land forms such as beaches, cliffs and coral reefs which are highly vulnerable to disturbances. Coastal regions represent some of the highest biodiversity areas on the planet. The Andaman and Nicobar Islands in the Indian Ocean are the location of a biodiversity hotspot.

The coral reefs there boast as many different species of marine living things as a tropical rainforest. Unfortunately, degradation of the coastline is leading to habitat destruction and irreversible damage to coastal communities.

What impacts ecosystem?

Because ecosystems are intertwined webs of living and non-living things, even the smallest change can impact the entire ecosystem. Things such as climate change and associated changes like increases in sea level and ocean temperature, as well as extreme natural events, such as hurricanes, droughts, and harmful algal blooms, can all impact ecosystems.

We can impact ecosystems, too, by causing pollution, introducing invasive species, or irresponsibly using land and water resources.

Features of Coastal Ecosystem:

1. Coral reefs are one of the most well-known marine ecosystems in the world, with the largest being the Great Barrier Reef. These reefs are composed of large coral colonies of a variety of species living together. The corals from multiple symbiotic relationships with the organisms around them. Sometimes called *rainforests of the sea*, shallow coral reefs form some of Earth's most diverse ecosystems. They occupy less than 0.1% of the world's ocean area, about half the area of France, yet they provide a home for at least 25% of all marine species,including fish, mollusks, worms, crustaceans, echinoderms, sponges, tunicates and other cnidarians.[7] Coral reefs flourish in ocean waters that provide few nutrients.

2. Mangroves are trees or shrubs that grow in low-oxygen soil near coastlines in tropical or subtropical latitudes. They are an extremely productive and complex ecosystem that connects the land and sea. Mangroves consist of species that are not necessarily related to each other and are often grouped for the characteristics they share rather than genetic similarity. Because of their proximity to the coast, they have all developed adaptions such as salt excretion and root aeration to live in salty, oxygen-depleted water. Mangroves can often be recognized by their dense tangle of roots that act to protect the coast by reducing erosion from storm surges, currents, wave, and tides. The mangrove ecosystem is also an important source of food for many species as well as excellent at sequestering carbon dioxide from the atmosphere with global mangrove carbon storage is estimated at 34 million metric tons per year.

3. Seagrass meadows are among the most productive ecosystems in the world. They provide habitats and food for a diversity of marine life comparable to coral reefs. This includes invertebrates like shrimp and crabs, cod and flatfish, marine mammals and birds. They provide refuges for endangered species such as seahorses, turtles, and dulongs. They function as nursery habitats for shrimps,

scallops and many commercial fish species. Seagrass meadows provide coastal storm protection by the way their leaves absorb energy from waves as they hit the coast. They keep coastal waters healthy by absorbing bacteria and nutrients, and slow the speed of climate change by sequestering carbon dioxide into the sediment of the ocean floor.

4. Kelp forests occur worldwide throughout temperate and polar coastal oceans. In 2007, kelp forests were also discovered in tropical waters near Ecuador. Physically formed by brown macroalgae, kelp forests provide a unique habitat for marine organisms and are a source for understanding many ecological processes. Over the last century, they have been the focus of extensive research, particularly in trophic ecology, and

continue to provoke important ideas that are relevant beyond this unique ecosystem. For example, kelp forests can influence coastal oceanographic patterns and provide many ecosystem services.

5. Estuaries occur where there is a noticeable change in salinity between saltwater and freshwater sources. This is typically found where rivers meet the ocean or sea. The wildlife found within estuaries is unique as the water in these areas is brackish - a mix of freshwater flowing to the ocean and salty seawater. Other types of estuaries also exist and have similar characteristics as traditional

brackish estuaries. The Great Lakes are a prime example. There, river water mixes with lake water and creates freshwater estuaries. Estuaries are extremely productive ecosystems that many humans and animal species rely on for various activities.

6. Lagoons are areas that are separated from larger water by natural barriers such as coral reefs or sandbars. There are two types of lagoons, coastal and oceanic/atoll lagoons. A coastal lagoon is, as the definition above, simply a body of water that is separated from the ocean by a barrier. An atoll lagoon is a circular coral reef or several coral islands that surround a lagoon. Atoll lagoons are often much deeper than coastal lagoons. Most lagoons are very shallow meaning that they are greatly affected by changed in precipitation, evaporation and wind. This means that salinity and temperature are widely varied in lagoons and that they can have water that ranges from fresh to hypersaline.

7. Salt marsh Salt marshes are a transition from the ocean to the land, where fresh and saltwater mix. The soil in these marshes is often made up of mud and a layer of organic material called peat. Peat is characterized as waterlogged and root-filled decomposing plant matter that often causes low oxygen levels (hypoxia). These hypoxic conditions causes growth of the bacteria that also gives salt marshes the sulfurous smell they are often known for. Salt marshes exist around the world and are needed for healthy ecosystems and a healthy economy.

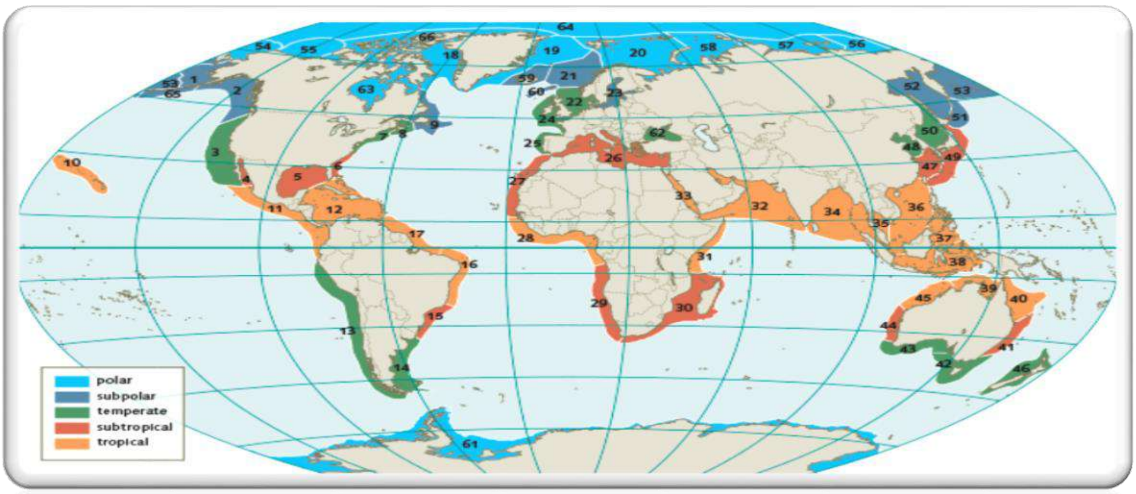
8. Intertidal zones are the areas that are visible and exposed to air during low tide and covered up by saltwater during high tide. There are four physical divisions of the intertidal zone with each one having its distinct characteristics and wildlife. These divisions are the Spray zone, Hgh intertidal zone, Middle Intertidal zone, and Low intertidal zone. The Spray zone is a damp area that is usually only reached by the ocean and submerged only under high tides or storms. The high intertidal zone is submerged at high tide but remains dry for long periods between high tides.

Components of Coastal Ecosystems:

Along with other ecosystems, this coastal ecosystem also has various biotic components and also abiotic components. Various kinds of biotic components and abiotic components owned by the coastal ecosystem include:

❖ Biotic Components. The biotic component is a component in the form of living creatures, where these living things are in the coastal environment of both animals and plants. Some biotic components located in coastal environments include algae, mangroves, marine anemones, shrimp, crabs, fish, and other plants and animals that live in coastal areas.

✓ Abiotic component. An abiotic component is a component that exists in an ecosystem in the form of an inanimate object. Even though it is an inanimate object, the existence of these components can affect the survival of living things around the coastal ecosystem. Therefore, some of the abiotic components possessed by the coastal ecosystem include sand, land, temperature, air, humidity, rocks, and also sunlight. These abiotic components are in the majority of the world's coastal ecosystems. That is because we can find objects that are components easily in the area around the coast.

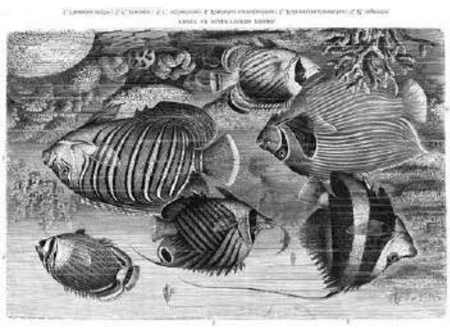


Wildlife of the Coast --

Coastal Fishes:

Intertidal fish are fish that move in and out with the tide in the intertidal zone of the seashore, or are found in rock pools or under rocks. Some rock pool fish which are temporary residents include the long-spined sea scorpion, the pipefish worm,[5] the rock goby and the common lumpsucker. However, some other rock pool fish are territorial in nature, and will stay with the same pool for extended periods. Examples are the common blenny and its near relative the butterfish.

Fishes that spend time in estuaries (or river mouths) need to be euryhaline (tolerant to a range of salinities). Estuaries provide an unstable environment for fish, where the salinity changes and the waters are often muddy and turbulent. In warmer climates, estuaries have mangroves around their edges. At times there may be only a few different fish species present in an estuary, but seasonal migrants, including eels, salmonids, and some forage fish such as herrings and sprats increase the diversity in the estuary.



In tropical waters, coral reef fish live amongst or in close relation to coral reefs. Coral reefs form complex ecosystems with tremendous biodiversity. Coral reefs often depend on other habitats in the surrounding area for the supply of nutrients, such as seagrass meadows and mangrove forests. Anthias are members of the family Serranidae and make up the subfamily Anthiinae. They are widespread in tropical waters. They have been called the "quintessential reef fish", and make up a sizeable portion of the colourful fishes seen swarming in coral reef photography. Butterflyfish are group of about 120 species belonging to the family Chaetodontidaeof Perchiformes. They include bannerfish and coralfish. They are widespread on coral reefs. Butterflyfish are mostly between 12 and 22 centimetres (4.7 and 8.7 in) in length. The largest species, the lined butterflyfish and saddle butterflyfish, grow to 30 centimetres (12 in). Many species are brightly coloured and strikingly patterned, though other species are dull in colour. Clownfish, anemonefish and damselfish are among about 360 species classified in the family Pomacentridae. Most Pomacentrids are associated with coral reefs in the Indo-West Pacific, with a few species occurring in temperate waters. Some species are native to freshwater or brackish estuarine environments. Goatfishes are a family Mullidae of about 55 species of perciform fishes, associated worldwide with tropical reefs. They are typically about 20 cm long, though the dash-and-dot goatfish, grows to 55 cm.

Coastal Birds:

Seagulls are probably the animal people associate most with the beach, but many people know me about seagulls. These birds are extremely manoeuvrable able to hover in the slightest of winds and dive with amazing speed. There are over 50 species of seagulls ranging in size from about 2017 cm with wingspans over 1.7 meters: Gulls are aggressive and will display such aggression when they are threatened. The piping plover (Charadrius melodus) is native to the beaches of the North American Atlantic coast and the West Indies in the Gulf of Mexico. The plover is an endangered species.

Pelicans live on every continent except Antarctica even though there are only about six species. This means that the birds are very well adapted to different conditions. Penguin**s** are a group of aquatic flightless birds. They live almost exclusively in the Southern Hemisphere, with only one species, the Galápagos penguin, found north of the Equator. Highly adapted for life in the water, penguins have countershaded dark and white plumage and flippers for swimming. Most penguins feed on krill, fish, squid and other forms of sea life which they catch while swimming underwater. They spend roughly half of their lives on land and the other half in the sea. Terns are seabirds in the family Laridae that have a worldwide distribution and are normally found near the sea, rivers, or wetlands.

Coastal Animals:

Sea turtles are generally found in the waters over continental shelves. During the first three to five years of life, sea turtles spend most of their time in the pelagic zone floating in seaweed mats. Green sea turtles in particular are often found in *Sargassum* mats, in which they find food, shelter and water. Once the sea turtle has reached adulthood it moves closer to the shore. Saltwater and American crocodiles: none of the extant species of crocodiles are truly marine; however, the saltwater crocodile (*Crocodylus porosus*) does display adaptations to saltwater inhabitation and dwells in the brackish waters of Southeast Asia and Australia.

Most marine mammals, such as seals and sea otters, inhabit the coast. Seals, however, also use a number of terrestrial habitats, both continental and island. In temperate and tropical areas, they haul-out on to sandy and pebble beaches, rocky shores, shoals, mud flats, tide pools and in sea caves. Some species also rest on man-made structures, like piers, jetties, buoys and oil platforms. Seals may move further inland and rest in sand dunes or vegetation, and may even climb cliffs. Sirenians live in shallow coastal waters, usually living 30 feet (9.1 m) below sea level. However, they have been known to dive to −120 feet (−37 m) to forage deep-water seagrasses.

Difference between Coastal Zone and Oceanic Zone

Coastal Zone

The **coastal zone** is the area where land and water meet and extends to ocean depths up to approximately 150 meters and it is also the area where most marine organisms live. The coastal marine waters are located over the continental shelf. These waters are shallow enough to allow sunlight to penetrate to the sea floor. This allows for photosynthesis to occur, which in turn provides food for fish and other living things.

The **oceanic zone** is the area of open ocean that extends beyond the continental shelf, where the ocean depth typically is greater than 100 to 200 meters. The depth of the sea floor in the oceanic zone can be deeper than 32,800 feet (10,000 meters), a depth greater than the height of Mount Everest. Most of the marine waters in the oceanic zone are too deep, dark, cold and devoid of nutrients to support living things.

Oceanic Zone

Nature of Coastal Ecosystem—

This coastal ecosystem is the most unique ecosystem because it is a meeting area between land and also the ocean. Therefore, this coastal ecosystem has several special properties that are not shared by other ecosystems. This coastal ecosystem has several special properties, namely:

- ### This Ecosystem is Affected by Tides
  - ✓ This coastal ecosystem is an ecosystem that is strongly influenced by tides. These tides are the daily cycle of sea water. Thus, the flora and fauna that can survive in the coastal region are the flora and fauna that adapt by attaching to the hard substrate so as not to be blown away by the waves.
- ### The Uppermost Region of This Ecosystem is the Area Least Affected by Water
  - ✓ This coastal ecosystem has the least water part which is the top part. The uppermost part of this ecosystem will only be exposed to water when the sea water is in the tide. Therefore, this region is very rarely affected by water. The uppermost coastal area is inhabited by fauna and flora, including the types of mollusks, algae, shellfish, and also some types of shorebirds.
- ### Has a Midpoint That is Submerged by Water When High and High Tides are Low
  - ✓ Coastal ecosystems have a middle nature that is submerged in water during high tides and low tides. This central place is inhabited by several organisms. Organisms that live in this area are sea anemones, mussels, snails, algae, Porifera, and so on.
- ### The Deepest Area is Inhabited by Several Types of Living Things
  - ✓ Some living things that live in this area include invertebrate animals, fish, and various kinds of seaweed.

Those are some of the properties possessed by this coastal ecosystem. These properties are a characteristic possessed by this coastal ecosystem. As for all the coastal ecosystems that exist on Earth, they must have the properties mentioned above.

Benefits of Coastal Ecosystem------------

Just like other ecosystems, this coastal ecosystem also has benefits or functions. Some of the benefits or functions possessed by this ecosystem include:

- **As the Area of Salt Ponds**
  - As we all know, salt is a daily needs. Indonesia's long coast, has abundant raw materials for making salt. When it's expanded, Indonesia can become a massive salt producer. This, of course, can help communities around the coast to get livelihoods.
- **Coconut and Banana Plantation Area**
  - Coconut and banana are two plants that are very suitable to plant in the coastal areas. It is very useful for creating two plantations around the coast.

- **Tidal Farming Area**
  - Coastal tidal areas can also be used as agricultural fields. These agricultural products are used as a source of livelihood by the surrounding community.
- **Tourist Attraction**
  - The beach is also very useful when used as a tourist attraction considering the beautiful and soothing scenery. Lately, there are many beaches that have been developed as tourist attractions.
- **Development of Typical Beach Crafts**
  - The results obtained from the beach can also be used to make various kinds of crafts because it has a high selling value and it can add to the income of local people.

Those are some benefits that will be obtained from the existence of a coastal ecosystem. Apart from those mentioned above, there are still many other benefits that we can find in this coastal ecosystem.

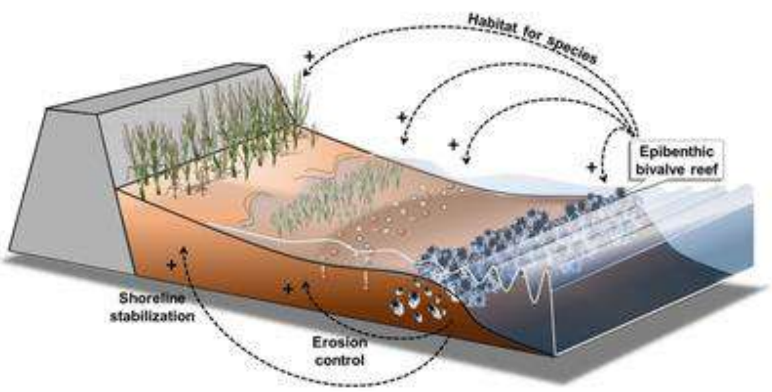
What is “Coastline Paradox”?

The coastline paradox is the counterintuitive observation that the coastline of a landmass does not have a well-defined length. This results from the fractal curve-like properties of coastlines, i.e., the fact that a coastline typically has a fractal dimension (which in fact makes the notion of length inapplicable). The first recorded observation of this phenomenon was by Lewis Fry Richardson and it was expanded upon by Benoit Mandelbrot.

The measured length of the coastline depends on the method used to measure it and the degree of cartographic generalization. Since a landmass has features at all scales, from hundreds of kilometers in size to tiny fractions of a millimeter and below, there is no obvious size of the smallest feature that should be taken into consideration when measuring, and hence no single well-defined perimeter to the landmass. Various approximations exist when specific assumptions are made about minimum feature size.

What is “Ecosystem Services”?

In addition to providing many benefits to the natural world, marine ecosystems also provide social, economic, and biological ecosystem services to humans. Pelagic marine systems regulate the global climate, contribute to the water cycle, maintain biodiversity, provide food and energy resources, and create opportunities for recreation and tourism. Economically, marine systems support billions of dollars worth of capture fisheries, aquaculture, offshore oil and gas, and trade and shipping.

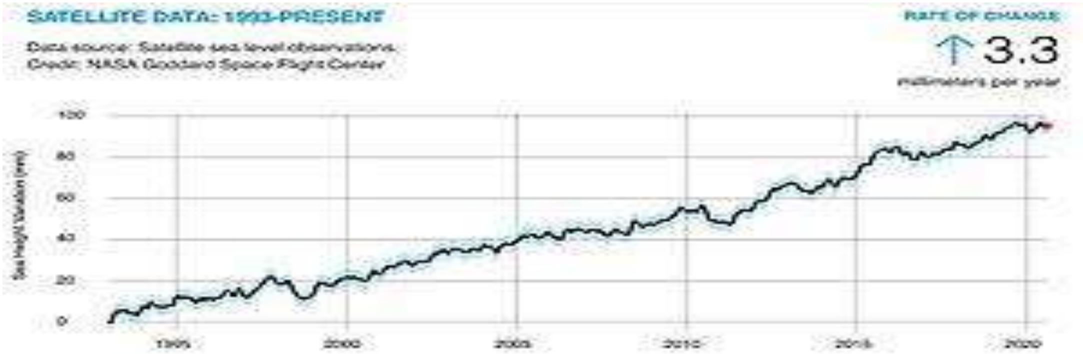


Ecosystem services fall into multiple categories, including supporting services, provisioning services, regulating services, and cultural services.

Threats to Coastal Ecosystem

Coastal Ecosystem also face many human-induced environmental impacts. principal among which are sea-level rise, and associated issues like coastal erosion and saltwater intrusion, and pollution, such as oil spills or marine debris contaminating coasts with plastic and other trash.

a. Sea level rise due to climate change



Tide gauge measurements show that global sea level rise began at the start of the 20th century. Between 1900 and 2017, the globally averaged sea level rose by 16–21 cm (6.3–8.3 in).[12] More precise data gathered from satellite radar measurements reveal an accelerating rise of 7.5 cm (3.0 in) from 1993 to 2017, which is a trend of roughly 30 cm (12 in) per century. This acceleration is due mostly to climate change, which is driving thermal expansion of seawater and the melting of land-based ice sheets and glaciers. Between 1993 and 2018, thermal expansion of the oceans contributed 42% to sea level rise; the melting of temperate glaciers, 21%; Greenland, 15%; and Antarctica, 8%. Climate scientists expect the rate to further accelerate during the 21st century, with the latest measurements saying the sea levels are currently rising by 3.6 mm per year.

Projecting future sea level is challenging, due to the complexity of many aspects of the climate system and to time lags in sea level reactions to Earth temperature changes. As climate research into past and present sea levels leads to improved computer models, projections have consistently increased. In 2007, the Intergovernmental Panel on Climate Change (IPCC) projected a high end estimate of 60 cm (2 ft) through 2099,[17] but their 2014 report raised the high-end estimate to about 90 cm (3 ft). A number of later studies have concluded that a global sea level rise of 200 to 270 cm (6.6 to 8.9 ft) this century is "physically plausible".

b. Pollution

Marine pollution occurs when harmful effects result from the entry into the ocean of chemicals, particles, industrial, agricultural and residential waste, noise, or the spread of invasive organisms. Eighty percent of marine pollution comes from land. Air pollution is also a contributing factor by carrying off iron, carbonic acid, nitrogen, silicon, sulfur, pesticides or dust particles into the ocean. Land and air pollution have proven to be harmful to marine life and its habitats.

The pollution often comes from nonpoint sources such as agricultural runoff, wind-blown debris, and dust. Pollution in large bodies of water can be aggravated by physical phenomena like the biological effects of Langmuir circulation. Nutrient pollution, a form of water pollution, refers to contamination by excessive inputs of nutrients.

c. Overfishing

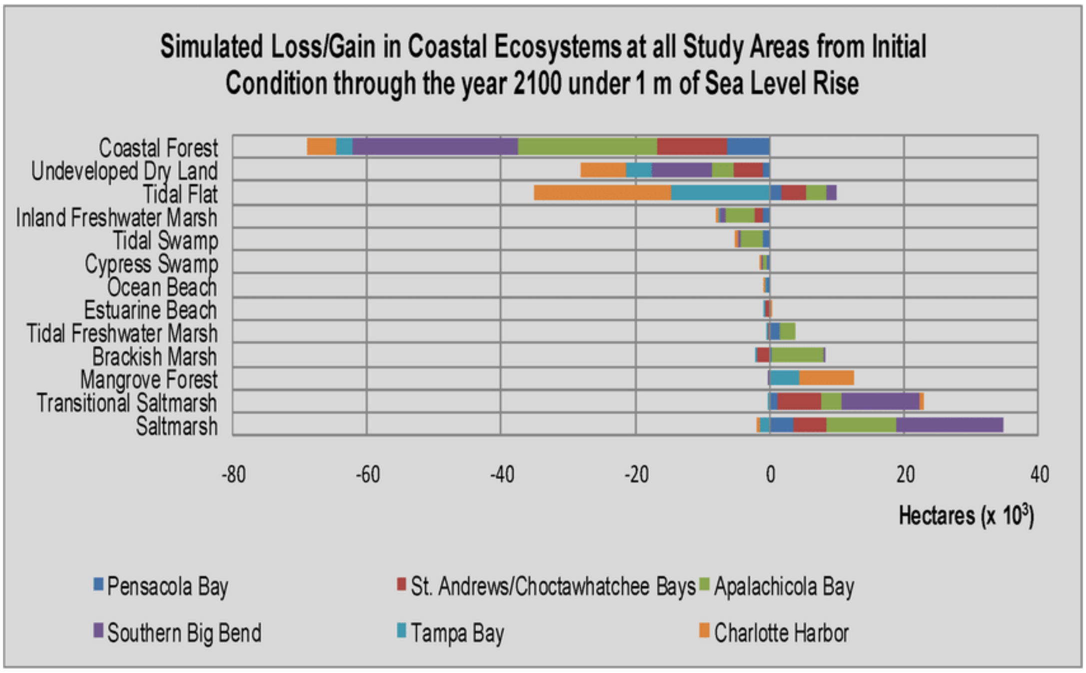
Fishing has declined due to habitat degradation, overfishing, trawling, bycatch and climate change. Since the growth of global fishing enterprises after the 1950s, intensive fishing has spread from a few concentrated areas to encompass nearly all fisheries. The scraping of the ocean floor in bottom dragging is devastating to coral, sponges and other long-lived species that do not recover quickly. This destruction alters the functioning of the ecosystem and can permanently alter species' composition and biodiversity. Bycatch, the capture of unintended species in the course of fishing, is typically returned to the ocean only to die from injuries or exposure. Bycatch represents about a quarter of all marine catch. In the case of shrimp capture, the bycatch is five times larger than the shrimp caught.

Overfishing has stripped many fisheries around the world of their stocks. The United Nations Food and Agriculture Organization estimated in a 2018 report that 33.1% of world fish stocks are subject to overfishing. Significant overfishing has been observed in pre-industrial times. In particular, the overfishing of the western Atlantic Ocean from the earliest days of European colonisation of the Americas has been well documented.

CONCLUSION

Coastal environments and ecosystems (from estuaries and shorelines to the edge of the continental shelf) are increasingly likely to be modified by changes in the delivery of materials from diffuse sources via rivers and the atmosphere, widespread habitat modification resulting from human activities, and the overexploitation of living and non-living resources.

These problems pose a different set of challenges to environmental policy, management, and science than traditional concerns of point source discharge, coastal land use, and spills of hazardous materials. As a result, concern is shifting from problems amenable to single-factor risk assessment paradigms to multiple-factor risk assessment and regulatory strategies that take into account indirect, cascading, and scale-related effects that require an ecosystem perspective (e.g., eutrophication, hydrologic and hydrodynamic modifications, resource sustainability, loss of biodiversity).



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URBAN ECOLOGY

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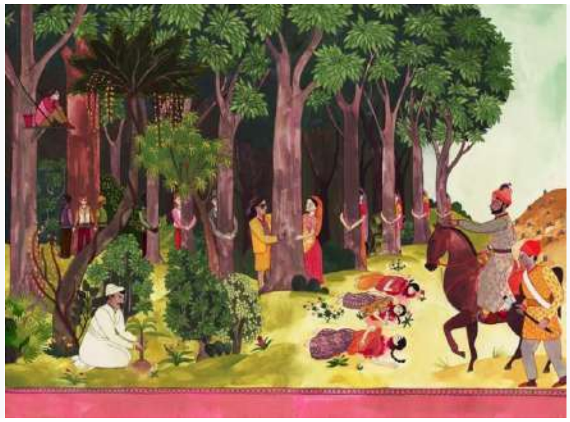
- ## What is Urban Ecology?

The international scientific journal, *Urban Ecology*, defines its eponymous discipline as
"...the study of ecosystems that include humans living in cities and urbanizing landscapes. It is an emerging, interdisciplinary field that aims to understand how human and ecological processes can coexist in human-dominated systems and help societies with their efforts to become more sustainable. ... Because of its interdisciplinary nature and unique focus on humans and natural systems, the term "urban ecology" has been used variously to describe the study of humans in cities, of nature in cities, and of the coupled relationships between humans and nature. Each of these research areas is contributing to our understanding of urban ecosystems and each must be understood to fully grasp the science of Urban Ecology."

Urban ecology is the scientific study of the relation of living organisms with each other and their surroundings in the context of an urban environment. The urban environment refers to environments dominated by high-density residential and commercial buildings, paved surfaces, and other urban-related factors that create a unique landscape dissimilar to most previously studied environments in the field of ecology. The goal of urban ecology is to achieve a balance between human culture and the natural environment.

Urban ecology is a recent field of study compared to ecology as a whole. The methods and studies of urban ecology are similar to and comprise a subset of ecology. The study of urban ecology carries increasing importance because more than 50% of the world's population today lives in urban areas. At the same time, it is estimated that within the next forty years, two-thirds of the world's population will be living in expanding urban centers. The ecological processes in the urban environment are comparable to those outside the urban context. However, the types of urban habitats and the species that inhabit them are poorly documented. Often, explanations for phenomena examined in the urban setting as well as predicting changes because of urbanization are the center for scientific research.

• History



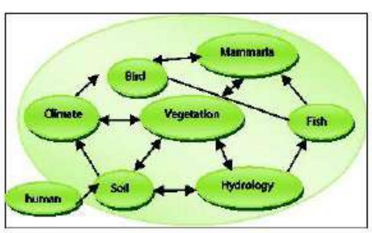
Ecology has historically focused on "pristine" natural environments, but by the 1970s many ecologists began to turn their interest towards ecological interactions taking place in, and caused by urban environments. Jean-Marie Pelt's 1977 book The Re-Naturalized Human, Brian Davis' 1978 publication Urbanization and the diversity of insects, and Sukopp et al.'s 1979 article "The soil, flora and vegetation of Berlin's wastelands" are some of the first publications to recognize the importance of urban ecology as a separate and distinct form of ecology the same way one might see landscape ecology as different from population ecology. Forman and Godron's 1986 book Landscape Ecology[8] first distinguished urban settings and landscapes from other landscapes by dividing all landscapes into five broad types. These types were divided by the intensity of human influence ranging from pristine natural environments to urban centers.

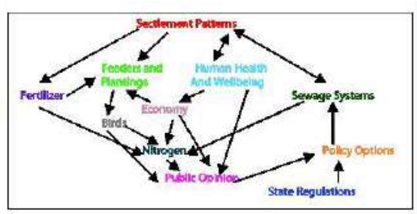
Urban ecology is recognized as a diverse and complex concept which differs in application between North America and Europe. The European concept of urban ecology examines the biota of urban areas, the North American concept has traditionally examined the social sciences of the urban landscape,[9] as well as the ecosystem fluxes and processes, and the Latin American concept examines the effect of human activity on the biodiversity and fluxes of urban ecosystems. The world's first urban ecology laboratories were founded, for temperate ecosystems, in 1999 (Urban Ecology Research Laboratory, University of Washington), and for tropical ecosystems, in 2008 (Laboratory of Urban Ecology, Universidad Estatal a Distancia of Costa Rica.

• Methods

Since urban ecology is a subfield of ecology, many of the techniques are similar to that of ecology. Ecological study techniques have been developed over centuries, but many of the techniques use for urban ecology are more recently developed. Methods used for studying urban ecology involve chemical and biochemical techniques, temperature recording, heat mapping remote sensing, and long-term ecological research sites.

Chemical and biochemical techniques :





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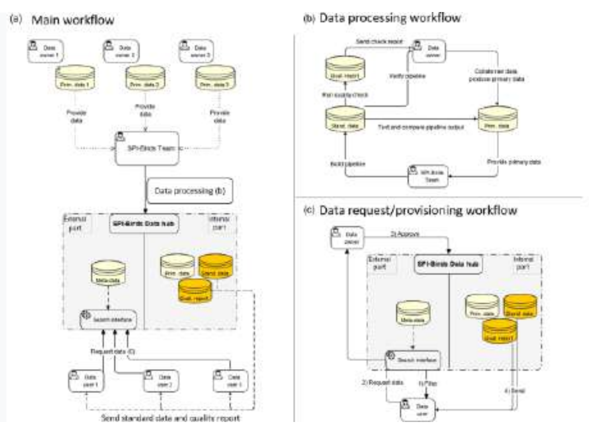
Chemical techniques may be used to determine pollutant concentrations and their effects. Tests can be as simple as dipping a manufactured test strip, as in the case of pH testing, or be more complex, as in the case of examining the spatial and temporal variation of heavy metal contamination due to industrial runoff. In that particular study, livers of birds from many regions of the North

Sea were ground up and mercury was extracted. Additionally, mercury bound in feathers was extracted from both live birds and from museum specimens to test for mercury levels across many decades. Through these two different measurements, researchers were able to make a complex picture of the spread of mercury due to industrial runoff both spatially and temporally.

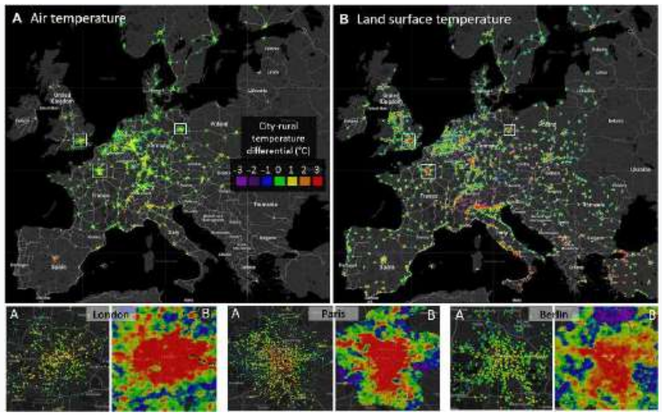
Other chemical techniques include tests for nitrates, phosphates, sulfates, etc. which are commonly associated with urban pollutants such as fertilizer and industrial byproducts. These biochemical fluxes are studied in the atmosphere (e.g. greenhouse gasses), aquatic ecosystems and soil vegetation. Broad reaching effects of these biochemical fluxes can be seen in various aspects of both the urban and surrounding rural ecosystems.

LTERs and long-term data sets :



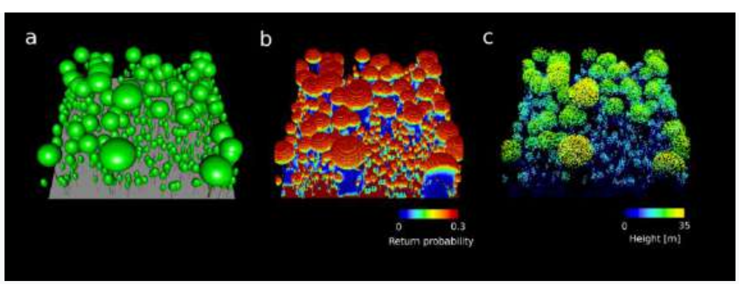
Long-term ecological research (LTER) sites are research sites funded by the government that have collected reliable long-term data over an extended period of time in order to identify long-term climatic or ecological trends. These sites provide long-term temporal and spatial data such as average temperature, rainfall and other ecological processes. The main purpose of LTERs for urban ecologists is the collection of vast amounts of data over long periods of time. These long-term data sets can then be analyzed to find trends relating to the effects of the urban environment on various ecological processes, such as species diversity and abundance over time. Another example is the examination of temperature trends that are accompanied with the growth of urban centers.

Temperature data and heat mapping :



Temperature data can be used for various kinds of studies. An important aspect of temperature data is the ability to correlate temperature with various factors that may be affecting or occurring in the environment. Oftentimes, temperature data is collected long-term by the Office of Oceanic and Atmospheric Research (OAR), and made available to the scientific community through the National Oceanic and Atmospheric Administration (NOAA). Data can be overlaid with maps of terrain, urban features, and other spatial areas to create heat maps. These heat maps can be used to view trends and distribution over time and space.

Remote sensing :



Remote sensing is the technique in which data is collected from distant locations through the use of satellite imaging, radar, and aerial photographs. In urban ecology, remote sensing is used to collect data about terrain, weather patterns, light, and vegetation. One application of remote sensing for urban ecology is to detect the productivity of an area by measuring the photosynthetic wavelengths of emitted light. Satellite images can also be used to detect differences in temperature and landscape diversity to detect the effects of urbanization.

• Urban effects on the environment

Humans are the driving force behind urban ecology and influence the environment in a variety of ways, such as modifying land surfaces and waterways, introducing foreign species, and altering biogeochemical cycles. Some of these effects are more apparent, such as the reversal of the Chicago River to accommodate the growing pollution levels and trade on the river. Other effects can be more gradual such as the change in global climate due to urbanization.

Modification of land and waterways :

Humans place high demand on land not only to build urban centers, but also to build surrounding suburban areas for housing. Land is also allocated for agriculture to sustain the growing population of the city.

Expanding cities and suburban areas necessitate corresponding deforestation to meet the land-use and resource requirements of urbanization. Key examples of this are Deforestation in the United States and Europe.

Along with manipulation of land to suit human needs, natural water resources such as rivers and streams are also modified in urban establishments. Modification can come in the form of dams, artificial canals, and even the reversal of rivers. Reversing the flow of the Chicago River is a major example of urban environmental modification. Urban areas in natural desert settings often bring in water from far areas to maintain the human population and will likely have effects on the local desert climate. Modification of aquatic systems in urban areas also results in decreased stream diversity and increased pollution.

Trade, shipping, and spread of invasive species :

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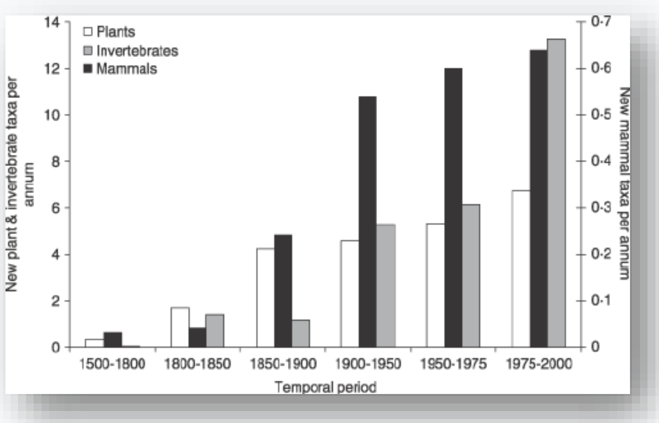
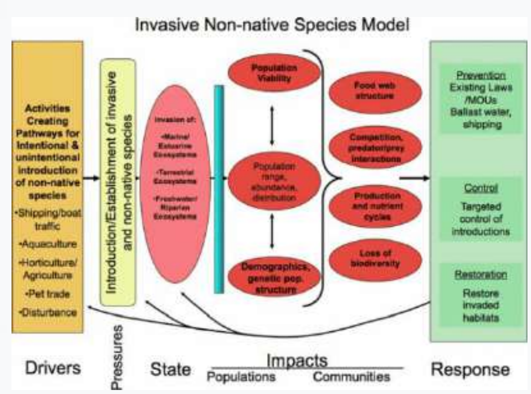
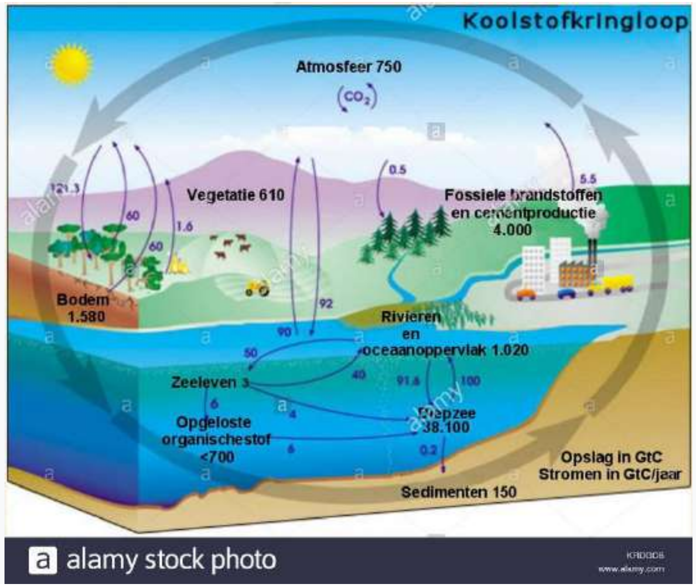




Both local shipping and long-distance trade are required to meet the resource demands important in maintaining urban areas. Carbon dioxide emissions from the transport of goods also contribute to accumulating greenhouse gases and nutrient deposits in the soil and air of urban environments. In addition, shipping facilitates the unintentional spread of living organisms, and introduces them to environments that they would not naturally inhabit. Introduced or alien species are populations of organisms living in a range in which they did not naturally evolve due to intentional or inadvertent human activity. Increased transportation between urban centers furthers the incidental movement of animal and plant species. Alien species often have no natural predators and pose a substantial threat to the dynamics of existing ecological populations in the new environment where they are introduced. Such invasive species are numerous and include house sparrows, ring-necked pheasants, European starlings, brown rats, Asian carp, American bullfrogs, emerald ash borer, kudzu vines, and zebra mussels among numerous others, most notably domesticated animals. In Australia, it has been found that removing Lantana (L. camara, an alien species) from urban green spaces can surprisingly have negative impacts on bird diversity locally, as it provides refugia for species like the superb fairy (Malurus cyaneus) and silvereye (Zosterops lateralis), in the absence of native plant equivalents . Although, there seems to be a density threshold in which too much Lantana (thus homogeneity in vegetation cover) can lead to a decrease in bird species richness or abundance .

Human effects on biogeochemical pathways :

Urbanization results in a large demand for chemical use by industry, construction, agriculture, and energy providing services. Such demands have a substantial impact on biogeochemical cycles, resulting in phenomena such as acid rain, eutrophication, and global warming. Furthermore, natural biogeochemical cycles in the urban environment can be impeded due to impermeable surfaces that prevent nutrients from returning to the soil, water, and atmosphere.



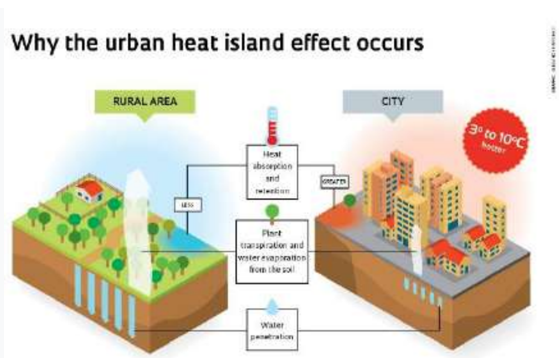
Demand for fertilizers to meet agricultural needs exerted by expanding urban centers can alter chemical composition of soil. Such effects often result in abnormally high concentrations of compounds including sulfur, phosphorus, nitrogen, and heavy metals. In addition, nitrogen and phosphorus used in fertilizers have caused severe problems in the form of agricultural runoff, which alters the concentration of these compounds in local rivers and streams, often resulting in adverse effects on native species. A well-known effect of agricultural runoff is the phenomenon of eutrophication. When the fertilizer chemicals from agricultural runoff reach the ocean, an algal bloom results, then rapidly dies off. The dead algae biomass is decomposed by bacteria that also consume large quantities of oxygen, which they obtain from the water, creating a "dead zone" without oxygen for fish or other organisms. A classic example is the dead zone in the Gulf of Mexico due to agricultural runoff into the Mississippi River.

Just as pollutants and alterations in the biogeochemical cycle alter river and ocean ecosystems, they exert likewise effects in the air. Some stems from the accumulation of chemicals and pollution and often manifests in urban settings, which has a great impact on local plants and animals. Because urban centers are often considered point sources for pollution, unsurprisingly local plants have adapted to withstand such conditions.

· Urban effects on climate

Urban environments and outlying areas have been found to exhibit unique local temperatures, precipitation, and other characteristic activity due to a variety of factors such as pollution and altered geochemical cycles. Some examples of the urban effects on climate are urban heat island, oasis effect, greenhouse gases, and acid rain. This further stirs the debate as to whether urban areas should be considered a unique biome. Despite common trends among all urban centers, the surrounding local environment heavily influences much of the climate. One such example of regional differences can be seen through the urban heat island and oasis effect.

Urban heat island effect :

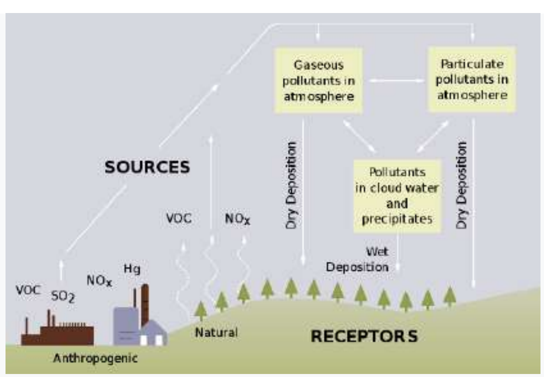


The urban heat island is a phenomenon in which central regions of urban centers exhibit higher mean temperatures than surrounding urban areas. Much of this effect can be attributed to low city albedo, the reflecting power of a surface, and the increased surface area of buildings to absorb solar radiation. Concrete, cement, and metal surfaces in urban areas tend to absorb heat energy rather than reflect it, contributing to higher urban temperatures. Brazil et al. found that the urban heat island effect demonstrates a positive correlation with population density in the city of Baltimore. The heat island effect has corresponding ecological consequences on resident species. However, this effect has only been seen in temperate climates.

Greenhouse gases :

Greenhouse gas emissions include those of carbon dioxide and methane from the combustion of fossil fuels to supply energy needed by vast urban metropolises. Other greenhouse gases include water vapor, and nitrous oxide. Increases in greenhouse gases due to urban transport, construction, industry and other demands have been correlated strongly with increase in temperature. Sources of methane are agricultural dairy cows and landfills.

Acid rain and pollution :



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Processes related to urban areas result in the emission of numerous pollutants, which change corresponding nutrient cycles of carbon, sulfur, nitrogen, and other elements. Ecosystems in and around the urban center are especially influenced by these point sources of pollution. High sulfur dioxide concentrations resulting from the industrial demands of urbanization cause rainwater to become more acidic. Such an effect has been found to have a significant influence on locally affected populations, especially in aquatic environments. Wastes from urban centers, especially large urban centers in developed nations, can drive biogeochemical cycles on a global scale.

• Biodiversity and urbanization

Research thus far indicates that, on a small scale, urbanization often increases the biodiversity of non-native species while reducing that of native species. This normally results in an overall reduction in species richness and increase in total biomass and species abundance. Urbanization also reduces diversity on a large scale.

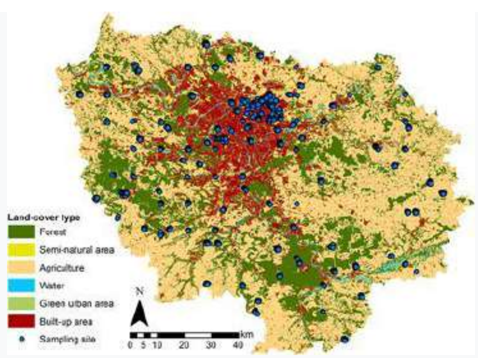
Urban stream syndrome is a consistently observed trait of urbanization characterized by high nutrient and contaminant concentration, altered stream morphology, increased dominance of dominant species, and decreased biodiversity. The two primary causes of urban stream syndrome are storm water runoff and wastewater treatment plant effluent.

Changes in diversity :

Diversity is normally reduced at intermediate-low levels of urbanization but is always reduced at high levels of urbanization. These effects have been observed in vertebrates and invertebrates while plant species tend to increase with intermediate-low levels of urbanization but these general trends do not apply to all organisms within those groups. For example, McKinney's (2006) review did not include the effects of urbanization on fishes and of the 58 studies on invertebrates, 52 included insects while only 10 included spiders. There is also a geographical bias as most of the studies either took place in North America or Europe.

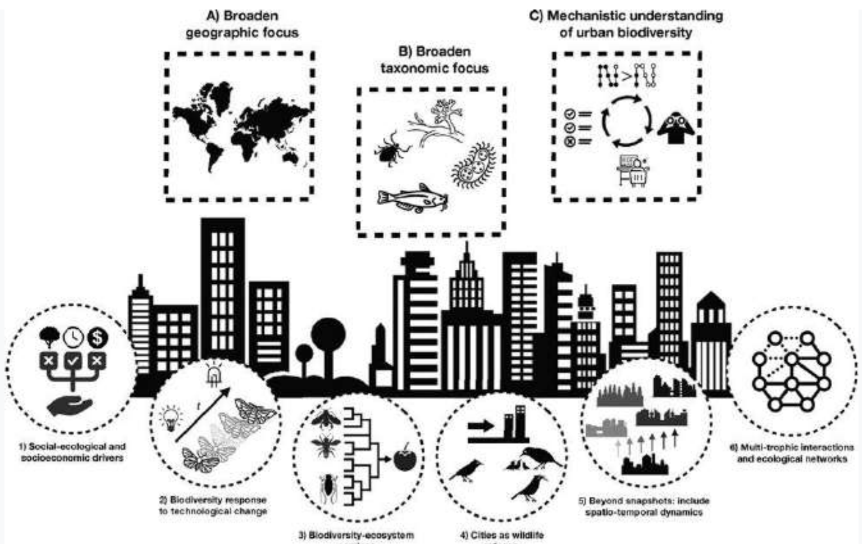
The effects of urbanization also depend on the type and range of resources used by the organism. Generalist species, those that use a wide range of resources and can thrive under a large range of living conditions, are likely to survive in uniform environments. Specialist species, those that use a narrow range of resources and can only cope with a narrow range of living conditions, are unlikely to cope with uniform environments. There will likely be a variable effect on these two groups of organisms as urbanization alters habitat uniformity. Surprisingly, endangered plant species have been reported to occur throughout a wide range of urban ecosystems, many of them being novel ecosystems.

A study of 463 bird species reported that urban species share dietary traits. Specifically, urban species were larger, consumed more vertebrates and carrion, and fed more frequently on the ground or aerially, and also had broader diets than non-urban species.



Cause of diversity change :

The urban environment can decrease diversity through habitat removal and species homogenization—the increasing similarity between two previously distinct biological communities. Habitat degradation and habitat fragmentation reduces the amount of suitable habitat by urban development and separates suitable patches by inhospitable terrain such as roads, neighborhoods, and open parks. Although this replacement of suitable habitat with unsuitable habitat will result in extinctions of native species, some shelter may be artificially created and promote the survival of non-native species (e.g. house sparrow and house mice nests). Urbanization promotes species homogenization through the extinction of native endemic species and the introduction of non-native species that already have a widespread abundance. Changes to the habitat may promote both the extinction of native endemic species and the introduction of non-native species. The effects of habitat change will likely be similar in all urban environments as urban environments are all built to cater to the needs of humans.



Wildlife in cities are more susceptible to suffering ill effects from exposure to toxicants (such as heavy metals and pesticides). In China, fish that were exposed to industrial wastewater had poorer body condition; being exposed to toxicants can increase susceptibility to infection. Humans have the potential to induce patchy food distribution, which can promote animal aggregation by attracting a high number of animals to common food sources; “this aggregation may increase the spread of parasites transmitted through close contact; parasite deposition on soil, water, or artificial feeders; and stress through inter- and intraspecific competition.” The results of a study performed by Maureen Murray (et. al.), in which a phylogenetic meta-analysis of 516 comparisons of overall wildlife condition reported in 106 studies was performed, confirmed these results; “our meta-analysis suggests an overall negative relationship between urbanization and wildlife health, mainly driven by considerably higher toxicant loads and greater parasite abundance, greater parasite diversity, and/or greater likelihood of infection by parasites transmitted through close contact."

The urban environment can also increase diversity in a number of ways. Many foreign organisms are introduced and dispersed naturally or artificially in urban areas. Artificial introductions may be intentional, where organisms have some form of human use, or accidental, where organisms attach themselves to transportation vehicles. Humans provide food sources (e.g. birdfeeder seeds, trash, garden compost) and reduce the numbers of large natural predators in urban environments, allowing large populations to be supported where food and predation would normally limit the population size. There are a variety of different habitats available within the urban environment as a result of differences in land use allowing for more species to be supported than by more uniform habitats.

•Ways to improve urban ecology: civil engineering and sustainability

Cities should be planned and constructed in such a way that minimizes the urban effects on the surrounding environment (urban heat island, precipitation, etc.) as well as optimizing ecological activity. For example, increasing the albedo, or reflective power, of surfaces in urban areas, can minimize urban heat island, resulting in a lower magnitude of the urban heat island effect in urban areas. By minimizing these abnormal temperature trends and others, ecological activity would likely be improved in the urban setting.

Need for remediation :

Urbanization has indeed had a profound effect on the environment, on both local and global scales. Difficulties in actively constructing habitat corridor and returning biogeochemical cycles to normal raise the question as to whether such goals are feasible. However, some groups are working to return areas of land affected by the urban landscape to a more natural state. This includes using landscape architecture to model natural systems and restore rivers to pre-urban states.

It is becoming increasingly critical that conservation action be enabled within urban landscapes. Space in cities is limited; urban infill threatens the existence of green spaces. Green spaces that are in close proximity to cities are also vulnerable to urban sprawl. It is common that urban development comes at the cost of valuable land that could host wildlife species. Natural and financial resources are limited; a larger focus must be placed on conservation opportunities that factor in feasibility and maximization of expected benefits. Since the securing of land as a protected area is a luxury that cannot be extensively implemented, alternative approaches must be explored in order to prevent mass extinction of species.

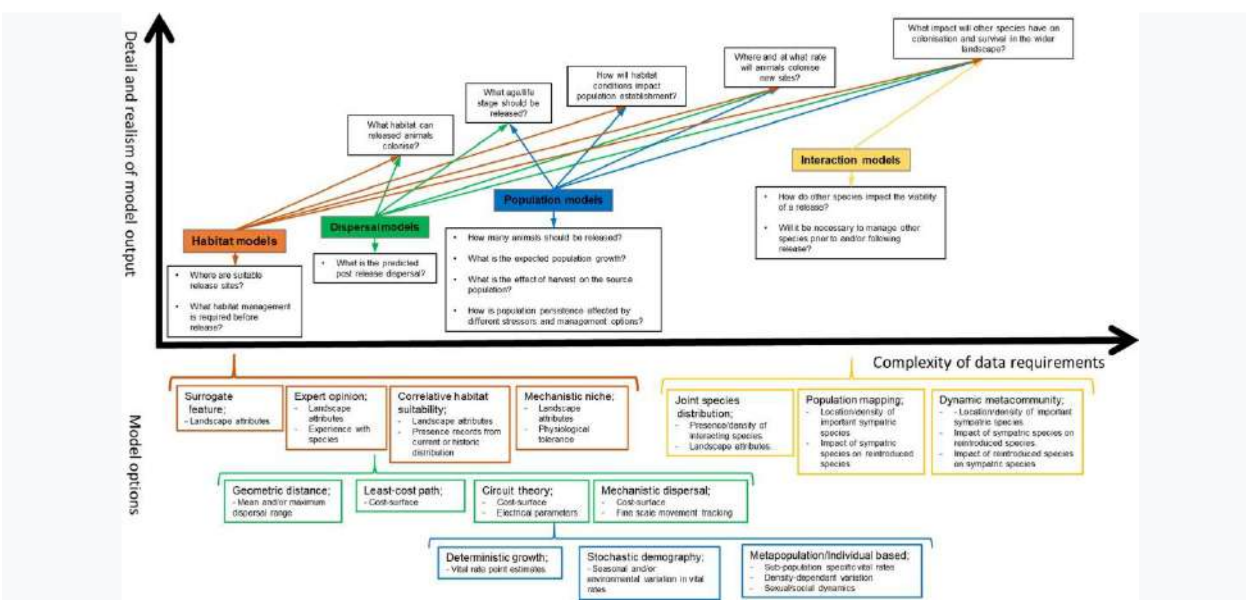
The need to pursue conservation outcomes in urban environments is most pronounced for species whose global distribution is contained within a human-modified landscape. The fact is that many threatened wildlife species are prevalent among land types that were not originally intended for conservation. Of Australia's 39 urban-restricted threatened species, 11 species occur at roadsides, 10 species occur in private lands, 5 species occur in military lands, 4 species in schools, 4 species in golf courses, 4 species at utility easements (such as railways), 3 species at airports and 1 species at hospitals. The spiked rice flower species Pimelea spicata persists mainly at a golf course, while the guinea-flower hibbertia puberula glabrescens is known mainly from the grounds of an airport. Unconventional landscapes as such are the ones that must be prioritized. The goal in the management of these areas is to bring about a "win-win" situation where conservation efforts are practiced while not compromising the original use of the space. While being near to large human populations can pose risks to endangered species inhabiting urban environments, such closeness can prove to be an advantage as long as the human community is conscious and engaged in local conservation efforts.

Species reintroduction :

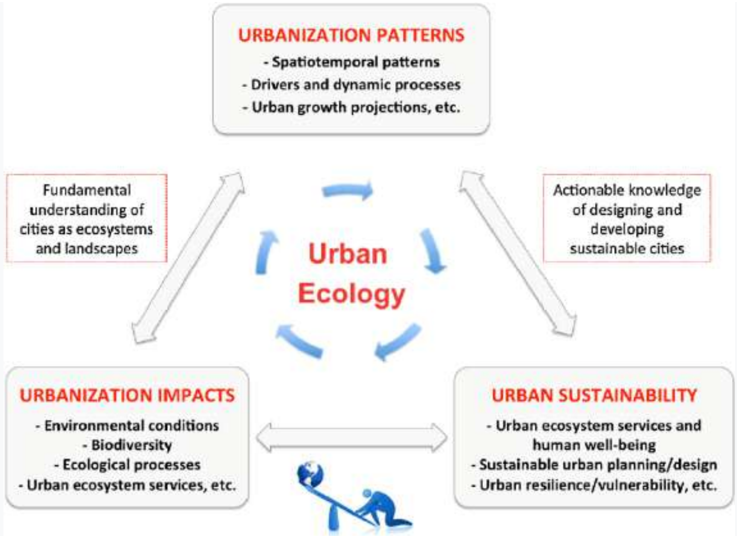
Reintroduction of species to urban settings can help improve the local biodiversity previously lost; however the following guidelines should be followed in order to avoid undesired effects.

1. No predators capable of killing children will be reintroduced to urban areas.
2. There will be no introduction of species that significantly threaten human health, pets, crops or property.

3. Reintroduction will not be done when it implies significant suffering to the organisms being reintroduced, for example stress from capture or captivity.
4. Organisms that carry pathogens will not be reintroduced.
5. Organisms whose genes threaten the genetic pool of other organisms in the urban area will not be reintroduced.
6. Organisms will only be reintroduced when scientific data support a reasonable chance of long term survival (if funds are insufficient for the long term effort, reintroduction will not be attempted).
7. Reintroduced organisms will receive food supplementation and veterinary assistance as needed.
8. Reintroduction will be done in both experimental and control areas to produce reliable assessments (monitoring must continue afterwards to trigger interventions if necessary).
9. Reintroduction must be done in several places and repeated over several years to buffer for stochastic events.
10. People in the areas affected must participate in the decision process, and will receive education to make reintroduction sustainable (but final decisions must be based on objective information gathered according to scientific standards).



Sustainability :



With the ever-increasing demands for resources necessitated by urbanization, recent campaigns to move toward sustainable energy and resource consumption, such as LEED certification of buildings, Energy Star certified appliances, and zero emission vehicles, have gained momentum. Sustainability reflects techniques and consumption ensuring reasonably low resource use as a component of urban ecology. Techniques such as carbon recapture may also be used to sequester carbon compounds produced in urban centers rather continually emitting more of the greenhouse gas.

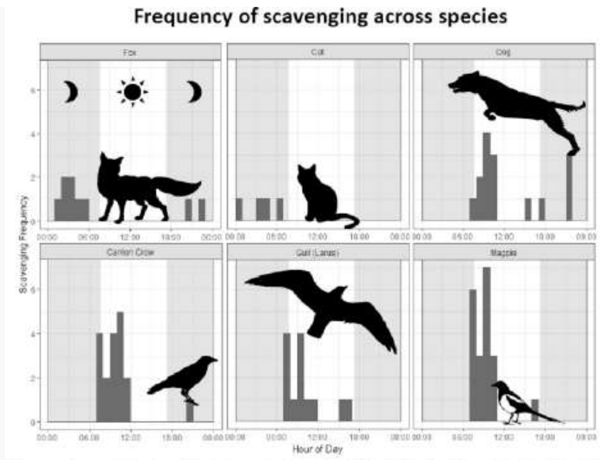
Green Infrastructure Implementation :

Urban areas can be converted to areas that are more conducive to hosting wildlife through the application of green infrastructure. Although the opportunities of green infrastructure (GI) to benefit human populations have been recognized, there are also opportunities to conserve wildlife diversity. Green infrastructure has the potential to support wildlife robustness by providing a more suitable habitat than conventional, “grey” infrastructure as well as aid in stormwater management and air purification. GI can be defined as features that were engineered with natural elements or natural features. This natural constitution helps prevent wildlife exposure to man-made toxicants.

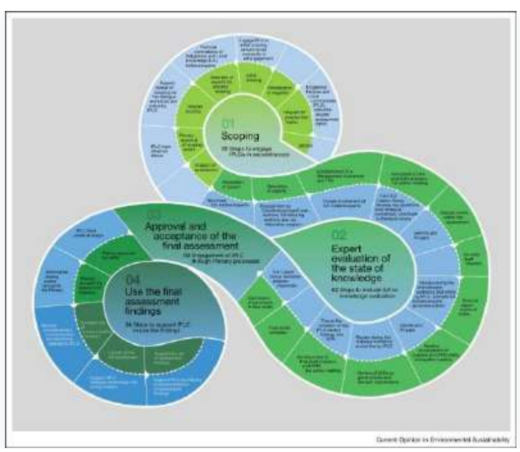
Although research on the benefits of GI on biodiversity has increased exponentially in the last decade, these effects have rarely been quantified. In a study performed by Alessandro Filazzola (et. al.), 1,883 published manuscripts were examined and meta-analyzed in reference to 33 relevant studies in order to determine the effect of GI on wildlife. Although there was variability in the findings, it was determined that the implementation of GI improved biodiversity compared to conventional infrastructure. In some cases, GI even preserved comparable measures of biodiversity to natural components.

Roadkill Mitigation :

In the United States, roadkill takes the lives of hundreds of thousands to hundreds of millions of mammals, birds and amphibians each year. Roadkill mortality has detrimental effects on the persistence probability, abundance and genetic diversity of wildlife populations (more so than reduced movement through habitat patches). Roadkill also has an effect on driver safety. If green areas cannot be reserved, the presence of wildlife habitats in close proximity to urban roads must be addressed. The optimal situation would be to avoid constructing roads next to these natural habitats, but other preventative measures can be pursued to reduce animal mortality. One way these effects could be mitigated is through implementation of wildlife fencing in prioritized areas. Many countries utilize underpasses and overpasses combined with wildlife fencing to reduce roadkill mortality in an attempt to restore habitat connectivity. It is unrealistic to try to fence entire road networks because of financial constraints. Therefore, areas in which the highest rates of mortality occur should be focused on.



Indigenous Knowledge :



Urban sprawl is one of many ways that Indigenous Peoples land is taken and developed, thus the intimate knowledge of the native area (ecology) is often lost due to the effects of colonization or because the land has been majorly altered. Urban development occurs around areas where

Indigenous Peoples lived as these areas are easy for transport and the natural environmental is fruitful. When developing areas of urban land, consideration should go towards the intimate levels of knowledge held by Indigenous Peoples and the biocultural and linguistic diversity of the place. Urban ecology follows western science frameworks and compartmentalizes nature. Urban ecology has the opportunity to be viewed in an interconnected and holistic way, through "Two-Eyed Seeing" and be inclusive of the Traditional Ecological Knowledge held by the local Indigenous Peoples of the area.

Urban restoration ecology would be enriched by partnerships with the local Indigenous Peoples, if done in a respectful way that addresses the currently inequitable relationship. Non-indigenous people can support their local Indigenous communities by learning about the history of the land and ecosystems that is being restored or studied. Ecological restoration built with strong Indigenous partnerships benefits the Indigenous culture and identity, as well as all urban dwellers.

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ENVIRONMENTAL SCIENCE PROJECT- ORGANIC FARMING

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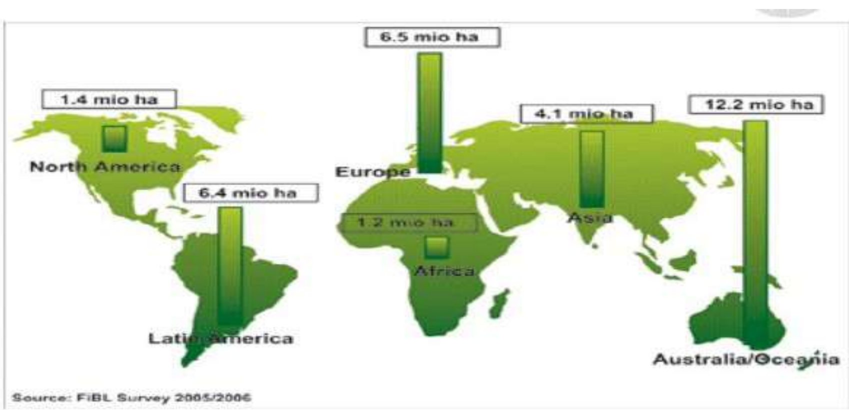
ORGANIC FARMING

Definition:

Organic farming “is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic agriculture systems rely upon crop rotations, crop residues, animal manure, legumes, green manure, off-farm organic wastes, mechanical cultivation, mineral bearing rocks, and aspects of biological pest control to maintain soil productivity, tilth, to supply plant nutrients, and to control insects, weeds, and other pests”. (USDA,1980). The concept of the soil as a living system which must be “fed” in a way that does not restrict the activities of beneficial organisms necessary for recycling nutrients and producing humus is central to this definition.

“Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including bio-diversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using wherever possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system” (Codex, 1999).



ORGANIC FARMING IN WORLD

Need of organic farming

With the increase in population our compulsion would be not only to stabilize agricultural production but to increase it further in sustainable manner. The scientists have realized that the 'Green Revolution' with high input use has reached a plateau and is now sustained with diminishing return of falling dividends. Thus, a natural balance needs to be maintained at all cost for existence of life and property. The obvious choice for that would be more relevant in the present era, when these agrochemicals which are produced from fossil fuel and are not renewable and are diminishing in availability. It may also cost heavily on our foreign exchange in future.

The key characteristics of organic farming include

- Protecting the long-term fertility of soils by maintaining organic matter levels, encouraging soil biological activity, and careful mechanical intervention
- Providing crop nutrients indirectly using relatively insoluble nutrient sources which are made available to the plant by the action of soil micro-organisms
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials including crop residues and livestock manures
- Weed, disease and pest control relying primarily on crop rotations, natural predators, diversity, organic manuring, resistant varieties and limited (preferably minimal) thermal, biological and chemical intervention
- The extensive management of livestock, paying full regard to their evolutionary adaptations, behavioural needs and animal welfare issues with respect to nutrition, housing, health, breeding and rearing
- Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats

Principles of organic farming

1. To produce food of high nutritional quality in sufficient quantity
2. To interact in a constructive and life enhancing way with all natural systems and cycles
3. To encourage and biological cycles with in the farming system, involving micro-organisms, soil flora and fauna, plants and animals and careful mechanical intervention
4. To maintain and increase long-term fertility of soils
5. To promote the healthy use and proper care of water, water resources and all life therein
6. To help in the conservation of soil and water
7. To use, as far as is possible, renewable resources in locally organized agricultural systems
8. To work, as far as possible, within a closed system with regard to organic matter and nutrient elements
9. To work, as far as possible, with materials and substances which can be reused or recycled, either on the farm or elsewhere
10. To give all livestock conditions of life which allow them to perform the basic aspects of their innate behaviour
11. To maintain all forms of pollution that may result from agricultural practices
12. To maintain the genetic diversity of the production system and its surroundings including the protection of wild life habitats
13. To allow everyone involved in organic production and processing a quality of life confirming to the UN Human Rights Charter, to cover their basic needs and obtain an adequate return and satisfaction from their work, including a safe working environment
14. To consider the wider social and ecological impact of the farming system
15. To produce non-food products from renewable resources, which are fully degradable
16. Weed, disease and pest control relaying primarily on crop rotation, natural predators, diversity, organic manuring, resistant varieties, and limited (preferably minimal) thermal, biological and chemical intervention
17. To create harmonious balance between crop production and animal husbandry
18. To encourage organic agriculture associations to function along democratic lines and the principle of division of powers

19. To progress towards an entire production, processing and distribution chain which is both socially just and ecologically responsible

Basic Steps of Organic Farming

Organic farming approach involves following five principles:

- Conversion of land from conventional management to organic management
- Management of the entire surrounding system to ensure biodiversity and sustainability of the system.
- Crop production with the use of alternative sources of nutrients such as crop rotation, residue management, organic manures and biological inputs.
- Management of weeds and pests by better management practices, physical and cultural means and by biological control system
- Maintenance of livestock in tandem with organic concept and make them an integral part of the entire system

Steps to a Successful Organic Transition

The transition from conventional to organic farming requires numerous changes. One of the biggest changes is in the mindset of the farmer. Conventional approaches often involve the use of quick-fix remedies that, unfortunately, rarely address the cause of the problem. Transitioning farmers generally spend too much time worrying about replacing synthetic input with allowable organic product instead of considering management practices based on preventative strategies. Here are a few steps new entrants should follow when making the transition to organic farming:

A) Understand the basics of organic agriculture and the organic farming standards

Since organic production systems are knowledge based, new entrants and transitional producers must become familiar with sound and sustainable agricultural practices. Transitional producers should be prepared to read appropriate information, conduct their own trials and participate in formal and informal training events. As mentioned, switching from conventional to organic farming is more than substituting synthetic materials to organic allowed materials. Organic farming is a holistic system that relies on sound practices focused on preventative strategies. Since there are often few organic remedies available to organic producers for certain problems, prevention is the key element in organic production.

B) Identify resources that will help you

Existing organic farmers are generally very helpful in sharing valuable technical information. A good mentor should be able to provide transitional producers with knowledge, practical experience and suggest appropriate reading materials. Mentors are able to identify some of the most important challenges transitional farmers will be confronted with. Mentors may also help source production materials that are otherwise difficult to find. Producers should also contact agrologists, veterinarians and other agricultural and financial consultants, in order to learn ways to improve their current farming practices.

The Internet is a valuable source of information, especially to new organic farmers. A broad range of reading materials are available from many organic/ecological organizations such as the Organic Agriculture Centre of Canada (OACC), the Atlantic Canadian Organic Regional Network (ACORN), the Canadian Organic Growers (COG), the Certified Organic Associations of British Columbia (COABC), the National Sustainable Agriculture Information Services/Appropriate Technology Transfer for Rural Areas (ATTRA), the Sustainable Agriculture Research and Education (SARE), and the Agri-réseau/agriculture biologique- Quebec. Consider joining an organic organization or network to access these valuable resources and establish good working contacts.

C) Plan your transition carefully

Develop a transitional plan with clear and realistic goals. The plan should clearly identify various steps to be taken in making the transition to organic and be sure to include realistic timeframes. Identify your strengths and weaknesses. Consider ways to address any weaknesses, while building on strengths. The business side of the transitional plan should contain a multiple year budget and an effective/realistic marketing strategy. Make sure your list of expenses is comprehensive. Include all prerequisites to begin the transition; such as, mechanical weeding equipment, specialized composting equipment and applicators, additional handling equipment dedicated to the organic products, and processing equipment. Although the demand for organic products is continually growing, growers need to make sure they have a reliable market for the organic products they plan to produce.

Careful planning is very important. During the early part of the transitional period, yields are often depressed and premium prices for certified organic products are generally not yet obtainable. Use realistic yields and prices when evaluating the feasibility of your project.

In some instances, it is preferable to continue using conventional measures early on in the transitional process in order to avoid dramatic yield reduction which could jeopardize the financial well-being of the operation. Farmers who are planning to convert their livestock operation should consider certifying their fields first. This allows time to learn more about organic livestock management requirements while, at the same time, starting to produce organic feeds.

Although organic certifiers generally want to see the entire farm become organic, certifiers generally allow new entrants several years of transition time before the whole farm is fully certified.

Parallel production is the simultaneous production, processing or handling of organic and nonorganic crops, livestock and other products of a similar nature. Although this type of activity is highly discouraged by certifiers, some allow it, especially during the transition period. If permitted to practice parallel production, producers must be prepared to deal with significant record keeping in order to ensure traceability and organic integrity.

D) Understand your soils and ways to improve them

Since soil is the heart of the organic farming system, it is crucial that new entrants understand the various characteristics and limitations of the soils found on their farm. Soil suitability may vary significantly from one field to the next. Fields with good drainage, good level of fertility and organic matter, adequate pH, biological health, high legume content, and with less weed and pest pressure, are excellent assets. Often these fields are the first ones ready for transition and certification.

Many tools exist to assess soils. Soil chemical, physical and biological analyses, soil survey and legume composition field assessments, and field yield histories are very important and should be considered early in the transition. Unhealthy soils require particular attention.

If farmers plan to grow crops without raising any livestock, it may be necessary for them to source allowable soil amendments such as composted manure, limestone, rock dust, and supplementary sources of nitrogen, phosphorus, potassium and micro-nutrients. Even with the best of crop rotations that include green manure crops like legumes (nitrogen fixing crops), transitional growers will be challenged if they want to obtain optimal yields without additional livestock manure, compost and/or other off-farm soil inputs. When these inputs are scarce or expensive, producers may benefit from integrating livestock on their farm.

Let’s not forget, under organic production, farmers must be able to recycle nutrients through proper nutrient management practices: recycling through good manure and compost utilization, crop rotations, cover crops (green manure, catch, and nitrogen fixing crops), and by reducing nutrient losses due to leaching, over-fertilization, as well as poor manure and compost management (storage, handling, and spreading).

E) Identify the crops or livestock suited for your situation

Before growing a crop or raising any livestock, consider the following: degree of difficulty to grow or raise the product organically, land and soil suitability, climate suitability, level of demand for the product, marketing challenges, capital required, current prices for conventional, transitional and organic products, and profitability over additional workload.

F) Design good crop rotations

Once the crops are chosen, carefully plan the crop rotation(s) and select the most suitable cover crops (green manure, winter cover crops, catch crops, smother crops, etc.). Crop rotations are extremely important management tools in organic farming. They can interrupt pest life cycles, suppress weeds, provide and recycle fertility, and improve soil structure and tilth. Some rotational crops may also be cash crops, generating supplemental income.

On some farms, land base availability may be a limiting factor when planning your crop rotations. The transitional plan should, therefore, include crop rotation strategies. Responding to external forces such as new market opportunities may also have a significant impact on crop rotations, so farmers need to consider the effect that growing new crops has on their crop rotations and land base availability.

G) Identify pest challenges and methods of control

It is important to know the crop’s most common pests, their life cycles and adequate control measures. For instance, Colorado potato beetle may be a pest of significant importance when growing potatoes; cucumber beetles in cucurbitaceous crops (cucumber, squash, and melons); flea beetle in many seedlings crops; clipper weevil and Tarnish Plant Bug in strawberry crops.

There are several measures available to reduce pest pressure: crop rotation, variety selection, sanitation, floating row covers, catch crops, flamers, introduction of beneficial insects, bio pesticides, and inorganic pesticides. Transitional growers should be prepared to use and experiment with some of these options. When considering a new type of production, discuss pest issues with your agrologists, IPM specialists and/or other existing organic producers to optimize your chances of success.

Availability of organic supplies has improved significantly over the past few years. New pest control products containing B.t., spinosad, kaolin clay are effective and currently available to organic growers. It is often reported that the types of weeds found on the farm evolve with time as growers change the way they grow their crops and control their weeds. By keeping track of the weed population, growers will be able to refine their crop rotations and improve their control measures.

Under organic livestock management, cattlemen must provide attentive care that promotes health and meets the behavioral needs of various types of livestock. With good herd health practices, farmers rarely need to rely on conventional medicine. Organic cattlemen should, however, try to familiarize themselves with alternative remedies such as herbal/aroma therapies, homeopathy, and immune system promoters.

H) Be ready to conduct your own on-farm trials

Successful organic farmers continuously try new and/or innovative management practices. Practices such as cover cropping, inter-planting, and use of various soil and pest control materials need to be evaluated regularly by organic farmers. Be prepared to try new approaches.

I) Be ready to keep good records

Record keeping is one of the most important requirements to maintain organic integrity. Farmers are expected to keep detailed production, processing and marketing information. This information includes everything that enters and exits the farm. Third party, independent inspectors require farmers to present the above mentioned documentation when inspecting the farm operation. Once the record-keeping requirements are understood and the reporting procedure established, paperwork becomes routine.

J) Avoid these common mistakes

- Underestimating the need for good transitional and marketing plans.
- Underestimating the need to fully understand the Organic Standard. Organic producers must understand the standard in order to know what is permitted and prohibited.
- Failing to think prevention. Transitional farmers should consider improving their crop rotation, soil and crop management skills, livestock management practices (feeding program, heard health program, grazing system, housing facilities, and husbandry).

Particulars	Conventional farming	Organic farming
Application of compost / FYM	√	√
Judicious application of inorganic fertilizers	√	×
Biofertilizers	√	√
Pesticide applications	√	×
Fungicide applications	√	×

<u>Components of organic farming:</u> Thus, organic agriculture is comparatively free from the complex problems identified with modern agriculture. It is basically a farming system, devoid of chemical inputs, in which the biological potential of the soil and the underground water resources are conserved and protected from the natural and human induced degradation or depletion by adopting suitable cropping models including agro-forestry and methods of organic replenishment, besides natural and biological means of pest and disease management, by which both the soil life and beneficial interactions are also stimulated and sustained so that the system achieves self-regulation and stability as well as capacity to produce agricultural outputs at levels which are profitable, enduring over time and consistent with the carrying capacity of the managed agro-ecosystem.

Crop production and health in organic farming systems is attained through a combination of structural factors and tactical management components to ensure products of sufficient quality and quantity for human and livestock consumption.

1. **<u>Diverse crop rotations</u>**: Crop diversification can deliver many agronomic and ecological benefits simultaneously, while maintaining or enhancing the scale and efficiency of production. Benefits of diverse crop rotations include yield stability, reduction in disease incidence & severity, reduced pest incidence, improved weed control, reduced soil erosion, recycling of nutrient reserves, transfer or nitrogen from nitrogen fixing species, structural improvement etc. There are many different forms of crop diversification viz., rotational cropping, sequential cropping, intercropping, multistoried cropping system etc., and in practice these can be combined within the farming system. Crop and variety choice and their spatial and temporal design are critical in ensuring an effective rotation. The inclusion of crops, which are able to fix atmospheric through symbiotic relationship with N-fixing bacteria that modulate on crop roots, enables organic farming systems to be self-sufficient in nitrogen.
2. **<u>Soil fertility management:</u>** The aim of nutrient or soil fertility management within organic farming systems is to work, as far as possible, with in a closed system .Organic farming aims to manage soil fertility through use of organic manures (FYM & farm compost, vermicompost), recycling of crop residues such as straw, plant residues, grasses etc., dung and urine from domesticated animals and wastes from slaughter houses, human excreta & sewage, biomass of weeds, organic wastes from fruit and vegetable production & processing units and household wastes, sugarcane trash, oil cakes, press mud and fly ash from thermal power plant. Biological nitrogen fixation through blue green algae, azolla for rice, rhizobium for legumes, azotobacter & azospirillum for other crops, green manuring & green-leaf manuring, manure form biogas plants, legumes in crop rotations & intercropping systems.
3. **<u>Weed control:</u>** Organic farmers often identify weeds as their key problem. Within organic systems an integrated approach to weed control using a combination of cultural and direct techniques is necessary. Appropriate soil cultivation viz., deep

ploughing in summer, harrowing, inter-cultivation using mechanical hoes and harrows, and the timing of field operations and good crop establishment are vital for successful control of weeds. Mulching the soil surface can physically suppress weed seedling emergence. Soil solarization, to heat field soil under plastic sheeting to temperatures high enough to kill weed seeds (>65 o C) can also be used for weed, control in some parts of India. Good seedbed preparation, timely sowing, line sowing, crop rotation, smoother crops & intercropping systems etc., suppress the weed growth and favour normal growth and development of crops in organic systems.

4. **Natural pest and disease control:** One of the important features of organic farming is the exclusion of plant protection chemicals for pest and disease control. The system relies on the on-farm diversity, improved health of the soil and crops, protective influence of beneficial soil organisms against soil borne pathogens and use of plant-based insecticides and biological control measures. The population of naturally occurring beneficial insects and other organisms which act as bio control agents multiplies making natural control of pests possible when the system is free from the indiscriminate use of chemicals.

Few examples are:

a) Manipulation of crop rotations, to minimize survival of crop- specific pests (in the form of, for example insect eggs, fungi) which can infest the next crop

b) Strip cropping, to moderate spreading of pests over large areas

c) Manipulation of the moisture level or pH level of the soil (in irrigated areas)

d) Manipulation of planting dates, to plant at a time most optimal for the crop, or least beneficial for the pest

e) Adjustment of seeding rate, to achieve an optimal density given the need to check weeds or avoid insects

f) Use of appropriate plant varieties for local conditions

g) Biological control methods, to encourage natural enemies of pests by providing habitat or by breeding and releasing them in areas where they are required.

- Bacillus thuringensis against caterpillars of Heliothis, Earias, Spodoptera etc
- Pseudomonas fluoroscenes against Pythium spp., Rhizoctonia spp., Fusarium spp.
- Nematodes like Green commandoes and Soil commandoes against caterpillars & grubs
- Nuclear Polyhedrosis virus (NPV) against caterpillars
- Trichoderma virdi against many common diseases of vegetables and spices
- Weevils Neochitina eichorniae & N. bruchi against water hyacinth
- Beetle Zygogramma biocolorata against parthenium

h) Trapping insects, possibly with the use of lures such as pheromones

i) Use of domesticated birds

j) Biological pesticides (for example neem oil, nicotine) of which the active ingredient is short-lasting, and which may be produced locally

Organic Farming Vs Conventional Farming

Organic and conventional agriculture belonged to two different paradigms. The fundamental difference between the two competing agricultural paradigms as follows

Conventional Farming	Organic Farming
Centralization	Decentralization
Dependence	Independence
Competition	Community
Domination of Nature	Harmony with Nature
Specialisation	Diversity
Exploitation	Restraint

In contrast, several agro-ecologically based researchers stress more the fluid transition between conventional, integrated and organic farming, as an outcome of different assessments of economic, ecological and social goals. Consequently, technique strategies such as integrated pest management of balanced nutrient supply might improve conventional agriculture to such as an extent that it may appear unnecessary to strictly ban pesticides and mineral fertilizers as required by organic standards.

However, there is scientific that organic agriculture differs from conventional agriculture not only gradually but fundamentally. Implementing organic methods consequently seems to provide a new quality in how the agro-ecosystem works. This functioning cannot be explained by summing up single ecological measures. Organic farming seems to improve soil fertility in a way and to an extent which cannot be achieved by conventional farming even if the later consistently respects some ecologically principles.

Organic agriculture is one of several to sustainable agriculture and many of the techniques used (e.g., inter-cropping, rotation of crops, double digging, mulching, integration of crops and livestock) are practiced under various agricultural systems. What makes organic agriculture unique, as regulated under various laws and certification programmes, is that:

1) almost all synthetic inputs are prohibited and 2) Soil building crop rotations are mandated.

The basic rules of organic production are that natural inputs are approved and synthetic inputs are prohibited, but there are exceptions in both cases.

Certain natural inputs determined by the various certification programmes to be harmful to human health or the environment are prohibited (e.g., arsenic). As well, certain synthetic inputs determined to be essential and consistent with organic farming philosophy, are allowed (e.g. insect pheromones). Lists of specific approved synthetic inputs and prohibited natural inputs are maintained by all the certification programmes and such a list is under negotiation in codex. Many certification programmes require additional environmental protection measures in adoption to these two requirements. While many farmers in the developing world do not use synthetic inputs, this alone is not sufficient to classify their operations as organic.

Vermicompost

Scope

It has been estimated that organic resources available in the country alone can produce not less than 20 million tonnes of plant nutrients (NPK). Vermicompost technology has promising potential to meet the organic manure requirement in both irrigated and rainfed areas. It has tremendous prospects in converting agro-wastes and city garbage into valuable agricultural input. Thus, various economic uses can be obtained from organic wastes and garbage and prevent pollution. From vermiculture, we get well decomposed worm casts, which can be used as manure for crops, vegetables, flowers, gardens, etc. In this process, earthworms also get multiplied and the excess worms can be converted into vermiprotein which can be utilised as feed for poultry, fish, etc. Vermi-wash can also be used as spray on crops

Feed ingredients

Cow dung and agro wastes in the ratio of 1:1 to 1:3 may be mixed and allowed to predecompose for about 2 weeks in a separate tank adjacent to the vermicompost tank, before being fed to the earthworms.

Cow dung and agro waste in 1:1 ratio

Cow dung and agro waste 1:3 ratio

Process

Ideal tank size for small scale vermicompost production is 10' x 6' x 2.5' (150 cu.ft.)

↓

Create adequate no. of holes (about 8 holes of 5 cm. diameter at the bottom) to facilitate drainage of excess water

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Bedding comprise of broken bricks, stone pieces, saw dust, sand and soil

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Release earthworms in this bedding

Pour the feed mix over this bedding of earthworms of about 15 to 20 cm thick

↓

Pre decomposed material need not be added in layers but its depth should not be more than 1.5 to 2 feet

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↓

Tank is covered with thatched roof to maintain the moisture of the tank feed (40% moisture should be maintained)

↓

Under sub optimal moisture conditions the earthworms have a tendency to move downwards towards the bed of the tank. When the moisture, temperature and organic matter are optimum, the size, weight and cocoon producing capacity of earthworm's increases.

Conversion: One kilogram of worms numbering about 600 to 1000 can convert 25 to 45 kg. of wet waste per week. The compost recovery would be around 25 kg per week under well managed conditions.

Harvest

The total decomposition may take about 75 – 100 days depending on various factors. Therefore one tank may be used to 4 to 5 times in a year for vermicompost. A few days before the harvest watering of the tank are discontinued to allow migration of worms towards the bottom of the bed. The compost is then transferred outside without disturbing the bed and heaped on a plain open surface. The compost is sieved through a 3 mm mesh and then packed in gunnies.

Conventional sieve

Hand operated sieve: About 1700 kg of compost can be obtained from each cycle. While sieving the unhatched cocoons can also be retrieved. The excess worms can be retrieved and put in new tanks or sold or can be sun-dried to make vermin-protein. The cost of vermin-protein can be taken @ Rs. 5/kg. The compost should be sun-dried and then bagged for sale / use.

3 mm mesh sieve

Vermicompost

Methods of waste treatment by Earthworms

1. Solid waste materials may be spread out over the soil surface, usually on pastures. But sometimes on crops or in forests. To be incorporated directly into the soil – earthworms are important contributors to the burial and decomposition of the waste materials.
2. Wastes may be stacked into heaps or placed in bins, where they are treated like compost heaps-earthworm activity results in the production of large quantities of earthworm casts, which are widely sold as manure.

The second method is easy and is widely practiced in our country.
Vermi Compost tanks – size 20' x 3 ¼' x 2'

Constraints of organic farming:

1. Heavy metal content of urban compost
2. Lack of quality assurance of organic inputs and non-availability of standards
3. Limited availability of sufficient quantity of locally available inputs like FYM, Compost and vermicompost.
4. Limited domestic market and lack of commodity wise market information on domestic global demand and supply.
5. Non availability of organic package of practice for all crops based on locally available inputs.
6. Non awareness of farmers and NGO'S on the impact of organic farming.
7. Regulatory mechanism in this regard.
8. Risk of low production in initial years of organic farming
9. Slow release of nutrient from organic sources which is not matching the nutritional demand of high yielding varieties.

Is Organic Food Better in Quality?

The USDA and FDA clearly mention that organic food is not superior to conventional food in any respect. It also mentions that conventional food is as healthy as organic food. There are no additional nutrients in organic food and they also taste, look and smell exactly same as conventional food products. What do Proponents of the Organic Movement Say? Recently, the food we consume has increased amounts of chemical residues due to increased use of harmful chemical fertilizers, pesticides and insecticides in farming. Consume a few millilitres of these chemicals by mistake and you are sure to be hospitalized immediately. However, usage of these chemicals is not limited to farming. Post-harvest processing of agricultural produce also involves usage of chemicals - in the form of preservative. All these chemical fertilizers, insecticides, pesticides and preservatives enter our body daily through the food we eat and get accumulated over a period of time making our body an abode for a number of diseases such as skin disorders, heart disease and even cancer. The World Health Organization provides more information on chemical risks in food. In addition to this, the genetically modified food has created a fear of hormonal and transgenic contamination. All this has called for a serious thought over our dependence on chemical farming. Organic Food is Better in Quality - Is It Proved? Though the claimed benefits of organic food have not been proved, people still believe them to be true. Organic food is considered to be far superior in quality than non-organic food items and hence has an ever-increasing demand. Research is being carried out throughout the world to prove/disprove these claims. Recently two different research teams from University of Aberdeen and Institute of Grassland and Environmental Research found that organic milk contains 71% more Omega 3 than conventional milk. Research conducted at the Danish Institute of Agricultural Sciences and the University of Newcastle has shown that organic milk contains 75% more beta carotene and 50% more Vitamin E than non-organic milk. These path-breaking research findings have firmed the belief of organic food consumers in their choice. So, if you prefer to have fewer chemicals in your food, or want something that is better for you and your family, or want something that is better for the environment, or prefer the taste and looks of organic, then ask or check if your purchase is certified organic. After all, you deserve to be assured that you are getting the best because that is what you pay for.

Health Benefits of Organic Food: The health benefits of organic food are more perceived than real. However, the public opinion that organic food is healthier than conventional food is quite strong and is the sole reason for about 30% growth in the organic food industry since the past 5-6 years. There is little scientific evidence to prove that organic food is better in quality than conventional food. Scientific research conducted so far on various organic food items have not been able to give strong signals about the superiority of organic food over non organic food. As a result, even the FDA and the USDA clearly mention that non organic food is as healthy as organic food. However, there are some scientific studies that have proved organic milk and organic tomatoes to be better than the non-organic ones. Organic Milk: Recent research conducted on organic milk has shown that it has more anti-oxidants, omega 3, CLA, and vitamins than non-organic milk. According to the researchers at the Danish Institute of Agricultural Research, University of Aberdeen, and the Institute of Grassland and Environmental Research, organic milk is healthier than non-organic milk as organic cows are pasture grazed which results in better quality milk. Organic Tomatoes: According to a 10 years study conducted by the University of California, Davis, organic tomatoes are produced in an environment that has lower nutrient supply as nitrogen-rich chemical fertilizers are not added. This leads to excessive formation of antioxidants such as quercetin (79% higher) and kaempferol (97% higher) in organic tomatoes. As we all know, antioxidants are good for health and help in reducing heart diseases. These studies have increased the hopes of numerous people who strongly believe that mankind should stop using chemical fertilizers and pesticides and shift to the more sustainable organic farming practices. There are many studies that prove that there is some pesticide and fertilizer contamination in non-organic food, and there are others which claim that organic food is not healthy (they contain harmful bacteria and viruses) because of non-usage of strong chemicals. However, none of these studies (showing chemical contamination or presence of bacteria/viruses) do not show any impact on health of individuals.

In general, organic food consumers, manufactures and farmers strongly believe in organic food having following benefits over non organic food:

- Better health: Since organic food is not prepared using chemical fertilizers and pesticides, it does not contain any traces of these strong chemicals and might not affect the human body.
- Better taste: People strongly believe that organic food tastes better than non-organic food. The prominent reason for this belief is that it is produced using organic means of production. Further organic food is often sold locally resulting in availability of fresh produce in the market.
- Environment safety: As harmful chemicals are not used in organic farming, there is minimal soil, air and water pollution; thus, ensuring a safe world for future generations to live in.
- Animal welfare: Animal welfare is an important aspect of producing organic milk, organic meat, organic poultry, and organic fish. People feel happy that the animals are not confined to a miserable caged life while eating organic animal products.

Organic Farming - a strategy for climate protection

Several the measures mentioned above are often referred to as “recommended management practices”. Any type of agriculture could use them, but Organic Agriculture is unique in the sense that it offers a strategy that systematically integrates most of them in a farming system. This strategy comprises compulsory standards superior in their impact on climate protection. It also comprises a well-functioning mechanism of inspection and certification that guarantees compliance of the organic principles and standards. The strictness of the system has made Organic Agriculture accountable and a generator for innovation.

As a conclusion, Organic Agriculture could contribute significantly to reduce GHG releases and to sequester carbon in soils and biomass. Secondly, there is sufficient evidence that Organic Agriculture is superior to mainstream agriculture. This is even more important as the capacity of Organic Agriculture to contribute to the mitigation of climate change can be considered as an ancillary benefit to its primary goal of sustainable land use. This primary goal is achieved by gains in soil productivity, consecutive food security, biodiversity conservation and many other benefits.

As opposed to the focus of conservation agriculture on a single technology, Organic Agriculture follows a site-specific and systematic approach that includes a comprehensive set of integrated technologies. Because of the inspection and certification systems required in Organic Agriculture, monitoring and evaluation of carbon sequestration is simplified and cost-effective in comparison to conventional agricultural practices.

Policymakers should recognize the potential of organic farming for GHG reduction and develop appropriate programs for using this potential. Such programs may look into the emission reduction potential, in the sequestration potential, in the possibility for organically grown biomass, or in combinations of all the aspects. This is as relevant in developed countries as in developing countries.

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