Environment and Unsustainable Human Life

Volume – II

(Degradation of Enviroment –I Pollution –Air and Water)

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Editors
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FOREWORD

Owing to natural and anthropogenic causes, a large number of environmental problems and issues have cropped up during the last few decades all over the world. The eminent scholars of different concerned disciplines, NGOs, international and national organizations have listed more than two dozen environmental issues and problems ranging from global, international, national and local levels. Although these are overlapping and duplications in them, they are directly or otherwise associated with atmosphere, biosphere, lithosphere and hydrosphere, and they may broadly be classified into four major categories viz. atmospheric, biospheric, lithospheric and hydrospheric issues and problems. They are so damaging and alarming that they need to be researched and investigated at all levels – macro to micro levels. In these perspectives Dr. M.Z.A. Khan and Dr. Sunil Verma have done a commendable work in inviting and collecting a large number of original research papers

from eminent scholars from across the world for edited book **"ENVIRONMENT & UNSUSTAINABLE HUMAN LIFE"**. They have scientifically and judiciously selected, thoroughly edited, and have classified them into different categories and put them into eight volumes.

The volume I entitled **Environment, Ecology and Ethics** contains 20 research papers dealing with conceptual issues and problems which have been scientifically discussed and explained within conceptual framework and case studies from different regions.

The crux of the problem is the deterioration in various components of the environment. Therefore, a large number research papers have been received from renowned scholars but the edition has selected only 42 related to air, water, land, soil and others. It was not feasible to put them in one volume. Hence, these papers have been put in two volumes i.e. Volume - II and Volume – III. The former volume entitled **Degradation of Environment – I** contains 21 papers dealing with air and water pollution, while the later volume entitled **Degradation of Environment – II** containing 21 papers discusses and explains the deterioration in land, soil and other components.

Due to unscientific and unplanned exploitation of our resources, the biodiversity is degrading very fast. Several biotic and abiotic species have disappeared and many are in dangerous position. Vultures and many other species are not even seen today. Therefore, as many as 21 scholars have contributed papers highlighting these problems, causes and consequences and finally their remedial measures for their conservations. Those papers have been included in volume IV entitled **Biodiversity and Its Conservation**.

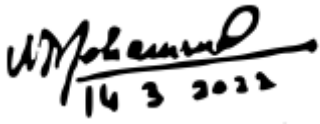
Climate change, global warming, ozone hole, ozone layer depletion, desertification, deforestation etc. are the burning

issues and problem of the day and is a matter of great concern to almost everyone across the world. Therefore, the noted scholars of the concerned discipline have contributed as many as 20 papers covering all these issues. The editors have put them in volume – V entitled **Environmental Issues** related to climate change, ozone, desertification, deforestation and other issues.

All the environmental issues and problems discussed and explained in earlier 5 volumes need to be managed in order to avoid or minimize their adverse effects. A large number of research papers have been received in this respect and it was becoming cumbersome to put them in one volume. Therefore, the editors have selected only 48 important papers and put them into two volumes i.e. **Environmental Management – I**, Volume – VI and **Environmental Management – II,** Volume – VIII. These volumes cover the management of wide range of issues and problems ranging from physical, social, cultural, economic and technological.

The volume VII entitled **Sustainable Development and Environmental Planning** contains 25 papers covering the various aspects of Sustainable Development goals of UNDP to support national plans to implement the 2030 Agenda.

This is an original and commendable work of its own kind being done by Dr. Khan and Dr. Verma. I am sure and confident that it would be quite useful to researchers, administrators and policy makers.



(Prof. Noor Mohammad)

PREFACE

Pollution is the introduction of harmful substances into the environment. These harmful substances are called pollutants. Pollutants can be natural, such as volcanic ash. They can also be created by human activities, such as factory-generated waste or streams. Pollutants cause poor air, water, and soil quality. Many things that are useful to people create pollution. Cars emit pollutants through their exhaust pipes. Burning coal that is extensively used to generate electricity also pollutes the air. Industries and homes generate waste and sewage that pollutes land and water. Pesticides Chemical toxins used to kill weeds and insects enter waterways and harm wildlife. All living things - from one-celled microbes to blue whales - depend on the earth's supply of air and water supply. It is worth emphasizing that all kinds of lives are threatened when these resources are polluted. Although pollution is a global problem, urban areas are generally more polluted than rural areas. Pollution can spread even to remote areas where people do not live. For example, pesticides and other chemicals have been found in Antarctic ice sheets. In the middle of the North Pacific Ocean, a large collection of fine plastic particles is formed, known as the Great Pacific Garbage Patch. Air and water flow pollute. Marine currents and migratory fish carry marine pollutants away. Winds can pick up radioactive material accidentally released from a reactor and scatter it around the world. Smoke from factories in one country travels to another.

The environment is defined as the total planetary heritage and the totality of all resources. This includes all the organic and inorganic factors that affect each other. All living elements such as birds, animals, plants, forests, fisheries, etc. are

biological elements whereas inorganic elements include air, water, land, etc. Rocks and sunlight are examples of inorganic elements of the environment. Environmental studies need to study the interrelationships between these biological and inorganic components of the environment.

The environment carries out four important functions. It provides resources: Resources here include renewable and non renewable resources. Renewable resources are resources that can be used without the possibility of running out or running out of resources. That is, there is a constant supply of resources. Examples of renewable resources are forest plants and sea fish. Non-renewable resources, on the other hand, are those which are depleted by excavation and use.

The biggest impact on the health of individuals and populations around the world is due to environmental degradation and social injustice. These include overpopulation, pollution, deforestation, global warming, sustainable farming and fishing practices, over-consumption, distorted distribution of wealth, the rise of corporations, the Third World Debt Crisis and militarization and wars. Outcomes include increased poverty, overcrowding, drought, climate change, species loss, acute and chronic medical illnesses, war and human rights violations, and increasingly volatile global conditions representing Malthusian chaos and disaster. Because of their scientific training, and their privileged socio-economic status, doctors are in a unique position to recognize these phenomena and work at all levels, from interacting with their patients, volunteering, serving and intervening in areas of great need, to direct political activism and participation.

The present book entitled "**Environment and Unsustainable Human Life**" covers the various aspects of the environment in the present scenario suggesting the way of conservation. We are thankful to all contributors for their

cooperation in compiling useful information on various facts of Environment. Heartfelt thanks go to these contributors who have endeavored to provide up-to-date information on their area of expertise and have willingly offered very valuable time and knowledge. The ideas and notions expressed by the authors with the help of textual contents are innovative, and we have labored hard to popularize their valuable ideas by publishing them in the original shape. We are confident that the information contained in this book will be useful to those who are interested in "Environmental Ethics & Sustainable Development" for the benefits of human life and welfare.

We are thankful to eminent geographer Prof. Noor Mohammad for writing the forwarding of edited book. We are also thankful to senior geographer Dr. H. M. Saxena for helping in complitation of edited book and for providing his valuable suggestions.

The Editors of this book are very grateful to their teachers & friends, Dr. S.S. Khinchi, Dr. Pawan Kumar Sharma, Julee Narzary & Sh. Sushil Saklani who made them rich by offering timely comments and kept them elevated and confident during their research work.

The Editors wish this work be so significant and trustworthy for further researchers in the future. Utmost care has been taken, even though the Editors beg your pardon for any printing error.

Dr. M.Z.A. Khan

Dr. Sunil Kumar Verma

CONTENTS

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Water Pollution and Purification Methods

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Abstract:

Water and air are the essential natural resources for sustaining life and environment, which we have always thought to be available in abundance and free gift of nature. Water is a common chemical substance that is essential to all known forms of life. Approximately three - quarters of the earth's surface is covered by water. But 97 % of all the water on earth is salty and it is too costly to make the water potable. Only 3 % water is pure, of which, approximately 79 % is locked up in the ice caps and glacier at North and South Poles, 20% is as ground water and rest of the 1% is easily available surface fresh water. In this chapter, water pollution and its various purification methods and their advantages and disadvantages are discussed.

Keywords: *Environment, Water Pollution, purification methods, silver metal nanoparticles.*

Water Pollution:

Water pollution is a large set of adverse effects upon water bodies such as lakes, rivers, oceans, and groundwater caused by human activities. Although natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water, these are not deemed to be pollution. Water is only called polluted when it is not able to be used for what one wants it to be used for. Water pollution has many causes and characteristics. Increases in nutrient loading may lead to eutrophication. Eutrophication is the fertilization of surface water by

nutrients that were previously scarce. Organic wastes such as sewage impose high oxygen demands on the receiving water leading to oxygen depletion with potentially severe impacts on the whole eco-system. Industries discharge a variety of pollutants in their wastewater including heavy metals, organic toxins, oils, nutrients, and solids. Discharges can also have thermal effects, especially those from power stations, and these too reduce the available oxygen. Silt-bearing runoff from many activities including construction sites, deforestation and agriculture can inhibit the penetration of sunlight through the water column, restricting photosynthesis and causing blanketing of the lake or river bed, in turn damaging ecological systems.

Pollutants in water include a wide spectrum of chemicals, pathogens, and physical chemistry or sensory changes. Many of the chemical substances are toxic. Pathogens can obviously produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry includes acidity, conductivity, temperature, and eutrophication. Even many of the municipal water supplies in developed countries can present health risks. Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily.

Waterborne Diseases:

Waterborne diseases are caused by pathogenic microorganisms which are directly transmitted when contaminated drinking water is consumed. Contaminated drinking water, used in the preparation of food, can be the source of food borne disease through consumption of the same microorganisms. According to the World Health Organization, diarrheal disease accounts for an estimated 4.1% of the total daily global burden of disease and is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries.

Unlike ground water, surface water does not contain any chemical pollutants from the ground; however, now a-days hazardous chemicals from industries are pumped into rivers in spite of strict legislation. The main contaminants in surface water are the pathogens; bacteria, viruses and protozoans. They cause virulent diseases like cholera, diarrhoea, diphtheria, measles and amoebiasis etc.

Cholera:

Cholera is a re-emerging infectious disease that threatens the global community. It is an acute intestinal infection caused by the bacterium Vibrio cholera.

It has a short incubation period and produces an enterotoxin that causes copious, painless, watery diarrhoea that can quickly lead to severe dehydration and death if treatment is not promptly given. Vomiting also occurs in most patients.

Cholera remains a global threat and is one of the key indicators of social development. While the disease no longer poses a threat to countries with good standards of hygiene, it remains a challenge to countries where there is no access to safe drinking water and adequate sanitation. Almost every developing country faces cholera outbreaks or the threat of a cholera epidemic.

Diphtheria:

Diphtheria is an upper respiratory tract illness characterized by sore throat, low-grade fever, and an adherent membrane (a pseudo membrane) on the tonsil(s), pharynx, and/or nose. A milder form of diphtheria can be limited to the skin. It is caused by Corynebacterium diphtheriae. Diphtheria is a highly contagious disease spread by direct physical contact or breathing the secretions of those infected. Diphtheria was once quite common, but has now largely been eradicated in developed nations. To control this, the DPT (Diphtheria-Tetanus-Pertussis) vaccine is given to all school children. Boosters of the vaccine are recommended for adults because the benefits of the vaccine decrease with age; they are particularly recommended for those travelling to areas where the disease has not been eradicated yet.

Diarrhea:

Diarrhea is a condition in which the sufferer has frequent and soupy, chunky, or loose bowel movements. In the Third World, diarrhea is the most common cause of death among infants, killing more than 1.5 million per year.

Thus, it is necessary to purify water from microorganisms before usage. Municipalities purify the surface water and pathogen free-water is being transported to the houses, colonies and public taps through pipelines. However, water has to travel long distances through these pipelines from the tanks before it reaches the destination. A small leakage in the pipelines helps microorganisms to grow in the pipelines. More over it is not possible to clean the pipelines, as they are placed at least three feet below the earth surface. Thus, microorganisms easily grow in the pipelines. Hence it is necessary to deactivate the microorganisms in the municipal water before use.

Amoebiasis:

Amoebiasis is a parasitic infection caused by Entamoeba histolytica. It is usually contracted by ingesting water or food contaminated with amoebic cysts. Amoebiasis is usually transmitted by contamination of drinking water and foods with fecal matter, but it can also be transmitted indirectly through contact with dirty hands or objects as well as by sexual intercourse. Most infected people, perhaps 90%, are asymptomatic but this disease has the potential to make the sufferer dangerously ill and it is estimated by the WHO that about 70,000 people die annually worldwide.

Purification of Water:

Water purification is the process of removing contaminants from a raw water source. The goal is to produce water for a specific purpose with a treatment profile designed to limit the inclusion of specific materials; most water is purified for human consumption (drinking water). Water purification may also be designed for a variety of other purposes, to meet the requirements of medical, pharmacology, chemical and industrial applications. Methods include, but are not limited to:

ultraviolet light, filtration, water softening, reverse osmosis, ultrafiltration, molecular stripping, deionization, and carbon treatment.

Water purification may remove: particulate sand; suspended particles of organic material; parasites, Giardia; Cryptosporidium; bacteria; algae; virus; fungi; etc. Minerals calcium, silica, magnesium, etc. and toxic metals (lead, copper, chromium etc). Some purification may be elective in the purification process, including smell (hydrogen sulfide remediation), taste (mineral extraction), and appearance (iron incapsulation).

Governments usually dictate the standards for drinking water quality. These standards will require minimum / maximum set points of contaminants and the inclusion of control elements that produce drinking water. Quality standards in many countries require specific amounts of disinfectant (such as chlorine or ozone) in the water after it leaves the water treatment plant (WTP), to reduce the risk of re-contamination while the water is in the distribution system.

It is not possible to tell whether water is safe to drink just by looking at it. Simple procedures such as boiling or the use of a household activated carbon filter are not sufficient for treating all the possible contaminants that may be present in water from an unknown source. Even natural spring water - considered safe for all practical purposes in the 1800s - must now be tested before determining what kind of treatment, if any, is needed. Chemical analysis, while expensive, is the only way to obtain the information necessary for deciding on method of purification.

General Methods of Water Purification:

Deionization:

Deionization is one of the important water purification methods, wherein, removal of ions and minerals by synthetic ion exchange resin. Particularly, cation resins remove positively charged ions and anion resins remove negatively charged ions.

Filtration:

Filtration is a facile water purification method. Use as a pretreatment or a stand-alone treatment. Water passes through a filter of specified porosity at normal line pressures. The filter retains most particulates, with water passing through.

Ultra Filtration:

Ultra filtration uses for removing pyrogens and bacteria. Under pressure, water is forced through a membrane with a pore size smaller than 0.005 μm. Particulates are retained, with only pure water passing through.

Water Softening:

Water softening reduces the dissolved calcium, magnesium, and to some degree manganese and ferrous iron ion concentration in hard water. A class of minerals called zeolites also exhibits ion-exchange properties; these minerals were widely used in earlier water softeners. Water softeners are typically required when the source of water is a well, whether municipal or private.

Reverse Osmosis:

Use primarily as a pretreatment. Equal amounts of pure water and saline solution are separated in a U-tube by a semipermeable membrane. When external pressure is applied to the saline side, the semipermeable membrane allows water to pass through while salts are concentrated and flushed down a drain.

Distillation:

In the process of distillation water is heated to a gaseous state and recondensed in a separate vessel.

Ultraviolet (UV) Oxidation:

In this method of water purification UV light (at <280 nm) passes through the water and destroys bacteria, viruses, and trace organics.

Chlorination:

Chlorination is the very effective technique for the control of microorganisms. The use of chlorine and its compounds is undoubtedly the most common disinfection method. Chlorine is known to be effective against bacteria and

requires short to moderate contact time. Chlorine treatment will control nuisance organisms such as iron, slime and sulfate-reducing bacteria. Iron bacteria feed on the iron in the water. They may appear as a slimy, dark-red mass in the toilet tanks. However, iron bacteria that have penetrated the water-bearing formation will be difficult to eliminate and will likely re-infest the system. In this situation you will need to repeat chlorination treatment periodically. Other nuisance organisms include sulphate-reducing bacteria, which produce a rotten-egg odour. Chlorination will kill or control these bacteria. Chlorination sharply reduced typhoid deaths. Shortly after this dramatic success, chlorination and filtration were resulted in the virtual elimination of waterborne diseases such as cholera, typhoid, dysentery and hepatitis-A. The adoption of drinking water chlorination has been one of the most significant advances in public health protection.

Iodination:

Since iodine is a halogen, like chlorine, that exerts a biocidal effect through its chemical property as a strong oxidant. The active disinfectant species are elemental iodine and hypoiodous acid. Water disinfection with halogens is a first-order chemical reaction: the primary variables are aqueous concentration of halogen and the time it is in contact with the microorganisms. In addition, different classes of microorganisms vary in their susceptibility to halogens. Bacteria are very sensitive, viruses are intermediate, and protozoan cysts are more resistant. Doses of iodine below 1 mg/L are effective for bacteria within minutes. Iodination has been proven effective in controlling most disease-producing bacteria, even with relatively short contact time. Iodine is effective at killing all of the dangerous organisms (except Cryptosporidium) and kills viruses effectively. This method has been used successfully for disinfections of swimming pools and drinking water.

Ozonization:

One common method of disinfecting wastewater is ozonization (also known as ozone disinfection). Ozone is an unstable gas that can destroy bacteria and viruses. It is formed when oxygen molecules (O_2) collide with oxygen

atoms to produce ozone (O_3). Ozone is generated by an electrical discharge through dry air or pure oxygen and is generated onsite because it decomposes to elemental oxygen in a short amount of time. After generation, ozone is fed into contaminated water to be disinfected. Ozone is a very strong oxidizing agent and is effective in killing bacteria with even little exposure time. Ozone is also effective in oxidizing organic matter, iron, and manganese. It produces no tastes or odors in the water.

Disadvantages of Conventional Water Purification Methods:

Chemical purification like adding chlorine, iodine or applying ozone etc. to kill the bacteria has several disadvantages.

Disadvantages of Chlorination:

Chlorination is very effective in controlling pathogens but it has some disadvantages even low concentrations of chloride react with humic and fulvic organic compounds in the water generating carcinogenic trihalomethanes (THMs). Because THMs are very seldom associated with groundwater, they are primarily a concern where surface water supplies are used. Chlorine compounds with some organic material will give unpleasant tastes and odors. Solutions of chlorine are moderately stable it can react with organic matter as well as iron, manganese forming insoluble compounds.

Disadvantages of Bromination and Iodination:

Both bromination and iodination have been proven effective in controlling most disease-producing bacteria, even with relatively short contact time. Bromine is also carcinogenic. These methods have been used successfully for disinfection of swimming pools, but bromine is not recommended for drinking water. Some people are allergic to iodine and cannot use it as a form of water purification. Persons with thyroid problems or on lithium, women over fifty, and pregnant women should consult their physician prior to use iodine for purification. Also, some people who are allergic to shellfish are also allergic to iodine. The EPA advises that iodine disinfection is acceptable for short-term

or emergency use, but that it is not recommended for long-term or routine drinking water supply application. Even 0.5 milligrams of iodine per day might have resulted in hyperthyroidism, thyroiditis, or increased rates of thyroid carcinomas.

Disadvantages of Ozonisation:

Ozone is unstable and has a very short life, so it must be generated at the point of use. Ozone is also effective in oxidizing organic matter, iron, and manganese. There is no simple test to determine whether or not the system is providing proper disinfection.

Disadvantages of Reverse Osmosis:

Requires large volumes of water – it may take as much as 90 gallons of water to recover 5 gallons of usable water. Flow rate is limited to a certain number of gallons per day. Reverse osmosis is not cost effective; require great care to handle the membrane for washing etc. if any small holes are developed pathogens can pass through it.

Disadvantages UV Radiation:

It does not remove suspended particles or ions. Suspended solid particles and organic matter can shield organisms against the light.

Table 1: Water Purification Efficiency of Different Purification Methods

Method	Pages Dissolved ionized solids	Dissolved organics	Dissolved ionized gases	Particulates	Bacteria	Pyrogens
Deionization	Excellent	Poor	Excellent	Poor	Poor	Poor
Adsorption	Poor	Excellent	Poor	Poor	Poor	Poor
Filtration	Poor	Poor	Poor	Excellent	Excellent	Poor
Ultrafiltration	Poor	Good	Poor	Excellent	Excellent	Excellent
Reverse osmosis	Good	Good	Poor	Excellent	Excellent	Excellent
Distillation	Excellent /Good	Good	Poor	Excellent	Excellent	Excellent
UV oxidation	Poor	Good	Poor	Poor	Good	Poor

Anthropogenic Influences on Wetland Ecosystem: The Case of Morikolong Beel, Nagaon, Assam

Dr. Nazneen Akhtar
Indrani Chakraborty
Pallabi Banik

Abstract:

Wetlands today are continuously being degraded despite their value and wide range of ecosystem services that they provide. The present paper has therefore, attempted to assess the wetland ecosystem services and the drivers of its change through a case study of Morikolong Beel of Nagaon district, Assam. Both qualitative and quantitative data were collected through focus group discussions and key informant interviews. The analyses showed that the changing land use pattern in the marginal wetland areas is contributing to gradual shrinkage of wetland area and creating a hurdle to the otherwise sustainable wetland ecosystem. This change in the land use has been brought about by a no.of anthropogenic factors at play, like pollution, encroachment and over exploitation of wetland resources. This suggests that there is an urgent need for a comprehensive participatory management plan. Actions are needed to maintain the Morikolong Beel and the flow of its services in a sustainable manner.

Keywords: *Morikolong wetland, ecosystem services, drivers of change, Anthropogenic.*

1. Introduction:

Wetlands constitute a very important component of the earth's natural system. The Ramsar Convention defined Wetlands as an "area of marsh, fen, peat land or

water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which at low tide does not exceed six meters" (Ramsar Convention Report, 2006). Recognised as transitional areas between the aquatic and terrestrial ecosystem, wetlands are one of the most productive life support systems on the earth's surface (Hazarika et al., 2005). Five major types of wetlands are generally internationally recognized- a) Marine wetlands: coastal lagoons, rocky shores, coral reefs, b) Estuarine wetlands: deltas, tidal marshes, mangrove swamps, c) Lacustrine wetlands: lakes, d) Riverine wetlands: wetlands along rivers and streams and e) Palustrine wetlands: marshes, swamps and bogs (Bhagabati, 2016).

Wetlands offer a no. of services to the community and the environment at large, the most important of which is, it helps in building a traditional hard infrastructure for natural hazard reduction thereby, increasing resilience of the local communities (Saikia, 2019). Inspite of its wide range of benefits, the 'wise use' of wetland resources still needs to be instilled into the mindset of the people as anthropogenic factors have led to serious degradation of such pristine sources.

The state of Assam is gifted with a no. of swampy areas and lakes which are locally known as "Beel (wetland)". The Beel in Assam are water-bodies of varying size connected to Brahmaputra and Barak River and to its tributaries. There are about 3513 numbers of wetlands, (inland wetlands, swampy/marshy areas, ox-bow lakes/cut-off meanders, lakes/ponds, tanks and reservoirs of different size and shape in the state. It constitutes 1.29 percent of the total geographical area of the state. A total 861 number of ox-bow lakes/cut-off meanders are observed throughout the state of Assam, covering an area of 15460.60 ha which constitutes 0.20 percent of the total geographical area of the state and 15.27 percent of the total area under wetlands. Highest number of ox-bow lakes/cut-off meanders are observed in Golaghat district (104

number) followed by Nagaon district (71 number). The Morikolong Beel of Nagaon falls under this category (National Wetland Atlas, 2011).

Unfortunately, in the present scenario, Morikolong beel has undergone varying degrees of degradation. Realising its significance, the present communication is an attempt to draw upon the ecosystem services of the beel and to review the human impacts with possible suggestive measures for its conservation.

2. **Materials and Methods:**

2.1. **Study Area:**

The Morikolong Beel is one of the largest wetlands of Assam situated in the south bank flood plains of mighty Brahmaputra in Nagaon district. It extends from 26°19/ N to 26°22/ N latitude and 92°40/E to 92°43/E longitude and its elevation is 60.6m from the mean sea level.

The Kolong River of Nagaon is a principal river of the region that had shifted its course many times in the past owing to several earthquakes that had occured in Assam. The Morikolong beel is a cut off meander of this river that ultimately took its final shape in the suburbs of Nagaon town.

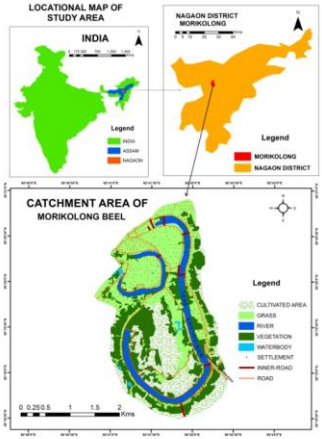


Figure 1: Location Map of the Study Area

2.2. **Objectives:**

1. To assess the wetland ecosystem services of Morikolong beel,
2. To detect the pattern of Land-use land-cover change (LULC) in the Beel over a period of ten years and to identify the drivers of wetland ecosystem change.

2.3. **Database and Methodology:**

Both primary and secondary sources of information have been used in the present study. Semi-structured interviews with people living in the catchment area of the wetland and focus group discussions with those involved in obtaining direct benefits and services from the wetlands like the farmers, fishermen and the local people, were done in a participatory mode during the period 2019-2021. Oral discourses with some elderly and experienced persons were made in order to know the change in the availability and use of the wetland resources in the study area over time.

To identify the area and preparing the location map of the study region, Survey of India topographical sheet No. 83 B/11 has been used and prepared on ARCGIS10.2, QGIS 3.14.1 and Google Earth Pro. Moreover, to assess the LULC change, Landsat 5 TM and Sentinel-2B satellite imageries of years 2011 and 2021 bearing resolutions 30M and 10M, 20M and 60M were used respectively that were obtained from USGS Earth Explorer. For the purpose of image classification and change detection, supervised classification was attempted with 94%-97% accuracy.

3. **Results and Discussion:**

3.1. **Ecosystem Services Provided by Morikolong Beel:**

Ecosystem services are the benefits people obtain from ecosystems. These may include both direct as well as indirect benefits. The Millenium Ecosystem Assessment called for by the United Nations Secretary-General Kofi Annan in 2000 and initiated in 2001, aimed to assess the consequences of ecosystem change for human well-being. This framework identified four types of ecosystem services.

These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (Assessment, 2005).

Broadly speaking, wetlands as ecosystems existing on the globe perform a no. of functions that are beneficial to its surrounding regions. Wetlands play a critical role in water quality improvement by preventing the release of both organic and inorganic pollutants into the natural water bodies, help in removal of sediments, production of oxygen, nutrient cycling etc. They act as habitats for fish, birds, mammals, reptiles and amphibians many of which have an economic value in terms of subsistence as well as commercial fishing, hunting and trapping. Non-consumptive uses may be many such as bird watching, aesthetics and recreational, educational as well as for scientific research purposes (Hazarika et al., 2005). Wetlands contain characteristics vegetation of aquatic plants and play an important role in water purification, carbon sink, flood control and shoreline stability. It supplies fresh water to the city and recharge the groundwater. Wetlands also have the ability to store large quantities of carbon because they store dead wood and plant matter in the soil. The water logging condition prevents the materials from decomposing thus releasing CO_2 (Saikia, 2019). Following Bhatta et al (2016) and Bhagabati (2016), the ecosystem services provided by the Morikolong beel have been summarised as follows:

Table 1: List of Ecosystem Services Identified in the Study Area

Ecosystem service category	Ecosystem service recorded
Provisioning	● There are farmers who cultivate Hali, Bodo paddy and few vegetables in the fringe areas of the beel ● The grass collected is used as fodder for the cattle ● The people breed fish for consumption as well as for their livelihood. Almost entire beel has been given out on lease (in three different parts) by the govt. for commercial fishing ● Collection of wetland resources such as edible plants, water lily seeds etc. and also sold in the local markets ● Livestock grazing ● Irrigation purposes, fuelwood for cooking
Regulating	● Climate regulation as it is a good sink for greenhouse gases ● Nutrient cycling ● Water storage; water purification ● Flood control
Cultural	● Recreational and aesthetic purposes ● Bird watching ● Educational and research purposes ● Potential for Ecotourism if planned and managed well
Supporting	● Habitat for aquatic life, wild fauna as well as flora

Source: Compiled by the Authors.

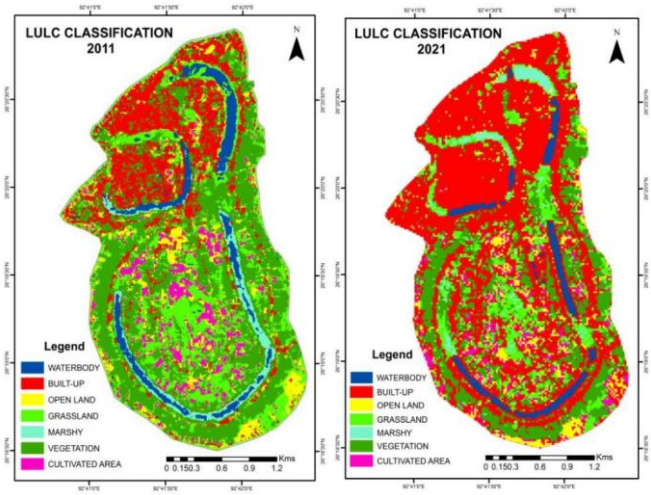
The Morikolong beel is home to a no. of aquatic as well as terrestrial plants. Mention may be made of a few

like Kolakasu (Colocasia esculenta), Borkachu (A. fornicate), Kachu (Alocasia acuminate), Muthabon (Cyperus rotundus), Meteka (Eichhornia crassipes), Parijat (Canna indica), Kolmou (Ipomoea aquatic), Bonjaluk (Dentella repens), Manimuni (Centella asiatica), Panijuali bon (Ranunculus scleretus), Laijabori (Drymaria cordata) etc. Apart from these, it is also the habitat of a variety of avian fauna like Sarali Hah (Whistling Duck), Bogoli (Cattle egret), Pani Kawri (Little cormorant), Masruka (Kingfisher) etc. Thus, the beel no doubt plays an important supporting function for different species.

According to (Bhagabati, 2016), the functions of wetlands are wide rangingand far- reaching in character. However, at micro-geographical level, the roles played bythe wetlands in the physical and socio-economicconditions of the concernedareas are either overlooked orunderestimated because of the long continued spontaneous relation of thelocal people to the wetlandenvironment. Hence, wetlands do not gather the much-needed response and significance that they otherwise deserve.

3.2. **Morikolong Wetland at Peril: The Analysis of Temporal Change:**

LULC change demonstrates how land has changed over time under the effects of natural factorsand anthropogenic activities. At present, LULC change has become an important theme of research in areas of ecologicalproblems and ecosystem services (Zorilla et al., 2014, Lin et al., 2018, Temgoua et al., 2021). Hence, the present study attempts to understand the degradation of the Morikolong beel ecosystem by assessing the temporal changes that have occurred in the catchment area of the beel over a period of 10 years (2011-2021).



(a) **(b)**

Fig 2: Landuse Map of Morikong Beel Catchment Area a. (2011) b. (2021)

In total, we identified 7 land-use types namely, vegetation, water body, grassland, built-up, cultivated area, open land and marshy. Land-use change analysis was assessed by comparing the areas occupied by each land use in each period using the ArcGIS software. For each study period (2011 and 2021), we calculated the total area lost or gained by each land-use type and the land-use dynamic index (Hao et al., 2012) using Eq. (1):

$$K = S_b - S_a/S_a * 1/t * 100 \quad (\%) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where K refers to the dynamic index of a given land-use category, S is the area (in ha) for a certain land-use category, “a” and “b” are the initial and final areas, respectively, and “t” is the study period.

Table 1: Landuse Dynamic Degree of Morikolong Catchment Region from 2011-2021

Landuse class	Area in ha (2011)	Area in ha (2021)	Areal change (in ha)	Dynamic degree (%)
Waterbody	45.02	29.46	-15.56	-3.46
Cultivated Area	48.48	38.4	-10.08	-2.08
Open land	53.14	37.02	-16.12	-3.03
Marshy	36.01	18.62	-17.39	-4.83
Grassland	162.10	111.93	-50.17	-3.10
Vegetation	284.84	143.49	-141.35	-4.96
Built-up	142.50	393.34	250.84	17.60

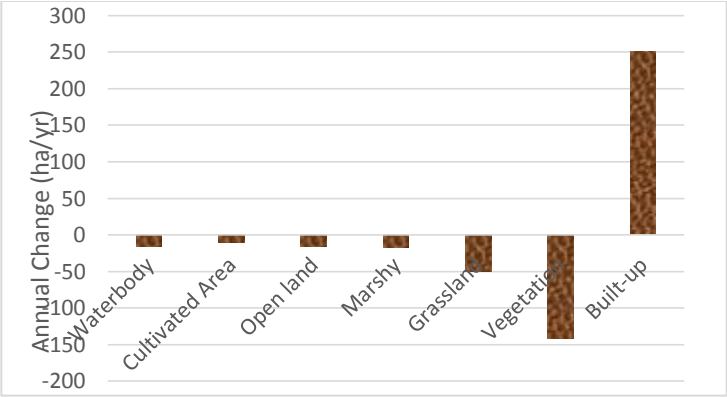


Fig 2. Annual rate of LULC Change in Morikolong Catchment Region from the Period 2011 to 2021

According to formula (1), the single dynamic degree of the research region in 2011–2021 was calculated. As shown in Table 1, the largest single dynamic degree of land use in the studied area is built up (17.60%), indicating that the urban area developed rapidly in this period and occupied the unused land for economic activities, resulting in rapid depletion of unused land region as well as water bodies and intense dynamic changes. In these two periods, vegetation and marshy areas had the highest negative

single dynamic degree of land use (-4.96% and -4.83%) respectively. In case of waterbody, particularly the beel in this case, the dynamic degree came to -3.46 % The dynamic change trends of these land categories were indicating that, with the deepening of urbanization in the studied area, the unused land and beel area decreased sharply and the built-up land increased rapidly.

3.3. **Drivers of Wetland Ecosystem Change:**

Dependent on a no. of driving forces at play, both human induced and natural, the Morikolong Beel has been facing multiple pressures over time. In a paper published in Geografiska Annaler Series a Physical Geography on Wetland loss in Louisiana, USA, Walker et al. (1987) had identified 4 major processes contributing to the loss of wetlands, which are more or less relevant to all parts and contexts of the world. These processes are: (i) geologic, (ii) catastrophic, (iii) biologic and (iv) human. Among these, however, the human factors have proved to be highly pervasive and destructive during the recent period so far, the status and functioning of wetlands are concerned.

Fig.3 (a) Dumping of garbage in the periphery of the beel, (b) Incomplete construction of bridge over the beel and a lady collecting edible plants from the beel, (c) High rise man-made constructions without proper planning, (d) The present Morikolong bus stand which lies towards the northern end of the beel, (e) Fishing nets installed along the banks for catching fish by the locals. (f) Dilapidated recreational park constructed in the fringe area.

As far as the present study area, i.e., Morikolong Beel is concerned, it has not remained untouched by the

increasing anthropogenic pressures due to population growth and development affecting the entire ecology and habitat. The main factors identified for wetland degradation are:

1. **Increased Habitation and Encroachment:** Rise in the no. of human settlements and also encroachments in and around the catchment area has led to its degradation. People have constructed both permanent and semi-permanent structures (both authorized and unauthorized) on the periphery of the beel which has greatly hampered and led to its littoral zone decline. Presently, a particular end of the beel towards the Nagaon town has been proposed to be further expanded and developed as a major bus terminus which might prove detrimental to the wetland ecosystem.

2. **Macrophytic Decline and Littoral Zone Reduction:** Macrophytic decline has been noticed in the beel due to littoral zone reduction, pollution, grazing by cattle and removal of macrophytes by locals for use as fodder for animals. The reduction in macrophytes has again caused a detrimental effect on the beel fauna specially birds, that rest on these macrophytes for feeding.

3. **Pollution Sources:** Dumping of garbage, entry of sewage drains from the nearby houses, hotels and shops etc. pollute the beel to a great extent resulting in excess nutrient load and thereby, in eutrophication. This results in growth of excess water hyacinth and other dense vegetation and reduction in the oxygen level of the wetland causing death of fishes in large numbers.

Apart from these, religious activities like dumping of wastes into the beel after performing rituals, dumping of ashes after cremation, runoff of fertilizers from nearby agricultural fields, irrational mode of fishing, deforestation, etc. are other drivers of beel ecosystem change.

3.4. The Way forward:

It is evident that anthropogenic factors are the primary drivers behind the change in the ecological

landscape of Morikolong beel. Keeping in view the above-mentioned problems, this wetland demands immediate need to take up measures to conserve and protect it from further degradation. First and foremost, step is to start from the grass- root level by making the local people aware of the significance of wetlands and the 'wise use' of the wetland resources which will help in its sustainable management and conservation. Other initiatives specific to the Morikolong beel include:

1. Encroachment, construction activities and other developmental practices in the catchment of the beel should be restricted. Demarcation of the wetland boundary can be done either by suitable vegetal cover or live fencing.

2. Afforestation programmes should be initiated in the catchment region so as to decrease soil erosion and infiltration of nutrients into the beel. Cultivation should also be barred in the vicinity of the beel

3. Littoral zone should be restored by dredging and regeneration of macrophytic plants. Growth of water hyacinth should be terminated by removing them on a time-to-time basis.

4. For reducing the pollution load into the beel, there should be diversion of sewage discharge points to other open areas, disposal of wastes should be strictly banned in the periphery of the beel.

5. Commercial exploitation of the wetland resources such as fishes and other fauna as well as flora should be highly discouraged.

6. Ecotourism can be a viable alternative towards restoration of the Morikolong wetland.

4. **Conclusion:**

In this case study, we argue that the Morikolong Beel of Nagaon is an important wetland ecosystem providing diverse ecosystem services to surrounding regions. However, there are a number of direct and indirect drivers negatively impacting the availability of such services and leading to degeneration of the wetland ecosystem. While over-exploitation and pollution were

identified by the people as the major issues resulting in the degradation of the wetland, the lack of a management plan for the area is an important factor contributing to the wetland's degradation. Therefore, an integrated and holistic management plan starting at the grass-root level could be effective in mitigating degradation of the wetlands while maintaining the supply of ecosystem services. Attention should also be paid to the indirect drivers of changes. For instance, analyzing the socio-political and economic drivers of changes to the wetland in the area should be the focus of further research in the area.

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Air Pollution and Its Impact on Children's Health

Dr. Shubhria Sharma

Abstract:

Every country experience pollution problem of same kind or another, however severity of pollution depends upon the nature of pollutants. At present time our planet is being degraded by our unsustainable resources, increase in vehicle population, housing and wastes has exacerbating many health problems. Many cities of India have been facing many environmental challenges due to increase in vehicular population. Today, most children in urban environments which are polluted by vehicular exhaust smog etc. Children are very sensitive to toxicants because their ability to metabolize toxicants is different from that of adults (Suk et al, 2003). Children don't seem to accommodate with the health hazards chemicals; therefore, they are more vulnerable to them. This paper will briefly discuss the air pollution and its hazards that societies may confront thus it is necessary to assess the routes of exposure and severity of these hazards on population especially on children.

Keywords: *Health, Air pollution and children.*

Introduction:

Man is always interfering with nature, sometimes intentionally, sometimes accidently or unconsciously (Arvill, 1976). Natural environment need protection rather than modification (Singh,1992). The rapid advancement of technology has been great source of desirable and undesirable changes (Mukherja et al;2001). As man has squandering the natural resources, thereby creating enormous strain on water we drink, and the air we breathe and the land on which we live. Any undesirable change in

physical, chemical and biological characteristics of water, soil and air that caused harm to man is known as Pollution (Agarwal, 2001). Clean air has become more than a luxury for him today (Rao,1998). Brundtland (1998) stated that "As people continue their endless quest for new materials, new energy forms and new processes, the constraints by depletion of natural resources and the pollution caused by human activities have brought society to cross roads".

Most people are not generally aware of what means by pollution, but also able to quite a range of examples of its impact on the life of this planet. Pollution is one of the increasing dominant themes of modern age. The brief description of pollution is:

- The Pollution may define as "Resource out of place" considers the mercury contained in a thermometer, it is useful and may resource as helps to indicate temperature by virtue of its liquid expansion properties however if thermometer breaks and mercury finds its way into drinking water, it may be considered a "Pollutant".
- A very comprehensive definition of pollution has been forwarded by Environmental of the U.S. President's Science Advisory Committee in 1965-Environmental pollution is nothing but unfavourable alteration of our surroundings wholly or largely as b aby product of man's action directly or indirectly by changes of energy patterns and physical and chemical changes.
- According to EPA, 1990, Sec.75-Any substances which constitutes a scrap or any effluent or other unwanted surplus substances.

At Present time our planet is being affected by the massive atmosphere, many cities of India have been facing many environmental challenges due to increase in vehicular population and now air pollution is at alarming state.

Impact of Air Pollution on Human Health:

Pollution is an inescapable consequence of the presence of man and his activities (Rao,2016). Air

pollution signifies the presence in ambient(surroundings) atmosphere of substances (gas, mixture of gases and particulate matter) generated by the anthropogenic activities of man in concentrations that interferes with human health. The main source of air pollution is automobiles, industries, domestic sources and miscellaneous etc. Average human being breaths about 22,000 and &7.2 kg of oxygen, sometimes injurious material settle down sometimes these health hazards materials stays back in atmosphere (Asthana,1999). In urban communities, children are often more sensitive to toxic action than younger adults. Elder group have diminished physiological capabilities so their body can deal with toxicity, whereas children are more susceptible to toxic effect even at less exposure (Liolin, EHS). Keller, 2000, stated that the effect on individual depend on the dose of concentration, however other factors depend on individual susceptibility.

Special Vulnerability of Children: Although the impact of environmental pollution on health widely studied but in this paper some studies on special vulnerability will be quoted. In a study of Chance,1998; Children are at often risk from the hazardous pollutants due to their rapid growth physiologic, and metabolic immaturity. They are at risk from exposure to toxic substances than adults. Children are believed to be especially vulnerable as they breathe relative higher doses of air pollution so absorb more pollutants. Children are more affected by air pollution because of their small diameter airways, more time outdoors and more active especially in the afternoon (Andrea Hricko et al; 1980). Bearer observed that children are at special risk because they often have more contact with dirt and dust. Effect on children may be lifelong (Carison, 1995).

According to Dr. Brundtland, WHO, 2002; people are most vulnerable in their youngest years; therefore, children must be at the centre of our response to unhealthy environments. Retha Newbold, NIEHS, 2001; Children don't have the same protective mechanism built in adults

do because they don't have differentiated metabolic process to breakdown some toxicants since a child have smaller body mass there may more of (a toxicant) hitting a smaller target. Most children have a few things in common, they play a lot, they eat a lot and they grow fast this healthy way of life puts kids at environments risks. WHO stated in "Children are not little adults" that children have different and sometimes unique, exposure to environmental hazards from those of adults. According to Landrigan, (1999) children's tissues are rapidly growing developing and differentiating at various stages. These growth processes create window(s) of great vulnerability to environmental toxicant. During the early childhood the bronchial tree is still developing, the number of alveoli in human lung increases from 24 million at birth to 280 million at epithelial layer in young children by the of 8 year (Dunnill, 1962).

Respiratory Illness and Lung Function Growth Due to Air Pollutants: Several studies reveal that air pollutants are associated with a variety of adverse health effects in children including increased death rates in very severe pollution episodes and increased mortality risks for those things in highly polluted areas (Bates et al, 1997). Bobak and Leon (1992) recently also examined the cross-sectional association between air pollution and infant mortality rates across town in Czech Republic.

The researchers found a significant association between the occurrences of upper respiratory of respiratory infections and living in an air polluted area (Jaakkola et al, 1991). A study in East Germany found levels of sulphur dioxide, particulate matter and nitrogen oxides were associated with an increased risk of developing upper respiratory infections in 9 to 11 years olds (Von Muius et al.,1995).

To maintain a normal rate of gas exchanges the removal of carbon dioxide and replenishment of oxygen the lungs must be able to inhale and exhale adequate volume of air. Numerous studies have showed that even brief exposure to air pollutants can impair lung function

(He, Q. C.et al,1993). There is a large body of literature associating in air pollution with short term change in lung function of children, Jedrychowski,1999 also found that air pollution was associated with lower levels of lung function growth in children in Poland. Horak et al, 2002, made repeated measurements of spirometry during a 3 years period in Austrian school children and found that after adjustment for covariates evaluated including initial lung function Lung function growth rates are associated with PM10 exposure. One study in Utah Valley indicated that deterioration lung complications were associated with elevated particulate level among elementary school age children as measurement by peak expiratory flow (Peak expiratory flow is the maximum rate at which air is exhaled from a maximum inhalation). Few reports on Canadian literature have focused on the specific vulnerability of children because of their rapid growth physiological and metabolic immaturity, the foetus and child are often at risk from toxic substances in their environments. Furthermore, greater air food and fluid intakes relatives to body compared with adults (Chance G.W. & Harmsen, E. 1998). A study conducted by Linares, et al, 2010; School going children closer to major stationary air pollution sources are more effected than those distant school people are not generally aware of what means by pollution, but also able to quite a range of examples of its impact on the life of this planet.

Environmental Pollutants and Human Health:

Recent studies estimate that 2% to 9%of human mortality is associated with particulate pollution. Particulars that enter in lungs may lodge there and chronic effects on respiration (Botkin & Keller, 2000). Some pollutants have synergetic effects greater than the sum of separate effects (Krishna & Rao,1998). There are major routes to exposure of hazardous materials which includes ingestion, inhalation and dermal absorption.

This is route entry of contaminants in the body, which deals with eating. Foods or other swallowed material are carried directly into the digestive system and they are

metabolized (Fatima, 2006). Pollutants are carried away throughout the body to the target areas where effects are felt. In the process of ingestion fat soluble chemicals (also known as lipophilic) also absorbed in the body. Water-soluble chemicals or hydrophilic can also be absorbed in human body due to water-based chemistry of human metabolism. In ingestion, biologically available form of contaminants in the body is called dose that interacts with internal target tissue or organ.

In inhalation toxic substances are readily absorbed in respiratory tract this route is fastest means of exposure to toxic substances. The factors effecting the inhalation are the concentration of toxic and hazardous substances in air and solubility of substance in the blood and tissue. Inhaled chemicals deposited in the respiratory tract. During breathing many hazardous air particles absorbed in lungs.

Pollutants also entered in the body via absorption. In dermal absorption chemicals can cross the barrier of skin and then absorbed into the blood system. After absorption these chemicals may damage to internal organs (EHS). Dermal absorption is enhanced by scratched, broken, roughened or abraded surfaces of the skin on ankles, hands and neck or facial areas (Gulraiz, 2006).

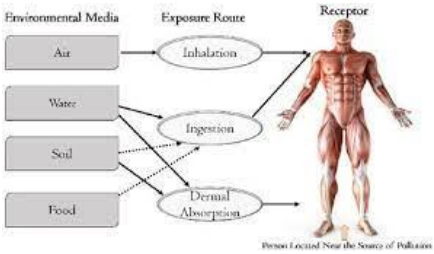

Image Showing Routes of Exposure of Pollutants

(Source: Environmental Health Insights; Richard Olawoyin,2018)

Today, most children live in urban environments which are polluted by vehicular exhausts, smog etc. School age children spend a significant period of time at school, a very different physical environment than house (UNICEF, WHO, UNEP, 2000). Children are particularly vulnerable

to environmental toxins. Several factors have the effect of increasing children's potential risk (National Academy of Science, 1993) because during the process of growth and development, their development processes are easily disrupted. Many organs system in infants and children undergo very rapid change parentally as well as in the first three months, years after birth; these developing system are very delicate and not well able to repair damage that may be caused by environmental toxicants (Suk, Landrigan et al. 2003).

Discussion:

Therefore, this has been cleared from above quoted studies that anthropogenic sources have undesirable effect on health. Nature has provided an efficient device which helps them to guard them against pollutants. Number of harmful materials, when absorbed by intestine tract then these materials are degraded or converted to harmless state before reaching to blood circulation. However, in case of respiratory tract, the pollutants absorbed enter straight into the blood circulation. This is very efficient route of entry of hazardous materials due to large.

These particles also change to heart blood vessels. Particles smaller than 0.1 micro meter in size remain suspended in the air and they cannot filter out. According to Mathias, 1993. The emission of toxic and hazardous material is now increasing through motorization, now the main source of outdoor air pollution is road traffic. In urban surface area of absorption and blood flow in close proximity of alveolar spaces is very high (Asthana & Asthana, 1999).

Andrew (2000) stated that particles are small and enough to pass deep into the lungs and they may cause irritation changing the body's chemistry therefore blood clot formation increased areas, road traffic produces volatile organic compounds suspended particulate matter, oxides of nitrogen and mono oxide, which makes adverse effects on exposed population. Basavaraju et al, 2014 stated that "particles emitted from the vehicular exhaust of <10 micron is held in respiratory tract and particles

<10micron (pm10) accumulate in lungs and produce respiratory abnormalities."

Recent studies estimate that 2% to 9%of human mortality is associated with particulate pollution. Particulars that enter in lungs may lodge there and chronic effects on respiration (Botkin & Keller, 2000).

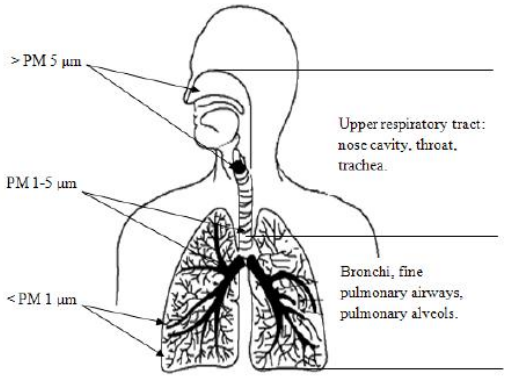

Image- (2) Penetration of particulates in Lung, (Source-Xiaotian Ziang et al, 2015)

Conclusion:

Today children appear to have been a particular risk and become two or four times more likely to experience breathlessness, coughing and other respiratory problems. Urban air pollution is a serious problem. Some pollutants have synergetic effects greater than the sum of separate effects (Krishna & Rao, 1998). It seems that next generation of kids will suffer some serious genetic defects related to respiratory health problems.

"Away with System. Away with a Corrupt World"

"Let us breathe the Air of Enchanted Island"

Without air there cannot be life, with air quality there can't be healthy life (Source-Arvill, 1972). To mitigate the threat of air pollution, every citizen should take oath to clean and protect our environment on earth and its treasure belongs to our future generations, therefore it's our responsibility to fight against the air pollution. Arvill stated that "Pollution is indivisible in the sense that shares

a common biosphere and action in one part and tend to affect another".

Little drops of water, little grain of sand
Make the mighty ocean, And the peasant

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Constitutional Perspective on Right to Clean Environment

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Abstract:

The environment has been one of the most basic subjects in today's time and it is beyond the international boundaries. To secure a clean and healthy environment, there is a need for proper regulatory set up both at international as well as national level. There are thus many provisions made for safeguarding the environment at national level that are framed by various countries. In India also, many special laws for the protection of environment as well as general laws under the constitution has been made. This article aims to Study the interpretations of the right to environment under the Constitution of India and also the international laws and treaties that are adopted in India to analyze the scope of environment law in India.

Keywords: *Environment, Special Laws, Environment Protection.*

1. Introduction:

The constitutional perspective on environment and how it has changed after the world conferences for the protection of environment has to be studied for understanding the changing contours of environment protection laws. The study thus includes the amendments done by the Indian legislature to implement the decisions of those conferences in domestic law. It is also to be seen in the writing that how Indian Constitutional provisions are evolving from time to time effectively, by way of amendment by the Parliament.

1.1. **Position Before 1972:**

Initially when our Constitution was drafted it did not contain any specific provisions on environment and even the word environment did not find any place in the Constitution although there were certain provisions which to a great extent has direct bearing on the environment such as improvement of public health organization of agricultural and animal husbandry on modern and scientific lines and protection of natural monuments from spoliation, disfigurement etc. The provisions contained in Article 47 is more important as it provides that the state shall regard the raising of the level of nutrition and standard of living of its people and improvement of public health as among its primary duties. Protection and improvement of the environment is inherently included in the improvement of public health because without it public health cannot be assured. This clearly reflects that the framers of our Constitution were very much conscious about environmental concerns.

1.2. **Position After 1972:**

The then Prime Minister of India Mrs. Indira Gandhi was the first head of the state to address the first International Conference on Human Environment at Stockholm in 1972. There she voiced deep concern about the degradation of the environment and eco imbalances. She also emphasized that pollution, population and poverty are interrelated problems and there must be an integrated approach to deal with them. India was also one of the signatories to Stockholm Declaration, which is known as Magna Carta on Human Environment. Therefore, to fulfill its promise made at the Stockholm Conference, the Indian Parliament passed the 42nd Amendment to the Constitution in 1976 and inserted two articles relating to protection and improvement of the environment.

So today, the Indian Constitution is among the few in the world that contains specific provisions on environmental protection. The directive principles of state policies and the fundamental duties explicitly enunciate

the national commitment to protect and improve the environment. Judicial Interpretation has strengthened this constitutional mandate.

2. Preamble and Environmental Concern:

Environmental concern is well embedded in the Preamble of the Constitution, as it is the soul of the Constitution and shows the reflection of ideals followed upon by the provisions therein. "Environment has become such an integral part of our life that we can't even think of affording a life without a healthy environment since it is connected to all spheres of our life be it social, economic or intellectual. Thus, when we are discussing aspects related to economic, social or political justice, the requisite is that we must include the environment as it has been a part of social structure. The State needs to therefore ensure that all the necessary steps to secure its citizen's environmental justice are taken.

The Preamble of our constitution is indeed of prime importance as it has been fondly referred to as the "Key to open the mind of makers". The Apex Court has indeed upheld the importance of our grundnorm law by saying that "the Preamble of our Constitution holds the extreme most importance and thus our Constitution should be read and interpreted in the light of the grand and noble vision expressed in the Preamble".

As it may be mentioned, the Preamble opens up with the words, 'We, the people of India' indicating on to the source from which the grundnorm law of India comes out of, i.e., the people of India. Thus, "we the people" only are solely responsible for constituting India into a "Sovereign, Socialist, Secular, Democratic, Republic" and in this, we find a glimpse of the concern for the society, as in such a society the state pays more attention to the social problems than any individual problems. Nowadays environmental pollution is the biggest problem around the world so it is the responsibility of the state to give more attention to this issue to fulfill the goal of socialism enshrined in our constitution's preamble.

Since environment has a great impact in all sorts of spheres of human life there is a dire need to get the benefit of a healthy environment as envisaged in the preamble itself which talks about justice and in present world justice also includes environmental justice in its ambit.

3. Environmental Matters and Division of Legislative Authority:

Since India is a country having a federal framework, i.e., there being a division of power between states and union government and not being complete concentration of power on one point, in order to frame laws on the various entries as it has been determined under the provision of seventh schedule of the constitutional law. Part XI of the grundnorm law ranging from the articles 245 to 255 of Constitution of India clearly determines the procedure so as how the very legislative power finds its division between the two levels of government in India, one at the center and other at state, Also, quite similarly the part XII of the Constitution of India brings in the provisions concerning the determination of division regarding the administrative power between the two areas.

Article 245 of Constitution of India gives the powers to central and state governments respectively to frame laws on the specified entries. Article also says that central government can make law for any part to the territory of India. Article 246 specifies the three lists viz. List I or the Union List, List II or the State List, List III or the Concurrent List contained in the Seventh Schedule of the Constitution demarcate the legislative fields of the center and the state.

As far as framing the laws is concerned, the Parliament is empowered enough as with respect to any entry provided in the Union List and same goes on with regard to the State Legislatures for such states or any part thereof, with respect to any of the entries provided in the State List. Here comes in the role of Concurrent List coinciding the power to both Central and State government to make the laws on entries as it has been specified therein.

There have been such instances provided as in the constitutional law wherein Parliament can go on to directly legislate with regard to the matters that are falling within the State List. With this regard, we may refer to the Articles 252 and 253 of Constitution of India. Article 252 specifically provides for the role of empowering the Parliament in order to legislate for two or more states at one time and provides for requisite that primarily the consent has been obtained with regard to concerned states. Thus, if in case such a situation arrives, wherein the center needs to reach on to the State Legislatures in order to get passed such legislation, even state has a requisite to get to the Central Govt. in order to get enacted the relevant legislation for them. This very procedure was first adopted by the Central Govt. while going on to pass a national law in order to curb the water pollution as water continues to be a subject included in the state list.

Now as far as implementation of India's international obligation is concerned, Article 253 of the Constitution of India also empowers the Parliament with regard to such exclusive legislation for whatever need is there to take decisions made at an international body or conference. Furthermore, if any such kind of reference is to be made in this regard, we may also bring on the focus on to the Entry 13 of the Union List which seems to be covering within its purview various avenues such as - "Participation in international conferences, associations and other bodies and implementing of decisions made thereat". Thus, post consideration and in view of the extended range of issues as they have been addressed by various international conferences and agreements, Articles 253 of the Constitution of India, when it is read with Entry 13 apparently very specifically provides with respect to Parliament the power so as to enact laws on virtually any entry construed to be provided in the state list. Also what needs to be taken into consideration is that by exercising this power only, the Parliament has brought forth the enactment of the Acts like Air (Prevention and Control of Pollution) Act, 1981 and the Environment (Protection) Act, 1986. As far as the Preamble for both of these Acts are

concerned, it clearly states that these laws were brought into enactment so as to bring on the implementation of the decisions as were reached to conclusion at the Stockholm Conference. This conference was concerned and focused on the environment and held in the year 1972 under the auspices of the United Nations. The said conference in fact even called upon each of the countries to work together in order to preserve the limited natural resources of the world.

As far as the inconsistency in context to the bridge in between the laws as made by the Parliament at Central level and laws as made by the State Legislatures on a matter falling in the Concurrent List, the law made by the former is bound to prevail. But what needs to be kept in mind is that, if a state law which has been passed and brought in motion subsequent to the central law and has also received the assent of the President under Article 254 of the Constitution of India, it is likely to prevail over the other provisions.

As such, there exist a number of Parliamentary enactments which involve thereby a certain number of environmental implications, as have been timely conferring power on the state. As the recent changes made in the Seventh Schedule to the Constitution by the Forty Second Amendment have brought forth a new motion, certain entries which were also transferred from one list to another accordingly as and when required.

Thereby, in the Concurrent List we can find Entries 17A, 17B and 20A which were all added so as to include terms like “forest”, “protection of wild animals and birds” and “pollution control and family planning”, so as to enable the Parliament to enact Central legislation, keeping in view the national and international environmental perspectives. Feeling the urgency and importance of pollution control and for better results, the Panchayats and the Municipalities were also giving wide ranging powers by way of amendments to the Constitution.

The Constitution (Seventy Third Amendment Act, 1992) introduced provisions relating to Gram Panchayats

and by adding a new schedule "Schedule Eleven" had several entries which are linked with environmental protection and conservation. The entries are soil conservation, water management, watershed development, social forestry and farm forestry, drinking water, fuel and fodder, means of communication, non-conventional energy sources and maintenance of community assets all of which become very significant, when they are looked upon from the environmental management perspective. Similarly, the Seventy Fourth Amendment Act, 1992 has indeed added terms like "urban forestry, protection of the environment and promotion of ecological aspects to the Twelfth Schedule and the functions as well were assigned to the municipalities accordingly.

Thus, giving power to the local bodies on these matters relating to the environment means to make the people actively participate in the procedure and make laws and act accordingly for the betterment of their lives and take necessary and adequate steps for the protection of the environment and water resources. From the standard of environmental considerations, it should not be takes for granted that these perspectives played any dominant role in the original scheme concerning distribution of legislative powers between the Union and the State. However, the present scheme of the Constitution is open with several ways and means so that with respect to the state subjects' Central enactments can be made. Thus, it may be concluded that the "Constitution contains a flexible structure that could serve as a spring board of taking meaningful measures in the field of environment."

4. Obligation to Implement International Environmental Treaties and Agreement:

India has played a very leading role from the 1972 UN Conference on the Human Environment at Stockholm to the 1992 UN Conference on Environment and Development at Rio de Janeiro and in Earth Summit Plus Five of 1997 at New York. Thus, India is under an obligation to translate the contents and decisions of international conferences, treaties and agreements into the

stream of national law. Article 51 (c) provides that "the State shall endeavor to foster respect for international law and treaty obligations in the dealings of organized people with one another.

Article 253 of the Constitution specifically empowers the Parliament so as "to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body". Entries No. 13 and 14 of the Union List (List I), which covers up the subject matters over which the Parliament can impose on to make laws as well as provide "participation in international conferences, associations and other bodies and implementing of decisions made thereof". Also "entering into treaties and agreements with foreign countries and implementing of treaties, agreements and conventions with foreign countries"

Thus, in view of the broad language used in articles 253 as also in entries 13 and 14 of the Union List, the Parliament has a very wide power of legislation including the subjects mentioned in the State List provided those issues are addressed at any international conferences, association or other body or it is the implementation of any international treaty, agreement or convention.

Now let us consider the impact of these broad provisions on the environment. The first consequence is that when we take into consideration the very view of article 253 of Constitution of India thereby read with Entries No. 13 and 14 of union List, the Parliament is empowered to pass any of the law thereby being inclusive of the law for environment protection and it becomes something put of purview of being put in form of a question before the Courts on the ground that the Parliament lacked legislative competence. Secondly, in India the Parliament has made use of this power to enact the Air (Prevention and Control of Pollution) Act of 1981 and the Environment (Protection) Act of 1986. The preambles to both of these laws clearly provide for and

state that these Acts were enacted to implement the decisions reached at the United Nations Conference on Human Environment that was held at Stockholm in 1972.

Even in the landmark case of **People's Union for Civil Liberties v. Union of India,** the Apex Court has provided and held that the provisions of the international covenant, which reiterate in a manner that they go to determine the fundamental rights as have been guaranteed by our Constitution, provided for and can certainly be relied upon by courts as determinants of those fundamental rights and hence are enforceable as such as well.

Also, in **Vellore Citizens' Welfare Forum v. Union of India,** the Supreme Court reiterated that it is one almost accepted fact of law, completely determined that the rules of customary international law which are not at all in contrary to the established municipal law in a manner that it would entertain any kind of confrontation, as such shall be deemed to have been incorporated in the very domestic laws as provided for and shall also be followed and regularized by the courts of law in equal manner.

Thus, Indian Constitution puts an obligation and authorizes the Parliament to implement the decision of any international treaty, agreement or convention with any other country or any decision made at any international conference, association or other body.

5. Fundamental Duty to Protect Environment:

Part IV-A of the constitution of India containing the fundamental duties of the citizens of India which has been incorporated in the constitution by the constitution 42nd Amendment Act, 1976. Article 51-A of this part enlists eleven fundamental duties. This part was added on the recommendations of the **Swaran Singh Committee** brining the constitution of India in line with article 29 (1) of the Universal Declaration of Human Rights. It is to be noted that these duties are the duties of the individual citizen. These fundamental duties are not enforceable by means of writ of mandamus.

The makers of the Constitution were concerned about moral and natural rights. The intention behind it was, that the citizens and the state would shoulder the responsibility to protect the constitutional order as their moral duty. Through the passage of time the citizens became conscious about their rights and thereby neglected their duties. Rights and duties are very important elements of law. They correlated to each other in such a way that one cannot be conceived without the other. A right is always against someone upon whom the correlative duty is imposed. Thus, to give a concrete shape to the Constitution, Part IV A was rightly inserted for healthy administration of justice.

Article 51-A (g) specifically deals with the fundamental duty with respect to the environment The clearly indicate the government's awareness towards a problem which is a contemporary phenomenon and of the need for providing a constitutional base for further action at the national, state and local level.

It is interesting to mention here that while Article 48A uses the expression "environment", Article 51A(g) uses the expression "natural environment". Again, while the former requires the state to safeguard the forest and wildlife in the country, the later imposes a duty on citizens to protect and improve among other things, forests, lakes, rivers and wildlife. Both the provisions contain exclusive obligation in respect of environmental protection and also, they symbolize the need for collaboration between the state and the people in evolving a more ecological sound order. As the protection of the environment is regarded as a constitutional priority, the fundamental duty imposed on the citizens with respect to the environment intends to promote their participation in restructuring the society. Thus, while considering the language used in both the Articles, the Article 48A and Article 51A (g) differ, yet the difference appears to relate to form rather than to substance. Together, the provisions highlight the national consensus on the importance of environmental protection

and improvement and lay the foundation for a jurisprudence of environmental protection.

Justice R.N. Mishra in **Rural Litigation and Entitlement Kendra v. State of U.P**. taking into consideration the duties of the citizens opined that "preservation of the environment and keeping the ecological balance unaffected is a task which not only the government but also every citizen must undertake. It is a social obligation and let us remind every Indian citizen that it is his fundamental duty as enshrined in Article 51A (g) of the Constitution."

Article 51-A (g) refers to the fundamental duty of every citizen to protect and improve the "natural environment". But in the present days the pollution is caused not only by exploiting the "natural environment" but also otherwise. In modem industrialized civilization such a concept may seem to be a misnomer. It is submitted that the word "natural" before environment has to be understood in a broad sense. Nature has given us the gift of a pollution free environment. The fundamental duty imposed on every citizen is not only to "protect" the environment quality if it has been polluted. Thus, the underlined emphasis of this fundamental duty is that every citizen has a duty to make an endeavor to preserve the environment in the same way as nature has gifted it to all of us.

Under article 51-A, only "citizens" are under the obligation of fundamental duties. The Parliament has used the word "citizen" instead of the word 'subject' to create a feeling of citizenship amongst the masses and also to see that the persons living in the country do not feel that they are subjects. We used to be subjects and now we are the citizens of the country. The requirement of the time is that we should be real citizens of the country striving towards excellence in all spheres of individual and collective activity including the protection of the environment.

Now coming to the question of ensuring the compliance of these fundamental duties; when these fundamental duties were incorporated in the Constitution

in 1976, it was considered that the fundamental law of the land reminds the citizens of their constitutional obligations. They could not be directly enforced. However, in due course of time the judicial activism provided an impetus to achieve the underlined objectives of the fundamental duties, particularly, article 51-A (g) relating to the environment.

The Constitution of India has made a joint responsibility of the state and every citizen to protect and improve the natural environment. While delivering his judgement in **Kinkri Devi v. State**, Justice P.D. Desai remarked:

"Thus, there is both a constitutional pointer to the state and a constitutional duty of the citizens not only to protect but also to improve the environment and to preserve and safeguard the forests, the flora and fauna, the rivers and lakes and all other water resources of the country."

The true scope of article 51-A (g) has been best explained by the Rajasthan High Court in **L.K. Koolwal v. State of Rajasthan**. The brief facts of this case were that the Municipal authority under the Rajasthan Municipalities Act, 1959, was charged with "primary duty" clean public streets, places and sewers and all spaces, not being private property, which are open to the enjoyment of public, removing of noxious vegetation and all public nuisance, and to remove filth, rubbish, night soil, odor or any other noxious or offensive matter. Mr. L.K. Koolwal moved the High Court under article 226 (writ jurisdiction) and highlighted that the Municipality has failed to discharge its "primary duty" resulting in the acute sanitation problem in Jaipur, which is hazardous to the life of the citizens of Jaipur.

The Court allowed the petition and explained the true scope of article 51-A in the following terms:

"We can call Article 51-A ordinarily as the duty of the citizens, but in fact it is the right of the citizens as it creates the right in favour of citizens to move to the Court to see that the State performs its duties faithfully and the

obligatory and primary duties are performed in accordance with the law of the land. Omissions or commissions are brought to the notice of the Court by the citizen and thus, Article 51-A gives a right to the citizens to move the Court for the enforcement of the duty cast on state, instrumentalities, agencies, departments, local bodies and statutory authorities created under the particular law of the State."

The Apex Court in the case of **M.C. Mehta v. Union of India** has held that under Art 51-A (g), it is the duty of the central government to introduce compulsory teachings of lessons at least for one hour in a week on protection and improvement of natural environment in all the educational institutions of the country the court further stated that all the citizens should have knowledge of the duties mentioned in the constitution. There should be wide and deep publicity so that this duty towards protection of the environment may be brought to the knowledge of every responsible citizen. It is now needed that compulsory teaching of these duties should be introduced at school and college levels. It would be highly desirable if the environment is made a compulsory part of the school/college syllabus. The central government should come forward and get the text books written on that subject and ensure free distributions of their relevant books to the educational institutions. The local bodies organize the city clean week, keep the town clean and keep the village clean week with the sponsorship of respective governments.

In **Goa Foundation v. State of Goa** The Bombay High Court examined the question of locus standi from the premises of the fundamental duties under the Constitution of India. In this case the petitioner was a society registered under the law relating to registration of societies and their members were citizens of India having fundamental duty under article 51-A to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures. The question before the court was whether such

a society also has the same duties. The court answered this question in affirmative and held that such a society also has the same duties. On the basis of this, the petitioner society was held to have a locus standi to move to the court to prevent ecological degradation, to formulate and implement programmes for rehabilitation of the environment and to restore ecological balance.

In **Sitaram Chhaparia v. State of Bihar** A public interest litigation was filed by five persons, residents of locality seeking directions from the court for closure of tyre retreading plant set up in residential area as the said industry was emitting carbon dioxide gas and other obnoxious gases from its furnaces causing harm to the environment of the locality. The Patna High Court held that protecting the environment is now a fundamental duty under article 51-A of the Constitution of India and accordingly the respondents were directed to wind up their industry and the State respondents were obliged to ensure that.

Thus, Article 51A has come as a boon so far as environmental protection is concerned. But its benefits can be availed only if people are alive to their duties regarding protection of the environment.

In **State of Gujarat vs**. **Mirzapur Moti Kureshi Kasab Jamat**, in this case court held that, while Article 48 provides for cows and calves and other milch and draught cattle, Article 51-A (g) enjoins it as a fundamental duty of every citizen to have compassion for living creatures, which in its wider fold embraces the category of cattle spoken of specifically in Article 48.

6. Environmental Protection and Directive Principles of State Policies:

Article 37 to 51 of the Constitution as detailed in Part IV of the Constitution form the Directive Principles of State Policy. These principles are the “embodiment of the ideals and aspirations of the people of India and the goal towards which they expect the state to march for their attainment”. They are merely the directives issued to the state and they are fundamental in the governance of the

country and also, they are not enforceable in any court of law. As Article 37 aptly says:

"The provisions contained in this Part (Part IV) shall not be enforced by any court, but the principles therein laid down are nevertheless fundamental in the governance of the country and be the duty of the state to apply these principles in making laws". .

The Directive Principles are policy prescriptions that guide the government. Some of them are in the nature of economic rights that India could not guarantee when the constitution was enacted, but that were expected to be realized in succeeding years. Although unenforceable by a court, the directive principles are increasingly being cited by judges as complementary to the fundamental rights.

So, these principles require a careful and imaginative approach and faithful adherence as they connect India's future, present and past and give strength to the pursuit of the social revolution in our great and ancient land.

The directives are in the nature of duties which the state is required to perform as per the direction of the constitution and 'raising the level of nutrition and standard of living and improving public health' are among such duties which is covered from the environmental point of view. As indicated earlier although our constitution does not contain the word 'environment' at initial stages, the concern of the farmers was reflected in Article 47 of the constitution which reads;

"The state shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties, in particular, the state shall endeavor to bring about prohibition of the consumption except for medical purpose of intoxicating drinks and drugs which are injurious to health".

Thus, this basic principle embodied in the Article very clearly denies the statement to some of the learned authors that initially our Constitution was environmentally

blind[1] and environment as subject has been left out of the Constitution. This Article calls upon the state to perform the basic duty to look after the health of the citizens and also take necessary and effective steps to improve their standard of living and also raise the level of nutrition. Improvement of public health forms the core of environment because due to various environmental hazards it is the health f general public which comes under severe threat. In order to protect this, i.e., keeping in mind the possible fallout of environmental hazards, the framers of the Constitution gave emphasis on the improvement of public health which is most vital for existence of the mankind.

In a public interest litigation field before Orissa High Court, it was alleged that due to operation of collieries in the **Talchar Area.** The people of Talchar Town and nearby areas have been affected as there is no pure air to breath and pure water to drink. They are forced to inhale such air being exposed to dust and effluent articles. It was also further alleged that due to extraction done from underneath the ground surface, land is becoming loose and there have been several instances of seepage of water and subsidence of earth, thereby endangering human life and property.

In another such case files before the Madhya Pradesh High Court where the attention of the court was drawn into the gross negligence on the part of the State Government in not taking proper measures before supplying drinking water from hand-pump which has resulted in colossal damage to the people, the court holding the state responsible said that in the present case the state has failed to discharge its primary responsibility. The court also linked the matter with right to life as enshrined in Article 21 of Constitution by saying it is also covered by Article 21 of the Constitution of India and it is the right of citizens of India to have protection of life, to have pollution free air and pure water.

With the objective of affording better protection to the environment, The Constitution (Forty-second Amendment) Act, 1976, added a new directive principle in article 48A dealing specifically with protection and improvement of environment. It provides:

"The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country."

Thus, Indian Constitution became one of the rare constitutions of the world where specific provisions were incorporated in the Supreme Law putting obligations on the "State" as well as "citizens" to "protect and improve" the environment. This certainly is a positive development of Indian law.

The article further provides "to safeguard the forests and wildlife". This is an important provision as the environment is greatly influenced by forest and wildlife. This was even reflected in the views of the then Prime Minister Mrs. Indira Gandhi when draft Article 48A came up for consideration in the Parliament. She was of the opinion that: "On the contrary, if the forests are better looked after and wildlife is preserved, there would be far greater opportunities for employment as well as a better ecological balance in the whole area which would lead to an improvement in the life of the tribal."

In Rajya Sabha, two amendments were moved which proposed that the article should also cover 'mineral wealth' and the state is required 'to undertake adequate and effective measures to check environmental pollution'. But the amendments were not accepted as the government maintained that "the concern underlying them could be taken care of within the framework of the provisions as it stood".

In the Lok Sabha it was proposed that the State should be required to "conserve and develop the water, soil and other natural resources" and to ensure that the state's efforts to protect and improve the environment would not harm tribal forest dwellers. Here also none of these amendments were accepted by the government although it

considered some of the provisions of the proposed amendment 'good'. The government felt that the provisions contained only a broad directive principle and that it was not necessary to set out details in such a provision.

With the adoption of Article 48A, the Parliament has imposed a new constitutional obligation on the state by incorporating it into the Constitution. The language of Article 48 A has been taken aid of by the courts in a number of cases relating to the environment. The Supreme Court also considering such a matter in '**Sachidanand Pandey v. State of West Bengal'** observed:

"Whenever a problem of ecology is brought before the court, the court is bound to bear in mind Article 48A of the Constitution and Article 51A(g) When the court is called upon to give effect to the Directive Principles and the Fundamental Duty, the court is not to shrug its shoulders and say that priorities are a matter of policy and so it is a matter for the policy making authority. The least that the court can do is to examine whether appropriate considerations are borne in mind and irrelevancies excluded. In appropriate cases, the court may go further, but how much further must depend on the circumstances of the case."

In **M.C. Mehta v. Union of India** popularly known as Taj Trapezium case, the petitioner M.C. Mehta presented his petition for the protection of Taj Mahal at Agra. His contention was that foundries, chemical/ hazardous industries at Narora, Mathura are the major sources which will damage the Taj. The Mathura refinery emits huge quantities of sulfur dioxide which when combined with oxygen in the presence of moisture in the atmosphere sulphuric acid is formed and then it falls on the earth in the form of rain known as 'Acid Rain'.

After examining reports of experts, the Court came to the conclusion that the emissions generated by the coke/ coal consuming industries are air pollutants and have damaging effects on the Taj and the people living in the Taj Trapezium. This has to be eliminated at any cost. In the

process of delivering judgment, the Court made the following observation;

"The '**Precautionary Principle'** and '**Polluter Pays Principle'** have been accepted as part of the law of land. Article 21 of the Constitution guarantees protection of life and personal liberty. There are other constitutional mandates to protect and improve the environment. Articles 47, 48A and 51-A(g). In view of the precautionary principle, the environmental measures must anticipate, prevent and attack the causes of environmental degradation. The 'onus of proof is on the industry to show that its operation with the aid of coal/coke is environmentally benign. It is, rather, proved beyond doubt that the emissions generated by the use of coal/coke by the industries in Taj Trapezium are the main polluters of the 'ambient air'.

It was further held that 292 industries located and operating in Agra must change over with in time schedule to natural gas as industrial fuel or stop functioning with coal/coke and get

Article 37 of the Constitution Provides:

"The provisions contained in this Part (Part IV) shall not be enforceable by any court, but the principles therein laid down are nevertheless fundamental in the governance of the country and it shall be the duty of the State to apply these principles in making laws."

In view of article 37 of the Constitution, the Court may not be able to actively enforce the directive principles by compelling the State to apply them in the making of law. The Court can, if the State commits a breach of its duty by acting contrary to these directive principles, prevent it from doing so.

Also, the non-enforceable nature of the directive principle does not preclude the judiciary from declaring any law unconstitutional which is in violation of the directive principles. The non-enforceable nature of the directives also does not preclude the right of the citizens to move to the Court to see the other organs of the state, i.e.,

the legislature and executive perform their duties faithfully and in accordance with the law of the land. Judicial process is also state action under article 37 and the judiciary is bound to apply the directive principles in making judgment.

Thus, the directive principles serve the Courts as a code of interpretation. Fundamental rights should be interpreted in the light of the directive principles and the later should, whenever and wherever possible, be read into the former. In other words, Part III dealing with fundamental rights and Part IV dealing with directive principles are complementary and supplementary to each other.

The directive principles now stand elevated to inalienable fundamental human rights. In several environmental cases the courts have been guided by the language of Articles 48-A.

In **M.C. Mehta v. Union of India** (popularly known as the CNG case) the Court observed that articles 39(e), 47 and 48-A by themselves collectively cast a duty on the state to secure the health of the people, improve public health and protect and improve the environment.

7. Fundamental Right and Right to Environment:

7.1. Right to have Clean Environment:

Modern life is full of complexities and it is difficult to maintain balance between life and the environment. As the country is heading for an enormous industrialization era and its impact can be seen as on ecological disturbances worldwide. The constitutional duty of the State and its agencies are not discharged merely by incorporating/enacting statutes. They are bound to bring environmental awareness among citizens. Originally, environmental protection and its related measures contained in Articles 48-A and 51-A (g) which is one of the Constitutional provisions in the Directive Principles of State policy and fundamental duty respectively. Thus, these constitutional provisions are not contained in Part III

i.e., Fundamental Rights. (Articles 14 to 35). It is clear that Article 21 of the constitution, which deals with the protection of life and personal liberty, is one of the fundamental rights.

However, Article 21 Reads as Under:

"No person shall be deprived of his life or personal liberty except according to procedure established by law"

The Supreme Court repeatedly made it clear that the right to life under Article 21 of the Constitution includes the right to pollution free air and water. The Supreme court has held that right to live is a fundamental right under Article 21 of the Constitution and it includes the right of enjoyment of pollution free water and air for full and complete enjoyment of life. Thus, the right to pollution free enjoyment is justiciable and enforceable. The Supreme Court observed that where anything endangers or impairs that quality of life in violation of law, a citizen has the right to have resource to Article 32 i.e., constitutional remedy before the Supreme Court for removing the pollution of air or water which may be detrimental to the quality of life. Therefore, under Article 226 of the Constitution a writ would be maintainable if there is violation of the environmental right in respect of pollution free air or water.

The Supreme Court in India Council for **Enviro Legal Action etc. v. Union of India,** ruled that if there is violation of the right to life because of pollution caused by the activities of private companies, it cannot be said that the writ petition is maintainable against the private companies. Thus, the activities of the private companies are amenable to writ jurisdiction. In this case the Supreme Court directed the Central Government to determine the amount required for remedial measures and recover the amount from the chemical industries liable for causing pollution in the said village in question. The Court passed direction for closure of the delinquent industries.

Encouraged by an atmosphere of freedom and articulation in the aftermath of the Emergency, the Supreme Court entered one of its most creative periods.

Specifically, the court fortified and expanded the fundamental rights enshrined in Part III of the Constitution. In the process, the boundaries of the fundamental right to life and personal liberty guaranteed in Article 21 were expanded to include environmental protection.

The Supreme Court strengthened Article 21 in two ways. First, it required laws affecting personal liberty to also pass the tests of Article 14 and Article 19 of the Constitution thereby ensuring that the procedure depriving a person of his or her personal liberty be reasonable, fair and just. Second, the court recognized several unarticulated liberties that were implied by Article 21. It is by this second method that the Supreme Court interpreted the right to life and personal liberty to include the right to a wholesome environment.

The first indication of the right to a wholesome environment may be traced to the **Dehradun Quarrying Case,** In July, 1983, representative of the Rural Litigation and Entitlement Kendra, Dehradun wrote to the Supreme Court alleging that illegal limestone mining the Mussoorie-Dehradun region was devastating the fragile ecosystems in the Area. On 14 July, the court directed its registry to treat the letter as a writ petition under Article 32 of the Constitution, with notice to the government of Uttar Pradesh and the collector of Dehradun. Over the years the litigation grew increasingly complex. By the time the court issued its final judgment in August, 1988, it had heard lengthy arguments from the Central and state governments, government agencies and my lessees, appointed several expert committees; and passed at least five comprehensives, interim orders. None of these orders, however, articulate the fundamental right to a healthful environment.

Eight years after entertaining the Dehradun Quarrying Case, the Supreme Court revealed the basis of its jurisdiction to entertain environmental cases. In **Subhash Kumar v. State of Bihar** the court held that the right to life includes the right to enjoy unpolluted air

and water. If anything endangers or impairs the quality of life in derogation of law, a citizen has a right to move the Supreme Court under Article 32 of the Constitution. Expanding upon this theme in a town planning case, **Virender Gaur v. State of Haryana,** the court observed.

"Article 21 protects the right to life as a fundamental right. Enjoyment of life including "the right to live" with human dignity encompasses with its ambit, the protection and preservation of environment, ecological balance free from pollution of air and water, sanitation, without which life cannot be enjoyed".

7.2. Right to Life and Right to Live in Healthy Environment:

In **M.C. Mehta v. Union of India.** (popularly known as Oleum Gas Leakage case), the Supreme Court once again impliedly treated the right to live in pollution free environment as a part of fundamental right to life under Article 21 of the Constitution A clarion call was given by the Andhra Pradesh High Court when in monumental judgment of **T. Damodar Rao v. S.O. Municipal Corporation**, **Hyderabad**, it observed:

"It would be reasonable to hold that the enjoyment of life and its attainment and fulfillment guaranteed by Article 21 of the Constitution embraces the protection and preservation of nature's gifts without which life cannot be enjoyed. The slow poisoning by the polluted atmosphere caused by environmental pollution and spoliation should also be regarded as amounting to violation of Article 21 of the Constitution."

In **F.K. Hussain v. Union of India.** The Kerala High Court pointed out that the right to sweet water and the right to free air, are attributes of the right of life, for, those are the basic elements which sustain life itself.

In **M.C. Mehta v. Union of India**, the Supreme Court took note of environmental pollution due to stone crushing activities in and around Delhi, Faridabad and Ballabgarh complexes. The Court was conscious that

environmental changes are the inevitable consequences of industrial development in our country, but at the same time the quality of the environment cannot be permitted to be damaged by polluting the air, water and land to such an extent that it becomes a health hazard for the residents of the area. Showing deep concern to the environment, the Court reiterated that "every citizen has a right to fresh air and to live in a pollution free environment." Thus, the Supreme Court once again treated it as violation of article 21 of the Constitution and passed the order in absolute terms under article 32 directing the stone crushing units to stop their activities in Delhi, Faridabad and Ballabgarh complexes. The Court further ordered the government to rehabilitate these stone crushers in "crushing zone" within the period of six months.

In **K.C. Malhotra v. State** It was held that the right to live with human dignity is the fundamental right of every Indian citizen and, therefore, in the discharge of its responsibilities to people, the State has to provide at least minimum conditions ensuring human dignity. Accordingly, the Court minimum conditions ensure human dignity. Accordingly, the Court directed that there must be a separate sewage line from which the filthy water may flow out. The drainage must be covered and there should be proper lavatories for public convenience which should be regularly cleaned.

In **Narmada Bachao Andolan v Union of India,** the court held that the right to water is a fundamental right under article 21 of the Constitution. Water is the basic need for the survival of human beings and is part of the right of life and human rights as enshrined in article 21 of the Constitution of India and can be served only by providing a source of water where there is none.

In **P.A. Jacob's case**, the Kerala High Court took into consideration the laboratory studies made by monitoring electroencephalographic (EEG) response and changes in neuro vegetative reactions during sleep, which shows that disturbance of sleep becomes increasingly

apparent as ambient noise levels exceed about 35 dB(A) Kg. The Court also while declaring the right to a safe environment, including safe air quality and safe from noise, as a part of article 21, made reference to WHO criteria. Thus, the judiciary has acted very cautiously while declaring the right to clean and safe environment as a part of article 21 of the constitution.

8. Conclusion:

The Environment is one of the most essential basic needs that a human being possess. Therefore, the article brought to light the provisions explicitly stated under the Constitution of India and also the interpretations that are drawn by the Apex court while adding a lot of rights relating to environment under the ambit of Fundamental Rights under part III of the Constitution. Along with the precedents and the Fundamental Rights, the Directive Principles of State Policy has also been studied and it is found that how the Directive principles of state policies have guided the state in the direction of environment protection. As the rights are assured to the citizens, in the similar way, certain duties are also implied upon the citizens for protecting the environment. It is observed thus, that a lot of steps are being taken up the State in protecting the environment by setting up various laws, rules, regulations and precedents.

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Smouldering Incense Sticks and Its Reverberation on Indoor Air Quality

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S. Sudalai

Abstract:

Indoor Air Quality is one of the pivotal concerns on the aspect of Environmental Air Pollution. People intend to spend most of their time indoors, thereby it is vital to cleanse the indoor environment as a priority. Utilisation of Incense Sticks has been a part and parcel of the Indian traditions and rituals. The dispersion of particulate matter from the incense sticks is perceived to levitate the PM concentration to the nines. A well cleaned Indoor room of considerable size has been taken for the anatomisation. Five different brands of Incense sticks have been garnered of different fragrances and varying chemical properties. The experiment was administered for 30 minutes and the readings were beheld for every 5 minutes using a PM monitor. Fluctuation in the concentration of PM has been indicated at different times for specific brands. However, there was a notable ascension in the PM concentration at every interval. The final concentration between the brands were correlated with linear regression and it proved to be congruous with one another. Regardless of the disparity in the interval concentration, each brand of incense sticks soared the PM_1, $PM_{2.5}$, PM_{10} *concentration to all intents and purposes. The difference between each brand upon playing their part in rising the PM concentration has also been enunciated. Owing to the recurring pandemic circumstances, most of the populace are confined to their dwellings. The existing course of events provides an explicit platform for pursuing this r. This study illustrates the level of impact that the incense sticks exert in deteriorating the indoor air quality using a low-cost portable*

PM monitor and thereby incidentally contributing to the subsequent health risks among humans.

Keywords: *Incense sticks, Particulate matter, Indoor air quality, Pandemic.*

Introduction:

Air Quality in the global level is one of the most worrying disturbances and the risk rates it produces due to its emission rates. It has been estimated that the quality of the Indoor air quality produces substantially greater health risk to humans as compared to the outdoors. The maintenance of indoor air quality is also crucial because it is also known to cause sick building syndrome and other serious health issues which affects the work efficiency and could be detrimental in the long run (Baek et al., 1997), (Yu et al., 2009). The sources of Indoor air quality are due to varied reasons such as cooking, smoking and other combustion processes. The indoor air quality would be extensively damaged due to biological organisms as well (CPCB, 2001). The emissions from the indoors are more likely to affect the lings than those in the outdoor environment (WHO, rule of 1000). This scenario is more known to affect the women, children and old age people, who are extensively subjected to such emissions. Deaths due to contaminated indoor air quality is more prevalent in the rural region as on comparison with the urban sector. This is due to the use of traditional cooking and biomass fuels which releases oxides of sulphur and aldehydes might get accumulated in ambient air in the Indoors and accentuates the health risks. Prolonged exposure to indoor air quality among pregnant women is known to cause pregnancy issues and may also cause stillbirths among them. It is due to the accumulation of carbon mono oxide in their systems (CPCB, 2001). Lack of ventilation in houses and work spaces is considered as a predominant factor in the Indoor air quality. The estimation of indoor air quality by the use of low cost PM monitors has been widely developing in the sense of air pollution monitoring (Brzozowski et al., 2019). The use of incense sticks for religious activities in the indoors enhances the

contaminantion of the ambient air. Incense sticks are mostly a bamboo stick over which all the chemical ingredients, flavours, fragrance and other components are embedded with, this in turn produces the pleasant ambient smell which lasts for approximately about 40 to 60 minutes depending on the length and the chemical composition of the stick (Jetter et al., 2002a). The combustion produces significant amounts of particulate matter along with formaldehyde, volatile organic compounds and other poly aromatic hydrocarbons which would be directly carcinogenic to sensitive people (Cohen et al., 2013), (Mannix et al., 1996). Incense sticks are of various brands and several chemical compositions, each of them has their peculiar way of emissions at different stages of burning. Incense sticks are estimated to generate massive amounts of carbon mono oxides, nitrogen oxides and other substances which is recognised to be in higher amounts than cigarettes. This corroborated the fact that the particulate matter from incense sticks are significantly higher than of cigarettes (Mannix et al., 1996). The combustion of incense sticks under indoor environment might provide detrimental health issues among the individuals who are subjected to such particulate matter over a prolonged period of time(Baek et al., 1997) . This article focusses on the effect of incense sticks in hoisting the particulate matter and other compounds, thereby causing deterioration in human health and adulterating the Indoor air quality using a low-cost PM monitor.

Review of Literature:

The literature review focusses on the incense sticks and their emissions in damaging the Indoor air quality. It has been estimated that the combustion from the incense sticks tend to produce heavy amounts of aromatic compounds, hydrocarbons and formaldehyde which are extensively carcinogenic to human health (Cohen et al., 2013). Particulate matter is already of substantially considerable threat to the environment, the usage of these incense sticks and their emissions (Ji et al., 2010). Regular exposure to this particulate matter, might induce reactive

oxygen species in the human body. This factually increases the viability of radicals and oxidative carbons, thereby causing adverse health effects in the human body (Charrier et al., 2014). Prolonged exposure to such hazardous chemical components might be detrimental and chronic with respect to the respiratory tracts and cancer (Chen & Lee, 1996). The aerosol particles from the incense sticks and their particle sizes varies from 0.13µm to 1.06g/cm^3. The emissions from the incense sticks occur at both pre and post combustion activities (Mannix et al., 1996), (Cheng et al., 1995), (Madany & Crump, 1994) .The ability of incense sticks to induce the mutagens with the presence of Salmonella typhimunium is also possible, but it would be considerably low on comparison with other mutagenic agents (Rasmussen, 1987). The emissions from the chemicals are considerably more than that those of cigarettes, which might be due to the length and the burning duration (Mannix et al., 1996). The chemical particles are of varying sizes and the aerosols of distinctive emissions which might get deposited along the respiratory tract and the ling peripherals indicating upon chronic exposure the health issues might be detrimental (Bitterle et al., 2006).

Materials and Methods:

Five brands of incense sticks are taken for this study, the incense sticks length was measured and all are of approximately the same length. A room of substantiable size is taken and the initial concentrations of formaldehyde, Particulate matter, total volatile organic matter are measured using a portable PM monitor (Celikkaya et al., 2019). The incense stick is then ignited and allowed the whole stick to burn. The concentrations are observed for every 5 minutes and the readings are noted. The rise in the chemical concentrations are detected. After a whole stick extinguishes, the final concentration is discerned. The time taken for the indoor air to return to initial concentrations were also counted. The trial is repeated for 3 incense sticks of the same brand and the mean value is considered significant. The

procedure is replicated for five brands of incense sticks (Lui et al., 2016), (Mannix et al., 1996).

Observation:

The reading was taken concurrently in a closed well cleaned room of size 16'x10'

Brand 1

Chemicals	Initial Concentration	Final Concentration
HCHO	0	0
PM1	0.39	1.15
PM2.5	0.52	1.52
PM10	0.60	1.76
TVOC	0	0

Brand 2

Chemicals	Initial Concentration	Final Concentration
HCHO	0	0
PM1	0.25	0.33
PM2.5	0.34	0.45
PM10	0.40	0.51
TVOC	0	0

Brand 3

Chemicals	Initial Concentration	Final Concentration
HCHO	0	0
PM1	0.15	0.21
PM2.5	0.21	0.28
PM10	0.23	0.34
TVOC	0	0

Brand 4

Chemicals	Initial Concentration	Final Concentration
HCHO	0	0
PM1	0.03	0.18
PM2.5	0.05	0.28
PM10	0.09	0.42
TVOC	0	0

Brand 5

Chemicals	Initial Concentration	Final Concentration
HCHO	0	0
PM1	0.12	0.3
PM2.5	0.18	0.38
PM10	0.21	0.43
TVOC	0	0

Time taken for one incense stick to burn- D_1 (in minutes)

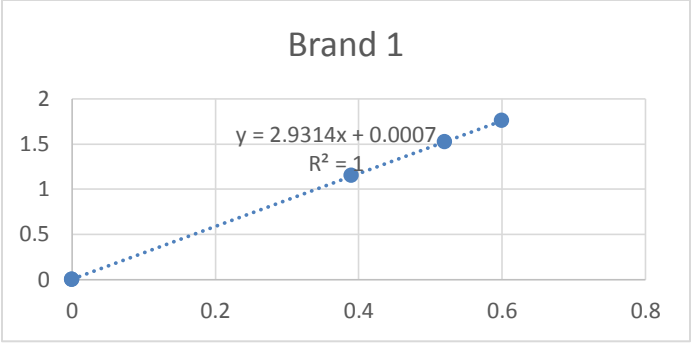
Time taken to return to initial conc.- D_2 (in minutes)

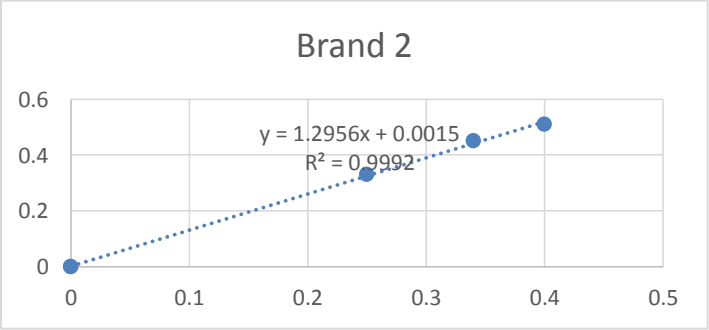
BRAND NO.	D_1	D_2
1	40	10
2	35	8
3	43	15
4	45	58
5	37	22

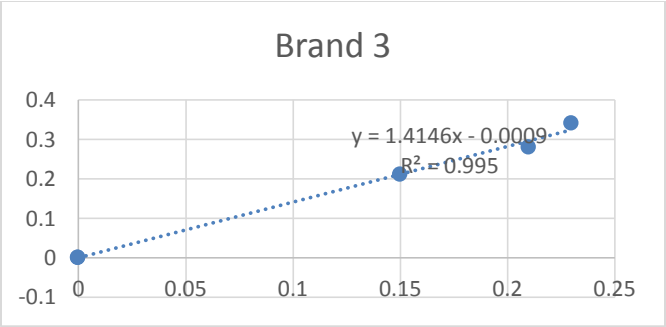
Results and Discussion:

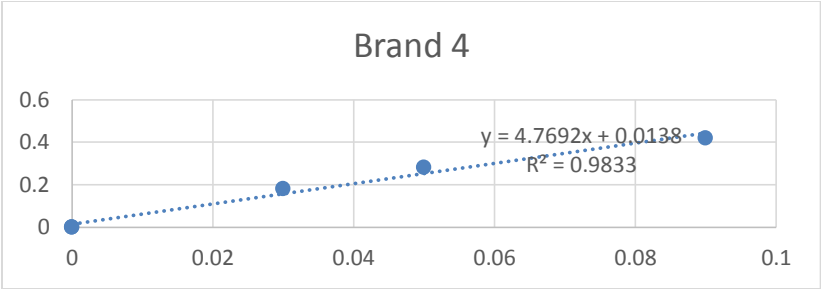
Five brands of different incense sticks were taken and the results were analysed. The mentioned procedure has been repeated for three different incense sticks of the same brand (Jetter et al., 2002b). A coherent and a gradual

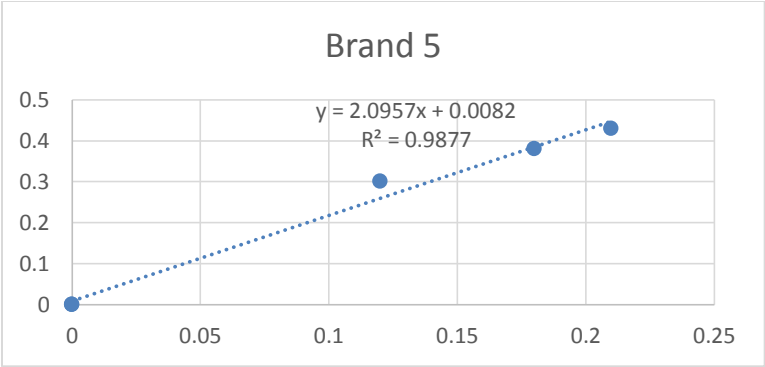
increase in the concentration of particulate matter and other components contributed by the incense sticks were observed. When the linear regression is plotted, an increase in the particulate matter of indoor air quality pollutants concentration is observed. The linear regression graphs are given below,





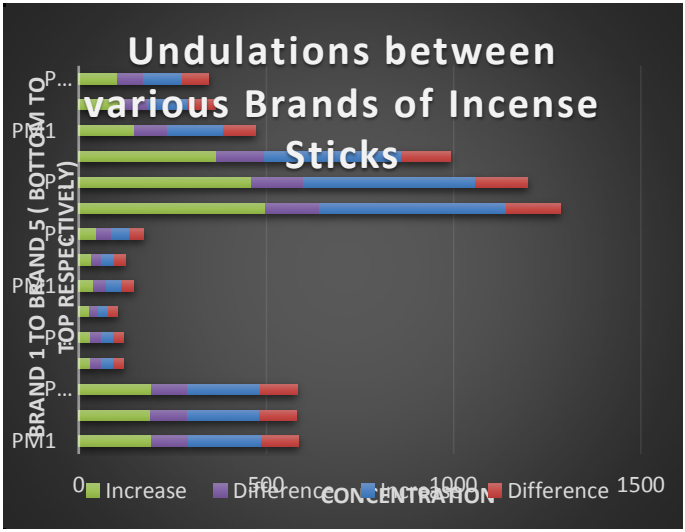






The linear regressions indicated that the concentrations of the particulate matter increased gradually and progressively. The results indicated that the excessive force of the particulate matter put on by the incense sticks dominated the indoor air quality and intended to increase as time prolongs. The percentage of increase observed were monumental respectively to brand 1 and brand 4. This might be due to the chemical composition present in them. Size, flavours and thickness too plays a prominent role in establishing the emission of particulate matter. Particulate matter of all sizes were prevalent and each were significantly higher than the initial concentrations indicating the contribution by incense sticks (Mannix et al., 1996). The concentrations of formaldehydes and other volatile compounds were limited, but not significant as the rise of particulate matters. There are also some allergic reactions pertaining to the aerosol from the incense sticks such as sneezing, coughing, irritation. The amount of increase in concentration and

their differences between the initial and final among the different examined brands were given below,



Conclusion:

The characterization of incense sticks has been studied by a bird's eye view in this chapter. By the observation from the experiments conducted, it has been evident that the incense sticks intend to increase the particulate matter concentration in the Indoor air quality by a significant amount (Jetter et al., 2002b). As mentioned above from this study using Portable PM monitor, the formaldehyde and the total volatile organic matter is not too that much of an extent at the end of one full incense stick. However, the HCHO and TVOC concentrations are significant at acute exposure. When considering the entire indoor space their contributions towards contaminating the indoor air quality are very negligible. Brand 4 is intended to be the highest tine taken to return back to the initial concentration. It may be due to the added flavour to provide the pleasant smell, in the indoors. Additionally, it also provided headache and irritation, which is prevalent along its whole blazing time. Further studies have to be performed on this, especially

regarding to health issues and the way that the aerosols from the incense sticks affects the respiratory tracts. The incense sticks have been a major part in the fluctuation of particulate matter in the indoor air quality. In some cases, it has been proved that the incenses ticks flaming intends to multiply the effect of particulate matter as compared to other factors such as cooking and cigarette smoking. Smoking of cigarette is already an indoor air contamination factor, but addition of incense sticks along with them tends to blow up the human health risk exponentially (Mannix et al., 1996). Hence the accumulation of particulate matter and aerosols from the incense sticks has to be monitored with respect to the indoor air quality. An alternative to the incense sticks could also be proposed. Incense sticks might affect the tender kids and infants prominently due to their immaturity to resist the emissions from it combined by the chemical components. A cohort study from Taiwan insisted that the emissions from the incense sticks is said to affect the pregnant mothers and the foetus in the mother's womb as well. In kid boys, the birth weight might be low as on with girl babies the circumference of head may be less on comparison with the babies whose mothers are not exposed to the smoke from the incense sticks that much. The alternatives to the incense sticks dhoop could be used, this is obtained as a result of the amalgamation of cow dung, neem and leaves which is mostly natural and less adulterants, while it serves as a best replacement for the incense sticks except for the aroma. This has pure natural ingredients and it is a firm ritual in India that the pregnant women are exposed to cow dung smoke for their good health and well being of the child. A homemade deodorant by mixing with baking soda and stir with other ingredients like oranges and lemon to help inducing a pleasant aroma into the indoor environment in a natural way without any chemical components or other adulterants. Either way, in case of compulsion of the usage of incense sticks proper ventilation might be provided in order to allow the easy circulation of air and forbid the particulate matter from settling on the inside. Furthermore, avoiding pregnant

women from direct exposure to the emissions from the incense sticks would also be highly solicited. This concludes the proportion of incense sticks and further studies on health risk assessment and modelling could also be made in order to obtain a detailed effect of the incense sticks.

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Effect of Air Pollution on Children's Health

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Abstract:

Concerns about the adverse effects of air pollution on children's health and development are important determinants of environmental and public health policies. Concerns about children's health and the factors that affect it are important determinants of health policy. In particular, policies aimed at preventing the adverse effects of environmental factors on health consider children to be a group of the population that deserves the highest level of protection. Reducing the adverse effects of air pollution on children's health, and especially on respiratory diseases, is one of the four regional priority objectives of the action plan.

Keywords: *Air Pollution, Health Challenges, Pregnancy Period, Children Health.*

Introduction:

The most effective strategic action is based on established evidence of a link between children's health and environmental exposure, preventing exposure improves health. As a result of studies conducted around the world in recent decades, knowledge and understanding of the risks of air pollution for children is increasing. Nevertheless, the available studies are not always consistent in terms of health outcomes and evaluations and use detailed analyses and reporting methods. Recent studies have become more sophisticated and consider in more detail the complexity of exposure to environmental factors in children, changes in the physiology of the developing organism, and deformity characteristics for the child's age. The synthesis of such evidence requires a

thorough and systematic analysis, finding logical links between studies that suggest a causal relationship between exposure and health effects. Such synthesis provides the most solid strategic basis and allows one to focus on the relevant exposure and effectively reduce the burden of the disease caused by this exposure.

The sensitivity of children or other special groups to air pollution is related to regulatory processes that seek to protect all individuals exposed to environmental agents, regardless of their sensitivity. While it is often acknowledged that it is not possible to protect the most vulnerable members of a vulnerable group, the need to protect the majority of such members has been acknowledged. By law, which clearly identified the challenge of sensitivity and the intention to protect even the most vulnerable citizens. Research scientists need to provide evidence to guide the protection of vulnerable populations. In fact, research on sensitive populations is often the focus of research, and some methods, such as time-series techniques, inevitably show effects on such groups. Many epidemiological studies have focused on the health effects of air pollution on children, because they can be easily studied at school age by collecting data from schools. Also, there are many biological reasons to be concerned about children's susceptibility to air pollution.

When you have a child, there are already numerous obstacles to overcome in the outside world. For an active parent, cyclists, walkers, runners are the only obstacles to your victory. But it's not just cyclists, runners and walkers among us who want to encourage their kids to enjoy the outdoors. Some of us hang out at local playgroups, enjoy the sunshine outside the sidewalk cafes, picnic in the park. All these pleasures should be low risk. But now that the UK air is considered a "public health emergency", you really need to know more about the air you breathe. And we need to understand the impact it has on our health and the health of our children. So this investigation is a guide as well. Together we will learn about the health effects of air pollution on children of all ages. Also what the government

is doing to help, what we can do about it ourselves and how we can help the clean air campaign.

Types of Air Pollution:

Here we are most concerned about the three types of air pollutants that cause environmental and health problems:

- **Particulate Matter (PMs):** The most dangerous small particles of air pollution can penetrate deep into your lungs and even into the bloodstream. Particles worsen heart and lung disease. Airborne particulate matter is responsible for 49,000 early deaths in 2018.
- **Nitrogen Dioxide (NO_2):** A poisonous gas that you will sometimes notice as an orange mist on a city. High levels of NO2 can cause asthma or symptoms such as coughing and difficulty breathing.
- **Ground Level Ozone (O_3):** Ground level or "bad" ozone is formed in the presence of sunlight by chemical reactions between nitrogen (NOx) oxides and volatile organic compounds (VOCs). This can cause irritation to the eyes, nose and throat.

Air Pollution and Health Effect on Adults:

There are either known or suspected types of air pollutants that have a detrimental effect on human health. The Department of Environmental Food and Rural Affairs (or DEFRA as we refer to them from now on), air pollution in the UK comes from a variety of sources but the government says road traffic pollution is now the biggest problem and diesel the worst. Every year, “around 45,000 deaths are caused by indoor air pollution, which contributes to many of the major health challenges of our time.” These health challenges cost more than $ 35 billion annually. “Health challenges” seem to be a term for a combination of long-term conditions and serious to life-threatening illnesses. Before we become optimistic, "How can we improve the air we breathe and stay healthy?" In the section, let’s first look at what damage air pollution can do to our health.

- **Cancer:** The World Health Organization (WHO) has declared outdoor air pollution, particulate matter (PM), as well as diesel exhaust, the most carcinogenic for humans. This is the class of tobacco.
- **Asthma:** Two-thirds of people with asthma say that poor air quality makes their asthma worse. This puts them at greater risk of developing an asthma attack, the report said. They also say that prolonged exposure to high concentrations of air pollution can cause asthma in adults.
- **Stroke and Heart Failure:** Short-term exposure to air pollution can increase the risk of death from hospitalization or stroke in the next week. According to research published in the medical journal, this matter has come to the fore.
- **Cardiovascular Disease:** Air pollution is associated with the development of cardiovascular diseases, in which the blood vessels are swollen. This can exacerbate the situation for those already suffering from heart disease. Research suggests that people with heart disease have an increased risk of hospitalization and death in areas with high levels of pollution.
- **Diabetes:** The development of type 2 diabetes is not only due to lifestyle or genetic factors but also due to traffic-related air pollution, according to research by the American Diabetes Association.
- **Dementia:** The link between environmental factors and Alzheimer's disease is suggested. Toxic magnetite particles from air pollution have been found in "abundant" quantities in the human brain, as detected by PNAS. This substance can cause oxidative cell damage, which is linked to neurodegenerative diseases such as Alzheimer's disease.

Effect of Air Pollution of Children's Health:

Air pollution is not good for any of us. As air quality deteriorates, so does your health. In cities with high levels of air pollution, residents have less sleep, less work efficiency, and are at risk for a variety of health problems, including lung disease and cancer. However, adults do not

have to deal with the effects of poor air quality. Instead, children are most at risk. Awareness of how air quality affects children, and more importantly, how you can limit it, is key to raising happy, healthy children.

Like adults, children's lungs do not fully develop. As a result, children breathe much faster than adults. In fact, at birth, most children have only about 20 percent of an adult's lungs. By the time they reach adolescence, they will have a full, strong set of lungs. Until then, they will breathe more air pollutants than any adult. Beyond the amount of air, children breathe, their ability to fight the effects of air pollution is much lower than that of adults. Their immune system is not yet strong enough to fight infections, which means they are more likely to develop respiratory problems related to air pollution. As a result, air pollution can have a greater impact on a child's overall health. This effect is more likely to be detrimental, as what can be inconvenient for an adult can be a developmental problem for a child. Even if physical elements are removed from other pictures, children are at higher risk of being affected by poor air quality than adults. Like adults who work in the office for large portions throughout the day, young children are more likely to spend hours playing in the park or in their yard. Even school-age children enjoy the holidays, keeping them out longer than most adults.

Asthma:

- Children and young adults with asthma are at higher risk of the effects of pollution because their breathing rate is higher and their lungs are still developing.
- Children living in high-pollution areas are more likely to have reduced lung function than adults.
- Prolonged exposure to high concentrations of air pollution can cause asthma in children.

Lung Development:

- Children aged 8-10 years, who live in highly polluted areas of cities, had 10% lower lung capacity than normal. One of the leading experts on the effects of air

pollution on children's health suggests that this reduced lung function can never be undone.

Brain Development:

Air pollution in pregnant women impairs brain development and leads to behavioural and cognitive problems in childhood.

Obesity and Diabetes:

It is possible that air pollution may be a catalyst for obesity and diabetes in young children. A recent study of children between the ages of 8 and 15 who were exposed to high levels of air pollution found that they were less sensitive to insulin. Also, a decrease in beta-cell function and high body mass index (BMI) at 18 years.

Precaution During Pregnancy Period:

Expectant parents should pay special attention to the air quality in their home. While young children are particularly at risk for air pollution, new studies suggest that the fetuses may also be affected by poor air quality. Sadly, an adult's ability to fight low levels of pollutants helps protect the baby more. Women who were exposed to low-particle solids from car exhaust and other sources were more likely to give birth prematurely. In fact, despite attention to all other risk factors, exposure to air pollution has led to an increase in premature birth rates in many cities. This can lead to a variety of health problems for premature babies, all of which can be avoided through steps to better manage air quality.

Effect of Air Pollution on Children's Lungs:

It is the largest source of information on lung development in childhood and its relationship to air pollution in Southern California children's health studies. Researchers tracked nearly 2,000 teenagers born in the 1990s and early 2000s. They found that adolescents who grew up in communities with high air pollution were more likely to have reduced lung development. As an adult, this can never be remedied due to a lifelong decline in lung capacity. The decline in lung development experienced by these adolescents can be compared to that of children

raised by smoking parents. These effects extend to lung function, with children in cities with high levels of air pollution more likely to develop asthma and other respiratory problems. And even if the adolescents studied have not yet reached adulthood, it is reasonable to predict that they will be more likely to develop problems such as lung disease and cancer. Part of the air pollution is impossible to avoid without government action. You all have to go out and you can't stop breathing while doing it. However, indoor air can be more dangerous than outdoor air. As a result, managing indoor air quality and limiting exposure to pollutants to children can ensure that air pollution has a serious impact on their lung development and overall health.

Managing Air Quality During Childhood:

The follow-up to the above study has created some hope for parents everywhere. In the late 2000's, California made significant efforts to improve air quality. To examine the results of those improvements, the same researchers studied adolescents who grew up from 2010 to 2018. They found that, due to better air quality, these children had improved lung function and capacity. The health risks that only a few years old children face are beginning to disappear. While not every state will work hard to improve overall air quality, you can take steps to ensure that your home air quality is as high as possible! First, you can clean well and often. We should especially focus on removing dust, pollen and pet dandruff. These common allergens can get into the lungs and make it difficult to breathe, especially for young children. Carpeting and rug removal can also be a great step, as they will combine and retain all those annoying elements at every step. Hardwood, tile and laminate are favourable options for the lungs. You should try your best to avoid harsh chemicals in your home. This means limiting the use of household cleaners, instead focusing on natural cleaners like vinegar. Chemicals released by many common household products can have harmful effects on childhood health. Unstable organic compounds are especially dangerous.

Protection of Adults and Children from Air Pollution:

We have already published a comprehensive guide on how to avoid air pollution from transportation and the advice is solid. I will break the guidance here, as well as add further advice from Defra,

- Leave your car at home when possible: Car drivers are exposed to twice as much air pollution as a person traveling on the same route.
- When walking, stay behind from the side of the road.
- When walking, cycling or running, avoid busy roads.
- Stop sitting in your car: Turn off the engine while waiting.
- Spend as much time as you can in the green, open space of your city.
- Limit the time you spend outside on high pollution days.
- Keep your car windows closed, especially if you are stuck in slow traffic.
- Walking or jogging the day before when the air quality is good.
- Avoid crowded times if possible.
- When outside pollution is bad, keep windows and doors closed so that smoke cannot enter. But remember to keep your home well ventilated for the rest of the time.
- Defra prepares daily and five-day UK pollution forecasts, so you can check your local area before leaving home.
- When air pollution is bad, check out Defra's Recommended Action and Health Advice

Conclusion:

The lungs of the developing fetus, as well as the lungs of young children, are more likely to be injured by toxic components in the lungs at lower doses than the levels that have no effect for adults. There may be several factors that affect hypersensitivity, but some have been investigated. The time-dependent efficiency of the

detoxification system during a child's lung development affects the sensitivity of air pollutants to health effects. Also, polymorphic differences in hypersensitivity genes, which protect against tissue injury or drive repair mechanisms, may explain some of the differences in children's large responses. Lung function is a well-studied result in terms of air pollution. The major difference in lung function in adults is due to the function of the lungs at maturity. Thus, factors that affect the development of lung function in childhood are important for determining the level of lung function in adulthood. Studies on the development of lung function in children have shown that living in areas with high levels of air pollution is associated with lung function. Animal studies also suggest that intrauterine and postpartum exposure to contaminants impairs lung growth. Furthermore, long-term elevated air pollution levels are associated with lower rates of development of lung function. Low air pollution levels improve lung function and / or growth rate, and acute exposure to air pollution is associated with clearly reversible deficiencies in lung function. A slight change in average lung function can lead to a significant increase in the proportion of children with "abnormal" low lung function. In addition, small changes in the population may reflect large changes in the sensitive subgroups of the population. Evidence for the impact of air pollution on infant mortality, mainly due to respiratory death in the postnatal period, is solid. Although less consistent, the link indicators for causes of air pollution are low birth weight, premature birth rate, and slow growth in the uterus.

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Water Pollution and Fresh Water Shortage

Khirod Borah

Abstract:

Water Pollution along with ground water depletion leading to Water shortage is a global issue of late. It is an accelerating problem for about two million people worldwide, hindering growth in food production and harming human health and economic development. The paper focuses on water pollution its cause, measures to minimize it and also how fresh water scarcity is created and can be avoided. These measures can eventually help to deal with physical water scarcity with a great impact on ecological systems & economic water scarcity.

Keywords: *Pollution, health, development, water scarcity.*

Objective:

The main objective of the paper is to focus on the causes of water pollution, its impacts on human well-being and the natural environment. It also aims to protect water resources from pollution and enhance & restore water quality, conserve water and use water efficiently.

Introduction:

Water is the most essential and basic resource that guaranties the lives of all living beings on the planet. Even though it is an existential need for humans it also is one of the most under prioritized and over abused commodity. Its pollution and scarcity have caused millions of people to have poor access to this much-needed asset. But since water is also one of the most manageable natural resources, as it is capable of diversion, transport, storage and recycling, the ground water and surface water resources of a country play a major role in agriculture,

hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities etc. The freshwater ecosystems of the world comprise only about 0.5% of the earth's surface. Rivers constitute an insignificant amount (0.1%) of the land surface. In spite of these low qualities running water are of enormous significance. In the last few decades, there has been a tremendous increase in the demand for freshwater due to the rapid growth of population and the accelerated pace of industrialization. (Rama Krishnaiah et al, 2009). In addition to this deficient, water resources have increased the restrained water pollution control and water quality improvement. (Bu et al 2010). Therefore, protecting river water quality and ground water is necessary for survival and stop the scarcity of water resources.

Water pollution refers to the substance which are capable of making any physical chemical or biological change in the water-body. They have an undesirable effect on living organisms. Water pollution can occur from two sources.

1. **Point Source**
2. **Non-Point Sources**

1. Point Sources of Pollution are those which have direct identifiable source e.g., are pipe attached to a factory effluent coming out from industries, oil spills from tankers. They also include wastewater effluent. (Both municipal and industrial).
2. Non-Point Sources of pollution are those which arrive from different sources of origin and number of ways by which contaminants enter the groundwater or surface water and arrive in the environment from different non identifiable sources e.g., are run off from agricultural fields urban waste etc. sometimes pollution enters in to the environment in one place but it has its effects hundred or even thousands of miles away. This is known as trans- boundary pollution. E.g., the radioactive waste that travels through the oceans from one end of the ocean where the processing plant is to another country. Water pollutants may be organic & Inorganic.

Organic are those that comprise of insecticides & herbicides & other forms of chemicals, bacteria from sewage & livestock farming etc.

Inorganic are those that arise from silt from surface run-off, logging, burning practices & land-filling, fertilizers, chemical waste from industrial effluents etc. some of the other forms of water pollution are (i) Urbanization, (ii) Sewage & other oxygen demanding waste. (iii) Industrial waste (iv) Agro-chemical waste (v) Thermal pollution (vi) Oil spillage (vii) Acid rain pollution (viii) Radioactive waste etc.

Global warming has also an impact on water resources, by enhanced evaporation, geographical changes & so on.

Effect of Water Pollution on Human Health:

Chemicals in water affect human health. Some of the chemical affecting human health are the presence of heavy metals such as Fluoride, Lead, Arsenic, Mercury etc. Fluorides in water leads to dental carries & weakening of the bones.

Water Borne Diseases:

The most dangerous form of water pollution occurs when faces enter the water supply. This is a Typhoid, Cholera, Dengue, Liver problem and over all maturity of the human organs are dependent on pure drinking water. Groundwater contamination is the leading worldwide cause of death & diseases.

These pollution and other causes lead to Water scarcity. Water scarcity is driven by two major reason growing fresh water use and depletion of useable freshwater resources. More than 1.2 billion people lack access to clean drinking water. Water scarcity has affected every continent. It involves water stress water shortage or deficits & water crisis.

While the concept of water stress is relatively new, it is the difficulty of offering sources of fresh water for use during a period of time & may resulting further depletion & deterioration of available water resources. Water shortage may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, increased human demand and over use of water. According to the United Nations development program, water scarcity and economy water scarcity is found more often in countries or regions experiencing water scarcity. Where they have enough water to meet household, industrial, agricultural and environmental needs. But lack the means to provide it in an accessible manner. In Indian

we have only 4% of the world's fresh water, we need to cater to 17% of the world's population. As per Niti Aayug India is facing & worse water crisis in history and that demand for potable water will outstrip supply by 2030 if steps are not taken. Nearly six hundred million Indian high to extreme water and about two lakh people every year due to inadequate access to safe water, if matter is to continue, there will be a 6% loss in the country's GDP by 20-50 the reports say.

India's ground water resource which accounted for 40% of India's water supply are being depleted at unsustainable rates and up to 70% of India's water supply is contaminated. In India there are water problems due to many causes:

A. Global warming has altered the rainfall pattern in India which has been decreased drastically.
B. Construction of dames and other hydroelectric project have led to the destruction of large river eco system.
C. Rapid urbanization has led to exploitation of ground water.
D. India uses more ground water as compared to other countries in the world.
E. India does not have a comprehensive water policy, there is no guideline available for uses of surface water and ground water.

To resolve all these problems our first and foremost duty is:

1. To educate the population about water pollution and its effect on us
2. They should be educated consumption and life style
3. We need to invent new water conservation technology, recycle waste water
4. Improve irrigation and agricultural practices
5. Improve water catchment and harvesting
6. Look to community-based governance and partnership
7. Develop and enact better policy and regulation
8. Manage the eco system holistically
9. Improve distribution infrastructure
10. Climate change mitigation
11. Population growth control

Solution to Shortage of Fresh Water can be Address and Implemented:

An awareness i.e., the population should be educated to changed their consumption and life style specially in urban areas citizen should be taught about proper conservation and water management. Secondly water conservation should be taken up to community level. In doing so the pressure we reduce in human consumption from ground water to supply water. So, community level water harvesting structure should be built up. In agriculture practices should be encouraged to grow drops where less water required. Irrigation system should be free leakages. In the Panchayat levels the farmer should be encouraged to take part in water conservation by utilization of water shed development and ground water monitoring. Water bodies, forest, ground water, rivers and streams should be protected and conserved. Recycling and harvesting of water should be encouraged, harvesting of rain water should be practice in every household and a government policy should be made mandatory. A government can also apply and charge tax in ground water. Large water bodies should be de-silted annually or over a particular period of time, so that we can enhance the water storage capacity during monsoon.

Traditional water recharging areas needs to be revived in order to balance the water bodies. Sewage and waste water drainage should be stopped immediately, into the traditional water bodies. There is also lack of water management between the urban consumers, agricultural sector and industry. Proper planning and adequate measures in optimum use of existing resources should be done.

Conclusion:

Mahatma Gandhi aptly said, “Earth provides enough to satisfy everyman’s needs but not every mans greed”. We the human beings need to be wiser and more practical in our approach to use of the natural resources.

“A nation that destroy it soil, destroy itself,” said Franklin Roosevelt.

This is what we are doing practically to our soil and our environment. Scientific study also shown that the structure of

water is affected by the emotion of people. So, to conclude we need to manage water resources. Since the demand for this limited resource continues to increase, sound management about the quantity and quality of water is very necessary. Understanding enhancing of all elements of water cycle and how to protect and develop it for better sustainability for the future is the need of the hour.

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Pollution in the Temple Tanks- An Environmental Issue

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Abstract:

Temple tanks are considered to be very holy and water from these tanks ae taken for all rituals. But now a days these tanks are found to be very polluted and cannot be used by the temple or by the public. In the present work we have made an attempt to study the water samples collected from two prominent temples of Kanyakumari district of Tamilnadu, Sri Sthanumalaya Swami Temple tank, Suchindram and Sri Madhusudana Perumal Temple tank, Parakkai. One is a very popular temple and the other is not visited much by tourists. The water samples were studied for their pH, Electrical Conductivity, Dissolved Oxygen, Total Dissolved Solids, Total Hardness, Alkalinity, Chloride and Calcium content. The obtained results (within the limits of experimental errors) were studied and the inferences were made. Data were collected using questionnaire covering every possible fact about the temple tanks among the residents and the tourists of that place. For comparison pure distilled water was taken for reference. Impurities present in the sample helped us find out whether the source is desirable or not.

Keywords: *pH, Electrical Conductivity, Dissolved Oxygen, Dissolved Solids, Hardness, Alkalinity, Chloride, Calcium*

1. Introduction:

1.1 Importance of Water:

"When water fails, functions of nature cease, you say,
Thus, when rain fails, no men can walk in duty's ordered way"

-THIRUKKURAL:20

Water is an elixir of life, a precious gift of nature. It is an inorganic, transparent, tasteless, odorless and nearly colorless chemical substance which is the main constituent of earth's hydrosphere, and the fluids of most living organisms. It is vital for all known forms of life, even though it provides no calories or organic nutrients. Its chemical formula is H_2O, meaning that each of its molecule contains one oxygen and two hydrogen atoms, connected by covalent bonds. Water is the name of the liquid state of H_2O at standard ambient temperature and pressure.

Water covers nearly 71% of the Earth's surface, mostly in seas and oceans. Small portions of water occur as groundwater, in the glaciers and the icecaps of Antarctica and Greenland and in the air as vapour, clouds (formed of ice and liquid water suspended in air), and precipitation. Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture.

Fishing in salt and fresh water bodies is a major source of food and economy in many parts of the world. Much of long-distance trade of commodities (such as oil and natural gas) and manufactured products is transported by ships/boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industries and homes. Water is an excellent solvent for a wide variety of substances, both mineral and organic. As such it is widely used in industrial processes and also in cooking and washing. Water, ice and snow are also important for many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, diving, ice skating and skiing.

From a biological standpoint, water has many distinct properties that are critical for the proliferation of life. It carries out this role by allowing organic compounds to react in ways that ultimately allow replication. All known forms of life depend on water.

1.2 Temple Tanks:

Usually in India, Temple tanks are wells or reservoirs, built in the temple premises. They are called Pushkarini, Kalyani, Kunda, Sarovara, Tirtha, Talab, Pukhuri, etc. in different languages and regions of India. It is said that taking bath in the sacred temple tanks cure various diseases and maladies. It is possible that these are cultural remnants of structures such as the Great Bath of Mohenjo-Daro or Dholavira, which was a part of the Indus Valley Civilization. Some are step wells with many steps at the sides.

Since ancient times, the design of water storage has been important in India's temple architecture, especially in western India where dry and monsoon seasons alternate. Temple tank design itself became an art form. The water from the temple tank is mainly meant for the ritual bath of the deity and to provide water for the flowering plants in the Nandhavanam (flower garden). Devotees also wash their hands and feet or even bathe in a separate tank maintained for that purpose before entering the temple. The temple tank is also a focal point of several religious activities like the Theppam or the float festival, for the offering of prayers to one’s ancestors and meditation on the banks of the tank.

1.3 Present Work:

In order to study the level of pollution we have selected two temple tanks one at Sri Madhusudana Perumal temple, Parakkai and other at Sri Sthanumalaya Swami Temple, Suchindram based on various criteria. The water samples were collected from the tanks and they were subjected to chemical analysis. Various chemical parameters are calculated for both the samples and the results are discussed herewith. Finally, few filled in questionnaires that were analyzed and discussed.

2. Review of Past Research Work:

Pollution in temple tank is a topic of extensive research taken up by many researchers and social welfare associations. Different people all over the world are doing a variety of studies on temple tanks, the pollutants in it, the ways of up keeping or maintaining it to be preserved to our future generation. It is high time that we should turn our interest towards temple tanks to preserve the holiness and purity of all temple tanks.

A temple tank may get polluted by different means. They may be polluted biologically or chemically. Anuja, J. in her work reported that the Thiruneermalai Temple tank, Chennai is undergoing a high-level organic pollution and is presently in the eutrophic status. If the anthropogenic disturbances are continued in this temple tank, in the near future the tank might become highly polluted and unfit for usage.

Meenakshi, P. has carried out studies in Sanjeevi Rayar Temple and Kailasanathar Temple pond water in Kancheepuram. She has concluded that the water is not good for human consumption and also stressed the danger for the life of the aquatic organisms. So, there is an immediate need of renewal, improvement and proper management of these water bodies for the human and environment.

Hemamalini et al has analysed the water quality and the results show that the Pandravedu tank and the wells located in Thiruvallur district, in its ayacut area are affected due to the mixing of untreated dyeing industry wastewater and sewage water. Focussed group discussion revealed that, due to water quality changes in Pandravedu tank there is reduction in paddy yield to about 40%, the water is also not suitable for livestock drinking, fish culture, and drinking purposes and hence the communities depend on other fresh water sources. These changing scenarios clearly reveal that the livelihoods of the community and the tank ecosystem are under severe threat which needs immediate attention for future sustainability.

Researcher M. Balaganessin has reported the health hazards to the residents of Tiruchirappalli caused by the polluted temple tank in the city. He has carried out his research at the 'Adi Theertha Theppakulam' near the western Gopuram of Sri Jambukeshwarar Akilandeshwari Temple in Trichy. "A foul smell emanates from the tank forcing you to remain indoors and close the door." says a local resident S. Sulochana. People also state that many anti-social elements cause nuisance in the platform and it should be checked out immediately. They also state, "though the temple authorities have taken many preventive measures anti-social elements have damaged the iron rods that blocked the entry of water into the tank platform".

The Center for Urban water Resource (CURE), Water Knowledge Centre and the DHAN Vayalagam (Tank) have carried out studies on temple ponds in and around Madurai and made the following conclusions.

The Azhagar Kovil Temple tank faces a lot of issues due to its high level of water pollution because of disposing organic, inorganic and plastic materials as part of the rituals. Samples revealed that the green color of the temple tank is due to algal suspension. Also, the presence of reeds in the tank shows the presence of silt depositions in the temple tank.

In the Karmega Perumal temple tank, located in the Thirumogur village of Madurai, it is reported that the tank water is slightly yellowish in color. The color may be due to the presence of dissolved solids present in the water which gets contaminated by the detergents, soaps, ritual disposals and thermocol pieces.

The water of Thiruparankundram Theppam, located in Madurai is highly infested with weed grass and algae. The tank is also dumped with floatable and settle able solid wastes. It is also said that the temple tank has no outlet. Once the tank is full, inlet channel is closed to avoid further filling of the tank.

About 90% of the Sri Yoga Narasinga Perumal Temple tank, Madurai is covered with lotus. This suffocates the carps in the temple tank. Ritual wastes are

disposed by the devotees. It is also said that, along with the ritual materials, devotees dispose plastic bags too.

The temple tank of Saravana Poigai leads to the collapse of tank ecosystem, as the fishes in the tank are completely caught. This leads to poor greenish water which smells bad and itches when taking bath in it. The number of people using it has reduced drastically. It is also said that the ecosystem of the tank has to be restored efficiently with proper solid waste management.

The Prasanna Venkatachalapathy Temple tank in Madurai also faces a lot of issues due to pollution. It is also said that the Periyar water, flowing through the feeder channel flushed and carried away solid waste disposals and sewage, thereby polluting the temple tank. The water also looks green due to algal growth in the sewage mixed tank water.

The open space around the Marugaal Udaiya Ayyanar Temple tank, Madurai is used as cow sheds. The area is highly polluted by cow dung and urine. The storm water used to carry all these wastes along with it before entering into the temple tank. The water is slightly yellowish and the tank is full of solid wastes disposals.

"The News Minute" on 06th September 2016 has published in their journal that in the temple tank of Sri Subramaniya Swamy Temple, Thiruparangundram, Madurai, thousands of fishes were found dead and floating on the surface of the temple tank. It is said that the death of the fishes was caused due to the increased level of pollution in the tank. The fishes couldn't acquaint themselves to the weather conditions because of the increase in pollution in the tank.

In a recent research conducted to study the pollution levels in the major temple tanks of Kanyakumari district it has been concluded that most of the physio-chemical parameters have crossed the maximum permissible limits prescribed by the WHO. "The total alkalinity, electrical conductivity, chloride, the total dissolved solids like calcium and magnesium have higher values and make ponds very harmful for human beings",

says P. Maria Pushpam in her doctoral thesis submitted to the Center for Marine Science and Technology of the Manonmaniam Sundaranar University.

3. Materials and Methods:

3.1 Selection of Research Area:

In order to study the pollution in the temple tanks, it was decided to select two temple tanks on the basis of the following criteria.

1. They should be in and around Nagercoil.
2. One of the temple tanks should be located in a village area while the other should be in a semi urban area.
3. One temple tank must be used exclusively by the residents of the place and the other should be used by a wide section of people.
4. The usage of tanks should be for different purposes.
5. They should be used by different types of people.
6. Both the tanks should belong to the temple and they should be managed by the local government authorities.

Based on the above criteria we have selected two tanks one at Parakkai (Village) and the other at Suchindram (Semi-urban) in and around Nagercoil. They both are at a distance of about 4 km from each other. Both the temple tanks are used for bathing, washing clothes and irrigation purpose. They are used by the residents of the place, tourists and devotees. They are owned by the temple and are managed by the Joint Commissioner, HR & CE, Government of Tamil Nadu.

3.2 Sri Madhusudana Perumal Temple Tank, Parakkai:

Parakkai is a Village in Rajakkamangalam Block in Kanyakumari District of Tamil Nadu State, India. It is located 5 km towards South from the District headquarters, Nagercoil. According to the 2011 census the total population is about 2524 and has nearly 706 houses. The total female population is about 50.4% and the literacy rate is about 84.5%.

The village is potentially important in agriculture and fishing. A Centre named Kanyakumari Parakkai Centre for Sustainable Aquaculture (KKPCeSA) was established at Parakkai, initially as Veterinary University Training and Research Centre (Fisheries) (VUTRC(F)) under Tamil Nadu Veterinary and Animal Sciences University during 2002. Later it was renamed as Fisheries Training Research Centre, Parakkai when it was transferred to Tamil Nadu Fisheries University during 2013. In 2017, the FTRC, Parakkai was attached with the Directorate of Centre for Sustainable Aquaculture as one of the production units of DCeSA and renamed as Kanyakumari Parakkai Centre for Sustainable Aquaculture (KKPCeSA).

Madhusudana Perumal Temple shown in Fig. 1 is a Hindu Temple dedicated to Lord Vishnu located at Parakkai Village. The temple is renowned for its mural paintings and for its exquisite art on stone. It was constructed before the 15thcentury. It has a gold plated Kodimaram (Flag Staff) which was constructed in 1956.The size of the temple tank is 150 x 100 x 15 feet and is shown in Fig. 1. The 10-day Pankuni (a Tamil month) car festival is celebrated every year. The ninth day festival is celebrated through a car and the tenth day with the theppam. The tank is used by the devotees for bathing and the people of the locality use it for bathing and washing.

Fig 1: Madhusudana Perumal Temple, Parakkai

3.3 Sri Sthanumalaya Swami Temple Tank, Suchindram:

Suchindram is a panchayat town in Kanyakumari district in the Indian state of Tamil Nadu. It has an average

elevation of 19 metres (62 feet). Suchindram is a temple town situated in the southernmost district of Kanyakumari in Tamil Nadu. It is 11 km from Kanyakumari and 7 km from Nagercoil town. As per the 2011 census, the total population is about14, 000, with a male population of about 6750 and female population of about 7250. There are nearly 3700 houses. As it is a place of tourist interest, there are many petty shops and small hotels or tea shops. The literacy rate is about 95 % and the growth of population is about 9.5% per annum.

The Sthanumalaya Swami Temple shown in Fig. 2, also called as the Thanumalayan temple is an important Hindu temple located in Suchindram in Kanyakumari district of Tamil Nadu, India. The Sthanumalaya Swami Temple is of importance to both Shaivaite and Vaishnavite sects of Hinduism, as the name Sthanumalaya denotes the Trimurtis; “Sthanu” means Siva; “Mal” means Vishnu; and the “Ayan” means Brahma. The temple is dedicated to the trimurthis. This 17th-century temple is famous for its architectural grandeur. The seven-storey white Gopuram is visible from the distance. There is an Anjaneya, (or Hanuman), statue which stands at 22 feet (6.7 m) and is carved of a single granite block. It is one of the tallest statues of its type in India. Thirumalai Nayak and the Travancore Maharajas, under whose administration the temple remained till Kanyakumari's merger with Tamil Nadu, have made many endowments for its upkeep. There are two important festivals, one in Dhanu (December/January) and the other in Medam (April/May). The temple has a big temple tank at the northern side of the temple. This temple tank shown in Fig. 2 is the largest one in the district. Its size is 450x380x15 feet and has a small mandapam in its center. It receives water from Manakudian Canal, which is the sub of Pazhayarriver. The water of the temple tank is used by the devotees for bathing and for various rituals in the temple.

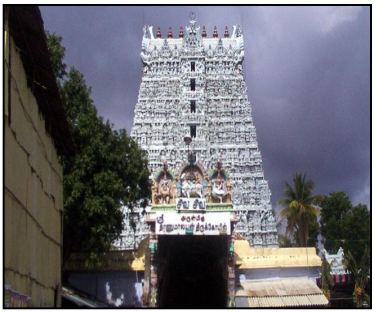
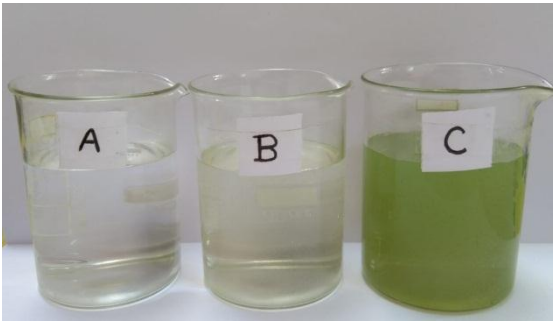


Fig. 2: Sri Sthanumalaya Swami Temple, Suchindram

3.4 Collection of the Sample:

Samples were collected at both the temple tanks and is shown in Fig. 3. The water samples were collected in one-liter capacity clean and dry bottles having well fitted stoppers. The bottles and the stoppers were thoroughly cleaned, filled thrice with water and rinsed before collecting the samples. After collecting the sample, the bottles with the stopper were well secured. The bottles containing the sample water were labeled and immediately transported to the laboratory for the estimation of various physio-chemical properties. Dissolved oxygen was measured immediately after sampling, at the field itself.

Fig. 1 Collection of Sample from left:



A- Reference sample,

B- Water sample from Sri Madhusudana Perumal Temple tank, Parakkai,

C- Water sample from Sri Sthanumalaya Swami Temple tank, Suchindram

3.5 Chemical Analysis:

In order to have a detailed pollution study in the samples they were analyzed for eight different physio-chemical parameters. They are:

1. pH
2. Electrical Conductivity
3. Dissolved Oxygen
4. Total Dissolved Solids
5. Total Hardness
6. Alkalinity
7. Chloride
8. Calcium

3.5.1 pH:

It is the measurement of the level of acid and alkali in a substance which ranges from 0 to 14. The neutral value of pH is 7 pH above 7 is basic and below 7 it is acidic. Determination of pH helps a person in studying the chemical nature of the sample. Low-pH water will corrode or dissolve metals and other substances. Rain water and ground water with pH 7 is suitable for human beings and other animals. Pollution can change water's pH, which in turn can harm animals and plants living in the water. pH was determined by using a digital pH meter.

3.5.2 Electrical Conductivity:

Electrical conductivity of the samples depends on the concentration of the dissolved salts in it. As the electrical conductivity increases with temperature, the total dissolved salts will also get increased along with the increase in the concentration of sulphates and other ions. So, increase in the electrical conductivity will pollute the water. The conductivity bridge is used to measure electrical

conductivity by finding the resistance it offers to the flow of current. This is an indirect method.

3.5.3 Dissolved Oxygen:

The dissolved oxygen (DO) is the oxygen that is dissolved in water. The oxygen dissolves by diffusion from the surrounding air, aeration of water that has tumbled over falls and rapids and as a waste product of photosynthesis. Total dissolved gas concentrations in water should not exceed 110 percent. Concentrations above this level can be harmful to aquatic life. Moreover, oxygen affects a large number of other water indicators, like the odor, clarity and taste. Consequently, oxygen is perhaps the most well-established indicator of water quality. The dissolved oxygen in the samples was found by a chemical method called Winkler's Iodometric method using Sodium Thiosulphate, Alkaline potassium iodide solution, Manganoussulphate solution, starch solution and sulphuric acid. Starch serves as an indicator in the titration done.

3.5.4 Total Dissolved Solids (TDS):

TDS stands for total dissolved solids which represents the total concentration of dissolved substances in water. It is made up of inorganic salts as well as a small amount of organic matter. It shows the ionic concentration of the water. If the level of TDS is less than 300 milligrams per liter, it is good for health. If it exceeds 1200 it poses health hazards. Normally it is better to have it in the range of 300 to 900. Total dissolved solids can be determined from the residue left out after evaporation of the filtered sample. A small amount of the sample was kept in a muffle furnace for an hour and evaporated. From this the amount of dissolved solids was calculated.

3.5.5 Total Hardness:

The definition of water hardness is the amount of dissolved calcium and magnesium in the water. Other metals like iron, aluminum, zinc and manganese also contribute to the hardness of this water sample. Generally, harder the water, lower the toxicity of other metals to

aquatic life. Large amounts of hardness are undesirable mostly for economic or aesthetic reasons. These ions give a wine-red color with Eriochrome Black T indicator from which the total hardness was found.

3.5.6 Alkalinity:

Alkalinity is the ability of the sample to neutralize the strong acids. Alkalinity is significant in the treatment of wastewater and drinking water because it will influence treatment processes such as anaerobic digestion. Water may also be unsuitable for use in irrigation if the alkalinity level in the water is higher than the natural level of alkalinity in the soil. Most water samples are rich in carbonates and bicarbonates and a small amount of other alkalinity imparting ions. Methyl orange added to the sample shows a color change from yellow to pink from which the alkalinity was found.

3.5.7 Chloride:

Scientists who study watersheds use elevated chloride levels as one indicator of pollution in a body of water. To find the amount of chloride ion, a known amount of the sample is titrated against silver nitrate solution after adding potassium chromate indicator which gives a red precipitate. The amount of chloride ion per liter is then calculated and tabulated.

3.5.8 Calcium:

Calcium in the sample under study was estimated by taking a known amount of sample and adding Solochrome black indicator and titrated against EDTA (Ethylene diamine tetra acetic acid) until the color changes from wine red to blue.

4. Results and Discussions:

4.1 Chemical Analysis:

The study and investigation on the pollution of water in the temple tanks of Sri Madhusudana Perumal Temple tank and Sri Sthanumalaya Swami temple tank was done. The samples were analyzed for various chemical parameters and the experimental results are attached. The observation agreed with various established concepts and

facts, associated with both the temple tanks. The parameters with which the samples were analyzed are given in Table 1 and are discussed below.

pH values:

The pH is one of the important parameters and most frequently tested and it is an important index of acidity and alkalinity of water. The change in the pH values can be noticed in Table 1. pH shows variation from location to location and among different water bodies. The higher acidity in both the temple tanks is due to the more amount of dissolved carbon-di-oxide in the water. The acidity is very much high compared to that of the reference value 7.1 which is the neutral point. Lower pH compared to the neutral point is dangerous for the organisms and people consuming it.

Electrical Conductivity:

The Electrical Conductivity is one of the major factors that determine the quality of water. It depends on the presence of ions and their total concentration. The Electrical Conductivity is inter-related to solubility. Solubility and conductivity are directly related. Conductivity values are indicative of soluble content of water and general nature of the quality of water. A measure of total electrolytes in water can be recurred by measuring the Electrical Conductivity. Higher conductivity of the water in the temple tanks denote higher TDS (total dissolved solids) hardness thus affecting the quality of the water for drinking purpose. So, it is harmful for the living organisms surviving in it.

Dissolved Oxygen:

An adequate supply of dissolved oxygen is essential for the survival of aquatic organisms. The presence of certain aquatic organisms like fishes play a vital role in the control of the pollution in the temple tanks. The minimum standard for dissolved oxygen is 5 mg/l. As the amount of dissolved Oxygen increases in water it is good and better for the aquatic beings to live. Dissolved oxygen is important for waste degradation and decomposition by

micro-organisms. Dissolved oxygen depends on temperature, salinity and pressure. The amount of dissolved oxygen in the temple tank of Suchindram is very much low compared to that of Parakkai. This shows that the aeration in the temple tank of Suchindram is very poor and the number of micro-organisms present in it is very less.

Total Dissolved Solids:

The total dissolved solids indicate the presence of various kinds of minerals. It refers to the fraction of solids that pass through a 0.45μm filter paper. The total dissolved solids are almost two times higher in Suchindram and also has a relatively higher value in Parakkai. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing color, taste and odour. Water with higher TDS (Total dissolved solids) content may have a reverse effect of constipation in some people.

Total Hardness:

Hardness of the water is one of the criteria in the determination of its sustainability for drinking purpose. It also serves as the basis for routine control check for softening process. Variation could be found from location to location. It is a measure of polyvalent cations in water. Hardness generally represents the concentration of calcium and magnesium ions, because they are most common polyvalent cations. The total hardness of the water in Parakkai is good compared to that of Suchindram. Its value is three time more in Suchindram compared to the reference value. The excess hardness of water is undesirable because of various reasons. It causes more consumption of soap.

Alkalinity:

Alkalinity is also an important property of water. The value of alkalinity is nearly two times higher in Parakkai and is almost three times higher in Suchindram when compared to the reference value. Consuming alkaline water may have many effects on human body like lowering of natural stomach acidity. It may cause gastro intestinal

issues and skin irritation. It may agitate the body's normal pH leading to metabolic alkalosis, which may lead to nausea, vomiting, muscle twitching, etc. it can also cause a decrease in free calcium in the body, which can affect bone health.

Calcium:

Calcium is one of the most abundant substances present in ground water. Calcium has no hazardous effect on human health except in hypocalcaemia which refers to an excess in calcium in the plasma. According to the World Health Organization (WHO), the standard for calcium in drinking water is 200ppm and ICMR limitation is 660ppm. In that case the amount of calcium in the collected samples of Parakkai and Suchindram are just 67 and 73ppm respectively. The water is safe in terms of the amount of calcium present in it. Also, small concentrations of calcium are beneficial in reducing the corrosion in the pipes due to the formation of a thin layer of scale.

Chloride:

Chloride occurs naturally in all types of water. It is one of the major inorganic anions by which the quality of water can be assessed. High concentrations of chloride is considered to be the indictors of pollution due to organic wastes of animal or industrial origin. High values of chloride are troublesome in irrigation water and is also harmful for aquatic life. The amount of chloride is high compared to that of the reference liquid. The chemical tests done on the water samples ompared with a standard water sample as the reference sample reveals the number of various materials and pollutants present in them.

4.2 Analysis Based on the Questionnaire:

Random sampling method was adopted by selecting residents or tourists in and around the temple tanks of Sri Sthanumalaya swami temple, Suchindram and Sri Madhusudana Perumal temple, Parakkai. A questionnaire was prepared covering the various aspects of temple tanks. It was issued to six people there and was collected and analyzed.

In general, it can be inferred that all the respondents at both the places feel that, the temple tanks are polluted to varying degrees. The residents are dissatisfied with the condition and maintenance of their respective temple tanks. Some feel that the pollution is due to the different soaps used there for washing, bathing cattle sometimes, disposing their unwanted dresses here and there sometimes, plastics and other covers that fly into the tank, throwing of soap covers, leaves carried away by wind that gets rotten in the water.

As a result of these, the quality of water in the place considered and believed to be very holy and sacred gets affected. Of the two tanks, Suchindram tank is more polluted than Parakkai tank. The color of the water in Suchindram tank is greener in color than that of the Parakkai temple tank. There is also a slight foul smell coming from the water sample collected from the Suchindram temple tank.

The residents feel that steps must be taken by both the government and also the local residents to maintain the tank. Some people even insisted to post a permanent guard to monitor the users of the temple tank. People must not be permitted to wash clothes, bath cattle or use soaps and shampoos in the temple tank. Plastics and other materials should not be permitted near the tanks.

Table 1: Chemical Parameters

Studies	**Reference Sample (Pure Water) A**	**Sri Madhusudana Perumal temple tank water sample B**	**Sri Sthanumalaya Swami temple tank water sample C**
pH	7.2	6.52	6.04

Dissolved oxygen (mg/l)	7.69	7.1	5.49
Electrical conductivity (10^-3 µmhos)	0.62	0.85	0.72
Total dissolved solids (mg/l)	155	250	360
Total hardness (mg/l)	15.3	18	50
Alkalinity (mg/l)	35	68.5	91.3
Chloride (mg/l)	43	55	70
Calcium (ppm)	59	67	73

5. Summary and Conclusion:

The work carried out on the temple tanks of the two places, Parakkai and Suchindram of Kanyakumari district is a beneficial one to the society. We have found the pollutants present in the sample, collected from both the temple tanks.

We have also instructed the residents and the people of the locality about the methods of maintaining both the temple tanks in a good, clean and hygienic manner. Only then the religious beliefs of the people in and around the place can be protected.

We have also planned to send a letter to the 'Water Reservoir Protection Organization' about the level of pollutants in the tank so that they may take the necessary steps to bring it to permissible limits. We are also planning to pass on the collected information to other related offices so that the purity of the tank is well preserved.

We will also communicate our findings regarding the pollution level and the odour of the water to the officials of Devasam Board or the local temple officials so

that they can take the necessary action in their own way. The youth are the building power of any nation. So young volunteers in and around the area can be selected and made to form a club to improve the condition of the temple tank.

Thus, the condition of both the temple tanks can be improved and can be presented as a great gift to our future generation to build an ecologically safe India.

In order to preserve the sanctity of the temple tanks, the local residents must be educated about the harmful effects they would have to face because of pollution. Some types of tank cleansing fishes can be grown in limited numbers in these tanks. The water in the tank must be emptied by certain methods before the onset of every monsoon, so that fresh rain water may fill the tank. Safe water purificants can be sprayed on the water by the government or the panchayat authorities at periodic intervals. This will protect the residents from getting into problems like skin allergies, fever, cold, etc. The water from the temple tank must not be used for drinking purpose. Also, the utilization of the temple tank by the devotees and the tourists must be monitored. Washing clothes inside the temple tank must be strictly prohibited. Every individual must consider it as his/her responsibility to take care of the condition of the temple tank and preserve it for future use. Bio-phy remediation processes can be used with the help of microbes and aquatic plants to clean up the water in the temple tanks. The tanks must also be desilted to improve ground water recharge from the tank. A regulatory mechanism such as 'Temple Tank Associations' can be established to maintain the purity of the temple tanks. By using these steps, the level of pollution in the temple tanks can be controlled.

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Air Pollution: A Health Hazard

Ms. Aparna Ravi

Abstract:

Air pollution is a major concern of new civilized world, which has a serious toxicological impact on human health and the environment. It is definitely an alarming issue for the health of our future generations in India. We are aware of the ill effects of environmental pollutants and toxicants on health status of human as well as other living organisms and the environment (Ghosh and Parida 2015). The most vulnerable to the toxic effects of the pollutants are children and old people. Some significant measures should be taken and some strict laws should be made to prevent environmental pollutions. Air pollution is considered as the major environmental risk factor in the incidence and progression of some diseases such as asthma, lung cancer, ventricular hypertrophy, Alzheimer's and Parkinson's diseases, psychological complications, autism, retinopathy, fetal growth, and low birth weight. In this article, we will discuss toxicology of major air pollutants, sources of emission, and their impact on human health.

Keywords*: Air pollution, causal factor, consequences, recommendations.*

Introduction:

Air pollution is a major problem of recent decades, which has a serious toxicological impact on human health and the environment. The sources of pollution vary from small unit of cigarettes and natural sources such as volcanic activities to large volume of emission from motor engines of automobiles and industrial activities. Long-term effects of air pollution on the onset of diseases such as respiratory infections and inflammations, cardiovascular dysfunctions, and cancer is widely accepted; hence, air pollution is linked with millions of deaths globally each

year. A recent study has revealed the association between male infertility and air pollution.

Air pollution has now emerged in developing countries as a result of industrial activities and also increase in the quantity of emission sources such as inappropriate vehicles. About 4.3 million people die from household air pollution and 3.7 million from ambient air pollution, most of whom (3.3 and 2.6 million, respectively) live in Asia.

In this paper, we will discuss sources of air pollution and propose some feasible solutions which may be beneficial for all.

Definitions:

Air pollution is defined as all destructive effects of any sources which contribute to the pollution of the atmosphere and/or deterioration of the ecosystem. Air pollution is caused by both human interventions and/or natural phenomena. It is made up of many kinds of pollutants including materials in solid, liquid, and gas phases.

Air pollution mainly affects those living in large urban areas, where road emissions contribute the most to the degradation of air quality. There is also a danger of industrial accidents, where the spread of a toxic fog can be fatal to the populations of the surrounding areas. The dispersion of pollutants is determined by many parameters, most notably atmospheric stability and wind.

Sources of Exposure:

It is known that the majority of environmental pollutants are emitted through large-scale human activities like use of industrial machinery, power-producing stations, combustion engines, and cars. Since these activities are performed at such a large scale, they are the major contributors to air pollution, with cars estimated to be responsible for approximately 80% of today's pollution. Some other human activities which are influencing our environment to a lesser extent, such as field cultivation techniques, gas stations, fuel tanks heaters, and cleaning

procedures, as well as several natural sources, like volcanic and soil eruptions and forest fires.

The classification of air pollutants is based mainly on the sources producing pollution. Therefore, the four main sources are: Major sources, Area sources, Mobile sources, and Natural sources.

1. Major sources include the emission of pollutants from power stations, refineries, and petrochemicals, the chemical and fertilizer industries, metallurgical and other industrial plants, and, finally, municipal incineration.
2. Indoor area sources include domestic cleaning activities, dry cleaners, printing shops, and petrol stations.
3. Mobile sources include automobiles, cars, railways, airways, and other types of vehicles.
4. Natural sources include, physical disasters such as forest fire, volcanic erosion, dust storms, and agricultural burning.

Climate and Pollution:

Air pollution and climate change are closely related. Climate is the other side of the same coin that reduces the quality of our Earth. Pollutants such as black carbon, methane, tropospheric ozone, and aerosols affect the amount of incoming sunlight, due to which, the temperature of the Earth is increasing which results in the melting of ice, icebergs, and glaciers.

Thus, climatic changes will affect the incidence and prevalence of both residual and imported infections. Climate and weather affect the duration, timing, and intensity of outbreaks strongly and change the map of infectious diseases in the globe.

Effect of Air Pollution on Health:

Air pollution is distinguished into two main types:

1. Outdoor pollution is the ambient air pollution.
2. Indoor pollution is the pollution generated by household combustion of fuels.

People who are exposed to high concentrations of air pollutants experience disease symptoms and states of

greater and lesser seriousness. These effects are grouped into short- and long-term effects affecting health.

Susceptible populations that need to be aware of health protection measures include old people, children, and people with diabetes and predisposing heart or lung disease, especially asthma.

As already stated, according to a recent epidemiological study from Harvard School of Public Health, the relative magnitudes of the short- and long-term effects have not been completely clarified due to the different epidemiological methodologies and to the exposure errors. New models are therefore proposed for assessing short- and long-term human exposure data.

Thus, in the present section, we deal with not only the more common short- and long-term health effects but also general concerns for both types of effects, as these effects are often dependent on environmental conditions, dose, and individual susceptibility.

Short-term effects are temporary and range from simple discomfort, such as irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, and breathing difficulties, to more serious states, such as asthma, pneumonia, bronchitis, and lung and heart problems. Short-term exposure to air pollution can also cause headaches, nausea, and dizziness.

These problems can be aggravated by extended long-term exposure to the pollutants, which is harmful to the neurological, reproductive, and respiratory systems and causes cancer and even, rarely, deaths.

The long-term effects are chronic, lasting for years or the whole life and can even lead to death. Furthermore, the toxicity of several air pollutants may also induce a variety of cancers in the long term.

Respiratory disorders are closely associated with the inhalation of air pollutants. These pollutants will invade through the airways and will accumulate at the cells. Damage to target cells should be related to the pollutant component involved and its source and dose.

Health effects are also closely dependent on country, area, season, and time. An extended exposure duration to the pollutant should incline to long-term health effects in relation also to the above factors.

Discussion:

In 2018, during the first WHO Global Conference on Air Pollution and Health, the WHO's General Director, Dr. Tedros Adhanom Ghebreyesus, called air pollution a “silent public health emergency” and “the new tobacco”. Children are more vulnerable to air pollution, especially during their development. Air pollution has adverse effects on our lives in many different respects. Diseases associated with air pollution have not only an important economic impact but also a societal impact due to absences from productive work and school. Despite the difficulty of eradicating the problem of air pollution, a successful solution could be envisaged as a tight collaboration of authorities, bodies, and doctors to regularize the situation. Governments should spread sufficient information and educate people and should involve professionals in these issues so as to control the problem successfully. Technologies to reduce air pollution at the source must be established and should be used in all industries and power plants.

The Kyoto Protocol of 1997 set as a major target the reduction of GHG emissions to below 5% by 2012. This was followed by the Copenhagen summit, 2009, and then the Durban summit of 2011, where it was decided to keep to the same line of action.

A more recent international agreement of crucial importance for climate change is the Paris Agreement of 2015, issued by the UNFCCC (United Nations Climate Change Committee). This latest agreement was ratified by a plethora of UN (United Nations) countries as well as the countries of the European Union.

Thus, parties should promote actions and measures to enhance numerous aspects around the subject. Boosting education, training, public awareness, and public participation are some of the relevant actions for

maximizing the opportunities to achieve the targets and goals on the crucial matter of climate change and environmental pollution.

Even though, technological improvements make our world easier and it seems difficult to reduce the harmful impact caused by gas emissions, we can limit its use by seeking reliable approaches. Synopsizing, a global prevention policy should be designed in order to combat anthropogenic air pollution as a complement to the correct handling of the adverse health effects associated with air pollution. Sustainable development practices should be applied, together with information coming from research in order to handle the problem effectively. International cooperation in terms of research, development, administration policy, monitoring, and politics is vital for effective pollution control. Legislation concerning air pollution must be aligned and updated, and policy makers should propose the design of a powerful tool of environmental and health protection.

Therefore, focus should be on fostering local structures to promote experience and practice and extrapolate these to the international level through developing effective policies for sustainable management of ecosystems.

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Urbanization & Environmental Degradation in India

Neha Boruah

Abstract:

Urbanization means increasing urban areas for which environmental degradation occurs. urbanization change the biodiversity and ecosystem of a region. Peoples need has been changing so, degradation is also growing which result different types of environmental problem. The cities of India is facing lots of problem which impact on degradation of environment and poses threat to biodiversity. Cities increasing population by directly and indirectly affect the environment in many ways. The study is based on secondary data collected from the field and different sources. This is a study of urbanization in India which leads to damaging environment. Although, it is impossible to restrict urbanization but it can controlled with minimum impact on environment. This paper examines the effect of urbanization through the aspect of transportation. The study concluded with some suggestions which can be beneficial to us directly or indirectly to stop further degradation of environment.

Keywords: *Urbanization, environment, degradation, unplanned, sustainable.*

Introduction:

Urbanization is the transformation of economic development due to rapid population and economic development caused great impact on environment damaging the region. Also, rapid infrastructure and economic growth. This urbanization have adverse impact on microorganism flora & fauna and also human. There is a growth in population with increase in urbanization. It contributes to urban environmental degradation. However, in recent studies we have seen that developing countries.

In India urbanization plays a key role in rapid population growth and expansion of developmental activities, and its result to depletion and degradation of environment (Duraiappah, 1996, Nagdeve 2007, Sharma 2008)

This paper highlights the effect of environmental degradation due to rapid urbanization.

About Environment:

The word environment is derived from the French word 'Environ' which means surrounding. This includes biotic factors and abiotic factors. Environment is a complex of many variables, which surrounds man as well as living organisms. Environment includes water air and land the inter- relationship which exist among and between water, air and land human beings and other living creatures such as plants, animals and micro organisms, (Kalavathy,2004).

The natural environment consists of four interlinking systems namely, atmosphere, hydrosphere, lithosphere and biosphere. These four systems are in constant change and such changes are affected by human activities and vice versa. (Kumarasamy et.al 2004). Environmental degradation means deterioration of environment through depletion of resources and destroying ecosystem which leads to extinction of animals. Today our environment is deteriorating from last centuries after industrial revolution the main cause of environmental changes is based on urbanization, population and economic growth.

Causes of Environmental Degradation:

The main causes of environmental degradation are urbanization, over-population, deforestation and industrialization. The major cause of environmental degradation is human activities. Human activities impact with the cause, the habitat plants and animals. Overuse of minerals and oil deposit also depleted. These condition changes that have turned hurtful to every single living being. Urbanization and industrialization have caused water, air and noise contamination. Chlorofluorocarbon,

nitrogen oxide, carbon monoxide and other particles. This disbalanced the ecological cycle of nature. Pollution is another cause f degradation toxic substances pollute the air and make unhealthy. Pollution occurs from vehicle emissions, chemical release from factories, agricultural chemical runoff.

Activities that Cause Environmental Degradation:

a) **Air Pollution:** Air pollution is the common cause of environmental degradation contamination of harmful substances that kill plants and animals.
b) **Acid Rain:** Sulphur- di- oxide combines with moisture and mix with air. This substance create precipitation which pollutes lakes ponds etc. Acid rain also effects soil. Aquatic animals started to disappear and also plants started to die.

Environment Sustainability Challenges:

India is experiencing rapid environmental degradation. Pressure on land and natural resources both due to over population. Mismanagement of natural resources demand of infrastructure. The problem become absence of proper law and regulation related to sustainability of environment.

Urban Development:

According to some environmentalist urban development is the root cause of degradation which is related t increase in population, need more homes and land where now wetlands, farmlands are filled up to make houses are constructed. So, the environment is changing over time. This new environment cannot cope up with the species will leads to degradation.

Urban Ecology:

The study of organisms and their surroundings are known as ecology. Most of the urban people is unaware about the cycle of nature. The relation between flora, fauna and their natural habitat is not appropriate in a city.

Urbanization in India:

Urbanization is growing in quicker rate. During 1901 only 11% people were living in urban areas. In 2001 it raises up to 28% in 2011 it evaluated to 31%. The trend of urban population is increasing ten times more than 90s. This is happening for lack of opportunities in villages and this force to people to move to towns. In Indian context urbanization means continuous growth of population. The pattern of urbanization in India is concentration of population in cities. However, we can say that urbanization is the main production of population exploitation.

Impact of Urbanization on Environment:

After the colonial rule India has witnessed rural influx into urbanization which has caused pressure in agriculture farmland which result degradation. In last 30yrs there is an increase in population some region of India also, urban population. By 2030 50% of India's population is expected to live in poor environment. The urban environment in large cities is deteoriating rapidly. Some of the important environmental problems are discussed below:

- **Exploitation of Resources:** Due to increase in population the consumption of natural resources has also increased example fossil fuel, forest products energy etc. There is no planning of judicious use of resources which result scarcity of forest products, groundwater, deletion, power cuts etc.
- **Rise in Temperature:** The unplanned construction of multi- stored buildings in urban areas with destruction of wetlands, green farmlands which absorbs radiation and increasing climatic pressure.
- **Solid Waste:** Urban areas consumes large quantities of material and release waste increases as increase in population poisonous gas smell can cause many diseases.
- **Slums:** The slum population areas are rising as rural people migrates to urban areas but cannot cope up with the standard of living in cities. So, they choose to live in slum areas where it is cheap but the construction of houses are with tins, jute and tripals etc. Overcrowded

no light to pass no proper drainage system. The waste disposal in everywhere which pollutes air as well as bad odor water related disease like typoid, jaundice is common among the people.

Adaptation Measures:

We cannot remove degradation totally but we can decrease them by some measures:

- Purchasing recycle products.
- Organizing awareness program
- Conserve energy and water.
- Not throwing waste inappropriate manner.

Conclusion:

Environment degradation is an issue due to damage of plants and animals that inhabited places. To reduce future impacts, industry city planners must consider environment with proper planning, public awareness future environmental degradation. From the above we conclude that the damage cause to environment due to urbanization is upon the country who don't regulates the planning. Due to which there is an informal settlements and slums that is totally unhealthy environment. Government should take urgent step to reduce the generation of solid waste. India will be more devastating if we don't take the steps. So, government take necessary steps to prevent the environment planner should concentrate more to protect the environment.

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Management of Abiotic Stress in Horticultural Crops

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Abstract:

With nutritional benefits, fruits are important part of human diets. These crops not only play an important role in nutritional security but also offer gainful employment and enhanced income to the farmers' community. However, the abiotic stresses, encountered at critical growth stages, adversely affect their productivity. Further, climate change is likely to increase frequency, intensity, and duration of abiotic stresses. The main abiotic stresses affecting tropical fruit crops in India are the drought/water-deficit, high temperature, and salinity stresses. These stresses cause many morphological, anatomical, physiological, and biochemical changes ultimately impacting both their productivity and quality. Thus, thorough understanding of the adverse influence of abiotic stresses on different crop species is imperative for devising innovative horticultural practices for overcoming the adverse impacts. Timely intervention with appropriate adaptation strategies would help in realizing sustainable yields. Practices like providing irrigation at critical stages, adopting micro-irrigation, use of growth regulators, soil mulching, amendments, and nutrient management need to be implemented for alleviating adverse effects. The advanced irrigation methods like partial root-zone drying (PRD) are another option for limited water conditions. The inclusion of tolerant crops or cultivars and adoption of tolerant rootstocks to graft the choice cultivars would further enable the farmers to overcome adverse effects of abiotic stresses. The focus should be on developing integrated crop-specific adaptation strategies. Integration of all available adaptation options would be the

most effective approach in sustaining the production and productivity of fruit crops under abiotic stresses.

***Keywords**: drought, Water Stress, climate change, Root Stock, fruit and vegetables.*

Introduction:

Horticulture provides employment opportunities, higher income, and nutritional security across various states of the country. The technology-led horticulture during the last two decades has made tremendous impact on production, productivity, and profitability of all horticultural crops. The Government of India has recognized horticulture crops as a means of diversification in agriculture in an eco-friendly manner through efficient use of land and natural resources. Fruits due to their nutritional benefits are highly valuable for humanity, and along with vegetables, they are part of everyday meals. Thus, fruits and vegetables contribute nearly 90% to the total horticulture production in India. Globally, India stands second in the production of fruits and vegetables (Anonymous 2015a). Fruit crops provide not only nutritional security but also livelihood security to the farmers.

In order to realize higher yields, the perfect match between climate of a region and the suitability of a particular fruit species to that region is very essential. The potential yield levels are seldom achieved due to the occurrence of various biotic and abiotic stresses. Worldwide occurrence of environmental stresses is the primary cause of crop losses, with average yield reduction by more than 50% for the major crops (Bray et al. 2000). The majority of fruit crops are peculiar mainly due to perennial nature and deep root system. They undergo vegetative and reproductive phases during different seasons. The abiotic stresses coinciding with these phenological phases play a significant role in determining the duration of phenology and productivity. Further, under climate change and climate variable conditions, fruit crops are likely to face abiotic stresses quiet frequently. Hence, under such circumstances, meeting the increasing demand

for fruits becomes challenging. Realizing sustained and enhanced yields under abiotic stress situations primarily depends on implementation of appropriate adaptation strategies. Hence, the adverse effects of abiotic stresses on important fruit crops and available adaptation options are discussed in this chapter.

Management Options:

Successful cultivation of crops and attaining reasonable yields under abiotic stress situations mainly depends on the available adaptation options. The adaptation efforts would enable us to channelize concerted efforts for the holistic development of horticulture sector empowering marginal and small farmers. Majority of the fruit crops are perennial, possess deep root system, and undergo vegetative and reproductive phases during different seasons in a year. The long time horizon of perennial horticulture crops itself is a challenge. The quick adaptation strategies, like switching over to tolerant cultivars and changing planting dates or season, followed in annual crops are not likely in perennial fruit crops. Hence, the choice of fruit crops should be guided by the suitability of a crop species and their varieties in a particular location. The planting and rearrangement of fruit orchards require long-term consideration. In addition, the preference for a choice variety of fruit delays adoption of a new cultivar than an annual crop. Even the perennial habit slows the process of developing new varieties and limits the options for shifting varieties (Koski 1996). Thus, with these limitations, the adaptation of new varieties of fruit crops takes time and requires long-term considerations. Hence, the abiotic stresses in perennial crops need to be managed mainly through alterations in cultivation practices.

Modification in Cultural Practices:

The alterations in cultivation practices help in effective management of abiotic stresses in perennial crops. In mango better tree growth, fruit retention, and fruit size and higher yields are realized under irrigation. The fruit size and yield increased in field-grown mango cv.

Hindi with more frequent irrigation (Azzouz et al. 1977). The bigger size fruits and highest yield were obtained with 7-day irrigation interval (Larson et al. 1989). Weekly irrigation during the first 6 weeks in cv. Dashehari reduced fruit drop compared with three weekly irrigation treatments (Singh and Arora 1965). Irrigation during the initial 4–6 weeks succeeding the fruit set is crucial for attaining better fruit size and yield, as cell division and cell wall development take place at initial stage (Whiley and Schaffer 1997). Since the occurrence of water stress immediately after fruit set increases fruit drop, protective irrigation is essential during the fruit development period (Anonymous 2014). Thus, providing irrigation at least during post-fruit set period under water-limiting conditions is very important for realizing sustainable yields.

Under water-deficit conditions, production practices that can improve water use efficiency would help in water saving and bringing more area under irrigation. Plastic mulching helps in reducing soil water evaporation and rainwater impact and provides effective weed control and congenial environment for soil micro flora. The use of mulching enhances the production and quality of produce under water limiting conditions. The production system employing drip irrigation, fertigation, and plastic mulching would help in realizing higher yields. During initial establishment of mango plants in the field, under water scarcity situations, application of 1.25 litre of subsoil irrigation per day through pitcher placed one foot below ground and mulching with sugarcane thrash at 1.0 kg/basin is suggested for better establishment. Rainwater harvesting through opening of circular trenches around trees at a distance of 6 ft and 9 in. width and depth and mulching the trenches with dry mango leaves helps in retaining sufficient moisture in the soil during flowering and fruiting, resulting in higher yield (Anonymous 2014).

Micro-Irrigation:

Systematic irrigation scheduling enhances water productivity largely because of improved efficiency and

timing of water applications. Through the precise and direct application of water in root zone through drip irrigation, better crop growth and yield can be realized along with considerable savings in water. Drip irrigation method enables judicious use of available irrigation water in fruit orchards. Overall it saves up to 30–70% irrigation water and also helps in realizing higher yields by 25–80% (Sikka and Samra, 2010). Various studies have shown that the adoption of micro-irrigation systems increased yield. And productivity of fruit increases by 42.3%. This resulted in improved water use efficiency, and an average irrigation cost has been brought down by 31.9%. This has helped the farmers to introduce new crops. However, in India, only around 8 Mha is under micro-irrigation, but the estimated potential for micro-irrigation is around 69 Mha. Hence there is great potential for adaptation of this technology (Anonymous 2016).

Micro sprinkler irrigation not only helps in water saving to the tune of 20 to 30%, but during summer it helps in reducing temperature in the microclimate and increases the humidity, leading to better growth and yield. Micro-irrigation, because of high cost and intensive management constraints, presently is adopted in few crops. However, it offers a great perspective for water savings due to its advantage of precise application of water at the root zone, and also it is an extremely flexible irrigation method. It could be adapted to almost any crop production situation and climatic conditions. In situations where limited water is available, providing irrigation during critical stages of the crop growth like active growth, flowering, and fruit enlargement is very essential. Micro-irrigation helps in achieving this feat and conservation of water under water-limiting conditions. Hence, appropriate management strategies are needed to solve the production problems.

Adopting Novel Irrigation Methods:

In addition to drip irrigation and mulching, novel irrigation methods, like partial root-zone drying (PRD), could be adapted for production of fruit crops under water

scarcity conditions. Partial root-zone drying is an irrigation water application technique alternating from one side of the plant to the other. This system purposefully imposes water stress to the plants at specific growth stages by providing limited amounts of plant's daily water use. The production of ABA hormone and other chemical signals in the drying roots presumably reduces stomatal conductance and leaf growth (Gowing et al. 1990) thereby increasing water use efficiency. In mango orchards where water is a limiting factor, PRD may be the key for a sustainable production (Spreer et al. 2007). A frequent response of fruit trees to deficit irrigation (DI) is earliness in flowering. This stress-induced flowering is often explained in terms of a lesser resource competition with vegetative growth effectively restrained by water deficit in evergreen and deciduous fruit trees (Behboudian and Mills, 1997). This tree response to DI has been successfully exploited to induce out of season blooming and to increase the levels of flowering in many tropical and subtropical fruit crops. The average yields of 4 years were 83.3, 80.1, 80.8, and 66.1 kg/tree when irrigated equal to ETc, RDI (regulated deficit irrigation 0.5 ETc), PRD (partial root-zone drying, 0.5ETc), and non irrigated control, respectively. Further RDI and PRD were at par during normal rainfall years while PRD out yielded RDI during deficient rainfall years. The trees receiving PRD also bore bigger size fruits (Spreer et al., 2009).

Choice of Tolerant Rootstocks:

In situations where there is a strong consumer preference for a select cultivar that is susceptible and if alternative tolerant cultivars are not available, the option of using rootstocks for better performance needs to be explored. Rootstocks with better root system, having capacity for enhanced water and nutrient uptake, could be used for grafting commercial cultivars to mine water from deeper soil layers. In grapes, cv. Pinot Noir on "101–14 Mgt" rootstock had higher CO_2 assimilation, transpiration rate, and higher water use efficiency than on "3309C" (Candolfi-Vasconcelos et al., 1994). Rootstocks, 110R, 99R,

and 1103P, belonging to Vitis berlandieri x Vitis rupestris crosses, show increased water use efficiency (Satisha et al., 2007). The rootstocks such as Dogridge, Salt Creek, and Vitis champini clone showed tolerance with reduced cytokinin level and increased ABA accumulation at 50% moisture stress compared to irrigated vines (Satisha et al., 2007). Rootstocks 110R, Dogridge, Salt Creek, and B2-56 though enhanced sugar and other compatible solute accumulation showed both moisture and salinity stress tolerance (Jogaiah et al., 2014). Mango rootstocks exhibited differential response during water stress. The cultivars Starch, Peach, and Kensington required 7–9 days, whereas Mylepelian took 16 days to reach negligible photosynthesis rates during water stress. But upon rewatering, Starch, Mylepelian, Peach, and Kensington recovered in 1, 2, 3, and 4 days, respectively (Laxman, 2015). Thus, availability of different suitable rootstocks enhances the farmers' ability to manage abiotic stresses.

Although saline conditions have adverse effects on plant height, number of leaves, leaf area, and stem thickness (Ahmed and Ahmed, 1997), the mono- and polyembryonic mango cultivars display differential tolerance to salinity stress. Studies have demonstrated that the polyembryonic genotypes appear to have greater tolerance to salinity compared to monoembryonic types (Jindal et al., 1975). The polyembryonic cultivars Kurakkan and 13-1 have shown tolerance to salinity stress. Among the different polyembryonic mango rootstocks evaluated, Olour and Kurukkan have been identified as tolerant to salt stress (Srivastav et al., 2009). The polyembryonic rootstock cvs. Bappakai and Olour have also been identified as moderately tolerant to salt stress. The Gomera-1 having ability to restrict uptake and transport of Cl and Na ions from root system to the aboveground parts is identified as tolerant to salinity stress. The tolerant seedlings exhibit physiological tolerance to chloride ion concentrations in leaf tissues.

Choice of Tolerant Crops:

In areas where the crops perennially face water and high temperature stresses, the knowledge should be shared with farmers on fruit crops which would be most suitable. In such circumstances, the selection of appropriate fruit species becomes very important. Many fruit crops are endowed with physiological and morphological adaptations and have capacity to withstand adverse effects of water stress. Leaf hairiness, hypostomatous distribution, and sunken stomata are all characteristic features of species that exist in drought-prone regions (Clifford et al., 2002). Ber sheds leaves to avoid extreme water stress during summer. Pomegranate is fairly winter hardy and tolerant to water-deficit and high temperature stresses. It tolerates concentrations up to 40 mm NaCl in irrigation water (Naeini et al., 2006). Fig has adopted to retain high-bound water in the tissue, by having sunken stomata, thick cuticle, and leaf wax coating. Aonla, being a hardy and drought-tolerant subtropical tree, can be grown well under tropical conditions. In salt-affected lands where cultivation of annual field crops is limited, adopting relatively tolerant crops like ber, aonla, guava, grape, karonda, jamun, and phalsa would help in utilization of such lands for horticulture. These crops could be considered as candidate crops to face the challenges of abiotic stresses under climate change conditions.

Conclusion:

Though various adaptation options like cultural practices, advanced irrigation methods, tolerant crops, or varieties and rootstocks are available, the productivity of fruit crops remains low in areas experiencing abiotic stresses. The main reasons are slow pace of adoption by the small and marginal farmers, limited awareness about the potential adverse effects of abiotic stresses, dearth of agro ecological zone-based perspective plans, lack of awareness about the risks associated with horticultural crops, and lack of integrated location-specific modules to overcome abiotic stresses. Therefore, focus is required for developing integrated location-specific and crop-specific adaptation strategies for various abiotic stresses. Dissemination of

already available adaptation strategies can be taken up through location-specific monitoring networks and creating awareness among farmers on likely climatic risks. The timely availability of planting material of tolerant cultivars needs to be assured through proper institutional mechanism. The institutional support to provide forecast and early warnings needs to be further strengthened. Robust insurance policies linked to climatic risks of a region, recent weather extremes, and weather forecasts are very much essential.

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A Geographical & Geological and Chemical, Physical Study on: Capture Carbon Particles from Atmosphere Organic and Inorganic Methods

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Abstract:

Carbon dioxide gas is mostly greenhouse atmospheric carbon dioxide is one of the primary stage greenhouse gases on earth and its continuous emission by manmade activities is leading to an Increase Day by day in atmospheric temperature. On the other hand, deferential natural phenomena exist that contribute to the sequestration of atmospheric carbon dioxide, i.e., its capture and long-term storage. These phenomena or situation are including oceanic, geological and chemical processes happening on earth. In addition to the above-mentioned non-biological methods, Deferent biological methods viz. soil carbon sequestration and phytosequestration/ adoption have also been contributing to fixation of atmospheric carbon. Phytosequestration is mainly performed by several photosynthetic mechanisms such as well as C_3, C_4 and crassulacean acid metabolism (CAM) pathways of plants, carboxysom of cyanobacteria and paranoids of microalgae. For an effective mitigation of globally climate change, it is required to stabilize the Carbon oxide concentration to viable levels.

Keywords: *Chlorofluorocarbon (CFC), biological, carbon dioxide, carbon dioxide sequestration, greenhouse gases, non-biological fixation, global climate change, seizer.*

Introduction:

At present human activities are increasing earth temperatures. In global surface temperature is the cumulative effect of successively increasing concentration

of greenhouse gases over several decades. Greenhouse gas emission/ejection results from the continuous use of many fossil fuels which are fulfilling 85% of world's energy requirement. Most of the greenhouse gases like methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFC) and carbon dioxide (CO_2) are contributing to overall climate change, wherein carbon dioxide is playing a major role. For a while, environmentalists who have been intensely involved in studying the adverse effects caused by greenhouse gases have been advocating the removal of excess CO_2 as the only way by which one can undo the harm that has already disturbed the natural balance.

There are three major strategies that could be used for reducing the carbon concentration in atmosphere: (a) reductions in CO_2 emissions in the global atmosphere, (b) carbon capture and long-term storage, (c) developing alternatives for carbon-based fuel.

The second strategy- i.e., carbon capture and long-term storage implicit carbon sequestration which involves capture and storage of CO_2 using various methods.

The main objective of carbon seizure is to balance the atmospheric carbon pool to keep the CO_2 concentration below a threshold level Carbon sequestration needs to be analyzed in terms of efficiency, cost, environmental impacts, stability of sequestered carbon and time-scale of sequestration because the

1. Sequestration Strategies:

There are different sequestration strategies which have been classified differently by different people because a unique classification is not possible for such a huge number of categories. There could be several possible criteria for categorization such as methods of sequestration, types of organisms involved in sequestration, on the basis of possible carbon sinks and many more. The major classification system is based on biological and non-biological sequestration strategies. Moreover, all these different strategies may also show few overlapping features. The following text involves discussion of

Non-Biological Adoption /Sequestration:

Non-biological sequestration methods involve capture of atmospheric carbon by non-biological means which is accomplished by different kinds of chemical and physical reactions and many other approaches which do not take into account the role of living organisms. This strategy includes oceanic, geological and chemical sequestration methods.

2. A.i Oceanic Sequestration:

Oceanic sequestration provides a way to store atmospheric carbon into deep oceans. At the global level, ocean contains 50 times more inorganic carbon than the atmosphere, thus providing a significant proof that oceans could also serve as a sink for storage of atmospheric carbon Oceanic carbon sequestration further can be categorized in abiotic and biotic types, which involve direct injection of CO_2 into the ocean and ocean fertilization methods, respectively Distribution of CO_2 between the ocean and atmosphere is affected by many factors including temperature, pH and salt concentration in water for example higher concentration of salt and high temperature negatively regulate CO_2 solubility in oceanic water .

2. A.ii Geological Sequestration:

Geological sequestration method provides an attractive opportunity for carbon storage using deferent underground geological formations. Various petroleum industries have been using this method for a long time because of two major advantages; first that it reduces greenhouse gas emission and secondly because it contributes in oil recovery process.

Kara's have reported that CO_2 can be stored in different geological structures including oil and gas reservoirs, UN mineable coal seams and deep saline aquifers, and it is believed that geological sequestration would be effective in terms of carbon storage for longer time duration. Petroleum industries have been using geological sequestration for enhanced oil recovery since

1970's because injected CO_2 displaces oil / gas, providing an economically beneficial scenario for oil recovery.

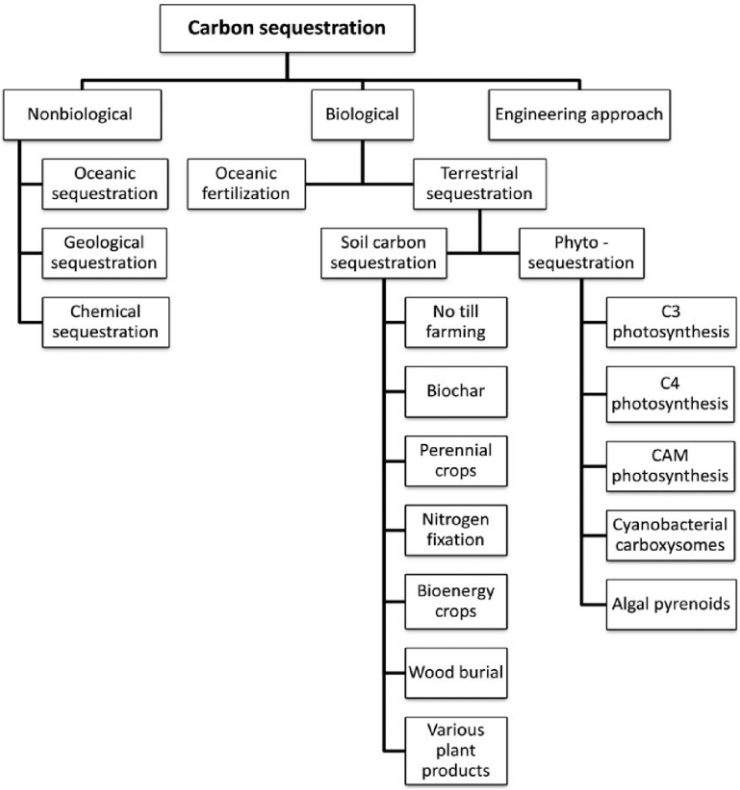

Figure 1. Deferent modes of carbon

Sequestration/ Seizure:

On but still safety, stability and public acceptance are the main issues which need to be addressed. Moreover, practical trials are the only successful and viable options for large scale sequestration projects.

Un mineable coal seams are inaccessible due to their depth of occurrence and uneconomical due to poor quality and land use restrictions though for CO_2 sequestration this could be a positively responding approach. Using un mineable coal seams for CO_2 sequestration offers advantages in the sense that these

formations can adsorb CO_2 with high efficiency and have the capability to displace adsorbed methane.

3. Chemical Sequestration / Adoption:

Chemical sequestration by mineral carbonation Chemical sequestration methods involves several specific chemical reactions and are hence known as non-biological methods. These chemical reactions convert atmospheric CO_2 into a modified and stable compound, one of which is chemical weathering of rocks by mineral carbonation. In this process, rocks are sources of minerals.

These carbonates remain stable in solid rocks and so CO_2 (in carbonate form) could be stored for a longer period of time Mineral carbonation reactions occur naturally as well as using industrial processes, although efficiency of the process is too less at industrial level Huijgen and Comans have reported that there are rocks which contain alkaline earth silicates in form of metal oxides viz. olivine ($MgSiO_4$) and wollastonite ($CaSiO_3$) and therefore suitable for mineral carbonation purpose. These reactions being exothermic and spontaneous provide a thermodynamically feasible approach.

As discussed previously, rock weathering naturally results into mineral carbonation. In this process, CO_2 present in rainwater reacts with minerals. This is an acid–base reaction in which an acid (CO_2) is neutralized by a base (mineral) to form stable carbonates. Some of the chemical reactions are as mentioned below -

$2Mg_2 SiO_4$ þ CO_2 ðgÞþ $2H_2O$.....

These chemical equations explain the mineral carbonation process. In Equations (1) and (2), formation of magnesium carbonate, while in Equation (3) formation of calcium carbonate have been shown.

3. a. Biological Sequestration:

Biological sequestration is basically performed by living organisms including plants and many microorganisms which lead to carbon capture and storage via various biological processes. Biological sequestration is majorly the result of natural processes, although now a

day, few artificial strategies are also considered to be a part of this. This mainly includes ocean sequestration through fertilization and terrestrial sequestration

3. a.i. Ocean Fertilization:

As mentioned previously, oceanic sequestration includes both biotic and abiotic modes of sequestration. We have earlier discussed about the abiotic mode of oceanic sequestration and now we will be discussing biotic mode. Ocean fertilization is basically a biological method which helps in carbon sequestration by the phytoplankton photosynthesis process enhance carbon fixation. Wolff studied the effect of iron in high nutrient, low chlorophyll oceanic water and found that iron addition enhances the primary production by stimulating the growth of phytoplankton. Raven and Falkowaski have reviewed that other nutrient including ammonium, nitrate and so on could also be used along with iron for enhancement of primary productivity in the ocean.

Terrestrial Sequestration:

Terrestrial carbon sequestration deals with storage of CO_2 in vegetation and in soils, in the above ground and below grow, processes termed as phytosequestration and soil carbon sequestration, respectively. This process has been widely accepted because of advantage of long-term storage. In terrestrial ecosystems, carbon storage mainly occurs by photosynthesis as well as in the form of live and dead organic matter, hence acting as major carbon sinks Lal has described several scenarios for terrestrial sequestration which include sequestration by soils, vegetation, forests and wetlands.

Soil Carbon Sequestration:

Atmospheric CO_2 captured by plants is majorly converted into organic material by photosynthesis while a small proportion of it is Trans located through plant roots into the soil, where it is stored in organic as well as inorganic forms Soil carbon sequestration and phyto-sequestration both are more or less co-related terms. The efficiency of soil carbon sequestration mainly depends on

climate, temperature, rainfall, clay content, mineralogy, moisture content and soil texture.

There are various ways for increasing soil organic carbon pool such as: -

No-Till Farming:

Farmers usually prefer tillage practices which includes physical disturbances in soil for enhancement of soil respiration as well as decomposition of soil organic pool. This practice increases turnover of soil aggregates and results in reduction in carbon content of soil

No-till farming practices promote minimum soil loss because soil is not mixed properly and remains more fertile due to the retention of residue from previous crops which improves carbon content of the soil.

Black Carbon/Bio Char:

Bio char means black carbon is bio char, acts as a very poor substrate for microorganisms and is therefore more resistant to microbial decomposition. Black carbon is generally assumed to be chemically inert and highly resistant towards degradation. Woolf et al. Reviewed various aspects of bio char decay kinetics, in which they had described Bio char as, 'Bio char is a mixture of heterogenous substances including both labile (easy to decompose) and recalcitrant (difficult to decompose) aromatic compounds, hence half-life depends on the percentage of both components. So, increase in the number of recalcitrant compounds lead to increase in the half-life of bio char.

Perennial Crops:

Besides the use of no-till farming method and bio char application, another technique available for management of soil organic carbon is introduction of perennial crop species.

This practice increases soil organic pool and assists in long-term carbon storage. Because of their expanded root system, larger amount of carbon can be stored in root biomass of perennial crops Moreover, perennial species respond positively toward agricultural activities with

minimum soil disturbances for example expanding the duration of growing season is considered as high-yielding better cultivation option than growing annual crops.

Nitrogen Fixation:

Nitrogen fixing plants having larger tendency of soil carbon accumulation than non-nitrogen fixing plants hence have greater effect on soil organic biomass. Nitrogen becomes a part of the ecosystem nutrient cycle further decreasing soil carbon decomposition and increasing its storage. Nitrogen fixation process favors litter fall and mycorrhizal production thereby increasing the carbon input of soil.

Bioenergy Crops:

A plant species which can be used as a renewable energy source for future prospective is called as bio-energy crop. These crops upon complete characterization can be intentionally designed for enhancing biomass and energy potential and hence increased production of bio-energy

These crops have been categorized as the fourth largest energy source in developing countries. Jansson et Have reported that at-present sugarcane, oil crops and some of the cereals such as maize and wheat are being utilized as bio-energy crops.

Wood Burial:

For producing wood burial, dead or live trees are collected and buried in above ground areas in largely anaerobic conditions. This will not allow decomposition but CO_2 will remain sequestrated. Zeng found that wood burial strategy can be used to mitigate global climate change by reducing atmospheric CO_2 concentrations.

Various Plant Products:

Various plant products including wood material used as raw material for construction of buildings, houses and furniture provide the way for long-term carbon sequestration.

Phytoliths are also a sort of plant products which are released after burning, digestion and decaying of plant

parts. These can be silicates and calcareous deposits. Parr and Sullivan have proposed that phytoliths could serve as sustainable soil carbon pool because these are very stable and insensitive toward various land use changes and hence carbon remains sequestered for millennia.

Photosynthesis is a natural process through which plants convert inorganic carbon into organic carbon, i.e., CO_2 into sugar in the presence of solar energy. This way atmospheric carbon is allocated to various plant parts such as seeds, stems, roots and various other organs. Hence, CO_2 fixation processes enhance sequestration of global atmospheric carbon.

C_3 Photosynthesis:

C_3 photosynthesis is the most ancient pathway for CO_2 fixation, found in a large group of plants. In this pathway, first product of photosynthesis is a three-carbon molecule, i.e., phosphoglyceric acid (PGA), so-termed as C_3 photosynthesis. This pathway involves carboxylation of ribulose bis-phosphate (RuBP) in the presence of enzyme ribulose 1, 5-bisphosphate carboxylase oxygenate (RuBisCO)

C_4 Photosynthesis:

C_4 photosynthesis is common among monocot plants. These plants have different leaf anatomy than C_3 plants, which facilitates reduction of RuBisCO oxygenase activity. Further, in this pathway, first product is a 4-carbon molecule and hence, the pathway is termed as C_4 photosynthesis. Under the conditions of low CO_2 and high temperature, C_4 plants are more efficient than C_3 plants because photorespiration rates are reduced in C_4 plants. While studying cross sections of leaves, it was observed that C_3 plants contain only mesophyll cells while C_4 plants have two different chloroplast containing cells:

CAM Photosynthesis:

In CAM plants, various adaptations are found to cope up with the hot arid conditions. CAM pathway is found in many epiphytes and succulent plants of arid region. These plants close their stomata during the hot day

time, to reduce water loss through transpiration and open during the cool night time to collect CO_2. Thus, they temporally regulate the efficiency of CO_2 fixation pathwa at the same time, in CAM plants also, spatial regulation similar to that of C_4 plants is found. During the night CO_2 is taken up by PEP carboxylase present in cytosol to form malate and then stored in vacuoles that further transport it to chloroplast during the day and where the CO_2 fixation of RuBPoccurs. This way CAM plants are able to work efficiently in water and CO_2 stressed conditions

Cyanobacterial- Carboxysomes:

Cyanobacteria possess a unique kind of CCMs to enhance photosynthetic efficiency of RuBisCO. In cyanobacteria carboxysome, structures and various inorganic carbon transporters are present for concentrating CO_2 nearby RuBisCO. Carboxysomes are proteinaceous polyhedral bodies covered by a protein shell. Most of the RuBisCO content of the cell is present in carboxysoRubiscu

Thus, carboxysomes are sites in a cyanobacterial cell where CO_2 levels remain high for further capture by RubisCO for CO_2 fixation process.

4. Conclusions:

Although there are various strategies already present and many others are continually being developed for sequestration of atmospheric carbon but still sustainability and long-term effects are not guaranteed. In the present day, environmental rise in atmospheric carbon level is the most debatable issue to be discussed, analyzed and most importantly resolved.

Increased carbon levels are affecting at the global level, so it is not possible to overcome this problem by using any of the single approach due to various drawbacks associated with each and every strategy. So, it can be concluded that for efficient carbon sequestration more than one strategy needs to be used in combination to achieve sustainability. Genetic engineering is emerging out

to be the most promising approach in this direction and hence should be given a thrust.

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Tourism and Environmental Degradation- A Threat to Human Life

Prakash Shaw

Abstract

Tourism is one of the largest and fastest growing sectors in the world today, having a profound impact on the environment, culture, society and economy. The development of tourism is affecting the environment in two ways. On the one hand, it is protecting the environment, on the other hand, it is becoming a threat to the environment. The main purpose of this paper is to discuss the relationship between tourism and the environment and the negative impact of tourism on environment as well as how environmental degradation is carrying a threatening message to human life. Emphasis has been placed on sustainable and environmentally friendly methods to reduce the environmental degradation caused by tourism. It is recommended to take initiatives in this regard both publicly and privately, as well as to increase the human awareness of the local community and tourists.

Keywords: *Tourism, environment, interrelation between tourism and environment, environmental degradation, pollution, human life*

Introduction:

Tourism industry is one of the largest and fastest growing industry in the world economy and known as the smokeless industry. It has significant impact on environment, culture, society and also on economy both positively and negatively Tourism defined as "the activities of persons travelling to and staying in place outside their usual environment for not more than one consecutive year for leisure, business and other purpose" (UNWTO).

Actually, it includes movements of all purposes. In developing countries like India tourism has become one of the major sectors of the economy. It contributes a large proportion of the national income and it is also able to create huge opportunities in job creation.

Tourism has the potential to create beneficial effects on the environment by contributing to environmental protection and conservation. It is a very way to raise awareness of environmental values and it can serve as a tool to finance protection of natural areas and increase their economic importance. Except the positive impact of environment, there are many negative impacts that result from tourism is linked with the construction of general infrastructure such as roads and airports, and of tourism facilities, including resorts, hotels, restaurant, shops, etc. the negative impact of tourism development can gradually destroy the environmental resources on which it depends.

Tourist inflow is a major source of development of any tourism destination. But environmental destructions are a major problem of tourism activities. if the level of visitor use exceeds the ability of environment to cope with, it causes a serious threat to the environment. Tourism not only contributes to environmental degradation, but at the same time affected by it as well. Therefore, tourism is a doubled edge activity as on the side contributes positively to the socio-economic achievement, on the other side its fast, unmanaged and uncontrolled growth is proving to be the major cause of degradation of the environment. It can even have a negative impact on the health of local communities and lead them to compete for critical social use. In tourism rich countries, depletion of natural resources and environmental degradation associated with tourism activities are considered a serious one. So, a complex problem for different levels of government is the management of natural resources to reduce the depletion of natural resources and environmental degradation. The reality is that in most tourist areas tourists adopt a relatively high pattern and as a result there is a lot of waste

generation. This paper discusses environmental degradation as a negative aspect of tourism industry and how it threatens human life.

Objectives:

The main objectives of this paper are given below:

1. To know the relationship between tourism and environment
2. To discuss how tourism degrades the environment
3. To highlight how environmental degradation threatens human life

Methodology:

The study has been carried mainly on the basis of literature survey and secondary information. The secondary data was collected through various articles, journals, books, newspapers and online sources and various organization like world tourism organization, world travel and tourism council, ministry of tourism, environmental policy etc.

Relation Between Tourism and Environment:

The relation between tourism and environment is very complex and both are interrelated and inter dependent to each other. Tourism always consumes natural resources and will continue to do so in the future. Tourism is the main reason for carrying the natural environment, both positive and negative. Tourism involves various activities which can have positive and negative effects on the environment of the concerned area. The relationship between tourism and environment is multifaceted and its impact is double sided.

Tourism can or does have a positive impact on the environment by contributing to the protection and preservation of the environment. Understanding tourism can create ideas about environmental values in people's minds. On the contrary, it can be said that tourism can gradually eliminate or reduce the dependence on the environment on a regular basis. Each environment has its own carrying capacity, when the number of tourists increases this capacity, it affects the balance position of the

environment. It can therefore be said that uncontrolled conventional tourism poses a potential threat to the natural environment.

Generally adverse environmental effects are mainly related to infrastructure development of street, air force, hotel, restaurant, golf courses, resorts etc. This potential threat to the environment can put a huge strain on any one region and lead to impacts such as natural habitat loss, soil erosion, increased pressure on endangered species, increased pollution etc.

Tourism and Environmental Degradation:

Environment is the sum total of living and non-living components, influence and events surrounding an organism. Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil, destruction of ecosystem, habitat and the extinction of wildlife and pollution. Environmental degradation is an Umbrella Concept which covers a variety of issues including pollution, biodiversity loss and animal extinction, deforestation, global warming and a lot more.

The United Nations international strategy for disaster reduction defines environmental degradation as "the reduction of the capacity of the environment to meet social and ecological objectives and needs". How tourism activities can cause environmental degradation is discussed below-

Depletion of Natural Resources: Resource depletion is the consumption of a resource faster than it can be replenished. Resource depletion occurs when the renewable and non-renewable natural resources become scare because they are consumed faster than they can recover. Example of resource depletion include overwater usage, land degradation, other local resource depletion etc.

Water Resource Depletion: One of the very important natural resources is freshwater. Water scarcity is the lack of sufficient available freshwater resources to meet water demand. In tourism industry, we all know that tourism demands for freshwater and other local resources which

are already scarce are very high, especially during peak season causing overuse of the freshwater in hotels, swimming pools, golf courses and personal use of water by tourists is greater than the average daily demand of a local resident. This led to water scarcity and degradation of water supplies, as well as creation of a greater volume of water waste. Even Water pollution in rivers, lakes and the sea may result from recreational and tourist transportation. For example, in dryer region like western part of India, Mediterranean the issue of water scarcity is particular concern.

Depletion of Local Resources: Tourism can create a huge pressure on the local resources like land, food, water, energy, recreational amenities and other raw materials that may already be in limited supply. Many tourist destinations have ten times more inhabitants in the high season than in the low season for the seasonal nature of the industry. A high demand is placed on these resources to meet the high expectation of tourists (proper food, light, hot water etc). of course, this can put pressure on local resource and infrastructure. Even local people are affected by it.

Land Degradation: Land is vital resource to humankind, like air and water. Land degradation is the deterioration or loss of the productive capacity of the soils for present and future- is a global challenge that affects everyone through food insecurity, higher food prices, climate change, environmental hazards and the loss of biodiversity and ecosystem service. It is one of the world's most pressing environmental problems and it will worsen without rapid remedial action. Rapid increase in construction of tourism and recreational facilities increased high pressure on the important land resources like forests, wetland and wildlife, fertile soil, mineral resource, scenic landscape etc. Tourism development include use of land for accommodation and other building materials, infrastructure provisions like construction of roads, dams, bridges, airport, railways, golf courses and so on, which can lead to degradation of soil,

land, loss of wild life and wetland and deterioration of scenic beauty.

Negative impact of tourism on forests due to deforestation caused by fuel wood collection and land clearing. For example, one trekking tourist in the Himalayan region (Nepal, Sikkim Assam) use four to five kilograms wood a day (UNEP, 1999).

Pollution:

Air Pollution: A major source of air pollution in the context of tourism is associated with transportation system. As the number of tourist arrival is increasing rapidly day by day, the air and road transport is also increasing significantly in recent day. Air pollution from tourism development may result from excessive use of vehicles (car, buses and motorcycle) by and for tourists at major tourist attraction areas that are accessible only or mainly by road. This increase in transportation has given rise in the release of carbon dioxide (CO_2), Sulphur dioxide (SO_2) and emission of greenhouse gases. Again, Shops and restaurants in any tourist areas installed their air conditioners' exhaust outlets close to the local residents' homes, chlorofluorocarbons (CFC) are come out from this exhaust. As a result, the area has faced the problems like Acid rain, global warming, photochemical pollution which has directly affected the natural ecosystem, landscape, human health, vegetation of the area.

Noise Pollution: Noise pollution is now a growing problem of modern life. Noise may be generated by a concentration of tourists, vehicles, aircraft, cars, buses and motor boats. Sometimes certain types of tourist attractions such as amusement parks, car or motorcycle races and also from the recreational vehicles such as snowmobiles and jet skis may generate noise that is unacceptable and irritating. As a result, humans and animals are affected by this noise pollution.

Visual Pollution: Visual pollution may result from several sources, like; Poorly designed buildings, e.g., hotels that are not compatible with local architectural style or environment, use of large and ugly advertising signs,

Overhead utility (electric and telephone) lines and poles, Buildings obstructing scenic views etc.

Solid Waste and Littering Disposal: Solid waste is the unwanted or useless solid materials generated from human activities in residential, industrial or commercial areas. It is due to large number of people using one area and the kind of activity they engage, like picnicking, trekking etc. Tourism is one of the main sources of solid waste and littering. This is another a serious problem found at all the tourist destinations, where tourism related activities are very high. Solid waste is mainly dumped in areas such as hotels, restaurants, small shops, lodges etc., and is scattered around in the form of littering. The unmanaged disposal has become a serious threat to the natural environment of rivers, streams, lakes, flora and fauna etc of the area. It can create significant health problems and a very unpleasant living environment if not disposed of safety and appropriately.

In mountain or hilly areas of Himalayas, Darjeeling, Chotonagpur plateau trekking tourist generate a great deal of waste. During the expedition travelers leave their garbage, oxygen cylinders and even camping equipment. For example, in march 2021, about 70 sacks of plastic items were unloaded from top of Sushunia hill in Bankura district of West Bengal.

Sewage Problem: The development of tourism in an area increases the construction of hotels, restaurants, roads, recreation and other facilities in that area, which amounts to sewage. It is the primary agent of degradation of water resources and natural flora and fauna. Increased tourism as the area becomes urbanized, the number of tourists also increases rapidly, which increases the amount of sewage. This untreated sewage runoff pollutes rivers, streams and any lakes or ponds or other local waters in the vicinity of tourist destinations and causes serious damage to coral reefs and coastal environment and natural ecosystem. For example, oil spills from cruise boats in resort harbors, untreated sewage from kitchens and bathrooms of island resorts may cause adverse effect on

the aquatic ecosystem and reduce the enjoyment of the tourists swimming there. Sewage pollution can threaten the human health and animals also. Examples of such sewage pollution can be seen in the coastal states of Goa, Kerala, Dal Lake of Jammu and Kashmir state, Chilka lake of Odisha state of India.

Others Physical Impact on Environment:

Deforestation: Plants are basis of life on this earth and all living things, including humans, depend on it. Forests play an important role in environmental conservation and deforestation can damage the entire ecosystem. Forests serve as a source of oxygen, wood, food, wildlife habitat on the one hand and absorb all pollutants, including carbon dioxide, on the other. But Rapid growth of tourism and urbanization are two major causes behind uncontrolled destruction of forests. Because, Hotels, restaurant, lodges, houseboats, roads and various construction are done to improve tourism in any tourist destination. Even in hilly region, forests are being cleared for road construction. As a result, deforestation creates serious problems such as soil erosion, loss of biodiversity, climate change and also effecting negatively to overall water cycle and environment of the region.

Ozone Layer Depletion: The ozone layer is the layer present in the lower stratosphere that is near about 20 to 35 km above the earth. This layer is important for the earth because it protects the earth by absorbing harmful UV (Ultra violate) radiation that comes from the sun. But now the indiscriminate activities of human beings are leading to the destruction of this ozone layer. The tourism activities may be part of the problem. Ozone depletion substances (ODSs) are present in air conditioner, refrigerators used in hotels, lodge, restaurant etc., which are widely used in the tourism industry. even toxic fumes emitted from jet air craft are main source of ODSs. Which are thinning ozone layer and creating pores.

Climate Change: Environment and climate change are the most important factors for tourism. Climate change is one of the most burning issue which tourism is facing

globally recently because tourism is a climate sensitive industry. Mainly the vital reason of climate change is rapidly increase of greenhouse gases, which is generated when fossil fuels (coal, oil, natural gas etc) are burned (e.g., in industry, electricity generation and automobiles). The relationship between tourism and climate change is twofold; tourism impacts on climate change and climate change impacts on tourism. In the tourism sector only the movement of people from their home to other destinations accounts about 50% of traffic (air, railways and road) which is the main contributor of global emission of CO2, SO2 and other greenhouse gases. Thus, tourism is the important contributor to the increasing concentration of greenhouse gases in the atmosphere. Increase temperature of air and ocean, changing rainfall pattern, decreasing snow and ice cover, coral bleaching is including with climate change. Recent estimates shows that transport sector including airways, railways and road generates the largest proportion, with 75% of all emission and the accommodation sector accounts for almost 20% of emission from tourism. (UNWTO et al., 2008)

Environmental Degradation and Human Life:

Just as the activities of tourism are degrading the environment, so the degradation of the environment is directly and indirectly affecting human life. As a result, environmental degradation has become a threat to human life.

Direct effect:

By the air pollution the physical and psychological wellbeing of human beings is affected. There are many organs and bodily functions that can be harmed, that's are- respiratory diseases, cardiovascular damage, irritation of the eyes, nose and throat, damage to reproductive organs, nervous system damage etc.

* Water pollution causes cholera, typhoid, jaundice, skin disease, black foot disease, which is the result of environmental degradation.

* Noise pollution can lead to hearing loss, attention deficit disorder and even the risk of heart attack, especially in the elderly.

* Ozone layer depletion causes the sun's ultraviolet rays to burn the skin, causes cancer and cause cataracts of human beings.

* Climate change increase sea level, causing flooding in coastal areas. As a result, there is a negative impact on agriculture and the population, resulting in food shortage.

* Climate change causes floods in some places and droughts in others. This has a negative impact on human life.

* As a result of deforestation, the soil becomes loose and fertile, which disrupting agricultural work.

* Deforestation in mountain areas also causes disasters like landslide, earthquake etc., resulting in loss of human life including ecosystem and property.

* Sewage in seawater destroys all ecosystems, including marine animals. As a result, people living in the coastal areas have to face loses.

Indirect Effect:

* By the loss of biodiversity, it threatens our food supply, opportunities for recreation and tourism, and source of wood, medicines and energy.

* Even It interferes with essential ecological function such as species balance, soil formation, and greenhouse gas absorption. So that human life is indirectly affected.

* As unplanned tourism causes environmental degradation, environmental degradation again has a negative impact on tourism. Because the deterioration of the natural and cultural environment in a tourist area reduces the desire for tourist arrivals. As a result, local people who are involved in tourism are economically disadvantaged.

* Other industries associated with the tourism industry also suffer, leaving the people involved in the industry mentally and economically backward.

Suggestions and Recommendations:

So, from the above discussion it is clear that unplanned and uncontrolled tourism growth is extremely harmful to the earth's natural environment. Therefore, to overcome its negative effects, tourism needs to be planned and managed in a way that is environmentally sustainable and socially beneficial. Some suggestions to prevent environmental degradation as a negative consequence of tourism are discussed below-

* **Stop Deforestation**: Stopping deforestation is crucial for our survival and for the development of the ecosystem. Forests conserve greenhouse gases, produce oxygen and as natural habitat for many animals and plants, we should not cut down or burn trees. It is even possible to promote tourism by focusing on forests and using the beauty of plants. Therefore, a large afforestation campaign should be started in the interest of environmental protection. Even through tree planting plans we can have a positive impact on the environment.

* **Governmental Step:** The government should intervene and set up a framework to address issues such as environmental degradation. Even complying with the tourism protection act (1986) highlights the negative aspects of tourism to local communities and tourists in tourist destinations as well as focus should be on environmental protection.

* **Fines and Punishment for Illegal Dumping:** To reduce this adverse effect on the environment, there should be higher fines for illegal dumping from the tourism area. Garbage generated and emitted from various tourist centers is dumped illegally. They know that even if they are caught, the fines are quite low. So, the government should increase the fines for illegal dumping, so that the waste is dumped in the right place and the incentive to dispose of waste is created.

* **Reduce Consumption Level:** The use of various products like plastic products such as water bottles, plastic buckets and other plastic products used in tourist centers should be gradually reduced. Legal action must be taken to

reduce the amount of non-degradable products that even foreign tourists use.

* **Advertising and Promotion**: There are a need for public and private advertising and publicity campaigns on environmental degradation and to address this degradation. At the same time humanitarian awareness must be raised.

Conclusion:

From the present chapter it is clear that the tourism and environment is interrelated and depend with each other. It can be concluded that tourism is a multidimensional activity and its impact is double sided. On the one hand, it creates employment, earns foreign exchange, promotes the overall economic and social development of the country, as well as ensure environmental protection and conservation. On the other hand, rapid uncontrolled and unplanned tourism growth leads to environmental degradation, ecological disturbance, depletion of local resources and many other serious problems. Which creates a threatening message in human life. So, tourism needs to be developed in such a way that it serves as a way of congratulating the visitors and the sustainable development of the environment as well as it maintains and supports the local culture where it is being conducted. In this context, more emphasis should be placed on the concept of ecotourism. Eco-tourism needs to be properly implemented in different parts of the world and if it can be done properly, it will go a long in preserving, protecting and sustaining the earth's natural and cultural environment. So, in the end it can be said that in addition to taking initiatives both publicly and privately to keep tourism alive and bring about sustainable development of the environment and promote ecotourism, as well as awareness and sense of humanity and responsibility of local community and tourists need to be awakened.

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Current Groundwater Status of Kavaratti Island, Lakshadweep

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Abstract:

Kavaratti Island is one of the 10 inhabited islands in the Union Territory of Lakshadweep, India. Groundwater is the only freshwater source for the inhabitants of the island. Due to population growth and urbanization, the demand for groundwater has increased over the years. Accurate understanding of the state of groundwater is critical to responding to this growing demand and shaping future development and management strategies. In this context, this research was conducted to evaluate groundwater usage pattern on Kavaratti Island and to understand the status and problems of groundwater development through field survey and collection of secondary data. Among the 14 physical, chemical and microbiological parameters studied, some parameters are much more than its normal range. The reason for the increase in Physico-chemical parameters may be due to the salt water intrusion. Total faecal contamination of drinking water is more in this present study. Here, the depth of the well is very shallow, which promote surface contamination of water source by accumulated wastes. It is also known that the rise in water level at high tide contributes to an increase in the epidemiologically important faecal bacteria in drinking water. However, the value of current studies is much lower than in previous studies. The main reason is the introduction of bio toilets. Anaerobic digestion is a microbiological process making it possible to degrade the matter and decrease the number of faecal coliforms. It can help to reduce faecal pollution of ground

water resources. Also, the introduction of other water conservation methods such as rainwater harvesting tank, rainwater recharging wells etc. are very useful for groundwater sustainability on the island. Introduction of Low Temperature Thermal Desalination (LTTD) plant is also helpful to maintain the groundwater extraction.

Introduction:

Kavaratti is the capital of the Union Territory of Lakshadweep in India. Kavaratti Island is located 360 km off the coast of Kerala at 10.57' N latitude and 72.64'E longitude, between Agatti Island in the west and Andrott Island in the east.

The big problem faced by the islanders is the lack of fresh water for drinking and cooking. Groundwater is the only source of fresh water available on the island and it is also very scarce. Due to population growth and urbanization, the demand for groundwater has increased over the years. Due to human and agricultural activities, the quality of limited freshwater groundwater is also rapidly deteriorating.

Understanding the status of groundwater in terms of availability, distribution and quality is essential. Therefore, the study of groundwater resources in island conditions is inevitable. There is no recent study on the groundwater condition of Kavaratti Island, which is the main reason for this study.

Study Area:

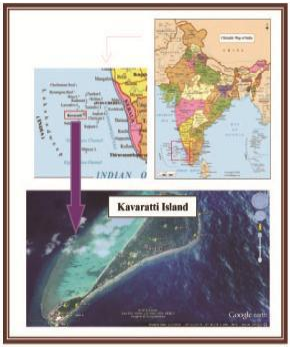

Figure: 1
Study area map

The area selected for the study is Kavaratti Island which is the second most densely populated island in Lakshadweep and consequently the demand for water is quite high. The land area under open space fall only 13.05% of total land which is quite less when comparing the overall average of approximately 37.96% (Fig.1)

Materials and Methods:

For this study, we chose 7 sampling stations which included ponds and wells. The sampling stations were selected in such a way so as to cover the entire island which included three from the centre, two from the north, one from the south and one from the low-lying area.

For Physico-chemical analysis the samples were collected in 300ml glass bottles. Samples for DO and BOD were collected in narrow mouthed glass-stopped bottles of 300ml capacities without turbulence and agitation and fixed by adding 2ml of Winkler A and Winkler B. All the samples were transported to the lab for further analysis.

For microbiological analysis, the samples were collected in 300ml sterilized glass bottles which were then immediately transported to the lab for further analysis. Water usage pattern of the Island has been collected through questionnaire. The information on the hydrology of the area was collected through secondary data. The length and depth of wells and ponds were collected through hydrogeological survey.

Drinking Water Quality Standard:

Table: 1- BIS Standards for Drinking Water

Substance/characteristics	Requirement/desirable limit
P^H	6.5-8.5
Conductivity (µS)	200-800
TDS (mg/L)	500
Turbidity	5
Alkalinity (mg/L)	200
Chloride (as Cl) (mg/L)	250

Total hardness (as $CaCO_3$) (mg/L)	300
Calcium (as Ca) (mg/L)	75
Magnesium (as Mg) (mg/L)	50
Salinity (ppt) (mg/L)	<0.6 -good 0.6-0.9 -fair 0.9-1.2 -poor >1.2 -unacceptable
Total coliform (mpn/100mL)	50
Faecal coliform (mpn/100mL)	0

(BIS 10500-2012)

Bathing Water Quality Standard:

Table: 2- CPCB Standards for Bathing Water

Substance/characteristics	Requirement/desirable limit
pH	6.5-8.5
Conductivity (µS)	200-800
TDS (mg/L)	500
Turbidity	5
Alkalinity (mg/L)	200
Chloride (as Cl) (mg/L)	250
Total hardness (as $CaCO_3$) (mg/L)	300
Calcium (as Ca) (mg/L)	75
Magnesium (as Mg) (mg/L)	50
Salinity (ppt) (mg/L)	<0.6 -good 0.6-0.9 -fair 0.9-1.2 -poor >1.2 -unacceptable
DO (mg/L)	5

BOD (mg/L)	3.0
Total coliform (mpn/100mL)	500
Faecal coliform (mpn/100mL)	500 – Desirable 2500 – Maximum

(CPCB bathing water quality standard)

Result:

Here, among the 14 physical, chemical and microbiological parameters studied, total hardness, magnesium hardness, chloride, salinity, conductivity and TDS were found to be higher in all the sampling stations and much more than its normal range at the chicken neck station. The main reason for this is the salt water intrusion. In Lakshadweep Island, groundwater table is near to sea water and therefore salt water is easily mixed with groundwater which may be the reason for the increase in the value of the above parameters.

Table: 3- Hydrogeological Information of Sampling Stations

Station No.	Observed Sites	Latitude and longitude	Water thickness (m)	Total depth of well / pond below ground level	If pump fitted HP	No. of persons using the well or Pond
1	Purathpally Pond	10.561518 N 72.637920 E	1.5	1.5	-	45
2	Purathpally Well	10.561648 N 72.637803 E	0.9	3.1	0.5	75
3	Juma-athpally Pond	10.568621 N 72.643336 E	1.1	1.1	0.5	200
4	Hilrupally	10.574824 N	1		-	50

	Pond	72.646877 E		1		
5	Hilrupally Well	10.574883 N 72.646987 E	0.6	2.7	0.5	20
6	Chicken Neck Well	10.547473 N 72.623325 E	0.95	2.95	0.5	0
7	JBS East Well	10.565189 N 72.646906 E	1	3.0	0.5	35

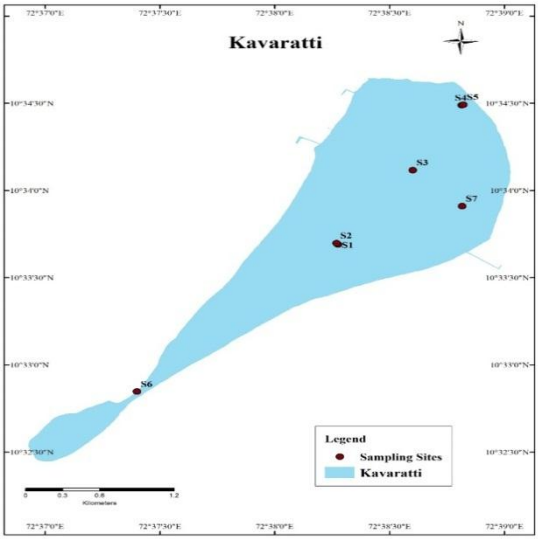

Figure: 2- Sampling Station

Groundwater Usage Pattern:

A small survey was done to find out the groundwater usage pattern in Kavaratti Island (Table 2). From the table it can be understood that people in the salty area are most dependent on LTTD water as well as rain water as their well water is terribly salty and has more

hardness. People in low land areas mostly depend on well water. Some of them use LTTD for drinking purpose. The rest of the people in the high land and normal area use well water and LTTD water for their daily use. Those who have a rain water tank also use it.

Table: 4 Survey Outcomes

House Number	Latitude and Longitude	Location type	Water Usage		
			Well (ml)	LTTD (ml)	RWHT (ml)
1	10.557834 N 72.630614 E	Salty Area	500	400	0
2	10.566886 N 72.642939 E	Low Land Area	1050	0	0
3	10.554521 N 72.628084 E	Salty Area	1000	75	60
4	10.564390 N 72.646083 E	High Land Area	500	12	0
5	10.565599 N 72.638534 E	High Land Area	500	0	0
6	10.561402 N 72.638568 E	Normal Area	750	45	30
7	10.562310 N 72.644559 E	Normal Area	500	45	0
8	10.568767 N 72.645500 E	Low Land Area	750	30	0

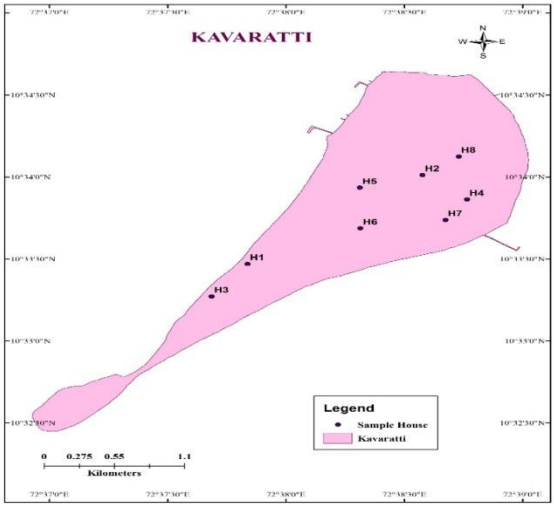

Figure: 3- Selected Houses for Survey

Discussion:

Table 5: Details of Sampling Spots

Sampling sites	TDS (mg/l)	Conductivity (µs)	Chloride (mg/l)	Salinity (mg/l)	TH (mg/l)	MH (mg/l)	TC (MPN/ 100ml)	FC (MPN/ 100ml)
PurathPally Pond	583.7	871.2	99.9	0.18	345	63	43	9
Purathpally Well	513.5	766.5	52.4	0.09	360	71	240	**240**
Juma-athpally Pond	230.4	344	59.9	0.10	130	20	**460**	43
Hilrupally Pond	869.3	1297	287.4	0.51	410	82	240	4
Hilrupally Well	804.5	1200	249.9	0.30	425	83	**460**	93
Chicken neck well	**4643**	**6931**	**4138**	**7.47**	**1165**	**262**	4	0
JBS East well	645.2	963	89.9	0.16	540	123	-	-

(TH-Total Hardness, MH-Magnesium Hardness, TC-Total Coliform & FC-Faecal Coliform)

The total dissolved solids varied from 230 mg/l in station 3 to 4643 mg/1 in station 6 (Table 5). The permissible limit of TDS is 500mg/l as per BIS for drinking waters and CPCB for bathing waters (Table 1&2). This shows that the level of total dissolved solids in fresh water tends to increase, and the TDS of most well water is above the required limit. This is a sign of seawater intrusion that increases the salinity of the water. This observation is similar to the data recorded by Madan Nanoti in (1989). He highlighted the high value of the densely populated areas in the southeast of the island and proposed a way to control water extraction. Near future. Water with a high total dissolved solids content shows a higher ion concentration, has a lower palatability and can cause undesirable physical and chemical reactions to consumers. Too high a total hardness concentration is not harmful to health, but it will prevent the soap from foaming and increasing the boiling point of the water. It is recommended that patients with high blood pressure or congenital heart disease limit their dietary sodium intake. High sodium intake can be dangerous. For people who are not accustomed to high concentrations of C1" in water, it has a laxative effect. A high concentration of SO42" can cause an electric charge reaction in humans and can also cause others. Side effects. respiratory problems (Madhusoodanan Pillai, G, et.al., (2002)).

The conductivity fluctuated from 344µS in station 3 to 6931µS in station 6 (Table 5). The desirable conductivity value as per BIS in drinking water and CPCB in bathing water is 200-800µS (Table 1&2). Most stations show a high conductivity value, beyond that. This is a clear indication of the popularity of the finds on the island.

The chloride content varied from 52.4mg/l (Station 2) to 4138.7mg/l (Table 5). The desirable chloride value is 250mg/l as per BIS in drinking water and CPCB in bathing water (Table 1&2). From this study stations 1,2,3,5 and 7 are below the limit value and station 4 has slight difference

from the limit value. But in the case of station 6, the value is much higher than the limit value. This station is very close to seawater. Here, seawater intrusion can be easily completed without any extraction. The high chloride concentration in groundwater can be attributed to the influence of salt water intrusion and tidal recharge. The high-power motor removal process improves the brine mixture. (Raheem, P., et.al, (2018))

Ca2 and Mg2 are the main ions responsible for total hardness (Rao et al., (2012)). The hardness of the water determines if the water is suitable for life, industry and drink. The hardness value recorded from 130mg/l (station 3) to 1165mg/l (Table 5). According to BIS for drinking water and CPCB for bathing water, the maximum permissible limit of total hardness as CaCo3 for drinking and bathing water is 300 mg/l and hence only the station 3 (130mg/l) come within the maximum permissible limit. The hardness of water can be due to the presence of higher levels of calcium and magnesium. Values with high hardness can be caused by crunchy lith stimulation and bicarbonate in coral reefs. Another main source is the presence of marine organisms with calcium shells. The calcium leaching process of these skins is mixed with groundwater to increase the level of calcium. The penetration of salt also contributes to the hardness of groundwater. (Raheem, P., et.al., (2018))

Mg2 is an ion necessary for cell function during enzyme activation, but at higher concentrations, it is considered a laxative. (Garg et al., (2009)). The acceptable limit of magnesium concentration is 50mg/l as per BIS in drinking water and CPCB in bathing water (Table 1&2). In the present study, the concentration of magnesium in samples ranges from 20mg/l (station 3) to 262mg/l (station 6), which indicates that Mg concentration, is high in most of the samples analysed from the study area. Even in the case of calcium precipitation due to supersaturation, the magnesium concentration can be increased. This, combined with the seawater mixture, results in a Mg:Ca ratio in certain areas. The magnesium: calcium ratio in

seawater is very high. This is because marine organisms consume more calcium. The mixed area of the island has a slight magnesium: calcium ratio. (Najeeb and Vinayachandran., (2013)).

Salinity is a major water quality issue on the island for an obvious reason. The severity of the problem depends on the distance of the well from the sea well and the season. (Prasad, N. N., (2005)). In the present study, the salinity of the study area ranges from 0.09ppt (station 2) to 7.4ppt (station 6) (Table 5). Higher salinity is due to the effect of sea water intrusion. According to the salinity classification less than 0.6 is the acceptable limit of salinity (Table 1&2) as per BIS in drinking water and CPCB in bathing water. Based on this, all stations are within the limit except the station 6. When the dissolved solid increases the salinity also increases.

Total coliforms count ranged from 4 mpn/100 ml in station 6 to 460 mpn/100 ml in Station 3 and 5. The BIS limit of drinking water is 50 mpn/100ml and the CPCB limit for bathing waters is 500 mpn/100ml. according to this study, all pond waters or bathing waters have a total coliform within the limit, but in the case of well waters or drinking waters, all the wells have a total coliform value cross the permissible limit. The occurrence of coliforms reveals the severity of contamination.

FC was enumerated in all water samples. The maximum count of faecal coliforms was 240 mpn/100ml in station 3 and the minimum count of faecal coliform was nil mpn/100ml in station 6. Except station 6, all the well water or drinking water samples are highly contaminated by faecal coliform.

In Lakshadweep, since the ability to receive well water is limited to assimilation, waste from human activity. The high density of population combined with frequent emissions of untreated domestic waste is a factor that contributes to cross pollution of well water instead of preventing it. As the natural purification capacity of this receptive water decreases, faecal contamination in basic water quality increases from 1 to 3 digits. Here, the very

low depth of the wells also increases the contamination of the surface of the water source by the stored residues. It is also found that the level increase in high tides increases epidemiologically important faecal bacteria in drinking water. (Madhusoodanan Pillai et al., (2001)). The authors report that the number of coliforms in faces collected from excavated well water during Kavaratti's low tide and high tide increased by 2 to 100 times. Research conducted on Kadmat Island in 1999 also showed that the microbiological and physicochemical properties of the excavated well water have increased significantly.

But when we compared the present study with the previous one, the amount of total and faecal coliform was high in previous data. For example, in a study by G. Madhusoodansn Pillai on the 'Coastal and Ground Water Pollution in Kavaratti Island, Lakshadweep Sea', the total coliform value ranged between 0 – 140000 cfu/ 100ml in 1997, 0 – 21000 cfu/100ml in 1999, 27 – 8500 cfu/100ml in 2000 and 8 – 27000 cfu/100ml in 2001. In the present study the total coliform value ranged between 4 – 460 MPN/100ml. In the case of faecal coliform, the previous study values ranged between 40×10^{12} cfu/100ml in 1997, 3800 cfu/100ml in 1999, 400 cfu/100ml in 2000 and 176 cfu/100ml in 2001. In the present study the values ranged between 0 – 240 MPN/100ml. This decline followed the establishment of a bio-toilet, a device used to accelerate the anaerobic microbial decomposition of organic waste by using a complex of micro-organisms. creature. This can help reduce the amount of manure contaminating groundwater. In Kavaratti Island, 860 biological toilets are made by Department of Science & Technology coincide with Defence Research and Development Establishment (DRDE), Gwalior.

The study proves that water quality management remains critical in Lakshadweep Islands since the ground water lens is continuously subjected to overdraft and bacterial contamination.

Lakshadweep government implemented many practices like biological toilets for the sustainable

management of groundwater. The LTTD plant implementation in 2005 by the Lakshadweep administration has also resulted in groundwater consumption. Similarly, the Rain Water Harvesting Tank implemented by the Lakshadweep government in 2001, also has also helped a lot in regulating groundwater usage. Therefore, continuous analysis of groundwater status is mandatory which is being done by the Lakshadweep Science and Technology department. It is imperative that the people work together with the government to protect groundwater

Suggestions:

On the basis of my study, the following measures have been suggested for sustainable development of the limited ground water resources in Kavaratti Islands

- Regulation of groundwater development.
- Encourage the construction of septic tanks instead of leakage pits to control microbial contamination of groundwater.
- Renovation, restoration, rehabilitation and protection of ponds. Land use and cropping pattern suitable for the hydro geological settings of islands.
- Periodic monitoring of water level and quality.
- Awareness and education about the importance of water, rainwater harvesting and water conservation

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Effect of Air Pollution on Health

Sahana Ghosh

Abstract:

One of the era's greatest bane is air pollution. Many studies had been done validating that air pollution drives adverse effects on human health associated to respiratory diseases. These effects could be short-term and long-term depending on the concentrations of air pollutants and period of exposure. Air pollutants of variable sizes could penetrate the respiratory system via inhalation, spawning cardiovascular diseases, cancer, reproductive and central nervous system dysfunctions beside respiratory problems. This review work was done to detect the different sources of air pollutants and the underlying factors which made an effect on COPD. Intensive research work needed to find out ways that could protect the living beings from the harsh environment.

Keywords: *Chronic obstructive pulmonary disease, Cancer, Air pollution, Asthma, Particulates Matter.*

Introduction:

Human activities influence the environment adversely. Environment is the mixture of biotic (living organisms) and abiotic (atmosphere, hydrosphere and lithosphere) features. Worldwide a major public health issue is air pollution. In fast growing countries where industrialization is in full swing for many years, air pollution is more severe due to high energy consumption, demolition in large scale, constructions of skyscrapers, urbanization. It is the main reason behind morbidity and mortality. Study revealed that in 2015 worldwide, exposure to $PM_{2.5}$ led to 4.2 million deaths and 103.1 million disability-adjusted life years (DALYs), accounting 4.2% global DALYs and 7.6% total global deaths. The term DAILYs (Disability-adjusted life years) was introduced by

WHO (World Health Organization). In the year 2017, ambient particulate matter (PM) pollution became the fourth-largest health risk factor, which cause damage to multiple organs of human body. Of which respiratory tract and delicate soft organs in human body, on exposure to surroundings are highly vulnerable to pollutants. COPD (chronic obstructive pulmonary disease) is a heterogeneous disease associated with exposure to noxious particles. Day by day cases of COPD have increased. Global prevalence of COPD is approximately 174 million, estimated from the Global Burden of Disease (GBD) study. Cough, shortness of breath, wheezing, asthma, COPD, respiratory disease result on short-term exposure to air pollution whereas cardiovascular diseases, cardiovascular mortality, pulmonary insufficiency and chronic asthma result on long-term effects of air pollution. COPD globally has become the third leading cause of death and fifth leading cause of disease in 2020, according to the World Health Organization (WHO). There are many factors responsible for COPD like smoking, air pollution, respiratory infection and genetic factors. Nowadays many studies have been conducted to explore the effects of COPD. This review focuses on the factors responsible for air pollution and its significant health effects on different parts and organs of human body and on COPD.

Sources of Air Pollution:

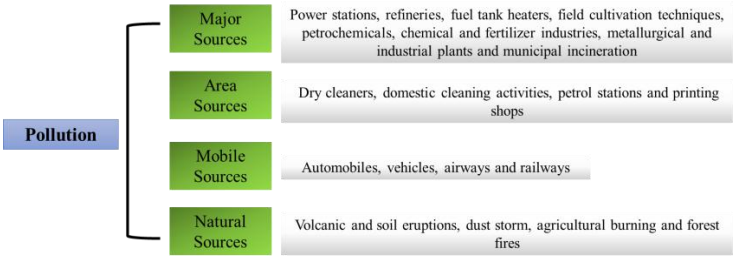

Figure 1. Classification of Air Pollution on the Basis of the Sources Producing Pollution

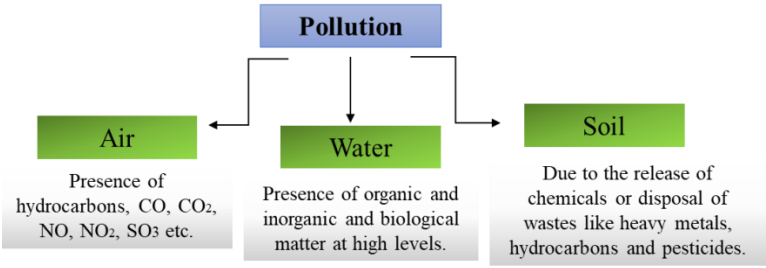

Figure 2. Classification of Air Pollution According to the Recipient of the Pollution

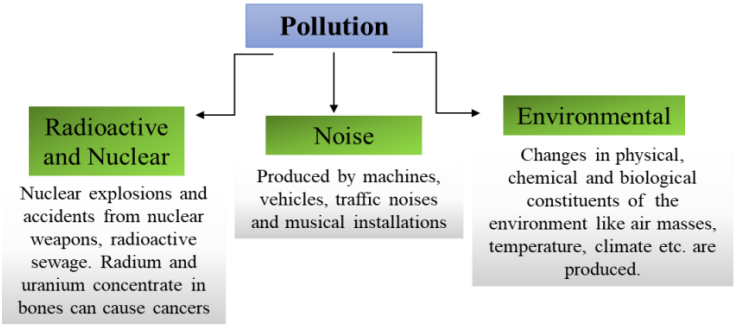

Figure 3. Classification of Air Pollution According to the Types of Origin

Depending on the ability for producing toxic effects, pollutants have physical and chemical properties. As for example, due to tiny size in the atmosphere, aerosol compounds have greater toxicity than gaseous compounds and have greater penetration capacity. Respiratory system has the ability to eliminate gaseous compounds more easily. Aerosols can even enter the bloodstream, leading to premature deaths. In addition to these, aerosols acidity ([H+]) seems to increase the production of secondary organic aerosols (SOA), but not much is known about its function yet. Further research work is carrying out.

Particle size	Particle size Penetration degree in human respiratory system
>11 µm	Passage into nostrils and upper respiratory tract
7–11 µm	Passage into nasal cavity

4.7–7 µm	Passage into larynx
3.3–4.7 µm	Passage into trachea-bronchial area
2.1–3.3 µm	Secondary bronchial area passage
1.1–2.1 µm	Terminal bronchial area passage
0.65–1.1 µm	Bronchioles penetrability
0.43–0.65 µm	Alveolar penetrability

Table 1. Penetration According to Particle Size

Air Pollution - Effect on Health:

The most predominant air pollutants are Particulates Matter (PM), benzene, dust and ground-level ozone. People on exposure to different concentrations of air pollutants face lesser or serious health hazards, which are divided into short- and long-term effects on human health depending on the levels and time of exposure to pollutants. Short-term effects comprise of coughing and chest tightness, wheezing, breathing difficulties, headaches, dizziness, nausea, irritation of eyes, nose, skin, throat to more serious cases of asthma, pneumonia, lung problems, bronchitis and heart problems. And on long-term exposure leads to respiratory problems, neurological, reproductive impairments, cancer and even rarely deaths. Health effects depends on country, area, season and time. Major factors responsible for COPD are of the long-term effects from industrial air pollution, polluted gases releasing from vehicles.

In case of heart, cardiovascular effects have also been noted on unmasking to air pollution. Further reports suggested that long-term exposure to traffic pollutions lead to coronary arteriosclerosis and ventricle hypertrophy is seen in humans on long-term exposure to nitrogen oxide (NO_2). And short-term exposure leads to stroke, heart insufficiency, hypertension and myocardial infracts. In case of adults and children, on exposure to air pollution at a stretch escort to neurological effects. Other complications that have been observed are autism, fetal growth,

psychological complications and low birth weight on long-term air pollution. The aspects for the development of neurodegenerative disease include inflammation, protein aggregation, oxidative stress and mitochondrial impairment in neurons **Figure 4**.

Investigations and extensive study showed that in Mexico, dogs living in highly polluted area for a long period of time suffered brain inflammation. In case of human adults, markers of systemic inflammation namely IL-6 and fibrinogen were observed to increase leading to the generation of acute-phase proteins. Study also showed that by long-term air pollution, oxidative stress and atherosclerosis are involved in the neurological disturbances. First comes oxidative stress and then inflammation that appears to be involved in the impairment of developmental maturation, affecting multiple organs. Nevertheless, diet is another decisive factor starting from breast-feeding. Diet is the main source of antioxidants, which play a pivotal role in protection of human against air pollutants. Antioxidants are the free radical scavengers. They prevent the interaction of free radicles in the brain. As for example, study showed that in asthmatic children homozygous for the GSTM1 null allele, antioxidant supplementation with vitamins C and E shows to modulate the effect of ozone.

In children after lead exposure, neurodevelopmental morbidities were observed. These effected children developed reduced intelligence, hyperactivity, delinquent behaviour, aggressive behaviour and learning difficulties. Due to poor air quality, immune system becomes dysfunction and neuroinflammation but still increase in the levels of IgA, IgM and complement proteins C3 are observed. Beside these there is another problem, which is, antigen presentation is affected by air pollution. In case of skin, ultraviolet radiation (UVR) plays the key role in skin diseases. Pollutants like as Polycyclic Aromatic Hydrocarbons (PAHs), Volatile Organic Compounds (VOCs), oxides, and PM are responsible for causing pigmented spots on human body skin. The

pollutants absorbed by the human skin confer skin aging, eczema, atopic dermatitis, psoriasis, urticarial and acne. Above all, pollutants can also cause skin cancer.

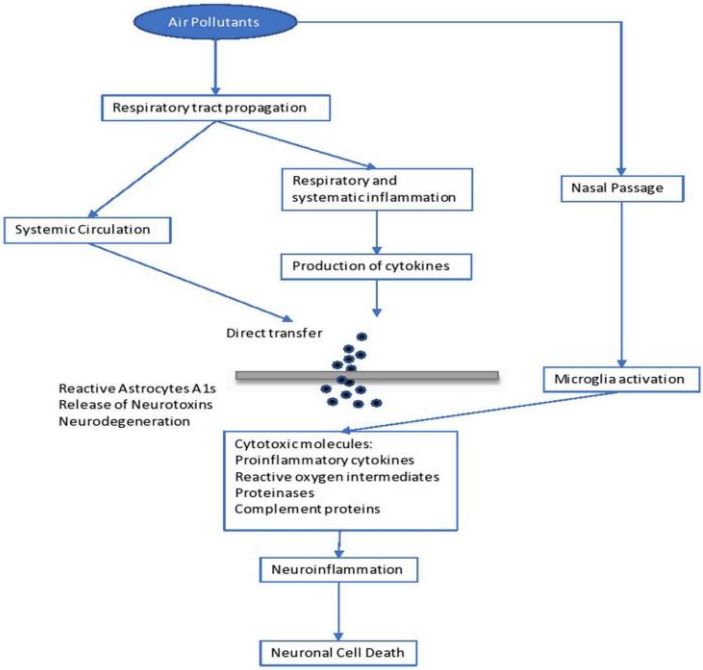

Figure 4. **Impact of Air Pollutants on the Brain**

Link Between Air Pollution and Lung Disease:

When people breathe in the air, air pollutants go deep into their lungs, causing serious damages to the lungs and respiratory tract. Lung is one of the delicate and soft organ in our body. So, damages in lung leads to serious health hazard triggering new cases of asthma, provoke the progression of chronic illnesses like COPD, lung cancer and emphysema.

Asthma: It is a chronic disease of lungs which is caused due to inflammation and narrowing of the airways, resulting in chest tightness, wheezing, shortness of breath and coughing. At present asthma is non curable and so the damage done to the lung tissues may lead to permanent

damage. But if it is untreated if can be fatal. In U.S., over 20 million people including children gasp for breathing because of asthma. There are many external stimuli that triggers asthma like pollen, dust, smoke, volatile compounds and outdoor pollutants (carbon monoxide, ozone, nitrogen oxides and sulphur oxides).

There is a connection between asthma and ozone. Ozone is one of the most important and widespread air pollutants. Increase in ozone lead to asthma and other lung diseases. People suffering in severe asthma problem, for them symptoms increase even when ozone level falls under the threshold level made by the EPA. Above all, increase levels of ozone aggravate heart problems like angina.

COPD, Chronic Bronchitis and Emphysema: COPD is another case of lung infection which is characterized by narrowing of the airways and causes permanent lung damage. COPD is caused due to inflammation, an immunological response, which is referred to as chronic bronchitis.

Lung Cancer: Lung cancer is associated with smoking tobacco. Beside this there are many other factors for developing lung cancer such as air pollution. Due to lung cancer the mortality rate is affected by particulate matter and ozone.

Pathogenic Effect of Air Pollution on COPD: Recent research revealed that certain factors are there which makes an effect on COPD. These factors include inflammatory damage, oxidative stress and genetic damage.

Inflammatory Damage: COPD occurs due to chronic inflammation of airways and the lung parenchyma, increase in inflammatory factors such as interleukin-6 (IL-6), IL-8 and tumor necrosis factor-a (TNF-a) and accumulation of inflammatory cells. On inhalation of $PM_{2.5}$, lung macrophages engulf them, stimulating the release of inflammatory factors. These factors on the other hand get accumulated in the damaged areas and enhance inflammatory cells to release more inflammatory factors,

thereby damages lung endothelial cells and further aggravates lung injury.

Oxidative Stress Damage: Free radicals especially oxygen free radicals play a key role in COPD pathogenesis. Oxygen free radicals are generated by PM, which after inhalation enhance cells to produce many reactive oxygen species (ROS). PM carrying metal ions and organic matter also induce ROS production. This ROS induce oxidative stress to the lung cells and damage them.

Genetic Damage: Further report showed that in cells chromosomal changes occur on exposure to air pollution, and this depends on the concentration of pollutants present in the air. Production of ROS on damage of lung epithelial cells and alveolar macrophages, leads to DNA damage and changes in gene expression. DNA modifications like DNA methylation, non-coding RNA modification and histone modification are the characteristics of epigenetic changes in gene expression. Air pollutants have the capacity to alter epigenetic modifications. Nitric oxide, considered a sensitive marker, present in air can inflame the air passages in COPD patients, if inhaled. Study conducted in Shanghai exhibited that there is a relationship between $PM_{2.5}$ and DNA methylation in COPD. This study found that $PM_{2.5}$ may regulate the production of FeNO by changing methylation markers in the NOS2A promoter region and further aggravating inflammation in the airway.

Discussion:

Evidences showed that air pollution is strongly associated with respiratory diseases like COPD. For the development of COPD, both the short-term and long-term exposure are responsible. Therefore, air pollution needs to be controlled to prevent these detrimental diseases. Comprehensive clinical studies and in-depth research works are needed that will cure the patients and above all policies need to be made to eliminate air pollution globally.

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Impact of Brick Kiln Industry on Environment and Society: Case Study of Diamond Harbour Block 1, West Bengal

Sumana Mondal

Abstract:

Brick kiln industry is the traditional industry of west Bengal; mainly southern part of west Bengal. The silted topography of deltaic region of south 24 paraganas is uniquely suited for making bricks. But the industry has some negative and positive consequences on physical and social environment. The present paper tries to reveals various impacts of brick kiln industry on environment and society. The work mainly based on primary data. Stratified random sampling has been made to fulfill the sample design. A simple random sample of 10 full time employees in brick kiln and 100 bonded labors are selected as a sample. Questionnaire survey has been done on them. Quantitative techniques are used for describe, analyses and interpret the data. The findings indicate that brick kiln industry causes very adverse impact on air. It generates different types of social issues like migration, occupational hazards related to vicious cycle of poverty.

Keywords: *Brick kiln, Pollution, Erosion, labour.*

Introduction:

Brick making is the pre dominantly rural industry. The Gangetic plains of North India including the states of Assam, Bihar, Haryana, Punjab, Uttar Pradesh (UP), and West Bengal account for nearly 65%of the total brick production of India. Central Pollution Control Board has denoted the brick production industry as highly resource and energy intensive and polluting industry. Owning to

existence of obsolete production technologies while the clusters are the source of local air pollution. This field also related to some socio-economic issues. Some socio economic and occupational hazards like extremes poverty, worse effect of child labour, bonded labour, violence against women and children. But, the people of different stages of our society get benefited from this industry. So that its need to find out the opportunity how to reduce environmental and social hazard through this micro level case study.

Statement of the Problem:

The brickfields in Diamond Harbor Block 1 have been set up for nearly 60-80 years ago. The silted topography of the region is uniquely suited for making bricks from long historical past; the Britishers primarily established the brick kiln in this place. They follow the traditional technology for producing the bricks. Brick production in this area is highly labour intensive. But the industry has some negative and positive impacts on physical, social and economic environment. In spite of adverse effects, the people of different stages of our society get benefited from this industry. So, it is necessary to highlight the basic problems of brick industry and find out the opportunity how to reduce environmental and social hazard through this micro level case study on Diamond Harbour Block-I of South 24 Paraganas and identifying the remedies of produce green bricks

Objectives of the Study:

The following objectives have been the main focus of the study.

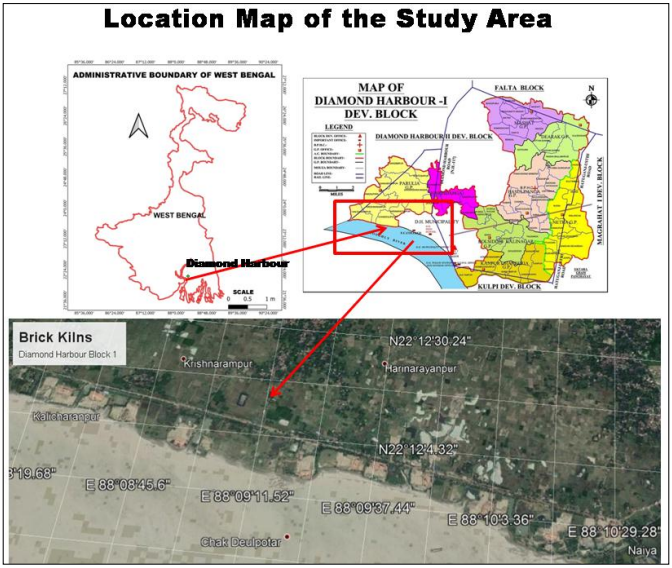
- **A.** To report the air pollution level in this area from different brick kilns.
- **B.** To discuss the negative impacts on the Hugli River bank at Diamond Harbour block-I
- **C.** To highlight its impacts on society, like migration, bonded labour, Child labour, violence against women and children etc.
- **D.** To highlight details of occupational hazards like health problems related to work at brick kiln.

Research Questions:

What are the majors environmental and socio-economic issues of brick kiln industry? In terms of air pollution or air quality degradation, issues of seasonal migration, occupational hazard and others vicious cycle of poverty.

Location and Background of the Study Area:

Diamond Harbour block-I is located at the left bank of River Hugli. The brick kilns were primarily established in this place by the British at the bank of the Hugli River during the 17th century. After independence, some local entrepreneurs have been attempts to introduce improved technologies, but the rate of improvement was slow. There are 13 number brick kilns are observed along the left bank of the river Hugli at Diamond Harbour block-I which were established after 1995. The Gangetic delta region provided vast source of raw materials and others equipment more cheaply. The kilns are geographically extended from 88°08'40"E to 88°10'40" E and 22°11'42"N to 22°12'05"N (approx).100-150 acre areas are covered under the brick kiln units.



Methodology:

1. **Population:** There are total 13 numbers of brick kiln are situated in diamond harbor block-I among them 10 brick kilns were selected for the study.
2. **Sample:** To draw a sample of sample of 110 workers, a simple random sample of 10 full time employees (manager of the brick kilns) were selected as simple random sample and simple random sample of 100 contractual bonded labour were selected.
3. **Sampling Procedure:** First of all the population is divided into two groups or strata eg a. full time employee (manager of the brick kilns) b. contractual bonded labour. Then a simple random sample is drawn from each stratum. So, the stratified random sampling techniques are used here.
4. **Tools:** For collect the data for detailed study researchers make a questionnaire as a research tool. Questionnaire Survey set according to four-point Likert Scale and access various derivational factors include (a) Air Pollution (b) occupational hazard etc.
5. **Collection of Data:** Data was collected by the purposive questionnaire survey within the brick fields of diamond harbor block 1.
6. **Analysis of Data:** Primary database has been collected by the questionnaire survey. Useful maps and diagrams are collected from atlas, Google Earth software. Systematically all primary and secondary data are drawn together. Statistical techniques are applied to illustrate and justify the objectives. The researchers analyzed the data from questionnaire survey by using software package Excel and Q-GIS.

Findings: In Diamond Harbour block-I impacts like deterioration of air and soil quality toward the wind direction of the brick kiln cluster are commonly observed.

1. **Adverse Impact on Air:**

According to Central Pollution Control Board "air pollutant" means any solid, liquid or gaseous substance present in the atmosphere in such concentration as may be

or tend to be hazardous to human beings or other living creatures or plants or property or environment, as the cluster of brick kilns in Diamond Harbour Block I followed traditional characteristics of semi-mechanized units, like fixed chimney kiln. Characteristics of the chimney and kiln capacity are related to air pollution. Most of the Chimney Height in this area are among 65-120ft. Chamber Width are within 20-30ft. Chamber Height 5-10ft. Kiln capacity of this area under 4000-40000 bricks per day in the peak seasons. There is no gravity settling chambers gravity settling. This results in deposition of the particulate matter in the settling chamber thereby reducing the ambient air emission but absent of gravity settling chamber that causes major air pollution in this area. Mainly Fixed Chimney Kiln has been the paramount technology practiced all over the block. It is estimated that almost 90% of air pollution of brick kiln are related with Combustion of coal and other biomass fuels (The energy use is 30-35 % of production cost). Ministry of Environment and Forest has recognized the brick kiln pollution according their trench capacity and daily production (Table-1):

Kiln Capacity/day	Size	Trench Width	SPM mg
<15000	Small	<15ft	1000
15000-30000	Medium	15-22ft	750
>30000	Large	>22ft	750
Source: Ministry Of Environment and Forest, the Gazette of India, Part II,2009			

Table-1

Air pollutant observed in different brick kiln daily during the working season (October –April) in different brick kilns of Diamond Harbour Block I are bellow: (Table-2)

Sites	Total Productio n/Day	Approximate Emission According to Daily Production in kg/day				
		SPM	PM 2.5	SO_2	CO	CO_2
1	40000	137.6	28.8	105.6	360	18400
2	45000	154.8	32.4	118.8	405	20700
3	20000	68.8	14.4	52.8	180	9200
4	10000	34.4	7.2	26.4	90	4600
5	30000	103.2	21.6	79.2	270	13800
6	20000	68.8	14.4	52.8	180	9200
7	30000	103.2	21.6	79.2	270	13800
8	8000	27.5	5.8	21.1	72	3680
9	8000	27.5	5.8	21.1	72	3680
10	35000	120.4	25.2	92.4	315	16100

Table-2

Coal being used as the principal fuel for brick production results in the release of several air pollutants in atmosphere which includes Suspended particulate matter, Respirable suspended particulate matter (PM2.5), sulphur dioxide (SO2), carbon dioxide (CO2), and carbon monoxide (CO). Amount of Co_2 and Suspended Particulate Matter is very high.

SPM is generated mainly due to incomplete combustion of fuel (Black Smoke) or come from fine coal dust ash present in coal and burnt clay Particles. Carbon monoxide (CO) also generated due to incomplete combustion of fuel. Dust fall in this site is very high, dust pollution generated during removal and lying down of ash layer on the top of the kiln and also due to blowing of ash stacked on the top and side of the kiln. Air Quality Index of this sites in non-operational stage and operational stage are taken (Table-3) which indicates the significant changes of the air quality in this area.

Sites	Air Quality in NON Operational Phase		Air Quality in Operational Phase	
	AQI µg/m^3	Remarks	AQI µg/m^3	Remarks
1	26	Fair	145	Unhealthy
2	28	Fair	148	Unhealthy
3	22	Fair	136	Unhealthy
4	25	Fair	130	Unhealthy
5	24	Fair	140	Unhealthy
6	25	Fair	136	Unhealthy
7	26	Fair	140	Unhealthy
8	26	Fair	125	Unhealthy
9	28	Fair	128	Unhealthy
10	26	Fair	145	Unhealthy

Table-3

2. Adverse Impact on Land:

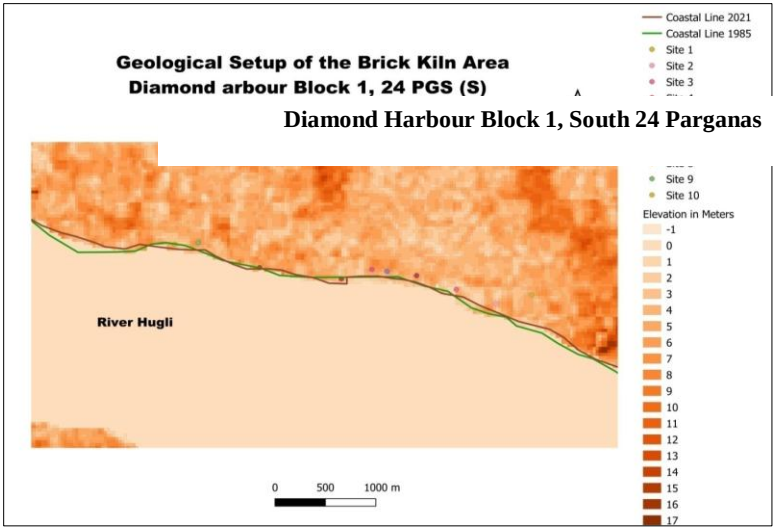
1986 The Central Government declared the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which were influenced by tidal action (in the landward side) up to 500 meters from the High Tide Line (HTL) and the land in between the Low Tide Line (LTL) and the HTL as Coastal Regulation Zone (Source: MoEF, Govt. of India) According to Integrated Coastal Zone Management Plan For West Bengal Diamond Harbour demarked CRZ II (Sea water tidal traverse along river Hugli up to south of Diamond Harbour Municipality and on the west upto Haldia port not above Diamond Harbour as required under CRZ notification) central sector.

A. Characteristics of the Estuary and Impacts of Soil and Sand Collection:

According to PMSL data distance of the Diamond Harbour block from Bay of Bengal is 70.1 km. Estuary width 1.88 km. Tidal range 5.04 meters, local mean water level 0.48 meters. Stream velocity highest in the month of July 0.22m/sec. On the basis of PMSL data it is assumed that after 10years later sea level may raise 20metres the

brick kilns will be destroyed under water. Approx 40000 tons Clay and approx 250 tons sand are collected monthly from the river beds for bricks making of 10 brick kilns during the ebb tide. As the river bank erosion highly observed in this area so unscientifically collection of clay and sand by the unskilled labour sometimes very harmful for estuary. The geological setup of the brick kiln area of Diamond Harbour block 1 are described below (Fig-1).

Fig-1

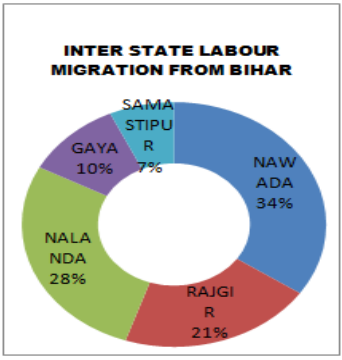


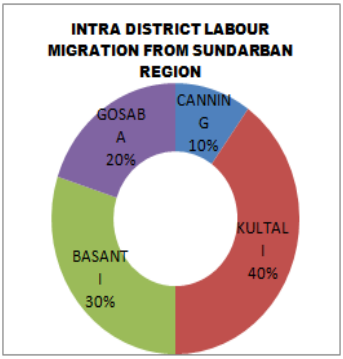
B. High Risk of River Bank Erosion and Subsidence:

Most of the brick kilns are situated among the 50metres of the Hugli River. According to the River Regulation Act the land is not safe for any industrial work. But they extract the soil for commercial purpose from gigantic area of the river bank and alluvial clay from the river during ebb tide .it might cause high rate of soil erosion some times its accompanies land subsidence. The area is also flood prone for its lower elevation. This is also great threat to ten thousand labour families, who lived at the slum area of brick kilns and surroundings.

3. Migration of Labour Family:

In Diamond Harbour Block I brick kiln are run by seasonal migrant labours coming from different districts of Bihar (56.42 percent) like as Nawada, Rajgir, Nalanda, Gaya,Jamui . In case of intra district migration, it is reported that 12.73 percent workers work in this block are





from Sundarban region among which 1.65 % labour are from Canning.10.26 % labour are migrated from Kultali.7.69 % labour are from Basanti and 5.13 % labour are from Gosaba village. Migration had both positive and negative effect. Positive effect included assured employment and income during lean period, it helped in procuring agricultural inputs for next monsoon season. Negative effect included loss of identity, loss of education for children, exploitation of children, family disputes, health hazards etc.

4. Bonded Labour:

The worker works in this kiln are bonded labour. The contractor collects workers for the brickfields from remote villages by paying *dadan*_or money advance to impoverished families and brings the worker from Bihar or Sundarban to Diamond Harbour it is also known as debt slavery. It is reported during primary survey that usually most of the poor families took cash advances ranged from Rs.5000 to Rs.7000. *Dadan* or the advance payment seems lucrative to a worker who is without regular employment and already under economic pressure due to dearth of money in the village. Kiln owner do an agreement

to ensure them employment for a stretch of six months November to April, season of brick making paid them. The *dadan*-workers are requisite to pay-off the advance by working for the contractor without any direct cash payment of wages instead of weakly per head subsistence rupees 500, known as kho*raki.*

5. Seasonal Unemployment:

During the peak times the months of November to April six month they work in the brick kiln but they would be unemployed during the off season When the brick kiln works are not available, they engage themselves in other activities like as agriculture work, rickshaw pulling and other works in their home land.

6. Child Labour:

Child labour has become one of the social issues in unorganized sector. Child workers (aged 5 to 17 years) in the brick kiln of Diamond Harbour block-I are not very high. Poverty is the main reason which forces poor children to accept the hazardous jobs like: work in the brick kiln and forgetting their childhood. Emotional loss, educational loss and incurred health problems. Because of family economic hardship and about 50% of the households believed that their living standards would decline if their children stopped working. Among child workers who live in brick factory compounds, their primary reason is that they worked because their families worked and lived there. In the primary survey it is reported that 66.67% child work there because of their families worked and lived there.

7. **Violence:**

During field research it is reported that Labour is addicted to drinking They faced the problem of physical violence. The labour gets off half day work on every Saturday weakly called 'hapta'. On that day the men take various drugs and this day is more vulnerable for violence against women and children.

8. Occupational Hazard:

Brick manufacturing plant uses many different raw materials and produces many intermediate substances;

hazardous dust is one of the most important exposures in brick kiln workers (Table-4). In the primary field survey, it is observed that most of the workers who works in the bricks cutting and clay extracting section sustained the sicknesses like back ache, body or muscle aches, headache. The workers who are associated with coal blending section sometimes they have showed difficult breathing, eye itches different skin disease etc. As workers are exposed to high levels of dust and temperature as they showed unnecessarily tiredness and weakness in daily routine life. Working long hours in the brick kiln causes digestive disorder.

STATEMENTS	SA	A	DA	SDA	TOTAL	MEAN	SD
Coal blending causes respiratory problems, caugh etc	58	52	0	0	110	3.527273	3.02715
Digging, Moulding, Loading and Unloading of bricks causes body ache, chest pain etc.	27	62	21	0	110	3.054545	2.590191
Firing, coal blending causes Skin irritation, rashes, eye disease	56	29	25	0	110	3.281818	2.854024
Working long hours causes disestive disorder	32	45	28	5	110	2.945455	2.54058

Table-4

Strongly Disagree (SDA)=1, Disagree (DA)=2, Agree (A)=3, Strongly Agree (SA)= 4

Discussion:

Under above situation some remedial measures are necessary

1. To control environmental pollution the kiln owner should change the technology; they may shift their technology from Fixed Chimney Bull Trench kiln to natural drought Zigzag kiln which causes significance reduction in air pollution and coal consumption in this kiln is low. The primary capital cost for retrofitting is very high, so the kiln owner may improve Fixed Chimney Bull Trench Kiln by creating Gravity Settling Chamber which is the basic techniques for arresting pollutants from BTK. The kiln where daily production is >30000 may introduce cyclonic separators to filter the air pollutants.

2. Build-up taller chimneys (height above 100 meters). Tall chimneys may ensure release of pollutant at a higher height which give more time to pollutants to disperse in the

atmosphere before reaching the ground which control local air quality.

3. Engineers can improve special kiln design construction and operation thus it produces small amount of black smoke.

4. Kiln owners recommended for not to build up the kiln at least 100metres of the Hugli Rivers, which kilns are already situated under 50 meters from the river are requested to create a tree line by plantation of woody trees along the river bank. It may also ensure the supply of fuels for labour family.

5. The house provides the labour families are unhygienic. The electricity, proper clean toilet, separate kitchen should be provided by the kiln owners. Housing of the labour family should be 500meter away from the high tidal level.

6. As the labour are illiterate and the children of the workers family have not attempt school for their mobile life so Education programme for the workers of the brick kilns should be implemented for making them literate. As every Saturday they get half day leave, if education and awareness program held in this day in the form of songs, one-act-plays, short poems it also gives them recreations and if the leave time utilized by the program, violence may decrease.

Conclusion:

The brickfield owners are small entrepreneurs. Most of the owners are local Bengali traders and have inherited the brickfields as ancestral property; they renovate the kiln to increase the production. Young owners prefer to invest in other business opportunities than in the brickfields because with boom in construction activity, demand for good quality bricks is high at present. The study it is concluded, as they follow traditional technologies so that there was high level of gaseous and particulate pollutant emitted in the environments. Present study clearly reveled that air pollutant are not only major cause of environmental pollution but also a threat to health of the workers. This is a hazardous job for them. Mobility

of bonded labour creates a mixed culture social and demographic problems in the brick kiln nearby slum area. But we cannot stop brick production, thus alternative planning towards ecofriendly bricks is essential for our sustainable society.

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Air Pollution: A Brief Account on Sources, Effects on Environment and Human Health

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Meena Godha
Dinesh Kumar Jangid

Abstract:

Air pollution is the supreme scourges of this era, due to its influence on climate change as well as on individual and public health, for instance health issues and mortality increase. Many pollutants play foremost roles in disease in humans, some of them are particulate matter (PM), ozone, nitrogen oxide, sulphur dioxide, volatile organic compounds (VOCs), heavy metals, dioxins, polycyclic aromatic hydrocarbons (PAHs) and carbon monoxide. They are responsible for respiratory illnesses, cardiovascular diseases, reproductive and central nervous system dysfunctions, direct poisoning or chronic intoxication, and cancer. Respiratory diseases occurring from the aforementioned substances include chronic obstructive pulmonary disease (COPD), asthma, bronchiolitis, lung cancer, cardiovascular events, central nervous system dysfunctions, and cutaneous diseases. Lastly, climate change caused by environmental pollution affects the geographical distribution of many infectious diseases, like natural disasters. This problem can only be solved or reduced by public awareness and multidisciplinary approach by scientific experts, national and international organizations to address the occurrence of the hazard and recommend sustainable solutions.

Keywords: *air pollution, air pollutants, environmental pollution, human health.*

1. Introduction:

Multiple human activities influence the environment, so the interactions between humans and their physical surroundings have been extensively studied. The biotic (living organisms, and microorganisms) and the abiotic (hydrosphere, lithosphere, and atmosphere) are collectively called environment. Introduction of substances into the environment which are harmful to humans and other living organisms is termed as pollution. Pollutants can be harmful solids, liquids, or gases produced in higher than standard concentrations that reduce the quality of the environment. Human activities have an adverse effect on the environment by polluting the water we drink, the air we breathe, and the soil in which plants grow. However, the industrial revolution was a huge achievement in terms of society, technology, and the establishment of multiple services, it also introduced the production of massive quantities of pollutants emitted into the air that are harmful to human health. Anthropogenic air pollution is one of the biggest public health hazards worldwide, it is responsible for about 9 million deaths per year[1]. All the aforementioned are closely related with climate change, and in the event of danger, the magnitudes can be severe for mankind[2]. The long-term effects associated with air pollution are pulmonary insufficiency, chronic asthma, cardiovascular diseases, and cardiovascular mortality. Furthermore, air pollution has innumerable damaging health effects in early human life, such as mental, cardiovascular, respiratory, and perinatal disorders[3], leading to infant mortality or chronic disease in adult age.

In developing countries, the problem is more severe due to overpopulation and unrestrained urbanization along with the excess industrialization. In India, extreme air pollution is recorded where the air quality touches hazardous levels and New Delhi is one of the most polluted cities in India. Pollution is occurring both in urban and rural areas in India due to the fast urbanization, industrialization, and rise in use of motor transportation. Three billion people around the world are using wood and

solid fuels as sources of energy for their daily heating and cooking needs[4]. Currently to improve air quality proposed programs by public authorities, and directives are issued with guidelines to be used. In present chapter, a brief account is given on air pollution, its causes and impact on public health.

2. Sources of Revelation:

The mainstream environmental pollutants are emitted through large-scale human activities such as the use of power-producing stations, industrial machinery, combustion engines, and cars. These activities are implemented at such a large scale that they are by far the foremost contributors to air pollution, with cars responsible for approximately 80% of today's pollution[5]. Some other less influential human activities are fuel tanks heaters, field cultivation techniques, gas stations, cleaning procedures[6], and some natural sources, like forest fires, volcanic and soil eruptions.

Air pollutants can be classified on the basis of sources producing pollution and they are: major sources, area sources, mobile sources, and natural sources. Major sources contain the emission of pollutants from power stations, refineries, and petrochemicals, the chemical and fertilizer industries, metallurgical and other industrial plants, and, finally, municipal incineration. Area sources include: Indoor area sources (domestic cleaning activities, printing shops, dry cleaners) and outdoor area sources (petrol stations). Mobile sources consist of cars, automobiles, airways, railways, and other kinds of vehicles. Natural sources include, physical disasters, for example dust storms, forest fire, agricultural burning, and volcanic erosion. One more type of classification is based on the recipient of the pollution i.e., pollutants present in large quantities in air and they are hydrocarbons, dispersed particles, CO_2, CO, NO_2, NO, SO_3, etc.

Air pollution can alter the quality of soil and water bodies by polluting precipitation, falling into water and soil environments, the chemistry of the soil can be amended due to acid precipitation by affecting cultures, plants, and

water quality[7]. Pollutants harm our environment either by enhancing levels above standard or by involving harmful toxic substances. Primary pollutants are directly produced from the above causes, and secondary pollutants are released as by-products of the primary ones. Pollutants can be non-biodegradable or biodegradable and of natural origin or anthropogenic.

3. **Effect of Pollution on Climate:**

Air pollution and climate change are thoroughly associated, climate is the other side of the same coin that eases the quality of Earth[8]. Amount of incoming sunlight affected by pollutants like methane, black carbon, aerosols, and tropospheric ozone, as a result, the temperature of the Earth is increasing which is melting the ice, icebergs, and glaciers. Further, climate and weather affect the timing, duration, and intensity of eruptions powerfully that can change the map of transferrable sicknesses in the globe[9]. Likewise, climate changes due to water-heating follows to a great frequency of waterborne contagions. Aerosol compounds are small in size and significantly affect the climate. They can be disintegrating sunlight by diffusing a quarter of the sun's waves back to space and decreased the global temperature over the last thirty years[10].

4. **Air Pollutants:**

Six main air pollutants reported by World Health Organization (WHO) are particle pollution, ground-level ozone, carbon monoxide, sulphur oxides, nitrogen oxides, and lead. Air pollution can have a devastating effect on all constituents of the environment, including soil, groundwater, and air. Moreover, acid rain, global warming, greenhouse effect, and climate changes have significant ecological influence on air pollution.

Particulate matter (PM) is generally made as a result of chemical reactions between the different pollutants in the atmosphere. Particulate matter contains tiny liquid or solid droplets that can be inhaled and cause serious health effects like respiratory diseases and affection of the immune system. Due to antimicrobial potential, ozone eases growth, yield of plant microflora and it

changes animal species composition by DNA damage in epidermal keratinocytes and leads to reduced cellular function. Incomplete combustion of fossil fuel is responsible for carbon monoxide production. The signs of poisoning due to breathe in carbon monoxide consist of dizziness, headache, nausea, vomiting, weakness, and loss of consciousness. Carbon monoxide is one of the greenhouse gases that are strongly associated to global warming and climate. Nitrogen oxide is a traffic-related pollutant and it is responsible for respiratory diseases, wheezing, coughing, dyspnea, bronchospasm, and pulmonary edema. Sulphur dioxide is mainly produced from fossil fuel consumption or industrial activities. It is responsible for mucus production, bronchitis, respiratory irritation, bronchospasm, skin redness, and cardiovascular diseases.

Lead is a heavy metal utilized in several industrial plants and released from batteries, petrol motor engines, waste incinerators, radiators, waste waters, metals, ore, and piston-engine aircraft. Lead toxicity affects the fetal nervous system, edema or swelling of the brain and it influence loss of concentration and memory, muscle and joint pain, in adults. PAHs are found in coal and in tar sediments and generated through incomplete combustion of organic matter like in forest fires, incineration, and engines. PAH compounds, for instance fluoranthene, benzopyrene, anthracene, and acenaphthylene are found to be mutagenic, toxic, and carcinogenic substances. Volatile organic compounds (VOCs), i.e., benzene, ethylbenzene, toluene, and xylene, is related with cancer in humans, irritation of throat, eyes, nose, and mucosal membranes. Industrial and natural processes, for example forest fires and volcanic eruptions are reasons for dioxins formation. Exposure to dioxin results in dark spots and lesions on the skin while, long term contact to dioxins can root impairment of the immune, developmental problems, nervous and endocrine systems, reproductive infertility, and cancer.

5. Effect of Air Pollution on Human Health:

Short-term effects of air pollution are brief and range from simple discomfort, for example irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, nausea, headaches, dizziness and breathing difficulties, to more serious conditions, such as pneumonia, asthma, lung and heart problems, and bronchitis. If exposure to pollutants extended for long-time exposure, it is harmful to the reproductive, neurological, and respiratory systems and causes cancer and sometimes deaths. Air pollution causes severe damage to the respiratory system, form predisposing disease state, chronic obstructive pulmonary disease (COPD) which increase morbidity and mortality. Multiple cardiovascular effects, coronary arteriosclerosis, hypertension, stroke, myocardial infracts, heart insufficiency, ventricle hypertrophy, inflammation, neurological effects, psychological complications, autism, retinopathy, fetal growth, and low birth weight are some diseases caused by exposure to air pollution.

Lead exposure in children causes neurodevelopmental morbidities which made them aggressive and delinquent behaviour, difficulty in learning, reduced intelligence, and hyperactivity. Poor air quality is accountable for impact on the immune system, causing dysfunction and neuro inflammation. Further, antigen presentation is affected by air pollutants because of upregulation of costimulatory molecules such as CD80 and CD86 on macrophages. Traffic-related pollutants, like PAHs, VOCs, oxides, and PM cause pigmented spots on skin. Air pollutants absorbed by the human skin may contribute to eczema, skin aging, acne, psoriasis, urticaria, wrinkles, spots, atopic dermatitis, dyschromia and skin cancer. Contamination generally comes from suspended pollutants and resulted in asymptomatic eye outcomes, irritation, retinopathy, or dry eye syndrome.

6. **Environmental Impact of Air Pollution:**

Air pollution is not only responsible for diverse effects on human health but also to the environment which

is important for living. The most significant environmental effects of air pollution are as mentioned:

Wet (rain, fog, snow) or dry (particulates and gas) acid rain contains toxic amounts of sulfuric, and nitric acids, so it can acidify the water and soil environments, damage plantations, trees, buildings, outdoor sculptures, statues, and constructions. When fine particles are dispersed in the air, haze produced and transparency of the atmosphere decreased which is initiated by gas emissions from power plants, industrial facilities, automobiles, and trucks. Ozone occurs both at ground level and in the upper level (stratosphere) of the Earth's atmosphere. Stratospheric ozone is shielding from the Sun's dangerous ultraviolet (UV) rays but ground-level ozone is dangerous to human health so it is a pollutant. Unfortunately, due to ozone depleting substances (chemicals, pesticides, and aerosols) stratospheric ozone is slowly impaired and thinned, so UV radiation can reach our Earth, with destructive effects for human life (skin cancer) and crops. The "greenhouse effect" keeps the Earth's temperature stable but anthropogenic activities have demolished this protecting temperature effect by producing huge amounts of greenhouse gases, and global warming is intensifying, with harmful effects on human health, animals, wildlife, forests, agriculture, and the water environment. People living in poorly created buildings in warm-climate countries are at risk for heat-related health problems as temperatures increasing. Eutrophication, reproductive failure and birth effects are also related to air pollution and climate change. Ozone destroys photosynthesis pattern and metabolism while sulphur and nitrogen oxides are responsible for acid rain.

7. Conclusion:

The WHO's General Director, Dr. Tedros Adhanom Ghebreyesus, called air pollution a "silent public health emergency" and "the new tobacco" in first WHO Global Conference in 2018. Infections connected with air pollution have socio-economic impact because of absences from productive work and school. Regardless of the

difficulty of eliminating the problem of anthropogenic environmental pollution, an effective solution can be visualised as a tight association of bodies, authorities, and doctors to normalise the condition. Governments should blow-out adequate facts and educate people and should include professionals in these issues to regulate the occurrence of the problem efficaciously. In all industries and power plants, technologies to reduce air pollution at the basis must be established. To achieve the crucial goals of reducing climate change and environmental pollution education, public awareness, training, and public participation are major actions. Reliable approaches can be used for improvements in technologies to make our world at ease like to reduce the harmful impact caused by gas emissions, its use can be limited.

Summarising, a global prevention policy should be considered in order to combat anthropogenic air pollution as a supplement to the correct handling of the hostile health effects related with air pollution. To handle the problem effectively, sustainable development practices must be applied, together with information coming from research. At present, international collaboration in terms of research, development, administration policy, monitoring, and politics is dynamic for operational pollution control. Regulation regarding air pollution must be associated and restructured, and policy makers should propose the strategy of a powerful tool of environmental and health protection. The foremost suggestion of this chapter is to emphasis on nurturing local structures to endorse experience and practice and extrapolate these to the international level through developing effective policies for sustainable management of ecosystems.

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Nitrate Contamination of Groundwater in Irrigated Environments: Filed Trials in Southeastern Part of Anantapur District, A.P. South India

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Abstract:
The current study was conducted with the goal of determining the causes of increasing nitrate concentrations in groundwater in the Anantapur District of Andhra Pradesh, India. This paper highlights on the increasing fears that chemicals in agriculture have found their way into drinking water resulting in health issues. Many chemicals, in fact, have not yet had these effects, but are waiting to do so by slowly sinking into groundwater and eventually reaching taps. These concerns are mostly due to the use of nitrate fertilizer. Fertilizer use would undoubtedly expand dramatically in order to satisfy the increased food demands resulting from the population explosion, thus aggravating the situation. Many chemicals, in fact, have not yet had these effects, but are waiting to do so by slowly sinking into groundwater and eventually reaching taps. These concerns are mostly due to the use of nitrate fertilizer. Fertilizer use would undoubtedly expand dramatically in order to satisfy the increased food demands resulting from the population explosion, thus aggravating the situation.

***Keywords**: Water Pollution, Nitrates, Fertilizers, Agrochemicals, South eastern part of Anantapur, Andhra Pradesh.*

Introduction:

Nitrogen, the most abundant element in the atmosphere (Berner and Berner, 1987), can be found in a variety of forms, with the most common ions being N_2, N_2O, NO, NO_2, and NH_3 (Gaillard, 1995). The most oxidized chemical form of nitrogen found in natural systems is nitrate, which is part of the nitrogen cycle. Nitrogen is required for the survival of all biological systems since it is utilized to make numerous vital components such as proteins, DNA, RNA, vitamins, hormones, and enzymes. Although nitrogen is vital for life, it is also one of the most common contaminants of groundwater in many regions of the world, and this is owing to the intensification of agriculture in many cases (Goldberg V. M., 1989).

In India, nitrate-related groundwater pollution is on the rise. NEERI's water quality assessment research in 17 Indian states found that 1,290 (27%) of 4,696 water samples had nitrate levels that exceeded the drinking water limit (Bulusu and Pande, 1990). In many nations, the concentration of nitrate in groundwater has risen in the previous 30 years (Guarda et al., 2004). More than required amounts of nitrogen-based fertilizers such as NPK (Nitrogen, Phosphorous, Potassium), urea, and organic manure such as cow dung and decomposed vegetal waste could result in nitrate leaching and percolation into the sub-surface water bodies. Unlined drainage and sewerage pipes, as well as improper human and animal waste disposal, may contribute to nitrate pollution of groundwater (Jack and Sharma, 1983). Nearly 80% of all nitrogen added to the environment comes from agriculture and livestock operations. Nearly 40% of fertilizers used in India are for paddy agriculture, and around 50% of nitrogen fertilizers used are leached out and released into the environment (Punjab Environment Information, 2005).

In recent years, it has been recognized that groundwater quality is nearly as important as groundwater quantity (Todd, 1980). The current realization of limited resources and competing needs is obvious. This has heightened the importance of monitoring and protecting groundwater quality. Nitrate (NO_3) is an important component of life's development. It is necessary for the growth of many plant species, including the majority of edible ones, but it becomes a problem when it enters water where it is not needed. As a result, there is a serious environmental concern as well as a health risk (WHO, 2007). Nitrate contamination of groundwater is a worldwide issue, and nitrate is a common contaminant of both ground and surface water. Agriculture, human and animal wastes, and other environmental sources all contribute to the total nitrate concentration of natural streams.

Nitrogen (N) is a critical nutrient for agriculture's long-term viability (Delgado 2002; Lake et al., 2003; Schroder et al., 2005). Groundwater contamination with nitrates, on the other hand, is a global issue (Birkinshaw, & J. Ewen, 2000; Saadi, 2003). Because nitrate is liquid and negatively charged, it has a high mobility and is susceptible to leaching from the unsaturated zone (Chowdary, V.M., 2005). Methemoglobinemia in babies and stomach cancer in adults can both be caused by high nitrate levels in drinking water (Hall et al., 2001). As a result, the US Environmental Protection Agency (USEPA) has established a 10 mg/l NO_3-N (50 mg/l NO_3) maximum contamination limit (MCL) (USEPA, 2000). Agriculture practices (notable is the use of inorganic fertilizers, pesticides, and herbicides), localized industrial activities (organic pollutants and heavy metals), and inadequate or improper disposal of wastewater and solid waste (including hazardous materials) are the main causes of groundwater pollution due to point and nonpoint sources (Almasri, 2004; UNEP, 2003). Because of both point and nonpoint sources, nitrate is the most prevalent contaminant identified in shallow aquifers (Postma, D. et al., 1991). Because of the cumulative impacts of multiple years of

practice with nonpoint sources, groundwater quality may be reduced over time (Addiscott et al., 1992; Schilling K.E et al., 2001). Fertilizers, manure application, and leguminous crops are all nonpoint sources of nitrogen from agricultural operations. The widespread use of fertilizers is thought to be a major nonpoint source of nitrate in groundwater. Nonpoint sources of nitrogen include precipitation, irrigation with nitrogen-rich groundwater, and dry deposition, in addition to agricultural operations. Nitrogen pollution of groundwater is proven to be caused by point sources of nitrogen (Almasri M.N et al., 2004). Septic tanks and dairy lagoons are two of the most significant point sources. Numerous investigations have revealed excessive nitrate concentrations in the area.

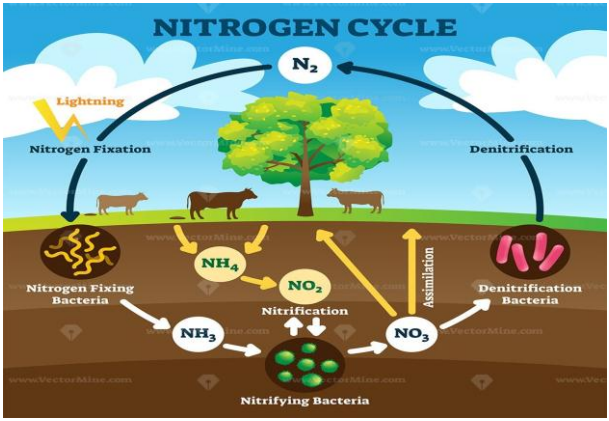

Fig: 1 Nitrogen Cycle

Nitrogen (N) is found in a variety of forms in the environment and has a complex cycle. The atmosphere, for example, is 78 percent nitrogen gas, with trace amounts of other nitrogen gases created naturally and by pollutants such as fossil fuel combustion. Organic (carbon-based) forms of N, such as those formed by decomposing plant and animal wastes, can be found in the soil environment. Inorganic forms of nitrogen, such as ammonia gas, which combines with water to generate ammonium, and nitrate,

are also formed during the decay process. Because nitrate, unlike ammonium, does not adsorb onto soil or aquifer geologic elements and only precipitates as a mineral under dry conditions, it is relatively mobile in soil and groundwater. However, nitrate can be taken up by plants and microorganisms in the soil environment and recycled back into plant and animal tissue, or changed into nitrous oxide, or turned back into innocuous nitrate. Nitrous oxide, produced in water-logged soils and by animals, is a 'green-house' gas, partly responsible for global warming. One of the molecular forms of nitrogen is nitrate (NO_3^-). In a complicated cycle, it coexists with different types of nitrogen. Atmospheric deposition, fertilizer application, manure, waste material, and dead plant and animal tissue are all sources of nitrogen in soil and water. Nitrate is a relatively stable form of nitrogen when it occurs under aerobic (oxygen-rich) circumstances. Other nitrogen forms that typically convert to nitrate include ammonium (NH_4^+) and organic nitrogen. The atmosphere, which is made up of 78 percent nitrogen gas, contains the majority of nitrogen on the planet. Other types of nitrogen can be found in the atmosphere, primarily from power plant emissions, internal combustion engines, fertilizer, and manure. Nitrogen oxides (NOx and N20), nitric acid (HNO_3), and ammonia are among them (NH_3). When N_2 is "fixed" (chemically altered) by legumes or lightning, or when contaminants are disseminated in precipitation, atmospheric nitrogen interacts with the earth's surface.

Mechanism of Nitrate Pollution in the Groundwater:

The presence of nitrate in groundwater is usually anthropogenic, as a result of soil contact with contaminants such as nitrate fertilizers. The secondary porosity of the aquifer and the porous and permeable soil cover are two factors that lead to aquifer contamination. Aquifer contamination could come from a leaching source, a point source, or a biochemical source (Abu Maila Y. et al., 2004).

Leaching Mechanism:

In order to meet the rapidly rising population's food and living needs, the use of nitrogen (N) fertilizer in agriculture has expanded dramatically during the last 30 years. As a result, the use of nitrate in fertilizers is a major source of groundwater contamination. Some fertilizers are infiltrated into the aquifer via irrigation and/or rainwater. The increased usage of nitrate fertilizers in the villages contributes to groundwater contamination. Local farmers in the research area agreed to using excessive nitrate fertilizers and feel that improving agricultural output is vital.

Point Source Mechanism:

Wastewater from cesspools or disposal ponds could enter the higher soil layer and reach the groundwater aquifer. The lack of a sewage infrastructure favours nitrate pollution of this nature. As a result of the sources of contamination, the level of nitrate in groundwater will continue to rise. Because of the daily usage of water, which then recharges the aquifer, these sources are more harmful than leaching sources.

Biochemical Mechanism:

The interaction of nitrogen molecules with the surrounding media causes oxidation, which ultimately contaminates the aquifer. Nitrate is produced when organic matter that is nitrate-bearing is scattered on the surface or near the surface of the earth (sewage water, cesspools, and drainage). The following reaction occurs when bacteria (Nitrosomonas) convert ammonia (from waste water, such as cesspools, sewage water, and disposal ponds) into nitrite:

$$2NH_4 + 2NO_2 + 4H_2O = 2NO_2 + 4H_2O$$

Another type of bacteria (Nitrobacteria) oxidizes nitrite to nitrate.

$$2NO_2 + O_2 = 2NO_3$$

Nitrification is the process of converting ammonia to nitrates. In the presence of oxidizing conditions and a large population of nitrifying bacteria, the rate of nitrification increases.

Study Area:

A study was carried out by collecting 150 samples of drinking water from several communities in the Anantapur District of Andhra Pradesh (Fig. 1). The findings revealed that locations fed by agricultural fields had greater nitrate levels in their water, whereas those with improved drainage had lower nitrate levels. WASA tube-wells in the metropolitan area produced similar results (Yaqoob, 1990). No study, however, was available for the agricultural fields under the conditions of this region for understanding the leaching behavior of nitrates. As a result, research was planned to look at the effects of different amounts of tillage, different types of equipment, different fertilizer doses, different irrigation depths, and different sampling times after fertilizer application. The nitrogenous fertilizers were administered under various soil and crop circumstances at various locations, and soil/water samples were collected using porous cups and tested for (NO_3-N) concentration. The research region comes under the Survey of India and is located between longitudes 77° 15' 0" and 780 50' 0" East and latitudes 140 0' 0" and 14° 35' 0" North. 57 J/3, J/4, 57 F/14, F/15, F/16, Mudigubba, Nallamada, Kadiri revenue mandals of Anantapur District are situated in the Southeastern part of Andhra Pradesh, India.

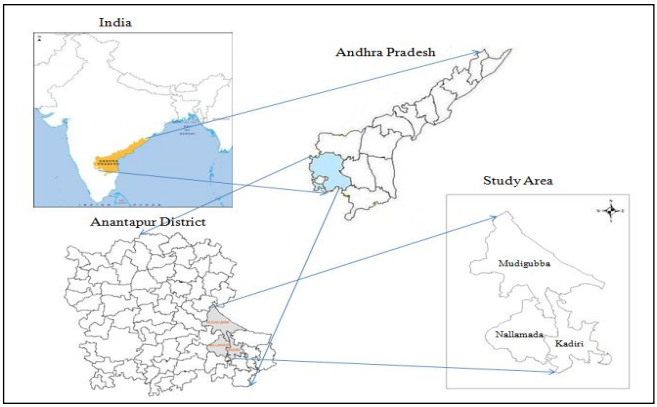

Figure 2: Location Map of the Study Area

Materials and Methods:

Topographic maps, Garmin GPS MAP 76, Arc GIS 10.3, and field investigations are all used in the study. The toposheets of the Survey of India are used to create the base map, drainage map, and a broad understanding of the research area. The location of each sampling well is mapped using GPS, and the data are then sent to the GIS for further analysis. Water level measurements and water sample collection from bore wells, tube wells, and open wells, as well as the study of geological and geomorphological aspects of the area in general, were all part of the field activity. pH, electrical conductivity, total dissolved solids, total hardness, main cations, and anions were all tested according to the American Public Health Association (APHA, 1995) protocol, with specified precautions followed to avoid contamination. NO_3^- are determined by spectrophotometric method. In one of the trials, five tillage treatments were chosen to compare their impact on nitrate leaching: tine cultivator, sweep cultivator, disk harrow, M.B plow, and chisel plow. Three replications of each treatment were made using fifteen plots, each measuring 57X10 M2. With their allotted implements, all of the plots were prepared at the same time. After seed-bed preparation and two sweep cultivations, 125 kg/ha of Diammonium Phosphate (DAP) was sprayed to all plots at the time of wheat planting.

Second, one month after applying area (125 kg/ha) and a 10cm surface irrigation, water samples were taken. The (NO_3-N) content of the samples was determined using the Disulphonic acid technique. The data on (NO_3-N) content was statistically evaluated.

Results and Discussion:

For the months of April and October 2019, groundwater nitrate concentrations were found in the range of 20 to 118 mg/l and 20 to 100 mg/l, respectively. In this region, the highest groundwater nitrate

concentration was observed in Ramaswamy Tanda (118 mg/l) and the lowest groundwater nitrate concentration was recorded in Pandulakunta (20 mg/l). In the command regions, intensive paddy farming was seen, with more than the required amount of water, nitrogen-based fertilizers, manure, and pesticides being utilized extensively, all of which lead to nitrate contamination in ground water from non-point sources. Another advantage of command areas for high nitrate buildup is that they are underlain by granites, which allow for more nitrate leaching into ground water. Many chemical elements had low content indicating decreased mineralization in the post-monsoon season due to aquifer dilution by rain or irrigation water. In the pre-monsoon season, high concentrations of nitrate are more common in granitic terrain, command areas, and discharge zones; only 12% of the samples have nitrate content of less than 45 mg/l, 82 percent of the samples have nitrate content of 45-100 mg/l, and 6% of the samples have nitrate content of more than 100 mg/l.

S. No.	Names of the Villages	Nitrate in mg/l		Depth of Wells
		Pre-monsoon	Post-monsoon	
1	Ralla Anantapuram	60	56	50
2	Krishnapuram	58	54	200
3	Nallacherlopalli	62	62	140
4	Yerravankapalli	70	70	150
5	Gunjepalli	90	90	200
6	Jonnalakothapalli	94	96	80
7	Muktapuram	72	75	50
8	Krishnapuram	34	32	60
9	Bapanakunta	64	65	150

10	Reddipalli	48	45	20
11	Vankarakunta	50	54	90
12	Nallamada	58	55	80
13	Pullagurapalli	74	72	85
14	Toletivaripalli	72	76	250
15	Donnekota	62	58	60
16	Sankepalli	52	45	70
17	Ramaswamy Tanda	118	100	10
18	Sanevaripalli	80	80	20
19	Rachavaripalli Tanda	68	70	50
20	Malakavemula	64	65	220
21	Nagurivandla Palli	24	82	60
22	Alampur	75	73	300
23	Vaddevari Palli	110	95	150
24	K.Kuntlapalli	46	45	70
25	Kondagattu Palli	56	50	140
26	Chenchugaripalli Tanda	90	85	100
27	Seelamvari Palli	97	90	210
28	Ramireddi Palli	88	85	120
29	Payagattu Palli	70	70	30
30	Yerikireddi Palli	66	65	300
31	Pandulakunta	20	20	220
32	Kothannagari Palli	68	65	250
33	Yerravanka Palli	49	45	350
34	Podaralla Palli	56	50	310
35	Timmanayana Palem	70	68	280
36	Mallepalli	77	70	50

37	Tappetavari Palli	56	50	50
38	Chiragarapalli	72	70	90
39	Guttakindapalli Tanda	54	52	120
40	Gollapalli	80	75	140
41	Eddulavaripalli Tanda	80	75	200
42	Choutakuntapalli	63	60	250
43	Kothapalli	33	30	320
44	R.Ramapuram	35	35	250
45	Chandrayani Palli	32	30	250
46	Pathabathala Palli	90	85	220
47	Uppalapadu	100	90	180
48	MalakavemulaCheruvu	110	95	250
49	Nakkalaguttapalli	90	100	220
50	Aakuthotapalli	78	90	300

Table 1: Sampling Locations of the Study Area in Pre-Monsoon and Post-Monsoon Season (mg/l)

In the post-monsoon season, high concentrations of nitrate are more common in granitic terrain, command areas, and discharge zones; only 16% of the samples have nitrate content of less than 45 mg/l, 84 percent of the samples have nitrate content of 45-100 mg/l.

As a result, research was planned to look at the effects of different amounts of tillage, different types of equipment, different fertilizer doses, different irrigation depths, and different sampling times after fertilizer application. The nitrogenous fertilizers were administered under various soil and crop circumstances at various locations, and soil/water samples were collected using porous cups and tested for (NO_3-N) concentration. Fertilizer use would undoubtedly expand dramatically in order to satisfy the increased food demands resulting from the population explosion, thus aggravating the situation. As a result, the use of chemicals in agriculture raises

worldwide concerns, particularly in Andhra Pradesh, where environmental degradation is pervasive and groundwater contamination from agricultural chemicals, particularly fertilizer, is rare. Table 1 shows the nitrate-nitrogen content of drift soil depths two weeks following application of diammonium phosphate (DAP). The data demonstrate that the upper soil layers have greater levels of (NO_3-N). This was clear because there was no irrigation or precipitation during this time period to move the fertilizer downward. Table 2 shows the mean (NO_3-N) contents in various soil layers following the application of area with first irrigation. After irrigation, an analysis of variance revealed that the influence of soil depth on (NO_3-N) content was statistically significant. The highest concentration of (NO_3-N) was found in the upper 0-60 cm layer, according to a comparison of (NO_3-N) content before and after irrigation. Leaching appeared to have happened up to 90 cm, while traces of nitrates were identified up to 150 cm soil depth with just a standard fertilizer dose and a single 10cm irrigation. Because of the exponential nature of data as soil depth increased, it was discovered that (NO_3-N) might even leach beyond 150 cm. This lower trend in nitrates is likely to continue in future irrigations. If this tendency continues in our agricultural areas year after year, the day will come when our ground water reservoirs will be severely contaminated.

The impact of the tillage implement was found to be non-significant statistically. This was to be expected, given the lack of evidence that the nitrate concentrations in each treatment differed. The primary goal was to investigate nitrate leaching behavior in order to create a view print of the implement-depth interaction. According to a considerable implement-depth interaction, different tillage strategies handled nitrates differently at different soil depths, but sweep and tine cultivators performed better than other implements. Sweep tilled plots were better than tine cultivation in retaining NO_3-N in the top (0-60cm) soil layer. It is apparent that sweep cultivation can be considered as an appropriate tillage practice among the

treatment included in this experiment. In short, the following conclusions were drawn from this study.

1. The downward flow of nitrates was aided by a simple 10cm watering system.
2. Sweep cultivators with narrow tines were shown to be more effective than other instruments at holding nitrates in the 0-60 cm soil layer.
3. There was a substantial nitrate leaching.

Tillage Treatment	0-30 cm	30-60 cm	60-90 cm	90-120 cm	120-150 cm
Narrow time cultivator	11.0	3.5	2.1	1.1	0.72
Sweep cultivator	8.1	4.6	2.0	0.8	0.73
Disk narrow	7.6	2.3	2.0	0.7	0.51
Mold board (M.B) plough	6.9	2.6	1.2	0.6	0.1
Chisel Plough	7.8	6.1	0.7	0.4	0.2

Table 1: Nitrate-Nitrogen (PPM) for Various Tillage Treatments (Before Irrigation)

Tillage Treatment	0-30 cm	30-60 cm	60-90 cm	90-120 cm	120-150 cm
Narrow time cultivator	8.4	5.4	2.5	1.4	0.76
Sweep cultivator	9.0	7.6	2.4	1.6	0.51
Disk narrow	5.7	4.5	2.80	1.43	0.6
Mold board (M.B) plough	4.4	3.0	1.45	1.60	0.34
Chisel Plough	5.13	4.4	2.0	0.52	0.43

Table 2: Nitrate -Nitrogen (PPM) for Various Tillage Treatments (After Irrigation)

An extrapolation of this trend suggests nitrates would certainly move too far from soil depths considered here. Heavy irrigations resulted in water loss through deep percolation and increased nitrate leaching, whereas light but frequent irrigations kept nitrates limited to mainly the surface soil layers. Light irrigations revealed more nitrates at 30 cm deep, similar to the pattern seen in sweep cultivation, while extensively irrigated plots had higher NO_3-N concentrations at 60 and 120 cm depths. Up to 120 cm depth, light irrigations resulted in a 9.2 percent reduction in NO_3-N concentration. The results showed that light but frequent irrigations retained more nutrients in the soil's root zone and so proved to be a better option. Even after the last irrigation, the split treated plots had higher nitrate concentrations in the upper soil layers. Split application resulted in 19.4 percent reduced nitrate leaching when compared to normal or conventional application. As a result, split fertilization was beneficial in that it kept the majority of the nitrates in the root zone for a longer period of time. The advancing sheet of water in surface irrigation delivered nitrates to the plots' tail end. The tail ends of the plots had 4.9 percent higher nitrates than the head ends. This effect could be owing to nitrates' high water solubility. As a result, medium-length plots with low gradient are recommended to decrease nutrient delivery to tail ends.

Conclusion:

The current research found that nitrogenous fertilizer in the form of NO_3-N was leached up to 150cm into the soil. To reduce the irreversible pollution of underground water, steps must be done. Unfortunately, the majority of our anti-pollution measures are focused on cities or industries, leaving agricultural sectors completely unaffected. To limit the threat of fertilizer on subsurface water contamination, drainage, tillage, irrigation, crop rotation, and fertilizer practices must be handled. The current study reveals that better soil, water, and fertilizer

management strategies could successfully reduce NO3-N leaching and protect our soil and water ecosystem.

Mitigation Measures:

The negative health and socioeconomic consequences of nitrate in drinking water sources are causing widespread concern in both urban and rural areas. As a result, developing a groundwater nitrate management strategy is critical, particularly in terms of understanding pollution processes and the significance of the unsaturated zone in groundwater protection. A groundwater preservation strategy should include a two-pronged approach: law and enforcement for pollution management and reducing nitrogenous inputs to the ecosystem, which can be supplemented by public education and mobilization. When it comes to water supply planning and management, groundwater is frequently overlooked. For a long time, it was thought that ground water could not be appraised as simply as surface water in terms of availability, development, chemical purity, and recovery economics. On the contrary, new hydrogeologic knowledge and understanding, as well as significant advances in analytical capabilities, have improved groundwater planning, development, and management. Ground water systems have been studied scientifically, allowing for more efficient use and protection. The lack of integration of ground water into water resource planning is partly due to a lack of communication between the ground water expert and the planning expert. Increased mutual awareness of ground water and its critical significance in the nation's water supply is being fostered by closer collaboration among these experts. Ground water is increasingly acknowledged as a critical component in the nation's complete integrated management of land, water, and waste.

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Lemna (Duckweed) as Indicator of Gaseous Pollutants

Baig Mumtaz

Abstract:
In order to develop plant-based pollution indicator species of Lemna were selected ash test plants. Responses of these species to pollutant gases like ammonia and sodium dioxide were assessed in terms of colour changes growth inhibition/ enhancement and changes in chlorophyll content. Exposure of lemna species to ammonia at different concentration indicated that mature lemna minor plants were more sensitive than young ones. 6 days old plants become pale green whereas 20 days old plants become grey after 30 minutes. The responses came earlier at higher concentrations. Maximum colour changes were observed at 4 x10^{-2}/ml,5 X10^{-2} /ml and 6 X 10^{-2} /ml(V/V) Concentration. Lemna perpusilla showed slightly different responses. In the higher concentration of ammonia a few plants settled at the bottom of the medium whereas the remaining turned grey as compared with control.

Exposure of lemna minor to sulphur dioxide at different concentration indicated that 6 days old plants become yellow whereas 20 days old plants become yellowish green following exposure for 10 minutes. Early early decolourisation was occurred at 6 x 10^{-2} / ml. 7 $^{X10-2}$ /ml 7 X10^{-2} /ml ,8 X10 $^{-2}$ml .9 X 10^{-2} and 10 X 10 $^{-2}$ /ml (V /V)· The lemna perpusilla also showed yellowish green colour at 3X10 $^{-2}$ / ml to 6X 10^{-2}/ml concentration and yellow colour was noticed at higher concentration from 7 X 10^{-2} / ml to 10 X10^{-2}/ ml.

Maximum reduction of total chlorophyll of both the species of Lemna was observed in exposure to Sulphur dioxide. However, there was no significant reduction in exposure to ammonia.

***Keyword**: lemna perpusilla, lemna minor, colour change gaseous pollutants growth chlorophyll.*

Introduction:

Gaseous air pollutants are emitted from various natural sources, such as volcanoes and forest fires. However, anthropogenic emissions of some gases may be greater than the natural ones, and are increasing because of population growth and industrialization. It is important known to know that substance enter our environment what is their quality quantity and how do they affect living organism. The physicochemical parameters do not tell anything about effect of pollutants on living organism. It is necessary to use living cells as indicators of pollution. When living organisms are used to detect pollutant level it acts as bioindicator.

Plant species and varieties show the striking variation in their sensitivity to air pollutants. The great majority of all plants are relatively tolerant and remain free from injury under all but the most severe air pollution episodes. A few though are highly sensitive and are injured by concentration that may be scarcely above background level. These unique sensitive species can be used to monitor the presence of concentration of specific air pollutants. They are often called biological indicator (Heck, 1966, Feder and Manning, 1979).

To order to develop plant-based pollution indicator species of Lemna were selected as test plants. Lemna species were known generally as Duckweeds (Cosmopolitan tiny, floating aquatic plant) occurring at the bank of Godavari River Nanded. Present investigation was made to observe the response of these species of Lemna two pollutants ammonia and sodium dioxide for the morphological and physiological changes in the test plants.

Materials and Methods:

The two species of lemna (Lemna minor and lemna perpusilla) were collected from the river Godavari Nanded both the species were brought in the laboratory and maintained in plant nutrient solution. The two species of Lemna were exposed to different concentration of sulphur dioxide and ammonia ($1 X 10^{-2}$ /ml ,$2 X10^{-2}$ /ml., $3 X^{-}10$ $-^{2}$ $10 X10^{-2}$ / ml V/V for 30 min. The plants were incubated

for 48 hours. The plants without exposure to sulphur dioxide and ammonia were treated as control. These plants were observed for the morphological changes. All the treated and untreated plants were also analyzed for total chlorophyll content by spectrophotometric method.

Result and Discussion:

The present investigation revealed that both the species of Lemna showed changes in the colour in exposure to Ammonia and Sulphur dioxide. It is clear from the results presented in table 1. That lemna minor turn grey at concentration of $4X10^{-2}$ as compared with control. It was observed that there was no change in colour below $4X10-^{2}$ concentration. The lemna perpusilla turned grey at $5 X 10^{-2}$ concentration of ammonia as compared to control. However, colour change was not observed upto the concentration of $4 X10^{-2}$. The lemna minor was found to be more sensitive to ammonia than the lemna perpusilla.

The result presented in table 2. show that both species of Lemna were sensitive to sulphur dioxide. It was observed that lemna minor return yellowish white at concentration $1 X10^{-2}$ to $4 X 10^{-2}$. Lemna minor turned colourless from concentration $5 X 10^{-2}$ to $10 X10^{-2}$ as compared to control. However, lemna perpusilla did not showed change in colour at concentration $1X 10^{-2}$, and $2 X10^{-2}$. It turned yellowish green at concentration $3 x10^{-2}$ to $6 X10^{-2}$ and turned yellow at concentration $7 X10^{-2}$ to $10 X 10^{-2}$ as compared to control. Similarly, responses of plants to Sulphur dioxide have been evaluated primarily by studying the effects of long-term exposure on the levels of visible injury growth and yield (Heggestad and Hack 1971).

The present studies also revealed that the pollutants like Sulphur dioxide and Ammonia also affect the chlorophyll content of laminar species. The total chlorophyll content of both the species of Lemna were reduced in exposure to higher concentration of SO_2 and NH_3. However recently it has been realised that even very low concentration of SO_2 can influence without concominant visible injury in plants (Mudd 1975).

The total chlorophyll content of Lemna minor (1.209mg/g fw) and lemna perpusilla (1.209 mg/g fw) when exposed to 3 X10 $^{-2}$ concentration of SO $_2$ was very much reduced than the chlorophyll content of lemna minor (1.408 mg/g fw) and lemna perpusilla (1.428mg/g fw) in exposure to NH3. The total Chlorophyll content of lemna minor was 0.017 mg /g fW (control 1.428 mg FW) it was zero in case of laminar perpusilla with SO2. It is concluded that both the species of lemna were more sensitive to SO_2 and then the NH3.It is also concluded that lemna minor is more sensitive than Lemna perpusilla for test pollutants.

It was reported earlier that the effect of air pollution was often accompanied by a chlorotic discoloration of foliage and decline in chlorophyll content. (Spedding and Thomas 1973). The present findings is also supported by(various worker (Rao and Le Blanc 1965 Shimazaki atal 1980, Malhotra 1977). Both the pollutant SO2 and NH3 affect the growth and chlorophyll content of lemna minor and lemna perpusilla. It is concluded that both the species of Lemna can be used as as indicator of pollution caused by SO2 and NH3.

Observations:

Table 1 Effect of NH3 on Morphological Changes of Lemna sp.

Concentration of Pollutants /ml	**Changes in Colour of Lemna after 48 hours Lemna minor**	**Lemna perpusilla**
1 X 10^{-2}	No colour Change	No colour Change
2 X 10^{-2}	No colour Change	No colour Change
3 X 10^{-2}	No colour Change	No colour Change
4 X 10^{-2}	Grey Colour	Grey Colour
5 X 10^{-2}	Grey Colour	Grey Colour
6 X 10^{-2}	Grey Colour	Grey Colour
7 X 10^{-2}	Grey Colour	Grey Colour
8 X 10^{-2}	Grey Colour	Grey Colour

9 X 10^{-2}	Grey Colour	Grey Colour
10 X 10^{-2}	No colour change	No colour change
Control	No colour change	No colour change

Table 2. Effect of SO2 Morphological Changes of Lemna sp.

Concentration of Pollutants /ml	**Changes in Colour of Lemna after 48 hours Lemna minor**	**Lemna perpusilla**
1 X 10^{-2}	Yellowish green	No colour change
2 X 10^{-2}	Yellowish green	No colour change
3 X 10^{-2}	Yellowish green	Yellowish green
4 X 10^{-2}	Yellowish green	Yellowish green
5 X 10^{-2}	Yellowish green	Yellowish green
6 X 10^{-2}	Yellow	Yellowish green
7 X 10^{-2}	Yellow	Yellow
8 X 10^{-2}	Yellow	Yellow
9 X 10^{-2}	Yellowish white	Yellow
10 X 10^{-2}	Yellowish white	Yellow
Control	No colour change	No colour change

Table 3. Effect of SO2 and NH3 on the Total Chlorophyll Content of Lemna sp.

Concentration of Pollutants /ml (V/V)	**Total Chlorophyll Content in mg/g Fw Lemna minor**		**Lemna perpusilla**	
	SO2	**NH3**	**SO2**	**NH3**
1 X 10^{-2}	1.310	1.410	1.428	1.428
2 X 10^{-2}	1.218	1.410	1.420	1.428
3 X 10^{-2}	1.202	1.410	1.209	1.428
4 X 10^{-2}	1.106	1.408	0.923	1.428
5 X 10^{-2}	1.002	1.392	0.800	1.422

6 X 10^{-2}	0.936 1.419	1.392	0.602
7 X 10^{-2}	0.510 1.417	1.306	0.134
8 X 10^{-2}	0.221 1.411	1.305	0.121
9 X 10^{-2}	0.010 1.411	1.297	0.028
10 X 10^{-2}	0.000 1.408	1.291	0.017
Control	**1.410 1.428**	**1.410**	**1.428**

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Physico-Chemical and Statistical Evaluation of Ground Water of Some Places of Jhalrapatan Tehsil in Jhalawar District (Rajasthan), India

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Manju Meena

Abstract:

The physico-chemical parameters and trace metals of ground water quality of Jhalrapatan tehsil in Jhalawar District have been studied from the bore wells of 15gram panchayats. The parameters studied were temperature, pH value, electrical conductivity, total hardness, total dissolved solids, sodium and potassium contents, fluoride, chloride, nitrate and sulphate contents. Trace metals in water samples were analyzed by using Atomic Absorption Spectrophotometer (Shimadzu-6300). Analyzed parameters were compared with the WHO (1973) and ISI (10500-91) water quality parameters. All contents except pH, TDS, nitrate, trace metals (Fe and Pb), were well within the safety limits recommended by WHO. A systematic calculation was made to determine the correlation coefficient 'r' amongst the parameters and the significant values of the observed correlation coefficient between the parameters were worked out. The study also indicates the need for periodic monitoring of groundwater for physico-chemical characteristics and heavy-metals in the study area.

Keywords: *Groundwater, Physico-Chemical Parameters, Trace Metals, Correlation Analysis, AAS-6300.*

1. Introduction:

Without water, life cannot survive. Water and life are two sides of the same coin. Life initiates and grows in the lap of water. Water is very small living creatures to very complex system of animals and human being (Metha, 2011). The importance of ground water quality has been significantly growing in India became of uncertainties of surface water resources. Groundwater is an important source of drinking water for much of the world's population and its quality and purity has a direct effect on human health. Hydrosphere pollution by chemical and heavy metals such as cadmium, lead, zinc, copper and iron etc. is accelerated dramatically during the last few decades due to mining, smelting, manufacturing, use of fertilizers and pesticides in agriculture, municipal waste and traffic emissions. Use of waste water for irrigation is also affect on ground water quality (Meena et al., 2010). The quality of groundwater is the resultant of all the processes and reactions that act on the water from the moment it condensed in the atmosphere to the time it is discharged by a well of spring and varies from place to place and with the depth of the water level (Sharma et al., 2008). Groundwater occurs as a part of the hydrological transformations of permeable structured zones of the rocks, gravel and sand. Groundwater can be obtained from aquifers and hypopheric zones. Fractured crystalline bed rocks are excellent sources of potable water in many parts of the world. Ground water satisfies the domestic, agricultural and industrial need of the people (Longe et al., 2010).

The health risk arising from environmental contaminants depends on many factors including absorption and toxicity of the substance, its level in food, the quantity of contaminated food consumed and duration of exposure to pollutant can occur through a variety of routes. In humans, the intake of poor-quality drinking water has been implicated in the incidence of motor neuron disease, reproductive disorders and cardiovascular disease (Mushekar, 2011; Taiwo et al., 2011). Hence,

periodical evaluation of water quality requires serious attention water quality assessment is pre-requisite to the water quality management. To protect and manage quality and quantity of groundwater is essential for the healthy development of any country (Maheswari et al., 2010; Yadav et al., 2011). This study involves the determination of physical and chemical parameters of ground water of Jhalrapatan tehsil at different gram panchayats.

The objective of this study is to assess the present water quality, through analysis of some selected water quality parameters like Temperature, pH, EC, Total Hardness, TDS, SO_4^{2-}, F^-, NO_3^-,Cl^-, Na^+, K^+ and some heavy metals (Zn, Pb, Cu, Cd, Fe) and to compare the results with the standards values recommended by WHO.

2. Material and Methods:

2.1. Study Area:

Jhalawar district is located in the south-east of Rajasthan, between the longitudes of 75° 27' 35" to 76° 56' 48" East and latitudes of 23° 45' 20" to 24° 52' 17" North, adjoining the neighboring state of Madhya Pradesh. Jhalrapatan is in the south-eastern plateau region of Rajasthan, where groundwater is mainly found in layers of basalt, sandstone and shale, intercalated with sandstone. The groundwater resource of the Jhalrapatan block covers over 1300 km, but is heavily exploited, mainly by abstraction for agriculture use.

2.2. Methodology:

Groundwater samples were collected from the bore wells of 15gram panchayats of Jhalrapatan tehsil in 2010-2011 (Figure 1).

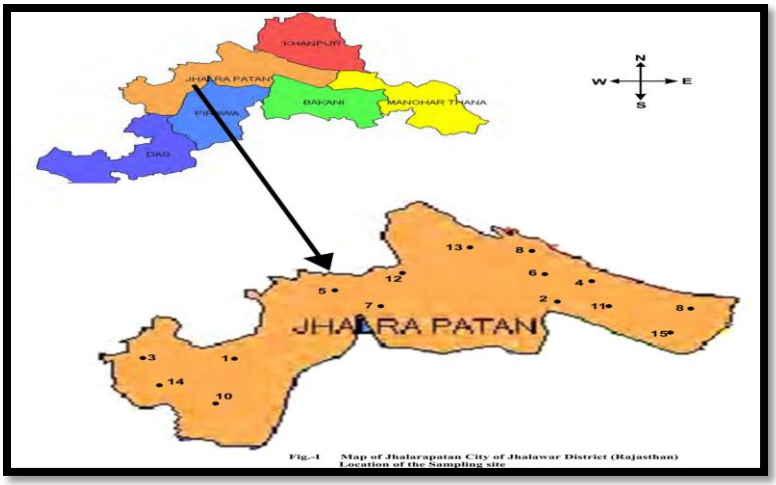

Figure 1: Map of Jhalarapatan City of Jhalawar District (Rajasthan)

Samples were collected in clean polythene bottles pre-washed with dilute hydrochloric acid and rinsed three to four times with the water samples before the samples were stored at a temperature below 4 ^{o} c prior to analysis in the laboratory. The physico-chemical parameters such as pH, TDS, EC, Cl^-, NO_3^-, SO_4^{2-} and F^- were determined by using standard methods (APHA, 1998). Sodium and potassium were determined by Flame Photometric methods. Trace metals were determined by Atomic Absorption Spectrophotometer (Shimadzu-6300). Specific reagents were used for the analysis and double distilled water was used for preparation of solutions. Results are shown in the Table 1 & 2.

3. Results and Discussion:

The observed physico-chemical parameters and trace metals are summarized below –

Table 1: Mean Concentrations of the Physico-chemical Characteristics of the Groundwater Samples from the Bore Wells of Jhalrapatan tehsil

S.N.	Sample No.	Sample Location	Physico-Chemical Prameters (mg/L)										
			T^0C	pH	EC (µS cm^{-1})	TDS	TH	Na^+	K^+	Cl^-	F^-	NO_3^-	SO_4^{-2}
1	T_1	Alawa	27.3	6.92	1535.2	537.3	139.93	54.21	51.53	30.6	0.23	15.5	54.5
2	T_2	Barodia	26.2	7.25	1954.3	690.2	218.77	48.26	57.16	60.2	0.11	55.2	65.0
3	T_3	Guradiyamana	27.5	8.92	2865.7	997.5	238.12	80.4	70.27	80.4	0.86	60.2	71.2
4	T_4	Gordhanpura	25.3	8.12	2013.8	729.7	174.12	49.36	56.79	77.8	0.94	19.2	34.5
5	T_5	Kanwara	26.9	8.16	1323.3	425.1	97.25	11.86	6.87	90.2	0.22	38.2	50.5
6	T_6	Iktasa	25.1	7.99	1402.5	469.9	114.84	14.64	9.95	76.4	0.80	9.3	43.5
7	T_7	Jhoomki	27.6	8.53	1618.7	486.8	191.99	22.05	14.69	55.9	0.81	19.3	25.5
8	T_8	Lawasal	27.2	8.54	1938.9	627.4	232.77	54.62	39.31	45.8	0.93	10.1	69.5
9	T_9	Mandawar	25.3	7.86	1199.2	360.9	104.12	9.22	5.02	93.2	0.31	40.9	19.3
10	T_{10}	Naharghtta	26.8	8.85	2455.9	885.1	199.14	55.53	62.0	37.8	0.82	10.4	32.2
11	T_{11}	Panwasa	26.0	8.83	1570.2	557.6	181.99	19.22	11.69	65.8	0.79	22.2	20.5
12	T_{12}	Rundlao	27.1	8.65	1085.4	347.3	88.92	16.77	12.21	69.6	0.71	16.5	25.5
13	T_{13}	Salotya	27.4	7.25	1247.1	389.5	119.48	21.56	18.21	71.0	0.41	8.5	25.0
14	T_{14}	Sarod	26.5	7.85	2143.6	769.7	168.21	39.58	12.72	53.8	0.63	18.2	19.5
15	T_{15}	Tandisohanpura	27.7	8.25	3215.8	1050.2	201.16	58.21	64.21	28.8	0.89	11.5	79.5
16		WHO	-	7.0-8.5	1400	1000	500	200	-	250	1.5	50	200
17		ISI	-	6.5-8.5	-	500	300	200	-	250	1.0	45	200

Table 2: Mean Concentrations of the Trace Metals in the Groundwater Samples from the Bore Wells of Jhalrapatan Tehsil

S.N.	Sample no.	Trace Metals (mg/L)				
		Zn	Pb	Cu	Cd	Fe
1	T_1	0.0688	0.0035	0.04	0.0321	0.5456
2	T_2	0.1702	0.1412	0.1385	0.0421	0.2019
3	T_3	0.0037	0.0193	0.0959	0.0429	0.9149
4	T_4	0.0559	0.0245	0.016	0.0325	0.6295
5	T_5	0.1329	0.0298	0.0293	0.0093	0.8058
6	T_6	0.0293	0.0018	0.016	0.0235	0.3357
7	T_7	0.0248	0.0456	0.1039	0.0345	0.512
8	T_8	0.0128	0.0666	0.0133	0.0432	0.4616
9	T_9	0.0458	0.0315	0.0559	0.0323	0.7806
10	T_{10}	0.0039	0.0421	0.0666	0.0492	0.713
11	T_{11}	0.0449	0.0351	0.0506	0.0132	0.2854
12	T_{12}	0.099	0.1209	0.0107	0.0292	0.369
13	T_{13}	0.0376	0.0754	0.024	0.014	0.47
14	T_{14}	0.551	0.0596	0.0719	0.039	0.184
15	T_{15}	0.1705	0.0421	0.0439	0.0459	0.3441
16	WHO	5.0	0.05	1.0	0.05	0.3

3.1. Temperature (T) in ^{o}C:

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. The temperature was ranging from 25.1 ^{o}C to 27.7 ^{o}C during the study period. This might be due to presence of the effluents. Our property of water is that with change in temperature, its density varies and it becomes less with warming up and more with cooling (Mushekar, 2011).

3.2. pH:

pH is a measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water. pH value below 4.0 produces sour taste and a higher value above 8.5 give alkaline taste (Metha, 2011). In the present study, the pH values of water samples varied between 6.92

to 8.92. It was notice that T_3 water sample have more pH as compare to WHO permissible limits.

3.3. Total Dissolved Solids (TDS):

TDS is the concentrations of all dissolved minerals in water indicate the general nature of salinity of water. Studies already made in last decade on TDS (Dhindsa et al., 1984; Prasad et al., 1994, Newlakhe et al., 1994; Raju, 1998). In the present study TDS values varied from 347.3 mg/l to 1050.2 mg/l. TDS in groundwater originated from natural sources, sewage, urban run-off (Meena et al., 2010). It was notice that T_{15} water sample have more TDS as compare to WHO permissible limits.

3.4. Electrical conductivity (EC):

It is an indicator of the degree of mineralization of water. It depends upon concentration and degree of dissociation and migration velocity of ions in the electric field (Bachenahalli et al., 2011). EC values were in the range of 1085.4 micro siemen per cm to 3215.8 micro siemen per cm. The EC is correlated with TDS.

3.5. Total Hardness (TH):

TH is considered as a major character of drinking water. Higher degree of hardness is due to dispose of sewage and untreated industrial effluents. Hardness is defined as the concentrations of calcium and magnesium ions (Meena et al., 2010). Ca and Mg are dissolved from most soils and basalts rocks, especially from lime stone, calcite, sandstone. The hardness values shown range from 88.92 mg/l to 238.12 mg/l. Which were found within WHO limit.

3.6. Sodium (Na^+):

Na^+ is the vital components of drinking water and mainly dissolved from most rocks and soils (Meena et al., 2010). Sodium concentrations were found in between 9.22 mg/l to 80.40 mg/l. all sampling sites showed lower sodium concentration than the prescribed limit by WHO.

3.7. Potassium (K^+):

The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water (Mushekar, 2011). Potassium content in the water samples varied from 5.02 mg/l to 70.27 mg/l.

3.8. Chloride (Cl^-):

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects (Mushekar, 2011). In the present analysis, chloride concentration was found in the range of 28.8 mg/l to 80.4 mg/l. The values are within the WHO limits.

3.9. Fluoride (F^-):

Fluoride is a geochemical contaminant and natural sources account for most of the fluoride in groundwater. Its concentration is dependent on solubility of fluoride causes skeletal and dental fluorosis. The non-skeletal fluorosis due to continuous intake of fluoride containing water, air and agricultural produce (Bachenahalli et al., 2011). Fluoride content of the study area in the present investigation is ranged from 0.11 mg/l to 0.94 mg/l. Which is well within the WHO permissible limits.

3.10. Nitrate (NO_3^-):

The nitrate value in the study area varies from 9.3 mg/l to 60.2 mg/l. Increased level of nitrate at various locations may be attributed due to the surface disposal of sewage and agricultural wastes. Nitrate is effective plant nutrient and moderately toxic and is considered important for drinking water supplies (Nath, 1996). Its concentration above 45 mg/l proves detrimental to human health.

3.11. Sulphate (SO_4^{2-}):

Sulphate occurs naturally in all kinds of water. It is dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. In the study area it ranged between 19.3 mg/l to 79.5 mg/l. All the samples showed the sulphate content within the prescribed limit of 200 mg/l.

3.12. Trace Metals:

The groundwater samples were analyzed for heavy metal such as Cu, Fe, Pd, Cd and Zn, which are characterized as undesirable metals in drinking water. Trace metals in the groundwater samples ranged from: Fe; 0.1840-0.9149 mg/l, Pb; 0.0035-0.1420 mg/l, Cu; 0.0160-0.1385 mg/l, Zn; 0.0037-0.1705 mg/l, Cd; 0.0093-0.0459 mg/l. Result showed that Zn, Cd and Cu values at all sites were under the WHO prescribed limit. Data revealed that Fe and Pb level at some sites was above the safe limit. Variation in concentration of Fe was due to presence of latarite soils and domestic waste water which used for irrigation in vegetable production (Kaur et al., 2011). It is evident that, Pb is used in paints, PVC plastic, pencils, batteries, pesticides etc. Which happens to be the human activities that introduce Pb into the environment (Kumali et al., 2011). Pollutants were leach out in soil and contaminate groundwater (Kaur et al., 2011).

3.13. Statistical Analysis:

For the values of physico-chemical parameters-min., max., mean, standard deviation, median, range, variance, and standard error are calculated and are shown in Table 3. In statistics, correlation is a broad class of statistical relationship between two of more variables. Hence, it can be considered as a normalized measurement of covariance. The correlation study is useful to find a predictable relationship which can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters. Hence, it is a helpful tool for the promotion of research activities (Jain et al., 2004; Joshi et al., 2009). It can put forward possible causal of mechanistic relationships of research work. The correlation coefficients (r) were calculated and correlation matrix was obtained (Prasad et al., 2010). The values of correlation coefficients are listed in Table 4. The negative correlations were found in 11 cases between Temperature and Cl^-, Temperature and NO_3^-, pH and SO_4^{-2}, EC and Cl^-, TDS and Cl^-, TH and Cl^-, Na^+ and Cl^-, K^+ and Cl^-, F^- and Cl^-, SO_4^{-2} and Cl^-, F^- and NO_3^-. Some of the highly significant

correlations were discernible between F^- and pH, EC and TDS, EC and Na^+, EC and K^+, TDS and TH, TH and Na^+, TH and K^+, TDS and Na^+, TDS and K^+, Na^+ and SO_4^{-2}, Na^+ and K^+, K^+ and SO_4^{-2}. Poor positive correlation was found between Temperature and EC, Temperature and TDS, Temperature and TH, Temperature and Na^+, Temperature and K^+, pH and EC, pH and TDS, pH and TH, pH and Na^+, EC and F^-, EC and NO_3^-, EC and SO_4^{-2}, TDS and F^-, TDS and SO_4^{-2}, pH and Temperature, Temperature and SO_4^{-2} , TDS and NO_3^- , TH and F^-, TH and NO_3^-, TH and SO_4^{-2}, Na^+ and F^-, Na^+ and NO_3^-, K^+ and NO_3^-, K^+ and F^-, Cl^- and NO_3^-, NO_3^- and SO_4^{-2}. Very negligible positive correlation was observed between Temp. and F^-, pH and K^+, pH and Cl^-, pH and NO_3^-, F^- and SO_4^{-2}.

Table 3: Descriptive Statics for Physico-Chemical Characteristics of Ground Water

Parameter	Min.	Max.	Mean	SD	Median	Range	Variance	SE
Temp.	25.1	27.7	26.66	0.88	26.9	2.6	0.785	0.228
pH	6.92	8.92	8.13	0.62	8.16	2	0.387	0.16
EC	1085.4	3215.8	1837.97	625.30	1618.7	2130.4	391000.89	161.57
TDS	347.3	1050.2	621.61	226.91	557.6	702.9	51490.27	58.63
TH	88.92	238.12	164.72	50.50	174.12	149.2	2551.01	13.04
Na^+	9.22	80.4	37.03	21.81	39.58	71.18	475.75	5.63
K^+	5.02	70.27	32.84	24.76	18.21	65.25	613.226	6.39
Cl^-	28.8	93.2	62.48	20.27	65.8	64.4	411.27	5.23
F^-	0.11	0.94	0.63	0.290	0.79	0.83	0.084	0.074
NO_3^-	8.5	60.2	23.68	16.84	18.2	51.7	283.63	4.35
SO_4^{-2}	19.3	79.5	42.38	21.11	34.5	60.2	445.87	5.45
Zn	0.0037	0.551	0.0967	0.1372	0.0458	0.5473	0.0188	0.035
Pb	0.0018	0.1412	0.0492	0.0392	0.0421	0.1394	0.0015	0.010
Cu	0.0107	0.1385	0.0517	0.0378	0.0439	0.1278	0.0014	0.00009
Cd	0.0093	0.0492	0.0321	0.0124	0.0325	0.0399	0.0001	0.0003
Fe	0.184	0.9149	0.5035	0.2258	0.47	0.7309	0.051	0.058

Table 4: Correlation Matrix

Parameter	Temp.	pH	EC	TDS	TH	Na^+	K^+	Cl^-	F^-	NO_3^-	SO_4^{-2}
Temp.	1.000										
pH	0.114	1.000									
EC	0.325	0.313	1.000								
TDS	0.253	0.297	0.987*	1.000							
TH	0.284	0.320	0.765*	0.767*	1.000						
Na^+	0.381	0.106	0.832*	0.855*	0.785*	1.000					
K^+	0.284	0.038	0.786*	0.808*	0.701*	0.927*	1.000				
Cl^-	-0.504	0.083	-0.480	-0.469	-0.459	-0.515	-0.489	1.000			
F^-	0.061	0.741*	0.465	0.447	0.428	0.304	0.219	-0.198	1.000		
NO_3^-	-0.090	0.004	0.124	0.140	0.208	0.181	0.185	0.493	-0.408	1.000	
SO_4^{-2}	0.372	-0.034	0.597	0.553	0.519	0.666*	0.675*	-0.332	0.041	0.268	1.000

*Significant at 5% level, r > 0.649

4. Conclusion:

The overall study of the physico-chemical parameters in the present investigation indicates that the quality of underground water varies from bore-well to bore-well. Higher values of certain parameters at certain bore wells indicate the unfitness of water for drinking purposes. It is high time to preserve and protect this valuable ground source. Far these various measures have to be taken which will control the contamination from different sources. These include proper treatment and disposal of the effluent, proper drainage for the domestic and agricultural wastes, less usage of chemical and hazardous fertilizers, proper and hygienic maintenance of the sanitary conditions of the area and above all, the inhabitants should be given proper knowledge to improve their own hygienic habits. The public should have protected potable water.

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Depleting Groundwater Resources in Rajasthan: A Challenge to Sustainability

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Abstract:

Groundwater represents 97% of the world's available freshwater resources and is extensively abstracted throughout the world. While abundant in a global context, it can only be developed to a certain extent without causing environmental impacts. Also, it is highly variable across the globe, and where it is heavily relied on, it is less renewable. Hence, it is critically important that this resource is managed sustainably. However, the Sustainable Development Goals (SDGs) of the 2030 Development Agenda do not, as a rule, account explicitly for the significant role that groundwater plays and will continue to play in sustainable development. The key features of groundwater relevant to the SDGs are its use, management and sustainability. Groundwater has emerged as the primary democratic water source and poverty reduction tool in India's rural areas. On account of its near universal availability, dependability and low capital cost, it is the most preferred source of water to meet the requirements of various user sectors in India. Ground water has made significant contributions to the growth of India's Economy and has been an important catalyst for its socio-economic development. Rajasthan stands first in terms of degree and extent of over-exploitation of groundwater resources in the country. One reason for this phenomenon is the absence of sufficient number of large-scale surface irrigation facilities, well-spread geographically. The low to medium rainfall in most parts, high evapo-transpirative demands for water, high frequency of occurrence of droughts resulting from the departure of rainfall from mean values, and the high per capita arable land (0.18 ha) increases the demand for irrigation water. This is being met through mining of groundwater resources. In the present study status of groundwater resources in Rajasthan and fluctuation of

groundwater level during pre and post monsoon season-2019 has been analyzed.

***Keywords**: Groundwater, groundwater depletion, Pre and Post Monsoon, Aravalli range, Thar Desert, Sustainable Development.*

Introduction:

During the 20th century, there was an enormous boom in well construction for urban water-supply, irrigation and industry, facilitated by advances in drilling and pump technology, geological knowledge, and support from state subsidies, especially for irrigation. Groundwater has therefore de facto become a key resource supporting human well-being and economic development. It presents a critical resource in terms of risks as well as opportunities for development in a changing world. Hence, it is obvious that any concerns related to water resources in general are equally pertinent to groundwater. Importantly, due to groundwater being indirectly recognizable in the landscape while acting as the underpinning and often fall-back resource, groundwater requires dedicated and explicit attention. However, groundwater use is often unsustainable. Groundwater supplies are diminishing in some regions, with an estimated 20% of the world's aquifers being overexploited (Gleeson et al., 2012). Groundwater quality deterioration is also increasingly becoming evident. It is essential that these trends are reversed in order to sustain the critical role of groundwater.

In 2015, the world leaders adopted the 2030 Agenda for Sustainable Development. The results' framework of the 2030 Agenda comprises 17 Sustainable Development Goals (SDGs). The SDGs are described in the 2030 Agenda as indivisible and integrated, balancing the economic, social and environmental dimensions of sustainable development (United Nations, 2015). Water is key to sustainable development. It supports industry, agriculture and ecosystems, and is essential for human life and livelihoods. Therefore, water will serve as a foundation

for the achievement of many of the SDGs, including SDG 6, the dedicated water goal: 'To ensure availability and sustainable management of water and sanitation for all'.

The management of groundwater resources for sustainable development is a challenging task in India because of its vast geographical extent (3287000 km^2), where about 1250 million people live. As a result, the Country is facing scarcity of drinking water quite often. This situation compels to adopt management practices for the development of sustainable groundwater resources.

The State of Rajasthan comprising of 33 districts has a geographical area of 3,42,239 square kilometre (sq km). It is situated between north latitudes 23°03' and 30°12' and east longitudes 69°30' and 78°17'. Physiographically the state is divided into four major units, i.e., Aravalli hill ranges, Eastern plains, Western Sandy Plain and Sand Dunes & Vindhyan Scarpland and Deccan Lava Plateau. The Aravalli Hill Ranges from the main water divide in Rajasthan. Luni is the only river west of Aravallis. In the remaining area of western Rajasthan comprising about 60% of the geographical area of the state, the drainage is internal, and the streams are lost in the desert sands after flowing for a short distance from the point of origin. In the east of Aravalli ranges, the main rivers are Chambal, Banganga, Banas, Sahibi, Kantli, Banas and Mahi. Rajasthan receives much lower rainfall compared to the other parts of the country. Out of the total rainfall, a sizable portion is in the beginning of the rainy season which is mainly used for building the soil moisture and is also lost to evaporation because of the arid conditions. The amount infiltrating through the soil mass to contribute to ground water storage is of the order of 5% to 7% in areas underlain by hard rocks and 10% to 15% in alluvial areas.

Rajasthan is the driest state in the country and is water scarce (having per capita water availability below 1, 000 m^3/year) precarious situation, the state has to face regarding water availability. With prevailing high growth rate of population, the per capita water availability is going

to further reduce to alarmingly low levels, implying that the challenges for water sector are much more and severe in the state (Pachori and Kumar, 2017). This is due to very low to medium rainfalls, high inter-annual variability in rainfall magnitudes, very few rainy days, and high aridity. The pressure on groundwater is further growing due to population growth and an increased number of industries. About 80% of the State areas have witnessed groundwater depletion and many towns and villages have experienced a shortage of drinking water, particularly in summer months (Chinnasamy et al., 2015). The mean annual rainfall, however, varies significantly from 100 mm in Jaisalmer to around 900 mm in Udaipur. The Thar Desert in Rajasthan receives the lowest annual rainfall of the entire country. Along with spatial variation in rainfall, the number of rainy days also changes with lowest figures for the areas receiving lowest rainfall in western parts to relatively larger number of rainy days for areas receiving higher rainfall in southern parts. In fact, this is one of the characteristics of Indian rainfall (Pisharoty, 1990). Implications of the depletion of groundwater resources can have adverse effects on the livelihoods of the rural poor that rely on agriculture, especially in semi-arid areas where supplemental irrigation is critical for crop growth (Reddy, 2005). Some studies indicate that up to 50 per cent of wells once in use have completely dried-up (Shah, 2002; Reddy, 2005). In view of this the present study analyzed the stage of groundwater development and its fluctuation during pre and post monsoon season at district level in Rajasthan.

Database and Methodology:

The present study is totally based on secondary data. The data related with groundwater status in the state has been collected from Ground Water Year Book Rajasthan, 2019-20 of Central Ground Water Board; Rajasthan State Groundwater Atlas-2013 and Ground Water Department Government of Rajasthan. The average depth to water level of blocks and districts of pre monsoon, 2019 and post monsoon, 2019 has been analyzed to know the depletion or rise of water levels during the year 2019.

Analyses of water level data for the year 2019 have been carried out and results are shown in tabular form as well as in diagram.

Result and Discussion:

Stage of Ground Water Development:

Stages of groundwater development have been categorized into four categories according to Table 1. It is worthy to mention that in Notified Blocks, development of groundwater is not permitted anymore. Block wise analysis of development status of ground water when categorized into safe to over exploited stage indicates that 55% of all the blocks are currently being overexploited whereas only 15% of the blocks fall under safe category. About 13% of the blocks have been notified where any further development of ground water is not permitted (Table 2).

Table 1: Basis for Categorization:

Ground water development	Categorization
<= 70%	Safe
70% - 90%	Semi critical
90% - 100%	Critical
> 100%	Over exploited (Notified)

Table 2 clearly shows that the districts which have comparative more developed agriculture also exhibit over exploitation of groundwater. The northern and eastern Rajasthan is bestowed with the technology which supply substantial amount of water in water deficient arid region. Gone are the days, when the farmer used to perform extensive farming in order to fulfill the basic needs. With commercialization in agriculture, the extensive farming has shifted rapidly towards intensive farming. The mechanization in farming has managed to improve the livelihood of the farmers of northern Rajasthan but the pressure on land and water resource is immense. The dependency on water resources has been broadened by submersible tube wells which have successfully replaced

traditional wells to extract groundwater. There is no visible shortage of water in Scheduled Tribe (STs) dominated southern region because people are successfully extracting groundwater to meet their requirements, which basically includes the irrigation of crops through conventional methods.

Categorization on the basis of development of GW	Percentage of state	Block Name
Safe	13.33%	Anandpuri, Anupgarh, Aspur, Bagidora, Banswara, Bap, Barmer, Bhadra, ChhotiSarwan, Ganganagar, Garhi, Gharsana, Ghatol, Hanumangarh, Karanpur, Lunkaransar, Nohar, Padampur, Peepalkhoont, Pilibanga, Raisinghnagar, Rawatsar, Sadulshahar, Sajjangarh, Sangaria, Sardar Shahar, Shahbad, Suratgarh, Tibi
Semi-Critical	9.05%	Bichhiwara, Churu, Dungarpur, Fatehpur, Itawa, Keshorai Patan, Khajuwal, Kishanganj, Kolayat, Kotra, Kushalgarh, Ladpura, Luni, Pali, Phagi, Ratangarh, Sagwara, Simalwara, Sultanpur, Todaraisingh, Tonk
Critical	14.46%	Sindhari, Chohtan, Kaman, Deeg, Bayana, Nagar, Bari, Sam, Khanpur, Nadoti, Karauli, Nagaur, Ladnu, Rohat, Sumerpur, Dhariawad, Pindwara, Abu Road, Deoli, Kherwara, Rishabhdeo, Jhadol, Sarada, Lasadiya, Salumbar.
Over Exploited	50.40%	Ahore, Alsisar, Amet, Antah, Arain, Arnod, Asind, Atru, Bakani, Balesar, Bali, Balotra, Bamanwas, Bandikui, Banera, Bansur, Baran, Bargaon, Bari Sadri, Baseri, Begun, Bhadesar, Bhainsrorgarh, Bhim, Bhinay, Bhinder, Bhopalsagar, Bikaner, Bonli, Bundi, Chaksu, Chhabra, Chhipabarod, Chhoti Sadri, Chitalwana, Dag, Danta Ramgarh, Dausa, Degana, Deogarh, Desuri, Dhaulpur, Dhorimanna, Didwana, Dudu, Dungargarh, Dungla, Gangapur, Gangrar, Girwa, Gogunda, Hindaun, Hindoli, Hurda, Jahazpur, Jaisalmer, Jaitaran, Jamwa Ramgarh, Jaswantpura, Jawaja, Jayal, Jhalrapatan, Kapasan, Kathumar, Kekri, Khairabad, Khamnor, Khandar, Khandela, Khetri, Kishangarh, Kishangarh Bas, Kotkasim, Kotputli, Kotri, Kumbhalgarh, Kumher, Lachhmangarh, Lalsot, Mahwa, Makrana, Malpura, Mandal, Mandalgarh, Mandawar, Manohar Thana, Marwar Junction, Masuda, Mavli, Nadbai, Nainwa, Neem Ka Thana, Neemrana, Niwai, Nokha, Parbatsar, Phalodi, Piprali, Pirawa, Pratapgarh, Railmagra, Raipur, Rajakhera, Rajgarh, Rajsamand, Ramgarh, Rani, Rashmi, Reni, Reodar, Riyan, Rupbas, Sahara, Sangod, Sankra, Sapotra, Sawai Madhopur, Sewar, Shahpura, Sheo, Sheoganj, Shergarh, Sikrai, Sirohi, Siwana, Sojat, Srinagar, Sujangarh, Suwana, Talera, Taranagar, Thanagazi, Tijara, Umren, Uniara, Viratnagar, Weir
Over Exploited (Notified)	11.66%	Amber, Bassi, Bawari, Baytoo, Behror, Bhinmal, Bhopalgarh, Bilara, Buhana, Chirawa, Chittaurgarh, Dhond, Govindgarh, Jalor, Jhotwara, Jhunjhunun, KuchamanCity, Mandor, Merta, Mundwa, Nawalgarh, Nimbahera, Osian, Peesangan, Rajgarh, Raniwara, Sambhar, Sanchore, Sanganer, Sayla, Shahpura, Srimadhopur, Surajgarh, Todabhim, Udaipurwati
Saline	1.10%	Khajuwala, Taranagar

Table 2: Stage of Ground Water Development

Source: Hydrogeological Atlas of Rajasthan, 2013 and Groundwater Year Book, Rajasthan-2019-20, Central Ground Water Board, Western Region, Jaipur.

Scenario of Ground Water Level in Rajasthan Year- 2019:

Depth to Water Level Pre-Monsoon – 2019:

During Pre-Monsoon 2019 survey a total network of 5676 key wells including 3088 piezometers were monitored in the months of May - June, 2019. Average depth to water observed is 25.38 meters below ground level (Table 3). Minimum water level has been observed as 0.05 mtrs, Mandal (Mandal block) of Bhilwara district whereas maximum water level observed as 167.90 mtrs below ground level in Kharia Khangar (Pipar City block) of Jodhpur district. While analyzing depth to water level of all the districts of the state it has been observed that 62.67% key wells show water level below 20 metres whereas 0.09 % (only five) key wells show water level more than 150 meters.

Block wise average of all the 295 blocks show that minimum average water level is of Talwara block (3.93 mt.) of Banswara district and maximum of block Bapini (110.78 mt.) of Jodhpur district during pre monsoon 2017. Banswara district shows minimum average water level as 8.15 meters whereas maximum average of water level is 66.65 of Bikaner district. Two districts fall in the category of less than 10 mtrs, nineteen districts in range of 10-20 metrs, eight districts in the range of 30-50 mtrs, four in 50-100 metres average depth to water.

Table 3: District wise average depth to water level of Pre and Post Monsoon 2019 and average water level fluctuation between Pre and Post Monsoon 2019								
S.N.	District	Pre 19 Av. Depth to WL (mbgl)	Post 19 Av. Depth to WL (mbgl)	Change in WL (Pre 19- Post 19) mtrs	Min. WL Pre 19 (mbgl)	Min.WL Post 19 (mbgl)	Max. WL Pre 19 (mbgl)	Max. WL Post 19 (mbgl)
1	Ajmer	12.75	10.89	1.86	1.37	0.40	56.00	50.20
2	Alwar	30.82	33.02	-2.20	2.10	1.70	74.30	77.20
3	Banswara	8.15	4.92	3.23	0.15	0.40	49.94	28.13
4	Baran	15.33	13.94	1.39	1.40	1.50	73.00	48.00
5	Barmer	36.21	35.38	0.83	2.30	1.10	111.22	112.40
6	Bharatpur	16.88	16.74	0.14	2.00	2.10	114.00	115.50
7	Bhilwara	12.76	8.68	4.08	0.05	0.10	35.25	29.80
8	Bikaner	66.65	67.01	-0.36	7.25	7.35	153.90	153.30
9	Bundi	11.17	11.24	-0.07	2.15	0.60	48.65	45.55
10	Chittaurgarh	15.08	7.66	7.42	0.30	0.10	33.10	28.60
11	Churu	44.00	41.76	2.24	10.10	10.31	128.52	127.75
12	Dausa	31.86	32.18	-0.32	9.10	10.20	60.30	60.00
13	Dholpur	14.91	14.85	0.06	2.50	3.00	50.40	50.00
14	Dungarpur	10.46	5.85	4.61	1.05	0.11	37.52	21.63
15	Ganganagar	11.17	11.05	0.12	1.46	1.26	42.30	42.17
16	Hanumangarh	16.61	16.61	0.00	0.86	1.35	44.47	44.54
17	Jaipur	41.61	41.40	0.21	2.50	3.40	90.65	90.50
18	Jaisalmer	45.76	45.33	0.43	1.69	1.22	141.55	141.25
19	Jalor	31.50	26.64	4.86	2.00	1.00	92.70	99.80
20	Jhalawar	10.53	7.88	2.65	1.10	0.70	45.70	26.90
21	Jhunjhunun	58.63	59.04	-0.41	24.20	24.55	98.58	99.70
22	Jodhpur	60.59	59.90	0.69	2.80	1.60	162.60	160.00
23	Karauli	20.16	21.50	-1.34	1.80	2.20	46.20	48.70
24	Kota	13.12	11.79	1.33	2.00	1.25	65.90	42.35
25	Nagaur	56.48	55.86	0.62	7.00	7.20	153.00	154.95
26	Pali	16.04	11.88	4.16	0.93	0.30	67.20	65.10
27	Pratapgarh	11.75	5.02	6.73	2.70	0.30	37.80	15.65
28	Rajsamand	12.57	8.27	4.30	0.10	0.09	37.90	26.90
29	Sawai Madhopur	15.49	17.43	-1.94	3.10	4.10	46.20	48.80
30	Sikar	46.65	46.25	0.40	5.65	5.38	92.58	93.08
31	Sirohi	22.10	15.08	7.02	3.26	0.23	92.58	93.08
32	Tonk	10.01	7.42	2.59	2.70	1.20	34.30	34.20
33	Udaipur	9.64	5.56	4.08	1.48	0.27	53.05	47.08
	State Level	25.38	23.58	1.80	0.05	0.05	162.60	160.00

Source: *Groundwater Year Book, Rajasthan-2019-20, Central Ground Water Board, Western Region, Jaipur.*

Depth to Water Level Post Monsoon - 2019:

During post Monsoon 2019 survey, a total network of 5724 key wells including 3088 piezometers were monitored in the months of October and November, 2019.

Minimum water level has been observed 0.05 mtrs, i. e. just on ground level, at Bodigama Chhota (Sabla block) of Dungarpur district to 164.80 mtrs below ground level in Kharia Khangar village (Block Bhopalgarh) of Jodhpur district. Average depth to water level of the state is computed as 23.58 meters below ground level. While computing Block wise average of all the 295 blocks it is observed that minimum average water level is of Sabla (4.21 mtrs bgl) block of Dungarpur and maximum of block Bapini (111.61mtrs bgl) of Jodhpur district. Likewise, computation of district wise data show that Banswara district has minimum average water level as 4.92 meters whereas maximum average of water level is 67.01 mtrs below ground level of Bikaner district. During post monsoon survey out of 5724 monitoring stations water level is available in 5523 key wells. Other key wells have either been dried up or could not be monitored due to one or other reason. Depth to water level ranges show that more than 60% wells (67.96) fall in the category of water level recording less than 20 mtrs below ground level. While analyzing district and block wise average depth to water level data of post monsoon 2019 it is inferred those 10 districts and 107 blocks fall in the category of less than 10 meters average water level and on higher side 4 district and 31 blocks fall in the category of more than 50 mtrs average depth to water level during post monsoon, 2019.

Change in Water Level (Fluctuation) Pre and Post Monsoon-2019:

For water level fluctuation between pre and post – 2019, water level data of pre monsoon 2019 and post monsoon 2019 have been considered (Table 3). Average water level fluctuation of the state has been computed as 1.80 meters whereas district water level fluctuation ranges between -2.20 meters (Alwar district) and 7.02 meters (Sirohi district) Block wise analysis of all the blocks of state has been done and it is observed that out of 295 blocks 86 blocks has shown depletion of average 0.98 metres whereas 207 blocks has shown rise in water level with average of 3.10 metres. District wise analysis of average

water level fluctuation shows that out of 33 districts seven districts namely Alwar (-2.20), Bikaner (-0.36), Bundi (-0.07), Dausa (-0.32), Jhunjhunu (-0.41), Karauli (-1.34), and Sawai Madhopur (-1.94) has shown minor depletion where as rest 25 districts show rise in water level. While one district (Hanumangarh) shows no change.\ Water level fluctuation (pre and post 2017) ranges from -9.93 mtrs (village Dabla, block Jaisalmer, district Jaisalmer) to 29.46 mtrs (village Bhuvana, block Badgaon, district Udaipur).

Conclusion:

Water table in the stateis continuously falling over the years and the blocks under the critical and over-exploited categories are increasing at alarming rate. Over-exploitation of groundwater leads toreduction in water yield in the wells, increase in pumping depth and cost of pumping, contamination of groundwater. The groundwater management rather than development is the major challenge facing the water resources, particularly in the dry land areas. Therefore, a focus on the development activities must be balanced by integrated management mechanism to achieve a sustainable utilization of groundwater resources, whic is an important driver for the management of watersheds for sustainable development in the state. For sustainable management of ground water resources, ground water withdrawal is to be controlled within the limits of annual replenishment. A legal framework is thus required to be developed for regulation and management of ground water resources. An overall plan is required to envisage how the transformation can be achieved and this is likely to begin with a new water policy to reflect the principles of sustainable management of water resources.

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