Handbook on Present Environmental Challenges: An Overview

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Published by
Book Rivers
WX6G+G77, Raj Vihar, Kalyanpur (West)
Lucknow, Uttar Pradesh 226022

2022

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Published By Book Rivers

Website: www.bookrivers.com

Email: publish@bookrivers.com

Mobile: +91-9695375469

Place: Lucknow

Year: 2022

MRP: 249/-INR

ISBN: 978-93-5515-086-8

Printed In India

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Preface

This book highlights the present environmental tribulation throughout the world and the management process to prevent degradation. The chapters deal with the various sources of degradation methods of our mother nature. It also encompasses issues related to the methods which can be adopted in a bigger way to resolve the crisis. The book unites the global concepts and illustrates an organized orientation towards a comprehensive understanding of the subject matter. This book would be helpful to the students, engineers, scientists, researchers and professionals who are involved in this area of science.

After several months of exhaustive efforts, this book is the final result of all the researchers who devoted their time for the publication of this handbook. It will definitely be a source for enhancing the latest knowledge in this area.

This book would not have been possible without the continuous effort of the contributors for such eloquent chapters and the publisher. I extend my sincere thanks to them.

Editor

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Illegal, Unreported and Unregulated Fishing and Environmental Crisis

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Overview

Nowadays, the world's fish stocks are not only under threat from intensive legal fishing activities; they are also in danger from illegal, unreported and unregulated (IUU) fishing. It is difficult to estimate precisely the entire catch from pirate fishing. Researchers are engaged in the painstaking process of collating data from various countries' fisheries control agencies, experts' estimates, trade figures and therefore, the findings of independent research expeditions to reach an approximate figure for the entire IUU catch. As this is often a black market, estimates are sure to be unreliable. Some experts put the annual figure at around 11 million tonnes; others suggest that it is going to be as high as 26 million tonnes – adequate to 14 or 33 per cent respectively of the world's total legal catch (fish and other marine fauna) in 2011. These catches are additional to the planet annual catch of fish and other marine fauna, currently 78.9 million tonnes.

Fig. 1 A chase at sea near South Korea: an entire fleet of illegal Chinese fishing vessels attempts to evade the South Korean Coast Guard
[https://worldoceanreview.com/en/wor-2/fisheries/illegal-fishing/]

For many years, insufficient steps were taken of IUU fishing in estimating the fish stocks. The legal catch quotas for a given maritime region cannot be determined correctly supported by the idea that less fish is being caught than is actually the case.

Experts then overestimate the dimensions of the stock and set the subsequent year's catch quotas too high, potentially entrenching and accelerating the over-exploitation of the stock. IUU fishing also increases the matter of overfishing because IUU vessels even operate in marine protected areas where a complete fishing ban has been imposed. It also pays little or no heed to fisheries management plans which are intended to conserve over-exploited or depleted stocks.

However, the most important reason why IUU fishing may be particularly a critical issue today is that a lot of fish stocks have already been over-exploited by legal fishing activities. IUU fishing, therefore, puts fish stocks under additional pressure.

What is IUU Fishing?

The Food and Agriculture Organization of the United Nations (FAO) defines three categories of IUU fishing:

A. Illegal fishing: It refers to fishing activities conducted by foreign vessels without any permission in waters under the jurisdiction of another state, or which contravene its fisheries law and regulations in another manner – for instance, by disregarding fishing times or the existence of the state's protected areas. Some IUU vessels operate in waters under the jurisdiction of West African states. As these countries generally cannot afford to determine effective fisheries control structures, the IUU vessels are able, in many cases, to work with impunity.

B. Unreported fishing: It refers to fishing activities which have not been reported, or are misreported, by the vessels to the relevant national authority- for instance, some vessels harvest more tonnage than they are entitled to catch under official fishing quotas. In 2006, several Spanish trawlers were inspected by the Norwegian Coast Guard near Svalbard (Spitsbergen). The trawlers were found to carry not only the reported catch of headed and gutted cod but also a complete of 600 tonnes of cod fillets which had not been reported to the Norwegian authorities. The Norwegian authorities subsequently imposed fines on the Spanish trawler company like 2 million euros.

C. Unregulated fishing: It refers to fishing activities in areas where there are not any applicable management measures to manage the catch; this is often case of South Atlantic. The term also applies to fishing for highly migratory species and certain species of shark, which is not regulated by a Regional Fisheries Management Organization (RFMO) and eventually, the term applies to fishing activities in high sea in violation of regulations established by the relevant RFMO. Although unregulated fishing is not actually illegal under the law of countries applicable to the high seas, it is nonetheless problematic. It leads to additional fish being caught over and above the utmost catches agreed by RFMO member states for his or her respective regions.

As a result, fully exploited stocks can easily become over-exploited. Furthermore, IUU fishermen often ignore the existence of marine protected areas established by the Regional Fisheries Management Organizations to support the recovery of over exploited stocks.

Why does IUU fishing exist?

From the fishermens' perspective, IUU fishing is very attractive as they pay no taxes or duties on these catches. An extra reason of why IUU fishing takes place on such an out-sized scale is that it can often be practised with impunity. This is often mainly the case within the body of water or exclusive economic zones of the nations which cannot afford to line up costly and sophisticated fishery control structures like those existing in Europe. The situation is particularly difficult within the developing countries. During a comprehensive analysis of IUU fishing worldwide, researchers conclude that IUU fishing is especially practiced in countries which exhibit typical symptoms of weak governance: large-scale corruption, ambivalent legislation, and a scarcity of will or capacity to enforce existing national legislation.

The Sub-Regional Fisheries Commission (SRFC), comprising of seven member states in West Africa (Cape Verde, Gambia, Guinea, Guinea-Bissau, Mauritania, Senegal and Sierra Leone), has produced an in-depth list of the varied causes of IUU fishing:

- There are insufficient and inadequately trained personnel within the relevant authorities.
- The authorities' motivation to take a position in relevant personnel is poor. Financially weak states set other priorities.
- Salaries are low, and are vessel owners are taking the advantage of this situation and make irregular payments to observers and fishery administrators to cover up their activities.
- The purchase, maintenance and operational costs of patrol boats and aircraft are very high. For effective control, sufficient time must be spent in ocean or air. However, in some states, although they are available, they are not operational because of logistic problems – lack of fuel, proper maintenance regime etc.

Where does IUU fishing take place?

The situation off the coast of West Africa is especially critical. Here, IUU fishing accounts for an estimated 40 per cent of fish caught – the biggest level worldwide. This is often a catastrophe for the region's already severely over-exploited fish stocks. Fishermen are confident of the fact that there will be no checking by fisheries control agencies or prosecution and some IUU vessels even fish directly off the coast – in some cases at a distance of only one kilometer from the shore. An identical situation exists in parts of the Pacific. Indonesian experts report that it is extremely difficult to trace the whereabouts of IUU vessels round the country's islands and archipelagos. The amount of the illegal catch here is correspondingly high, amounting to 1.5 million tonnes annually. The Arafura Sea that lies between Australia and Indonesia is additionally very severely affected. After West Africa, the Western Central Pacific is that the region with the very best rate of IUU fishing worldwide. Within the Western Pacific, IUU fishing accounts for 34 per cent of the entire catch.

A similar situation exists within the Northwest Pacific, especially within the West Bering Sea. Here, IUU fishing is especially practiced by China and Russia and amounts to 33 per cent of the catch. Figures for the Southwest Atlantic are unreliable, but experts estimate that IUU fishing here amounts to 32 per cent.

What basically catch is?

IUU fishing often targets high-value demersal species (i.e., those which live and prey on or near rock bottom of the sea) like cod, also as salmon, trout, lobster and prawns. It is mainly curious about species which are already over-exploited by legal fishing or which are subject to restrictions for fisheries management purposes. As these species can only be traded in small quantities, demand and costs are high – making this a lucrative business for IUU fishermen.

Impacts on nature:

A. Degradation of ecosystems

Overfishing can impact entire ecosystems. It can change the dimensions of fish remaining, also as how they reproduce and, therefore, the speed at which they mature. When

too many fishes are taken out of the ocean it creates an imbalance which will erode the food cycle and cause a loss of other important marine life, including vulnerable species like sea turtles and corals.

B. Decreasing food & economic security

Demand for fish continues to extend round the world, which means more businesses and jobs are hooked in to dwindling stocks. Fish ranks together of the foremost highly traded food commodities and fuels a $362 billion global industry many people in largely, developing coastal communities depend upon the fishing industry for his or her livelihood and half the world's population relies on fish as a serious source of protein. When fish disappear, so do jobs and coastal economies. High demand for seafood continues to drive over-exploitation and environmental degradation, exacerbating this circular problem.

C. Declining wildlife

Decades of destructive fishing has resulted within the precipitous decline of key fish stocks like bluefin tuna and Grand Banks cod, also as collateral impacts to other marine life. Many thousands of marine mammals, seabirds, and sea turtles are captured annually, alongside tonnes of many sharks. Many of those species are endangered and guarded, while some like the vaquita, Eastern Pacific leatherback, and Maui dolphin are on the brink of extinction.

Bycatch of vulnerable species

Fishermen sometimes catch and discard animals they are doing not want, cannot sell, or aren't allowed to stay. This is often collectively referred to as "bycatch". Bycatch are often fish, but also includes other animals like dolphins, whales, sea turtles, and seabirds that become hooked or entangled in tackle.

Unwanted catch is a problem both ecologically and economically. Animals that are discarded often die and cannot reproduce, impacting marine ecosystems. Bycatch can slow the rebuilding of overfished stocks, and place protected species like whales and sea turtles at further risk. Bycatch of species like corals and sponges can cause damage to protected corals and to big fish habitat.

Discards

Many marine animals that are caught unintentionally by fisheries lack economic value, they'll be too small to sell legally or are unpopular commercial species. These animals are sorted from the profitable catch and discarded back to the water, often dead or injured. While the populations of those bycatch species might not be threatened, the amount of individual animals unintentionally killed are often large in some fisheries and this impacts on the marine food cycle. Discarding also can occur when fishermen have filled their catch allowance (quota) for a specific species.

Ghost fishing

Fishing gear lost within the water or left behind by fishermen can kill considerable numbers of marine animals. Modern synthetic material does not biodegrade and kit lost, discarded or unchecked by fishermen can still catch fish, sharks and other animals indefinitely. Though now banned, drift netting on the high seas continues illegally and ghost fishing from these nets may be a conservation concern. Impacted species and places are Albacore Tune, Arctic, Bigeye Tuna, Bluefin Tuna, Coastal East Africa, Coral Triangle, Gulf of California, Mesoamerican Reef, Skipjack Tuna, Southern Chile, The Galapagos, Tuna, Yellowfin Tuna, Eastern Pacific leatherback turtle and Maui dolphin

Fig. 2 Ghost nests: Silent killer

[https://fastcdn.impakter.com/wp-content/uploads/2017/10/1013106.jpg?strip=all&lossy=0&quality=90&sharp=1&ssl=1]

Problems faced in combating IUU fishing

Combating illegal, unreported and unregulated fishing is usually extremely expensive and really complex. Affluent countries like Norway can afford to enforce stringent controls within the waters under their jurisdiction and deploy an out-sized fleet of vessels and many excellent personnel for this purpose. An efficient and possibly less expensive alternative is to hold out rigorous checks in port. However, this only helps to curb IUU fishing if all ports cooperate.

In the European Union (EU), regulations effective since 2008 and 2009 contain uniform provisions on the sort of controls to be administered in EU ports. Since then, it is become very difficult for IUU vessels to land their catches in EU ports.

Nonetheless, there are still ports in other regions where IUU fishermen can land their illegally caught fish with no repercussions. Here too, it is mainly the developing countries, with their absence of controls, which are particularly suitable for illegal transshipment. However, examples like the Spanish trawlers near Svalbard show that even fishermen from EU countries are not resistant to temptation which the prospect of a healthy profit may persuade them to fish illegally.

The problem is exacerbated by the very fact that not every IUU vessel must put into port so as to land its catch immediately. In many cases, especially off the coast of West Africa, the smaller fishing vessels load their catch onto larger refrigerated ships (known as reefers). During this transshipment, fishermen on board also are resupplied with food and fuel, enabling them to stay stumped for several months.

The Sub-Regional Fisheries Commission (SRFC) concludes that some IUU vessels off West Africa are operational three hundred and sixty-five days of the year, putting massive pressure on fish stocks. The refrigerated ships then bring ports in countries with lax controls, enabling them to land their catches unhindered. The practice of employing a flag of

convenience (FOC) also makes it easier to interact in IUU fishing activity rather than registering the ships within the shipping company's home state, IUU fishers operate their vessels under the flag of another state, like Belize, Liberia or Panama, with less stringent regulations or ineffective control over the operations of its flagged vessels.

By switching to a far off register of ships, restrictive employment legislation and wage provisions within the home country also can be circumvented, allowing the shipping companies to pay lower wages and social welfare contributions for his or her crews than if the vessel were registered in Germany, for instance. Furthermore, fisheries legislation in "flag-of-convenience" states is usually extremely lax. These countries rarely, if ever, inspect their vessels for illegal catches.

Monitoring of onboard working conditions is additionally inadequate, and conditions are correspondingly poor. The fishermen work for low wages on vessels whose standards of accommodation are spartan within the extreme, and which rarely suits the present safety standards applicable to merchant shipping under the International Convention for the security of Life stumped (SOLAS regulations). The Convention contains exact details of kit that has got to be available to make sure safety on board.

Combating IUU fishing

Today, IUU fishing may be a global problem, with vast amounts of fish being caught illegally. Nonetheless, the worst seems to be over. IUU fishing was at its peak within the mid 1990s. Since then, consistent with the FAO, it is declined in various maritime regions, partly thanks to more stringent government controls. In Mauritania, for instance, fisheries control structures are established with support from German development assistance, with ships now being tracked by a satellite-based vessel monitoring system (VMS).

Other countries are now more inclined to suit the relevant laws and agreements. Poland may be an exemplar for several years, Polish fishermen were constantly in breach of the EU's quotas for cod fisheries for the eastern Baltic, routinely catching much more fish than the entire allowable catch. This was tolerated by the Polish government of those days. With the change of state in November 2007, however, things changed, and Poland is now complying with the quotas.

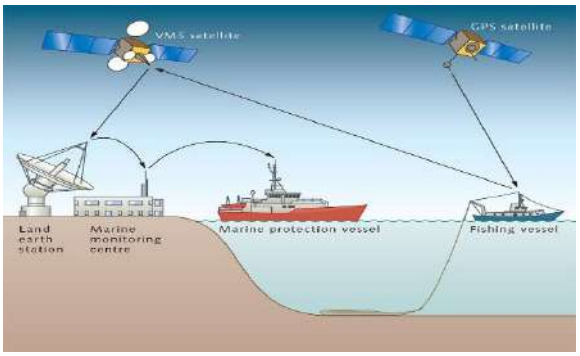
World increase is probably going to approach the demand for fish even further. IUU fishing will therefore still be a beautiful option, and may only be curbed with more stringent controls. Thereto end, controls and sanctions must be coordinated and consistently enforced at the international level. The FAO therefore adopted the Code of Conduct for Responsible Fisheries (CCRF) in 1995, which was endorsed by around 170 member states. Although, the CCRF is voluntary and non-binding, variety of nations, including Australia, Malaysia, Namibia, Norway and South Africa, have incorporated a number of its provisions into national law. Predictably, IUU fishing has decreased in these regions.

In order to stop landings of illegally caught fish within the EU, Council Regulation (EC) No 1005 on IUU fishing was adopted in 2008; this was followed by Council Regulation (EC) No 1224 establishing a community system for ensuring compliance with the principles of the common fisheries policy in 2009. These regulations describe in precise detail which vessels

may land fish within the EU, which specific documents they need to produce, and the way the catch is to be controlled. The aim is to stop IUU fishing EU-wide and shut any loopholes. The present procedure for landing catches in an EU port is therefore as follows:

A) Before the vessel lands its catch, it must provide reasonable advance notice.
B) Once the vessel has docked,

- The fishing license is checked. This includes the vessel's operating licence issued by the flag state and knowledge showing who is permitted to work the vessel.
- The fishing authorization is checked. This contains detailed information about the vessel's permitted fishing activity, including sorts of fish, times, locations and quantities.
- The catch certificate is checked. This contains information about the catch currently on board, including where and when it had been caught.
- The logbook in electronic format is checked. The master of the vessel must record on a day to day when and where the fish was caught, and during which quantities.



If a ship lacks any of the relevant documentation, it's not permitted to land its catch and must head instead for a port outside the EU. Permission to land the catch is additionally refused if there are any discrepancies between the figures given within the catch certificate and therefore the daily entries within the electronic

Fig. 3 Illegal fishing world ocean view

[https://worldoceanreview.com/en/wor-2/fisheries/illegal-fishing/] logbook. During this case, the fisheries control agency – in Germany (this is often the federal department for Agriculture and Food), may require vessel monitoring data to be produced. Nowadays, electronic devices, or "blue boxes", are installed on board fishing vessels and form a part of the satellite-based vessel monitoring system (VMS). The blue box regularly sends data about the situation of the vessel to the fisheries monitoring Centre (FMC) liable for the world where the vessel is currently fishing. If the vessel enters body of water or fishing grounds where it's not permitted to fish, the master of the vessel is often prosecuted.

Ways to prevent illegal fishing

A. Require fishing vessels to possess unique identification numbers:

As the most straightforward and effective initiative toward transparency in industrial fishing, every fishing boat weighing 100 gross tonnes or more should be required to possess a singular identifying number that stays with it from construction to scrapping and a tamper-proof, mandatory global tracking system.5 These will prevent vessels suspected of illegal fishing from having the ability to vary their identities or disappear, literally, off the radar. The

gold standard of unique vessel identifiers is that the International Maritime Organization, or IMO, number. These numbers, very similar to the serial numbers on cellphones, automobiles, and other products, are already required for cargo and passenger vessels that meet certain size requirements.

The lack of an identical requirement for fishing vessels may be a glaring oversight. Given the importance to police authorities worldwide of identification numbers to acknowledge and solve a variety of crimes, there is no credible counterargument to requiring IMO numbers on fishing vessels.

Requiring identification numbers and global tracking systems would offer stronger supply chain standards for the fishing industry at a time when demand for transparency and accountability in commodity has never been greater.

Achieving this is able to require working with central players within the fisheries industry—legitimate fishermen, vessel financers and insurers, fish buyers and retailers, regional fisheries management organizations, port authorities, and key governments—to encourage them to need IMO numbers and global tracking systems for all large vessels with which they are doing business.

While this process is happening, Pew is additionally working in selecting countries to make one, publicly accessible fishing boat data system , supported IMO numbers, that other countries can eventually take part order to determine a reliable, cost-effective "one-stop" global system for identifying vessels.

B. Increase port controls:

Ports known for lax enforcement or limited inspections are prime spots for IUU fishermen to maneuver their ill-gotten catch. One important step to seal this gap within the supply chain is that the Port State Measures Agreement. Adopted in 2009 by the U.N. Food and Agriculture Organization, or FAO, the treaty requires parties to exert greater port controls on foreign-flagged vessels and as a result keep IUU to find out of the world's markets, removing a number of the motivation for dishonest fishing operators to continue their illegal activities. The treaty will be effective once 25 parties have ratified it.

States enforcing the treaty would refuse entry or access to port services, including landing and shipment of fish, to foreign-flagged vessels known to possess engaged in IUU fishing. These vessels would be a subject to immediate inspection, with the results communicated to relevant states and organizations to assist enforcement efforts. As more ports exclude illegal catch, it might become costlier to urge those fish to plug, and harder for unscrupulous operators to form a profit.

Once in situ, the treaty would promote sustainable fishing, boost cost-effective fisheries management and enforcement, increase transparency and knowledge sharing among fisheries authorities, and help developing states improve IUU monitoring and enforcement.

C. Stronger enforcement against fisheries crime:

Many sorts of illegal fishing—such as fishing during a no-take marine reserve or catching and trading in endangered marine species—qualify as environmental crimes in some

countries, but not in others. This inconsistency limits the power of governments to enforce fisheries and conservation policies equally round the world. Illegal vessel operators have forged and altered licenses and other required documentation as a canopy to fish illegally. consistent with the United Nations Office on Drugs and Crime, or UNODC, illegal fishing is also linked to transnational gangland, including human trafficking (often for forced labor on fishing vessels), and drug and arms smuggling. UNODC notes that illegal fishers often commit other crimes, including evading taxes, bribing fisheries enforcement personnel, and hiding ill-gotten profits. The United Nations Commission on Crime Prevention and Criminal Justice in 2013 urged states to strengthen enforcement and increase international cooperation to combat transnational gangland committed stumped.

A big a part of stopping any transnational crime is to make sure that authorities, regardless of where they're within the world, can communicate and cooperate effectively with authorities elsewhere thereto end, Pew and therefore the Norwegian government have partnered with Interpol to determine Project Scale, an initiative which will leverage Interpol's 190 member countries to:

- Raise awareness about fisheries crime and its consequences.
- Establish national environmental security task forces to make sure cooperation on fisheries crime within and across borders.
- Assess the requirements of nations that are particularly susceptible to illegal fishing.
- Conduct operations to suppress criminal activity stumped and in port, to disrupt trafficking routes, and to make sure that national laws and policies are enforced.
- Increase surveillance to raised police fisheries crimes.
- Gather better data on fisheries crime to assist improve monitoring and enforcement.

Interpol will conduct targeted monitoring and enforcement operations with attention on vulnerable regions, including western and southeastern Africa. Working through each member country's National Central Bureau, Interpol will strengthen marine enforcement expertise and, ultimately, improve fisheries compliance and enforcement worldwide. The worldwide police organization has also developed a fisheries crime working party, which met for the primary time in February 2013. This group will help Interpol member countries enhance their ability to stop and answer fisheries crimes, with greater information sharing and analytic and operational support. With its global reach and extensive experience fighting environmental crime, Interpol is ideally positioned to be a major player within the worldwide fight against illegal fishing and other fisheries crimes. The organization is leading effective global operations that have helped reduce illegal logging, rhinoceros poaching, and therefore the ivory trade through better training of—and enforcement by—authorities policing those crimes.

Governments round the world can advance this goal by acknowledging the links between IUU fishing and transnational gangland, and by introducing legislation to acknowledge the foremost severe cases of illegal fishing as environmental crimes. Governments should also bolster fisheries and criminal laws with an eye fixed toward shutting down criminal activities related to IUU fishing.

Develop a worldwide fisheries enforcement system:

For years, a distant group of experts on illegal, unreported, and unregulated fishing, many working independently, has tracked vessels and spotted irregular vessel activity round the world. In many cases, those experts were ready to tip enforcement officials to possible IUU violations.

It is a time to bring structure and consistency to such investigative work and leverage it globally. Pew and its partners are establishing an independent fisheries analytical unit and knowledge clearinghouse, guided by a working party of experienced IUU fishing investigators.

The analytical unit will have an independent global capacity to systematically organize, assess, and use data from a good range of sources to tell enforcement authorities about suspicious vessels, allowing quick response to suspected criminality. The new unit will work closely with the Interpol fisheries crime program to make a comprehensive public-private hub for generating and sharing information and intelligence.

Targeting illegal fishing hot spots:

Illegal fishing may be a problem in every ocean, but it disproportionately affects coastal states with limited resources or ability to reply. Those countries need an enforcement model that permits them to require effective action without large long-term costs. FISH-i Africa is that model. it's been tested under real-world conditions and designed to be replicated globally in resource-poor regions.

Launched in December 2012, FISH-i Africa may be a Pew supported partnership among seven southeastern African nations—the Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, and Tanzania—to share information and coordinate responses to suspected illegal fishing in each other's waters. The Western Indian Ocean is one among the world's hot spots for IUU fishing. Regional governments, fisheries organizations, and nongovernmental bodies have demonstrated a robust commitment to tackle the matter. Within weeks of its launch, FISH-i Africa produced results, as several partner countries shared information that led to the denial of fishing licenses and port entries for the Premier, a South Korean-owned tuna vessel strongly suspected of IUU fishing off the Indian Ocean and Atlantic coasts of Africa.

As the project continues, Pew will encourage high-level political engagement among southeastern African states, develop data sharing and enforcement training, and work with the partner countries to implement common tools, including vessel databases and monitoring software to supply a more accurate picture of ocean activity which will help national enforcement agencies steel oneself against action against illegal vessels and aid in documenting any enforcement actions and resulting judicial penalties.

Putting new technology to work

In addition to automatic identification system transponders to trace the situation of vessels, Pew is assessing other available software and hardware that would cost-effectively increase efficiency and accuracy within the effort to curtail illegal fishing.

We have joined with several fisheries and maritime enforcement entities and personal companies to assess existing technology and ways to deploy it more dynamically and effectively to support rapid information exchange, tracking, and data analysis to interdict and successfully prosecute ship owners suspected of IUU fishing.

A focus is going to be on identifying technologies not currently utilized in the fisheries sector that would be adapted in these efforts, or specifically designed to be used by the analytical unit, Interpol, or both.

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Mining and Environmental Crisis

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Introduction

In our days, mining for resources is inevitable. The resources we normally like are valuable. These resources mined up are coal, copper, gold, silver, and sand. However, mining poses environmental risks which will degrade the standard of soil and water. This may affect us if proper care is not taken of and lots of of the damages are irreversible in nature [1]

Air pollution

Opencast mining operation creates enormous quantity of dust of varied sizes which passes into transportation and disperse significant amount of suspended particulate matters (SPM) and gaseous pollutants in to the atmosphere. These pollutants affect both the mine workers and the nearby populations, agricultural crops and livestock. Again, RSPM refers to particulate matter with diameter of less than or equal to 10 micrometres which have been produced from vehicles and industrial sources, combustion process. During the sector study it is been observe that RSPM and SPM is that the major source of emission from opencast granite mining in Jhansi. The minimum and maximum value of RSPM and SPM is 155µg

Fig. 1 Air pollution due to mining

Fig. 2 Water pollution by natural pollutants

M-3 to 234µg m-3; and 393µg m-3 to 541µg m-3 respectively. The extent of harmful affects depends largely on environmental condition prevailing within the region. Suspended particulate, depending on dimension, may cause (a) respiratory disease in animals and human thanks to inhalation of fine particles, (b) Ophthalmic disease, as particulates act as carrier of pathogens, (c) Lower agricultural yields thanks to obstruction of sunshine needed for photosynthesis by the dust cover on surface layer of plants, and (d) Poor visibility near crusher. Generally the SPM load altogether the sampling stations was quite larger than the RSPM concentration and this is often as per expectation [2, 3].

Water Pollution

Mining activities are known to affect both the surface and groundwater areas. The local

topography and drainage pattern may influence the severity of pollution. The most sources of liquid effluents in strip mining are: (a) De-watering of mine water, (b) Spent water from dust extraction and mud suppressing system and (c) escape from waste dumps. The water composition of the mine water primarily depends upon the host rock composition also because the mineralization process. Generally, sulphides containing minerals yield acidic mine water whereas in mineral bearing oxides, the pH of the water may go up to eight .0. pH of the mine water of the world was alkaline in nature (7.6-8.5) and conductivity varied between 372 and 1642 µS cm-1. The typical conductivity (1,009 µS cm-1) and TDS (839 mg l-1) values for mine water are higher as compared to the groundwater (864 µS cm-1 and 669 mg l-1) and surface water (411 µS cm-1 and 303 mg l-1). Thanks to excessive soil and other structural erosion the runoff water contains high amount of suspended solids. These decrease the penetration of sunshine in water bodies receiving the runoff water affecting the survival of living organisms. The leachate water are often extremely toxic containing heavy metals counting on the overburden composition and should pollute the bottom water.

Noise pollution

In open cast mining, blasting may be a common practice which produces high intensity of noise. Deafness starts from degeneration of neuro-sensorial cells of the internal ear. Besides, noisy working environment within the mining sites are known to result into communication impairments, task interference, sleep interference, change in personal behaviour, etc. of the mine workers. Additionally, noise produces other health effects, influences work performance and makes communications harder. Besides, the fauna within the forests and other areas.

Fig. 3 Noise sources **Fig. 4 Mining land degtrtadation** **Fig.5 Improper disposal of mine wastes**

Surrounding the mines and industrial complexes is additionally effected by noise and it is generally been believed that wildlife is more sensitive to noise and vibrations than the citizenry. The background level is relatively high within the active zones within the granite quarries thanks to drilling, blasting and therefore the mine service stations. It had been found to be within the range of 96 to 125 dB. These are much above the band of 75 dB prescribed by WHO for day time industrial areas (WHO 1980). Within the granite quarries the exposure for long periods to those high levels of noise is probably going to affect the ear diaphragms of the workers. Instantaneous loudness from blasting can reach 100 dB and vibrations are often felt to 2 km distant. At 10 metres, the noise from excavators, spreaders, conveyor belts and their driving stations all may attain 85-95 dB. Even at 1,000 metres noise sources of 75 dB create loudness levels as great as 49 dB (UNECE 1988).

Land degradation

Opencast mining excavates large land areas to extract the mineral ore and at an equivalent time requires huge areas to dump the mine spoils. During this course of action often lands under the duvet of forest or agriculture are diverted for mining. Some important impacts on the lands thanks to strip mining may be: (a) Change in topography leading to drastic change in drainage pattern and reduction in aesthetic value, (b) Slope stability problems triggering lands slides and rapid erosion, (c) Rapid siltation and degradation of surface water bodies and (d) Blanketing mine spoils within the nearby agricultural and grazing lands. A change of land use pattern in Gorama Chiya village has changed massively thanks to mining activities.

Improper disposal of mine wastes

Dumping of mine wastes without proper location will cause adverse impact on environment. This relies on the sort of mineral, the tactic of mining and nature of topography round the mines. Actually in course of mining materials, many minerals are extracted and mixed up. The remainder other than the desired one is disposed at mine site. The rejected materials could also be the overburden, inter burden, side burden, on the tailing rejected after benefaction. This material is physically, chemically and structurally unstable and is to be dumped on the adjoining acreage, increase be the deleterious impact susceptible to subsistence chemically also as hydrological unstable for plant growth because it carried for with water streams and degraded environment on the land in vicinity.

Loss of biodiversity

One major crisis of this day in Bundelkhand region is that the rapid loss of biodiversity. Large scale operations of mining activities have created directly or indirectly to the depletion of the biological diversity within the region. Vegetative covers are open up at various places to expedite excavation of ore, development of mining infrastructure and dumping of overburdens. Removal of vegetative cover is usually followed by massive erosion, siltation of river and reservoirs. The direct impacts on the living organisms within the mining areas may range from death of plants and animals thanks to mining activity or contact with toxic wastes and mine drainages, disturbance of wildlife habitat thanks to blasting and heavy machines. Indirect impacts may include changes in nutrient cycling, disruption of organic phenomenon and instability of ecosystem.

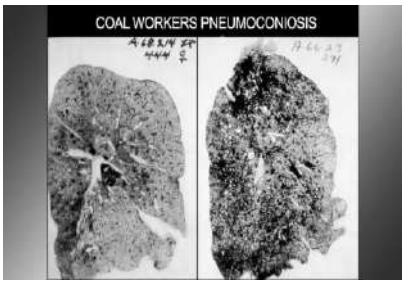

Fig.6 Loss of biodiversity **Fig.7 Pneumoconiosis** **Fig.8 Afforestation and reforestation**

Occupational Human Health Problems

Opencast mining is more severe for pollution problem as compared to underground mining. In active mining sites, miners are persistently exposed to large concentrations of dust, gaseous pollutants, high levels of noise and last but not the smallest amount accidents, which constantly pose a severe threat to miner's life. Health problems associated with skin and respiratory disease are widely prevalent within the area. Maximum of the respondents complain problems associated with skin and respiratory diseases. a complete of 108 respondents have skin problems which comprises of 74 men and 35 women. The digging, blasting and drilling of granite mine generated dust particles of varied sizes into the immediate atmosphere. Crystalline silica may be a common but variable component of granite. Most of this dust is typically made from silica (occurring as silica SiO_2). Because the mining is increasing, workers exploitation is additionally increasing. Workers face serious problems of their health, livelihoods, and minimum wages. The foremost prevalent occupational diseases among the mine workers in Bundelkhand are: (a) Hearing problems: Effect of heavy noise from use of heavy machineries and rock blasting cause auditory effect also as non-auditory effects in mine workers and surrounding people, (b) Auditory impact: Auditory effect of noise causes impairing of hearing, (c) Non-Auditory impacts: These sort of effect cause loss of working efficiency thanks to the physiological disorders like hypertension, disorder then on, (d) respiratory problems: Mineral dust particles originating from mining activities on inhalation by lungs and thereby causing variety of concerned problems like silicosis. These diseases are common in Goramachiya and Dagara village of Jhansi. (e) Eye problem: Dust particle from mining activities contribute to explanation for certain eye problem like conjunctivitis and kerato conjunctivitis and (f) Skin problem: Deposition of dust particles on skin interrupts U.V. radiation, which causes different skin diseases.

An environmental management plan (EMP) for sustainable mining activities

It is a known incontrovertible fact that most mining adversely impacts on the environment and India is not exception of it. Hence, it is mandatory to draft an environmental management plan (EMP) before commencing any environment related projects in India. Several countries have adopted different strategies for tackling pressing environmental problems within the industry. For effective implementation of an EMP, a mid-term corrective measure is important, like a time bound action plan, this includes a programmed for land reclamation, afforestation, mine water treatment, surface drainage and check dams, and sewage treatment. Development has environmental costs. Therefore, the role of the law is to ascertain how and where to soak up these costs to stay damages at a minimum. The responsibility to enhance environmental management

rests with the Project Officer of the project. As far as air, water, noise and soil pollution control measures are concerned; samples are collected and tested at strategic locations during all four seasons. The implementing authority is guided and advised as per the info received from the laboratories.

Objectives of the EMP

The main aim of Environmental Management Plan is to give warning to the the industrial development in an identified particular study area needs to be entangled with judicious utilization of non-renewable resources and to ensure that the stress or load on the ecosystem should be within its permissible assimilative capacity i.e. its carrying capacity. In above connection assimilative capacity refers to the maximum amount of pollution load that can be discharged into the environment without affecting the designated use of various environmental attributes and is governed by dilution, dispersion and removal due to physico-chemical and biological process. An effective EMP ensures that these environmental requirements and objectives are satisfied during all phases of project. The long-term objectives of the EMP for all the environmental attributes are as under:

- To comply with all the applicable laws and regulations stipulated by Central & State Pollution Control Boards.
- To offer good working environment (devoid of air and noise pollution) for the employees • To rationalize and streamline environmental activities to add value in efficiency and effectiveness
- To inspire and achieve highest performance and response from individual employees and contractors
- To make complete strategic plan for stakeholder engagement
- Proper budgeting and allocation of funds for environment management expenditure
- To encourage support and conduct developmental works for the purpose of achieving environment standards and to improve methods of environment management
- Continuous development and search for innovative technologies for a cleaner and better environment
- To contribute significantly for sustainable development
- To prepare a schedule for monitoring and compliance
- To establish a watchdog committee voluntarily with an ultimate aim to get ISO 14000 certification

Environmental impact assessment

Environmental Impact Assessment (EIA) is one among the proven management tools for integrating environmental concerns in development process and for improved deciding. As EIA and EMP are made statutory requirements for starting new mining ventures also as for existing mines, (at the time of renewal of mining plans) measures to stop environmental degradation became a topic of priority with the mine managements. Within the initial years, environmental clearance was only an administrative requirement. Since 1994, EIA and environmental clearance are made statutory for 30 categories of developmental activities within the sectors of industry, thermal power, mining, river-valley infrastructure and atomic power.

The minerals reserves within the Bundelkhand region are varied and large in quantities, it is

expected that the mining activities could also be intensified in future further deteriorating the environmental quality. Proper environmental impact assessment and a few times a socio-economic impact assessment should be administered. Baseline data should be effectively incorporated in management of the mining sites in Bundelkhand region. For proposed mining projects, it's necessary to deal with the potential environmental impact issues which will arise thanks to proposed mining activities i.e. an assessment of the potential impacts of a project on the pre-mining environment. The plans required for the EIA must be at appropriate scales to point out the extent of detail required for the actual project or aspect described. The economic process and development of the country depends not only on resource optimisation but also on environment management. This aspect of industrialization wasn't envisaged by planners within the past.

Afforestation and Reforestation

Afforestation practices help in restoring and enhancing the vegetative cover in mine areas in various ways where reforestation is the replantation of trees in deforested land [11-13]. For reclamation through Afforestation following inventories are the prerequisites like area to be planted, slope gradient, quality of soil, climate conditions and nature of biotic pressure. For plantation priority must tend to native species within the following order, mining sites, overburden sites and abandoned sites. Those species need to be selected having fast growing tendency to enable to maximum canopy briefly time also as hard woody and skill to repair direct atmospheric nitrogen. Both the processes can contribute to negative emissions since the growth of additional plant sequesters atmospheric CO_2 and naturally sink it in their biomass and in the soil [14-16]. Afforestation, reforestation and other forms of conservational forestry methods are often thought to be used for stopping the effects of climate change by reducing atmospheric carbon. The issue is which type of tree sequesters the most amount of carbon and does this have a positive or negative effect if any at all? The tree types that are widely discussed are old growth vs young-growth forests. Old growth forests are known to have massive carbon storage capabilities but their carbon capturing capacity are incredibly slow or they are unable to capture any more. With reforestation, this issue may be solved by cutting down old growth and planting young-growth trees. Unfortunately, when an old growth forest is cut down, a lot of the stored carbon gets released into the atmosphere thus preventing a net positive effect. Afforestation is being thought of as a solution to the reforestation issue. By planting a new young-growth forest in an area that has not previously had a forested, this could be a viable option for sequestering more carbon from the atmosphere. However, planting trees in an area previously unforested may have an impact on the original ecosystem negatively such as reducing soil moisture in an area and forcing many species to leave their preferred habitats [17].

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Solar Cell: The solution to the energy crisis

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Introduction

Energy is the capacity of doing work, so it is a basic need of life. The comfort devices require energy for their functioning. All the communication systems require energy. We need energy in the industries. Concisely, we can say that without energy we can't survive. Due to the excessive and unmanaged use of the energy from the conventional sources, energy crisis occurred. Increase of global population and overuse of energy from the non-renewable sources may also be the prime cause of this huge difference in supply and demand, resulted in this crisis. The solution of this crisis can be given by the renewable sources such as solar energy. Global climate change has necessitated for controlled emission of greenhouse gases in our environment, so solar energy can be better alternative of green energy with less investment. The solar panels have no moving parts and it requires less maintenance and can last for decades.

Solar energy is the most abundant energy source which can be stored and used using second most abundant material in the earth-silicon. The device used to convert solar energy in electrical energy through photo-voltaic effect is called as solar cell. Solar cell is originally a p-n junction diode whose electrical characteristics like current, potential difference, resistance varies with the exposure to light. Solar cells are combined to form modules which are called as solar panels. To generate large amount of solar energy, solar cells are combined together to form solar panel.

History

Nearly 100years ago solar energy was used to produce the steam for driving the machines. Solar energy got attention after the discovery of photovoltaic effect by Edmond Becquerel. World come to know the conversion of solar energy to electric energy. In 1883, Charles Fritts made the first solar cell by coating selenium with a thin layer of gold. In 1941, Ohl patented the first silicon solar cell. The efficiency of his solar cell was 1 percent. The actual photovoltaic era in U.S.A. started with the development of silicon photovoltaic cell by Chapin, Fuller and Pearson at Bell laboratories in 1954. The efficiency of this cell was 4 percent which was later enhanced to 11 percent after some modifications. The solar panel produced then was capable of driving the electrical equipment by conversion of Sun's energy into power. In 1957, Hoffman Electronics have achieved 8% efficient photovoltaic cells which was increased by the same company to 9% in 1958. The use of solar energy in space satellites using silicon PV cells started in 1958. The most remarkable turning point in use of solar cell was installation of a 242Watt solar cell array on a light house in Japan in 1963. Although NASA has started to use the solar cell array to power the spacecraft in 1964, but the most brilliant achievement was solar-powered aircraft – Pathfinder in 1998. The altitude achieved this aircraft was 80, 000feet, higher than any prop-driven aircraft till then. The largest rooftop solar power system was installed in U.S. in 2001 with the power generation capacity of 1.18MW.

Advancement

With the advancement in the technology and to achieve higher efficiency, solar cells are made with Perovskite, organic compound and quantum dot (a nanomaterial). To improve the efficiency of solar cell multijunction solar cells are manufactured now.

Construction of Solar Cell

The construction of solar cell is a little different than a p-n junction diode. On a relatively thick layer of p-type semiconductor, a thin layer of n-type semiconductor is grown. The upper layer of n type material is known as emitter layer and the lower layer of p-type material is known as base layer. The upper layer is made thinner so that the light can easily reach to the depletion region with less investment of energy to reach there. So, on a substrate at first a thick p-type layer is grown using suitable doping followed by the growing of thinner layer of n type material using doping. The surface is coated with anti-reflection coating to avoid the loss of light from the surface due to reflection. There is a finger like front electrical contact called busbar to bring the electrons reached in the n-side after their production due to falling of light in the depletion region. Similarly, there is back contact to bring the holes reached to the p-side after their production in depletion region.

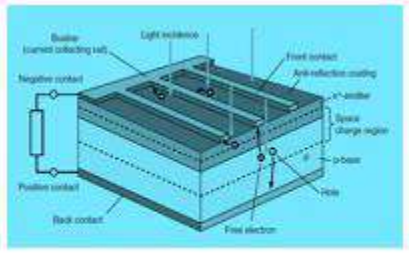

Fig. 1: construction of solar cell

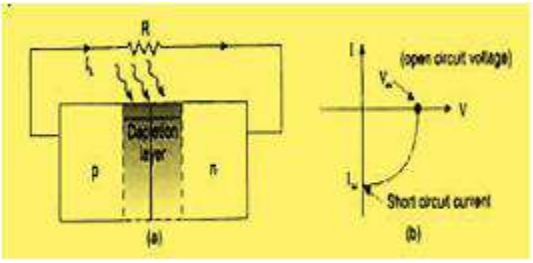

Fig: 2: Working of solar cell

Working of solar cell

When light of greater energy than the band gap is allowed to fall on solar cell, a number of electron-hole pairs are created due to the energy supplied at the junction by the photons. Actually, when the light interacts with the neutral silicon atoms at the junction, the electrons are knocked out from the atoms produces electron- hole pairs. The free electrons can come to n side and holes can come to p side quickly from the depletion region. Due to the potential barrier of the junction, the newly created holes reached to the p side and the newly created electrons reached to the n side from the depletion region and they cannot further cross the p-n junction.

Due to the higher concentration of electrons in n-side and the higher concentration of holes in p-side of the junction, this p-n junction will behave like a cell, so here biasing is not required due to the setting of potential difference due to light (photons). If a load is connected across the junction, there will be a current flowing through it.

Categories of solar cells

1. First generation solar cells 2.Second generation solar cells 3. Third generation solar cells

The first generation solar cells were wafer based mono and multi crystalline. The second generation solar cells are thin film cells and the third generation solar cells are dye sensitized, organic and quantum dot solar cells.

Classification of solar cell

Depending upon the cell architecture, either N-type or P-type doped silicon is used as the substrate of the cell. The majority of the manufacturers of both mono and multi-crystalline cells uses a P-type base that has a base of boron-doped silicon. Some of the manufacturers have started the use of N-type substrate.

Generally, solar cells can be classified on the basis of:

1. Thickness of active materials 2. Type of structure of the junction 3. Type of the active material used

On the basis of thickness of active material, the solar cells are of two types:

(a) Thick film solar cell (b) Thin film solar cell

On the basis of type of structure of the junction, the solar cells are classified in following four types:

(a) PN homojunction (b) PN heterojunction (c) Metal semiconductor junction (d) P-i-N junction

On the basis of type of active material used, the classification of solar cell is

(a) c-Si

(i) Single crystalline (ii) Multi crystalline

(b) a-Si (c) GaAs (d) CIGS (e) CdTe (f) Organic

(c)

Fig 3: Monocrystalline silicon cells

Fig 4: Polycrystalline silicon cells

Monocrystalline silicon cells are the cells which are made from a single silicon crystal. Thus the whole volume of the cell is a single crystal of silicon. The Monocrystalline silicon solar cells are used in space application, navigation, railway, astronomy, meteorology, agriculture and animal husbandry. The monocrystalline silicon cells are manufactured using Czochralski method.

Polycrystalline cells have many small grains of crystals. A cube-shaped ingot from molten silicon is casted, then sawn and packaged like monocrystalline cells. A thin ribbon of polycrystalline silicon from a mass of molten silicon is drawn in edge-defined film-fed growth (EFG) technology. Comparatively, the efficiency of Polycrystalline panel is lower than monocrystalline silicon solar panel. Polycrystalline panels have lower heat tolerance than monocrystalline solar panels.

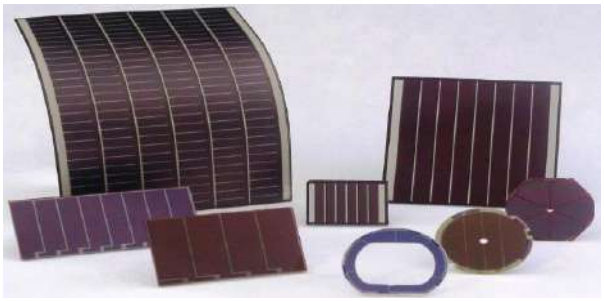

Fig 5: Amorphous silicon cells

Fig 6: Thin-film solar cells for power production

The efficiency of amorphous solar cell is higher than the efficiencies of monocrystalline and polycrystalline solar cells. The flexibility of this type of solar panel is high and they can be handled better at higher temperatures. They can perform better when the intensity of light is less due to their ability of absorbing a wider band of the visible light spectrum.

Some popular solar cells:

- Amorphous Silicon solar cell (a-Si), Biohybrid solar cell, Cadmium telluride solar cell (CdTe), Concentrated PV cell (CVP and HCVP), Copper indium gallium selenide solar cells (CI(G)S)
- Crystalline silicon solar cell (c-Si), Float-zone silicon, Dye-sensitized solar cell (DSSC), Gallium arsenide germanium solar cell (GaAs), Hybrid solar cell, Luminescent solar concentrator cell (LSC)
- Micromorph (tandem-cell using a-Si/μc-Si), Monocrystalline solar cell (mono-Si), Multi-junction solar cell (MJ), Nanocrystal solar cell, Organic solar cell (OPV), Perovskite solar cell, Photoelectrochemical cell (PEC), Plasmonic solar cell, Polycrystalline solar cell (multi-Si), Quantum dot solar cell
- Solid-state solar cell, Thin-film solar cell (TFSC), Wafer solar cell, or wafer-based solar cell crystalline, Non concentrated hetrogeneos PV cell

Solar modules are of three different types - monocrystalline, polycrystalline, and thin-film solar modules.

Crystalline silicon cells are produced using crystal lattice in which silicon atoms are connected to each other. For the more efficient conversion of light into electricity, this lattice provides the organized structure. Solar cells made up of silicon have low cost and long life time.

Thin-film solar cells are made by deposition of one or more thin layers of photovoltaic material on a supporting material like glass, plastic, or metal. CdTe(cadmium telluride) and CIGS(copper indium gallium diselenide) are two main types of semiconductor photo voltaic materials available in the market. These two can be deposited directly on any side-front or back of the module surface easily.

CIGS (copper indium gallium diselenide) suits for manufacturing of solar cell and their efficiency in the lab is also high, but the manufacturing CIGS is more critical which requires the combination of four elements. For operation of these two cells in outdoor more protection is essential than silicon solar cells.

Perovskite solar cell

Fig 7: Perovskite solar cells for power production

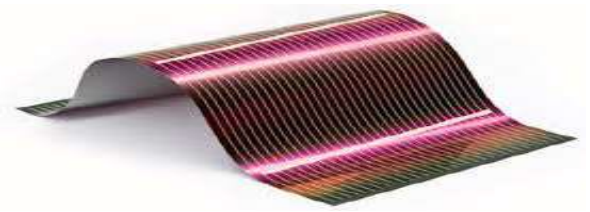

Fig 8: Organic Solar Cells

Perovskites are the materials which have a special type of crystal structure and they can offer high light absorption, charge-carrier mobilities and lifetimes. The Perovskite materials can be used for making low-cost and higher efficiency solar cell is due to all these reasons. The conversion efficiency of perovskite solar cell has increased significantly from 3% in 2006 to over 25% in 2020. There are some challenges for using perovskite as competitive commercial technology. Among the most challenging issues there is environmental compatibility and stability of the cell which requires permanent attention. Perovskite cells are manufactured with layers of materials which are printed, coated, or vacuum-deposited onto the substrate. Comparatively, it is easy to assemble the Perovskite cells and their efficiency can also increase with modifications. The efficiency of the cell has improved faster than any other photo voltaic material.

Organic solar cell

With the advancement in IOT (internet of things) technology, the organic solar has become more desirable for indoor applications. Its light weight, flexibility and color are the cause of increased demand. In indoor conditions, the power conversion efficiency is found over 20% with excellent stability. Organic photo voltaic cells are made of organic (carbon-rich) compounds. but it could be used for production of solar cell with low cost in bulk. Organic solar cell has less environmental impact.

Quantum dot solar cells

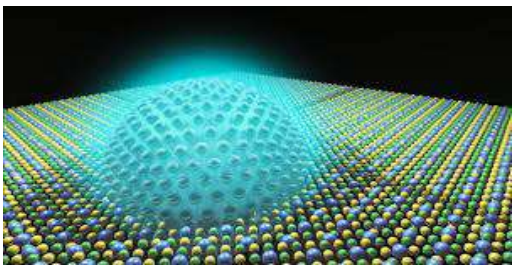

Fig 9: **Quantum dot solar cells**

Fig 10: Multijunction solar cells for space exploration

This is the third generation solar cell in which quantum dots (diameter range 2-10 billionth of a metre) are used. Quantum dots can increase the efficiency, possibly it can even double the efficiency in some devices—due to their ability to generate more than one bound electron-hole pair, or exciton, per incoming photon. Variation of size of the quantum dots make them suitable to respond to the different wavelengths of the light. NREL has shown that quantum-dot solar cells operating under concentrated sunlight can have maximum theoretical conversion efficiencies twice that achievable by conventional solar cells—up to 66%, compared to 31% for present-day first- and second-generation solar cells. The problem arises in connecting quantum dots electrically. For highly efficient quantum dot solar cell, the technology of splitting excitons produced by quantum dots and the collection of the resulting free electrons and holes with high efficiency have to learned. The beauty of quantum dots solar cell is that it can collect light which is difficult to capture and to

be paired with other semiconductor, perovskite or organic semiconductor by customizing their bandgap. About, half of the solar energy received by the Earth is in the infrared region. Conversion of infrared light energy to electrical energy using conventional solar cell is difficult. Lead sulfide colloidal quantum dots can make the conversion easier. The quantum dots solar cell reduces the wasteful heat and increases the efficiency of a solar cell. Quantum dots solar cell could convert more than 65 percent of the sun's energy into electricity. Rather than rooftops, they can be installed in window also as they require relatively less power.

Multijunction solar cell

For the improvement of solar cell efficiency layering of multiple semiconductors are done to make multijunction solar cells. These cells are stacks of different semiconductor materials. The maximum theoretical efficiency which a single-bandgap solar cell can achieve with non-concentrated sunlight is about 33.5% due to the broad range of solar emission. Whereas multijunction solar cells can achieve record efficiency. The light which can't be absorbed by the first semiconductor layer is captured by the layer below it. As, every layer has different bandgap, so each of them absorb different part of the solar spectrum, making maximum use of sunlight in comparison to single-junction cells. Multijunction devices have a high-bandgap top cell to absorb high-energy photons while allowing the lower-energy photons to pass through. A material with a slightly lower bandgap is placed below the high-bandgap junction to absorb photons with slightly less energy. Generally, multijunction cells uses two or more absorbing junctions and theoretically efficiency increases with the number of junctions. Multijunction solar have achieved the efficiencies higher than 47%. But they are reserved for space exploration, research and military uses because of their cost and difficulty in manufacturing. The multijunction solar cells made by combining the semiconductors from columns III and V in the periodic table are called multijunction III-V solar cells. This architecture can also be tested to other solar cell technologies. Multijunction cells made from CIGS, CdSe, silicon, organic molecules, and other materials are being investigated.

Efficiency of solar cell

Efficiency of the solar cell is defined as the ratio of electrical power generated by the cell to the amount of sunlight it receives. The amount of electrical power generated by a photovoltaic cell depends on the properties of the light available and multiple performance attributes of the cell. To obtain the efficiency, the cells are arranged into modules, which are in turn assembled into arrays. The resulting panels are then placed in front of a solar simulator which mimics ideal sunlight conditions: 1,000 watts (W) of light per cubic meter at an ambient temperature of 25°C, using all these we can calculate the electrical power generated and efficiency of the solar cell. The maximum theoretical efficiency of a PV cell is around 33%. This is referred to as the Shockley-Queisser limit.

Solar Panel

Solar panels or photo voltaic modules collect the sunlight and converts it into electricity. The power generated is used for electrical loads. In a solar panel several individual solar cells which are themselves composed of layers of silicon, phosphorous and boron are arranged. If there is requirement of power in an area where there is no supply from the electric utility grid, solar panels are better answer. A solar electric system is comparatively less expensive and can provide power for decades if properly maintained.

Applications of solar cell

Solar cells are used in Military power systems, Unmanned aerial vehicles, Satellites, Solar aircraft, Auxiliary power units for vehicles, Electric vehicle charging stations, PV distributed generation for smart grid systems, Building-integrated photovoltaics, Utility-scale PV power plants, Communications systems.

Advantages of Solar Cell

1. Pollution free 2. Long lasting 3. No maintenance cost.

Disadvantages of Solar Cell

1. Installation cost is high 2. Relatively less efficiency 3. On cloudy day, the energy cannot be produced.

Present advancement and Future research

Innovations for development of highly efficient and cost effective multijunction solar cell is going on. A thin interlayer of selenium as the bonding material between wafers is used for making a high-efficiency multi-junction solar cell at NASA. This innovation has disclosed a process of making multi-junction solar cell where lattice need not be matched. This innovation led a cell which is lower in cost, more rugged, and more efficient than existing space-based solar cells. For generation of power on earth, it can provide a very high efficiency for auxiliary power units in vehicles, solar roof tiles, power plants, and smart grid systems.

But, more research is required to harness the potential of Solar energy. America, China and other developed countries are increasing their target of production of solar power per year and they are investing huge in research and development of solar panels. Developing countries like India should also shift its dependence of power requirement from conventional sources to this highly potential renewable energy source, which is clean and green energy. Government of India should subsidies the initial cost of installation of solar panels to every Indian for a pollution free India along with that there must be substantial research grant on developing cost effective highly efficient solar cell.

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Rainwater harvesting: A boon for the environment

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Introduction

In today's world, water scarcity has become one of the major issues which might turn out to be a hazard if not dealt with in time. As the population is increasing with every passing day, the demand for good quality water is also increasing. Despite its abundance, less than a percent of the world's water is readily accessible for various human resources. (Pina et. al. 2009). The 2011 FAO study titled "The State of the World's Land and Water Resources for Food and Agriculture: Managing Systems at Risk" raises questions on availability of water, claiming that the demand of water has been increasing worldwide at a faster rate, thereby resulting in a variation between support and fulfilment of human requirements.

India was best known for its traditional water harvesting methods. However, many of the traditional water harvesting systems are nowadays not in use due to physical, social, economic, cultural and political factors. This resulted in the deterioration and decline of institutions which have nurtured the traditional water harvesting methods and even lost their relevance in the present context as they fail to meet the desires of the communities (Keskar et. al., 2016).

To face this challenge of water scarcity, one suggested solution is water harvesting practices, and more specifically Rain Water Harvesting (RWH). Rainwater harvesting is the process of collecting rain, filtering and using it for several purposes instead of allowing it to letting it overflow. This method is implemented using several pipes, canals, and even small barrels depending upon the economic condition of the area. The unfiltered water can be used for washing cars, laundering clothes as well as for gardening purposes. The filtered water can be used efficiently to recharge the groundwater and storing the excess water in tanks for domestic use. In most areas, Rainwater Harvesting system is economically cheaper compared to the various water conservation resources such as dams, wells, etc.

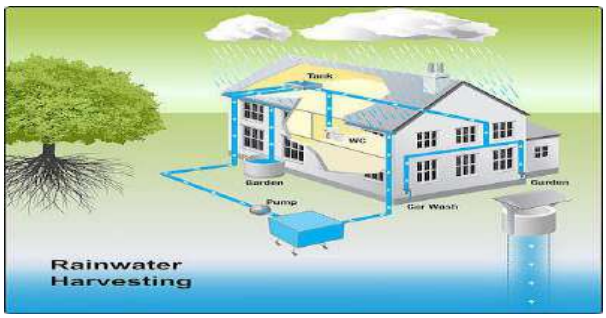


Fig. 1 Rainwater Harvesting

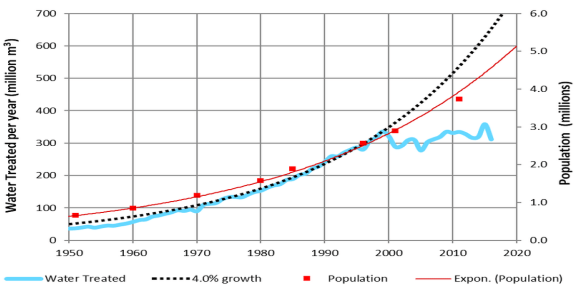


Fig. 2 Water Demand V/s Population Size

Factors leading to the increase in water demand

The average daily consumption per capita is used to calculate water use or demand (per person). For home and public purposes in India, the average is around 380 litres (100 gallons) per capita per day. There are several factors that lead to the increase in the demand of water. Some of these are as follows:

- There is no attention on prospective local supplies and the demand they must meet: local supply potential is low in most water-stressed locations, which is exacerbated by poor dependability, and demand far outstrips supply potential.
- The economic evaluation of RWH is complicated because to a lack of scientific data on inflows, runoff collection and storage efficiency, beneficiaries, the value of the added benefits created, and scale factors.
- There is a considerable 'trade-off' in many basins between maximising hydrological benefits and enhancing cost effectiveness.
- Many water-scarce basins have a large discrepancy in demand between upper and bottom catchments, thus there is a trade-off between maximising upstream water harvesting advantages and optimising basin-wide benefits.
- In many water-scarce basins, local water collecting divides rather than augments hydrological advantages.

Demographic changes

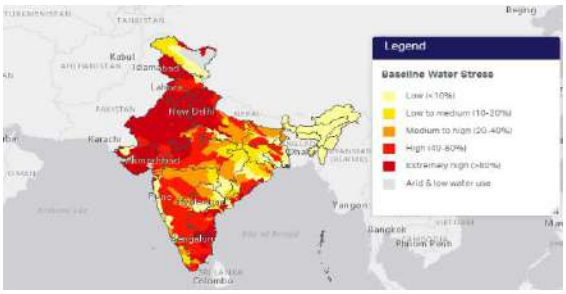
The demographic effects on the environment are caused by global population growth and the rapid growth of urban areas. Population growth is generally thought to be one of the most important factors threatening water sustainability. (Agarwal, et. al, 1997). This is reflected in the consumption of water and health of natural ecosystems both directly and indirectly.

Population size

In spite of this, the size of the population and how it changes are very influential factors in determining the amount of water we use and the impact of humans on freshwater ecosystems. The greatest impact of population growth on water resources is usually attributed to demographic trends.

Socioeconomic changes

All environmental, human, and social systems require water. It is an essential component of both life and development. It is an irreplaceable commodity and a basic resource for economic activity because of its important function in food and sanitation: agriculture and many other industrial and commercial operations require it as a raw material, and it also serves as a source of energy. Water shortage has economic consequences when the difficulty of acquiring water necessitates a change in consumption. (Gomez et. al., 2019). For example, copious snowmelt may be of little benefit to would-be farmers if they are unable to utilise it due to constraints (cost, institutional, etc.). Changes in yearly cropping patterns to conserve water are quicker to implement and have a lower economic impact than shutting down thermal power output during a lengthy drought. Water supply cutbacks in one place may raise demand for water in another, creating both physical scarcity and economic benefit in ways that are difficult to predict ex ante.



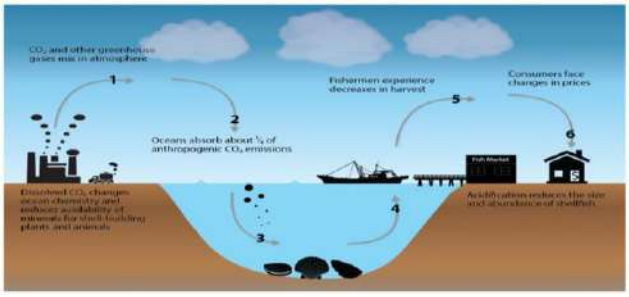


Fig. 3 Socioeconomic Changes in India Fig. 4 Ocean Acidification Impact Pathway for Shellfish

Changes in agricultural practices

Carbonate, a vital building ingredient of saltwater, is depleted as a result of ocean acidification. This makes it more difficult for marine animals to produce shells and skeletons, such as coral and certain plankton, and existing shells may disintegrate. (Dolan et. al., 2021). Different species are affected by ocean acidification in different ways. Higher CO2 concentrations in the water may benefit certain algae and seagrass by increasing their photosynthetic and growth rates. Other marine organisms, such as molluscs, corals, and some types of plankton, will be harmed by a more acidic environment. In reaction to ocean acidification, marine creatures may face changes in growth, development, abundance, and survival. (Boberg, 2005). In their early phases of life, most species appear to be more susceptible.

Rainwater harvesting: a boon for water storage

Water harvesting is the process of collecting rainfall directly from the sky. Rainwater can be collected and stored for immediate consumption or returned into the groundwater system. Rain is the first type of water in the hydrological cycle that humans are aware of, making it a key supply of water for humanity. (Mohammed et. al. 2006). Rivers, lakes, and groundwater are all examples of secondary water sources. In today's world, we rely solely on such supplementary water sources. Rain, the ultimate source that feeds all of these secondary sources, is neglected in the process, and its worth is underestimated. Understanding the value of rain and making the most use of it where it falls is what water harvesting entails.

Methods of rainwater harvesting

Rainwater Harvesting methods are of two types:

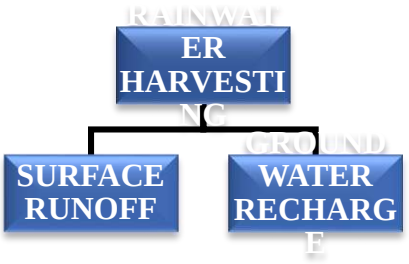
Surface runoff: Rainwater is collected as surface runoff and stored for later use in this approach. The flow of minor creeks and streams can be diverted into surface or subsurface reservoirs to store surface water. It can offer water for agriculture, animals, and ordinary household usage.

Groundwater recharge: Water travels downhill from surface water to groundwater during groundwater recharge. The most common way for water to enter an aquifer is through recharge. The aquifer also functions as a mechanism for water delivery. Using artificial recharge techniques, the excess precipitation may be utilised to recharge the groundwater aquifer. Despite the fact that rainwater collecting has become a popular notion in recent years, it is rarely used in rural India.

A case study: Bankura (West Bengal), center of rainwater harvesting

The research was conducted in Hirbandh, the westernmost block of Bankura district, which runs along the boundary with Purulia district. The region's average elevation ranges from 180 to

120 metres, with a gradient of 1:100. (Banerjee, 2012). Geographically, the location is located near the confluence of the Shilabati and Knagsabati rivers.



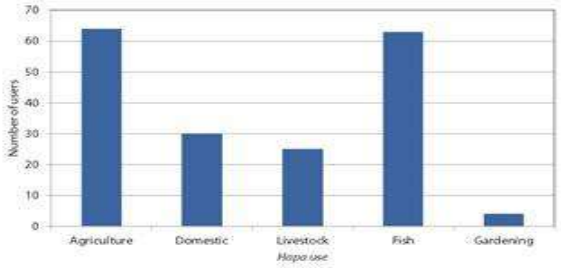


Fig. 5 Methods of Rainwater Harvesting **Fig. 6 Uses of Hapas**

A failure to emphasise local water demand and potential suppliers:

Ground water level depletion and fluoride intrusion in ground water have been documented throughout a large portion of the district. The district also has high iron concentrations in groundwater. The water demand is fulfilled by (i) a piped water supply scheme (PWSS) with a ground / subsurface water source, transmitted either directly or via an overhead tank (OHR), or (ii) spot sources (primarily hand pumps and shallow tube wells). According to the PHED project report, 29 of the 283 habitations in Bankura have been covered with PWSS, while the remaining 264 are still unconnected.

Table 1: Habitations Covered under Piped Water Supply Scheme

Name Of The Block	Total Habitations	Habitations Covered Under Piped Water Supply Scheme, Based On			Habitations Under Piped Water Supply Scheme	Percentage Of Total Habitations Connected To Piped Water Supply
		Surface Source	Sub-Surface Source	Ground Water		
Indpur	283	-	18	11	29	10

The reasons for water scarcity in Bankura:

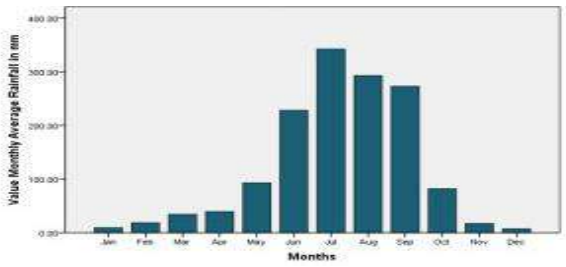
Water shortage has a long history in Bankura. Every summer, ladies in Bankura village begin to wander around the village streets with earthen pots and pitchers in search of water. Bankura's water constraint is caused mostly by a number of issues. Due to significant population increase, the gap between demand and supply of water has recently widened. Bankura is experiencing both physical and economic water shortage. Physical water shortage refers to insufficient water resources to fulfil a country's or region's demand, including the water required for ecosystems to function successfully (UNDP, 2006). Physical water shortage is common in arid climates. Economic water scarcity is caused by a lack of investment in infrastructure or technology to extract water from rivers, aquifers, or other water sources, as well as a lack of human ability to meet demand for water. Water scarcity impacts every continent and four out of every ten people on the planet. Due to population expansion, urbanisation, and increased home and industrial water demand, the situation is deteriorating. People are forced to rely on dangerous sources of drinking water due to a lack of water. The country's per capita fresh water availability has decreased from an acceptable level of 5,180 m^3 in 1951 to 1,820 m^3 in 2001, and it is expected to fall to 1,340 m^3

by 2025 and 1,140 m^3 by 2050. (Paramasivan et al., 2010). The significant water scarcity in Bankura district can be attributed to a variety of factors. It might be natural or man-made. All of the variables are active at different scales.

Month-by-month rainfall distribution

Rainfall data analysis confirms the monsoonal rain's concentric structure. IMD's daily rainfall data for the past 35 years (1969-1991; 1995-1996; 2006-2011) reveals that the monsoon months of June to September receive roughly 79 percent of the rain. As pre- and post-monsoon rain, a moderate quantity of rain is obtained in May (92mm) and October (81mm). A relatively small quantity of rain falls throughout the six-month dry period

(November-April) (Fig. 7). Water shortage is mostly caused by this seasonal concentration. Understanding the distribution of rain throughout wet and dry seasons is critical (Linsey et al.1982). The wet season is defined as the months of June through October. According to the data, this five-month period receives the majority of the yearly rain (between 70 and 91 percent). Again, 16.44% of yearly rainfall is concentrated in a single storm that



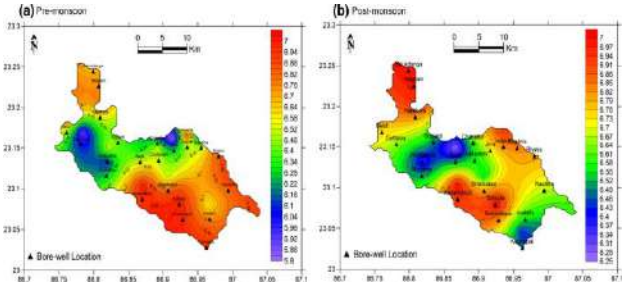


Fig. 7 The Average Monthly Rainfall Distribution **Fig. 8 Fluctuation of Water Levels During Pre-Monsoon and Post-Monsoon**

lasts an average of 7-8 days. During a prolonged dry period of seven months, just a little quantity of rain falls, maybe as little as 9% of the yearly total (in 1984).

Fluctuation of water levels

The water level in Bankura-I block drops from 1 m to 2 m during the pre-monsoon and, to certain extents, maintains the post-monsoon level. During the pre-monsoon season, the average water level is 6.20 metres. And after the monsoon, it's 4.50 m. The fall in water level in Bankura-II is 6 m during pre-monsoon and 4.65 m during post-monsoon. The average water level is 7.26 m during peak summer and 5.15 m during post-monsoon. The situation in Saltora block is the same as before. During peak summer, the water level drops up to 2.5 m to 3 m, then rises to 1 m during the post-monsoon. During peak summer, the average water level is 6.65 metres, while during post-monsoon, it is 4.80 metres. Water levels drop up to 2 metres in peak summer at Mejia and Gangajalghati, Indpur, Khatra, and Ranibandh, and rise up to 1 metre during the rainy season. The reason for this is because due of the hard rock disposition, there is less infiltration. The average pre-monsoon water level is 8.20 metres, whereas the average post-monsoon water level is 5.50 metres. The water level at Barjora Block is rather excellent. The average water level over the previous five years has been 5.95 m in the summer and 4.25 m in the post-monsoon. The water level in Sonamukhi Block is 1.82 m (average) during the pre-monsoon season and 1.48 m during

the post-monsoon period. The water level has been relatively constant. Similarly, Bishnupur, Onda, Simlapal, Taldangra, and a portion of Raipur have rather excellent water levels. During peak summer, the water level drops by just 0.5 m to 1 m, then rises by 1 m during the post-monsoon period. The average water level in Patrasayer block during peak summer is 3.99 metres, and during post-monsoon 2.80 metres. The average in pre-monsoon time is 3.10 metres, while in post-monsoon season is 2.45 metres.

How much water is harvested?

The rainwater endowment of an area refers to the entire quantity of water obtained in the form of rainfall over a certain region. The amount of water that can be efficiently gathered is referred to as the water harvesting potential. Consider constructing your own structure with a 100-square-meter flat patio. Assume that your area's average yearly rainfall is around 600 mm (24 inches).

The land is 100 square metres in size (120 square yards)

Rainfall height = 0.6 metres (600 mm or 24 inches)

Volume of rainfall on the plot = plot area x rainfall height

Using the assumption that only 60% of total rainfall is efficiently gathered.

36,000 litres of collected water (60,000 litres x 0.6)

This amount is roughly equivalent to a 5-person family's annual drinking water needs. Each person needs 10 litres of water each day on average.

Per-household water demand

A survey using a structured questionnaire is used to estimate the demand for water per home for drinking and cooking. The demand differs from one hamlet to the next. On average, a household uses 63.3 litres of water each day for drinking and cooking. The demand for washing and bathing could not be measured because they share the ponds for these activities. For the remainder of the computations, a daily demand of 60 L per family is assumed.

Anthropogenic factors

Poverty, population increase, ignorance of the water supply, unscientific use of water, grazing, deforestation, agriculture, archaic methods of ground water withdrawals, and other socio-economic and anthropogenic causes all play a key influence in Bankura's water shortage. The majority of Bankura's blocks are classified as backward, and the district is dominated by S.T. people. In the Bankura district, agriculture is the primary source of income. Agriculture employs over 70% of the working population, either as cultivators or as agricultural labourers. The agriculture industry contributes a significant amount of the district's revenue. Despite the fact that the labour participation rate in agriculture is relatively high, the average income of cultivators is very low, resulting in slow agricultural growth. As a result, poverty is prevalent across the district. As a result, the residents of Bankura are unable to implement current scientific ground water removal procedures, resulting in low ground water use. (Boers et. al., 1981). At the moment, just 13.78 percent of the net groundwater reserve is being used. As a result, a vast potential lies untapped. One of the key causes of the water shortage in Bankura is the growing trend of population increase. The current population is unable to deal with the constant changes in surface and ground water. Another source of water shortage is excessive use of surface and ground water for agriculture. Agriculture plays an important role in the Bankura district, with net sown area accounting for about 55 percent of the region's total reported area of 348,500 hectares. This

district's agriculture is primarily monocropped. Upland land accounts for around 60% of all farmed land. Small and marginal farmers with scattered and fragmented smallholdings account for around 73 percent of overall agricultural holdings. Paddy is the district's main cash crop. Only 17 percent of the net cultivated area is under multi-crop cultivation, despite the fact that net cropping covers 50% of the total land area. Aman paddy farming covers a total of 77 percent of the net-cropped area. The crops are largely cultivated in a rain fed environment with little fertiliser input. Because the district's productivity is substantially lower than that of other West Bengal districts, the maximum quantity of water is required for agriculture (Table 2).

Table 2: Ground water utilization blocks of Bankura

Ground Water Utilization Classes	Name of the Blocks
Very low (below 300 ham)	Bishpur, Joypur, Kotulpur, Patrasayer and Indus
Low (300–599 ham)	Bishpur, Onda, Barjora, Simlapal
Medium (600–899 ham)	Bankura-I, Bankura-II, Gangajalghati, Indpur, Khatra, Ranibandh, Mejia (part) and Raipur (part)
High (900 ham and above)	Taldangra, Mejia (part), eastern part of Sarenga, Hirbandh

Proposed project

By interviewing 64 beneficiaries and 36 non-beneficiary households in three villages in Hirbandh block, this research studied about the impact of hapas, a water land which were unused in past. Several government officials and PRADAN, the implementing agency, were also interviewed. After a long discussion it was concluded that irrigation infrastructure is scarce in the district as a whole, with no tube wells, 268 dug wells, 506 surface flow irrigation systems, and 14 surface lift structures. The main focus on the cultivation in the Hirbandh block are on paddy cultivation in the kharif season and mustard cultivation in the rabi season. It is observed that there are no irrigation infrastructure and the farmers uses hapas for their irrigation purpose. Thus, in this chapter we mainly focus on the effects of using hapas in irrigation system in the above block.

Fig. 9 Hapa Irrigation

Fig. 10 Expansion of hapas in Hirbandh block

Problems with cost and economic analysis

The average yearly income of hapa owners in the research group is greater than that of non-owners. This is significant since current owners were previously more likely than non-owners to

be below the poverty line (BPL). Increased agricultural yield (INR 5,792) and fish culture produced an additional net yearly revenue of INR 6,918, on average (INR 1,126). Agriculture alone provided a 34 percent increase in revenue above pre-hapa levels.

Probable solutions

Hapas have a benefit-to-cost ratio of 3.03. Over a 15-year period, the internal rate of return on cash flow is 24.8 percent.

- ✓ Increase in involvement of all communities in the planning and implementation of the project.
- ✓ Increase in involvement of all political parties to keep the approach from becoming politicised.
- ✓ Provide better training in planning and implementation to implementing agencies, including how to include all parties and stakeholders.
- ✓ Ensuring that water lifting technology is available in order to optimise the benefits of hapas. According to the poll, 39% of farmers use their own pump and 44% rent one.
- ✓ Encouraging other districts to establish hapas with Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS).
- ✓ Demonstrating the benefits of hapas to government officials in charge of MGNREGS financing.

Effects

Introducing the concepts of hapas for rainwater harvesting became an efficient management of water scarcity in the area of concern (Bankura).

More land being cultivated

Smallholder farmers were initially hesitant to give up land for rainwater gathering, but by 2010, the number of hapas had rapidly increased, with beneficial results.

Area expansion:

Farmers were able to irrigate fallow land and level sloping terrain using soil dug from the hapas, resulting in an increase in cultivated land. 86 percent of hapa owners expanded their cultivated area. In comparison to non-hapa owners, farmers with hapas increased their cultivated area by 0.31 acres per farmer, bringing it to 1 hectare per farmer.

Livelihood diversification

Many hapa owners have expanded their agricultural diversification: 78 percent now grow an extra crop, and 95 percent grow multiple crops such as maize, mustard, and other vegetables. Non-owners, on the other hand, only farm various crops in 50% of cases. Crop yields have increased, according to farmers. Mustard yields have quadrupled on certain fields, while rice yields have climbed by 20%. Hapas are utilised for a variety of functions, including agriculture, gardening, cattle and home usage. Except for one farmer, everyone has added Fish to their pond. Farmers were once given fish seeds, but now they must invest their own funds. Because fish is traditionally exclusively consumed by wealthy families, the practise has increased the nutritional and social standing of homes. The quantity of cattle held by farmers with hapas grew, maybe as a consequence of greater water or fodder availability, or as a result of the general improvement in

the economy. Cattle numbers increased by 9%, goats by 57%, and ducks by 35%. The ponds have cut down on the distance people, mostly women, have to trek to get household water.

Social benefits

69 percent of hapa-owning households said they no longer travel during the dry season. As a result, there are more youngsters in school. Landless farmers are renting additional land to grow with hapa water, and the initiative has created jobs in hapa construction and agricultural labour. Groundwater levels are rising, and the neighbourhood is becoming greener, according to residents. This plant will aid with soil erosion management.

Conclusion

Water is the most plentiful material on the planet, the most important component of all living things, and a major force that is continually sculpting the earth's surface. It's also a big part of keeping the earth comfortable for humans and influencing civilisation's growth (Chow et. al., 1988). Water shortage impacts all social and economic sectors and jeopardises the natural resource base's long-term viability. Water shortage necessitates a multidisciplinary and intersectoral strategy to water resource management, one that enables the coordinated development and management of water and related resources to maximise economic and social welfare in an equitable manner while preserving essential ecosystems.

Despite getting adequate rainfall, the region suffers from water shortages because to a lack of suitable retention effort, according to the report. Surface runoff water collection based on a decentralised participatory strategy targeting family units may be beneficial in communities against irregular and concentrated rain and the resulting water shortages in the context of global climate change. Only a reservoir at the household unit that stores a part of the discharge (90 percent) from the surface can guarantee the supply of whole domestic demand throughout the year. Reservoirs can be made of concrete or polythene tanks (Myres, 1967). These might be placed in each housing unit's open courtyard in the research area. Excess reservoir outflow may be directed to recharge the subsurface water table, but necessary precautions must be taken to avoid pollution. A large recharge pit must be dug up to a depth of 6-8 feet beyond the lateritic hard pan. To create a recharge pit, an elevated location away from an open toilet must be identified, and a cemented dike must be built around it to prevent surface and seepage passage of polluted water from the toilet or waste water drain.

To meet the various challenges, waste water collection system managers must be extraordinarily skilled in a wide range of technical and non-technical abilities required to operate and maintain a collection system efficiently and effectively. Finally, in light of the foregoing facts about the importance of water, the effects of water scarcity, and sustainable water use, it is critical that people from all walks of life in Bankura, as well as governmental and non-governmental organisations, work together in a holistic manner to secure water for future generations and protect the world's natural ecosystem (Chatterjee, 2018).

Reference:

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Air Pollution: Cause, Effects and possible solutions

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Introduction

Pollution is the introduction of pollutants into the natural environment that causes negative impacts. Pollution can take the form of any substance (solid, liquid, or gas) or energy (such as radiation, heat, sound, or light).Although pollution can be caused by natural phenomena. In 2015, pollution killed 9 million people worldwide. The main types of pollution include air pollution, garbage, light pollution, noise pollution, heat pollution, plastic pollution, soil pollution, radiation pollution, visual pollution and water pollution.

Nowadays air pollution is a serious problem in India.In 2016 it is reported that, at least 140 million people in India breathe air that is more or equal to 10 times ofWHO safe limit and 13 out of 20 most air polluted cities of this worlds are in India [1].In 2019 it was reported that 22 out of 30 most air polluted cities in the world, were situated in India [2]. Industrial pollution causes51% of the total pollution.27% of the air pollution is caused by vehicle emission, 17% by crop burning and 5% by other sources [3]. Due to the air pollution every year 2 millionpremature deaths are caused by air pollution in India. In the rural area pollution stemscome from biomass burning for cooking and keeping warm. Burning of crop residue is the cheaper alternative to mechanical tilling in agricultural field is the cause of smoke, smog and particulate pollution in the rural area, in autumn and spring months [4, 5].

After China and the United States, India is the 3rdlargest greenhouse gas producer country [6]. In 2013 it is observed that non-smokers Indians have 30% weaker lung function than Europeans [7]. In 1981, the Air Act was passed to Prevention and Control the air pollution, but due to the poor enforcement of the rules it was failed to reduce the air pollution [8]. In 2015, the National Air Quality Index launched by the government of India, together with IIT Kanpur [9].'The National Clean Air Program' was lunched in the year 2019 in India with national target of 20%-30% reduction in PM2.5 and PM10 concentrations by 2024, considering 2017 as the base year for comparison. It was decided that it will be rolled out in 102 cities which have worse quality air than the National Ambient Air Quality Standards [10]. It was decided that 1.35 billion new native tree will be planted along the Great Green Wall of Aravalli green ecological corridor(1,600 kilometer long and 5 kilometer wide) along Aravalli range from Gujarat to Delhi which will also connect to Shivalik hillover 10 years to reduce the pollution [11].In partnership with the McKelvey School of Engineering of Washington University in St. Louis,IIT Bombaylaunched the Aerosol and Air Quality Research Facility to study air pollution in India in December,2019 [12]. According to a Lancet study, nearly 16.7 lakh deaths and an estimated loss of USD 28.8 billion worth of output were India's prices for worsening air pollution in 2019 [13].

Due to the industrialization urban centers in small countries have experienced unexpected growth and more than 10 million people appearing in many countries in recent decades [14]. Only in India there are four such cities, and another three are expected to enter in the next 20 years. Fast-growing cities are facing environmental problemsdue to the air pollution [15].Due to the urgency of air pollution as a public health issue, scientific study of the health issue caused by air pollution in Indian cities is limited, and there is a lack of scientific reports on health effects [16]. It is clear

to scientists that the India's major cities are facing serious health problem as a result of air pollutants [17].The study on various pollution is monitored more systematically (especially in urban areas), but very few studies have focused on exposure of this pollution.Some of the researcher devoted their time to study the health effects of air pollution in Indian cities, and a few studies have attempted to compile information on human health risks arising from air pollution in an integrated manner [18]. In this book chapter, we review the literature and highlight important issues in calculating the cause and effects of air pollution in Indian cities and give some preventive measures.

Causes of Air Pollution

Most Indian Metropolitan cities rank among the most polluted cities in the Whole world. According to the World Air Quality Index Bhiwandi, Gaziabad, Delhi, Noida, etc.are topmost polluted cities in the world. In 2014, according to the World Health Organization (WHO), 37 cities from India feature in the top hundred, 45 world cities with the worst PM10 pollution. In 2021 this has risen to 63 cities. The levels of PM2.5 and PM10 (Air-borne particles smaller than 2.5 micrometres in diameter and 10 micrometres in diameter) as well as concentration of dangerous carcinogenic substances such as Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2) have reached alarming proportions in most Indian cities

Causes by Category

Some of the main categories of air pollution sources in Indian cities are industrial emissions, automotive gas emissions, and fuel consumption for domestic purposes such as cooking that combines with burning of household waste and emission from small businesses.

Vehicular Emission

In India rapid urbanization has led to an increase in transportation demand that public transport systems are unable to meet adequately. The uses of personal vehicles are increasing dramatically. In India, the vehicle population is growing at the rate of over 5% per annum and today the vehicle population is approximately 295 million registered vehicles. The vehicle mix is also unique to India in that there is a very high proportion of two-wheelers are 76% [19]. In 2019 that share was around 74.8%.

The majority pollutants released as a vehicle/fuel emissions are carbon monoxide, nitrogen oxides, photochemical oxidants, air toxics namely benzene, aldehydes, 1,3-butadiene, lead, particulate matter, hydrocarbon, oxides of sulphur and polycyclic aromatic hydrocarbon [20]. Approximately 261 tonnes of CO2 is emitted due to transportation, out of which 94.5% is contributed by road transport [21]. In India 17% of total energy is consumed in transportation sector and 60% of greenhouse gases produced from various activities. The pollution from vehicles is due to discharge like CO, unburnt HC, Pb, NO2 and SO2 and SPM mainly from tailpipes (Dayal, 2011). Vehicles in big metropolitan cities are estimated to account for 70% of CO, 50% of HC, 30- 40% of NOx, 30% of SPM and 10% of SO2 of the total pollution load of these cities, of which two-thirds is contributed by two-wheelers alone [22].

Industrial Emission

The primary source for SO2 emissions is coal and diesel burned at industries (56 %) and diesel usage in HDVs. The manufacturing industries range from steel, textiles, paper, pharmaceuticals, and paints. In 2001, an environmental audit as part compliance and regulation exercise conducted by APPCB listed more than 650 industries. In 2005, a similar environment

audit listed only 390 industries in the clusters, as a result of a combination of closing down, relocation, and merging of industries into designated estates. Relocation and merging of the industries inherently led to improvement in the energy efficiency [23].

In 1947, after gaining independence, India embarked on a path of rapid industrialization in all the major manufacturing sectors—heavy manufacturing, iron and steel, agricultural and paper products and industrial and petrochemicals. The CPCB has catalogued over 1500 large-scale industrial units in 17 industrial categories [24], accounting for about 60% of India's industrial output.Small-scale industries are account for the remaining 40% of the industrial output. They are an important part of the Indian economy. At present, there are over 5000 large manufacturing companies in India and around 25000 small and medium manufacturing companies in India (2020).

A variety of gaseous organic and inorganic compounds are emitted from industries, complex vapours and PM with process-specific composition (e.g. heavy metals and PAHs) undergoes phase transformation after emission into the atmosphere [25]. Due to the industrial combustion pollutants (SOx, NOx, CO, HC, and PM) are released, may be quantified to the first order on the basis of overall estimates of fuel used and average emission factors for various industrial activities [25].

Major air polluting industries in Jamshedpur are iron, steel and tin-plate company, engineering and locomotives, agricultural tools and tubes manufacturing company. All the industries in the region emit about 848 kg/h NOx. Tata Iron and Steel Company Ltd. (TISCO) is the largest source of air pollution in the region contributing about 79% of NOx emissions. Various processes of steel making, viz. blast furnaces, steel melting shop, rolling mills and niching mills, power plants, coke ovens, refractories and centring plants, generate substantial air pollution [26].

Power Plants

India has the fifth largest electricity generation sector in the world at 210 GW in 2012. In the Twelfth and Thirteenth Five-Year Plans, additional capacity of 76 GW and 93 GW are planned [27]. Of the total electricity generated, thermal power plants (gas and coal) account for 66%, hydroelectricity for 19%, and the remaining 15% from other sources including natural gas and nuclear energy.

In 2011, it was estimated that the 111 coal-fired power plants consumed 503 million tonnes of coal in total – emitting 580 kilotons particulates with diameter less than 2.5 micrometres (PM2.5), 2,100 kilotons of sulphur dioxides (SO2), 2,000 kilotons of nitrogen oxides (NOx), 1,100 kilotons of carbon monoxide (CO), 100 kilotons of volatile organic compounds (VOCs) and 665 million tonnes of carbon dioxide (CO2) [28]. The particulate matter (PM) pollution from coal-fired power in central India covering Madhya Pradesh, Jharkhand, Odisha, and Chhattisgarh, is the highest due to the density of the power plants in the region and higher installed generation capacity because of its proximity to coal mines. The Delhi-Haryana region with the highest population density, with more than 21.5 million inhabitants in Delhi and its satellite cities, also experiences substantial PM pollution from coal-fi red power plants [29].

Domestic Fuel Combustion

A major cause of pollution in India is fuel combustion from domestic sources. These sources cause great health risks in rural areas, there are significant emissions in cities as well. Smoke emissions from burning coal, cattle dung, wood and other biomass fuels are a significant source of indoor PM in many cities, even these sources can also produce outdoor PM [30]. The combustion of coal and biomass is generally incomplete and often takes place in simple stoves, which are either

open clay boxes or small pits. The resulting emissions contain large quantities of carbon monoxide, unburned hydrocarbons and PM. In biomass combustion the emissions also contain a large number of polyaromatic hydrocarbons, such as benzo(a)pyrene, that are carcinogenicandmutagenic. The coal, kerosene smoke also contains SOx and trace metals. Besides biomass liquefied petroleum gas (LPG), coal, kerosene are the main fuels for domestic uses. From a health viewpoint, the solid-biomass-based fuels are burned inefficiently and vented in close proximity to people it is the cause for greater concern. In this section, we examine emissions from the domestic sector in urban India and estimate the range of total emissions of PM. Smith and coworkers [31, 32, 33] studied the general question of the effect of indoor air pollution on the entire Indian population, particularly in rural areas. Household fuel usage is the key reason of domestic air pollution, some fuels such as wood and dung that are lower on the "energy ladder" are more polluting than modern clean-burning fuels such as electricity and LPG [34]. Intermediate fuels (for example - paraffin) are less polluting and more efficient than biomass-based fuels. PM10 and other emissions from biomass fuels can be two or more orders of magnitude higher than those of modern gasoline with the same level of ultimate power consumption. The use of better ventilation and efficient stoves can reduce emissions and pollution. However, while advanced stoves help to reduce exposure to pollutants, they do not eliminate them. Over time, only pure fuel can help eliminate exposure [35].

Sulfur Dioxide:

The combustion of fossil fuels containing sulphuristhe major source of sulphur dioxide. These are predominantly coal and fuel oil since natural gas, petrol and diesel fuels have a relatively low sulfur content. Combustion of coal in power stations is far the most major single source of SO2 emissions [36].

Suspended Particulate Matter:

Airborne particles are very diverse in character, including both organic and inorganic substances with diameters ranging from less than 10 nm to greater than 100 pm. Since very fine particles grow rapidly by coagulation and vapour condensation, and large particles sediment rapidly under gravitational influence, the major part (by mass) generally exists in the 0.1--10um range. Primary particles from motor vehicle exhaust and sulphuric acid formed from SOz oxidation are initially in the transient nuclei mode. Coarse particles, are mostly greater than 2 pn.1 with sizes extending up to about 100 pm. This is comprised in the main of mechanically generated particles such as wind-blown dust, sea spray and primary volcanic particles. These are formed by attrition of bulk materials and tend to be appreciably larger than transient nuclei or accumulation range particles [37].

Gravimetrically Determined Particulate Matter:

PM 10 particulate matter is determined gravimetrically and therefore includes both primary and secondary particles. Two sources of these are dominant; one is road traffic emissions and the other is secondary particulate matter, mostly ammonium sulphate and ammonium nitrate particles. Whilst the former are black in colour, the latter are white and hence are not determined by the black smoke method. Other sources such as sea spray and wind-blown dust alsocontribute to urban PM10. 435T here are many other minor sources such as particles from building work and demolition, and biological particles such as pollens, spores and bacteria.

Oxides of Nitrogen:

The most abundant nitrogen oxide in the atmosphere is nitrous oxide, N20. The pollutant nitrogen oxides of concern are nitric oxide, NO and nitrogen dioxide, NO2. By far the major

proportion of emitted NO, (as the sum of the two compounds is known) is in the form of NO, although most of the atmospheric burden is usually in the form of NO2. The major source of NO, is the high temperature combination of atmospheric nitrogen and oxygen in combustion processes, there being also a lesser contribution from combustion of nitrogen contained in the fuel [38].

Effects of Air Pollution on the Environment:

Acid Rain:

Pure water, meaning distilled water or deionised water, has the value of pH7 whereas water from rainfall is between 5 and 5.5, which is slightly acidic. Rainwater will become much more acidic when it is mixed with certain air pollutants such as sulphur dioxide and nitrogen dioxide [39]. Typically, rain with a pH value of 4 is considered acid rain, of which the acidity is 10 times that of pH 5. Acid rain is incredibly harmful to natural ecosystems, in particular, its impact on soil. About 45% of the components of soil are minerals including aluminium. If soil becomes acidic, its aluminium will become soluble and interfere with the root's cell division as well as its ability to elongate. At the same time, essential nutrients for plants such as calcium will be reduced by exposure to acid rain; this makes it difficult for plants to consume water. Acid rain also threatens wildlife, especially aquatic animals since most function at the optimal pH value between 6.5 to 8.5.

Eutrophication:

Eutrophication is the situation in which a water body is enriched with minerals and nutrients that may eventually result in excessive growth of algae. Algae not only blocks out the sunlight from underwater plants, which is necessary for photosynthesis, but it also consumes large amounts of oxygen in the water. Consequently, animals and aquatic plants may die due to the scarcity of nutrients in the water.

Although this phenomenon can occur naturally, it is indisputable that human activities have been accelerating the process. Nitrogen dioxide that is excessively generated during the production of energy is one of the fundamental nutrients that the growth of algae requires. The use of fertiliser also contributes to eutrophication as nitrogen fertilizer is often applied in agriculture for multiple reasons: Increasing the speed of development of plants, preventing leaves from turning yellow et cetera. Excessive fertilizer not absorbed by plants that are left on the land will eventually be deposited into the waterbody nearby via rainfall.

Climate Change:

The relationship between climate change and air pollution is complex as air pollutants are generally distinguished from greenhouse gases in terms of their effects, even though they are produced from similar sources and human activities [40].

Air pollutants are substances that have direct impacts on our health and the ecosystem while greenhouse gases damage the planet by warming it, which threatens the survival of all lives on it. Yet, on some occasions, this categorization results in an overestimation of the scale of the differences between the two categories. Some air pollutants such as ground-level ozone also possess warming power, which can trap heat from the sun in the atmosphere.

However, it is worth noting that some air pollutants have been discovered to have a positive effect on resisting climate change. Aerosol, a suspension of airborne particles usually formed during the process of burning fossil fuels, is found to possess cooling power. Aerosol helps to cool the planet in two different ways: to change the amount of solar energy entering and leaving the

atmosphere, and its ability to form clouds. Since aerosol is mostly light-coloured, it can bounce solar radiation back to space. The cooling power of aerosol can be enormous. For example, during the volcanic eruption of Mount Pinatubo in the Philippines in 1991, about 20 million tons of sulphur dioxide and ash particles were blasted into the atmosphere over 12 miles. Afterwards, the planet cooled for two consecutive years.

Its other cooling power is its ability to facilitate the formation of clouds. To form a cloud, water vapour needs to be condensed into water droplets. Condensation will not be possible without airborne particles, which provide surfaces for water vapour to transform itself into liquid. More surfaces reserved for condensation are available in the atmosphere due to the emergence of aerosol, more clouds are hence formed. The cooling power of clouds can also be attributed to the light colour, which helps to reflect the sunlight out to space. Scientists have been exploring the possibility of manipulating aerosols to slow down climate change, but the challenge is to control the number of airborne particles within a range where no threat is posed to our health and the ecosystem.

Humans:

Sporadic air pollution events, like the historic London fog in 1952 and a number of short- and long-term epidemiological studies investigated the effects of air quality changes on human health.

The different composition of air pollutants, the dose and time of exposure and the fact that humans are usually exposed to pollutant mixtures than to single substances, can lead to diverse impacts on human health.

Effects of air pollutants on different organs and systems:

Respiratory system:

It is found in numerous studies that air pollution affects the world badly. Due to the increase of nitrogen oxides [41], sulphur dioxide [42] and certain heavy metals such as nickel or vanadium, arsenic, throat and nose irritation occurred along with dyspnea and bronchoconstriction, especially in asthmatic individuals. Ozone initiates lung inflammation [43] and penetrates the alveolar epithelium [44]. The condition of the patients with lung disease become worsens day by day due to the air pollutants. Air pollution due to the increase of nitrogen oxides increased the infection in respiratory system [45]. Finally the lung function reduces due to certain heavy metals and ozone [46, 47]. People are also suffering in emphysema, asthma and even lung cancer due to such pollution [48, 49]. Due to the nitrogen oxide emphysema like symptom is also been observed in mice [50].

Cardiovascular system:

Carbon monoxide modifies the conformation of haemoglobin and reduce the capacity of haemoglobin to transfer oxygen[51]. Due to the lack of oxygen, brain and heart are highly affected, inflammation in the lung and other organs are observed, affects blood clotting in the vessels as a result cardiac attack observed[52], creates myocardial infraction [53]. Due to the air pollution by heavy metal such as mercury, nickel and arsenic, tachycardia symptoms, blood pressure, anemia observed [54]. It is also observed that triglyceride increase due to the air pollution by heavy metals [55].

Nervous system:

The nervous system is highly affected by the air pollution due to heavy metals such as lead, mercury and arsenic. Due to the increase of lead, arsenic and mercury into the air so many symptoms occure, such as Neurotoxicity, neuropathies, memory disturbances, sleep disorders, fatigue, anger, blurred visionand slurred speech [56, 57]. Dopamine system, glutamate system are also affected by air pollution [58, 59]. Neurological cancer, decrease mental development of the children is also observed due to air pollution by mercury [60, 61].

Urinary system:

Kidney is the leading organ in the urinary system, which is damaged due to the air pollution by heavy metals. Discharge of low molecular weight protein reduces due to the dysfunction of tube, which is caused by the heave metals as a result glomerular filtration (GFR) is depreciated. Also the heavy metals are liable to form stone [62, 63,64] and renal tumor [65, 66]. Renal tumor is also formed due to heavy metals [65, 66].

Digestive system:

Liver cells are damaged due to the increase of dioxins [67]. Due to the dioxins certain enzyme are increased and as a result gastrointestinal and liver cancer are happening [68].

Exposure during pregnancy

Another important dangerous effect of air pollution is observed during pregnancy. The developing foetus are affected by air pollution such as fetal growth is decreased, premature delivery, low weight birth and increase the risk of abortion [69].Congenital malformations is also happen due to parental exposure to air pollutant [70]. As a result significant impairments in the newborn's skills and understanding are observed [71]. It is observed that dioxins transferred from mother to new born baby which affects the development of the central nervous system of the foetus [72].

Reduction of Air Pollution:

Sustanable Energy Resourcs

Sustainable and State of the Art Energy Resource Technologies is one of the most effective ways to control air pollution as most of the country's and global air pollution are in the grip of power generation and the car itself. At present, many mature and reliable renewable energy sources are increasing and competing with conventional energy sources. Coastal wind, solar, concentrated solar, geothermal, marine energy, and bio energy are on the way; and in some cases, they have overcome economic barriers. The share of renewable energy sources in global energy use is growing.

In 2012, renewable energy accounted for an estimated 19% of global energy consumption, and increased to 23.7% in 2014 [73, 74].

Renewable energy technology can be categorized as conventional energy technology and emerging energy technology. Typical renewable energy sources include hydropower, wind power, solar energy, biomass energy, biofuels, and geothermal energy while renewable resources include ocean energy, concentrated solar photovoltaic, renewable energy from the earth, cellulosic ethanol, as well as synthetic photosynthesis [75].

Marine Energy

Marine energy, also known as ocean energy, is one of the very attractive renewable energy sources. Oceans cover about three-quarters of the earth and several techniques have been tested and practiced for extracting energy from these mighty oceans. These techniques consist of wave power (wave energy), tidal power, tidal currents, salinity gradients, and temperature gradients. The major advantage of marine energy as compared to other renewable sources is its consistency and predictability [75].

Various type of marine energy are there, such as wave energy, tidal energy, tidal and ocean currents, concentrated solar power which can be taken as a measure of reduction of air pollution [76].

Hydrogen gas [77], Biomass energy [78], Natural gas [79], Biofuels [80], Enhanced geothermal energy [81], Cellulosic ethanol [82] can also be taken as a measure of reduction of air pollution.

Alternative Energy Efficient and Low Pollution Vehicles

In present times, electric vehicles (EV) are gaining popularity, and the reasons for this aremany. Most notable is their contribution to reducing greenhouse gas (GHG) emissions. So Battery Electric Vehicle (BEV)[36], Hybrid Electric Vehicle (HEV), Plug-In Hybrid Electric Vehicle (PHEV), Fuel Cell Electric Vehicle (FCEV) can also be used to reduce the air pollution.

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Solid Waste Management: Problems and Solution by Using Microbes & Bacteria

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Introduction

In the last few decades waste management becomes a major concern. There are so many methods for waste management. One of the remarkable methods for waste management is use of Microbes & Bacterias. Before going to the waste management by using Microbes & Bacterias, we introduce the term waste.

Waste

Waste are unwanted or unusable materials which is discarded after primary use, or is worthless, defective and of no use coming from house, commercial place such as industry, medical system etc., or in other words waste is a by-product or joint product which have minor economic value [1]. There is several type of waste which is included into solid waste. Solid waste is divided into two parts, one is Hazardous waste and other is known as Non- Hazardous waste.

Hazardous waste:
Hazardous waste are potentially dangerous or harmful to the environment or human health. Hazardous waste is further divided into listed waste, Characteristic waste, Universal waste, Dual waste, Mixed wastes, House hold Hazardous waste.

Non Hazardous waste:

Non Hazardous waste is of two types: Municipal Solid waste and Industrial solid waste

Listed waste: Listed waste is of 4 categories: F-listed, K-listed, P-listed and U-listed wastes.

Characteristic waste: Characteristic wastes are one type of hazardous wastes having characteristics ignitability, corrosivity, and reactivity.

Universal waste: Universal wastes are also hazardous waste includes few light bulbs, batteries, mercury containing pesticides and equipment.

Mixed waste: Mixed waste is also one type of hazardous waste which is radioactive. The waste coming from veterinary medicine which are associated with radiology are known as mixed waste.

Dual waste: Dual waste is also hazardous waste, includes infectious items. Medical waste such as non-empty syringe with needles belongs to dual waste.

Household hazardous waste: Household hazardous waste is a solid waste which is generated in small amounts by individual households throughout the world. Cleaners, paints, solvents and other chemicals that are used in house hold are included into house hold hazardous waste. Batteries, light bulbs and pesticides are known as household hazardous waste.

Non-hazardous waste
Non-hazardous waste is also solid waste that does not meet the Resource Conservation and Recovery Act. **Non-hazardous waste** is of two types, one is municipal solid waste and other is industrial waste.

Municipal solid waste

Municipal solid waste is a non-hazardous solid waste that includes animal carcasses as well as the typical garbage or trash.

Agricultural solid waste

Agricultural solid waste is also a subcategory of municipal solid waste which is generated by the rearing of animals and the production or harvesting of crops or trees. Animal waste and animal carcasses are example of Agricultural solid waste.

Industrial solid waste

Industrial solid waste is a second type of non-hazardous solid waste which is generated by industrial processes and manufacturing. Medical waste relevant to veterinarians is also Industrial solid waste.

Medical waste/Regulated medical waste

Medical waste is also industrial solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals. Infectious animal wastes such as bedding, carcasses or tissues are medical waste.

Waste Management

Due to the innovation and development, solid waste management will definitely bring the economic, social and environmental benefits.

Due to the industrialization and modernization with a high growth rate, substantial increase of population of the society is happening day by day, which caused a large amount of waste from household activities, production, and business activities that is thrown into the nature. The total amount of solid waste is predicted to be increase by 54 million tons by 2030. If the solid waste increased enormously in number with increasingly complex components, it absolutely puts massive pressure on waste collection and treatment [2].

For, this we need proper waste management. In, simple words waste management means, long-recognized hierarchy of management of wastes, in order of preference consists of prevention, minimization, recycling and reuse, biological treatment, incineration, and landfill disposal[3].There are different modern waste management techniques. One of the most efficient techniques is using microbes & bacteria. In, different cases of waste management, this approach are effectively applicable. For example, nuclear waste effects on nature effectively. There is a massive dangerous substance of radioactive waste in the last 60 years of nuclear activity. So the special attention should be given to the waste management of radioactive wastes to form pollution free environment and make a diseases free environment to the living organism. Deinococcus radiodurans is an extremophile bacteria which can resist the radiation and can survive in the extreme condition such as cold, dehydration, high-temperature, high-radiation exposure and in vacuum also [4]. There are so many E-Waste present in the society. Some of them are computers, televisions, VCRs, stereos, copiers, and fax machines. Many of these products can be reused, refurbished, or recycled [5]. Chromobacterium violaceum is a non-sporing coccobacillus, which produces an antimicrobial agent known as violaceum. Bacterium can recover precious metals from e-waste. C. violaceum is e-waste–processing microbes [6].

Nuclear Waste Management Using Microbes & Bacteria

Nuclear waste is hazardous waste which contain radioactive material. Radioactive waste is a result of many activities, including nuclear medicine, nuclear research, nuclear

power generation, rare-earth mining, and nuclear weapons reprocessing. Radioactive waste is broadly classified into low-level waste (LLW) [7]. Nuclear fuel is used to produce electricity. The sewage from nuclear industry consists of actinide compounds such as U235, U238, Np237, Cs137 etc. [8].

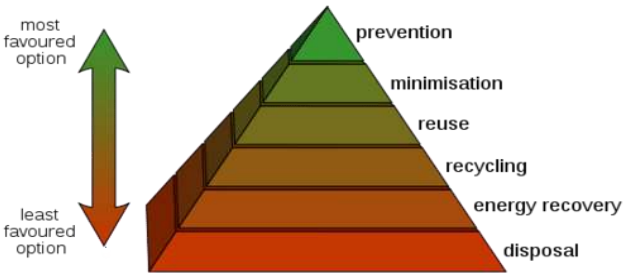

Fig.1 Hierarchy of waste management

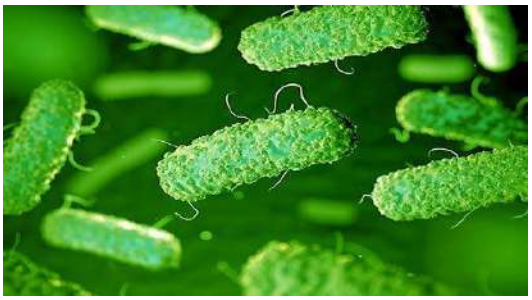

Fig. 2: An example of common microbe – *Escherichia coli*

Source: Drstuey via Wikimedia Commons [3]

Till now the nuclear industry has no solution to their waste problem. Transportation of this waste poses an unacceptable risk to the world. Plutonium is one of the most dangerous materials in the world [9]. Some of the critical problems are –

- Nuclear waste should be transmuted into harmless materials.
- Affects on Nature
- Health Effects [9]

In the recent year's lot of researcher devoted their time to process radionuclides. Soil and groundwater are getting contaminated with various radioactive wastes [10, 11]. Nuclear energy is one of the remarkable energy to sort out the energy demand, but the problem is the management of nuclear waste which is more dangerous to the living organism. Due to the nuclear activity in the last 60 years a large scale of radioactive waste are contaminated in to the nature. So it becomes a necessity to pay a special attention to the management of radioactive wastes through various clean-up strategies to make the environment pollution-free. Bioremediation is one of the powerful techniques to manage the radioactive wastes.

In this process the radioactive waste is disposed from the environment with the help of microorganism. The metabolic activity of microorganism helps to remove or convert the radioactive compound to less radioactive or non-radioactive element. There are different processes which are discussed below –

Deinococcus radiodurans is an extremophile which can live in extreme condition such as high temperature cold and high radiation. *D.* radiodurans possess multiple copies of their chromosomes and can recover from a limited number of double-strand DNA breaks by reassembling an intact chromosome from overlapping fragments via homologous recombination. However, multiple copies of chromosomes do not themselves confer radiation resistance [11]. It has the capability to convert high toxic and volatile metal species into less toxic and less mobile form. It has the ability to convert the toxic Hg (II) ions to elemental mercury. From the above observation we can conclude that D. radiodurans can be used to dispose and/or remove various types of contaminants of nuclear waste [7].

The microbe, B. sphaericus, can bind and store large amount of radioactive metals, which are obtained from the uranium mining waste that contains piles of a paracrystalline proteinaceous surface which is defined as S-layer, in which the toxic elements such as various metals, metalloids, and radionuclides including uranium, cesium, and cadmium were found to localize [12]. B. sphaericus can use radionuclides such as uranium and neptunium in place of oxygen, and convert them from soluble to insoluble forms [13]. So the filter has been designed by the bacterial S-layer to trap uranium ions present in radioactive waste. So a huge ammount of radionuclide can be removed easily [12, 14, 15]. Pseudomonas strain can isolate uranium and thorium ions by biosorption [7]. A Gloeomargarita lithophora bacterium containing carbonate granules (white spheres). The microbe's ability to form such granules internally might explain how it draws radioactive isotopes from its surroundings [13].

Bioremediation of radioactive waste is an application of bioremediation which is based on biological agents such as bacteria, plants and fungi to catalyse chemical reactions of the sites affected by radionuclides [16]. Plants can be used to remove the contaminants which are present in soil and water the process is known as Phytoremediation. It is an eco-friendly and cost-effective remediation technology [17, 18].

Electronic or E-Waste Management Using Microbes & Bacterias:

E-waste is a electronic products by the end of their "useful life." There are different electronics products like Computers, televisions, VCRs, stereos, copiers. From these, many products can be reused, recycled [5, 20]. For the technological advancement in the materials and composition of the e-equipment, recycling of e-waste is complicated [21].

- One of the biggest environmental impacts of e-waste is when e-waste is exposed into heat then the released chemicals affect the whole atmosphere [22].
- The air pollution caused by e-waste mainly effects on animals.

An antimicrobial agent called violacein is produced by bacterium Chromo bacterium violaceum. The bacterium is capable of recovering C. Violaceum which is one of the potential e-waste processing microbes [23]. Bioleaching microbes are used for gold recovery is non-pollutive and it depends on the secretion of a lixiviant chemical cyanide for extraction of gold from e-waste. Here our main focus is the construction of strain of C. violaceum that makes more cyanide lixiviant approximately 70%. After that, it recovers gold from electronic waste [24].

Fig. 3 The growing environmental Risks of E-Waste

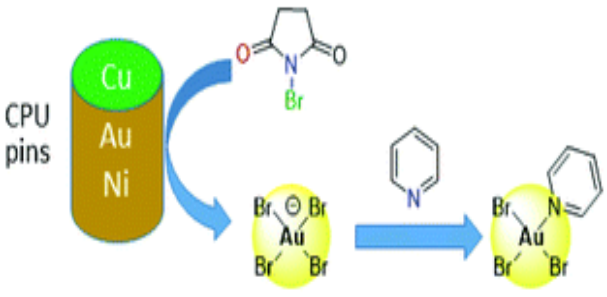

Fig. 4 Leaching of gold from e-waste Cyanide Boost

Nowadays in the modernisation, e-waste creates huge problem and the handling of e-waste are very hard to track. The expected number of e-waste is 52 million metric tons. Only 20% of it recycled properly, 4% of e-waste is used to fill up the land. In the land filled, e-waste toxic chemicals may pollute the environment, some of the remaining (76%) e-waste are shipped to developing countries, where people burn the e-waste in an open fire and use acids to extract metals which release toxic chemicals [25]. N-bromosuccinimide/pyridine is used for leaching of gold from e-waste [26].

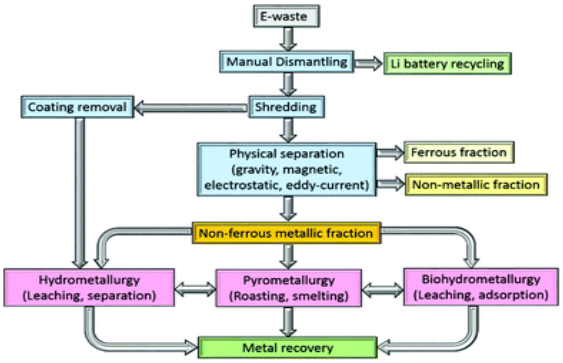

Fig. 5 Overview of stages involved in metal

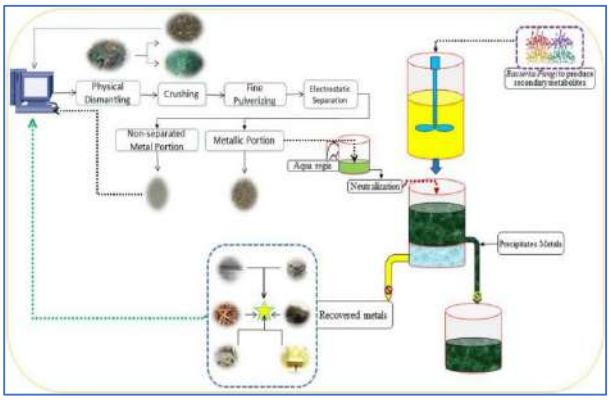

Fig. 6 Schematic Diagram of E-Waste Management Process recycling from electronic waste.

Landfilling Waste Management:

Landfilling is a vital step in any waste management strategy, but it can constitute a threat for the environment for a long time. Nowadays in most countries, sanitary landfilling is common way to eliminate municipal solid wastes (MSW). In spite of many advantages, generation of heavily polluted leachates, presenting significant variants in both volume and chemical composition, creates a major drawback. To control the pollution the impact of landfill leachate on environment has forced the authorities to fix more requirements. There are so many advantages and drawbacks in different treatments which are discussed under the items: (a) leachate transfer, (b) biodegradation, (c) chemical and physical methods and (d) membrane processes. Here mainly we discuss about the leachate and biodegradation process [27]. The need to save the environment and world from devastating landfill emissions makes risk factor a decision tool of high necessity. The various types of wastes and the complexity of physical existence, chemical and biological method that occur in the body of a landfill require specific process in order to execute the groundwater risk for the environment [28, 29]. Given the complexity of the material of landfill leachates, the exact importance of each potential toxic substance cannot be known errorless. Although complexion of heavy metals with dissolved organic matter is significant, the heavy metals are in most cases still strongly attenuated in leachate-polluted aquifers. Today, the use of membrane technologies, more especially reverse osmosis (RO), is used as a main step in a landfill leachate treatment [30]. Aerobic bioreactors is a process where the air is being pumped by vertical and horizontal combination of pipes. Organic compounds, toxicity and methane are decreased in a huge percentage by aerobic bioreactor process.

There are more than 98% metallic salts in municipal solid waste (MSW) and the pH of this waste is slightly acidic or neutral, to solve this problem we may use bacterial concepts [31,32]. A

primary eco-toxicological inquiry with luminescent bacteria has been carried out on different leachates from traditional and most sustainable landfills in order to ranking the chemicals those are better characterized the leachate (heavy metals, ammonia and dissolved organic compound). The attention has been focused on ammonia because it is present in high concentration and can last for centuries and can seriously contaminate the groundwater. There are many useful bacteria for this purpose [31, 32, 35, 36, 37, 38]. Now we use the micro-organism and microalgae. It is a special type of bacteria for this purpose. Microalgae have a high potential for the bioremediation of landfill leachate, mainly via nutrients removal, with the possibility of using the biomass for different purposes, depending on its characteristics. Thus we can developed the bacterial technology for this purpose [39, 40].

Fig. 7 Landfilling Waste Management.

Fig. 8 Industrial Waste management

[https://www.verifiedmarketresearch.com/download-sample/?rid=11677]

Industrial Waste Management:

Economic and environmental factors led many industries to find new and attractive ways of waste management. Clean biotechnology is an integrated platform to convert wastes into valuable and less toxic end products [41]. All the toxic products such as non-degradable, non-recycle materials are not being decomposed from many years. For this type of specific problem we use the bacterial cellulose technique which is very much forwarding technology now a days [42]. Bacterial cellulose (BC) is produce from the biodiesel industries and confectionery industries. Highest bacterial cellulose and concentration can be achieved by using commercial sucrose (4.9g/L) and glycerol (3.2g/L). To produce bacterial cellulose production (13.3 g/L), the combination of sunflower meal protein and crude glycerol can be used as the media of sole fermentation. This method is cost effective significantly. The Keratinolytic microorganisms is also another method to solve this problem [43, 44].

Keratinases are one of the most diverse enzymes for their source and application. Capability to utilize keratin can be seen from prokaryotic microbes to eukaryotes. Even in the microbial world, keratin degradation ability can be found in all the domains like as Eukarya, Bacteria and Archea in distinct locations ranging from Antarctic soils to hot springs, and aerobic to anaerobic environments. Extensively reviewed keratinolytic microorganism's action which involves the initial phase of disulfide bond reduction followed by proteolytic action. As the beverage food industry grow up very much like coffee, tea, milk we introduce the bacterial cellulose technique for this purpose [45,47]. The findings revealed that, in three days of cultivation, the bacterial strain in whey produced up to 5.45 g/L of B and C structural properties analysis showed similarities

between the synthesised cellulose with plant cellulose, despite morphological differences associated with crystallinity [46]. The findings also indicated that acidic byproducts of dairy industries, such as wheat stillage and whey, are potential affordable sources of nitrogen and carbon for BC production. Several studies on the practicability of using different sources of agro-industry waste in BC production are reported [47]. For instance, using Komagataeibacter hansenii for BC manufacturing from sisal juice as the substrate.The researchers evaluated the effects of various variables on the potential of production, including the sugar concentration, pH, duration of cultivation, and nitrogen supplementation [48]. From the findings, the best BC yield achieved from sisal waste was 3.38 g/L, which was yielded after 10 days of cultivation at a pH of 5. The study recommended that sisal waste is a precious resource for BC production; however, concerns arise regarding the ease of availability of sisal waste for large-scale manufacturing. However the bacteria are many stability factor for their respective purposes.As in the tannery industry are also we use this. Animal fleshing (ANFL) is the major proteinaceous solid waste generated during the manufacture of leather, which requires to be disposed of by environmentally sound manner. This study reports about the treatment of ANFL into an organic compost and its effects on physiological parameters of different crops in a laboratory study. The ANFL was hydrolysed using *Selenomonas ruminantium* and then the hydrolysed ANFL was mixed with cow dung and leaf litter for producing composted organic fertilizer. Now from the industry large amount of pollutants are mixed with the air and as garbage also stored. For that we use Heavy metals tolerant bacteria [48]. One of the major source of heavy metal pollution is activities of electroplating and metal processing industries. Beverage industries waste mainly affects BC production, and similar influence can be seen from other different wastes such as wastewater sugar industries, lignocellulosic biorefineries wastes, and micro-algae biomass industries waste [41,47]. Whey is known to be rich in various nutritional components; hence, a growing literature body examines the feasibility of utilizing waste products as low-cost substrates for improved BC production. Specifically, whey protein functions as an excellent source of nutrients. Proteases are widely utilized in the detergent industry as safe alternative replacing harmful chemicals such as caustic soda. Applications of keratinolytic proteases also results in an improved dehairing process as compared with chemical treatment using large quantities of alkali. Thus we conclude the effect of bacteria effect in industrial waste management [48,49].

Water Waste Management

Wastewater management and disposal in aquaculture is becoming increasing due to stringent water regulations regarding waste discharges into natural water systems. The antibiotics which is present and high concentration OC found in subsoil and siege-water's some amount of quantity describes the waste had been transported from the surface sheet to siege-water [50]. Although antibiotics are not considered in the currently in force, they are precise environmental substances and have the power to reason for health issues through drinking water exposure and create resistance genes in the natural environment, especially at other substances concentrations .Hence we needs to be particular concern if they are present in siege-water, the reason of both , may be used as drinking water and because of its naturally slow remediation storage[51].For using the bacteria useful-,fungi, microorganisms for this management there is some reason behind this. In aerobic waste management systems the bacteria are the basic block. Growth of any species depends upon its ability to obtain a part of the available organic components in the system. The family of bacterial normally divide itself into two major parts, one is bacteria utilizing the organic compounds in the waste and the other is bacteria utilizing the lysed products of the first group of bacteria [52]. There are many different bacteria which have the ability to flocculate. The prime

factors affecting flocculation are the surface charges of the bacteria and their energy level. The electrical surface charge on bacteria growth in dilution of organic waste systems has been shown to be below the critical charge for auto-agglutination, 0.020 volt.

Recirculation aquaculture is one of the technologies designed to reduce waste discharge through the nitrification process. However, nitrification results in nitrate accumulation which is normally reduced by dilution through water exchange. Water exchange is only possible with sufficient water. Although nitrification is a conventional process, it has limitations because the autotrophic bacteria require long start-up and multiplication periods. The nitrifiers require high levels of oxygen with relatively higher aeration costs. In the sweage waste water there are lot of heavy metals that really obstackle the drain water and a sustainable environment also. For that bacteria are used as a abosorption in a heavy metal like The chemical analysis of the three water drains revealed that the average concentrations of the heavy metals (Fe2+, Cd2+, Zn2+, Cu2+, and Pb2+) were within the normal ranges except for cadmium concentration in the sweage water waste[53, 54]. The number of living bacteria (no. living bacteria approx.·mL−1) found at three different process points and at three different depths) proofs that it was not inversely related to either the depth or the high dissolved organic carbon.vNow there are many sulfate component which is reason for the water very hard and no further process can be done for water purification[54] .Long-lived radioactive waste will be buried several hundred meters below ground in metal canisters surrounded by a buffer of compacted bentonite. Sulfate-reducing bacteria present in the bentonite may induce canister corrosion by production of hydrogen sulphide [54 56]. Here we show that survival of sulfate-reducing bacteria in bentonite depends on the availability of water and that compacting a high quality bentonite to a water activity.one other process are there called fluorosence in-situ hybridization (FISH). When this special technique was applied to the latter siege-water samples, only a few bacterial family (β-Proteobacteria and sulphur-reducable heterotrophic epsilon) were precisely identified, which can be ascribed to both low bacterial community diversity and low cell viability and activity [55].

Conclusion

Due to the industrialization and modernization population are increased enormously day by day, which caused a large amount of waste from household activities, production, and business activities that is thrown into the nature. So the waste management system should be given a special priority to form a healthy society. In this book chapter we have tried to sum up some of the problems caused by the waste and its management in a cost effective way by using Microbes & Bacteria.

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Population growth: it's impact on the environment

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Introduction

The World has changed rapidly during the 20th century, from the early 1960s to the 1970s. The rapid increase in the global population in the developing world resulted in a severe global crisis. India is the second-largest populous country in the world after China accounting for about 16 percent of the world's population on barely 2.4 percent area. The final figures of the 2001 census put India's population at 1028.61 million at the early March 1, 2001, indicating a further decline in the exponential growth rate from 1.93 % during 1991-2001 to 2.0 % during 2001-2011. Earlier, the 1991 census had also revealed a decline in growth rate, albeit marginally, during the 1980s as compared to the previous decade.

In fact, since ancient times, India has been the home to considerably large size of population. Though census taking in the country is a matter of only recent past, based on archaeological and historical evidence, scholars have tried to construct the trends in population growth since ancient times. Land of the world's one of the earliest civilizations, India possessed a fairly high level of technical knowledge to support a large and dense population even some three to seven thousand years ago.

Kingsley Davis, in his pioneering book Population of India and Pakistan, has mentioned that "before the Christian era, India had a substantial population, firstly because of its advanced technology and secondly because of the fertile environment for the application of this technology" (Davis, 1968:29). One of the estimates puts India's population in the range of 100 to 140 million in 300 BC (Bhende and Kanitkar, 2000:86). The population size, however, appears to have remained more or less un-deviated for almost another two thousand years.

The underlying reasons for this un-deviated population size were the same (i.e., an abnormally high death rate) as that which checked population growth elsewhere in the world during the pre-industrial stage. According to Davis, the population of the country remained in the neighbourhood of 125 million until the middle of the nineteenth century, and thereafter a gradual increment in the growth rate began taking place. The first census in India was conducted during 1867-72.

However, it was neither simultaneous nor did it cover the whole country. This was followed by another census count in the year 1881, which was simultaneous and covered a much wider area. Since then, in the span of every ten years, census enumeration has been conducted in the country. In the early stage, however, with each census, additional territories were covered and improvement was affected in the methodology of data collection. Therefore, it will be more meaningful to confine, the present discussion on the trends in population growth during the more recent times [1].

The incrementing population and economic development are leading to a number of environmental issues in India because of the unrestrained growth of urbanization and industrialization, expansion and massive intensification of agriculture, and the destruction of forests. The major environmental issues are forest and agricultural degradation of land, resource depletion (water, mineral, forest, sand, rocks, etc.), environmental degradation, public health, loss of biodiversity, loss of resilience in ecosystems, livelihood security for the poor [2].

The rapid acceleration of population in a developing country like India is frightening the environment through the expansion and intensification of agriculture, the uncontrolled growth of urbanization and industrialization, and the destruction of natural habitats. The pressures on the environment intensify every day as the population grows [3]. The increasing population and consequent demand for food, energy, and housing have considerably altered land-use practices and severely degraded India's forests and also the environment also. The growing population puts immense pressure on land extensification at cost of forests and grazing lands because the demand for food could not increase substantially the population. Thus, the horizontal extension of land has fewer scopes and relies mostly on vertical improvement that is supported by technical development in the field of agriculture i.e., HYV (High Yield Variety) seeds, Fertilizers, Pesticides, Herbicides, and other agricultural implements. All these practices cause degradation and depletion of the environment with multiplying ratios. Poverty is amongst the consequences of population growth and its lifestyle plays a major role in depleting the environment, either its fuel demands for cooking or for earning livelihood for their survival [4]. The unequal distribution of resources and limited opportunities factors and pull factors for people living below the poverty line that in turn overburdened the population density and environment get manipulated by manifolds.

Over-population and environmental degradation

At the beginning of the 21st century, the increasing population and rising levels of consumption per capita are depleting natural resources and degrading the environment. We can notice the poverty-environmental damage nexus in India in the context of population growth as well. The pressure on the environment intensifies every single day as the population increases. The rapid increase of human numbers combined with poverty and rising levels of consumption is depleting natural resources on which the livelihood of present and future generations depends. Poverty is one of the main repercussions of population growth and its lifestyle plays a major role in environmental degradation. The increasing population in the world has been tending towards an alarming situation. According to Population Reference Bureau, it has been estimated that a 6.15 billion world population within mid-2001. The contribution of India alone to this population was estimated to be 1033 million. It is estimated that the country’s population will increase to 1.27 billion by the year 2016. The estimated population indicates that India will be the first most populous country in the world and China will be second in 2050. India is having 18% of the world's population on 2.4% of the world's total area which has greatly increased the pressure on its natural resources. Water shortages, soil exhaustion and erosion, deforestation, air, and water pollution afflict many areas. If the world population continues to increase at its pace, then the impact on the environment could be devastating [5].

A-2 DECADAL VARIATION IN POPULATION SINCE 1901

State Code	District Code	India/State/ Union Territory	Census Year	Persons	Variation since the preceding census		Males	Females
					Absolute	Percentage		
1	2	3	4	5	6	7	8	9
00	000	INDIA	1901	23,83,96,327	---	---	12,07,91,301	11,73,58,672
			1911	25,20,93,390	+ 13,697,063	+5.75	12,83,85,368	12,37,08,022
			1921	25,13,21,213	- 772,177	- 0.31	12,85,46,225	12,27,74,988
			1931	27,89,77,238	+27,656,025	+11.00	14,29,29,689	13,57,88,921
			1941	31,86,60,580	+39,683,342	+14.22	16,36,85,302	15,46,90,267
			1951	36,10,88,090	+42,420,485	+13.31	18,55,28,462	17,55,59,628
			1961	43,92,34,771	+77,682,873	+21.51	22,62,93,201	21,29,41,570
			1971	54,81,59,652	+108,924,881	+24.80	28,40,49,276	26,41,10,376
			1981	68,33,29,097	+135,169,445	+24.66	35,33,74,460	32,99,54,637
			1991	84,64,21,039	+163,091,942	+23.87	43,93,58,440	40,70,62,599
			2001	1,02,87,37,436	+182,316,397	+21.54	53,22,23,090	49,65,14,346
			2011	1,21,08,54,977	+18,21,17,541	+17.70	62,32,70,258	58,75,84,719

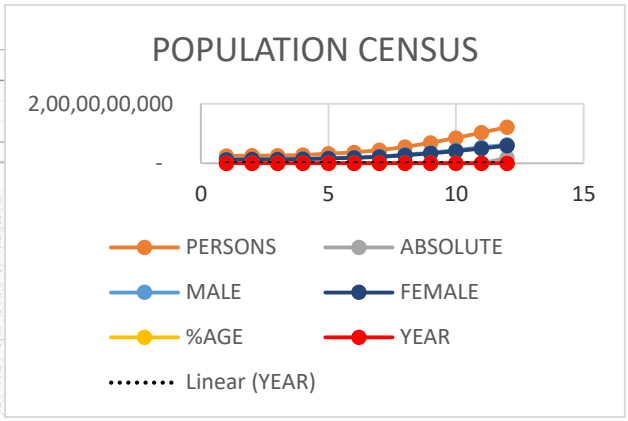


Fig. 1 Population Census since 1901 till 2011 [6-7]

Fig. 2 Population Census since 1901 till 2011 graphical representation

Tackling the covid-19 crisis

COVID-19 is the name of the deadly pandemic, given by the World Health Organisation (WHO) on February 11, 2020, for the disease caused by the novel coronavirus SARS-CoV-2**,** COVID-19 is a serious global infectious disease outbreak with nearly 3,400,000 cases and around 238,000 deaths worldwide and has incremented severely. It is a part of a family of viruses called coronaviruses that infect both animals and people. This particular one originated in China at the end of 2019, in the city of Wuhan. The economic and social disruption caused by the pandemic is devastating, more than tens of millions of people are at risk of falling into extreme poverty, while the number of undernourished people, currently estimated at nearly 690 million, could increase by up to next 132 million by the end of the year. According to the latest census it is estimated that presently INDIA is having 5,97,608 inhabitant villages, 43,324 un-inhabitant villages, and 7,933 towns, and the population is estimated to be 382 per square km. INDIA has a total of 43,486 private hospitals, 1.18 million beds, 59,264 ICUs, and 29,631 ventilators. On the other hand, there are 25,778 public hospitals, 713,986 beds, 35,700 ICUs, and 17,850 ventilators [8-9].

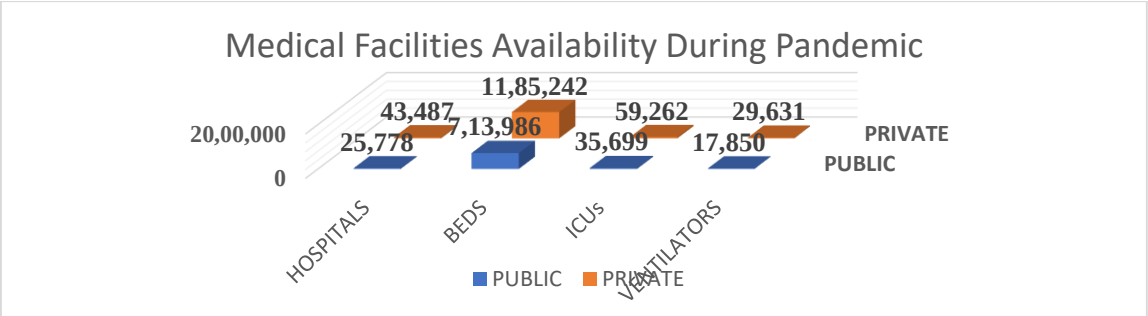
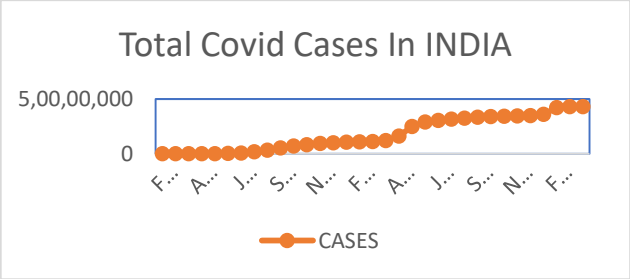


Fig 3 Medical facilities availability during pandemic graph

The graph shown in Fig 3, depicts the total number of private and public sectors hospitals with the total number of beds, ICUs, and ventilators during the pandemic period.



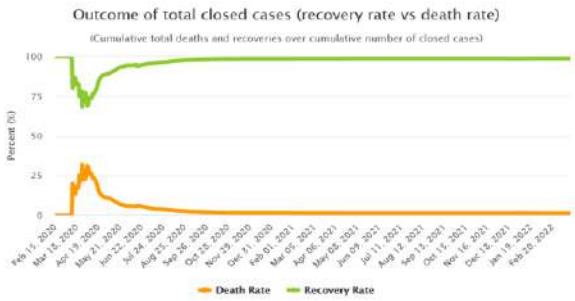
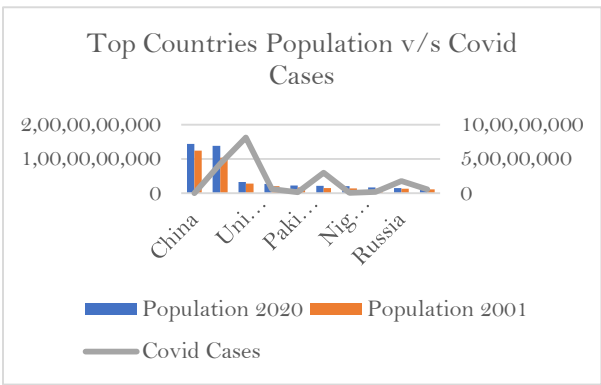


Fig. 4 Graph of total Covid cases in INDIA **Fig. 5 Graph of death rate vs recovery rate in India**

The above graph, i.e., Fig 4, illustrates the total number of covid cases in India from Feb 15, 2020, to Mar 18, 2022.

The above graph, i.e., Fig 5 [10], distinguishes between the death rate and the recovery rate in INDIA. One can easily conclude that the death rate was a bit high than the recovery rate in early 2020 and the rate reverses in late 2021.

India is a developing country and does not have any advanced medical techniques like other developed countries. In early 2020, there was a shortage of beds, ICUs, and oxygen cylinders too as already shown in fig. 4. Many peoples haven't got the proper treatment, not even the proper medical and financial facilities. In rural areas medical facilities are not too good, as a result, many people have died due to covid without any treatment. As there is a limited number of beds and innumerable patients. Moreover, many people couldn't afford private hospitals due to the high cost of medical treatment so they had to depend on government hospitals. Due to the increasing population, the risk of covid 19 also increases, thus resulting in an increasing death rate and decreasing recovery rates.



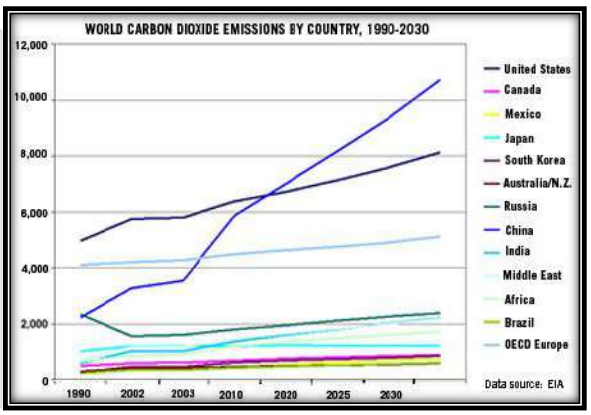
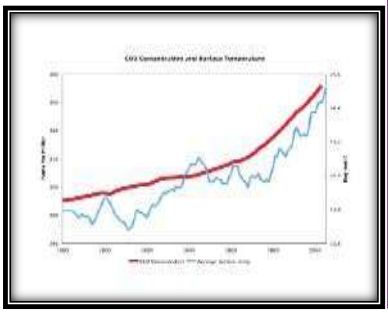
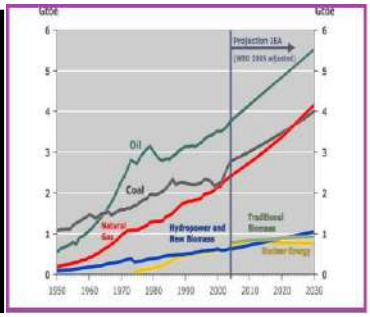


Fig. 6 Top Countries Population v/s Covid Cases **Fig. 7 World CO2 Emission Rate [12]**

Effects of overpopulation on the global cycle

The uncontrollable growth in population plays a vital and growing role in global warming. Global warming is one of the main reasons behind climate change. Human activities are highly responsible for almost all of the rapid increase in greenhouse gases in the atmosphere over the last years. The main causes of emissions of greenhouse gases caused due to human activities are such as burning fossil fuels for electricity, transportation, and the production of heat. Global warming brings an impact on the climate such as in the precipitation pattern, marine system, and ocean circulation. The expeditious growth of carbon dioxide, CFCs, and other pollutants in the environment is one of the main reasons for ozone layer depletion. Ozone layer depletion can cause different health complications such as skin cancer due to the possibility of UV rays acting directly upon the skin. Global warming causes the melting of ice caps due to excessive heat generation. Soil moisture, water availability, and rise in sea level brings an impact on the life of beings. This would also bring an impact on agriculture, forestry, a natural ecosystem like wetlands fishers, etc. Also, with the increase in heat, human life comes at a risk. The chances of health hazards increase. The condition of migrating population suffers from different diseases such as vector-borne disease. Natural calamities such as floods, earthquakes, tsunamis can also risk the lives of people and wildlife. In 2020, greenhouse gas concentrations reached new highs. Levels of carbon dioxide (CO_2) were 413.2 ± 0.2 parts per million, methane (CH_4) at 1889 parts per billion (ppb)) and nitrous oxide (N_2O) at 333.2 ppb, respectively, 149%, 262%, and 123% of pre-industrial (1750) levels. The increase has continued in 2021 [11].





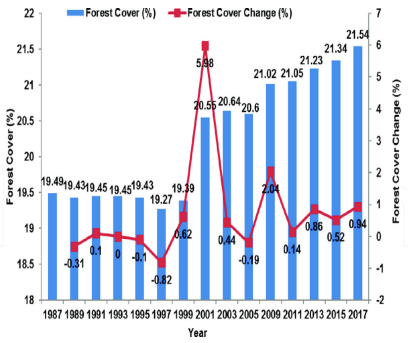


Fig. 8 CO_2 concentration and surface Fig. 9 World Natural Resources [19] Fig. 10 India Forest Cover [20] Temperature [13]

Effects on natural resources

The rapid increase in the population makes excessive demand on natural resources. With the great demand for food, the land is being over gazed and is getting eroded. Food security depends on the condition of the soil and whether it can or cannot produce viable crops. Excessive use of natural resources will lead to an energy crisis. Due to the tendency of hyper-consumption, the production of a huge amount of waste is a major threat to the environment. There are two types of resources: non-renewable and renewable resources [14].

A non-renewable resource is a natural resource that cannot be readily replaced by natural means at a pace quick enough to keep up with consumption such as oil, natural gas, coal, and nuclear energy [15].

On the other hand, a renewable resource, also known as a flow resource, is a natural resource that will replenish to replace the portion depleted by usage and consumption, either through natural

reproduction or other recurring processes in a finite amount of time in a human time scale. The extensive use of resources increases the demand for supply.

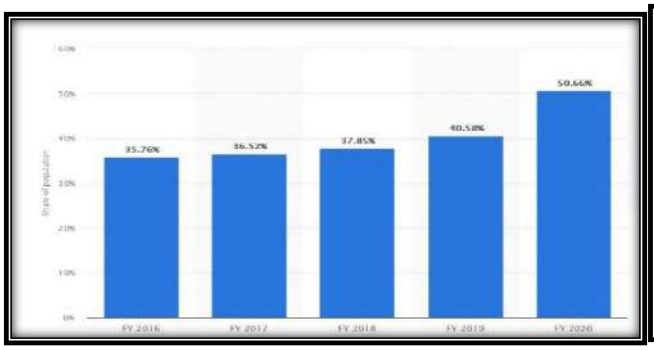
Globally, people have started replacing non-renewable resources with renewable sources such as solar, wind, biogas, and geothermal energy but maintaining these brings a huge economic challenge. It would take 1.5 earth to fulfill all our demand for natural resources. Overpopulation has increased the demand for land resulting in deforestation putting wildlife at risk.

The process of sanitization and demand for plastics has increased resulting in the destruction of land and soil. Forest area (% of land area) in India was reported at 24.27 % in 2020, according to the World Bank collection of development indicators, compiled from officially recognized sources. As of 2019, the total forest cover in India is 712,249 sq. km (71.22 million hectares), which is 21.67 percent of the total geographical area. The total forest cover as per the IFSR-2021-22 is 80.90 million hectares which are 24.62% [16-17].

Forests are one of the main sources of resources, due to overpopulation hectors of lands of forests are being deforested for one's sake, due to which many environmental problems occur such as an increase in global warming, ozone layer depletion, water, air, and land pollution and any more. As of 2019-2020, the total forest cover in India is estimated to be 712,249 sq. km (i.e., 71.22 million hectares), which is 21.67 % of the total geographical area. The total forest cover as per the IFSR-2021-22 is 80.90 million hectares which are 24.62% [18].

Availability of fresh water

Water plays an important role in one's life cycle, human body is comprised of 70% of water. So, access to Safe freshwater with proper sanitization is a basic need. Access to safe drinking water in many households is non-existent and remains an urgent need. In India, in the year 1981, approximately 38% of households were access to safe drinking water facilities which was then increased to 62 % of households in 1991. Around 27 % and 75 % of rural and urban households were access to safe drinking water facilities in 1981 it was increased to 55% and 81 % of rural and urban households in 1991 respectively. According to Statistical data the percent of safe drinking water is now raised to 50.66% in the year 2020. The situation in some rural areas is much worst. In India, there are eleven states and five union territories that were access to safe drinking water more than the national average, and the households in 13 states and two union territories were access to safe drinking water below the national average during 1991. More than 50 % of households in thirteen states and five union territories were access to safe drinking water in rural India as compared to 21 states and six union territories in urban India. In India, almost all surface water resources are contaminated and unfit for human consumption. The impact of drinking unhygienic water is more severe on the poor. The problems have become more severe in the slum areas where such basic necessities of life are either non-existent or are inadequate and extremely low in standard. The diseases commonly caused due to contaminated water are diarrhoea, trachoma, intestine worms, and hepatitis. Improper access to safe fresh drinking water leads to intestinal mortality and intestinal diseases [21-22].



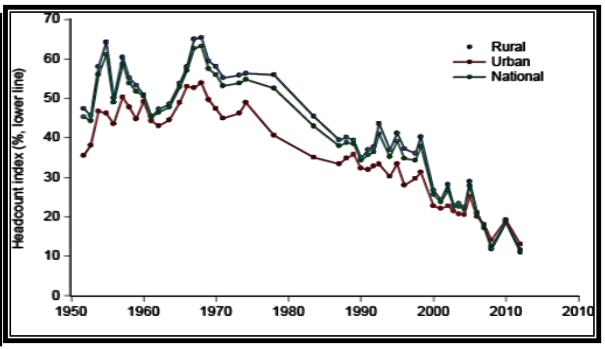


Fig. 11 Fresh water availability yearly 2016-2020 [23]

Fig. 12 Revisiting poverty reduction in India with 60years of data [27]

Trends in poverty and its environment effcets in India

India is the second-largest populous country in the world with approximately 1.38 billion population. The total rural population was estimated to be 450 million in 2017, and presently it is 506 million in 2022. Rural area consists of nearly 64.6 % of the total population of India. On the other hand, urban area consists of 35.4% of the total population of India. Most Indians reside in rural areas and therefore strongly depend on agriculture. India with a high-density population relative to resources basically faces developmental challenges in alleviating massive poverty and deprivation and in the rising quality of life of rural people. The growth performance of states has crucial implications in poverty reduction, which is an important objective of the economic policy. India's poverty reductions through the anti-poverty and employment generation programs along with overall economic growth-planning efforts have helped to reduce the poverty ratio in the country. The poverty line has declined from 55% in 1973 to 26% in 2000 and further decreased to 11.4% in 2020. India as a whole consists of 19 states and some union territories which have a lesser percentage of the population below the poverty line than the national average. There is a wide interstate variation in the poverty ratios of different states. The poverty ratio in Orissa at 47.15% is about eight times that of the population in Punjab (6.16 %). Almost half the population in Orissa and Bihar is below the poverty line. On the other hand, there are 14 states, which have less than 20 % of the population below the poverty line. The highest percentage of the population below the poverty line is found in Orissa, Bihar, and Madhya Pradesh whereas the lowest percentage of the population below the poverty line is found in Jammu and Kashmir, Goa, Punjab, Himachal Pradesh, and Haryana. Poverty is considered as both the effect and cause of degradation of the environment. Poverty and rapid population growth are seen to coexist and hence seem to reinforce each other. The poverty-stricken people, who basically rely on natural resources, consume the resources faster as they have no real prospects of gaining access to other types of resources. Poor people, who cannot meet their maintenance needs through purchase, are commonly using the property resources such as forests for food and fuel, pastures for fodder, and ponds and rivers for water. Moreover, a degraded environment can accelerate the process of impoverishment, again because the poor depend directly on natural assets or resources. It also contributes to the degradation to the environment through overexploitation of natural resources like land and water. The deterioration of natural resources and unsafe living conditions affects the environment and health of poor people [24-26].

Effects on agriculture

The extreme growth in population leads the requirement of food supply. For growing healthy crops, the land must be extremely fertile in nature but due to rapid increase in population the pollution has increased resulting in the degradation of land.

Due to the rapid growth in population, the requirement for development and construction has increased. The land for cultivating crops is decreasing but the demand for food is increasing resulting in poverty. Water pollution, land degradation, and environmental hazards are some of the main causes behind the downfall of agriculture.

Conclusion

The rate of overpopulation growth results in increasing population density, an increasing number of people below the poverty line, and increasing pressure on natural resources which contributes to environmental degradation through overexploitation of natural resources. A recent study reveals that the rapid increase in population continues to be a matter of concern for the country as it has manifold effects, the most important effects being land degradation, soil erosion, deforestation, and declining per capita land, forest and water resources. If human beings want to exist on earth, there is now high time to give top priority to protecting natural resources and the environment. Moreover, environmental protection should not only be the responsibility of the government alone but also local people and leaders should be encouraged to make dedicated efforts to eradicate the environmental problems. Special efforts should be made for concerning and educating the people and local leaders about the adverse effects of the large population through specially designed Information, Education, and Communication (IEC) activities. In order to increase green cover and to preserve the existing forests, afforestation and social forestry programs should be implemented at the local level and should be increased gradually to the national level. There is a need for preventive and curative measures to control water pollution due to chemical fertilizers, pesticides, and other wastes. More emphasis should be laid on compulsory environmental education at the school level in order to make people aware of environmental protection. The growth of population is a fundamental factor in its relationship to natural resources, the environment, and technology. Summing up the whole partition, there is an urgent need to control the growth of the population and poverty, conserve and protect natural resources and the environment for healthy human beings.

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Renewable Energy: A Solution to Green and Sustainable Future

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Introduction

"Renewable energy is energy obtained from naturally repetitive and persistent flows of energy occurring in the local environment" [1]. Inexhaustible natural resources are the core of renewable energy sources and thus are also known as 'green energy' or 'clean energy'. These energy sources have a faster renewable rate or are available in infinite abundance. For instance, sunlight, water, wind.

Fossil Fuels are often considered as the most frequently used energy source. As a result of the prolonged use of fossil fuels like coal, petroleum, these resources are slowly depleting. Thus, it is high time to replace the ever-deplorable fossil fuels with green energy resources. Solar rays, wind or water cycles are theoretically available in unlimited abundance, on the contrary the more frequently used fossil fuels are non-renewable.

There are uncountable uses of renewable energy sources such as, heating, transportation, electricity and the list goes on. Wind energy is primarily used in windmills, to grind grain and also in sea transportation, wherein the direction of the boat is controlled by the wind powered sails. The use of solar rays as a source of light and also to kindle fire has been prevalent in society for a long time. However, with the advancement in technology and developing times, humans have inclined to depend on cheaper and easily available energy resources like coal, petroleum and fracked gas. With the innovation in science and modern technology, we have discovered easy and cheaper ways to retain wind and solar energies and utilize these as important power sources. Clean energy resources are renewable and also environment friendly, thus they are gradually becoming a more important power resource. According to records, these energy resources have provided 8% of the world's electricity in 2017 and they now cover 1/3rd of the power house of Europe. Along with that, renewable energy sources take up 1/4th of the energy grid in China, and 1/6th in the United States of America, India and Japan.

The expansion of green energy resources has begun on small and large scales across the world. Some rural communities entirely depend upon green energy for heating and lighting, along with rooftop solar panels and offshore farms powered by wind energy.

Renewable Energy Resources

The naturally recurring and interminable flow of energy in the environment becomes a source of sustainable energy resource known as Renewable Energy which includes solar, wind, water (hydro and tidal), biomass (biofuels and wastes), and geothermal heat [2]. Further, non-renewable sources of energy are unsustainable, obtained from fossils that remain unscathed until human intervention.

Solar Power

Peoples are using solar power for thousands of years—for agriculture, staying warm and drying foods. The National Renewable Energy Laboratory, says that the energy coming from sunlight in an hour is comparatively more than that consumed by the entire world. Today, we have come up with quite effective ways to harness some of this energy.

Fig.1 Solar panels on the rooftops of East Austin, Texas

Fig.2 Wind turbines and a large solar panel in California

Solar, or photovoltaic (PV) cells are made up of silicon or other semiconductor materials that transforms sunlight directly into electricity. Rooftop panels are set up for households, offices, etc. to trap the solar rays and power the entire unit. Solar farms concentrate the sunlight by using solar panels which act like mirrors and by this process solar farms are generating a lot of powers.

Floating solar farms which are called "floatovoltaic" is also a useful way to use wastewater accommodations that do not tend to the cause of ecological damage. Solar energy systems are environment friendly. No air pollutants are produced by the solar energy system and maximum solar panels have less environmental impacts in their manufacturing process.

Hydroelectric Power

Hydroelectric power can be considered as primary green energy source for electricity generation. However, wind energy is on the top of the list, the effective convenience of water bodies provides hydropower generations. Fast moving water in a large river is the main source for hydropower generation. Hydroelectric power is generated by spinning turbine blade, which convert water into electricity.

In spite of its easement of access, large hydroelectric plants like mega-dams- are sometimes considered as non-renewable energy. Mega-dams divert and reduce natural flows of rivers that give restrictions on access for animal and human populations. Thus, small hydroelectric plants (below 40 megawatts of installed capacity) divert only a fraction of flow, which can minimize the cause of environmental damage.

Wind Power

With technological advancements, the present day wind-mills are more efficient than the old-fashioned ones, so much to say a turbine is of the same dimension as that of a skyscraper. If said in a theoretical way, the wind rotates the turbine blades, this mechanical energy produced is converted into electrical energy by feeding it into a generator.

Wind turbines can be located in any place with an altitude from the ground and with high wind speed i.e., in places near open water bodies. This is the foremost reason why some of the top wind-powered states of the US are- California, Texas, Oklahoma, Kansas, and Iowa. Thus, wind energy, the cheapest energy source in these states, collectively accounts for more than 6 percent of the total US power generation.

Biomass Energy

Organic materials such as dead plants, animal body waste, waste wood are most frequently used biomass energy resources. The Organic materials when scorched, it releases chemical energy by heat which produces electricity by the steam turbine.

Sometimes biomass is labelled as a clean and a greener substitute of coal and other fossil fuels for generating electricity. Although, in recent studies, many forms of biomass, especially from forest produce higher carbon emissions. There are also negative significances for biodiversity. Under the right circumstances, some forms of biomass energy can still aid as a low-carbon option. For instance, chips and sawdust from sawmills that quickly decompose and release carbon can be a low-carbon energy source.

Geothermal Energy

If you've ever relaxed in a hot spring, you've already used geothermal energy. Due to the slow decay of radioactive particles, the earth's core is almost as hot as the surface of the sun, which in turn heats up the underground water at particular places. Drilling deep wells brings that hot water to the surface, which is then pumped through a turbine to create electricity. Geothermal plants can also be artificially created where there are no underground reservoirs, but they can increase the chance to earthquake in already considered geological hot spots areas.

Tidal Power

The energy obtained from tides, mainly hydropower, is converted into electricity to serve various purposes, this type of energy is known as Tidal energy. There are several methods to enhance the production of tidal energy in particular regions. For instance, shelving, funneling, reflection and resonance. India has a vivid potential to harness Tidal energy. The effective way to harness energy from tides is- by building a reservoir to use as a barrier, so that tidal waters passing through them turns the turbines which in turn generate electricity. For this method to be cost effective, the average tidal difference should be greater than 4m along with favorable topographical conditions.

Fig.3 The Svartsengi geothermal power plant, Iceland

Non-Renewable Energy Resources

Fossil fuels such as oil, coal, gas etc. constitute the Non-renewable or 'dirty' energy resources. These resources are available in nature in a limited amount and take much longer to regenerate. The gas pumped at a station is a refined form of a finite resource, crude oil, that has been preserved in nature since prehistoric times.

The availability of non-renewable energy resources in a country is greatly affected by its geological location. These resources are so present, that in some countries coal, petroleum is present in more abundance than in other countries. This eventually leads to national security problems, as some countries have to depend more on fossil-fuel rich nations. On the contrary wind, water and solar rays are not geologically specific and every country has access to it.

Environmental pollution and its adverse effects on human health is another striking disadvantage of using Non-renewable resources. For example, while extraction of oil from the sea, it might lead to leakage which not only causes ocean pollution but kills a number of aquatic animals on a large stretch. The machinery used in coal extraction causes air pollution and also may lead to earthquakes in the proximity. All in all, extreme use of nonrenewable resources results in extensive global warming.

Renewable Energy in India with Global Comparison

India is world's 3rd largest consumer of electricity and world's 3rd largest renewable energy producer with 38% of energy capacity installed in the year 2020 (136 GW of 373 GW) coming from renewable sources [3,4] Ernst & Young's (EY) 2021 Renewable Energy Country Attractiveness Index (RECAI) ranked India 3rd behind USA and China. In November 2021, India had renewable energy capacity of 150 GW consisting solar (48.55GW), wind (40.03GW), small hydro power (4.83GW), bio-power (10.62GW) and large hydro (46.51GW), and the nuclear (6.78GW) [5]. The Indian Oil Corporation stated in August, 2019 that they wants to invest 250 Billion Rupee in renewable energy projects [6]. India has committed for a goal of 500 GW renewable energy capacity by 2030 [7].

In 2016, Paris Agreement's Intended Nationally Determined Contributions targets, India made commitment of producing 50% of its total electricity from non-fossil fuel sources by 2030 [8]. In 2018, India's Central Electricity Authority set a target of producing 50% of the total electricity from non-fossil fuels sources by 2030 [9]. India has also set a target of producing 175 GW by 2022 and 500 GW by 2030 from renewable energy [10,11].

India’s excessive population density and extreme sun irradiance are a really perfect aggregate for India's Solar power. As introduced in November 2009, Indian government has proposed launching the Jawaharlal Nehru National Solar Mission as a part of the National Action Plan on Climate Change. The target of the mission, released through former Prime Minister Manmohan Singh on January 11, 2010, focused on 20 GW of grid capacity and 2 GW of off-grid installations through 2022. The target has expanded to 100 GW by the Narendra Modi government on the same date at Union budget of India, 2015 [12]. By attaining the National Solar Mission target, India is fixing a goal to become a global leader in solar energy generation [13]. In 2020, 3 of the world's top 5 largest solar parks were in India including world's largest 2255 MW Bhadla Solar Park in Rajasthan and world's second-largest solar park of 2000 MW Pavgada solar Park Tumkur in Karnataka and 100MW Kurnool in Andhra Pradesh [14].

India's wind power development began in 1990 and has expanded significantly in passing years. Compared to Denmark and United States, India is becoming the 4th largest wind farm in the world. Indian Wind Power has an effective manufacturing base consisting of 20 manufacturers of 53 distinctive wind turbine models up to 3 MW in size and exports to Europe, US and other countries. As of June 30, 2018, India's wind power installation has a capacity of 34,293 MW [15], specifically Tamil Nādu (7,269.50 MW), Maharashtra (4,100.40 MW), Gujarat (3,454.30 MW), Rajasthan (2,784.90 MW), Karnataka (2,318.20 MW), Andhra Pradesh (746.20 MW) and Madhya Pradesh (423.40 MW). Wind power is about 10% of the total capacity of power installation in India. India has set a goal of generating 60,000 MW power from wind power by 2022.

India is ranked 5th worldwide for its hydroelectric power installed capacity. As of March 31, 2020, India's integrated utility-scale hydropower capacity has reached 45,699 MW or 12.35% of its total electricity production capacity. Additional small hydropower plants are set up with 4.380 MW

(1.3% of the total utility power production capacity) as the total capacity [16]. Up to 25 MW capacity of small hydropower plants are lying under the domain of the Ministry of New and Renewable energy (MNRE) while large hydro of above 25 MW is lying under the domain of Ministry of Power [17]. India is endowed with vast potential of pumped hydroelectric energy storage which can be used economically for converting the non-dispatchable renewable energy like wind, solar and hydro power into highest load electricity supply for its maximum energy requirements.

Indian environment is appropriate for biomass production due to its tropical location, sunshine and rainfall. The extensive agricultural potential of the country offers agro-residues, which can be useful to fulfill the energy needs both in temperature and electricity use. According to IREDA "Biomass is capable of supplementing the coal to the tune of about 260 million tonnes", saving of about Rs. 250 billion, every year [18]. The potential of biomass energy in India is estimated as 16,000 MW from biomass energy and 3,500 MW from bagasse cogeneration [19]. Biomass materials such as bagasse, rice sleeves, straw, cotton, coconut shells, soybeans, scooped cakes, coffee waste, jute waste, peanut shells and sawdust which are very commonly used for electricity generation.

The International Solar Alliance (ISA) has been launched by Narendra Modi, the Prime Minister of India and Francois Hollande, the President of France on 30 November 2015, which is now an alliance of 121 countries. India was first country in the world for setting up a ministry of renewable energy sources (MNRE) on the year 1980. A public sector undertaking, Solar Energy Corporation of India (SECI), is accountable for the expansion of solar energy industry in India.

Table1. Year wise renewable energy generation in GW as of 3 May 2019 as follows: [20]

Source	2014-15	2015-16	2016-17	2017-18	2018-19	2019-2020
Large Hydro	129.2	121.4	122.3	126.1	135.0	156.0
Small Hydro	8.1	8.4	7.73	5.1	8.7	9.4
Solar	4.6	7.5	12.1	25.9	39.3	50.1
Wind	28.2	28.6	46.0	52.7	62.0	64.6
Bio mass	15.0	16.7	14.2	15.3	16.4	13.9
Other	0.4	0.3	0.2	0.4	0.4	0.4
Total	191.0	187.2	204.1	228.0	261.8	294.3
Total utility power	1,105	1,168	1,236	1,303	1,372	1,385
% Of Renewable power	17.28%	16.02%	16.52%	17.50%	19.1%	21.25%

Renewable Energy Production by Source in India

India is the 3rd largest electric power manufacturer in the world. [21] As of December 31, 2021, India's electrical grid has a 393,389 GW of installation capacity. Sustainable power plants, including huge hydroelectric power plants, accounts for 37% of the entire installation capacity of India. During fiscal year (FY) 2019-2020, the maximum power generation by utilities was 1.383.5 Twh, and total power generation including utilities and non-utilities was 1.598 twh in India [22]. The total power consumption in FY2019 was 1.208 kWh per person. In FY2015, the world's highest electrical energy consumption in agriculture was recorded (17.89%). Despite India's low power rates, per capita power consumption in India is recorded as low as other countries.

India's power generation capacity is enormous, but its efficiency is hampered by inadequate distribution and transmission infrastructure. India's electricity sector is dominated by fossil fuels, especially coal, which can produce almost three-quarters of the country's total electricity [23]. The government has made some efforts to increase investment in renewable energy. The government's National Power Plan of 2018 will be built by 2027 as a 50,025 MW coal-fired power plant is already under construction and an additional 275,000 MW of sustainable power capacity will be added after decommissioning. An old coal-fired power plant of about 48,000 MW [24]. Contributions to non-fossil fuel power generation are expected to account for approximately 44.7% of total power generation by 2029-30.

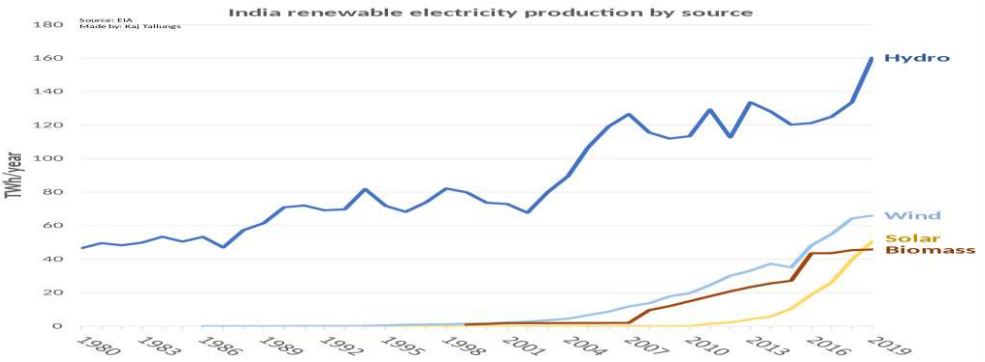

Fig. 4 Renewable Electricity Production by Source in India

Top five Renewable Energy Production companies in India are:

- **Adani Green Energy Ltd.-** This is the only company on our list that has wind, solar, and hybrid power as its product offering and this company currently has a production capacity of 13,990 MW.
- **Borosil Renewables Ltd.-** Borosil, which is popular as a glass company, engages in the production of labware and solar glass. Borosil Renewable is the only company that produces solar glass in India. With a factory in Bharuch, Gujarat, Borosil Renewables fulfils around 40% of India's solar glass needs.
- **Websol Energy System Ltd.-** The company is engaged in producing photovoltaic crystalline solar cells and related modules. The company is top-rated solar cell manufacturers in our country.
- **Zodiac Energy Ltd.-** Zodiac Energy Ltd is engaged in providing solar energy solutions to other solar power companies. The services provided by Zodiac Energy include; design, supply, installation, Testing & Commissioning (EPC) and Operation and Maintenance (O&M) of relevant equipment.

- **KP Energy Ltd.-** Formed in 2010, KP Energy Ltd is a subsidiary of the KP Group of Companies. KP Energy Ltd. is engaged in the production of wind energy infrastructure.

Proposed Initiatives to Increase Production of Renewable Energy:

Due to the finite number of non-renewable energy sources, the rate at which they are replenished is slower than the rate at which they are consumed. Therefore, renewable energy is the best alternative to providing relief during these difficult times. Keep the world's needs away from current energy sources. Profit is not only an incentive for this shift, but due to the negative effects of fossil fuels, some governments are also encouraging to shift conventional energy sources to renewable energy sources.

Solar Power

We can produce solar power in regular houses by harnessing solar lights at a smaller scale using rooftop PV cell solar panels or passive solar home design. Passive solar homes are intended so that to welcome in the sun rays through south-facing windows it can welcome in the sun rays and then hold the heat through bricks, tiles, and other materials that can hold heat.

If more than enough solar power is produced at home, then the homeowner can sell excess power and for their economical appeal they can store the excess energy using batteries for their night use purpose. Scientists are working on numerous developments that balance form and function like solar skylights and roof shingles.

Geothermal Heat Pumps

A recent domestic renewable energy sources is geothermal technology. Sometimes, geothermal heat pumps are known as ground source heat pumps that use the constant temperature of the Earth, a few feet below the surface to maintain space heating or cooling and maintain room temperatures in winter or summer. Such heat pumps are also present at the back of the refrigerator which essentially preserves the food.

Geothermal heat pump is definitely an efficient renewable energy technology and despite the high expense of setting up, has received good acceptance worldwide. Due to its fewer maintenance issues and durability, it is considered as a value for money and is not only used in residential buildings but also in commercial places.

Small Wind Systems

Small wind turbines are regularly deployed by boats, ranchers and cell phone companies. There are many dealers who help set up sites and install wind turbines for residential areas too. Again, many enthusiasts like to get their hands dirty in installing the turbines themselves. Thus, we can reduce dependency on the electrical grid, by setting up small wind systems depending on the geological location, wind speed in the area and demand of electrical energy.

Electric Vehicles

Keeping in mind, the high retail prices of petrol and diesel in India, electrically driven vehicles seem more economically viable. The retail prices of diesel and petrol in India as of 2021-22 is almost Rs.101.00 per litre and Rs.110.00 per litre respectively. Alternatively, the retail price of electricity is about Rs. 12.21/Kwh (860 Kcal/Kwh amounts to about 75% input electricity to shaft power efficiency, the calorific value of diesel is 8572 Kcal/lt at 40% fuel energy). And then the amount required to replace petrol would be Rs. 17.79/Kwh. According to statistics, in 2012-

2013 India used about 15.744 million tons of petrol and about 69.179 million tons of diesel, which is usually extracted from imported crude oil.

Electric vehicles are expected to gain popularity in India as energy storage/battery technology improves range, life, and maintenance. Vehicle-to-grid options are also appealing, as they may allow electric vehicles to help reduce peak loads on the electricity grid. India is exploring the potential to charge electric vehicles continuously via wireless electricity transmission technology.

Selling the Energy

Another smart and effective way of making people generate power by themselves, is net metering. In this many electrical utilities make the homeowners pay a lesser amount for the grid - supplied electricity. The electricity generated by the owners is subtracted from the gross electricity supplied by the powerhouse. In other words, wind and solar power generated houses can either stand alone or remain connected with the large electrical power providers and get a retail price in exchange for self-generated electrical power.

Conclusion

As fossil fuels are depleting and creating more pollution causing global warming, and also since energy demand is increasing day by day, energy production from renewable energy sources becomes the best solution in the present condition as these resources are not exhaustible, clean, and green energy. The Indian Government has planned to increase the renewable energy production capacity to 500 GW by 2030.

Despite the fact that sustainable renewable energy sources are a wider choice for a cleaner and better future, we cannot neglect the fact that the installation process of these sustainable energy generators is expensive and many cannot afford it. Thus, people who cannot personally install solar panels or geothermal heaters should advocate for renewables or resort to clean energy resources and purchase renewable energy certificates to offset their use. This small step can also accelerate the transition to a cleaner and greener future where we would not be totally void of the natural resources.

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Over Consumption of Natural Resources: A Threat to Environmental Sustainability

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Introduction

Resources that are useful to human beings to fulfil their necessity and demands are directly available from nature are often termed as Natural Resources. Depletion of natural resources increases due to faster consumption rate than that of replenishment. The idea of natural resources relates to living and non-living of our eco-system which includes plants, animals' habitant in water, fungus etc. together with soil, water and minerals. The best way to say about natural resource is to discuss about it in terms of depletion risk: are they regenerate, if so, at what rate? Some resources like trees, plants are renewable as they regenerate at a certain observable rate. Other resources like cooper, oil take a long time to form and considered as non-renewable. Natural resources together build up an opaque net of interdependence, constructing ecosystems that include human beings. The dissemination of resources gives shape of our planet and local distinguishes of our surroundings. We have built different kinds of cultural social and subsistence-based relationship with environment, acquiring value-system that go far away economic farming.

Exhaustion of natural resource has been contemplated an essential element in support of human rights and economic development. The main source of our overall development is natural resources that have grown the utilization of it time by time and with the development. Sometimes too much exploitation is damaging natural resources as well as harming the people. As a result, they are depleting and the ecosystem is facing problems.

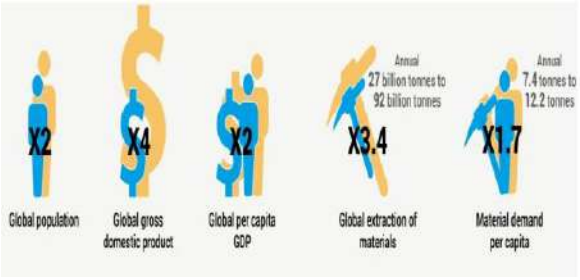
Regardless of the Stockholm Declaration of 1972, that stated the basic principles for tenable resource governance, there hasn't been much change in the human behavior. According to the International Resource Panel (IRP), which was started by the United Nation Environment Programme (UNEP), it has been noticed that there was an elevation in the demand of the material per capita from 7.4 tons in 1970 to 12.2 tons in 2017, worldwide [1-4]. This remarkably increased greenhouse gas emissions, which caused severe impacts on the natural ecosystem. In 2019, an IRP statistic pointed out the uneven distribution of natural resources, its related advantages and environmental influence across nations and regions. The material footprint of each individual seemed to vary with country's economic status. For instance, economically rich countries utilize thirteen times more than low-income countries.

As acknowledged by WWF, considering an average US resident as standard, in order to meet human dependencies on nature it would require almost four earths. As they generally depend on the other countries resource extraction, affluent countries deploy segments of their consumption when it comes to the environmental and social impacts. Simultaneously, the IRP also declared that the economy generated from these traded materials is comparatively low in the nations where they came from are originally extracted. This imbalance indicates the global inconsistencies in the dispersal of benefits and bleak results rooting from the resource use, wherein the valuable resources from rich countries do not always get benefited from their activities like unsheathe, distribution, and use, but still, they are the ones who cause the most environmental damage.

Relation between Natural Resources and Sustainable Economic Growth

Due to the excessive use of natural resources, pollution is having a tremendous impact on economic growth which is having a huge impact on society and as a result, along with economic problems, the amount of renewable and non-renewable natural resources on earth is reduced due to the environmental problems. A stable state has always relied on long-term economic growth and strives for the ability of its population to supply increasingly diverse economic products so that this advanced technology grows very well. One important factor in creating wealth that promotes economic growth is that with the decreasing and decaying character of the factor input of natural resources, we recognize the importance of natural environmental resources that is definitely going to be the most worthwhile strategy to use and achieve sustainable growth. Natural resources have such an impact on the economic chart that these resources increase its own output, but increase its rate of decline.

Natural resources are capable of meeting people's needs but have limited economic use. These assets are transformed into goods and services so that the economic value of these resources to society increases and utilization of them also increases comparatively and the overall economy becomes sustainable. But to make the economy sustainable, the utilization of natural materials resources is inevitably necessary. A few years of documents exhibit that the population has doubled while the global Gross Domestic Product (GDP) has quadrupled. This requires a large number of natural resources. It has been perceived that the utilization of natural resources has enlarged more than five times and it becomes a purpose for which there has been an increasingly negative impact in human well-being and the environment (IRP, 2019).



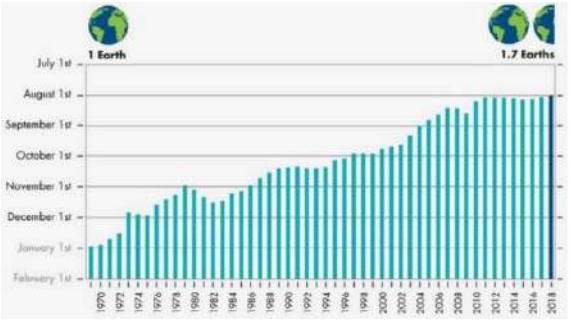


Fig. 1 Trends associated with resource use 1970-2017 (IRP, 2019) Fig 2: Earth Overshoot Day 1969-2018 (Global Footprint Network, 2018)

To illustrate the extent of this increase, in 2018 the world reached the Earth Overshoot Day on August 1, which is earlier than at any time before. That is, it will take 1.7 million years on Earth to provide nature with the natural resources. [5,6]

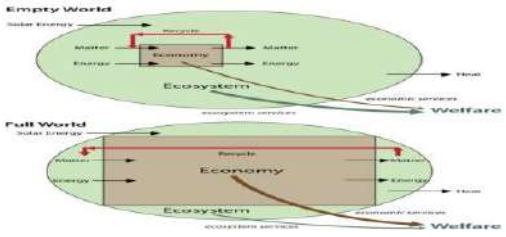
This is definitely over the Earth's capacity and a long way from gratifying the 2030 target to make a long-standing management related to natural resource and efficient use of it (SDG target 12.2 and 8.4). These tendencies emphasize the flaws in our current economic paradigm, the "old couple." The link is based on a faulty assumption: that increasing economic progress and human well-being requires an unending supply material that are recyclable extracted, processed, and disposed of as waste or emissions. However, a sustainable development requires a paradigm shift in the process of economic growth and the critical role of natural environmental resources in economic development lies on incorporating the environmental-ecological concerns when sustainable development is planned and programmed.

Importance of natural Resources in Economic Development and Human Well-Being

A standard indicator to gauge development is the Gross Domestic Product (GDP), which is based on input and output (exchange) materials used in the market. For the last 20 years, many researchers (Costanza 1997, 2014; Daly 1996, 2013, 2015; Dasgupta 2004, 2010 and others) have called for modernizing development and the associated economic approaches [7-11]. So far, we have little success. The current utilitarian view of economy still prevails with a strong focus on materials without considering the source of those materials. Nature's goods and services and its capacity to absorb and process the waste that we create, is completely overlooked in the state economies' input and output equations. Daly (2015) clearly outlines the importance of nature's services/resources towards human welfare by contrasting an Empty World model that existed in the past when nature's resources were in plenty with a Full World model that exists at present with resources becoming limited whereas the economy has expanded to its full capacity, as evident from Figure 3. The paradox is that although our economy is becoming constrained by the boundaries of the natural world, we still continue to dismiss the role of nature towards our well-being and overall economic development.

It is observed that there has an increasing Inequality between citizens in emerging and rich countries has grown in recent years. past 20-30 years and so we face social mayhem (Daly 1996; Humphreys 2003; Keeley 2015; Organization for Economic Cooperation and Development (OECD) 2008; 2017; Sen 1989; Shiva 2013; 2016).

The irony is that, despite all of the technical advancements, advances as well as extensive use of natural resources to support our material-based development over the last century, yet we can't fulfil a basic need for food for the billions of the world's populations who are starved (MA 2005e; Human Development Report (HDR) 2016; UN 2016) [12,13].



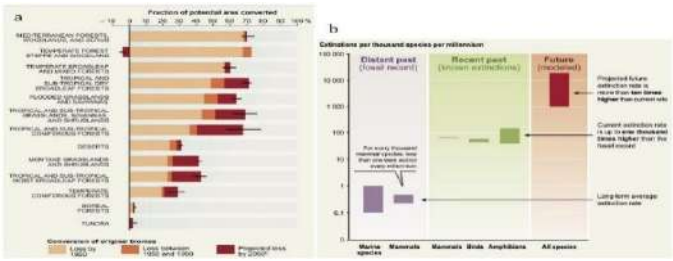


Fig. 3: Limits to growth: An Empty World model when nature's resources were abundant in the past, and a Full World model where those resources are becoming limited to contain the growth of modern economy (Daly 2015)

Fig. 4. Decline of natural systems (Source: MA 2005e): a. Conversion of terrestrial systems for cultivation systems b. Extinctions of species

From an ecological perspective, the feeling of 'oneness' and 'relatedness' to land or nature among the local and Indigenous peoples helps them to follow customs and practices that sustain land and water resources. This ethical approach seems to be the primary cause why several local and Indigenous communities have not exploited nature's resources, instead they integrated themselves with nature to co-exist as one entity. The view of 'oneness' fosters the sense of harmony with nature, particularly when we realize the basic needs for our living are directly

derived from natural systems (Fig. 5). It is something we are desperately missing in the modern world where our focus remains on materials and consumerism, using nature to produce more and more items to enhance our comforts. We often consider various aspects of human life e.g. the social, health or economics without deeming the linkages that exist between them and with nature.

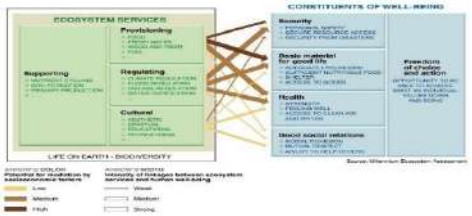


Fig. 5: Dependence of human well-being on natural resources (Source: adapted from Sangha 2015).

Fig. 6. Links between human well-being and ecosystem services (MA 2003)

A UN's initiative, Millennium Ecosystem Assessment (MA) Programme, was commenced in 2000, was considered as the first noteworthy global effort of its kind which produced several groundbreaking reports (MA 2003, 2005 a-e). The work by MA has remarkably advanced our understanding of connections with the natural systems by proposing an extensive framework of connecting ecosystem services to the well-being of the people (Fig. 6). There has been another UN initiative, an Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2017), which now obeys from the MA for connecting science with policy [14]. To date, 127 nations are signatories to the IPBES. The IPBES particularly highlights the role of nature and its resources in to public policy through developing targeted policy documents and frameworks, thus showing the way to intensify human well-being for developing tenable economies.

Interaction between Nature and Economy

Latest scientific evidence confirms that we are now in an era when human activities are having a significant global impact on Earth's natural systems (the 'Anthropocene'), leading to growing risk of global warming and exceeding the Planetary Boundaries, with resulting socio-economic and political impacts on development, leading to calls for a fast transition towards a low carbon, resource resilient economy. Simultaneously, while the European economy is still struggling to recover from the economic crisis trapped in the 'secular stagnation', the recovery program being put into practise in the EU-28 seems to have missed the window of opportunities offered by the green economy to support sustainable and inclusive development. Whilst ecological economics has established itself as a coherent but pluralist approach, based on seeing the economy as a subsystem of the biosphere and recognizing agents as social beings, more work is needed to link to other heterodox economics approaches which emphasize other challenges to mainstream economic thinking.

A new economics paradigm is required to rethink sustainability as a complex adaptive system. The neoclassical based general equilibrium modelling approaches and apparatuses are not able, by construction, to model the dynamics of a complex system, such as the green economy, which is characterized by non-linearity, multiple feedbacks, time delays, non-rationale and short-term thinking agents. Instead, evolutionary economics approaches, linked to complexity science and based on System Dynamics, Models with Agents and Network Analysis, could fill this modelling gap and contribute to understanding and action, by providing policy makers and the

broad non-academic audience accessible results, combining quantitative and narrative scenario analyses.

Therefore, the Environment-Economy Interactions research area welcomes submissions which embrace heterodox ways to analyse the finance – growth – environment nexus, such as (but not limited to):

- Methodological innovation for modelling the transition to low carbon, resource resilient economies through green policies (e.g., fiscal, monetary) using different heterodox modelling approaches in the simulation and computational areas (Agent Based Models, System Dynamics, Network analysis);
- Understanding the role of modelling uncertainty (model structure, parameters, behaviours, etc.) in the assessment of climate risks and costs, opening a dialogue among different modelling approaches with the goal to leverage added value from mutual learning eventually exploring advantages from integration;
- Evidence-based policies to finance the green economy, focusing on (i) the drivers and bottlenecks which prevent actors and financial markets to mobilize capital into the green sector and assets, disinvesting from the brown ones and reversing the current dysfunctional market allocation, and (ii) the effects of alternative green fiscal and monetary policies, regulations and incentives to unlock investors capital and promote the green transition;
- Carbon risk disclosure: development of tools for quantitative assessment of investors' exposure to carbon stranded assets and the potential trickle-down effects on the real economy, and climate stress testing in order to understand the potential sources of instability (stranding assets, green bubble) as well as how they might spread within the system;
- Climate finance policy network: Analysis of the relationships that characterise actors and stakeholders in the green economy and policy arena, with the goal of informing climate policy and increasing transparency in the progress of international sustainability governance.

The goal is to provide a platform for evolutionary and institutional economic thinking to help develop a new economic paradigm that is both sustainable and inclusive.

Cause of Depletion of Natural Resources

Natural resources are depleted when they are consumed at a faster rate than they are replenished. Natural resources exist in the absence of human intervention and can be renewable or non-renewable. Natural resource depletion is frequently defined as the value of a resource being measured in relation to its availability in nature. A resource that becomes scarce on the planet due to depletion has a higher value than a natural resource that is about to become extinct. The causes of natural resource depletion are explained in detail here.

Over population

The population growth rate is the reason for the decline in natural resources. The world's population exceeds seven billion people. Expands the need for resources and conditions require to sustain population growth. According to research, developing countries are focusing heavily on their growing populations with the goal of increasing industrialization and using more resources to do so. When it starts to live in the 19th century, in world history for the first time the number of

people exceeded more than 1 billion. Afterward growth enhanced and around 1920 the number of people surpassed by 2 billion. With this continuous growth, another billion had been added by 1960 that takes time 40 years while it was supposed to take 120 years' time. And it sustained to go even quicker: 4 billion by 1974, 5 billion by 1987, 6 billion by 1999 and 7 billion in 2011. [15-17].

Poor Farming

Agriculture has been practiced in human society for the last 10,000 years. But for most part, human population stayed under 1 billion. Today, in order to ensure enough food is produced, farmers have to adopt "modernized" agricultural practices. But the increased use of chemicals, as fertilizer and pesticide, has disturbed the natural composition of nutrients in the soil. Most farmers overuse these products. If a farmer overuses the NPK fertilizer, the nitrogen, phosphorous and potassium content of the soil drastically increases. While this may aid in the growth of nearby crops, most plants cannot survive in such harsh conditions. In the long run, increasing nitrogen, phosphorus, and potassium in the soil causes the soil to become more acidic, reducing nutrient uptake. As a result, after a critical threshold is reached, adding fertilizers has no increasing benefit. According to research, we can get the same yield with 40% less fertilizer than is currently applied to fields. Excess macronutrients, especially nitrogen and phosphorus, are washed away by irrigated water and end up in local water bodies, causing eutrophication.

Logging

Logging activities have numerous impacts on aquatic systems in the Sierra Nevada. The end result of logged landscapes is a highly altered forest system which creates significant problems related to erosion, sedimentation and altered stream flow patterns. Logging removes large trees that normally fall into streams and provide shelter and thermal cover, raises water temperatures and pH, and deteriorates chemical and environmental conditions and food webs that fish need to survive. Logging and the roads created to facilitate logging also significantly degrade stream ecosystems by introducing high volumes of sediment into streams, changing natural streamflow patterns, and altering stream channel morphology. Major landslides and erosion events, which deposit abnormally high levels of sediment into area streams, are far more likely to occur in logged areas. Roads, ditches, and newly created gullies form new, large networks of flow paths across the landscape. These logged areas therefore, sustain much higher discharge volumes after a storm event than they ever did when the forest was intact.

Industrial and Technological Development

Today's world has become advanced in terms of industrialization because more countries are making breakthroughs every moment. But with the advancement of technology, there is a substantial growth of industries that exert toxins and chemical wastes that are eventually deposited in different areas of our environment like lakes, soils, and lands. In fact, if you want to be more formal, you can say, this leads to alteration of natural habitat of wildlife and aquatic system.

Few examples are acidic lakes, death of aquatic life, dead zones. Then comes the demand of raw goods for the progress of mankind.

Consequences of Depletion of Natural Resources

Natural resource depletion is now widely regarded as a major environmental concern. Human quality of life and unrestricted economic growth are major contributors to depletion, and it has

been suggested that we need to improve our lifestyles in order to consume fewer non-renewable natural resources. Here are some of the consequences of natural resource depletion.

Water Shortages

Poor agricultural practices, deforestation, then there are all types of pollutions which is wastage is a major source of depletion, contamination and the destruction of our natural water catchment places. It's already affects to the society. Water use has increased at a rate more than twice that of population growth over the last century, and an increasing number of regions are experiencing shortages. It's reaching the limit at which water services can be sustainably delivered, especially in arid regions. Still now, nearly one billion people are void of clean water access. This results in several famines and food insecurity. Most of the water extraction is in utilization definitely for agriculture and it becomes a certain and major discussion to make the agricultural sector a sustainable user of water resources maintaining our growth of economic development associated with this sector. Let's take a view on the situation in India [18].

Loss of Forest

Nearly, 18 million acres of vast forest cover are destroyed every year that shows that nearabout half of the world's natural forest has already been destroyed. Furthermore, researches give an indication of increase in deforestation in the last three decades has emerged to a 12% to 17% increase of greenhouse gases all over the globe [19]. Other disastrous effects of deforestation involve soil erosion, a high increase in the greenhouse gases resulting to global warming, deprivation of biodiversity, then there is increased flooding, and drought.

Global Warming

Global warming is now the biggest problem of all ages. Our world is constantly warming up more and more and we are definitely part of this problem and also cause of this problem. It is a phenomenon of climate change characterized by a general uptick in average temperatures of the Earth. However, the increase in greenhouse gases is linked to human activities. It's no surprise, then, that the world's top climate scientists believe human actions are the chief cause of global warming since the mid-twentieth century.

Solutions for Natural Resource Depletion

We need to use more natural resources that includes minerals, water and more due to continuous Economic development and population growth. Often, we use these resources brisker than the nature's replenishment. As per Global Footprint Network, in 2018 [20] the utilization of resources in one year becomes equal with that in seven months. Once a day will come when the earth is fully out of resources and there would be no path to revert back. We need to take some immediate essential actions for saving our earth for our better present and bright future. Natural environmental resource conservation has become a thoughtful area to discuss and we have taken a few steps to begin protecting our environment.

Make Electricity Use More Efficient

Electricity acts a major part in our livelihood and as we have become accustomed to it now it is difficult to exist without electricity. However, without thinking about its safety and potential use, we use energy to a greater degree. Starting to save electricity is necessary so that we can also save it for our future generations.

There are different methods by which electricity can be saved, including turning off the appliances while not in operation, saving thousands of watts. Often, we can save a great deal of

energy if we use our air conditioners, washing machines and other electrical appliances wisely. For example, we should use natural sunlight during the day instead of using lights and lamps to light up the room. We can start using alternative methods of saving energy. Usually, the old appliances consume more watts than needed, so we have to replace our old appliances with the new ones in order to remain energy-efficient.

In every sphere of existence, electricity is required, almost everything and work is dependent on electricity. The stations of the railways, airports, corporate offices, processing units, hospitals, etc. all use electricity to do their everyday work. So, if we don't use energy efficiently, one day it will disappear and we won't be able to live on Earth any longer. Saving is the only way left to conserve electricity, so all human beings need joint efforts to maintain this crucial necessity of life.

Advanced technologies, such as smart thermostats, also help conserve energy by automatically turning appliances on and off as needed.

Controlling Deforestation

Working to end forest degradation and deforestation while helping to restore lost forests is our best chance to solve the climate emergency, protect wildlife, and defend Traditional local communities' and Indigenous Peoples' rights. Greenpeace's forest campaign historically has called for an end to deforestation but our current climate emergency requires a genuine and just restoration of all natural ecosystems, and reduced degradation of the world's most critical landscapes. Few steps are required to be taken as follows to control deforestation.

- Support efforts to amplify the voices of Indigenous Peoples and traditional forest communities.
- Reduce your consumption of single-use products.
- Demand that the forest-derived products you purchase are made from 100% post-consumer recycled content materials and when products are made from virgin forest, demand that the sourcing is done in an environmentally and socially responsible manner.
- Make informed food choices. There is a myriad of reasons to adopt a plant-based diet or reducing your animal products consumption including the protection of forests and nature.
- Demand that companies commit to reduce deforestation through forest-friendly policies and follow through on those commitments.
- Educate your friends, family, and community about how our everyday actions can impact forests around the world.
- Demand that your governments only source forest commodities in a way that protects the environment and respects our rights.
- Avoid false solutions like biofuels, biomass, or carbon offsets that rely on wishful thinking, yet in practice release more greenhouse gas emissions.

Utilization of Renewable Energy Resources

Renewable energies (or renewables) are ways to generate energy from (theoretically) unlimited natural resources. These resources are either available with no time limit or replenish more rapidly than the amount they are consumed.

Renewable energies are generally spoken of as opposed to fossil fuel energies. The fossil fuels' stocks are limited and non-renewable in the human timescale. The most known examples of these resources are coal, oil or natural gas. On the contrary, renewable energies are produced from renewable sources. Here, we're talking about energy coming from solar rays, wind or water cycles – all theoretically unlimited on a human scale time.

Renewable energies are also often referred to as "green energies" or "clean energies". Still, this doesn't mean that these energies aren't harmful to our surroundings and have lesser impact. Nonetheless, they have a low environmental impact compared to fossil fuels. That's why they're increasingly becoming important elements in companies' CSR strategies in terms of sustainable development.

There are several types of renewable energies that are produced by different sources such as the sun, wind or water. In fact, these renewables' power consumption has been rising over the past few years. They have provided 8% of the world's electricity in 2017 and they now cover 1/3 of the power mix in Europe. At the same time, the energy grid gets 1/4 of the total energy in China and 1/6 in the United States, India, and Japan.

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Application of nanotechnology in clean energy production

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Introduction

Clean energy is generated from renewable energy sources which emission free and do not pollute the atmosphere. Examples of these sources of energy include solar, wind, biomass, hydrogen and geothermal energies. The current global energy problem can be attributed to insufficient fossil fuel sources and excessive gas emissions resulting from increasing fossil fuel consumption. It was reported that the present petroleum consumption was 105 times faster than nature can create and with such huge rate of consumption, the world's fossil fuel reserves will be replenished by 2050. Also, it is interesting to mention that the global demand for energy is predicted to be approximately 30 and 46 TW by 2050 and 2100, respectively.

Fossil fuels are crude oil, coal and natural gas meet 90% of our energy demand but at the cost of our environment. Energy generation from fossil fuels has been identified as the main reason for environmental pollution. The concentration of CO_2 in the environment has increased from 280 to 370 ppm over the past 150 years. It is expected to cross 550 ppm in this century.

Renewable energies are sources of clean, inexhaustible sources of energy that neither produce greenhouse gases nor polluting emissions. Growth in clean energies is the only way to address the current energy crisis that the world is going to face in the coming years. According to the IEA (International Energy Agency), world electricity demand will have increased by 70% by 2040. Nowadays, there is a huge interest in this subject since it is expected to provide 50% of the world's primary energy by 2040. Moreover, renewable energy can play a crucial role to reduce gas emissions to the environment by about 70% during 2050.

On the other hand the emerging field nanotechnology can be successfully applied for clean energy production. Nanomaterials are substances, which have at least one dimension less than 100 nm. Their exceptionally small dimensions provide a high surface area to volume ratio which increases the number of active sites for various reactions and processes. Nanoparticles (NP) also have different morphologies which have further increase their scope of application in different fields.

Nanomaterials are exceptional candidates in numerous biofuel systems due to their large surface areas and special characteristics including high catalytic activity, crystallinity, durability, efficient storage, stability as well as adsorption capacity [11]. In addition, nanostructured materials, in comparison with large particles, have a faster reaction rate with other molecules [10]. A number of direct and indirect applications of nanomaterials in bioenergy production have been reported.

Biofuel production involves different bioprocesses, rate of which can be enhanced with the use of nanoparticles. The different nanoparticles used in different bioprocesses are nanofibers, metallic nanoparticles and nanotubes. Nanoparticles mainly act as catalytic agents in the bioprocesses and also can take part in enhancing the growth and activity of anaerobic bacteria involved in biogas production. Nano-crystals, nano-droplets and nano-magnets are also used as nano-additives which increase the efficiency of biofuel - petrol and biofuel-diesel blends.

Application of nanotechnology in solar energy & solar cells

Solar energy is one of the best sources of renewable energy. It can be used efficiently in various practical applications like solar power plants, solar cell, seawater desalination, solar collectors etc. In fact, sunlight falling on Earth offers a solution, since the hourly solar flux incident on Earth's surface is greater than the annual human consumption of energy in a year [1]. That is why the sun is appearing as an ultimate energy source on the earth. The quantity of solar energy received by earth is a function of the season, with the highest quantity of incoming solar energy received during the summer months [2]. The big challenge in using these devices is the clear weakness in the absorption properties of the conventional fluids which leads to reducing the efficiency of these devices. Nowadays, this problem can be solved easily and effectively by using the concept of nanotechnology. The increased surface area to volume ratio of nanoparticles should enhance solar energy collection and efficiency by exposing more conducting surfaces to the sunlight. Another area that nanotechnology will increase solar cell efficiency is by using materials like lead-selenide. These materials cause more electrons (and therefore more electricity) to be released when hit by a photon of light [3]. Furthermore, the cost is a major factor in the success of any solar technology. Because, converting solar energy into electricity occurs at a price comparable with fossil fuel. Semiconductor materials that exhibit a photovoltaic (PV) effect can be used to convert solar radiation into electricity through a photovoltaic process. Photovoltaic are surfaces typically consisting of a conducting oxide layer and a catalytic platinum layer that directly convert sunlight to electrical energy. If a distributed solar grid meets 1% of the world's electricity demands, approximately 40 million tons of carbon dioxide emissions can be saved per year. QDSSCs can be utilized to develop highly efficient solar cells. Sandeep Kumar et.al. (2017) reviewed the progress of QDSSCs along with future scope of innovative graphene structures like graphene-semiconductor nanomaterial, graphene-carbon nanotubes and graphene-metal nanomaterial hybrids in PV cells. In addition to graphene, they discussed other 2D materials that have remarkable optoelectronic properties for PV devices. Present available nanotechnology solar cells are not as efficient as traditional ones, however their lower cost offsets this. In the long term nanotechnology versions should both be lower cost and, using quantum dots, should be able to reach higher efficiency levels than conventional ones.[4] The conventional materials used in solar cells generate just one electron whereas quantum dots produce three electrons for every photon of sunlight that hits the dots. Electrons moves from the valance band into the conduction band. The dots also catch more spectrums of the sunlight waves, thus increasing conversion efficiency to as high as 65 percent. Another application of quantum dots could be in the making of hot carrier cells. Usually the extra energy supplied by a photon is lost as heat, but with hot carrier cells the extra energy from the photons result in higher-energy electrons which in turn leads to a higher voltage [4, 5] . The transport of electrons across the particle net-work is the major problem in achieving higher photo conversion efficiency in nanostructured electrodes. Utilization of CNT network support to anchor light harvesting semiconductor particles by assisting the electron transport to the collecting electrode surface in DSSC. Charge injection from excited CdS into SWCNT excitation of CdS nanoparticles. When CNTS attached in Cdse & CdTe can induce charge transfer process under visible light irradiation. The enhanced interconnectivity between the titanium dioxide particles and the MWCNTs in the porous titanium dioxide film was concluded to be the cause of the improvement in short circuit current density.[5]

Nanotechnology might be able to increase the efficiency of solar cells, but also reduce the manufacturing cost. Chemists at the University of California, Berkeley, have discovered a way to make cheap plastic solar cells that could be painted on almost any surface. These new plastic solar

cells achieve efficiencies of only 1.7 percent; however, Paul Alivisatos, a professor of chemistry at UC Berkeley states, "This technology has the potential to do a lot better. There is a pretty clear path for us to take to make this perform much better" [6,7]. Picture of a solar cell, which utilizes nanorods to convert light into electricity, is shown in fig.1. These new plastic solar cells utilize tiny nanorods dispersed within a polymer. The nanorods behave as wires because when they absorb light of a specific wave-length they generate electrons. These electrons flow through the nanorods until they reach the aluminum electrode where they are combined to form a current and are used as electricity [38].

Tidal/water energy:

As the Earth rotates the repeated changes in the oceanic and sea level leads to the formation of tides. These regular rise and fall of tides are utilised for production of tidal energy. Thus tidal energy represents another important source of renewable as well clean energy [8]. Use of tidal energy dates back to Roman times. The US and Europe have been using rotating turbines to generate electricity since the 19th Century.

Though not used widely, tidal energy has tremendous potential for generation of electricity in future. Importance of tidal energy is due to facts like (a) 70 percent of the earth's surface is covered by water and (b) World's potential for wave energy is about (10,000–15,000 TW h) per year. The major drawbacks are the high cost of the process and lack of suitable sites with high tidal flow. However, application of recently developed technologies indicates that the process cost can be brought down to a competitive level and consequently the availability of the tidal power will be much higher than calculated earlier.

The power obtained from the sea waves can be used in water desalination, hydrogen production, ocean mining, liquid and solid state synthesized fuels and ice production [9].

Qu et al. [10] in their recently reviewed application of nanotechnology to develop next-generation water supply systems. They explained that nanomaterials due to their high surface volume ratio have high photosensitivity, electrochemical, optical, and magnetic properties. These features can be useful for developing sensor based technology for water quality monitoring, membrane technology, selective adsorbents, disinfection, decontamination, etc. They also highlighted that along with the application of nanotechnology, the possible impact on the environment should be given equal emphasis to develop sustainable water management systems.

Wind energy & Wind turbines

Wind energy is another type of renewable energies where wind is used as the source of energy. A wind turbine converts the kinetic energy of the wind into mechanical or electrical energy which can be utilized for practical purposes. As wind turbines do not need any fuel, they are considered to be the most eco-friendly energy source. Wind power plants are dependent on wind speed and wind speed needs to be at least (13–15 m/s). The energy provided by a wind turbine is proportional to the square of its blade length. For more information about wind energy, the reader can be go back to Sherif et al. [11] and Dalili et al. [12]. Recently, more than 23 billion kW h of clean and cheap electricity are being produced annually around the world. India power production utilizing wind energy is estimated around 1000 MW, while Germany produced about 4400 MW of electricity from wind energy [100]. As of 2011, Denmark is generating more than a quarter of its electricity from wind and 83 another countries around the world are using wind power on a commercial basis. In 2010, wind energy production was over (2.5%) of total worldwide electricity usage and growing rapidly at more than (25%) per annum [13].

Nano-composite materials have an excellent strength to weight and stiffness to weight ratios. Therefore, they enable the construction of longer, stronger blades of wind turbine. Several researches have shown the improvement of composites properties by adding nano-reinforcement in matrix. Additions of small amount (at the level of 0.5 weight%) of nanoreinforcement (carbon nanotubes or nanoclay [14]) in the polymer matrix of composites, fiber sizing or inter laminar layers can allow to increase the fatigue resistance, shear or compressive strength as well as fracture toughness of the composites by 30–80% [15, 16]. Loos et. al.[17] developed various wind turbine blades with secondary carbon nanoparticles reinforcement (vinyl ester, thermoplastic, epoxy composites containing CNTs) and demonstrated that the incorporation of small amount of carbon nanotubes/CNT can increase the lifetime up to 1500% . Another group of researchers [18] used graphene as a secondary reinforcement for the modification of wind turbine composites and developed stronger, long-life turbine blades for the wind industry. Merugula et.al. [19, 20] calculated that the addition of 1–5 wt % of carbon nanofibers to the interfaces of glass fiber reinforced epoxy composites for blades in 2 MW and 5 MW turbines leads to improved tensile stress and modulus, and allows 20% weight reduction of the blades which will also increase longevity. Also, the feasibility of using hybrid and nanoreinforced composites in wind blades, as a replacement for the currently used glass fiber/epoxy composites is evaluated in [21]. It was demonstrated in numerical studies that the gains in the lifetime of the composites justify additional investments to produce the wind turbine blades from hybrid and nanoreinforced composites. Still, as noted in [22], there remains a lot of practical and economical challenges before the nanoengineered wind turbines are used. Nanotechnology can also be used to increase the wind turbine efficiency by reducing energy losses caused by some tribological issues like micro-pitting, wear, scuffing and spalling in gear boxes. Nano-lubricants can be used to address the problem [23]. Greco et al. [24] evaluated experimentally using a sliding contact linear reciprocating rig, the friction and wear behaviors of a boron nitride based surface treatment and nano- particle lubricant additives for wind turbine gearbox applications to accommodate severe operating conditions and mitigate surface originated failure. Nano-colloidal boronnitride based lubricant additives were considered as a complementary technology to react with the borided surface to form a wear protective tribofilm.

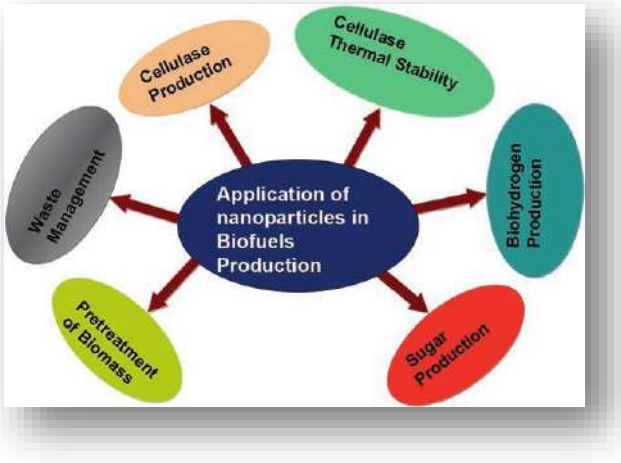
Biomass/bioenergy

Biomass energy is derived from the residue of plant and agricultural remains. The main components of biomass are cellulose, hemicellulose, lignin along with proteins, pectins and extractives). Lignocellulosic biomass energy was estimated that only 3% out of 13 billion t/y of plant residues were fabricated into manufacturing goods and the remaining were left for decomposition [23]. Therefore, these plant residues can be properly utilized by converting them into bioenergy. Bioenergy is the only alternative and cheap source of energy which can be made easily available to the world. Biomass is presently estimated to contribute of about 10–14% of the world's energy supply [25, 26].This can be increased by the application of the newest technology available with nanoscience. Thus, incorporating nanotechnology into these alternative biomasses could greatly contribute to bioenergy production by acting as an aid to improve efficiency in various applications such as manufacturing, energy resources, transportation, mechatronics, healthcare and pharmaceutical technologies.

A lot of research is going on microalgae as the third-generation biofuels feedstock with a wide diversity of photosynthetic species [35,36]. The ability of microalgae to grow in adverse conditions, high carbon dioxide uptake and rapid growth have made them an alternative biofuel feedstock. These microalgae-based biofuels have similar chemical properties compared to those

from fossil fuels which are deemed to be a promising natural source for bioenergy production. MNPs which comprise a magnetic core (e.g., magnetite (Fe3O4) or maghemite (g-Fe2O3)) are some of the most profound inorganic nanomaterials [20]. The MNPs are most frequently used over all the nanoparticles examined for bioenergy production since their magnetic properties give them easy recoverability. Several reports are available which show magnetic nanoparticles (MPNs) can be used for the hydrolysis of the microalgae cell wall by immobilizing cellulase on MNPs followed by lipid extraction [44]. MNPs used for immobilizing cellulase allows the microalgae cell wall to be hydrolyzed easily for the release of lipids. Due to the high surface-to-volume ratio of these MNPs facilitates the rate of hydrolysis in comparison to usual chemical methods also the separation of the NPNs is easier and can be recycled and reused which minimizes the overall process cost.

Yet, the limitation of MNPs has evolved nanobiocatalysts through using silica-based NPs (Si-NPs), nickel-based NPs and carbon nanotubes. Si-NPs are usually coated on the surface of the nanoparticles which functions to immobilize a lignocellulolytic enzyme such as cellulase.



Biofuels:

Biofuels are considered as a potential automotive fuel with a bright future. Bio-Ethanol and bio-methanol made by certain yeast are considered as excellent biofuels and are highly flammable. Currently, Brazil and USA account for nearly 80% of global biofuels production. They produce mainly bioethanol(USA from maize and Brazil from sugar cane). Bioethanol has similar auto-ignitability properties to those of gasoline fuel. In the next few years use of biofuels is expected to show **a** sharp growth. Nanomaterials has been tested as additives on biofuels which increase various properties like viscosity, flash point density, cetane number and many more. This will accelerate the growth in demand for biofuels, as they are expected to make an increasing contribution to meet the future energy needs of mankind [27]. Sajith et al. [32] illustrated experimentally that using nano-sized cerium oxide particles as additives on biodiesel fuel were found to appreciably reduced the emission levels of hydrocarbons and NOx components. Several reports are available which show use of metal-oxide NPs as a fuel additive can enhance the physicochemical properties of biodiesel [45]. Cerium oxide NPs increase the fluid layer resistance and viscosity thus increasing the lubricating property and overall increasing the fuel delivery performances. Available reports make it clear that metal-oxide NPs are thermally stable to promote the oxidation of hydrocarbons and the reduction of nitrogen oxide. Aluminum and silicon based NPs also improve the combustion quality of biodiesel engines [45]. Other applications include improvement of cetane index on using carbon nanotubes, increase in both cetane number and calorific value on using iron oxide-based NPs. Nanofluids as additives are also promising for the improvement of brake thermal efficiency of diesel engines, as these additives promote complete combustion due to the higher evaporation rates, reduced ignition delay, high flame temperatures and lengthy flame sustenance [41,43]. Other effects such as carbon monoxide emission, hydrocarbon emission, NOx emission, combustion and evaporation can be resolved by

adding nano-additive blends into biodiesel fuel. Despite having many benefits, the production cost of NPs stands in the path of commercialization of nanofluids.

Enzymes used in biodiesel or bioethanol generation can be immobilized with MNPs as a carrier. Meanwhile, Nematian et al. [39] reported the use of superparamagnetic nano-biocatalysts for the conversion of bio-oil extraction from Chlorella vulgaris microalgae to biodiesel production. The results showed that the transesterification reaction using 3-aminopropyl triethylenesilane-glutaraldehyde (MNPs-AP-GA) was 69.8 wt %. Application of nanomaterials such as high metal concentration (Fe) during the cultivation of microalgae Chlorella vulgaris increases the lipid accumulation in the algal cells [42]. Nanoparticles also prevent algae from dying and bring up the re-cultivation process from these extracted microalgae [43].

Biogas

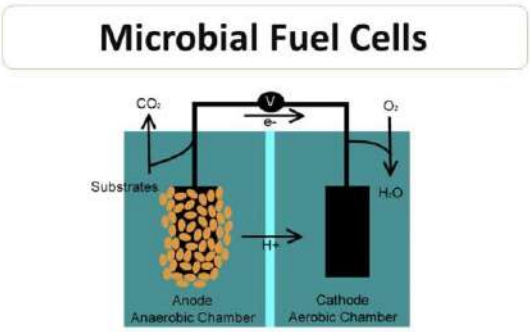
Biogas is flammable gas with a composition of 40 % carbon dioxide and 60% methane approximately which can be used instead of natural gas for heating and cooking and is considered to be an important source of renewable energy. Biogas is generated during the anaerobic digestion of biomass waste (organic matter). The success of gas production depends on the activity of two groups of bacteria; acidophilic and methanogenic bacteria.

Since the introduction of the term nanotechnology by Feynman in 1959, researchers have been exploring the effect of nanomaterials in a variety of fields along with energy production from biomass. Application of nanotechnology for production of biogas via anaerobic digestion (AD) of biomass waste is a very attractive and challenging task. However, the adoption of nanoparticles (NPs) to the AD process can influence its performance. Till date three types of nanoparticles i.e. metal oxide NPs, zero-valent metallic NPs, and carbon-based NPs are being studied for their use in AD. Otero-González et al. [39] investigated the long-term effect of the addition of 1.4 mg/l of 37 nm CuO nanoparticles (NPs) on the rate AD of anaerobic granular sludge (AGS). Luna-delRisco et al. [38] applied both micro-sized and nano-sized CuO (5 mm–30 nm) and ZnO (15mm, 50–70nm) particles for biogas production during anaerobic digestion of cow dung under optimised conditions. Both the nano-sized CuO and ZnO showed the negative effect on the rate of biogas production probably due to the toxic effect of nano-materials on the anaerobic bacteria. But with the advancement of time, an increase in biogas production was observed, which indicates the anaerobic bacteria became familiar with the toxic effect of the added materials. Thus the addition of metal oxide NPs showed a mixed effect on biogas production whereas zero-valent metallic NPs could be regarded as the most promising for enhancing biogas production especially the Ni and Co NPs.

Microbial Fuel Cells (MFCs)

A typical MFC is made up of two electrodes (anode and cathode) and a semi-permeable membrane known as the proton exchange membrane. The most common materials used for electrodes are carbon and graphite. The ideal electrodes should have high electrical conductivity and thermal stability, low resistance, highly biocompatibility, large surface area, good mechanical strength and also low production cost. The anodic chamber of MFC is made up of an anode, microbes (bacteria) and a substrate.

An essential aspect of the anode is the ability of the microbes to facilitate the formation of biofilms and increase the probability of EET to occur. The most common materials used in the fabrication of anode are graphite or carbon with variable size and geometry. On the other hand, the cathode is the electrode where the oxygen reduction takes place. Overall, the limiting factor of the process is the oxygen reduction reaction occurring at the cathode. Another component of MFC is a physical membrane that separates anode and cathode called the proton exchange membrane (PEM).



There are a few challenges that need to be addressed to produce bioenergy in pilot-scale by MFC.

Low power density: The maximum power density achieved by the conventional electrodes is about 26 mWm−2 for 3D graphite rods

Temperature dependent: can operate only at optimal temperature

Biocompatibility of the materia

High manufacturing cost of the MFC components

Use of nanomaterial has revolutionized the fabrication of MFCs parts and the production of bioenergy compared to the traditional MCFs. Nanomaterials are mainly used for modification of electrodes (anode and cathode) and the overall performance of MFC depends on the electrodes. The nanomaterials successfully used for electrodes are (a) metal nanoparticles like copper, gold, platinum, palladium and silver (b) CDs, CdSe and ZnS quantum dots (c) metal-oxides (i.e., CeO2, TiO2, ZnO, SiO2, Al2O3 and MnO2), (d) graphene and carbon and (e) nanocomposites. However, the use of nanomaterials in the modification of components of MFC in the pilot-scale is still in progress due to the high production cost.

Conclusion

The present work gives a comprehensive overview and understanding of nanotechnology applications in renewable energy field. For example, nanotechnology makes a huge revolution in the size and design of renewable energy devices utilized for energy conversion and storage, environmental monitoring, as well as green engineering of environmental friendly materials. It is shown that, nanomaterials play a significant role on the human life, by providing a cheap and clean energy which is now become a global industry. Some important conclusions are summarized below:

The use of nano-materials in the renewable energy field can play a crucial role in increasing the efficiency of solar cell, fuel cell and wind turbine. Nanotechnology can improve the developed country's ability to reduce the environmental impact of burning fossil fuels to produce energy. Nanotechnology makes a significant reduction in the cost of expensive components, such as solar cells as well as in the areas of hydrogen production and storage. Nanotechnology can be considered as a key enabler of the increasing hydrogen energy utilization. Bio fuels industry greatly improved by utilizing nano-particles. Further researches are needed to study the effect of nanotechnology in geothermal, wind and tidal energies, since the number of published papers in these fields are very limited compared with the corresponding papers related with the other types of the renewable

energies.

Solar energy has tremendous potential which is yet to be harnessed by us. Going by the statistics, we hardly have the technology and infrastructure at present to tap its full potential and protect our environment to a large extent from the dangers and harmful consequences of using non-renewable resources for energy production. The application of nanotechnology in solar cells has opened the path to the development of a new generation of high-performance products. Nanotechnology is absolutely crucial to achieving high efficiency solar power. The best solar cells out there are tandem multi-junction cells consisting of several thin-film (< 1 um) layers of semiconducting materials. Nano-scale patterns are used to enhance photon absorption. Fuel cells are a great source of clean energy production which involve the redox reaction of Hydrogen and Oxygen to produce water as a byproduct. But they have been discovered and in use since a long time now. What is new about modern fuel cells is that scientists have used nanotechnology to develop vastly superior fuel cells designed to drive us into the future of automotive fuel cells and beyond. With the goal of zero-emissions vehicles and elimination of our reliance on fossil fuels, nanotechnology is improving the design and durability of fuel cells and may eventually even lower the cost of production.

Also, the uses of nanoparticles in Diesel Engines have also majorly contributed in increasing their efficiency and reducing emissions. It is clear from the current article that the incorporation of nanoparticles during biofuel production enhanced this significantly. This enhancement is mainly due to the unique physico–chemical properties of nanoparticles such as large surface-area-to-volume ratio, high reactivity, good dispersibility, high specificity, etc. Several nanoparticles such as metal, metal oxide, magnetic, and carbonous materials are successfully used for enhancement of biofuel production from various substrates. Apart from the production process, nanoparticles are also used in the pretreatment process to enhance the digestibility of substrate leading to enhanced biofuel production. However, successful commercialization of this process requires the addressing of several technical barriers. These barriers include synthesis and application nanoparticles that are non-toxic to microorganisms, use of less expensive and environment friendly nanoparticles, and adaptation of biological. The demand for developing stronger and lighter WTBs has caused an increase in research for using nanotechnology using carbon nanotubes (CNTs), nanosilica and graphene as a reinforced hybrid composite to replace fibre reinforced polymers (FRP) currently used.

The application of nanotechnology in wind turbine blades is still in the research and development stage but it can be said that they offer many advantages over the current fibre reinforced polymers used to date. They allow for a reduction in blade weight, increased reliability, longer operational life and improved efficiency/cost in the near future. The main factors under consideration are manufacturing cost, environmental factors, site-specific etc. Wind energy competes with other conventional sources for market share.

Further researches are required to study the effect of nanotechnology to enhance the renewable energy industry especially in geothermal, wind and tidal energies, since the available papers in these fields are limited.

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Hydraulic Fracking and its Environmental Detriments

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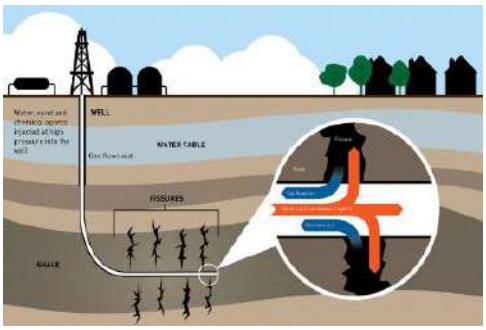
Introduction

Fracking, or hydraulic fracturing, has been attracting both negative and positive headlines for many years. To some critics, it's a public health risk that encourages fuel usage and contributes to global climate change. On the other hand, it's one among the foremost crucial energy discoveries of the last 50 years, creating jobs, wealth, and meeting our increasing power demands. Drilling down into rock formations and blasting out the oil and gas remains a controversial extraction method, regardless of what percentage technological advances or safety features are added. Potential local pollution and health risks are ignored by some countries determined to ride an energy boom. However, many countries have also banned fracking due to those self-risks.

The Fracking Process

In simple terms, fracking, or hydraulic fracturing, is oil and gas extraction from deep underground wells. The process involves the high-pressure injection of a water, chemical, and sand mix into underground rock formations or shale formations. This breaks up the shale rock, releasing oil and gas, which then flow up to a wellhead for collection. Thus, the term fracking originates from "fracturing" the shale and bedrock [1].



Fracking helps the oil and gas industry access oil and gas reservoirs that otherwise would be unreachable. These reserves are called unconventional reserves, or sometimes "tight oil" or "tight gas" due to the way they're trapped in rock formations deep underground. A typical fracking process starts with the preparation for drilling, which can take a couple of weeks. Companies usually begin by constructing roads to and from their chosen site. Next, a drilling site is erected with appropriate stone and impermeable lining to guard the world from any spills. There are two sorts of drilling: vertical drilling and horizontal drilling

Vertical drilling

This involves drilling straight down into the bottom, creating what's called a wellbore or borehole. The borehole eventually passes the deepest freshwater aquifer at typically 300-1,000 feet (90-305 meters). Then, a steel pipe replaces the drill. The steel pipe is named surface casing. It'll help protect the water system by keeping fluids, gas, and oil within it and faraway from water sources. To achieve this, cement is pumped down the surface casing and between the casing and borehole. Once set, the cement creates an impermeable barrier between the borehole and any underground freshwater sources. Counting on the area's geology, engineers may put in extra casing sections to make sure no fluids or gas can mix with groundwater sources. Vertical drilling continues until the specified depth is required.

Horizontal drilling

Shale formations usually require horizontal drilling. Workers drill vertically to the specified depth then curve the drilling to horizontal. Again, upon reaching its target, another surface casing is shipped down then covered with cement to make an impermeable barrier from the surface to the target reserve. Drilling can typically take 8-12 weeks to finish. One vertical borehole can access several reserves through horizontal drilling. Imagine the hands on a clock. The vertical borehole is within the center of the clock. Horizontal drilling can reach bent underground gas or oil fields situated at different points on the clock dial , perhaps at the three, the seven, then halfway to the nine [2].

How Fracking provides Access to Oil and Gas

Creating a fracking well is the next step, connecting the underground oil and gas with the surface via the sealed, impermeable surface casing. A tool called a perforating gun is lowered into the surface casing, right down to the targeted rock. Once in position, the perforating gun is fired, creating small holes a couple of inches long within the surface casing. There's now a connection between the oil and gas and therefore the bore well. However, operators say this firing isn't detectable above ground. After all this preparation work, we are finally at the part which provides this process of hydraulic fracturing, or fracking.

A stimulation fluid is pumped high down the surface casing to the holes made by the perforating gun. The fluid is especially water (90-95%), sand, and between 3-12 chemical additives, mixed for max performance and to stop bacteria from forming. This high-pressure pumping pushes the liquid out of the perforating gun holes. The excessive pressure fractures the shale rock where the oil and gas lie. The fossil fuels now flow up the surface casing pipe to the wellhead.

Oil and gas extraction can now begin because the oil and gas start to flow to the surface. Production can last 20-40 years, counting on the dimensions of the reserves. Wells are filled, and pipes are sealed below ground once production is not any longer economical. Companies should remove all surface equipment and return the land to its previous state.

Is gas a Byproduct of Fracking?

Shale gas is just another word for gas extracted from shale geological formations. They're found underground with petroleum, also referred to as oil, or petroleum. The "gas" that North Americans put in their cars isn't actually a gas; it's a liquid made up of petroleum, aka petroleum.

How the gas is collected in Fracking?

Natural gas collected in fracking is additionally referred to as shale gas. Like oil, trapped shale gas flows into the bore hole surface casing and rises to the surface, thus it is collected at the surface by a gas well.

Which countries practice Fracking?

According to the U.S. Energy Information Administration (EIA), only four countries produce commercial volumes of shale gas or oil from fracking. These are the US, Canada, China, and Argentina, with the US is the most important fracking country within the world.

Many countries like France, Germany, Spain, Italy, and Switzerland have banned fracking whereas England initially allowed fracking but stopped it in 2019 as the activity provoked some local earthquakes.

Chemicals utilized in Fracking

There is a spread of chemicals utilized in fracking for various reasons. The industry is usually quick to mean that the overwhelming majority of fracking fluid pumped underground is water. However, fracking requires many gallons of water, meaning vast quantities of chemicals are used. for instance, a four-million-gallon fracturing operation might use 80-330 plenty of chemicals.

Some studies have shown up to 90% of water and thus the chemicals remain underground after fracking, affecting water resources also as polluting them. A few of the chemicals utilized in fracking include: Hydrochloric, Methanol, Benzene, 1,2-Dichloroethane etc.

Advantages of Fracking

Fracking can provide quick access to fossil resources: One important advantage of fracking is that it gives us rather easy and efficient access to fossil fuels like gas or petroleum. Until we finally and completely switch to alternative energies, we'll need to believe in fossil fuels like gas.

Therefore, fracking can help us to form this access as easy as possible in order that we've a secure and reliable supply of fossil fuels for subsequent decades.

Additional fuel deposits: Fracking also gives us the chance to take advantage of additional fuel deposits.

Many people don't realize it but our fossil resources will only last for a limited period. This also implies that we might run out of fossil fuels sooner or later. However, through the technology of fracking, we've access to additional fuel deposits. In turn, our overall global access to those fuels improves significantly and the likelihood is that fracking provides us with the chance to provide humanity with gas for several additional years.

May give us longer to transit to renewable energies

Another advantage of hydraulic fracturing is that it gives us longer to transit to renewable energy sources. While politicians often claim that we've to shift to alternative eco-friendly energies as soon as possible, the truth is that it'll take a few years or maybe decades until we accomplish this energy transition process on a worldwide scale. Hence, so as to not run out of energy within the near future and to provide us with sufficient energy during this transition process, fracking also can be an excellent thanks to help us during this regard [4].

Fracking can help countries to become more independent

Fracking also can help many countries to become more independent. Many countries currently believe other countries to make sure their supply of fossil fuels. However, this creates a huge dependence and this dependency is usually not always a honest thing, since the party that's hooked in to another party will often need to accept quite poor trading conditions.

Through the technology of fracking, more countries could become independent from other countries regarding their energy supply since they might now be ready to exploit gas deposits in their own country.

May strengthen the economy of some countries

If a country is in a position to supply higher amounts of fossil fuels, the economy of this country will likely also enjoy this development since the country can export more fossil fuels and can have extra money for important infrastructure projects.

In turn, the overall public would likely also enjoy this development since people would recover access to medical treatment or also recover education opportunities.

Lower prices for gas and oil

Since the worldwide production costs for fossil fuels like gas are often lowered through the utilization of fracking, likelihood is that that also the general world-market price for gas will drop also. In turn, this will be quite beneficial for several companies and also for personal persons who believe products that are manufactured with the assistance of gas. Consequently, numerous people everywhere the planet could take advantage of hydraulic fracturing, to a minimum to a particular extent [5].

Numerous jobs depend upon the fracking industry

Since fracking has become quite popular over the past decade, numerous jobs have been created during this industry. In fact, many of us everywhere on the planet take advantage of job opportunities associated with hydraulic fracturing. Especially in poor regions with high unemployment rates, fracking companies are often the most employers in a region and without this industry branch, many of us would lose their livelihood and would need to migrate to other regions so as to survive.

Thus, fracking also can be important to scale back the general level of poverty in poor parts of our planet.

Why Is Fracking Controversial?

The fracking process uses many materials, and critics say it damages both the environment and public health.

The EIA states the subsequent issues:

• Wells require a large amount of water, which may affect water availability and native habitats.

• Fracking fluid may contain hazardous chemicals which will spill or leak, contaminating local areas.

• Fracking leads to large amounts of surface wastewater.

• Hydraulic fracking can cause minor earthquakes, which may bring gas and fracking fluids back to the surface. Additionally, some companies inject this material back underground, into deep wells, which itself can trigger small earthquakes and pollute.

• Natural gas, predominantly methane, may come to the surface and be released into the atmosphere [3].

The US Environmental Protection Agency also found that water supplies are in danger. Fracking fluid injected directly into groundwater supplies or unlined water pits can later seep into groundwater reserves. They listed a number of the hazardous chemicals as possible carcinogens along with benzene.

Apart from the above mentioned fracking activity endangers people, the environment, and wildlife, and also damages the local wild landscapes. Residents near fracking sites complain about groundwater contamination, pollution, earthquakes, sound pollution, and more.

There's also the consideration of fracking's impact on global climate change that comes from using fossil fuels like gas and oil as a part of our energy mix.

Several studies suggest negative health consequences for people that live on the brink of oil and gas fracking developments. In the United States alone, an estimated 17.6 million North Americans

live within one mile of a fracking site i.e. Texas has 4.5 million people living within a mile of a well. Similarly, California, Texas, Ohio, Oklahoma, and Pennsylvania have a million or more people living within one mile of a well [7]. Exposure to hydrogen sulfide gas, found in many shale oil and gas formations, can cause difficulty breathing and eye and throat irritation. High levels of exposure can be fatal [10].

Fracking can affect air quality and contaminate surface water, groundwater, and soil. Residents who live nearby list respiratory problems, headaches, and fatigue after fracking started within the area. Low birth weights and maternal stress are linked to California's fracking pollutants and congenital heart defects in Colorado [8].

Fracking Causes Pollution

According to a report by Earthworks [9] fracking does cause pollution. Key findings included that 90% of water injected underground at fracking gas wells isn't returned to the water cycle. Many chemicals form a part of the water pumped underground.

Looking at specific cases, some 80% of the water utilized in West Virginia's fracking industry came from rivers and streams, with only 8% reused or recycled. At the Susquehanna Basin in Pennsylvania, that recycling figure was 14%. Additionally , the U.S. Environmental Protection Agency (EPA) found that up to nine of the 36 beverage wells in Northeastern Pennsylvania are impacted by stray gas (methane and ethane) related to nearby hydraulic fracturing activities.

In Killdeer, North Dakota, the EPA also found brine and tert-butyl alcohol that had entered aquifers was due to a blowout at a fracking site that released fracking fluid. People living near fracking sites have reported localized methane leaks, which scientists have backed with data.

There are more examples. Earthjustice, a nonprofit public interest environmental law organization, has an interactive map of the United States listing fracking-related pollution issues.

Fracking wells often need to flare, which suggests burning unwanted or excess gas (mainly methane) that can't be or is just too expensive to gather. Estimates think flaring is liable for nearly 1% of all global CO2 emissions. (6)

Harmful chemicals are utilized in the fracking process

A few of the chemicals utilized in fracking include: Hydrochloric or muriatic acid dissolves minerals and initiates cracks in rocks.

Methanol: Reduce rust on steel tubes, casings, tanks, etc. — only fracturing fluids contain acid

Petroleum distillates like benzene: Reduces friction during high-pressure pumping

Other chemicals, such as 1,2-Dichloroethane, are found in fracturing fluid wastes at levels exceeding beverage standards, which the US Environmental Protection Agency has identified as a probable carcinogen. Also, benzene is understood to cause cancer.

Huge Water consumption & water scarcity

Fracking is a quite water-intensive process. In fact, significant amounts of water need to be utilized in the fracking process, which successively can cause water shortages for the local population. (6)

Hence, especially in areas that currently struggle with their local water system, fracking won't be a practice. This is very true for decent and dry regions. Due to heating, water scarcity will become

a big problem within the future and thus, we should always protect our natural groundwater reserves as best as possible, which also implies refraining from using fracking in those regions.

Air pollution

Critics of fracking often claim that this system can cause serious local air pollution. In fact, during the fracking processes, significant amounts of gases and fine particles are emitted into the air, which might be potentially harmful for the local population who lives nearby those fracking stations.

Nitrogen oxides (NO_x) and volatile organic compounds (VOCs) are associated with oil and gas development; in the presence of sunlight, these may react to form ozone and contribute to regional air problems.

Nitrogen dioxide and particulate matter ($PM_{2.5}$) emissions are also worrisome, but may be more of a local than a regional issue.

Many operations necessary for oil and gas development use diesel-powered engines, which emit diesel particulate matter. Furthermore, natural gas fired engines can be significant sources of formaldehyde, which is also a secondary pollutant. Aromatics (e.g., benzene and toluene) and other VOCs can be released during shale gas production.

Fugitive emissions released during shale gas extraction are also composed of greenhouse gases such as methane. Black carbon from diesel fuel combustion impacts climate. How the benefits of natural gas shift when emissions that directly impact climate change are factored in is an issue to be examined.

Dr. Robinson categorized the pollutant as major or minor sources of pollution. He noted that there is reasonable understanding of the emissions from diesel-powered engines (e.g., drill rigs, fracturing pumps, and truck traffic). There is less knowledge about emissions from other sources, for example, completion venting, blow down venting, and fracturing ponds. Dr. Robinson noted that the main concern is what the net effect is when these pollutants mix in the atmosphere [8].

Methane emissions

Fracking also can be considered as rather harmful for our planet from a worldwide warming perspective since within the fracking process, significant amounts of methane are emitted into the air. Methane may be a quite harmful greenhouse emission and therefore the emission of methane also accelerates global climate change.

Health risks for workers

Many workers within the fracking industry work without proper masks or other protective equipment, which may cause serious adverse long-term health effects for those workers.

Earthquakes

Fracking does cause minor earthquakes, albeit most are within the sort of tremors. In February 2019, two people died, and 12 were injured in Gaoshan in China's Sichuan Province after a 4.9 magnitude earthquake, the primary deaths attributed to earthquakes caused by fracking activities. In August 2019, a 2.9 magnitude tremor occurred in Lancashire in England, on the brink of the country's only fracking site and since then it has been closed.

Effect on aquatic ecosystems

A study has found that water displacement from high-volume hydraulic fracturing could have negative impacts on aquatic biodiversity and ecosystems in freshwater streams. Typically, concerns have focused on water quality, with fears of water contamination from chemicals utilized in the method. Most water utilized in hydraulic fracturing is sourced from small, free-flowing streams and dammed streams, referred to as 'frack ponds".

Hydraulic fracturing requires gallons of freshwater to extract oil and gas from shale. On average, quite five million gallons of freshwater are wont to fracture one well within the US, enough to fill over seven Olympic-size swimming pools. Much of this is often obtained by pumping freshwater from local streams.

A current research, administered by the American Chemical Society (ACS), focused on disruptive effects of withdrawing large amounts of water from nearby streams on biodiversity and ecosystems. The study, featuring in ecology and Technology, focused on the Fayetteville Shale streams in Arkansas, US. Researchers estimated the water stress that hydraulic fracturing might create on streams within the gas field. Streams within the area of study were found to provide beverages to thousands of individuals within the region and are home to 10 aquatic species that are declining at a concerning rate.

The researchers concluded that improved monitoring and access to water withdrawal and stream flow data are needed to ensure protection of streams, both as beverage sources and valuable habitats for aquatic wildlife within the future.

Noise pollution

Fracking also implies significant sound pollution. In fact, the method of fracking is sort of noisy and lots of people that live nearby those fracking stations are suffering from this noise in a quite negative manner.Thus, fracking can have significant negative effects on people that live nearby those fracking facilities.

Soil pollution

Chemicals used in fracking can alter the structure of the soil and may also cause the contamination of local ecosystems, with rather unclear effects on the local flora and fauna.

The chemicals will enter the soil profile sooner or later. Moreover, since large amounts of rocks are fractured during the fracking process, likelihood is that those harmful elements present in those rocks are going to be released into the soil also. Hence, fracking can cause significant soil pollution over time. Additionally, if the soil gets polluted, the nearby groundwater will suffer sooner or later. Due to heavy rain, harmful elements within the soil are going to be washed through the soil into the groundwater and may cause serious groundwater pollution.

Endangerment of species

Sometimes natural habitats get destroyed due to fracking, which also contributes to the loss of species problem. In fact, many animal and plant species become endangered or maybe extinct over the past years and the likelihood if we continue like that, we'll lose many additional species over subsequent years. Hence, so as to guard our animal and plant species from extinction, we've to guard our natural habitats also and thus, we might want to refrain from using fracking techniques when it involves the extraction of gas.

Loss of ecological imbalance

Due to the various kinds of pollution associated with fracking, it is mostly likely that the local ecosystems may get out of balance. Due to the utilization of chemicals in fracking, numerous useful microorganisms within the soil may die out. Moreover, bigger animals will also drop in populations. In turn, the likelihood is that the balance between predator and prey species are going to be altered in a way that results in significant loss of ecological imbalance.

Methods which will make Fracking Cleaner

Innumerable evidence is available showing that air gets polluted from oil and gas operations which threaten the health of nearby communities and immediate protections are needed. Where possible, ongoing unconventional oil and gas development should be put on hold to conduct comprehensive health assessments before determining whether or how these technologies should be allowed to proceed [12].

Few practice and technique can reduce the problem to some extent:

1. **Using water-less fracking systems:**

Traditional fracking uses large amounts of water. Emphasis to be given on development of water-free fracking systems. Few industries companies use gelled fluid in their fracking system, which contains propane in place of water. This alternative method gives an equivalent result as water but uses just one-eighth of the fluid and pumps the liquid at a slower rate [6].

2. **Using recycled water or brine rather than freshwater:**

Recycled water or brine, also works perfectly in fracking operations. Deep subsurface saline water can replace freshwater.

3. **Replacement of diesel-powered equipment:**

Diesel controlled equipment produces toxic toxins and ozone-depleting gas. Diesel-powered equipment can be replaced with eco-friendly gas or solar panels to scale back the massive number of harmful gasses emitted and lower the general damage to the environment.

4. **Introduction of waste-water purification:**

The waste-water contains chemical and natural water from the rock formation. The waste-water is especially shipped to individual storage facilities that are underground; however, treating waste-water can significantly reduce pollution caused by waste-water. The treated water is often reused within the fracking system.

Matthew et.al. investigated by numerical simulation, gas and water transport between a shallow tight-gas reservoir and a shallower overlying freshwater aquifer following hydraulic fracturing operations, if such a connecting path- way has been created. They highlighted two general failure scenarios: (a) communication between the reservoir and aquifer via a connecting fracture or fault and (b) communication via a deteriorated, pre existing nearby well [11].

They also observed that hydrostatic tight-gas reservoirs are unlikely to act as a continuing source of migrating gas, as gas contained within the newly formed hydraulic fracture is the primary source for contamination.

5. Reduce methane leaks:

One of the many fears of fracking is methane leaks. Consistent with a recent study, methane emissions are likely 50 percent above official government estimates. So, if chemical companies reduce methane leaks, damage to the environment is automatically reduced. This helps companies

economize by reducing the loss of a big component of gas, methane. Two main modifications can reduce methane leaks. First, use an infrared camera which will detect leaks at fracking sites. Second, innovations are replacing traditional pressure-monitoring pneumatic controllers with lower-bleed designs.A nationwide movement can work to reduce methane leaks by up to 35 billion cubic feet each year. Replacing conventional controllers, ban currently used chemical injection pumps, and replacing them with solar-power pumps can reduce up to 5.9 billion cubic feet of emissions.

6. Leak detection and repair (LDAR) programs

7. Advanced technologies to control fugitive emissions and reduction of diesel particulate matter

8. Use of cleaner combustion engines and alternative fuel types.

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Ozone Layer Depletion: A Brief Analysis on the Consequences and the Alternative Measures for Protection

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Introduction

The ozone layer is a protective shield in the upper layer of the atmosphere (Stratosphere), which helps to save life on Earth from harmful ultraviolet (UV) radiation. During 1974, scientists established the fact that emissions of chlorofluorocarbons, or CFCs [1], were exhausting stratospheric ozone as shown in Fig. 1. CFCs were commonly used in aerosol propellant, spray, in the manufacturing of refrigerants, solvents, and foam-blowing agents. During the 1980s, scientists noted an ozone declination over Antarctica considering as an "ozone hole." Moreover, many other research works have also shown that ozone exhaustion takes place over most of the continents. Chemicals containing the chlorine and bromine atoms are released in the atmosphere through human activities. These chemicals combine with certain weather conditions to cause reactions in the Ozone Layer, leading to ozone molecules getting destroyed. Exhaustion of the Ozone Layer occurs globally, but the severe depletion of the Ozone Layer over the Antarctic is often referred to as the 'Ozone Hole' [2]. Increased depletion has recently started occurring over the Arctic as well.

Widespread use of fossil fuels in our daily life has led us to an era of global warming and ozone layer depletion. Fossil fuels such as gasoline, diesel, natural gas, etc., when used, emit harmful greenhouse gasses such as CO, CO_2, SO_2, NOx, etc [3]. With the realization of such harmful attributes of fossil fuels, global researchers have started researching alternative sources of energy which are both eco-friendly and renewable in nature. Solar energy is one such substitute energy source which is both renewable and environment friendly. The solar energy systems make use of the ample amount of energy in solar light intensity by converting it into either electricity or heat or both, depending on solar photovoltaic [4], solar thermal, or solar photovoltaic or thermal technology used, respectively. Nitrous oxide is the most significant element causing damage to the ozone layer. It is because CFCs and many other gases that demolish the ozone layer were banned by the Montreal Protocol (MP) [5]. Nitrous oxide is not bound by MP, so while the usage of other ozone depleting substances (ODS) [6] are declining, nitrous oxide levels are slowly increasing. These effects are anticipated to become more serious if concerted efforts are not made to reduce emissions. The ozone layer screens out dangerous ultraviolet radiation shown in Fig. 2, that is related to increased probability of some fatal diseases like skin cancer and predominating diseases like cataracts as well as reduced production in the agricultural field and most importantly disruption of oceanic ecosystems. The United States of America approved the Montreal Protocol in 1988 and has joined four successive modifications. It has been a leader within the Protocol throughout its existence, and has held firm and bold domestic action to reduce and gradually cease the production and consumption of ODS such as Chlorofluorocarbons (CFCs). The full implementation of the Montreal Protocol, the US Environmental Protection Agency(EPA) envisages that the Americans born between 1890 and 2100 (7) are anticipated to avoid 443 million cases of skin cancer, approximately 2.3 million skin cancer deaths, and more than 63 million cases

of cataracts, with further greater advantages worldwide. We are serious about ozone depletion due to extreme exposure of UV rays that can result in a series of health effects, comprising optical damage, skin damage, and suppression of the immune system. The opinion of Researchers, which too much exposure of UV radiation [8] contributes to an enhancement in melanoma, the most dangerous of all skin cancers. The scientific evaluation panel of Montreal Protocol studies that with the usage of this Protocol we can hope to have a near complete recovery of the stratospheric ozone layer by the middle of the 21st century.

Fig. 1 Ozone Layer Surface

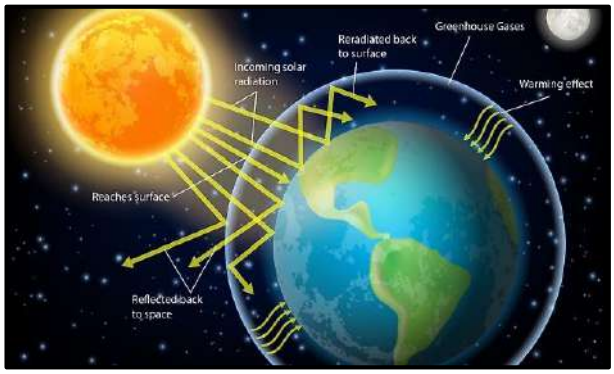

Fig. 2 UV Radiation on Earth

Ozone cycle

The stratospheric ozone gas formation occurs when the oxygen molecules photo-dissociate after absorbing UVC photons. It converts a single O_2 into two atomic oxygen radicals, further combining with separate O_2 molecules creating two O_3 molecules. Then, the O_3 molecules absorb UV rays to divide in an O_2 molecule and an oxygen atom. Finally, the oxygen atom combines with an O_2 molecule to create ozone gas. This process is continued till an oxygen atom combines with an O_3 molecule to create two oxygen molecules [9]. Fig. 3 clearly shows the ozone cycle in the atmosphere. Ozone can also be destroyed by free radical catalysts like hydroxyl radicals (OH·), nitric oxide radicals (NO·), chlorine radicals (Cl·), and bromine radicals (Br·). Most of the catalysts have natural sources, but human involvement has vastly increased the chlorine and bromine levels.

A single chlorine atom forms from hydrogen chloride and chlorine nitrate can destroy ozone for two consecutive years without any reaction to its removal from this cycle. It can react with about one million ozone molecules before moving away from the catalytic cycle. In addition, the annual releasing amount of chlorine in the atmosphere by chlorofluorocarbons (CFCs) and hydro chlorofluorocarbons (HCFCs) jeopardizes the environment [10-11]. Bromine is more effective than chlorine in ozone destruction on a per-atomic basis, but recently, the amount of bromine in the air is much lower. Moreover, fluorine reacts quickly with H_2O and CH_4 to form HF acid, which binds strongly to the Earth's stratosphere, also participates in ozone depletion.

Causes

The unclear scientific knowledge and public misconceptions have led to the natural disbalance of the ecosystem. Some of the reasons for the ozone depletion are mentioned below:

Chlorofluorocarbons: CFCs are significant for the reduction in ozone thickness [12]. It generally occurs when the natural balance is disrupted. These gases are released from spray aerosols, adhesives, solvents, fire extinguishers, refrigerators, air-conditioners, etc. CFCs are highly volatile and non-combustible. So they are very quickly evaporated and can easily reach the stratosphere and start depleting ozone molecules. These CFCs have also harmful effects on human health [13].

Natural causes: Due to the climatic changes, few natural processes such as Sun-spots and stratospheric winds are accountable for ozone layer exhaustion. In addition, various nitrogenous compounds such as NO_2, NO, and N_2O are released by human activity which adds to ozone exhaustion [14].

Unregulated Rocket Launches: It has been found that the unexamined rocket launches result in ozone layer reduction than the CFCs do. It is estimated that if the rocket launch is kept uncontrolled, it will cause huge ozone depletion by 2050. Therefore, rocket launches may require more rigid regulation to prevent significant damage to Earth's stratospheric ozone layer in the coming decades.

Global Warming: The rising levels of carbon dioxide, CFCs, and other pollutants have created a major barrier to climate change. Due to this global warming and greenhouse effect, most of the heat is trapped in the troposphere. Since ozone exists in the stratosphere, heat does not reach the troposphere and so it stays cold. However, the concept of global warming is controversial, although researchers have provided relevant data to support the fact that temperatures continue to rise globally. There are various causes of global warming that harm people, plants, and animals. These factors may be natural or maybe the result of human activity. Addressing the damaging effects of global warming is important in controlling the problems by providing effective solutions.

Consequences

The ozone layer depletion is rising day by day due to the penetration of harmful UV rays of the Sun and the increasing use of CFCs. It is causing a lot of impact on the environment, including different health-related issues. However, there is no confirmed evidence for the rise in skin cancer and optical damage to human beings associated with ozone depletion. It can be partly because of the UVA rays that are not absorbed by ozone layer and may also be due to changing lifestyle over time. It brings us to the reason for creating the Montreal Protocol [15]. It is an international treaty whose objective is to shield the ozone layer by gradually eliminating the production of different substances that are causing ozone depletion. Fig. 3 clearly shows the milestones of the Montreal Protocol.

Increased UV

Ozone is a tiny constituent in the air that is responsible for the maximum absorption of ultraviolet radiation. It determines the stratospheric temperature field. But, nowadays it is in contrast to the atmospheric circulation [16]. The amount of UV rays entering the Earth through the atmosphere is rapidly decreasing with the density of the ozone layer. It affects the biosphere and tropospheric ozone which causes stress on plants [17].

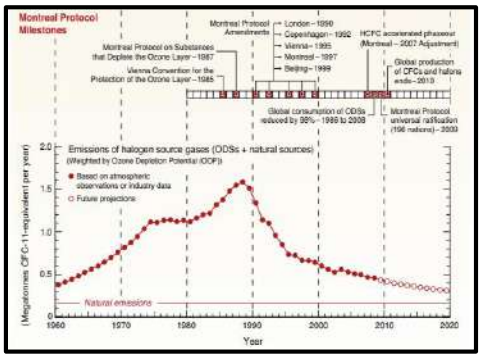

Fig. 3 The Montreal Protocol

In the HIPERION report it is stated that the study used ground instruments and information from 12 satellites of different countries over the last two decades. It has been found that UV rays reaching equatorial latitudes is much higher than expected as UV indicators show greater health risks than normal. The authors in [18] even conclude that depleted ozone layers around the planet's mid-latitudes are already threatening large peoples in the region.

Biological Effects:

The influence of ozone depletion has no direct evidence to cause health problems in most latitudes. However, the ozone hole above continents like Antarctica and Australia has been an indication of increased UV rays' penetration [19]. It demarcates both the positive and negative impacts on human health, wildlife, and plant life.

Skin cancer: The basal and squamous cell cancer is strongly affected by UVB rays. Here, the absorption of such rays causes the DNA pyrimidine bases to form dimers. It results in transcription error whenever there is a DNA replica. However, these cancers are mild and fatal but the treatment may require extensive reconstructive surgery. Another skin cancer that is dangerous to diagnose is malignant melanoma where both UVA and UVB radiation is involved. One study [20] shows that for every 10% rise in the UV rays there is a 19% increase in melanomas.

Increased tropospheric ozone: The Ground-level or tropospheric ozone is at high risk due to its toxicity nature and strong oxidant properties. These toxic chemicals are reactions between oxides of nitrogen and volatile organic compounds that form ozone in the presence of sunlight [21]. The risk of shortness of breath, such as asthma, is relatively high for children and the elderly.

High Vitamin D production: The Vitamin D in the human produces by the body's cholesterol when it comes in contact with sunlight. People possessing deficiency in vitamin D are advantageous and reduce a variety of problems related to health. In a study it was found that blood levels of vitamin D appear to increase blood calcium levels, but our body's mechanisms adjust themselves to prevent excessive vitamin D production [22].

Cortical cataracts: The epidemiological studies illustrate that a connection between ocular cortical cataracts and UVB exposure can be computed by means of different exposure estimates with the help of cataract-related techniques. Even a detailed study on this topic is mentioned in [23]. It is also predictable that ozone depletion will cause numerous cataract cases by 2050 [24].

Additionally, in this extremely exposed UV radiated surface the group of white men is predominantly expected to have cortical opacities.

Impact on plant life: Increase in the UV rays' penetration has caused changes in the physiological processes in trees and vegetation. Plants like rice retain nitrogen from their roots through cyanobacteria. They are delicate to UV radiation as they cannot adapt to the high UVB ray levels. Furthermore, excessive intake of these rays damages the plant DNA and its respiration stomata. The authors in [25] have also mentioned that the radiation has caused a reduction in the yield of the photosystem. However, most plants have flavonoids that help them acclimatize to the present radiation. These plants are unprotected to radiation throughout the day, so they shift the levels and types of flavonoids. It helps them to get protection from harmful rays. But the rest of the trees are affected because sunlight cannot penetrate through the leaves, compromising photosynthetic systems. In addition, if the plants and trees are exposed to extreme levels of ultraviolet radiation, they may have leaf pigmentation. Even they can produce harmful volatile organic compounds like isoprene which can severely impact the environment by increasing the amount of carbon in the atmosphere. It will ultimately lead to change in climate [26]. Another long term impact is the decrease in plant growth and productivity due to the rise in oxidative stress resulting in the reduction of carbon.

Effects on animals: A study in Landon's Institute of Zoology found that whales near California coast have been victims of epidermal damage due to acute or severe sunburn, and these researchers think that it is because of the diminishing ozone layer [27]. Further, many other creatures along with the terrestrial ecosystems also exposed to the detrimental effects of increased UV radiation.

Impacts of Halogen Gases: The preliminary process of the ozone depletion occurs with the emission of halogen gases by natural processes. These compounds contain at least one halogen atom and one carbon atom, which makes them chemically stable, commonly known as halocarbons [28-29]. The gases comprising chlorine and bromine have a long atmospheric life span. Many halocarbons are also termed as ozone-depleting substances (ODSs). These chemicals are mostly emitted into the environment due to human activities. These compounds undergo chemical damage in the troposphere because they do not dissolve easily in rain or snow. Then through the air, these accumulated gases are transported to the stratosphere, further converting to more reactive halogen gases. Finally, when air returns to the tropospheric region, these reactive gases are removed by rain and snow and deposited on Earth's surface.

Ozone holes

Ozone hole is not technically a "hole" where no ozone is present, but is actually a region of exceptionally depleted stratospheric ozone over the polar regions of the Earth. It happens at the beginning of Southern Hemisphere spring (August–October) over Antarctic glacial and during the month of March in Arctic stratosphere. The satellite instruments provide us with daily images of ozone over the Antarctic and Arctic region.

Arctic Zone Mini-Hole: Ozone levels above the Arctic region have reached a record low for March. An analysis of satellite observations shows that ozone levels reached their lowest point in March 2019 at 205 Dobson units. Although such low levels are rare, they cannot be left unnoticed.

Similar low ozone levels occurred in the stratospheric region in 1997. Sometimes, these waves travel upward from the mid-latitude lower atmosphere to disrupt the circumpolar winds that swirl around the Arctic zone as shown in Fig. 4. When they disrupt the polar winds, they generally create two situations. First, they bring stratospheric ozone by filling Arctic reservoirs. Second, they warm the Arctic air. The temperature then makes the situation unfavorable for the formation of polar stratospheric clouds. These clouds help to release chlorine for ozone-depleting reactions. During March, 2011, a great loss in ozone layer was observed over the Arctic [31-32]. The change was occurred due to progressively chilly winters in the Arctic region at an approximately 20 km altitude. Therefore, a variation related with the ozone layer depletion and the global warming is still under exploration [33]. At the beginning of October, 2011, a survey stated that during the winter-spring season of 2010-2011 around 80% of the ozone layer was destroyed [34] in the Arctic region compared to the ozone depletion that formed over South Pole in each winter. Also, in a study, satellite data shows unusual lengthy period of cold season in the Arctic caused more ozone depletion than normal, allowing for the formation of chlorine compounds [35].

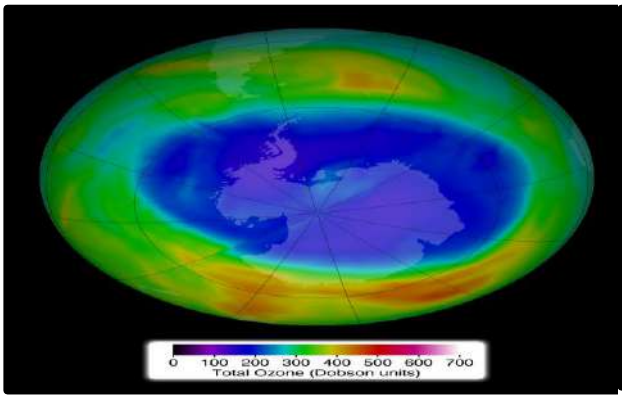

Fig. 4 Ozone-Hole in Antarctic Region

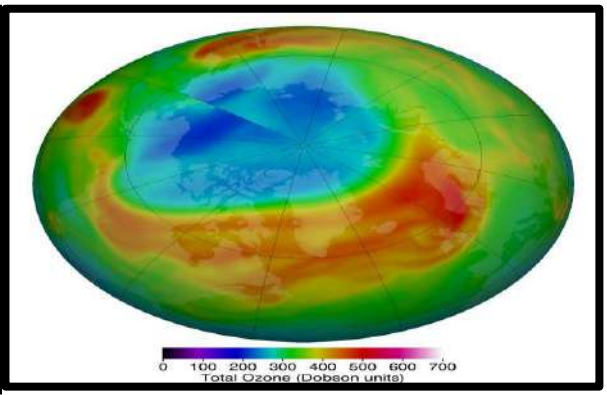

Fig. 5 Ozone-Hole in Arctic Region

Antarctic Ozone-Hole

The ozone hole in the Southern Hemisphere extending from pole to the equator has damaged atmospheric circulation, resulting in heavy rainfall at subtropical regions in the South Pole. During the year, 2021 Antarctic ozone hole has reached its peak on October 7. Scientists from NASA and NOAA reported that this hole developed a colder zone than usual Southern Hemisphere winter, which led to a deep and larger-than-average ozone hole. With the increased atmospheric chlorine levels, the ozone hole magnifies during the Southern Hemisphere spring. An atmospheric researcher at NOAA suggests that the chemical reaction of polar stratospheric clouds in the Antarctic stratosphere further stimulates ozone depletion by increasing the chlorine amount present. The Antarctic polar stratospheric cloud is formed when the temperature is very low. In such cases, cloud ice crystals offer an appropriate surface for the reactive chlorine compounds to damage ozone. One of the report found that in recent decades, global ozone has been growing at a slower rate, almost to the stagnation point. However, during spring season the ozone hole over the Antarctic zone is predicted to take long period to recover [36]. During the year 2012, the NOAA and the NASA described that due to the warmer temperatures over the Antarctic, it will lead to the second-smallest ozone hole in the next 20 years [37], slowly turning to recovery [38-39].

Solutions

Ozone depletion is a serious problem and governments of different countries have launched various agendas to prevent it. However, steps should be taken individually to prevent ozone depletion.

Use of Public Transport: The best transportation option is a bicycle or walk. If one uses a private car to the destination, carpooling with others is a great option to reduce pollution and save fuel. The easiest way to reduce ozone depletion is to limit the number of vehicles on the road. These vehicles emit large amounts of greenhouse gases which eventually lead to fog, a catalyst for the degradation of the ozone surface. Vehicles emit large amounts of greenhouse gases that lead to ozone depletion and global warming. So, the use of fuel vehicles should be reduced as much as possible. Battery-electric cars are a better alternative to current vehicles. It will significantly reduce the use of volatile organic compounds that reduce the ozone layer. Moreover, the solar powered Ozonator can be installed in atmosphere by balloons to reduce the ozone holes.

Use Eco-friendly Cleaning Products: Almost all the cleaning products include chlorine and bromine releasing chemicals that degrade the atmospheric ozone layer. These harsh chemicals may contain dangerous solvents and corrosive substances. So, these chemicals should be substituted with natural non-toxic products such as vinegar or bicarbonate to shield the environment.

Discontinue Using Pesticides: Pesticides are great chemicals to rid the farm of pests and weeds, but they contribute enormously to ozone layer depletion. The reliable solution to remove pests and weeds is to practice the usage of natural methods. Just weed the farm manually and use alternative eco-friendly chemicals to alleviate pests.

Use of Nitrous Oxide should be forbidden: The Montreal Protocol helped a lot in the limitation of Chlorofluorocarbons (CFCs) but nitrous oxide was left uncovered, which is a known harmful chemical that can exhaust the ozone layer. However, nitrous oxide is still in use in nuclear explosions and high altitude supersonic jet. The government should take severe actions and forbid the hazardous chemicals usage that is unfavorably destroying the ozone layer. People should be educated and made more cautious concerning the effects of nitrous oxide so that its use is minimized.

Prohibition of CFC usage: CFCs are colorless, volatile, liquids and gases having a faintly sweet ethereal odor. Overexposure may cause dizziness, loss of concentration, depression, and/or arrhythmia. Even CFC vapors displace air and so can cause asphyxiation in confined spaces. Thus, the use of hazardous gases should be avoided, due to their content or production process [40]. However, modern technology uses certain gases as refrigerants as an alternative to harmful CFCs. These refrigerants are also used for cooling purposes. Nowadays, modern refrigerators typically use a refrigerant called HFC-134a instead of Freon, which does not diminish the ozone layer. Chlorofluorocarbons (CFCs) such as R12, have been proven to cause greenhouse effects and have been mostly discontinued. Hydrochlorofluorocarbons (HCFCs) such as R22, which are slightly less destructive to the environment as compared to R12, are still advised against.

Hydrofluorocarbons (HFCs), such as R410A and R134 is the safest among all refrigerants. Alternatives for spray applications include carbon dioxide/water and HCFC-141b. The current alternatives for integral-skin polyurethane products include HCFC-22, hydrocarbons, HFC-134a,

pentanes, and HCFC-141b. The long-term alternate is predicted to be carbon dioxide/water. Phenolic foams can now be made using HCFC-141b, hydrocarbons, injected CO2, or HFC-152a rather than CFCs. In the future, HFCs could also be the predominant alternative. Polyolefin is now manufactured using alternatives such as HCFC22 and HFC152a. Hydrocarbons and injected CO2 are going to be long-term alternatives. Although the utilization of ammonia for a few cold storage facilities, there are questions of safety, and a few regulatory jurisdictions restrict its use. Other alternatives to CFCs in cold storage and enormous commercial food preservation facilities include HCFC-22 and HFC blends. Hydrocarbons and HCFC-22 will continue to be the favored alternatives until equipment using other alternatives is developed; ammonia is used in selected applications. Moreover, precision cleaning applications are defined as requiring a high level of cleanliness to maintain low-clearance or high-reliability components in working order. To meet exacting specifications, the alternatives that have been produced include solvent and non-solvent options. Solvent applications include alcohols, aliphatic hydrocarbons, HCFCs and their blends, and aqueous and semi-aqueous cleaners. Non-solvent applications include supercritical fluid cleaning (SCF), ultraviolet (UV)/ozone cleaning, pressurized gases, and plasma cleaning. Several solvents exist to replace ozone-depleting solvents that have traditionally been used by the dry cleaning industry. Perchloroethylene has been used for over three decades. Petroleum solvents, while flammable, can be safely used when appropriate safety precautions are adopted. They include white spirit, Stoddard solvent, hydrocarbon solvents, iso-paraffins, and n-paraffin. Many HCFCOs can be used but should only be considered as a transitional option.

Conclusion

Ozone acts as a contaminant in the biosphere and as shield gas in the stratosphere. Destructive UV rays entering through the ozone hole is damaging the health of species, reducing the eatable items, altering the ecosystem balance and causing huge monetary losses. In this connection, massive global efforts have to be initiated. The Montreal Protocol is a universal agreement to protect the Earth's ozone layer by phasing out the chemicals that deplete it. The landmark agreement entered into force in 1989 and it is one of the most successful global environmental agreements [41]. A warm appreciation should be given to the collaborative effort of different nations around the world, the ozone layer is on its way to recovery and many environmental and economic benefits have been achieved. "Protection of the ozone layer is our long-term commitment and responsibility. Each generation must take up the baton to ensure the continued survival of our planet's protective shield. Teaching the next generation about the Montreal Protocol empowers them with the knowledge that environmental challenges can be overcome if we listen to the science and work together" said Andrea Hinwood, UNEP's Chief Scientist.

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Waste plastic to biodiesel

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Introduction

Plastic waste to biodiesel is an alternative source of fuel to avoid the conventional energy sources, exhaustion problem, plastic pollution problem, waste plastic management problem, etc. The renewable energy source that is biofuel can be a huge remedy in this regard. Here, it is explained that how biodiesel is prepared from waste plastics by pyrolysis technology, hydrothermal process and how the performance of biofuel can be enhanced by mixing palm oil. This chapter also shows the validation of biofuel in rural areas and in the case of women empowerment.

Biodiesel

Biodiesel is an unsaturated fatty ester which is extracted from vegetable oil or creature fats through a transesterification (or esterification) response and is utilized as diesel fuel. Biodiesel, as an elective fuel is contrasted with diesel fuel and is characterized as an oxygenated, high cetane number, sulphur free, biodegradable, non-harmful and eco-accommodating elective diesel fuel.

The utilization of different sources and unrefined components for biodiesel fuel keeps on being assessed. One of them is utilized for cooking oil that can be utilized for regular handling. The traditional course of utilized cooking oil to biodiesel fuel keeps on looking for the ideal nature of biodiesel fuel and as per diesel fuel determination. The utilization of utilized plastics give various benefits, including low cost, simplicity to acquire and expansion of the effectiveness brought about by the removal of waste plastic. Biodiesel is the most effective substitute for mineral diesel as it is sustainable as a fuel for diesel motors, non-poisonous, carbon nonpartisan and biodegradable (produced using vegetable oils, creature fats and different lipids) Biodiesel contains physical and synthetic properties which are like that of ordinary fuel. In this way, biodiesel has been generally used as a substitute for diesel fuel, introducing great outcome as far as combustibility and lower natural effects of fumes outflows in pressure start motors arte concerned. This fuel essentially doesn't produce build-ups of sulphur and has lower outflow of toxins because of the presence of the oxygen in its particles. Nonetheless, it has higher thickness and consistency and lower calorific worth when contrasted with diesel fuel. The kinematic thickness of biodiesel is multiple times higher; its thickness is around 10% higher and has around 10% less energy than diesel fuel. Biodiesel brings about execution decrease and expansion in fuel utilization, contrasted with diesel fuel. However, motor warm productivity when biodiesel is utilized appears to increase and the degrees of PM, HC, and CO outflows are lower contrasted with diesel. Biodiesel is a fuel with properties basically the same as those of diesel. This similitude makes it conceivable to utilize biodiesel as an elective fuel in diesel-controlled vehicles, either unadulterated or blended in with diesel [1].

Why are we concerned about biodiesel?

Biodiesel refers to the non-petroleum-based diesel fuel containing esters. It can be waste plastic, chicken waste, vegetable waste, etc. There are four reasons for the depletion of coal stocks at the power plant end- unprecedented increase in demand for electricity due to the increase of industries; in coal mines areas heavy rains cause adverse effect on coal production; increase of

prices of imported coal raising to unprecedented high level, causing substantial reduction in power generation from imported coal- based power plants [2].

The petrol, diesel which consumers put into their automobiles such as car, bike, etc are produced by the energy-intensive production methods and from resources other than "conventional" oil. This transition is the result of three trends occurring worldwide: the output energy from the conventional oil fields is declining, new fields are neither large nor productive as old fields and areas with conventional resources are off-limits to investment by independent oil companies. These trends are inducing investment in substitutes for conventional petroleum, such as the Alberta tar sands, or synthetic fuels from coal or oil shale [3].

Biodiesel v/s Diesel

Petrol diesel are known as "diesel fuel" or simply "diesel". Petrol diesel is created from fragmentary refining of raw petroleum between 200C (392F) and 350 (662F) at climatic strain, bringing about a combination of carbon chains that regularly contain somewhere in the range of 8 and 21 carbon iotas for each particle. Petrol diesel falls under the details laid out by ASTM D975 in the United States and EN590 in Europe.

Biodiesel is a renewable, biodegradable fuel. Biodiesel is defined under the standard of ASTM D6751 as "a fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils and animal fats" [4].

Table 1. Difference between biodiesels and diesel

Sl. no	Property	Biodiesel	Diesel
1	Cetane No	51-62	44-49
2	Lubricity	Greater than diesel	Lower
3	Biodegradability	Good	Poor
4	Toxicity	Non-toxic	Highly-toxic
5	Oxygen	11% free oxygen	Very low
6	Aromatics	No aromatics	18-22%
7	Sulphur	None	0.05%
8	Cloud Point	Slightly more	---
9	Flash Point	300-4000F	125
10	Spoil Point	None	High
11	Heating Value	2-3% higher than diesel	---
12	Renewable Supply	Renewable	Non renewable
13	Alternative Fuel	Yes	No
14	Production Process	Chemical reaction	Reaction

Waste plastic

Plastic is an important and essential good in recent days. Plastic is produced in large quantities due to great demands in many fields such as household items, children's toys, packaging materials, automobile parts, electronic components, agricultural supplies, etc. So the amount of plastic waste is increasing rapidly. There are two types of plastics waste such as municipal and industrial.

Industrial plastics are generally useful for downcycling into lower-grade plastic products due to them being more homogeneous and contamination-free.

Municipal plastics tend to be more heterogeneous and contain extraneous materials.

According to projects, the total amount of plastic waste ever generated from primary plastic has reached 5800 million tons. Only in 2015, global plastic emissions reached 302 million tons [5].

Plastic is a manufactured polymer produced using oil which has the properties of bundling, building and development of family and athletic gear, vehicles, gadgets and agribusiness. More than 300 million tons of plastic are delivered each year, a big part of which is utilized to make single-use things like shopping packs, cups and straws. Whenever disposed off inappropriately, plastic waste can hurt the climate and biodiversity. Somewhere around 14 million tons of plastic accumulate in the sea consistently. Plastic are regularly found on the coastlines of each landmass. More plastic squanders are found close to famous vacationer locations. The principal wellsprings of plastic garbage found in the sea are land-based, coming from metropolitan and stormwater spillover, sewer floods, lacking garbage removal and the board, modern exercises, development and illicit unloading. Sea based plastic contamination starts essentially from the fishing business, nautical exercises and hydroponics. Affected by sun based UV radiation, wind, flows and other normal elements, plastic separates into little particles called microplastics (particles less than 5 mm) or nano plastics (particles less than 100 nm). The little size makes them simple for marine life to consume inadvertently. Numerous nations came up short on foundation to forestall plastic contamination, for example, clean landfills; burning offices; reusing limit and roundabout economy framework; appropriate administration and removal of waste frameworks. This prompts 'plastic spillage' into streams and the sea. The lawful and unlawful worldwide exchange of plastic waste may likewise harm environments critically [6].

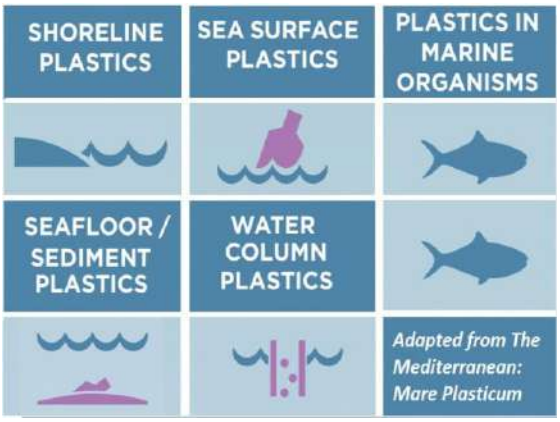


Fig. 1 Source of plastics

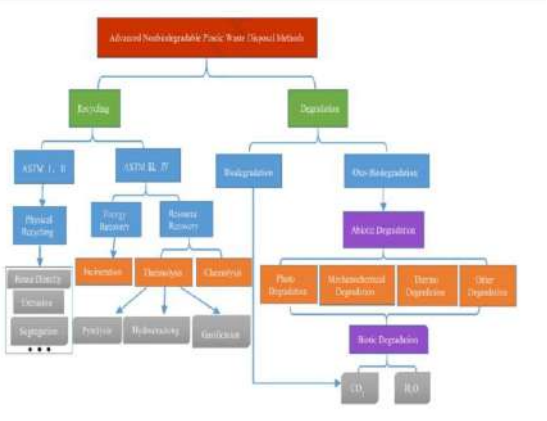


Fig. 2: Classification of advanced NPW disposal methods

Method: conversion of waste plastic to biodiesel:

Pyrolysis of waste plastics

Waste plastic processing technologies include recycling (physical recycling, energy recovery and resource recovery) and degradation (biodegradation and oxo-biodegradation). Pyrolysis technology (Fig. 2) is an environmentally friendly process. It is very acceptable for converting waste plastics into useful biodiesel. Pyrolysis oil cannot be used directly in engines due to its complex mixture of oxygenated compounds and aliphatic hydrocarbons. The pyrolysis of plastics typically yields an average of 10–20% tar, 35–40% gas, and 45–50% oil. In some cases, the pyrolysis of individual plastics can produce up to 80% liquid, which is higher than the pyrolysis processes of wood biomass in general. Different studies show a two-stage pyrolysis-catalysis of high-density polyethylene where the first stage is the pyrolysis of plastic and the second stage is the catalysis of hydrocarbon pyrolysis gases leading to the production of hydrocarbon oil in the gasoline range (C8-C12). The study results also show that from high density polyethylene oil can be obtained with high yield (83.15%) when using phased catalyst. The use of pyrolysed oil as a fuel for diesel engines has become increasingly important in recent years. Use of pyrolysis oil obtained at different temperature is being studied by several researchers and investigation is still going on.

There are numerous methods to upgrade pyrolysis oil: chemical, physical, thermal and catalytic upgrading technology. Recently the catalytic upgrading technology has attracted the attention of researchers. In the biomass/plastic co-pyrolysis, the catalyst plays an important role. Various catalysts have been introduced into the biomass/plastic co-pyrolysis to improve the quality of the pyrolysis oil, including: carbon-based catalysts (activated carbon), zeolites (ZSM-5, HY, SBA-15, etc.), metal oxides (Fe_2O_3, Al_2O_3, ZnO, CaO, MgO2 and TiO_2). The effect of MgO on rice husk/polyvinyl chloride co-pyrolysis was studied and the results showed that MgO increased the hydrocarbon content (~35%) and decreased the acid content (~2%). Similarly, the effect of zeolite-type catalysts (HY (5.1), H-Beta (25), and HZSM-5) on the catalytic pyrolysis of commercial WPCs via the use of Pry-GC/MS was studied and the small-pore HZSM-5 and large-pore HY both negatively affected the formation of aromatics. Another study shows that the preparation of aliphatic and aromatic hydrocarbons by co-pyrolysis process is facilitated by the addition of CeO_2 (with the highest selectivity of monocyclic aromatics reaching 73% and the maximum yield of hydrocarbons at 85%). In the co-pyrolysis of biomass and plastics, these catalysts (especially HZSM-5) have been widely used. However, due to some disadvantages such as corrosion, easy inactivation (leading to short service life), relatively high cost, these catalysts are often used in a very limited way in a large scale.

Pyrolysis is an environmentally acceptable process which contributes to the conservation of petroleum resources. The pyrolysis of high-density polyethylene (HDPE) and low-density polyethylene (LDPE) has been studied by many researchers. However, very few researchers have analyzed the characteristics of the bio-oil obtained by pyrolysis of the film from the fraction not collected selectively from municipal solid waste plants. To obtain liquid fuel, pyrolysis is basically performed on waste plastic (polyethylene film) from the fraction that is not selectively collected. Different oil samples were subjected to experimental studies under different operating conditions to determine their physical and chemical properties. The main objective of these works was to determine whether the quality of these fuels depends on the operating conditions. The results show that the characteristics of the studied fuel do not change with the operating conditions. The used oil samples under study showed close chemical and physical properties to commercial gasoline and diesel.

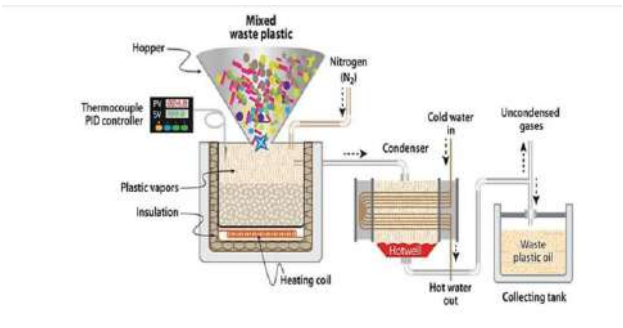


Fig. 3 Energy extraction routes from waste plastic

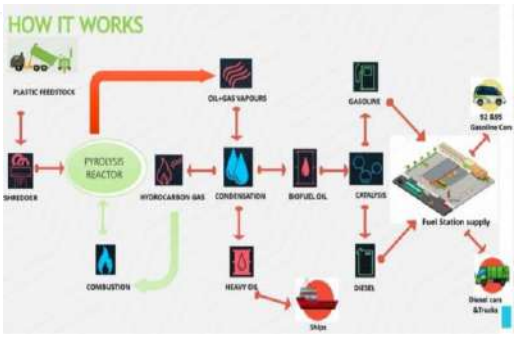


Fig. 4: The pyrolysis process

Hydrothermal Process

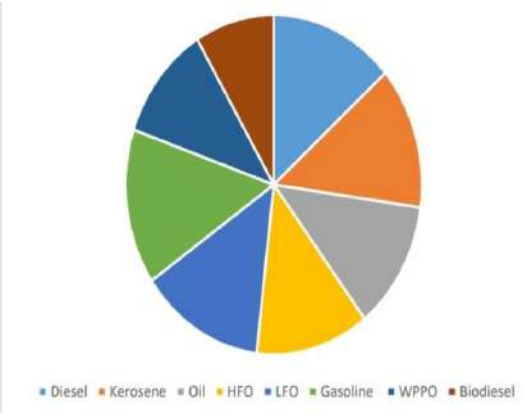
One system to battle plastic contamination is to change the plastic junk into something important. The most recent study in this approach comes from a group at Purdue University, which has concocted a strategy to change over a generally utilized plastic into oil. The cycle, detailed in ACS Sustainable Chemistry and Engineering, is more energy-productive than reusing or consuming waste plastic, the scientists say.

Around six billion tons of plastic waste has been produced all over the planet in the last 50 years. Very little of this waste is reused, and near 80% of it sits in landfills or in the common habitat, where it hurts untamed life, drains unsafe synthetics, and discharges ozone harming substances.

Almost a fourth of all plastic waste is polypropylene, used to make things like food holders, jugs, lines, and attire. Plastics are hydrocarbons that are produced using oil, and they can be changed over back to fluid fuel. Scientists have regularly utilized an interaction called pyrolysis to do this, which requires warming the plastics at a high temperature.

A procedure has been utilized called aqueous handling. Others have utilized it before to change different kinds of plastic feedstock over to oil, yet the yield of those cycles has been low. Polypropylene was placed in a reactor loaded up with water, and heated up to temperatures from 380-500°C for as long as five hours at a strain of 23 Megapascals. At the high heat and strain, water separates the plastic and converts it into oil.

The specialists had the option to change 91% of the plastic into oil. The oil, which is a blend of various hydrocarbon compounds, can be utilized to make structures blocks for gas and different fills and synthetic substances. Investigation shows that the change cycle involves less energy and results in less emanations than burning polypropylene plastics or precisely reusing them. Presently, attempts are being made to upgrade the transformation cycle to deliver top notch gas or diesel fuels [8].



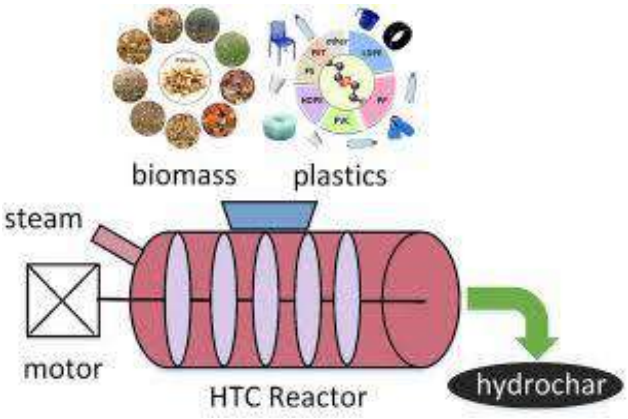


Fig. 5 Similarity of plastic oil waste to the other fuel products Fig. 6 Hydrothermal Process

Addition of Palm Oil Biodiesel in Waste Plastic Oil on Diesel Engine Performance, Emission and Lubricity

The diesel engine's performance and emission are analyzed for secondary fuels (produced by mixing of waste plastic oil and plastic oil biodiesel) by gas chromatography -mass spectroscopy (GC-MS) Five secondary fuels (10-50%), POB in WPO were prepared by mechanical stirring process. Among the SFs(secondary fuels), WPO90 showed the highest brake power(BP) and brake torque (BT) and the values which were determined are 0.52 and 0.59% respectively greater than B10.The WPO70 showed the lowest brake specific fuel consumption (BSFC).In the case of WPO50, the lowest emission of hydrocarbon (HC,37.21%) and carbon monoxide (CO, 27.10%) among the SFs was shown. The WPO90 showed the highest reduction in CO_2 emission and it also showed maximum reduction in wear scar diameter (WSD).Among the SFs, SAE40-WPO90 showed the lowest COF with 5.98%, reduction compared to SAE40-WPO100. Overall WPO90 showed the optimal efficiency for diesel engines [9].

Examining the Potential of Biofuels for Rural Development and Empowerment of Women

When we began considering local production of biofuels as a possibility for expanding access to energy in developing countries, there was much enthusiasm about the idea of home-grown renewable energy. Studies show that the present available energy does not meet the needs of poor people. They mainly rely on traditional biomass (wood, charcoal, dung and agricultural residues) without the access to electricity.

Many people in rural areas are being left without basic energy services. Gender considerations also come into play due to the current lack of energy in rural areas which impacts disproportionately on women.

The overburden on women due to long hours work like gathering wood or dung, carrying water, growing crops, processing food and caring for their families - all without basic needs results from no education in them which affects the society as a whole. In addition, women are the main producers of food crops in many areas. If they could grow and sell oil-producing crops, and also use the oil for motorized power, electricity generation, household activities and profitable enterprises, this could open up exciting new opportunities for local economic development. Studies have shown that women can also profit by establishing and sharing in bioenergy processing operations. At the 2007 session of the UN Commission on Sustainable Development (CSD), which included discussions and rec-commendations on energy for sustainable development, a number of governments announced that they were launching or expanding biofuels programs. Women's

representatives at the CSD recommended that Government should explore investments in local production of biofuels for use in meeting the energy needs of the poor in an environmentally friendly way.

The case studies

As a feature of bigger projects of work on orientation and biofuels, we started to search for substantial instances of ventures and projects that connected biofuels creation with rustic monetary and social turn of events, and that especially affected the strengthening of ladies. One of the difficulties was that most tasks were simply getting in progress, and there was little information to break down. We discovered a few tasks that explicitly target ladies, however the vast majority of them don't solely zeroin on ladies. It's surely feasible for ladies to profit from biofuels drives that are not especially orientation touchy. This can assist with guaranteeing that ladies are not underestimated, or successfully barred from preparing programmes, extension administrations, or other basic components of the program. In Cambodia, a pioneering rancher is utilizing developing Jatropha and separating oil from the seeds to run a diesel generator that provisions electrical power for a scaled down network adjusting 80 homes. The diesel generator has been adjusted so it can work productively utilizing unadulterated plant oil. In Nepal, local gatherings are gathering seeds from existing Jatropha plants, removing the oil, and utilizing the unadulterated plant oil instead of diesel to run water system siphons to advance expanded agrarian creation.

In Ghana, a ladies' gathering deals with developing Jatropha, removing the oil from the seeds and blending the oil in with diesel (70% plant oil/30% diesel) to fuel as a lamp oil substitute for use in lights. In India, local gatherings in segregated towns gather neighborhood seeds from the close by woods and utilizing oil from the seeds to make biodiesel in a little pedal-fueled processor. The biodiesel is utilized to run water siphons, a power generator, and turner. In Uganda, ladies' gatherings explore different avenues regarding utilizing biodiesel from plant oils to run a multifunctional stage framework that utilizes a diesel motor to control gear and create power. In Sri Lanka and Zimbabwe, the activities include enrolling little ranchers to develop Jatropha financially to supply an enormous biodiesel creation plant. The Sri Lanka project is a generally limited scale pilot project blending business fuel crop creation in with neighborhood energy applications. In Zimbabwe, it is a far reaching project oversaw by the public oil organization through agreements with partaking ranchers. The South Africa project is additionally a huge scope drive that includes requesting and preparing ranchers to develop feedstock for a biodiesel plant - for this situation sunflower seeds and soya beans. It has been coordinated with the cooperative commitment of the public authority, the private area and examination establishments [10].

Biofuels Intervention

Table 2 summarizes the macroeconomic impacts of an oil price increase by 50% on the Indian economy during 2010–2030. As mentioned earlier, most of the predictions expect 50%–100% increase in oil prices between 2010 and 2030. The lower bound is used for the analysis. The reference scenario (S1) shows that a 50% increase in oil prices during the next 2 decades will have significant negative macroeconomic impacts on India.4 All the macroeconomic indicators show a decline and their interpretation should be made in comparison to the scenario without an oil price increase. For example, real GDP growth being less by 4.8% would mean that the potential growth without oil price increase will be achieved with a 10-month delay in 2030. Similarly the other results are the percentage difference from the scenario without an oil price increase. Energy imports will be reduced by about 28% due to slower growth in the economy, and energy price inflation will be close to the oil price increase. The positive result in S1 is the significant reduction

of carbon emissions but this is accompanied by contraction of the economy. The negative macroeconomic impacts would be much larger if the upper bound of oil price increases (100%) materializes.

Table 2: Macroeconomic Effects: Oil Price Increase and Biodiesel Intervention

Macroeconomic Indicators	Percent Change from Reference Level in 2030		Offset	Percent Offset
	S1	S2		
Real GDP	–4.80	–0.50	4.30	89.58
Real Consumption	–6.60	–1.00	5.60	84.85
Exports	–4.10	–0.90	3.20	78.05
Imports	–9.30	0.00	9.30	100.00
Food imports	–8.30	2.30	10.60	127.71
Energy imports	–27.60	–10.60	17.00	61.59
GDPPC_PPP	–4.10	-0.90	3.20	78.05
CPI	3.00	0.70	–2.30	76.67
Food CPI	–2.60	0.40	3.00	115.38
Energy CPI	48.60	5.40	–43.20	88.89
Real Household Income	–4.70	-0.40	4.30	91.49
Real Wages	–5.90	–0.20	5.70	96.61
GHG Emissions	–26.20	–6.70	19.50	74.43

CPI = consumer price index, GDP = gross domestic product, GHG = greenhouse gas

Table 2 also shows the macroeconomic effect of price hike and biodiesel intervention. Consumption losses are compensated by about 84% while household income losses and negative wage impacts are offset by over 90%. Biodiesel intervention reduces the inflationary pressures due to hike of oil price. Thus, comparison of the macroeconomic indicators of S1 and S2 shows that biodiesel intervention can counteract the negative economic impacts of oil price hikes to some extent As a result, the ability of biodiesel to neutralize the effects of oil price hikes is in agreement with the results of the Indian CGE model. The results in Table 3 show the macroeconomic indicators when both biodiesel and ethanol interventions are applied together. A study in S3 with S2 shows that ethanol intervention cannot improve economy in significant extent. Using a cost-benefit analysis, it is shown that sugarcane ethanol production does not improve social welfare, i.e., social costs exceeds the benefits. Moreover, they show that only molasses ethanol shows a positive net present value when there is no opportunity cost due to diversion of other uses such as potable and industrial uses. The study shows there is a limited scope with bioethanol as an

alternative fuel. The impact on the agriculture sector can be seen in a significant (5.3%) food import increase and a modest (0.2%) food CPI increase.

Table 3. Macroeconomic Effects: Bioethanol Intervention

Macroeconomic Indicators	Percent Change from Reference Level in 2030		Offset (%)
	S2	S3	
Real GDP	–0.50	–0.50	0.00
Real Consumption	–1.00	–1.00	0.00
Exports	–0.90	–1.00	–1.00
Imports	0.00	–0.10	–0.10
Food Imports	2.30	3.00	0.70
Energy Imports	–10.60	–12.50	–1.90
GDPPC_PPP	–0.90	–0.90	0.00
CPI	0.70	0.80	0.10
Food CPI	0.40	0.60	0.20
Energy CPI	5.40	5.80	0.40
Real Household Income	–0.40	–0.40	0.00
Real Wages	–0.20	–0.30	–0.10
GHG Emissions	–6.70	–7.50	–0.80

CPI = consumer price index, GDP = gross domestic product, GHG = greenhouse gas.

The outcomes plainly show that biodiesel can possibly balance the negative financial effects of oil cost climbs. One key supposition utilized in the investigation is that biodiesel yields will be filled in waste or decrepit grounds and there is no uprooting of food crops. This approach has merit in a steady market climate, however on the off chance that the costs of food, land, or both were to raise altogether, minimal or squander terrains might be recovered to deliver food. Motivators and a steady, helpful business climate for biodiesel may instigate change of food lands for biodiesel crops, sabotaging food security. Moreover, the present food cropland could be extended assuming that the general cost of food is sufficiently high to legitimize interests in land recovery, woods transformation, or other development of cultivating. To a developing degree, these elements might be driven by powers outer to India as an arising working class triggers more prominent food import reliance. Subsequently, any program to help biodiesel should consider this and fuse extra approach measures to guarantee that food security isn't impacted by biodiesel extension. [11]

Conclusion

From the above discussion, it is concluded that the biodiesel is essential for future need because the conventional energy sources such as coal, fossil fuels etc. will be exhausted. Biodiesel will help to settle the energy requirements of future need. It will also settle the waste plastic

management problem. The conversion of waste plastic to biodiesel would help the wildlife environment to survive properly in future.

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Impact of Industrial dyes on Environment: Problems and Sustainable Solutions

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Introduction

In the 21st century, people thriving in rural India solely rely on groundwater resources for potable purpose and surfeit water for miscellaneous activities viz., domestic cleaning, harvesting etc. The severe deterioration in the quality of water amplifies the health investment which imposes a severe threat to the current economy thereby constraining the advancement in the rural livelihood. There is a well acclaimed saying that "**We never know the worth of water till the well is dry.**" Water contamination causes inadequate access to clean water which has become a burgeoning issue that arise an exigency for addressing the problem with utmost concern and priority. Water can be contaminated by various pollutants including biological (aquatic weeds, plants) and chemical toxins (heavy metals, lethal textile effluents like dyes, pigments *etc*). To be more precise, wastewaters released incautiously from various textile industries consist of bio-hazardous effluents and toxic complex compounds. These components if not appropriately treated can cause severe environmental impact causing disruption of aquatic ecosystems as well as human health.

The undesirable presence of minuscule concentration of dyes and pigments in aqueous sources is certainly noticeable and is not desirable. These colouring agents not only compromise the aesthetic beauty but also obstruct the penetrating ability of sunlight thereby reducing the photosynthesis phenomenon within the aquatic ecosystem [1]. The intensely coloured effluents are predominantly poisonous and carcinogenic to both animals and human beings [2]. In consequence, removal of these toxic industrial contaminants is being prioritized prior to their direct disposal into receiving water bodies. Amongst several dyes, owing to the industrial applications as well as acute toxicity, cationic (basic) dyes including Malachite Green (henceforth abbreviated as MG) and Nile Blue (henceforth abbreviated as NB) have been taken into consideration in the present book chapter.

In this deliberation, as scientific researchers it is our societal liability for conserving the natural resources as well as safeguarding our environment. Keeping this in mind the present book chapter comprehensively consolidates the problems allied with MG and NB dyes utilized in textile industries and thereafter focusing on the sustainable remediation methodologies-chemical, biological, physical and hybrid systems-for their mitigation from industrial wastewaters for improving the Quality of Life (QoL) of the rural people.

Sources of dyes in the aquatic environment

In the current day scenario, there is very scanty information regarding the prevalence of synthetic organic dyes in the environment including water, soil and biotic environment. Dyes are usually present in environmental samples *viz*., water (river, pond, drinking water and wastewater), suspended particulate matters, sediments, soils along with wild fishes.

Amongst the various origin of introducing dyes into the aquatic environment, a few have been enlisted:

(a) Industrial Waste Water: Rapid worldwide organic dyes synthesis and their indiscriminate exploitation, the dyes are readily permeable to the diverse environmental part. These may either of direct or indirect sources of dyes in aqueous environment. The main sources include textile, tannery along with paper industries which consume significant volume of water and is responsible for contamination by releasing an enormous amount of wastewater directly into aquatic ecosystems (**Fig.1**) [3]. The tanneries located in the district of Jaimau, India directly releases 9000 cubic meters of untreated effluents per day into River Ganges [4].

(b) Wastewater emanated from households: The waste water emanated from domestic sources contributes another pathway of introduction of the synthetic organic dyes into the marine environment. This may plausibly be owing to the undesirable release of expired or unutilized dye-originated drugs, hair dyeing, use of dye comprising cosmetics or chemical agents that are disposed to the sewers and ultimately either paving its way to a sewage treatment plant (STP) or directly released into the environment [**5].** In the year 2003 Eriksson *et al*. surveyed that an enormous amount of grey wastewater was disposed from a building consisting of 17 flats wherein the regular water intake was around 750 L. The result of this analysis revealed the presence of 11 synthetic organic dyes including acid orange 7, acid blue 25 and acid orange 24 in the grey wastewater. For necessary preventive measures whilst the sampling practice, the residents were advised not to dye their hair or clothes. In consequence, the occurrence of dyes was particularly aligned with the use of domestic chemicals, shampoos, soaps or laundry detergents.

(c) From Sewage Sludge: In addition to extensive utilization of raw industrial wastewater towards irrigation of farmlands, the indiscriminate exploitation of sludge (sewage sludge) in the fertilizers form may plausible be liable for soil and as well as dyes contamination. For instance, it was detected that the wastewater generated from tannery industries in India instigated pollution of greater than 55,000 ha of land causing a depletion of potable water quality for humans. In another case study, it demonstrated that owing to prolonged (20 years) exploitation of dye-containing water for crop irrigation resulted in serious life-threatening symptoms that include pain in the joint, greying of hair which particularly affected the farmers living in the neighbouring areas of the infected farmlands [6].

(d) Pharmaceutical industries and hospitals: The pharmaceutical industries, hospitals are inclined to produce an enormous quantity of bio-hazardous wastewater which is saturated with pharmaceuticals, disinfectants, pigments and dyes. Moreover, these wastewaters are usually directly released into the sewage systems devoid of any appropriate treatment. In the current situation there are a scanty hospital that does not have any Sewage treatment plants (STPs), and in consequence the wastewater engendered therein is directly disposed into the municipal sewage systems. An extensive national literature survey revealed that the effluents originated from hospitals were profusely genotoxic and imposed a severe threat causing ecological imbalance as well public health deterioration.

(e) From Aquaculture: Lastly, aquaculture constitutes a direct probable origin of dyes contamination in water environments wherein the waste generation has increased from 34.6 million tons in 2001 to 66.5 million tons during 2012. The upsurge in this production caused a massive

growth in use of pharmaceuticals in the fish farming that has gradually become inevitable. The remarkable efficacy, effortlessness of attainment and cost effectivity of few synthetic organic dyes *viz*., Malachite Green, Nile Blue have made these rationales for their prohibited use towards preventing along with treatment of parasitic, fungal or bacterial infections prevailing within the fishes [7]. Once the unauthorized synthetic organic dyes are directly released by the fish farmers into the water bodies it may consequence in contamination of water and sediments. One step ahead, when the water from these fish farms is released into a receiving river it might further contaminate the other fish farms in the surrounding areas (especially in open or semi-closed water aquaculture systems) along with human water resources.

Figure 1. Release of toxic industrial dye effluents into the aquatic environment causing water pollution.

Problems related to textile dyes: Environmental contamination

The textile dyes as well as a huge number of industrial pollutants are extremely poisonous and equally potent carcinogen. As a result, these colouring agents are directly aligned with the environmental degradation and the underlying source of several ailments in humans as well as animals. Although the dyes are well acquainted to mankind since ancient times nevertheless not until the 19th century since organic synthetic dyes started to be profoundly explored causing acute probabilities of cancer in the bladder, especially for dyes including benzidine, 2-napthylamine [8]. The health ailments caused by textile effluents and dyes range from dermatitis to disorders of the central nervous system. It may also be aligned with substituting the enzymatic cofactors that eventually result in deactivation of enzymatic activities.

Toxicity of Dyes: Malachite green

Malachite green is another example of basic dye, which readily dissolute in aqueous media and most frequently is recognized for its usage in dye industries along with controlling of external

fungal and protozoan infections caused in the fishes since 1933. Nevertheless, on account of its probable carcinogenicity, mutagenicity and teratogenicity in mammals it has not ever been authenticated as a veterinary drug in food fish. MG at present is not allowed as food colouring pigment or for usage in food fish in the United States; yet, it is still explored elsewhere in aquaculture, seafood industries, even in the absence of consent from governing establishments. Most importantly, Malachite green and its reduced form, leucomalachite green, may plausibly exist in edible fish tissues for prolonged period. In consequence, there exist chances of both environmental as well as human health concerns underlying bioaccumulation of MG and leucomalachite green in terrestrial and aquatic ecosystems. The basic chemical structure of MG (**Fig. 2)** and its metabolites is denoted herein which indicates a mark of carcinogenicity. MG is chemically transmuted within the organisms to leucomalachite green that additionally gets accumulated in the tissues of organisms being exposed wherefrom it can readily pave into the human into food chain. Both clinical and experimental investigations reported till date unveiled that malachite green is a potent multi-organ toxin [8]. Additionally, it belongs to the identical group of triphenylmethane dyes including crystal violet, wherein carcinogenicity is well proven. The toxicity of Malachite Green has been highlighted below:

- Persistent in the environmentally.
- Causes damage to nervous system, brain and liver when ingested.
- Burning of eyes, fast breathing, profuse sweating and cancer of different parts of the body.
- Acutely toxic to a wide range of aquatic and terrestrial animals.
- Decrease in food intake, development and fertility rates.
- Damage to the liver, spleen, kidney and heart.
- Inflicts lesions on the skin, eyes, lungs and bones.
- Produces teratogenic effects.
- Cytotoxic to mammalian cells.
- Acts as a respiratory enzyme poison.
- Decrease of RBC count (Dyscrasia), Hb (Anemia), and HTC (%).
- Increase of WBC count (Leukocytosis) and delayed blood coagulation.
- Its presence in the hydrosphere decreases photosynthesis by blocking penetration of sunlight thereby unfavorably affecting the marine ecosystem.

Figure 2. Structural formula of malachite green, its carbinol form and leucomalachite green metabolite.

Negative effects of Malachite Green on Fishes: Since mid-1930s, the fungicidal outcome of this dye is known to mankind. MG is recognized to be an efficacious antiseptic to combat internal and external parasites. Scientific suggestions evidently indicated that this colouring agent in particular in its reduced form, *i.e*., leucomalachite green (LMG), has a propensity to remain in the edible fish tissues for a considerable time period [9]. Bills et al. unveiled extreme noxiousness of MG to fingerling fish along with non-target marine creatures [10]. On account of the fear of general public being exposed to MG *via* intake of treated fishes, the usage of this dye for edible fishes was debarred in the European Union in 2000. Extreme health ailments and its related potential human noxiousness owing to the existence of malachite and leucomalachite green (a metabolite) in the marine ecosystem has caused an improved monitoring of it particularly in the diet materials. Even though MG is banned in the United States for treating of contaminated fish, MG is exceedingly effective, readily abundant, and comparatively low-cost. Consequently, there is an immense inclination towards exposing of MG *via* ingesting treated fish by the general public, as well as to the workers working in the dye and aquaculture industries.

Negative effects of Malachite Green on Mammals: There is an immense exigency in association with the overaccumulation of malachite green which is primarily due to the studies implicating that MG is responsible for reproductive abnormalities in mammals likewise rabbits and fishes [11] which increases the probabilities of hepatic tumours development in rats [12]. MG is also proficient of undergoing DNA intercalation and/or binding [13], which is not surprising owing to the electrophilic character of its chromatic form. Additionally, the structure of leucomalachite green is analogous to the aromatic amines that induce carcinogenicity and have displayed DNA adduct formation in humans and rodent tissues. MG also triggers lipid peroxidation, a procedure that leads to endogenous damage formation of DNA. One step ahead, ROS (reactive oxygen species) may also be involved in promoting of tumours in association with MG [14]. If proper consideration is not levied to the problems related to Malachite green promoted contamination, there are extreme probabilities of this lethal content in the water bodies or industrial waste water to profoundly percolate into the marine ecosystem and ultimately being exposed to humans resulting in severe health ailments. On account of the acute toxicity of Malachite Green, there rises an upsurge towards the mitigation of this dye from aquifers and industrial wastes by cost effective, readily synthesized adsorbent material.

Toxicity of Nile Blue

Nile Blue is another coloured effluent dye (**Figure 3**) that is responsible for contributing to major problems in alliance with industrial waste waters. When this coloured wastewater effluent is directly released it not only causes destruction of the overall aesthetic landscape and scenic beauty of receiving streams and the neighbouring environment but it is equally hazardous to the marine lifecycle. The strong colouration of NB is mainly due to the instable dye. NB is an azo dye that contributes the foremost class of dyes that are thoroughly utilized in varying dye and textile industries. It is a probable photosensitizer which is rigorously exploited in the photodynamic therapy for treating malignant tumours. Nevertheless, this cationic dye has a propensity to undergo aggregation in tumour cells, in particular within the lipid membranes, and is eventually over accumulated within the sub-cellular organelles which is immensely damaging. It is also noxious for the respiratory tract upon inhalation and might cause skin and eyes irritation [15].

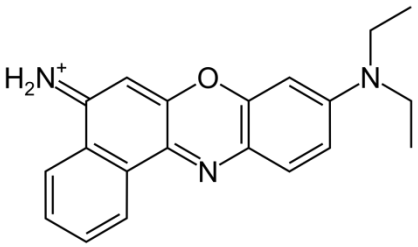

Figure 3. Chemical Structure of Nile Blue.

Recent Advances in new generation dye removal technologies

Synthetic dyes are typically endowed with particular characteristics that render them unaltered for a substantial time period owing to abrasion resistance, photolytic stability, resistance to chemical and bacterial outbreak. In consequence, majority of these compounds have posed a two-fold ecological annoyance in terms of aesthetic and toxicological viewpoint. The existence of these in water bodies consequences in eutrophication, under oxygenation, change in colour, odour, persistence and longstanding bioaccumulation. Unfortunately, the wastewater comprising of these dyes are directly released into the nearby rivers, drains, stagnant ponds or lakes without undergoing proper treatment. The dyes are inclined towards absorption as well as reflecting of sunlight that enters into the water ultimately interfering in proliferation of bacteria and thereafter impeding photosynthesis in plants, growing under water [16]. The existence of even infinitesimally small concentration of dyes in water (<1 ppm for some dyes) is highly evident and objectionable [17]. Most of these dyes are poisonous and potentially carcinogenic which brings severe danger to the aquatic living organisms. It is therefore extremely essential to efficaciously eliminate the dyes prior to their discharge into the water bodies. To date literature is replete with plethora of treatment methods for the detoxification of dyes from waste water effluents. The methodologies can be classified into physical, chemical and biological methods. The following are a few conventional methods for removal of toxic dyes from wastewater.

(1) Electrocoagulation: This technique utilizes direct current source between metal electrodes immersed in polluted water. The electrical current is responsible for dissolution of metal plates that includes iron or aluminium into wastewater. The as-generated metal ions are deposited at the anode and hydrogen gas is evolved from the cathode. At suitable pH condition the metal ions tend to undergo coagulation thereby forming metal hydroxides that weakens and causes aggregation of suspended particles or precipitation further adsorbing the dissolved pollutants. The H_2 gas so evolved assists in floating of flocculated particles out of the water. This methodology provides standout advantages involving inexpensive equipment, easily operative, less maintenance time, high velocities, less sludge generation, and no toxic chemical additives. However, the requirement of extensive electrical energy and high cost restricts its practical utility.

(2) Advanced Oxidation Process (AOP): AOP is a chemical treatment methodology that cultivates in wastewater management industries. Advanced oxidation processes (O_3, O_3/H_2O_2, O_3/UV, H_2O_2/UV, O_3/H_2O_2/UV, Fe^{2+}/ H_2O_2) towards the degradation of non-biodegradable organic contaminants present in the industrial effluents are lucrative alternatives over traditional treatment methods. The basic principle of AOP includes production of hydroxyl radicals (OH•), that is plausibly generated from hydrogen peroxide (H_2O_2), ozone, photo-catalysis or oxidating

agents together with the ultraviolet rays. The OH• is mainly responsible for decaying of organic compounds.

(4) Electrochemical methods: Electrochemical oxidation is one amongst the treatment methods that have achieved specific attention in the wastewaters treatment polluted with organic compounds. In this process, the organic and toxic pollutants that are present in wastewater in particular the dyes are usually destroyed by either direct or indirect oxidation process.

(5) Biological methods: Biological materials that include algae, bacteria, fungi and yeasts have capability of disintegrating and absorbing varying types of synthetic dyes. The bioremediation is cost effective, environmental benign and produces limited sludge volume in comparison to other procedures. It instigates the synthetic dyes to degrade to a relatively less poisonous inorganic compound on account of breakdown of bond present within the chromophoric group and finally aids in decolouration.
However, prolonged intake of time and incapability of degrading complicated dyes are its disadvantages.

(6) Membrane technology: Membranes are widely exploited in varying industries of separation processes due to their ability of controlling the materials that would selectively pass through the membrane, thus achieving high extent of separation that makes this procedure broadly acceptable. Nevertheless, inhibition of membrane fouling in these advanced membrane separation technologies is considered to be a critical task for ensuring their economic feasibility.

(7) Nano technology: This refers to the materials that possess either one or multiple external dimensions ranging between 1 to 100 nm range. Its small size provides extraordinary properties including extensive surface area, a larger number of surface-active sites, quantum effect, exceptional properties of electron conduction *etc*. These properties extraordinarily benefit the performance of nonmaterials when it is used as adsorbents, catalysts, sensor, or in other myriad applications that would promote the biodegradation of dyes in wastewater. However, there are certain challenges including extensive cost and poor separating ability that still limits their engineering applications.

(8) Adsorption: This is observed to be one amongst the most efficient and a recognized methodology for treatment of wastewater in textile industry since it is cost effective for mitigation of dyes and/or decolouration of textile effluents. The process includes the transfer of miscible organic dyes from wastewater to the surface of adsorbent which is solid and highly porous in nature. The main factors that influence the dye adsorption include interaction prevailing between dye and adsorbent, specific surface area, particle size of adsorbent, pH, temperature and time period of contact.

The overall advantages and disadvantages of various traditional methodologies for elimination of synthetic dyes are summarized herein (**Table 1)**

Table 1. Advantages and Disadvantages of the various conventional techniques for dye removal.

Techniques	Advantages	Disadvantages
Chemical methods		
Coagulation–flocculation	Simple method and economically viable. Rapid detention time and reduced capital costs. Appreciable efficiency of removal.	High production of sludge. handling and disposal problems. Costly chemicals required for adjusting of pH. Dewatering and problems related to sludge handling.
Ozonation	Ozone can be applied in its g state and does not enhance the volum wastewater and sludge	Short half-life period (20 mins)
Fenton's reagent	Capable of decolorization of var wastes. No attention is levi volume. Effective decolorization of soluble and ins dyes	Prohibitively expensive. Sludge generation
Biological methods		
Biodegradation	Economically attractive. Publicly acceptable treatment	Slow process. Necessary to create an optimal favorable environment. Maintenance and nutrition requirements
Emerging technologi		
Photocatalysis	Process carried out at ar conditions. Inputs are toxic and inexpensive Complete mineralization with sh detention times. No sludge is pro	Effective for minuscule amount of colorants. Expensive process. Formation of extensive by-products
Sonication	Simple in use. Very effective in integrated systems	Relatively new method and is awaiting For full scale applications

Conclusion

Dyes constitute an important class of organic contaminants and are well acquainted for their hazardous effects in general on marine ecosystem and in particular on human beings. Such substances are extensively utilized for producing consumer products that includes paints, pharmaceuticals, food, cosmetics, plastics, photographic and paper industry. The disposal of dyes in wastewater with appropriate treatment is tricky as well as challenging. This is primarily because synthetic dyes used in industries are in particular designed to resist fading upon exposure to sweat, heat, light, water, many chemicals that include oxidizing agents, and microbial attacks. Henceforth, for reducing the negative effects of dye polluted wastewater on humans and environment, the wastewater should be carefully treated prior to its discharge into the main streams. Consequently, various societal awareness programs should be initiated in this regard.

The conventional methodologies that are under active progress for toxic dyes discoloration mainly include reverse osmosis, electrocoagulation, electrodialysis, ultrafiltration, ion-exchange, chemical precipitation *etc*. Nevertheless, all these approaches are allied with certain gaps and challenges that include imperfect removal, high reagent and energy generation of toxic sludge or other waste products that require careful disposal, high capital and operational costs, labour intensive *etc*. In this deliberation, adsorption technique by utilizing cost-effective R&D modified bio-adsorbent materials has developed to be an efficient and budget friendly alternative in comparison to traditional methodologies. Application of these modern techniques would unambiguously assist in reaping enormous advantages including reduced effluent treatment and water consumption cost to a greater extent. The present book chapter systematically illustrates the problems allied with toxic industrial dye effluents (herein Malachite Green and Nile Blue) and their subsequent remedies for sustainable discoloration of sorption of toxic dyes that are released from the industrial, textile waste water.

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The Language of the Tide Country

[A reading of Amitava Ghosh's *Hungry Tide* and Arundhati Roy's *The Greater Common Good* in light of eco criticism and socio-political momentum]

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Introduction

Literature has always been a voice of people and of the marginals and probably this characteristic of literature has given birth to eco criticism. Majority of the environmental issues are nothing but after effects of human activities on the environment which harm Nature. The key issues which have got the attention of the critics are pollution, climate change, global warming, overpopulation, waste disposal, dam building, deforestation, unethical construction etc. Environment cannot speak against all the injustice it tolerates. It shows its wrath through natural calamities and makes humans vulnerable against it. To avoid it, it is very important to save nature and the environment. Environment is nothing but the surrounding where everyone including animals, planets, human beings, water bodies reside together. Nature is for all. Affecting nature will bring destruction on the whole planet. But, we humans tend to forget all these and it is very disheartening to observe that man-made reasons are the main villain of the environment. Literature has always talked about or criticized many issues similarly, it has raised its voice against environmental issues. Literature has a different genre, concerning environmental issues and that is known as eco-criticism. Scholars of literature analyze the underlying issues of nature through various literary works, also they illustrate their concerns over the environment, and sometimes along with the depth of the issues, and the probable solutions are also discussed. Eco-criticism is the relation between physical environment and literature. [1]

This book chapter proposes to explore the various intricacies of man versus wild or nature, which is portrayed by Indian English writers through their various works. It deals with issues like climate change, global warming, deforestation, damage of the habitats of water creatures etc. This chapter focuses mainly on the works of Amitav Ghosh [2] and Arundhati Roy [3], where their concerns about the environment have been reflected. Many Indian writers including Raja Rao, R.K. Narayan, Ruskin Bond, Rahul Azim have depicted their concern for the environment. This book chapter mainly deals with the issues which were discussed in Amitav Ghosh's *'The Hungry Tides'* and in Arundhati Roy's *'The Greater Common Good'*. In both the books genuine concerns for nature along with marginal people and water habitats have been observed.

The issues which kept the Indians in front for a long period of time were: how to save lands, how to prevent deforestation, how to stop soil erosion, how to save the fertile lands and the biggest issue was saving the marginal people. Climate change is discussed vividly in Amitav Ghosh's *'The Hungry Tides'*. Similarly issues like deforestation and saving the lives of marginal people echoed in every page of Arundhati Roy's *'The Greater Common Good'*.

The chapter aims at establishing intertextuality between *'The Hungry Tides'* and *'The Greater Common Good'* focusing on the concerns of both the writers over nature and also depict the vulnerability of humans in front of the wrath of nature. There are not any literary similarities between these two texts but the theme of both the texts revolve around saving Nature and is also about the sufferings of the marginal people being a part of the larger greater nature encompassed in its thrall. Both authors are bringing forward to the global community the issues which can damage nature and human beings. This chapter also puts effort into bringing out the hidden socio-political reasons which have been discussed in both the texts along with environmental issues. This paper is a cumulative study of nature, its damage, reasons behind its damage, socio-political issues. All these will be done through literary texts of Amitav Ghosh and Arundhati Roy.

At present the world is solely concerned and is debating over ecological problems and India is no exception to it. Ecological problems are the changes in the natural environment, which result in natural disasters or have some serious anthropogenic impacts, leading to the disturbance in the functioning and the structure of nature. Major environmental issues include pollution, global warming, and climate change, degradation of environment and depletion of resources. In the post-colonial era, the Indian environment has witnessed air pollution, water pollution, climate change, deforestation, biodiversity loss, and ozone depletion damage in the natural environment, mining, ocean acidification, dam building, acid rain, overpopulation, greenhouse gas emission and some. Along with above mentioned issues the tendency of the government to harm nature in order to indulge in temporary development, is very harmful. This attitude of the government as well as the citizens has cost immense damage to nature which is irreparable. Various seminars and conferences have been organized by environmentalists to raise awareness among common people. Similarly literary personnel also have been part of the same endeavor to portray Man and Nature through the various literary texts. Eco criticism thus became the neoliterary cult [4]. This form of criticism has gained a lot of attention during recent years due to higher social emphasis on environmental destruction and increased technology. It is hence a fresh way of analyzing and interpreting literary texts, which brings new dimensions to the field of literary and theoretical studies. Eco criticism is an intentionally broad approach that is known by a number of other designations, including "green (cultural) studies", "eco poetics" [5], and "environmental literary criticism." Earlier theories in literary and cultural studies focused on the issue of class, race, gender, and region are criteria and "subjects" of critical analysis. The late twentieth century has woken up to a new threat: ecological disaster. The most important environmental problems that humankind faces *as a whole* are: nuclear war, depletion of valuable natural resources, population explosion, proliferation of exploitative technologies, conquest of space preliminary to using it as a garbage dump, pollution, extinction of species (though not a human problem) among others. In such a context, literary and cultural theory has begun to address the issue as a part of academic discourse.

From Bhopal gas leakage to severe pollution in Yamuna River; the rampant usage of minerals, heavy mining, unethical constructions, the tendency to build dams on every river have disturbed the ecological balance and made the sustenance precarious. It is obvious and inevitable that any developmental project leads to the benefit of some out and sufferance of the others. Humans along with trees, rivers, seas, forest soil, and animals are part of Nature and an important element of it. Making any of these elements suffer would eventually harm existence as nature would get damaged as a whole. Impacts the way humans conduct their lives.

Man vs. Environment

In *'God of Small Things'* [6] Arundhati Roy raised her voice against the marginal and she portrayed the relationship of nature with man through various symbols. Sometimes she took the help of metaphors and sometimes of metonymy. She fought for the right of the marginals and also concerning the condition of nature through her literary works, *'God of Small Things'* and *'The Greater Common Good'* are examples of that. Similarly through the various works of Amitav Ghosh it is seen that environmental issues along with climate change is one of the major concerns. His famous Trilogy which is the *'Shadow Lines'* [7], *'The Hungry Tides'*, and *'The Great Derangement'* [8] deals with the topics of ecology in the post-colonial era. There are writers like Frank Schatzing whose novel *'The Swarm'* [9] critically noted the reasons behind water pollution. Poisoning the water of the sea can kill millions of people and that the author shared in his book. Another very important novel is *'The Man With The Compound Eyes'*, which is written by Wu Ming-Y talks about the terrific Tsunami and discusses the reasons behind it.[10] In his book he talks about the manmade reasons behind natural calamities. His work has a lyrical beauty which includes reality fantasy and dystopian environmental tales. The connection of the history of imperialism with climate change is seen in the style of Amitav Ghosh's writing. According to Ghosh, only focusing on a major Monday in life would be very unrealistic in this age. Because frequent disasters related to climate floods in various places of India increase in the frequency of earthquakes deforestation pollution of the water bodies are current issues which should be there in literature as they are affecting the lives of people.

This chapter bases its discussion of climate change along with other environmental issues which are reflected in the literary texts of Amitav Ghosh's *'The Hungry Tide'* and Arundhati Roy's *'The Greater Common Good'* issues regarding water pollution, poisoning river waters, snatching the livelihood from the marginal people are the main key points of Arundhati Roy's *'The Greater Common Good*'.While issues regarding climate change, deforestation, National calamities, vulnerability of humans in front of the wrath of nature are presented in Amitav Ghosh's *'The Hungry Tide'*. They deal with how environmental issues, cultural issues concerning the environment and attitudes towards nature are presented and analyzed. One of the main goals in ecocriticism is to study how individuals in society behave and react in relation to nature and ecological aspects which is the focal point of the mentioned texts.

River and life: A discussion of The Greater Common Good and The Hungry Tides.

Population of 6,000 endangered dolphins under threat from climate change and fishing, US conservationists warn. [11]

Shortage of drinking water was a common issue during the post-independence era. To address that issue the government decided to build many dams on Narmada River. According to the government, dam building will eradicate the issues of water shortage and irrigation problems .All these were decided without the consent of the people who were going to get affected due to the dam building. In this essay author Arundhati Roy captures her vehement resistance to the dam building as it could affect nature badly as well as it would cost many marginal people's residences. It was not just a fight to save the valley of the river, rather it was a fight to claim justice for those helpless poor people .This essay vividly portrays how in the name of development a state runs autocracy and harm nature as well as its elements.This essay starts with the speech of Jawaharlal Nehru where he said "If you are to suffer you should suffer in the interest of the country" (Jawaharlal Nehru, speaking to the displaced villagers for the creation of the Hirakud dam). [3] This clearly shows how the marginal people have nothing to do except accepting the orders of the higher authority. This chapter also sheds light on the harmful sides of the dam building which could damage nature on a larger scale. "Development "is a favorite tool of the Indian ministers and using it they actually serve their own interest and never think about the common people and their needs. This the the topical essay was a very important tool as it gave 'Narmada Bachao' andolan a different outlook. The project of the Sardar Sarovar dam was a very complex one which involved the price of immense damage to the environment, displacements of the tribal and marginal people and the economic development of developing India. The river and ecosystems wreck which was about to come through the dam building were not even considered or thought or probed upon by the government.

Humans are elements of nature specially the tribal people as they are closer to nature. This Sardar Sarovar Dam building uprooted those people from their own homes destroying their livelihood and prospects of the coming future. They were left with nothing. Irrigation, hydropower, navigation, recreation are the prime selling points for those political and economic elite class people, whose main agenda was to follow western development building without realizing if it would be fruitful in the Indian soil. The dam proponents claimed the affected people would get improved lifestyles But they failed inevitably to think about the fights of the ancestral land owners within that developmental zone. In the name of development people were being tortured by the government. A curfew-like situation was created where it was forbidden to gather more than 5 people. [3] Farmers were not given proper compensation against their forcefully taken lands. Many scholars and historians have criticized the writer for being unrealistic and overemotional, the Supreme Court even sentenced her one night jail and fine of ₹2000 for raising voice against the courts judgment. The writer's stand was still the same and she stood by the poor people against the government.

Similarly Amitav Ghosh in his' The *Hungry Tides'* has tried to portray the bond between nature and man. This book is also a part of eco-criticism as it analyzes the importance of awareness regarding environmental issues. The novel starts with Piya Roy [2] who is a young Indian American biologist who has come to Sundarban in search of an endangered river dolphin, which is very rare.On her way she falls off a boat into crocodile infested river and later is saved by Fokir, a fisherman. Piya and Fokir did not understand each other's language yet they were attracted towards each other. Piya seeks help from Fokir in order to complete her research and find Kanai who is also a businessman. The whole area is settled in Sundarban. Kanai's uncle was killed in the massacre and his aunt Nilima is still very impacted by his uncle's death. Also the change in the environment and physical properties is something which caught Kanai's attention as he is visiting the island after a long time. On reading his uncle's personal notebook Kanai discovers about the

socio-political mysteries of the island. Kanai understood that his uncle Nirmal tried and fought to protect the refugees who hid in the island to protect themselves from the government. Piya, Fokir and Kanai set off on their journey along with Horen, Nilima and Nirmal's friend who has a large boat. Suddenly the boat's engine died and had no other option but to take shelter in a village. That night the locals of that village capture a tiger, Piya tried to protect the tiger but Kanai stopped her making her stand in front of the question, if the locals who live here are less to her than the tiger??! One day, Kanai and Fokir observe the dolphin and they go to an island nearby which is in Fakir's village, protected by 'Bon bibi', a local goddess[12]. Bipod e poriya bon e jeijon e daak e, Ma boliya Bonbibi doya r maa take … Uddhariye taro torey aponaro gun e, Maaer o hujura koto likhibo ekhane …

"Facing any danger inside the forest, whoever prays to Her, Mother Bonbibi protects them all" [13]

On being unable to adjust in the village atmosphere Kanai decided to leave but the leader of that area disturbs him the most; later he encounters a tiger and joins the rest of the gang. A major cyclone was approaching them drowning but Horen and Kanai decided to leave and return back but they could not find Piya and Fokir and could not wait all night as they wanted to save themselves. They left that island and came back to Lusi Bari. As the cyclone approached Piya and Fokir tied themselves with a tree where a flying object hit fokir and somehow Piya navigates back to Lusi Bari, [2] where she stayed for few more weeks and decides to name the project after Fokir's name. The whole story revolved around Sundarbans, discerning its dreadful part, also presenting the socio-political incidents that shaped the island into the present Sundarbans. The story also showed the vulnerability of human beings in front of the wrath of nature. Also man binging havoc onto himself by destroying Nature is portrayed here.

Statistics

Residents of the Narmada Valley protest on the Kasrawad Bridge on 17 September, even as the Prime Minister Narendra Modi inspected new projects built to boost the dam's tourism appeal. AKSHIT SHARMA [14]

In Arundhati Roy's *'The Greater Common Good'* to build Sardar Sarovar dam, 57.6% of the total people who were mainly tribal were displaced. The government backed a national rehabilitation policy. It was announced that 30 dams would be constructed on river Narmada and among them Sardar Sarovar dam would be the largest. For that 3,20,000 people would be displaced with little or no compensation. At first the World Bank funded 450 million dollars in the project, later when 'Narmada Bachao' andolon was in full swing, the World Bank backed off. 30 big dams, 135 medium sized dams and near about 3000 minor dams were proposed by Jawaharlal Nehru on

Narmada River among all Sardar Sarovar Dam was the largest structure which was to be built. The advisors who were 57.6% of the total population displaced for the construction of the dams were provided with nothing. [3] The world was deprived of everything, even their shelter and livelihood were snatched by the government. Similarly in' *The Hungry Tide'* we see Amitav Ghosh to portray the suffering of the refugees who took shelter in Marichjhapi. No exact numbers are disclosed like how many refugees were there on that island or how many got killed by the police. But several articles, journals predicted that more than 40,000 refugees took shelter in that island and more than 7000 men, women and children were killed in the massacre. Many refugees were forcibly evicted and the number would be more than 10,000 people. Rape, assault, were very common occurrences in the refugee camps and most of them came from the government personals according to some of the witnesses. [15] The suffering of the common people or the marginalized are common in both the texts along with the Mentality of the government. And nature plays a key role in both the texts. In '*The Greater Common Good*' government approach and deeds went against nature whereas in *'The Hungry Tide'*, in the name of protecting the environment the government damaged the lives of marginal people.

Proposition of the obvious in light of Marichjhapi Massacre and Narmada Bachao Andolan (NBA).

Marichjhapi is one of the 102 islands in the Sundarban, the delta dominated by mangroves cover one-third of which lies in West Bengal, and the rest is in Bangladesh. [17]

There are many similarities between Arundhati Roy's *'The Greater Common Good"* and Amitav Ghosh's *'The Hungry Tide'*. Both the text shows concern for the environment and climate change is a very pivotal issue in the text. Both the text through various symbols depicted the environmental concern. The title *'The Hungry Tide'* itself carries a symbol, rivers are portrayed to be the central symbol of the text. *'The Hungry Tide'* title is the combination of many rivers which are small and large in size, tides bring both life and death in Sundarban. Here the river carries the symbol of human's duelist and complicated relationship with nature. Through tiger the text symbolized the extraordinary natural power of the environment. Tigers are a representation of the deadly Sundarban. Local people treat the tiger with fear and respect and the text claims that Sundarban must be represented with that fear and respect and that would save the landscape from degradation. The use of 'Gamccha' (a cotton linen washcloth), has a motive which later turns out to be a mode of savior, as during the cyclone it protected both Piya and his uncle and Horen and it is associated with preservation and safety. In Arundhati Roy's *'The Greater Common Good"*, we can find sarcasms but very less number of symbols are present in this text. To start with symbols the dam is a symbol itself. Building of the dam symbolizes both life and destruction. Small dams represent life whereas dams larger than fifteen meters from its foundation represent destruction. The title of

the text is sarcastic. The title says *"The Greater Common Good"*, and in that greater word certainly the poor, marginal and adivasi people are not included because the Sardar Sarovar Dam project did nothing good to them, rather it took everything from shelter to food to livelihoods form them. Another sarcasm was presented in the text where the judgment of the Supreme Court was talked about. The writer sarcastically wrote that the Supreme Court's only concern was to seek whether the displaced children got any playground in their re-settled colony or not! This is very disturbing, where millions of millions people were asked to vacate their land which made them loose not only their home but also made them loose their means of livelihood and for the government their sacrifices went unrecognized. It clearly indicates that ministers take deconstruction for their own interest not for the wellbeing of the country. Both the text have the theme, Man vs. Environment. Amitav Ghosh shows the wrath of nature when something is done against it, whereas Arundhati Roy puts more attention on the injustice against nature and its elements. The theme of both the texts in somewhat relatable as both has eco-criticism in it along with socio-political scenarios, including the debatable issues like climate change, water habitats,debrutation dam building and ecological imbalances made the writers choose the topic and create text like the *Hungry Tide* and the *Greater Common Goods.* Both are connected to each other through the line of environment and its wellbeing along with its elements. Also both the texts have got some solid humanitarian grounds, which makes them connect to the reader on a larger scale, beautifully.

Socio-political aspect: Law vs. Common man

The primary reason to write *'The Hungry Tides'* and *'The Greater Common Good'* was the ecological concerns. Another major reason behind the texts is to bring in front the socio-political issues of that time. Arundhati Roy was deeply shocked with the government's ignorance towards the wellbeing of the marginal and poor people of the river valley. In this context "Narmada Bachao Andolan" is very important. It is a social movement led by native tribes, environmentalists, human right activists and farmers, against the dominance of the government. It was said that 30 major, 135 medium sized dams and 3000 small dams will be built on Narmada River, in order to eradicate the issues of drought and lack of drinking water. The Sardar Sarovar dam was the tallest among all of the dams and building it became very troublesome as a great unrest among most of the citizens was perceived. Narmada River has passed through Gujarat, Madhya Pradesh, Maharashtra and the main aim to build this dam was to provide electricity and irrigation to people of these states. In the process people who lived in the river valley were asked to leave their homes for the greater interest of the country. Even the environmentalists and the forest department of the government checked the project and as it did not fulfill the basic environmental conditions. This project lacked proper planning and detailed studies which were other reasons for the scholars to protest. Arundhati Roy focused mainly on the humanitarian grounds and in her essay mainly the sufferings of the poor people is echoed along with various protests against the government. She condemned the government for ruining the lives of the poor and marginal people and of the adivasis. She advocated against the government's hypocrisy and the mentality to put focus on temporary development. Even the writer gave all her man-booker prize money which she got for her novel '*God of Small Things',* to this 'andolan'. Arundhati Roy had to spend a night behind the bars for raising her voice against the government asking for the rights of the poor. .

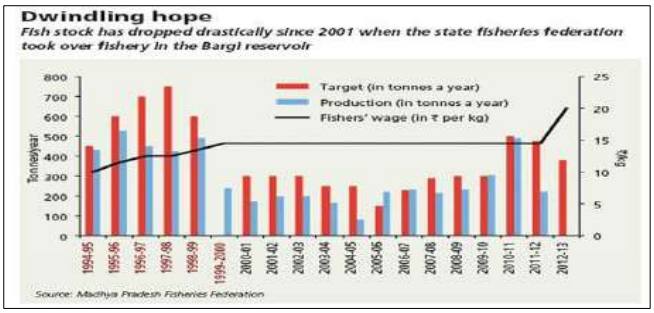
Amitav Ghosh is an ardent follower of eco criticism and in most of his books, nature plays an important role. '*The Hungry Tide*' is a very renowned book by the author and this book has a deep socio-political background which makes the story even more mysterious and interesting and in this regard, 'Marichjhapi Massacre' is very important. It refers to the incident where Hindu Dalit

refugees forcibly occupied the reserved forest land. These lands were legally protected and situated at Marichjhapi Island of the Sundarbans. This incident took place in 1979. It also depicts the death of some refugees and policemen due to the violent actions, gunfire and disease. Through Nilima and Nirmal's characters the subsequent time of the massacre is clearly depicted in the novel. The government of that time which was the Communist Party of India came in force and refugees across the neighboring countries started to come in large numbers to India. Some of the refugees who claimed to be Hindu dalits, started to live in Marichjhapi Island. They established a colony there and named it "Netaji Nagar". [2] In fear of losing a reserve mangrove forest, the government asked the refugees to evacuate the lands, which the latter disobeyed. As a result, violent activities took place. There are reports that Ananda Margis of that region started cross border arms smuggling and that had been caught by the police. Thirty police started patrolling the place to prevent illicit activities. The group of Ananda Margis attacked those policies and killed ten of them. Then the police retaliated and open-fired and killed thirteen people. The remaining refugees were brought to the police launch of Hasnabad. This incident was depicted in the novel through the characters of Fokir's father (as a refugee) and Nirmal (as a supporter of the refugees). On the other hand, Nilima represents the left government as she was in support of them and their ideologies.

Seat of power: The role of court and state:

The above discussions on both the texts have made it very clear that the role of court and the state were not satisfactory. The state must strive towards the wellbeing of all the inmates and law must treat every citizen equally. All decisions of a state must include the welfare of the citizens of the country. But law is not impartial and most often it talks in favor of the majority or it speaks for the rich people. On the other hand, the state lacks the ability to think about the marginal people and this is reflected in the text vividly. In "*The Greater Common Good'' lack* of resettlement planning for the millions of people who were displaced from their lands, shows that incompetency of the government only. The government and law work for the rich and influential people. Environment, its damage, marginal poor people and their wellbeing are never considered by the government. Same cycle is noticed in Amitabh Ghosh's "*The Hungry Tide"* , where without proper planning and infrastructure the state indulged in a massacre in the name of saving the environment. The irony in both the texts is - the law and the state in the name of doing well to nature and to develop the country, actually harm them the most. Human beings are part of nature, specially the tribal people and the marginals. Harming them is a form of destruction of the environment indirectly. Poor and marginal people have always been very helpless in front of the prowess of the state. Most of them are illiterate and barely understand law, diplomacy and their rights. As a result they are exploited the most and they are deprived of every governmental facility. Rather these poor people are the one that suffer the most because of the government's ill planned projects. This irony is established thoroughly in both the texts very gracefully. Both the writers have raised their voices against this injustice. Amitabh Ghosh said it in subtle form and Arundhati Roy said it aloud.

Victor and victim: Sustenance of Man vs. Environment



Statistics showing a steep downfall in fish stock. [18]

Humans have a very deep relationship with Mother Nature from the time of creation. From their birth, they are cradled in the lap of nature. Nature nurtures humans with food, clothes and shelter since the time immemorial. But the more civilized society became, the more it started to destroy nature. As a result their lives are at stake. In Arundhati Roy's "*The Greater Common Good "* essay, the writer has given the details of the controversies regarding Sardar Sarovar Dam on Narmada river. The main aim of this essay is to shed light on the inner politics of that time. Also, it reflects the writer's immense concern for the environment. According to Arundhati Roy, the dam was not made for the wellbeing of the countrymen, it was rather made to satisfy the hidden political interests of the concurrent government. Jawaharlal Nehru insisted the villagers to suffer for the betterment of the country. It clearly indicates these marginal people were not included in Nehru's perception of countrymen. People, who were asked to vacate their lands were mostly farmers, adivasis and from very poor backgrounds. In every riverside belt, farming is very famous, so are small scale industries and fishing. Asking to vacate the lands of those poor people would make them say goodbye to their livelihood as well. These people could not afford to start their lives from scratch. For a country's betterment development is very important as it helps the country to evolve and progress. But harming poor people by snatching away their livelihood from them in the name of development is pathetic and shameful. India has witnessed lots of developmental projects post-independence era, and most of them were harmful to nature. These issues induced various protests, gatherings, and rallies in the country. These are clear indications that the countrymen were not happy with the project. The picture of helpless people of the valley is very well described in this essay. In this regard 'Chipko Movement' of Uttaranchal, or 'Narmada Bachao Andolan' are very crucial. These movements were done to protect nature as well as to raise a voice against the injustice of the marginalized people. Various theories are already there to show the harmful effects of deforestation or dam-building. Theories also show when a country steps towards deforestation, poisons the water of rivers and seas, or builds unnecessary dams it can be fatal as it might cause natural calamities. In the name of globalization, people tend to harm nature which can be compared to digging one's own grave. We must remember:

"For dust you are

And to dust you

shall return".

(Genesis 3:10) [19]

Nature is considered as God, and harming it will endanger human's existence. For the temporary developments damaging this planet indeed is an ugly act as it can lead to permanent damage to

nature. It is the habit of the government to suppress the voices of the minorities and to impose law and order of the state on the minors. The sufferings and hidden tears of those people were always unheard to the government. And these acts of the government made the writer visit Gujarat.

With the help from the internationals the government imposed military rule on the land so that the voices of the oppressed did not come out. The whole country decided for their own benefit, and the marginals had to suffer. The Supreme Court's diction was in the favor of the government. It did not care to give justice to the poor people. The sufferings and tears were ignored by the people who used to earn from that river. The motto of the project was to bring water to the barren lands. In the whole process the government failed to cater the needs of the environment as this project has entailed huge flooding of various villages and fertile lands which were considered to be productive. These activities of the government adversely impacted nature. Downstream fishing was immensely affected by it. It was considered a great threat to wildlife's natural habitat. Morse Reports of 1992 has found it to be a threat to waterlogging, salinization of water, deforestation and silting of the riverbed. Morse Reports also condemned the fact that there was nothing such a resettlement plan to the government for the people who were to be replaced. The World Bank at first invested in this project, later after several protests, criticism from the environmentalists and for the lack of proper planning they withdrew from this project. Another important adverse effect of this dam was suspected to be climate change. The ecological damage was something Sardar Sarovar Dam did to India, plus its effectiveness was questionable.

Due to this project, land submerged in Madhya Pradesh was near about 20,822 hectares, in Maharashtra it was near about 9590 hectares and in Gujrat it is about 7112 hectares. And most of these lands were fertile. Negative impacts of big dams are numerous. Dam wall blocks the migration of fishes, it changes the physical property of a river, it also adversely affects the ecological property of the river. Aquatic plants and animals are not habituated with the artificial reservoir habitat and it changes their system. Some reports also suggest that there were many forest areas in the riverbed which submerged. Arundhati Roy tried to focus on all these above-mentioned points in her essay.

In Amitabh Ghosh's "*The Hungry Tide*", from the very beginning the vulnerability of human life in front of the wrath of nature is expressed.[20] Piya's fall on the river is such an instance. The cyclone is another example of nature supremacy. The tidal powers have the ability to reshape the lands and to charge the course of rivers. Endangered species like Irrawaddy dolphins and Royal Bengal Tigers are the main treasures of the Sundarban Islands. [21] The conflict in this island is between non-human and the human, mainly for space. The myth of Bonbibi expresses the relation between the predators and the human settlers. The role of government in terms of nature protection is ridiculed and mocked in the scene of Piya's meeting with the village forest guard. The killing of the tiger near the village emphasizes the man versus nature conflict. The Bonbibi myth is an instance which clearly shows that residents of Sunderban want to reside there without harming nature and the animals. Government wanted to clear mangrove forests in Marichjhapi and thought of planting cashew and coconut trees there. This act was indeed very short sighted as mangrove forests balance the ecology of Sunderbans. This is another conflict which is beautifully presented in the novel. The nylon nets and motor steamers tend to disrupt the ecological balance of the water and also pollute it. This conflict is also presented in the novel. Also the beautiful portrayal of Fokir's character, tells us that the residents of Sunderbans are the true caretaker of the island and not the government officials, who barely have knowledge about the lands. [22] Fokir's death also

presents another conflict between man and nature and again it depicts the vulnerability of human lives in the face of natural disasters.

Man and Man

The relationship between two human beings is one of the prime highlights in both the texts. Fokir's unconditional help to Piya expresses the uncomplicated simple mindset of the rural islanders. This part is beautifully depicted in *'The Hungry Tides*'. In the essay *'The Greater Common Good'* , the activists, environmentalists, social workers, farmers , marginal and the deprived stood together to help each other in order to save their home. This tells us about the humane bond that binds us together in the face of adversity. The innate urge to stay as a social being in communities rising above the segregation of caste and creed, color and status just like Piya and Fokir.

Power and Man

In *'The Greater Common Good'* power resembles the institutional law and the seat of rule, i.e. the government which took away everything from the poor people in the name of development. In *'The Hungry Tide'* the left government took the lives of refugees in the name of preserving and conservation which they did not perform later. Even today, Marichjhapi remains a curious blot on the canvas of Bengal politics and civilization. Both the writers through their texts deal with unmasking the hypocrisy of power and corruption.

Man and Nature

Man to nature is the ancient of all relationships. [23] As far as we can trace the existence of humanity backwards, we have been on the receiving end of bountiful nature. This innate relationship is depicted in every page of both the texts. We are made out of nature, the elements in it. So, it is one of our primary duties to protect the mother who nurtured us with care. In both the texts it is seen that a section of our civilization, who are categorized as minority or the deprived are fiercely taking up their oath to preserve the surrounding. This can be seen as a symbiosis of the root to our root. They are the primordial beings dependent on the bounty directly to sustain their livelihood. Whereas the urban 'developed' beings, the man in power tends to usurp everything that is natural only to paint the sprawling concrete canvas of urbanization and development. Multiple instances from the texts explicitly examine the bane of development. *'The Greater Common Good'* and *'The Hungry Tides'* thus bring forth a mirror reflecting the subconscious of man. We get a glimpse of our darkness, projecting through the hunger in our eyes in the name of greater common good.

Conclusion

"Beauty is nothing but the start of terror we can hardly bear, and we adore it because of the serene scorn it could kill us with..."

This line from Amitav Ghosh's *'The Hungry Tide'* depicts the situation of Sunderbans and its environment. The island is very beautiful with its landscapes, serene rivers, beautiful environment, natural vegetation, and mangrove forests. This beauty is protected by the islanders along with some natural caretakers of the island, who are the royal Bengal tigers and crocodiles and snakes. Any predator who wants to harm the nature and the environment of sundarban, need to face the terror lying there in the form of animals. Even the rivers and the currents in it along with the tides play a very important role in preserving the covered area. Crocodiles swimming in the rivers stop the poachers from doing any harm to the island. How Nature uses its own mechanism to protect itself and its elements that is beautifully presented in the novel. Amitav Ghosh with his immense wit,

graceful writing, and huge concern and advanced knowledge has written the story. The key issues are presented in such a way that the readers will get a clear picture of the concurrent situation. Along with that the neo political aspects which are presented by the author, will make the readers understand the ongoing socio politics of the land and time. The text is written in a manner, where the reader will not suffer from monotony and rather it will melt their souls. Similarly Arundhati Roy in her *'The Greater Common Good'* and other texts critically writes about the marginalized, about their rights, their sufferings along with environmental concerns - in both her fiction and nonfiction, the same self-voice is echoed. She speaks for the people who are pushed to the periphery of our society. Also, her concerns for Nature are expressed on many occasions. Her books speak for her care regarding ecological balance. Her book *'The Greater Common Good'* starts with Jawaharlal Nehru's quote "If you are to suffer, you should suffer, in the interest of the country." From this line the intention of the government is exposed. Nehru's concurring government take on dam building shook the entire country. With the chanting of 'development', the government was actually indulging in the damage of Nature. And that made the writer condemn the government's act through her works.

'The Greater Common Good' is an essay with detailed statistics on Sardar Sarovar Dam [24] and all other previous and future dams which were proposed to be made on river Narmada. The adverse effects of dam building are given in the work along with the detailed data from authentic sources. [25] The picture below depicts the statistically the obscene number of people displaced in the name of development.

Dams and the displacement of tribal people

Name of project*	State	Population facing displacement	Tribal people as % of displaced
Karjan	Gujarat	11,600	100
Sardar Sarovar	Gujarat	200,000	57.6
Maheshwar	M.P.	20,000	60
Bodhghat	M.P.	12,700	73.91
Icha	Bihar	30,800	80
Chandil	Bihar	37,800	87.92
Koel Karo	Bihar	66,000	88
Mahi Bajaj Sagar	Rajasthan	38,400	76.28
Polavaram	A.P.	150,000	52.90
Maithon & Panchet	Bihar	93,874	56.46
Upper Indravati	Orissa	18,500	89.20
Pong	H.P.	80,000	56.25
Inchampalli	A.P.-Maharashtra	38,100	76.28
Tulluli	Maharashtra	13,600	51.61
Daman Ganga	Gujarat	8,700	48.70
Bhakra	H.P.	36,000	34.76
Masan Reservoir	Bihar	3,700	31.00
Ukai Reservoir	Gujarat	52,000	18.92

*Projects are either under construction or have been planned

Source: Sanjay Singh, Taming the Waters, OUP, 1997, and government figures

At the end, the writer has concluded with the sufferings of the marginalized communities whose voice remains under the rock. The government didn't stop, nor did it think about the future of the displaced poor people. [26] The marginal did not get any benefit; rather they were the ones who suffered because of the government's unplanned, lack of research project. The government is only obligated to provide a cash compensation in the event of displacement. Whole communities were split up and sent to different relocation sites and in the process there is a loss of culture, language and archaeological record. The suffering of the subaltern is present in both the texts. In the *'The Hungry Tide'.* Fokir's death at the end is symbolic of the pain and suffering of the marginal. The title is justified through the death though unjust, as the hunger of the river is finally satiated through Fokir's sacrifice. [27] Thus ensuring the establishment of balance in the eco community of river and people. The river restores and goes back to being the benevolent mother only after calming

the mayhem. Thus, Fokir's death becomes the synecdoche in the bigger scheme of things, where suffering becomes the purgation in interest of the country.

In 'The Greater Common Good', Arundhati Roy has presented their facts through analysis and lucid interpretation, but Amitav Ghosh expressed their life through meticulous symbolism and well knitted words. Both the texts are exploration of a far darker and deeper question to the human heart. Nature which is sympathetic to man, which not only gives solace to man but is also its teacher, guide, guardian and anchor; then why should then man destroy it? The question thus is ---- What man can do to take the true measure of another?

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ISBN 978-93-5515-086-8
9 789355 150868

₹ 249/-