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SUSTAINABLE GREEN BUILDINGS AND CHALLENGES

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ABSTRACT
The Goals and the narrative of the 2030 Agenda for Sustainable Development emphasize the importance of the spatial dimension of sustainable development. Population growth rate is one of the major concerns in most of the world's low-income countries. There exists a bilateral relationship between population growth and housing/commercial building development in parallel. On one hand, rise in population creates a demand for housing and commercial facilities and on the other hand supply of them ensues opportunities for high population density through migration. A step towards an ecofriendly approach in the construction of housing and commercial premises is the concept of 'green' buildings. Designing, constructing and effectively maintaining green buildings will improve the quality of life. This article discusses the concept of sustainable green buildings and the challenges for the same.

Keywords: Green house, LEED certification, recycles, IGBC

INTRODUCTION
Rapid increase in population is both a cause and a consequence of slow progress in development. Low and lower-middle-income countries facing multiple challenges with limited resources may achieve slow progress in reaching certain Goals and targets of the 2030 Agenda for Sustainable Development due to population growth. As population increases more space is required for accommodation and commercial areas for employment. This necessitates the construction of more buildings. Consequently this results in increased energy consumption, waste generation and pollution which negatively impact the environment. On a long term basis, this could manifest as an environmental threat. A sustainable approach to this scenario would be construction of Green Buildings. As the word "green" suggests, it definitely implies something which is eco-friendly. A green building is constructed with proper planning and designing with strategies to achieve sustainability in use of resources and management of waste [1]. In this article, the concept of green buildings and challenges are discussed with a few examples.

GREEN BUILDINGS
Green buildings provide solutions for accommodating large populations in a sustainable way. It reduces the impact of over-population on the environment by effective methods of construction and practices. Green buildings can be constructed for housing as well as for commercial purposes. Either a completely new green building can be constructed or a conventional existing building can be converted into a green building by adhering to some green practices. Although green building is a famous concept, its implementation is a tedious task as it requires knowledge and skills, quality materials and most importantly concern and responsibility towards the environment. Principles of green building revolve around the goal of environmental sustainability. It focuses on its impact on the environment which makes it different from other sustainable buildings. Basic principles for the construction of green buildings include - energy efficiency, water conservation, efficient use of land, waste reduction, minimal environmental impact and conservation of natural characteristics and material efficiency [2-4]. Construction of sustainable buildings takes into account the aspects of people, planet and profit simultaneously whereas green buildings are primarily concerned with the environmental aspects [5]. To achieve these principles, appropriate design techniques, construction practices and affordable housing is required.

COMPONENTS AND STRATEGIES
For a green building to be fully efficient it has to be properly built by taking into account every possible way to increase its sustainability towards the environment. There are many strategies followed and components used according to the infrastructure and budget of the project - some of which are discussed here in brief. The components used can be modified and renewed by innovation and new technology.

- Building orientation - Orientation provides a building with passive thermal and visual comfort. Successful orientation minimizes energy loads and maximizes free energy from the sun and wind. Good solar orientation favors efficiency of solar devices in relation to the direction of sunlight [6].
- Using passive solar panels - Passive solar panels can be used to deflect sun rays according to the needs during weather change. The amount of heat allowed depends on window size and orientation [6]. Though it is less efficient than active solar panels, passive solar panels are less expensive to install and maintain.

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- Site Design and Planning - Building design should include surrounding natural features like trees, streams and soil in its development pattern. Buildings must be connected to natural sunlight and wind for significant energy saving and improve wellbeing of occupants. One more strategy would be to group buildings to reduce impacts, provide valuable community green space and cut costs.[7]
- Water harvest system and greywater usage - For water conservation, water harvesting systems can be built to store water during rains. Grey water can be made to use for watering plants, in toilets etc. Another adaptation would be planting more xerophytic plants which require less water.[3]
- Compost and recycle system - Waste generated can be managed by building compost pits for organic waste and other waste like plastic, glass etc. can be recycled. Proper segregation of waste is required to achieve this.
- Constructing green - Implementation of green windows, green flooring, green roofs and green plumbing. These green techniques include use of mostly natural and high efficiency material with high durability.[6]
- Improving indoor air quality - Indoor air refers to air quality inside buildings with less toxins and pollutants. It mainly depends on proper design, material used, location, ventilation, humidity control and use of green appliances with less CFCs. Control on these would automatically improve indoor air quality leading to well being of occupants with less respiratory problems.[8]
- Renewable energy - Use of solar water heaters, solar photovoltaic panels and green appliances are energy efficient.[6]
- Green Appliances - Bureau of Energy Efficiency (BEE), Government of India proposes to make it mandatory for certain appliances in India to have ratings by the BEE to conserve energy.

RATING SYSTEMS AND BENEFITS

A building is said to be green even if it follows any one of the green practices and not every green building have the same impact on the environment. The degree of greenness depends on the overall efficiency of the building during its life cycle and also well-being of its occupants. It is based on the components and strategies used to construct it. Green buildings are rated to measure its actual impact on the environment. In India there are three rating system to check the efficiency of a green building:

Indian Green Building Council (IGBC): It is mainly designed for newly built structures, both air-conditioned and non-air-conditioned buildings including residential, factories, schools, integrated townships, offices, commercial buildings, etc. The validity of the IGBC certification is for a period of three years. Based on the total level of credits earned, a building is awarded a level of certification which is related to some recognition of buildings which are certified (good practice), silver (best practice), gold (outstanding performance), platinum (national excellence) and super platinum (global leadership) [9].

Leadership in Energy and Environmental Design (LEED) - It comes under the purview of IGBC. LEED India encompasses rating systems for: Existing Buildings (EB), New Construction (NC), Core and Shell (C&S) and Green Homes [10]. Their rating system is based on points and is abided by some criteria behind every credit. Based on the number of points received, a project can earn one out of four levels of LEED certification which are: Certified (40-49 points earned), Silver (50-59 points earned), Gold (60-79 earned), Platinum (80 + earned) [9].

Green Rating for Integrated Habitat Assessment (GRIHA) - The framework was developed by TERI (The Energy and Resource Institute) in the year 2005, keeping in mind the local climatic conditions and national codes and bylaws [11]. The objective of GRIHA is to reduce the consumption of resources and promote the use of renewable and recycled materials. The validity of GRIHA certification is for five years. Rating system is based on stars awarded for points: one star (50-60 points), two stars (61-70 points), three stars (71- 80 points), four stars (81- 90 points), five stars (91 - 100 points) [9].

High rated green buildings prove very beneficial to the environment as well as to society. The benefits of green buildings can be divided as environmental, social and economical [12]. Environmental benefits is the obvious purpose of green building, being eco friendly is ultimately in the favor of humankind itself. Being eco-friendly also offers social benefits like positive changes in psychological, emotional and spiritual aspects of one's life. Being near to nature and environment heals a person from within and brings peace,calmness and stability. Employees, workers and occupants in green buildings prove to show an increase in productivity, high cognitive scores, better sleep experience and improvement in performance. Reduction in cost of electric and water bills and improved health conditions are something which fall under economic benefits of a green building, going green turns out to be a good business strategy.

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Examples of Green Buildings

Green building is just not a theory concept, it is the practical solution for today's existing environmental problems mainly due to population explosion. The benefits of constructing a green building encourages society to go green. Below are examples of green construction including housing and commercial premise, which are taken randomly without any preferences.

1. Indian - Suzlon One Earth, Pune : This is an office, a commercial area in Pune which received LEED platinum rating in 2010. The architect and builder came up with the concept of "office in garden". The area is spread over 10 acres and is one of the largest green projects of the country with LEED certification [13].
2. T-ZED Homes, Bengaluru: T-ZED, completed in 2009 is India's first IGBC Platinum-rated residential apartment complex. The project was accomplished by the company Biodiversity Conservation India Ltd. (BCIL), Bangalore. Completed in 2009, the building was constructed without the use of concrete blocks, bricks, vitrified tiles, chemical paints, or ceramics , and a very reasonable amount of reinforced steel and composite cement was used. In the complex that spreads in 5 acres, there are 80 apartments and 15 individual houses [14].
3. Infosys limited, mysore : Infosys Limited has been awarded the LEED India 'Platinum' rating by IGBC for its Software Development Block 5 (SDB 5) in Mysore, India. The Project completed in the year 2011. SDB 5 has been built keeping in mind key areas constituting the principles of green buildings and heading towards environmental sustainability [15].
4. Indira Paryavaran Bhawan : Indira Paryavaran Bhawan, the new office premises for Ministry of Environment and Forest (MoEF) is India's first new on site net zero building. The building is located in New Delhi and has the accommodation capacity of around 600 officials. It uses innovative solar mechanisms for energy generation and has been built by using energy efficient building materials [16]. The Project received an award from Adarsh/GRIHA of MNRE for exemplary demonstration of Integration of Renewable Energy Technologies, Feb 2013. The Project was accorded 5-Star Green Building Certification by GRIHA under MNRE, Jan 2014 [17]. It is now India's highest rated green building i.e.GRIHA 5-Star and LEED India Platinum.The building is also earthquake resistant. More than 50% of the area outside the building has plantations and grassing. Even circulation roads and pathways are a soft area to enable groundwater recharge, solar power generation systems have been provided at terrace level along with many other sustainable features [16].

Currently, Hospitality and travel-tech firm Oyo, is working towards bringing a 'green tag' for sustainable hotels listed on its platform, informed by its CEO. The 'green tag' will be assigned to hotels that are eco-friendly in terms of features like using solar power, enhanced efficient lighting and rainwater harvesting. The future plan is to launch green tagged hotels for more eco- friendly customers [18].

CHALLENGES

In spite of knowing the environmental issues and the benefits of green building, the number of green buildings is so low and not every building constructed is a green building. The investigation of these questions lead us to the challenges and shortcomings in the construction of green buildings.

The main challenge is lack of awareness. Though it is thought that green building is the most famous and trending thing, there still exists a large sector of population inadequately aware of green buildings and green practices. Secondly, even if the concept is known, the implementation becomes difficult because of the attitude towards the idea of green buildings. The false notion that it is an unachievable goal is a hindrance. Further construction of green buildings is a tedious task and requires effective planning, design and use of high quality sustainable materials. Expert guidance including skilled Engineers, Architects, Workers and high investment in the initial stages of building is required which makes its adoption difficult by profit loving contractors [19].

India is setting its goals for green building but these initiatives are not complemented by government rules and regulations. There are no sufficient government policies in order to support large scale implementation of green building construction. There is a long tedious process which builders and developers have to face in order to get approvals. Currently, incentives plans available in favor of green buildings are not sufficient to encourage its extensive adoption in India. Also, the ones which exist are not uniform due to diverse governing bodies across different states and cities. All these form potential reasons for why the adoption of green building practices is challenging [19].

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Alternative for Sustainable Green Building Materials

Materials used for building conventional buildings are not environmentally sustainable. Concrete and cement have been the most fundamental ingredients in buildings since the 1950s in India [20]. It has adverse environmental impacts like increase in carbon and greenhouse gas emission, global warming, damage to topsoil etc. Production of concrete requires extensive mining of stone to produce coarse aggregates, creating many new fault lines in the natural rocky terrain, making it prone to earthquakes and other environmental threats . An alternative to this would be the use of Green Concrete. Concrete produced with recycled or waste materials from construction and demolition of buildings or with substitutes such as flyash, quarry dust, marble powder/granules, plastic waste and masonry as aggregates has less impact on the environment and may be termed as Green Concrete [21]. Its production process does not lead to environmental destruction, has high performance and life cycle sustainability and can be used for construction purposes [22]. However, this alternative is not so straightforward in the sense that even green concrete has some drawbacks which has to be taken into consideration.Water absorption, shrinkage and creep are high compared to conventional concrete, flexural and tensile strength are less, and has a shorter lifespan [21]. However there is a need to check whether these disadvantages overcome the benefits of green concrete on the environment compared to traditional concrete in today's urban world and accordingly changes can be made.

In India a company named Navrattan Green Cement Industries Pvt. Ltd. (NGCIPL) is involved in the production of green cement called green crete. NGCIPL is the one-sixth part of the entire Navrattan Group of Companies. The business group is involved in innovating and acquiring Intellectual Property Rights from all over the world. Navrattan Green Crete, a product of NGCIPL, is an Environment-friendly crete that is a stronger and more durable alternative of Ordinary Portland Cement (OPC). The company is one of its kind ventures in the world that has worked with researchers and scientists and innovated Green Crete [23].

There are also alternatives to other building materials such as use of Bamboo Concrete Blocks, Ferrocement and Aerocon panels, FiberCement composites, Flyash bricks, Mud Blocks (compressed), Rice husk, Straw bale (with bricks), Bagasse-Cement Boards and Panels, Bagasse-PVC Boards etc.[24].

Conversion of Existing Buildings into Green Buildings

The concept of green buildings is achievable in two possible ways: either a completely new green building can be constructed or an existing conventional building can be converted into a green building. The latter can be achieved by introducing and implementing some green practices. Construction of green buildings *de novo* is a tedious task and it is gaining pace currently but the beneficial outcomes will come in near future, meanwhile ideas to convert existing buildings to green buildings will drive us more towards environmental sustainability.

By looking into marketing dynamics, infrastructure and other factors certain green practices can be introduced to upgrade a building to green building. Some of the techniques and ways are mentioned below which can be adopted to turn a building green.

- Vertical gardening - As the name suggests, it is a garden that grows vertically upward with the help of trellis or other support system, rather than on the ground (horizontally). These vertical gardens can be self - sufficient green walls /Living walls that can act as a natural air conditioner,control humidity levels and also help to improve indoor air quality.
- Grass pavers - Grass pavers are the paving tiles which have a large number of rhombus shaped openings so that water can percolate through ground and thereby help in raising the ground water table. By using this product, it allows surface water to seep into the aggregate and slow down the runoff that would have been on a concrete or asphalt surface.
- Vermicomposting - Vermicompost is the end product of a process called vermin composting, which uses earthworms to increase the speed of the composting process and ensure higher-quality compost. Vermin compost essentially ends up being applied to plants in the garden [25].
- Water harvest system - Water harvest system can be implemented in existing buildings by some simple steps including cleaning the catchment area where most water collects during rains,redirecting water with pipes,installing rain separator and storage tank filter and overflow pipe for extra water [26].
- Aluminum paint -Aluminum paint would be a better alternative than conventional paints for protective coating of walls. It consists of a base made up of resin which is filled with solid freckles of aluminum. It gives strength and durability to walls along with a shiny appearance. Aluminum based paint has the capacity to reflect the sun rays falling on it which ultimately reduces the heat intake in the building and thereby creates a better atmosphere to live in.

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- Solar power plants - Photovoltaic (PV) solar power plant is used for larger development of solar power generation. This may come up with storage facilities using battery or grid connections. In a solar rooftop system, the solar panels are installed on the roof of any building whether it could be residential, commercial, institution or industrial. By photovoltaic process these solar PV cells generate electricity by using sunlight. Solar water heaters can also be installed to convert the sun's energy for heating water which is used mostly in residential and industrial buildings.
- LED lighting - LED lights are up to 80% more efficient than traditional lighting such as fluorescent and incandescent lights.

Overall cost analysis will give an insight on the advantageous outcomes of once the building is converted to green building. However, the advantages and benefits of the green buildings are spread out over the life span of the building and should be looked upon on a long term basis rather than initial cost [25].

Role of Government for Green Buildings

There are some government schemes and plans existing to increase adoption of green building practices.Some of which provide incentives like reduced property tax, extra percent ground coverage for FAR (floor area ratio) free of cost, reduction in permit fees etc. depending on the certification received by IGBC. The magnitude of these incentives differ from state to state governments [27]. The government is currently providing subsidies for solar panels on rooftops to ensure sustainable use of electricity. The subsidy on the solar panels is available broadly in many categories differing from state to state. India had a target to install 40GW solar panels at residential home buildings, but India has achieved only 5GW till 2021. The Indian Government sets a target of 280GW solar panels by 2030 [28-30]. Other suggestion would be to successfully incorporate green building ideas in upcoming redevelopment projects in order to increase their number and ensure enhanced well being of the occupants.

CONCLUSION

In today's world of increasing population and pollution, going green is the best option to ensure environmental sustainability and survival. The idea of green building serves a way to achieve this incentive. However there is a need to take this idea more seriously by people and government for implementation and adoption of green building practices. Existing schemes and incentives of government are good but there is a need to monitor their effectiveness on green building development, updating them whenever necessary and also coming up with new plans. Advanced technology has to be incorporated in green buildings to ensure high energy efficiency. Green concrete supplements as a better substitute for traditionally used concrete in order to ensure higher environmental safety. There are also other alternative materials available for sustainable green construction. Thus the idea of green building is still gaining its pace in India and we may be able to see its development in the near future with collective efforts from government as well as citizens. One way to do this in the current state is to incorporate green design ideas in new upcoming redevelopment projects to ensure its early establishment.

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SEGREGATION OF WASTE: A CHALLENGE DURING PUBLIC FESTIVAL TIME

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ABSTRACT
Segregation of waste into dry and wet components has been made mandatory by the municipal authorities in Mumbai since a long time. It is an essential step towards reduction of burden on waste management methods. Large area, ever growing population and social diversity have proven to be several challenges in achieving the desired success with regards to waste segregation in Mumbai city. These challenges are more evident during social festival times, when the waste is generated in tremendous amount as compared to the normal times. Segregation of such huge amount of waste is not only environmentally but socially harmful. Thus, it calls for a need to assess the level of awareness among population about waste segregation methods and its importance. This paper makes an effort towards understanding the acceptance, adaptability and challenges faced by waste segregation methods during festive times. It also tries to suggest effective approaches towards creating awareness.

1. INTRODUCTION
Solid waste management is a challenge faced by every human habitat in the current times. Tremendous population growth, expansion of new suburbs, uncontrolled use of resources and lack of seriousness about the aftermaths of waste disposal are leading to chronic issues related to waste disposal. The nature of waste also differs from one another depending upon the source. Whereas certain types of wastes can be seemingly non-hazardous (e.g paper), more serious threat can be caused due to waste materials like bio-medical waste. If not treated in the prescribed method, any type of waste can be a nuisance for the well-being of the members in the surrounding area.

A city like Mumbai creates several thousand metric tons of waste in a single day. Managing such large amount of waste is a challenge for the waste management systems. Basic strategies like segregation of waste into dry waste and wet waste may help in managing the issue to a certain extent. However, the segregation methodologies do not seem to be followed in many parts of the city, even after them being made mandatory.

The challenge of waste segregation is intensified further during the public festival times, such as Ganesh Utsav, Navratri, etc. These festivals are celebrated not only in the public spaces, but also at the household levels. Large amount of material is utilized for decoration and during worshipping, containing both: ecofriendly and non-ecofriendly substances. In ideal circumstances, the segregation of waste during such festivals will help in lifting off pressure from the already crumbling waste disposal methods. However, according to the recent statistics, such festivals add up to the waste generation by one thousand to three thousand metric tons of waste during the time they are celebrated. This waste is usually not segregated and thus leads to even more trouble. The dry waste consists of paper, plastic, thermocol, synthetic fabric, etc. The wet waste generally contains natural flowers, paper, etc.

2. OBJECTIVES OF THE PAPER
- To estimate the level of awareness among the general public towards the segregation of waste
- To co-relate the level of awareness with the age group
- To co-relate the level of awareness with exposure to education
- To suggest measures to create awareness to reduce the amount of harmful waste during the Ganpati festival at the household level

3. RESEARCH METHODOLOGY
The paper required the study of secondary data as well as primary data.

The secondary data was collected from the websites, e-journals and newspapers. Data was also collected from various previously published research papers and review papers on the topic of segregation waste in the urban areas.

For the purpose of collecting the primary data for this paper, the recent public festival of Ganesh Utsav was considered. The focus of study was concentrated only on the household Ganesh festival and not the publicly celebrated one. Thus, the sample study was made only on people who celebrated the festival at home. The data

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was collected through an online structured questionnaire, asking questions about the level of awareness and willingness to segregate the waste during Ganesh festival at their homes.

The data was gathered from a sample size of 140 respondents.

The data was further studied to understand the current practices followed by the respondents in order to gauge their cautiousness towards segregation of waste.

4. DATA ANALYSIS AND INTERPRETATION

The data collected from the primary sources was subjected to filters and the following key observations were made:

For 140 responses:

Age groups:

- 45% people from 0-25 years
- 55% people from 25-40 years

Duration of Ganpati festival:

- 40% people have for 1.5 days
- 25% people have for 5 days
- 15% people have for 7 days
- 15% people have for 10 days

Material used for decoration:

- 90% people used mainly eco-friendly material (Natural flowers and paper- 65%)
- 10% people used mainly non eco-friendly material (Thermocol- 20%, Plastic- 10%)

Material of the Ganpati idol:

- 65% people had an idol made from natural material
- 35% people had an idol made from artificial material

Total amount of garbage generated per day:

- 95% of people say between 0-2 kg

Proportion of the waste (Dry waste: Wet waste)

- 30% people say it was 25:75
- 25% people say it was 75:25
- 20% people say it was 50:50

Active segregation of waste:

- 75% people segregated the waste
- 25% people did not

Method adopted for treating the waste after collection:

- 60% people dumped the waste in the dustbin separately after segregation
- 25% people dumped the waste in the dustbin together
- 15% people dumped the waste directly in a water body outside

Awareness about importance of segregation of waste:

- 90% people are aware
- 5% are not
- 5% are not sure

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Need for reform in order to reduce waste generation:

- 90% people agree
- 5% do not
- 5% are not sure

Source of information about segregation of waste:

- 65% from school/college syllabus
- 20% from municipal initiatives
- 15% from social media

5. INTERPRETATION & CONCLUSION

- Higher number of people claiming to use eco-friendly material for decoration (90%), but still at least 25% of the total waste is non-ecofriendly.
- Significantly less people used non-ecofriendly material for decoration (10%).
- However, people using Ganpati idol of artificial material is still significantly higher (35%).
- There is a gap between people segregating the waste (75%) and actually dumping it separately (60%).
- High level of awareness (90%), but low level of practice (60%).

6. RECOMMENDATIONS

- Fundamental information about what constitutes dry waste and wet waste.
- Emphasis on awareness imparted through education.
- Positive use of social media by municipal corporations. Awareness can be created through posters, street plays etc.

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IMPACT OF POPULATION GROWTH AND ANTHROPOGENIC ACTIVITIES IN INDIA

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ABSTRACT
Burgeoning population growth has a significant impact on anthropogenic activities. Uncontrolled urbanization along with industrialization has caused destruction of natural habitats. The present paper is an attempt to study the impact of population growth on land, forest, water and energy resources. The analysis reveals that huge population growth rates are causing population density to rise thereby pushing people below the poverty line.

Excessive population growth contributes to land degradation, soil erosion which in turn affects overall productive resource base of the economy.

The rising population and growing affluence have resulted in excess demand for energy production and over utilization of resources in India.

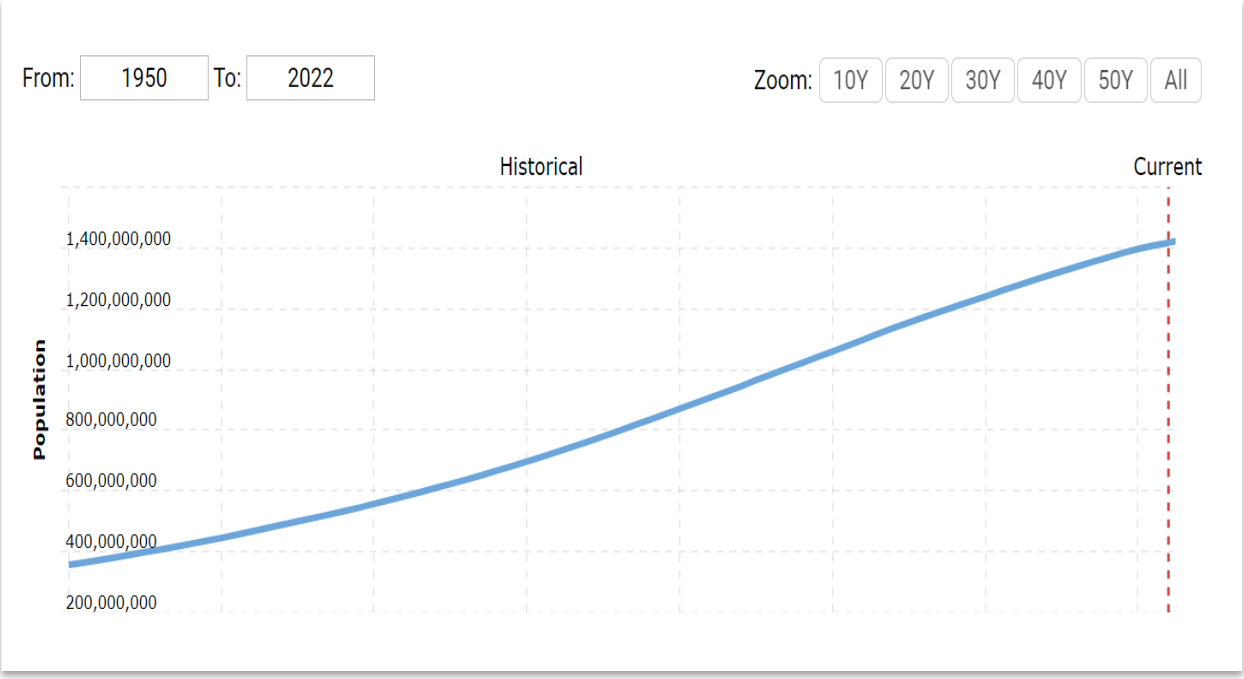
The environmental side effects like ground water pollution, air pollution and global warming are the aftermaths of this excessive consumption. The paper concludes with policy analysis and emphasizes the need of energy conservation keeping sustainability as a crucial factor.

Keywords: Population, India, Sustainability, Environment and Degradation.

INTRODUCTION
The fundamental cause of environmental degradation can be attributed to burgeoning population growth of a country which affects the quality of natural resources and environment available for next generations. Sustainable development in India faces major threat due to the uprising population and callous attitude of general public towards consumption of natural resources. Changing consumption pattern has resulted in exceeding demand of energy resources. There is intense pressure on ground water, land, soil, natural habitat and biodiversity. Due to excessive urbanisation and industrialization, there is tremendous pressure on environment in India.

As per United Nations Report global population has almost tripled amounting to 8 billion people in 2022. China and India together contribute for roughly 36% of the world population. As of 2022 China amounts to 1.44 billion people and India amounts to 1.39 billion people. India is the second most populated country in the world and accounts for 17.5% of the world's total population on 2.4% of world's geographical area.

There has been a steady growth of population in India from 1950s onwards till 2022**.**



Source – World Bank Reports

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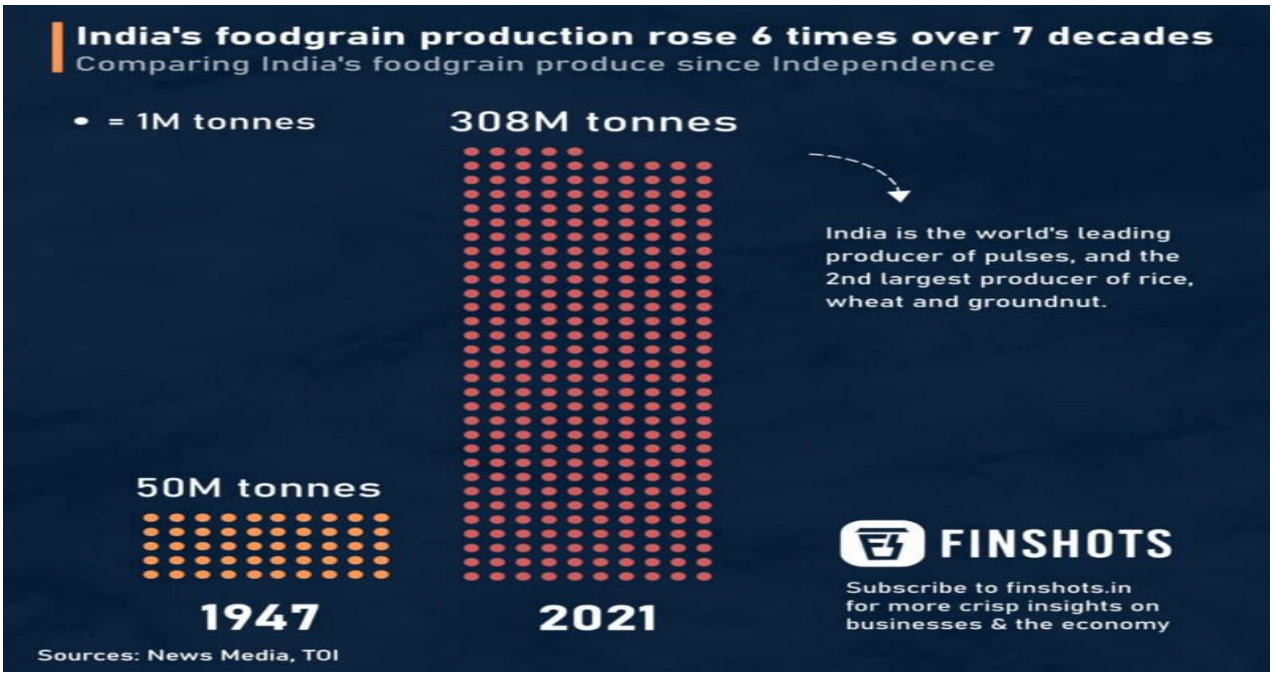
Growth of Population in India:

Census Year	Population (In Crores)	Decadal Growth (%)	Average Annual Exponential Growth (%)
1971	54.82	24.80	2.20
1981	68.33	24.66	2.22
1991	84.64	23.87	2.16
2001	102.87	21.54	1.97
2011	121.02	17.64	1.64

Source – Census 2011



Source – TOI

Rising population creates demand for food and energy thereby altering the land usage, cropping patterns and excessive ground water consumption. India's food production has increased 6 times over 7 decades. The pressure on environment intensifies significantly with rise in population. To add fuel to the fire India is plagued with the problem of poverty along with unequal distribution of resources which manifolds the problem of environmental degradation. A sustainable growth strategy in line with UN sustainable goals is need of the hour to tackle this double-edged sword of population growth and environmental degradation.

OBJECTIVES

1. To elucidate trend of population growth in India
2. To understand impact of population growth on natural resources
3. To analyse the impact of population growth and urbanization on natural ecosystem
4. To provide solutions keeping sustainability as a crucial factor

RESEARCH METHODOLOGY

The primary research area involves analysing the direct role of population growth on anthropogenic activities in India. The study is primarily based on secondary data derived from census reports, World Bank reports, United Nations reports and literature review of ecological journals, government ministries and websites.

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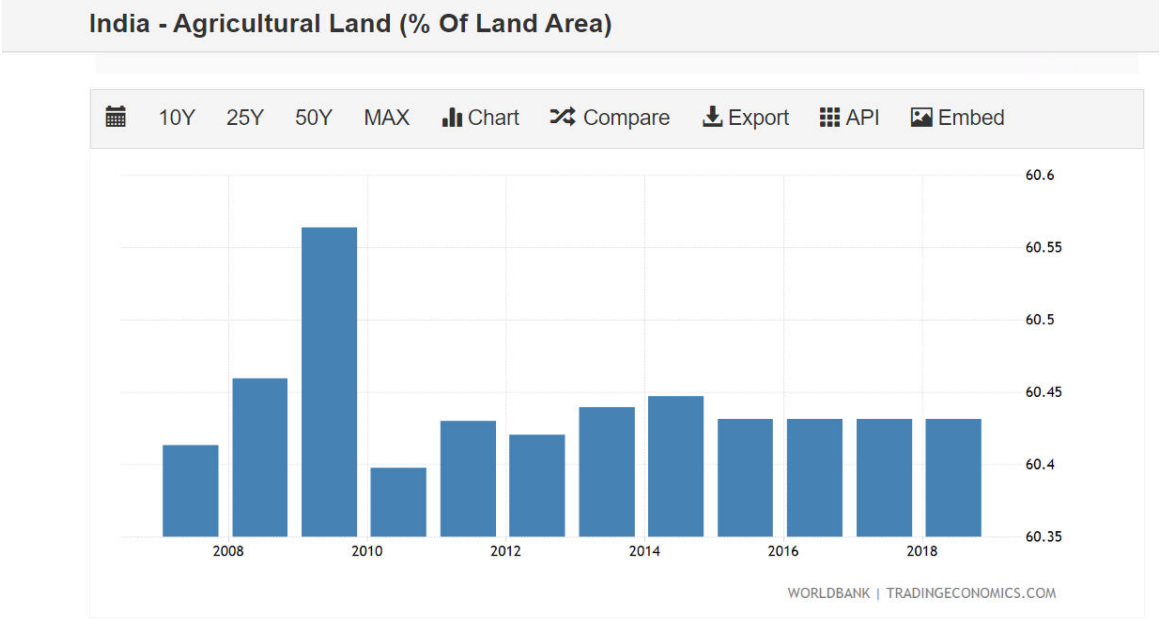
RESULTS AND DISCUSSION

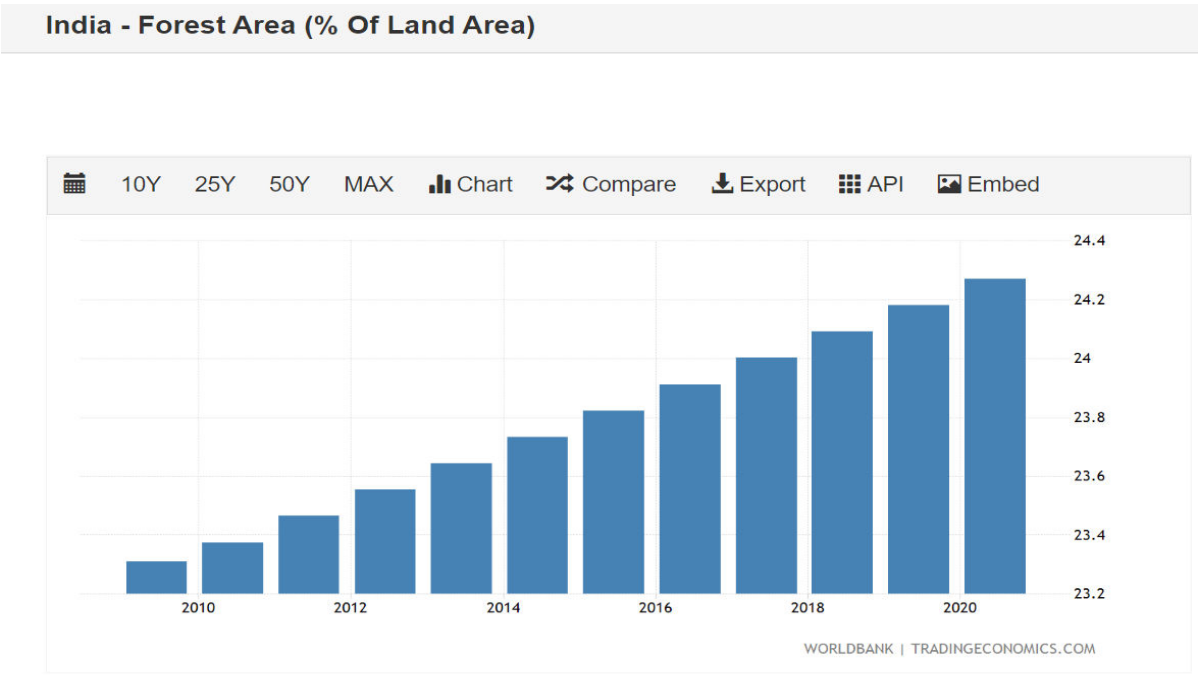
Impact of population growth on land in India



Source – World Bank Report

There is tremendous pressure on agriculture land in India. As per World Bank report in 2018 agriculture land in India amounts to 60.43% and one can notice a stagnation in land available for agricultural purposes. In order to offer food security for rising population farmers need higher yields thus causing excess increase in cropping, irrigation, over use of chemical fertilisers, insecticides and pesticides. This in turn causes exploitation of underground water resources. Excess use of chemical fertilisers contributes to water pollution.

Impact of population growth on forests in India



Source – World Bank Report

Forests play a pivotal role in maintaining environmental and ecological balance. **As per ISFR (India State of Forest Report 2021) total forest area amounts to 21.71% of the geographical area as against 33% as per national forest policy 1952 and 1988**. There **has been a decline in forest cover in comparison to the mandated 33%** due to population growth, economic development, industries, housing and lastly to meet the food requirements of a population.

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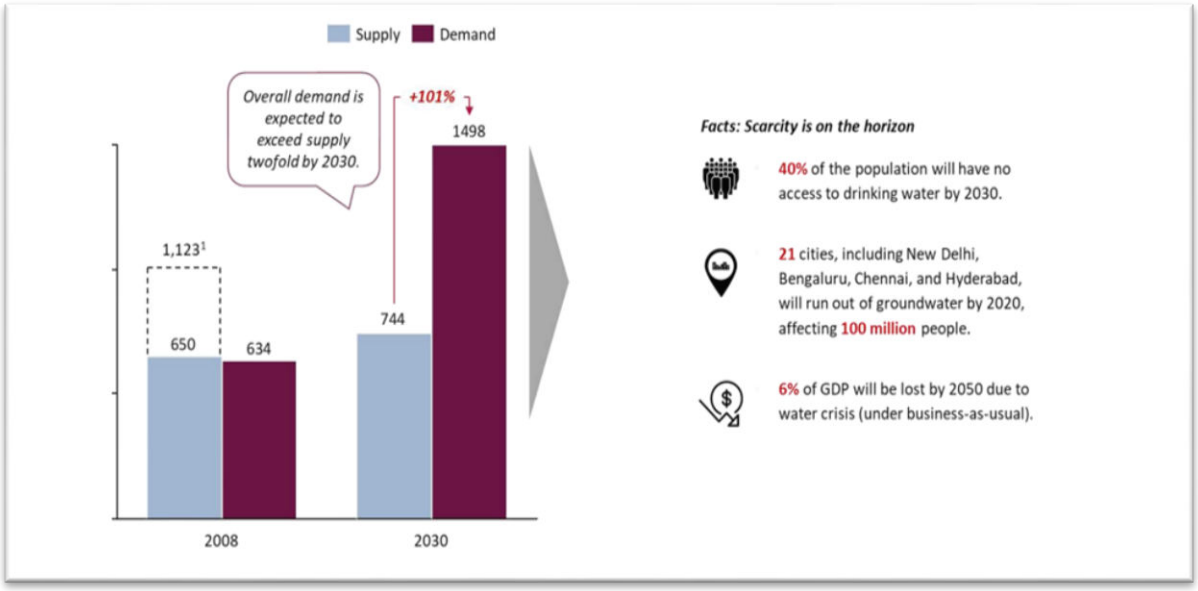
Impact of population growth on water resources

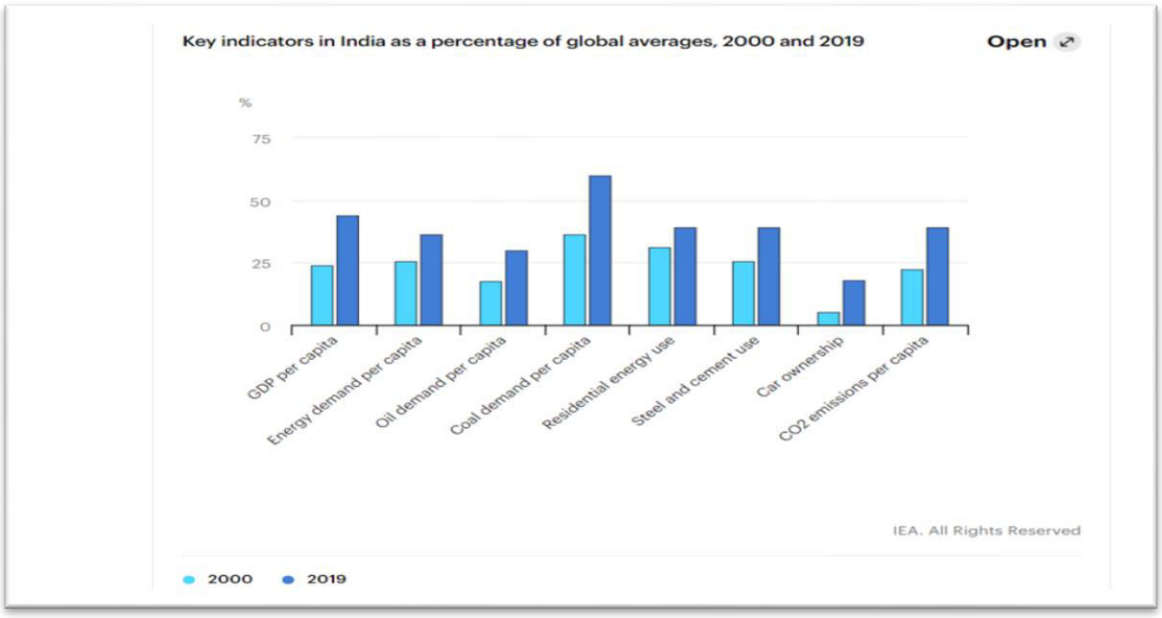


Source – Niti Ayog Report 2018

It is a fundamental human right and basic need to have access to safe drinking water and adequate sanitation facilities. As per World Bank reports India is among the most water stressed countries in the world. **In India in 1950 per person there was a water availability of 3000 to 4000 cubic meters of water. As of 2019 this has fallen to 1000 cubic meters of water per person. India is the largest user of ground water roughly pumping 25% entire ground water in the world**.

As per NITI Ayog report titled composite water management index (2018) there is heavy mismatch in the demand and supply of water resources. The demand for water resources is going to be twice the supply and **approximately 40 % of India's population will have no access to drinking water by 2030.**

Impact of population growth on energy resources



Source – India Energy Outlook report 2021

As per India Energy Outlook report 2021 the consumption of energy has doubled since 2000 to 2019. India's rising urbanisation and population growth will create need for huge energy demand. Most of commercial energy needs are achieved by burning fossil fuels which causes severe air population as it increases C02 in the atmosphere and respiratory diseases and greenhouse gases further contributing to global warming

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Solutions for sustainable population control in India

- Offer tax benefits to all non-government employees who take efforts to keep population in check by having two or less children
- People having two or less children and who are following population control measures should be motivated by offering increments, housing loan concessions and job promotions
- Government employees across all religions who follow two child norms should be given benefits under NPS, maternity benefits and increments
- A couple which has only one living child and by free will choses to get sterilized the government can incentivize by offering free higher education to such child and even employment post his education
- Encourage informed family planning by making contraception easily accessible for the vulnerable and poor sections of the society
- In order to reduce the total fertility rate, we need to improve our medical infrastructure
- As per United Nations DESA policy India's economy growth must be more than its population growth to ensure sustainable growth

CONCLUSION

The study concludes that India's population growth is adding burden on the country's limited natural resources. It is going to be a tough task for government to satisfy the needs of ever-increasing population as the energy consumption needs increase. There will be a huge pressure on the arable lands which in turn will affect the overall resource productivity. There is immense pressure on ground water resources to satisfy the human needs of water consumption and one can only expect the need to only keep escalating. One can conclude to sum up there is crucial need to control population growth, conserve and protect natural resources, look for eco-friendly energy resources and to keep environment healthy for future generations.

ACKNOWLEDGEMENTS

We would like to thank our college and colleagues for their valuable inputs, support and suggestions. We are grateful to Ruparel College for giving us the opportunity to work on such an interesting topic. I am grateful to my college librarian for providing me the resources for conducting my research.

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THE EFFECTS OF GREENWASHING IN COSMETIC INDUSTRY

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ABSTRACT
Cosmetics are one of the fastest growing industries. These cosmetics are formulated using various chemicals, some of which are major causatives of almost every type of pollution. This brings a hike in popularity of herbal products which results in a fierce competition between various agencies involved in this business. Because of this, marketing agencies play an important role in manipulating the psyche of the consumers. Here, greenwashing comes into picture. Greenwashing is when an organization spends more time and money on marketing itself as environmentally friendly than on actually minimizing its environmental impact. (Robinson, D. 2021) It has become a market trend where products are claimed to be natural, vegan, organic and many more, by using green packaging techniques. The benefits of such products are increasingly being portrayed falsely. In our approach, we try to ascertain the reality of products claiming to be sustainable by identifying and testing toxic chemicals that are present in such products. We further surveyed the consumers to evaluate the effect of such marketing techniques on the sale of the product. Even though these products may contain some natural ingredients, the process of deriving these can harm the environment in irreversible ways which in turn becomes a disadvantage to the environment. On the contrary, we encourage techniques like green marketing which is when companies sell products or services based on legitimate environmental positives. Our area of focus is to grab the attention of consumers and the manufacturers on this concern and provide sustainable alternatives for the same.

Keywords: Greenwashing, Cosmetics, Pollution, Sustainability.

INTRODUCTION
The cosmetic industry describes the industry that manufactures and distributes cosmetic products. These include skincare, haircare, and a lot more. These products are widely used all over the world which makes this industry one of the fastest growing industries, and also one of the most profitable businesses. Due to the high demands and better profits, the industry is constantly developing and coming up with new innovations in marketing strategies. Various products are being developed based on the demand trends which are being analyzed by marketing agencies that are capable of manipulating the psyche of the consumers. Various marketing campaigns in the current market focus on proving themselves to be sustainable. (Danley, S. 2012) This paper explains the effect of these marketing trends on the consumers and also the effect of these products on the environment, and offers credible alternatives for such false portrayal by these companies.

The growing pace of environmental concerns has led many people to adapt a more sustainable lifestyle which has become a trend that most of the people are following. Taking advantage of this, many companies have started advertising their products as sustainable to attract more customers. These efforts can sometimes result in misleading marketing techniques such as greenwashing.

GREENWASHING
Nowadays, many companies are coming up with innovative marketing strategies with the sole purpose of increasing the sale of their products, one of which is greenwashing. Greenwashing is basically deluding people so that they will buy the products irrespective of the reality behind them, but we are going further and stating that it's not just bad for human health but harmful for the environment as well. The effects that greenwashing can have, are far more hazardous in the long run than what is seeming right now. It’s not just about the pollution that they are causing, but about the green skin that these brands are wearing which is deceiving. Our concern is only that what we, as consumers, think is sustainable is not really sustainable and we need to change our perspective before it's too late because the environment is degrading at an alarming rate.

LEGAL FRAMEWORK
According to the Drugs and Cosmetics Act, 1940 and Rules, 1945, (by Government of India)

[17C. Misbranded cosmetics. — For the purposes of this Chapter,] a cosmetic shall be deemed to be misbranded, --

(a) If it contains a colour which is not prescribed; or

(b) If it is not labelled in the prescribed manner; or

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(c) if the label or container or anything accompanying the cosmetic bears any statement which is false or misleading in any particular.

- This implies that the brands that are posing as natural, but in reality, aren't so, are also violating the law. (Drugs and Cosmetics Act,1940 and rules 1945)

PSYCHOLOGY OF INDUSTRIALISTS:

Anthropocentrism means human centric view towards nature i.e., exhibiting efforts towards sustainability which are directed to concerning only human welfare (Gribben. J. 2016), is the point of view of industrialists behind inventing marketing techniques like greenwashing.

RESEARCH METHODOLOGY

With an objective of being all inclusive, pH testing is the method incorporated, as the vital pH range for the skin is relatively identical.

Materials: Distilled water, Universal Indicator, Test tubes, Test tube stand, Beaker, Pipettes.

Cosmetics: Conditioner, Body Washes (3 Samples), Face Wash, Sunscreen, Lip Balm, Soap, Face Cleanser, Tooth Paste.

The samples used in the experimentation are products of the brands pretending as herbal.

We had taken 2ml of distilled water in a test-tube and added two drops of Universal Indicator in it. The pH of distilled water was used as a standard, which was found to be 7.5. All the samples were dissolved in 2ml of distilled water and two drops of Universal Indicator were added in each. Then the pH was calculated according to the standard pH scale. Total 10 products were tested.

SURVEY

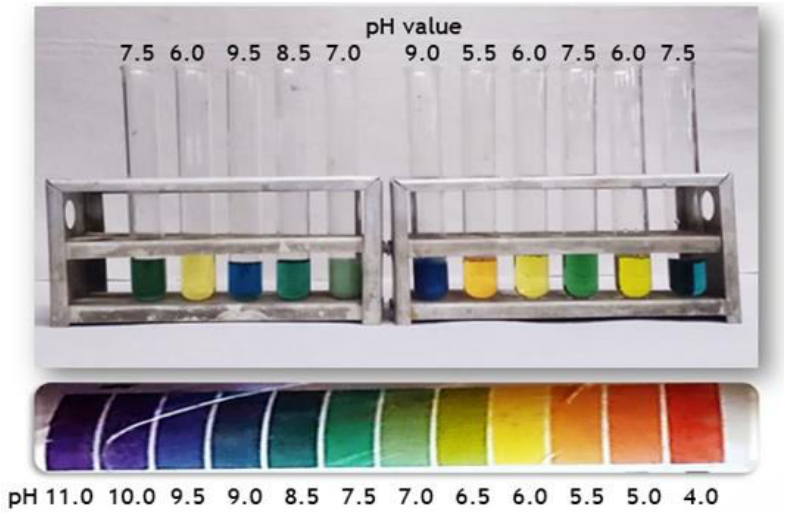
We have conducted an online survey in which we have asked people about their preferences on the following things.

1. Checking the ingredient list before buying.
2. Awareness about the harm caused by the cosmetics.
3. Awareness about effects of manufacturing process on environment.
4. Side effects of synthetic products.

RESULT AND DISCUSSION

pH Test:

The results of pH test were as follows:



1. No. of products whose pH was found to be <7 (Acidic)= 4
2. No. of products whose pH was found to be =7 (Neutral)= 1
3. No. of products whose pH was found to be >7 (Basic)= 5

(From right to left according to the image above)

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Products	pH value	Property
Standard (water)	7.5	Basic
Conditioner	6.0	Acidic
Body wash sample 1	7.5	Basic
Body wash sample 2	6.0	Acidic
Body wash sample 3	5.5	Acidic
Face wash	9.0	Basic
Sunscreen	7.0	Neutral
Lip balm	8.5	Basic
Soap	9.5	Basic
Face cleanser	6.0	Acidic
Tooth paste	7.5	Basic

The optimal pH of a product which is not harmful for the human skin is 5.5 but only 1 product out of 10 was found to have pH 5.5.

1. EFFECT ON ENVIRONMENT

Chemical and solid pollutants released from factories which manufacture cosmetics can include heavy metals, detergents, micro-fibre, plastic or non-plastic waste materials, toxic chemicals, and preservatives, etc.

- **Effects on Aquatic Life**

Most aquatic ecosystems have a normal tendency to dilute pollution to some extent, but severe contamination of aquatic ecosystems results in alteration in the flora and fauna of the community. Chemicals reaching aquatic ecosystems like, industrial solvents and volatile organic compounds, preservatives- methylisothiazolinone, methylchloroisothiazolinone and other toxic chemicals like sodium lauryl sulphate, sodium laureth sulphate, methyl paraben, polyethylene glycol (PEG) can pose serious threat to aquatic life. (Bashir, I. 2020)

These contaminants are toxic to aquatic life in many ways, most often reducing an organism's lifespan and ability to reproduce, also affecting their ecosystem.

Residue of the cosmetics containing chemicals goes into drainage systems which later reaches the sewage systems which contains industrial wastes, municipal wastes and domestic wastes. It is estimated that 58% of the waste water from urban areas and 81% of industrial wastes are discharged directly into waterbodies with no or inadequate treatment which results in contamination of nearly 73% of the waterbodies. (Bashir, I. 2020)

- **Effects on Agriculture**

The process of manufacturing these cosmetic products includes the extraction of natural herbs from the environment on a large scale which leads to overexploitation of these resources.

The toxic chemicals contained in the water bodies tend to seep into agricultural land along the riverbed. Thus, crops cultivated on such land have high concentration of these toxic chemicals which can be hazardous for everyone feeding on such crops.

2. EFFECT ON HUMANS:

- **Effects of Acidic pH:**

On human skin, the effect of acidic pH includes Acne, Dryness, Itching, Rashes.

- **Effects of Neutral pH:**

On human skin, the effect of Neutral pH includes Dehydration of skin, Irritation, and Allergies.

- **Effects of Basic pH:**

On human skin, the effect of Basic pH includes Dryness, Broken Skin Barrier, Wrinkles, Bacterial Outbreak.

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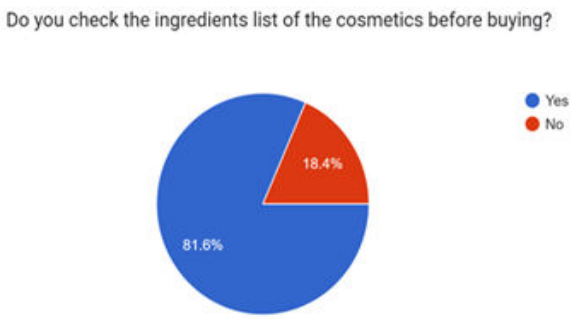
Survey:



Graph A

Graph B

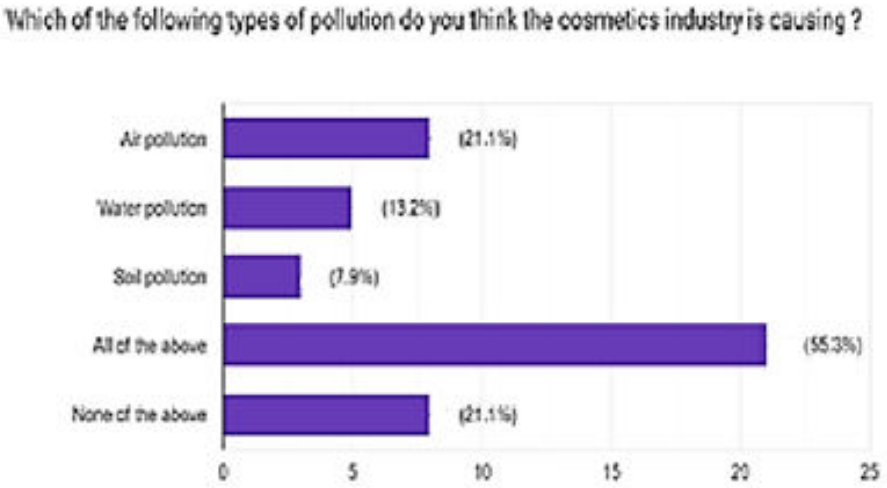
The Graphs for, "Checking the ingredients list before buying".

Graph A shows that 81.6% of people are conscious about knowing the contents of the cosmetics that they use.

Graph B shows that 86.8% of people are inclined towards choosing herbal products over artificial ones, which alternatively states that the chances of people buying products which are portraying themselves as herbal are more.

The Graph for, "Awareness about the harm caused by the cosmetics".

The graph above shows that for 64.9% of people the name of a popular brand matters.



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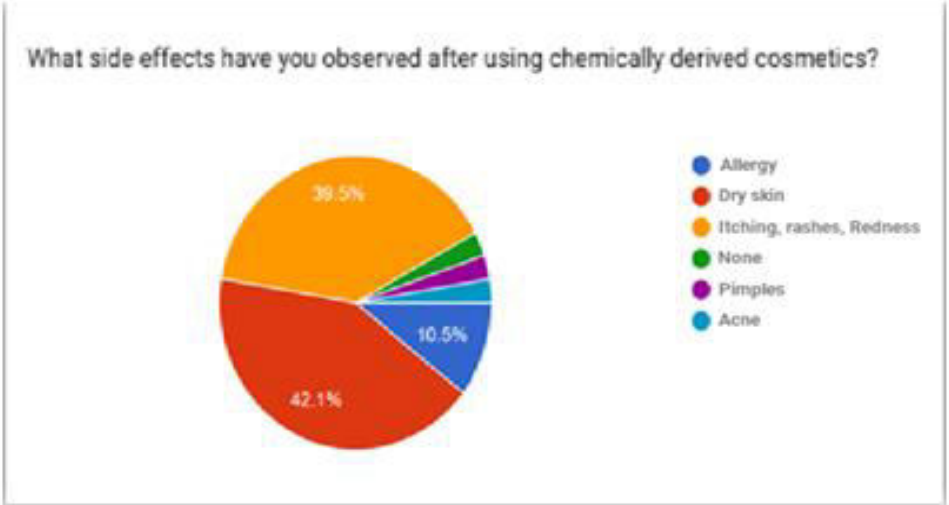
The Graph for, "Awareness about effects of manufacturing process on environment".

The graph shows that 55.3% of people are aware of the harmful effects of the manufacturing process of these cosmetics on the environment.



The Graph for, "Side effects of synthetic products".

The graph shows that most of the people have experienced some kind of side effects after using synthetic products.

42.1% of people have experienced dry skin as a side effect.

39.5% have experienced itching, rashes, redness.

10.5% have experienced some or the other allergies.

Very few people experienced onset of pimples and acne.

CONCLUSION

Marketing techniques such as greenwashing are not new, but just another way of making people believe what they see. In today's time, such strategies have become a serious threat to the environment as well. The damage that these activities are causing are irreversible and need to be stopped as early as possible. This would not be possible without changing our view towards sustainability.

If viewed from a different perspective, marketing techniques can have a really good impact on psychology of customers which can be used in a positive way by encouraging sustainable marketing practices like green-marketing. Green-marketing represents marketing where brands stick to the values of sustainability and maintain transparency in advertising their products. (Kotler, P.,2011-2013) However, some companies can still conceal the toxic ingredients used, behind labels such as "Base", "Fragrance", etc. which can still be misguiding. Such loop holes in the system can not be avoided even after making strict rules to protect the rights of the brands. That's why, change in everyone's perspective is essential.

Anthropocentric view of business personnel is the main cause behind such practices which leads to false belief in customer's mindset that a product is sustainable even though it is not. If we change our perspective to being non-anthropocentric and treat humans as a part of nature and not as a superior entity to nature, (Gribben. J. 2016) then our efforts towards sustainability will also become more considerate towards nature which can lead to more realistic approaches towards sustainable market trends such as green marketing.

ACKNOWLEDGEMENT

The Authors would like to thank Dr. Dilip Maske (The Principal of The D.G. Ruparel College, Mahim). Authors also gratefully acknowledge the guidance received from Mr. Suyash Singh (Asst. prof. The D.G. Ruparel College, Mahim)

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HYDRO-BIOLOGICAL STUDY OF KAMWARI RIVER AND ITS ESTUARY TO EVALUATE WATER QUALITY

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ABSTRACT
Over the past few decades there has been considerable deterioration in the water quality of major rivers and their tributaries over the globe due to increased population overburdening the existing waste management systems. The rapid booms of infrastructure coupled with the discharge of untreated industrial effluents are adding to the pollution. The present study focuses on the evaluation of Hydro-biological parameters of River Kamwari and its estuary flowing through Bhiwandi city and adjoining areas. A seasonal assessment of the physico-chemical and biological parameters of river water was carried out to understand the impact of anthropogenic activities on river water. Pollution indicating parameters like DO, BOD, COD, Oil and Grease ranged between 0-8 mg/l, 5.71 to 200 mg/l, 20-360 mg/l, and 20-270 mg/l respectively whereas; nutrients like Phosphate and Nitrate ranged between 0.94-4.1 ppm and 0.5-3.5 ppm respectively. The presence of Coliform was detected throughout the river stretch while the Total Coliform count was higher (>1600) within zone 2 (Location 3 and 4) of the study area. The presence of coliform indicates faecal matter contamination which makes the water unfit for domestic usage and also increases the chances of water-borne diseases. Zone 2 of the study area was found to be highly polluted. Discharge of untreated sewage from residential areas and effluents from textile units in the adjoining areas, agricultural runoff, and waste from slaughterhouses and cattle sheds along with dumping of solid waste were found to be detrimental to the riverine ecosystem.

Keywords: Kamwari River, Pollution, Coliform, Seasonal Variation

INTRODUCTION
Rivers are known to be present on every continent providing fresh water, varied ecological and consumptive services (Masseger. M. *et. al*.2021). These flowing water bodies have a fundamental role in supporting global biodiversity, biogeochemical cycles and human societies. It is one of the main reasons why ancient civilizations flourished on river banks all over the world which can be even observed today. Not only Major cities of India like Delhi and Kolkata are situate at river banks but also foreign cities like London and New York are situated on river bank. It was estimated that there was a six-fold rise in demand for water from 1990 to 1995 which was more than the rate of population growth (Postel, 1997). With a rising standard of living and easy availability of amenities in cities, an increase in migration rate from rural to urban areas occurred. Increased population led to increased generation of waste and wastewater exerting pressure on the existing waste management facilities. Further, the amount of water required by urban establishments is more as compared to rural and the quality of wastewater is also considerably more toxic (Bandy J.T., 1984). Population pressure, unplanned development, discharge of waste water at inappropriate places enhanced the infusion of harmful compounds into water bodies. Further discharges of partially treated or untreated wastewater without consideration of the assimilative capacity of the receiving water body have resulted in pollution of river globally (Zingde M.D., 1999). Dumping of solid waste in areas adjacent or in the river basin has aggravated the riverine pollution thereby affecting the quality of life.

Even though being a country with more than four hundred perennial rivers, the Indian sub-continent is facing water scarcity. Surface water pollution has reached a critical point in India where, almost every river system in India has been polluted to a considerable extent. A study by NEERI, Nagpur revealed that, about 70% of the water bodies in India are polluted (Martin P., 1998). Major rivers like Ganga, Yamuna, Godavari, and Gomati have been assessed for their water quality. The majority of monitoring stations under the National water quality monitoring program are stationed on major and perennial rivers. Non-perennial rivers and streams that periodically cease to flow tend to be overlooked from a pollution study point of view.

Identification and quantification of pollutants play a crucial role in planning mitigation strategies and establishing management approaches for the future. Water quality assessment for different water use purposes, such as domestic use, irrigation, conservation and industrial usage, form an important strategy for food safety and human health. The present study focuses on the assessment of hydro-biological parameters along the stretch of the Kamwari River flowing through Bhiwandi, Maharashtra.

STUDY AREA
Geographically, Bhiwandi taluka lies in the coastal lowland of Maharashtra's Konkan region. At an elevation of 24 m from the mean sea level, it is situated at the northeast of Greater Mumbai. The city of Bhiwandi was a

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historic port and is known for the largest number of power looms in the country. Due to the Handloom and the textile industry, it was nicknamed “Manchester of India”. There have been tremendous changes in land-use patterns in and around the Bhiwandi. Surrounding notified areas are witnessing intensive industrial development (Kandpal, R. & Saizen, I., 2018)

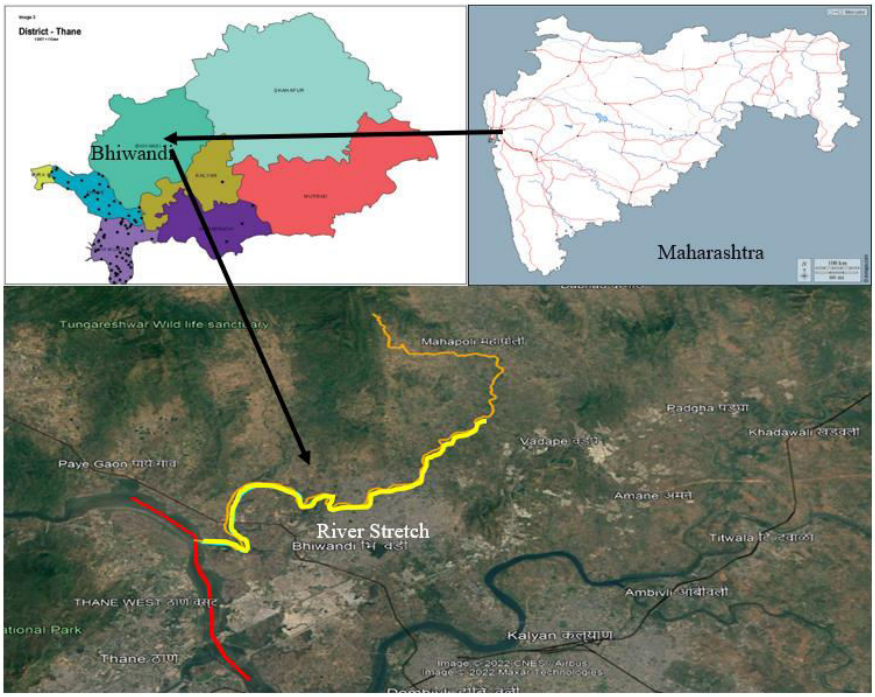

Figure 1: Political and Geographical map of the study area

Kamwari River which is a tributary of Ulhas River, originates in the foothills of the Tungareshwar mountain ranges in the Tungareshwar Wildlife Sanctuary near Depoli, Dist. Palghar. After running southwest for 34.5 Km through Bhiwandi City it confluences with the Ulhas River at Kevni Village. Kamwari River is a Monsoon fed river and is the only river in this part of Bhiwandi taluka. It is one of the major sources of water for irrigation purpose after monsoon. A stretch of 21km was considered for the study which was further divided into three zones based on geography and the land use pattern around the river. Water samples for studying various parameter were collected from six locations from three zones

Table no 1.Sampling Locations

Zone	Location No.	Latitude/Longitude
Zone 1	Location 1	19°16'31.85"N 73° 0'27.00"E
	Location 2	19°17'43.03"N 73° 0'9.06"E
Zone 2	Location 3	19°18'2.60"N 73° 2'22.10"E
	Location 4	19°18'11.95"N 73° 4'24.83"E
Zone 3	Location 5	19°19'31.17"N 73° 4'24.83"E
	Location 6	19°18'52.76"N 73° 3'56.13"E

MATERIAL AND METHOD

The Present study was carried out to assess the hydro-biological condition of the Kamwari River to gain insight into the prevailing pollution levels. The study period was divided into three seasons i.e. Pre-Monsoon (PrM), Monsoon (MoN) and Post-Monsoon (PoM). Water samples were collected twice every season from six sampling stations in three different zones within the study area. Grab samples were collected in clean polyethene bottles while the samples for microbiological analysis were collected in sterile bottles. Parameters like temperature, pH and DO were assessed on the field whereas other parameters like COD, BOD, TDS, TSS, Nitrate, Phosphate, Oil and grease were assessed using standard methods prescribed by APHA and AAWA. Most Probable Number was used to assess the Total Coliform Count.

RESULT AND DISCUSSION

Seasonal variation and the prevailing land-use pattern have a major impact on the water parameters influencing its quality which in turn impacts the biotic components within an aquatic ecosystem. Rivers flowing through urban habitats predominately receive untreated sewage and effluent polluting the riverine ecosystem. Solid waste disposal has been reported in major river basins over the globe adding to the riverine pollution.

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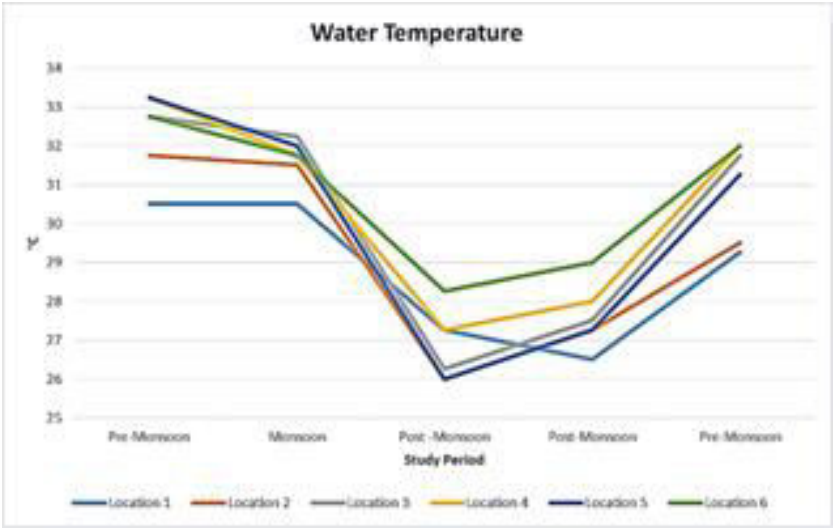

Figure 2: Variation in Temperature

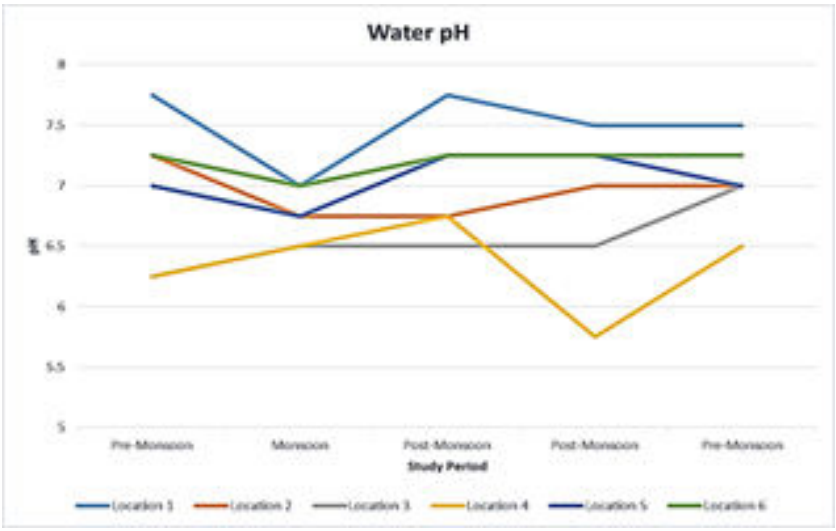

Figure 3: Variation in pH

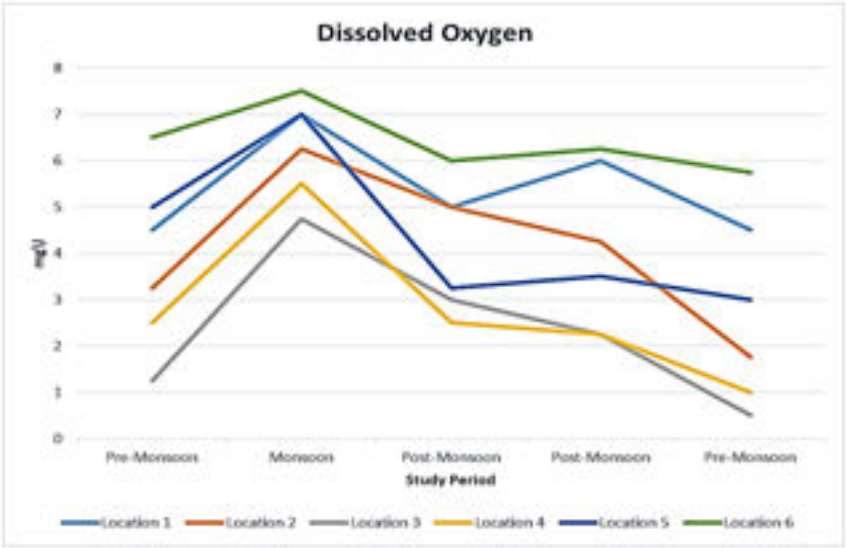

Figure 4: Variation in Dissolved Oxygen

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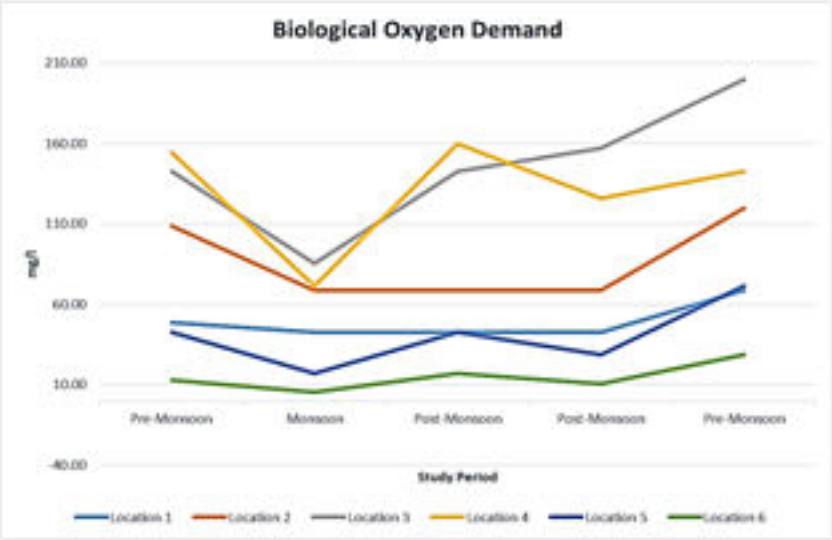

Figure 5: Variation in Biological Oxygen Demand

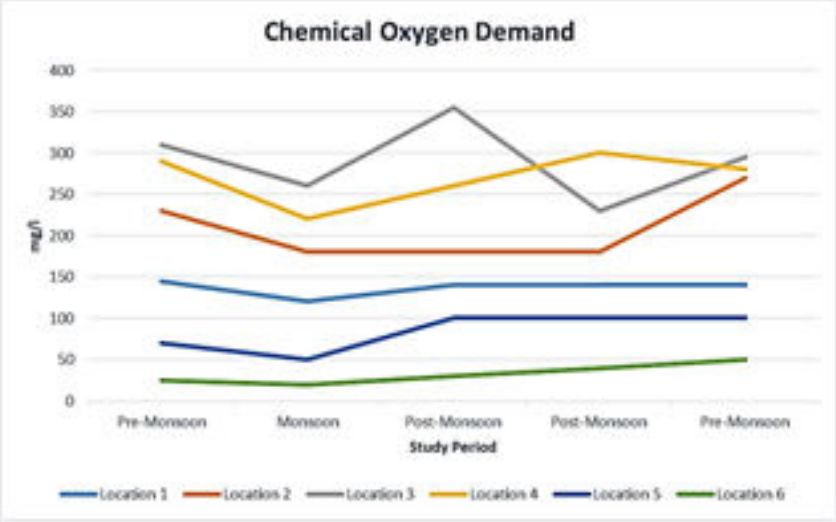

Figure 6: Variation in Chemical Oxygen Demand

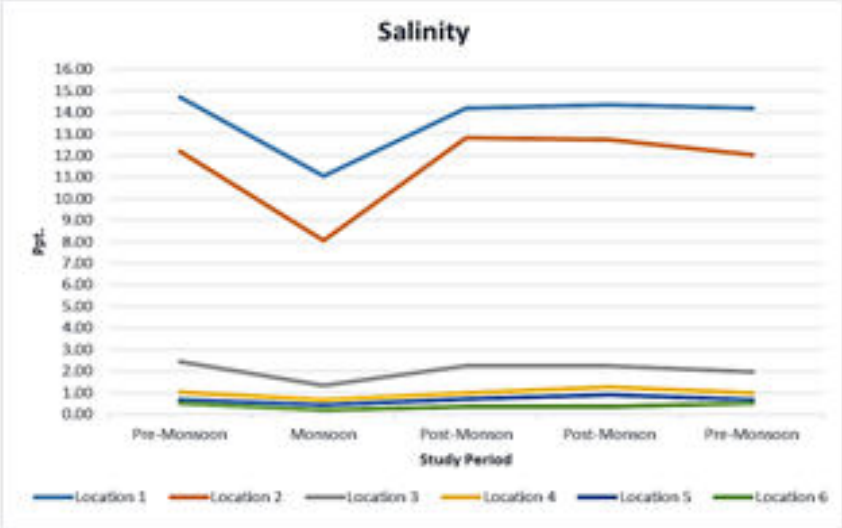

Figure 7: Variation in Salinity

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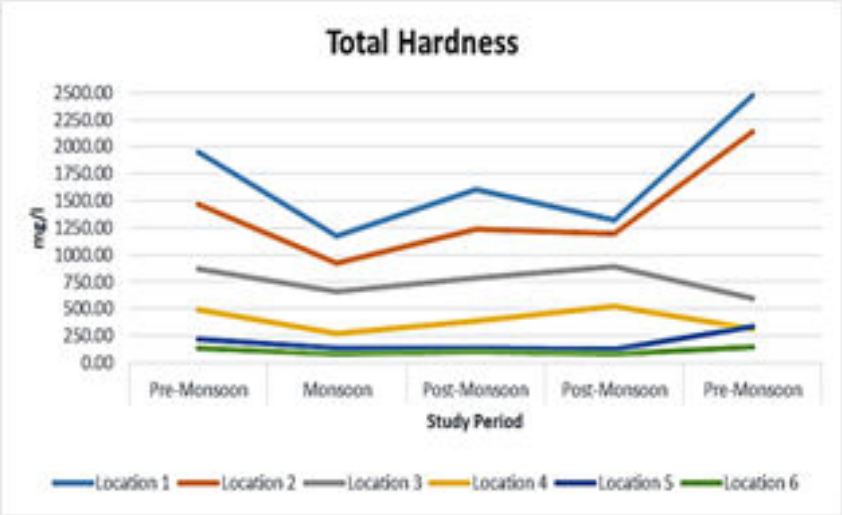

Figure 8: Variation in Total Hardness

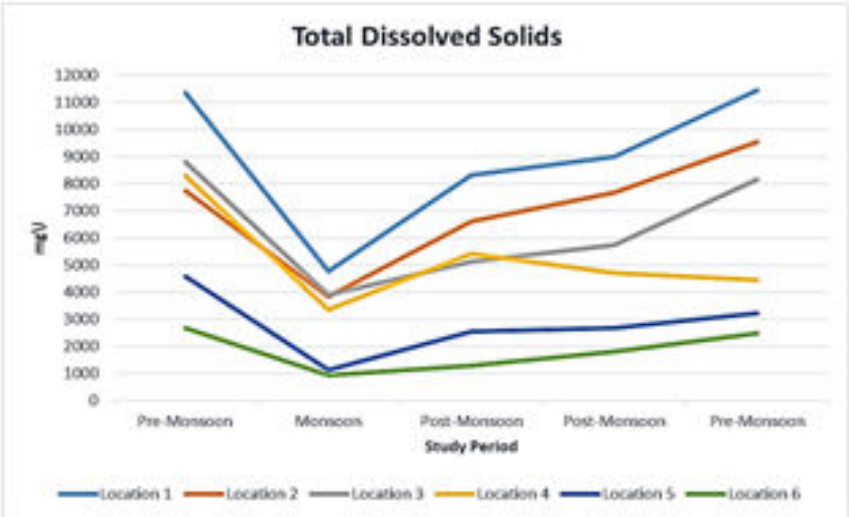

Figure 9: Variation in Total Dissolved Solids

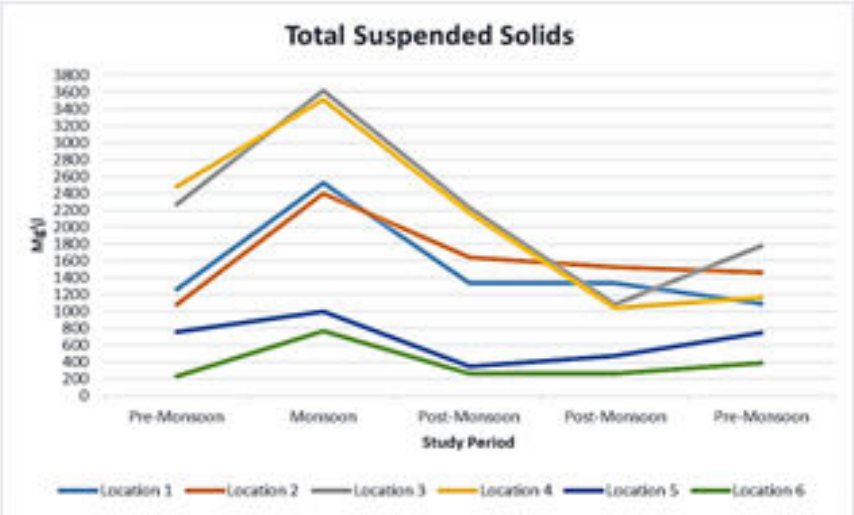

Figure 10: Variation in Total Suspended Solids

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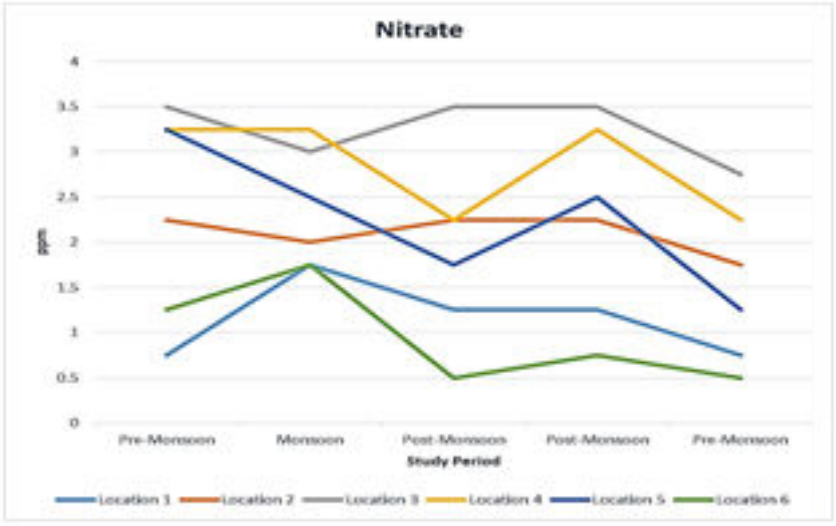

Figure 11: Variation in Nitrate

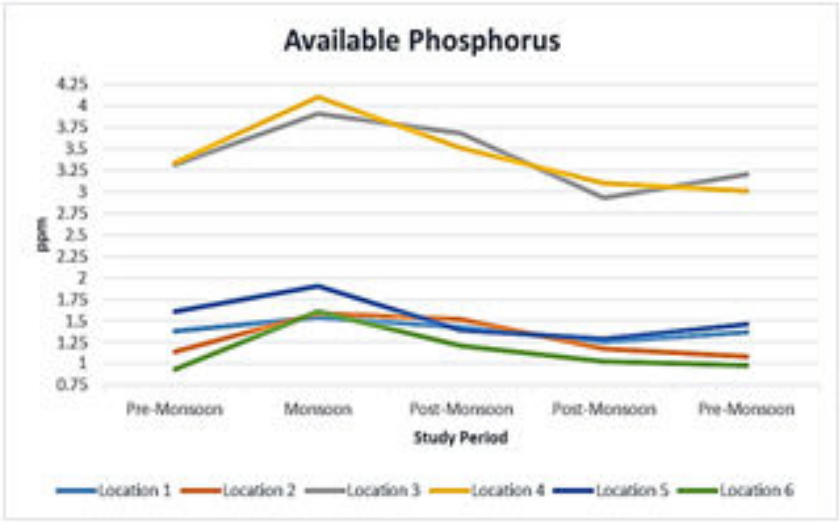

Figure 12: Variation in Available Phosphorus

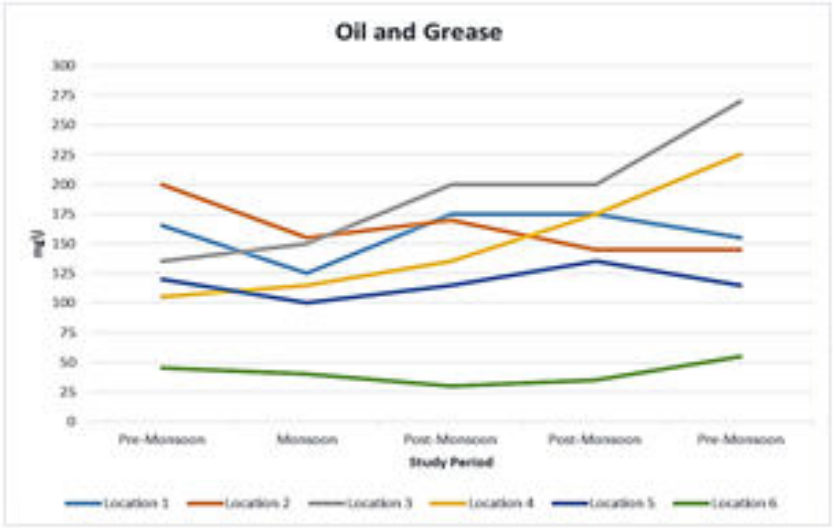

Figure 13: Variation in Oil and Grease

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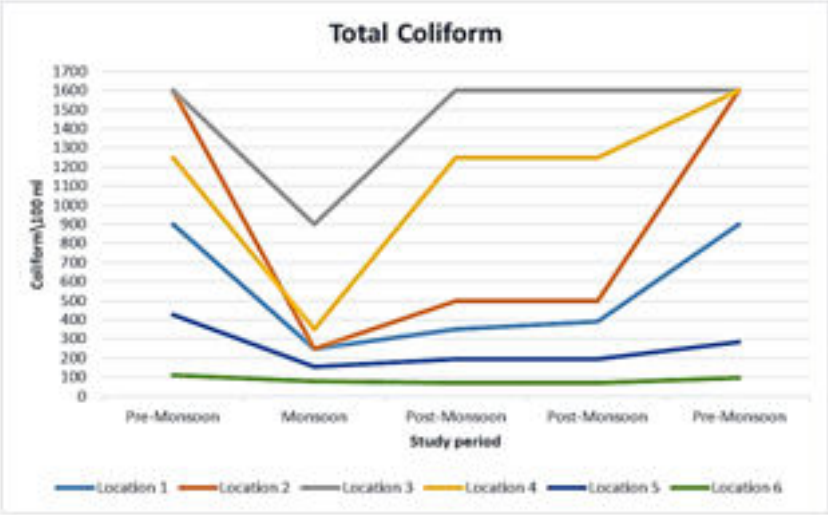

Figure 14: Variation in Total Coliform

The importance of temperature in the riverine ecosystem has been studied by several researchers (Smith, 1972; Ward, 1985). The temperature within the study area was found to be ranging between 26°C to 33.25°C. It was observed that the atmospheric temperature governed water temperature. A similar phenomenon was observed by Quadros G. *et .al*. 2003 in Thane Creek. The temperature within zone 2 was highest during the study period which could be attributed to the anthropogenic activities on the bank. The pH values indicate the level of acidity or alkalinity in the present ecosystem. Water pH in the study area was found to mildly acidic to slightly alkaline with slight spatial variation. The pH values were in the range of 5.5 to 7.75 which is slightly acidic for the propagation of wildlife and fisheries as per the designated best water quality criteria by MPBP. Acidic condition was observed at location 3 owing to the effluent load being discharged whereas alkaline pH was observed at locations 1 and 2 due to the proximity to Ulhas Creek.

DO, BOD and COD are usually used as indicators of health of the aquatic ecosystem (Zaghloul A. *et al.*, 2019). Low DO values indicating hypoxic condition (Laponite B.E.and Clark M.W., 1992) were observed throughout the study area, except at location 2, 5, and 6 where the DO levels were within the permissible limits required for propagation of commercial fishery, bathing and contact water sports (Schedule VI, EPA,1986) The concentration of DO in water is inversely proportional to BOD/COD concentrations (Edokpayi, J.N.*et.al*. 2017). BOD and COD levels in the study area were in the range of 5.71 to 200 mg/l and 20 to 360 mg/l respectively. Except for location 6 and to some extent at location 5, rest all locations showed BOD levels higher that the permissible limit of 30 mg/l (effluent discharged by industries) put forth by MPCB. COD values above the permissible limit of 250 mg/l (Schedule VI, EPA, 1986) were observed at location 2, 3 and 4 which could be predominantly due to the discharge of untreated industrial and domestic sewage within this stretch of the river. DO, BOD, COD showed seasonal and spatial fluctuation.

Salinity fluctuation can be observed in aquatic habitats like estuaries owing to the influx of saline and freshwater alternately during tidal currents (Anirudhan T.S. & Nambissan P.N.K., 1990). Higher Salinity was observed towards the estuarine end whereas; lower salinity was recorded upstream. A similar trend was observed with Total hardness levels. The total Hardness of water was maximum towards the estuarine end which might be due to the presence of higher salt content as compared to the freshwater upstream. The salinity and Total hardness value were in the range of 0.18 to 14.72 ppt. and 85 to 2475 mg/l could. The hardness values were above the permissible limit of 600mg/l (IS 10500:2012) within location 1, 2 and 3 making the water hard for domestic usage. Total dissolved solids are known to create an osmatic imbalance in aquatic organisms whereas; higher Total suspended solids may impact the gaseous exchange within aquatic organisms. Total Dissolved values were found to be high during the Pre-monsoon (PrM) while total suspended Solids were high during the Monsoon (MoN). Total dissolved Solid and Total Suspended Solids ranged from 920 to 11450 mg/l and 230 to 3620 mg/l respectively. Higher Suspended solids during Monsoon could be attributed to agricultural runoff and storm water carrying particulate matter. TDS and TSS values were above the permissible limit of 500 to 2000mg/l for TDS (IS 10500:2012) for sewage water and 100mg/l for suspended solids for effluents to be discharged in inland surface water (Schedule VI, EPA, 1986).

Phosphate is the nutrient that, regulates productivity in aquatic ecosystems. In surface water, natural levels of phosphate do not pose any threat to living organisms or the environment. Effluent discharge and agricultural runoffs are known to increase nutrient content in water bodies (Czerniawski *et.al*. 2020). In present study

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available phosphorus varied between 0.94 to 4.1 ppm. Higher levels of available phosphorus were observed at location 3 and 4 throughout the study period. This is majorly due to the release of untreated sewage and waste from cattle sheds present on the bank of the River (Prakasa R., *et.al* 2017).Most of the Indian rivers observe rise in phosphorus level due to agricultural runoff carrying the washed fertilizers. Nitrate was in the range of 0.5 to 3.5 ppm. Higher nitrate levels could also be attributed to discharge of sewage and agricultural runoff. Constant fluctuation within nutrient levels was observed. Large patches of *Eichhornia sps*. could be observed near location 5 within zone 3 during the post-monsoon indicating presence of high nutrients levels within the river water (Yu H , *et.al*.2019).

Oil and grease contribute to the organic load within the water body thereby increasing the demand for oxygen. If present in larger volume it may cause formation of oil layer on the surface affecting the gaseous exchange. Devastating physical effects, such as coating animals and plants with oil and suffocating them by oxygen depletion has been observed (USEPA, 2019). In present study Oil and Grease ranged from 30 mg/l to 270 mg/l. The Oil and grease values were above the permissible limit of 100mg/l (EPA, 1986) throughout the study location except location 6 which has very minimal human activity. Higher Oil and Grease value could be due to effluents, washing of vehicle or spills from the boats in the estuarine end.

Coliform bacteria are a group of aerobic and facultative anaerobic forms found in the intestinal micro flora of all warm blooded animals including humans. (Li D. and Liu S., 2018; Martin N. H. *et al.*, 2016). Presence of coliform in water sources indicate contamination of the water body by faecal matter which may eventually lead to serious water borne diseases. About 80 % of communicable diseases in the world are water borne In the present study Total coliform count was found to be higher than the permissible limit of 100MPN /100ml throughout the study area except for location 6 upstream. The high Total Coliform count could be due to the indiscriminate release of sewage and waste water from cattle shed and Slaughter houses. Washing of cattle upstream at location 6 may be the reason for presence of coliform in water. Such higher coliform counts may prove lethal as it can lead to epidemics.

	pH	*Temp.*	*DO*	*BOD*	*COD*	*Salinity*	*Total Hardness*	*TDS*	*TSS*	*Nitrate*	*Available Phospho rus*	*Oil and Grease*	*Total Coliform*
pH	1												
Temperature (º C)	-0.11266	1											
DO (mg/l)	0.373873	0.039162045	1										
BOD (mg/l)	-0.48207	0.087570037	-0.804340911	1									
COD (mg/l)	-0.5599	-0.0195372	-0.750079238	0.871862961	1								
Salinity (ppt.)	0.424546	-0.263373774	0.10651678	-0.064340628	0.0772418	1							
Total Hardness (mg\l)	0.300179	-0.147762031	-0.114940168	0.177607421	0.286744641	0.892801	1						
TDS (mg/l)	0.160004	-0.022120337	-0.425173798	0.452531611	0.488690864	0.706387	0.826139	1					
TSS (mg/l)	-0.39221	0.192396044	-0.106746053	0.421270065	0.594951288	0.110263	0.213158	0.248602	1				
Nitrate (ppm)	-0.68805	0.103317995	-0.44820445	0.560892077	0.64300806	-0.31775	-0.18888	0.03039	0.492899	1			
Available Phosphorus (ppm)	-0.70005	0.105344926	-0.462063906	0.642122028	0.709677183	-0.40554	-0.2067	0.014322	0.633797	0.730863	1		
Oil and Grease (mg/l)	-0.14149	-0.175331151	-0.622479204	0.646048863	0.708739362	0.372409	0.45687	0.554974	0.322301	0.387382	0.377775	1	
Total Coliform	-0.37828	0.044314105	-0.792986169	0.866671215	0.846156908	0.07652	0.351405	0.550228	0.338087	0.498703	0.530828	0.685723	1

Figure 15: Correlation between parameters

Pearson's correlation analysis makes an attempt to institute linear relationship between multiple variables (Florence P.L.*et.al*.., 2012). Pearson Correlation Coefficients test was computed during the present study to understand the influence of parameters on one other. A strong positive correlation was observed between COD and BOD (r-0.8718) while DO showed negative correlation with both BOD (r- -0.8043) and COD (r- -0.7500). TDS showed correlation with Salinity (r- 0.7063) and Hardness (r-0.8261) as these variables are dependent on salt concentrations. Sewage inputs may decrease pH while there may be increase in nutrient levels. Positive correlation was observed between Nitrate and COD (r-6430), Available Phosphorus and BOD (r-0.6421) and COD (r-0.7096) while both Nitrate and Phosphorus showed a negative correlation with pH. Oil and grease showed a positive correlation with BOD (r-0.6460) and COD (r-0.7087) while a negative correlation with DO (r- -0.6224). Total Coliform Count increases with increase in sewage load hence positive correlation was observed with BOD (r- 0.8666) and COD (r-0.8461) while it showed a negative correlation with DO (r--0.7929). A strong positive and negative correlation was seen among the water parameters.

CONCLUSION

In the present study hypoxic condition with nutrient build-up was observed in Zone 2 and some parts of Zone 1 of the study area indicating poor water quality within the Kamwari River. Water parameters like DO, BOD, COD, Hardness, Nitrates, Phosphorus, Oil and grease were found to be beyond the permissible limits set by monitoring authorities for the majority of the study period. Seasonal and Spatial variation in water parameters

were seen. The spatial variation can be attributed to the changing land use pattern or the anthropogenic activities in and around the river stretch. Water quality was found to be good in the upper stretch of the river in zone 3, but as soon as the river enters the city limit, pollutants are being added through multiple sources thereby deteriorating quality of water downstream within zone 1 and 2 before the confluence into Ulhas River. Agricultural runoff, discharge of untreated wastewater from residential settlements, textiles units, slaughter houses and cattle sheds along with unmanaged solid waste disposal are responsible for the decline in the water quality of Kamwari River. A detailed study of the pollutant sources is needed to develop future plan to restore and prevent further deterioration of the Riverine ecosystem. All anthropogenic activates and the Land use change has to be carried meticulously so as to avoid the undue pressure on the ecosystem.

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IMPACT OF CLIMATE CHANGE ON MANGROVES: A CASE STUDY OF MUMBAI METROPOLITAN REGION

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ABSTRACT
Climate change refers to long-term shifts in temperature, precipitation, humidity and other weather elements. Since the beginning of industrial revolution anthropogenic activities have been the main driver of climate change, primarily due to burning of fossil fuels such as coal, oil and natural gas. The impacts of climate change in Mumbai Metropolitan Region (MMR) are already being witnessed through increase in flooding, erosion of coastlines, salt water intrusion, increase in number of cyclones and storm surges. The best estimates of climate change are presented by extensive review of literature work. It was found that rise in sea level is the most important factor influencing the future density and diversity of mangrove species. The predicted increase in air temperature and moisture was likely to cause thermal stress which would start affecting roots and seedlings and at times make the leaves stop their process of photosynthesis.

Keywords: climate change, mangroves

INTRODUCTION
The term mangrove comes from the Senegalese word 'mangue' which means 'into the sea'. Mangroves are characteristic littoral plant found in sheltered waters of tropical and subtropical coastlines. They support genetically diverse communities of terrestrial and aquatic flora and fauna which are of direct and indirect environment, economic and social value to human societies across the globe. Mangrove ecosystems are now being subject to increasing non-sustainable developmental activities as economic and population pressure rises in many of the coastal zones in tropical regions of the world. Mangrove forests are important sources of energy for detritus based coastal food-chains involving fish, mollusks and crustacea of economic value. They also help to reduce coastal erosion by dissipating the force of wave action.

Mumbai Metropolitan Region (MMR) is spread over 6,328 sq. kms. The area takes up four districts of Maharashtra State i.e., Mumbai City, Mumbai Suburban District, Parts of Thane and Raigad Districts. As per the Forest Survey of India (2021) report, the total mangrove cover of MMR was 282 sq. kms with 20 to 22 true mangrove species found. The mangroves of Airoli and Vikhroli are counted among the 12 unique mangrove forests of India.

Mangrove ecosystems are dynamic and there is geological and contemporary evidence that they can extend or contract rapidly in response to regional topographical and climatic changes. They are also likely to be affected by stress related activities by man and they will exhibit marked spatial and temporal fluctuations as a result of such influences. It is thus important to identify changes to mangrove ecosystem due to climate change. The primary climatic factors to be considered are temperature, rainfall, atmospheric carbon di oxide concentration and rise in sea level (Field, 1995).

CLIMATE CHANGE
Many reports have been published which address the issue of climate change that might arise as a result of man's activities, examining the possible effects. This review will not attempt to reiterate the extensive discussion that exists on the relatively short-term changes to our climate that are likely to result from the activities of man. It will try to summarize the key predictions and then examine what these may imply for the future of mangrove ecosystem. The Energy and Resources Institute (TERI) in partnership with United Kingdom's Climate Change Research Center studied the impact of climate change in Maharashtra, submitted a project report to the state's environment department in 2014. It predicted that the temperature of Maharashtra is likely to increase by 1 to 3^0C in the next 50 years, making evening and nights warmer by 1.5 to 2^0C. It also stated that by 2030 the coastal areas of the state would have a higher ambient temperature as compared to central areas of the state. The mean sea level along the coast was projected to increase by 2 to 4 m between 2050 - 2100. As per its findings, even rainfall shows an increasing trend of 20 to 40 percent throughout the state.

Evidences from radiocarbon age data of beach rocks indicate that the sea level along the Konkan coast has risen by +6 m from the mid-holocene period - 15,000 years before present YBP (Agrawal, 1967 and Guzder, 1980).

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Historical analysis of 100-year tide gauge data and 17-year satellite data showed a sea level rise of 0.13 - 2 cm. In the near future, mean sea level is projected to increase by 30 to 55 cm by the end of 21st century for a medium range climate scenario. The Monument Management Board (MMB), in its shoreline management plan estimated an SLR of 0.45mm/yr along the entire coast of Maharashtra (Black, Mathew and Anjali, 2017). This makes the tide move steadily inwards and the water level in the creeks to rise alarmingly. It also translates into the salt water intruding up to 1 km inland damaging mangroves, eroding beaches and filling creeks with sand and silt through erosion. The reasons are attributed to global warming and disturbance from construction along the sea coast. The impact is more along the flatlands than in areas where the coast is rocky (Karlekar, 2010).

The Indian Institute of Tropical Meteorology (2006), predicted an increase of 1.2 to 1.4 ^{0}C in the surface temperature of sea water, increasing the wind speed by 5% resulting in severe cyclones and storm surges. An analysis on the frequency of cyclones in the west coast of India during 1891 - 2006 revealed than 48 tropical cyclones crossed the west coast, out of which only 24 were severe cyclonic storms. Maharashtra recorded 13 such severe cyclones. Out of which Mumbai recorded 3, Thane 4, Raigad 0. The recent occurrence of two cyclones in consecutive seasons (Nisarga - 2020) and (Tuktae - 2021) has been highly unusual for the west coast of India, making it clear how important it is to protect mangroves and other coastal features that act as buffers against storm surges, high winds and flooding. Many studies have shown that up to 60% of the wave force is dissipated by the first 100 m of mangroves along a coast (Bavadam, 2021). The rising sea levels, accompanied by stronger waves and currents has started reshaping the coastline of MMR and potentially inundating or even submerging many low-lying areas on a regular basis (Rajasree, Gopikrishna and Deo, 2018).

Overall, the summer monsoon will show a 20% increase than the current rate. Simulations with climate models and observations indicate that rainfall extremes such as the Mumbai deluge of 2005 could become more frequent in India under the impact of climate change. Both 2005 and 2006 had spells of excessive rainfall that normally would have occurred once in about hundred years. It has been observed that till 1989 the average rainfall of Mumbai was 2129 mm. However, in 2005 - 2006 the average annual rainfall was found to be 3214 mm, an increase of 50%. The increase in rainfall and rise in mean sea level (MSL) in addition to the poor drainage of the city will increase the frequency of floods. Almost one fourth of Mumbai comprises of low-lying areas below or at MSL, making 50% of its population very vulnerable to profound consequences from climate change (Kumar, Jawale and Tandon, 2008). The National Environmental Engineering Research Institute (NEERI), commented that Mumbai could face damages worth Rs. 35,00,000 crores by 2050 because of climate change. The wave action has increased in the north western area and has eroded the 16 km long coastline by 500 meters in the past 35 years (Shyam, 2016). The coastal vulnerability index has placed 20% of the coastline along MMR as highly vulnerable to sea level rise and identified it as a hotspot for cyclones and severe storm surges. Areas most prone to flooding include Colaba, Cuff Parade, Worli, Dadar, Girgaum, Kurla, Deonar, Trombay, Thane Creek, Gorai, Andheri, Mira-Bhayandar, Navi Mumbai, Uttan, Uran Alibaug and Murud. Alterations to coastal features and landforms corelated with inundation characteristics make the coastal areas of Mumbai more vulnerable in the coming decades due to huge developmental activities and population pressure (Pramanik, 2017).

The coastal areas of Thane district have become very vulnerable to excessive flooding as the creek is getting shallower and its drainage capacity during monsoon is getting badly affected. During heavy rains and high tide days water is easily entering the city spaces even with a subtle increase in the sea level scenario. Siltation at the mouth and shrinking width of the creek along Mumbai, Thane, Navi Mumbai and Uran has complicated the problem. The volume of water in the estuary between high tide and low tide during non-monsoon months has been altered due to changes in land use, putting many coastal townships in the region at risk of inundation during the monsoon months. The shoreline changes along Alibaug coast have been investigated and studied extensively. On a comparison with topographical map and satellite imagery, it was found that a large variation in the shoreline existed at many places along the coast. Accretion was found to be about 6.5 km^2 during the period 1971 to 2005, with an average accretion rate of 0.2 km^2 per year.

Impacts of sea level rise in MMR are being witnessed more frequently along patches of the creeks, with local livelihood of the coastal communities being at stake. A basic visit to any of these settlements located near the coast will reveal how agricultural land is being lost due to excess siltation. While protecting mangroves is a necessity in the face of more cyclones and sea level rise, losing existing farmlands, khar lands and water ways will be double whammy for local residence. Thus, there is a need to boost ecologically sensitive policy measures and ramp up disaster preparedness keeping these scientific submissions in mind (Kesbhat, 2021).

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RESPONSE OF MANGROVE ECOSYSTEM

SEA-LEVEL RISE

As all mangrove systems occur between high and low tide mark it is clear that they are likely to be significantly influenced by any change in sea level. Different mangrove species appear to have a marked preference for the level of salinity of the surrounding environment and therefore they are found to be at varying distances and elevations from the seaward edge reflecting the degree of mixing of freshwater input and tidal influx. Mangrove ecosystem accumulates peat or mud and this gives them the opportunity to adjust to a rising sea level. If the sediment accretion rate equals the rate of rise in sea level, then inundation preferences of the different mangrove species can be maintained. If the rate of sea level rise exceeds the rate of accretion, then some rearrangement of existing vegetation will take place and loss of mangroves will occur if the mean tide level becomes higher than the elevation of the substrate. Mangrove ecosystem should be able to keep pace with a rising sea level of 8 - 9 cms per 100 years. They come under stress between 9 to 12 cms per 100 years and cannot adjust at rates above this level. The predicted rates of sea level rise caused by climate change would be too fast for such mangroves to adjust and that there would be a collapse of mangroves as a viable coastal ecosystem (Ellison and Stoddart, 1991). From geological record it appears that previous sea level fluctuations presented a series of crises and opportunities for mangroves and that they tended to survive or even expand in several refuges, the most important being continental coastlines with healthy sediment budges.

The Maharshtra's Forest Department has predicted that most of the mangrove species in Mumbai's wetlands will not survive the rising sea levels. The present mangrove species distribution, especially grey mangroves (Avicennia marina) which make up 95% of Mumbai's mangrove trees have aerial breathing roots that rise 15 - 20 cm over the soil, with the predicted sea level rise its roots would be under complete submergence, thereby killing the trees. It has been reported that during the last 25 years about 40% of mangrove area in Maharashtra has been reduced due to human activities. Satellite imagery data shows that in Maharashtra coast the mangrove area is only 148.4 km2. The examples of this are already being witnessed at Thane creek where Avicennia Marina trees are getting submerged during high-tide and dying. In isolated cases, other species with higher roots like Sonneratia alba or Sonneratia apetala roots ranging between 30 - 80 cm are taking over.

TEMPERATURE RISE

Many species show considerable variation in their sensitivity to temperature but the majority of them seem to produce maximal shoot growth when the mean air temperature rises to 25^0C and only Avicennia marina continues to produce leaves when the mean air temperature drops below 15^0C (Saenger and Hutchings, 1987). It would therefore appear that if the average air temperature increases, the species composition of the mangrove forests may change and the presences of mangroves move further north and south. Some species demonstrate a decline in leaf formation rate at temperatures above 25^0C (Saenger and Moverly,1985). The optimum leaf temperature for photosynthesis in mangroves appears to be 28^0C to 32^0C and photosynthetic capacity falls close to zero at leaf temperature of 38^0C to 40^0C (Clough et.al., and Andrews et.al., 1984). It is generally accepted that plant development will be accelerated by increased temperature, as long as the temperature reached does not exceed the upper threshold. Very little is known about the effect of changing temperature on metabolic processes in mangroves. Superficially the predicted global warming between 1.5^0C and 4.5^0C over the next century would seem likely to be of little consequence for the development of various species of mangroves. This impression is reinforced when the expected increase is compared to the diurnal oscillations in temperature, which can be in excess of 20^0C at the limits of mangrove occurrence. However, the temperature increase could become significant when the cumulative effects of temperature on plant development are considered. The elevation of the average temperature of the plant will be a critical factor in terms of growth but how this will manifest in mangroves remains unknown (Field, 1995).

RISE IN ATMOSPHERIC CO_2 LEVELS

A change in atmospheric CO_2 level alters the net carbon balance of the plant by changing the substrate resources but development of the plant will still be determined principally by the rate of temperature and other controlling factors such as enzyme activity and photoperiod. It is therefore difficult to generalize the effect of changes of atmospheric CO_2 levels on plant development (Rawson, 1992). For Avicennia marina and Aegiceras corniculatum the rate of photosynthesis was limited by stomatal conductance to CO_2 and the internal efficiency of carboxylation which suggest that for these species photosynthesis would be enhanced if the ambient $C0_2$ levels increased (Ball and Farquahar, 1984). Contrary to these results, Cheeseman et. al., (1991) working with Rhizophora apiculata, Bruguiera parviflora and Bruguiera gymnorrhiza suggested that the photosynthesis performance was unlikely to be enhanced by increased levels of ambient $C0_2$. The effect of CO2 enrichment on mangrove forests cannot be interpreted within a simple framework as it will depend on complex interactions between several different physiological and environmental factors. Information is needed from long term

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assessments of growth where high CO_2 concentration, temperature, water stress and nutrient stress are controlled (Field, 1995).

WATER AVAILABILITY

It is well established that mangroves flourish in warm wet humid conditions where there is plentiful input of fresh water into their normal saline environment. One of the effects of global warming may be change in the pattern of precipitation in the tropics and this could have profound effect on the growth of mangrove areas. The growth rate of mangrove is critically related to the availability of water to the trees and this is reflected in the soil water content and soil salinity. As most mangroves are tidally inundated, soil water content only becomes a problem when the inundation is occasional and the rainfall is very limited. However, soil salinity characterizes the mangrove habitat and growth of some mangrove have been shown to be maximal under relatively low salinities (Burchett at.al., and Clough, 1984). As the salinity of the soil increases mangrove face the problem of increasing salt levels in the tissues and decreasing availability of water. The increasing salt levels in the tissue may bring about a lessening in the net assimilation rate per unit of leaf area and therefor reduce growth (Ball, 1988). Water availability can also control growth and growth can be expressed as the product of transpiration rate and the carbon gain per unit water loss or water use efficiency. As the salinity increases above optimum levels the stomatal conductance inhibits CO_2 diffusion into the leaf and leads to low assimilation rates. The humidity of the surrounding atmosphere and leaf temperatures are also critical factors in these processes (Field, 1995).

Mangrove have unusually high-water use efficiency showing adaptation for minimal water use for a given carbon gain, which is reflected in relatively low rates of growth (Ball, 1988). The water use efficiency of mangroves increases with increasing environmental stress thereby maximizing photosynthetic carbon fixation while minimizing water loss (Clough and Sim, 1989). Elevated CO_2 can enhance the water use efficiency of mangroves but this may or may not result in enhanced growth. There may be enhanced growth with elevated CO_2 if growth is limited by water, carbon and nitrogen but that elevated CO_2 would have little effect on growth when the salinity is too high for a species to maintain water uptake (Ball and Munns, 1992). If the change in precipitation pattern in reduces the soil salinity, then an improvement in growth rates can be expected in some species.

FUTURE ACTION

Considering the ecological significance and critical role that mangroves play as 'shore keepers', it is thus imperative to protect them from adverse effects of climate change by bringing in correct and timely mitigation measures. Some of them include working out nature-based solutions, making sustainable choices, clearing wetlands from waste, debris and encroachments, planting mangrove samplings in nursery, restoring degraded mangroves, promoting eco-based livelihood for locals, creating better awareness, involving youth in conservation and management activities, constant patrolling, razing down illegal structures, enforcing stricter rules and regulations, fast tracking cases related to mangrove destruction and degradation, celebrating world mangrove and wetland day etc. Further, adopting a multi-disciplinary approach in solving problems and deriving meaningful solutions would go a long way in its conservation and management.

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BIODEGRADATION OF TEXTILE DYES USING SOME FUNGI

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ABSTRACT
A large amount of dyes is used in textile industries and these dyes have become one of the major contributors to water pollution across the world. The conventional methods of waste water treatment are not always efficient in degrading the dyes. Therefore, an innovative and effective alternative method of degradation of dyes from wastewater is required. In present investigation, biodegradation of two dyes Sudan IV and Bromophenol blue have been carried out using three fungal isolates viz., Aspergillus niger, Aspergillus giganteus and Fusarium oxysporum. The fungi were isolated from soil using Warcup method. Each fungus was grown separately on liquid media as well as solid medium containing the said dye to explore their dye degradation capacity. Aspergillus niger is the most effective in degradation of both of the dyes among the three fungi. Aspergillus niger recorded maximum decolourization of the dye bromophenol blue (96.69%) followed by Sudan IV (95.32%). Aspergillus giganteus also showed maximum decolorization of the dye bromophenol blue (96.69%) followed by Sudan IV (95.32%). However, Fusarium recorded maximum decolourization in Sudan IV (91.04%) followed by bromophenol blue (57.74%). The results of this study suggest that A. Niger and A. giganteus can be used effectively for the biodegradation of these dyes.

Keywords: Textile dye, water pollution, biodegradation

INTRODUCTION
Prior to 1856, dyes were prepared from natural sources such as flowers, vegetables, woods, root, insects, etc. However, with the increasing needs and demands, industries became dependent on dyes manufactured from petrochemicals, i.e., synthetic dyes. These dyes are soluble in water, easily absorbed, and very fast in coloration as compared to the natural dyes and provide a large versatility in colors. In the current picture, the worldwide production of dyes is nearly 800,000 tons per year. A large amount of dyes produced is used in textile industries. Textile processing is water-intensive, releasing a huge amount of wastewater. Unfortunately, incomplete exhaustion of dyes onto textile fiber from an aqueous dyeing process leads to a major fraction of dyestuff being released with the wastewater. The released wastewater contaminates water and soil, resulting in a considerable amount of environmental pollution. In addition, it can alter oxygen levels and pH, can impede the penetration of light in the water causing disruption of the aquatic ecosystem, and is potentially toxic and mutagenic to aquatic flora and fauna. Several human health impacts are also associated with the residual dyestuff including irritation, respiratory problems, and effects on the immune system (Jamee and Siddique, 2019).

A variety of physiochemical treatments have been devised previously for the dyes and textile wastewater. However, these suffered from some serious drawbacks in terms of their limited applications or their high cost. Besides, chemical treatments created an additional chemical load in water bodies that eventually resulted in sludge disposal problems thus causing a negative effect on photosynthesis (Rani *et al*., 2014).

Microorganisms are able to degrade synthetic dyes to non-coloured compounds or even mineralize them completely under certain environmental conditions Bioremediation is one of the most effective and successful cleaning techniques for the removal of toxicants from polluted environments (Singh, 2017)

Biodegradation of different dyes of Textile Effluent by different microorganisms was reported by many authors (Singh, 2011; Nascimento *et al*., 2011; Bumpus *et al*., 2004). Al-Tohamy et al. (2020) concluded that *Sterigmatomyces halophilus* SSA1575, is valued for textile azo dye wastewater processing and detoxification. Priyadarshani and Sumathy (2014) and Mohan *et al*. (2012) studied biodegradation of textile azo dyes using various fungi under stationary and shaking conditions. Ali *et al.* (2010) studied role of brown-rot fungi in the bioremoval of Azo Dyes under different conditions.

The present study aimed at testing the efficiency of few fungi to test their capacity in degradation of textile dyes.

MATERIALS AND METHODS
Three fungi viz., *Aspergillus niger*, *Aspergillus giganteus* and *Fusarium oxysporum* were isolated from soil collected from D. G. Ruparel college campus using Warcup method (Nagmani *et al*., 2004). The cultures were purified, sub-cultured and maintained on PDA media throughout the study. Sudan IV and Bromophenol blue are selected as textile dyes for the present study.

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Dye degradation at the liquid media was performed using PD broth. PD broth with 1 per cent dye solution was prepared. 50 ml media supplemented with dye was taken in four Erlenmayer flasks of 150 ml capacity. The contents of the flasks were autoclaved at 121^0C for 15 minutes. After cooling, three flasks were inoculated with adding 8 days old fungal culture disc in sterilized conditions. All the flasks were incubated at room temperature for 8 days.

Dye Degradation Assay at liquid medium was performed according to Roy *et al.,* (2018) by a spectrophotometer. The percentage of dye degradation by each fungus was examined by analyzing the reduction in absorbance. After 8 days of incubation, the medium was filtered with Whatman filter paper no. 1 and absorbance was recorded using spectrophotometer. PD broth was used as blank. Un-inoculated PD broth containing respective dyes was used as a control. For bromophenol blue absorbance was recorded at 530 nm while for Sudan IV at 520 nm.

The dye degradation was calculated using following formula:

$$\text{Percent dye degradation} = \frac{\text{Initial Absorbance} - \text{Final Absorbance}}{\text{Initial Absorbance}} \times 100$$

The dye degradation at solid media was also tested. PDA medium supplemented with 1 per cent dye was used. Three PDA plates were inoculated with fungal disc of 8 days old fungal culture. All the plates were incubated at room temperature. A visual observation was recorded after 8 days of incubation.

RESULTS AND DISCUSSION

Fungal isolates used in the present study showed a noticeable decolorization of both the dyes used in liquid as well as in solid media. Dyes decolorization may be due to both fungal biosorption and biodegradation (Ali *et al*., 2010). Fungi and bacteria, both are the principal degraders of organic matters, but fungi are better known for the purpose due to their superiority in the enzyme production (Singh, 2017).

Table no. 1.A showed Bromophenol Blue Dye decolorization while Table no. 1.B showed Sudan IV dye decolourization in liquid media. The control flask showed highest ΔOD throughout the study while the all the fungi inoculated flasks showed a prominent decrease in ΔOD compared to control flask. The fungal isolates *Aspergillus niger,* and *Aspergillus giganteus* showed a clear removal of both the dyes. However, *Fusarium oxysporum* showed least decolorization of both dyes.

Table No. 1.A. Absorbance (Δ OD) for Bromophenol Blue Dye Decolourization					
Fungus used	**Control**	**1**	**2**	**3**	**Average**
Aspergillus niger	0.97	0.05	0.02	0.03	**0.033**
Aspergillus giganteus		0.09	0.04	0.08	0.070
Fusarium Oxysporum		0.37	0.42	0.45	0.410
Table No. 1.B. Absorbance (Δ OD) for Sudan IV Dye decolourization					
Fungus used	**Control**	**1**	**2**	**3**	**Average**
Aspergillus niger	1.754	0.082	0.084	0.081	0.082
Aspergillus giganteus		0.142	0.143	0.156	0.147
Fusarium oxysporum		0.121	0.179	0.171	0.157

Table No. 2: Per cent discoloration of Bromophenol blue		
Fungus used	**Per cent decolourization**	
	Bromophenol Blue	**Sudan IV**
Aspergillus niger	**96.690 %**	**95.32 %**
Aspergillus giganteus	92.780 %	91.61 %
Fusarium Oxysporum	57.739 %	91.04 %

From Table no. 2, it is cleared that *A. niger* showed highest discolouration of the dye while *Fusarium oxysporum* showed lowest decolourization of both the dyes. *A. giganteus* also gave a sharp decrease in ΔOD exhibiting large amount of discolouration. A dye degradation capacity of *Aspergillus niger* is supported by many authors (El-Rahim *et.al*., 2021; Priyadarshini and Sumathy, 2014). *Aspergillus giganteus* also showed the quite high degradation of dye about 93% and 92% in Bromophenol Blue and Sudan IV respectively. *Fusarium oxysporum* showed the least decolourization. A decrease in absorbance showed there is some degradation of dye. However, *Fusarium* produces some colored compounds which may be the reason of such high absorbance.

As compared to liquid media, solid media showed similar degradation of bromophenol blue dye. However, the fungi failed to show satisfactory degradation of Sudan IV dye on solid media.

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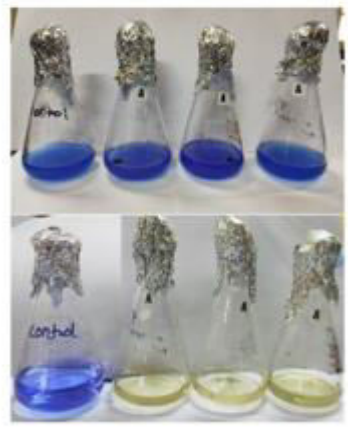
Photoplate 1: Biodegradation of Bromophenol Blue		
		
Aspergillus niger	**Aspergillus giganteus**	**Fusarium oxysporum**
Photoplate 2: Biodegradation of Sudan IV		
		
Aspergillus niger	**Aspergillus giganteus**	**Fusarium oxysporum**

CONCLUSION

Although textile dye degradation or decolorization is a difficult process, several fungi have been identified as a potential degrader of textile dye. In the present study, three fungal isolates viz., *Aspergillus niger*, A*spergillus giganteus and Fusarium oxysporum* were explored for their dye degrading capacity. *Aspergillus niger* was the most effective in degradation of both of the dyes among the three fungi. *Aspergillus niger* recorded maximum decolourization of the dye bromophenol blue (96.69%) followed by Sudan IV (95.32%). *Aspergillus giganteus* also showed maximum decolorization of the dye bromophenol blue (96.69%) followed by Sudan IV (95.32%). However, *Fusarium* recorded maximum decolourization in Sudan IV (91.04%) followed by bromophenol blue (57.74%). The results of this study suggest that *A. niger* and *A. giganteus* can be used effectively for the biodegradation of these dyes and can be employed for waste water treatment in textile industries in order to biodegradation of dyes. Furthermore, to the best of our knowledge, this study indicates the first report of *Aspergillus giganteus* strains to degrade dyes.

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LOCAL AND REGIONAL SUSTAINABILITY STRATEGIES IN INDIA: A META-ANALYSIS

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ABSTRACT
Over the past three decades, "sustainable development" has been one of the key goals in spatial and environmental planning. A varied range of initiatives have been proposed and implemented for mitigating the environmental damage together with facilitating human economic and social development. These initiatives vary in their characteristics like, their targets for planning and management, their bureaucratic structure and their sustainability goals.

The objective of this paper is to produce an easy analytical framework of diverse array of sustainable initiatives in India for assessing their objectives, strengths and weaknesses at both urban and rural scale. Drawing upon a review of theoretical and applied research based on local and regional sustainability development initiatives, we categorized them into different typologies, including a. Smart development strategies in urban cities; b. Rural areas sustainability strategies; c. effective waste management and d. Climate change mitigation using renewable resources. Each one of these initiatives is analyzed based on their focus, scope, fields of action and successes.

Through this analysis, we aim to highlight the prominent characteristics between diverse approaches to sustainability.

Keywords: Sustainable development, smart city, smart villages, effective waste management, renewable resources

INTRODUCTION
Environmentally sustainable economic growth is the 'need of the hour' in today's world since, for the past two to three decades we have seen that, the health of the environment has taken a toll for the sake of economic growth [1]. As a result, there has been an impact on the environment such as decline in air quality and climate change because of greenhouse gases. Sustainability development encourages the citizens to conserve and enhance our resources by which it can exist for a long duration without compromising on the provision of resources for future generations. There are three pillars of sustainability development; a. Economic pillar which includes the companies' ability to contribute to economic development and growth, that is , they must encourage and promote the protection of the environment by limiting the risks posed by their production.; b. Environmental pillar which includes saving and preserving natural energy or agricultural resources, assessing the carbon footprint and reducing total greenhouse gas emissions and forestall water scarcity and reduce overall waste in both urban and rural areas and lastly, c. Social pillar that refers to values that promote equality and respect for individual rights. All United Nations Member States in 2015 adopted the 2030 Agenda for Sustainability Development which provides a blueprint for peace and prosperity for people and therefore the planet, now and into the future. An urgent call for action by all countries, developed and developing were the seventeen sustainable development goals which were adopted by all the United Nation Member States. These sustainable goals must be followed not only by the member countries or states but also at an urban and local scale at an individual level. In this paper, we explore the various local and regional sustainable development strategies that were adopted and that can be adopted at both urban and rural scale.

Smart Development Strategies In Urban Cities
There is a rapid increase in urban population [2] from 26% in 1990 to 32% in 2014 and is predicted to reach about 50% by 2050. The urbanization in India is filled with contradictions. With having such high percentage of country's population living and working in urban areas, these cities witness varied range of issues like informal settlements, insecurity, high levels of pollution, etc. A new style of a city planned to encourage healthy economic activities with the help of information and communication technology (ICT) [3] while improving quality of life and providing sustainable growth is a 'smart city'. A 'bottom-up' approach is followed by smart cities which suggest that the concept of a smart city is oriented towards local needs and challenges rather than global, as each smart city may have its own environmental and socio-economic structure. The various factors to be considered while strategizing to achieve sustainable development in smart cities in local and urban areas are as follows:

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Climate
The cities will need mitigation measures to scale back urban heating, pollution and vulnerability to natural disasters. To devise policies to mitigate the effect of climate change on cities, climate data from global and local organization/institutes are needed. A few of the cities such Haryana and Uttarakhand are already doing real-time monitoring of the climate for purposes of devising these policies

Geography and Land
The primary challenges which require to be addressed through land-use management are climate change adaptability and food security and each city local or regional areas need its own designing to overcome the challenges posed by geographical conditions. For instance, Jaiselmer which is a city close to desert areas will face challenges of particulate matter pollution and water scarcity; therefore, the management policy of these cities will need to focus particularly in that aspect.

Atmospheric Pollution
One of the highest numbers of people affected due to air pollution in the world is India. The cities need continuous monitoring, identification of sources, and finding solutions to air pollution to create sustainable smart cities. . The air pollution can be reduced effectively using, separate lanes for bicycles, more green-belt areas, green transport, more renewable energy, and discouraging burning of municipal and agricultural wastes. The rapid collection of big data, modeling, analyses, and forecasting, and converting it to tangible information is important for the benefit of the smart city citizen

Water Resources
The major challenges that smart cities face are the, pilferage during supply, depletion of ground water tables and issues of economic valuation and allocation for agriculture and households. Watershed, maintenance of wetlands management, renewal of step wells, and water harvesting are some important measures that are needed in India

Energy Resources
The reliance on green energy for most of the demand fulfillment [8] should be encouraged as well as efforts at trying to minimize the carbon footprint should be advertised. The green building concept should be promoted to reduce energy consumption right from household level, local and regional scale and the state level. Energy consumption in the cities needs to be in balance with its surroundings and the environment.

Urban Green Space (UGS)
UGS provides several ecosystem services [4][7] such as natural forests, wetlands, grasslands parks, and gardens. These ecosystem services range from agriculture, carbon sequestration, health benefits, pollination, air purification, wetland and water purification, urban cooling, and noise reduction which are very useful in overcoming several environmental problems.

Sustainability Strategies in Rural Areas
Rural communities are face challenges in the context of, land degradation, deforestation, climate change biodiversity loss and fragmentation of natural habitats, poverty, and geographical isolation.

The closest to the environment that have the potential to play a cardinal role in protecting land conserving, water, and forests are the rural households. It is imperative to link the global and local use of natural resources. Success of local and regional development programs in rural areas is dependent on several factors.

Local Participation and Sustainability Programs
Local participation builds transparency, a participative approach, and local capacity and sustainability programs create awareness among communities that tend to have an advantageous effect. Working with communities to improve knowledge and choices in village development programs is one of the best ways forward for inclusive and sustainable development.

Renewable Energy
Setting up renewable energy resources in the rural areas can impact on long term sustainability of rural communities [6]. This can also lead to capacity building and community empowerment. As people become more specialized and accumulate skills in the new industry, their capacity to learn and innovate is enhanced. Several rural regions have developed specific institutions and authorities to deal with renewable energy deployment, often in reaction to large investments and top-down national policies. This dynamic has been observed both in regions where local communities fully support renewable energy, and in regions where the population is against potentially harmful developments. Renewable energy can reduce the “fuel poverty” that can be a common feature of remote regions, by allowing isolated communities to produce their own energy

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instead of importing expensive conventional fuels. Eco-houses can built, a climatically appropriate house, which integrates solar cooking and water heating with rooftop rainfall harvesting using a multi fed biogas plant. This would raise the standard of living of people living in rural areas and promote renewable and environment friendly technologies in remote villages.

Smart Villages

62 villages, all over India in 19 states have been recognized under smart villages. Clean and big roads, , broad streets, pucca homes big trees for shade, proper school for the children, properly demarcated properties, waste management, potable water, regular electricity, in short, a model place of residence. One of the examples of smart villages is the Dhanora village [9] in Dholpur district of Rajasthan and this project was undertaken by a regional organization. Under this project, various efforts were made towards sustainable development including proper housing, road reconstructions, sanitation access to solar power and clean drinking water, tree plantation, and water conservation, among others.

Agriculture

India has maximum area of arable land after USA but productivity per hectare is nowhere near the best. Cardinal reasons behind this are highly fragmented nature of Indian farming with near 33% of arable land held in units of less than 2 hectares per owner. It doesn't let farmers enjoy the economies of scale in operations and modern farming equipment proves very expensive for them and because of it qualityis additionally an issue. One of the initiatives to combat this was the launch of a virtual app called 'e-Choupal' which means "village meeting place [10]. Internet access is given to the farmers as a part of the e-Choupal project which enables the farmers to acquire information on mandi prices, good farming techniques and also place orders for agriculture inputs like seeds and fertilizers. This helps farmers in improving the quality of the produce and helps in realizing a better prize.

Effective Waste Management

A key concept of the circular economy is sustainable waste management that offers many opportunities and benefits to the society, the economy and the environment. Collecting, sorting, treating, recycling, and when properly facilitated providing a source of energy and resources are involved in sustainable waste management. Hence, improving waste management methods, and lessen the impact of human activities on the environment, therefore, enhancing the air and water quality. It also keeps heavy environmental costs at bay, reduces food wastage and prevents some human health conditions. Avoidance, reduction, reuse, recycling, energy recovery, and finally, treatment or disposal is the aspects of a sustainable waste management hierarchy. Solid waste management and liquid waste management are the two main categories of sustainable waste management and to follow these, the segregation of waste right from the grass root level is cardinal.

Solid Liquid Waste Management Techniques

Sustainable solid waste management techniques involve composting methods. NADEP method where composting takes place in a rectangular brick tank with aeration holes is one of the methods along with vermicomposting, biogas from organic solid waste

Liquid waste management is done through waste water treatment techniques such as water stabilization pond system, duckweed pond system, constructed wetland, up flow anaerobic sludge blanket, package and extended aeration system, sequence batch reactor system.

Apart from these strategies, establishing local and regional collection and safe disposal of wastes, preventing and avoiding solid waste incineration, reducing and treating food waste, boosting recycling rates and setting a zero waste goal to reap social, economic and environmental rewards are some of the actions to improve waste management and reduce greenhouse emissions. [11]

Waste to Energy Technologies

The waste to energy narrative is to clean the city by scientifically disposing the solid waste and by generating energy it can help reduce the large electricity deficit. To put this initiative into action, it is imperative that the quality of the waste is good enough to generate clean energy which can be achieved if the waste is segregated at each of the level of waste disposal. India however has not yet managed to achieve that, hence the waste to energy technologies is still at its very initial stage and under debate to be implemented or not. [12]

Climate Change Mitigation Using Renewable Sources

The main objective of renewable energy deployment in India is to enhance energy security, encourage economic growth, increase energy access, and reduce climate change. By the use of clean energy and by ensuring access to affordable and reliable energy for every citizen sustainable development is possible [13]. Some of the successful local and regional strategies and initiatives are:

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NIWE, The National Institute of Wind Energy has installed a remote sensing instrument called LIDAR for assessment of offshore wind resource at the Gulf of Khambat situated off the Gujarat Coast [14]. Renewable energy of capacity 31.67 GW has been installed through the implementation of various renewable energy programmes.

Infosys, India's second-largest software services firm saw over 43% of its electricity requirements being met through renewable energy sources during 2017/18 and 43.7% of the company's electricity requirements that equates to more than 100 million units. This energy is sourced from renewable resources. They have an installed a capacity of 46.1 MW of solar energy across the country.

The Gosaba Island situated in the Sunderbans region of West Bengal in India is brings water of high salinity (more than 30 dS/m) because it is surrounded by tidal rivers connected with the Bay of Bengal, making it unfit for irrigation in agriculture. Due to various technical reasons Good quality groundwater is also unavailable for irrigation. Farmers in this village are unable to grow Rabi crops due to these difficulties and farm ponds are the only source of water for irrigation in the post-monsoon period which harvests the rainwater during monsoon. So, in order to increase the cropped area, solar powered drip irrigation technology has been introduced in the island [15].

CONCLUSION AND DISCUSSION

The growth of smart cities and smart villages in the future will depend on the success of the inclusion of big data and the management of our resources, effective waste management and efficient use of renewable resources for climate change mitigation for society's use. Efficient use of environment is going to need good evaluation, monitoring, feedback, and policy formulation, both at local and regional levels and global level at urban and rural scale, which is only possible through meaningful information. Information on the environment of smart cities and smart villages can be obtained from several international, national, and local authorities or agencies. This will thus require technological expertise for the information to be processed since the information collected will be big. Prior to establishing infrastructure for smart cities and smart villages for sustainable development, the formation of data centers is paramount, which will lead to the identification of problems and also help in providing solutions. An incessant monitoring system of water quality, land use changes, green space, energy consumption and waste management should be made public through an online platform to ensure that the society is also able to participate. The calculation of carbon footprint of each household should be encouraged so as to reduce greenhouse emission It is also imperative that we include various components of the environment's ecosystem, as these parameters provide a holistic view to the Indian mission of smart cities The digital ecosystem, consisting of big data, ICT should be integrated into our natural environment to make sustainable development a success.

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ASSESSMENT OF HEAVY METAL CONTENT IN VEGETABLES GROWN NEAR RAILWAY TRACKS IN AND AROUND MUMBAI CITY (MS INDIA)

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ABSTRACT
The migration of people from rural areas to cities in search of job opportunities adds to the demand for basic resources. To cope with the ever-increasing demand for resources particularly, food resources farming has been practiced along the railway tracks in cities wherein there is less availability of land. Uncontrolled use of chemical pesticides and fertilizers by such farmers leads to pollution of water and soil proving lethal and toxic to the consumers. The present study was carried out to assess the presence of heavy metals in water, soil, and vegetables grown near railway tracks in and around Mumbai city. Physio-chemical assessment of water and soil from the agricultural area was carried out. MPN, Turbidity, and COD values were found to be high during monsoon throughout the study area. COD, TDS and Nitrate values were between 290 - 450mg/L, 300 - 5200mg/L and 0.5 - 50mg/L respectively. Soil pH and Potassium levels were less than the IARI standard which is 6-8 for pH and 120kg/hectare for Potassium. During late post-monsoon, heavy metals assessment revealed cadmium levels higher than allowed by WHO 1996and FAO in both the leafy vegetables. Heavy metal toxicity could prove detrimental to the lives of the consumer and consumption for a long duration may lead to Cancer.

Keywords: heavy metals, total dissolved solids, railway tracks, monsoon season

1.0 INTRODUCTION

India is an agricultural country with almost 58% population depending upon agriculture as a primary source of livelihood in India. (IBEF, 2022). Reduced quality of agricultural land coupled with uncertain rains has forced farmers to migrate from rural areas to the city in a search of job opportunities to fulfill their basic needs. To cope with the ever-increasing demand for resources particularly, food resources farming has been practiced along the railway tracks in cities wherein there is less availability of land. Most of the unhygienic places like dumping grounds, construction sites, slums, industrial outlets, and gutters are near railway tracks. These unhygienic places create favorable conditions for pests and insects to grow which leads to the increased chances of attacks on vegetables grown near railway tracks. To minimize the losses of vegetables uncontrolled use of chemical fertilizer and pesticides for profit leads to pollution of water and soil proving lethal and toxic to the consumers. Vegetables like spinach, radish, amaranth, red amaranth, taro, cauliflower, lady's finger, etc. are grown throughout the year near the railway tracks (Vzhacharickal P.J., et al, 2013) Leafy vegetables are an important part of our regular diet. They are rich in many essential nutrients, vitamins, and dietary fibers and low in calories which helps to maintain blood pressure, and reduced the risk of obesity, digestion problems, heart diseases, etc. The quality and quantity of vegetables are also equally important in the diet. One of the main concerns of agricultural practices near railway tracks is the use of sewage water for irrigation purposes. Wastewater contains industrial effluents, drainage pipelines, and domestic discharge which may contain several harmful elements like heavy metals and other toxic chemicals (Doshi and Zele, 2014). Agriculture runoff also contains chemical fertilizers, pesticides, and insecticides and the use of such water for irrigation purposes leads to the contamination of soil and vegetables. Consumption of such vegetables is proven to induce hypertension, depression, memory decline, destabilization of moods, migraine problems, etc. These heavy metals have chronic effects like cancer, birth defects, and decreased fertility (Balali-mood M., et al, 2021). In many cases, they imitate human hormones which may be lethal. These chemicals can even transmit toxicity genetically which is the real worry. The present study focused on the assessment of heavy metal content in the soil, water, and vegetables grown near railway tracks in and around Mumbai city and the physiochemical parameters of soil and water.

2.0 RESEARCH METHODOLOGY STUDY AREA

Mumbai is the largest metropolitan city in Maharashtra and Navi Mumbai is a part of the Mumbai metropolitan region. The study was carried out near Central, Trans-harbour, and Harbour railway tracks and compared with organic agricultural practices in the Mumbai Metropolitan region. Table no. 1 provides geographical coordinates for the study location.

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Map 1: Geographical map of the study area

Table No. 1: Geographical co-ordinates for study location

Study Locations	Code	Latitude and Longitude
Central line	CL	19.1968 N, 72.9977 E
Harbour line	HL	19.0265 N, 73.0595 E
Trans- harbour line	THL	19.1585 N, 72.9994 E
Organic farming	OF	19.2100 N, 73.1849 E

The study locations are in the vicinity of construction sites, gutters, slums, dumping grounds, and the footwear industry. The study period was divided into 3 seasons i.e., Late post-monsoon, Pre- monsoon, and Monsoon whereas sampling was carried out once every 3 months. Random composite sampling was carried out and collected soil samples were stored in plastic pouches. The grab sampling technique was used to collect water samples in plastic bottles (Almaleeh A., 2022).

Physico-chemical analysis of soil and water was performed using standard procedures given by APHA (20th Edition 1998). The physico-chemical like pH, COD, TDS, Nitrate, Sulphate of water and pH, Organic matter, Nitrogen, Phosphate, and Potassium of soil were studied. The heavy metal content in vegetables, water, and soil samples was assessed by using the ICP-AES method.

3.0 RESULTS & DISCUSSION

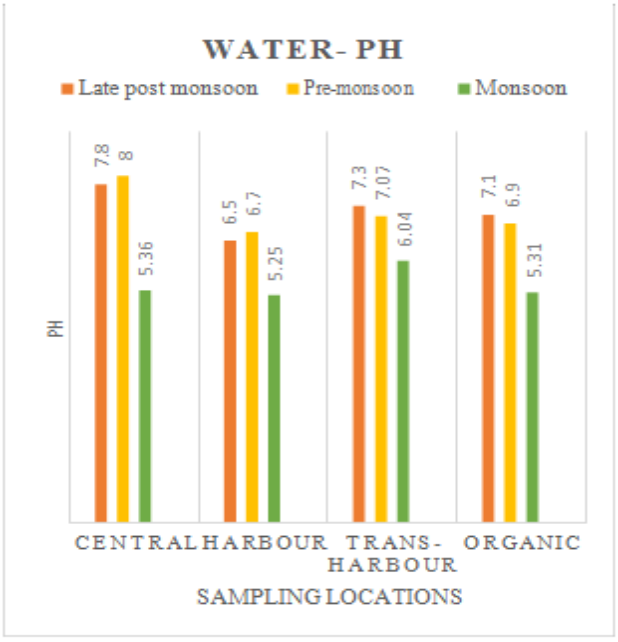

Figure No.1 pH of water samples

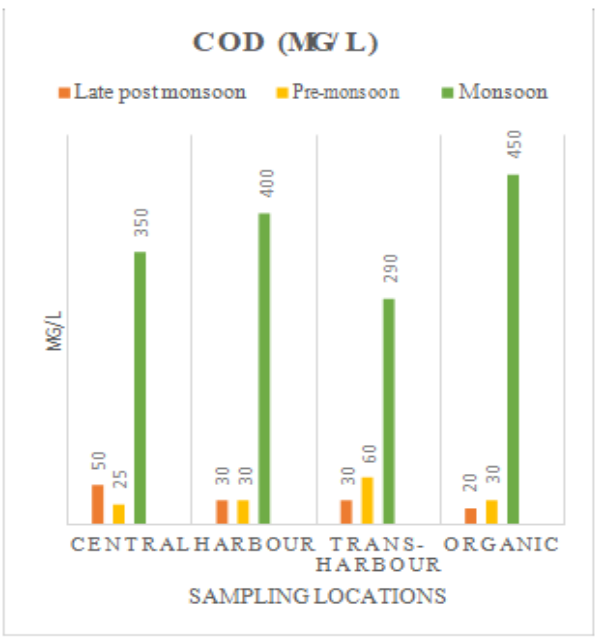

Figure No.2 C.O.D. of water samples

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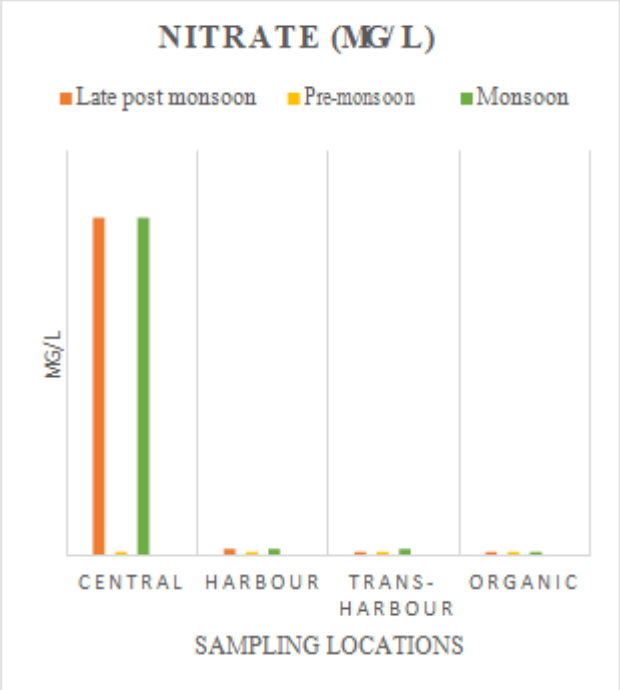

Figure No.3 Nitrate in water samples

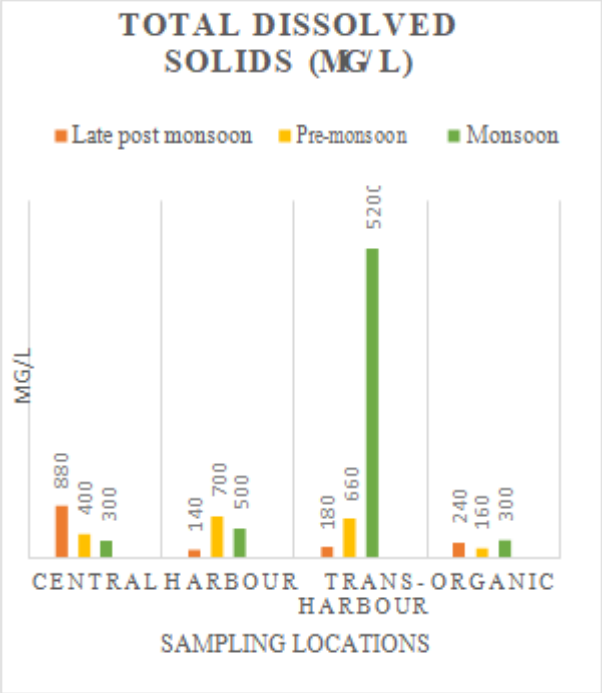

Figure No.4 T.D.S of water samples

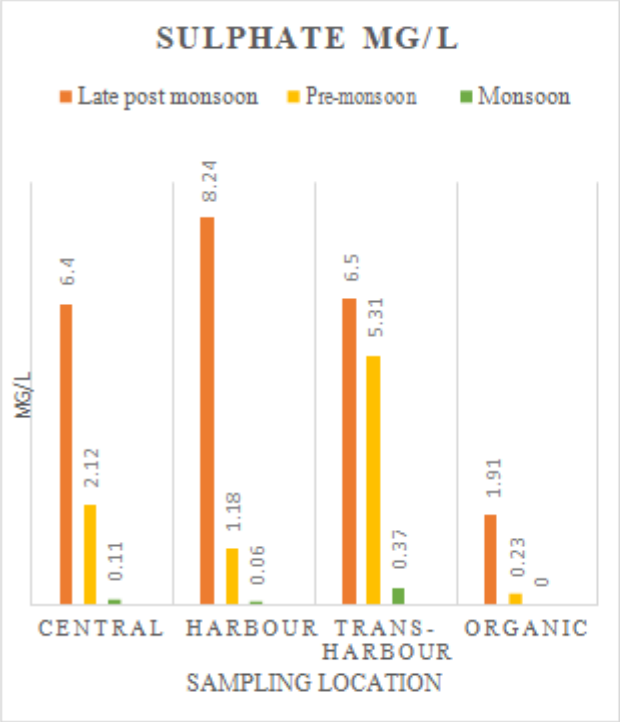

Figure No. 5 Sulphate in water samples

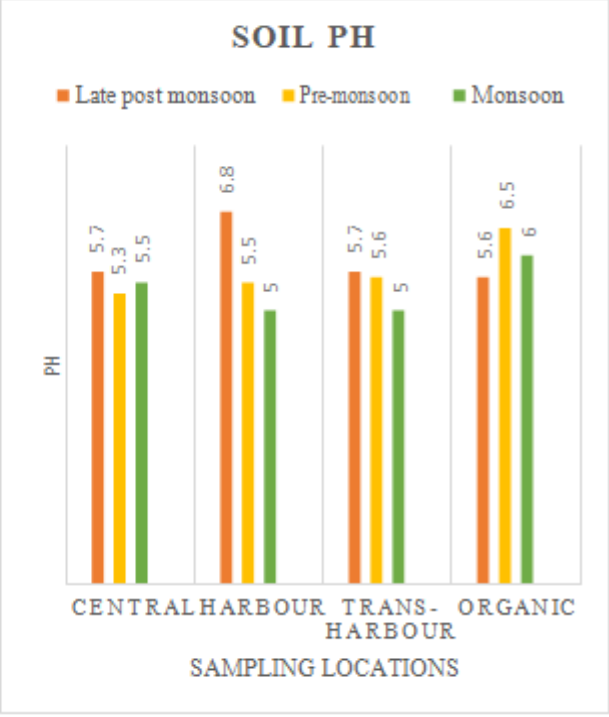

Figure No.6 pH of soil samples

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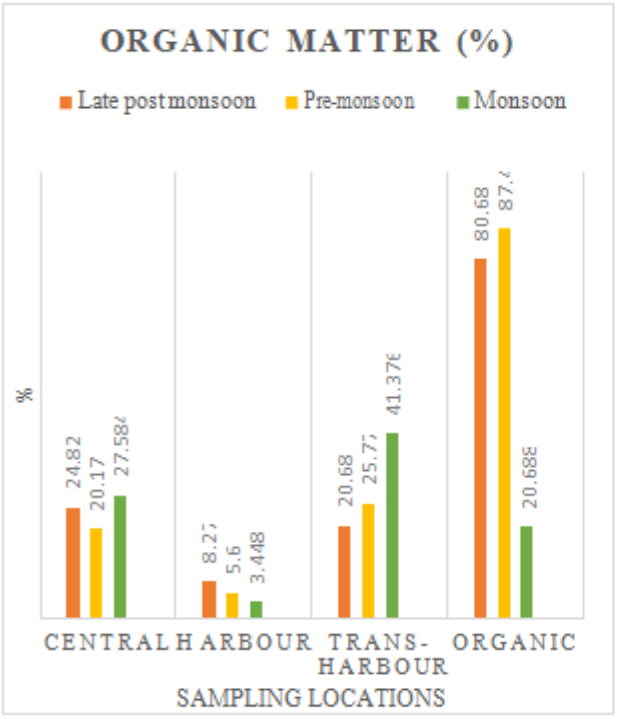

Figure No.7 Organic matter content of soil

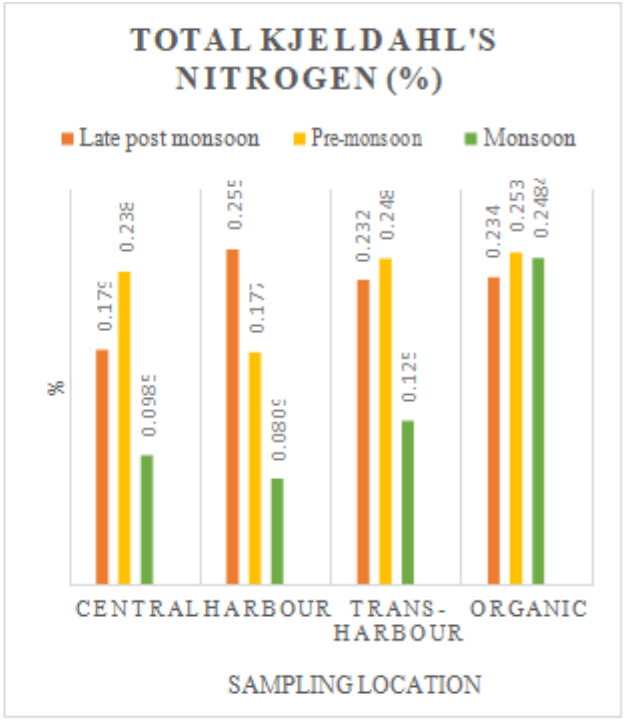

Figure No.8 Nitrogen content of soil samples

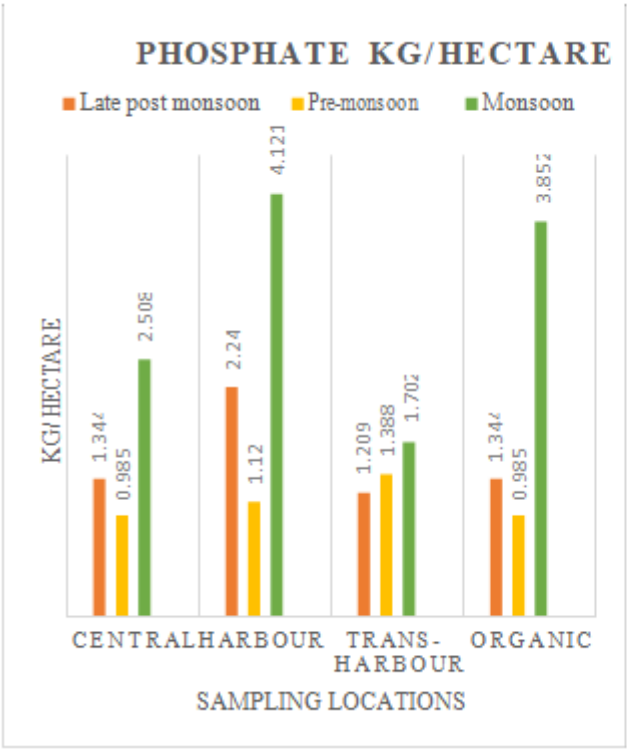

Figure No.9 Phosphate content of soil samples

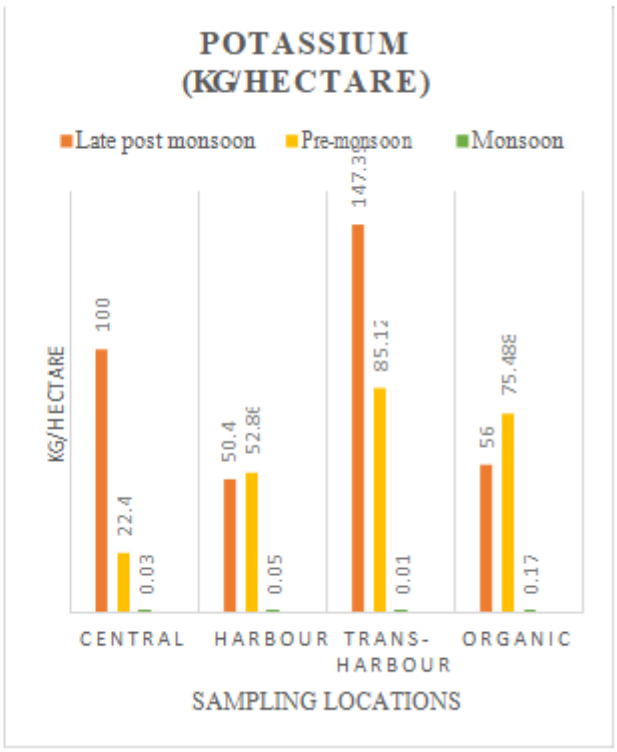

Figure No.10 Potassium content of soil samples

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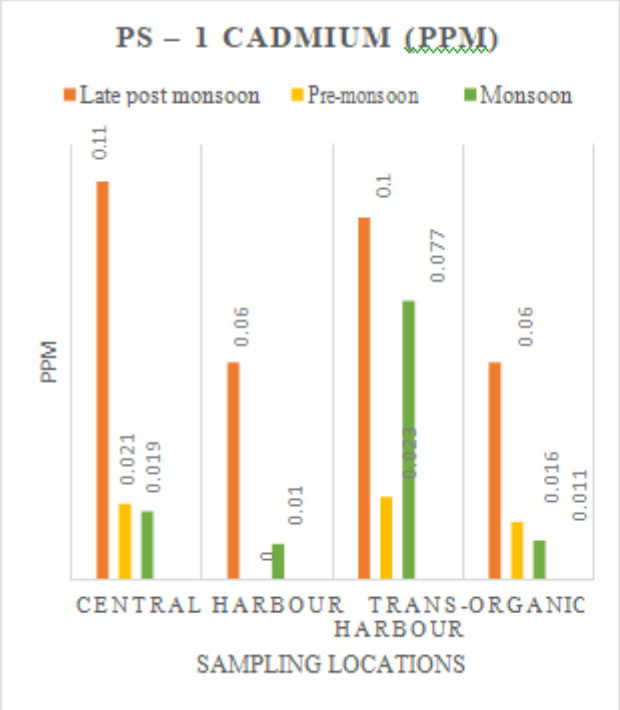

Figure No. 11 Heavy Metal Cadmium-PS1

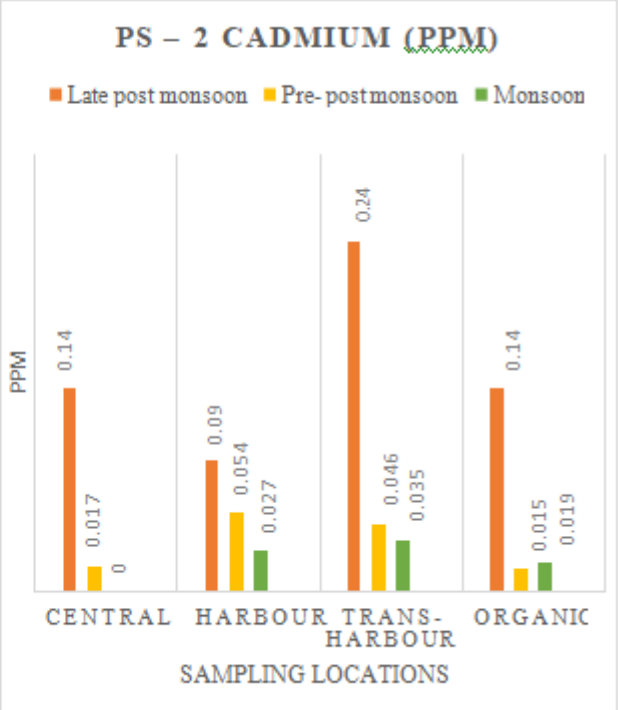

Figure No. 12 Heavy Metal Cadmium-PS 2

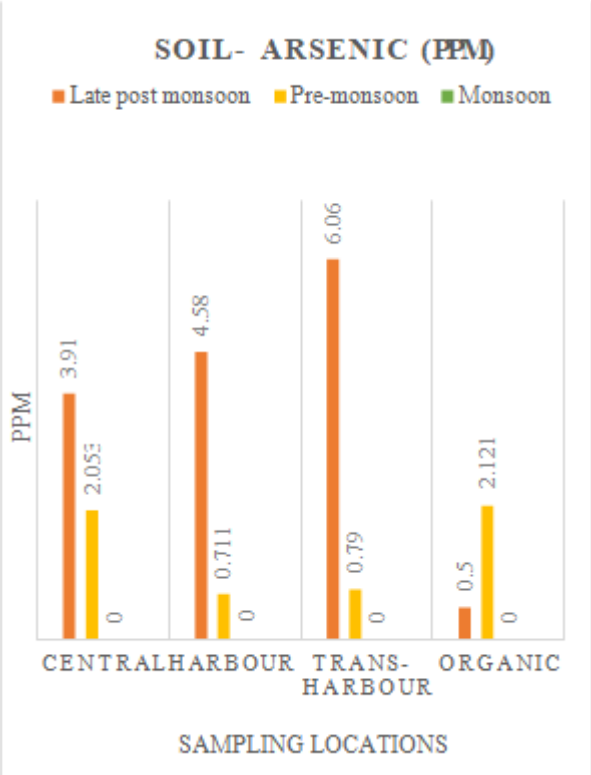

Figure No.13 Heavy Metal (As) in soil samples

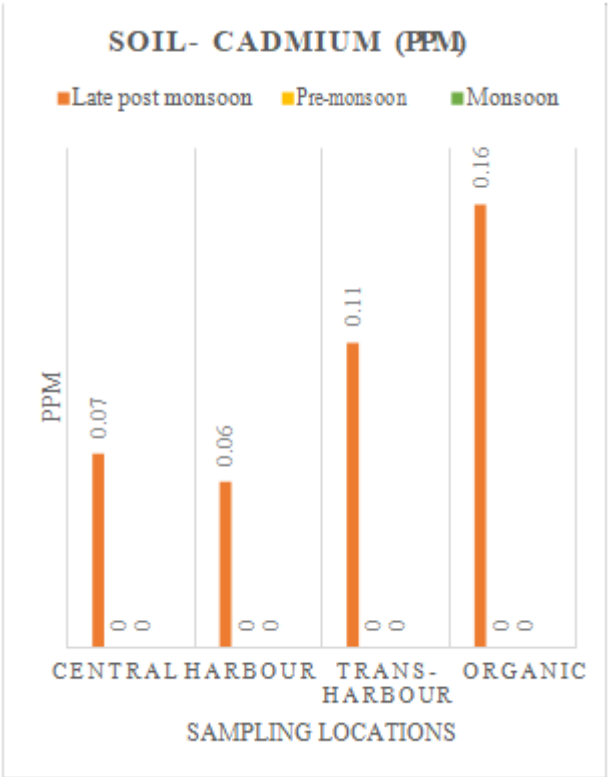

Figure No. 14 Heavy Metal (Cd) in soil samples

The pH of the water was found to be in the range of 5.25 to 8 during the study period (Poyen F. B., et al, 2018). Water pH was found to be moderately acidic during the monsoon, whereas it was found to be near neutral in late post-monsoon and pre-monsoon. A slightly alkaline pH of 8 was found in a Central line during pre-Monsoon. Use of rainwater for irrigation in agriculture practices is common in India and rainwater is naturally acidic. The COD level for all the sampling locations was found to be in the range of 20-450 mg/L. During monsoon season COD for water was found to be in the range of 290 to 450 mg/L which is higher than the permissible limit of 250 mg/L set by MOEF (Fig.2) (Desai P. and Jadhav R., 2016). High COD level in water indicates the presence of contamination by chemicals and the use of such water for agriculture practices may affect the quality of the soil in the future. The TDS values were found to be in the range of 140 to 5200

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mg/L. During monsoon season, an unusually high amount of TDS was observed (5200 mg/L) at the trans-harbour location which was higher than the permissible limit provided by BIS 10500: 2012 for sewage water i.e., 500 to 2000mg/L (Fig.4). High TDS indicates the mixing of particles in water due to agriculture and surface runoffs during monsoon season. A continuous supply of water with high TDS levels also affects plant growth. The nitrate level throughout the study locations was found to be in the range of 0.5 to 50 mg /L during the study period. For monsoon and post-monsoon seasons, nitrate was found to be 50 mg/L, whereas the acceptable limit of nitrate is 10 mg/L (LaBorde L. 2019). The high concentration of nitrate in water samples indicates pollution due to chemical fertilizers and urban drainage (Kiani A. et al, 2022). The sulphate concentration of water samples was found to be very less than the standard range prescribed by CPCB i.e., 200-400mg/L. If water containing higher sulphate levels is used for irrigation purposes it affects the growth, yields, and quality of fruits (Papadopoulos I., 1984).

The pH values for soil at Central, Trans-harbour, Harbour, and Organic locations were found to be 5 -6.8 which was less than the standard range of CPCB 6-8 pH. The soil pH was found to be acidic throughout all the seasons (Fig.6) and leafy vegetables like amaranth, radish, spinach, cauliflower, and okra can grow in acidic soil (Ganeshmurthy A. N., et al, 2016). The organic matter content of soil samples was found to be in the range of 3.448 to 87.2% which indicates a good quantity of carbon in the soil. As the sampling areas are nearing the dumping ground, slums, and sewer lines, biomass generated from such agriculture practices is sun-dried and again mixed with the soil which increases the carbon content of the soil. Such type of soil is good for the growth of vegetables (Desai P. and Jadhav R., 2016). The potassium in soil was found to be in the range of 0.01 to 147.39

Kg/hectare during the study period. Potassium content in soil was found to be in the range of 0.01 to 0.17Kg/hectare which was remarkably less than the I.A.R.I. standard of 120 Kg/hectare. A low concentration of potassium in soil affects the soil fertility and the productivity of vegetables. Using chemical fertilizer to full fill potassium levels in soil on regular basis has minor adverse effects on humans. Low pH soil (acidic soil) is also responsible for less potassium content in soil (Ganeshmurthy A. N., et al, 2016). Nitrogen is one of the essential elements for the growth of plants. The nitrogen content was found to be in the range of 0.0809 - 0.255 % which indicates the soil is good for the cultivation of vegetables. The high amount of nitrogen is necessary to maintain soil fertility and also helps to increase crop yields and accelerate the growth of vegetables (Doshi and Zele, 2014). The phosphate content in soil was found in the range of 0.98- 4.121Kg/hectare. As per the government document manual for soil fertility nutrients, the phosphate content in soil was found to be very less. (Shah and Pawar, 2009). (I.C.A.R.). The pH level must be increased with the application of lime.

The assessment was carried out to gain insight into the presence of heavy metals like Arsenic (As), Cadmium (Cd), and Lead (Pb) in water, soil, and vegetables. These heavy metals are naturally available in soil but the concentration rarely reaches the toxic level. The anthropogenic activity like excess use of chemical fertilizers and pesticides in agriculture activity, mining, industrial, pharmaceutical, or discharge of effluents are responsible for the increase in toxicity levels due to heavy metals in soil. The arsenic level of soil was found to be in the range of 0.05 to 6.06 ppm, which was less than the permissible limit recommended by WHO 1966, FAO, and European Union for agricultural soil (20ppm) (Gupta N., et al, 2012). During late post-monsoon, the cadmium level in soil was found to be in the range of 0.06 to 0.16 ppm which was less than the standard permissible limit recommended by WHO 1996 i.e., 3 to 6 ppm (Gupta N., et al, 2012). The cadmium level was found to be in the range of 0.01 to 0.24 ppm in both plant 1 and plant 2. During post-monsoon cadmium was found to be in the range of 0.06 to 0.24 ppm in both the plant samples, which was higher than the permissible limit of leafy vegetables provided by WHO 1996 and FAO (0.02ppm). A high concentration of cadmium in soil indicates the higher use of chemical fertilizer. Heavy metals were absent in water samples from all the study locations during the study period (Mensah E., et al, 2009)

4.0 CONCLUSION

The quality of water used for irrigation and soil in which vegetables are grown was found to be comparatively low. The presence of arsenic and cadmium in soil and leafy vegetables grown near railway tracks is undesirable to consumers. The quality of soil and water needs to be upgraded by sustainable practices. Uncontrolled use of chemical fertilizers and pesticides must be avoided. To increase crop productivity and improve soil quality, chemical fertilizers and pesticides must be replaced with organic fertilizers and pesticides. To tackle the problem, sensitization of agricultural workers at the grassroots level must be carried out.

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CARBON SEQUESTRATION POTENTIAL OF TREES IN URBAN AREA: A CASE STUDY

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ABSTRACT
Carbon sequestration is the process of transferring CO2 from the atmosphere into the soil, plants or plant residues, and other organic solids, which are stored or retained in the unit as part of the soil organic matter. Retention time of sequestered carbon in the soil (terrestrial pool) can range from short-term (not immediately released back to the atmosphere) to long-term (millennia) storage. In the present investigation aboveground biomass and belowground biomass carbon sequestration potential of selected tree species of D.G.Ruparel college campus in Mumbai city coordinates at 19° 1' 40"NL & 72° 50' 42"EL and covers around 10 acres was measured. The total of 260 trees of 25 tree species present in the campus area of D.G.Ruparel College, Mumbai was taken for study. Total biomass and carbon sequestration in the tree species have been estimated using non-destructive methods. The aboveground and belowground organic carbon (unit) and total organic carbon of each species were calculated. The calculated total organic carbon has been compared with an allometric model. Ficus benghalensis species were found to be dominant with an average sequestration of 93364.38CO_2 equivalent per tree, followed by Caryota mitis sequestrated average of 13084.61 CO_2 equivalents per tree. The species Neolamarckia cadamba has lowest average carbon sequestration potential i.e. 120.49 CO_2 equivalent per tree. The average carbon sequestration of each species was taken and the sum of the average carbon sequestration of all species was 166119.3937 CO_2 equivalent till date.

Keywords: College campus, Carbon Sequestration, Climate change.

INTRODUCTION
There has been major expansion in terms of industries, automobile manufacturing, and infrastructure since a long time and there are many key factors that are responsible for pollution that go hand-in-hand with the urban developments. The biosphere includes a complex mixture of carbon compounds, They are originated, transformed and decomposed within this sphere. Carbon (C) is the fourth most abundant element in the Universe, after hydrogen , helium , and oxygen, and is the building block of life. Carbon is a chemical element that is an essential part of all living organisms. It is found in the bodies of plants and animals. Carbon bonds with itself to form long chains. Other elements then bond to the sides of such carbon chains, forming millions of different organic compounds that serve as the building blocks for the bodies of plants and animals. For example, enzymes, carbohydrates, and DNA are all based on carbon. Carbon dioxide,which remains in the atmosphere for more than 100 years, is responsible for more than 55% of the current global warming from GHGs produced by human activities. Its concentration has increased by more than 30% since pre-industrial times (around 1750), and currently increasing by 1 % every year. (Houghton RA, 2016)

Carbon dioxide being the important one, whether the carbon is in the form of a sugar or carbon dioxide gas, we all need it.The Earth only has a fixed amount of carbon. Carbon dioxide is constantly being released from burning fossil fuels, plants, and animal respiration. The rise of greenhouse gasses, especially anthropogenic emissions of CO2, is the main cause of global climate change. (Wang Y ,2019) (Xiaojing Zhao, 2022) In 2021, global CO2 emissions from energy consumption and industrial processes rebounded to reach an amount of 36.3 gigatonnes (Gt), the highest ever annual level (IEA, 2022). According to the World Economic Forum (WEF), without stronger action, global capacity to mitigate and adapt to climate change will be diminished,eventually leading to a “hot house world scenario. CO2 is a major contributor to global warming. Thus increasing CO2 emission is one of the major environmental concerns and it has been well addressed in ‘Kyoto protocol’ (Hangarge 2012).It has direct effect on carbon sequestration, more than 116 millions tons of CO2 per year is sequestered contributing to reduce atmospheric carbon. (SKS Jasmin 2011) (Hangarge, 2012)

Change is a fundamental characteristic of the environment. But what is disturbing today are the human activities that lead to an unprecedented acceleration in climate changes. The scientific evidence suggests that the earth’s climate is changing, the atmosphere is warming and this trend will continue. By the year 2050, scientists predict that the world will be warmer by an average of between 1.5 and 4.50C (IPCC, 2003, 2006).

Urbanization refers to the population shift from rural to urban areas, "the gradual increase in the proportion of people living in urban areas", and the ways in which each society adapts to the change. The process whereby a society changes from a rural to an urban way of life. It is predicted Carbon dioxide is one of the 3 greenhouse gasses that are receiving increasing attention, CO2, methane and nitrous oxide are believed to trap heat from the

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atmosphere the same way glass does in a greenhouse. Accumulation of gasses likely to cause changes in climate (Williams and Nelson, 2000).

Other observed climate changes reportedly caused by emission of greenhouse gasses (GHGs) through anthropogenic activities including land-use change, deforestation, biomass burning, draining of wetlands, soil cultivation and fossil fuel combustion. Consequently, the concentration of atmospheric GHGs and their radiative forcing have progressively increased with increase in human population, but especially so since the onset of industrial revolution around 1850 (Lal 2008). There has been a worldwide attempt in management of the same through summits and conferences and various methods have been studied and carried out for reduction of the emission of these gasses.

Carbon sequestration is a process, therefore created and is defined simply as the 'removal of carbon dioxide gas and its storage in a system'. It can also be elaborated as a method to reduce the amount of carbon dioxide in order to reduce global climate change. Carbon sequestration in soils, grasslands and woody perennials, and the transfer of carbon credits through market structures, represent win-win opportunities. Among the alternatives, tree planting offers perhaps the greatest potential. There is also considerable evidence that urban gardens including trees planted in educational institutes and large landscaping projects in developing countries provide substantial benefits to the environment and national economies. (Juwarkar 2011) It can be carried out in various other ways but trees prove to be more beneficial as they are what can be called as the "largest terrestrial sink of carbon dioxide" and are also very beneficial and most importantly a convenient method.

There are five most important systems in this process altogether, namely, Above ground biomass, Below ground biomass, Soil organic matter, wood debris and Litter. In which, The Above ground biomass and Below ground biomass are considered to be more prominent. The partitioning of above- with respect to below-ground plant biomass influences many of the functions performed by diverse terrestrial communities as well as the functions performed by individual plants (Cheng 2007). Biomass refers to all organic matter existing in the biosphere, whether of plant or animal origin, as well as those materials obtained through their natural or artificial transformation. (Ostertagová 2013) Biomass can be further explained as the estimation of plants taking up carbon dioxide in presence of sunlight and storing it in the form of starch in the tissues. Hence, carbon content in these tissues is half their biomass. Therefore, through the course of time, trees go onto sequester carbon dioxide and store it in the form of carbohydrates till its death. Trees absorb carbon dioxide through photosynthesis and release it through respiration; the difference is new biomass. Some of this biomass is dropped to the forest floor as litter. Trees produce food and help stabilize the environment cycle. When the trees die, the carbon dioxide is respectively given back into the atmosphere hence completing the Carbon cycle.

Trees also influence air temperature in urban environments along with adding aesthetic value to it. Trees, through their growth process, act as a sink for atmospheric carbon. Therefore, growing trees in urban areas can be a potential contributor in reducing the concentration of CO2 in the atmosphere by its accumulation in the form of biomass (Baes et al., 1977). In terms of atmospheric carbon reduction, trees in urban areas offer the double benefit of direct carbon storage and stability of natural ecosystem with increased recycling of nutrient along with maintenance of climatic conditions by the biogeochemical processes. (Juwarkar 2011) Therefore, quantification of carbon in the form of tree biomass can help us in understanding the current ongoing situation of carbon concentration in our surroundings and thus help predict potential future status of local and global climatic conditions. The present study tries to identify the species suitable for the urban environment based on their carbon sequestration potential (Sahu 2020). Carbon sequestrated or stored carbon is not emitted into the atmosphere and this will reduce the greenhouse gas effect on the environment and lessen the impact of climate change.

MATERIALS AND METHODS

Geographical Location of the Area, Sampling and Instruments

The urban area selected for the present study is D.G.Ruparel college in Maharashtra, Mumbai, on the western coastal region of India .It is geographically located at 19° 1' 40"N Latitude & 72° 50' 42"E Longitude. It was founded in 1952. The campus is located in Mahim, a suburb of Mumbai known for educational institutes. Since trees are the major component and an efficient prerequisite for this process and D.G. Ruparel College being situated at the heart of Mumbai city, with over 300 trees in record, from which 260 trees of 25 species had been selected to carry out Carbon sequestration and estimate the amount of carbon dioxide that has been given out. The total area of 10 acres was considered for the sampling in year 2022.

The tree species were identified by the name and species tags given to the trees by the college. The app used for mapping the position of the trees in college is Trees GPS System (Tree count).

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Image1- Map showing the aerial view of trees distribution in D.G Ruparel College.

The biological analysis was carried out over three months during monsoon from June to August of the year 2022. The number of trees for individual species were considered on the basis of availability of trees on the college campus. Calculation of annual CO2 sequestration by certain dominant species with the help of girth and height of the tree was done by non-destructive method for carbon estimation, in this method we need not harvest the Entire Biovolume and Sacrifice the Trees (Avadh 2021).

Table 1: Average GBH (m) and Average Height (m) of the trees in college campus during 2022

Sr. No.	Species Name	Local name	Species abbreviation	GBH (average/sp)	HEIGHT (average/sp)
1.	Polyalthia longifolia	Fake Ashoka	P.l	0.899497142	11.18620557
2.	Acacia catechu	Supari	A.c	0.412941304	9.369335664
3.	Cocus nucifera	Coconut	C.n	0.963269047	8.345332462
4.	Roystonea regia	Royal palm	R.r	1.587188235	18.34223458
5.	Peltophorum pterocarpum	Copper pod	P.p	1.918833333	10.78107893
6.	Delonix regia	Gulmohar	D.r	1.663927273	10.81828656
7.	Mangifera indica	Mango	M.i	1.379230769	9.147455441
8.	Casuarina equisetifolia	Suru	C.e	0.699	13.29796951
9.	Artocarpus heterophyllus	Jackfruit	A.h	1.926666667	9.418851626
10.	Ficus religiosa*	Peepal	F.r*	1.777777778	8.666155149
11.	Syzygium cumini	Jambool	S.c	4.11	11.89164634
12.	Azadirachta indica	Neem	A.i	0.815	6.164634146
13.	Alstonia scholaris	Saptaparni	A.s	3.2	12.93823171
14.	Sterculia foetida	Jangali badam	S.f	2.43	14.35481707
15.	Couroupita guianensis	Cannon ball	C.g	1.0236	9.707317073
16.	Cassia fistula	Bahava	C.f	1.1	7.01949187
17.	Caesalpinia pulcherrima	Peacock flower	C.p	1.3	5.530304878
18.	Psidium guajava	Guava	P.g	0.645	2.743902439
19.	Phyllanthus emblica	Amla	P.e	1.88	4.906097561
20.	Ficus racemosa**	Umbar	F.r**	0.95	5.499237805
21.	Millettia pinnata	Karanj	M.p	0.83	6.165121951
22.	Nyctanthes arbor	Parijat	N.a	0.7874	9.403597561
23.	Neolamarckia cadamba	Cadamba	N.c	0.53	5.487987805
24.	Caryota mitis	Fishtail palm	C.m	1.4025	15.96574695
25.	Ficus benghalensis	Banyan	F.b	5.6	22.4219054

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Estimation of Carbon Sequestration potential of trees. There are generally two methods to estimate carbon sequestration in plant biomass (i) direct method- that involves cutting of the trees (ii) Indirect method - that is calculated through the above ground biomass and below ground biomass method without cutting the trees (Sahu 2020).To prevent the degradation of the biomass in our current surrounding the second method is considered more feasible for this study.

Allometric methods were used for estimation, girth at breast height (GBH) of trees was measured using a measuring tape at a height 1.22m from the ground surface. The trees under study was selected based on the their girth at breast height (GBH) to be at least 0.15m.The height of the trees was calculated using Abney Level (an instrument used for the measurement of slopes, taking cross-sections, tracking contours,etc) for which the distance between the tree (whose height was to be found) and the height of the person using the Abney level was noted , further using the Abney level the angle that coincided with the tip of the tree was noted .For detailed description of Abney level instrument, it is highlighted in ("Abney Level", n.d.) ("Using an Abney Level to Measure Relative Heights" 2015)

- Formula for calculating height of the tree = tan theta of observed angle(noted) × horizontal distance (noted)

The above ground biomass (AGB) and below ground biomass (BGB) was calculated by:

- Basal area(m^2)= $(GBH)^2/4\pi$
- Bio-volume (m^3) =Basal area× Height of the tree
- AGB (kg)= Bio-volume × wood density (kg/m^3)
- BGB (kg)= AGB x 0.26

Where, 0.26= Root to shoot ratio

- Total Biomass(TB) in kg/tree= AGB+BGB
- Total Carbon Sequestration (TC) in kg/tree= TB/2

The CO2 equivalent was calculated using formula:

- CO2 equ.= (TC×44)/12

Where, 44 and 12 are the molecular and atomic weight of CO2 and C, respectively

The average carbon sequestration of each of the species was taken which is mentioned in table 2 .The wood density of individual species was obtained from the literature in [1] ("List of Indian timber trees", n.d.),("Wood Density", n.d.) The site for observing wood density was mentioned in (Kale 2022)

Table 2 - ANOVA TEST FOR SPECIES OVER 9 NUMBER OF SAMPLE SIZE (SS- Sum Square, df- degree of freedom, MS-Mean Square, F- ratio of two variance, P value- probability of obtaining F ratio, Fcrit- F critical)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1277322032	8	159665253.9	43.593938	0	1.98124882
Within Groups	794774722.4	217	3662556.325			
Total	2072096754	225				

Analysis of variance (ANOVA) is a statistical procedure concerned with comparing means of several samples. It can be thought of as an extension of the t-test for two independent samples to more than two groups. The purpose is to test for significant differences between class means, and this is done by analyzing the variances. ("Methodology and Application of One-way ANOVA", 2013)

RESULTS AND DISCUSSION

Due to varying size of Girth at breast height (GBH) and height as well as different wood densities of the trees along with the age of the plant, the carbon sequestration potential of the tree varies. The carbon sequestration potential of the tree was found to be higher in older trees and faster in younger trees. The trees not only fix carbon in the environment above the soil surface but it also fixes it below the soil therefore it is important to study both above ground and below ground biomass of the trees ,this study can provide an insight into the ambient air quality of urban areas . The present study was an attempt to assess the growth rate and carbon sequestration potential of trees in an urban area i.e. Mumbai City.

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Table 3: Total Biomass, Carbon Sequestration and average CO2 equivalent per tree

Sr no	Abbreviations	TB (kg/tree) Average (AGB+BGB)	TC (kg/tree) Average	CO^2 equivalent Average
1	P.l	605.1056874	302.5528437	1109.360427
2	A.c	101.1038864	50.55194321	185.3571251
3	C.n	405.1929658	202.5964829	742.8537707
4	R.r	4836.725712	2418.362856	8867.330471
5	P.p	2691.908092	1345.954046	4935.164835
6	D.r	1746.855313	873.4276565	3202.568074
7	M.i	1899.468712	949.734356	3482.359306
8	C.e	677.3140599	338.6570299	1241.742443
9	A.h	1968.496131	984.2480655	3608.909574
10	F.r*	1406.008092	703.0040461	2577.681502
11	S.c	3813.518491	1906.759245	6991.450567
12	A.i	342.4259415	171.2129707	627.7808927
13	A.s	5585.847357	2792.923678	10240.72015
14	S.f	1545.512206	772.756103	2833.439044
15	C.g	685.6617907	342.8308953	1257.046616
16	C.f	725.5823937	362.7911968	1330.234388
17	C.p	984.4779274	492.2389637	1804.8762
18	P.g	97.33923448	48.66961724	178.4552632
19	P.e	1391.62676	695.8133801	2551.315727
20	F.r**	184.2181178	92.10905891	337.733216
21	M.p	272.6834224	136.3417112	499.9196078
22	N.a	514.6932035	257.3466017	943.6042064
23	N.c	65.72562318	32.86281159	120.4969758
24	C.m	7137.060858	3568.530429	13084.61157
25	F.b	50926.02642	25463.01321	93364.38178

Table 1 in this study gives the account of average GBH and height of individual species observed in college campus. Table 3 gives the account of calculated average of total biomass along with average total carbon sequestrated and CO2 equivalent of the different species. From these tables we observe that the species with average highest carbon sequestration rate is *Ficus benghalensis* (93364.38 tons) followed by *Caryota mitis* with average carbon sequestration rate of 13084.61 tons. The lowest average carbon sequestration rate was seen in *Neolamarckia cadamba* (120.49 tons).

The average carbon sequestration potential of trees in D.G.Ruparel college was in the following order: *Ficus benghalensis* (93364.38) > *Caryota mitis* (13084.61) > *Alstonia scholaris* (10240.72) > *Roystonea regia* (8867.33) > *Syzygium cumini* (6991.45) > *Peltophorum pterocarpum* (4935.16) > *Artocarpus heterophyllus* (3608.90) > *Mangifera indica* (3482.35) > *Delonix regia* (3202.56) > *Sterculia foetida* (2833.43) > *Ficus religiosa* (2577.65) > *Phyllanthus emblica* (2551.31) > *Caesalpinia pulcherrima* (1804.87) > *Cassia fistula* (1330.23) > *Couroupita guianensis* (1257.04) > *Casuarina equisetifolia* (1241.74) > *Polyalthia longifolia* (1109.36) > *Nyctanthes arbor* (943.60) > *Cocos nucifera* (742.85) > *Azadirachta indica* (627.78) > *Millettia pinnata* (499.91) > *Ficus racemosa* (337.73) > *Acacia catechu* (185.35) > *Psidium guajava* (178.45) > *Neolamarckia cadamba* (120.49).The bracket values indicate the average carbon-dioxide equivalent absorbed by each tree of that specific species .

The calculated value from ANOVA test was found to be more than that of critical value which proves that different species of trees have different carbon sequestration rates as mentioned above.

When percent increase in carbon sequestration potential of trees was taken into account the young trees were found to sequester carbon at faster rate. This might be attributed to a faster rate of photosynthesis activity in the young trees so as to gather the required energy, enhance their chances of survival and acclimatize in the surrounding environment (Sahu 2020).

Some species of the plants have more carbon sequestration rate than others therefore species with higher CO2 sequestration rate can be strategically planted in urban cities. Awareness can be spread to encourage young minds and other colleges to take a step towards green energy.

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CONCLUSION

The study was done to calculate carbon sequestration potential of trees in the campus. Based on the carbon cycle, after a certain period of time, when the trees die the carbon is given back into the atmosphere hence completing the cycle. But since there is an extreme increase in pollution and deforestation the trees lose their ability to absorb gasses like carbon efficiently. Therefore the atmospheric gasses remain intact leading up to consistent manners of pollution and climate change. To overcome that, the result of the study suggests, with an increase in the GBH and height of the tree, the carbon sequestration rate of trees increases, therefore in urban cities plants like *Ficus benghalensis* (bigger GBH and higher heights) can be planted for higher absorption of carbon.

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DRONES: A STEP TOWARDS MODERN AGRICULTURE

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ABSTRACT
Today, with population growth need for food security is rising, agriculture has become the most coveted occupation, but in reality, majority of people are opting for jobs from service sector due to better income prospects. Climate change has adversely affected the crops and one of the ways through which the agricultural sector can grow is through technological advancements. Climate change also alters plant physiology, making them less resistant to pathogens. When these pathogens infect staple crops and commercial crops, any delay in detection of pathogens can lead to risk of food and economic security. Early detection of plant pathogens can save the crops from getting spoilt and guarantees food security. Drones which are unscrewed aerial vehicles can be used to detect these pathogens. Using image capturing drones in agriculture can help in tackling the plant pathogens through early detection which will help in providing timely treatment to the plants. As we need development and sustainability to coexist, plants play an important role in this coexistence. Plants found in habitats which are difficult to observe, example: mangroves. Manually, collecting information is time consuming and requires manpower and resources. Here, drones with imaging technology are helpful in reaching such remote places and can provide information for studies. Data was collected through a online survey wherein farmers were asked a set of predetermined questions. Our findings based on the survey we conducted indicate that the uses of drones are an effective way to deal with plant pathogens and monitoring.

Keywords: Drones, Climate change, Agriculture, Early Detection.

INTRODUCTION
During the Paleolithic era, human existence remained mostly vulnerable , revolving around daily survival and the very basic existential issue of having enough food daily to remain alive, life was nomadic which changed about 10 millennia back, when the milestone point of Neolithic Revolution entered and this is what marked the beginning of agriculture, the activity of nurturing farms, which has been a key event that changed the human race from nomadic hunter-gatherer to being a part of a sedentary permanent settlement. The onset of this period is conjectured to be an outcome of an important climate change. It began with the end of the last great ice age that the inclement weather became more bearable, permitting the idea of annual crops and then eventually, seasonal crops. Agriculture is one of the pillars of human settlements and survival. It contributes to 16% of India's GDP out of the total and 10% of the total exports.

In today's time with the growing human population the need for food security is rising and that calls for agriculture to be the most anticipated occupation; but the reality is different and more and more people from the upcoming generations are opting for jobs and professions related to the service sector due to the better lifestyle and higher income. This brings us to the fact that the manpower is becoming lesser day by day in the agricultural sector. Agricultural sector is one of the most important sectors as it provides us with economic and food security to some extent. Climate change has affected all of us in some or the other ways and in that scenario, plants are no different. The crops are suffering due to climate change and becoming less resistant to many pathogens attacking them which results in crop failures multiple times. Frequent crop failures due to pathogen attacks can affect both economic and food security and one of the ways in which the agricultural sector can benefit is through technological advancements. One such technological advancement can be drones. Our approach talks about the use of image capturing drones as an early detection tool for the detection of various plant pathogens and also for the analysis of plants which are found in habitats that are difficult to reach.

CLIMATE CHANGE AND PLANT PATHOGENS
Climate change has resulted in heavier summers and milder winters which has brought significant changes in the physiology of plants. Changes in physiology also alters their resistance against the pathogens. In a lot of plants their resistance decreases. Also, these pathogens survive better and become more active at certain temperatures. With considerably more active pathogens and lesser resistance the chances of crop failures are more. Climate change is also causing emergence of pathogens on new plants as well. These pathogens proliferate at a very fast rate and with globalization and trade they easily get spread from one geographical location to the other.

When such pathogens infest staple crops like wheat, rice, potato, etc., they can affect our food security. Also, when they infest economically important crops like sugarcane, cotton, maize, etc., it can affect our economic security. Hence, timely detection of the presence of pathogens and their treatment is a way through which crop failures can be reduced.

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DRONES IN AGRICULTURE

A drone, an Unmanned Aerial Vehicle (UAV) which makes it an aircraft without any human pilot, crew, or passengers on board. UAVs are a component of an unmanned aircraft system (UAS), which includes adding a ground-based controller and a system of communications with the UAV. The flight of UAVs may operate under remote control by a human operator, as remotely-piloted aircraft (RPA), or with various degrees of autonomy, such as autopilot assistance, up to fully autonomous aircraft that have no provision for human intervention.

Drones were originally developed through the twentieth century for military missions and were considered too dull, dirty or dangerous for humans, and by the twenty-first century they have become essential assets to most militaries. As control technologies improved and costs fell, their use expanded to many non-military applications. These include forest fire monitoring, aerial photography, product deliveries, agriculture, policing and surveillance, infrastructure inspections, entertainment, science, smuggling, and drone racing.

In recent times, the agricultural sector has undergone a lot of changes with respect to the tools and technologies used for farming. Also, the traditional methods of farming are being brought back and the drawbacks of those techniques are being minimized using certain modernizations through technology. Drones or UAVs are also becoming an effective tool being used in agriculture for various purposes like spraying treatments, irrigation, livestock management, etc. (Kalamkar.R,2021)

DRONES AS AN EARLY DETECTION TOOL FOR PLANT PATHOGENS

Drone technology can also be used as an early detection tool for plant pathogens. The use of specific type of drones which have attached cameras and can capture high quality images can provide us with real time analysis of the entire cropland and the pathogens present on plants can be detected through these images. Reaching some crops like tea and coffee which grow at higher elevations is challenging and manually checking these plants for the presence of pathogens is a quite tedious and time-consuming task. Here, drones can prove to be a game changer. Further, these images can be analyzed using Data Learning (DL) based technologies for finding out the type of pathogen present and the extent of damage that has been caused by the pathogens. These DL technologies also suggest treatments to tackle the identified pathogens (Masood.M,2020) With on time detection through drones, crop failures due to pathogens can be avoided.

DRONES FOR MONITORING PLANTS FROM SECLUDED HABITATS

Drones can also be used for reaching plants in secluded habitats, example : mangroves. Mangroves grow in places with limited access and due to various anthropogenic activities like coastal development, wood harvesting, pollution; one out of six species of mangroves in the world are under the threat of extinction. Considering the importance of mangroves for a healthy ecosystem, various rehabilitation strategies for mangrove forests are being implemented. When doing so, monitoring these sites happens to be an important part of the strategy. Here, UAVs can be used to monitor the sites. This can save a lot of time and other resources and also provide real time and accurate results consistently.

METHODOLOGY

Data was collected through an online survey. The target population for this survey were farmers. Farmers from various states of India participated in this survey. A set of predetermined questions were asked. The questions were formulated with an objective of knowing their opinion on early detection and also collecting basic information like the total land area of their farm, the crops they grow, the frequency of pathogen encounters on their croplands, etc.

ANALYSIS

A. "Frequency of pathogens seen on croplands".

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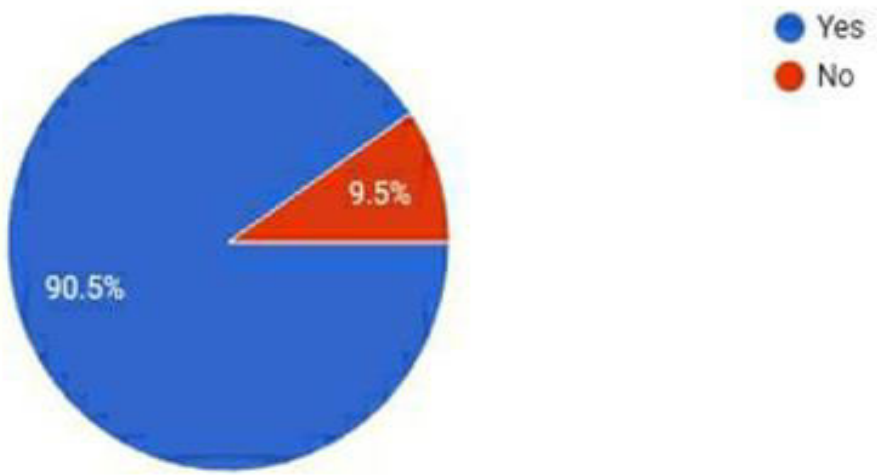
Graph A shows the frequency of the plant pathogens seen by the farmers on their field. Here, 61.9% agreed to encountering pathogens once every year and 33.3% agreed to encountering pathogens more than once a year which somewhere proves how active pathogens are, and how frequently they are present on fields. With this, we can gauge how damaging they can be**.**



B. "Opinion of farmers on early detection of pathogens"

Graph B represents the opinion of farmers on whether early detection through drones can save the crops or not. A whopping 90.5% responded positively which suggests that majority of the surveyed farmers agree with our objective of the research which advocates the use of drones for early detection of plant pathogens.

CHALLENGES IN USING DRONES

- Registration of unmanned aircraft system on the digital sky platform is mandatory for using drones under Drone rules, 2021(The Drones rule,2021)
- In certain areas, like places near the borders and in the perimeter of airports and other airspaces the use of drones is not allowed due to security and safety reasons.
- The initial cost of drones is very high.
- As they fly above the ground, they can cause accidents if they lose control and can also possibly injure birds which fly around the croplands.

However, these challenges can be subjugated by carrying out certain re-evaluations in policies (Beriya. A, 2022) and developments in technical aspects then, drones can be used more effectively for agriculture.

ADVANTAGES OF USING DRONES

- Saves a lot of manpower and time.
- Effective in reaching remote places which are usually hard to reach for humans.
- Can cover long distances in less time.
- Easy to develop and manage.

CONCLUSION

Agriculture is one of the major occupations of our country. It largely supports our economy and provides us with food security. Irrespective of the era we live in, agriculture will be something we will always need to survive as the human race. It will always be our need to have food security, nutritional crops and affordable produce. These factors make agriculture the cornerstone of sustainability. So, considering the importance of agriculture for our survival it needs to be our priority.

Due to climate change, which is also a result of various anthropogenic activities, or humans trying to dominate nature, agricultural sector is suffering. If timely measures aren't taken, we might have to return back to being a hunter gatherer which is from were we started.

Drones won't be able to solve all the problems at once, but every step counts right now and this Techno-centric approach is one step towards combating one of the effects of the massive climate change problem that we are dealing with. The need of the hour is to get more out of less, be it man power, or natural resources; and drones can help us in achieving this need.

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POLITICAL ECONOMY OF TRIBAL LAND ACQUISITION IN INDIA

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ABSTRACT
Land ownership confers tangible benefits such as shelter and livelihood as well as intangible benefits such as security and a standing in society. Land owners are thus often reluctant to part with their land unless mutually acceptable terms for compensation are agreed upon. Problems arise when land is required for "Public purpose" and the state can invoke laws that allow for compulsory acquisition through "eminent domain". Land acquisition for generating public goods such as infrastructure projects has remained an important policy concern in India. Land is a fixed resource and redistributing it among different groups through the market might result in second best allocations. In this research researcher has worked on the objectives such as to study the Tribal Land Acquisition process in India, to study a role of Government in tribal land acquisition in India and to study Rehabilitation and resettlement policies of Government of India for displaced people. This study is purely based on doctrinal and qualitative approach for thorough analysis of existing data through studies, research papers, websites and observation of focus groups. For this research empirical review of literature been done and on the basis of that gap of research found for the research. Researcher has stated that to continue with high growth rate, it is an urgent need to address this land acquisition issue especially displacement and compensation. There should be justifiable compensation for land. Social land audit committee is essential to set up. The principle of land for land should be focused on compensation policies, especially for the tribal area. It should be mentioned that it is not only the land owner who actually suffers loss because of the land acquisition, but there are many other landless people who lose their means of livelihood, attached to the land which is acquired. Land price can be determined on the basis of opportunity cost which is ignored in the market system. Compensation based on the market mechanism is insufficient to satisfy all the heterogeneous land owners having different preferences based on their occupations and skills while acquiring land from them.

Keywords: Land Acquisition, Displacement, Livelihood, Eminent Domain, Compensation policy, Land Price, Rehabilitation and resettlement.

INTRODUCTION
Land is the most significant natural resource upon which almost all human activities are based since ancient time. Land is an asset that has significant value for the households as a regular source of livelihood, security for future and social status. Land continues to have enormous social, economic and symbolic relevance particularly in case of India where affiliation with land is not only source of livelihood and same time emotional one too. Access to land, ownership of land its documentation are issues essential to the livelihoods of the population of India, particularly in the rural and tribal areas (Levien, 2012). Land acquisition refers to the process by which the government forcibly acquires private land for a public purpose with or without consent of the owner of the land, which could be different from a market price of the land. Land acquisition for generating public goods such as infrastructure projects has remained an important policy concern in India. Land is a fixed resource and redistributing it among different groups through the market might result in second best allocations. This implies that one group, the buyer or the seller, might be worse-off after the transaction occurs.

It is evident that the entire mechanism of land acquisition, development and transfer to corporates involves profit for rich without the primary land owners gaining anything in process. It has been observed that the issue is not about the magnitude of land acquisition but rather about undiscriminating practice of power by the state and it is becoming a party to accumulation of profit.

IMPORTANCE OF THE STUDY
Land is a real estate and is considered to be the main component of wealth Even today, most of the population in rural areas is dependent on agriculture, and forests and land is the main source of livelihood of the Tribal, But when the government acquires tribal land, no proper compensation is paid and some generations have far-reaching consequences.

RESEARCH QUESTIONS
1. What is the Socio-economic condition of the Tribal after the land acquisition in India?
2. How land acquisition impacts on Tribal and what are the changes in the social and economic condition of Tribal?
3. Did fair compensation given for affected Tribal by government?
4. Are there any changes in the livelihood of Tribal?

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OBJECTIVES OF THE STUDY

1. To study the Tribal Land Acquisition process in India.
2. To study a role of Government in tribal land acquisition in India.
3. To study Rehabilitation and resettlement policies of Government of India for displaced people.

RESEARCH METHODOLOGY

This study is purely based on doctrinal and qualitative approach for thorough analysis of existing data through studies, research papers, websites and observation of focus groups.

LITERATURE REVIEW

Singh, S., (2018) Land is a non-expandable factor of production. This very finiteness tends to cause competition for this scarce resource between various economic activities. In capitalist societies, the industrial and service sectors, dominated by the bourgeoisie and supported by the state's right of eminent domain, adopt land usurpation and acquisition by hyper commercialisation and commodification of land. The land acquisition process in India has come under close scrutiny within the overall context of economic growth and transformation from an agrarian economy to an industrial economy. Land acquisition with regard to resource based project becomes more complex as these resources are geographically located and projects becomes region specific.

Das S, (2011) Researcher argued that while public authorities charged with the responsibility of forcibly displacing people cannot eliminate human suffering, they are ethically and legally obligated to act with integrity, to ensure that displaced people are informed of and accorded their rights and receive requisite resettlement and rehabilitation without harassment and without being subjected to extortion and violence. Research finds that the human rights failures in the Kalinga Nagar industrial complex raise fundamental questions about the nature and structure of corporate sponsored and large-scale development, and within it, the viability of industrialization. Research also finds that the deliberate abandonment of the rights of the project affected people and their mistreatment on the part of the Government of Orissa, central and corporate authorities have gratuitously escalated people's experience of dispossession and disenfranchisement in conjunction with the construction of the industrial project. Further, he also found that the failure of state and corporate authorities to ethically carry out their responsibilities and uphold the rights of the project affected in the Kalinga Nagar evidenced the breakdown of governance with affiliated and far-reaching consequences.

Nandal V, (2017) in this research researcher observed that the land acquisition process is too long. It consumes nearly one or two year. So, the process of land acquisition should be short in the cases studied, whether land acquiring agency is state or any private company. Farmer's consent plays a vital role in the land acquisition process. While acquiring agriculture land the farmers should be given full opportunity to find out whether they want to sell their agriculture land or not. Their free consent must be there. This is the principle nature of justice. Agriculture land is acquired on the name of 'public purpose'. So, it is very important that before acquiring the agricultural land this public purpose should be clear to the affected people. The practice of providing compensation only to landholders, ignoring the landless labour or sharecroppers who depended on that land has left the agricultural Labours at crossroads. It may be suggested that the land acquiring agency should provide proper skill development training to the affected landless labour who attached with the acquiring land. The government or private company should provide them some kind of employment so that they earn their livelihood and can look after their families too.

RESEARCH GAP / STATEMENT OF THE PROBLEM:

Land acquisition by the government(s) can adversely affect the economic, social and cultural life of tribal' Land is the only source of livelihood of the tribal. Their economic and social status depends on the land they own, so land is a matter of their communion. Whenever the government acquires land tribal are often affected, and compensation given by government is always in monetary terms not in physical asset this is also being important issue to be solved. On the basis of the above literature that there is the scope to understand and extend study on the following aspects, the impact of land acquisition on changes in the socio-economic condition of the Tribal, Intergenerational occupational mobility, changes in the livelihood and role of government policies respect to land acquisition and rehabilitation policies or the Tribal.

GENESIS AND RELATED CONCEPTS OF LAND ACQUISITION

Land has been the biggest single source of conflicts among humans, even though it is not a product created by him, rather a produce of geologic and geomorphic processes. Land being the primary producer of food and one of the most important assets, the principles of ownership and usufruct rights has drawn attention of thinkers in all ages. Aristotle in early Greek civilization documented rules on ownership and management of land. In the

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Egyptian and Sumerian history or the Inka civilization, land related principles abound. However, the guidelines differ. The situation today, however, is no different. However, there is a broad unanimity in following the policies and processes related to land acquisition. The guidelines of the legal treatise of De Jure Belli et Pacis, written by the Dutch jurist Hugo Grotius in 1625, used the term dominium eminence (Latin for supreme lordship). This is being followed not only by USA, UK and others with free economies but also by the single party ruled countries like China or Vietnam. He has upheld the authority of the State to infringe upon the property of subjects on all occasions, where ever the public good was involved.

LAND ACQUISITION IN INDIA

Based on the Agriculture Census 2015-16, conducted by Department of Agriculture, Cooperation & Farmers Welfare reveals that the total number of holdings in respect of all sizes is 146,454 thousand. Among them 12,669 thousand (8.7 %) belongs to Scheduled Tribes. Percentage of area operated to total area is highest for Marginal category (24.03%) for all social groups, Semi-medium category (26.72%) for Scheduled Tribes. Average operated area per holdings is highest for large category (17.07% for all, 15.11% for ST) and lowest for marginal category (0.38% for all, 0.48% for ST).

FINDINGS

- India faces serious challenges in creating development processes that generate economic growth while being socially inclusive, ecologically sustainable, politically feasible, and in accordance with rule of law. Efficient and equitable acquisition of land by the state for development projects, including infrastructure and industry, lies at the heart of these challenges.
- Displacement of the STs from their land dose not only make them economically vulnerable, but it also threatens to destroy their cultural identity as a tribal group
- Public authorities charged with the responsibility of forcibly displacing people cannot eliminate human suffering, they are ethically and legally obligated to act with integrity, to ensure that displaced people are informed of and accorded their rights and receive requisite resettlement and rehabilitation without harassment and without being subjected to extortion and violence
- Public authorities charged with the responsibility of forcibly displacing people cannot eliminate human suffering, they are ethically and legally obligated to act with integrity, to ensure that displaced people are informed of and accorded their rights and receive requisite resettlement and rehabilitation without harassment and without being subjected to extortion and violence
- While acquiring agriculture land the farmers should be given full opportunity to find out whether they want to sell their agriculture land or not. Their free consent must be there. This is the principle nature of justice.
- Agriculture land is acquired on the name of 'public purpose'. So, it is very important that before acquiring the agricultural land this public purpose should be clear to the affected people
- There is a protection for tribal land as non-tribal cannot purchase tribal land, but no protection on state land acquisition of tribal land

CONCLUSION

To continue with high growth rate, it is an urgent need to address this land acquisition issue especially displacement and compensation. What are the alternative possible policies for land acquisition and compensation related to development project? There is a need to redefine the compensation mechanism; otherwise, economic development becomes unsustainable depriving and-losers. There should be justifiable compensation for land. Social land audit committee is essential to set up. The principle of land for land should be focused on compensation policies, especially for the tribal area. It should be mentioned that it is not only the land owner who actually suffers loss because of the land acquisition, but there are many other landless people who lose their means of livelihood, attached to the land which is acquired. Land price can be determined on the basis of opportunity cost which is ignored in the market system. Compensation based on the market mechanism is insufficient to satisfy all the heterogeneous land owners having different preferences based on their occupations and skills while acquiring land from them.

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FOOT NOTES

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MICRO FORESTS: A HINDRANCE FOR GROWTH OF INDIAN NATIVE SPECIES

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ABSTRACT
The Earth's green cover continues to shrink as global warming and climate change become more imminent; it is necessary to be conscious of the fragile ecosystem we live in. Indian organisations are adopting the Miyawaki Method of Afforestation, which is to grow dense urban forests on small patches of land. The main aspect of the study is to check the feasibility of Miyawaki method for which surveys were conducted at sites; Colaba Woods Garden and CRWC in Mumbai, which revealed that the trees grown under inadequate space, grow up straight without natural maturation and cannot produce natural canopies. The trees are unable to play ecological services due to stress and competition. This violates the fundamental code of restoring the natural ecosystem to its original state.

Keywords: Miyawaki Method, Afforestation, Native species and Urban forests.

INTRODUCTION
Global climatic changes, together with recent rapid urbanisation and industrialization, have been the main anthropogenic effects worldwide in destroying natural environments and increasing risk of desertification. In the last two decades, scientists all around the world have gained fresh insights into both theoretical and practical approaches to natural ecosystem restoration and reconstruction. The Miyawaki Afforestation method pioneered by Japanese botanist Akira Miyawaki is a unique way to create an urban forest within a short span of 20-30 years.The method involves plantation of 2-7 native plant saplings, per square metre. This amplifies the process of establishing a mature forest in 20 years which is 30 times denser and becomes maintenance-free after the first 3 years. These forests help lower temperatures in concrete heat islands, create carbon sinks, reduce air and noise pollution as well as attract local birds and insects.

A conventional forest takes around 600-1000 years to grow naturally whereas in the case of urban forests its growth is rapid for the first two to three years, but over time the competition for light and water between the trees begins. Trees that do not have access to sunlight are stunted and after 5-6 years its survival is threatened. Trees such as Banyan, Peepal, Mango, Jamun, etc that have high canopy reduce the intensity of sunlight reaching the ground which restricts the growth of surrounding trees planted close to each other making it difficult for them to synthesise food for themselves. Although these forests do bring back greenery to congested cities, it is not an alternative to natural forests.

RESEARCH METHODOLOGY
Data collection was done by carrying out site visits to places where trees were planted using Miyawaki Technique, for which Colaba Woods Garden in Colaba and CRWC in Jogeshwari were selected. These two sites were selected taking into consideration the year of plantation and the growth which took place in those years. During the site visit, the people in charge of the project were asked a set of predetermined questions for instance - No. of trees planted, list of saplings planted, area covered by this method and the maintenance period. For documentation, photographs were taken to authenticate our observations. The information about sites chosen is as follows: -

Site 1:- Colaba Woods Garden (Forest Creators)
Address: - T.L, Sadhu Vaswani Marg, Mumbai - 400005

This land at Colaba Woods's garden has been afforested in the year 2019 and it is still under maintenance.

Site 2:- CRWC Limited (Green Yatra)
Address:- Central Railside Warehouse Company(CRWC), Jogeshwari East, Mumbai - 400063

This project started in the year 2019 which is now maintenance-free.

RESULTS AND DISCUSSION

Table A

Site	Area covered	No. of trees planted	Year of plantation
Colaba Woods Garden	1250 sq.m	8000	7 Sep, 2019
CRWC	2000 sq.m	7000	1 Feb, 2019

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In table A, the area covered, number of trees planted and the year of plantation has been mentioned, which highlights that a large number of trees have been planted in a small area. The study revealed that the trees in the forests are planted closely without considering the space the tree might need to grow to its maximum size in near future. For example, Indian native species like Teak, Jamun, Ashoka were planted not even a metre away from one another which totally contradicts the idea of a forest wherein trees are allowed to grow freely and expand their branches and roots around. It was observed that the trees were selected without proper research and consideration of how big the tree would turn out to be and there is a necessity to carry out detailed field surveys in case potential native vegetation is unknown. The small trees growing under trees with huge canopies showed less growth as their source of natural light and nutrients from the soil were obstructed by the bigger trees. As claimed by the technique, the biodiversity would be restored, but no local birds or other fauna could be seen at the site.

CONCLUSION

A forest is not only restricted to trees but also includes vines, tuberous plants and shrubs. It violates the fundamental code of restoring the natural ecosystem to its original state. This technique gives the forest a rather monotonous appearance due to trees being of relatively the same age. The whole concept of this method is to plant native species in a small area which is not feasible in a country like India that has species which grow up to be big dense trees with big canopies. It is necessary to take the space required for the tree to grow to its full potential with adequate necessities into consideration before selecting a group of saplings to grow in the forest. Accordingly appropriate space needs to be designated to each and every tree that has not been observed in the urban forests in Mumbai. The overall technique is quite expensive as there is a high cost in the initial phase for land preparation, survey and tree saplings which are directly bought and planted in Miyawaki. As the density of saplings to be planted is high, in turn the cost of plants becomes high. So, although it is affordable when planting trees in a small area, it is not the case for planting trees in a large area.

The present studies can serve as a basis for further work focusing on how proper execution can help the Miyawaki forest technique flourish in India. Deep research associated with the appropriate species of trees to be planted, the space between them and how they would be maintained should be carried out before plantation.

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IDENTIFICATION OF WATER CONSERVATION SITES IN KALU WATERSHED FOR SUSTAINABLE GROUNDWATER RESOURCE MANAGEMENT

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ABSTRACT
Groundwater is a precious natural resource which plays a vital role to cater the demand of water supply arising due to inadequate surface water resource. The Kalu watershed comprises of Kalyan, Murbad and Shahapur talukas of Thane district in Maharashtra. Kalu watershed receives enormous amount of rainfall during monsoon, but during the summer seasons, the rivers are mostly dry. Hence identifying sites to conserve the groundwater can help to cope the water scarcity in the dry months. Groundwater management remains a challenging area and hence development and recharge are still to be seen in the holistic phase. However, with the advent of the tools like Remote Sensing and GIS most of the information are retrieved in a holistic manner.

The main objective of this study is to identify water conservation sites in Kalu watershed of Thane district for a sustainable groundwater resource development and management. In the present study, the Survey of India toposheet number 47 E/7, 47 E/10, 47 E/11, 47 E/12 and 47 E/15, the district resource map, LANDSAT 8, and SRTM (DEM) satellite data were processed in ArcGIS to prepare the various thematic layers i.e., Geology, geomorphology, topography, soil, land use/land cover, slope, drainage and drainage density. All these influencing parameters which affects the groundwater development of Kalu watershed were analysed on GIS platform by using weighted overlay technique through Analytical hierarchy Process (AHP). Sub-watershed wise action plan of the area has been developed for Kalu watershed using these thematic layers following the criteria given by NRSA, 1995. Development of water harvesting structures like Check dam, Nala bund, Contour bund etc. are proposed in this paper.

Thus, it is suggested that execution of the proposed sub-watershed wise action plan will help in development and management of groundwater resources of the area. Excavation of the proposed structures at their suitable sites identified at Kalu watershed will enhance the groundwater recharge potential of the area.

Keywords: Conservation site, Groundwater recharge, GIS, Weighted overlay analysis

1. INTRODUCTION
Watershed management is an integration of technology within the natural boundaries of a drainage basin for optimum development of land, water, and plant resources to meet the basic needs of the people in a sustained manner. Groundwater being the main source of water especially during non-monsoon months, its development and exploitation has to be properly managed in a watershed. In order to advocate appropriate strategies to recharge groundwater the spatial distribution of aquifer system and study of aquifer parameters in spatial domain is significant. (Aarti Kelkar- Khambete, 2015)

Though large parts of Maharashtra lie in the rain-shadow region of the Western Ghats, Thane district receives enormous amount of rainfall during monsoon season. Maharashtra is a relatively better off state in the country in terms of rainfall, but it may soon become a state facing increasing water crisis with perennial water shortages, if urgent measures are not undertaken to address quantity and the quality issues related to groundwater. The variability in rainfall, topography and the geology of the region poses a number of limitations in terms of groundwater availability, recharge and storage in the state. (Kelkar, 2015)

The main aim of this study is to identify water conservation sites in Kalu watershed of Thane district for a sustainable groundwater resource development and management. Some of the objectives of this study are to identifying sites suitable for ground water recharging, enhancing the groundwater storage and to manage and utilize runoff for sustainable purposes (AHP)

2. STUDY AREA
The study area encompasses the Kalu river basins, which is the sub-basin of the Ulhas River in the Thane district. The Kalu River lies between 19°18'8" to 73°11'17" North Latitude to 19°20'68" to 73°30'15" East Longitude (Fig. 1). It flows from east to west. This river after flowing westward in its downstream receives a small river Bhatsa and later meets the Ulhas River near Kalyan, an industrial suburb of Mumbai. The total length of the Kalu River is nearly 110 km. The source of the river is at Tolar Khind near Khireshwar village of Junnar Taluka in Pune District. The annual precipitation in this region is about 2500mm and the post-monsoon

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availability of water is plentiful. However, owing to the higher slopes and scarps of the western limb of the Sahayadris (Western Ghats) flanking the eastern parts of the basin, the surface runoff is quite high. So quite an acute shortage of water in dry months specially in the upper part of the Kalu river basin.

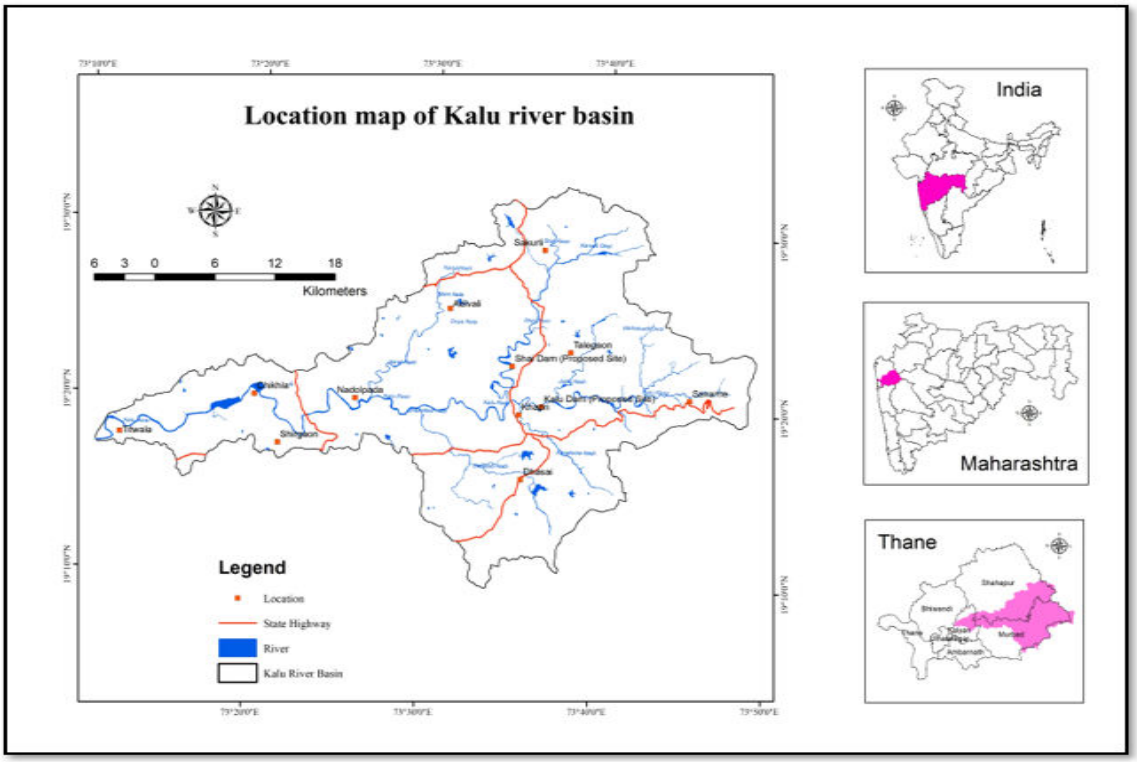

Figure 1: Location map of the study area

3. MATERIALS AND METHODS

The ground water recharge potential has been assessed for quantification of groundwater recharge in study area. Figure 2 portrays the technique implemented and procedures adopted for groundwater recharge potential mapping in the study area. The Survey of India Toposheet no 47 E/3, 47 E/7, 47 E/10, 47E/11, 47 E/12 and 47E/15 on 1: 50000 scale has been used. The Shuttle Radar Topography Mission (SRTM Arcnovoid) DEM of 30 meters spatial resolution data and LANDSAT-8 of 30 meters spatial resolution data of the year 2019 have been used in the present study. The rainfall data was obtained from the Scarcity report of Ground Water Surveys and Development Agency. Whereas, circle wise rainfall data was acquired from the Rainfall Recording and Analysis, Department of Agriculture Maharashtra State. The District Resource map was acquired from the Geology Survey of India for understanding the Geology and lithology of the study area.

Watershed wise action plan of the area has been developed for Kalu watershed using these thematic layers following the criteria given by NRSA, 1995. Multi-criteria decision analysis (MCDA) method such as Analytic Hierarchy Process (AHP) is used to delimit the weightage of feature layer to eliminate the biasness in the output map. Based on MCDA analysis, resultant weightage was given to the thematic layer and suitable ranking was allotted to each class of respective theme (Kadam A ,2018). The rank was assigned in the scale of 1–9. The comparisons are made using a scale of absolute judgements that represents, how much more, one element dominates another with respect to a given attribute. Based on that, the availability surplus water for recharge was calculated, which helps in calculating watershed groundwater availability. Further, the developed action plan addresses identification of sites for groundwater recharge, through the anticipated artificial recharge structures.

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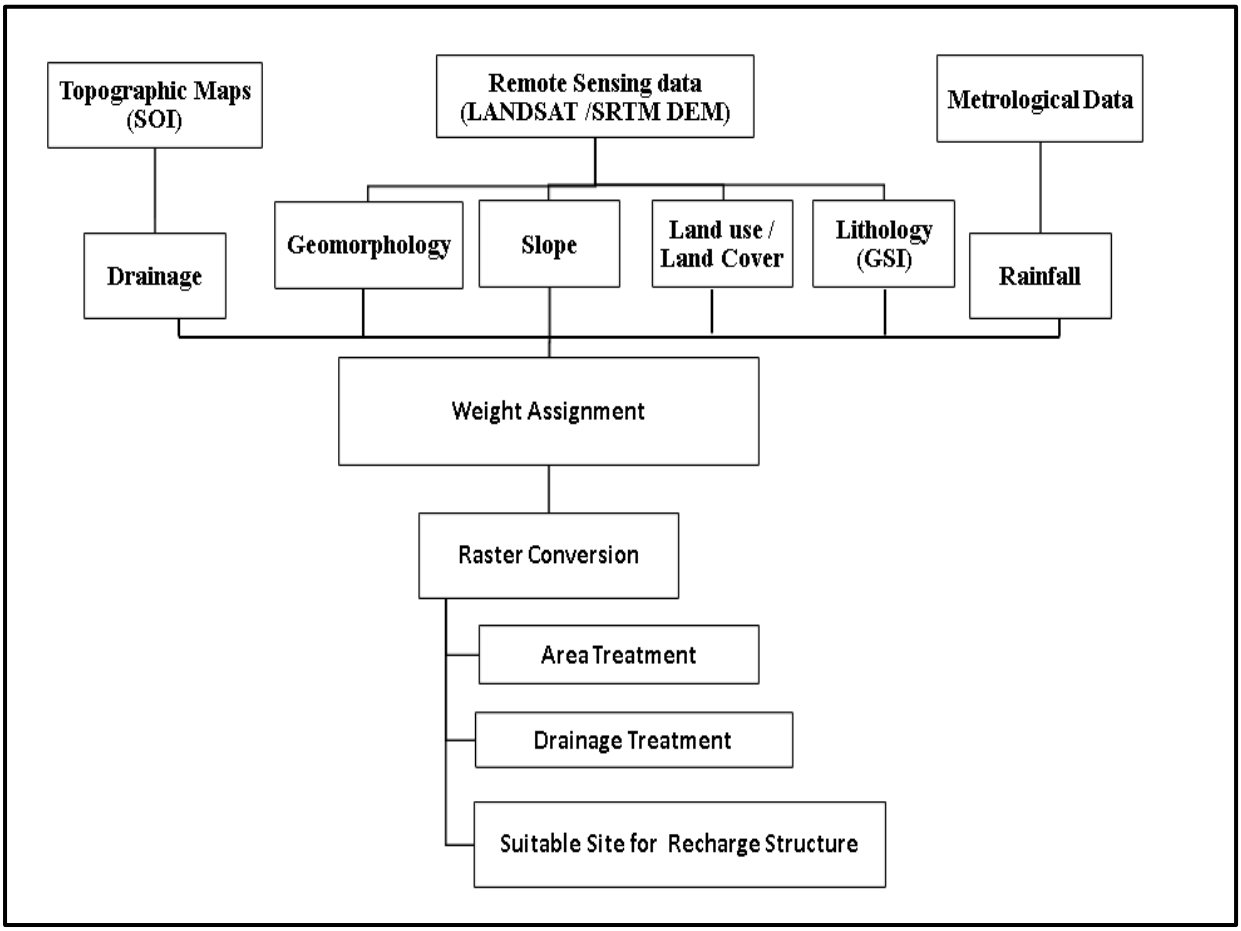

Figure 2: Flow chart of Methodology

3.1 Criterion

A detailed procedure for groundwater resource evaluation of particular area needs the thorough investigation of various thematic layers like lithology, geomorphology, LULC, slope and rainfall so as to identify groundwater potential. In the present study all these thematic maps were prepared and the specifics of the thematic layers prepared from Remote Sensing information and field overview was composed with the groundwater potential outcomes (Mundalik *et al*., 2018; Rahman *et al*., 2012; Rahmati *et al*., 2015).

3.1.1 Lithology

The major lithological units encountered in the study region are basaltic in nature. Basalt is a common extrusive volcanic rock. It is the generic term for solidified volcanic lava. The study region comprises the vesicular basalt, the massive basalt and the mixed basalt (Fig 3). Vesicular basalt units are filled with secondary minerals like calcite, silica, etc. The upper portion of the lava flow are vesicular in nature, which is generally weathered. More than 60 per cent of the study area comprising Shahapur and Murbad talukas comes under vesicular basaltic region. This is also evident with the presence of various dykes, joints and fractures. Hence due to high porosity and permeability, it serves good potential for the recharge of groundwater. Massive basalt unit encircles the ridges of Shahapur and cliff section near Savarne of Murbad taluka. This basaltic structure is fine grained and dark grey-black in colour. They are quite thick and extensive. Here cavities are absent and comprises 35 % of the Kalu watershed. This type of basaltic unit doesn't favor groundwater recharge to that extent. Mixed basalts are found in big pockets near Nadolpada, Adivali and Titwala of Kalyan taluka. They are filled with secondary minerals like calcite, silica, etc. It occupies around 5 % of the Kalu watershed.

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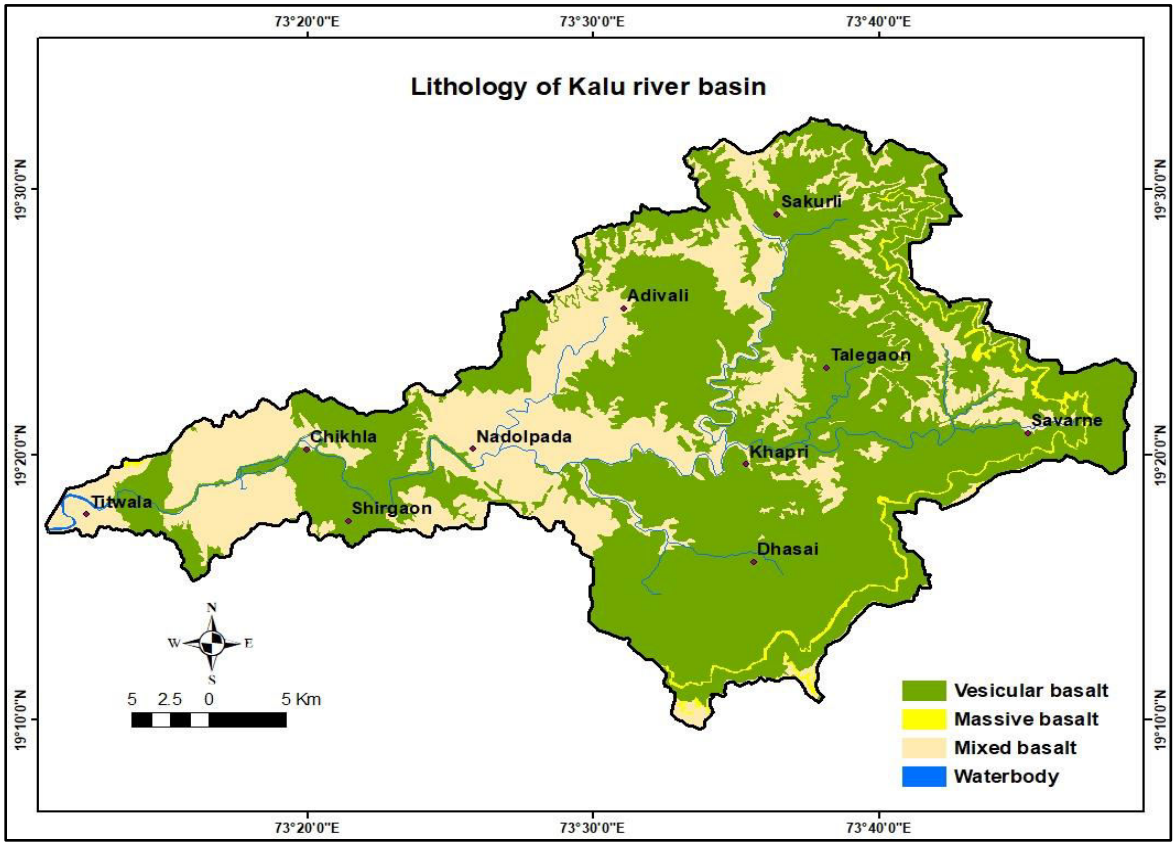

Figure 3: Lithology

3.1.2 Geomorphology

Understanding the geomorphology of an area is one of the most significant features in the evaluation of groundwater potential and managing the watershed.

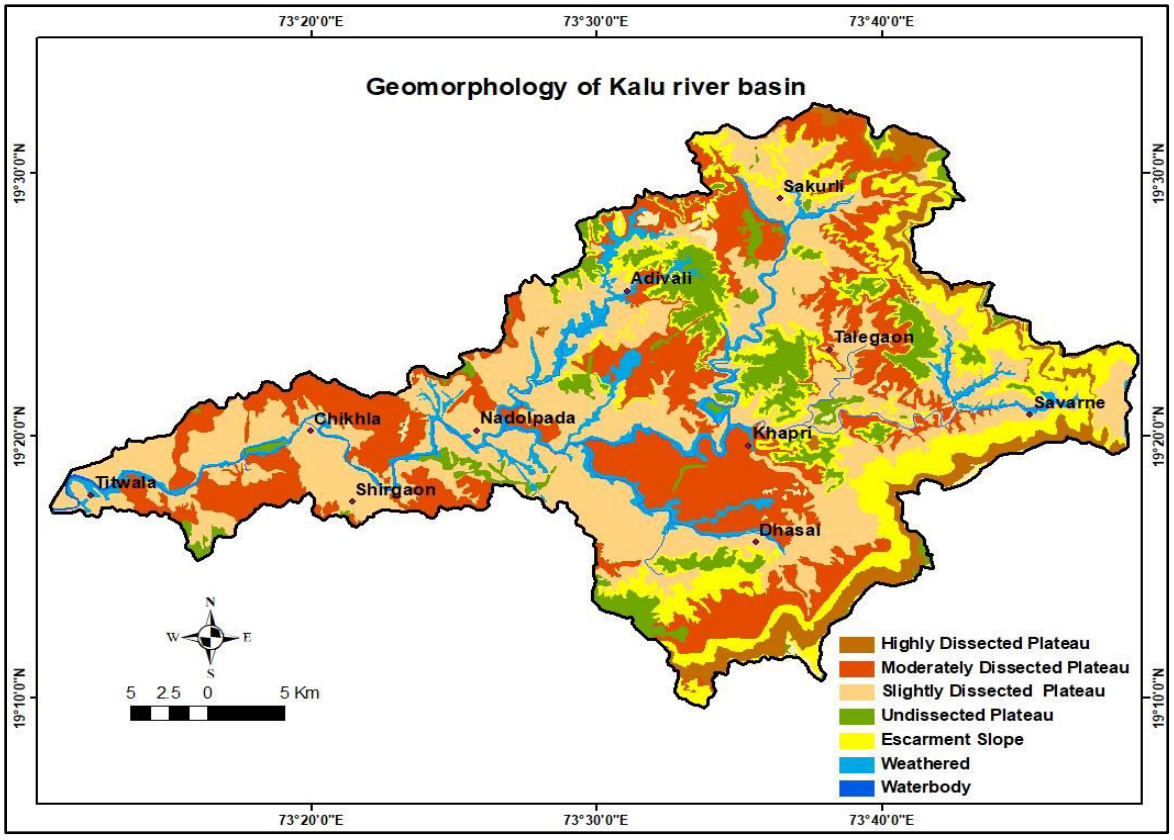

Figure 4: Geomorphology

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The Highly Dissected Plateau is severely eroded due to the sharp relief of Kalu river (Fig 4). Around 60 sq. km of the study area comprises highly dissected plateau. This landscape unit is dominant in the northern and south eastern part of the Kalu river basin. It is dissected by the streams of the Kalu river giving rise to flat topped ridges and steep scarp. Due to its high run off, groundwater infiltration is minimal, hence low weights is been assigned. Moderately Dissected Plateau are moderately fractured and weathered surfaces. It occupies around 300 sq. km of the study area. It serves as good potential for groundwater hence higher weights are assigned comparatively. The Slightly Dissected Plateau are poorly weathered plateaus which occupies the major portion of the Kalu river basin i.e., 406 sq. km. In the Undissected Plateau, the thickness of the weathered material is more and the stream channel in the basaltic terrain is normally lineament control. Undissected plateau occupies 58 sq. km area. Escarpment slope offers a zone of transition between highly dissected and slightly dissected plateau in the north eastern region of the Kalu river basin.

3.1.3 Land use/Land cover:

On the basis of the interpretation of the remote sensing imagery, the study area is been classified into five categories. Out of the total area of Kalu river basin (1134 km^2), around 626.79 km^2 area comprises of agricultural land, 188.98 km^2 area falls under forest, 270.97 km^2 under barren land, 21.91km^2 comprises of water body and 25.85 km^2 occupied by settlement Figure 5 shows that agriculture is the predominant occupation in the study region. Areas under forest are comparatively less than the barren land. Forest, agricultural fields and water bodies are the potentials sites for groundwater recharge, so maximum score is given in the AHP criteria table. Built up areas, barren land and settlements indicates poor potentials sites for groundwater recharge, hence minimum score is given accordingly.

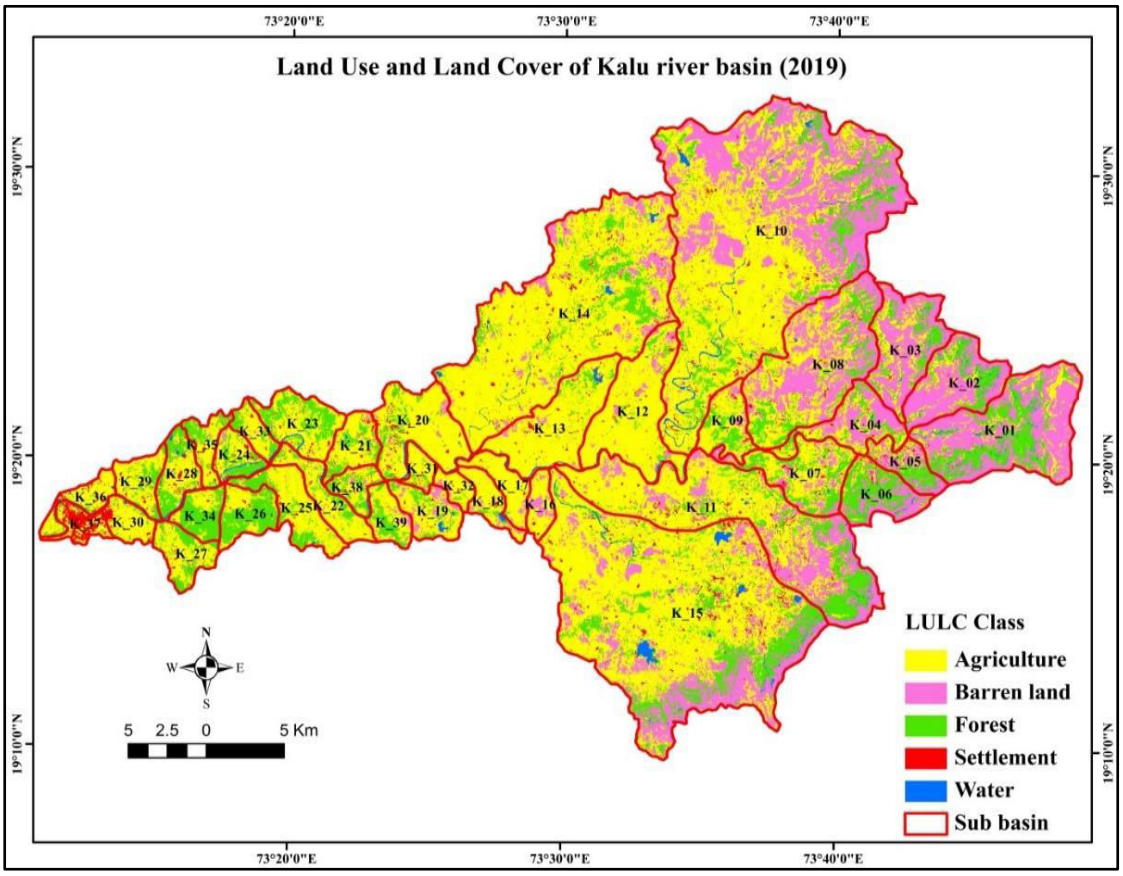

Figure 5: Land use/Land cover

3.1.4 Slope

Slope plays a significant character in determining the surface run-off. Very low and Low surface run-off (< 10 degree) occupies 82.83 % of the Kalu river basin (Fig 6) . Here, the surface run-off is moderate, enabling good opportunity for water to infiltrate into subsurface in gentle slopping area thereby serves as good potential for groundwater recharge. High score is been assigned in the AHP analysis. Whereas, moderate surface run-off (10 -20 degree), high surface run-off (20 - 40 degree) and very high surface run-off (40 > degree) occupies 17.16 % of the Kalu river basin (Table 1). High slopping zone enables high surface run-off permitting less infiltration. Hence not suitable for groundwater storage, so low scores are been assigned in the AHP analysis

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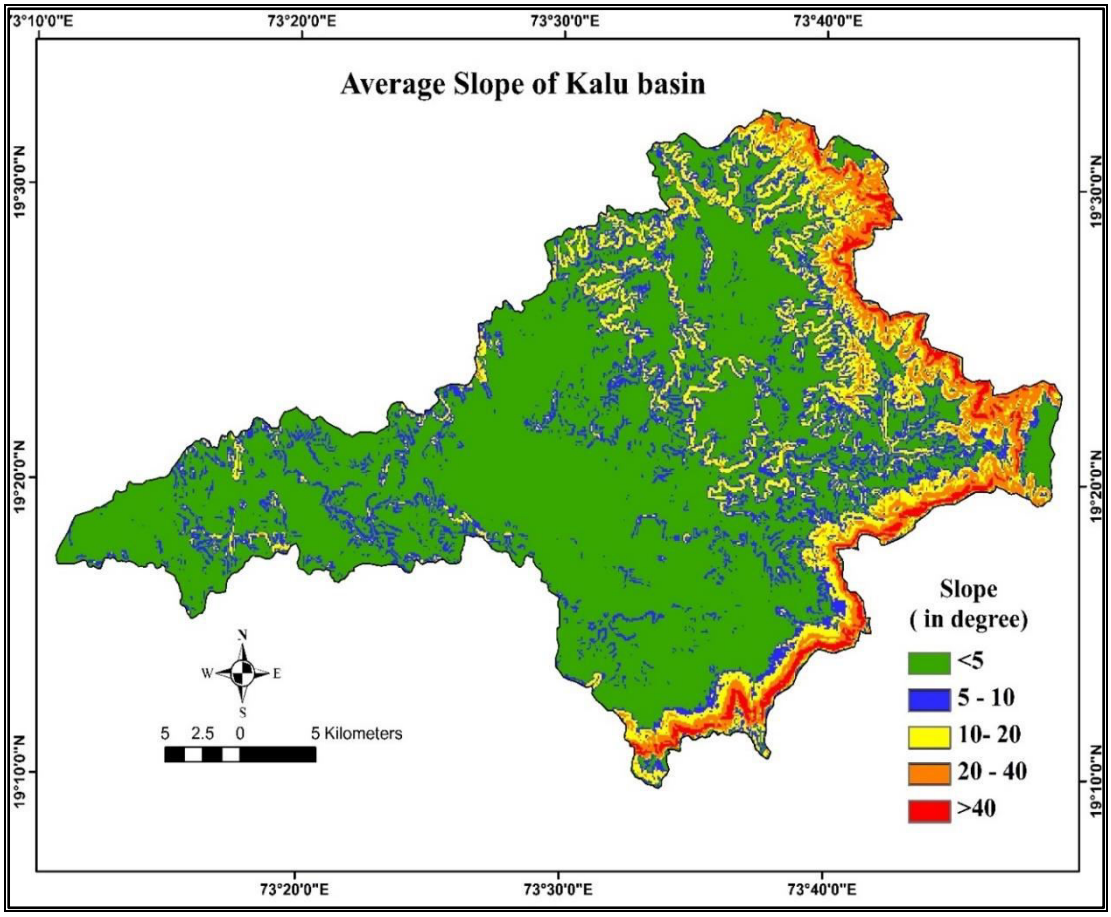

Figure 6: Slopes

Table 1: Distribution of Average Slope and Run-off of Kalu river basin

Sr. No.	Slope (in Degree)	Area		Category of Slopes	Category of Surface Run-off
		Sq. km	Per cent		
1	<5	717.77	63.28	Gentle	Very Low
2	5-10	221.70	19.55	Moderate	Low
3	10-20	112.78	9.94	Moderately steep	Moderate
4	20-40	49.46	4.36	Steep	High
5	>40	32.49	2.86	Very steep	Very High
Total		1134.21	100.00		

3.1.5 Annual Rainfall

Figure 7 represents the circle -wise annual rainfall for the year of 2018 from nine rain gauge stations of the Kalu river basin. Saralagaon of Murbad records the lowest precipitation with1963 mm, and Dolkhamb of Shahapur records the highest precipitation with 2751 mm. The isohyet map gives a vivid idea of the distribution of the Kalu river basin. The disparity in rainfall is the main cause of variation in recharge. The formation of surface water is amongst the most critical parameters of rain water harvesting. The average weight given to the rainfall varies from 1500mm to 2500mm for very low to very high potential of recharge, respectively Accordingly, scores are been given in the AHP analysis.

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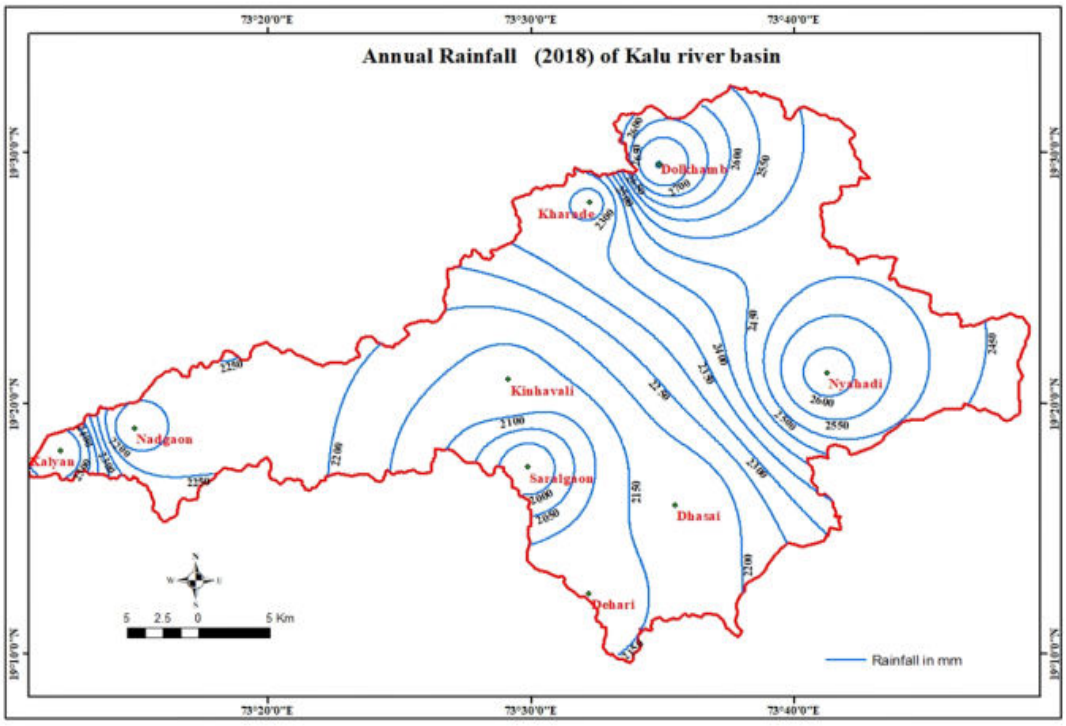

Figure 7: Annual rainfall

3.2. Analytical Hierarchy Process

Analytical Hierarchy Process is a multi-criteria analysis technique, used to define the weightage of thematic layer to remove the biasness in the resultant map. The AHP technique provides the comparative assessment between the parametric layers using pair-wise matrix that is further used for deriving the consistency of the assumption. (Table 2 and 3). The relative importance of parameter within themselves is given by referring the scale of 1–9 digits (Fig 8), where the 1 value is having equal importance for both comparative parameters while the 9 is having extreme important of one parameter over other

Table 2. Criterions: Weights, Influences And Scores

Sr. No	Main Criteria	Weights	Influence %	Sub-Criteria	Score
1	Land use/ Land cover	0.493	49.3	Agricultural land	6
				Forest	7
				Barren land	3
				Water	8
				Settlement	3
2	Lithology	0.31	31	Vesicular basalt	7
				Massive basalt	8
				Mixed basalt	6
4	Geomorphology	0.112	11.2	Highly Dissected Plateau	6
				Moderately Dissected Plateau	6
				Slightly Dissected Plateau	7
				Undissected Plateau	4
				Escarpment Slope	7
				Weathered Plateau	7
5	Slopes (degree)	0.54	5.4	<5	8
				5-10	6
				10-20	5
				20-40	4
				>40	3
6	Precipitation (mm)	0.31	3.1	1500-2000	6
				2000-2500	7
				> 2500	8

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Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
5	Much more important
7	Very much more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values

The ratio scale and definition of AHP (Saaty 1990)

Figure 8: AHP Ratio Scale, Saaty, 2008

The last step in AHP procedure is to find consistency of resultant weight as well as the reliability of assumption. Based on AHP analysis for groundwater recharge zone identification, the Consistency Ratio (CR) value got is 7.8% which is below than 10% so the weightages assigned to themes are accepted (Thomas L. Saaty 2008).

Table no 3: Pair-Wise Comparison Matrix

Criterion	Land use/ Land cover	Lithology	Geomorphology	Slopes (degree)	Precipitation (mm)	% Weights
Land Use / Land cover	1.000	3.000	5.000	7.000	9.000	49.3
Lithology	0.333	1.000	5.000	7.000	8.000	31
Geomorphology	0.200	0.200	1.000	2.000	7.000	11.2
Slopes (degree)	0.143	0.143	0.500	1.000	2.000	5.4
Precipitation (mm)	0.111	0.125	0.143	0.500	1.000	3.1

4. RESULTS AND DISCUSION

The spatial thematic maps including land use/land cover, slope, lithology, geomorphology and rainfall were integrated in the GIS environment as per the criteria listed above for the construction of site suitable for ground water recharge.

4.1 Drainage treatment for water conservation plan for Kalu watershed:

Based on the integrated thematic maps, overlay analysis was carried out in the GIS environment. Drainage treatment map (Fig 9) was prepared by considering different stream orders of the Kalu watershed. Gully plug and loose bolder structure are suggested for the first order stream network. Blocking of gullies by stone or earth check dams or vegetative barriers leads to the deposition of fertile sediments and organic matter which leads to collection of water during heavy rainfall events. In the Loose bolder structure are measures for preventing soil erosion and arresting water. This is been suggested for first order streams. Earthen bund and gabion are suggested for the second order streams. Earthen bunds are the protective bund on the drains having depth less than 1 meter. generally they are quite bigger structure than the gully plug. This engineered structure will help Ground water recharge in Kalu watershed. Check dam and KT Weir are recommended across 2nd and 3rd order streams in moderate slope. It will prevent water from joining higher order stream, instead permit to spread around the lower order stream and recharge the aquifer. Check dams would be constructed in some of the areas to promote growth of vegetation that will consequently lead to the stabilisation of the slope area and prevention of further deepening of gully erosion. Different types of check dams would be required for different conditions comprising different materials depending upon the site conditions and the easy availability of material at local level. Above 4th order stream, recharge sites are not recommended, since there are presence of numerous small dam and tank.

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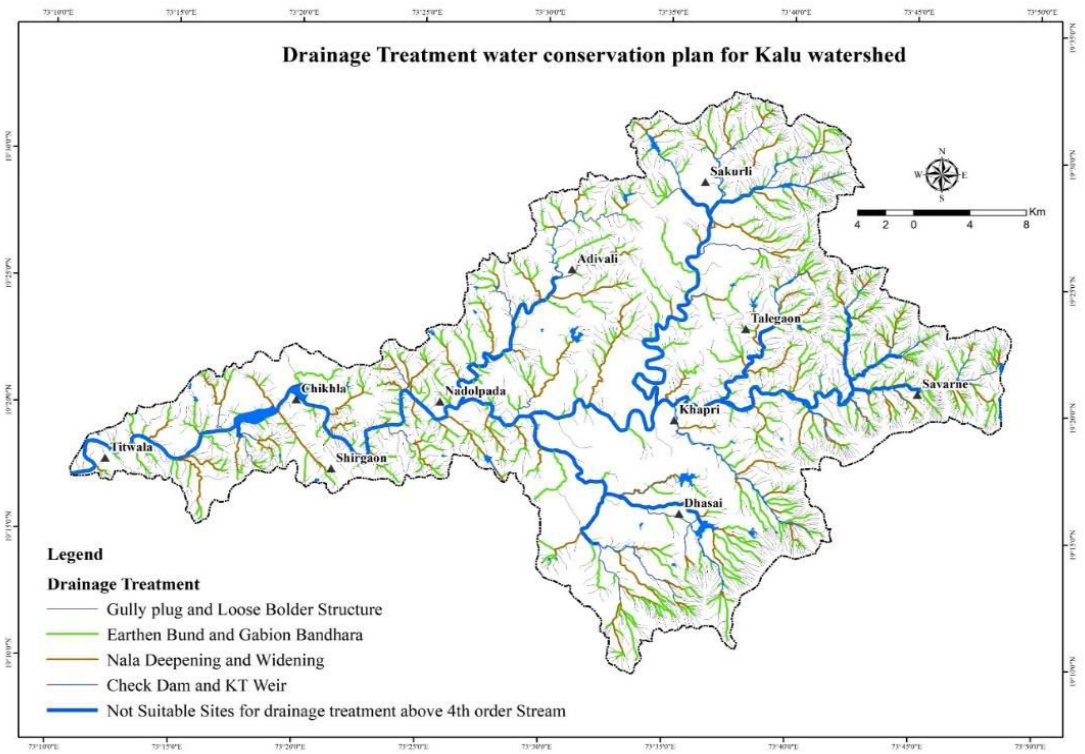

Figure 9: Drainage Treatment conservation plan

4.2 Area treatment for water conservation plan for Kalu watershed:

The catchment area treatment involves the understanding of the erosion characteristics of the terrain and identifying and suggesting remedial measures to reduce the erosion rate for ground water percolation. Water conservation structure like continuous contour trenches, percolation tank, nala bund, check dam and inverted well is been suggested taking into consideration of the slope of Kalu watershed (Fig 10). The Continuous contour trenches and contour bund decreases the speed of the run off thereby helps in soil conservation on slope. Percolation tank, nala bund, check dam and inverted well are recommended in favorable recharge storage zones to ensure more recharge in the non-monsoon period in forest area. Farm pond and compartment bunding are suggested in the plain area where storage of the rain water in the agricultural field can be done by constructing bunds.

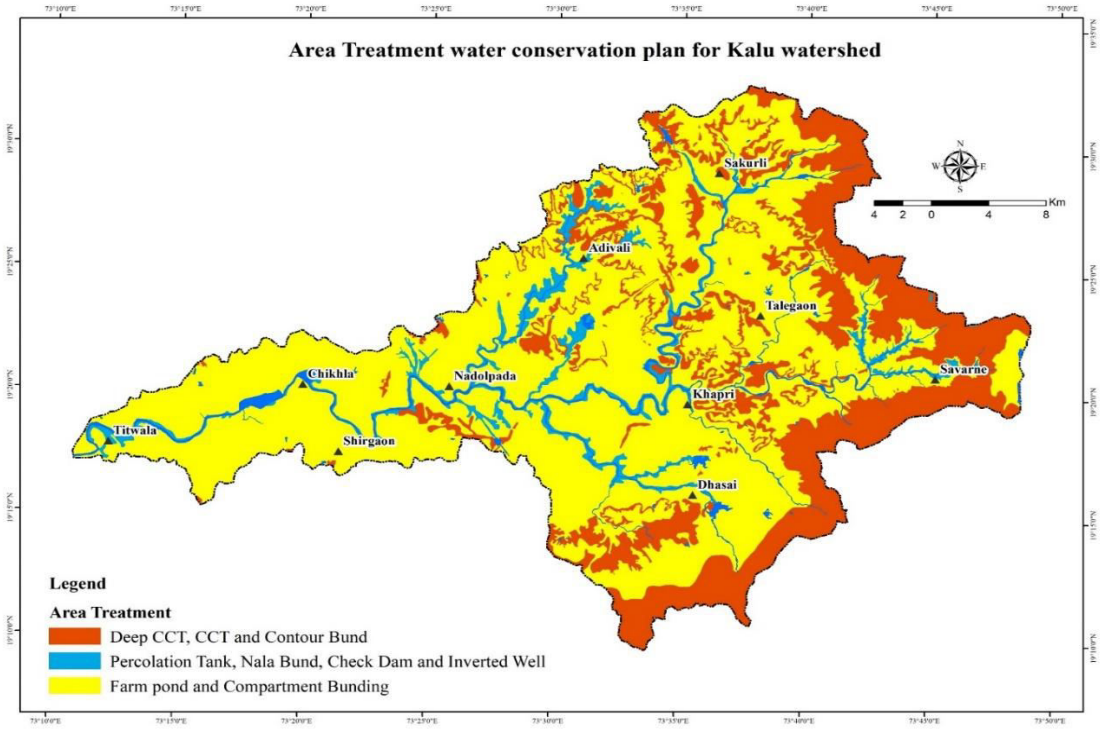

Figure 10: Area Treatment conservation plan

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4.3 Suitable site for recharge structure for Kalu watershed:

Distinctive soil water conservation sites have been recommended by various topographical and hydrogeological constraints and plausibility of structures in the Kalu watershed, site suitable for artificial groundwater map is prepared using AHP technique to propose different artificial recharge structures (Kumar *et al.*, 2016).

The suitability of the 83 Check Dams, 21 Farm ponds, 37 invert well and 3 major desilting of tank for areas near the villages was determined (Fig 11). Check Dams are recommended to be located in along the first order stream of Kanakvira nadi, Jalond nadi and Dohifidi nadi of Murbad taluka and Devi nadi, Umbar ohal, Danmantak Ohal, Julan nadi and Shai nadi of Shahapur talukas. 21 Farm ponds are recommended to be located on the cultivable land of Dhasai village, Khapri, Talegaon and Adivali villages of Kalu watershed. Three desilting of tank are located near Titwala, Takurli and Talegoan. Each of the structures was identified based on the specific need for the construction and environmental sustainability. The Eastern part of the region has proven inadequate groundwater recharge potentials. This analysis shows precise site suitability for artificial recharge in the region.

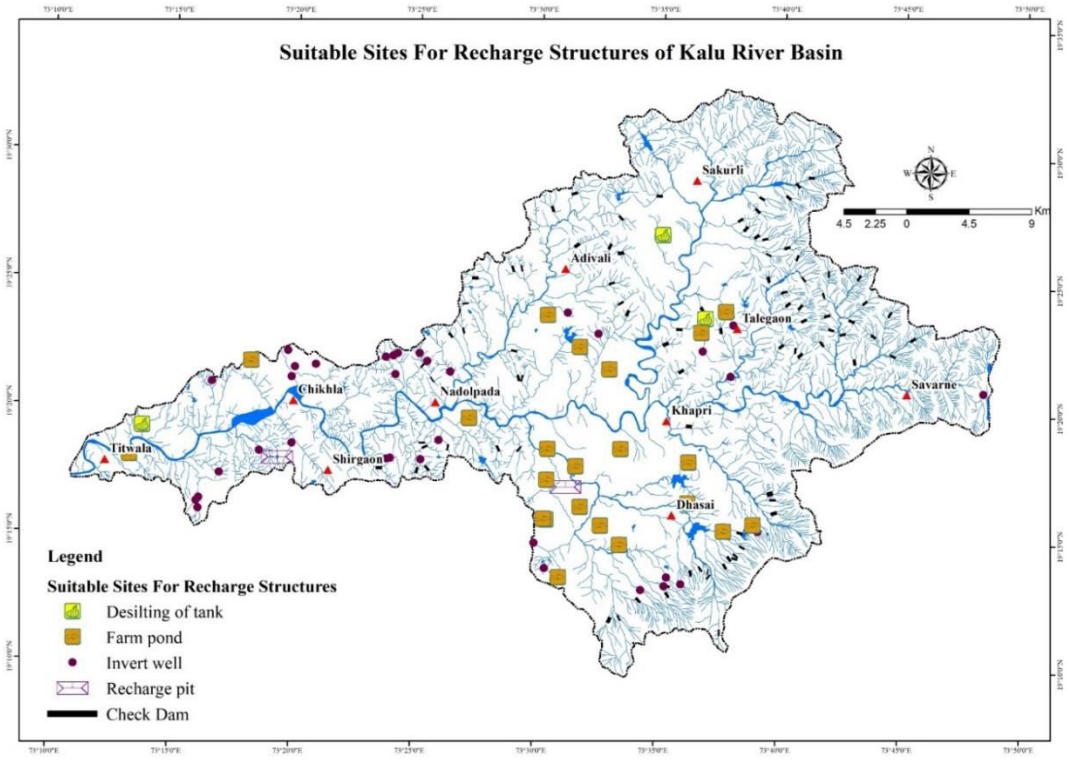

Figure 11: Suitable sites for groundwater recharge structure

5. CONCLUSIONS

Construction of the Artificial Recharge Structure is the most important conservation measure to effectively tackle water scarcity problems by augmenting surface water supplies on a long-term basis. However, the demarcation of potential locations of groundwater storage structures are quite challenging for the planners and water managers. The current research demonstrated the strong capability of geospatial and AHP multi-criteria decision analysis method for identification of site suitable for rechargeIn the present research, AHP based procedure has been embraced to identify Artificial Groundwater Recharge Zone Suitable sites for Artificial Recharge Structure was proposed to improve groundwater status of the Kalu watershed. Over 83 Check Dams, 3 major desilting of tank, 21 Farm Pond, 37 invert well and 2 Recharge pit were found suitable in the region. Further, drainage treatment, area treatment for water conservation plan and location for various site suitable for groundwater recharge will help to augment the present water scarcity experienced during the dry season of Kalu watershed.

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EVALUATION OF ANTI-BACTERIAL ACTIVITY OF SEMECARPOUS ANACARDIUM.LINN LEAF EXTRACTS AGAINST GRAM POSITIVE AND GRAM NEGATIVE BACTERIA

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ABSTRACT

Background: *The present investigation was carried out to evaluate the antibacterial activity of different extracts of Semecarpous anacardium. Solvents like methanol, acetone, Ethanol, and aqueous extract were used and tested against the most predominant human fastidious pathogens. Like B.subtilis, P. aeruginosa, E.coli, S. aureus.*

Methodology: *The antibacterial activity was performed using the well diffusion technique, and the MTCC bacterial strains were obtained from IMTECH Chandigarh. The test samples were loaded into wells with different concentrations Negative and positive controls were respective solvents and Azithromycin.*

Results: *The results revealed a good inhibitory activity against the pathogens where the extracts of aqueous and acetone were exhibited good inhibitory activity followed by methanolic and acetone extracts. The results suggested that Semecarpous anacardium exhibited a good antibacterial activity*

Keywords: Antibacterial; Semecarpous anacardium, multi-drug resistance, Azithromycin.

INTRODUCTION

Plants are vital source of potentially beneficial drugs for the growth of new chemotherapeutic techniques. Medicinal plants have been a major source of drugs for thousands of years, and even today they are the basis of systematic traditional medicines in almost all countries of the world (1)**.** Medicinal plants are very rich in phytochemicals which can be structurally improved and processed into new drugs (2)**.** For the present study, a highly potent medicinal plant *Semecarpus anacardium* Linn from Ayurvedic and siddha system of medicine was selected to understand the potentiality of the plant against selected bacterial strains. *Semecarpus anacardium Linn*. belonging to Family Anacardiaceae is a plant recognized for its medicinal importance in Ayurvedic and Siddha system of medicine. *Semecarpus anacardium L.* is a deciduous tree distributed in the sub-Himalayan tract and in tropical parts of India. The word *Semecarpus* is derived from Greek word *simeion* meaning marking or tracing and *carpus* meaning nut, *anacardium* means like cardium; - *"Heart shaped marking nut* and so the plant is commonly called as Marking Nut commercially. The fruits and the seeds exhibits abundant medicinal properties, and are used to treat the wide range of diseases like skin diseases, tumors, malignant growths, fevers, haemoptysis, excessive menstruation, vaginal discharge, deficient lactation, constipations, intestinal parasites (3). A wide range of phyto-pharmaceuticals of *S. anacardium* plant parts have been isolated and reported. Some of the important phyto-constituents present indifferent parts of the plant are Bhilwanols, phenolic compounds, biflavonoids, sterols and glycosides (4). The fruit and nut extracts of *S.anacardium* are remarkable for its antioxidant, antimicrobial, anti-inflammatory, anti-reproductive, CNS stimulant, hypoglycemic, antiatherogenic, anticarcinogenic and hair growth promoter activity, thus making the plant mark their own significant value in the traditional system of medicine. Anacardium species comprise various secondary metabolites in its leaf and shoot powder, fruits and other parts of the plant, which can be used concerning their nutraceutical, medicinal and biological traits. The problem of increasing antimicrobial resistance has become a serious public health threat worldwide. The present paper deals with the screening for anti-bacterial activity of *S. anacardium* against two gram positive bacteria (*Bacillus subtilis* and *Staphylococcus aureus*) and two gram negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*). Gram-positive bacteria are multi-resistant bacteria that cause infections and affect the mortality and mobility of a person. Gram negative bacteria like *Escherichia coli* and *Pseudomonas aeruginosa* are known for the cause of food poisoning and other food contamination related diseases. Antimicrobial properties of substances are desirable tools in the control of undesirable microorganisms especially in the treatment of infections diseases (5).The use of plant extracts with known antimicrobial properties can be of great significance in therapeutic treatments.

MATERIALS AND METHODS

a) COLLECTION AND PREPARTION OF PLANT SAMPLE

Fresh leaf samples of *Semecarpus anacardium* were collected from Mavelikara, Alleppy, Kerala, India The plant materials were shade dried and grounded to coarse powder. Exposure to direct sunlight was avoided to prevent the loss of active components.

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b) PREPARATION OF CRUDE EXTRACT

The fresh leaves were separated, and thoroughly washed with water, and rinsed with 70% ethanol to remove dirt. Aqueous extract was prepared by boiling 50gms of leaves in 100ml water, whereas the solvent crude extracts (Acetone, Ethanol and Methanol) were prepared by taking 1 :2 ratio of the sample to solvent and extracted by Soxhlet extraction method.

c) IN VITRO ANTI-BACTERIAL ASSAY

Test strain bacteria, such as Bacillus subtilis (MTCC), Staphylococcus aureus (MTCC 96), Escherichia coli (MTCC) and Pseudomonas aeruginosa (MTCC) were obtained from IMTECH, Chandigarh and used for in vitro antibacterial activity.

The antibacterial activity was determined by well diffusion methods (6). About 25 mL of molten Mueller Hinton agar was poured into a sterile Petri plate (Himedia, Mumbai, India). The plates were allowed to solidify, after which 18 h grown (OD adjusted to 0.6) 100 µl of above said pathogenic bacteria were transferred onto plate and made culture lawn by using sterile L-rod spreader. After five min setting of the pathogenic microbes, a sterile cork borer was used to make 5 mm well on the agar. The test samples were loaded in to wells with different concentration of 50 µg/mL, 100 µg/mL, 150 µg/mL, 200 µg/mL. Negative and positive controls were respective solvents and Azithromycin (200 µg/mL). The plates were incubated at 37°C in a bacteriological incubator for 24 hours. The antibacterial activity was determined by measuring the diameter of the zone of inhibition around the well using antibiotic zone scale (Himedia, Mumbai, India).

RESULTS AND DISCUSSION

Four preparations from *Semecarpus anacardium.L* (Aqueous extracts, Acetone extract, Ethanol extract and Methanol extract) were used to test for antibacterial activity against clinically important bacteria.

The therapeutic properties of medicinal plants are due to the presence of various active metabolites. The Zone of inhibition for gram positive bacteria (*Bacillus subtilis* and *Staphylococcus aureus*) and gram negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) of Semecarpus anacardium leaf extract is shown in Table 1 and Figure 1 displays the comparaison of the different extraction against the selected strains . The test samples were studied with positive control Azithromycin. From the results, we can draw an idea that the different extractions of the leaves have significant action on the selected bacterial strains. Among the four extractions, the aqueous extract and acetone extract of the leaf samples shows high anti bacterial activity compared to the other two extractions. The aqueous extract of *S.anacardium* leaves in the presence of active metabolites shows a inhibition value of 16mm at 200µg concentration against *B.subtilis* whereas for *E.coli* the extract exhibits a value of 15mm at 200µg concentration. In the contrary, the methanolic extraction shows high inhibition activity of 13mm at 200µg concentration against the gram negative bacteria *E.coli* and shows least inhibition of 2mm 50µg concentration against the gram positive bacteria *S.aureus.* Among the four extractions, Ethanolic extract shows a inhibition zone value of 17mm at 200µg concentration aginst the gram positive bacteria *B.subtilis.*

Table 1: Antibacterial activity of *Semecarpus anacardium.L* Leaf extract against selected Bacterial strains

	Bacillus subtilis				Staphylococcus aureus			
Concentration	Aqueous Extract	Acetone Extract	Ethanol Extract	Methanol Extract	Aqueous Extract	Acetone Extract	Ethanol Extract	Methanol Extract
50µg/well	7	7	9	7	6	6	5	2
100µg/well	9	9	11	9	7	8	7	6
150µg/well	11	13	15	11	9	11	8	9
200µg/well	16	15	17	12	11	15	11	12
Positive control 200µg/well	23	22	23	21	25	24	24	25
	Escherichia coli				Pseudomonas aeruginosa			
Concentration	Aqueous Extract	Acetone Extract	Ethanol Extract	Methanol Extract	Aqueous Extract	Acetone Extract	Ethanol Extract	Methanol Extract
50µg/well	7	9	9	10	6	6	2	7
100µg/well	9	11	10	11	7	8	6	8
150µg/well	13	13	12	13	9	10	8	10
200µg/well	15	15	14	15	11	12	11	12
Positive control 200µg/well	22	21	21	21	17	17	16	15

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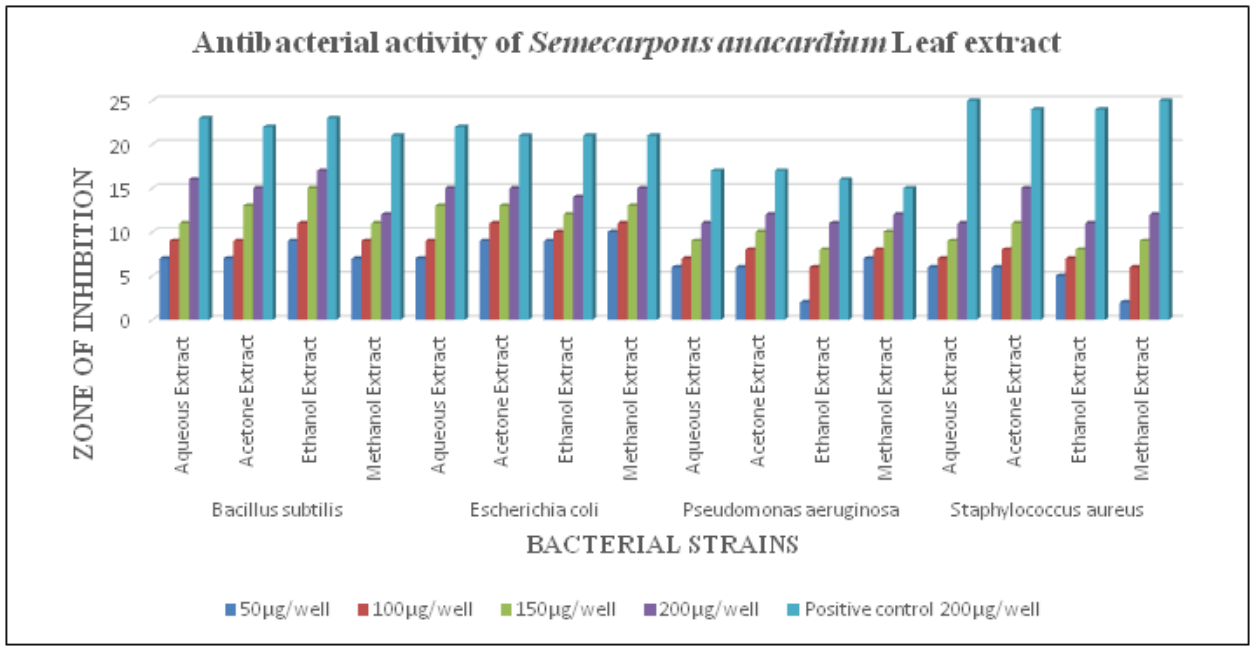

Figure 1: Antibacterial activity of *Semecarpus anacardium.L* Leaf extract against selected Bacterial strains

The antimicrobial properties of plant extracts are awaited tool in the control of undesirable microorganisms specially in the treatment of infectious diseases and in the food spoilage. Many studies have been reported against different disease causing pathogens by different types of plants and their parts. In the nuts of *Semecarpus anacardium*, the petroleum ether and aqueous extract fractions exhibited inhibitory activity against *Staphylococcus aureus* (10 mm) and *Shigella flexneri* (16 mm) at 100 mg/ml, respectively, Whereas chloroform extract showed inhibition against *Bacillus licheniformis*, Vibrio cholerae and *Pseudomonas aeruginosa*, the ethanol extract showed inhibition to *Pseudomonas aeruginosa* and *S. aureus* (7). The alcoholic extract of dry nuts of *Semecarpus anacardium* showed bactericidal against three gram negative strains (*Escherichia coli, Salmonella typhi and Proteus vulgaris*) and two gram positive strains (*Staphylococcus aureus and Corynebacterium diphtheriae*) (8). *Anacardium occidentale L* belonging to the same family Anacardiaceae inhibits the growth of the test organisms *Escherichia coli and Staphylococcus aureus* and the mentioned organisms were found to be very sensitive to the plant extracts (9).

Hydro-ethanolic extracts of leaf and bark of *Anacardium occidentale L* exhibited positive effects against *Escherichia coli, Staphylococcus aureus, Enterobacter species, Streptococcus pneumoniae, Corynebacterium pyogenes, Enterococcus faecalis, multiresistant S. aureus, Acinetobacter species, Pseudomonas aeruginosa,* and multiresistant *P. aeruginosa* during cavity diffusion tests with inhibition ranges varying from 6 to 14 mm (10).

In addition to well diffusion method, the Broth dilution method antibacterial assay of Petroleum ether nut extract of *S.anacardium* was most effective against Gram negative strains (*Salmonella typhi, Klebsiella pneumonia and E.coli*) compared to Gram positive strains (*Micrococcus luteus, Streptococcus aureus and Bacillus subtilis*) (11). Three medicinal plants namely *Anethum graveolens, Foeniculum vulgare and Trachyspermum ammi* were extracted with aqueous and acetone and were tested against the growth of *Enterococcus faecalis, Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Salmonella typhi, Salmonella typhimurium, Shigella flexneri.* Acetone extracts of all the plants showed better activity than the corresponding aqueous extracts (12).

Antibacterial activity of the hydroethanolic extract from *Caryocar brasiliense* against *Enterococcus faecalis, Escherichia coli, Pseudomonas aeruginosa and and Staphylococcus aureus* observed among which the best activity was observed against *P. aeruginosa* at 1.5 and 2.0 mg/mL, followed by *S. aureus* (13).

Leaves of *Hypericum roeperianum* had the highest yield (12%), followed by *Maesa lanceolata* (11.12%) against Gram-positive bacteria (*Staphylococcus aureus, Enterococcus faecalis and Bacillus cereus*) and Gram-negative bacteria (*Escherichia coli, Salmonella Typhimurium and Pseudomonas aeruginosa*) (14). Gram positive organisms lack an outer membrane in their cell walls but Gram negative organisms do possess it, this outer membrane may be liable for the variance in the degree of sensitivity of the organisms to the crude plant extracts (15).

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CONCLUSION

According to World Health Organization, more than 80% of the world's population depends predominantly on herbal medicines. Medicinal plants provide a new approach for understanding the framework for synthetic drug design and development. Traditional plant medicine will become an area of major importance in the health care system. The present study could be an alternative approach for the treatment of bacterial disease with less side effect and cost effective.

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PHYTOREMEDIATION POTENTIAL OF SOME ORNAMENTAL PLANTS: A REVIEW

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ABSTRACT
One of the major contributors to Green Revolution which started in the late 1960s, were the chemical pesticides and fertilizers. Indiscriminate use of these chemicals over the years has led to their accumulation and persistence in the soil. Contamination of agricultural soils by heavy metals and pesticides is major problem faced by modern agriculturists. This leads to these toxic chemicals leaching into the groundwater, or polluting the rivers through surface run-off, and ultimately posing a threat to human health. The effective solution to this pressing problem of pesticide or heavy metal contamination lies in the eco-friendly process of phytoremediation, in which living plants clean-up the soil via processes such as, phytoextraction rhizodegradation, rhizofiltration, phytodegradation, phyto-stabilization. Some of the plants are able to metabolize, stabilize, or volatilize such substances. Ornamental plants besides being used for aesthetic purposes, are now being considered for their phytoremediation potential. An added advantage is that they not only beautify the location, but also, help in achieving land recovery. Some of the ornamental plants which have been tested for their phytoremediation potential are Calendula officinalis, Coleus blumei, Celosia cristata, Tagetes patula, Euphorbia milii, Nerium oleander, Cordyline fructicosa, etc. This opens up new and exciting avenues to be pursued in the field of phytoremediation.

Keywords: phytoremediation, ornamental plants, contamination, Coleus blumei, Cordyline fructicosa, Nerium oleander, Euphorbia milii.

INTRODUCTION
Pollution of water, air, soil is an anthropogenic problem of recent times. Management and removal of toxic substances accumulated in the environment is a significant global issue of importance in agriculture, environmental health, and human health. Use of physical or manual methods to mitigate this problem is an expensive as well as tedious task. Hence, people are moving towards green chemistry in order to find a solution to this problem (Kumar, 2017).

Phytoremediation basically refers to the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environment. It is also called botanical bioremediation or green remediation (Kumar 2017). Phytoremediation is widely accepted as a cost-effective environmental restoration technology. Plants are considered to be natural mitigators for pollutants in the environment. They are ideal contenders for performing bioremediation because of their autotrophic nature, cost-effectiveness, ease of management and ability to produce large biomass with minimum nutrient input (Adki, Jadhav, & Bapat, 2013).

Ecological restoration of the environment calls for adopting clean-up technologies that are primarily eco-friendly and cost-effective. Phytoremediation involves various mechanisms such as phytovolatilization, phytodegradation, phytoextraction, phytostabilization, and rhizofiltration. Phytoremediation encompasses physical, chemical, and biological processes to eradicate/ degrade/ transform, or stabilize pollutants within soil and groundwater (Ghosh & Singh, 2005; Prasad & Prasad, 2012).

Phytoextraction is characterized by accumulation of pollutants into the plant shoot; rhizofiltration shows accumulation of pollutants into the plant roots; phytostabilization means the roots release certain enzymes/chemicals that make the pollutants more stable in the soil; phytovolatilization is the evaporation of volatile compounds by plant roots; phytodegradation means the degradation of toxic compounds in the root zone; phytotransformation is characterized by the stabilization & subsequent degradation of organic volatile compounds by plant leaves (Kumar, 2017). Plants with a high rate of biomass production like crop plants and ornamental plants have been explored for phytoremediation potential.

Ornamental plants are plants that are grown for decorative purposes with a range of shapes, sizes, and colors that are suitable to a broad array of climates, landscapes, and desired gardening characteristics. Ornamental plants also aid in separating soil contaminants from the food chain. Along with aesthetic importance, ornamental plants have been found to be of significance in remediating contaminated soils. Contaminated areas can also be developed for ecotourism via plantations of ornamentals which can also contribute to revenue generation (Nakbanpote, Meesungnoen, & Prasad, 2016).

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Plants can also be genetically modified in order to show greater remediation potential. The gene transfer can be done from microbes which perform bioremediation to ornamental plants with a high rate of biomass production. Genetically modified ornamental plants may have the added characteristics of drought resistance, stress tolerance and heat & pest resistance, etc. These plants also have the most potential for remediating contaminated lands with pest/disease infestations and harsh environmental conditions. One of the main goals of these studies is to bridge the gap between laboratory testing of selected ornamental plants and their applications in the field.

PREFERENCE FOR ORNAMENTAL PLANTS IN PHYTOREMEDIATION

Ornamental plants are those which are grown for the purpose of decorating land in gardens, landscapes, etc. They are of vital significance in increasing the green cover of urban areas. They are mostly grown for their attractive foliage, flowers, fruits, and overall appearance. It has been observed that many of these ornamental plants serve a dual purpose: improving the aesthetic appeal of an area as well as mitigation of pollutants in the environment. Hence, these plants contribute not only to the beautification of the landscape, but also to the remediation of polluted soils/water (Nakbanpote, Meesungnoen, & Prasad, 2016).

Such areas where ornamental plants are being used to clean up polluted soils can also be used to generate revenue through eco-tourism. Plant tourism is a rapidly growing industry with ecological as well as economic benefits (Rocha, 2021).

It is noted that many of the ornamental plants are hyperaccumulators of heavy metals- they uptake & accumulate heavy metals in their biomass. This biomass can subsequently be harvested easily & treated/ disposed to get rid of the accumulated pollutants (Cui *et. al*., 2013). The short life cycle of herbaceous ornamentals enables us to study their remediation potential throughout all stages of the life cycle. Plants having tolerance to biotic (pest and disease resistance) & abiotic (heat, drought, salt) stress are considered for bioremediation activities.

It is evident that genetically modified ornamental plants have the maximum resistance to drought, stress tolerance and heat & pest resistance, etc. These plants have the most potential for remediating contaminated lands with pest/disease infestations and harsh environmental conditions (Samudro & Mangkoedihardjo, 2021).

Ornamental plants with greater potential for phytoremediation can be mainly assessed according to their morphological characteristics. The root, stem, and leaf morphologies play important roles in the phytoremediation process. Root length, density, and surface area are important characteristics that can directly influence the uptake or degradation of contaminants. The tolerance and accumulation of contaminants by the ornamental plants relates with the height as well as the diameter of the stem. The leaf area index plays a major role in biomass increases through its impact on photosynthesis, and the leaf is also the major site for volatilization and excretion, which is one detoxification mechanism for hazardous materials (Capuana, 2020). Screening is done via pot culture by enforcing stress conditions in the laboratory, which is extended into field trials.

Experiments show that higher the bioavailability of pollutant molecules, higher is the rate of phytoremediation. In order to improve the phytoremediation potential of ornamental plants, it is important to increase the bio-availability of pollutants to the plants (Prasad, 2012).

PHYTOREMEDIATION POTENTIAL OF ORNAMENTAL PLANTS

Metals like zinc (Zn), copper (Cu), nickel (Ni) are indispensable for many biological functions in plants, but the problem arises only when they are present in the high intensities in the soil. This condition ultimately may lead to metal toxicity for the plants (Liu *et al*., 2017). Toxicity is, also, seen to be caused by arsenic (As), selenium (Se), cadmium (Cd), and lead (Pb). Toxicity caused by such heavy metals ultimately leads to reduction in soil quality, reduced crop yield, ground water pollution, thereby posing a threat to human and animal health by entering the food chain. It is important to study the physiological responses of the plants, in the present case, ornamental plants, to understand their capacity to tolerate such environmental stress. This eventually helps the researchers to narrow down on the ornamental plants possessing phytoremediation potential.

Plants are known to tolerate excessive concentrations of heavy metals in the environs that they thrive in. The type of physiological responses of the plants can be attributed to their individualistic character, the concerned metal and its form, as well as, it depends on the concentration and duration of exposure to the specific heavy metal (Baker and Walker, 1989).

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METHODOLOGY EMPLOYED FOR CHECKING PHYSIOLOGICAL RESPONSES UNDER HEAVY METAL STRESS

Growth responses of ornamental plants under heavy metal stress in pot cultures, in a hydroponic set-up, or in field experiments can be assessed by checking several parameters such as root length, shoot height, and plant fresh and dry weight, chlorophyll content, anti-oxidant properties, proline content, inhibition rate, tolerance index, etc. *Tagetes erecta* has been tested for its heavy metal tolerance against Pb and Ni by carrying out a hydroponic analysis (Bardiya-Bhurat *et al*., 2017). *Tagetes patula* has also been tested for its potential to phytoremediate in pot experiments (Sun *et al*., 2011). Pot experiments enable the researchers to give a variety of treatments, and help in narrowing down probable ornamental plants for their phytoremediation capabilities. Such methodology can pave way for field trials. A field trial spanning 180 days was conducted by Li *et al*., 2022, to investigate the potential of *Tagetes patula* L. to remediate Cd polluted soil. Soil total Cd and organic matter, along with plant Cd extraction was assessed. Field experiments have been considered to have more validity than any other methodology of assessment, as they can emulate the natural settings in which the plants grow, hence providing authentic results (Liu *et al*., 2017).

Many a times heavy metals are accumulated inside different plant parts, with only a few physiological changes in the plant. Such plants are great contenders for remediation of heavy metal contaminated soils. Bioaccumulation factor (BCF) and translocation factor (TLF) can be calculated to evaluate plants for their phytoremediation potential of heavy metals. The formula for calculation of BCF and TLF is given below:

$$TLF = \frac{metal\ concentration\ in\ the\ aerial\ parts}{metal\ concentration\ in\ the\ roots}$$

$$BCF = \frac{metal\ concentration\ in\ plant\ tissues}{metal\ concentration\ in\ the\ soils}$$

Values of BCF >100 and TLF >1 have been seen in plants which are ideal for phytoextraction of heavy metals. Such factors help the researchers to authenticate their studies and bring conclusive evidence to the table. This paves way for researchers to look for hyperaccumulators of some heavy metals, for e.g., Ni has a vital role to play in the physiology of plants (Sreekanth *et al*., 2013), and it is for this reason it has been seen to be hyperaccumulated in many plants. It is imperative to have standard indices for quantifying a plant's capability to accumulated heavy metals.

PHYTOREMEDIATION MECHANISMS OF HEAVY METALS AND THEIR ENHANCEMENT

Ornamental plants, like other plants, can be classified according to the mechanisms they apply for metal uptake. Uptake mechanisms are influenced by a few factors such as plant species, bioavailability of the metal, soil properties and the type of enhancer added (Tangahu et al., 2011). Phytoextraction, and phytostabilisation are pretty reliable than phytovolatilization and rhizofiltration (Laghlimi *et al*., 2015).

Plants which are 'Excluders' can limit the heavy metal mobility and translocation into the shoot. This can be termed as phyto-stabilisation. Chromium (Cr) containing wastewater could be phytostabilised by *Commelina communis* L. as studied by Tang and Xi (2002). Plants like *Cyperus alternifolius*, *Canna indica*, *Eichhornia crassipes*, and *Pistia stratiotes* were considered as strong excluders by Sricoth *et al*. (2018).

Plants that behave as 'Indicators' or 'Accumulators' amass heavy metals in their parts which are above the soil. Mentha villosa and Lavandula anqustifolia, along with *Helianthus annuus* were tested to be accumulators of heavy metals (Barouchas *et al*., 2019; Alaboudi *et al*. 2018).

'Hyperaccumulator plants' take up heavy metals from the soil and compartmentalise them in shoots and leaves. Toxic symptoms are rarely observed in such plants. For e.g., hyperaccumulators of Cd can form organic complexes containing Cd, thereby influencing the interactions of Cd with other elements. This gives the plants an ability to tolerate and accumulate toxic degrees of Cd in their tissues (Shanying *et al*., 2017). *Pteris vittata* which is a common ornamental fern, is a very well known hyperaccumulator of As (Xie *et al*., 2009). Similarly, *Cosmos bipinnata* was found to be an hyperaccumulator of Cd by Huang *et al*., (2017).

Various analysis methodologies have brought forth a plethora of ornamental plants with promising capabilities to phytoremediate contaminated environments. Ornamentals like *Mirabilis jalapa* L. and *Calendula officinalis* have shown high tolerance towards Cd with maximum tolerance concentration at 100 mg/kg. *Celosia cristata pyramidalis* and *Chlorophytum comosum* have shown a greater tolerance towards Pb, with maximum tolerance concentration at 5000 mg/kg and 2000 mg/kg, respectively (Liu *et al*., 2017). Soils containing *Ralstonia eutropha* and *Chrysiobacterium humi* has been seen to reduce loss of biomass, and aids in metal bioaccumulation in heavy metal exposed plant, such as *Helianthus annuus*. Similar effect has been seen when

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plants are infected with arbuscular mycorrhizal (AM) fungi such as *Glomus* spp. (Nakbanpote et al., 2016). Uses of soil conditioners such as biochar, peat moss, chelators, compost, biosolids, etc., can also aid in the bioaccumulation and mobilisation of heavy metals (Khan *et al*., 2021).

GROWTH RESPONSES UNDER ORGANIC POLLUTANT STRESS

Another major problem, apart from heavy metal contamination, is the contamination of soil by organic pollutants. Incessant uses of pesticides and herbicides have led to this grave problem.

Persistant organic pollutants (POPs) are of chief concern among the other organic contaminants. The major POPs are polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs) and Polychlorinated biphenyls (PCBs) (Megharaj *et al*. 2011). Their persistence in the soil, bioaccumulation in living organisms and high toxicity make them quite notorious. Incidences of mutagenicity and carcinogenicity have been prevalent because of the presence of such compounds in the soil. Kaur *et al*., 2018, have reported bioaccumulation of pesticide residues in study group of people selected from Bathinda district of Punjab. Chlorpyrifos is an organo-phosphate pesticide which poses a great risk the environment. Propargite, an organosulphur compound, is another notorious organo-sulphur liquid poses a similar threat to mankind. Hlihor *et al*. (2016) assessed the health risks of various pesticides and their study revealed that propargite was likely to pose a greater health risk to children from the age of three to ten years.

Microbial remediation has been effective but researchers are looking for solutions among plants, as well. For such assessment for organic pollutants, growth parameters such as the height of the shoots, dry biomass of the plants, photosynthetic rate, and ultrastructure of the leaf cells needs to be checked for damage. Peng *et al*., (2009), have demonstrated that *Mirabilis jalapa* plant had a good tolerance towards petroleum contaminants in the soil. Zhang et al., (2010) observed that *Pharbitis nil* L. had a good potential for remediating soils contaminated with TPHs. An influence of microbial population of on the phytoremediation potential was also recorded.

PHYTOREMEDIATION MECHANISMS OF ORGANIC POLLUTANTS AND THEIR ENHANCEMENT

Ornamental plants have been known to have a high tolerance towards organic pesticides/insecticides, as well. Many plants show no stress symptoms on exposure to organic pollutants; growth parameters are not drastically inhibited. For example, *Mirabilis jalapa* has been seen to strongly survive in nitrobenzene-contaminated soils (Zhou *et al*., 2012). *T. patula* was found to be suitable for phytoremediation of B[a]P, and as well as B[a]P–Cd contaminated sites (Sun *et al*., 2011).

The mechanisms by which organic pollutants are taken up by the plants are similar to the take up of heavy metals. Roots translocate the organic pollutants to other tissues. There these pollutants may get stored, partially or completely degraded, or volatilized. A few processes can be enumerated here to give an idea of how organic pollutants are treated by plants: 1) Plants uptake organic pollutants from the soil. 2) Xylem then transfers the organic pollutant to other plant tissues. 3) From some plant tissues the organic pollutants can be volatilized to the atmosphere. 4) Another mechanism that can take out organic pollutants from the soil is metabolizing the pollutant, or lignifying it by plant enzymes (Liu *et al*., 2018). Majorly the mechanism employed by the plants for uptake of organic pollutants is by phytodegradation. It is also referred to as phyto transformation, in which, the complex organic pollutants are degraded into their lesser harmful forms. This process entails phytostimulation, where enzymes or exudates are secreted out in the root zone of the plant to degrade organic matter along with pollutants. The process is supported by the soil microorganisms, which ultimately leads to the acceleration in the breakdown of organic pollutants (Sophia and Kodialbail, 2020).

Another aspect that comes to the fore is the enhancement of the degradation process. Microorganisms have been said to aid in the process of breakdown of an organic pollutant. For e.g., *Lolium multiflorum* system was used in the phytoremediation of Arabian medium crude oil, which was supplemented with arbuscular mycorrhiza individually, and a mixture of *Sphingomonas paucimobilis*. Another set of plants was supplemented with the filamentous fungus, *Cunninghamella echinulate*, or a combination of organisms. This was shown to have a positive effect on the phytoremediation process (Alarcón *et al*., 2008). Arbuscular mycorrhizal phytoremediation was applied on soils contaminated with phenanthrene and pyrene (polycyclic aromatic hydrocarbons). Plants like *Medicago sativa* L. were infected with *Glomus mosseae* and *G. etunicatum*, as a result 98.6% and 88.1% of polycyclic aromatic hydrocarbons were degraded. Using an optimal combination of mycorrhizal fungi can significantly enhance the phytoremediation potential of plants (Gao *et al*., 2011).

The addition of organic soil amendments, such as, willow root exudates, a nonionic surfactant (Tween 80), and carboxylic acids (citrate and oxalate) can aid in the process of the degradation of organic contaminant.

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Mamirova *et al*., 2020, found out in their study on the phytoremediation potential of *Miscanthus sinensis*, that the efficiency of phytoremediation of organo-chlorine pesticides can be increased by addition of activated carbon and Tween 20 by speeding up the remediation process. Mitton *et al*., 2012, studied the effect of Tween 80, roots exudates and some carboxylic acids in the uptake and translocation of DDTs by Willow plants. Carboxylic acid supplemented treatment showed the highest translocation factor. The addition of enhancement mechanisms for the uptake of organic pollutants serves as good prospect for achieving efficiency in the phytodegradation of these pollutants.

DEGRADATION OF ORGANIC CONTAMINANT BY ORNAMENTAL PLANTS

Chlorpyrifos pesticide has been to be removed from water under greenhouse conditions by aquatic plants like *Pistia stratiotes* L. and *Lemna minor* L. (Prasertsup and Ariyakanon, 2011). Similarly, the combination of *E. crassipes* and the bacterium *Acinetobacter* sp. strain WHA present a proficient system for removal of chlorpyrifos from contaminated waters (Anudechakul et al., 2015). Miticide like propargite is known to be degraded by certain microorganisms, such as *Pseudomonas putida* (Sarkar *et al*., 2010). Propargite and its metabolite 2-(p-t-butylphenoxy)-cyclohexanol [TBPC] have been known to be existing as residual compounds. Kumar *et al*., 2004 have studied the degeneration of propargite in soil by apple and tea plants. With the evidence available, undoubtedly ornamental plants also can be screened for their potential to degrade pesticides like propargite and their metabolites. It can be opined that the metabolization of the pollutants serves as the key for future studies regarding phytoremediation of these pollutants.

Plants like *Gaillardia aristata*, *Echinacea purpurea*, *Festuca arundinacea* Schreb, *F. arundinacea*), and *Medicago sativa* L. were found to effectively reduce petroleum hydrocarbon levels from the soil (Liu *et al*., 2012). Fifteen ornamental plants, grown hydroponically, were tested against formaldehyde stress. Out of the lot, *Spathiphyllum floribundum*, *Alocasia cucullata*, *Davallia bullata*, *Syngonium podophyllum*, and *Schefflera octophylla* showed the best capability to withstand formaldehyde stress (Wang *et al*., 2020). Such screening strategies can help researchers to identify ornamentals which can be solely employed for ridding the environment of contaminants.

SOME PLANTS WITH PHYTOREMEDIATION POTENTIAL

Coleus spp

In a study by Leon et. al.,2011, the capacity of *Coleus blumei* to extract and accumulate aluminum was evaluated. It showed that even though *Coleus* was designated as a non-accumulator of Al, it can be used safely for the treatment of polluted waters. *Coleus blumei*, thus, can be designated as a metal stress tolerant plant with phytoextraction capacity of heavy metals from contaminated soil. There is also evidence to suggest that *Coleus* can remediate the soils of cadmium & lead as well (Pandya Kirti, 2022). *Coleus* shows the ability to concentrate selenium in its roots & leaves; effects of selenium toxicity are visible at concentrations more than 0.1 mmol/L of soil solution (Hu, M. H., & Yuan, J. H., 2015).

Five species of *Coleus* were studied under salinity stress by Kotagiri and Kolluru (2017). *Coleus aromaticus* and *Coleus amboinicus*, showed better phytoremediation performance by increased carbohydrate contents and water absorption potential. They concluded that increased carbohydrate content under salinity indicates higher salt tolerance in the plant (Hayat et. al., 2022).

Coleus blumei has also been grown in a floating hydroponic system using plantation cups in domestic wastewater. It was observed that *Coleus* showed good growth in this system and significantly reduced the pollutant load from the wastewater (Liu, 2004). It is also one of the few lead tolerant plants and shows mild lead accumulation in the leaves without exhibiting toxic effects. Selenium can be used to mitigate the toxic effects of lead accumulation in *Coleus* (Yuan, J., & Hu, M., 2013).

Euphorbia spp

The potential of *Euphorbia milli* to tolerate and remediate soils contaminated by chromium was investigated by Ramana S, et. al., 2015. *Euphorbia prostata* is an excellent candidate for remediation & biosorption of heavy metals such as cadmium, chromium & lead (Husnain, A., Ali, S. S., & Zafar, R. (2013). *Euphorbia pithyusa* was observed to have metal ion collecting properties when grown in conjunction with metal-tolerant bacteria (Sprocati *et. al.,* 2014).

Euphorbia thymifolia remediated soil contaminated with cadmium more efficiently when organic acids were added to the soil (Shuwei *et. al.,* 2015). Another species of *Euphorbia*: *E. macroclada* was found to be a macro accumulator of Manganese (Lorestani, B., Cheraghi, M., & Yousefi, N., 2011). *E. indica* is a well-known weed which commonly grows in fallow lands. It's investigation has revealed that E. indica is an excellent

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accumulator & detoxifier of chromium in soil (Jabbar, *et. al*., 2019). *Euphorbia tithymaloides,* a common garden plant is a very promising candidate for phytoremediation of diesel contaminated soil (Nangai & Venkatachary, 2017).

Cordyline Fruticosa

Study carried out by Herlina et. al, 2020, observed that the metal (lead) tolerance index for *Cordyline fruticosa* ranged from 90.87% - 93.07%. The Translocation (TF) and Bioaccumulation Factor (BAF) were also of significance. The authors observed that the TF values indicated towards the translocation of metal from roots to other organs of the plant, but the TF values decreased with the duration of lead exposure. The value of TF *C. fruticosa* ranged between 0.4836 - 1.2810. Hence, it could be concluded by the authors that the lead did move from the roots to other organs initially, but as the duration was extended, at the end of two months or three months, the metal translocation was decreased. This led to more accumulation of lead in the roots than any other plant parts.

Furthermore, the authors deduced that the Bioaccumulation (BAF) values increased with the time of lead exposure, with the values ranging from 0.2539 - 1.7997. BAF values were high for the T0 treatment, which indicated that significantly lesser amounts of lead can be accumulated efficiently by the plants under study. Metal extraction amount (MEA) values also seen to increase in the initial first month for the samples taken from root, stem and leaves of the study plant.

Muryani *et al*., 2020 have suggested the use of *Cordyline* for land rehabilitation in Cinangka Village, Bogor, Indonesia. The plants that were tested for their lead uptake potential were *Cordyline fruticosa* and *Ipomea reptans* Poir. Cordyline was the preferred choice for rehabilitation of land, as it is an ornamental plant.

Jayanthi et. al, 2017, studied the potential of *Cordyline* sp. plant and *Duranta* variegated for the phytoremediation of heavy metals (Pb, As, Mn, Ni, and Cr) from the leachate contaminated soil. The results showed that *Cordyline* sp. tends to accumulate high amounts of heavy metals in comparison to *Duranta*. Based on the above findings, the authors concluded that *C. fruticosa* plants show an adaptability to grow in lead contaminated areas.

Another facet that can be explored is the potential of *Cordyline* sp. to degrade organic pollutants. *Cordyline* has been seen to uptake the air contaminants toluene and ethylbenzene (Sriprapat *et al*., 2014). This opens up several doors for exploration of Cordyline as a phytoremediation plant. Potential of *Cordyline* to remediate pesticides from the soil can be explored further.

Nerium Oleander

The capacity of *Nerium oleander* to phytoremediate has been explored. Ibrahim and Afandi, 2020, in their study, developed a simple uptake plant model using *Nerium*. The heavy metals studied were Pb, Cd, and Zn. The uptake of the mentioned heavy metals was traced by several pathways. Soil-root-leaf pathway, soil-air-leaf pathway, and their accumulation was tested. It was observed that Pb was accumulated in the root, while Cd and Zn were concentrated in the aerial parts of the *N. oleander* plant.

Furthermore, Koucim et. al, 2021, took samples of *Nerium oleander* from twenty urban areas in Setif Province, in Algeria. The concentrations of Cd, Mn, Pb, Sb, Cu, Bi and Fe were determined. It was observed that *N. oleander* showed high concentrations heavy metal accumulation in its leaves. Conclusively, *N. oleander* can be designated as a hyper-accumulator of Sb, Mn and Pb. The authors have suggested the use of *N. oleander* as a biomonitoring plant.

Elloumi *et al*. 2016, studied the response of N. oleander to phosphogypsum amendment of soil. The leaves of *N. oleander* contained higher concentrations of Zn, Fe, Ni, and Cr. Bioaccumulation factor values for Zn, Ni, and Cr were greater than 1 in the roots, which represents the metal deposition potential of the plant. Translocation factor of Ni and Cr was less than 1 which showed that those metals were phytostabilised in the roots.

Hence, it can be inferred from the available literature that Nerium is an excellent contender to phytoremediate heavy metals from soils, however, more research needs to be done in the field of phytoremediation of organic pollutants by *N. oleander*.

CONCLUSION

Plants in general have several lines of defences when under stress. Specific heavy metal stress triggers the first line of defence sometimes is seen in the reduction in the uptake of heavy metals when present in high concentrations. This may also lead to restriction in the entry of metals in the cells. The toxicants can be then sequestered into the plant vacuoles, and there is a subsequent release of stress related compounds such as proteins, some signalling molecules, hormones, etc., (Ghori *et al*., 2019). Hence, employing plants towards

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environmental phytoremediation is a wise path which many researchers have taken up. Moreover, ornamental plants hold an added advantage of land rehabilitation. To give a significant boost to the economic and ecological value of the ornamental plants, researchers can venture into this field and subsequently protect the environment from contaminants and preserve it in the process.

From the studies undertaken by many researchers in the field of environmental sciences, it is evident that the scientists are working towards minimizing the environmental risks posed by heavy metals and pesticides. Focus should be further shifted towards molecular mechanisms through which the hazardous substances are being accumulated by the ornamental plants. The ultimate goal is to find safe and gregarious measures to optimise and rationalise the final disposal of the ornamental plants. This will only come with coming up with new screening processes and remediation methods using ornamental plants. The future indeed covets the augmented approaches to safeguard the environment.

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BIOLOGICAL ACTIVITY OF CARAPACE EXTRACTS OF CRUSTACEANS FOUND IN COASTAL REGIONS OF MUMBAI

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ABSTRACT
*The crab carapace is the shell covering the body of the crab. The carapace of crab consists of 25-30% Chitin, 25% Protein, and 40-50% Calcium carbonate. Chitin is the second most abundant polysaccharide after cellulose. More than 10*11 *tons of chitin is produced annually in the aquatic biosphere. The current work is focused on the biological activity of some species of Crustaceans against gram-positive Staphylococcus aureus and gram-negative Escherichia coli. We selected two species of crabs, Scylla serrata & Portunus pelagicus, and two species of Indian prawn Fenneropenaeus indicus and Prawn sp. (tiger prawn). The carapace of all the selected species is soluble in the proper solvent. The powdered carapace of all species was studied for antibacterial activity against Escherichia coli and Staphylococcus aureus. The disc diffusion method with nutrient agar extract was used for antibacterial studies. The lowest concentration of 0.004% of the Scylla serrata sample shows an inhibition zone up to 20mm against Escherichia coli and 9mm against Staphylococcus aureus. As compared to the standard studied samples, it showed 100% activity against Escherichia coli and 70% against Staphylococcus aureus. The rest of the species also showed an inhibition zone against both bacteria. According to the results, all four species act against both bacteria, so may be used as raw material in medicines like the preparation of ointment, dusting powder for skin infections, etc.*

Keywords: antibacterial agents, Crustaceans species, disc diffusion method, coastal region of Mumbai

1. INTRODUCTION
The carapace is the basic source of Chitin found in arthropods, jellyfish, shrimp, lobster, crabs, nematodes, fungi, squids, green algae and exoskeletons of insects, etc. The crab shell contains 25-30% chitin, 25% protein and 40-50% calcium carbonate [1]. Chitin is the second most abundant polysaccharide after cellulose. Every year around 6-8 million tons of crab, shrimp, and lobster waste is produced globally. This shell waste can be used as a raw material in medicine. Chitin has numerous biological applications. Recent research has focused on the possibility of developing chitosan as a natural disinfectant [3]. The work focuses on studying the biological activity of the carapaces of crabs and prawns. The selected sample species of crabs are *Scylla serrata* & *Portunus pelagicus* and prawns are *Fenneropenaeus indicus* & *Prawn sp*. (tiger prawn). To study the antibacterial activity the bacteria used are gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli*. These two bacteria were used because they are most commonly found in the environment and also in the nose & on the skin of humans. *Escherichia coli* is commonly found in the intestines of animals & in the environment and is the most infectious bacteria among the genera.

2. MATERIALS AND METHODS

SAMPLE COLLECTION

Figure a: Scylla serrata

Figure b: Portunus pelagicus

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Figure c: Fenneropenaeus indicus

Figure d: Prawn sp. (tiger prawn)

The raw material of crabs and shrimp were collected from a fish market in the coastal region of Mumbai. Their carapaces were parted from their body. The carapaces were washed several times and made sure that there were no tissues or any other impurities left. The carapaces were cleaned and dried under the sun. After making sure all of the carapaces are dried, fine powder was made of all of them in the grinder.

METHODOLOGY

- 0.4 g of the powdered carapace of all the sample species was weighed accurately. The Dimethyl sulfoxide (DMSO) solvent was used to dissolve all the sample species.
- The sample solutions were heated in the water bath for complete dissolution.
- The discs were made of Whatman filter paper no. 41 and were saturated in all 4 sample species.
- The activities were checked by the disc diffusion method [4-5].

DISC DIFFUSION METHOD

The Disc diffusion method for antimicrobial susceptibility testing was carried out to assess the presence of antibacterial activities of all sample species.

- All the apparatus used for the culture were autoclaved.
- Nutrient agar solution was poured into the plates and was kept to settle.
- The plates were swabbed by *Staphylococcus aureus* and *Escherichia coli*. The saturated discs of all different samples were placed on agar plates.
- Each plate comprises three discs. One positive control, which is a standard commercial antibiotic disc, one negative control, and one saturated sample disc. The standard antibiotic disc taken was ampicillin 250mg. The negative control was DMSO (100%).
- All agar plates were incubated at 37°C for 48 h.
- Observed agar plates and measured inhibition zones from each disc in mm.

3. RESULTS AND DISCUSSION

The inhibition zones observed in all the samples were subtracted from the inhibition zone of the negative control taken (DMSO) and compared with the positive control Ampicillin. The results are given below in the table.

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INHIBITION ZONES OF THE SAMPLES

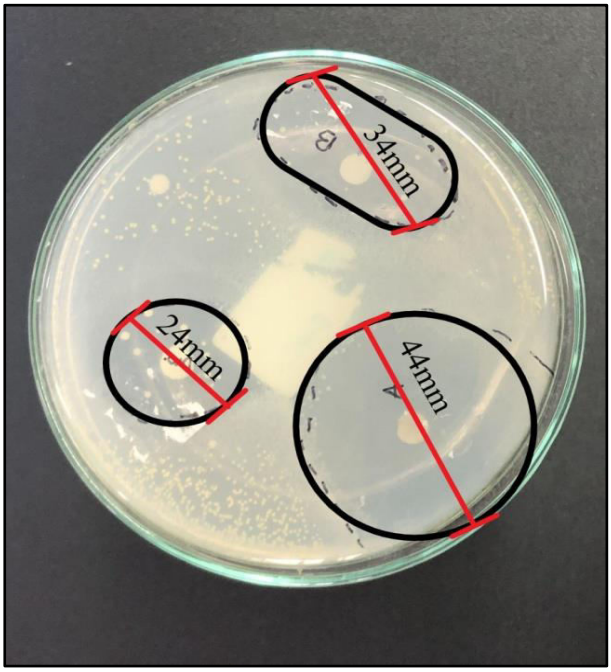

Figure e: Inhibition zone of Scylla serrata (44mm) & Portunus pelagicus (34mm) and DMSO (24mm) in E. coli.

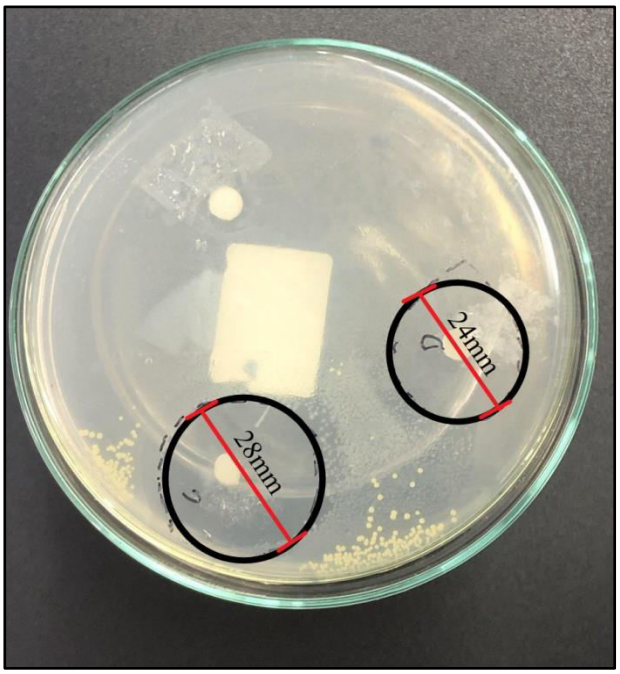

Figure f: Inhibition zone of Prawn sp. (tiger prawn) (28mm) and Fenneropenaeus indicus (24mm) in E. coli.

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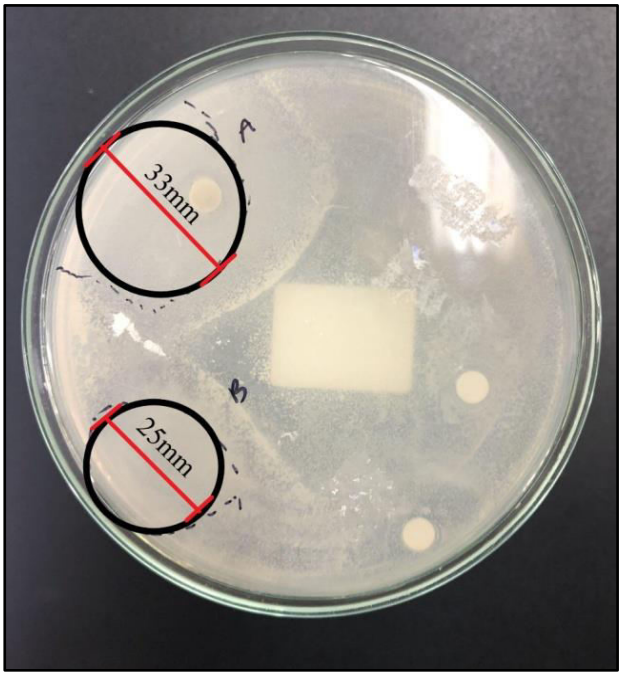

Figure g: Inhibition zones of Scylla serrata (33mm) & Portunus pelagicus (25mm) in S.aureus.

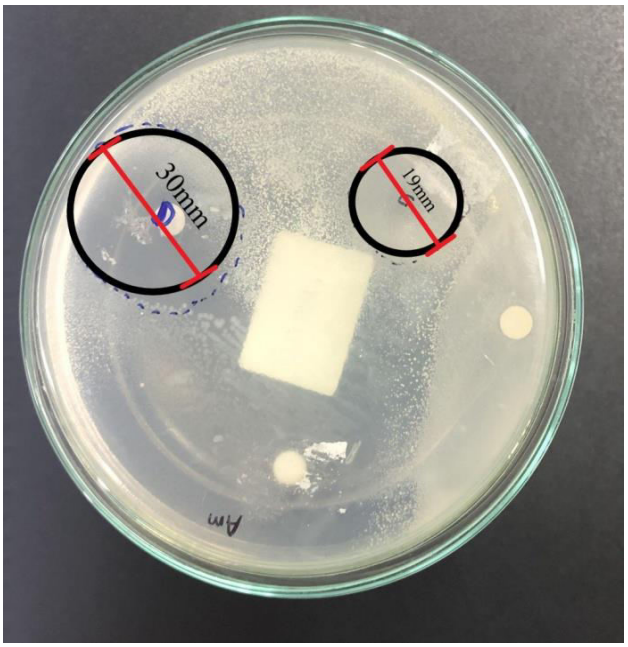

Figure h: Inhibition zone of Prawn sp. (tiger prawn) (19mm) and Fenneropenaeus indicus (30mm) in S.aureus.

Table: 1

Samples	E.coli	S.aureus
Scylla serrata	++++(20mm)	+++(9mm)
Portunus pelagicus	++++(10mm)	+(0.7 mm)
Tiger prawn	++(4mm)	++(5mm)
Indian prawn	+(0.4mm)	+(7mm)

Ampicillin shows ++++ activity 100% against both the bacteria.

In the above table,When compared with the standard taken, we can see that *Scylla serrata* shows 100% antibacterial activity against *E. coli* and 75% against *S. aureus*; *Portunus pelagicus* shows 100% activity against *E. coli* and 25% against *S.aureus*; *Prawn sp*. (Tiger prawn) shows 50% antibacterial activity against both the bacteria; *Fenneropenaeus indicus* (Indian prawn) shows 25% activity against both the bacteria.

The inhibition zone was seen in all four samples taken either because the samples blocked the active binding sites of the bacteria or the bacteria was killed [6-7].

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4. CONCLUSION

The antibacterial activity of the carapace from crab & prawn shells was tested against two strains. They were *Staphylococcus aureus* and *Escherichia coli*. All the selected species showed inhibition zones. The advantage is, it is biodegradable, biocompatible, and has tremendous applications in the medicinal and pharmaceutical industry. According to the observations, carapaces can be used in the treatment of skin infections as an ointment, dusting powder, etc. It can be used as a calcium supplement in the treatment of rickets [8].

5. ACKNOWLEDGEMENT

Authors are thankful for the Department of Zoology, D.G. Ruparel College, Mumbai for providing facility of biological activity.

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GREEN ROUTE FOR BENZIMIDAZOLE SYNTHESIS USING SYZYGIUM CUMINI WATER EXTRACT

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ABSTRACT
In recent years environmental pollution is major concern arising globally. To full fill human needs we are running factories, industries and all other possible ways, which leads to pollution. Pharma Industry is one of the major industry, which is continuously trying to develop new product for human health. Benzimidazole is one organic compound widely used in all fields of chemical and pharma industry. In current research project we are trying to synthesize benzimidazole molecules using biocatalyst. Biocatalysts are the one which are obtaining from natural resources and they show same effect as other chemical compounds. Biocatalyst proposed here are WESC - water extract of Syzygium Cumini (White jamun).

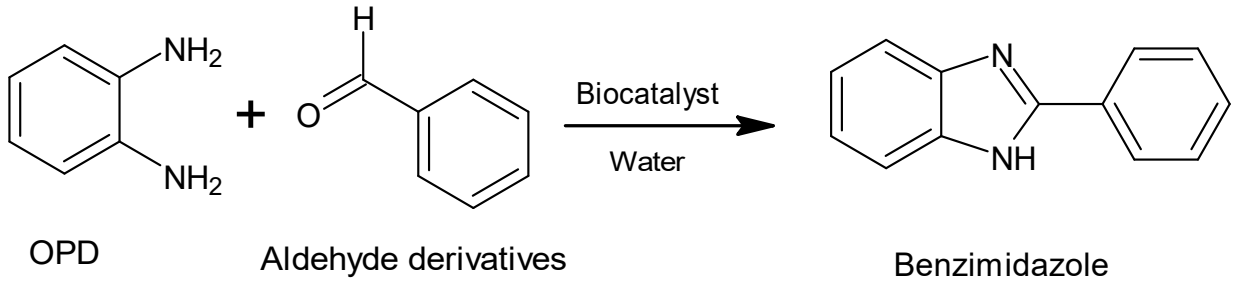
Keywords: Green Route, bio-catalyst, benzimidazole, Syzygium Cumini

INTRODUCTION
In recent years environmental pollution is major concern arising globally. In COVID pandemic situation of 2020 we peoples lock down into homes, most of the activities were stop and this was the time when lowest pollution in all fields were observed. Air quality, Water quality, river water quality was surprisingly developed to excellent level. To full fill human need we are running factories and all other possible ways, which leads to pollution. Chemicals used are one of those factors which affect the environment. Pharma Industry is one the major sector of industry, which is continuously trying to develop new product for human health. Benzimidazole is one organic compound widely used in all fields of chemical and pharma industry. Benzimidazole has versatile application in pharmaceutical industry. Benzimidazole used in antihypertensive[1], anti-inflammatory[2], anticancer[3], antifungals[4] and many other applications. There are many researchers who employed various methods and catalyst for synthesis of benzimidazole. Most of the catalyst are again a chemical like Acetic Acid[5], $K4[Fe(CN)_6]$[6] and polyphosphoric acid[7] and many more.

In current research paper we are trying to synthesize benzimidazole molecules using biocatalyst. Biocatalyst is the one which are obtaining from natural resources and they show same effect as other chemical compounds. Over regular chemical advantage of biocatalyst is that they are biodegradable, cheap, easily available and safer to use. Some of the research used some fruit juices for benzimidazole synthesis like coconut juice, orange juice, citrus limetta juice[8]. Biocatalyst proposed here are WESC - water extract of Syzygium Cumini (White jamun).

RESEARCH METHODOLOGY
Preparation of Water Extract of *Syzygium Cumini*: *Syzygium Cumini* (White jamun) fruits were washed with deionised water and cut into pieces, about 50 gm of white jamun fruit pieces were squeezed into beaker and stirred for half an hour. Obtain liquid slurry was filtered with filter paper and separated into beaker.

Benzimidazole Synthesis:
Benzaldehyde (0.01mol), O-phenyl diamine (0.01 mol) and catalytical amount of WESC - water extract of *Syzygium cummini* were mixed together in water as a solvent, reaction refluxed and monitored for completion using TLC. After completion of reaction product was separated, recrystallized and dried.



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RESULT AND DISCUSSION

Derivative preparation list with different solvents with their reaction time, yield

Sr. No.	Aldehyde Derivatives	Solvents	Biocatalyst	Time (min)	Yield (%)
1	Benzaldehyde	Water	WESC	45	83%
2	Benzaldehyde	Ethanol	WESC	50	81%
3	Benzaldehyde	Methanol	WESC	48	84%
4	Salicylaldehyde	Water	Lemon	65	80%
5	Salicylaldehyde	Ethanol	Lemon	60	80%
6	Salicylaldehyde	Methanol	Lemon	61	83%

Benzimidazole characterized on the basis of spectral technique

IR values: 1600, 1636, 2900, 3436 cm^{-1}.

NMR Values: 7.20-7.23 (m, 2H), 7.49-7.62(m, 5H), 8.20-8.21 (m, 2H), 12.96 (s, 1H, D_2O exchangeable).

CONCLUSION

Here we have reported new catalyst for benzimidazole synthesis, from its purity and yield we can conclude its possible to use such *Syzygium cummini* as biocatalyst. Biocatalyst for organic synthesis will reduce the hazardous chemical catalyst use. Biocatalyst will also helpful in cost cutting for reaction setup.

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DETECTION OF MICROPLASTICS ALONG COASTAL REGIONS OF MUMBAI

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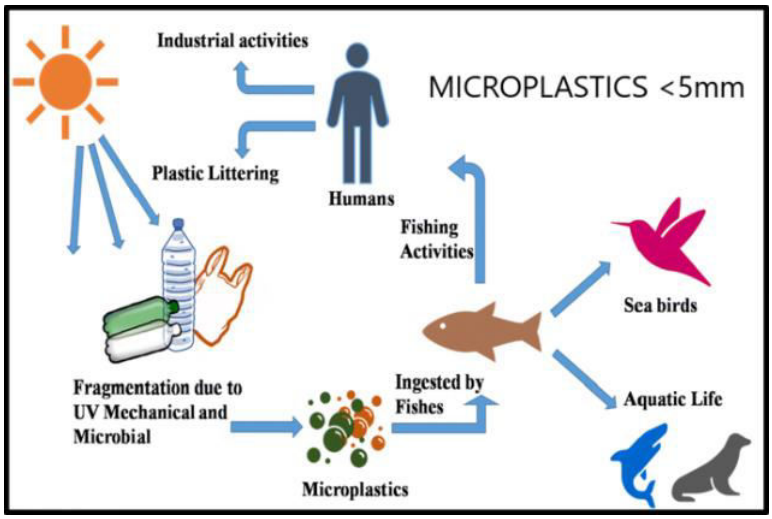
ABSTRACT
Plastic, being a versatile material, has penetrated everyday life from clothing to coatings, and from transport to cleaning products. The plastic revolution creates innovative ways of usage but indirectly contributes to pollution and becomes a serious issue. Between 4.8 to 12.7 million tonnes of plastic enter the ocean every year. This impacts our planet's precious biodiversity and damages the fragile ecosystems upon which we all depend. Cleaning our oceans still leaves small particles, known as microplastics (MPs), that degrade from large plastic pieces. MPs enter the bodies of marine life and make their way to humans through the consumption of seafood. Consuming MPs may severely ill human health and marine diversity.

This study aims to detect microplastics in seawater from coastal regions of Mumbai. Microplastics were observed in 1 litre of seawater and sediment which flowed with the water that was collected from each sampling site. The presence of plastic in our seawater and our diet highlights the overuse and improper handling of plastic waste. Single-use plastics, improper disposal of materials, and disposal of waste in aquatic systems are some of the leading causes of plastic pollution. Closing the plastic tap requires recycling plastics into other items of use, reducing the use of single-use plastics, increasing the use of alternative materials, better designing and manufacturing processes, etc. Changes in our lifestyle and reducing plastic usage is the only way to reduce microplastic content.

Keywords: Microplastics, Coastal regions, Pollution, Marine biodiversity

INTRODUCTION
Microplastics (MPs) are plastic particles with sizes less than 5 mm in length [1]. They are emerging aquatic contaminants since they are persistent, can reach high densities and interact with abiotic and biotic environments. While potential negative impacts are less obvious, their release into the oceans may also have far-reaching consequences. Human health concerns are suspected through the accumulation of microplastics in the food chain and/or the sorption of toxicants to plastic while travelling through the environment. Microplastics are classified into two types based on their sources; "primary" and "secondary" [1]. Primary microplastics are plastics directly released into the environment in the form of small particulates. They can be a voluntary addition to products such as scrubbing agents in toiletries and cosmetics (e.g., shower gels). They can also originate from the abrasion of large plastic objects during manufacturing, use or maintenance such as the erosion of tyres when driving or the abrasion of synthetic textiles during washing. Secondary microplastics are microplastics originating from the degradation of larger plastic items into smaller plastic fragments once exposed to the marine environment. This happens through photodegradation and other weathering processes of mismanaged waste such as discarded plastic bags or unintentional losses such as fishing nets.

The small size of microplastics leads to their ingestion by a wide range of marine organisms. These MPs then make their way higher up the food chain and can enter the human digestive system.



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Microplastics In Environment

MPs can cause tissue damage, oxidative stress, and changes in fish' immune-related gene expression and antioxidant status. After being exposed to MPs, fish suffer from neurotoxicity, growth retardation, and behavioural abnormalities. The consequences of MPs on human health are poorly understood. Due to the abundance of MPs in the environment, exposure may occur *via* consumption, inhalation, and skin contact. Humans may experience oxidative stress, cytotoxicity, neurotoxicity, immune system disruption, and transfer of MPs to other tissues after being exposed to them [2].

RESEARCH METHODOLOGY

Selecting Sampling Sites

This project aims to detect the number of microplastics present along some popular beaches of Mumbai city on the western coast of India. These beaches are some of the most polluted beaches in Maharashtra (Hindustan Times, 20 Sept 2017). The beaches selected for the project, in decreasing order of pollution are Juhu beach, Versova Beach, and Girgaon Beach. These beaches are popular amongst both tourists and locals. They also appear frequently in newspaper articles highlighting the levels of pollution along the shores.

Sample Collection

The samples from all sampling sites were collected on the same day i.e., 28th August 2022. The samples were collected during the monsoon but the skies were clear. Versova sample was collected at 08:45 am during low tide with minimal people present at the site. The Juhu sample was collected at 9:45 am between low and high tide with a small crowd present. The Girgaon sample was collected at 11:45 am which was 1 hour before high tide with minimal people present.

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Samples of seawater were collected in plastic bottles of 1-litre capacity. Any sediment which flowed with the seawater was also collected. The water was collected at a depth of approximately 10 cm. These bottles were washed with distilled water before collecting the samples. Plastic bottles were preferred over glass bottles for price and fragility. The collected samples from each collection site were capped and stored until processing. The area around the sampling site was also photographed.

Sample Processing

- Saturated KCl solution
- Concentrated HCl

The collected samples from the sites were filtered using vacuum filtration and the solid matter was separated. This solid matter consisted of sediment, microplastics, and other organic matter like leaves, driftwood, and pieces of shells. This solid matter was then added to a saturated solution of KCl with a density of 1.3g/mL and the mixture was kept undisturbed for 24 hours to ensure density separation of MPs. After 24 hours, the MPs which were visible to the naked eye were collected with the help of tweezers and glass droppers. These particles were treated with concentrated HCl to remove any organic matter present. They were then washed with distilled water and placed on a watch glass. The remaining sediment was then visually inspected for any microplastic particles and transferred to the watch glass. This process was repeated for each sample and the final microplastics which were removed were then photographed with a mobile phone camera. The microplastics were counted and characterised. The results are reported in a tabular form and their possible origins were discussed.

Special care

The use of plastic equipment was avoided during processing. Plastic bottles were only used during sample collection and cello tape was used for sealing. Bottles used for packaging drinking water were preferred to ensure minimal microplastic contamination in samples. Natural clothing was worn during sample collections and the samples were collected against the wind to prevent any sample contamination. The samples were always kept covered

RESULTS AND DISCUSSION

The results of this project are tabulated and described below. Microplastics were found in each sample collected. They varied in colour, size and materials. They were mostly secondary microplastics. The table indicates the number of MPs found per litre of each sample.

Table 1

Sample site	Versova	Juhu	Girgaon
No. of MPs present per litre of seawater collected	5 + 4	9 + 4	2 + 1

The number of microplastics in each sample correlates to the pollution level as per the article in Hindustan Times [3].

Each MP in the sample is labelled with an alpha-numeric code in which the first character is the first letter of the sample collection site and the second character is a number.

Sample-Versova

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The site of the collection was littered with plastic waste. The sample collected contained pieces of plastic of various sizes along with some fibrous substance.

1. V1: This is a white-coloured, low-density MP which was floating in the sample before treatment. It may be a Low-Density Polyethylene particle (LDPE).
2. V2, V3: These are blue-coloured particles which were denser than seawater. A possible source could be a plastic barrel made from High-Density Polyethylene (HDPE).
3. V4: This is a black-coloured MP floating on the surface. It might be a degraded black polythene bag, usually used by fisherfolks to sell fish.
4. V5: These fibrous substances resembled cotton. However, upon treating with concentrated HCl, there was no reaction, indicating that these are manmade fibres.

Sample-Juhu

There was a small amount of plastic waste on the beach and some plastic waste was also present in the water.

1. J1, J2, J3, J4: These are blue-coloured MPs which were floating on the surface. These are most likely degraded from blue polyethene bags.
2. J5, J6: These are translucent plastic pieces which may have turned reddish brown due to atmospheric and saline degradation.
3. J7, J8: These are clear plastic particles present in the sample. These may be parts of clear wrap used in packaging.

Along with these MPs, some coloured fibres were also noticed.

Sample-Girgaon

The collection site was the cleanest with no visible waste in the vicinity. The water collected was also clear apart from some particles.

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1. G1: This was a greenish-yellow coloured rope-like particle. This would be a part of a fishing net made of nylon or other synthetic material.
2. G2: This was an MP with pink colour, possibly originating from decorative articles.

Prevalence of Microplastics

Microplastics have been found in the air we breathe [4], in the food we consume [5,6a], or in the soil where our crops grow [7]. They were discovered at peak of Everest [8] and the depths of the deep ocean [6b,9]. In humans, the existence of microplastics in the human stool [10] and for the first time, MP fragments in the human placenta [11] were confirmed. According to an article in The Times of India, microplastics have been found in fish caught off Mumbai's coast.


Printed from
THE TIMES OF INDIA

Fish found off Mumbai coast contains microplastics: Study

TNN | Mar 7, 2022, 03.43 AM IST

MUMBAI: Next time you are getting fish cleaned and cut, try to get a good look at its parts. The Central Institute of Fisheries Education (CIFE) has found an abundant variety of microplastics in the gastrointestinal (GI) tracts and gills of croaker fish (Johnius dussumieri) netted off Mumbai's coast.

WHAT LIES BENEATH

- Gastrointestinal (GI) tract and gills of croaker fish contained (6.6 ± 1.7 and 6.2 ± 1.7) microplastics(MPs) respectively
- Microplastics hav-

What's a demersal fish?

- Bombay duck is among the most prominent of demer-sal fish species. Demersal fish

Since fish forms an important part of the diet, microplastics are consumed by many people. Daily average exposures of 382 ± 205, 594 ± 269, and 1036 ± 493 particles per person were observed through drinking water, air, and food, respectively for a person living in Mumbai [12]. The plastic intake was calculated to be 122.25 ± 177.38 to 202.80 ± 294.25 mg per person per day with food ingestion being the dominant pathway [12].

Effects of Microplastics

Due to their small size, microplastics are easily ingested by marine animals. In fishes, the ingestion and subsequent accumulation in their systems cause adverse effects on aquatic organisms. In fishes, microplastics cause blockages, toxicity, bioaccumulation and low efficiency in functioning. They also hinder the growth of aquatic plants by obstructing their root systems [15].

MPs contain certain additives and their consumption can lead to certain health complications in humans. The additives, their uses, and their health effects are mentioned in table 2.

Table 2: Additives present in microplastics [14]

ADDITIVES	PROPERTIES	EFFECTS
UV Stabilizers/Absorbers	Prevents photodegradation	Mutagenic, toxic, bioaccumulated and show estrogenic activity
Antioxidants	Delay oxidation, prevents ageing	Estrogenic effect
Plasticizers	Renders the material pliable	Renal, reproductive, cardio, and neuro-toxicity
Flame Retardants	Diminish flammability	Endocrine disruptors
Pigments	Colour	Duplication of food resulting in gut blockage
Surfactants	Modification of surface properties	Destroy mucus layer, damage gills

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Preventive Measures

Certain lifestyle changes are required to reduce the microplastic contents in our ecosystems. This includes stopping the use of single-use plastics wherever possible, recycling plastic wastes, and disposing of waste appropriately. Dumping our waste in the oceans is not an option as the oceans return the waste to the coasts. Also, the marine ecosystem is damaged due to this waste. Reducing the usage of plastic is the only way to repair the damage created by plastic waste.

CONCLUSION

The plastic revolution has greatly improved human life. We find new ways to use plastic every day. This increased use, however, has created many problems of its own. Plastics are found everywhere on earth. These may enter the systems of marine organisms and humans in the form of microplastics and have adverse effects on health.

We need to find eco-friendly and sustainable ways to reduce plastic waste. This includes the use of enzymes, green solvents and other chemical and physical techniques. Changing our lifestyle is the best way to reduce the issues of microplastic and plastic waste in general.

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3. Samples imaging by Redmi Note 10 Pro Max

a. Juhu: f/1.9 1/33 6.04mm ISO145

b. Versova: f/1.9 1/25 6.04mm ISO775

c. Girgaon: f/1.9 1/20 6.04mm ISO822

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PRODUCTION OF CITRIC ACID USING SOME FUNGI

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ABSTRACT
Citric acid is a weak organic acid that can be obtained from citrus plants, but with of science and technology, it can be produced from other plant sources or microbial fermentation . The culture filtrate were examined using paper chromatography analysis for the production of citric acid . In present work, effect of different concentrations of sugar was studied on citric acid production by two fungi Aspergillus niger and Fusarium oxysporum using star fruit as substrate. From the study of effect of different concentrations of sugars, it can be said that the final yield of citric acid in fermentation by Aspergillus niger and Fusarium oxysporum is strongly dependent on the type and concentration of carbon source. It can be said that Aspergillus niger yields high amount of citric acid as compared to Fusarium oxysporum

Keywords: Citric acid, Aspergillus Niger, Fusarium oxysporum

INTRODUCTION
Citric acid is a weak organic acid that can be obtained from citrus plants, but with of science and technology, it can be produced from other plant sources or microbial fermentation.

Citric acid has high economic potential owing to its numerous applications. It is mostly produced by microbial fermentation. In view of surges in demand and growing markets, there is always a need for the discovery and development of better production techniques and solutions to improve production yields and the efficiency of product recovery. To support the enormous scale of production, it is necessary and important for the production process to be environment friendly by using readily available and inexpensive agro-industrial products, while maintaining high production yields .Fungi are group of organism having a great biodiversity.They are the second largest group after insect and key component of the tropical ecosystem throughout the world. Fungi are not only beautiful but play a significant role in the daily life of human beings besides their utilization in industry, agriculture, medicine, food industry, textiles, bioremediation, natural cycling, as bio fertilizers and many other ways. Fungal biotechnology has become an integral part of the human welfare

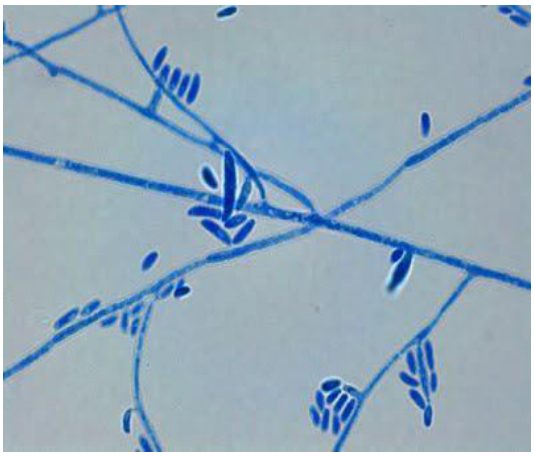
MATERIALS AND METHOD

Plant used: Star fruit (*Averrhoa carambola*), Family Oxalidaceae.

Fungi used: *Aspergillus Niger, Fusarium oxysporum*

Fermentation media were selected: PD broth, two different carbon source glucose and sucrose


Aspergillus Niger


Fusarium oxysporium

1. Isolation and Identification of Organism
Different fungal isolates were obtained from cultivated soil sample. PDA supplied with rose bengal as bacteriostatic agents was used for isolation of fungi. For the isolation, plates were incubated at 28 ± 2°C for 7 days, and developing fungi were purified and identified by macro- and microscopic characteristics. Isolated fungi were maintained on potato dextrose agar (PDA) slants and incubated at 30°C for 7 days. The slants were stored at 4°C and subcultured every month.

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2. Fermentation Technique
Citric acid fermentation was carried out by submerged fermentation in 250 ml cotton wool plugged Erlenmeyer flasks with 50 ml of fermentation media: fermentation media were selected: PD broth ,two different carbon source glucose and sucrose

3. Dry Biomass Estimation
The growth of three fungi *Aspergillus niger, Fusarium oxysporum* was compared. The content of each flask was filtered and the mycelial residues were washed with distilled water. These mycelial residues were dried in an oven for 24 h at 90℃ till their weight are to be constant and the dry biomass was calculated in g/l of fermentation medium. The filtrate were used for biochemical analysis.

4. Biochemical Analysis

A) Assay of Total Acidity
The total acidity of the culture filtrates was determined by titration against standard alkaline solution , using phenolphthalein as an indicator.

B) Detection of Citric Acid
The citric acid produced was determined qualitatively and quantitatively by chromatographic analysis.

The growth of fungal species and its production of citric acid in different fermentation media for 7 days.

		Weight of biomass (g)	Amount of citric acid in 1000 ml
Aspergillus niger	**Control**	0	0.406 g
	5% Glucose	1.79	1.043 g
	10% Glucose	3.94	1.197 g
	15% Glucose	5.85	1.176 g
	5% Sucrose	1.58	1.239 g
	10%Sucrose	3.12	1.533 g
	15%Sucrose	5.85	1.421 g

		Weight of biomass (g)	Amount of citric acid in 1000 ml
Fusarium Oxysporum	**Control**	0	0.406 g
	5% Glucose	1.74	0.273 g
	10% Glucose	2.04	0.413 g
	15% Glucose	4.18	0.266 g
	5% Sucrose	1.06	0.469 g
	10% Sucrose	1.86	0.273 g
	15% Sucrose	3.70	0.231 g

DISCUSSION
In the present work, effect of different concentrations of sugar was studied on citric acid production by two fungi *Aspergillus niger* and *Fusarium oxysporum* using star fruit as substrate. Biomass is a fundamental parameter in the characterization of microbial growth. It was observed that the biomass increased with increase in sugar concentrations of both Sucrose and Glucose in both the fungi.

From the study of effect of different concentrations of sugars, it can be said that the final yield of citric acid in fermentation by *Aspergillus niger* and *Fusarium oxysporum* is strongly dependent on the type and concentration of carbon source. It can be said that *Aspergillus niger* yields high amount of citric acid in 10% sucrose than glucose and it produced more citric acid compared to *Fusarium oxysporum.*

CONCLUSION
The project under study illustrated that the acids can be produced using fungi. This valuable potential of fungi, if exploited at commercial level, the pressure on the plant source will be reduced and the fungi can become best substitute to fruits for extraction of organic acids. Besides, there will be utilization of these fungi for good purpose. Besides, star fruit which is not consumed on a large scale is used for beneficial use.

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EDUCATION FOR OF SOCIAL CHANGE, THE CONTRIBUTION OF SOCIAL REFORMERS: PAST, PRESENT AND FUTURE

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The Social Reformers of Maharashtra had created the various impacts in regarding to the adjustments adopted for development of education in the various regions of Maharashtra. Especially Mahatma Jyotiba Phule, Gopal Ganesh Agarkar, Mahadev Govind Ranade, Gopal Hari Deshmukh, Savitribai Phule, Balshastri Jambekar, Vitthal Ramji Shinde, Vishushastri Chiplunkar, R.G. Bhandarkar, B.M. Malbari, K.T. Telang, Pandita Ramabai, Dadabai Naoroji, Jagannath Shankarshet, Bhau Daji Lad, Dadoba Pandurang, Bhaskar Pandurang, Atmaram Pandurang, Swami Dayanand Saraswati, Swami Vivekanand, Ramkrishna Paramhans, Vishnu Shastri Pandit, Dr. Babasaheb Ambedkar, Dhondo Keshv Karve, Vinoba Bhave etc.

The Indian society had various challenges for developing education within the Indian society. Some social reformers often worked for the expansion of education in Maharashtra. Education turned into beneath the welfare hood of the king Rajarshi Shahu Chhatrapati of Kolhapur, in the end it flourished and nourished in Kolhapur state and Kolhapur come forward as one of the best centre of education in India.

The contemporary educationist, thinkers and philosophers, supported the kings for the sake of education inside the Kolhapur kingdom, among them the notable are Rakhamabai Kelkar, Vasudev Topkhane, Dikshit Guruji, Kramaveer Dr. Bhaurao Patil, Dr. Appasaheb Pawar, Bapuji Solunkhe, Dr. D. T. Patil Dr. J. P. Naik etc. were the pioneers of education.

HISTORY OF EDUCATIONAL AND SOCIAL REFORMS: LANGUAGE AND EDUCATION POLICY

Initially, the East India Company did now not evince any precise hobby in matters of schooling. Although the British had captured Bengal in 1757. The study of ancient texts written in Arabic, Persian and Sanskrit nevertheless endured. In 1781, Warren Hastings mounted a Madrasa in Calcutta to encourage observe of Muslim laws in conjunction with Arabic and Persian languages.

A decade later in 1791 because of the sincere efforts of the British resident, Jonathan Duncan, a Sanskrit College became hooked up to sell the study of Hindu legal guidelines and philosophy in Banaras. Different educational surveys of Madras, Bombay and Punjab additionally show comparable statistics. There turned into at the least one faculty in every village of India at that time. The Charter Act of 1813 followed a provision to spend one lakh rupees per annum for the spread of education in India.

In 1828, after assuming the workplace of the Governor-General of India, Lord William Bentinck, emphasized at the medium of English language in Indian schooling. In the beginning of 1835, the ten contributors of the General Committee of Public Instruction have been sincerely divided into equal companies. In 1854, Sir Charles Wood despatched a complete dispatch as a grand plan on schooling. Besides, the dispatch also laid emphasis on the established order of schools for technical education, teacher and ladies schooling. Over and above those forms of, the dispatch endorsed the repute quo of one University each in Calcutta, Bombay and Madras, at the version of the London University. Consequently, inside the next few years, the Indian schooling became all at once westernized.

SOCIAL POLICIES AND LEGISLATION

Some of the British administrators like Lord William Bentinck had evinced personal hobby in the reply. There had been usually two areas wherein laws have been enacted, laws bearing on women emancipation and the caste machine. These viewpoints of British administrators on Indian progressive education brought the new framework of social change in Indian territories.

RAJA RAM MOHAN ROY

He believed that radical reforms have been necessary within the Hindu faith and its social practices, and therefore, founded the Brahmo Samaj. He believed schooling to be the most essential agent of social reform. He turned into a lifelong educator and helped observed many educational establishments inclusive of the Hindu College, Anglo-Hindu School, Vedanta College and Scottish Church College.

ISHWAR CHANDRA VIDYASAGAR

Quite like Roy, school textbooks celebrate Ishwar Chandra Vidyasagar as the Indian reformer behind the Widow Remarriage Act of 1856. What many don't recognize is that Vidyasagar become a social reformer who

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understood that a mere act of rules can not exchange the fate of women inside the use of a, nor would it assist girls combat centuries of social oppression. Educating ladies was, therefore, the larger, lifelong goal he tireless worked towards. As one of the main educators of the time, Vidyasagar held electricity to foyer for colleges for the Indian female toddler, and the truth that he exercised this electricity to the hilt is a reality that cannot be denied.

Vidyasagar prepared a fund called the Nari Shiksha Bhandar, and led door-to-door campaigns asking households to allow their daughters to be enrolled in schools. He often campaigned for ladies' s schooling through contemporary English and Bengali courses just like the Hindu Patriot, Tattwabodhini Patrika and Somprakash. He no longer only opened 35 ladies schools throughout Bengal, enrolling 1,three hundred women efficiently, but also helped JE Drinkwater Bethune establish the first everlasting ladies' college in India, the Bethune School, in 1849

Mahatma Jyotirao Phule: The reality that Jyotirao Phule, and his spouse, Savitribai Phule, were the pioneers of women's training in India is widely known. Phule's lifelong force for ladies' s training stemmed from his personal studies as a Dalit guy dwelling in nineteenth century India. He realized that so long as the shudras, ati-shudras and ladies all marginalized categories—were disadvantaged of education, they would no longer be capable of get a voice in their very own, not to mention broaden as groups with self-respect and fundamental human rights. So, in August 1848, Phule opened the primary women' school in the house of Shri Bhide in Pune. It's stated that on the very first day, 9 ladies from exceptional social backgrounds enrolled at the school. Between 1848 and 1852, Phule and Savitribai opened 18 schools in and round Pune, all of them for girls in addition to for children from Dalit households. What's extra, staring at that many had been unable to wait faculty due to the fact they laboured during the day, Phule additionally opened many night faculties by way of 1855.

PERIYAR EV RAMASWAMY

"Only education, self-admire and rational characteristics will uplift the down-trodden," the Dravidian social reformer EV Ramaswamy, popularly known as Periyar or Thanthai Periyar, is thought to have quipped as soon as upon a time—and in no way have words been more true, particularly for ladies. A pupil of historic Tamil literature, Periyar used instances from these texts to show that training is a primary ladies's proper. Not only did he actively campaign for women's education, but also desired it to be holistic with an inclusion of physical pastime in order that girls increase bodily strength as well as mental acuity.

DR. BABASAHEB AMBEDKAR

Dr Bhimrao Ramji Ambedkar is popularly celebrated because the leader architect of the Indian constitution, and also as an icon for the Dalit rights actions inside the country. But Ambedkar believed that ladies have a key role to play in the emancipation of oppressed communities, and this may be finished via making sure their personal rights to assets and schooling. "I degree the progress of network by way of the degree of progress which women have done," he stated at the Second All-India Depressed Classes Women's Conference held on 20 July, 1942. "I shall let you know a few things which I suppose you ought to undergo in thoughts. Learn to be clean; preserve free from all vices. Give schooling on your kids. Instil ambition in them. Inculcate on their minds that they're destined to be first rate. Remove from all of them inferiority complexes."

To attain these dreams, Ambedkar advocated for women's right to be knowledgeable along with men within the same schools and faculties, due to the fact that it would make sure that each get the equal first-rate of schooling. He believed that girl's training may want to assist them obtain purposes: their personal empowerment, and the empowerment of others via them. However, Ambedkar argued against professional or vocational schooling as per the British education machine, because it ambitions at growing a clerical nature of people. His emphasis, instead, turned into on secular education for social emancipation and freedom in order that depressed training can decorate their social, economic and political popularity. Social scenario to involve all deprived, women and downtrodden in education led to rational movement. *People's education society* was established by Dr. Babasaheb Ambedkar on 8th July 1945. The Siddharth Arts and Science College, turned into set up in 1946, Milind College became mounted in Aurangabad in 1950, Siddharth Commerce and Economics College turned into established in 1953, Siddharth Law College was set up in 1956.

DHONDO KESHAV KARVE

While an instructor in arithmetic (1891–1914) at Fergusson College, Poona, Karve have become worried with breaking down orthodox Hindu competition to widow remarriage, and he hooked up the Widow Marriage Association in 1893. Karve have become increasingly worried with illiteracy amongst girls, and on his retirement from Fergusson College he commenced Shreemati Nathibai Damodar Thackersey Women's

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University in 1916. He later widened his social reform efforts to consist of the status quo of societies for village number one education and the abolition of caste. Karve's autobiography became entitled Atmavritta (1915). On his 100th birthday he became presented India's maximum honour, the Bharat Ratna ("Gem of India").

KARMAVEER BHAURAO PATIL

Karmaveer Bhaurao Patil (22 September 1887 – 9 May 1959), born in Kumbhoj, Kolhapur, turned into a social activist and educator in Maharashtra, India. A strong advice of mass education, he based the Rayat Education Society. Bhaurao performed an essential role in teaching backward castes and low profits humans through coining the philosophy earn and examine.

He became an outstanding member of Satyashodhak Samaj (Truth seeker's society), founded by using Mahatma Jyotirao Phule. The people of Maharashtra honoured him with the sobriquet Karmaveer (King of movements) and the Government of India offered him with Padma Bhushan in 1959 in India. various educational schools, colleges were later on established under Rayat Education Society.

DR. PUNJABRAO DESHMUKH

Dr. Bhausaheb Deshmukh turned into born within the yr 1898. He changed into born in a farmer's family at Papal in Amravati district. The higher education was obtained at Edinburg and Oxford universities. He had carried out his regulation doctorate in Briton. The situation of his studies was" The sunrise of faith and its boom". He again again in Amravati and started out regulation exercise. He became elected as a member of provincial law board in 1930 and went on to grow to be Minister of Education, Agriculture and Co-operative Departments. He was the member of the committee for the development of Indian Constitution after independence. He became elected Member of Parliament in 1952, 1957 and 1962.

He was Union Minister of Agriculture from 1952 to 1962. His other critical contributions were beginning wells to the so-called Untouchables and establishing of Shri Ambadevi Temple to this equal communities in 1928. He also started Shraddhanand hostel for poor college students. He was the founder of famous Shri Shivaji Education Society. Today this society runs numerous instructional institutes, which encompass Medical College, Engineering college and other academic institutes and hostels. In order to enhance the situation of farmers he fashioned "Bharat Krushak Samaj" and to advise it's regulations he commenced a newspaper particularly "Maharashtra Kesari", he passed away in 1965.

RAJARSHI SHAHU CHHATRAPATI

Chhatrapati Shahu liberally helped meritorious students from the dominion that went in a foreign country for take a look at. During 1910-eleven, 15 outstanding college students were despatched out for higher research at kingdom fee. Shahu helped liberally even outsiders like Babasaheb Ambedkar, for observe remote places. Shahu changed into, truly, a champion, a friend of the needy college college students in which they're; this became one of the seen steps for the national improvement. Today, if lots of such stake holders take such duties that will be an outstanding step closer to 'Education for actual National hobby'.

SOCIAL REVOLUTION IN EDUCATION

In 1894 the amount of students turned into 10844, which rose to 27830 in 1921-22. The variety of students from the commonplace majority groups multiplied to 21027 from the not unusual majority groups multiplied to 21027 from the meagre 8088 in 1892. Even the range of college students from the untouchable companies rose from 234 to 2162. Expenditure on Education mounted to Rs. 300000 from mere 70000.

This top notch fulfilment in schooling became feasible due to the truth Shahu in my view regarded into its implementation. It changed into properly planned for sure preferred effects. It changed into now not unplanned and aimless as gift schooling system appears to be more advanced due to the efforts made through Chhatrapati Shahu. The works of Rajarshi Shahu Chhatrapati in regards to spread of education becomes towering because of his ceaseless efforts through his policies, plans, boarding hostel movement, women education, all castes schools etc. even though he made spontaneous changes in social reforms and educational reforms he got actual life of 48 year, which was very less in comparison to other social reformers and educationists. He was rightly called as a pillar of social democracy by Dr. Babasaheb Ambedkar. Chhatrapati Shahu was convinced of the fact that industrialization was the sine qua non for rapid growth of economy. As soon he ascended the throne in 1894, he ordered a comprehensive industrial survey of his principality, covering rural as well as urban areas and education, agriculture, means of transport, small-scale and cottage industries, agro industries etc. he personally visited the industrial places. In order to better the lot of the poor artisans, business men and entrepreneurs to promote employment and at the same time obviate the pitfalls of monopoly, capitalism and statist in the fields of industry, finance and commerce, he laid emphasis on co-operative and joint sector organizations. Henceforth the works of social reformers such as Shahu Chhatrapati was extremely important.

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The social reformers has made the first-rate contribution towards uplifting the downtrodden, untouchables, and girls, tribes who were provided the education and improvised the situations of education. Social reformers had been notable philanthropists, facilitators who made top notch benchmarks to establish colleges and various educational institutes. But todays conditions which might be favouring globalization, privatization, advertising and advertising and marketing, monitory benefits of wealthy businessmen, creates hustles before governments encouragement to aids to sustain schools, faculties etc. Academic institutes. Bringing social reforms is the need of time, in place of political reforms, today's conservative sections favours disparity in place of equality of education. It have to be recruitments of diverse aided institutes with certified instructors to fulfil needs of fine training, the authorities ought to pay a proper attention towards giving teachers ample possibilities to get educated underneath diverse schemes. They ought to get research involvements each durations of academic years. Students should get instructional and studies surroundings. Social reformers made this feasible in history, we should allow and try to at least encourage social reformers among us to revive the academic gadget.

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ECO- SUSTAINABILITY OF THE DIVERSITY OF BUTTERFLY SPECIES IN CAMPUS OF THE DR. HOMI BHABHA STATE UNIVERSITY, INSTITUTE OF SCIENCE, FORT, MAHARASHTRA, INDIA

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ABSTRACT
Dr. Homi Bhabha State University's, the Institute of Science is of the oldest and most prestigious Institution, located at Mumbai, Maharashtra owes its prime conservation value in India. The species composition and abundance of butterflies were documented in this study in order to manage and conserve them in the future on the Institute of Science's lush campus because they are crucial to the health of the ecosystem. A record of 39 species and 30 genera under five butterfly families was made from the campus of the Institute of Science and surrounding areas are surveyed during January, 2022 to August, 2022. Nymphalidae with 15 species over 38.46% of the total individuals was the most dominant taxonomic group of butterflies. According to the availability of their nectar and feeding plants, the overall species richness and diversity of butterflies changed with the seasons, with summer and autumn showing the highest similarity in butterfly composition. Based on the findings, it is necessary to manage and conserve the mosaic of plants in the area around the college campus in order to maintain the ecological health and integrity of the area and its rich butterfly diversity. The outcomes also showed that human activities in the research area have an adverse impact on the diversity of butterflies, thus it was preserved by establishing a butterfly garden.

Keywords: Butterfly, Garden, Institute of Science, Species Composition, Species Richness, Sustainable Development.

INTRODUCTION
An insect fauna represents more than 70% of the ecosystem and also plays a vital role in the food chain and acts as bio-indicators (Clark et al., 2007). Butterflies are beautifully colored insects with scaled wings and belong to the order Lepidoptera under the class Insecta. Butterflies are vital part of any natural ecosystem and their adults act as a bio- pollinators and larvae feeds on crops and called as primary herbivores. They are the bio indicators species in urbanized area and are very sensitive to changes in the environment and the availability of host plants for egg laying and larval development (Nimbalkar et al., 2011; Fordyce et al., 2003). The construction of roads, buildings and green lawns are increased which ultimately affects the butterfly species diversity, abundance, and richness (Blair et al., 1997; Clark et al., 2007). Seasonal variations is fundamental process in butterfly population and the seasonal fluctuations including the temperature, light, rainfall, pH, variation in the availability of larval food resources and greeneries such as herb and shrubs can also affects the butterfly diversity (Rajagopal et al., 2011). The butterfly fauna is very rich and diverse in the surrounding areas of Panchavati garden and Aarey colony due to the accessibility of diversified habitats associated with microclimate regimes. The detailed study funded by MMR -EIS in two phases from 2009 to 2012, clearly expresses the ecological importance of the highly biodiverse Aarey Milk Colony (Anand Pendharkar et al., 2021; Anne Magurran, 1988). The awareness regarding butterfly conservation, sustainable development and its importance is lacking among the public in cities. There are several surveys done on butterfly diversity by many researchers in isolated pockets of Mumbai City related to diversity and population abundance. This is the first attempt was made to fulfil the lacuna in the area of butterfly diversity in the campus of the Institute of Science.

MATERIALS AND METHODS
The butterflies were observed in the campus of The Institute of Science located in the Fort, Mumbai (Figure 1) from various ecosystems viz., Butterfly Garden and bushy areas etc. Survey for butterflies was made in a 8 months from January, 2022 to August, 2022. The study areas were surveyed every 6 days of a week and the data were documented. The data on butterfly diversity and its relative abundance were recorded based on observation of the individual butterfly species and also by photographic documentation. The survey was made from morning

7.30 to 11.30 hr. Line transect count method according to Kunte (2000) were followed to find the butterfly abundance. The transects were fixed in the routes of the Butterfly Garden thrice in a week covering an area of 5 meter around a radius of 5 meter front from the observer and 2.5m on either sides. All zoological names and identification used in the present study are in accordance with Varshney (1983), Kehimkar (2008) and

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common English names were used from Wynter- Blyth (1957). The observed butterflies were categorized into five groups on the basis of relative abundance in the study area as VC-very common (08-15 sightings), C-common (19-25 sightings), LC-less common (06-10 sightings), R-rare (05-10 sightings), VR-very rare (1-5 sightings). The diversity indices and evenness were worked out by following Shannon Wienner diversity index.

Table 1: Butterflies of Family: Hesperiidae (Skippers) recorded in the Campus of the Institute of Science, Fort, Mumbai, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance
Subfamily: Hesperiinae (Darters, Darts, Dartlets, Swifts, Aces, Bobs, Redeyes, Demons.)			
01	Rice Swift	Borbo cinnara (Wallace, 1866)	R

Table 2: Butterflies of Family: Papilionidae (Swallowtails) recorded in the Campus of the Institute of Science, Fort, Mumbai, and Maharashtra**.**

Sr. No.	Common Name	Scientific Name	Relative Abundance
Subfamily: Papilioninae			
01	Common Jay	Graphium doson (C. & R. Felder, 1864)	C
02	Tailed Jay	Graphium agamemnon (Linnaeus, 1758)	VC
03	Common Mormon Male	Papilio polytes Linnaeus, 1758	VC
04	Common Mormon Female (Form romulus)	Papilio polytes Linnaeus, 1758	LC
05	Common Mormon Female (Form stichius)	Papilio polytes Linnaeus, 1758	LC
06	Blue Mormon	Papilio polymnestor polymnestor	R
07	Lime Butterfly	Papilio demoleus Linnaeus, 1758	C
08	Common Rose	Pachliopta aristolochiae (Fabricius, 1775)	C

Table 3: Butterflies of Family: Pieridae (Whites and Yellows) recorded in the Campus of the Institute of Science, Fort, Mumbai, Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance
Subfamily: Coliadinae (Yellows)			
01	One Spot Grass Yellow	Eurema andersonii (Moore, 1886)	VC
02	Small Grass Yellow	Eurema brigitta (Stoll, [1780])	C
03	Common Grass Yellow	Eurema hecabe (Linnaeus, 1758)	VC
04	Common Emigrant	Catopsilia pomona (Fabricius, 1775)	R
Subfamily: Pierinae (Whites)			
05	Yellow Orange Tip	Ixias pyrene (Linnaeus, 1764)	LC
06	Common/Indian Wanderer Male	Pareronia hippia (Fabricius, 1787)	C
07	Common Wanderer Female	Pareronia hippia (Fabricius, 1787)	VR
08	Common Gull	Cepora nerissa (Fabricius, 1775)	C
09	Common Jezebel	Delias eucharis (Drury, 1773)	LC
10	Psyche	Leptosia nina (Fabricius, 1793)	VC

Table 4: Butterflies of Family: Lycaenidae (Blues) recorded in the Campus of the Institute of Science, Fort, Mumbai, and Maharashtra.

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Sr. No.	Common Name	Scientific Name	Relative Abundance
Subfamily: Miletinae (Brownies, Mottles, Forest Pierrot and Apefly)			
Subfamily: Polymmatinae (Weak Blues)			
01	Common Pierrot	Castalius rosimon (Fabricius, 1775)	C
02	Common Cerulean	Jamides celeno (Cramer, [1775])	C
03	Red Pierrot	Talicada nyseus (Guérin-Méneville, 1843)	C
04	Gram Blue	Euchrysops cnejus (Fabricius, 1798)	R
05	Plains Cupid	Chilades pandava (Horsfield, [1829])	C

Table 5: Butterflies of Family: Nymphalidae (Brush Footed Butterflies) recorded in the Campus of the Institute of Science, Fort, Mumbai, and Maharashtra.

Sr. No.	Common Name	Scientific Name	Relative Abundance
Subfamily: Danainae (Milkweed Butterflies)			
01	Blue Tiger	Tirumala limniace (Cramer,[1775])	C
02	Striped Tiger	Danaus genutia (Cramer, [1779])	VC
03	Plain Tiger	Danaus chrysippus (Linnaeus, 1758)	C
04	Common Crow	Euploea core (Cramer, [1780])	C
Subfamily: Satyrinae (Browns)			
05	Common Evening Brown	Melanitis leda (Linnaeus, 1758)	C
06	Common Palmfly	Elymnias hypermnestra (Linnaeus, 1763)	C
Subfamily: Heliconinae (Costers)			
07	Tawny Coster	Acraea terpsicore (Linnaeus, 1758)	R
08	Common Leopard	Phalanta phalantha (Drury, [1773])	C
Subfamily: Limenitinae (Barons, Sailers and Others)			
09	Common Sailer	Neptis hylas (Linnaeus, 1758)	VC
10	Common Baron	Euthalia aconthea (Cramer, [1777])	VC
Subfamily: Biblidinae			
11	Common Castor	Ariadne merione (Cramer, [1777])	LC
Subfamily: Nymphalinae (Painted Lady, Pansies, Eggflies, Oakleafs and Others)			
12	Grey Pansy	Junonia atlites (Linnaeus, 1763)	C
13	Great eggfly	Hypolimnas bolina (Linnaeus, 1758)	C
14	Danaid Eggfly	Hypolimnas misippus (Linnaeus, 1764)	C
15	Painted Lady	Vanessa cardui (Linnaeus, 1758)	R

Table 6: Relative abundance of butterflies observed in the Campus of the Institute of Science, Fort, Mumbai, and Maharashtra.

Sr.No.	Family	VR	R	LC	C	VC	Total
01	Hesperidae	00	01	00	00	00	**01**
02	Papilionidae	00	01	02	03	02	**08**
03	Pieridae	01	01	02	03	03	**10**
04	Lycaenidae	00	01	00	04	00	**05**
05	Nymphalidae	00	02	01	09	03	**15**
Total		**01**	**05**	**06**	**19**	**08**	**39**

VR=Very Rare, R= Rare, LC= Less Common, C=Common, VC=Very Common

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Figure 1. Map of the study area

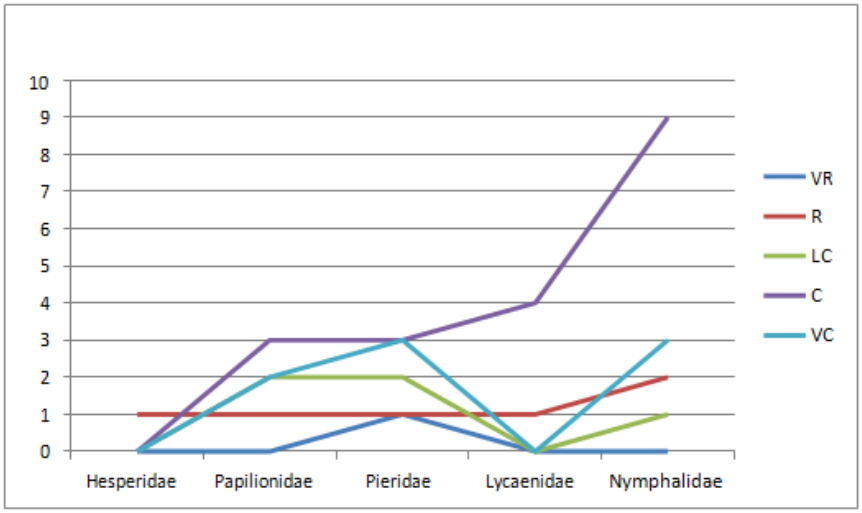

Figure 2: Relative abundance of butterflies observed in the Campus of the Institute of Science, Fort, Mumbai, and Maharashtra.

RESULTS AND DISCUSSIONS

The butterfly diversity and abundance were observed in the campus of the Institute of Science, Fort,Mumbai from January, 2022 to August, 2022 is given in Table 1 to Table 5. There were 39 species of butterflies identified and segregated under five different families according to the Kehimkar I. classification (Kehimkar, 2011). The families namely, Hesperidae Papilionidae, Pieridae, Nymphalidae, and Lycaenidae. Among the butterflies recorded in the surrounding areas of the campus of the Institute of Science, 08 of them were very common (Common Crow, Common Jay, etc.) and they were recognized under Papilionidae and Nymphalidae, 19 species were common (Common Wanderer, Small Grass Yellow etc.) and they were recognized under Pieridae, Nymphalidae and Hesperiidae while 06 number of butterflies were categorized under rare and very rare (Crimson Tip, Yellow Orange Tip, etc.). 06 numbers of butterfly species belong to Lycaenidae, Blues (Apefly) one each was found rare in the investigation areas based on their relative abundance. Regarding the abundance of the butterflies in the survey area, Psyche and Common Grass Yellow was found all over the 8 months from January, 2022 to August, 2022 (Pendharkar et al., 1986-2021).

A Butterfly garden constructed in the Institute of Science in Mumbai's Fort Campus, the city with the highest density of people, examined the significance of butterfly gardens in the conservation and management of Butterfly Diversity (Maharashtra, India). As a result of the introduction of host plants and nectar plants with habitat management, there was a tremendous increase in the butterfly population, with 39 sightings of butterflies belonging to 30 species during January, 2022 to August, 2022. Butterfly gardens can provide suitable habitats that protect butterflies and their caterpillars and provides healthy ecosystem for the sustainable development.

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Host plants are critical for all butterflies to maintain their populations (Dennis et al. 2004, Minno and Emmel 1993, Vickery 1995; adult butterflies are less abundant in areas lacking such plants (Mathew and Anto 2007). The establishment of a butterfly garden in college grounds can aid in the rehabilitation of endangered butterfly species both in rural and urban areas of southern Mumbai (Louv 2008, Miller 2005, Pyle 1978).

Butterflies can be used as flagship species to educate and raise public awareness of many important environmental issues because they are charismatic and provide attractive models for conservation (Guiney and Oberhauser 2009, Leader-Williams and Dublin 2000, Walpole and Leader-Williams 2002. The establishment of butterfly gardens, such as those created for the Schaus and Coastal Hardwood Hammock curriculum unit, can provide habitat for other vulnerable species and generate an "umbrella" that can protect multiple species against negative human impacts (Guiney and Oberhauser 2009, Malone et al. 2015, Mathew and Anto 2007, Vickery 1995). The Shannon-Wiener diversity index of the butterfly families collected in the study area indicated that the Nymphalidae was rich in species diversity with 1.31 than other families. The evenness was also found more with Nymphalidae matched with the results of (Mirza, et al., 2010).

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Figure 3: Some of the Photographs documented of butterflies observed in the Campus and Butterfly Garden of the Institute of Science, Fort, Mumbai, and Maharashtra.

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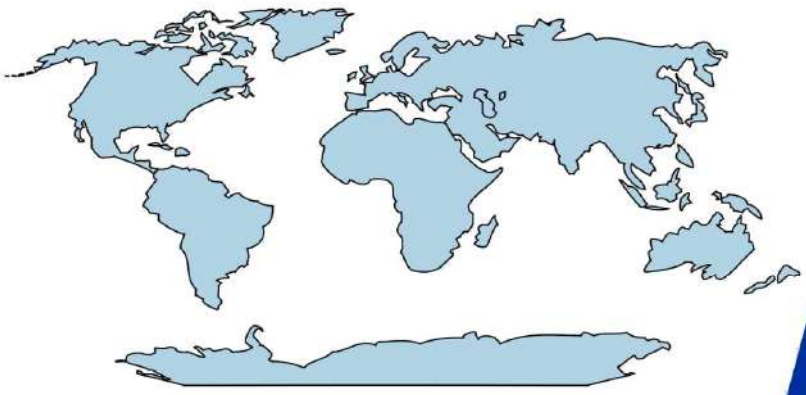

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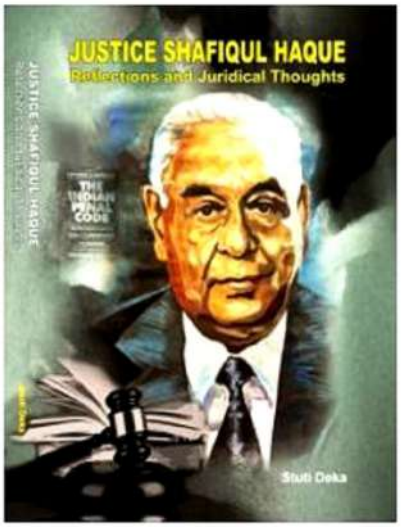

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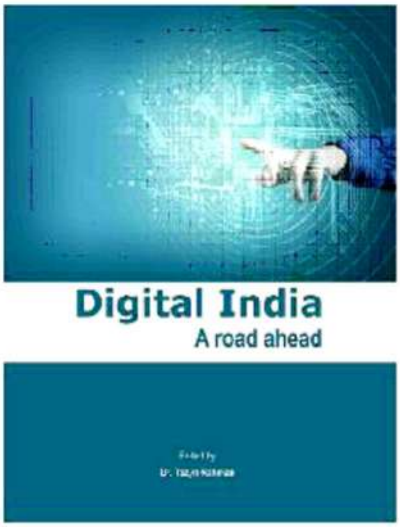

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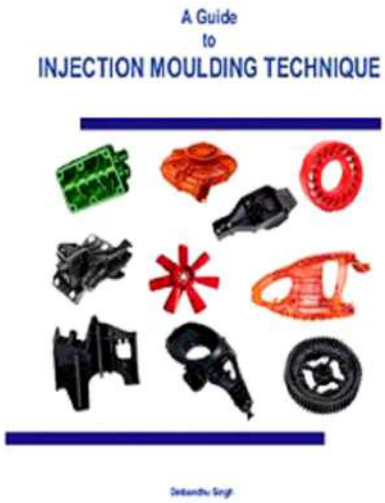

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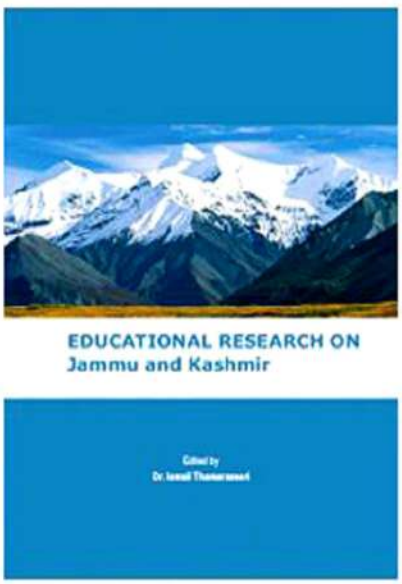

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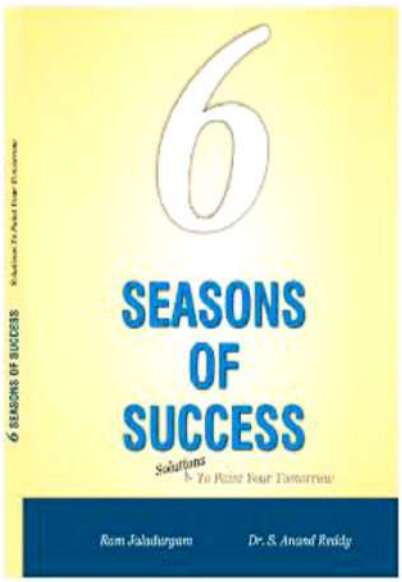

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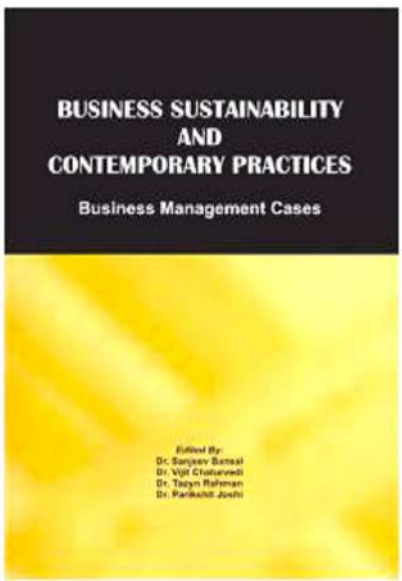

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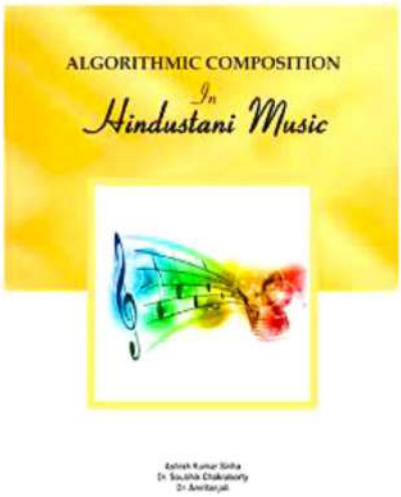

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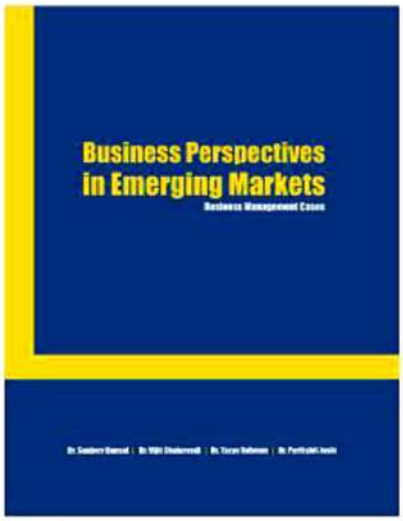

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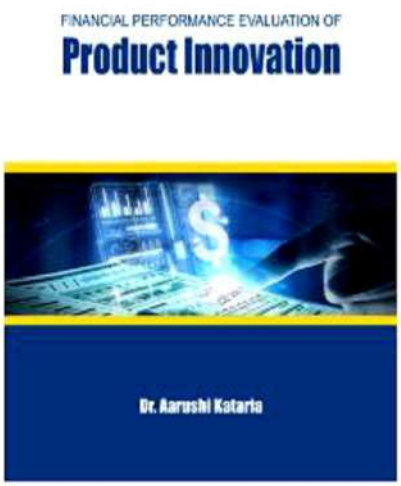

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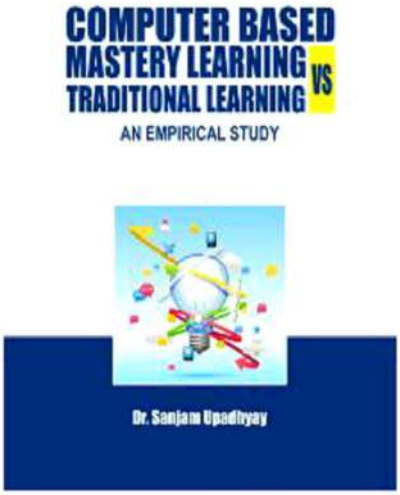

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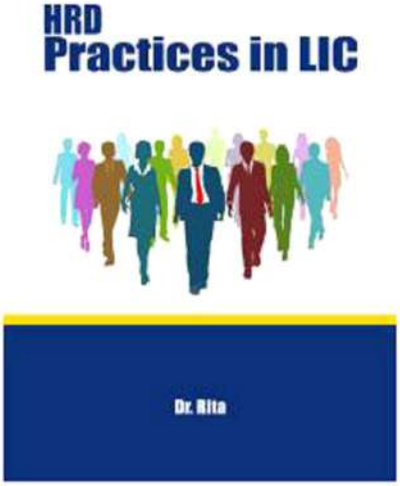

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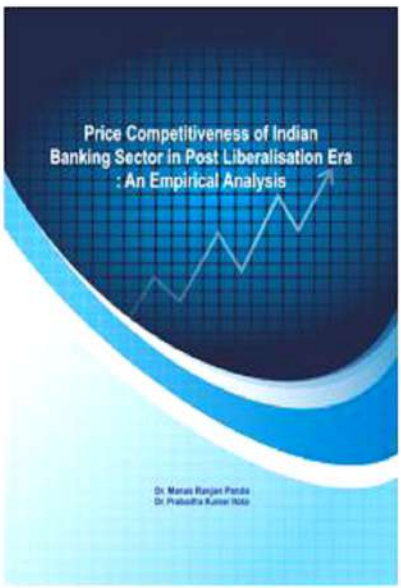

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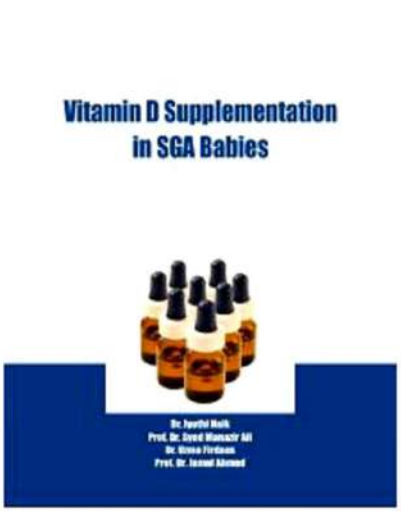

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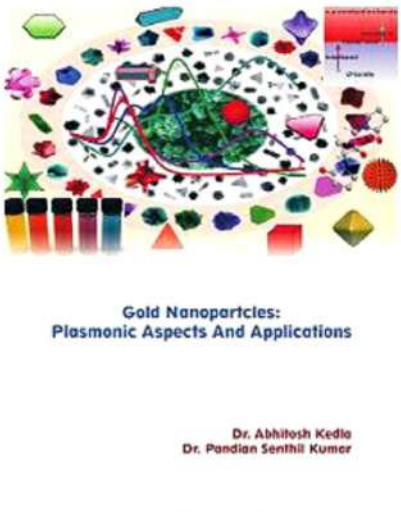

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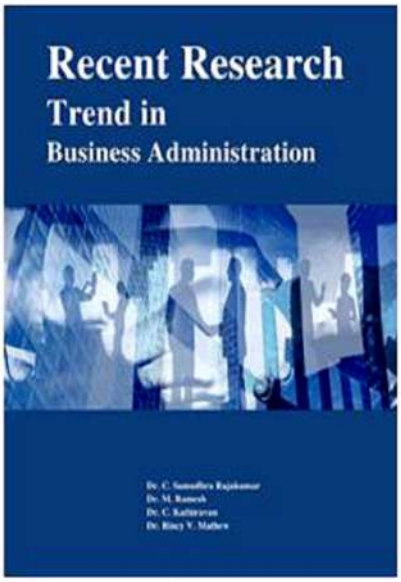

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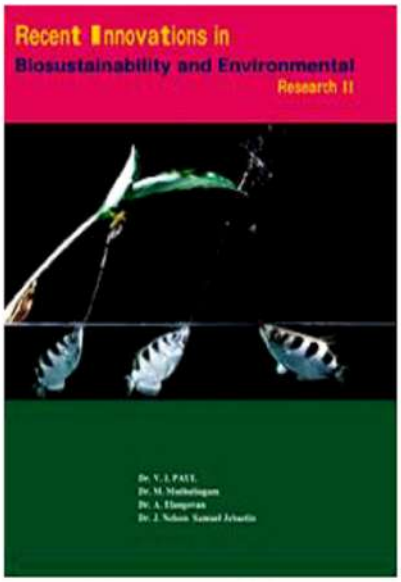

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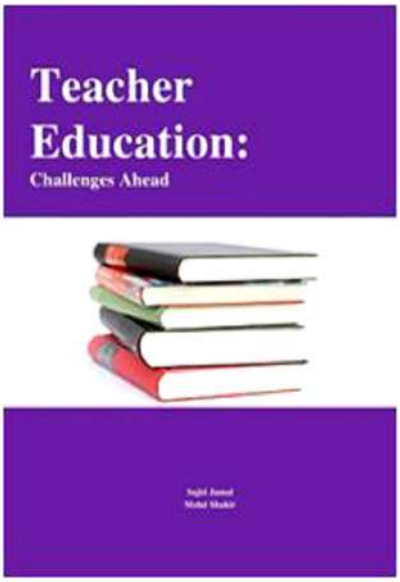

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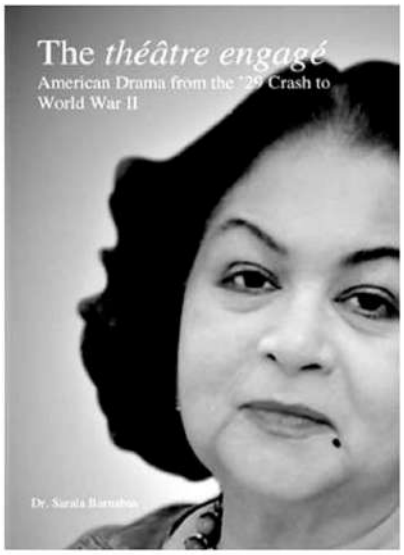

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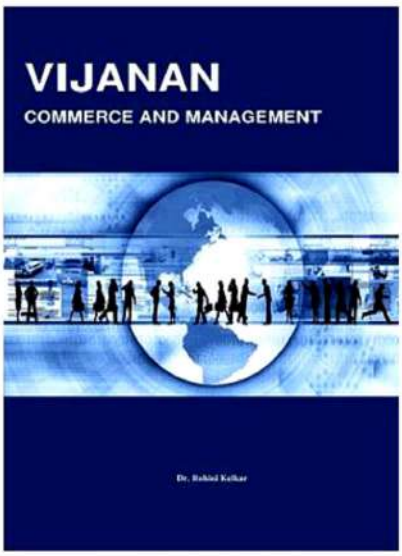

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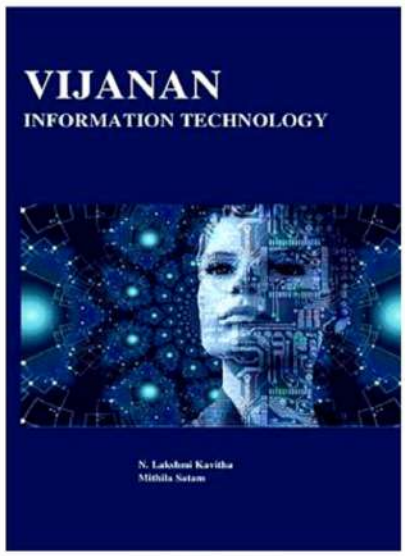

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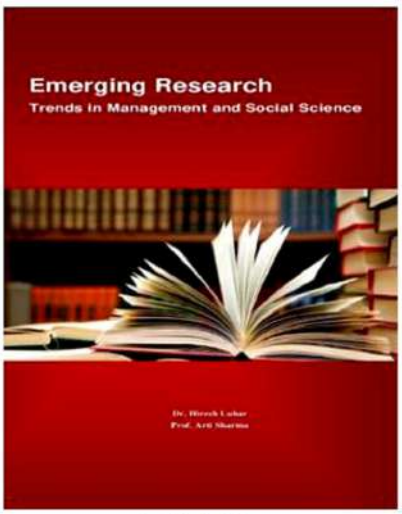

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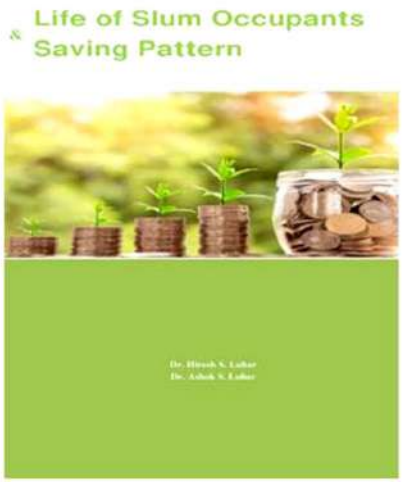

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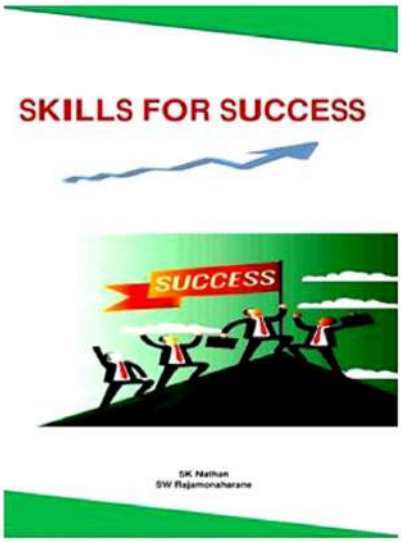

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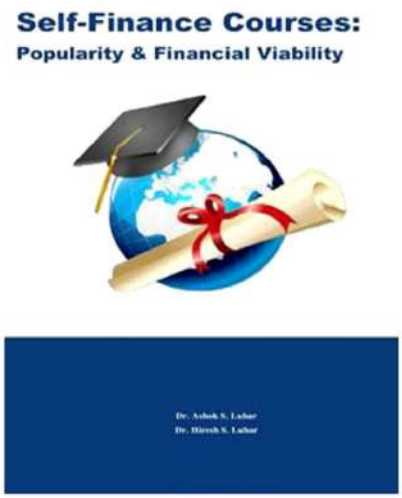

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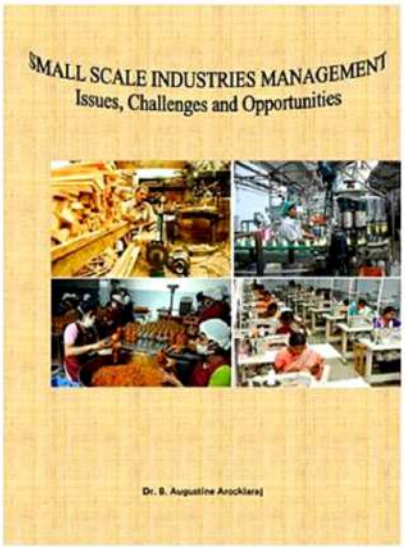

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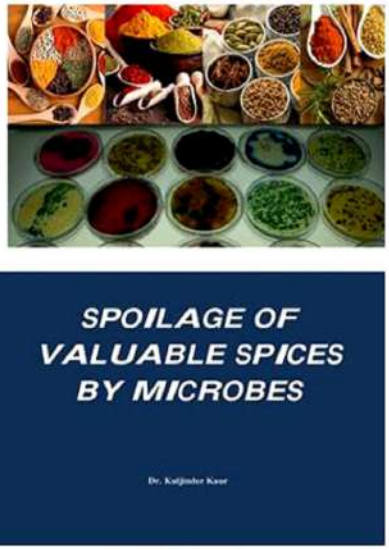

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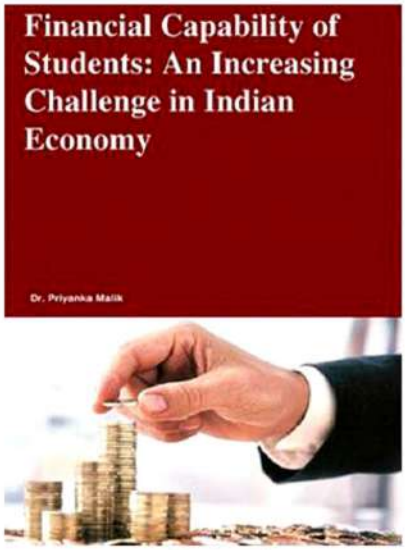

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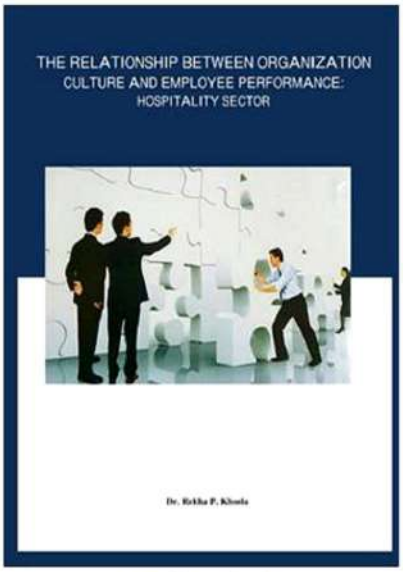

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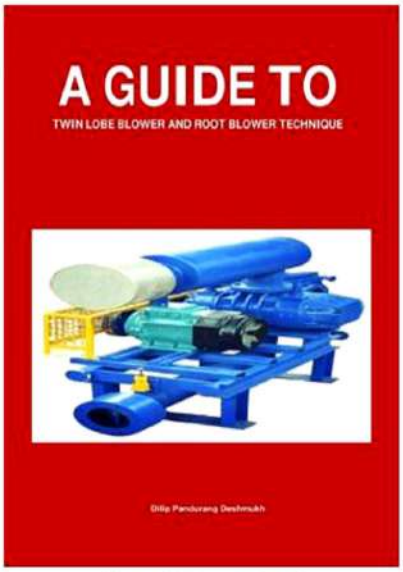

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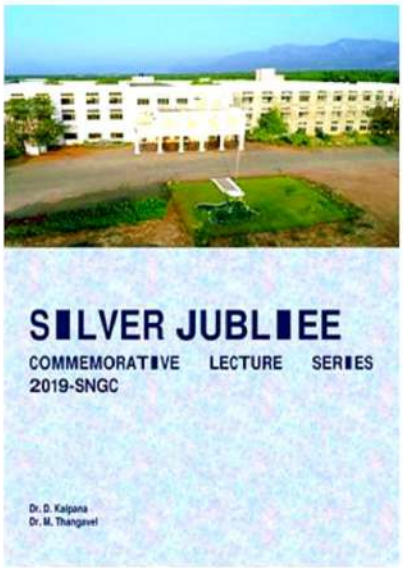

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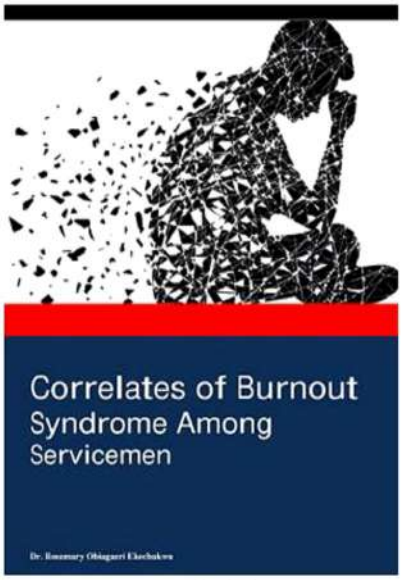

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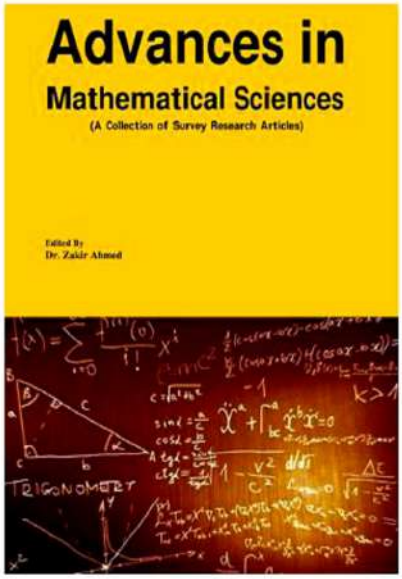

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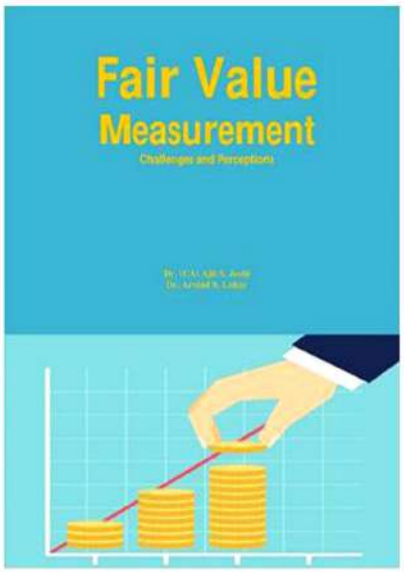

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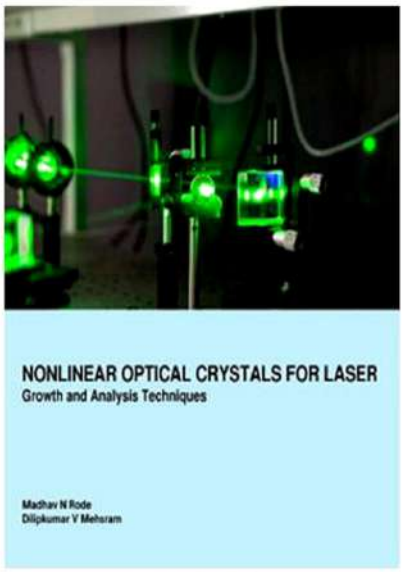

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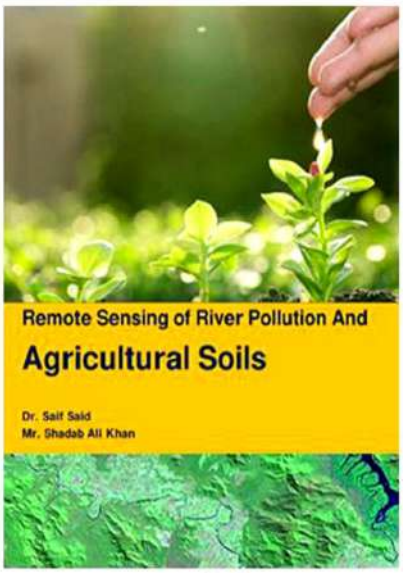

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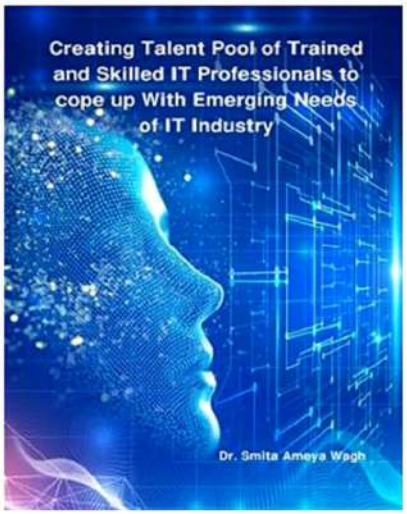

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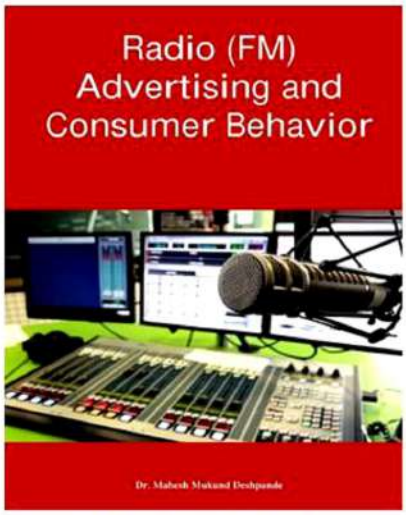

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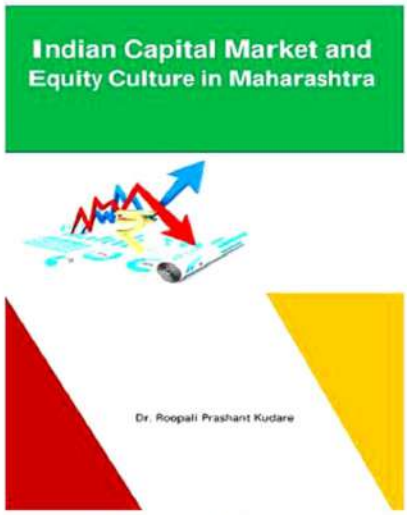

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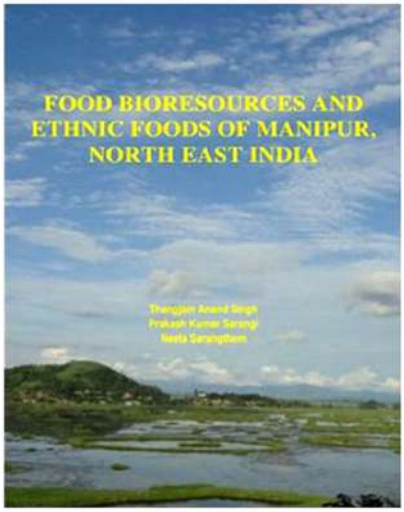

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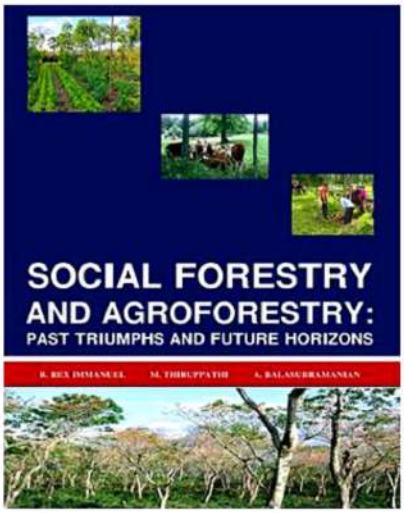

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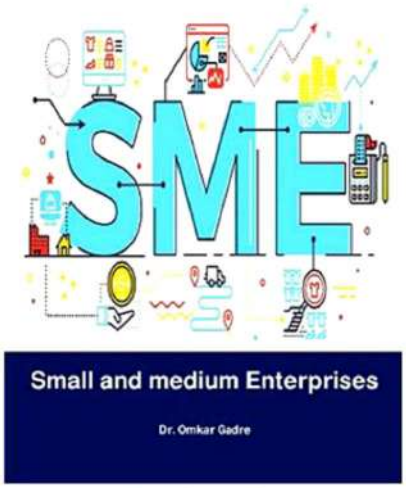

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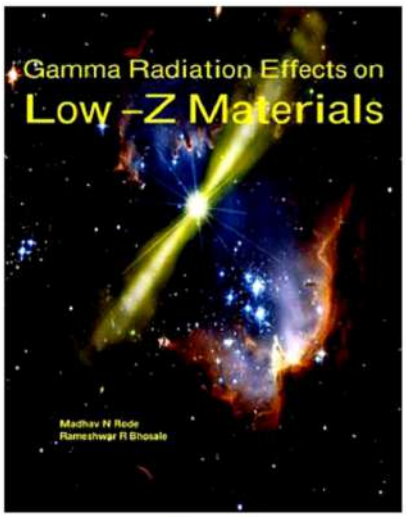

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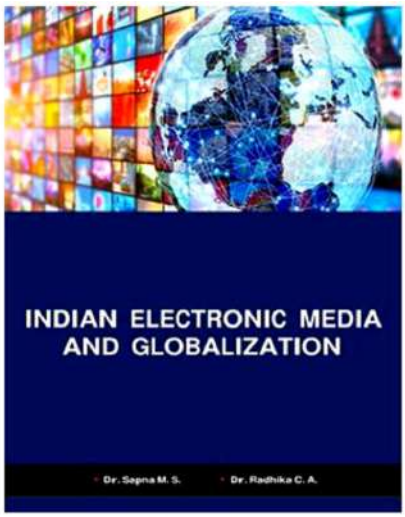

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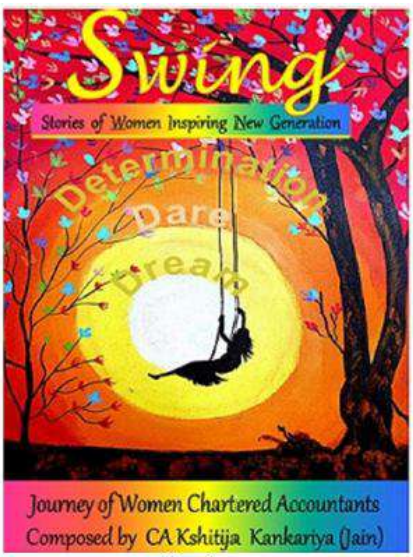

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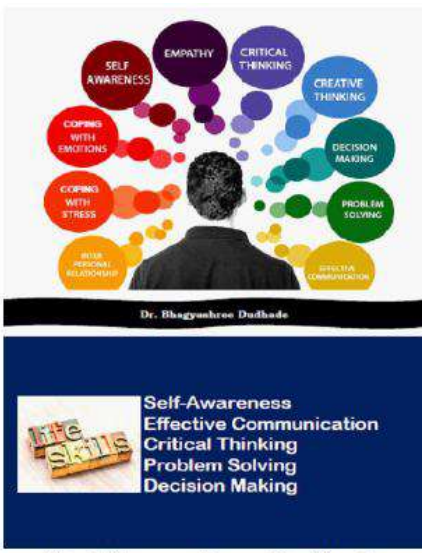

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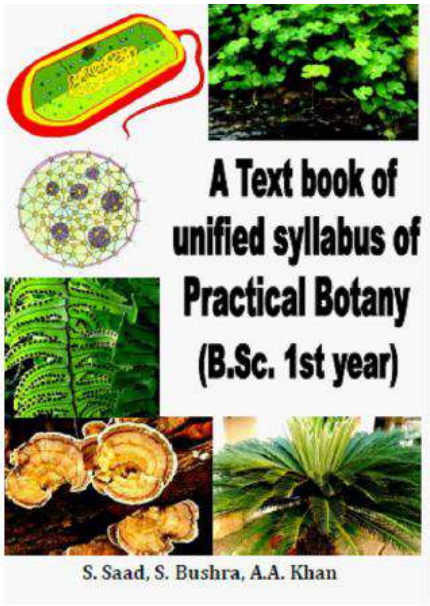

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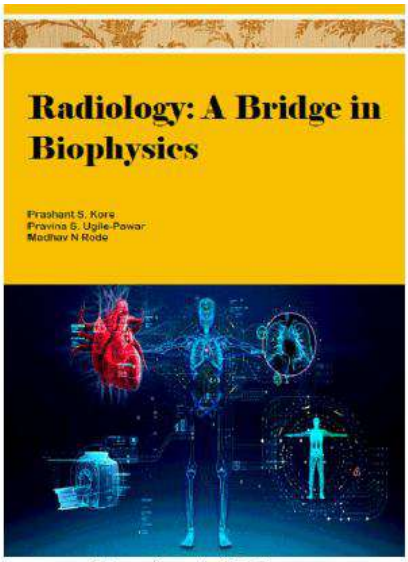

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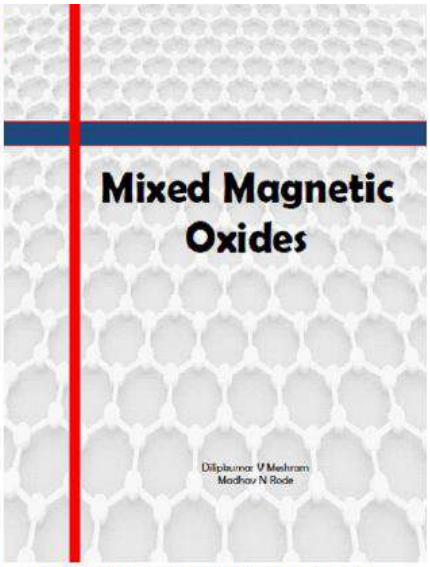

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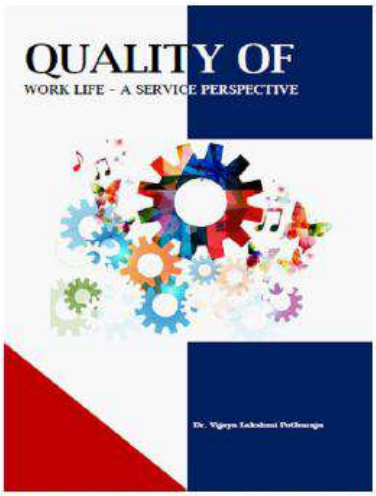

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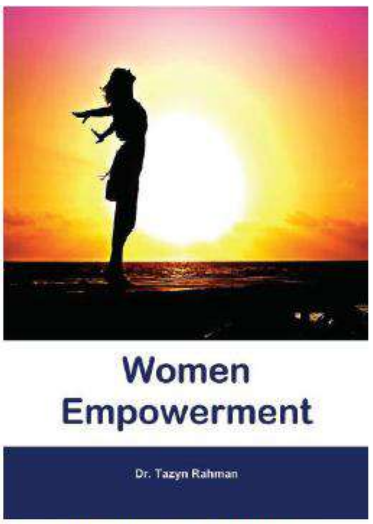

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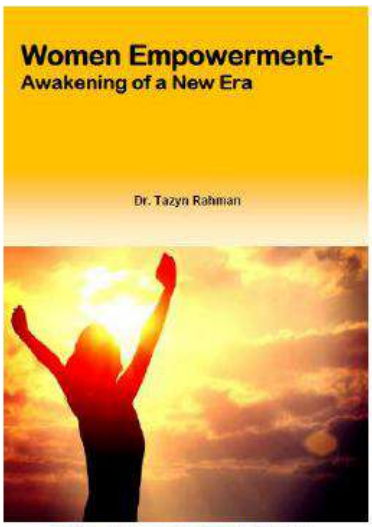

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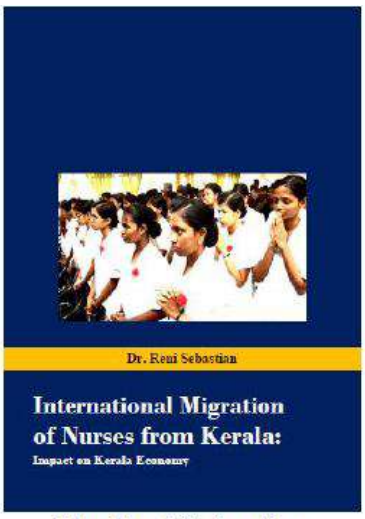

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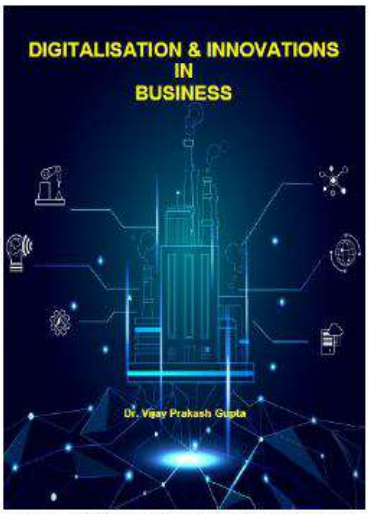

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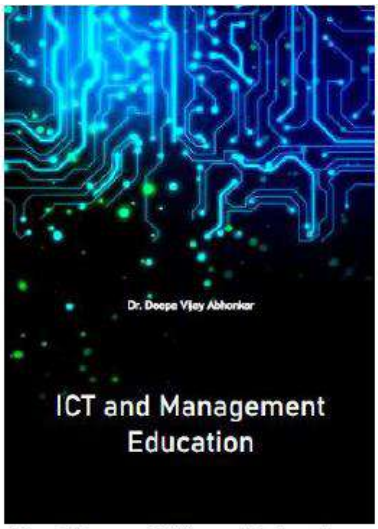

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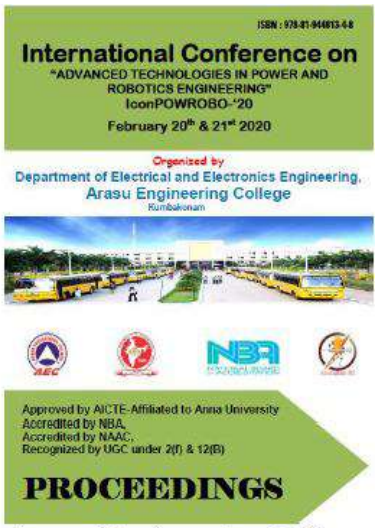

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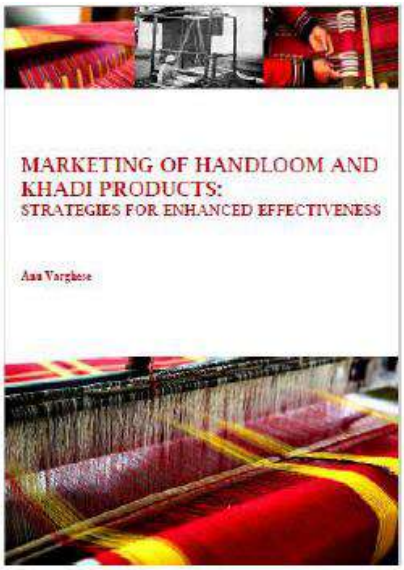

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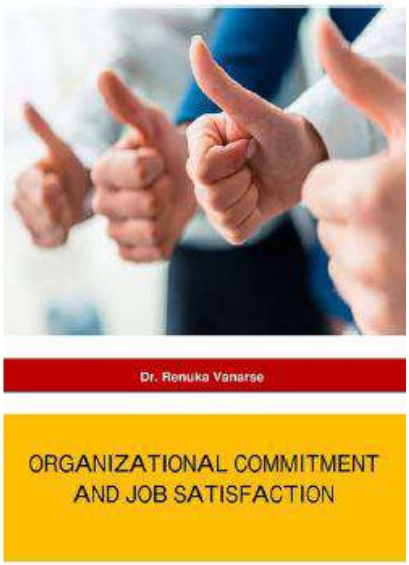

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