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From the Desk of Editor-in-Chief

Dear Readers,

We are so glad to be back with you, and from now on we shall be regular with our issues. We have made lot of efforts and put across a new vibrant team and wherewithals to be regular and in time.

This issue is dedicated to the universal problem of all kinds of pollution air, water, noise, industrial, wild fire and ground being faced by us in our day today live's which has a long lasting effect and impact.

We are reproducing the articles contributed by imminent personalities on the subject and previously published in **'Environment Conservation Challenges Threats in Conservation of Biodiversity' edited by Mr. Mukul Machhindra Barwant & Dr. Vishnu Kiran Manam and published by Sciengpublications Tamilnadu**

The sole aim of reprinting these articles is because of our firm belief that well researched high quality content on the topic must not remain confined to subject specific special journals only, but it must also reach the common man and the policy makers in the system simultaneously.

We hope that the topics covered shall make the appreciation of the problems and possible remedial measures easy to understand and the readers shall be better informed. We shall love to receive your feed back and input.

Happy reading.

Climate Resilient Rice Fish Farming In Assam

Department of Fisheries, Government of Assam
Source: Best Practices in Social Sector: A compendium 2023 by Niti Ayog

The Fishery Department, Assam has been implementing a pilot of rice – fish farming in about 431 ha of water bodies in 11 districts of Assam, covering 867 beneficiaries for the last three years 2018-19, 2019-20 and 2020-21. In paddy – fish systems, paddy and fish form a mutualistic symbiosis. The fish excreta provide nutrients for paddy. Also, the fish control pests in paddy fields by feeding on insect eggs, larvae and on planktons. Rotation type paddy-cum-fish farming as a climate resilient farming practice gives an opportunity to increase the incomes of rural farmers, apart from nutritional security.

Around 2.3 million ha of seasonally flooded paddy cultivated lands of Assam have the potential for fish production along with paddy farming. However, productivity and viability of conventional paddycum-fish farming is very low due to the lack of capacity and technological knowhow. Due to this, the paddy-fish farming system contributes only 5.43% of total fish production in Assam.

The technology partners of this initiative are World Fish and International Rice Research Institute. Some of the technical help extended include:

- Trench/pond preparation, renovation of canals, liming of ponds etc.
- Stocking fish seed, maintaining stocking density, feeding the fingerlings etc.
- Techniques in effective disease management of the fish.

Impact

The production of a fish crop between the rice crops gives the farmers an off-season occupation which increases the income without increasing expenses.

The combined culture leads to a reduction in labour in weeding and an increase in the yield of paddy by 10 to 25%. The increase in rice production (average 7.0 tonne/Ha/year) and nearly 2.0 tonne fish production/ha/crop is ascribed to various factors:

- Increase in organic fertilization by fish excreta and remains of artificial feed.
- Better tillering of the rice seedlings due to the activity of the fish.
- Reduction in the number of harmful insects, such as paddy stem borers, whose larvae are eaten by fish.
- Increased mineralization of the organic matter and increased aeration of the soil resulting from the puddling of mud by benthic feeders.
- Control of algae and weeds (by phytophagons fish) which compete with rice for light and nutrients.

The success and the experience gained in this pilot project will inspire other similar projects to be taken up, increasing both income and nutritional security of rice farmers.

The Impact of Pollution on Human Health

Snehan. Dhawale & D. A. Dhale

Introduction

Pollution is a significant worldwide concern on account of the unsafe impacts of pollution on an individual's wellbeing and climate. The meaning of natural components to the wellbeing and prosperity of human populations' is progressively clear (WHO, 2010b). Climate pollution is an overall issue and its capability to impact the wellbeing of human populations is extraordinary. Ecological pollution emerges in different structures, for example, similar to air pollution, water pollution, soil pollution, Noise pollution, Thermal pollution, and so forth Air pollution might be characterized as the presence of at least one toxin like residue, fog, smoke, and shading in the environment that are damaging to people, plants and creatures. Water pollution might be characterized as the extreme defilement of hurtful synthetic compounds in water bodies, with the goal that the degree of oxygen in water diminishes and it will influence unfavorably on widely varied vegetation of water bodies. Soil pollution worries with violation of soil through different bio composts, this will result in diminishing the richness pace of soil and impact on soil supplement quality.

Soil Pollution implies creating any sort of toxins to the dirt that brings down or stops typical development in soil. Because of soil pollution helpless development, low yield creations, lastly loss of many kinds of typical vegetation and territory. The primary wellsprings of soil pollution incorporate risk modern waste, sewage, pesticides (Sancini, et al., 2012). There are numerous substances present in the environment which might diminish the well-being of Humans, plants, creatures and decline the future (lifetime). Among this pollution air pollution is a large worry about human wellbeing. Worldwide ecological pollution is to a great extent a consequence of individuals' exercises through urbanization, industrialization, huge scope petrochemical use, power age, weighty industry, and mining and investigation, all of which antagonistically influence the strength of neighborhood networks through their working and private activities(Mudu, et al., 2014; Ukaogo, 2020).

Pollution is a main source of unexpected Death in numerous more modest low-and center pay nations where the death rates per 100,000 individuals are a lot higher than those in more crowded, top level salary countries. Helpless water sterilization and sullied indoor air are significant executioners on the planet's least fortunate countries. India, the second most crowded country, shows up on both Top Ten records with the largest number of passing's as well as the tenth most noteworthy demise rate. India has seen expanding modern and vehicular pollution from metropolitan development while helpless sterilization and sullied indoor air continue in low-pay networks (Pollution & health metrics, Dec. 2019). Everyone is presented to various synthetic pollutions consistently. Some accumulate and a large portion of us have a horde number of compound pollutions put away in our bodies. We endeavor to deal with this harmful weight through our regular detoxification frameworks, yet in the event that the weight is excessively, a portion of our cells work unusually or pass on. Environmental pollution is arriving at stressing extents around the world (Loux et al., 2011; Abbasi and Abbasi, 2011).

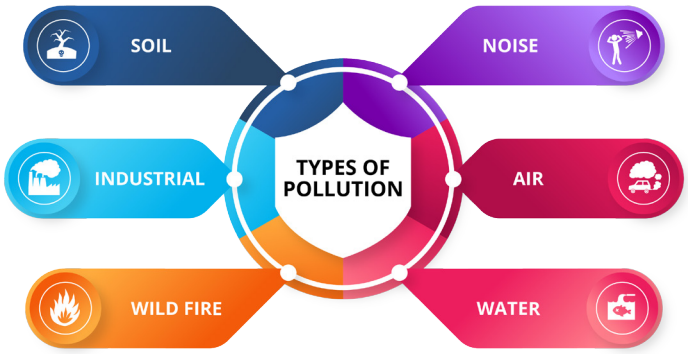


Fig. 1: Kinds of Pollutions

Air Pollution And Human Health

Individual responses to air toxins rely upon the sort of pollution an individual is presented to, the level of openness, the singular's wellbeing status, and hereditary qualities. Substances not normally found noticeable all around or at more prominent focuses are in various areas from common are alluded to as 'poisons'. On hot, smoggy days increment their openness to

poisons noticeable all around. With expanding the utilization of mechanized vehicles is additionally expected to proceed with expansion in the coming years, conceivably deteriorating air quality. Helpless air quality thusly has been displayed to have truly antagonistic impacts on general wellbeing. The impact of air pollution incorporates breathing (respiratory framework) issues, irritation of existing respiratory and cardiovascular infection, and modification in body safeguard frameworks against unfamiliar materials, harm to lung tissue, carcinogenesis, and unexpected passing (Malley, et al., 2017).

Fig. 2: Chemicals affects public health (Yuan, 2012)

A report from World Health Organization details that 4.6 million individuals kicked the bucket each year because of direct Causes owing to air pollution. Direct reasons for air pollution-related passing incorporate irritating asthma, bronchitis, emphysema, lung and heart sicknesses, and respiratory hypersensitivities including STRESS (WHO, 2010b). Air poisons are radically affecting human wellbeing. Both family and surrounding (outside) pollution, for instance, from cook stoves and vehicle emanations, add to these effects. Air pollution greatest affects human wellbeing of any ecological wellbeing hazard. It hurts wellbeing and kills similarly to smoking: by expanding the danger of creating cardiovascular and respiratory infections, and cellular breakdown in the lungs (Steffan et al., 2018).

If proportion exceed more than this composition that leads to severe effects not only on human health but also on other animals present on the earth.

Causes (sources) of Air Pollution:

Air pollution results from gaseous emission from mainly industry, thermal power stations, automobiles, domestic consumptions, domestic sources and other sources such as pesticides, dust from agricultural practices, field burning.

Table 1: Good Air composition for breathing

Composition of Gases	Content Level
Nitrogen	78%
Oxygen	21%
Argon	less than 1%
Carbon dioxide	0.037%
Water vapor	Remaining
Ozone, Helium and ammonia	Trace amount

Water Pollution and Human Wellbeing

Contaminated water is the fundamental driver of various sicknesses. Contaminated water influences the existence of present age as well as influences the existence of forthcoming ages since its impact stays for long. Water pollution in India is a significant issue. Indian constitution doesn't make this right a particular right. Article 21 of the constitution of India gives that each individual has the privilege to life. This Article encapsulated in it, the right to unadulterated water for drinking. Life of a human can't be supported with dirtied water. The main driver of various illnesses is the dirtied water.

There are various causes liable for dirtying the water. Dirtied water doesn't come from a solitary source. Article 47 forces obligation on the state to raise the

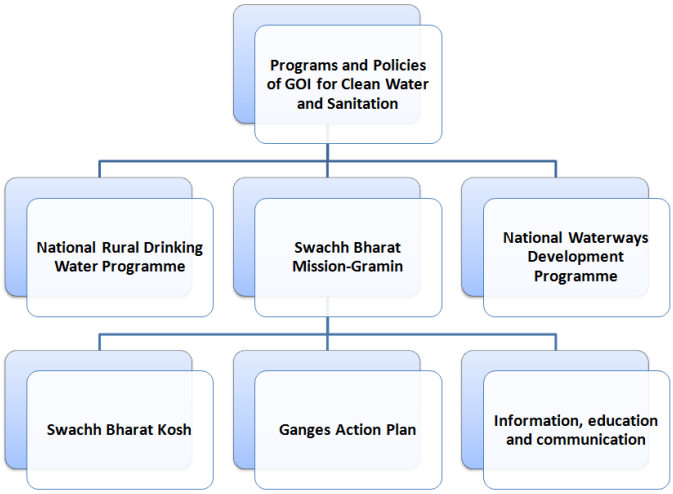


Fig. 4: Programs and Policies of Government of India (GOI) for Clean Water and Sanitation

degree of sustenance and the way of life including improvement of general wellbeing. It is the obligation of the state to give unadulterated water to general society. It is likewise the obligation of each resident under article 51 (A) g to secure and further develop the common habitat including woods, lakes, streams and natural life and to have empathy for living animals (Subodh Kumar et al., 2017).

substantial metals, pitch pellets, natural poisons, oils, supplements, and solids. Releases can likewise have warm impacts, particularly those from power stations and these lessen the accessible oxygen. City sewage is additionally the fundamental driver of water pollution. Sewage is otherwise called wastewater which normally contains clothing waste, dishwashing waste, pee and dung (Subodh Kumar et al., 2017).

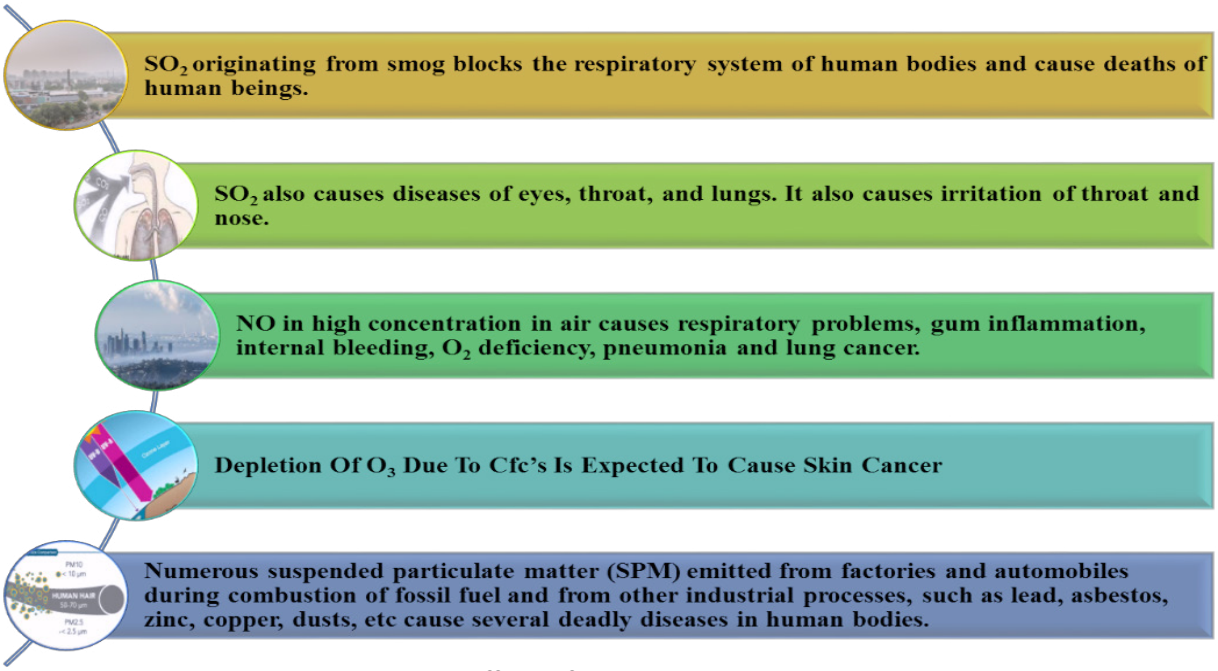


Fig. 3: Hazardous Effects of Air Pollution on Human Health

Person can't live without the water. For a sound life unadulterated and pollution free water is key. Assuming in any space the water is contaminated, individuals or the other living animals are compelled to drink that dirtied water since they have no other choice nor would they be able to live without it. As of late, water pollution has turned into a major issue the nation over, for the most part because of the presence of untreated effluents, synthetic compounds and pesticides in it. There are many reasons for water pollution one of the significant reason for water pollution will be pollution of synthetic substances in different water bodies additionally the modern waste is tossed in water bodies seriously harm the nature of water.

A significant number of the synthetic substances are harmful. Microorganisms can deliver waterborne illnesses. Modification of water's actual science incorporates causticity, electrical conductivity, temperature and eutrophication. Enterprises release an assortment of pollutions in their wastewater including

Effects or Hazards of Water Pollution

Water pollution causes irreparable damage to plants and animals including man. The most sufferers are human beings and microorganisms. Polluted water is the major cause for the spread of epidemics and several dangerous diseases such as cholera, typhoid, paratyphoid, diarrhoea, etc. The water polluted with solid minerals for drinking purpose causes fatal diseases, e.g. the consumption of water contaminated by fibres as asbestos causes lung cancer and stomach disease called Asbestosis, water polluted with mercury causes Mina Mata disease.

Soil Pollution and Human Health

Soil has a profound effect on the health and well-being of humans. Depending upon the condition of the given soil and the interactions of interest, this effect can be either positive or negative and direct or indirect. Soils that affect human health include natural soil, which usually has little anthropogenic pollution, and

soils in agro ecosystems, urban areas, mines, oil and gas extraction areas, landfill sites and other locations where anthropogenic pollution is more likely. People in professions that work closely with soil, such as farmers, construction workers or miners are at a greater risk of health problems that involve direct contact with soil, but everyone's health is affected by soil to some extent. This is because soil provides many of the nutrients we require and can pass on harmful substances through the food that we eat. Some dusts generated from soil can travel thousands of miles and affect people long distances from where they originated. Although recent advances in the role soil plays in human health are being made and continue to be investigated, few people probably think about soil having an effect on their health (Steffan et al., 2018).

The quality of soil depends upon the nutrients (both-organic and inorganic), humus content, moisture, temperature, etc. present in the soil. Soil pollutions can reach humans through soil, dust, air, water or food. Decrease in the quality of soil is caused due to the accelerated rate of soil erosion, decrease in plant nutrients, decrease in soil microorganisms, excess or deficit of moisture content, high fluctuations of temperature, lack of humus contents and input and concentration of various types of pollutants.

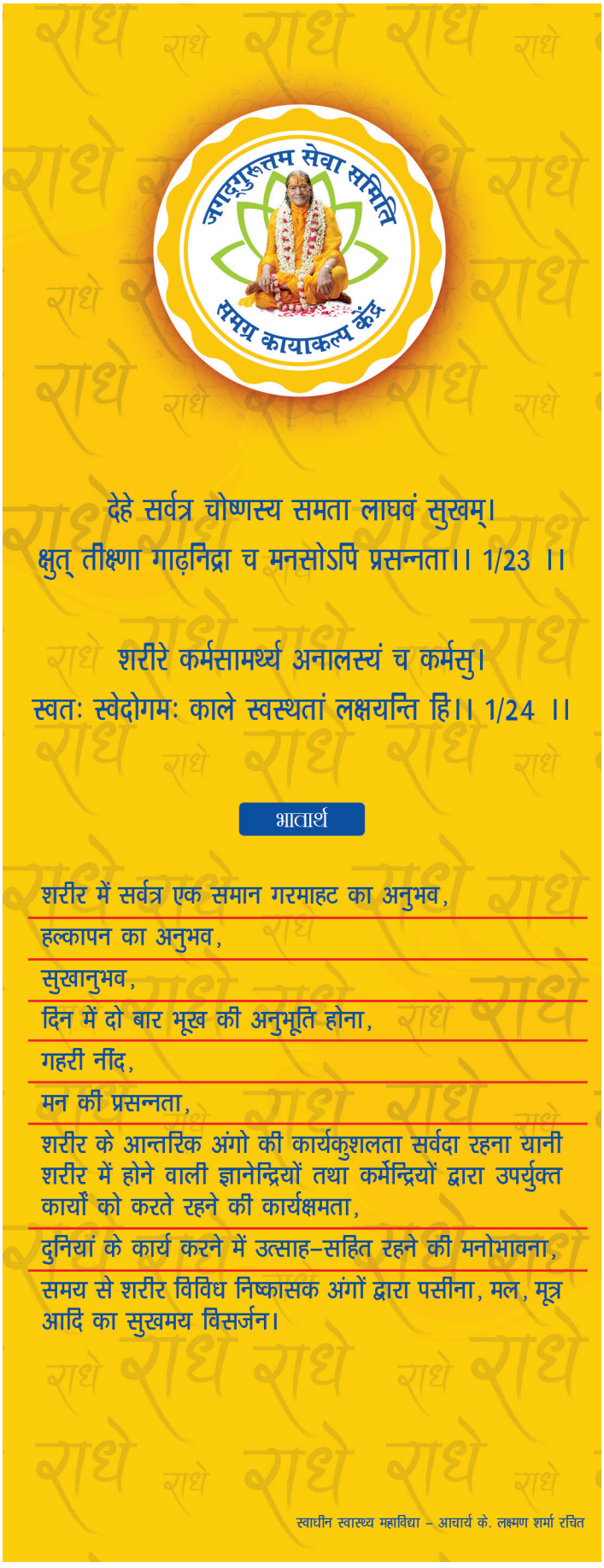
Sources of Soil Pollution:

There are some important sources of soil pollution such as physical sources, biological sources, air borne sources, chemical sources which include rainfall, temperature, wind, microorganism, human volcanoes, chemical fertilizers etc.

Effects of Soil Pollution:

Effects of soil pollution on human beings, animals and plants are far reaching

1. Soil pollution results in substantial decrease in agricultural production. Some forms of soil pollution even make the land unusable for crop farming.
2. Chemical pollutants in the form of chemicals, fertilizers, pesticides, insecticides and herbicides after reaching the soil, reach the human and animal bodies through food chain and cause various diseases and several deaths. According to an estimate, about 500,000 persons die every year in the world because of insecticides and pesticides, especially by DDT.



Pollution (Air, Water, Soil) Causes Effect Strategies To Control Precaution

Prof. Dr. Sunita Gulabrao Gaikwad

Introduction

Environmental pollution is multidisciplinary science chemistry, physics, agriculture, life sciences, health, medicine, etc. In a broader sense it is the study of the sources, reactions, transport, effects and fate of chemical species in the air, water and soil and the effect of human activity on this. Pollutant means a substance in the environment, greater than the natural abundance due to human activity, which ultimately has a detrimental effect on the environment and so on living organisms and the human race. Examples are lead, mercury, sulfur dioxide, carbon monoxide, etc. Accumulation of air pollution, especially sulfur dioxide and smoke, reaching 1,500 mg/m3, resulted in an increase in the number of deaths (4,000 deaths) in December 1952 in London and in 1963 in New York City (400 deaths) (Kassomenos P, Kelessis et al 2012). An association of pollution with mortality was reported on the basis of monitoring of outdoor pollution in six US metropolitan cities (Dockery DW, Pope et al 1993). In every case, it seems that mortality was closely related to the levels of fine, inhalable, and sulphate particles more than with the levels of total particulate pollution, aerosol acidity, sulfur dioxide, or nitrogen dioxide (Dockery DW, Pope et al 1993).

Private and governmental entities and authorities implement actions to ensure the air quality (Newlands 2015). Air quality standards and guidelines were adopted for the different pollutants by the WHO and EPA as a tool for the management of air quality (US EPA). These standards have to be compared to the emissions inventory standards by causal analysis and dispersion modelling in order to reveal the problematic areas (NEPIS 2017). Inventories are generally based on a combination of direct measurements and emissions modelling (Sivitanides M, Shah V 2011).Concerning industrial emissions, collectors and closed systems can keep the air pollution to the minimal standards imposed by legislation (Spiegel J, Maystre 2019).

Water pollution is organic and inorganic charge and biological charge (10) at high levels that affect the water quality (Maipa V, Alamanos Y, Bezirtzoglou E 2001). (Bezirtzoglou E, Dimitriou D, Panagiou 1996). Toxic effects induced by ozone are registered in urban areas all over the world, causing biochemical, morphologic, functional, and immunological disorders (Lippmann M 1989).Pollution is the introduction of harmful materials into the environment. These harmful materials are called pollutants. Pollutants can be natural, such as volcanic ash. Pollutants damage the quality of air, water, and soil.

- Air Pollution
- Water Pollution
- Pollution

Air Pollution

Polluted air can be dangerous, even if the pollutants are invisible. It can make people's eyes burn and make them have difficulty breathing. It can also increase the risk of lung cancer volcanic gases, such as sulfur dioxide, can kill nearby residents and make the soil infertile for years. Mount Vesuvius, a volcano in Italy, famously erupted in 79, killing hundreds of residents of the nearby towns of Pompeii and Herculaneum. Most victims of Vesuvius were not killed by lava or landslides caused by the eruption. They were choked, or asphyxiated, by deadly volcanic gases. Smog makes breathing difficult, especially for children and older adults. Some cities that suffer from extreme smog issue air pollution warnings. The government of Hong Kong, for example, will warn people not to go outside or engage in strenuous physical activity (such as running or swimming) when smog is very thick.

Acid rain can kill all the trees in a forest. It can also devastate lakes, streams, and other waterways. When lakes become acidic, fish can't survive. In Sweden, acid rain created thousands of "dead lakes," where fish no longer live. Acid rain also wears away marble and other kinds of stone. It has erased the words on gravestones and damaged many historic buildings and monuments. The Taj Mahal, in Agra, India, was once gleaming white. Years of exposure to acid rain has left it pale. Greenhouse gases are another source of air pollution. Greenhouse gases such as carbon dioxide and methane occur naturally in the atmosphere. In fact, they are necessary for life on Earth. They

absorb sunlight reflected from Earth, preventing it from escaping into space. By trapping heat in the atmosphere, they keep Earth warm enough for people to live. This is called the greenhouse effect. Global warming also contributes to the phenomenon of ocean acidification. Ocean acidification is the process of ocean waters absorbing more carbon dioxide from the atmosphere. Fewer organisms can survive in warmer, less salty waters. The ocean food web is threatened as plants and animals such as coral fail to adapt to more acidic oceans.

Fig. 1: Air Pollution

Air Pollution Control

Following are the measures one should adopt, to control air pollution:

Avoid Using Vehicles

People should avoid using vehicles for shorter distances. Rather, they should prefer public modes of transport to travel from one place to another. This not only prevents pollution, but also conserves energy.

Energy Conservation

A large number of fossil fuels are burnt to generate electricity. Therefore, do not forget to switch off the electrical appliances when not in use. Thus, you can save the environment at the individual level. Use of energy-efficient devices such CFLs also controls pollution to a greater level.

Use of Clean Energy Resources

The use of solar, wind and geothermal energies reduce air pollution at a larger level. Various countries, including India, have implemented the use of these resources as a step towards a cleaner environment.

Other Air Pollution Control Measures Include

By minimizing and reducing the use of fire and fire products. Since industrial emissions are one of the major causes of air pollution, the pollutants can be controlled or treated at the source itself to reduce its effects. For example, if the reactions of a certain raw material yield a pollutant, then the raw materials can be substituted with other less polluting materials. Fuel substitution is another way of controlling air pollution. In many parts of India, petrol and diesel are being replaced by CNG – Compressed Natural Gas fuelled vehicles. These are mostly adopted by vehicles that aren't fully operating with ideal emission engines. Another way of controlling air pollution caused by industries is to modify and maintain existing pieces of equipment so that the emission of pollutants is minimized. Sometimes controlling pollutants at the source is not possible. In that case, we can have process control equipment to control the pollution. A very effective way of controlling air pollution is by diluting the air pollutants.

Water Pollution

Some polluted water looks muddy, smells bad, and has garbage floating in it. Some polluted water looks clean, but is filled with harmful chemicals you can't see or smell. Sometimes, polluted water harms people indirectly. They get sick because the fish that live in polluted water are unsafe to eat. They have too many pollutants in their flesh. Sewage that has not been properly treated is a common source of water pollution. Many cities around the world have poor sewage systems and sewage treatment plants. Delhi, the capital of India, is home to more than 21 million people. More than half the sewage and other waste produced in the city are dumped into the Yamuna River. This pollution makes the river dangerous to use as a source of water for drinking or hygiene. It also reduces the river's fishery, resulting in less food for the local community. A major source of water pollution is fertilizer used in agriculture. Fertilizer is material added to soil to make plants grow larger and faster. Fertilizers usually contain large amounts of the element's nitrogen and phosphorus, which help plants grow. Rainwater washes fertilizer into streams and lakes. There, the nitrogen and phosphorus cause

cyanobacteria to form harmful algal blooms. Heat can pollute water. Power plants, for example, produce a hugeamount of heat. Power plants are often located on rivers so they can use the water as a coolant. Cool water circulates through the plant, absorbing heat. The heated water is then returned to the river. Aquatic creatures are sensitive to changes in temperature. Some fish, for example, can only live-in cold water. Warmer river temperatures prevent fish eggs from hatching. Warmer river water also contributes to harmful algal blooms.

Fig. 2: Water Pollution

Control Measure of Water Pollution

An ambitious plan to save the river called the Ganga Action Plan was launched in 1985. Treatment of sewage water and the industrial effluents before releasing it into water bodies.

Hot water should be cooled before release from the power plants. Excessive use of fertilizers and pesticides should be avoided. Organic farming and efficient use of animal residues as fertilizers can replace chemical fertilizers. Water hyacinth (an aquatic weed, invasive species) can purify water by taking some toxic materials and a number of heavy metals from water. Oil spills in water can be cleaned with the help of Bregoli — a by-product of paper industry resembling sawdust, oil zapper, microorganisms. It has been suggested that we should plant eucalyptus trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapor into the atmosphere.

Soil Pollution

Various Sources of Soil Pollution

1. Agricultural Sources

Agricultural practices such as the use of non-organic products in crop and livestock production lead to soil pollution. These substances include artificial chemical pesticides, herbicides, fungicides, and fertilizers, as discussed below:

i) Pesticides, Herbicides, and Insecticides

The introduction of modern pesticides, herbicides, and insecticides has resulted in an increase in the use of agricultural chemicals. These chemicals are used to control the pests, insects, weeds, fungi, and diseases that attack crops. Most of these chemicals are non biodegradable, while others decompose to products that are toxic to soil. These products seep into the ground and act on the soil, thereby changing its structure, composition, and ph.

ii) Improper use of Fertilizer

Fertilizers are mostly used to correct the deficiency of soil nutrients. A soil that is deficient of potassium, calcium, nitrogen, and sulfur, among other important macro-nutrients, should be treated with the right fertilizer and at the right amount. However, some farmers use fertilizers indiscriminately, leading to soil pollution. What is more, the materials used to manufacture fertilizers contain impurities that add to soil toxicity. For instance, the rock phosphates mineral used for the manufacture of mixed fertilizers contain traces of Asbestos, Cadmium, and Lead, which are transferred to the fertilizer during production. These metals are non-biodegradable and, with time, accumulate to toxic levels.

2. Industrial Sources

Industrial wastes or by-products are among the leading causes of soil pollution. They can be in the form of gas, liquid, or solid substances. Carbon dioxide, nitrogen dioxide, sulfur dioxide, and carbon monoxide are some of the gases produced from industrial activities that cause considerable pollution to soil indirectly. These by-products combine with the rainwater causing the production of acidic rain, which changes the soil pH and, after that, affects the overall crop production. Industries also dump their solid and liquid effluents into the soil.

3. Urban Waste

Most developing countries have a problem controlling the disposal of municipal garbage. The garbage is dumped anyhow and contains wastes such as food waste, plastics, industrial wastes, e-waste, and general household wastes. It appears as if the urban administrators do not know that most of the non-biodegradable waste materials could be recycled and the organic materials disposed of in areas designated for natural decomposition.

4. Sewer Sludge

Sewage plants also contribute to soil pollution owing to how they dispose of sewage sludge from domestic and commercial waste. The sewage sludge is usually treated before being disposed of into land or bodies. When disposed of on land, the sludge can release high amounts of nutrients depending on the source that may surpass the natural soil nutrient requirement, thus posing a risk to human health and/or the ecosystem at large. Sewer sludge may also contain high levels of metals, further polluting the soil.

Fig. 3: Soil Pollution

Control of Soil Pollution

Reducing chemical fertilizer and pesticide use: Applying bio fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution. Reusing of materials: Materials such as glass containers, plastic bags, paper and cloth can be reused at domestic levels rather than being disposed, reducing solid waste pollution. Recycling and recovery of materials: This is a reasonable solution for reducing soil pollution. Materials such as paper and some kinds of plastics and glass can and are being recycled. This decreases the volume of refuse and helps in the conservation of natural resources. For example, the recovery of 1 tonne of paper can save 17 trees.

Reforesting:

Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion, and floods. Crop rotation or mixed cropping can improve the fertility of the land: Use of pesticides should be minimized.

Microalgal Green and Clean Approach to Mitigate Water Pollution

K. M. Aradhana & Mukesh Kumar

Introduction

Nowadays, pollution-related issues are a major source of concern for society. Environmental regulations have become more widely applicable, and their enforcement has become more stringent. In many parts of the world, increased pollution, industrialization, and rapid economic development pose serious threats to the quantity and quality of water resources. It is, nevertheless, critical to ensure that appropriate treatment standards are chosen to fit local conditions and that alternative novel wastewater treatment technologies are examined. Both traditional and novel methods should be assessed. Traditional wastewater treatment uses a series of aerobic/anaerobic processes to transform pollutants in wastewater into benign chemicals that may be safely disposed of or reused.

These traditional methods remove sufficient amounts of carbon, nitrogen, and phosphorus, but at the cost of considerable energy use and nutrient loss. Furthermore, traditional wastewater treatments are complicated, needing experienced employees to properly handle them. Because of the inadequacies of traditional tertiary wastewater treatment, more sustainable alternatives have been introduced. A green and clean approach to water pollution mitigation based on algae is thought to be an effective strategy for lowering nutrient concentrations. Microalgae biomass culture has the potential to create oxygen and absorb nutrients from the water, making it a viable option for wastewater treatment. When algal biomass breaks down, dissolved oxygen levels decline, resulting in the death of aquatic animals and a general decline in ecosystem health and functions.

What is Water Pollution /Aquatic Pollution?

Water pollution is the contamination of water bodies caused by the release of pollutants into groundwater or lakes, streams, rivers, estuaries, and seas to the point where the substances obstruct beneficial water usage or ecosystem function. Polluted water, according to the World Health Organization (WHO), is water whose composition has been altered to the point where it is no longer acceptable.

Source of Water Pollution

Pollutants in the water arise from either concentrated or distributed sources. A pipe or channel, such as those used for discharge from an industrial facility or a city sewerage system, is referred to as a point source. A nonpoint source, such as runoff from an agricultural area, is a large, unconfined area from which a variety of pollutants enter the water body.

Effect of Water Pollution on Aquatic Life

Although nutrients are vital for plant and aquatic life, too much of them can be hazardous. When wastewater and fertilizer enter rivers, lakes, and coastal areas, they trigger rapid and uncontrolled growth of vegetation and algae on the water surface. Algal blooms also reduce oxygen sources and when a microorganism's oxygen supply is reduced, it dies. Water filters become clogged and drinking water becomes contaminated.

Typical Wastewater Composition

Pollutants enter waterways from a variety of sources, which vary in strength and volume (see figure 1). The composition of wastewater is a reflection of the producing society's lifestyles and technologies. Carbohydrates, lipids, proteins, amino acids, and volatile acids are a source of organic carbon. Large amounts of sodium, calcium, potassium, magnesium, chlorine, sulfur, phosphate, bicarbonate, ammonium

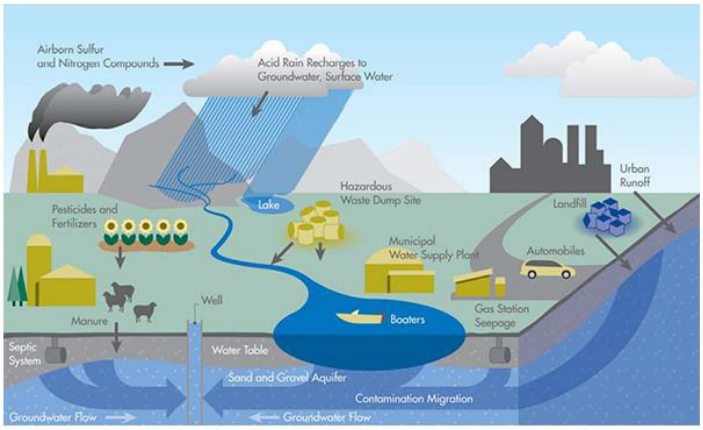


Fig. 1: Types of aquatic pollutants include floating debris, organic material, inorganic plant nutrients (Source: www.aadnc-aandc.gc.ca)

salts and heavy metals are among the inorganic ingredients.

Conventional Wastewater Treatment System for Water Pollution

Mitigation

The main purpose of a wastewater treatment system is to remove major pollutants such as suspended particles, biochemical oxygen demand (BOD), nutrients (organic and inorganic), toxic substance, and coliform bacteria. The sedimentation process is used in a conventional wastewater system to eliminate dissolved organic matter and suspended particulates. Conventional wastewater treatment employs the activated sludge technique, which is widely used around the world but they have several drawbacks, including high energy consumption, costs connected with the aeration process, and sludge management. Various companies and research organizations throughout the world have attempted to develop traditional wastewater treatment to a more resilient, energy-efficient, low-carbon intensive system with improved ease of operation and profitability. Anaerobic treatment, membrane bioreactors, microbial fuel cells, anammox technology, built wetlands, and microalgae treatment are some of the advances in wastewater treatment. A feasible alternative to traditional wastewater treatment has been proposed: microalgae-based wastewater treatment (see figure 2).

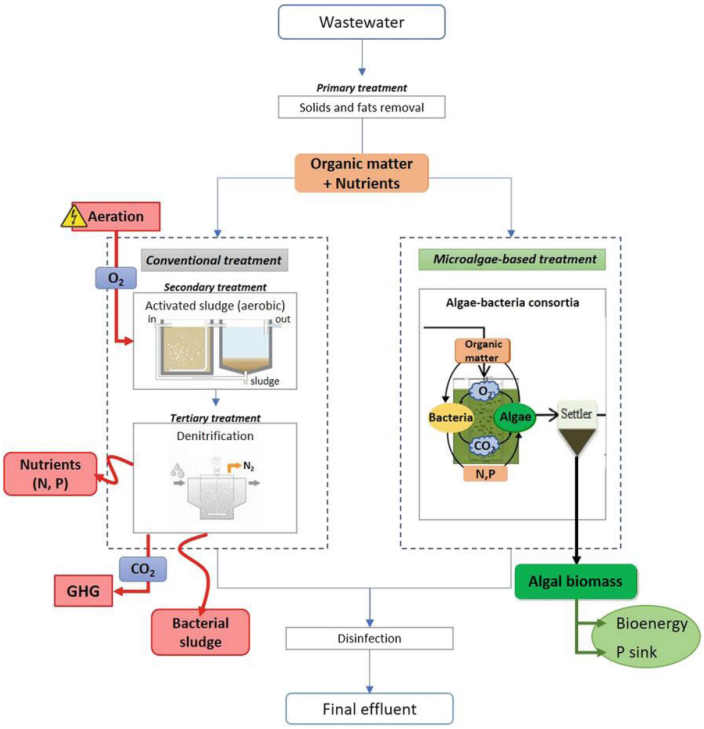


Fig. 2: Comparison between conventional wastewater treatment and wastewater treatment-based microalgae (Source: Muñoz and Guieysse, 2006).

Microalgal - Based Water Pollution Mitigation

History

Oswald advocated for the first time the use of microalgae for wastewater treatment in the 1950s (Oswald and Gotass, 1957) and the concept was later refined to propose employing this system for energy production by harvesting and utilizing algal biomass. Interest in algae-based integrated wastewater treatment systems has increased over time as a result of the sustainable production of lipid and other high-value biomolecules-rich biomass using nutrients from wastewater and carbon dioxide from the air and flue gases, addressing environmental concerns whereas simultaneously producing renewable energy.

Algae's Availability And Features

Microalgae are classified into algal divisions such as Charophyta, Bacillariophyta, and Chlorophyta, as well as kingdoms such as Plantae, Protozoa, and Chromista. They are predominantly eukaryotes, except bacterial cyanobacteria, and are too small to be seen without a microscope. Although algae lack roots, stems, or leaves, they do contain chlorophyll and other pigments. Algae are phototrophic organisms that use light to convert water and carbon dioxide into oxygen and carbohydrates, providing energy for biomass growth. Algae exist in both multicellular and unicellular forms. Algae are ubiquitous in their distribution, and they are most usually found in water.

They can also be found in hot springs, deserts, and permanent snowfields, as epiphytes or parasites on plants and animals. Chlorophytes, Euglenophytes, Chrysophytes, and Cyanophytes are common Algae found in waste waters. Algae can be utilized in wastewater treatment for a variety of reasons, including the elimination of coliform bacteria, the reduction of both chemical and biological oxygen demand, the removal of nitrogen and phosphorus, and the removal of heavy metals, to name a few. Algal systems have been presented as a viable secondary treatment technique and have historically been used as a tertiary process. All organic ions are removed during the tertiary treatment process. It can be done in two ways: biologically and chemically. Chemical procedures

are generally too expensive to adopt in most regions and can contribute to secondary contamination. As a result, a complete tertiary procedure to remove ammonia, nitrate, and phosphate will cost roughly four times as much as basic treatment. Micro algal cultures, with their ability to utilize inorganic nitrogen and phosphorus for growth, provide an elegant answer to tertiary and quaternary treatments. Because of their photosynthetic capabilities, microalgae are particularly appealing for bio treatment as they transform solar energy into useable biomasses and incorporate nutrients like nitrogen and phosphorus, causing eutrophication. Human sewage, livestock wastes, agro-industrial wastes, industrial wastes, piggery effluent, and food processing factory effluent can all be treated with algal systems.

Microalgae are used to mitigate wastewater in open or closed systems. Because open systems like natural lagoons, manmade ponds are easy to build and manage, they're the best choice for algae-based wastewater treatment. Closed systems, provide you more control over the treatment process, but they're also more expensive to set up and maintain (see figure 3).

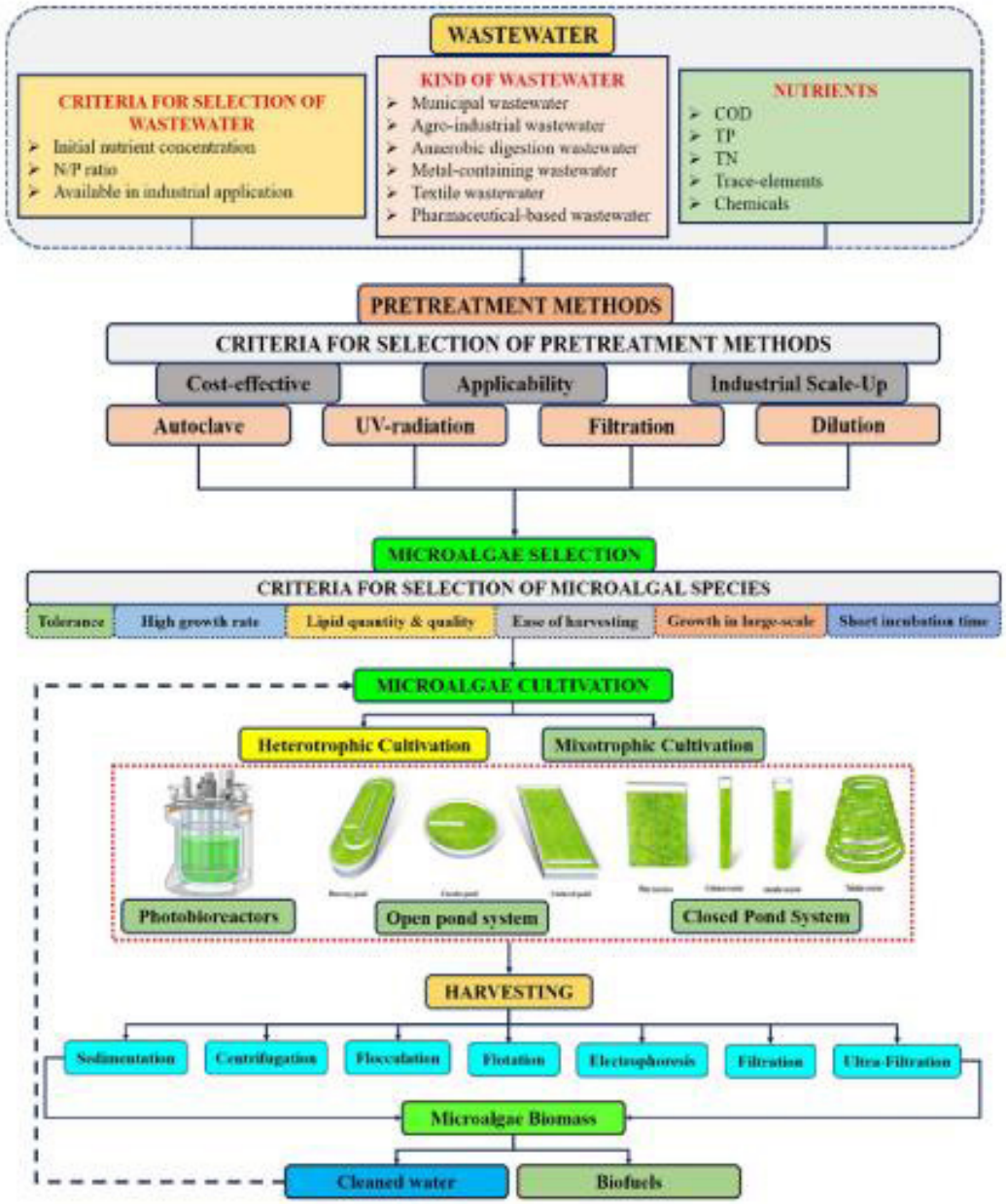


Fig. 3: Schematic presentation of factors influencing micro algal cultivation for wastewater treatment and biofuel production. (Source – Yadav et al., 2021).

Benefits of Microalgae Based Water Pollution Mitigation

The advantages of Micro algal based mitigation of water pollution are as follows:

1. Heavy metals and nutrient contaminants are removed.
2. Affordable
3. energy consumption
4. Biomass Production for Use
5. Sludge Formation Reduction
6. Algal biomass contains more than 50% oil.
7. They provide substantially higher biomass and fuel yields.
8. can be grown in conditions that are unsuitable for conventional crop production.
9. They have a yield that is 10-100 times higher than equivalent energy crops.

Factors That Affect Algal Growth And Wastewater Treatment

Abiotic factors such as temperature, light, pH, oxygen, carbon dioxide, and salinity; operational factors such as dilution rate, mixing, depth, and harvesting frequency; and inhibitory substances such as ammonia all harm algae production rate and wastewater treatment performance when algae grazers, such as zooplankton or rotifers, are present.

Heavy Metal Elimination by Algae

Heavy metals and hazardous organic compounds have been found in high concentrations in municipal wastewater. As a result, the ability of wastewater treatment systems to tolerate and eliminate toxicity is critical. Heavy metal elimination by algae is known as phytoremediation. Microalgae are effective heavy metal absorbers, carbon dioxide absorbers, oxygen producers, and can improve biogas production from biomass. Metal bioaccumulation by algae could be a viable technique for metal-contaminated wastewater remediation.

Alternative Methods For Culturing Algae And Wastewater Treatment

1. Immobilized Cell System

The challenge of harvesting and recovering algal biomass from treated effluent can be solved by immobilizing microalgae. Immobilized living cells on appropriate support, as opposed to suspended cells, can simplify the treatment procedure by contributing to increased cell retention time in the reactor. Immobilized living cells have various advantages over suspended cells; for example, the entrapment of living cells in immobilized microalgae on an appropriate substrate simplifies the treatment of liquid substances, which adds to increase the cells retention period in the reactor. It will be fascinating to see if immobilized microalgae and cyanobacteria can be used to remove nitrate, ammonium, and phosphate from high-volume effluent discharges.

2. Tubular Photobioreactors

Algae are cultured inside these reactors, which are made up of closed, translucent tubes. These tubes can either be laid flat on the ground or stacked in lengthy vertical rows. A pump (centrifugal, peristaltic, diaphragm, or lobe) circulates the algae, and these photo bioreactors have a gas exchange unit via which carbon dioxide can be introduced and oxygen produced can be extracted from the system. Several aspects are considered, including oxygen and carbon dioxide management, circulation speed, temperature control, and algae growth on the inner surface of tubes. Tubular reactors feature several issues that can reduce algal productivity. Temperature management, O2 and CO2 regulation, algae growth on the inner surface of the tubes, and proper circulation speeds without damaging the rather fragile algal cells are all important factors.

3. Waste Stabilization Ponds (WSPS)

Anaerobic, maturation, and facultative ponds are placed in single or several parallel series in WSPs. They are made up of big and shallow basins where raw sewage is treated using natural resources (mainly sunlight). They prove to be the most cost-effective, user-friendly, and dependable technique of wastewater treatment. Waste stabilization ponds may, in the

future, lead to a more environmentally sustainable wastewater treatment system. The sedimentation process and aerobic algae, respectively, are used to remove biochemical oxygen demand (BOD) in anaerobic and facultative ponds.

Mechanism Of Microalgae-Based Water Pollution Mitigation

The metabolic activities of algae are responsible for reducing water pollution. Nutrients are taken up and changed within the algal cell, where they are absorbed by the cell for the growth of algal biomass (Cai et al., 2013). Organic nitrogen and inorganic nitrogen molecules such as ammonium and nitrate are both present in wastewater. Ammonium is the preferable form for the uptake of nitrogen by algae, while nitrate is converted to ammonium within the algal cell and absorbed into amino acids for protein synthesis (Beuckels et al., 2015). Ribosomal RNA (rRNA) is synthesized using inorganic phosphorus. Furthermore, microalgae can ingest excess phosphorus via a luxury absorption, store it as polyphosphate, and use it when external phosphorus availability is low. The technologies used in microalgae-based wastewater treatment are as follows (see figure 4):

1. Adsorption

Adsorption is a physical process in which contaminants are passively bonded to the removal agent, whether it be microalgae or something else. On their cell surfaces, micro algal cells have hydroxyl (–OH), phosphoryl (-PO3O2), amino (–NH2), carboxyl (–COOH), sulfhydryl (–SH), and thiol groups, as well as polymer assemblages (cellulose, hemicellulose, proteins, and so on) (Rai et al., 1981). Microalgae can provide a solution for tertiary and quaternary wastewater treatment because of the charge and affinity of these

2. Accumulation

Microalgae can remove contaminants from wastewater by accumulation or uptake into intracellular compartments, rather than adsorption. The main mechanism is build-up, which is followed by intracellular biodegradation. Algal enzymes break down the contaminant completely either inside or outside the cells during biodegradation.

3. Immobilization

The use of suspended microalgae is widely known for nutrient removal from waste streams. Nutrient removal (nitrate, phosphate, and ammonium ions), heavy metal ion removal, biosensors, and stock culture management have all been done with immobilized microalgae. Wastewater treatment techniques, which typically entail heavy metal and nutrient removal from liquid effluents, appear to be one of the most promising applications for immobilized microalgae. This technique is favorable since it avoids the tedious, energy intensive, and costly cell separation phase.

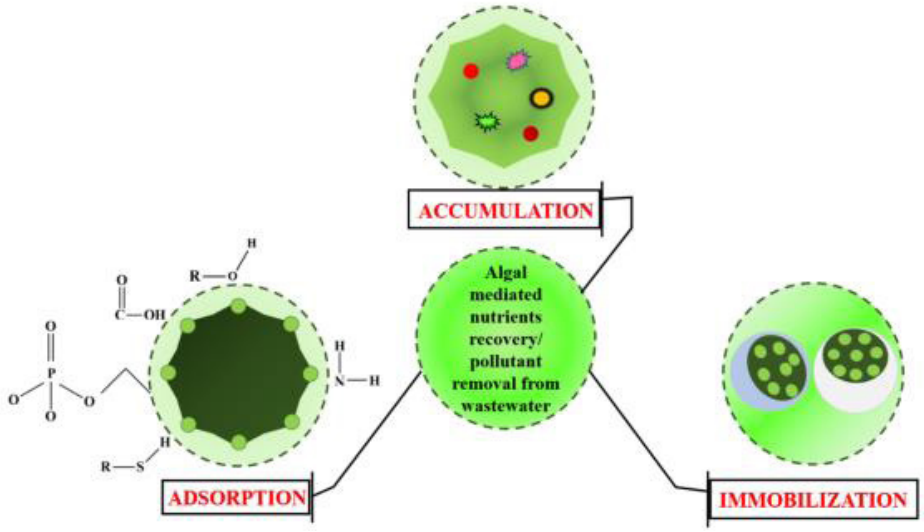


Fig. 4: Strategies implemented in nutrient recovery and pollutant removal using microalgae. (Source - Yadav et al., 2021).

Bacterial Contamination In Ground Water: A Review

Prity Mall & Anil K Dwivedi

Introduction

Water is the most valuable resource present on the earth (Hossain, 2015).It spread abundantly on the earth surface (71% of earth's surface) but only little amount (0.3%) is usable by human beings. [https://www.geographyrealm.com/water/earth (2020)]. Water is basic need of our life. Human body is made up of almost 70% of water, which plays incredible role in maintaining physiology of body. Thus, we can say that life is not possible without water (Hossain 2015). In current time, ground water status is also considerable in terms of living healthy life. For this many government and private agencies are trying to do their best for acknowledgment of quality status of ground water in world wide. Besides this, peoples should have to proper knowledge of drinking water status of their own areas for that they used prevention strategies according to their status of drinking water as well as reported to government agencies for better treatment of their area's water. Through this, peoples may be saved from outbreaks of waterborne diseases like [diarrhoea, cholera, dysentery].

Ground Water

Ground water is present under the earth's surface within the soil and rocks layers. During the rainfall water is trapped in soil and it percolates into the ground, which is called ground water. Ground water is directly related to surface water [https://Albertawater.com/What is ground water (2015)]. With enhancement of population (Sharma and Bhattacharya, 2017) almost, 1.1 billion people in the world does not access safe and clean water (Nyagwencha et al. 2012).

Peoples used water for drinking, cleaning, food preparations, and irrigation and also in industries (Shukla et al. 2013).In production of electricity a huge amount of water is also used (Hossain, 2015). Different uses of water influence status and quantity of ground water (Sasakova et al. 2016).

Water Contamination

Water pollution can be defined as any obnoxious substances that enter into the water which is unfavorable or harmful towards the environment of water, these undesirable substances are known as pollutants which may be inorganic or organic pollutant (Sasakova et al. 2016).Urbanization, industrialization and enhancement of population, all these work as factor for the increment of pollution of surface and ground water (Bhalme and Nagarnaik, 2012). Improper dumping of sewage wastes, domestic wastes and agriculture water runoff creates deterioration of ground water with the help of percolation (Sasakova et al. 2016). So, we can say that most of the time ground water pollution is the result of surface water pollution (Singh et al. 2013).Water pollution is increasing with the increment of time due to anthropogenic activities. Therefore, it is becoming a serious issue of current time. From the ancient time, surface and ground water is being used for drinking, industrial and agricultural purposes. Due to this, water is fiercely contaminated and brutally affects human health, soil nutrients, livestock, biomass and environment (Sarala and Babu, 2012). Adamou et al. (2020), studied on drinking water quality in rural area of western Niger. Result revealed that the collected water samples unfit for the consumption due to extremely contamination. Ground

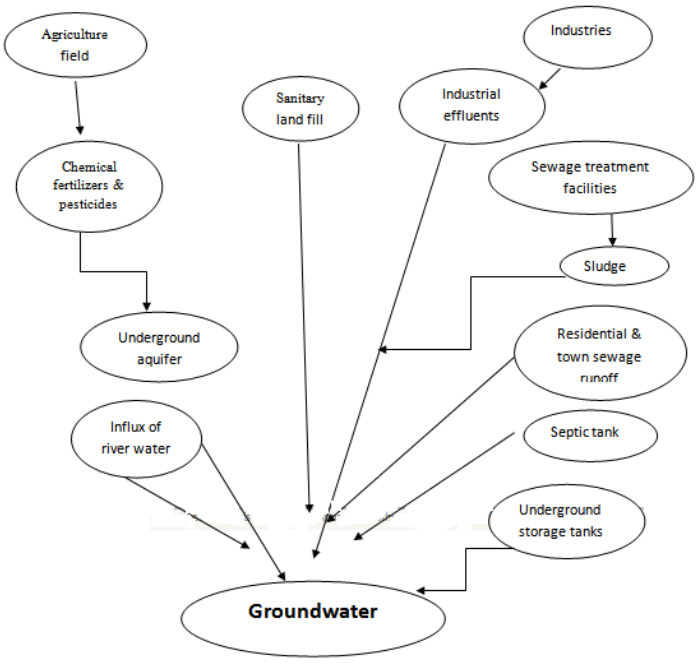


Fig. 1: Representation of sources of ground water pollution.

water is highly affected by anthropogenic activities. Thus, people face high risk of waterborne disease in these areas. For the prevention of this pollution, people should have awareness of proper disposal of domestic and sewage wastes. Inspire of this, they also avoid excess use of chemical fertilizers as well as pesticides in agriculture.

Bacteriological Contaminaton Of Ground Water

Due to anthropogenic and zoogenic activities different types of pollutants (fecal and chemical) released into the aquatic ecosystem. Fecal contaminations in water sources affect the diversity of aquatic microbial community. The water microorganisms are considered as important factor in sustainability of natural water ecosystem. Generally, water ecosystems have both types of microorganism pathogenic as well as non-pathogenic microorganisms. But pathogenic microorganisms caused water borne illness in human beings after the consumption of contaminated drinking water.

So, assessment of potential of impact of fecal contamination on microbial communities in natural water sources seems to be important. In this examination, result shown that natural water has highest micro biome but least focally polluted where as in urban water were mostly polluted with fecal pollutants and low in micro biome. Thus, from the result it has been concluded that extremely polluted water reduced the diversity of aquatic micro biome (Paruchetal, 2019). 70% of Indian drinking water supply is polluted due to sewage contamination in most of the cases. In polluted water, the survival and occurrence of pathogenic microbes is increased with the increment of aquatic pollution due presence of sufficient nutrient for microorganisms.

This contaminated water has been considered as major source of water borne diseases. For the detection of microorganisms in drinking water of Kerala experiment were conducted by Ambili and Scbastian (2015). In this experiment, 45 drinking water samples were collected from the Malabar region of Kerala and samples were analysed for the indicator microorganism by applied of MPN Techniques. These drinking water samples showed MPN counts between range of 2-1600 MPN/100ml. Pseudomonas sp., Klebsella sp., Enterobacter sp., Citrobacter sp. and Shigella sp. were also detected in collected drinking water samples. Wastes of sewage as well as domestic wastes considered as one of the most important pollutant which highly effect water quality in the world (Bartram et al. 1996). Agriculture activities impact on the physiochemical and bacteriological status of ground water. In wet season, contamination of nitrates has been increased due to leaching through rain fall and irrigation (an agriculture activity). Kadaoni et al. (2019).

Water And Disease

Bacteria (Escherichia coli, Pseudomonas aeruginosa, Vibrio cholera, Klebsella spp., Enterobacter spp., Shigella spp., Streptococcus spp., Proteus vulgaris and Salmonella typhi) are found in contaminated ground water that leads various water borne diseases. Poor sanitation, unhygienic conditions and contaminated water sources are act as factor which is responsible for the huge death of people in a year worldwide due to diarrhoea (waterborne disease). This study suggested that good hygienic practices, cleanness of storage household tanks and disposal of wastes (sewage and domestic) as well as industries effluents in proper ways reduces the contamination level of water sources which also minimize chance of waterborne diseases especially diarrhoea Basavaraja and Praveena (2013). In most of the rural area water sources are surface water, river water as well as borehole water and its water are used without knowing its potability which leads waterborne diseases. For the knowledge of potability of these type of water sources Obioma et al. (2017) collected water samples from different water sources in different communities in khana and determined bacterial load in samples. In this experiment, bacterial isolates include:

Staphylococcus aureus, Shigella spp., Salmonella spp., Enterobacter spp., Streptophyloccocus spp., Proteus spp., and E. coli were found. Bacillus spp., were most isolated isolates (23.6).

Most of the microorganism showed gastrointestinal illness. Results revealed that microbial load of borehole were average (1.78×103 cfu/ml). However, river water showed high microbial count (5.48×104). Coliforms and fecal coliforms count highest in surface water (42.6/100ml & 14.8/100ml) and borehole water had least total coliform (4.6/100) and fecal coliform (0) counts. Drinking of contaminated water results several harmful diseases like diarrhoea, cholera, dysentery,

and typhoid etc. especially in developing countries, where availability of potable water is major challenge. In the investigation of bacteriological quality of sampled water found to be unacceptable, MPN of total coliforms in 100ml of sampled water range between 0-33 cfu/100ml for both total and fecal counts. In all borehole sample showed presence of E. coli (20%) and Klebsiella sp. (19%). In terms of seasons, 67% microbes were isolated in dry season in comparison of 33% microbes were isolated in rainy season. Above experiment also concluded that number of isolates different in different season (Odonker et al. 2013). For the avoidance of any type of water borne bacterial infectious diseases, water treatment is the most effective way (Thirumalesh and Fatima, 2015). For the small drinking water supply system, chemical disinfectants are used for the improvement of water quality in rural areas (Singh, et al.2013).

Antibiotic Resistant Bacteria and Water

Several cases reported that antibiotic resistant bacteria present in water which is become a major issues in concern of public health. Presence of antibiotic resistance gene in the water sources represent the presence of multiple drug resistance bacteria (like Pseudomonas aeruginosa, Escherichia coli) Foka et al. (2018) which caused serious waterborne diseases which treatments are time taking or tough. The microbial interaction inside municipal distribution pipe negatively effect on quality of the supply water. Distribution of this poor quality of water to houses this extensively affect the health of consumers (Towhid, 2018).

Importance Of Bacteriological Determination of Ground Water

Urbanization, industrialization and enhancement of population, these are work as factor for the increment of pollution of surface and ground water (Bhalme and Nagarnaik, 2012).Water is related to the health of organisms as well as indirectly related to economic development. Routine evaluation of drinking water quality is needed in concern of health issues (Shukla et al. 2013).These virulent microorganisms containing water, consumed by humans because they have no idea about the quality of water, this is risky for the health of peoples. From this aspect, determination of water quality is beneficial (Bartram et al. 1996) and also proper management of sewage and domestic disposal play valuable role to prevent high risk of bacteriological contamination of water.

Conclusion

This review article shows importance of water in our life as well as impact of bacteriologically contaminated water on the peoples. Contaminated water environment basically organic pollutant provides favorable conditions to pathogenic bacteria, which is the main source of waterborne diseases. In contaminated water, multi-drug resistant bacteria are also found. Presence of these causes serious waterborne diseases which treatments are time taking in current time.

Above statement illustrated that quality as well as quantity of ground water is influenced by bacterial contamination which negatively affects human health. That's why regular determination of water quality is the demand of current time.

Global Warming and Climate Change in Refrence to Indian Scenario

Arushi Aren And Mukesh Kumar

Introduction

Global warming is the long-term heating of Earth's climate system observed since the pre industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. Multiple observations of air and ocean temperatures, sea level, snow and ice have shown these changes to be unprecedented over decades to millennia. Human influence has been the dominant cause of this observed warming. According to IPCC (2007)1, climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period typically decades or longer.

What Is Climate Change?

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, but since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil, and gas), which produces heat-trapping gases. Natural causes have triggered various changes in the Earth's climate.

For centuries, the climate of the Earth has significantly been changing in response to natural causes. With a wide range of meteorological conditions across a vast geographical scale and varying topography, in fact, the Indian climate is the most unpredictable. Floods, droughts, cyclones, and other natural calamities have displaced or killed millions of people in India due to monsoonal and other weather patterns during previous years. Climate change is an important problem in scholarly debate because of its unpredictability, severity, and impact on the Indian economy. Other effects include on-going and future vegetation changes, present sea level rise, and alleviant flooding of India's low-lying coastal territory. The climate of the Earth is influenced by a variety of factors that operate on different time scales and produce diverse changes at different geographical areas and geological epochs. The global climate system, which includes the atmosphere (see figure 1), seas, ice sheets, biosphere (all living species), and soils, sediments, and rocks, is responsible for the flow of heat around the Earth. The climate system is made up of several subsystems, each with its own set of processes taking place inside and between them (see figure 2).

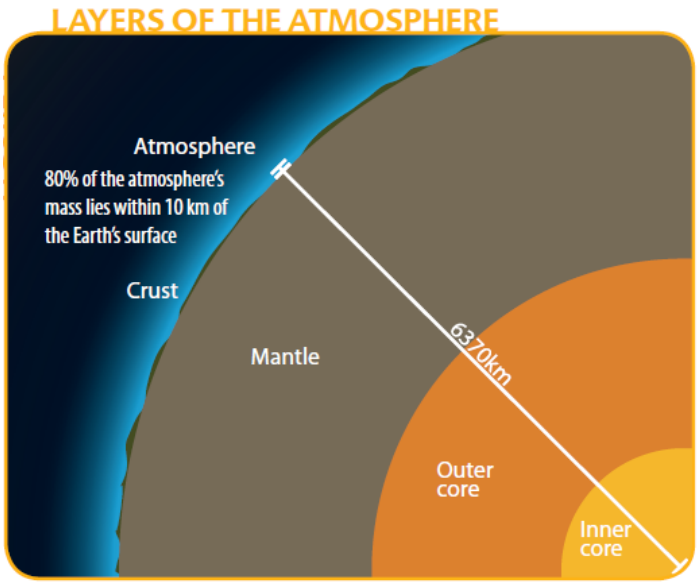


Fig. 1: Representation of sources of ground water pollution.

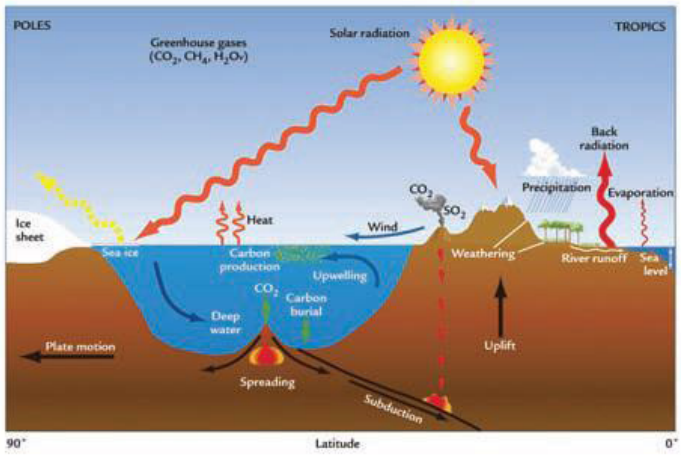


Fig. 2: The earth's climate system components

What Is Greenhouse Effect?

The greenhouse effect is a natural phenomenon in which the atmosphere lets part of the energy we get from the Sun (ultraviolet and visible light) while

preventing it from being reflected back into space (infrared radiation or heat). As a result, the Earth is warm enough to support life. The atmosphere has been delicately balanced for thousands of years, with relatively consistent amounts of greenhouse gases. As a result of human activities, the equilibrium has been thrown off, resulting in climate change and its adverse impact on humanity and natural resources. The salient features of the greenhouse effect have been summarized hereunder-

1. UV sunlight strikes the Earth; some is absorbed by the atmosphere, while others penetrate through and strike the Earth's surface.
2. Snow and ice-covered areas of the Earth reflect the majority of UV back into space. UV that isn't reflected hits the Earth and is converted to Infrared Radiation (IR), or heat energy, which is then emitted by the Earth. Most IR departs the atmosphere and is lost to space.
3. Greenhouse gases in the atmosphere trap some IR, which heats the air, water, and land. Warming effect of the atmosphere is directly proportional to the availability of the greenhouse gases in the air.

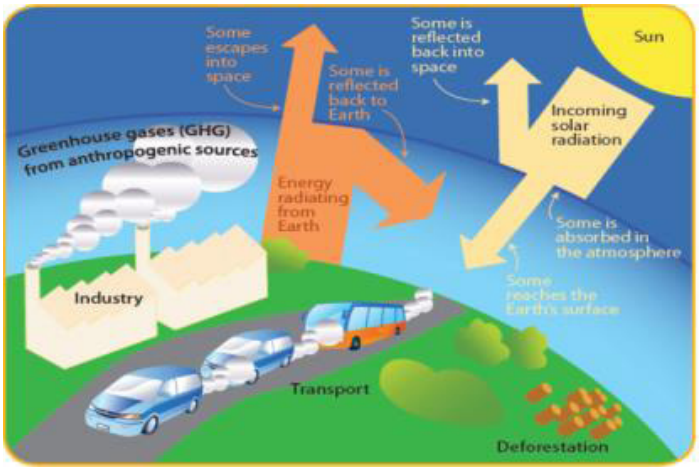


Fig. 3: The greenhouse effect

What is the Composition of the Atmosphere?

The atmosphere is relatively a thin layer of gases that fades fast with height and lacks a distinct top. Below 10 km in altitude, around 80% of the mass of the atmosphere is enclosed. The atmosphere is only a sixth of one per cent of the Earth's radius (6370 km). Nonetheless, it is a vital multifunctional layer made up of a variety of gases in variable amounts in different places, each serving a particular role. It is mostly composed of nitrogen (78%) and oxygen (21%). Aside from water vapor, numerous additional gases (Carbon monoxide (CO), Carbon dioxide (CO_2), Neon (Ne), Oxides of nitrogen, Methane (CH_4), Krypton (Kr), and Ozone (O_3) are present in considerably lesser levels.

This mixture of gases helps the atmosphere's multifunctional character by enabling a portion of the solar energy directed at the Earth to reach the surface while also preventing long-wave radiation (in the form of heat) from escaping back into space. This heat-trapping function is known as the 'greenhouse effect,' and it is what keeps the Earth's surface at a temperature that allows life to exist as we know it (see Figure 3). Carbon dioxide, methane, and ozone are the most important 'greenhouse gases' (GHGs) after water vapor. These GHGs can stay active in the atmosphere for a long time (see Table 1). Gases and particles emitted by significant volcanic eruptions, such as Mt. Pinatubo in 1991, can affect the global climate over shorter time periods. The relative position and movement of continents, on the other hand, affects global climate over millions of years, among other variables. Many GHG-emitting activities have become indispensable to the global economy and an integral component of modern living. The largest single source of GHG emissions from human activity is carbon dioxide from the combustion of fossil fuels. About 80% of mankind's carbon dioxide (CO_2) emissions, one fifth of methane (CH_4) emissions, and a considerable amount of nitrous oxide (NO_x) emissions are attributed to the supply and use of fossil fuels (N_2O). In summary, power and heat (24.9 per cent), industry (14.7 per cent), transportation (14.3 per cent), and agricultural (13.8 per cent) are the major contributors to anthropogenic GHG emissions (see Figure 4).

TABLE 1: Relative contribution of major gases to the greenhouse effect and atmospheric lifetimes

Climate Change in India

India is a big greenhouse gas emitter as well as one of the world's most vulnerable countries to climate change. Water stress, heat waves and drought, severe storms and flooding, as well as the detrimental implications on health and livelihoods, are already occurring throughout the country as a result of climate change. With a population of 1.3 billion people and

a reliance on agriculture, India is likely to be badly impacted by continued climate change. Given the inherent uncertainty in global climate projections, India's future climate is expected to alter in numerous ways:

1. Global measurements of melting glaciers indicate that climate change is already affecting the region, with glaciers receding at a rate of 10–15 metres per year on average.

GHG	Contribution (%)	Mean lifetime
Water vapour	36% to 66%	9 days
Carbon dioxide	9% to 26%	Tens of thousands of years
Methane	4% to 9%	12 years
Ozone	3% to 7%	9—11 days

2. If the pace of glacial melt accelerates, river valleys supplied by these glaciers are likely to flood, followed by a reduction in flow, resulting in a scarcity of water for drinking and agricultural irrigation.
3. Over the Indian subcontinent, all models show a tendency of overall warming in mean annual temperature, decreased diurnal temperature range, and increased precipitation.
4. 2030, a warming of 0.50°C is anticipated across all of India (about similar to the warming of the twentieth century), with a warming of 2-40°C by the end of the century, with the greatest increase over northern India.
5. More precipitation will likely come in the form of fewer rainy days but more days of intense rainfall events, each with increasing volumes of rain, resulting in major floods. Drizzle-type precipitation, which replaces soil moisture, is anticipated to diminish.
6. Rising levels of tropospheric ozone pollution and other air pollution are expected in India's main cities as a result of rising temperatures.

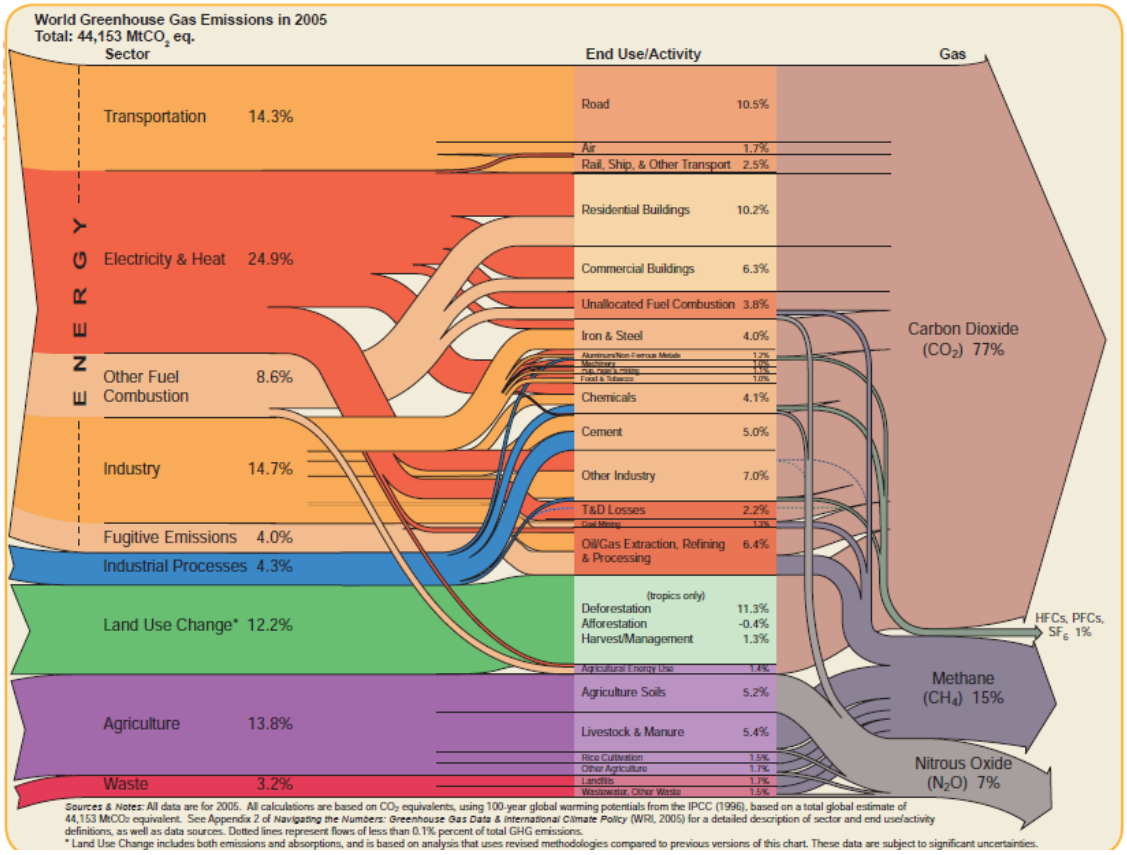


Fig. 4: World greenhouse gas emissions by sector (Image courtesy: World Resources Institute, 2005)

7. Most global models predict that as the climate warms, the Indian summer monsoons will become more intense. It's also possible that the timing will change, resulting in dryness during the late summer growing season.
8. models also forecast early snowmelt, which might have a considerable negative impact on both irrigated and non-irrigated agricultural productivity.
9. Growing aerosol emissions from energy production and other sources may suppress rainfall, resulting in drier conditions with more dust and smoke from the burning of drier vegetation, affecting regional and global hydrological cycles and agricultural production.
10. Recent trend in agriculture has become to burn hay (purely) while in the fields. This cause heavy smoke which coagulates with the water droplets present in the air and seen with a smoke layer near the earth. This has become a serious problem in north India, especially in Delhi and entire NCR area.

Impacts Of Climate Change

The most important impacts of climate change will likely include the following:

1. Agriculture: Even as demand for food and other agricultural goods rises due to an expanding population and hopes for a better standard of living, high-input, high output agriculture will be harmed. Due to their inability to foresee climate conditions, millions of subsistence and smallholder farmers would face suffering and starvation. To some extent, trade may be able to make up for these deficits.
2. Water: Glacier melt may result in greater runoff in short term, but in the medium and long term it will be less. More violent storms (particularly cyclones) will wreak havoc on infrastructure and livelihoods, as well as worsen salt water intrusion during storm surges. Changes in the timing and amount of monsoon rains will make the production of food and other agricultural goods more uncertain, making farmers more likely to make decisions that result in decreased yield, even in excellent weather years.
3. Exacerbation of Inequality: Those who are harmed by climate change and have insufficient resources to adapt may act as a force that changes governments, strains public budgets, and causes unrest. Approximately one-third of Indians are extremely impoverished, and 60% rely on agriculture for a living.
4. Energy: As India seeks new energy sources to satisfy expanding demand, climate change mitigation initiatives may limit its use of domestic and imported coal, oil, and gas, while nuclear energy development will be gradual at best and likely to face opposition. Technology transfer and capacity-building will be required for other non-emitting technologies.
5. Immigration: India welcomes people from a variety of countries. It may be inundated with many more as a result of climate change, notably from Bangladesh. Such migration has the potential to aggravate tensions between the two countries while also placing pressure on the Indian central and state governments. In India, adaptive capability varies by state, geography, and socioeconomic class. Water availability, food security, human and social capital, and the ability of government (at the state and national levels) to cushion its people through difficult times are all aspects that have been studied. When adaptive capacity is inadequate, the risk of displaced people, deaths and damage from heat, floods, and storms, as well as disputes over natural resources and assets, is higher.

India's Climate Friendly Measures

Despite the fact that India's contribution to greenhouse gas emissions is minimal; the Indian government has made numerous steps to ameliorate the issue. India's nodal agency for climate change issues is the Ministry of Environment and Forests. India has taken a number of climate-friendly initiatives, particularly in the renewable energy sector. It has one of the most active renewable energy programmes in the world, as well as may be the world's only specialized Ministry for non-conventional energy sources (Ministry of New and Renewable Energy).

India adopted the National Environment Policy in 2006, which outlines a number of policies and policy

efforts aimed at raising awareness about climate change and assisting in the development of capacity for adaptation. Active measures to expand carbon sinks by increasing forest and tree cover are also included in the National Forest Policy. India released its National Action Plan on Climate Change (NAPCC) on June 30, 2008, with the goal of laying out the government's goals and future measures for tackling climate change, as well as updating India's national Programme pertinent to combating climate change. The National Action Plan identifies initiatives that advance our development goals while also providing co-benefits for effectively addressing climate change. Eight national missions (solar mission, energy efficiency, sustainable habitat, water, Himalayan environment, green India, Eco-green agriculture, and knowledge) have been expressly outlined to improve India's development while also addressing climate change adaptation and GHG mitigation objectives.

We have not, however, set any quantifiable targets for reducing emissions. Furthermore, on 7 May 2007, the Government established an "Expert Committee on Impacts of Climate Change" under the chairmanship of Dr. R. Chidambaram, Principal Scientific Advisor to the Government of India, to study the impacts of anthropogenic climate change on India and to identify the measures that India may have to take in the future in relation to addressing vulnerabilities, as announced by the Finance Minister while presenting the Union Budget 2007-08. Furthermore, on June 6, 2007, a Council chaired by India's Prime Minister was established, consisting of eminent persons, to develop a coordinated national response to climate change challenges and offer oversight for the formation of action plans in the area of assessment. In addition, the Indian government has launched the "Green India" Programme, which aims to recolonize damaged forest land across the country. Funds available under the "Compensatory Afforestation Fund Management and Planning Authority (CAMPA)," mobilizing funds from the market, forming partner associations, and income from tree felling at ecologically suitable intervals are among the financial resources to be mobilized. In around ten years, the "Green India" Programme is expected to cover about six million hectares across the country.

Relation of Climate Change with Diseases

Dr. Rajesh Sudhakar Wakchaure

Introduction

Climate change's effects on human health, ecosystems, metropolitan areas and catastrophe frequency will all have a significant impact on the objective of sustainable development. Global climate change is now universally acknowledged as a phenomenon that is strongly related to human activities. The earth's climate has changed dramatically in the previous hundred years. The earth's temperature has risen, and this has had an almost immediate impact on coastal areas, small islands, food security, health, and other factors. Tropical cyclone intensity and storm flood height are projected to increase as sea surface temperatures rise. Cyclones have several public health effects, including the loss of clean water, hygiene, and sanitation, as well as the destruction of homes and property, population displacement, chemical exposures, and the potential of starvation and malnutrition due to food scarcity (Keim, 2006).

Climate change, particularly changes in temperature, precipitation, and humidity, can have an impact on biological organisms and the processes that lead to the spread of infectious illnesses. Deaths from cardiovascular disease will increase as the temperature and cold rise as a result of climate change. The global appearance, reappearance, and redistribution of infectious illnesses are being increasingly influenced by a warming and unstable environment (McMichael et al., 1996). Temperature and precipitation variations, which produce changes in soil moisture, sea level increases, and more extreme weather events like floods and droughts, are among the most well known impacts of global climate change (WHO 2009). When it comes to the health effects of climate change, factors such as increased air pollution or extreme heat can influence people who have respiratory problems (Lamy & Bouchet, 2008). Heat stress and related disorders are the most direct consequences of a warming planet (Donoghue et al., 1997). Suicide has long been observed to vary with the weather (Page et al., 2007). Dementia is a risk for hospitalization and death during heat waves (Hansen et al., 2008). Psychotic diseases including schizophrenia (Cusack et al., 2011) and drug abuse (Martinez et al., 2002) have also been related to an increased risk of mortality when exposed to extreme heat. Increased frequency of kidney stones also occurs during heat waves (Tasian et al., 2014).Outdoor workers are affected by heat, so economic concerns on work capacity can be large (Kjellstromet al., 2011). Future temperatures will very certainly increase the risk of wildfires in many areas by producing more droughts (Handmer et al., 2012).

A study on global mortality estimated that pollution from forest fires, particularly particulates, caused 3, 39000 premature deaths per year (2, 60000-6, 00000) (Johnston et al., 2012), Change may aggravate allergies by increasing pollen production and other allergens from nature. Fifty-five percent of the US population tests positive for allergens (Allergyusa, 2014) and more than 34 million have asthma (Centers for Disease Control and Prevention, 2010).Childhood gastrointestinal illnesses in the United States (Uejio et al., 2014) and India (Bush et al., 2014) have been related to a lot of rain. Climate change is projected to reduce wheat, maize, sorghum, and millet yields by approximately 8% across Africa and South Asia by 2050 (IPCC, 2014). Climate change would result in an additional 25 million undernourished children by 2050 (Nelson et al., 2009), having stunted growth rates (Grace et al., 2012) increasing dramatically.

Plant diseases caused by fungi, bacteria, viruses, and oomycetes, which now account for 16 percent of crop losses, could become much worse as a result of climate change (Chakraborty& Newton, 2011). Depression, anxiety, and other associated illnesses are major causes of morbidity around the world (Whiteford et al., 2013). Besides vulnerability to adverse effects from heat exposure, climate change may threaten mental health (Berry et al., 2011). Disasters likely to increase with climate change, including floods (Fewtrell & Kay, 2008), dam collapses, heat waves (Hart et al., 2011), wildfires (McFarlane & Van Hooff, 2009), physical injury, property loss (Goldmann & Galea, 2014), witnessing others with illness or injury while they were in pain or were dying during the disaster, loss of family, displacement, and history of psychiatric illness (Kessler et al., 2005). Children may be at special risk (Norris et al., 2009). Adverse birth

outcomes may be higher among people exposed to meteorological factors such as high temperature, heat, sunlight intensity, cold, and humidity (Kuehn & McCormick, 2017). Low birth weight, preterm birth, eclampsia and preeclampsia, hypertension, and pregnancy length are among the effects. Sunburn is proportionally associated with higher temperatures and UV light exposure (Zuo et al., 2015) as well as skin cancer (Nichols et al., 2009), while low humidity and low temperatures were associated with eczema and skin irritabilities in children (Gao et al., 2014).

Vector-Borne Diseases

Vector-borne diseases continue to contribute considerably to the global burden of disease, causing epidemics that impair health security and have far-reaching socio-economic consequences. Vector-borne diseases have broader social consequences, contributing to health discrepancies and impeding socio-economic progress. The poorest people are the ones who take the burden of climate-sensitive diseases. Because of the significant illness burden and high susceptibility to climatic influences, vector-borne diseases are among the well-studied climate-change-related diseases. Climate change has an impact on the transmission of vector-borne diseases, as a warmer climate and shifting rainfall patterns may produce more conducive habitats for climate-sensitive vectors (mosquitoes and ticks) and infections. Changes in temperature and precipitation patterns have the potential to spread malaria across South Asia's temperate and arid regions. In India, for example, malaria is predicted to spread to higher latitudes and altitudes. Climate and disease dispersal have a complicated relationship. Aedesaegypti and Aedesalbopictus are the main vectors of dengue fever, chikungunya, and Zika. Based on current climatic circumstances, Aedesaegypti and, more broadly, Aedesalbopictus have a potential distribution throughout southern and western Europe. Although Aedesalbopictus poses a public health risk as a result of human activities, the influence of changing climate is also an issue to consider.

Water-borne diseases like cholera and diarrhoeal diseases like giardiasis, salmonellosis, and cryptosporidiosis could become more common as the temperature warms. Waterborne diseases including cholera and various diarrhoeal disorders like giardiasis, salmonellosis, and cryptosporidiosis are common in many South Asian countries due to contaminated drinking water. In many countries, climate change has a direct impact on vector-borne illnesses, particularly in South Asia. An increase in ambient temperature would result in net increases in the geographic spread of certain vector species all over the planet (malarial mosquitoes). Furthermore, temperature-related changes in the life-cycle dynamics of vector species and harmful organisms (flukes, protozoa, bacteria, and viruses) would increase the risk of vector-borne diseases like malaria, dengue fever, and a variety of parasitic and viral diseases like leishmaniasis (sand-fly), human African trypanosomiasis, Rift Valley Fever and Japanese encephalitis (Fouque & Reeder, 2019). Human African trypanosomiasis (HAT) or African sleeping sickness is caused by tsetse flies, which are extremely sensitive to changes in temperature and rainfall patterns. Food-borne and water-borne infections are expected to become more common, resulting in greater diarrhoea and stomach troubles.

Similarly, when the environment warms, vector-borne diseases will spread through mosquitoes. A rise in temperature and precipitation could lead to an increase in water borne, vector-borne, and rodent-borne diseases (Charronet al., 2008). Climate change will create considerable changes in human–pathogen connections, particularly in tropical areas (Sattenspiel, 2000). Changing temperatures and precipitation patterns linked with climate change will impact the ecology of various vector-borne diseases, including malaria, dengue, chikungunya, Japanese encephalitis, kala-azar, and filariasis (Dhimanet al., 2008). Warmer ambient temperatures in both the Ethiopian and Colombian highlands are projected to increase malaria in densely populated locations (Sirajet al., 2014). Most disease-carrying arthropods are susceptible to environmental factors such as humidity, daily high and low temperatures, rainfall patterns, winter severity, snowpack, and so on. On warm, humid days, black-legged ticks (deer ticks), which carry Lyme disease, are most active. The Lyme disease vector, Ixodesscapularis, grows faster in warmer climates in North America (Altizer et al., 2013) as well as in Canada (Ogden et al., 2014). Northern and central Europe is at risk for the Chikungunya virus due to warmer, wetter weather (Fischer et al., 2013).

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