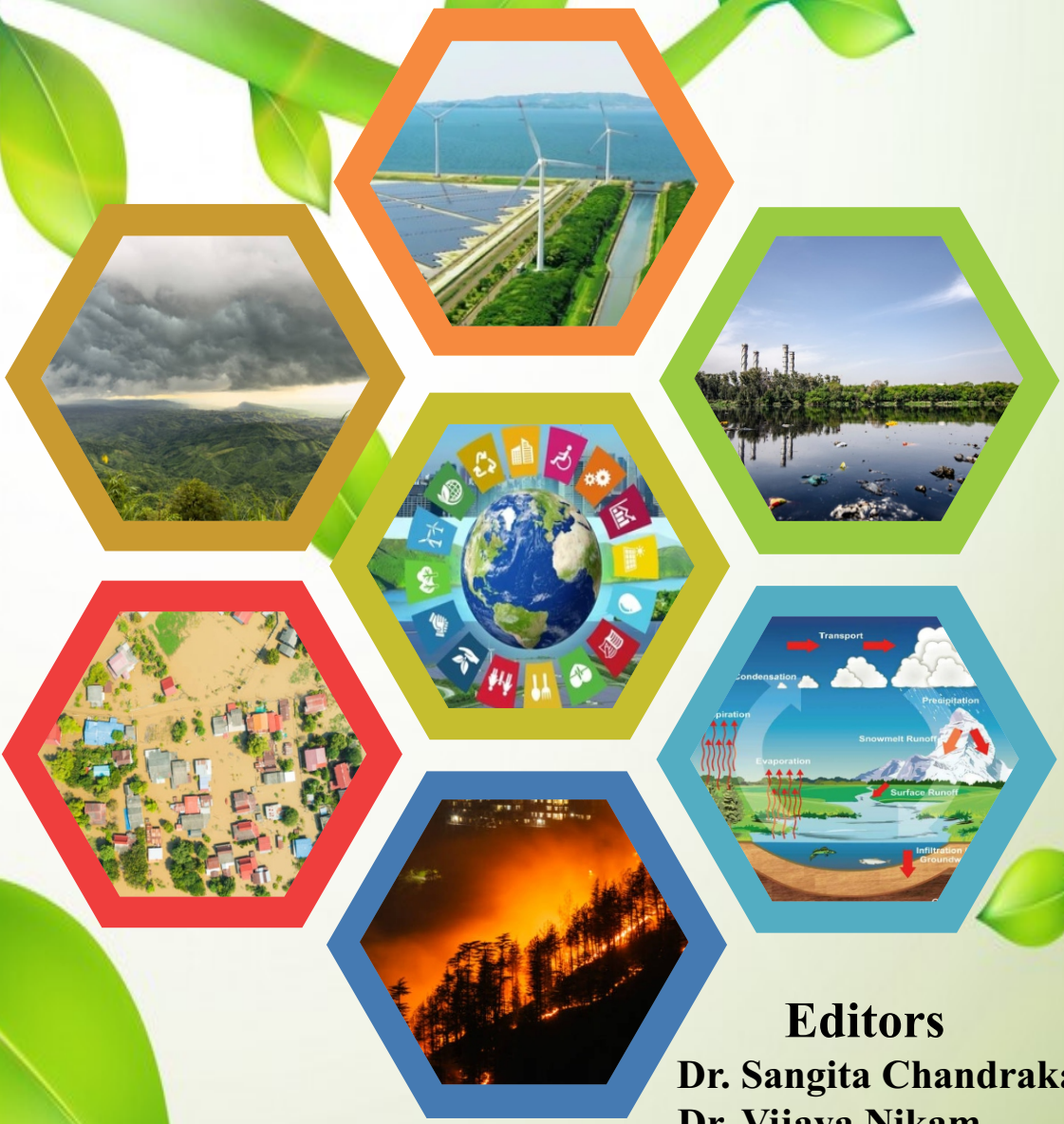
An International Edition

ISBN: 978-81-981142-8-0

Environmental Change: Challenges and Opportunities for a Sustainable Future



Editors

Dr. Sangita Chandrakar
Dr. Vijaya Nikam
Dr. Neelam Bajpai
Mr. Hrishikesh Khodade

An International Edited Book *ISBN-978-81-981142-8-0*

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

Editors

Dr. Sangita R. Chandrakar
Associate Professor
Department of Geography
Dhandai Arts & Science College,
Amalner, Dist-Jalgaon, Maharashtra, India.

Dr. Vijaya K. Nikam
Associate Professor,
Department of Botany,
Sadguru Gadage Maharaj College,
Karad (Dist. Satara) - 415 124, Maharashtra, India.

Dr. Neelam Bajpai
Assistant Professor
Department of Zoology
Mahamaya Government Degree College,
Kaushambi, Uttar Pradesh, India

Mr. Hrishikesh Khodade
Assistant Professor
Department of Botany,
S. M. Joshi College, Hadapsar, Pune, Maharashtra, India.

Published By

Nature Light Publications, Pune

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

Editors

Dr. Sangita R. Chandrakar
Dr. Vijaya K. Nikam
Dr. Neelam Bajpai
Mr. Hrishikesh Khodade

First Edition: 30 March, 2025

An International Edited Book

ISBN- 978-81-981142-8-0

Published by:

Nature Light Publications, Pune
309 West 11, Manjari VSI Road, Manjari Bk.,
Haveli, Pune- 412 307.
Website: www.naturelightpublications.com
Email: naturelightpublications@gmail.com
Contact No: +91 9822489040 / 9922489040

Preface

We are happy to welcome the idea of publishing a book on relevant topic, "Environmental Change: Challenges and Opportunities for a Sustainable Future". Further, it is good that the articles from various sub-disciplines are included in the book. The scholars from Environmental science have attempted to identify the current trend and to provide ideas to doing the recent study.

The 21st century stands at a critical crossroads. Environmental change—driven by a complex interplay of natural processes and human activity—has become one of the defining challenges of our time. From climate instability and biodiversity loss to pollution and resource depletion, the planet's systems are undergoing rapid transformation. Yet, amid these pressing challenges lie profound opportunities to rethink, reshape, and redirect our trajectory toward a more sustainable and equitable future.

Environmental Change: Challenges and Opportunities for a Sustainable Future brings together diverse perspectives from scholars, practitioners, and policy experts working across environmental disciplines. This edited volume seeks to explore not only the multifaceted nature of environmental change but also the innovative responses that are emerging to address it. It emphasizes the need for integrative thinking, cross-sector collaboration, and forward-looking strategies that bridge science, policy, and community action.

The book is structured around three interrelated themes: understanding the drivers and impacts of environmental change, exploring adaptive and technological responses, and reimagining governance and sustainability pathways. Each chapter contributes to a broader dialogue on how societies can navigate uncertainty, mitigate risk, and embrace resilience.

This volume is the result of a collaborative effort by contributors who are at the forefront of research and action. We are grateful to the authors for their insights and commitment, and to the reviewers who provided thoughtful feedback throughout the editorial process. We also acknowledge the institutions and communities that support this essential work on the frontlines of environmental transformation.

Our hope is that this book will serve as a resource and a catalyst—for educators,

students, decision-makers, and citizens—who are striving to understand and shape the complex dynamics of our changing world. As the global community seeks solutions, we must remember that every challenge holds within it the seed of opportunity—and every decision we make today can help build a more sustainable tomorrow.

Date: *30 March 2025*

Editors

Environmental Change: Challenges And Opportunities for A Sustainable Future

Table of Content

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 01 - 06 |

Unequal Earth: Examining Environmental Injustice and The Struggle for Climate Justice in Marginalized Communities

[1]B. Vivilia Arivu Mani

[2]B. Isaac Tamil Durai

[1]PhD Research Scholar (Full-Time), Department of English, Thiruvalluvar University, Vellore, Tamil Nadu.

[2]MA. M.ED. Department of Education, Indian College of Education, VIT Road, Katpadi, Vellore, Tamil Nadu.

Email: viviliabeya@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188415

*DOI: **10.5281/zenodo.15188415***

Abstract

Environmental injustice in India disproportionately impacts marginalized communities, including Dalits, Adivasis, and economically disadvantaged groups, who face the harshest consequences of climate change, industrial pollution, and resource exploitation. Despite contributing minimally to environmental degradation, these communities bear the brunt of deforestation, air and water pollution, and displacement due to large-scale developmental projects. The paper examines the historical and socio-political factors that perpetuate environmental inequality in India, focusing on cases such as the Bhopal gas tragedy, displacement due to dam projects like the Sardar Sarovar, and the water crises in regions like Bundelkhand. It critically analyzes the role of state policies, corporate interests, and global climate frameworks in exacerbating these injustices while highlighting the resistance movements led by affected communities. By integrating insights from environmental justice theories and grassroots activism, the paper aims to analyze the urgent need for inclusive climate policies that prioritize equity, Indigenous knowledge systems, and participatory governance. Addressing environmental injustice in India requires a paradigm shift toward sustainable development that centers on the rights and voices of the most vulnerable. The paper aims to contribute to the discourse on climate justice by advocating for systemic reforms that align environmental sustainability with social justice.

Keywords: Environmental injustice, climate justice, marginalized communities, India, Dalits, Adivasis, industrial pollution, displacement, environmental racism, resource

exploitation, grassroots activism, sustainable development, climate policy, environmental governance, social justice.

Introduction:

The term Environmental injustice refers to the disproportionate exposure of marginalized communities often low-income or racial minority groups to environmental hazards such as pollution, toxic waste, and climate-related disasters. The father of environmental justice Robert D. Bullard, states "Environmental injustice refers to any policy, practice, or directive that differentially affects or disadvantages (whether intended or unintended) individuals, groups, or communities based on race or socio-economic status" (07). These communities typically have less political power, making them more vulnerable to harmful environmental policies and industrial activities while lacking adequate resources for mitigation and recovery.

The former President of Ireland and UN High Commissioner for Human Rights, Mary Robinson says "Climate change is happening because of the great disproportion of power and wealth in the world. It is, at its heart, a justice issue" (34). Climate justice is a broader concept that recognizes the ethical and political dimensions of climate change. It emphasizes that climate change is not just an environmental issue but also a matter of human rights and social equity. Climate justice seeks to address the unequal burdens of climate impacts by advocating for policies that prioritize vulnerable populations, ensure fair access to resources, and hold major polluters accountable. It also acknowledges the historical responsibility of developed nations in contributing to climate change and calls for equitable solutions, such as financial and technological support for affected communities.

Climate justice is highly relevant to India due to its vast population, economic disparities, and vulnerability to climate change. Rising temperatures, erratic monsoons, and increasing natural disasters like floods and cyclones disproportionately affect marginalized communities, including farmers, coastal populations, and urban slum dwellers. India also faces severe environmental injustices, with industrial pollution, deforestation, and water scarcity disproportionately impacting poor and indigenous communities. Despite contributing relatively little to historical carbon emissions, India bears significant climate burdens, highlighting the need for equitable policies, sustainable development, and international climate finance. Addressing climate justice in India is crucial for ensuring social equity, protecting livelihoods, and building climate resilience. "The impacts of climate change are not felt equally; those who have contributed least to the problem are often the most vulnerable" ((Intergovernmental Panel on Climate Change 2022).

The research paper aims to explore the extent and impact of environmental injustice on marginalized communities in India, examining their struggles in seeking climate justice. It investigates systemic inequalities in resource distribution, exposure to environmental hazards, and socio-political challenges. The research paper examines important laws and grassroots campaigns for climate justice. A qualitative

methodology is used, which includes policy analysis, activist and expert interviews, and case studies of impacted communities. Disparities in pollution exposure, climate vulnerability, and policy effectiveness are evaluated using quantitative data from government reports, environmental organizations, and scholarly research.

"Environmental degradation and climate change do not affect all people equally; caste, class, and gender determine who suffers the most and who has the least access to resources for adaptation and survival" (Behera 45). Climate change and social inequality are deeply interconnected, as climate-related disasters disproportionately affect marginalized communities with limited resources and adaptive capacity. In India, extreme weather events like heatwaves, floods, and droughts exacerbate existing socio-economic disparities, hitting the poor, rural populations, and informal laborers the hardest. These groups often lack access to resilient infrastructure, healthcare, and financial support, making recovery from climate shocks more difficult. Additionally, caste and gender-based inequalities intensify vulnerabilities, with Dalits, Adivasis, and women facing greater livelihood disruptions due to displacement and resource scarcity. While wealthy populations can afford protective measures, low-income communities bear the greatest environmental burdens despite contributing the least to carbon emissions. Addressing climate change as a social justice issue requires policies that center equity, ensuring that adaptation and mitigation efforts do not reinforce existing disparities but instead empower vulnerable populations through inclusive governance and sustainable development.

The intersections of caste, class, and environment play a critical role in shaping environmental injustices faced by marginalized communities in India. Caste-based hierarchies often determine access to natural resources, land ownership, and exposure to environmental hazards. Dalit and Adivasi communities, historically relegated to the most polluted and ecologically fragile areas, are disproportionately affected by industrial waste, deforestation, and water scarcity. Similarly, class disparities influence climate vulnerability, as lower-income groups lack the financial means to relocate from disaster-prone regions or invest in climate-resilient infrastructure. The informal labor sector, comprising a large portion of marginalized workers, faces heightened risks due to extreme heat, air pollution, and unsafe working conditions. Additionally, women within these communities experience compounded burdens, as they are primarily responsible for securing water, fuel, and food, all of which are increasingly threatened by climate change. Addressing these intertwined inequalities requires an intersectional approach that integrates caste, class, and gender considerations into environmental and climate policies.

Environmental injustice in India manifests through industrial pollution, displacement, deforestation, and stark rural-urban disparities, disproportionately affecting marginalized communities. The Bhopal Gas Tragedy (1984) remains a glaring example, where toxic gas exposure from

a pesticide plant killed thousands, with poor laborers and slum dwellers suffering the worst long-term consequences. Similarly, the Narmada Dam project led to the displacement of thousands of Adivasi and rural families, stripping them of their traditional livelihoods. Deforestation and land grabs, particularly in mining-intensive states like Jharkhand and Chhattisgarh, have dispossessed Adivasi communities, undermining their rights and cultural heritage. Meanwhile, the urban-rural divide in environmental injustice is evident in the stark contrast between Delhi's severe air pollution, which disproportionately affects informal laborers and slum residents, and chronic water crises in rural villages, where groundwater depletion and erratic monsoons leave farmers struggling for survival. Addressing these injustices requires stronger environmental governance and inclusive policy frameworks.

Caste-based inequalities in India significantly shape climate vulnerability, with Dalits, particularly manual scavengers, facing extreme environmental and occupational hazards. As the most marginalized caste group, Dalits are often relegated to the most polluted and disaster-prone areas, lacking access to clean water, sanitation, and resilient infrastructure. Manual scavengers, who are forced into unsafe sewage and waste disposal work due to caste-based discrimination, suffer from chronic exposure to toxic gases, waterborne diseases, and extreme heat, which climate change further exacerbates. During climate-induced disasters such as floods or heatwaves, Dalit communities experience greater displacement and neglect in relief efforts due to systemic caste bias. Furthermore, their socio-economic marginalization limits access to adaptation resources, making them disproportionately vulnerable to food insecurity and livelihood loss. Addressing caste-based climate vulnerability requires inclusive policies that integrate social justice with environmental resilience, ensuring equitable access to clean environments, healthcare, and climate adaptation programs.

The struggle for climate justice in India is driven by grassroots movements, civil society efforts, and legal interventions. Community resistance and indigenous movements have played a crucial role, with movements like the Chipko Movement (1970s) advocating forest conservation and Narmada Bachao Andolan resisting large-scale displacement due to dam construction. NGOs and civil society organizations support vulnerable communities by providing legal aid, promoting sustainable practices, and holding corporations accountable for environmental damage. Judicial interventions, such as the Environmental Protection Act (1986) and the establishment of the National Green Tribunal (2010), have strengthened legal mechanisms to address environmental violations and promote climate justice. However, gaps in enforcement remain a challenge. The debate between global and local climate justice advocacy highlights the need for international climate finance and equitable resource distribution while ensuring that India's local communities retain agency in climate policies. Strengthening grassroots resistance and inclusive

governance is key to achieving meaningful climate justice. "Environmental governance in India remains ineffective not due to a lack of policies, but due to weak enforcement, corporate influence, and the marginalization of vulnerable communities in decision-making" (Baviskar 54).

India faces significant challenges in achieving climate justice due to policy gaps and weak implementation. While environmental laws exist, enforcement is often inconsistent, with marginalized communities continuing to suffer from pollution, displacement, and climate disasters. Corporate influence exacerbates environmental degradation, as industries prioritize profit over sustainability, often bypassing regulations through political and economic clout. The expansion of mining, deforestation, and industrial projects frequently disregards the rights of indigenous and rural populations. However, technology and sustainable development present opportunities for change. Innovations in renewable energy, climate-resilient agriculture, and waste management can mitigate environmental harm while creating sustainable livelihoods. Moving forward, stronger policy enforcement, corporate accountability measures, and community-led climate adaptation programs are essential. Empowering grassroots activism, increasing public awareness, and integrating climate justice into governance can ensure a more equitable and sustainable future for India's most vulnerable populations. Collaborative action between government, civil society, and local communities is crucial.

Therefore, India's environmental injustice disproportionately affects marginalized communities, with caste, class, and geography determining climate vulnerability. Key findings highlight that industrial pollution, deforestation, and poor environmental governance exacerbate these inequalities, while grassroots movements and legal frameworks, though significant, often face implementation challenges. Climate justice in India requires stronger enforcement of environmental laws, corporate accountability, and policies that prioritize vulnerable populations. The implications of inaction are severe—rising climate disasters, deepening social inequalities, and worsening public health crises. To address these issues, a combination of legal reforms, grassroots activism, and sustainable development policies is essential. Strengthening indigenous and local resistance, promoting climate education, and ensuring community participation in decision-making can lead to more equitable and just environmental policies. A holistic, intersectional approach—one that integrates climate action with social justice is necessary to build a resilient and inclusive future for all.

References

1. Baviskar, Amita. "Ecology and Equity: The Challenge of Environmental Justice in India." Seminar, vol. 738, 2021, pp. 45-50.
2. Behera, Ambika Prasad. "Caste and Climate Justice: The Intersection of Social Hierarchies and Environmental Vulnerabilities in India." Economic and Political Weekly, vol. 57, no. 12, 2022.

3. Bullard, Robert D. Dumping in Dixie: Race, Class, and Environmental Quality. Westview Press, 1990.
4. Intergovernmental Panel on Climate Change. Climate Change 2022: Impacts, Adaptation and Vulnerability. Cambridge UP, 2022.
5. Robinson, Mary. Climate Justice: Hope, Resilience, and the Fight for a Sustainable Future. Bloomsbury Publishing, 2018
6. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of Statistical Techniques for Monitoring and Evaluation of Water Quality of Bhima River, Indian Journal of Natural Sciences, 14(80) 62440-62451
7. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of geospatial technique for monitoring Groundwater Level Fluctuation in Karjat Tehsil in Ahmednagar District of Maharashtra, Sanshodhak, 90(04) 362-372
8. Agastirishi Bharat Toradmal, Vilas Vasant Patil (2021) Assessment of Groundwater Level Fluctuation In Karjat Tehsil In Ahmednagar District of Maharashtra State Using GIS Technique, Wesleyan Journal of Research, 14(11) 31-39
9. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2021) Assessment of Jalyukt Shivar Abhiyan Water Conservation Scheme in Karjat Tehsil of Ahmednagar District, Maharashtra-Using GIS Technique, Ecology, Environment & Conservation 27 (February Suppl. Issue) S71-S78
10. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020) Identification of Groundwater Potential Prospect Zones in Semi-Arid Region- A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra, Journal of Xidian University 14(05) 814 - 824 https://doi.org/10.37896/jxu14.5/085
11. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020), Identification of Probable Water Scarcity Zones in Marathwada Region of Maharashtra. Gedrag & Organisatie Review, 33(02) 687-696
12. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Assessment of Rainfall Variability trend in Solapur District of Maharashtra. Aegaeum Journal, 8(4) 234-241
13. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Digital Terrain Analysis for Watershed Characterization and Management-A Case Study of Vincharna River Basin Maharashtra, India. Journal of Information and Computational Science, 10(2) 637-647

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 07 - 20 |

Nanded Suburbs: Changes in Land Use

Dr. Rathod S. B.

Associate Professor & Head, Dept. of Geography, Shri. Raosaheb Ramrao Patil Mahavidyalaya, Savlaj Ta. Tasgaon Dist. Sangali.

Email: suryakantb.rathod@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188372

*DOI: **10.5281/zenodo.15188372***

Abstract

A number of factors in suburbs around the city are affected at the time of extension in city. In this process of extension land is one of the major factors in which the changes are taking place on large extent. The extension of the city motivates the population to take refuge in vacant area around the city in order to settle there. Some effect mentioned above has taken place in 19 suburbs around Nanded city. There is no doubt that Nanded is extending rapidly. In the present study researcher has observed the changes in land available for Agriculture, the change in unfertile land, which is proper to cultivate, and the change in land which is not worth to cultivate. For this study researcher has chosen the period of twenty years that is from 1981 to 1991 and 1991 to 2001 and the change in year 1981 to 2001 are divided in four parts such as Very High, High, Medium and Low and are shown on Map by Choropleth Method. Throughout this study of Nanded as Changes in Land Use researcher has focused on relationship amongst different factors such as Geographical conditions, Urbanization, Industrial Development and Demographic factors.

Keywords: change in land available' cultivation, barren land, agriculture.

Introduction:

With the growth of urbanization, rural areas are constantly being engulfed into urban landscape, and villages in the immediate vicinity of cities and towns acquired eventually an urban character. The study of cities is, therefore, incomplete without a proper appraisal of the location, characteristics and development of these peripheral settlements, which have a potentiality of urban growth.

Housing is one of the most critical problems facing in this country, especially in urban areas. If this problem is solved successfully, it will result not only in providing one of the basic necessities of the population, but will also generate employment on a massive scale. The social scientists and

geographers are encouraged to pay attention to the study of land use and functions of suburbs due to suburban growth in the world and India. The pattern and characteristics of the suburb of an urban complex depends upon the physiography and transportation facilities of the area and also the characteristics of urban complex itself. The change in land use pattern is a major variable of the morphological factors, which controls the growth of residential pattern on space in the suburbs. The transfer of agricultural land into various urban uses i.e. residential, commercial and industrial land use change the land use pattern in the suburban area.

Along with sub-urbanization the housing structure of suburbs changes very rapidly. Original houses in core villages are of traditional type, built up of materials like brick, stone, mud, tiles etc. while houses in the suburban areas are made out of burnt brick, cement and concrete. The socio-economic status and life style of residents determines the housing structure of the suburb.

Aims And Objectives

Nanded city is located in Eastern part of Maharashtra, place of district and the place of Municipal Corporation. There are near about 19 suburbs around the city. These suburbs are located at 180 30' North Latitude and at 770 10'East Longitude. The total area of suburb is about 8619.46 Hectares.

The present study includes following main objectives-

1. To study the Analysis of change in land available for cultivation.
2. To study the Analysis of change in cultivable barren land.
3. To study the Analysis of change in land, not available for agriculture.

Research Methodology

Various methods have been used to the study the population characteristic of the study region. After the collecting data it has been tabulated and represented with the help of various statistical techniques, various maps and diagrams have been prepared to show different types of data and information. To study the suburbs areas of city the field work method has been used with help of questionnaire. Basically, the entire study is based on primary data and information obtained through the field survey conducted by the author. Secondary data have also been used in the present study. Sources of the secondary data are as District Census Handbook of Nanded District, 1981, 1991, 2001.

The analysis and interpretation of data has been done from the geographical point of view. Finally, the personal observation method has been used to study the problems of Nanded city.

Review Of Literature

The analysis of suburbs in various way has been the objective of both theoretical and empirical work in the post-world war era. Our concern here is with the choice an appropriate conceptual framework for the analysis of this study.

The extent characteristics are problem of suburbs vary from one city to another. Geographers, economists, sociologists, and urban planners have studied the residential suburbs. These studies have been carried out for planning of cities and solving the problems. These studies deal with portions of suburban population, which are selected for the particular study. Faust (1942), Andrews (1946), Firey (1946), Gist (1952), have studied suburbs with the help of selecting houses by random sample.

Press and Hein (1962), Pahl (1965), Burnight (1953), Zimmer and Mawley (1958), Andrews and Eshleman (1963), have studied suburbs with the help of selecting sample size and non-random, both random and stratified sampling methods. Therefore, to select sample size, both random sampling and stratified sampling methods were used. There are various factors which control the choice of particular sample, it may be physical, economic, social and cultural factors of suburbs.[1]

Present idea about characteristics of the suburbs originated from an article, published by Wehrwin (1942) which has now been regarded as one of the basic papers in this field of study. In his investigation of Indianapolis, he recognized the growth of railways as the main cause of decentralization of urban population and of changing of landuse from farm to non-farm ones.[2]

Andres (1942) had attempted to identify the general landuse characteristics. Dickinson (1956) identified suburbs and analysed its functions.[3]

Pryor (1966) characterized the rural-urban fring by the incomplete availability of utility services, inadequate network of public transport and a relatively high ownership ratio of residential house.[4]

One of the initial studies in this topic is by Golledge (1966). This study is also the first one which deals with fring area lying out of Western Europe and North America. According to him, urban suburbs have seven major characteristics viz. constantly changing landuse pattern, small farm, intensive crop production, mobile and low and moderately dense services and public utility, rapid residential expansion, common speculative sub division of buildings. He examined each characteristic with respect to Sydney's suburb. [5]

Many economists are discussed below to understand the different factors which control land value of an area and also the relation between land values and land uses have studied by Hard (1908), Haigh (1926), Ratcliff (1949), Alonso (1960), Yeasts (1968), Brigham (1965), Northam (1975).

The perception of neighbourhood by the residents had been studied by Lee (1963), H. J. Klein (1967), Lynch's (1960).

In India sometimes suburbs are studied as a part of the whole metropolitan area. Kar (1963) attempted to investigate the characteristics and norms of the metropolitan economy in and around Calcutta. Bagchi (1966) studies Howrah conurbation as an urban Sprawl of Calcutta metropolitan region. Singh (1967) has described as the rural land with urban phenomena Alam (1972) used some principle and reflective elements, for example, suburban transport service, commuting areas of workers of factories, retailing, water supply, percentage of non-agricultural workers, electricity consumption, growth rate and density of population etc. to study patterns of development of suburbs of Hyderabad.[6]

Jadhav and Kulkarni (1967) studied the landuse planning and its problems of suburbs of Poona. Nangia (1976) studied various aspect of settlement pattern of Delhi metropolitan region. Bor Gowda and Mahadev (1977, 1981, 1982). Studied the changing landuse pattern, growth and development of co-operative housing societies, process and policies of landuse conversion in the suburbs.[7]

Some other studies on suburbs have appeared during the last four decades. Rajagopalan (1962) the Greater Bombay, Deshpande (1973) suburbs of Greater Bombay, Ranchandran and Srivastava (1974) rural – urban fringe sequence of Delhi, Sundram (1977) Urban and Regional planning in India, Sinha (1980) rural urban region of Patna, Gopi (1979) Process of Urban Fringe Development, Hussain (1980) emphasized on haphazard urbanization by urban encroachment on rural lands of Muzaffar Nagar. Kabra (1980) identified a set of appropriate action programme for the improvement of Indian suburbs with reference to Tajganj, a small neighbourhood of Agra. Pramila Kumar (1980) agricultural in novations on the fringe of Bhopal, Desai (1980) crore city of Ahmedabad for the perception studies of urban environment. Kayastha (1980), Nag (1980), V. S. Phadke and K. Sita (1981) various aspect of Bombay metropolitan region. Wadhva (1982), land value and landuse of suburbs of Ahmedabad, Saha (1982) studied the suburbs and cities from different perspective which contributed to the subject.

From the above-mentioned studies in various parts of India, it is found that a great deal of work has been done on changing land use pattern of residential suburbs its characteristics and growth, commuting pattern problems and land use planning. Here an attempt has been made to study the distribution and growth of suburbs around Nanded city. A case study of Babulgaon suburbs has been carried out with considering various aspect such as growth pattern of residential area, population characteristics, occupational structure, economics structure and standard of living comparing with old village and newly emerged suburban area.

Change In Land Use in Nanded Suburb

Number of factors in suburbs is coming under the impact of urban area, mainly the changes in land use in suburbs taking place on large extent. In last two decades Nanded, city is extending extremely fast and this growth of city has affected on suburban area nearest to Nanded. So in the present study researcher has made an attempt to find out the changes taking place in land use in suburbs around Nanded - Wagala Municipal Corporation. The extension of Nanded city according to 2001 is about 80 Km2. There are 19 suburbs around the Nanded City. Now a day they are known as suburban villages. According to 2001 the area of the suburban villages is 18619 Hectares. These suburbs are increasing extremely fast. They are leaving their effect on land utilization. For this present study researcher has taken the time from 1981 to 2001. Secondary documents as well as the Statistical Methods were used for this research. The suburbs are considered as an object of study. The present study shows the contrast taking place in the land use. On one hand there is increase in the land under settlement; on the other hand, there is decrease in the land under Agriculture. In the whole area chosen for the study the decrease in the land under Agricultural use is recorded by 29.52 % during the period of 1981 to 2001. At the same time there is an increase in the area of land under settlement by 19.2 %. The present study is useful for city planning.

Nanded city is located in Eastern part of Maharashtra, place of district and the place of Municipal Corporation. There are near about 19 suburbs around the city. These suburbs are located at 180 30' North Latitude and at 770 10'East Longitude. The total area of suburb is about 8619.46 Hectares.

The Changes in Land Available for Cultivation

1. Change During 1981 -1991

In 1981 land available for agriculture in suburbs was 8746 hectares. It was decreased by 5916 hectares in 1991. In this decade from 1981 to 1991 the area of land under Agriculture decreased by 32.4 % when this proportion is compared with the total average of suburbs the change on large extent is recorded in Jangamwadi (91.3%) the lower change than Jangamwadi is recorded in Brahmapuri (78.2%) Goplachawadi (91.7%) Wadi Bu (40.7%) Dhanegaon (38.1%). The cause of decreasement in the area of land under Agriculture in these six suburbs the inclination of the extension growth of the Nanded City was at East and North East. So, the area of land under agriculture was diminished. The less change than the average has taken place in Babulgaon (5.5%) and next to this recorded in Gundegaon (10.1%) Vishnupuri (17.2%) Kotirath (26.5) Hasapur (18.4%) Naraspur (19.1 %) Taroda Buduk (22.3%) Taroda Kh (20.9%)

The causes of this lower change in these eight suburbs are mentioned as the inclination of the growth trend of the Nanded city was not much at North and at South. The suburbs are located on the Bank of Godawari. There is lack of urban facilities. In the same decade no change is recorded in Sangavi (BK). But in the suburbs of Munjampeth (11.3%) and Wajegaon (4.8%) land under Agriculture is increased. (Table No. IV – I & Fig. No. 4.2 (A)

Table No. 1
Changes In Land Use of Nanded Suburban Area
(Land Available for Cultivation)
(1981 – 2001)

Sr. No.	Name of suburb	1981 - 1991		1991 - 2001		1981 - 2001	
		In hectares	In %	In hectares	In %	In hectares	In %
1	Taroda (Kh)	-71.26	-20.9	-49.63	-18.4	-120.89	-35.42
2	Taroda (Bk)	-108.81	-22.3	-89.55	-23.6	-198.36	-40.6
3	Wadi (Bk)	-633.47	-40.9	-72.01	-7.9	-705.48	-45.6
4	Nasaratpur	-17.48	-19.1	-8.88	-11.9	-26.36	-28.8
5	Hassapur	-40.54	-18.4	-18.95	-10.5	-59.49	-26.9
6	Jangamwadi	-489.56	-91.3	-6.13	-13.1	-495.69	-92.41

7	Sangavi (Bk)	0	0	-26.05	-4.6	-26.05	-4.6
8	Mahalja	-21.23	-12.8	-28.98	-25.3	-80.21	-48.4
9	Brahmapuri	-613.95	-78.2	-51.02	-29.8	-664.97	-84.7
10	Kottirath	-77.51	-26.5	-34.99	-16.3	-112.5	-42.8
11	Vishnupuri	-168.36	-17.2	-155.03	-19.2	-323.39	-33.1
12	Pangri (Tf.)	-38.33	-7.7	-13.9	-3.1	-52.23	-10.5
13	Gundegaon	-23.78	-10.1	-16.97	-7.9	-40.75	-17.3
14	Munjampeth	+4.03	+11.3	+0.99	+2.5	+5.0	+13.9
15	Dhanegaon	-175.04	-38.1	-59.99	-21.1	-235.03	-51.2
16	Balirampur	-115.56	-82.2	-8.93	-35.6	-124.49	-80.51
17	Gopalchavadi	-168.86	-61.7	-18.99	-18.2	-187.85	-68.7
18	Babulgaon	-50.02	-5.5	-80.06	-9.3	-130.08	-14.2
19	Wajegaon	+10.19	5.8	-19.04	-10.3	-8.85	-5.1
	Total	-2829.54	-32.4	-758.11	-12.8	-3587.65	-41.1

Source: Author (2006)

Changes In Land Use of Nanded Suburban Area
(Land Available for Cultivation)
(1981 – 2001)

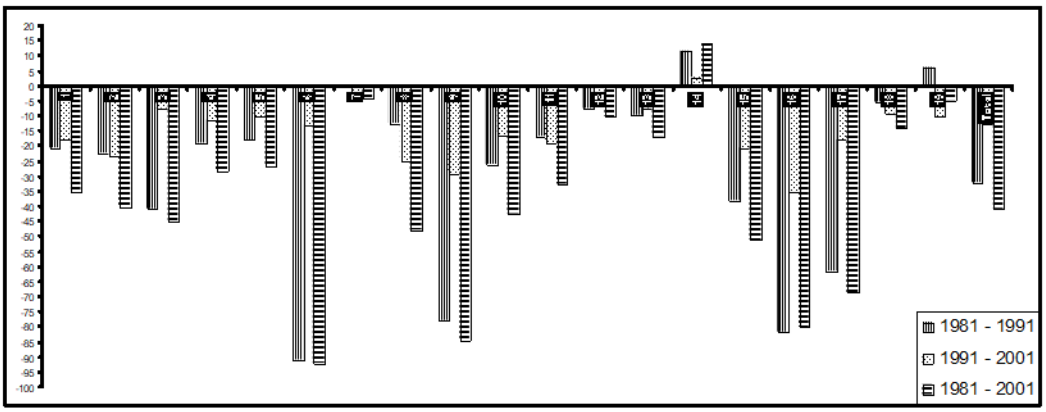


Fig. No.2(A)

2. **CHANGE DURING 1991 – 2001**
In 1991 the land available for agriculture was about 5916 hectares in suburbs. And in 2001 it was about 5158 hectares. It means land under agriculture is decreased by 12.8 %

during 1991 - 2001. When this proportion is compared with the total average of suburbs the change extend is recorded in suburb named Balirampur (356%) the next lower change than Balirampur is recorded in Brahmapuri (23.6%), Taroda Kh (18.4%), Gopalchawadi (18.2%), Dhanegaon (21.1%), Vishnupuri (13.1%). The land under agriculture in this period is decreased due the establishment of University in West, the availability of all urban facilities in the Eastern area and little area of land in North. The proportion compared to the total average lowest change is recorded in Pangari (30.1%). After Pangari change is recorded in Sangavi (BK) (4.6%), Wadi (BK) (7.9%), Narasatpur (11.9%), Hassapur (10.5%), Gundegaon (7.9%), Babulgaon (9.3%) and Wajegaon (10.3%) (Table No. IV – I & Fig. No. 4.2 (A))

3. The Change During 1981 - 2001

In 1981 the area of land available for agriculture in suburbs was 8746 hectares in 2001 it is recorded 5158 hectares. In this period of 20 years the area of land under agriculture is decreased by 41 %. When this proportion is compared to the total average of the suburbs the change in large extent is recorded in Jangamwadi (92.4%) next lower change to Jangmwadi is recorded in suburbs, Brahamapuri (84.7%), Balirampur (80.5%), Gopalchawadi (68.7%) where the land under these four suburbs is decreased.

When this proportion is compared with total average of suburbs the highest level of change is recorded in Dhanegaon (51.25), followed by Mahalja (48.4%), Kotirath (42.85), Wadi BK (45.6%). The land under agriculture in these four suburbs is decreased.

The medium change is recorded in the suburbs like Taroda Bk (40.6%) Taroda Kh (35.42%), Vishnupuri (33%), Nasatpur (28.8%) In the same period land under agriculture in suburbs like Wajeagaon (5.1%), Gundegaon (17.3%), Pangari (10.5%) and Sangavi Bk (4.6%) has been changed.

The main causes for this change are the favorable situation for the settlement and nearest to the central area of city, establishment of university and on the other hand the factors such as Bank of River, muddy soil, lack of urban facilities, lack of drinking water are responsible for lowest change in land under agriculture.

Only Majumpeth is an exception in land under agriculture. There is an increase of area of land under agriculture by 13.9%. This happened due to religious and flood affected factor. (Table No. IV – I & Fig. No. 4.2 (A & B))

The Changes in Cultivable Barren Land

A) The Change During 1981 - 1991

In 1981 the area of land in suburbs useful to cultivate but unfertile was 518 hectares. In 1991 it is recorded 1111 hectares. In the period of 1981 to 1991 land under agriculture is increased by 114.3%.

When this proportion is compared to the total average of the suburbs the highest change is recorded in Jangamwadi (43017.9%) the next lower change than Jangamwadi is recorded in Wadi Bk (205.6%), Balirampur (314.35), Gundegaon (205.6%), Narsatpur (172.25) and Mahalaja (170.4%). The percentage given above shows an

increase in the area of land which can be brought under agriculture purpose but temporarily infertile.

When this proportion is compared with the total average of suburbs the lowest change is recorded in Taroda Kh (16.2%) and next change is recorded in Taroda Bk (37.4%), Vishnupuri, Babulgaon (66.9%), Kothirath (78.8%), Wajegaon (109.4%) and Hasapur (113.1%).

In the suburbs like Brahmapuri (72.7%), Munjampeth (15.4%), Dhanegaon (7.85), Goplachawadi (24.5%) the area of the infertile land is decreased.

Though the land is purchased by people for the settlement but the N.A. of that land is not passed. So, the land is being not cultivated it is in the infertile state and the area of land not decreased despite it is increasing. (Table No. IV – II & Fig. No. 4.3 (A))

Table No. 2
Changes In Land Use of Nanded Suburban Area
(Cultivable Barren Land)
(1981 – 2001)

Sr. No.	Name of suburbs	1981 - 1991		1991 - 2001		1981 - 2001	
		In hectare	In %	In hectare	In %	In hectare	In %
1	Taroda (Kh)	+7.92	16.2	+29.04	51.1	+36.96	75.5
2	Taroda (Bk)	+21.31	37.4	+43	55.2	+64.31	113.6
3	Wadi (Bk)	+227.26	430.9	+25.27	9.1	+252.53	478.8
4	Nasaratpur	+26.17	172.2	+3.99	9.6	+30.16	198.4
5	Hassapur	+11.01	113.1	+11.51	55.5	+22.52	231.2
6	Jangamwadi	+167.77	43017.9	+2.99	1.8	+170.76	43784.6
7	Sangavi (Bk)	0	0	+11.94	89.9	+11.94	89.9
8	Mahalja	+22.72	170.4	+12.02	33.4	+34.74	260.6
9	Brahmapuri	-107.71	-72.7	+6.85	16.9	-100.86	68.1
10	Kottirath	22.67	-78.8	+14.11	232.1	-8.56	29.8
11	Vishnupuri	199.42		+27.03	13.5	+129.11	85.9
12	Pangri (Tf.)	+7.06	226.3	+8.03	78.9	+15.09	483.6
13	Gundegaon	+7.01	205.6	+8.12	77.9	+15.04	441.1
14	Munjampeth	-4.03	-15.4	-2.08	9.4	-6.11	23.3
15	Dhanegaon	-3.94	7.8	-5.03	10.8	-897	17.7

16	Balirampur	+8.83	314.3	+8.5	73.1	+17.33	616.7
17	Gopalchavadi	-2.57	-24.5	-0.03	0.4	2.6	24.7
18	Babulgaon	+17.18	66.9	-23.01	-53.7	+40.19	156.51
19	Wajegaon	+10.23	109.4	+7.4	-38.81	+17.8	190.7
	Total	+592.97	114.3	+235.78	21.2	+828.75	159.7

Source: Author (2006)

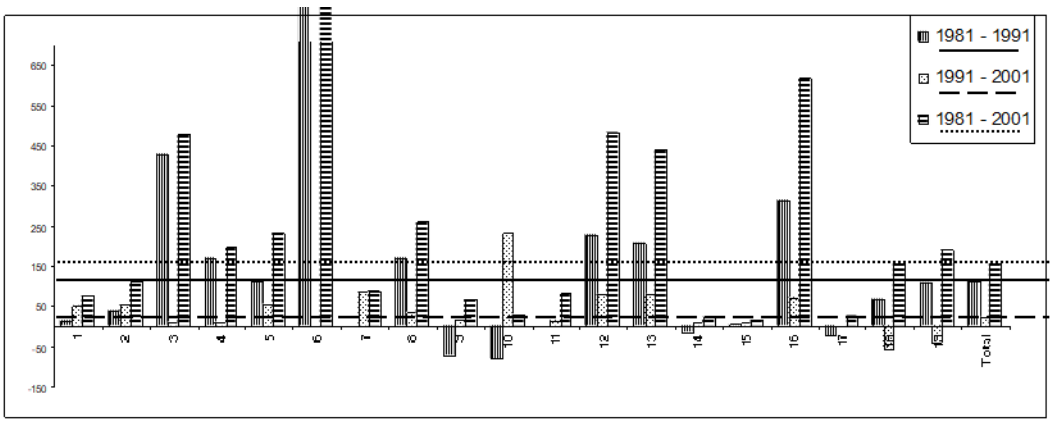


Fig. No. 3 (A)

The Change During 1991 To 2001

In 1991 the area of land to cultivate but being infertile was 1111 hectares. Which is recorded 1347 hectares in 2001. In the decade of 1991 to 2001 the infertile land increased by 21.2 %. When this proportion is compared to total average of suburbs the highest level of increase is found in the suburb Kotirath (232.1%) next to Kotirath low increase is recorded in Sangavi Bk (89.9%), Gundegaon (77.9%) Pangari (78.9%), Balirampur (73.9%), Mahalaja (33.4%), Hasapur (55.1%), Taroda Bk (55.21%), Taroda Kh (51.1%).

When this proportion is compared to total average of suburbs the lowest increase is recorded in Gopalchawadi (0.41%). After this Wadi Bk (9.1%), Vishnupuri (13.5%) and Brahmapuri (16.9%) the percentage shows the decreased area of infertile land. (Table No. IV – II & Fig. No. 4.3 (A))

Babulgaon (53.7%), Gopalchawadi (0.41%) and Munjumpeth (9.4%) the percentage recorded before these three suburbs given above shows the decrease in the area of infertile land.

The Change During 1981 To 2001

In 1981 the area of land to cultivate but infertile was 518 hectares. In 2001 it is recorded to 1375 hectares. In these 20 years the area of infertile land increased by 159.7%. When compared to the total average of suburb the highest level of change is recorded in suburbs Jangamwadi (43784.6%) next lowest

change to Jangamwadi was recorded in Balirampur (618.7%), Pangari (483.6%), Wadi Bk (478.8%), Gundegaon (441.1%). The percentage above shows increasing area of infertile land. The effect of Waghala emerging as Municipal Corporation has motivated the people to purchase on large extent. Yet houses are not built on this land. So temporarily it can be counted as infertile land.

When it compared to the total average if suburbs the highest level of change is recorded in Hassapur (231.2%) and Mahalja(260.6%).

Medium level of change is recorded in the suburbs such as Torada Bk (113.6%), Nartpur (198.8%), Babulgaon (156.51%) Wajegaon (190.7%). When it compared to the total average of suburbs the lowest change (100%) is recorded in Torada Kh., Sangavi Bk., Dhanegaon, Gopalchawadi, Vishnupuri. In these suburbs the proportion of increase in infertile land is recorded lowest. In these twenty years the area of infertile land in the two suburbs namely Munjumpeth (23.3%) and Brahamapuri (68.1%) is diminished. (Table No. IV – II & Fig. No. 4.3 (A & B)

The Changes in Land Not Available for Agriculture

A) The Change During 1981 To 1991

In 1981 520 hectares land in suburbs was not available for Agriculture. In 1991 it recorded 1607 hectares. During 1981 - 1991 the land not available for agriculture is increased by 208.8 %. When this is compared to total average of suburbs it shows Gopalchawadi (5320.2%) suburb in which the highest level of increase took place. And next highest level of growth has taken place in Gundegaon (3506%), Mahalja (1880.2%) and Balirampur (1101.4%).

When this is compared to total average of suburbs the lowest growth is recorded in Sangavi Bk, Suburb that is only 0.6% the next to lowest growth is recoded in Tirada Bk, Wadi Bk (14.7%), Hasapur (34.7%), Jangamwadi (19.4%), Vishnupuri (16.75), Nasaratpur (81.8%), Brahmapuri (35.1%), Babulgaon (76.7%) Taroda Kh (111.5%), kothirath (152.1%), Dhanegaon (180.6%).

The main change of this extremely fast increasement is the growth of Nanded city. (Table No. IV – III & Fig. No. 4.4)

B) The Change During 1991 To 2001

In 1991 the area of land in suburbs not useful for agriculture was 1607 hectares in 2001 it recorded 2113 hectares. The decade 1991 to 2001 the area of land not useful for agriculture is increased by 31.4 %. When it is compared to total average of suburbs the highest-level growth is recorded in suburb named Taroda Kh (118.6%) the next highest level of growth but lowest to Taroda Kh is recorded in Taroda Bk (112.3%), Jangamwadi (116.7%), Vishnupuri (84.6%), Gundegaon (49.6%), Dhanegaon (47.7%), Babulgaon (74.3%), Kotirath (33%), Mahalaja (42.4%). The growth in the land unuseful not available for agriculture is recorded in the suburbs given above.

Comparison to the total average of suburbs shows the lowest growth in suburb namely Balirampur (2.6%), Wadi Bk (8.8%), Pangari (7.65), Hasapur (25.1%), Sangavi Bk (24.5%) Brahmapuri (27.3 %). (Table No. IV – III & Fig. No. 4.4)

C) The Change During 1981 To 2001

In 1981 the area of land not available for agriculture in suburbs was 520 hectares. In 2001 it recorded 2113 hectares. During 1981 - 2001 the land not available for agriculture increased by 305.9%. Its comparison with total average of suburbs the highest level of growth is recorded (more than 350 %) in Gopalchawadi (5908.9%), Gundegaon (5294%), Mahalja (1234.6%), Balirampur (1038.4%) and Taroda Kh (362.2 %).

Highest growth (250 – 350 %) in the land not useful for agriculture is recorded in the four suburbs namely Wajegaon (282.7%), Dhanegaon (314.6%), Kotirath (235.5%), Taroda Kh (269.2 %).

Table No. 3
Changes In Land Use of Nanded Suburban Area
(Non-Cultivable Land)
(1981 – 2001)

Sr. No.	Name of suburbs	1981 - 1991		1991 - 2001		1981 - 2001	
		In hectare	In %	In hectare	In %	In hectare	In %
1	Taroda (Kh)	+9.23	111.5	+20.76	118.6	+29.99	362.2
2	Taroda (Bk)	+17.62	76.	+46.55	112.3	+64.17	269.2
3	Wadi (Bk)	+43	14.7	+29.74	8.8	+72.74	24.9
4	Nasaratpur	+6.94	81.8	-10.5	-68.3	-3.59	-42.4
5	Hassapur	+7.66	34.7	+7.44	25.1	+15.1	68.5
6	Jangamwadi	+0.48	19.4	+3.14	116.7	+2.62	81.6
7	Sangavi (Bk)	+0.33	0.6	+14.11	24.5	+14.44	25.3
8	Mahalja	+37.98	1880.2	+16.96	42.4	+24.94	1234.6
9	Brahmapuri	+42.14	35.1	+44.17	27.3	+86.31	71.9
10	Kottirath	+38.17	152.1	+20.80	33.0	+59.05	235.3
11	Vishnupuri	-30.45	16.7	+128.0	84.6	+97.53	53.7
12	Pangri (Tf.)	+31.52	68.4	+5.87	7.6	+37.39	81.1
13	Gundegaon	+17.53	3506	+8.94	49.6	+26.47	5294.0
14	Munjampeth	00	00	+1.09	2.6	+1.09	2.6
15	Dhanegaon	+87.65	180.6	+65.02	47.7	+152.67	314.6
16	Balirampur	+106.73	1101.4	+0.43	0.4	+107.16	1038.4

17	Gopalchavadi	+171.84	5320.2	+19.02	10.8	+190.86	5908.9
18	Babulgaon	+32.34	76.7	+57.05	74.3	+89.39	200.8
19	Wajegaon	+45.55	225.9	+11.44	17.4	+56.99	282.7
	Total	+1087.2	208.8	+505.5	31.4	+1592.7	305.9

Source: Author (2006)

Medium growth (150 to 200 %) is recorded in Babulgaon (200.8%) suburb.

The lowest (less than 100%) growth is recorded in the suburbs such as Munjampeth (2.6%), Pangari (18.1 %), Vishnupuri (53.3%), Brahmapuri (71.9%) Sangavi (25.3%), Jangamwadi (81.6%), Hasapur (68.5 %) and Wadi Bk (24.9 %). (Table No. IV – III & Fig. No. 4.4 & 4.5)

Changes In Land Use of Nanded Suburban Area

(Non-Cultivable Land)

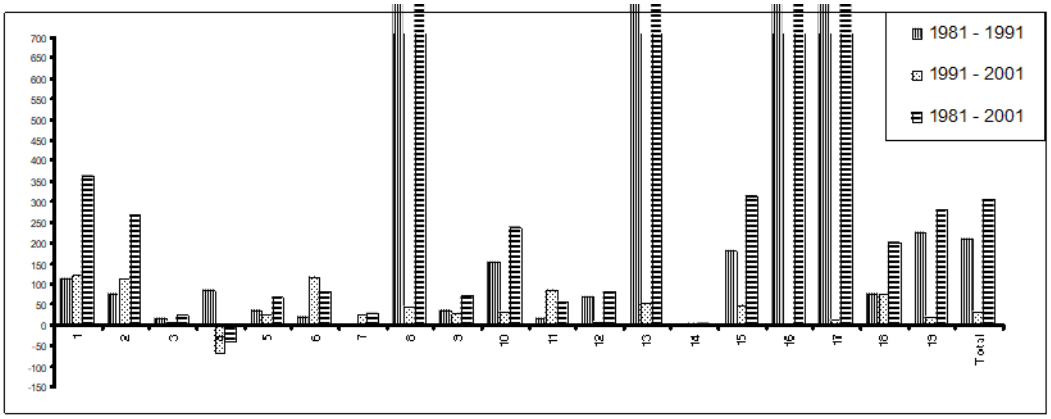


Fig. No.4

The study shows

1. The land available for Agriculture is decreased by 41.1% in the two decades from 1981 to 2001 but in the suburb named Manjumpeth it is increased by 13. 9%.
2. Land useful for Agriculture but infertile is increased by 159.7 % during 1981 – 2001. During the same period the area of infertile land is diminished in a suburb named Munjumpeth by 17.7 %

Conclusion

As far as the changes in the land-use pattern of suburban villages are concerned.

The study shows that,

1. The land available for Agriculture is decreased by 41.1 5 in the two decades from 1981 to 2001 but in

the suburb named Manjumpeth it is increased by 13. 9 per cent.

2. Land useful for Agriculture but infertile is increased by 159.7 per cent during the year 1981 to 2001. During the same twenty years the area of infertile land is diminished in a suburb named Manjumpeth by 17.7 per cent.
3. During 1981 to 2001 the land not useful for Agriculture is increased by 305.9 per cent. It means that the extension of Nanded city is affected on land utilization in suburbs and consequently the area under cultivation is decreased and at the same time the land under settlement is increased.

References

1. Alam, S. M. (1965), 'Hyderabad and Secunderbad: A study in urban geography,' Allied Publisher Pvt. Ltd. Osmania University, Press, Hyderabad.
2. Alam, S. M., and Khan w. (1972), Metropolitan Hyderabad and Its Region: Strategy for Development, Ashia Publisher, Bombay.
3. Andrew, R. B, (1942), Element of Urban Fringe Pattern, Journal of Land and Public Utility Economics, 18, pp. 169 – 183.
4. Arya, D. S. and Abbasi, S. A. (1995), Urbanisation and it's environmental impacts. A case study of Roorkee, Discovery Publishing house New Delhi.
5. Bal, S., The Rural Urban Fringe: A Case Study of Dighori. The Deccan Geographer, Secunderabad, Vol. 13, 1975.
6. Bhende, Asha A., Kanitkar, Tara (1988 Fourth Edition), Principles of Population Studies, Himalaya Publishing House, Bombay p. 339.
7. Bijlani, H. U. (1977), Urban Problems, Indian Institute of Public Administration, New Delhi, pp. 122 – 140.
8. Bore, Goda P. and Mahadev, P. D. (1977), Changing Nature of Agriculture in the Rural Urban Fringe: A Case Study of Bangalore, Indian Geographical Journal, Vol. 52.
9. Census of India, 1981, 1991, 2001. Maharashtra Part XII – A and B, District Census Handbook, Nanded District.
10. Census of India, District Census Handbook, Nanded, Series – 14, Part XII – A & B, 1981, 1991, 2001.
11. Chandana R. C. and Sidhu, M. S. (1984) Introduction to Population Geography, New Delhi. p. 104.
12. Gibb's J. P. (1966), A Method for Comparing the Spatial Shapes of Urban Units, The Urban Research Methods, Van Nostrand Co. Inc. p. 107
13. Gibbs Jack. P. (1966), Urban Research Method, East – West Edition, New Delhi. P. XIX
14. Golledge, R. G. (1960), Sydney's Metropolitan Fringe – A Study in Urban Rural Relation.
15. Hanumappa, H. G. (1981) Urbanization Trends in India: Case Study of a Medium Town, Ashish Publishing House, New Delhi, p. 16.
16. Hazra, Jayati (March 2000), Calcutta: A Study of Urban Health, Geographical Review of India Vol. 62, No. 1.
17. Humanappa, H. G. (1981), Urbanisation Trends in India, A case

study of a medium town, Ashish Publishing house, New Delhi.
18. Jadhav, R. S. and Kulkarni G. S. (1967), Landuse Planning in Rural Urban Fringe of Poona, National Geographic Journal of India. 13 pp. 158-167.
19. Kayastha, S. L. (1999), Environmental Problems, In G. S. Gosal (Ed.) Fourth Survey of Resarch in Geography, Mank Publication (P) Limited, New Delhi.
20. Kulkarni, K. M. (1997), 'Urban structure and interaction: A study of Nasik city region' Concept Publishing Co. New Delhi.
21. Kumar, Pramila, (1980), Agricultural Changes in Urban Fringe, Rajesh Publications, New Delhi. pp. 146 – 175.
22. Mishra, H. N. (1980) Urban System of Developing Economy, Heritage Publishers, New Delhi p. 153.
23. Mishra, R. P. (1990), Medical Geography of India, Concept Publishing Company, Delhi pp. 12, 181.
24. Misra, H. N., (1988), Urban System of a developing economy, Heritage Publishers, New Delhi. pp. 9 – 35 and 142 – 165.
25. Sinha, B. N. (1970) SIRSI: An Urban Study, In Application of Research Models, Karnataka University, Dharular p. 22 – 58.
26. Sinha, S. P. (1984) Processes and Pattern of Urban Development in India: A Case Study of Haryana, The Associated Publishers, Ambala Cantt, p. 73 – 80.
27. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Assessment of Rainfall Variability trend in Solapur District of Maharashtra. Aegaeum Journal, 8(4) 234-241
28. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Digital Terrain Analysis for Watershed Characterization and Management-A Case Study of Vincharna River Basin Maharashtra, India. Journal of Information and Computational Science, 10(2) 637-647
29. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of geospatial technique for monitoring Groundwater Level Fluctuation in Karjat Tehsil in Ahmednagar District of Maharashtra, Sanshodhak, 90(04) 362-372
30. Vibhute N.M., Mr. Agastirishi Bharat Toradmal, (2013), GIS Based Analysis on Rural Electrification (Rajiv Gandhi Gramin Vidyutikaran Yojana) In Maharashtra, "Rajarshi" A Refereed International (Multidisciplinary) Research Journal, 3, 96-100.

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 21 - 28 |

Soil Quality Monitoring Techniques

[1]Dr. G. D. Mhaske

[2]Dr. Ujwala G. Mhaske

[3]Jyoti Pekhale

[4]Priya R. Sonawani

[5]Kirti Jadhav

[1]Department of Environmental Science, KRT Arts, BH Commerce & AM Science (KTHM) College, Nashik - 422002, M.S, India

[2]Department of Physics, HPT Arts and RYK Science College, Nashik- 422005, M.S, India

[3]Department of Biotechnology, RNC Arts, JDB Commerce and NSC Science College, Nashik Road, Nashik-422101, M.S, India

[4]Department of Biotechnology, HPT Arts and RYK Science College, Nashik- 422005, M. S, India

[5]Department of Zoology, LVH Arts, Science and Commerce College, Panchavati, Nashik 422003, M.S, India.

Email: ganeshdmhaske@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188486

DOI: 10.5281/zenodo.15188486

Abstract

The development of physical and chemical properties is caused by soil constituents. Consequently, it is important to conduct investigations on soil qualities. Composite samples are gathered and subjected to physical and chemical examination. For factors including colour, texture and water-holding ability, soil samples underwent physical analysis. The soil chemically analysed for a number of parameters, including pH, EC, OC, CaCO3, Ca, Mg, Na, K, N, P, Cl, S, HCO3 and micronutrients as B, Cu, Zn, Fe, Mn. These characteristics aid in determining the crop pattern best suited for a certain type of soil.

Keywords: Physicochemical analysis, Soil quality.

Introduction:

The most important and valuable natural resource on earth for sustaining life is

soil. A single inch of topsoil is produced every almost a thousand years. According to Sparks (1988), soil is one of the most valuable resources and should be given a lot of consideration. The formation of soil is a result of the weathering of rocks. Parent material, vegetation and climate are the key determinants of soil composition and texture (USGS 1993). Wrong farming methods are now destroying soil quality. Chemicals used in modern agricultural methods (fertilizers, herbicides, insecticides, fungicides, etc.) have a long-term impact on the agroecosystem. Concerns about agricultural chemicals centre on their on- and off-site consequences, including spray drift and the contamination of soil, groundwater and surface waters. Numerous global groups have started monitoring initiatives. Among them are the World Health Organization (WHO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO). This is owing to the fact that soil deterioration has started to happen as a result of both natural and human-induced processes, which is hurting productivity. To sustain a high agricultural yield, it is crucial to understand how composition and physicochemical characteristics of the soil.

Collection of Soil Sample

Remove the debris, grass, stones etc. from the top layer when collecting soil samples, and the layer of soil immediately underneath (0–20 cm) is physically collected and put in a clean bucket. Five of these samples can take in the same bucket and properly mixed from the uniform region of the chosen field. The expected one kilogram of the sample put into a plastic bag by quartering. The soil has just been freshly dug to the necessary depth (Sonar et al., 1984, Somwanshi et al., 1999). The soil samples deliver to the lab and air-dried shortly after being collected. The air-dried samples gently pounded in a wooden pestle and mortar to break up the dirt lumps. For additional physicochemical analyses of soil parameters, these ground samples store in a cotton bag with the required labelling after being passed through a 2 mm sieve.

Analysis of Soil Samples

The analysis of soil for different physicochemical parameter is important. The soil's colour is identified using the Munsell soil colour chart. Textural soil analysis (% of sand, silt and clay) is carried out using standard procedures (Piper, 1966 and Somwanshi, 1999). The soil's water-holding capacity is determined using a circular soil box. The pH is measured in 1:2.5 soil water suspension using a glass electrode pH meter, and EC (dS-1m) is measured in the supernatant solution of 1:2.5 soil water suspension using a conductivity meter (Jackson, 1973). Calcium carbonate is measured by the rapid titration method. Organic carbon by Walkley and Black method (Nelson and Sommers, 1982). Available Nitrogen was estimated by the alkaline KMNO4 method. Available phosphorus is extracted by Olsens (NaHCO3 extraction) method. Available potassium is estimated by the Ammonium extract method. Ca, Mg and Na were estimated by AAS. Sulphur is estimated by

spectrophotometer. HCO3 and Cl is determined by the titrimetric method. Micronutrients, including B, is estimated by spectrophotometer and Cu, Zn, Fe, and Mn estimated by AAS. The details of the analytical methods are summarized below:

Saturation Extract

The soil-to-water ratio is fixed at 1:5 to prepare a saturation extract of the soil (Jackson, 1973). One drop of sodium hexametaphosphate solution containing 0.1% is added for every 25 ml of extract. This stops calcium carbonate from precipitating while you stand still. The methods used to determine the various parameters, such as pH, EC, bicarbonate, chloride, calcium, magnesium, sulphate and sodium in saturation extract and groundwater water analysis, are the same.

Colour

The mineral makeup of the soil, as well as its water and organic content, all have an impact on its colour. For instance, white, reddish and dark brown to black are typical colours for high-calcium, high-iron and high-humus soils, respectively. How light or dark a colour depends on the Munsell soil colour chart value. The value scale travels vertically from the lightest (at the top) to the darkest (at the bottom). The Munsell Color System uses Hue (basic colour), Value (lightness) and chroma to characterise a soil's colour (colour intensity). A collection of colour chips with varied levels of hue, value and chroma is called the Munsell Book. To identify the soil colour, take a small soil sample and compare it to the relevant colour chip.

Texture

The proportional proportions of silt, sand, clay and other types of gravel that make up the soil mass are referred to as the texture or nature of the soil. The International Pipette Method is used to conduct the textural analysis, as described by Richards in 1968 and Somwanshi et al. in 1999.

Air-dried in a beaker, 10 g of soil is taken. The oxidation of organic materials is then facilitated by the addition of 25 ml of H2O2. For the purpose of evaporating H2O2, the suspension is heated for five minutes. The suspension left overnight after being cooled to room temperature, and a small amount of H2O2 is added once again. A 20 ml addition of sodium metaphosphate dispersion is made to this. The entire contents were rinsed with tap water using sieve number 230. The sand that was still on the sieve put into an initially weighted evaporating dish. A sample of the soil is placed in a 1000 ml measuring cylinder, and the final volume is adjusted to the desired level. The mixture is forcefully agitated for one minute while using a volumetric pipette. A 20 cm-deep insert is used to extract 20 ml of material for silt. The material is moved into a spotless evaporating dish. Once more, the suspension is agitated for one minute, and then exactly one hour and four minutes later (the time required for sedimentation), a 20 ml solution is pipetted out and inserted up to a depth of 5 cm for clay. The material moved to an evaporating dish. The weight loss is estimated while the contents were maintained in an oven at a temperature of 105° C. Sand, silt and clay percentages for soil samples estimated from weight losses.

Water Holding Capacity

The maximum amount of water a soil can hold when it is saturated is typically called its water-holding capacity. The amount of water absorbed by a unit weight of dry soil when submerged in water is typically used to measure it. (Trivedi and Goyal, 1994). First, the filter paper is placed inside the circular soil box's perforated bottom before the crushed soil sample dried in an oven at 105°C. The soil box then weighed (W0 gm) and filled with the dried soil sample, causing the weight to be W1 gm. After that, the box is placed in a water-filled petri dish with a 10 cm diameter for roughly 12 hours, remove from the water, clean and dry on the outside before recording its weight (W2 gm). The formula used to compute the percentage water holding capacity,

% WHC=(W2-W1)–(W1-W0)/(W1-W0) x 100

Calcium Carbonate

Calcite, dolomite and magnesite are examples of carbonates that are found in soils, especially in sub-humid areas. The carbonates can alter the texture of the soil when they are present in significant levels as fine earth carbonates. The selection of amendments to be given to sodic soil can be influenced by the presence of carbonates, which provide a potential supply of calcium for the replacement of exchangeable sodium during reclamation (Piper, 1966).

The rapid titration method is used to calculate the amount of calcium carbonate in the soil. This approach as it is presented by Jackson (1973) and Piper in 1966. To neutralise all carbonates in the soil, a known quantity of standard hydrochloric acid is applied. Any excess hydrochloric acid is then back-titrated with sodium hydroxide using a bromothymol blue indicator. The amount of HCl needed for neutralisation converted into its CaCO3 equivalent.

Organic Carbon

The organic matter in the soil aids in giving nutrients and it is utilised to alter the soil's needs for nitrogen, sulphur and lime. According to Hesse, 1971, Jackson, 1973 and Ghosh et al., 1983, the organic carbon, as well as organic matter fractions from the soil, is determined using the Walkley and Black method. Using heat to dilute the sulphuric acid, the soil is digested using chromic and sulfuric acid in this procedure. The excess of chromic acid that is not being reduced by the soil's organic matter is then measured using a standard ferrous sulphate titration.

A 500 ml conical flask filled with a 1 gm sieved (0.5 mm) soil sample. A tiny amount of silver sulphate applied on the tip of the knife. Following the addition of 10 ml of 1N potassium dichromate solution, the mixture is gently stirred in the flask. After that, a measuring cylinder was used to add 20 ml of concentrated sulfuric acid and the flask was set aside on an asbestos pad for 30 minutes. 200 ml of distilled water, 10 ml of orthophosphoric acid, 0.2 g of sodium fluoride and a few drops of the ferroin indicator are added after 30 minutes. It has been concluded to titrate against 0.5 N ferrous sulphate, when the colour transitioned from brown-green-blue to red. Additionally, the blank is run in unison. The amount of ferrous sulphate used to oxidise the organic matter in the soil sample, which is comparable to chromic acid, is determined by the difference between the values.

These calculations produced the results

% Organic Carbon = (B - T) x N x 0.003 x100/ Weight of soil

Where,

B = ml of standard ferrous sulphate required for blank.

T = ml of standard ferrous sulphate required for soil sample.

N = normality of standard ferrous sulphate solution.

% Organic Matter = % organic carbon x 1.724.

Available Nitrogen

Most of the nitrogen in the soil is found in organic matter (97–99%). The activity of microbes, which break down organic matter and change nitrogen into mineral forms of nitrogen, is linked to the availability of nitrogen. The rate at which accessible nitrogen is released from the organic matter in soil is known as its nitrification rate. The nitrogen is released by microbial activity from both the native soil organic matter and the fresh organic crop leftovers in the form of NO3 (Miller and Donahue, 1992). The alkaline permanganate method, as described by Perur et al. (1973) and Page et al. (1983), is described to determine the amount of available N in the soil. In the presence of NaOH, KMn04 oxidises soil organic matter. To create ammonium borate, the ammonia that is produced after oxidation is absorbed in boric acid. Titrating the produced ammonium borate with common H2SO4. The available N is estimated from the volume of standard H2SO4 needed for the reaction with ammonium borate.

So, 20 g of soil that had been sieved (0.2 mm), put into a 1-litre distillation flask. Following the addition of the freshly made 0.32% KMn04 solution and 2.5% NaOH, 20 ml of water is added. The mixture then distilled, and the ammonia produced (approximately 100 ml of the distillate) is collected in a 250 ml conical flask containing mixed indicator and 20 ml of a 2% boric acid solution. This is adjusted against a solution of sulfuric acid (0.02 N) until the colour changed from green to red. 0.2g of sugar used to run blank concurrently. A little amount of glass beads and 1 ml of liquid paraffin were added to the distillation process to prevent bumping and foaming, respectively. This is how the available N is determined,

$$\text{Available N (kg/ha)} = \frac{(A-B) \times N \times 0.014 \times 2240000}{\text{Weight of soil (g)}}$$

Where,

A = Volume of H2SO4 required for soil samples.

B = Volume of H2SO4 required for blank.

N = Normality of H2SO4.

Available Phosphorus

In soil, phosphorus is found as orthophosphate in a variety of forms, including H2PO4, HP04-, P04- and their mixtures. It is possible that just a tiny portion of the total P present is accessible to plants, which is directly relevant to determining the soil's fertility level. According to Watanabe and Olsen's instructions, ascorbic acid is used to measure the amount of phosphorus in the soil (1965). The approach is based on the idea that when soil phosphorus is extracted with 0.5 M NaHCO3, molybdate ion forms a heteropoly complex. Ascorbic acid reduction of the complex results in a distinctive blue colour. Because the blue

colour of the reduced complex is long-lasting, ascorbic acid is preferred as a reducing agent over stannous chloride (Hesse, 1971).

A 25 g soil sample suspended in a 250 ml conical flask with a teaspoon of carbon black and 50 ml of 0.5 M NaHCO3 extraction solution (pH=8.5). 30 minutes spent shaking the material before filtering it through Whatman No. 1 filter paper. After transferring the 5 ml aliquot of the clear filtrate to the 25 ml volumetric flask, 2 drops of the 0.25% p-nitrophenol solution are added. The fluid was then gradually acidified with 5N H2SO4 until the yellow colour vanished (pH = 5). After that, 4 ml of colorimetric phosphorous reagent was added to bring the volume up to the required level. At a wavelength of 882 nm, the colour intensity is determined using a spectrophotometer. In parallel, a reagent blank used. The concentration of accessible P determined using the standard curve.

P (kg/ha) = R x 8.96

Where,

R = ppm from a standard curve.

Available Potassium

The parent material and level of weathering are the main determinants of a soil's potassium concentration. Feldspar and mica are the minerals that contain the greatest potassium in weakly weathered soils (Hesse, 1971). When the salt solution is applied to the soil, the cations are free to exchange with the available K. According to Ghosh et al. (1983) description, the accessible potassium in soil measured using a flame photometer and the ammonium acetate extraction method.

A 125 ml flask filled with a 5-gm sieved soil sample, and then 25 ml of NH4OAC (pH=7) added after 5 minutes of stirring, filtering, and concentration measurement with a flame photometer using the appropriate KCl standards.

Available K (kg/ha) =Kppm (from standard curve) x 11.20

Trace Elements in Soil

AAS enables the quick analysis of several samples and is an efficient approach for multi-element analysis. The atomic absorption spectrophotometric methods are a commonly used instrument in soil investigation. The technique is based on the detection of the light intensity reduction that happens as analyte element atoms pass through a layer of vapour (De, 1994). The analysis is conducted using flame atomic absorption spectrometry techniques.

For the Flame atomic absorption photometry investigation of trace elements, samples are collected in plastic bags and processed in a 1:2 soil solution (De, 1994). Before measuring the dissolved metals, the samples were filtered via 0.45 um membrane filter paper. The samples were then supplemented with standard solutions of the chosen metals for analysis. The accuracy of the analysis of trace metals such as Cu, Zn, Fe, and Mn is improved by using this standard addition method.

Boron

The very small time period between toxicity and deficit for plant growth makes boron in soil unique. Boron levels below 1 ppm may indicate a deficit, while levels above 3 ppm may be hazardous (Hesse, 1971). A contributing factor to the toxicity of boron in soil is

irrigation with water containing significant elements (Eaton, 1950). This is a common occurrence in arid areas and the issue is made worse in saline-alkali soils where sodium is the major cation and there is not enough calcium (Singh and Kanwar, 1963). The water-soluble form of boron is the most practical indicator of its availability. pH, organic matter and colloidal concentration all have an impact on the amount of water-soluble boron in soils.

Carmine and azomethine-H methods can be used to measure the amount of boron in soil (Hatcher and Wilcox, 1950). Because of its simplicity of use in the colour development, the azomethine-H is widely utilised worldwide in determining boron. Buffer masking reagent has been added to the process to get rid of ionic interference and boost determination sensitivity. As stated by Saha and Singh, (1997), the azomethine-H technique is utilised in the current investigation to estimate the amount of boron. This procedure develops a stable compound between azomethine-H and H3BO3 at pH 5.1. 50 ml of distilled water and 0.5 g of activated charcoal were added to the flask that contained 25 g of sieved, air-dried soil. The substance promptly filtered using Whatman No. 42 filter paper. Then, a 25 ml volumetric flask filled with 5 ml of this aliquot, 2 ml of buffer masking reagent and 2 ml of azomethine-H reagent. The volume is adjusted to the desired level after giving the colour an hour to develop. The solution's absorbance is determined at a wavelength of 420 nm on a spectrophotometer. The standard curve is used to calculate the concentration of B.

References

1. APHA, AWWA, and WPCF (1995). Standard methods for the examination of water and waste water (19th ed.). American Public Health Association.
2. Asthana, D.K. and Meera Asthana. (1999). Environment, problems and solutions, S. Chand and company, New Delhi.
3. DE, A. K. (1994). Environmental Chemistry (3rd Ed.). Willey - Eastern Ltd., New Delhi, 361 p.
4. Eaton, (1950). Significance of carbonate in irrigation water. Soil Science, 69, 123-133.
5. Ghosh, A. B., Bajaj, J. C., Hasan, F., and Dhyan Singh (1983). Soil and Water Testing Methods, Laboratory manual (pp. 21-22). ICAR Publication.
6. Ghosh, A. B., Bajaj, J. C., Hasan, F., and Dhyan Singh (1983). Soil and Water Testing Methods, Laboratory manual (pp. 21-22). ICAR Publication.
7. Hatcher, J. T., and Wilcox, L. V. (1950). Colorimetric determination of boron using carmine. Analytical Chemistry, 22, 567-569.
8. Hesse, P. R. (1971). A Textbook of Soil Chemical Analysis. John Murray (Publisher) Ltd., London, U.K.
9. Jackson, M. L. (1973). Soil chemical analysis. Prentice-Hall of India, New Delhi.
10. Miller, R. W., and Donahue, R. L. (1992). Soils: An introduction to soils and plant growth. Prentice Hall of India Pvt. Ltd., New Delhi.
11. Page, A. L. (1983). The methods of soil analysis. Part H. Am. Soc.

Agron. Inc. Soil Sci. Am., Madison, Wisconsin.

12. Perur, N. G., Subramaniam, C. K., Muhr, G. R., and Ray, H. E. (1973). Soil fertility evaluation to serve Indian Farmers. Mysore Deptt. of Agri. Mysore Univ. of Agri. Sci., U.S. Agency for International Development, Bangalore.
13. Piper, C. S. (1966). Soil and plant analysis. Hans Publ., Bombay, pp. 135-136.
14. Saha, J. K., and Singh, M. V. (1997). Effect of temperature on determination of boron by azomethine-H method. Journal of Indian Society of Soil Science, 45(1), 57-61.
15. Santra, S.C. (2001). Environmental science, New Central Book Agency, Calcutta (India).
16. Singh, S. S., and Kanwar, J. S. (1963). Journal of Indian Society of Soil Science, 11, 283.
17. Somwanshi, R. B., Kadu, P. P., TamboH, B. D., Patil, Y. M., and Bhakare, B. D. (1999). Analysis of plants, irrigation water and soils. MPKV, Extn. Publ. No. 284, Rahuri (Maharashtra).
18. Sonar, K. R., Patil, N. D., Kadam, J. R., Dhage, A. R., and Bagul, K. M. (1984). Soil testing: Key to efficient fertilizer use and higher profits. MPKV, Rahuri (Maharashtra).
19. Sparks, D. L. (1988). Soil physical chemistry. CRC Press Inc.
20. Trivedi, R. K., and Goel, P. K. (1994). Chemical and biological methods for water pollution studies. Environmental Publications, Karad.
21. USGS. (1993). National water summary: 1990-1991: Stream water quality. USGS Water Supply Paper No. 2400
22. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of Statistical Techniques for Monitoring and Evaluation of Water Quality of Bhima River, Indian Journal of Natural Sciences, 14(80) 62440-62451
23. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020) Identification of Groundwater Potential Prospect Zones in Semi-Arid Region- A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra, Journal of Xidian University 14(05) 814 - 824
24. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020), Identification of Probable Water Scarcity Zones in Marathwada Region of Maharashtra. Gedrag & Organisatie Review, 33(02) 687-696
25. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Assessment of Rainfall Variability trend in Solapur District of Maharashtra. Aegaeum Journal, 8(4) 234-241

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 29 - 40 |

Geographical Analysis of Solid Waste Management in Nashik City

[1]Mr. Swapnil. P. Dhatrak

[2]Dr. R. A. Jadhav

[1]Research Scholar, Ph.D., P.G. Department of Geography, Loknete Vyankatrao Hiray Arts, Science and Commerce College Panchavati, Nashik-03

[2]Research Guide, Ph.D., P.G. Department of Geography, Department of Geography Loknete Vyankatrao Hiray Arts, Science and Commerce College Panchavati, Nashik-03

Email: swapnildhatrak45@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188595

*DOI: **10.5281/zenodo.15188595***

Abstract

This study examines the solid waste management system in Nashik City from a geographical perspective, analysing the spatial distribution, infrastructure, and environmental implications of waste management practices. The research explores how urban growth, population density, and land use patterns impact waste generation and disposal. It also assesses the efficiency of collection, segregation, transportation, and treatment processes while highlighting geographical disparities in waste management services across different areas of the city. By mapping waste generation hotspots and examining landfill locations, the study identifies challenges such as environmental degradation, inadequate infrastructure, and policy gaps. Finally, it offers recommendations for sustainable waste management strategies, emphasizing the importance of spatial planning and community involvement to ensure equitable and effective solutions for Nasik's growing urban population. it with leachate which is not suitable for the environment the study focuses on adopting multi-level strategies to address SWM challenges comprehensively, with an emphasis on ensuring active citizen participation.in Public Health. In addition, the city lacks treatment facilities and sanitary landfill facilities for the proper management system of solid waste.

Keywords: Urbanization, Waste Segregation, Public Health, Waste Segregation, Contaminates. Sanitary Landfill Facilities

Introduction:

Nashik stands fairly well in the solid waste management sector. NMC

estimates that the per capita solid waste generation in their area is over 300 gms per person per day. In 1996, NMC had introduced "GhantaGadi" (vehicles with bells) for door-to door-collection of waste. This system helped Nashik become a bin-free city successfully. NMC uses full-sized and mini-trucks, as well as tractor trailers to transport solid waste collected by the GhantaGadis to the waste disposal sites the effect of human activity on the environment has emerged as one of the most significant policy issues in environmental sustainability- a fact that is known to all. As the countries grow and develop in terms of the economy, enormous pressure is created on the environment in terms of the residuals. There is a growing concern about the effect of economic activity upon the environment and increasing recognition that economic growth and human welfare are dependent upon benefits obtained from the environment. India too is rapidly marching ahead towards the 'fastest growing economy'. The unprecedented levels of urbanization in India, growing consumerism and emergence of new mega-cities, along with growth in population has resulted in massive increase in the consumption and imports. As a consequence of huge annual material consumption, there is a significant pressure on the management of all forms of residuals in the country. If these residuals are not properly treated or are disposed of irresponsibly, irreversible environmental degradation is bound to happen. This will have far reaching consequences affecting the public health and well-being which will have a negative impact on all forms of life on earth. The long-term environmental strategy of the country, based on the principles of sustainable development, may not be feasible to achieve without adequate waste management. The importance of planning in residual management is reflected in the fact that the management plans need to integrate the most appropriate option for the environment, considering economic, technical, social and environmental factors. The term solid waste management mainly refers to the complete process of collecting, treating and disposing of solid wastes. In the waste management process, the wastes are collected from different sources and are disposed of. This process includes collection, transportation, treatment, analysis and disposal of waste. It needs to be monitored so that strict regulations and guidelines are followed. Due to improper disposal of solid waste particularly by waste management organizations, the collected wastes get heap up and become a problem for both the environment and also for the public. By dumping of huge garbage, drives biodegradable materials to decay and decompose under abnormal, uncontrolled and unhygienic conditions. After a few days of decomposition, it becomes a breeding ground for different types of disease-causing insects as well as infectious organisms. A foul smell is produced and it also spoils the aesthetic value of the area. The solid wastes collected from different industries include toxic metals, chemicals, and other hazardous wastes. When these wastes are released into the environment, they can produce biological and physicochemical problems to the environment, the chemicals may drain into the soil and

pollute the groundwater and also alter the productivity of the soils in that particular area. In rare cases, the hazardous wastes may get mixed up with the ordinary garbage and other combustible wastes causing the disposal process even harder and risky. By burning the paper and other scraps along with the hazardous wastes, dioxins and poisonous gasses are produced and released into the air which results in causing various diseases including chronic disease, skin infections, cancer, etc. The recent analysis of solid waste components collected within the NMC area reveals that 37.8% are easily compostable (short-term biodegradable) materials, 19.50% are hard lignitic materials (long term biodegradable) while 16.20% are an assortment of textiles, plastic, rubber, etc (source: DPR on SWM, NMC).

Objectives

1. To study the spatial distribution of solid waste generation, collection and disposal methods in Nashik city.
2. Suggest suitable remedial measures for solid waste strategic plan of Nashik city.

Study Area

Nasik, a city located in the northwest of Maharashtra State in India, is 180 km away from Mumbai and 202 km from Pune. Nashik is the administrative headquarters of Nashik District and Nashik Division. Nashik, which has been referred to as the "Wine Capital of India", is located in the Western Ghats, on the western edge of the Deccan peninsula on the banks of the River Godavari. According to the Census of India, 2001, Nashik had a population of 1,076,967 and present population is estimated to be 1,590,000 (projected in year 2008) with a total area of 259 km² which makes it the fourth largest urban area in Maharashtra in terms of population. Nashik is the third most industrialized city in Maharashtra after Mumbai and Pune.

Municipal Solid Waste (MSW)

Comprising household waste, street sweeping, and commercial waste.

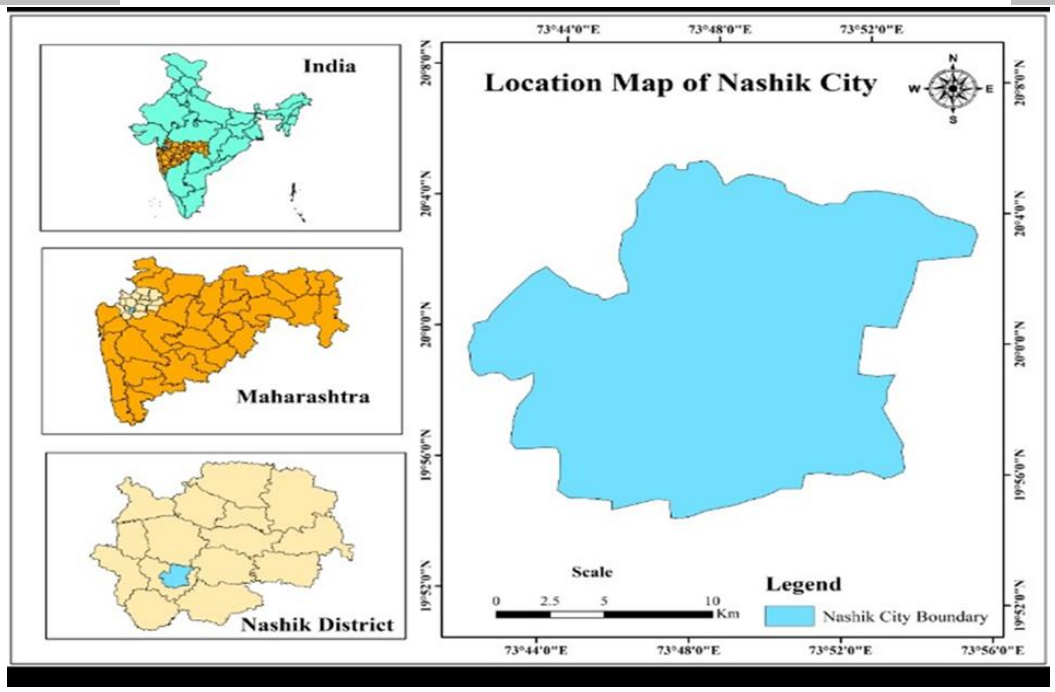
1. **Industrial Waste**
   Waste generated by manufacturing and industrial processes.
2. **Hazardous Waste**
   Includes toxic, reactive, flammable, and corrosive materials.
3. **Biomedical Waste**
   Waste generated by healthcare facilities, such as hospitals and clinics.

E-waste

Discarded electronic devices and components

Processing of MSW

The new processing plant includes the following: • Pre-sorting Unit: It is electromechanical segregation system for incoming non segregated MSW with the capacity of 500 TPD and it comprises of two lines with all necessary requirements and materials. After mechanical segregation compostable material will go to windrow composting, material with calorific value goes to RDF plant and inert will be further processed at Inert Processing plant.



Location Map of Nashik city

Aerobic Composting Unit

Composting is done through windrow composting method and sheds have been constructed for windrows. Today out of total MSW 3 to 5 % is converted into compost. The compost has already become popular amongst the farmers within 100 km radius of Nashik. By maintaining the price line of Rs2000/MT Ex-factory level for loose form and Rs. 2450/- for packed form with necessary backup support, entire quantity of compost will be saleable in this belt. Once segregation at source will be practiced then the quantity of generation of compost will increase up to 10 to 15 % of total MSW. • Inert processing unit Inert processing unit, with capacity of 50 TPD, comprises of mechanical sieve and air density separator. Main purpose of inert processing plant is to recover the construction material from the waste and to recycle it by selling or utilizing it for in-house construction activities. This is mainly to minimize landfill burden on O&M cost and also saving of land. • Leachate treatment plant: Leachate treatment plant with capacity of 0.4mld leachate or 10 TPD organic wastes has been installed for treatment of leachate coming out from the windrows, the solid waste dumps and sanitary landfill site. Proper arrangement for collection and transportation of leachate has been made.

Refuse Derived Fuel (RDF) Plant

The high calorific energy containing materials present in MSW are to be handled separately from the stage of receiving at the tipping floor onwards. RDF plant with capacity of 150 TPD is installed for generation of fuel pellets from high calorific value materials. Woody materials, paper products, textiles, jute etc forms the main

constituents of RDF which is a valuable source of alternate energy. The technology for RDF primarily focuses on refinement of MSW through material re-combinations, segregation, drying, size reduction, blending and homogenization. This material is further refined for separation of sand, dust, metals, glass etc before grinding or shredding. The shredded material is obtained as fluff.

Animal Carcass Incinerator

Dead animal carcass incinerator with the capacity of 250Kg per hour is installed for the incineration of dead animals such as dogs, cattle's etc.

Sanitary Landfill

The solid waste that is not suitable for any processing is transported to the sanitary landfill site. For this purpose, a sanitary landfill in an area of 2 hector has been developed. All the necessary aspects of scientific land filling were considered during creation of sanitary landfill. Proper arrangement for leachate is also provided and this is connected to the leachate treatment plant for further processing.

Complaint Redressal System

NMC has appointed six Divisional Sanitary Inspectors (DSI) and below them there are Sanitary Inspectors (SI). Most of the complaints are addressed by DSI and SI at division level. A 24 hrs toll free numbers 145 are operational for receiving complaints. All the complaints will be addressed within 72 hours. In addition, citizens can file their complaints in written either to divisional office or to NMC headquarters.

Visited Solid Waste Management Department for Data Collection
Current Activities to reduce/recycle/reuse/ of MSW Waste Streams in Nashik

1. **Glass, paper, metal:** A substantial amount is collected by Ghantagadi workers and informal rag pickers and this is further handed over to scrap merchants in the city.
2. **Organic Waste:** Organic waste is segregated at the processing facility through the mechanical segregation process and it is then converted to compost through aerobic composting. Most of the organic waste is converted in compost and sold to farmers. Waste from permanent and temporary vegetable markets is collected and transported to the composting plant and reused as organic manure.
3. **Construction Debris:** NMC has identified sites for dumping the construction debris. This waste stream is currently not entering the MSW stream. The responsibility for disposing the construction debris is with the waste generators and not with the Corporation.
4. **Street Sweeping/ Drain Cleaning:** This material is collected by the safai karamcharis and transported to the Ghanta Gadis in the respective wards.
5. **Other Waste Streams in Nashik:** Hazardous Waste Hazardous waste is waste that poses substantial or potential threats to public health or the environment and which is ignitable (i.e., flammable), reactive, corrosive and toxic. In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries. Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles. The process of handling and management of this waste stream is currently planned by NMC and will be informed in due time.
6. **Bio-medical Waste:** 'Bio-medical waste' means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining thereto or in the production or testing of biological. It means any solid or liquid waste which may present a threat of infection to humans, including non-liquid tissue, body parts, blood, blood products, and body fluids from humans and other primates; laboratory and veterinary wastes which contain human disease-causing agents; and discarded sharps. This is currently being handled by M/s SMS Water Grace BMW Pvt. Limited in Nashik.

Nashik Solid Waste Management Awareness Programme

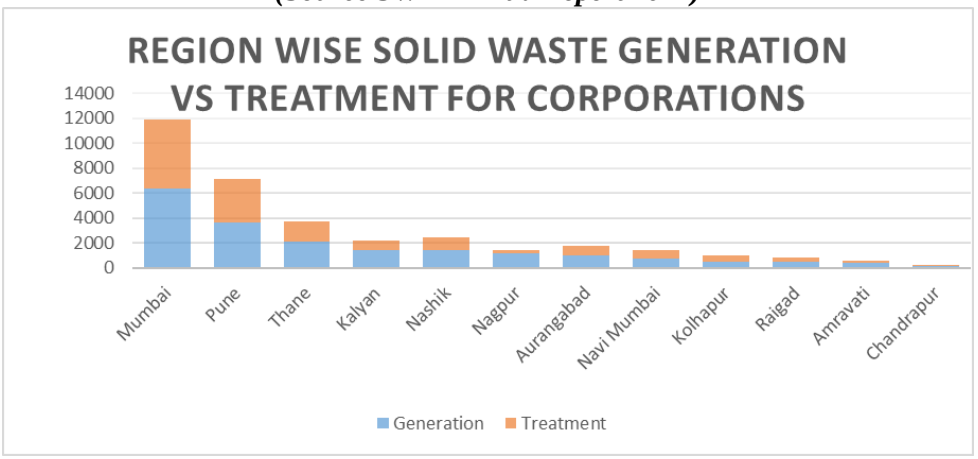
Every citizen should be made aware of the duty to keep neighbourhoods and city clean. Creation of awareness is the first step to bring an attitudinal change among people. Most of the people are ignorant about the various ways in which waste can be stored, transported and safely disposed and also about their ill effects to health and environment. Therefore, it is necessary, to create awareness among the people about the entire process of Municipal Solid Waste Management system i.e. from generation to safe disposal. Waste comprises of 3 different categories wet waste (vegetable peels, food waste etc), dry (paper,

plastic, metal etc) waste and toxic waste (batteries, CFLs etc). Source segregation of waste into different categories and its effective collection system is the key to success in MSWM system, and the role of common man as a responsible citizen is very crucial in implementing effective and efficient system.

Region wise solid waste Generation vs Treatment for Corporations

Regions	Generation	Treatment
Mumbai	6385	5517.26
Pune	3612	3485
Thane	2145	1587.5
Kalyan	1398	834
Nashik	**1395.45**	**1075.34**
Nagpur	1200	200
Aurangabad	985	822
Navi Mumbai	712	681
Kolhapur	525	484
Raigad	470	335
Amravati	376	200
Chandrapur	113	113

(Source SWM Annual report 2022)



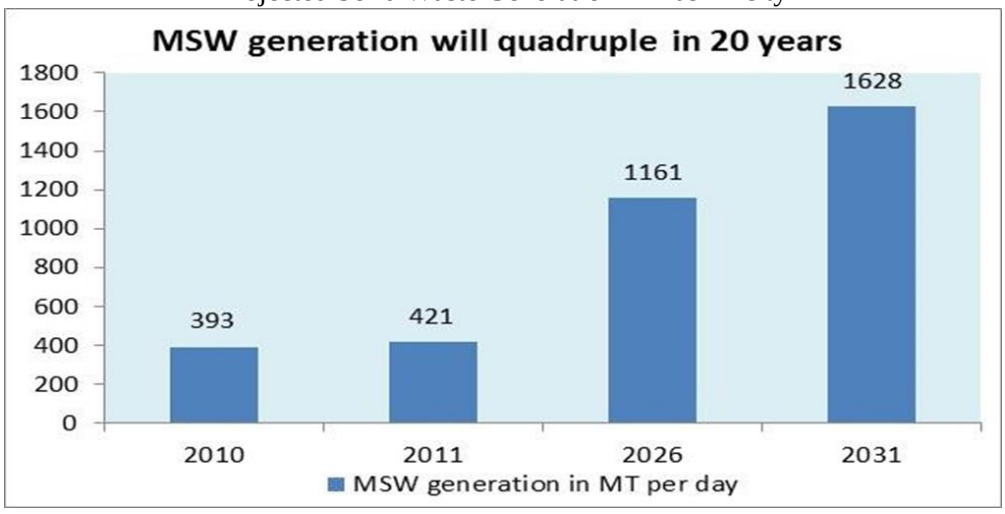
Nashik: Moderate Waste Generation

Interpretation

- **Generation:** 1395.45 MT/day.
- **Treatment:** 1075.34 MT/day (~77% treated).
- Nashik, a cultural and industrial hub, shows moderate waste generation with a decent treatment percentage. Its smaller urban area compared to Mumbai and Pune helps in better

managing waste Expand Waste Treatment Infrastructure: Particularly in cities like Nagpur, Kalyan, and Amravati. Promote Decentralized Waste Management: Smaller cities like Raigad and Amravati can adopt decentralized models for better efficiency. Invest in Technology: Advanced waste-to-energy and recycling systems are essential for high-generation areas Public Awareness: Encouraging citizens to segregate waste at the source will reduce the burden on treatment facilities.

Projected Solid Waste Generation in Nashik city



(Source SWM Annual report 2022)

Interpretation

This bar graph illustrates the projected increase in **Municipal Solid Waste (MSW) generation** over a span of 20 years, from 2010 to 2031, measured in **metric tons (MT) per day.** 2010 and 2011 Data In 2010, MSW generation was 393 MT/day.By 2011, it slightly increased to 421 MT/day, indicating a modest annual growth. Midpoint Projection (2026): By 2026, MSW generation is projected to rise significantly to 1161 MT/day.This marks nearly a threefold increase compared to 2010. **Long-Term Projection (2031)**: By 2031, MSW generation is expected to, reaching 1628 MT/day.This reflects a steep increase in waste generation over two decades. The trend demonstrates a rapid growth in waste generation, particularly after 2011. The rate of increase accelerates sharply in the years between 2011 and 2031.Factors contributing to this trend could include population growth, urbanization, and increased consumption patterns, leading to higher waste production.

Solid waste generation status in Nasik city

The Nashik Municipal Corporation is collecting about 370 MT of municipal solid waste per day. All the waste from different areas are collected and transported to MSW facility at Pathardi which is 15 km from core area. The bio hazardous waste generated by hospitals in the city is treated at 1000o C in an

incinerating plant located near Kannamwar Bridge (near core area). With better collection and transportation measures, the collection efficiency should increase. It is estimated that the projected quantity of municipal solid waste will be 1200 TPD by the year 2031.Analysis of city waste carried out recently reveals 47% easily compactable materials, 31% non- bio-degradable and 22% other waste. These, last 2 components have become a major cause of concern. These materials are a negative contributor to the processing plant efficiency and rapidly exhaust available land for land filling. Mounting heaps of high volume of low-density waste is common scene around each compost plant. Municipal solid waste Management: Nashik Municipal Corporation has abolished the waste bins system and introduced door to door collection of waste through ghanta gadis' from 1996 (Vehicles with bells). Each ward has at least one ghanta gadi. A total of 124 ghanta gadis are on contract, including one driver and two helpers per vehicle. Nashik Municipal Corporation collects garbage from households, hotels and restaurants, commercial establishments, hospitals, etc. following table shows the numbers of establishments.

Challenges faced in Solid Waste Management in Nashik city

1. **Population Growth and Urbanization:**

With the rapid increase in population and urbanization, the amount of waste generated has increased exponentially. Urban areas are experiencing a surge in the amount of solid waste generated, making it challenging to manage and dispose of effectively.

2. **Inadequate Infrastructure:**

Many cities in India lack proper infrastructure and facilities for the collection, segregation, transportation, and disposal of solid waste. The existing infrastructure is often outdated, insufficient, and not equipped to handle the increasing volume of waste generated.

3. **Inadequate Collection and Transportation System:**

There is a lack of efficient and regular collection and transportation systems for solid waste in many cities. The existing systems are often inefficient, irregular, and unable to cover all areas, leading to improper disposal and accumulation of waste.

4. **Lack of Awareness and Public Participation:**

There is a general lack of awareness and understanding among the public about the importance of proper waste management practices. This results in improper disposal of waste, non-compliance with waste management rules and regulations, and resistance to segregation and recycling initiatives.

5. **Policy and Regulatory Challenge**

There is a need for robust and comprehensive policies, regulations, and guidelines for solid waste management at both the national and local levels. The existing policies are often outdated, inadequate, and not effectively implemented, leading to inefficiencies and gaps in the SWM system.

6. **Lack of Technological Solutions**

The adoption of advanced and innovative technological solutions for waste management, such as waste-to-energy plants, composting facilities, and recycling units, is still limited in many cities due to financial, technical, and operational challenges.

Informal Sector Involvement: The involvement of the informal sector, such as waste pickers and recyclers, in waste collection and recycling is significant in many cities. However, they often work under poor and unsafe conditions, within of bio-medical waste.

Suggestions for solid Waste Management in Nashik city

Scientific studies and planning: It means understanding the type of waste, the costs involved, and the best locations for disposal facilities. Nashik city needs to invest in innovative technologies and develop a better recycling infrastructure.

Improve waste collection: Nashik city has more frequent services, use machines to collect waste, and coordinates the timing of collection with waste generation.

Combining informal and formal waste collection sectors: This will help with segregation and collection. Other ways to improve include decentralized waste management, where local communities take care of waste treatment, and promoting recycling by implementing supportive policies and regulations.

Treating organic waste through composting and bio-meth nation can reduce the amount going to landfills.

Integrating technology like RFID-enabled monitoring and GPS tracking can also help in efficient waste management.

Waste-to-energy methods like bio-meth nation can convert organic waste into fuel, which is beneficial. The concept of common waste treatment facilities is being promoted, involving public-private partnerships. The Nasik city needs to ensure proper treatment facilities for biomedical and hazardous waste.

Conclusion

study of solid waste management in Nashik City reveals significant insights into the challenges, practices, and effectiveness of waste management systems in an urban setup. The findings underline the following key: Generation of Waste Nashik's growing population, urbanization, and economic activities have led to a substantial increase in the generation of solid waste. Residential areas, commercial establishments, and industrial units are the primary contributors. Waste segregation at the source remains a challenge, with limited public awareness and inconsistent enforcement. Door-to-door collection systems are functional but need greater efficiency and coverage in peri-urban areas. The role of informal waste collectors is crucial but largely unorganized, highlighting the need for their integration into formal systems. The transportation of waste is partially mechanized but suffers from inefficiencies due to vehicle shortages and operational delays. Open dumping remains prevalent, though efforts are being made to improve landfill management. Existing landfill sites are nearing capacity and require immediate attention. Recycling practices are limited, with inadequate infrastructure for composting organic waste and recycling inorganic materials.

Opportunities exist to expand resource recovery through public-private partnerships and community-driven initiatives. A lack of sustained public awareness campaigns limits community participation in waste management practices. Schools, residential societies, and local NGOs can play a pivotal role in promoting waste reduction and segregation behaviours. While Nashik Municipal Corporation (NMC) has implemented several initiatives, including Swachh Bharat Mission activities, gaps remain in enforcement and long-term planning. Effective monitoring, transparent governance, and allocation of adequate funds are critical for sustaining waste management improvements. Ineffective waste management practices contribute to environmental degradation, including air, water, and soil pollution. Poor waste disposal poses health risks to both formal and informal workers involved in waste handling and the general population: Promote source segregation through awareness campaigns and strict enforcement. Upgrade transportation systems with a focus on mechanization and efficiency. Invest in modern waste processing facilities, including composting plants and material recovery facilities. Strengthen public-private partnerships to enhance recycling and waste-to-energy projects. Integrate informal waste workers into formal systems for better livelihood opportunities and efficiency. Ensure regular monitoring and community participation to create a sustainable, inclusive waste management ecosystem. By implementing these measures, Nashik City can move towards a cleaner, more sustainable environment while setting a benchmark for other urban centres in solid waste management.

References

1. Bamb, N., Bahade, I., & Jawale, M. (2023, January). Best Practices of Solid Waste Management and Its Application to Nashik City. In Invitation to National Level Conference on Sustainable Waste Management Practices (pp. 1-20). Singapore: Springer Nature Singapore.
2. Gadakh, B. L., Gaikwad, D. G., Jaybhae, R. G., & Pardeshi, S. D. (2013). An assessment of solid waste management: a case study of Nashik Municipal Corporation. South Asian Journal of Marketing & Management Research, 3(6), 56-63.
3. Yadav, V., MISHRA, H., KARMAKAR, S., & Dikshit, A. K. (2015). Feasibility study of transfer stations siting: a case study on city of Nashik, India. In Proceedings of the Sardinia 2015, Fifteenth International Waste Management and Landfill Symposium S. Margherita di Pula (pp. 5-9).
4. Ganpat, M. M. (2013). Nashik A Study in Urban Geography.
5. Yadav, V., & Karmakar, S. (2021). Multi criteria decision making for sustainable municipal solid waste management systems. In Computational Management: Applications of Computational Intelligence in Business Management (pp. 587-598). Cham: Springer International Publishing.
6. Yadav, V., Karmakar, S., Dikshit, A. K., & Bhurjee, A. K. (2018). Interval-valued facility location model: An appraisal of municipal

solid waste management system. Journal of Cleaner Production, 171, 250-263.

7. Sarkar, S., Patil, S. A., & Endait, M. S. (2023, December). Assessment of Physicochemical Characteristics and Groundwater Pollution Potential of Urban Landfill Leachate. In International Conference on Pollution Control for Clean Environment (pp. 387-395). Singapore: Springer Nature Singapore.
8. Yadav, V., Bhurjee, A. K., Karmakar, S., & Dikshit, A. K. (2017). A facility location model for municipal solid waste management system under uncertain environment. Science of the Total Environment, 603, 760-771.
9. Annepu, R. K. (2012). Sustainable solid waste management in India. Columbia University, New York, 2(01), 1-89.
10. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of Statistical Techniques for Monitoring and Evaluation of Water Quality of Bhima River, Indian Journal of Natural Sciences, 14(80) 62440-62451
11. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2023) Application of geospatial technique for monitoring Groundwater Level Fluctuation in Karjat Tehsil in Ahmednagar District of Maharashtra, Sanshodhak, 90(04) 362-372
12. Agastirishi Bharat Toradmal, Vilas Vasant Patil (2021) Assessment of Groundwater Level Fluctuation In Karjat Tehsil In Ahmednagar District of Maharashtra State Using GIS Technique, Wesleyan Journal of Research, 14(11) 31-39
13. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020) Identification of Groundwater Potential Prospect Zones in Semi-Arid Region- A Case Study of Karjat Tehsil, Ahmednagar District, Maharashtra, Journal of Xidian University 14(05) 814 - 824
14. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020), Identification of Probable Water Scarcity Zones in Marathwada Region of Maharashtra. Gedrag & Organisatie Review, 33(02) 687-696
15. Vilas Vasant Patil, Agastirishi Bharat Toradmal, (2020), Assessment of Rainfall Variability trend in Solapur District of Maharashtra. Aegaeum Journal, 8(4) 234-241
16. https://www.nextias.com/blog/waste-management-in-india/
17. https://swachhindia.ndtv.com/nashik-waste-management-takes-another-step-towards-sustainability-inaugurates-segregation-facility-76981/
18. https://swachhindia.ndtv.com/nashik-waste-management-takes-another-step-towards-sustainability-inaugurates-segregation-facility-76981/

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 41 - 47 |

Fostering a Circular Economy in Zambia: Opportunities for Sustainable Development and Innovation

Dr Sidney Kawimbe

DBA, MBA, BBA, AZIBFS, Director – Research and Innovation, ZCAS University, Dedan Kimathi Road, Lusaka Zambia 35243.

Email: skawimbe@yahoo.com

Article DOI Link: https://zenodo.org/uploads/15188694

DOI: 10.5281/zenodo.15188694

Abstract

The global shift towards a circular economy offers a transformative approach to economic growth, emphasizing resource efficiency, waste minimization, and sustainability. Moving away from the linear "take-make-dispose" model, this regenerative system seeks to maximize the utility of resources, reducing environmental impact while fostering economic innovation. As climate change and resource scarcity pose escalating global challenges, the circular economy emerges as a strategic pathway to sustainable development. For Zambia, a country rich in natural resources yet vulnerable to environmental degradation, adopting a circular economy framework holds immense potential. The country's key sectors—mining, agriculture, and waste management—contribute significantly to the economy but also generate substantial waste. Mining tailings and agricultural residues, for instance, are often underutilized, while urban areas face growing challenges in managing waste. By embracing circular principles, Zambia can transform these challenges into opportunities, creating value from waste, reducing greenhouse gas emissions, and enhancing resilience. Despite notable efforts, such as the Eighth National Development Plan (8NDP) Strategy 2: Improve Sanitation Services and commitments under the Paris Agreement, Zambia's circular economy remains underdeveloped. Key barriers include inadequate infrastructure, policy gaps, and limited public awareness. Overcoming these challenges requires strategic investments, robust policies, and collaboration among government, private sector, and civil society. This study highlights actionable strategies to foster a circular economy in Zambia, including waste valorisation, biofertilizer production, and innovative recycling initiatives. It emphasizes the need for targeted policy reforms, improved infrastructure, and community engagement. By leveraging international partnerships and fostering local innovation, Zambia can redefine its economic growth, ensuring environmental sustainability, social equity, and economic resilience. This transition represents a critical step toward a sustainable and prosperous future.

Keywords: Circular Economy, Sustainable Development, Resource Efficiency, Waste Management, Environmental Resilience

Introduction:

The global transition to a circular economy presents an opportunity to redefine economic growth, moving away from the traditional "take-make-dispose" linear model towards a regenerative system where resources are reused, recycled, and maintained at their highest utility for as long as possible. As the world grapples with the dual challenges of climate change and resource scarcity, the circular economy has emerged as a powerful strategy for sustainable development. By embracing principles of waste minimization, resource efficiency, and closed-loop systems, countries can simultaneously address environmental challenges and unlock new economic opportunities. For Zambia, a nation endowed with abundant natural resources and a growing population, the circular economy offers a promising pathway to sustainable growth and innovation. Zambia's economy is heavily reliant on natural resources, particularly in mining, agriculture, and forestry. While these sectors contribute significantly to national income, they also generate substantial waste and environmental degradation. For instance, the mining sector produces significant quantities of tailings and slag, while agricultural waste often remains underutilized. These challenges, coupled with increasing urbanization and waste generation, have put pressure on Zambia's ecosystems, exacerbating climate vulnerability and threatening long-term sustainability. The adoption of a circular economy framework can help Zambia transform these challenges into opportunities by creating value from waste, reducing environmental impact, and fostering innovation.

In recent years, Zambia has demonstrated a commitment to sustainable development through initiatives such as the Eighth National Development Plan (8NDP), which emphasizes green growth and resource efficiency. Additionally, the country has signed international agreements, such as the Paris Agreement, underscoring its dedication to addressing climate change. Despite these efforts, the circular economy concept remains underexplored in Zambia, leaving room for greater policy alignment, stakeholder engagement, and investment in circular solutions. This paper seeks to explore the potential of fostering a circular economy in Zambia, focusing on the opportunities it presents for sustainable development and innovation. By examining key sectors such as mining, agriculture, and waste management, this paper highlights strategies for creating a more resource-efficient and resilient economy. It also discusses the policy and institutional frameworks needed to support this transition, as well as the role of private sector innovation and community engagement in driving change. Through this analysis, the paper aims to provide a roadmap for Zambia to harness the benefits of a circular economy, contributing to environmental sustainability, economic resilience, and social well-being.

Literature Review

The Concept and Global Context of Circular Economy

The circular economy (CE) is a systems-focused approach aimed at eliminating waste and maximizing resource efficiency through reuse, recycling, and sustainable design. Globally, this model is seen as an alternative to the traditional linear economy, which operates on a take-make-dispose principle.

Source: European Parliament Research Services

Figure 1: The circular economy model: less raw materials, less waste and fewer emissions

CE aligns with sustainable development goals (SDGs) especially SDG No 17 Promotes collaboration among stakeholders, essential for achieving the balance between economic growth, environmental protection, and social equity, particularly in addressing environmental sustainability, economic growth, and social equity.

Circular Economy in Zambia: Current Status

Zambia has immense potential for implementing CE due to its high levels of waste generation, particularly in urban centers. The country produces approximately 3.6 million tonnes of waste annually, of which a significant portion is unmanaged. Studies have identified key sectors for CE integration, including waste management, manufacturing, and agriculture. For instance, transitioning to CE in the waste sector could involve separating waste streams like plastics, textiles, and organic materials, which present opportunities for recycling and energy recovery. Prioritizing these sectors aligns with Zambia's broader developmental goals of reducing environmental degradation and creating green jobs (ACEN Foundation, 2023; Sustainable Inclusive Business, 2024).

Key Opportunities for CE Adoption in Zambia

Waste Management: Improved waste collection and separation are critical. Around 55% of waste is uncollected annually, posing health and environmental risks. Properly managed waste could be converted into biogas or recycled into valuable products. For example, biogas production from food waste could supply energy to over 500,000 households (Finland Abroad, 2023). Agriculture: CE practices in agriculture include using organic waste as biofertilizers and promoting sustainable farming practices. These initiatives can increase productivity while reducing environmental impacts, such as soil degradation. Manufacturing and Innovation: Leveraging local resources to manufacture recycled products can reduce dependence on imports, stimulate local industries, and foster innovation. For example, recycling textile waste into fibres has the potential to generate products like t-shirts, substituting imported goods. Policy and Infrastructure Development: A supportive policy framework and investment in infrastructure are necessary for a successful transition. The government, in collaboration with stakeholders, has initiated the

development of roadmaps, such as those targeting plastics, to enhance CE practices (Sustainable Inclusive Business, 2024). Kawimbe, 2024 indicated that there are several opportunities for SMEs in circular economy especially when designing curriculum as it forms part of the national education integrated in other subjects such as Business Studies, Commerce and Principles of Accounts.

Challenges and Barriers

Despite these opportunities, Zambia faces several challenges in transitioning to a circular economy. These include inadequate infrastructure for waste processing, limited public awareness, and policy gaps. Collaboration with international partners, such as Finland and the Netherlands, has been instrumental in identifying these challenges and developing strategies to address them, such as policy reforms and capacity building (ACEN Foundation, 2023; Sustainable Inclusive Business, 2024). In summation, Zambia's transition to a circular economy represents a strategic avenue for sustainable development. With its abundant resources and increasing stakeholder interest, the country is well-positioned to harness the economic, social, and environmental benefits of CE. Continued investment, policy support, and stakeholder collaboration are crucial for overcoming barriers and fostering innovation in CE practices.

For further insights, references include recent studies and initiatives highlighted by the ACEN Foundation (2023), Sustainable Inclusive Business (2024), and Finland Abroad (2023).

Discussion

The global transition toward a circular economy (CE) offers a reimagined approach to economic development, addressing critical challenges such as climate change, resource scarcity, and waste management. This model shifts the focus from traditional linear production systems to a regenerative framework that emphasizes resource efficiency, waste reduction, and the continuous use of materials. For Zambia, the circular economy presents a unique opportunity to foster sustainable development, promote innovation, and mitigate the environmental degradation associated with key economic sectors like mining, agriculture, and manufacturing.

Opportunities for Circular Economy in Zambia

Zambia’s abundant natural resources, coupled with its growing waste generation, provide fertile ground for implementing CE strategies. For instance, the mining industry, a cornerstone of Zambia's economy, produces substantial waste materials such as tailings and slag. These byproducts, often perceived as liabilities, could be reprocessed into usable materials for construction or other industrial applications. This aligns with global practices where mining waste is recycled into road aggregates or industrial raw materials, reducing environmental impact while creating economic value. Similarly, agriculture in Zambia contributes significantly to GDP but generates large volumes of organic waste. By adopting CE principles, this waste could be transformed into biofertilizers or biogas, enhancing soil fertility and providing renewable energy.

Such practices not only address resource scarcity but also support climate adaptation by reducing greenhouse gas emissions from organic waste decomposition. Waste management, a critical aspect of CE, also holds vast potential in Zambia. With over 3.6 million tonnes of waste generated annually, much of which is unmanaged, there is an urgent need for enhanced collection and recycling systems. Prioritizing waste streams such as plastics and textiles could lead to the creation of sustainable industries focused on recycling and repurposing, generating employment and reducing environmental pollution.

Challenges in Transitioning to a Circular Economy

Despite its potential, Zambia faces significant challenges in transitioning to a CE framework. Infrastructure gaps in waste collection and processing remain a primary barrier. For example, an estimated 55% of waste in Zambia is uncollected, leading to environmental and public health risks. Addressing these gaps requires substantial investment in infrastructure, such as recycling plants and waste-to-energy facilities, as well as the development of efficient logistics networks. Policy and regulatory frameworks also need strengthening. While Zambia has demonstrated commitment through initiatives like the Seventh National Development Plan (7NDP) and its alignment with the Paris Agreement, there is a need for more targeted policies promoting CE. Incentives for businesses adopting sustainable practices, along with penalties for excessive waste generation, could catalyze the transition. Public awareness and stakeholder engagement are equally crucial. Limited understanding of CE principles among communities and businesses often hampers adoption. Educational campaigns, capacity-building programs, and collaborations with international organizations could play a pivotal role in bridging this gap.

The Role of Innovation and Collaboration

Innovation is at the heart of the circular economy, driving the development of new technologies and business models. In Zambia, fostering partnerships between academia, industry, and government can spur innovation tailored to local challenges. For example, research into low-cost recycling technologies or the use of agricultural residues in bio-based industries could yield solutions adapted to Zambia's context. International collaboration is also vital. Partnerships with countries like Finland and the Netherlands, which have advanced CE practices, can provide technical expertise, funding, and policy insights. Initiatives such as the EU-funded waste stream roadmap for plastics in Zambia exemplify the benefits of such collaborations, offering a blueprint for scaling CE practices across other sectors.

Conclusion

The discussion underscores that Zambia's transition to a circular economy represents both an opportunity and a challenge. While the country has inherent strengths, such as abundant resources and growing stakeholder interest, addressing infrastructure, policy, and awareness gaps is critical. By leveraging innovation, fostering partnerships, and investing in targeted

solutions, Zambia can pave the way for sustainable growth, transforming waste into wealth and fostering resilience in the face of environmental and economic challenges.

Conclusions and Recommendations

The transition to a circular economy represents an invaluable opportunity for Zambia to redefine its growth trajectory, addressing environmental, economic, and social challenges.

By shifting away from the linear "take-make-dispose" model, Zambia can unlock the potential of its abundant natural resources while mitigating the negative impacts of waste and environmental degradation. The principles of resource efficiency, waste minimization, and closed-loop systems provide a framework for sustainable development, enabling Zambia to create value from waste, reduce greenhouse gas emissions, and foster economic resilience. However, the path to achieving a circular economy is fraught with challenges, including inadequate infrastructure, policy gaps, and limited public awareness. Overcoming these barriers will require strategic investments, targeted policy reforms, and a collaborative approach involving government, private sector, academia, and civil society. With its existing commitments, such as the Seventh National Development Plan (7NDP) and adherence to international agreements like the Paris Agreement, Zambia is positioned to advance its circular economy agenda. Continued innovation, stakeholder engagement, and international partnerships are essential for transforming challenges into opportunities and building a more sustainable future.

Recommendations

In an era marked by growing environmental concerns and finite natural resources, the concept of a circular economy has emerged as a powerful strategy for achieving sustainable development. Unlike the traditional linear economic model, which follows a "take-make-dispose" approach, a circular economy emphasizes resource efficiency, waste reduction, and the continuous use of materials through innovative design, recycling, and reuse. By shifting towards this model, countries can unlock significant economic, social, and environmental benefits. For Zambia, a resource-rich nation with a diverse economy spanning mining, agriculture, and manufacturing, fostering a circular economy presents a timely opportunity. The country faces challenges such as environmental degradation, high levels of waste generation, and dependency on raw material exports. However, these challenges also open pathways for innovation, job creation, and sustainable growth through circular practices. From leveraging its abundant natural resources to tapping into global trends in green technology and sustainable consumption, Zambia stands poised to become a regional leader in circular economic transformation.

This paper explores actionable recommendations for fostering a circular economy in Zambia. It examines the potential opportunities across key sectors, highlights the role of policy and innovation, and emphasizes the importance of multi-stakeholder collaboration to drive long-term sustainability and inclusive growth.

Strengthen Policy Frameworks

1. Develop and implement comprehensive policies that incentivize circular economy practices, such as tax benefits for businesses adopting sustainable production methods and penalties for waste mismanagement.
2. Align national policies with international best practices and integrate CE principles into existing development strategies like the 7NDP.
3. Invest in Infrastructure Development
4. Establish waste processing and recycling facilities to manage urban waste effectively, particularly in high-impact sectors such as plastics, textiles, and organic waste.
5. Improve waste collection systems to increase efficiency and coverage, focusing on urban and peri-urban areas.
6. Enhance Public Awareness and Education
7. Launch nationwide campaigns to educate communities and businesses about the benefits of the circular economy, emphasizing practical ways to reduce waste and adopt sustainable practices.
8. Include CE principles in educational curricula to foster a culture of sustainability among future generations.
9. Promote Innovation and International Collaboration
10. Support research and development in circular economy solutions tailored to Zambia's unique challenges, such as low-cost recycling technologies and bio-based products.
11. Foster partnerships with international organizations and countries with advanced CE systems to gain technical expertise, financial support, and insights for policy and infrastructure development.

These recommendations can act as a roadmap for Zambia to harness the full potential of a circular economy, ensuring a sustainable and prosperous future for its citizens

References

1. ACEN Foundation (2023) Circular Economy Market Study in Zambia. African Circular Economy Network. Available at: https://acenfoundation.org/project/circular-economy-market-study-in-zambia (Accessed: 5 December 2024).
2. Finland Abroad (2023) Strengthening the Circular Economy in Zambia Through Finnish Partnerships. Available at: https://finlandabroad.fi/ (Accessed: 5 December 2024).
3. Kawimbe, S. (2024). Entrepreneurship Education as Panacea to Job Creation among University Graduates: A Case of ZCAS University. Journal of Entrepreneurship and Project Management, Vol No 9 (2), pp: 15–25.
4. Sustainable Inclusive Business (2024) Assessment of the Current Status of the Circular Economy in Zambia. Available at: https://sustainableinclusivebusiness.org/ (Accessed: 5 December 2024).

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 48 - 53 |

Application of organic manure on infertile land for creating a vegetable garden

[1]Kavita E. Shelke

[2]Vijay Kisan Hile

[3]Suraj Gajbhiye

[4]Jai Knox

[1]Asst. Prof. Konkan Gyanpeeth Karjat College of Arts, Science & Commerce Karjat - Raigad.

[2]Asso. Prof. Bhavan's H. Somani college, Chowpatty, Mumbai-7.

[3]Asso. Prof. Bhavan's H. Somani college, Chowpatty, Mumbai-7.

[4]Asso. Prof., Department of Botany, Wilson College (Autonomous), Mumbai- 400007

Email: kavitairnak@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188740

DOI: 10.5281/zenodo.15188740

Abstract

Organic manure is a natural product utilized by farmers to improve sustainable crop production. The primary objective of application of organic manure on infertile land for growing organic vegetable is to enhance the health and productivity of the interconnected communities of soil, plants, animals and humans. Here, using college premises infertile land to create vegetable garden and awareness towards the organic farming and organic vegetables and their value. Among the vegetables planted, the maximum growth was recorded in Solanum melongena (L.), Solanum lycopersicum (L.), Anethum graveolens (L.), Trigonella foenum-graecum (L.) and satisfactory growth in Luffa cylindrical (L.), Lablab purpureus (L.) and Spinacia oleracea (L.). No lowest growth was recorded in any vegetables while using the organic manure in vegetables garden. Luffa cylindrical and Lablab purpureus cultivated in bed border and found that fruitful results. Now a day's chemical fertilizers were used in excess amount to increase the crop production for economical purpose. Such chemical vegetables are affected the human body parts and to create measure disease like cancer. So, one of the main motives of this research is to cultivate vegetable using organic compost and bio pesticide to increase nutritive value as compared to chemical fertilizers.

Keywords: Vegetables, organic manure, infertile Soil

Introduction:

India is the land of vegetable crops and ranked second in the world in vegetable

production. In Indian kitchen vegetable play an important role. Vegetables are so common in human diet that a meal without a vegetable is supposed to be incomplete in any part of world. All the vegetables have presented a great variant nutrient as per human diets which are necessary. Vegetable requirement is 300g/day/person as recommended by dietician. Vegetables are herbaceous plants and produce large amount of biomass within short period (Chatterjee and Thirumdasu, 2014). Research conducted by the School of Vegetable Gardening indicates that consuming grains, fruits, and vegetables cultivated with chemical fertilizers causing the development of serious health issues in humans, including cancer, skin diseases and kidney problems. The utilization of natural manure has demonstrated a positive impact on both agricultural productivity and human well-being, facilitated by the consumption of organically cultivated fruits and vegetables in daily life (Basnet and Chidi, 2019).

So, the demand for fresh and healthy organic vegetable is increasing sharply both in domestic and international market due to the harmful effects of chemically treated vegetables on human health and soil quality. If the soil contains a beneficial living organism and organic manure is the most important factor for crops production and maintain soil fertility at the same time. Farmers are most influenced by observing and using this method. Soil quality defines the characteristics and dynamics of soil properties, while soil health defines function in terms of a given soils capacity to supply a service based on the existing stock or process. Zhao et al. (2024) stated that combining of organic manure with mineral fertilizers effectively boosts crop production and the economic income of farm while mitigating the harmful effects of solely using chemical fertilizers on the soil.

Organic manure is the most natural and chemical-free substance way to boost crop yield and enhance soil productivity. Organic manure prepared from decaying animal waste, plant scraps and food waste (Verma et al., 2021). The use of this type of manure in farming, enriches the soil with a variety of essential nutrients for plant growth. In today's generation, the heavy use of chemical fertilizers has negatively impacted on the land, leading to higher crop yields but also an increase diseases and pests in cereals. As a result, many farmers have now that turned towards the traditional farming by using natural fertilizers instead of chemical ones (TNAU, 2016). Organic manure enhances the soil's ability to retain water, makes it more porous for better gas movement and boosts the population of beneficial soil microorganisms (Sanasha, 2014). Poikayil (2021) told from his research that Holstein Friesian cow dung significantly enhances crop productivity due to its high quality in creating farm yard manure, surpassing the contributions of other Indian breeds. Farm yard manure content 0.5% N, 0.2% P2O5 and 0.5% K2O in well-rotted manure (TANU, 2016) while green manure (compost) content 0.5-0.1% N, 0.4-0.8% P2O5 and 0.8-1.2% K2O nutrient (Katyayan, 2019). Organic manure contains nitrogen, phosphorus and other essential nutrients that plants need to grow.

In this study, compost and fertilizers were applied to infertile land, making it suitable for the cultivation of fresh, healthy and chemical-free vegetables. Solanum melongena (L.), Solanum lycopersicum (L.), Trigonella foenum-graecum (L.), Spinacia oleracea (L.), Anethum graveolens (L.), Luffa cylindrical (L.) and Lablab purpureus (L.) vegetables were grown on prepared fertile land by providing plant nutrients. A good number of vegetables in India are an introduction from foreign countries. Growing the vegetables on land they as to maintain the soil quality and avoid soil erosion. Study on the creation of vegetable garden as on infertile land in college premises has a challenge to take the production from same land. The concept of creativity of vegetable garden in college premises has one of the distinct changes regarding the organic vegetables and organic farming.

Material and Method

Using farm tools and equipment's to made land in level removing many stones as possible and other unwanted material. All the weeds and grasses were removed from the soil. Then loosen the soil with rototiller or shovel, to a depth of at least 12 inches. Two inches of dried compost to 17% moisture content and ground into fine soil like texture (Traunfeld and Nibali, 2013) was incorporated into the superficial layer of the land and were left for two weeks. After that the soil analysis was done with several parameters like organic matter, pH, electrical conductivity, nitrogen, sulphur, phosphorus, potassium and soil texture to make the soil suitable by maintaining these all parameters for vegetable growth.

All over the places soil is not more fertile to grow various crops. First it is essential to prepare the infertile soil by enriching it with organic material while maintaining the proper pH and moisture levels to make it suitable for use. On the same land to prepared square and rectangular shape of soil beds. There are 21 beds prepared for this work. Each bed cultivated single vegetable in triplicate. Removed rocks were used to make borders of the garden. Three-four weeks old seedling of vegetable viz. Solanum melongena (L.), Solanum lycopersicum (L.), Luffa cylindrica (L.), Lablab purpureus (L.), Anethum graveolens (L.), Trigonella foenum-graecum (L.) and Spinacia oleracea (L.) was transplanted on prepared soil beds. There was providing plant nutrient, sufficient water and weeding was done manually throughout the growing period of the vegetables (Abegunrin et al., 2016). Biological fertilizers are also provided to ensure the continuous and healthy growth of planted vegetables, protecting them against both external and internal fungal diseases. The normal and healthy growth of vegetables was recorded.

Result and Discussion

For crop cultivation, soil is incorporated with composts, green manure, bio fertilizers and makes more humus. It is necessary to maintain soil fertility. The vegetables are cultivated on it, provides a good production.

Growth showing various vegetables planted on prepared fertile land.

Sr. No.	Vegetables Name	Growth
1.	*Solanum melongena* (L.)	++++
2.	*Solanum*	++++

	lycopersicum (L.)	
3.	*Luffa cylindrica* (L.)	+++
4.	*Lablab purpureus* (L.)	+++
5.	*Anethum graveolens* (L.)	++++
6.	*Trigonella foenum-graecum* (L.)	++++
7.	*Spinacia oleracea* (L.)	+++

++++ - High growth
+++ - Satisfactory growth
++ - Low growth

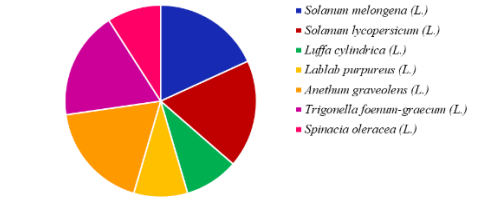


Fig. 1. Growth showing various vegetables planted on prepared fertile land.

All planted vegetables show variation in growth and production. Solanum melongena (L.), Solanum lycopersicum (L.), Anethum graveolens (L.) and Trigonella foenum-graecum (L.) shows higher production and healthy growth as compared to Luffa cylindrical (L.), Lablab purpureus (L.) and Spinacia oleracea (L.). The results revealed in (Table. 1 and Fig. 1) shows that S. melongena (L.), S. lycopersicum (L.), A. graveolens (L.) and T. foenum-graecum (L.) produces more branches, busy structure and maximum healthy biomass while L. cylindrical (L.), L. purpureus (L.) and S. oleracea (L.) produces satisfactory. This study aims to investigate the potential advantages of using organic manure in vegetable gardens specifically focusing on its ability to increase leaf count, fruit yield, stem diameter and plant height compared to the current widespread use of chemical fertilizers by farmers.

Several previous studies have reported findings relevant to this research conducted by other researchers. Nair (2018) stated that, the application of organic manure results in improved soil physicochemical and biological parameters, mitigating nutrient deficiencies and consequently fostering optimal plant growth and increased crop productivity. Due to this it improved soil health through organic manure enhances the storage life and nutritional value of horticultural crops while also improving their overall quality. Conversely, excessive use of chemical fertilizers can increase the susceptibility of crops to diseases and pests. Organic manure application does not demonstrate any discernible influence on production levels, which remain satisfactory. Zhao et al. (2024) evaluated that the amount of nutrients supply and soil organic matter were positively correlated with the average grain production. This revealed that because of soil organic matter affects the uptake of nutrients, it positively affects crop yields. So, their findings demonstrated that applying the organic manure enhances soil qualities and increases crop productivity.

Bayu et al. (2006) noted that increase the total nitrogen and organic carbon of a soil due to addition of farm yard manure; cow dung (Ewulo et al., 2007) and compost (Angelova et al., 2013). The increased soil TN with increasing rate of cow dung showed that remarkable amount of N would be available for plant because of increased organic matter and favourable pH (Zupanc and Justin, 2010). The addition of doses of compost and plant nutrient had significant effect

on vegetable growth of vegetables expressed by higher number of leaves, plant height and stem girth. Ewulo et al. (2007) also reported that the improved plant growth and yield of pepper under different doses of cow dung. The use of compost for soil amendment increased the organic matter content and improved the physical properties of the degraded soil (Abegunrin et al., 2016). Application of animal dung was found necessary to improved farm productivity of upland vegetable crops (Daño & Midmore, 2002). Wu et al. (2024) noted that applying moderate amounts of organic manure is most effective in improving microbial resources in rhizospheric soil, without causing over-application of organic fertilizer or any adverse effects. Our results suggested that the application of compost and plant nutrients had positive impact on vegetables growth.

Conclusion

Creativity of vegetable garden on infertile land using farm techniques gives an inspiration to farmer to adopt a maximum infertile land as to progress in farming. Plantation of vegetables on land to avoids soil erosion, increase soil quality, production and soil nutrient. For this way they take a good and healthy vegetable production to give a great economic benefit to farmer and people. Thus, if all farmers transform barren and waste land into fertile land for cultivation, it will lead to significant sustainable improvements in farming.

References

1. Abegunrin, T., Awe, G. & Ateniola, K. (2016). Soil Amendment for Vegetable Production: An Example with Cow Dung Manure and Eggplant (Solanum melongena). International Journal of Current Microbiology and Applied Sciences, 5(8), 901–915. https://doi.org/10.20546/ijcmas.2016.508.102
2. Angeloya, V. R., Akova, V. I., Artinova, N. S. & Ivanov, K. I. (2013).The effect of organic amendment on soil chemical characteristics. Bulg. J. Agric. Sci. 19(5), 958-971.
3. Basnet, N., & Chidi, C. L. (2019). Impact of pesticide and fertilizer on human health: a case study in Godawari area, Lalitpur, Nepal. The Geographic Base, 6, 65–76. https://doi.org/10.3126/tgb.v6i0.26168
4. Bayu, W., Rethman, N. F., Hammes, P. S. & Alemu, G. (2006). Application of farmyard manure improved the chemical and physical properties of the soil in a Semi-Arid area in Ethiopia. Biological Agriculture & Horticulture, 24(3), 293–300. https://doi.org/10.1080/01448765.2006.9755027
5. Chatterjee, R. & Thirumdasu, R. K. (2014). Nutrient management in organic vegetable production. International journal of food, agriculture and veterinary sciences ISSN: 2277-209X, vol. 4(3).
6. Daño, A. M. & Midmore, D. J. (2002). Analyses of Soil and Water Conservation Technologies in Vegetable Based Upland Production System of Manupali Watershed. 12th ISCO Conference, Beijing. https://tucson.ars.ag.gov/isco/isco12/VolumeIV/AnalysesofSoilandWaterConservationTechnologies.pdf

7. Ewulo, B., Hassan, K. & Ojeniyi, S. (2007). Comparative effect of cowdung manure on soil and leaf nutrient and yield of pepper. International Journal of Agricultural Research, 2(12), 1043–1048. https://doi.org/10.3923/ijar.2007.1043.1048
8. Katyayan, A. (2019). Fundamental of Agriculture, Kushal Publication's and Distribution, pp. 231-235.
9. Nair, A. (2018). Importance of Soil Fertility in Vegetable Crop Production, Department of Horticulture, Iowa State University, Ames, LOWA.
10. Poikayil, G. (2021). The Indian Express News Published: 28th January 2021.
11. Sanasha, 2014, https://www.slideshare.net/sanasha_999/ishita-manures-fertilizers
12. TNAU, 2016 https://agritech.tnau.ac.in/ta/org_farm/orgfarm_introduction.html
13. Verma, P., Tomar, B. & Ttipathi, L. K. (2021). Role of Organic Manure in Agriculture: a Review. Marumegh, 6(3), 22-28.
14. Wu, Z., Han, X., Chen, X., Lu, X., Yan, J., Wang, W., Zou, W., & Yan, L. (2024). Application of organic manure as a potential strategy to alleviate the limitation of microbial resources in soybean rhizospheric and bulk soils. Journal of Integrative Agriculture, 23(6), 2065–2082. https://doi.org/10.1016/j.jia.2023.10.021
15. Zhao, N., Ma, J., Wu, L., Li, X., Xu, H., Zhang, J., Wang, X., Wang, Y., Bai, L., & Wang, Z. (2024). Effect of organic manure on crop yield, soil properties, and economic benefit in Wheat-Maize-Sunflower rotation System, Hetao Irrigation District. Plants, 13(16), 2250. https://doi.org/10.3390/plants13162250
16. Zupanc, V. & Justin, M. Z. (2010). Changes in soil characteristics during landfill leachate irrigation of Populus deltoides. Waste Management, 30(11), 2130–2136. https://doi.org/10.1016/j.wasman.2010.05.004
17.

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 54 - 62 |

Eco-Cloud Computing for Sustainable Urban Futures

Swati Kharade

Bismah Killedar

Assistant Professor, Anjuman Islam Janjira Degree College of Science, Murud-Janjira.

Maharashtra, India.

Email: swatideshmukh814@gmail.com

Article DOI Link: https://zenodo.org/uploads/15188818

DOI: 10.5281/zenodo.15188818

Abstract

The increasing demand for digital infrastructure in urban areas has led to significant environmental concerns, including high energy consumption and carbon emissions. Eco-Cloud Computing offers a sustainable solution by integrating eco-friendly computing technologies with urban planning strategies. This paper explores the role of plant-based cooling systems, eco-infrastructure, and environmental education in minimizing the ecological impact of cloud computing. By leveraging renewable energy, AI-driven energy management, and biophilic design, cities can enhance energy efficiency while maintaining technological growth. Implementing these strategies can help reduce the urban heat island effect, improve air quality, and create healthier living environments.

Furthermore, this study examines case studies of green data centers that have successfully adopted sustainable practices, showcasing their benefits in reducing operational energy demands. Policy recommendations and future research directions are also discussed, emphasizing the importance of interdisciplinary collaboration between policymakers, technology providers, and urban planners. The integration of Green Cloud Computing into smart cities is essential for achieving long-term sustainability, balancing digital transformation with environmental responsibility.

Keywords: Green Cloud Computing, Sustainable Cities, Eco-Infrastructure.

Introduction:

As urban areas expand and technology usage increases, the demand for energy-intensive digital infrastructure continues to grow. Cities, being hubs of innovation and economic activity, are responsible for a significant share of global energy consumption. However, this growth often comes at the cost of environmental degradation, including rising carbon emissions and excessive resource depletion. To address these challenges, Green Cloud Computing has emerged as a transformative approach, combining sustainable digital technologies with eco-friendly urban planning. By

incorporating plant-based cooling systems, green infrastructure, and environmental education, cities can create a balanced ecosystem where technological progress aligns with environmental responsibility. This approach enables urban areas to reduce their carbon footprint, optimize energy efficiency, and improve overall livability. The integration of nature-inspired cooling solutions with cloud computing presents an opportunity to develop resilient, resource-efficient, and environmentally conscious smart cities.[1]

Eco-Cloud Computing refers to the practice of optimizing cloud computing resources in a manner that minimizes environmental impact. This involves utilizing energy-efficient technologies, renewable energy sources, and sustainable practices to reduce carbon footprints associated with data centers and cloud services. By leveraging virtualization, energy-efficient hardware, and innovative cooling solutions, Eco-Cloud Computing aims to create a more sustainable digital infrastructure that supports the needs of urban populations while conserving natural resources. Sustainability is at the core of modern urban development, as cities account for a substantial share of global energy consumption and carbon emissions.[2] The unchecked expansion of urban areas and technology-driven economies places immense pressure on natural resources, necessitating a shift towards sustainable urban planning.

By integrating Eco-Cloud Computing with urban development, cities can:

- Reduce their carbon footprint while maintaining technological growth.
- Enhance energy efficiency in data-driven industries.
- Ensure long-term environmental resilience by adopting nature-inspired cooling solutions.
- Create healthier, livable urban spaces that balance technological progress with ecological conservation.

Objectives

- The objective of this study is to explore and promote the integration of green cloud computing technologies with plant-based cooling systems, eco-friendly infrastructure, and environmental education to support the development of sustainable cities. This research aims to:
- Reduce energy consumption and carbon footprint through eco-efficient cloud computing solutions.
- Investigate the role of plant-based cooling techniques in mitigating urban heat island effects.
- Promote eco-infrastructure models that align with smart and green city development.
- Enhance public awareness and engagement through environmental education initiatives for sustainable urban living.

Data and Methodology

Eco-infrastructure and green technologies play a vital role in the realization of sustainable cities. Eco-infrastructure refers to the interconnected networks of natural and semi-natural systems that provide essential services, such as air and water purification, biodiversity conservation, and climate regulation. By integrating

eco-infrastructure with urban planning, cities can enhance their resilience and adaptability to environmental changes. Green technologies, such as plant-based cooling systems, renewable energy solutions, and smart waste management systems, further contribute to urban sustainability. [3] These technologies not only reduce the environmental impact of urban activities but also promote community engagement and environmental education, empowering citizens to participate actively in sustainability initiatives. The integration of Green Cloud Computing, eco-infrastructure, and green technologies is essential for creating sustainable cities that can thrive in harmony with their natural surroundings. This holistic approach not only addresses the challenges of urbanization but also paves the way for a more sustainable and equitable future.

Traditional data centers are among the largest consumers of energy, primarily due to their high cooling requirements, inefficient hardware, continuous operation, and power supply inefficiencies. [4] These facilities generate significant heat as a byproduct of their computational processes, necessitating advanced cooling mechanisms. Most traditional data centers rely on energy-intensive air conditioning systems, which significantly contribute to overall power consumption. Additionally, many centers continue to operate with outdated hardware that lacks energy-efficient designs. Older servers and storage systems consume excessive electricity compared to modern, optimized alternatives, leading to unnecessary energy waste. Another major challenge is that data centers run 24/7, regardless of actual demand, resulting in energy consumption even during periods of low usage.[5] This constant operation not only increases power consumption but also contributes to environmental degradation. Furthermore, inefficiencies in power supply system add to the overall energy waste. Traditional data centers often use power supply units that are not optimized for energy conversion, leading to further loss of electricity during distribution and utilization.

To address these environmental and energy consumption challenges, the integration of renewable energy into cloud computing has become a crucial step toward sustainability. By shifting to renewable energy sources such as solar, wind, and hydroelectric power, cloud providers can significantly reduce their carbon footprint and minimize their reliance on fossil fuels. [6] The adoption of renewable energy solutions enhances energy independence by reducing dependence on non-renewable resources, leading to more stable and predictable energy costs. Additionally, various technology companies are actively investing in green initiatives, including solar farms and wind turbine projects, to power their data centers with clean energy. These sustainable infrastructure developments not only reduce emissions but also contribute to a more resilient and eco-friendlier digital ecosystem. Furthermore, organizations that integrate renewable energy into their cloud operations can achieve internationally recognized certifications, such as LEED (Leadership in Energy and Environmental Design) and ISO 14001, which validate their commitment to environmental sustainability. These

certifications not only enhance their corporate social responsibility (CSR) profile but also encourage widespread adoption of green computing practices across the industry. By prioritizing energy efficiency and renewable energy adoption, cloud computing can transition towards a more environmentally responsible and sustainable future.

Case Studies of Sustainable Data Centers

1. Google's Data Centers:

Google has committed to operating its data centers on 100% renewable energy, integrating cutting-edge IT solutions to enhance efficiency. They have invested in solar and wind projects globally, achieving significant reductions in carbon emissions. Additionally, Google leverages AI-powered energy management systems to optimize cooling and power usage in real-time, further improving sustainability. These systems use machine learning to analyze data center performance, adjusting cooling mechanisms dynamically to minimize energy consumption while maintaining optimal server conditions.

2. Microsoft's Project Natick:

This innovative project explores the concept of underwater data centers powered by renewable energy sources, using advanced IT frameworks to ensure operational efficiency. The submerged environment naturally cools the servers, reducing the need for traditional cooling systems and significantly lowering energy consumption. Microsoft's use of automated remote monitoring and IoT-based performance tracking enhances system reliability while minimizing maintenance requirements. The integration of cloud-based analytics helps in predictive maintenance, ensuring that these underwater data centers remain operational with minimal human intervention.[7]

3. Amazon Web Services (AWS):

AWS has pledged to reach 100% renewable energy usage by 2025, implementing advanced IT-driven energy-efficient practices across its global data centers. AWS utilizes machine learning algorithms to optimize server workloads, ensuring maximum efficiency with minimal energy wastage. They have also invested in wind and solar energy projects to power their operations sustainably. Additionally, AWS employs AI-powered predictive analytics to monitor power distribution and enhance energy conservation strategies, making its cloud services more environmentally responsible.

4. Facebook's Data Centers:

Facebook has designed its data centers to be highly energy-efficient by incorporating smart cooling systems and AI-driven temperature regulation technologies. These centers utilize renewable energy sources such as wind and solar power to minimize their environmental impact. Facebook has also implemented advanced water recycling systems for cooling, significantly reducing water wastage. By integrating IoT sensors and automation, Facebook ensures real-time monitoring of energy consumption, optimizing performance while maintaining sustainability standards. Several of their facilities have achieved LEED certification, underscoring their commitment to green IT infrastructure.[8]

Biophilic Design in Technology

Biophilic design is an innovative approach that integrates natural elements into urban environments and technological systems to strengthen the relationship between humans and nature. This concept emphasizes the inclusion of plant life, natural light, and ecological processes in architectural and technological solutions. In the context of plant-based cooling, biophilic design facilitates the incorporation of vegetation into urban spaces, creating a more sustainable and climate-resilient environment. By blending nature with infrastructure, this approach not only enhances aesthetics but also provides psychological and environmental benefits, improving overall well-being and sustainability in smart cities. Plant-based cooling systems leverage vegetation to regulate temperature and enhance air quality. These systems include green roofs, vertical gardens, and urban forests, which contribute to a more sustainable urban climate. Their cooling mechanisms function through:

1. **Evapotranspiration:**

Plants naturally release moisture into the air through transpiration, which, when evaporated, creates a cooling effect in the surrounding environment, reducing overall temperature levels.

2. **Shade Provision:**

Vegetation acts as a natural barrier against direct sunlight, minimizing heat absorption by buildings and urban surfaces, thereby reducing ambient temperatures and decreasing energy demand for artificial cooling.

3. **Air Quality Improvement:**

Plants play a crucial role in filtering pollutants from the air, absorbing carbon dioxide, and releasing oxygen, leading to a healthier atmosphere with improved respiratory conditions for urban populations.

The integration of green data centers within smart cities is essential for developing a more sustainable and energy-efficient urban environment. These data centers are designed to operate using renewable energy sources such as solar, wind, and hydroelectric power, significantly reducing their carbon footprint. By strategically placing these facilities within urban areas, cities can improve digital connectivity while ensuring energy consumption aligns with sustainable practices. Additionally, smart city frameworks enable real-time monitoring and optimization of energy usage, leveraging AI-driven analytics and IoT-based energy management systems to enhance efficiency. [9] By adopting these advanced technologies, cities can create data centers that are not only environmentally friendly but also cost-effective and resilient against energy crises.

Green infrastructure, including green roofs, vertical gardens, and urban forests, plays a pivotal role in improving urban sustainability and ecological balance. Green roofs help regulate building temperatures by absorbing rainwater, providing insulation, and reducing the urban heat island (UHI) effect. Similarly, vertical gardens, often incorporated into building facades, enhance aesthetic appeal while improving air quality, reducing noise pollution, and supporting biodiversity by serving as microhabitats for insects and birds. Urban forests, consisting of strategically planted trees and vegetation within cityscapes, contribute to carbon

sequestration, mitigate air pollution, and provide natural shading, thereby reducing the reliance on artificial cooling systems. Collectively, these elements create a resilient, climate-adaptive urban ecosystem, improving both environmental quality and public health.[10]

Implementing sustainable infrastructure is key to addressing rising urban temperatures and mitigating the adverse effects of climate change. Permeable pavements allow water to be absorbed into the ground, reducing heat absorption and promoting groundwater recharge. Reflective materials used in building exteriors and road surfaces help deflect solar radiation, significantly lowering surface temperatures. Furthermore, expansive green spaces integrated into city planning provide essential cooling benefits, reducing energy consumption for air conditioning in surrounding buildings. Plant-based cooling systems, which utilize natural vegetation to regulate urban temperatures, are an integral component of sustainable urban design. [11] These systems not only help lower ambient heat levels but also contribute to reducing greenhouse gas emissions, creating a healthier, more livable, and energy-efficient urban landscape.

Result and Discussion

Environmental education plays a vital role in promoting sustainability by empowering individuals and communities to understand the environmental impact of their actions. It fosters a culture of responsibility and awareness, encouraging sustainable decision-making at all levels of society. By integrating environmental principles into education, we can equip future generations with the knowledge and skills needed to address pressing ecological challenges and drive meaningful change.

The shift from traditional data centers to green cloud computing represents a major leap toward sustainability in the digital infrastructure sector. While traditional data centers rely on high-energy-consuming cooling systems and fossil fuel-powered electricity, green data centers incorporate energy-efficient solutions, AI-driven optimizations, and renewable energy sources to minimize their environmental impact.

Feature	**Traditional Data Centers**	**Green Data Centers**
Energy Source	Primarily dependent on fossil fuels	Utilizes renewable energy (solar, wind, hydro)
Cooling Mechanism	Air conditioning, mechanical chillers (high energy usage)	AI-optimized cooling, plant-based cooling, liquid cooling
Hardware Efficiency	Operates on legacy systems with high power consumption	Uses energy-efficient servers, virtualization, and load balancing
Carbon Footprint	High CO_2 emissions due to excessive energy consumption	Low CO_2 emissions due to sustainable energy practices

Operational Cost	Higher due to energy inefficiency and cooling costs	Lower due to optimized power usage and AI-driven automation
Sustainability Certifications	Often lacks compliance with environmental standards	Achieves LEED, ISO 14001, and carbon neutrality certifications
Scalability	Requires significant infrastructure expansion for growth	Cloud-based, allowing for dynamic scalability with minimal environmental impact

The adoption of plant-based cooling systems presents several technical and financial challenges that must be addressed to ensure their widespread implementation. The successful integration of green roofs, vertical gardens, and plant-based cooling walls requires specialized expertise in both horticulture and architectural engineering. Designing these systems to be effective across various climates and urban settings adds complexity, as plant selection, water retention, and structural considerations must be optimized for different environments.

Maintenance challenges also pose a significant hurdle. Regular irrigation, pruning, pest control, and soil quality management are essential for ensuring the longevity and effectiveness of plant-based cooling solutions. In densely populated urban areas, limited space and resource constraints make maintenance logistics even more challenging. The high initial costs associated with plant-based cooling solutions can deter investment from developers and city planners. Expenses related to structural modifications, irrigation systems, and ongoing upkeep often exceed traditional cooling methods, making these solutions less financially attractive in the short term. Quantifying the return on investment (ROI) for green infrastructure remains a challenge, as the economic benefits such as energy savings, improved air quality, and enhanced urban resilience are often realized over extended periods. This uncertainty can make it difficult to convince stakeholders to prioritize plant-based cooling over conventional alternatives. o Governments should introduce financial incentives such as tax breaks, grants, and low-interest loans to encourage investment in sustainable cloud infrastructure and plant-based cooling systems. These incentives can help offset the higher initial costs and make green solutions more accessible to businesses and city planners. Subsidies for eco-friendly building materials, renewable energy integration, and sustainable technology innovations can further reduce the financial burden on developers, promoting the widespread adoption of green infrastructure. [12]

The integration of Artificial Intelligence (AI) and Internet of Things (IoT) technologies into sustainability initiatives presents exciting opportunities for optimizing plant-based cooling systems and cloud computing efficiency.[13] The integration of Green Cloud Computing, plant-based cooling, and eco-infrastructure represents a transformative shift toward sustainable urban environments. By leveraging AI, IoT, and renewable energy, cities can enhance energy efficiency, reduce

carbon footprints, and mitigate climate change. [14,15] Despite existing technical and financial barriers, government policies, industry collaborations, and continued research in smart energy management can drive large-scale adoption. Moving forward, fostering interdisciplinary collaboration will be crucial in shaping climate-resilient, tech-driven, and eco-conscious urban landscapes.

Conclusion

To ensure a truly sustainable future, the widespread adoption of Green Cloud Computing, AI-driven optimizations, and plant-based cooling must become an immediate global priority rather than a distant goal. As data centers continue to expand exponentially, failure to integrate eco-friendly technologies will only accelerate climate change, resource depletion, and urban overheating. Governments, industries, and academic institutions must act now by enforcing stronger policies, investing in renewable energy, and fostering interdisciplinary collaboration to drive green technological innovation. The time for incremental change is over swift, decisive action is required to create resilient, climate-adaptive, and technologically advanced smart cities. The next decade will determine whether urban environments become sustainable hubs of innovation or unsustainable digital wastelands. The choice is ours, and the moment to act is now.

References

1. M. Brown and T. Jones, Sustainable Smart Cities: Integrating Technology and Ecology. Cham, Switzerland: Springer, 2020.
2. A. Gupta and R. Sharma, Green Cloud Computing: Principles and Practices. Hoboken, NJ: Wiley, 2021.
3. P. Kumar and S. Singh, Biophilic Design and Urban Sustainability: Case Studies in Climate-Resilient Infrastructure. Amsterdam, Netherlands: Elsevier, 2019.
4. United Nations Environment Programme (UNEP), Sustainable Infrastructure and Climate Adaptation Strategies, UNEP Reports, 2022.
5. Y. Zhang and X. Li, AI in Smart Cities: Data-Driven Sustainability Solutions. Boca Raton, FL: Taylor & Francis, 2023.
6. R. Buyya, C. S. Yeo, and S. Venugopal, "Market-oriented cloud computing: Vision, hype, and reality for delivering IT services as computing utilities," Future Generation Computer Systems, vol. 25, no. 6, pp. 599–616, 2009.
7. A. 1Berl, E. Gelenbe, M. Di Girolamo, G. Giuliani, H. De Meer, M. Q. Dang, and K. Pentikousis, "Energy-efficient cloud computing," Computer Journal, vol. 53, no. 7, pp. 1045–1051, 2010.
8. J. Koomey, "Growth in data center electricity use 2005 to 2010," Oak Ridge National Laboratory, U.S. Department of Energy, Tech. Rep., 2011.
9. S. Aruna, R. Rajesh, and P. J. Ezhil, "Green computing strategies for eco-friendly cloud environments," in Proc. 2nd Int. Conf. on Advances in Computing, Communication & Automation (ICACCA), Bareilly, India, 2016, pp. 1–5.

10. S. M. R. Islam, J. Rahman, and A. Noor, “Integration of AI and IoT in energy-efficient smart cities,” IEEE Internet of Things Journal, vol. 8, no. 5, pp. 3421–3435, 2021.
11. T. T. Wang, Y. X. Liu, and H. K. Zhu, “The role of vertical gardens and green roofs in urban cooling,” Environmental Sustainability Journal, vol. 17, no. 4, pp. 233–247, 2020.
12. K. G. Xie, P. Sun, and R. S. Huang, “A review of AI-based smart cooling solutions for cloud computing and data centers,” IEEE Transactions on Sustainable Computing, vol. 6, no. 3, pp. 215–229, 2022.
13. R. K. Mishra and P. V. Rao, “Biophilic design and green cloud computing: Enhancing sustainability,” in Proc. IEEE Conf. on Smart Green Technologies (ICSGT), Dubai, UAE, 2022, pp. 142–148.
14. T. H. Nguyen and L. P. Chen, “Renewable energy integration in green cloud computing for sustainable urban development,” IEEE Access, vol. 10, pp. 11456–11472, 2023.
15. Google, “Data centers powered by 100% renewable energy,” Google Sustainability Report, 2022. [Online]. Available: https://sustainability.google/reports

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 63 - 68 |

Major Ecological Threats to Biodiversity

Ms. Bhagyashri B. Naiknaware

Assistant professor, Department of Botany Karmveer Bhaurao Patil Mahavidyalaya, Pandharpur, Maharashtra, India.

Email: naiknawarebhagyshri@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189198

DOI: 10.5281/zenodo.15189198

Abstract

The important and main attribute of the planet earth is the presence of life, and the remarkable trait of life is the variety or the diversity, which is also known as biodiversity. As per Science Daily news 2020 recent information it is assessed that near about 15 million distinct species are present on earth. Out of these only 2 million of them are presently identified. Biodiversity is diminishing at an alarming pace. It is our responsibility to protect biodiversity as early as possible. In the previous few years lot of importance has been laid on establishing that biodiversity loss is one of the great problems which can threat even the very own existence of human race on earth, if left neglected. It is high time, we put our sincere efforts in understanding the underlying causes responsible for the loss of various species on our planet. The present review discusses the principal influences responsible for the loss of biodiversity such as pollution, habitat loss, hunting, introduction of invasive species, overexploitation of preferred species, climate change and natural disasters.

Keywords: Biodiversity, climate change, pollution, habitat loss, overexploitation.

Introduction:

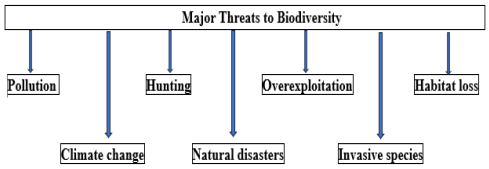
Biodiversity is simply called as the diversity of life. As per Convention on Biological Diversity (CBD) is "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species of ecosystem" [1]. The presence of difficulty of life on the planet earth determines the capability of nature to provide the resources required for human presence. The mere nourishment of humanity depends on Biodiversity. Even more, the poor people are affected the most by biodiversity loss as they directly depend on biodiversity to meet their daily needs for existence. Biodiversity secures various resources for our survival from clean water, air, and food to traditional and modern medicines [2] Biodiversity loss is not only an environmental problem, but it would also eventually turn to

developmental challenge if left neglected. Development increases are at higher risk due to loss of biodiversity loss. The continuous biodiversity loss could lead to less nutrition, decreased wild foods, poor pollination, and subordinate and less irrepressible agriculture systems [3]. This can further result in more weakness to Agrichemicals, decreased traditional medicines access, less chance or development of drugs, further leading to superior disease strains [4].

Major Threats to Biodiversity

The numerous factors are responsible for the loss of Biodiversity such as pollution, habitat loss, hunting, introduction of invasive species, overexploitation of preferred species, climate change, and natural disasters.

Major Threats to Biodiversity



Pollution

Pollution apparent in various forms as following

Air pollution

Air pollution influences the respiratory system of the animals and negatively impact their well-being including the egg laying capability [5]. Air pollution is also known to influence the reproductive ability of the animals. [6]. Hence, air pollution on animals is difficult to evaluate and examine in controlled environment. The large amount of discharge of greenhouse gases like nitrous, carbon dioxide, methane is quickly modifying the climate of the earth. The animals and plants find it hard to adjust and this influence the biodiversity. Acid rain is other pollutant, and it causes suffocation in fishes. Soil disposed to acid rain has weakened activity of microbes [7]. This influences the food chain and other tropic levels in ecosystems.

Water pollution

Water pollution had harmful effect on biodiversity. The pesticides negatively affect non-flowing waterbodies such as lakes and ponds result into the animals in water bodies have difficulty in reproducing [8]. Various human caused activities such as production of cement, cars, mining etc. led to the introduction of heavy metals like arsenic, cadmium, mercury into the water bodies [9]. Heavy metals disturb the survival rates of aquatic animals specially fish. Oil spills greatly impact the wildlife specially in the deeper oceans. Oil spills cause disturbance in the animal senses, suffocation, vital organs of the organisms, reduction in growth rates and induce the higher larval mortality [10]. Like the oil spills, plastic in the environment for longer time-period and hence influence the nature. Lager animals particularly turtles fail to vomit and causing internal injuries leading to death. It has been reported that the seabirds like Layson albatross due to consumption of plastic die prior to fledging the nest. Microplastics in the environment also impact the survival rate of larvae, weakened food consumption and gradually weight loss in aquatic animals [11].

Soil pollution

Soil pollution is another major cause which adversely affecting biodiversity. The excess of heavy metals present in the soil are not easily broken down and are accumulated by plants [12]. The over-use of fertilizers, pesticides and antibiotics used in agriculture is also very deleterious for the biodiversity.

Light pollution

The late-night streetlights, lights from the buildings, vehicles headlights etc. have specially affected the nocturnal animals such as bats. The feeding activity of bats has decreased. The behaviour of the moths is also largely affected by the light pollution. Moths are prey for other species and pollinators of many species [13].

Noise pollution

It has also been noticed that it shows harmful impact on biodiversity. The studies have reported that birds in noisier areas begin laying less eggs. [14]. In Brazil due to the machinery noise at mining site was found to negative impact on wildlife. Species numbers declined at sites nearer the mine.[15].

Hunting

Hunting is the cause of death of large numbers of animals which are holding the position in food web. Due to this, the various species in the region are adversely affected. Hunting is wide cause of loss of biodiversity. Hunting activities exert a significant burden on environment. [16].

Overexploitation

It is the assemblage of species from their natural habitat at higher estimates than the native communities can recover. Fishing and hunting are the examples of overexploitation. Similarly, various individuals of both plants and animals are collected to be used as pets and awards. [17]. Overexploitation of plants which have medicinal values have lossed from native habitats. Many plants such as Drosera sp., Gnetum sp., pitcher plants, Psilotum sp., Napenthes Khasiana etc. are persistently hunted and collected for laboratory experiments. Similarly, various orchids have also been damaged [18].

Habitat loss

The destruction, degradation and fragmentation of habitat are the three predominant categories of habitat loss [19]. The habitat destruction is the massive destruction of the natural habitat of the species. This ultimately results in species extinction. The deforestation for preparing the agricultural field, filling the wetlands for creating residential or commercial sites, are all examples of habitat destruction [20]. Development of agricultural practices, reduced resources such as food, water, air quality. Activities related to urbanization are the main basics of degradation of habitat. The erosion, depletion of nutrients and desertification cause the further loss of the degraded land. [21] Habitat fragmentation is another huge issue ascended due to human developmental activities. Human beings for the purpose of development and to the never ending needs to expand converts large wild areas into smaller fragments of land. These split up areas and break down the habitats. [22].

Climate change

The biodiversity and climate change are strongly connected. The climate has constantly altered during the hole of earth’s history. With these ecological

communities and species evolving. Accelerated climate change disturbs ecological systems and species capability to acclimate and hence the loss in biodiversity enhances. The rapid climate change, stimulating biodiversity loss. Security for water, air, medicines, and additional natural resources would be difficult to attain due to reduced flora and fauna. Climate change, along with other components such as habitat loss, land degradation, hunting, overexploitation etc., is become a risk high factor to loss of biodiversity on earth [23].

Natural disasters

Natural calamities, like volcanos, wild fires, floods, hurricanes, draughts, epidemics, tsunamis etc. cause a heavy loss of biodiversity [24]. Due to flooding, large amount of nutrients from the soil gets washed away and due to drought soil become dry and decline in the level of water table [25]. In this state, both animals as well as plants suffer. Similarly, wild fires and earthquakes significantly disturb the life of the organisms and thus affecting biodiversity. Volcanoes frequently affect animals and plants in the adjoining areas. Epidemics occasionally wipe out majority of the population. The occurrence of epidemics in nature is normally restricted to certain population of animal or plant. [26].

Invasive species

The introduction of invasive species is the major cause of biodiversity loss. Such species are harmful as they effect the ecosystem excessively compared to any other species. Most of the new species introduced in the ecosystem are not become invasive, but few of them become invasive species and badly affect the ecosystem [27]. The invasive species affect the native ecosystem in many ways like they modify the habitat, import pathogens, are herbivorous on plants in native ecosystem, lead to decline of genetic diversity by hybridizing with natives, for the resources they directly compete with and prey on the native species [28]. The prevention of biodiversity loss is a huge developmental issue as the climate change. [29].

Conclusion

The major cause for biodiversity loss is due to the influence of mankind on world's natural system. The people have intensely modified the environment. Several factors discussed in the review such as pollution, hunting, invasive species, habitat loss and degradation, exploitation of natural resources etc. are the encouraging factors for biodiversity loss. The phenomenon of biodiversity loss has severe negative impact on all the living organisms including human beings. It is our responsibility to save our planet and take some crucial steps to avoid the loss of biodiversity. This is highly important if we wish to secure a hospitable planet for next generation and for all the plants and animals.

References

1. Wilson E.O (1988) The National Academic Press, Washington. Link: https://bit.ly/38ZQ4kV
2. Alves R.R & Rosa I M. (2007) traditional medicine, and public health: where do they meet? Link: https://bit.ly/3bVDsgv
3. Isbell F, Reich P.B, & et al. (2013) Nutrient enrichment, biodiversity loss, and consequent declines in ecosystem productivity.

Proceedings of the National Academy of Sciences of the United States of America 110: 11911-11916.

4. Roe D., Seddon N.& et.al (2019) Biodiversity loss is a development issue: a rapid review of evidence. IIED Issue Paper, IIED London. Link: https://bit.ly/2LRF2oV
5. Sanderfoot O.V. &Holloway T. (2017) Air pollution impacts on avian species via inhalation exposure and associated outcomes. Environmental Research Letters 12: 083002. Link: https://bit.ly/35TKOxm
6. Mohallem S.V., de Araújo & et.al (2005) Decreased fertility in mice exposed to environmental air pollution in the city of Sao Paulo. Environ Res 98: 196-202.
7. Pennanen T., Fritze H. & et al. (1998) Structure of a microbial community in soil after prolonged addition of low levels of simulated acid rain. Applied and Environmental Microbiology 64: 2173–2180.
8. Bhateria R. &Jain D (2016) Water quality assessment of lake water: a review. Sustain Water Resour Manag 2: 161-173.
9. Singh V& Verma K. (2018) Metals from cell to environment: connecting metallomics with other omics. Open Journal of Plant Science 3: 001-014. Link: https://bit.ly/3is9RMO
10. Brussaard C.P., Peperzak L. & et al. (2016) Immediate ecotoxicological effects of short-lived oil spills on marine biota. Nature communications 7: 11206. Link: https://bit.ly/39RPWmR
11. Wright S.L., Rowe D&et.al (2013) Microplastic ingestion decreases energy reserves in marine worms. Current Biology 23: R1031-R1033. Link: https://bit.ly/3oZbO5S
12. Singh V., Tripathi B.N. 7et.al (2015) Interaction of Mg with heavy metals (Cu, Cd) in T. aestivum with special reference to oxidative and proline metabolism. J Plant Res 129: 487-497.
13. Macgregor C.J., Evans D.M.7&et.al (2017) The dark side of street lighting impacts on moths and evidence for the disruption of nocturnal pollen transport. Glob Chang Biol 23: 697-707.
14. Wouter H., Holleman L.J. &et.al (2011) Negative impact of traffic noise on avian reproductive success. Journal of applied Ecology 48: 210-219.
15. Duarte M.H., Sousa-Lima R.S.&et.al (2015) The impact of noise from open-cast mining on Atlantic Forest biophony. Biological Conservation 191: 623-631.
16. Symes W.S., Edwards D. P&et.al (2018) Combined impacts of deforestation and wildlife trade on tropical biodiversity are severely underestimated. Nature Communications 9: 4052. Link: https://go.nature.com/35WtyaC
17. Hammerschlag N.& Gallagher J.A. (2017) Extinction risk and conservation of the earth's national animal symbols. Bioscience 67: 744-749.
18. Bodeker G., Charlotte K.& et.al (2014) The Journal of Alternative and Complementary Medicine. 810-822.

19. Klappenbach L. (2020) Habitat loss, fragmentation, and destruction. ThoughtCo. Link: https://bit.ly/3iFsUUh
20. Martins I.S., Rosa I.M.&et.al (2018) Projecting impacts of global landuse scenarios on biodiversity change across scales and species groups. 5th European Congress of Conservation Biology. Link: https://bit.ly/3bW0BQ4
21. Carrete M., Tella J.L. &et. al (2009) Effects of habitat degradation on the abundance, richness, and diversity of raptors across Neotropical biomes. Biological Conservation 142: 2002-2011.
22. Bright P.W. (1993) Habitat fragmentation-problems and predictions for British Mammals. Mammal Review 23: 101-112.
23. Abrahms B., Dipietro D.&et.al (2017) Managing biodiversity under climate change: challenges, frameworks, and tools for adaptation. Biodiversity Conservation 26: 2277-2293.
24. Rondeau D., Perry B. &et.al (2020) The Consequences of COVID-19 and Other Disasters for Wildlife and Biodiversity. Environ Resource Econ 76: 945- 961.
25. Chapin F.S.& Diaz S. (2020) Interactions between changing climate and biodiversity: Shaping humanity's future. Proceedings of the National Academy of Sciences 117: 6295-6296.
26. Isbell F. (2010) Causes and Consequences of Biodiversity Declines. Nature Education Knowledge 3: 54. Link: https://go.nature.com/3bW1lVm
27. Linders T.E., Schaffner U.&et.al (2019) Direct and indirect effects of invasive species: Biodiversity loss is a major mechanism by which an invasive tree affects ecosystem functioning. J Ecol 107: 2660- 2672.
28. Doherty T.S., Glen A.S.&et.al (2016) Invasive predators and global biodiversity loss. Proc Natl Acad Sci U S A 113: 11261- 11265.
29. Kilpatrick A.M., Salkeld D.J. &et.al Titcomb G, Hahn MB (2017) Conservation of biodiversity as a strategy for improving human health and well-being. Philos Trans R Soc Lond B Biol Sci 372: 20160131. Link: https://bit.ly/3nZJijs

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 69 - 77 |

Green Policies for Businesses and Sustainable Development

Laxmi Math

Dr. Chandrashekar Patil

BLDEA's Sanganbasav Mahaswameji College of Pharmacy and Research Centre, Vijayapura, Karnataka.

Email: drccpatil@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189281

DOI: 10.5281/zenodo.15189281

Abstract

In today's evolving commercial landscape, adopting green policies and sustainable development practices is essential for long-term success. This report explores key environmental initiatives that businesses can implement to reduce their ecological footprint while enhancing operational efficiency, achieving cost savings, and increasing brand recognition. Sustainable practices such as energy efficiency, waste reduction, responsible supply chain management, and water conservation play a crucial role in building environmentally conscious organizations.

Energy efficiency is a fundamental pillar of green initiatives, with businesses encouraged to implement LED lighting, smart thermostats, and energy-efficient devices to reduce consumption. Waste reduction and recycling programs, including comprehensive material reuse and composting, promote a circular economy and decrease landfill contributions. Similarly, sustainable supply chain management ensures ethical sourcing, reduced transportation emissions, and compliance with environmental standards.

Water conservation techniques, along with low-flow fixtures and greywater reuse, enhance sustainability efforts. Furthermore, green building design that adheres to LEED and Energy Star certifications optimizes energy use, improves indoor air quality, and incorporates sustainable construction materials. Measuring and reporting environmental performance through standardized frameworks, such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB), fosters transparency and accountability.

Beyond environmental benefits, businesses that embrace sustainable regulations gain a competitive advantage by complying with regulations, attracting eco-conscious customers, and enhancing employee engagement. Future sustainability trends, such as the circular economy, carbon pricing, and increased producer responsibility, underscore the importance of proactively adapting to global environmental challenges.

In conclusion, sustainable business practices are not optional; they are essential for long-term viability. Companies that adopt environmentally friendly policies contribute to a healthier planet while ensuring economic growth and market relevance. A collective commitment to sustainability will foster innovation, financial resilience, and environmental stewardship in the years to come.

Keywords: Green regulations, sustainable techniques, environmental duty, resource efficiency, and business sustainability.

Introduction:

In the rapidly evolving landscape of commercial enterprise, the integration of green policies and sustainable development is no longer a mere option but a necessity for long-term success. This text explores the critical importance of environmental responsibility for businesses of all sizes, offering a comprehensive overview of practical strategies and real-world examples to guide organizations toward a more sustainable future. It delves into key areas where companies can make a significant impact, ultimately enhancing their reputation, reducing costs, and attracting top talent. Topics covered include energy efficiency, waste reduction, sustainable supply chain management, and green building design. Climate change, the decline of biodiversity, and the depletion of natural resources are all crucial aspects of environmental protection. Economic Benefits: Reducing costs through energy efficiency, waste reduction, and resource optimization. Social Responsibility: Enhancing company reputation, attracting socially conscious customers, and fostering a positive work environment.

Compliance: Adhering to regulatory requirements and industry standards. Long-Term Sustainability: Ensuring the enduring viability of communities and the planet.

Theory

Green regulations are business practices that prioritize environmental safety and social responsibility, aiming to minimize negative impacts and contribute to a more sustainable future.

Energy Efficiency

Renewable Energy: Transitioning to solar, wind, and other renewable energy sources.

LED Lighting: Install energy-efficient LED lights in the vicinity of conventional bulbs.

Energy Audits: Regularly assessing electricity consumption and identifying areas for improvement.

Energy Efficiency and Conservation Energy efficiency is the cornerstone of any effective green policy. Reducing electricity consumption not only lowers operating costs but also minimizes a business's carbon footprint. Several practical strategies can be implemented across various sectors to achieve significant energy savings. Switching to LED lighting is one of the simplest and most impactful changes, reducing energy use by as much as 75% compared to traditional incandescent bulbs, according to the U.S. Department of Energy. Implementing smart thermostats, such as those offered by Nest and Eco bee, allows for optimized heating and cooling based on occupancy patterns and real-

time weather conditions. Reason: Improved clarity, vocabulary, and technical accuracy; corrected grammar and punctuation errors.

Investing in energy-efficient gadgets, particularly appliances certified by Energy Star, can significantly reduce power consumption. Regular energy audits conducted by qualified professionals can identify areas of energy waste and recommend targeted improvements. The Environmental Protection Agency (EPA) estimates that organizations can achieve average savings of 5-15% through professional energy audits. A compelling case study is Google's data centres, which have achieved 50% greater energy efficiency than the industry average through AI-powered optimization, demonstrating the potential of technology to drive substantial energy savings. By adopting these energy-efficient practices, companies can not only minimize their environmental impact but also gain a competitive advantage through reduced operating costs and enhanced brand reputation.

Waste Reduction

Recycling: Establishing robust recycling programs for workplace waste and manufacturing materials.

Composting: Composting meal scraps and yard waste.

Reducing Packaging: Minimizing packaging materials and utilizing environmentally friendly options.

Water reduction and recycling programs that minimize waste generation and maximize recycling efforts are essential components of a comprehensive environmental policy. Implementing comprehensive recycling initiatives for paper, plastic, glass, and metal is a critical step. The Environmental Protection Agency (EPA) estimates that recycling one ton of paper saves 17 trees, underscoring the significant environmental benefits of recycling. Reducing packaging waste through minimalist designs and reusable materials is another effective strategy. For instance, using corrugated cardboard with at least 80% recycled content can substantially reduce the environmental impact of packaging.

Composting food waste and organic materials can significantly reduce landfill waste while simultaneously creating nutrient-rich soil amendments for landscaping and gardening. Collaborating with waste management companies that specialize in sustainable practices, such as Teracycle and Rubicon, can offer innovative solutions for handling hard-to-recycle materials and implementing zero-waste initiatives. Subaru's zero-waste programs, which have reduced landfill waste by over 90%, exemplify the potential of waste reduction and recycling efforts to yield substantial environmental benefits. By prioritizing waste reduction and recycling, organizations can contribute to a more circular economy, where resources are utilized more efficiently and waste is minimized.

Water Conservation

Water-Efficient Appliances: Utilize low-flow toilets, showers, and other water-saving fixtures.

Rainwater Harvesting: The collection and utilization of rainwater for irrigation and various other purposes.

Regular Water Audits: Consistently evaluating water consumption and pinpointing opportunities for enhancement.

Conservation and Control of Water Since water is a scarce resource, companies are obligated to reduce their water usage and minimize water pollution. Installing low-flow toilets and faucets can significantly decrease water consumption, reducing it by as much as 60%, according to the EPA. Implementing water-efficient landscaping techniques, such as xeriscaping, can lessen the need for irrigation. Additionally, reusing greywater for non-potable purposes, including irrigation and toilet flushing, is another effective method for conserving water. ### Reason: Improved clarity, vocabulary, and technical accuracy while correcting grammar and punctuation errors.

It is essential to protect water sources to prevent water pollution by properly managing hazardous waste and implementing effective stormwater management practices. Additionally, corporations must reconsider and reduce the water footprint of their products and services. A commitment to responsible water management is exemplified by Coca-Cola's water stewardship projects, which focus on replenishing the water used in its beverages and operations. By prioritizing water conservation and management, businesses can help ensure the availability of clean water for future generations.

Eco-Friendly Materials: Utilizing recycled, renewable, and sustainably sourced materials in both merchandise and operations.

Fair Trade Practices: Ensuring fair wages and favourable working conditions for providers and employees.

Supply Chain Transparency: Monitoring the origins and environmental impact of materials and products.

Sustainable supply chain management involves assessing and improving the environmental impact of the entire supply chain, from sourcing raw materials to delivering finished products to customers. This requires careful consideration of several factors, including the sustainability practices of suppliers, emissions from transportation, and adherence to dealer conduct codes. It is crucial to source materials from responsible and sustainable suppliers. For example, using Forest Stewardship Council (FSC) certified wood ensures that timber is harvested from responsibly managed forests.

Reducing transportation emissions through optimized logistics and consolidated shipments can significantly decrease the carbon footprint of the supply chain. Studies have shown that route optimization can reduce the carbon footprint of transport by 20 to 40%. Implementing codes of conduct that emphasize environmental responsibility is crucial. These codes should require suppliers to obtain environmental certifications, such as ISO 14001. Conducting regular audits of suppliers to ensure compliance with environmental standards is also important for maintaining a sustainable supply chain. Unilever's Sustainable Living Plan, which integrates sustainability into its supply chain, serves as a leading example of how companies can achieve

cost savings and improved resource efficiency through sustainable supply chain management.

Green Marketing

Eco-Labels: Utilizing eco-labels to communicate the environmental credentials of products and services.

Sustainable Packaging: Utilizing environmentally friendly materials and designs for packaging.

Green Advertising: Promoting environmentally friendly products and services.

Green Transportation

Electric Vehicles: Utilizing electric motors for deliveries and employee transportation.

Bike-Friendly: Infrastructure Implementing motorcycle racks and shower facilities for personnel who commute via motorbike.

Telecommuting: Encouraging employees to work from home to minimize commuting.

Green Building and Facility Design There are several benefits for both the environment and the economy when homes are built or renovated according to green building standards such as LEED (Leadership in Energy and Environmental Design) and Energy Star. Key features of green homes include energy-efficient design and construction, the use of sustainable building materials, improved indoor environmental quality, and water-efficient landscaping and fixtures. Energy-efficient design and construction can reduce energy consumption by 20-40% compared to conventional homes. ### Reason: Improved clarity, corrected grammatical errors, and enhanced vocabulary for better readability.

The environmental impact of production can be minimized through the use of sustainable building materials, such as recycled content, low-VOC paints, and FSC-certified wood. Enhancing the quality of the indoor environment through improved ventilation and natural lighting can lead to a healthier and more efficient workspace. Additionally, installations and landscaping that utilize less water can further decrease consumption. The Empire State Building retrofit, which achieved a 38% reduction in energy consumption through sustainable building improvements, serves as an excellent example of the potential of green building and facility design.

Measuring and Reporting Environmental Performance Tracking and disclosing environmental performance is essential for demonstrating accountability and fostering continuous improvement. Organizations must monitor greenhouse gas emissions (Scope 1, 2, and 3), energy and water consumption, waste generation and recycling rates, and sustainable sourcing practices. Reporting frameworks, such as the Global Reporting Initiative (GRI) standards, the Sustainability Accounting Standards Board (SASB) standards, and the Carbon Disclosure Project (CDP), provide guidance on how to measure and report environmental performance. Reason: Improved clarity, vocabulary, and technical accuracy while correcting grammar, punctuation, and mechanics.

These frameworks assist companies in standardizing their reporting and providing stakeholders with consistent

and reliable data. Microsoft's annual sustainability report, which highlights its commitment to carbon neutrality and renewable energy, serves as a prime example of transparent and comprehensive environmental reporting.

Sustainable Development as a Competitive Advantage

Implementing sustainable practices offers numerous long-term benefits for businesses, including cost savings, enhanced reputation, regulatory compliance, and the ability to attract top talent. As consumers, investors, and employees increasingly prioritize sustainability, companies that adopt environmentally friendly policies gain a competitive advantage. Future trends, such as the circular economy, carbon pricing, and extended producer responsibility, will further incentivize businesses to embrace sustainable practices. The circular economy aims to reduce waste and improve resource efficiency by designing products that can be repaired, recycled, or reused. Carbon pricing mechanisms, such as carbon taxes and cap-and-trade systems, create financial incentives for companies to lower their greenhouse gas emissions. Extended producer responsibility regulations encourage manufacturers to design products that are easier to recycle or reuse by holding them accountable for the management of their products' end-of-life. Businesses that proactively adapt to these trends will be well-positioned for long-term success in a more sustainable future. Reason: Improved vocabulary, clarity, and technical accuracy while maintaining the original meaning.

Methodology

Green guidelines for companies involve integrating environmental and social responsibility into their operations, with the goal of achieving sustainable development. This can be accomplished through practices such as reducing waste, conserving resources, and minimizing environmental impact, while also promoting economic growth and social well-being.

It prioritizes environmental safety and social responsibility, aiming to minimize negative impacts and contribute to a more sustainable future.

Practices and procedures that help companies become more transparent are considered sustainable for business. This approach transforms their social and environmental impacts while simultaneously contributing to a better society. It goes beyond merely reducing emissions and pollutants; instead, it encompasses a comprehensive range of social, economic, and environmental responsibilities in every strategy.

Partnership is not the first term that comes to mind when considering the relationship between business and environmental agencies. For the past three decades, the majority of interactions between the environmental movement and the private sector have been characterized by conflict. This dynamic began to shift in the early 1990s with the emergence of sustainable development, which introduced a new perspective on environmental, economic, and social issues. Consequently, representatives from both business and the environmental movement have, in some instances, begun to collaborate in the search for alternatives and solutions. Sustainable development remains an elusive concept; some economists and

environmentalists have dismissed it as an impractical compromise. However, others argue that sustainable development provides a foundation for innovative responses to complex, seemingly insurmountable challenges. One of our key arguments is that partnerships between businesses and environmental organizations are essential strategies for implementing sustainable development in practice. The phenomenon of business-environmentalist partnerships in the 1990s also offers renewed hope for achieving a global consensus on sustainability.[1]

What are the benefits of sustainability coverage?

Having a robust sustainability policy in place for your business can yield numerous benefits. Firstly, it demonstrates that you are taking steps toward becoming an ethical and responsible corporation. Legislation is evolving, and customer expectations are shifting; it is no longer sufficient to merely claim that you are doing your part. Proving your commitment to sustainability will lead to increased customer loyalty and new opportunities. Additionally, it can differentiate your business from the competition, as investors, environmentally conscious consumers, and other stakeholders will recognize your dedication to a sustainable future. This could result in improved financial performance and greater access to capital. Furthermore, a strong sustainability policy can help you meet legal requirements while also reducing costs through enhanced energy efficiency and resource optimization.[2]

Moderating Role of Organizational Green Subculture

An "organizational culture" refers to a set of shared beliefs, values, and practices that management teams establish to guide organizational behaviour and mindset toward achieving common company goals. An organization's "green culture (OGC) is one in which environmental protection is regarded as essential. A core value of the firm's employees is thus integrated into the company's mission statement, fostering a sense of responsibility among all team members for protecting the environment.

Employees are increasingly concerned about environmental issues due to the rise of green culture (Lee et al., 2022), which has a positive impact on their work. To foster a green culture, managers must demonstrate greater commitment to environmental protection (Azhar & Yang, 2021). A company's capacity to innovate and challenge the status quo is ignited by a green culture, which also significantly motivates employees to take environmental issues seriously.

According to Tahir et al. (2020), values, the foundation for a formal framework promoting a green lifestyle, can assist enterprises in implementing environmentally friendly operational changes. A company's seasoned environmental strategy can be transformed into green innovation through its green organizational culture (Cherian et al., 2021). However, Al-Swidi et al. (2002) noted that organizations addressing environmental issues can benefit from a green corporate culture. A company's ability to implement green innovation is enhanced

by its capacity to manage green waste. Employees are more engaged with environmental issues when they work in a green workplace (Abbas & Dogan, 2022). An organization's ability to tackle environmental challenges may further motivate its employees to protect the environment, as evidence suggests that an organizational green culture (OGC) positively influences team members' attitudes and behaviours toward environmental protection. Consequently, the more environmentally conscious a company's culture is, the more involved its employees will be in environmental matters. To produce sustainable products, scholars argue that companies must adopt the values of a green organizational culture.

The organizational inexperienced lifestyle enhances the relationship between inexperienced talent management and green innovation.

The connection between inexperienced understanding, control, and sustainable improvement is reinforced by an organizational green culture.

Benefits of Implementing Green Policies

Cost Savings: Decreased power and water consumption, lower waste disposal expenses, and reduced raw material costs.

Enhanced Reputation: Improved brand image and increased customer loyalty.

Increased Innovation: Promoting advancements in sustainable technologies and practices.

Competitive Advantage: Attracting traders and customers who prioritize sustainability.

Contribution to Sustainable Development: Playing a role in addressing global environmental and social challenges.

Conclusion

A Call to Action for a Greener Future In conclusion, the integration of green policies is not only a moral imperative but also a strategic advantage for organizations. By adopting sustainable practices, companies can reduce their environmental impact, enhance their profitability, and improve their reputation. As we move closer to a future increasingly defined by environmental challenges, the organizations that prioritize sustainability will be the ones that thrive. It is time for all companies, regardless of size or industry, to implement environmentally friendly policies and contribute to a world that is more sustainable and prosperous for everyone. The transition to a green economy requires a collective effort. Governments, businesses, and individuals must work together to create a more sustainable future. By embracing green policies, organizations can play a vital role in this transition, contributing to a healthier planet and a more prosperous economy. Reason: Improved clarity, vocabulary, and grammatical accuracy while maintaining the original meaning.

The time for action is now. Let's all come together to create a more sustainable future for generations to come by embracing green practices.

Reference

1. Murphy DF, Bendell J. In the company of partners: business, environmental groups and

sustainable development post-Rio. Policy Press; 1997 May
2. https://esgthereport.com/sustainability-policy-why-companies-need-them/
3. https://www.sciencedirect.com/science/article/pii/S2444569X2200107X
4. Utting P. Business responsibility for sustainable development. Geneva 2000 Occasional Paper; 2000.
5. Singh PB, Pandey KK. Green marketing: policies and practices for sustainable development. Integral Review. 2012 Jun;5(1):22-30.
6. Kushwaha GS, Sharma NK. Green initiatives: a step towards sustainable development and firm's performance in the automobile industry. Journal of cleaner production. 2016 May 10;121:116-29.
7. https://business.vanderbilt.edu/corporate-sustainability-certificate/article/sustainability-in-business/
8. https://fsc.org/en/blog/sustainable-business-practices
9. https://www.researchgate.net/publication/338690653_GREEN_MARKETING_POLICIES_AND_PRACTICES_FOR_SUSTAINABLE_DEVELOPMENT
10. Karagülle AÖ. Green business for sustainable development and competitiveness: an overview of Turkish logistics industry. Procedia-Social and Behavioral Sciences. 2012 Jan 1; 41:456-60.
11. Lotfi M, Yousefi A, Jafari S. The effect of emerging green market on green entrepreneurship and sustainable development in knowledge-based companies. Sustainability. 2018 Jul 4;10(7):2308.
12. Bombiak E, Marciniuk-Kluska A. Green human resource management as a tool for the sustainable development of enterprises: Polish young company experience. Sustainability. 2018 May 25;10(6):1739.
13. Corbett H, Swibold S. Guide to sustainable development and environmental policy. Duke University Press; 2002 Mar 29

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 78 - 86 |

Climate Adaptation and Mitigation Strategies: Bulding Resilence for A Sustaniable Future

Sahenaz Khatun Mallick

Dr. Chandrashekar Patil

BLDEA's Sanganbasav Mahaswameji College of Pharmacy and Research Centre, Vijayapura, Karnataka.

Email: drccpatil@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189335

*DOI: **10.5281/zenodo.15189335***

Abstract

In today's evolving commercial landscape, adopting green policies and sustainable development practices is essential for long-term success. This report explores key environmental initiatives that businesses can implement to reduce their ecological footprint while enhancing operational efficiency, achieving cost savings, and increasing brand recognition. Sustainable practices such as energy efficiency, waste reduction, responsible supply chain management, and water conservation play a crucial role in building environmentally conscious organizations.

Energy efficiency is a fundamental pillar of green initiatives, with businesses encouraged to implement LED lighting, smart thermostats, and energy-efficient devices to reduce consumption. Waste reduction and recycling programs, including comprehensive material reuse and composting, promote a circular economy and decrease landfill contributions. Similarly, sustainable supply chain management ensures ethical sourcing, reduced transportation emissions, and compliance with environmental standards.

Water conservation techniques, along with low-flow fixtures and greywater reuse, enhance sustainability efforts. Furthermore, green building design that adheres to LEED and Energy Star certifications optimizes energy use, improves indoor air quality, and incorporates sustainable construction materials. Measuring and reporting environmental performance through standardized frameworks, such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB), fosters transparency and accountability.

Beyond environmental benefits, businesses that embrace sustainable regulations gain a competitive advantage by complying with regulations, attracting eco-conscious customers, and enhancing employee engagement. Future sustainability trends, such as the circular economy, carbon pricing, and increased producer responsibility, underscore the importance of proactively adapting to global environmental challenges.

In conclusion, sustainable business practices are not optional; they are essential for long-term viability. Companies that adopt environmentally friendly policies contribute to a healthier planet while ensuring economic growth and market relevance. A collective commitment to sustainability will foster innovation, financial resilience, and environmental stewardship in the years to come.

Keywords: Green regulations, sustainable techniques, environmental duty, resource efficiency, and business sustainability.

Introduction:

In the rapidly evolving landscape of commercial enterprise, the integration of green policies and sustainable development is no longer a mere option but a necessity for long-term success. This text explores the critical importance of environmental responsibility for businesses of all sizes, offering a comprehensive overview of practical strategies and real-world examples to guide organizations toward a more sustainable future. It delves into key areas where companies can make a significant impact, ultimately enhancing their reputation, reducing costs, and attracting top talent. Topics covered include energy efficiency, waste reduction, sustainable supply chain management, and green building design. Climate change, the decline of biodiversity, and the depletion of natural resources are all crucial aspects of environmental protection. Economic Benefits: Reducing costs through energy efficiency, waste reduction, and resource optimization. Social Responsibility: Enhancing company reputation, attracting socially conscious customers, and fostering a positive work environment.

Compliance: Adhering to regulatory requirements and industry standards. Long-Term Sustainability: Ensuring the enduring viability of communities and the planet.

Theory

Green regulations are business practices that prioritize environmental safety and social responsibility, aiming to minimize negative impacts and contribute to a more sustainable future.

Energy Efficiency

Renewable Energy: Transitioning to solar, wind, and other renewable energy sources.

LED Lighting: Install energy-efficient LED lights in the vicinity of conventional bulbs.

Energy Audits: Regularly assessing electricity consumption and identifying areas for improvement.

Energy Efficiency and Conservation Energy efficiency is the cornerstone of any effective green policy. Reducing electricity consumption not only lowers operating costs but also minimizes a business's carbon footprint. Several practical strategies can be implemented across various sectors to achieve significant energy savings. Switching to LED lighting is one of the simplest and most impactful changes, reducing energy use by as much as 75% compared to traditional incandescent bulbs, according to the U.S. Department of Energy. Implementing smart thermostats, such as those offered by Nest and Eco bee, allows for optimized heating and cooling based on occupancy patterns and real-

time weather conditions. Reason: Improved clarity, vocabulary, and technical accuracy; corrected grammar and punctuation errors.

Investing in energy-efficient gadgets, particularly appliances certified by Energy Star, can significantly reduce power consumption. Regular energy audits conducted by qualified professionals can identify areas of energy waste and recommend targeted improvements. The Environmental Protection Agency (EPA) estimates that organizations can achieve average savings of 5-15% through professional energy audits. A compelling case study is Google's data centres, which have achieved 50% greater energy efficiency than the industry average through AI-powered optimization, demonstrating the potential of technology to drive substantial energy savings. By adopting these energy-efficient practices, companies can not only minimize their environmental impact but also gain a competitive advantage through reduced operating costs and enhanced brand reputation.

Waste Reduction

Recycling: Establishing robust recycling programs for workplace waste and manufacturing materials.

Composting: Composting meal scraps and yard waste.

Reducing Packaging: Minimizing packaging materials and utilizing environmentally friendly options.

Water reduction and recycling programs that minimize waste generation and maximize recycling efforts are essential components of a comprehensive environmental policy. Implementing comprehensive recycling initiatives for paper, plastic, glass, and metal is a critical step. The Environmental Protection Agency (EPA) estimates that recycling one ton of paper saves 17 trees, underscoring the significant environmental benefits of recycling. Reducing packaging waste through minimalist designs and reusable materials is another effective strategy. For instance, using corrugated cardboard with at least 80% recycled content can substantially reduce the environmental impact of packaging.

Composting food waste and organic materials can significantly reduce landfill waste while simultaneously creating nutrient-rich soil amendments for landscaping and gardening. Collaborating with waste management companies that specialize in sustainable practices, such as Teracycle and Rubicon, can offer innovative solutions for handling hard-to-recycle materials and implementing zero-waste initiatives. Subaru's zero-waste programs, which have reduced landfill waste by over 90%, exemplify the potential of waste reduction and recycling efforts to yield substantial environmental benefits. By prioritizing waste reduction and recycling, organizations can contribute to a more circular economy, where resources are utilized more efficiently and waste is minimized.

Water Conservation

Water-Efficient Appliances: Utilize low-flow toilets, showers, and other water-saving fixtures.

Rainwater Harvesting: The collection and utilization of rainwater for irrigation and various other purposes.

Regular Water Audits: Consistently evaluating water consumption and pinpointing opportunities for enhancement.

Conservation and Control of Water Since water is a scarce resource, companies are obligated to reduce their water usage and minimize water pollution. Installing low-flow toilets and faucets can significantly decrease water consumption, reducing it by as much as 60%, according to the EPA. Implementing water-efficient landscaping techniques, such as xeriscaping, can lessen the need for irrigation. Additionally, reusing greywater for non-potable purposes, including irrigation and toilet flushing, is another effective method for conserving water. ### Reason: Improved clarity, vocabulary, and technical accuracy while correcting grammar and punctuation errors.

It is essential to protect water sources to prevent water pollution by properly managing hazardous waste and implementing effective stormwater management practices. Additionally, corporations must reconsider and reduce the water footprint of their products and services. A commitment to responsible water management is exemplified by Coca-Cola's water stewardship projects, which focus on replenishing the water used in its beverages and operations. By prioritizing water conservation and management, businesses can help ensure the availability of clean water for future generations.

Eco-Friendly Materials: Utilizing recycled, renewable, and sustainably sourced materials in both merchandise and operations.

Fair Trade Practices: Ensuring fair wages and favourable working conditions for providers and employees.

Supply Chain Transparency: Monitoring the origins and environmental impact of materials and products.

Sustainable supply chain management involves assessing and improving the environmental impact of the entire supply chain, from sourcing raw materials to delivering finished products to customers. This requires careful consideration of several factors, including the sustainability practices of suppliers, emissions from transportation, and adherence to dealer conduct codes. It is crucial to source materials from responsible and sustainable suppliers. For example, using Forest Stewardship Council (FSC) certified wood ensures that timber is harvested from responsibly managed forests.

Reducing transportation emissions through optimized logistics and consolidated shipments can significantly decrease the carbon footprint of the supply chain. Studies have shown that route optimization can reduce the carbon footprint of transport by 20 to 40%. Implementing codes of conduct that emphasize environmental responsibility is crucial. These codes should require suppliers to obtain environmental certifications, such as ISO 14001. Conducting regular audits of suppliers to ensure compliance with environmental standards is also important for maintaining a sustainable supply chain. Unilever's Sustainable Living Plan, which integrates sustainability into its supply chain, serves as a leading example of how companies can achieve

cost savings and improved resource efficiency through sustainable supply chain management.

Green Marketing

Eco-Labels: Utilizing eco-labels to communicate the environmental credentials of products and services.

Sustainable Packaging: Utilizing environmentally friendly materials and designs for packaging.

Green Advertising: Promoting environmentally friendly products and services.

Green Transportation

Electric Vehicles: Utilizing electric motors for deliveries and employee transportation.

Bike-Friendly: Infrastructure Implementing motorcycle racks and shower facilities for personnel who commute via motorbike.

Telecommuting: Encouraging employees to work from home to minimize commuting.

Green Building and Facility Design There are several benefits for both the environment and the economy when homes are built or renovated according to green building standards such as LEED (Leadership in Energy and Environmental Design) and Energy Star. Key features of green homes include energy-efficient design and construction, the use of sustainable building materials, improved indoor environmental quality, and water-efficient landscaping and fixtures. Energy-efficient design and construction can reduce energy consumption by 20-40% compared to conventional homes. ### Reason: Improved clarity, corrected grammatical errors, and enhanced vocabulary for better readability.

The environmental impact of production can be minimized through the use of sustainable building materials, such as recycled content, low-VOC paints, and FSC-certified wood. Enhancing the quality of the indoor environment through improved ventilation and natural lighting can lead to a healthier and more efficient workspace. Additionally, installations and landscaping that utilize less water can further decrease consumption. The Empire State Building retrofit, which achieved a 38% reduction in energy consumption through sustainable building improvements, serves as an excellent example of the potential of green building and facility design.

Measuring and Reporting Environmental Performance Tracking and disclosing environmental performance is essential for demonstrating accountability and fostering continuous improvement. Organizations must monitor greenhouse gas emissions (Scope 1, 2, and 3), energy and water consumption, waste generation and recycling rates, and sustainable sourcing practices. Reporting frameworks, such as the Global Reporting Initiative (GRI) standards, the Sustainability Accounting Standards Board (SASB) standards, and the Carbon Disclosure Project (CDP), provide guidance on how to measure and report environmental performance. Reason: Improved clarity, vocabulary, and technical accuracy while correcting grammar, punctuation, and mechanics.

These frameworks assist companies in standardizing their reporting and providing stakeholders with consistent

and reliable data. Microsoft's annual sustainability report, which highlights its commitment to carbon neutrality and renewable energy, serves as a prime example of transparent and comprehensive environmental reporting.

Sustainable Development as a Competitive Advantage

Implementing sustainable practices offers numerous long-term benefits for businesses, including cost savings, enhanced reputation, regulatory compliance, and the ability to attract top talent. As consumers, investors, and employees increasingly prioritize sustainability, companies that adopt environmentally friendly policies gain a competitive advantage. Future trends, such as the circular economy, carbon pricing, and extended producer responsibility, will further incentivize businesses to embrace sustainable practices. The circular economy aims to reduce waste and improve resource efficiency by designing products that can be repaired, recycled, or reused. Carbon pricing mechanisms, such as carbon taxes and cap-and-trade systems, create financial incentives for companies to lower their greenhouse gas emissions. Extended producer responsibility regulations encourage manufacturers to design products that are easier to recycle or reuse by holding them accountable for the management of their products' end-of-life. Businesses that proactively adapt to these trends will be well-positioned for long-term success in a more sustainable future. Reason: Improved vocabulary, clarity, and technical accuracy while maintaining the original meaning.

Methodology

Green guidelines for companies involve integrating environmental and social responsibility into their operations, with the goal of achieving sustainable development. This can be accomplished through practices such as reducing waste, conserving resources, and minimizing environmental impact, while also promoting economic growth and social well-being.

It prioritizes environmental safety and social responsibility, aiming to minimize negative impacts and contribute to a more sustainable future.

Practices and procedures that help companies become more transparent are considered sustainable for business. This approach transforms their social and environmental impacts while simultaneously contributing to a better society. It goes beyond merely reducing emissions and pollutants; instead, it encompasses a comprehensive range of social, economic, and environmental responsibilities in every strategy.

Partnership is not the first term that comes to mind when considering the relationship between business and environmental agencies. For the past three decades, the majority of interactions between the environmental movement and the private sector have been characterized by conflict. This dynamic began to shift in the early 1990s with the emergence of sustainable development, which introduced a new perspective on environmental, economic, and social issues. Consequently, representatives from both business and the environmental movement have, in some instances, begun to collaborate in the search for alternatives and solutions. Sustainable development remains an elusive concept; some economists and

environmentalists have dismissed it as an impractical compromise. However, others argue that sustainable development provides a foundation for innovative responses to complex, seemingly insurmountable challenges. One of our key arguments is that partnerships between businesses and environmental organizations are essential strategies for implementing sustainable development in practice. The phenomenon of business-environmentalist partnerships in the 1990s also offers renewed hope for achieving a global consensus on sustainability.[1]

What are the benefits of sustainability coverage?

Having a robust sustainability policy in place for your business can yield numerous benefits. Firstly, it demonstrates that you are taking steps toward becoming an ethical and responsible corporation. Legislation is evolving, and customer expectations are shifting; it is no longer sufficient to merely claim that you are doing your part. Proving your commitment to sustainability will lead to increased customer loyalty and new opportunities. Additionally, it can differentiate your business from the competition, as investors, environmentally conscious consumers, and other stakeholders will recognize your dedication to a sustainable future. This could result in improved financial performance and greater access to capital. Furthermore, a strong sustainability policy can help you meet legal requirements while also reducing costs through enhanced energy efficiency and resource optimization.[2]

Moderating Role of Organizational Green Subculture

An "organizational culture" refers to a set of shared beliefs, values, and practices that management teams establish to guide organizational behaviour and mindset toward achieving common company goals. An organization's "green culture (OGC) is one in which environmental protection is regarded as essential. A core value of the firm's employees is thus integrated into the company's mission statement, fostering a sense of responsibility among all team members for protecting the environment.

Employees are increasingly concerned about environmental issues due to the rise of green culture (Lee et al., 2022), which has a positive impact on their work. To foster a green culture, managers must demonstrate greater commitment to environmental protection (Azhar & Yang, 2021). A company's capacity to innovate and challenge the status quo is ignited by a green culture, which also significantly motivates employees to take environmental issues seriously.

According to Tahir et al. (2020), values, the foundation for a formal framework promoting a green lifestyle, can assist enterprises in implementing environmentally friendly operational changes. A company's seasoned environmental strategy can be transformed into green innovation through its green organizational culture (Cherian et al., 2021). However, Al-Swidi et al. (2002) noted that organizations addressing environmental issues can benefit from a green corporate culture. A company's ability to implement green innovation is enhanced

by its capacity to manage green waste. Employees are more engaged with environmental issues when they work in a green workplace (Abbas & Dogan, 2022). An organization's ability to tackle environmental challenges may further motivate its employees to protect the environment, as evidence suggests that an organizational green culture (OGC) positively influences team members' attitudes and behaviours toward environmental protection. Consequently, the more environmentally conscious a company's culture is, the more involved its employees will be in environmental matters. To produce sustainable products, scholars argue that companies must adopt the values of a green organizational culture.

The organizational inexperienced lifestyle enhances the relationship between inexperienced talent management and green innovation.

The connection between inexperienced understanding, control, and sustainable improvement is reinforced by an organizational green culture.

Benefits of Implementing Green Policies

Cost Savings: Decreased power and water consumption, lower waste disposal expenses, and reduced raw material costs.

Enhanced Reputation: Improved brand image and increased customer loyalty.

Increased Innovation: Promoting advancements in sustainable technologies and practices.

Competitive Advantage: Attracting traders and customers who prioritize sustainability.

Contribution to Sustainable Development: Playing a role in addressing global environmental and social challenges.

Conclusion

A Call to Action for a Greener Future In conclusion, the integration of green policies is not only a moral imperative but also a strategic advantage for organizations. By adopting sustainable practices, companies can reduce their environmental impact, enhance their profitability, and improve their reputation. As we move closer to a future increasingly defined by environmental challenges, the organizations that prioritize sustainability will be the ones that thrive. It is time for all companies, regardless of size or industry, to implement environmentally friendly policies and contribute to a world that is more sustainable and prosperous for everyone. The transition to a green economy requires a collective effort. Governments, businesses, and individuals must work together to create a more sustainable future. By embracing green policies, organizations can play a vital role in this transition, contributing to a healthier planet and a more prosperous economy. Reason: Improved clarity, vocabulary, and grammatical accuracy while maintaining the original meaning.

The time for action is now. Let's all come together to create a more sustainable future for generations to come by embracing green practices.

Reference

1. Murphy DF, Bendell J. In the company of partners: business, environmental groups and

sustainable development post-Rio. Policy Press; 1997 May
2. https://esgthereport.com/sustainability-policy-why-companies-need-them/
3. https://www.sciencedirect.com/science/article/pii/S2444569X2200107X
4. Utting P. Business responsibility for sustainable development. Geneva 2000 Occasional Paper; 2000.
5. Singh PB, Pandey KK. Green marketing: policies and practices for sustainable development. Integral Review. 2012 Jun;5(1):22-30.
6. Kushwaha GS, Sharma NK. Green initiatives: a step towards sustainable development and firm's performance in the automobile industry. Journal of cleaner production. 2016 May 10;121:116-29.
7. https://business.vanderbilt.edu/corporate-sustainability-certificate/article/sustainability-in-business/
8. https://fsc.org/en/blog/sustainable-business-practices
9. https://www.researchgate.net/publication/338690653_GREEN_MARKETING_POLICIES_AND_PRACTICES_FOR_SUSTAINABLE_DEVELOPMENT
10. Karagülle AÖ. Green business for sustainable development and competitiveness: an overview of Turkish logistics industry. Procedia-Social and Behavioral Sciences. 2012 Jan 1; 41:456-60.
11. Lotfi M, Yousefi A, Jafari S. The effect of emerging green market on green entrepreneurship and sustainable development in knowledge-based companies. Sustainability. 2018 Jul 4;10(7):2308.
12. Bombiak E, Marciniuk-Kluska A. Green human resource management as a tool for the sustainable development of enterprises: Polish young company experience. Sustainability. 2018 May 25;10(6):1739.
13. Corbett H, Swibold S. Guide to sustainable development and environmental policy. Duke University Press; 2002 Mar 29

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 87 - 94 |

Reducing Plastic Waste and Promoting Biodegradable Alternative

Sakshi Chavan

Dr. Chandrashekar Patil

BLDEA's Sanganbasav Mahaswameji College of Pharmacy and Research Centre, Vijayapura, Karnataka.

Email: drccpatil@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189421

DOI: 10.5281/zenodo.15189421

Abstract

Plastic waste is causing an unprecedented global crisis that has serious effects on the environment, human health, and the economy. Devastating effects like pollution, climate change, and biodiversity loss have resulted from the unregulated production and disposal of conventional plastics. A multifaceted strategy that emphasizes waste reduction and the promotion of biodegradable alternatives is necessary to lessen this crisis. A fundamental change in consumption patterns is necessary to reduce waste production, and governments, corporations, and individuals must be encouraged to embrace sustainable practices. It is essential to put in place efficient waste management systems and give recycling, composting, and appropriate waste disposal top priority. Furthermore, in order to create and implement laws, guidelines, and policies that support sustainable waste management, governments and corporations must work together. By implementing a circular economy strategy, we can drastically cut down on waste production, preserve natural resources, and mitigate environmental impacts.

Promoting biodegradable alternatives is a critical component of this strategy. Biodegradable plastics, derived from renewable resources such as corn starch, sugarcane, or potato starch, offer a sustainable solution to traditional plastics. These alternatives can replace conventional plastics in various applications, including packaging, textiles, and disposable products. By promoting biodegradable alternatives, we can significantly reduce greenhouse gas emissions, conserve natural resources, and mitigate environmental impacts associated with plastic production and disposal.

Furthermore, biodegradable plastics can also contribute to a significant reduction in marine litter, which is a major threat to marine ecosystems. By adopting biodegradable plastics, we can reduce the amount of plastic waste that enters the ocean, protecting marine life and preserving the health of our oceans.

In the end, governments, corporations, and individuals must work together and be committed to lowering waste production and promoting biodegradable alternatives. Through the implementation of efficient waste management systems, the adoption of sustainable practices, and the promotion of biodegradable alternatives, we can alleviate the issue of plastic waste, build a more sustainable future, and guarantee a healthier environment for future generations.

Keywords: Biodegradable plastic, Plastic waste, Sustainable, Environmental impact, Recycling.

Introduction:

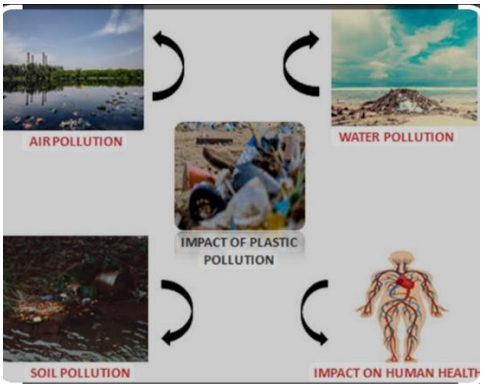
The Need for Sustainable Solutions to Address the Plastic Crisis Although plastics are now a necessary component of our everyday lives, their effects on the environment have drawn criticism. With millions of tons of non-biodegradable plastics contaminating our ecosystems, the world is experiencing an unprecedented plastic waste crisis1.Bioplastics are starting to show promise as a substitute for conventional plastics. Although they only make up a small portion of the world's plastic production, they are predicted to increase dramatically over the next several years.Bioplastics are defined by the International Union of Pure and Applied Chemistry (IUPAC) as products of plant-based monomers or biomass. Despite their frequent interchangeability, "bio-based" and "biodegradable" plastics are two different ideas. While biodegradable plastics can break down naturally, bio-based plastics are created from biological resources other than petroleum2.

The advantages of biodegradable plastics include the fact that they provide a sustainable alternative to conventional plastics. In contrast to traditional plastics, which can take hundreds to thousands of years to break down, they can break down into carbon dioxide and water in 20 to 45 days3.4,5.

The Devastating Impact of Plastic Waste

Making the Switch to Biodegradable Alternatives: Reducing plastic waste and fostering sustainable growth require a move to biodegradable plastics. With an emphasis on biodegradable substitutes and efficient waste management techniques, this initiative seeks to investigate sustainable solutions for a future free of plastic3.The effects of plastic pollution on wildlife, the environment, and human health are dire. The data is concerning: plastic waste contributes to climate change, contaminates the food chain, and damages marine life. Furthermore, the economic consequences of plastic pollution are substantial, as it damages industries and clogs landfills and waterways.

A Group Initiative to Cut Down on Plastic Waste Together, we can make a significant impact and build a more sustainable future. Among our objectives is the preservation of marine ecosystems. Preserving the health and welfare of people Reducing the effects of climate change Encouraging sustainable economic development and growth.



Embracing a Zero-Waste Lifestyle

support a methodical and careful strategy to address the plastic waste problem. Important tactics consist of:

1. **Avoiding single-use plastics:** Choosing reusable substitutes.

2. **Reducing plastic consumption:** Selecting goods with biodegradable or minimal packaging.

3.**Reusing items:**

Making the most of bottles, bags, and containers.

4. **Responsible recycling:**

Recycling plastic waste and taking part in neighborhood projects. By implementing these tactics, we can drastically cut down on plastic waste and build a more sustainable future for future generations.

Overview of Biobased and Biodegradable Plastics

The packaging industry has seen a dramatic change as a result of the growing concern about plastic waste, with an emphasis on biodegradable plastics. Retail bags, food packaging, and agricultural applications are just a few of the many uses for this new technology.8.

The Value of Choosing Appropriate Biodegradable Packaging Materials To guarantee that packaged goods have the best possible shelf life, it is essential to select biodegradable packaging materials. Low water vapor barrier is one of the special qualities of biodegradable plastics that can be advantageous in some applications but problematic in others9.

Bio-Based Plastics' Contribution to Sustainable Development Because they lessen reliance on fossil fuels and reduce CO2 emissions, bio-based plastics are essential to sustainable development. A large amount of waste from homes and businesses is made of traditional plastics.

The Limitations of Traditional Plastic Recycling Methods

The intricacy of recycling due to polymer composition, the absence of advantageous qualities, and the requirement for sophisticated technologies are some of the drawbacks of traditional plastic recycling techniques.11,12. Dust and harmful gases are also released into the atmosphere when conventional plastics are recycled13,14. The Development of Biodegradable Polymers In order to meet the increasing demand for plastic packaging, biodegradable plastics provide a competitive substitute for conventional plastics. Microorganisms in water can easily break down these plastics, which lowers greenhouse gas

emissions and plastic pollution. The Advantages of Bio-Based Polymers Reduced reliance on petroleum supplies, lower carbon emissions, and sustainable production methods are just a few advantages of bio-based plastics made from renewable resources. Two common bio-based and environmentally friendly plastics are polylactic acid (PLA) and polyhydroxyalkanoates (PHAs)25.

The Rise of Biodegradable Packaging

Biodegradable alternatives have emerged as a result of the extensive use of plastics in packaging. Short-term packaging no longer needs to rely on polymers, which has led to a move toward biodegradable packaging17.With its quick disintegration in industrial composting facilities, biodegradable packaging presents a practical option. Numerous sources can be used to create this novel material18. Biodegradable Plastic Types There are two primary categories of biodegradable plastics:

1. **Synthetic biodegradable plastics**: Made from goods derived from petroleum.
2. **Natural biodegradable plastics**: Made from renewable materials or synthetically derived from renewable resources19.
3. **Accepting a Future Without Plastic**: Examining Biodegradable Substitutes Biobased and biodegradable plastics provide a good substitute for conventional plastics and are essential for sustainable development.
4. **Natural Fibers**: Sustainable alternatives to plastic bags, packaging, and textiles are offered by products made from natural fibers like hemp and bamboo.
5. **Seaweed-Based Packaging:** Seaweed-based edible and biodegradable packaging transforms food and drink packaging while cutting down on plastic waste.
6. **Mushroom-Based Packaging:** Mycelium-based biodegradable packaging is a revolutionary way to package delicate goods, making conventional plastic packaging obsolete20.

Why to Choose Biodegradable Alternatives?

10 Compelling Reasons to Choose Biodegradable Alternatives.

1. **Reduce Plastic Waste:** Biodegradable substitutes decompose organically, cutting down on plastic debris in landfills, oceans, and other environments.
2. **Fight Climate Change:** Biodegradable materials reduce greenhouse gas emissions and help to mitigate climate change because they have a lower carbon footprint.
3. **Preserve Marine Ecosystems:** Biodegradable substitutes for plastic pollution save marine life, maintaining biodiversity and fostering a healthy ocean.
4. **Preserve Natural Resources:** Biodegradable materials frequently use renewable resources, which lessens reliance on fossil fuels and preserves natural resources.
5. **Empower Sustainable Development:** Businesses and individuals can make environmentally friendly decisions thanks to biodegradable alternatives, which promote sustainable development and a more environmentally friendly future.

6. **Protect Human Health:** Biodegradable substitutes help protect human health from harmful chemicals and microplastics by lowering plastic pollution.
7. **Enable a Circular Economy:** Biodegradable materials encourage a circular economy in which waste is reduced and resources are valued.
8. **Preserve Environmental Quality:** Ecosystems, air, water, and soil quality are all preserved when biodegradable substitutes reduce environmental pollution.
9. **Boost Corporate Social Responsibility:** Companies that use biodegradable substitutes show their dedication to sustainability, which improves their reputation and fosters client loyalty.
10. **Ensure a Sustainable Legacy:** We can build a more sustainable future and save the environment for future generations by selecting biodegradable substitutes.

Objectives

Objectives for a Plastic-Free Future

Cutting Down on Plastic Waste

1. **Minimize Plastic Waste Generation:** By using conscientious production and consumption methods, less plastic waste will be produced.
2. **Boost Recycling Rates:** By implementing efficient waste management strategies and educating the public, recycling rates can be raised.
3. **Eliminate Single-Use Plastics:** Encourage the use of reusable alternatives and gradually phase out single-use plastics.

Encouraging Biodegradable Substitutes

1. **Scale Up Biodegradable Plastic Production:** In order to satisfy the rising demand, biodegradable plastic production should be increased.
2. **Promote Sustainable Agriculture Practices:** Encourage sustainable agricultural methods that reduce waste and give preference to biodegradable materials.
3. **Create Novel Biodegradable Materials:** Promote the study and creation of novel biodegradable materials.

Promoting Sustainable Practices

1. **Educate and Raise Awareness:** Encourage sustainable lifestyle choices and increase knowledge of the effects of plastic waste.
2. **Promote Sustainable Lifestyle Choices:** Motivate people to make sustainable lifestyle decisions, like cutting back on plastic consumption and recycling more.
3. **Inspire Companies to Adopt Sustainable Practices:** Work with companies to promote biodegradable substitutes, cut down on plastic waste, and adopt sustainable practices.

Data And Methodology

Methodology

We used a strict and methodical approach to data collection and analysis in order to carry out this investigation.
Several crucial steps were included in our methodology:

Information Gathering

1. **Keyword Selection:** To direct our search, we carefully chose pertinent keywords.

2. **Database Search:** To find relevant literature, we looked through reliable databases.

Analysis of Data

1. Initial Review: We checked the preliminary data to make sure it was accurate and pertinent.
2. Quality Assessment: Using strict criteria, we assessed the data's quality and dependability.
3. Data Integration: To give our study a thorough basis, we integrated the verified data into our analysis.

Review of Literature

Our review of the literature sought to give a comprehensive picture of the state of knowledge at the moment, pointing out any gaps and potential areas for further study. By synthesizing the existing literature, we laid the groundwork for innovative ideas and suggestions.

Result And Discussion

Results

Important Results According to the study's findings, the average amount of plastic waste produced daily per person in the study area was 0.5 kg. Notably, the majority of plastic waste produced was made up of single-use plastics like straws, bottles, and bags. Adoption Barriers for Biodegradable Plastics The study found a number of barriers to the use of biodegradable plastics, such as:

1. **Higher costs:** Compared to conventional plastics, biodegradable plastics are frequently more costly.
2. **Limited availability:** In local markets, biodegradable plastics are not readily accessible.
3. **Lack of awareness:** The advantages and benefits of biodegradable plastics are frequently unknown to consumers.

Discussion and Recommendations

The results of the study highlight the necessity of Biodegradable Plastics for a Sustainable Future Imagine a world without environmental damage caused by plastics. This vision is becoming a reality thanks to biodegradable plastics. Biodegradable plastics can help protect the natural beauty of our planet and save petroleum resources for future generations by taking the place of conventional plastics. Biodegradable Plastics' Potential Biodegradable plastics have already demonstrated promise in a number of uses, such as sterilizing medical equipment. Food packaging, we can solve environmental problems and guarantee a green future for future generations by using biodegradable plastics. Overcoming Obstacles Although biodegradable plastics have a lot of potential, there are obstacles to overcome: Exorbitant production expenses Performance that varies More research is required to address these issues and guarantee that biodegradable plastics don't have unforeseen environmental effects. waste management techniques to reduce the production of plastic waste. Promoting biodegradable plastics can help cut down on plastic waste, but it's imperative to address the obstacles mentioned above. Methods for Encouraging Biodegradable Polymers The following tactics can be used to promote the use of biodegradable plastics:

1. Education and awareness campaigns: Educating consumers about the advantages of

biodegradable plastics can boost adoption and awareness.

2. Economic incentives: By providing manufacturers and consumers with subsidies and incentives, the price of biodegradable plastics can be lowered.
3. Improving availability: Making biodegradable plastics more widely available in local markets can make them more accessible to customers.

Conclusion

Biodegradable Plastics for a Sustainable Future Imagine a world without environmental damage caused by plastics. This vision is becoming a reality thanks to biodegradable plastics. Biodegradable plastics can help protect the natural beauty of our planet and save petroleum resources for future generations by taking the place of conventional plastics. Biodegradable Plastics' Potential Biodegradable plastics have already demonstrated promise in a number of uses, such as sterilizing medical equipment. Food packaging, we can solve environmental problems and guarantee a green future for future generations by using biodegradable plastics. Overcoming Obstacles Although biodegradable plastics have a lot of potential, there are obstacles to overcome: Exorbitant production expenses Performance that varies More research is required to address these issues and guarantee that biodegradable plastics don't have unforeseen environmental effects.

Reference

1. Terry B (2012) Plastic Free: How I kicked the Plastic Habit and How You can too

2. G. Coppola, M.T. Gaudio, C.G. Lopresto, V. Calabro, S. Curcio, S. Chakraborty Bioplastic from renewable biomass: a facile solution for a greener environment
3. Golden Ecosystem Sdn. Bhd A Study on Plastic Management in Peninsular Malaysia December 2011
4. J. Wang, Z. Tan, J. Peng, Q. Qiu, M. Li The behaviours of microplastics in the marine environment
5. S. Ghimire, M. Flury, E.J. Scheenstra, C.A. Miles Sampling and degradation of biodegradable plastic and paper mulches in the field after tillage incorporation
6. Dr Judith Enck (2020) Protect your Health in a changing Environment.
7. Johnson B (2013) Zerox waste Home: The Ultimate Guide to simplifying Your Space
8. E. Matsuura, X. He Sustainability Opportunities and Challenges of Bioplastics
9. Z.S. Mazhandu, E. Muzenda, T.A. Mamvura, M. Belaid Integrated and consolidated review of plastic waste management and bio-based biodegradable plastics: challenges and opportunities
10. M. Kolybaba, L.G. Tabil, S. Panigrahi, W.J. Crerar, T. Powell, B. Wang, Q. Inn, A. North, N. Dakota Biodegradable polymers: past, present, and future, 2003 CSAE/ASAE annu. Intersect. Meet. Spons. By red river sect
11. Y. Zoungranan, E. Lynda, K.K. Dobi-Brice, E. Tchirioua, C. Bakary, D.D. Yannick Influence of natural factors on the biodegradation of simple and composite bioplastics based on cassava starch and corn starch

12. M. Shovitri, R. Nafi'ah, T.R. Antika, N.H. Alami, N.D. Kuswytasari, E. Zulaikha Soil burial method for plastic degradation performed by Pseudomonas PL-01, Bacillus PL-01, and indigenous bacteria
13. Y. Wang, J. Yin, G.-Q. Chen Polyhydroxyalkanoates, challenges and opportunities
14. D. Briassoulis, A. Pikasi, M. Hiskakis Recirculation potential of post-consumer/industrial bio-based plastics through mechanical recycling-Techno-economic sustainability criteria and indicators
15. Ipsos, The Last Straw Discouraging Single-Use Plastic
16. Seigle L (2011) To Die For: Is Fashion Wearing Out the Planet
17. V. Siracusa, I. Blanco Bio-Polyethylene (Bio-PE), Bio-Polypropylene (Bio-PP) and Bio-Poly (ethylene terephthalate) (Bio-PET): recent developments in bio-based polymers analogous to petroleum-derived ones for packaging and engineering applications
18. M. Kolybaba, L.G. Tabil, S. Panigrahi, W.J. Crerar, T. Powell, B. Wang Biodegradable Polymers: Past, Present, and Future
19. S. Walker, R. Rothman Life cycle assessment of bio-based and fossil-based plastic: a review

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 95 - 102 |

Media, Social Platform, And Environmental Advocacy

Samiksha. A. Aitawade

Dr. Chandrashekar Patil

BLDEA's Sanganbasav Mahaswameji College of Pharmacy and Research Centre, Vijayapura, Karnataka, 586103.

Email: drccpatil@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189461

DOI: 10.5281/zenodo.15189461

Abstract

Social media has become a vital tool for the spread of knowledge, and media coverage of environmental issues, such as biodiversity loss and climate change, has surpassed that of traditional venues. Campaigns for environmental activism have the power to go viral and influence public officials, businesses, and legislators to act. User-generated content is frequently the driving force behind many efforts. Movements like #FridaysForFuture, #SaveTheAmazon, and #PlasticFree have acquired traction and influenced public opinion and governmental agendas through the use of hashtags, viral videos, and grassroots mobilizations. Furthermore, social media platforms give a voice to a variety of viewpoints, especially those of underrepresented groups who are frequently disproportionately impacted by environmental degradation. By encouraging cooperation and information exchange between scientists, impacted communities, and environmental activists, these platforms help to take a more comprehensive approach to environmental concerns. Nonetheless, there are drawbacks to promoting environmental causes through the media and social media. Real advocacy activities can be hampered by social media monetization, disinformation, and problems with the digital divide. Notwithstanding these challenges, implementing systemic environmental change and making stakeholders responsible for their ecological impact still heavily relies on the media, social media, and grassroots action. In the end, the collaboration of various groups creates fresh chances to promote sustainability and build a more ecologically aware world community.

Keywords: Media, social platform, Environmental advocacy, public awareness, social mobilization, sustainable development.

Introduction:

In the current day, social media and the media have become powerful tools for shaping public opinion, influencing behaviour, and motivating individuals to support a variety of causes, including environmental advocacy. People and groups may now voice their concerns,

launch movements, and raise awareness globally thanks to the digital age's democratization of knowledge. Because social media platforms like Facebook, Instagram, TikTok, and Twitter provide governments, organizations, and activists with access to a global audience, they have become essential in the fight against environmental change.

In order to solve environmental concerns such pollution, deforestation, climate change, biodiversity loss, and sustainable development, "environmental advocacy" refers to initiatives to alter laws, customs, and attitudes. It includes everything, from grassroots programs to corporate sustainability initiatives. Television, print media, and live protests have always been a part of environmental campaigning. But the rise of digital technologies has altered the way these causes are publicized, making them more impactful both now and in the future.

Social media platforms' ability to instantly build connections and disseminate information makes them crucial to this shift. Social media is utilized in environmental campaigning in a number of ways. Users can share articles, captivating images, or popular videos regarding environmental issues on social media. These platforms facilitate the rapid dissemination of awareness, which often results in global movements urging governments and corporations to take immediate action. For example, the #FridaysForFuture campaign, started by Swedish activist Greta Thunberg, became very popular on social media sites like Instagram and Twitter, leading to large-scale protests and global conversations on climate change. By creating an online community where likeminded individuals can collaborate, debate problems, and advocate for change, hashtags have enabled voices to be heard1.

The visual nature of social media also enables the engaging portrayal of environmental challenges. By stirring viewers' emotions with pictures of deforestation, polluted oceans, and endangered species, one can promote a sense of urgency and empathy. The emotional appeal of visual content is one factor contributing to social media platforms' effectiveness in environmental initiatives. Websites like Instagram2 that let users post images and videos have been essential in influencing purchasing decisions and spreading environmental awareness.

Despite its shortcomings, social media has been demonstrated to be a valuable instrument for environmental campaigning. The spread of misleading information and "greenwashing"—the practice of companies or individuals making inflated claims to be environmentally conscious—on social media platforms is one of the main problems. Additionally, the volume of information on these platforms can sometimes dilute messages, making it harder to see important issues3.

Additionally, because platforms are algorithm-driven, they may create echo chambers where users are only shown information that confirms their preconceived notions. This can restrict the variety of perspectives and therefore, hinder the depth of public discourse on environmental issues. Despite these obstacles, social media, the press, and the fight for a sustainable future still heavily rely on opportunities as well as

risks. However, with proper management, these platforms can be utilized to influence policy decisions, motivate individuals to take meaningful action, and promote systemic change.

Objectives

1. **Examine the Role of Social Media in Environmental Advocacy**

This essay's goal is to examine how social media platforms like Twitter, Facebook, Instagram, and TikTok have evolved into essential tools for environmental advocacy. The study will look at how these platforms allow individuals, organizations, and movements to reach a worldwide audience in order to help them mobilize support, convey messages, and increase awareness about environmental concerns like pollution, climate change, and biodiversity loss.

2. **Assess the Impact of User-Generated Content and Viral Campaigns**

The purpose of This essay will look at how social media platforms like Twitter, Facebook, Instagram, and TikTok have grown to be essential tools for environmental advocacy. It will look at how these platforms allow individuals, organizations, and movements to reach a global audience, allowing them to mobilize support, disseminate messages, and raise awareness of environmental issues including pollution, climate change, and biodiversity loss.

3. **Understand the Inclusivity of Social Platforms in Advocacy**

Because marginalized populations are often disproportionately affected by environmental deterioration, the study will examine how social media has provided a platform for them to voice their concerns. It will look at how social media platforms promote inclusivity, facilitate collaboration between scientists, environmentalists, and impacted communities, and encourage a more diverse approach to environmental problem-solving.

4. **Evaluate Challenges in Digital Environmental Advocacy**

An important objective is to assess the challenges presented by social media's involvement in environmental activism. These include the spread of misinformation, platform commercialization, and the digital divide, all Activists & social advocacy groups/organisation of which can undermine sincere lobbying efforts. The project will evaluate the ways in which these problems limit social media's ability to drastically change the environment.

5. **Propose Strategies for Effective Digital Advocacy**.[4,5]

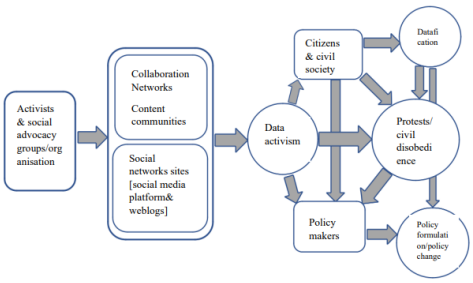
Spreading misleading information to increase social media's power to encourage sustainability and environmental change the study will offer strategies for getting over the challenges posed by goals and commercialization.

Data And Methodology

Data

The media and social media have become essential instruments in environmental advocacy because of their capacity to disseminate messages and motivate action on pressing environmental challenges. Social media platforms like Facebook, Instagram, TikTok, and Twitter allow individuals,

organizations, and grassroots projects to quickly reach a global audience. Greta Thunberg's #FridaysForFuture campaign is a well-known example that attracted significant attention from many media sites. It supported the global youth climate strike movement and had an impact on climate policy discussions. Campaigns like #SaveTheAmazon have also used social media to draw attention to deforestation and put pressure on governments and corporations to take action to save the Amazon Rainforest7.
Social media makes it possible for user-generated content and viral marketing to quickly spread environmental themes. Social advocacy groups and advocates
Collaboration



Methodology

Data collection

The media and social media have become essential instruments in environmental advocacy because of them capacity to disseminate messages and motivate action on pressing environmental challenges. People, organizations, and grassroots movements may quickly reach a global audience through social media platforms like Facebook, Instagram, TikTok, and Twitter. Greta Thunberg's #FridaysForFuture campaign is a well-known example that attracted significant attention from many media sites. It supported the global youth climate strike movement and had an impact on climate policy discussions. Caraise The investigation's primary data sources will be two. Data from organizations, social advocacy groups, and identified/selected data activists will first be gathered through formal interviews and surveys. Following the extraction of data from the selected activists' and civil society advocacy groups' social media accounts, hashtags and keywords will be

Data Analysis

Predictive Analytics

The media and social media have become essential instruments in environmental advocacy because of them capacity to disseminate messages and motivate action on pressing environmental challenges. People, organizations, and grassroots movements may quickly reach a global audience through social media platforms like Facebook, Instagram, TikTok, and Twitter. Greta Thunberg's #FridaysForFuture campaign is a well-known example that attracted significant attention from many media sites. It supported the global youth climate strike movement and had an impact on climate policy discussions. Caraise In addition to sentiment analysis, the research data (tweets, posts, comments, views, and opinions) will undergo both supervised (classification techniques) and unsupervised learning approaches.

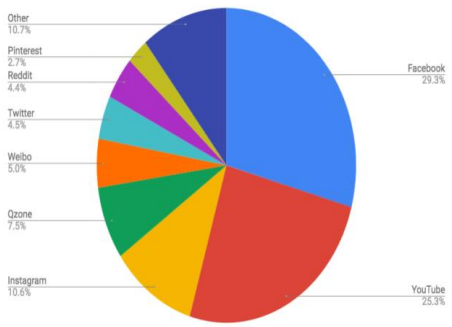
Clustering Analysis

The media and social media have become essential instruments in environmental advocacy because of them capacity to disseminate messages and motivate action on pressing environmental challenges. People, organizations, and grassroots movements may quickly reach a global audience

through social media platforms like Facebook, Instagram, TikTok, and Twitter. Greta Thunberg's #FridaysForFuture campaign is a well-known example that attracted significant attention from many media sites. It supported the global youth climate strike movement and impacted discussions about climate policy.

Image Processing:

The media and social media have become essential instruments in environmental advocacy because of them capacity to disseminate messages and motivate action on pressing environmental challenges. People, organizations, and grassroots movements may quickly reach a global audience through social media platforms like Facebook, Instagram, TikTok, and Twitter. Greta Thunberg's #FridaysForFuture campaign is a well-known example that attracted significant attention from many media sites. It supported the global youth climate strike movement and had an impact on climate policy discussions. Caraise The collected data will undergo a clustering analysis in order to identify and identify trends in textual sources. For unsupervised learning, a variety of machine learning methods are available, such as K-Means, K-Nearest Neighbour, and Hierarchical for clustering analysis.



Visual Analytics & Further Analysis

Scalable and high-resolution data visualization tools are crucial for revealing hidden patterns in data and helping decision makers make well-informed choices. Tableau is among the most user-friendly data visualization tools. The R and Python tools for making scalable data visualization are Matplotlib and Plotly/ggplot2, respectively.

Result

Area under the ROC Curve (AUC)

According to the Area under Curve statistic, the area under the Receiver Operating Characteristic Curve (ROC) is frequently less than 1.0. The AUC is frequently used to quantify a classification algorithm's separation power for two or more classes. The AUC is used more frequently than the Classification Accuracy since it is seen as a more reliable metric.

Classification Accuracy

The ability of a classification algorithm to correctly classify a binary or multiclass response is measured by classification accuracy (CA). In other words, classification accuracy is the proportion of data instances for which the class prediction was correct.

Precision

The percentage of situations that are labelled as positive but are actually positive is one way to think of precision as an exactness statistic. The percentage of relevant examples that the classification algorithm finds or recovers is known as precision.

Recall

Recall can be viewed as a measure of completeness, or the percentage of

positive events that are actually categorized as such. In other words, recall is the percentage of relevant examples that the classification system locates and recovers.

Cross-Validation

Testing the efficacy of the machine learning algorithms used for data modelling is necessary to increase the prediction metrics' precision. 10-fold cross-validation is a widely used data analytics technique for supervised learning outcomes. However, there are more practical methods for validating models.

Software Requirements

	Software Application	Usage	Availability
1	Enthought Canopy	Python 3.5 and relevant modules	Free
2	Anaconda/Spyder	Python 3.7, R, Orange	Free
3	R-Studio R	statistics and machine learning	Free
4	Gephi Social	Network Analysis	Free
5	MATLAB	Simulink Image and Video analysis	Subscription
6	Tableau	Data Visualisation & Presentation	Subscription
7	SPSS	Analysis of Questionnaires	Subscription
8	RapidMiner Studio	Text Mining & sentiment Analysis	Subscription

Discussion

Advocacy movements have benefited immensely from social media's capacity to build online communities and elevate voices globally. Campaigns have been able to cross political and regional boundaries thanks to hashtags like #BLM and #MeToo, which have united people from many backgrounds. 10. Despite ongoing issues with algorithmic biases and misinformation, campaign visibility has increased thanks to visual narrative, influencers, and algorithmic targeting11. Despite these obstacles, movements like as #BLM and #MeToo have impacted policy reforms and altered public discourse12. However, issues like digital disparities and activist weariness persist, making strategies like decentralized platforms and mental health services13 necessary.

Conclusion

This study highlights the significance of social media in advocacy and activism, focusing on the global impact and reach of movements like #BlackLivesMatter (#BLM), #MeToo, and #EndSARS2. The findings demonstrate how social media may foster online communities that transcend national and cultural boundaries, fostering global solidarity and giving voice to marginalized populations. The rapid growth of interconnected networks made possible

by social media platforms such as Instagram, WhatsApp, and Twitter14 has facilitated participation in social justice campaigns. These movements have been amplified by the purposeful application of communication strategies like algorithmic targeting, influencer endorsements, and visual storytelling. These tactics have been essential in raising social issues' profile, level of participation, and attention15. However, the report also highlights significant barriers to using social media for advocacy, such as misinformation, algorithmic filtering, and the digital divide. These challenges reduce advocacy's social media influence, particularly in politically restrictive contexts like #EndSARS16. Despite these challenges, the study affirms social media's transformative power to shape public opinion, advance legislation, and sustain activism. These issues need to be addressed in future advocacy campaigns to maximize the potential of digital platforms to encourage systemic change. 17

References

1. Bruns, A., Highfield, T., & Burgess, J. (2015). The Role of Twitter in the Environmental Activism of the Australian Climate Movement. In M. F. & P. P. (Eds.), Social Media and the Transformation of Public Space. Springer.
2. Kemp, S. (2020). Digital 2020: Global Digital Overview. We Are Social and Hootsuite.
3. Tufekci, Z. (2017). Twitter and Tear Gas: The Power and Fragility of Networked Protest. Yale University Press.
4. Bruns, A., Highfield, T., & Burgess, J. (2015). The Role of Twitter in the Environmental Activism of the Australian Climate Movement. In M. F. & P. P. (Eds.), Social Media and the Transformation of Public Space. Springer.
5. Tufekci, Z. (2017). Twitter and Tear Gas: The Power and Fragility of Networked Protest. Yale University Press.
6. Fuchs, C. (2020). Social Media and Environmental Justice: From Climate Change Denial to Activism.Sustainability, 12(15), 6274.
7. Schneider, E. E., & Hartmann, T. (2017). The Role of Social Media in Environmental Activism. The Journal of Environmental Communication, 11(2), 214-229.
8. Smith, A. (2019). Engagement and Mobilization in Digital Environmental Movements: The Case of #FridaysForFuture. Environmental Politics, 28(5), 853-875.
9. Andrews, L., & Cavanagh, D. (2018). Digital Activism in the Age of Social Media: Challenges and Opportunities for Environmental Advocacy. Environmental Communication, 12(3), 339-354.
10. Freelon, D., McIlwain, C. D., & Clark, M. D. (2020). "Beyond the Hashtags: #BlackLivesMatter and the Power of Digital Protest." Oxford University Press.
11. Noble, S. U. (2018). "Algorithms of Oppression: How Search Engines Reinforce Racism." New York University Press
12. Ray, V., et al. (2021). "The Social and Political Impact of #BlackLivesMatter." Pew Research Centre.

13. Freedom House (2021). "Freedom on the Net 2021: The Global Drive to Control Big Tech." Freedom House.
14. Bennett, W. L., & Segerberg, A. (2013). The Logic of Connective Action: Digital Media and the Personalization of Contentious Politics. Information, Communication & Society, 16(5), 739-768.
15. Freelon, D., McIlwain, C. D., & Clark, M. D. (2020). Beyond the Hashtags: #BlackLivesMatter and the Power of Digital Protest. Oxford University Press.
16. Noble, S. U. (2018). Algorithms of Oppression: How Search Engines Reinforce Racism. New York University Press.
17. Ray, V., et al. (2021). The Social and Political Impact of #BlackLivesMatter. Pew Research Center

ENVIRONMENTAL CHANGE: CHALLENGES AND OPPORTUNITIES FOR A SUSTAINABLE FUTURE

ISBN: 978-81-981142-8-0| Year: 2025 | pp: 103 - 110 |

Geographical Analysis of Human Resource and Development Planning

Dr. S. B. Rathod

Associate Professor& Head, Dept. of Geography, Shri. Raosaheb Ramrao Patil Mahavidyalaya, Savlaj Ta. Tasgaon Dist. Sangali.

Email: suryakantb.rathod@gmail.com

Article DOI Link: https://zenodo.org/uploads/15189540

DOI: 10.5281/zenodo.15189540

Abstract

Human resource management is the practice of recruiting, hiring, deploying and managing an organization's employees. Human Resource Management, or HR, is the strategic approach to managing people within an organization to achieve its objectives, encompassing areas like recruitment, training, compensation, and employee relations, aiming to maximize employee performance and contribute to the company's success. A company or organization's HR department is usually responsible for creating, putting into effect and overseeing policies governing workers and the relationship of the organization with its employees. Human resource development has been an important area of research practice. Human resource plays a significant role in the exploitation of basics resources and conservation at any stage. Human resource development is considered as a basics factor in the process of national development. Human resources development is the process of increasing the knowledge, the skills, and the capacities all the people in a society. The processes of resources development unlock the door to modernization. Satara district is well known district in western Maharashtra, but the levels of human Resource development is medium class in Satara district Karad Tahsil has first rank in human resource development, because development of Agriculture, industries, infrastructural, facilities, educational institution are largest proportion as compared to other tahsils. Lowest human resource development is found in man Khatav, Mahabaleshwar, Khandala tahsils, because these are dry prone area, adequate rain falls, and other physiographic conditions.

Keywords: Development, Planning, Human resources, Geographical analysis.

Introduction:

The purpose of human resource development practices is to manage the people within a workplace to achieve the organization's mission and reinforce the corporate culture. When people management is done effectively, HR managers can help recruit new

employees who have the skills to further the company's goals. HR professionals also aid in the training and professional development of employees to meet the organization's objectives. Human resources development is a people-oriented concept that focuses on developing the skill, knowledge and competencies of people. Human resources is one of the most important resources. Human resoures development is considered, as a basic factor in the process of national development, it is quantitative aspect of population Geography. Human resource is defined as the process of increasing qualitative values such as knowledge, skills, creative abilities, talent etc. These elements of human resources are the result of education, health food and nutrition etc in brief human resource development means resource nothing but a development of mantel and physical quality of individual, this quality of individuals brings a region to the way of devolvement. It is clear that a country which is unable to development the skill and knowledge of its people and to utilize them on effectively in national economy will be unable to develop anything else. Human resources development can be applied boath at the organizational level as well as the national level. Human resources are uneven from one region to another due to the variation in nature and human characteristics in space and time indicates, in balance in the overall development of an area in the present investigation an attempt has been made to analyze the variation in the development of human resources in satara district at tahsil level. Human resources professionals manage the day-to-day execution of HR-related functions. Typically, human resources is a standalone department within an organization. Human resources departments vary in the size, structure and nature of their individual positions. For small organizations, one Human resources generalist might perform a broad array of functions. Larger organizations have several Human resources professionals who handle specialized roles, such as recruiting, immigration and visas, talent management, employee benefits and compensation. Though these HR positions are specialized, job functions might still overlap.

Studay Area

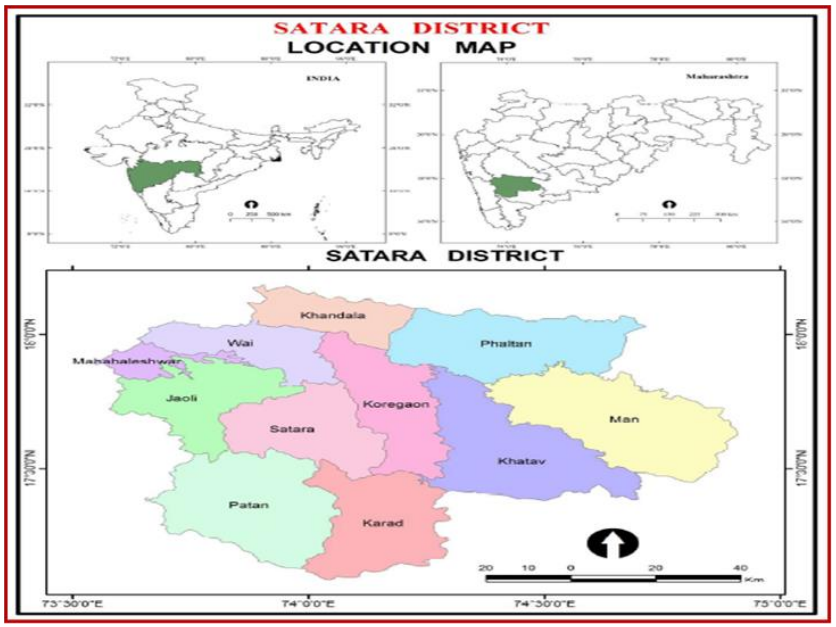
Satara district is situated in western part of Maharashtra state. There are the district lies between 17.5 degree and 18.11-degree North latitude and between 73.33 degree and 7 4.54-degree East longitudes. The district is completely landlocked being surrounded by Ratnagiri district on the West, Sangli district on the south, Solapur on the East, Pune on the north and Raigad on the North West. It covers 10,480 sqkms. Most of the central satara district’s area fallsin the river Krishna basin and limited area falls in the river Bhimabasin.Sataraa east west extent of 135 km and a north south extent of 112 km. The district is divided into seven Sub Division and eleven administrative sub units (tahsils) - Satara, Wai, Khandala, Koregaon, Phaltan, Khatav, Man, Karad, Patan, Jawali and Mahabaleshwar.

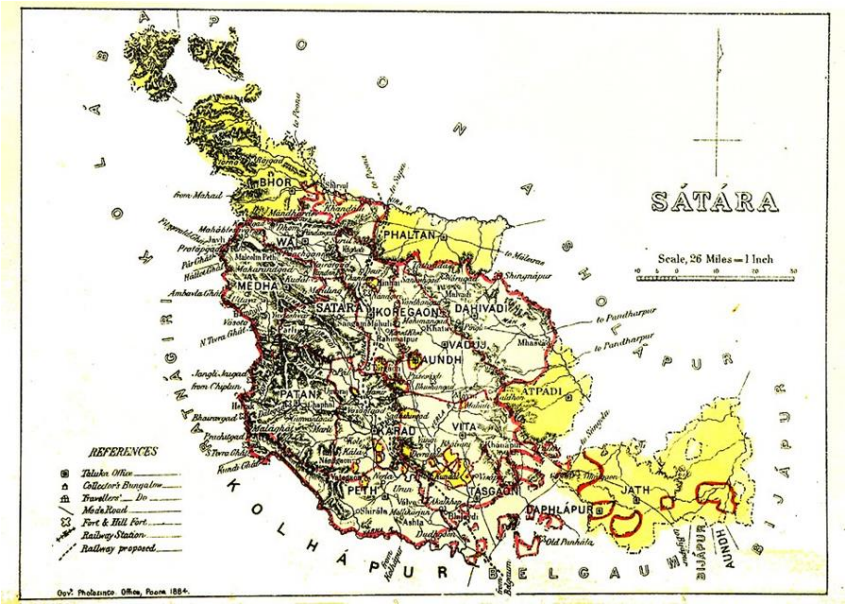
Objectives

In view of the above, the specific objectives of the present study to.

1. To making the planning strategies for improving the levels of Rural Human resource development in the study region.
2. To identify spatial disparities in various attributes of population and analyze and find out the levels of human resource development in the study region at the tahsil level.

Studay Area: Location Map





Data base and Methodology

The present study is based on the secondary data, which is obtained from census of Indian -2011, socioeconomic abstract of Satara district -2015, In this research paper Ten variables have been selected for measuring the levels of human resource development for each of the tahsil, with the help of ken dais ranking co-efficient method. Here the index. values are inversely related to the levels of development. It means that the tahsil which having least index value is more developed. Collected data is processed and represented with choropleths method for representation of co-efficient index.

Co-efficient index=-£R/N

Where,

£R=sum of the all ranks.

N=No of variables.

Results and Discussion Co-efficient **index=-£R/N**

Where,

£R=sum of the all ranks.

N=No of variables.

Results and Discussion

The table NO.1 Shown the, Human Resource development in Satara District with demographic characteristics such as, literacy, sex-ratio, Education, Urban Population, working population etc. some other variables like post office, educational facilities and health facilities, these all variable adopted to find out ranking co-efficient index method. Table No. 1 reveals the co-efficient index of Satara district has human resource development is found in the medium size. We make three categories of co-efficient index value i.e. development of high levels (index below 6), development of moderate levels (index value 6 to 8), and development of low levels (index value above 8) respectively. High co-efficient index value is found in two tahsil of Satara district namely Khandala Mahableshwar which shows low levels of Human resource development. The low co-efficient index value is found in Karad, Satara and Patantahsil of Satara district, which shows high levels of human resource and agricultural development.

The table NO.1 Shown the, Human Resource development in Satara District with demographic characteristics such as, literacy, sex-ratio, Education, Urban Population, working population etc. some other variables like post office, educational facilities and health facilities, these all variable adopted to find out ranking co-efficient index method. Table No. 1 reveals the co-efficient index of Satara district has human resource development is found in the medium size. We make three categories of co-efficient index value i.e. development of high levels (index below 6), development of moderate levels (index value 6 to 8), and development of low levels

Levels of Human ResourseDevelopment InSatara District (2022)

Levels of development	Scale Value	No.ofTahsil	Name of the Tahsil
High	Below 4	03	Karad,Satara,Patan

Medium	4 to 8	06	Wai,Phaltan,Koregoan,Man, Khatav,Javali
Low	Above 8	02	Khandala,Mahableshwar

Source: -Socio-Economic Abstract, Satara district, 2022

Table No.-1 Human Resourse Development in Satara District (2022)

Human Resourse Development in Satara District (2022)													
		r1	r2	r3	r4	r5	r6	r7	r8	r9	r10		
Sr. No.	Tahsil Name	Literacy	Education	Sex-Ratio	Population Density	Urban Population	Health	Post Office	Bank Facility	Drinking Water	Working Population	ΣR	Co-efficient index
1	Satara	2	3	6	1	1	3	2	2	3	11	34	3.4
2	Karad	1	2	7	2	2	2	1	1	2	9	29	2.9
3	Wai	8	7	4	3	5	8	6	7	7	7	62	6.2
4	Phaltan	3	8	9	4	3	5	6	6	8	6	58	5.8
5	Mahabaleshwar	11	9	10	11	6	11	10	9	9	10	96	9.6
6	Koregoan	9	6	5	6	4	7	5	4	5	8	59	5.9
7	Man	6	10	6	5	7	6	9	5	10	1	62	6.2
8	Khatav	5	5	3	10	11	4	4	3	6	2	53	5.3
9	Javali	10	4	1	9	10	9	8	8	4	3	66	6.6
10	Patan	4	1	2	8	9	1	3	5	1	4	38	3.8
11	Khandala	7	11	8	7	8	10	7	9	11	5	83	8.3

Source: -Socio-Economic Abstract, Satara district, 2022

(index value above 8) respectively. High co-efficient index value is found in two tahsil of Satara district namely KhandalaMahableshwar which shows low levels of Human resource development. The low co-efficient index value is found in Karad, Satara and Patantahsil of Satara district, which shows high levels of human resource and agricultural development.

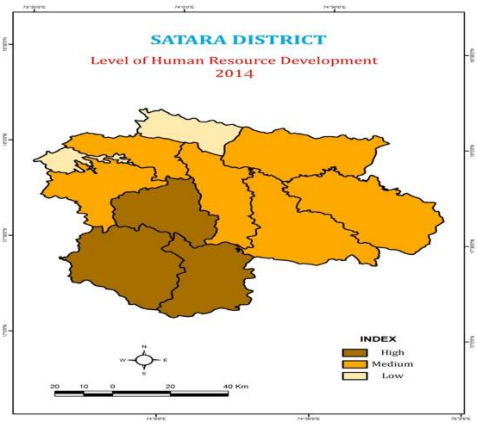
Levels of Human Resources Development

1. High Developed Region

In the study area, there are three tahsils included in this category. Highly developed region covers an area of 332528 sq km. (31.42%) with the 13585643 (46.13%) population of the region. These tahsil are laying in the central and southern part of the study region. It comprises Karad, Satara and Patantahsils. In this region urban population educational and health facilities, Bank and Drinking water facilities, literacy, post office, population density, working population is very better than another region. Industrial sector, agricultural sector, marketing as well as transport and communication facilities are the highest proportion, due to this the levels of Human resource development is found high in these tahsils. Karadtahsil is most developed tahsils in whole of the region. In this region development of sugar industries are very high concentration of co-operative societies. Karad tahsils get first rank due to the highly developed agricultural sector, high percentage of fertile soils, sufficient rainfall and perennial irrigation facilities leads high agricultural efficiency and development of agro based Industries.

2. Moderately Developed Region

In this region six tahsils areaWai, Phaltan, Koregaon, Man, Khatav and Javali. These tahsils having less development of human resources,because physiographic and climate conditions are responsible for it. This region also covers an area of 649917 sq km. (31.42%) and the population of this region is 1407880 (46.87%) included. Wai and Javalitahsils have more than 50 per cent of hilly area. Undulating topography highrainfall in this region.Phaltan, koregaon, Man, and Khatavtahsils have adequate rainfall whichadversely affected on agriculture irrigation, mining industries, transportation and infrastructurafacilities are less developed therefore the levels of human resource development is low as compared to developed region. In this region natural resources, health, education facilities status are well but proper utilization 0f natural resources are not sufficient.



Low Developed Region

It is called as problematic region. In this region there are two tahsils included namely Khandala and Mahableshwar. These regions are mostly hilly and highest rainfall is found there. Above tahsils have lack of infractural,

educational, health facilities and urban population, work participation rate is also compared other tahsils of Satara District. Low developed region occupies an area about 75798 sq. km. (7.16%) and 210248(6.99%) population is concentrated. These Mahabaleshwar tahsil are facing problem of less urbanization and industrialization, due to that reason most of people migrated from rural to urban area of Satara, Pune, Mumbai in search of better job and education. Population density and literacy rate is less in this region because hilly area, inaccessibility and educational institution also low in proportion.

Conclusion: Satara district is well known district in western Maharashtra, but of Human Resource development is medium class. In Satara District Karad tahsil has first rank in human resource development, because of agriculture, Industries, infrastructural facilities; educations are largest proportion as compared to other tahsils. Central and southern part of the study area is well developed, but the east, west and northern part of the study area is less developed. Lowest Human resource development is found in Mahabaleshwar and Khandala tahsil, because these are under thick forest excess rainfall and other physiographic condition.

References

1. Becker. B.E. & Huselid., M.A. (1996): "Methodological issues in Cross-sectional and panel estimates of the Human Resource firm performance Academy of Management Journal 38: 635 - 672 18.
2. Cappelte. P 8b Crocker - Heffer A (1996): "Distinctive human resources are firms' core competencies' organisational Dynamics. 24(3): 7 - 22 27.
3. J.T., Lew in D., &Ichiniolwski, C. (1989) "Human resource policies and practices in America firms. Wasting DC" US government act print once. 37.
4. Dyer L (1984) "Linking human resource and business strategies", Human Resource Planning, 7(2): 79 - 84 Socio-economic review of Satara District 2022
5. Satara District –census of India 2011.
6. MajidHussen, Systmatic Agricultural Geography, Ratwat Publication pvt.Ltd. Delhi.
7. Hangargi S. S. (2008), The dimensions of inter-taluka disparities in the levels of development of old Bijapur district of Karnataka state, Indian Journal of regional science, vol. xxxx, No,2 pp. 269-278.
8. Jasbirsingh S.S. AND Dillon, Agricultural Geography, Tata McGraw-hill Publishing company limited, New Delhi.
9. L. & Baird Mashulam I (1988): "Managing the job of strategic human resource management" Academy of Management Review. 13: 116 - 128 10. Balasubramanian A.G. (1994): "Evolution of Personnel functions in India. A Re-examination", Part-I, Management and Labour Studies: 19(4) 196 - 210. 11.
10. Mishra, R.P. (1978), Regional Development Planning in India, Vikash Publication, New Delhi.
11. Singh R. (2006): Regional Disparities in level of Socio-economic development in post Reforms period-A District level

analysis, Annals of NAGI, Vol. 26, Dec., No.2, pp. 87-94.

12. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2021) Assessment of Jalyukt Shivar Abhiyan Water Conservation Scheme in Karjat Tehsil of Ahmednagar District, Maharashtra-Using GIS Technique, Ecology, Environment & Conservation 27 (February Suppl. Issue) S71-S78
13. Vilas Vasant Patil, Agastirishi Bharat Toradmal (2020), Identification of Probable Water Scarcity Zones in Marathwada Region of Maharashtra. Gedrag & Organisatie Review, 33(02) 687-696
14. Agastirishi Bharat Toradmal, A Geographical Study of Contemporary Potential Status of Renewable Energy in India, 'Research Journey' International E-Research Journal, 108, 50-55.
15. Vibhute N.M., Mr. Agastirishi Bharat Toradmal, (2013), GIS Based Analysis on Rural Electrification (Rajiv Gandhi Gramin Vidyutikaran Yojana) In Maharashtra, "Rajarshi" A Refereed International (Multidisciplinary) Research Journal, 3, 96-100.

ABOUT THE EDITORS

Dr. Sangita R. Chandrakar

She is working as an Associate Professor in the Department of Geography at Dhandai Arts & Science College, Amalner, Dist-Jalgaon. With 20 years of teaching experience at both postgraduate and undergraduate levels, She has also served as an Assistant Registrar at Dr. C. V. Raman University, Bilaspur, Chhattisgarh. Her research credentials include over 30 publications in international and national research journals, as well as more than 20 research papers presented at national and international conferences, workshops, and seminars worldwide. She is a recognized research guide at Kavyitri Bahinabai Chaudhary North Maharashtra University, Jalgaon. she has completed the N.N.R.M.S. course at the Indian Space Research Organization, Dehradun. Notably, her book, "Urban Planning In The New Millennium: The Challenge of Change," has been published in Germany.

Dr. Vijaya K. Nikam

She is currently working as Associate Professor, Department of Botany, Sadguru Gadage Maharaj College, Karad (Dist. Satara) - 415 124, Maharashtra, India. She accomplished M.Sc. (Botany with specialization in Plant Physiology) course in the Botany Department at Shivaji University, Kolhapur, in 2002. She had been awarded a Ph.D. from Shivaji University, Kolhapur, for her research work on the physiology of a medicinal plant, *Chlorophytum borivilianum*. She has been involved in teaching and research programs in senior colleges of the renowned educational institute Rayat Shikshan Sanstha (Maharashtra) for the last 14 years. She has co-authored 20 textbooks for undergraduate courses in botany. She also published a reference book on her research and a patent. She has successfully conducted two minor research projects in plant science. She has recognized research guide affiliated to Shivaji University, Kolhapur.

Dr. Neelam Bajpai

Dr. Neelam Bajpai is an Assistant Professor of Zoology at Kaushambi, Uttar Pradesh, India. Born on June 1, 1981, Dr. Bajpai holds a D. Phil. in Zoology from the University of Allahabad (2011),Dr. Bajpai's academic excellence has been recognized with multiple awards, including gold medals for her performance in B.Sc. (First position). She also received Dr. Ram Saran Das Memorial Silver Medal for standing first in order of merit of Zoology at B. Sc. Examination of University of Allahabad. She also qualified for JRF-NET conducted by CSIR-UGC. Her doctoral research focused on the 'Genetic relationship of sarcophagid flies' employing molecular markers such as RAPD-PCR, PCRRFLP, and DNA sequencing. Her work has led to the submission of approximately sixty gene region sequences to GenBank. She has extensive research experience in areas, utilizing molecular markers. Dr. Bajpai has numerous peer-reviewed publications in National and International journals and contributed chapters to several books. She has also participated in numerous seminars, conferences, workshops, and training programs. She has membership of different academic bodies and reviewer of different journals. She has supervising a D. Phil. student also. With teaching experience at Mahamaya Government Degree College, Kaushambi (since August 2013), Dr. Bajpai is actively involved in academics and research. Dr. Bajpai is passionate about fostering a strong understanding of Zoology among her students

Mr. Hrishikesh Khodade

Mr. Hrishikesh Khodade is an Assistant Professor in Department of Botany, S. M. Joshi College, Hadapsar, Pune. with over 12 years of experience in teaching and research. His primary research interest lies in nanotechnology, with a strong focus on the green synthesis of metal nanoparticles using plant extracts. He has published multiple research papers, authored book chapters, and holds patents in the field of sustainable innovations. His work explores the antimicrobial, antioxidant, and anticancer potential of biogenically synthesized nanoparticles.

Nature Light Publications

(An International Publication)

309 West 11, Manjari VSI Road, Manjari Bk.,
Haveli, Pune- 412 307.

Website: www.naturelightpublications.com

Email: naturelightpublications@gmail.com

Contact No: +91 8625060096/ 9822489040 / 9922489040

ISBN: 978-81-981142-8-0

Price- 750/-

Nature - 38