Editor's Message

Dear Readers

I am truly honoured to edit the special issues of the Indian Economic Journal. While writing this message towards the end of 2022, I would like to retrospect the impact of COVID-19 pandemic on the normal activities of the IEA. It has reminded us the need to ensure continuity and taught us the culture of strengthening human fabric and solidarity.

This year in August 2022 we celebrated India's 75th year of Independence. Over these 75 years we have recorded substantial advancements in many fields from Agriculture to Space Exploration. However, in areas like Human Development Indicators, inequalities and poverty, the progress has lagged far behind when compared with countries that are similarly footed. Moreover, there has been huge variations observed in the indicators between and within states. If India has to become more efficient, competitive and resilient, it needs to learn lessons from its development history as well as from its crisis years of 1966, 1981 and 1991. India also is set to become a USD 10 trillion economy to become the third largest economy by the year 2030. In this context the overarching theme of the 105th Annual Conference is taken as "India at 75: Reviewing Indian Economy for Sustainable Development." The sub themes are: 1. Lessons Learnt from the Past for Planning and Rapid Growth; 2. Drivers of High Economic Growth; 3. Social and Economic Equality for Inclusive Growth; 4. Efficient Resource Use & Environmental Protection; and 5. Green and Inclusive Growth for Sustainable Development. The articles in the volumes of the special edition of IEJ are select articles from each sub-theme.

The Indian Economic Journal (IEJ) is an important organ of the Indian Economic Association (IEA) that provides support and services to professionals and researchers both in India and overseas. For over a century the IEA has been one of the largest and the oldest body of teachers, researchers, academicians, and policy makers drawn from the background of Economics and affiliate discipline. Founded in 1917, the IEA is a, "not-for-profit, non-political, and scholarly" voluntary professional association with membership open to those who fulfil the eligibility criteria laid by the constitution of IEA. Through regular outreach programs like, "Conferences, Courses, Publications and Seminars"

IEA disseminates information among scholars to increase their understanding of economics. Both IEJ and IEA work in tandem encouraging members to share their research work findings and contribute scholarly articles in Annual Conferences and for publishing in special editions of the IEJ by maintaining relevance of the journal.

The Indian Economic Journal was founded by Prof. C.N. Vakil and Prof. R Balakrishna in 1953 and has over the years become a coveted internationally acclaimed journal in Economics due to high ethical and quality standards maintained by successive editors. The IEJ is at present included in the 'Abstract Services' of the American Economic Association through their Journal of Economic Literature. I take the opportunity to acknowledge the contributions of Prof. Sukhadev Thorat in transforming Conference Volumes of IEA into special editions of Indian Economic Journal and Dr. Anil Kumar Thakur, Chief Convener of IEA for taking efforts to sustain the quality and ratings of IEJ along with the Managing Editor of IEA, Prof. Sudhanshu Bhushan.

I would like to thank all the authors, and co-authors for their scholarly article contributions for the 105th Annual Conference. I also express my deepest gratitude to editorial team that is fully engaged and committed to the success of these outstanding volumes. I also thank all the authors, reviewers and the editorial support team, especially the services extended by Dr. Kumari Manisha Mrs. S. Sunitha, Dr. Taibangnganbi, Mr.R. Subramanian and Dr. M. Dillip Anand in bringing out the special issues of IEJ in scheduled time. Last but not the least, my sincere thanks to Mr. A. Aashik Ahamed, TAMCOS Ltd. Chennai and his team our print service provider for their neat execution and timely delivery of print collaterals.

B.P. Chandramohan

CONTENTS

Factors Influencing the Purchase Recommendation of Small Format E-Mobility In India : A Structural Equation Modeling Approach

M Kalpana
K P Radhika
Bhuvaneshwari D

Abstract: Rapidly growing concerns about global warming are being caused by the transportation Industry's carbon dioxide emissions. The environment and society benefit greatly from fully electric vehicles (EVs) because they have zero tailpipe emissions. It is crucial to comprehend how people feel and perceive EVs because the vast majority of people in India have not yet adopted electric mobility as a standard mode of transportation. The economic, social, and environmental gains can be achieved if the government and the automotive sector concentrate on EVs and ensure their adoption by the people of the country. This article examines the different indicators that influence the customers' perception towards purchase recommendation of EVs. The study used primary data collected from respondents on their perception of EVs, which were measured using three constructs; environmental, economic and social. Structural Equation Modeling (SEM) was used to identify the extent of influence of the constructs on the purchase recommendations by the respondents. It was found that environmental and social factors significantly influenced the perception that lead to the purchase recommendation of the respondents in the study.

Keywords: Electric Vehicle, Perception, Purchase Recommendation, Indian Automotive Industry, Structural Equation Model

INTRODUCTION

India is no exception to the rule that a nation‟s infrastructure drives economic growth. Since India's independence, the automotive industry is growing rapidly and has experienced large- scale innovations, to the changing times and needs of households. The liquidity crisis and high production costs witnessed during 2018 caused a slowdown in the Indian automotive sector. COVID-19 accelerated the downturn despite the OEMs‟; and mobility players‟ best efforts to reverse it. Despite the obstacles, the sector is developing new ideas and solutions to the pressing environmental and crude oil scarcity problems. In this regard, the introduction of EVs is seen as a breakthrough for the future of the industry.

The Indian Scenario and Target Ahead: Indian companies have also proved themselves with the introduction of the first electric car in 2001. The Indian automotive industry stands to benefit from the shift to the EV market, owing to the skilled manpower availability and renewable

resources in the manufacturing sector. The electric mobility supply chain includes major organizations participating actively over the past ten years, but the penetration is only 0.8 percent. The ease of accessibility, affordability, and efficiency of small-format electric mobility, which includes two-wheelers (2W), three-wheelers (3W), and four-wheelers (4W), has gained popularity.

The developments that have promoted small-format E-mobility in India include:

- Incentives from the government with the introduction of FAME (The Faster Adoptionand Manufacturing of Hybrid and EV, implemented in 2015)
- Economical battery prices

Associate, Department of Humanities, PSG College of Technology, Coimbatore , Tamil Nadu.
Assistant Department of Humanities, PSG College of Technology, Coimbatore , Tamil Nadu.
Assistant Department of Humanities, PSG College of Technology, Coimbatore, Tamil Nadu.

- Lower Total Cost of Ownership (TCO)
- Launch of the „e-AMRIT" portal
- Increased consumer acceptance

In light of the substantially unrealized market potential, the sector is functioning with high goals in the E-mobility category. In a report titled "India"s Electric Mobility Transformation" published in April 2019, the federal think tank NITI Aayog estimated that by 2030, commercial vehicles would account for 70% of EV sales in India, while private vehicles would account for 30%, buses for 40%, and 2W and 3W vehicles for 80%. If these goals are met, 846 million tonnes of CO2 emissions and 14 exajoules of energy might be saved overall over the lifetime of the deployed vehicles (India Briefing Report, 2021).

The Ministry of Heavy Industries and Public Enterprises introduced the Faster Adoption and Manufacturing of Electric and Hybrid Vehicles in India (FAME) scheme in 2015 to encourage the development and marketing of environmentally friendly vehicles, such as EVs and hybrid vehicles. The plan is being put forth to create a charging infrastructure (Jose, 2018). The National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission plan that lays out the strategy for accelerating the uptake of EVs and their production. This strategy aims to increase national fuel security, provide accessible, ecologically friendly transportation, and help the Indian automotive sector take the lead in global production (Gulati, 2013). The objective of the current study is to investigate the impact of social, economic, and Environmental factors on how people perceive and recommend the purchase of EVs.

REVIEW OF LITERATURE

The potential of EVs for the future necessitates adequate research to comprehend the difficulties, advantages, perceptions, purchase intentions, and requirements for evolving the electric mobility market. In this regard, this section attempts to highlight the significant studies from the literature on the perception and adoption of EVs.

Sriram et al. (2022) set out to determine the potential influences on consumers' intentions to purchase EVs. An online survey method using the snowball sampling technique was used to collect data from 172 respondents from Bengaluru using a quantitative methodology. The adoption of EVs was influenced by factors like financial barriers, vehicle performance barriers, a lack of infrastructure for charging, environmental conservation, societal influence, and social awareness of EVs, according to an exploratory factor analysis that was conducted. Asadi et al. (2021) determined what influences consumers' decisions to purchase EVs. A structural equation model was used to empirically assess the influencing factors on the propensity to purchase electric automobiles from 177 valid questionnaires. The findings showed that perceptions of value, attitude, responsibility, subjective and personal norms, perceived consumer efficacy, and awareness of repercussions significantly and favorably influenced consumers' intentions to acquire EVs.

Tupe, Kishore and Johnvieira (2020) discovered that consumers are willing to switch from conventional to eco-friendly vehicles since they are conscious of the state of the world's climate. If the necessary infrastructure is in place, respondents are willing to consider EVs as a potential future purchase. The initial purchase price, a dearth of charging stations, and the length of time needed to recharge the battery were all cited as obstacles to increasing consumer confidence in purchasing EVs. Khurana, Kumar and Sidhpuria (2020) looked at the various elements that influence consumer EV adoption. The study's respondents were Indians who now own cars. With the aid of structured equation modeling, the data were examined, and consumers" attitudes emerged as the potential mediator in the uptake of EVs.

Singh and Arneja (2020) made an effort to evaluate how the general public views EVs and how it affects respondents' purchase intentions. The information was gathered from 438 participants in the

Indian state of Punjab. The findings showed that perceived quality, expected benefits, perceived difficulty, and perceived value were the four factors that determine perception. It was also discovered that each of these factors significantly affected the intention to buy an EV. Gujarathi, Shah and Lokhande (2018) discussed the current state of Indian road transportation as well as the market for two- and four-wheelers, market players, and recent advances. Internal combustion (IC) engine technology would continue to be in demand with automatic transmissionvehicle demand will rise in the future. The cost would constrain the growth of hybrid fuel technology, but, India may have a sizable market for converting conventional vehicles into plug- in hybrid EVs through retrofitting.

Bhalla, Ali and Nazneen (2018) researched the elements that affect consumers' adoption of EVs in India. The study discovered that cost, infrastructure, and social acceptance are the variables that hold back the adoption of EVs, while environmental concerns and consumer trust in technology are the precursors. Therefore, the government must take the lead in promoting the sales of EVs by developing environmental legislation, and infrastructure, subsidizing the cost of the vehicles, or lowering bank borrowing rates. Degirmenci and Breitner (2017) looked into how consumer purchase intentions for EVs were affected by environmental performance in comparison to price value and range confidence. Interviewing 40 end-user individuals about theirattitudes toward EVs helped the researchers to establish our theory. Then, to test the idea, the researchers drove 167 plug-in battery EVs for test purposes. The environmental performance of

EVs was a better predictor of attitude and, consequently, purchase intention than price value and range confidence, according to the findings of a structural equation modeling.

Egbue and Long (2012) provided insightful information about the tastes and viewpoints of tech enthusiasts, people who are closely connected to technological advancement and are better able to distinguish between the differences between conventional and electric automobiles. If they believe EVs perform better than conventional cars, this group of people is more likely to be earlyadopters of them. Biswas and Biswas (1999) revealed that developing nations like India might currently find EVs to be a more natural option than wealthy nations. Even a low-end EV technology appears to be economically viable and appropriate given the country's warm climate, the current dire state of the environment in urban India, the resource balance (India has enough coal reserves but not much oil), and the transportation needs and driving habits of its people (most personal transport vehicles are driven only twenty to forty kilometers per day).

NEED AND OBJECTIVES OF THE STUDY

The review of literature provides ample studies from developed countries on both the perception and adoption of EVs. In India, there is still a dearth of studies that analyze the significant factors influencing the perception of EVs. This gap gives scope for the present study to empirically analyze the influence of environmental, economic, and social parameters on the perception of EVs (Rastogi, Thomas and Digalwar, 2021). The present study attempts to identify the influence of the environmental, economic and social parameters on the perception of the respondents in recommending the electric values based on the influencing factors. The following hypotheses were set up and tested using the SEM approach.

H_1: There is no significant relationship between environmental constructs and purchase recommendation.

H_2: There is no significant relationship between economic constructs and purchase recommendation.

H_3: There is no significant relationship between social constructs and purchase recommendation.

METHODOLOGY

Data: The data was gathered using a standardized questionnaire consisting of two sections. The initial section retrieved information about the respondents' demographic characteristics, including age, gender, educational level, occupation, annual family income, and residential status. The assumed factors influencing perception towards EVs are included in the second section, which forms the variables of the Structural Equation Modelling (SEM) model. 101 valid responses were collected from the respondents and used for the SEM analysis. The questionnaire used a 5-point Linkert Scale with 5 as strongly agree and 1 as strongly disagree. The final instrument included 8 items measuring the input variables instead of the original instrument's 12

items. The independent factors used to analyze the perception of the respondents towards EVs were divided into environmental, economic, and social parameters.

Measurement: The demographic characteristics are measured as categorical data in the first section. The model variables are measured in the second section using a 5-point Likert scale (5 as strongly agree and 1 as strongly disagree). The Software Package for Social Sciences (SPSS) version 21.0 and the SmartPLS 4.0 using measurement model and SEM were used to analyze the data. Structural equation modeling was used to do an empirical analysis of the data and present it in a review of numerous studies on customers' perceptions, buying intention, and decision- making about the adoption of EVs. Asadi et al. (2021) identified elements that affect people's tendency to buy EVs and Degirmenci and Breitner (2017) investigated how consumer purchase intentions for EVs were influenced by environmental performance in relation to price value and range confidence using the SEM technique. A similar methodology is used for Indian data in the present research paper. The measurement model and the structural model are the two parts of structural equation modeling. The measurement model is validated in the first stage and the relationship's strength and direction are assessed in the second stage.

II. ANALYSIS AND INTERPRETATION

Socio-Economic Indicators: Literature suggests that socio-economic characteristics like age, gender, and education of the respondents have an impact on the perception decisions in general. The Theory of Planned Behavior suggests that humans make decisions based on logical evaluations of stimuli and the plausible outcomes of decisions (Ajzen, 1991). Customers‟ knowledge and experiences have a great influence on attitude (Ajzen and Fishbein, 1980). Table 1 presents the descriptive statistics of the socio-economic indicators of the respondents of the study.

Table 1 Descriptive Statistics

Statistic	Category	Frequency	Percentage	Mean	Standard Deviation
Age	25-30 years	28	27.72	2.39	1.41
	31-40 years	45	44.55		
	41-50 years	21	20.79		
	Above 50 years	7	6.93		
	Total	**101**	**100**		
Gender	Male	76	75.25	1.25	0.43
	Female	25	24.75		
	Total	**101**	**100**		
Marital Status	Married	48	47.52	1.54	0.54
	Unmarried	51	50.50		
	Ever Married	2	1.98		
	Total	**101**	**100**		

Educational Attainment	Primary school	0	0.00	3.59	0.87
	High school	8	7.92		
	Bachelor‟s/diploma degree	43	42.57		
	Master‟s degree	32	31.68		
	PhD	18	17.82		
	Total	**101**	**100**		
Occupation	Salaried private	58	57.43	1.85	0.91
	Salaried government	15	14.85		
	Self-employed	17	16.83		
	Retired	6	5.94		
	Homemaker	5	4.95		
	Total	**101**	**100**		
Annual Family Income	Less than Rs.5,00,000	40	39.60	1.88	0.82
	Rs.5,00,001 - Rs.10,00,000	33	32.67		
	More than Rs.10,00,001	28	27.72		
	Total	**101**	**100**		
Residential Status	Urban	80	79.21	1.21	0.41
	Rural	21	20.79		
	Total	**101**	**100**		
Source: Author‟s Calculation					

Among the 101 respondents, 75 percent of the respondents were male, and 25 percent were female (Khurana, Kumar and Sidhpuria, 2020), and most of the respondents belong to the age group of 31 – 40 (45 percent). The maximum percentage of the respondents‟ educationalattainment is a bachelor's and/or diploma degree (43 percent) and most of the respondents are employed in private organizations (57 percent). The annual family incomes of the respondents are almost evenly distributed between the three categories. The majority of the respondents were from urban areas (79 percent).

Reliability and Validity of the Constructs: Table 2 presents the reliability (Cronbach‟s Alpha Score) and validity (AVE Score) for the constructs via; environmental, economic and social and purchase recommendation.

Table 2 Cronbach's Alpha Value

S. No.	Construct	Cronbach's Alpha	AVE Score	No. of Items
1	Environmental	0.772	0.688	4
2	Economic	0.659	0.588	4
3	Social	0.733	0.627	4
4	Purchase Recommendation	0.712	0.528	1
Source: SmartPLS Results				

The reliability coefficients (Cronbach‟s Alpha Scores) for the variables chosen for this study are above the threshold limit of 0.60 (Churchill 1979 and Malhotra 2005), supporting the reliability of the constructs. The ability of the constructs to provide accurate results is tested through the Average Variance Extracted (AVE) validity score. The AVE scores of the constructs used in the study have values greater than 0.5 (thumb rule), suggesting their validity.

Factor Loading: Table 3 presents the factor loadings of the indicators that are higher than the threshold point of 0.5 and significant at a 0.05 percent level of significance.

Table 3 Factor Loading

Measured Indicators	Construct	Factor Loading
ENV1: EVs help to reduce air pollution	Environmental	0.700**
ENV2: EVs promote environmental consciousness	Environmental	0.866**
ENV3: EVs serve as an aid to conserve the environment	Environmental	0.908**
ECO1: EVs have lower operational cost	Economic	0.793**
ECO2: EVs help to reduce my fuel expenses	Economic	0.739**
SOC1: EVs will form a major part of India‟s domestic vehicle market in the next 10 years	Social	0.761**
SOC2: Incentives should be provided by the Government to promote EVs	Social	0.911**
SOC3: Owning an EV is advantageous over a gasoline-powered vehicle	Social	0.789**
PR: Will you recommend EV?	Purchase Recommendation	0.987**
Source: SmartPLS Results Note: **Significant at 0.05% level of significance.		

The factor loadings of the measurement model given in the above table support the validation of the model and the influence of the indicators on purchase recommendation.

Structural Equation Model: Fig. 1 represents the Structural Equation Model that brings out the relationship between the constructs.

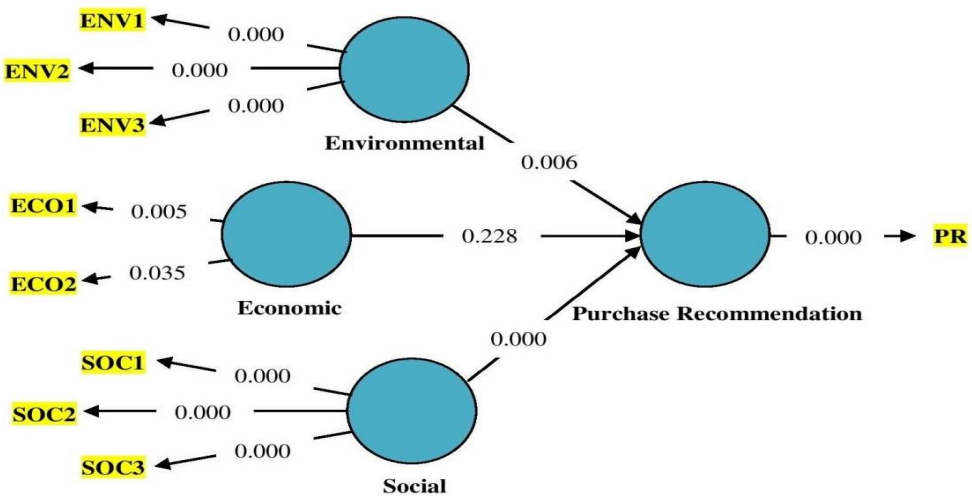


Fig. 1 Structural Equation Model

The analysis using the structural model tested the three proposed hypotheses at the 0.05 percent significant level. The results indicated that the constructs of environmental and social were significant at the 0.05 percent significance level, inferring that environmental and social indicators influenced the purchase recommendation of the respondents. However, it was found that the economic indicators were not significant and hence does not influence the purchase recommendation of the respondents.

Table Hypotheses Results

H	Relationship of Constructs	Sample Mean	Standard Deviation	T Statistics	P Values	Result
H_1	Environmental ---> Purchase Recommendation	0.181 (0.198)	0.088 (0.087)	2.266 (2.497)	0.012 (0.006)	Significant Rejected H_1
H_2	Economic ---> Purchase Recommendation	0.087 (0.106)	0.101 (0.112)	0.626 (0.745)	0.266 (0.228)	Not Significant Accepted H_2
H_3	Social ---> Purchase Recommendation	0.464 (0.445)	0.106 (0.109)	4.309 (4.006)	0.00 (0.000)	Significant Rejected H_3
Source: SmartPLS Results						

Regardless of one's status or position in society, the environment is a concern for everyone, including the government. The installation of green license plates on EVs can represent environmental awareness (Khurana, Kumar and Sidhpuria, 2020). According to Pierre, Jemelin, and Louvet (2011), people who care about the environment are more inclined to buy and recommend EVs. The findings of the present study are supported by the results of Bhat, Verma and Verma (2022) that social image and social influence have a positive impact on consumers' intention to adopt EVs in India. Even while EVs offer a host of advantages, there are still some barriers that prevent their widespread adoption. One such barrier is the economical barrier as people seek financial incentives to buy EVs. Though the provision of several financial incentives, such as the reduction in GST or tax exemptions are provided by the government, the customers are not satisfied with the high initial and maintenance costs of the EVs (Goel, Sharma,Mathiyazhagan and Vimal, 2021).

CONCLUSION

Innovations drive the economy from one stage to another. EVs are the recent innovations that have greater potential to solve the dependence on crude oil that always suffers supply deficit. In India, the Government gives adequate impetus to the production of EVs. The automotive market sees a greater influx of organizations coming out with EVs in both the two-wheeler and four- wheeler segments. In this scenario, the present study is an attempt to analyze the purchase recommendation of the respondents, based on three significant factors; environmental, economic and social. The SEM approach was used to validate the indicators under each factor to identify the factors that influence the purchase recommendation by the respondents. It was found that both environmental and social factors contributed significantly to the recommendation of EVs by the respondents. Economic factors did not significantly influence the purchase recommendation, which could be largely due to the lack of awareness of government schemes, the cost of maintenance, and battery replacement.

LIMITATIONS AND SUGGESTIONS

- The study primarily used the data collected from respondents of a specific region and hence the results cannot be generalized.

- The study has considered only three significant factors to analyze the purchase recommendation of EVs.

- The recommendation to purchase EVs need not always translate to buying in the market and hence further research can help in understanding whether the recommendation transforms into buying.

REFERENCES

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology& health*, *26*(9), 1113-1127.

Ajzen, I. and Fishbein, M. (1980). *Understanding Attitudes and Predicting SocialBehavior*. Englewood-Cliff, NJ: Prentice-Hall.

Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M. H., &Yadegaridehkordi, E. (2021). Factors impacting consumers" intention toward adoption ofelectric vehicles in Malaysia. *Journal of Cleaner Production*, *282*, 124474.

Bhalla, P., Ali, I. S., & Nazneen, A. (2018). A study of consumer perception and purchase intention of electric vehicles. *European Journal of Scientific Research*, *149*(4), 362-368.

Bhat, F. A., Verma, M., & Verma, A. (2022). Measuring and Modelling Electric Vehicle Adoption of Indian Consumers. *Transportation in Developing Economies*, *8*(1), 1-13.

Biswas, T. K., & Biswas, N. M. (1999). Electric vehicle: A natural option for India?. *IETE Technical Review*, *16*(3-4), 367-373.

Degirmenci, K., & Breitner, M. H. (2017). Consumer purchase intentions for electric vehicles: Is green more important than price and range?. *Transportation Research Part D:Transport and Environment*, *51*, 250-260.

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy*, *48*, 717-729.

Goel, P., Sharma, N., Mathiyazhagan, K., & Vimal, K. E. K. (2021). Government is trying but consumers are not buying: A barrier analysis for electric vehicle sales in India. *Sustainable Production and Consumption*, *28*, 71-90.

Gujarathi, P. K., Shah, V. A., & Lokhande, M. M. (2018). Electric vehicles in India: Market analysis with consumer perspective, policies and issues. *Journal of Green Engineering*, *8*(1), 17-36.

Khurana, A., Kumar, V. R., & Sidhpuria, M. (2020). A study on the adoption of electric vehicles in India: The mediating role of attitude. *Vision*, *24*(1), 23-34.

Pierre, M., Jemelin, C., & Louvet, N. (2011). Driving an electric vehicle. A sociological analysis on pioneer users. *Energy Efficiency*, *4*(4), 511-522.

Rastogi, A., Thomas, R. G., & Digalwar, A. K. (2021). Identification and analysis of social factors responsible for adoption of electric vehicles in India. *Current Science*, *121*(9), 1180- 1187.

Singh, J., & Arneja, R. S. (2020). Public perception and purchase intentions about electric vehicles in the Punjab state of India. *International Journal of Control and Automation*, *13*(3), 251-259.

Sriram, K. V., Michael, L. K., Hungund, S. S., & Fernandes, M. (2022). Factors influencing adoption of electric vehicles–A case in India. *Cogent Engineering*, *9*(1), 2085375.

Tupe, O., Kishore, S., & Johnvieira, A. (2020). Consumer perception of electric vehicles inIndia. *European Journal of Molecular & Clinical Medicine*, *7*(8), 2020.

Bhardwaj, N. (2022). Electric Vehicle Industry in India: Why Foreign Investors Should Pay Attention. https://www.india-briefing.com/news/electric-vehicle-industry-in-india-why-foreign-investors-should-pay-attention-21872.html/ Jose, (2018). What is

FAME IndiaScheme?. https://www.indianeconomy.net/splclassroom/fame-india-scheme/

The Path Of Energy Transition For Global Economies

Anita Das

ABSTRACT

Global energy consumption in 2018 increased at nearly twice the average rate of its growth since 2010, this result is due to the world economies being highly carbon intensive. All over the world, demands for fuels have increased, and it's mostly led by natural gas, even though solar and wind energy resources have shown high growth. Most of growth in energy needs happened due to high rise in electricity demand throughout the world. Energy-related CO_2 emissions have risen to a historic high of 33.1 Gt CO_2 and are expected to rise in the years to come. The power sector accounted for nearly two-thirds of emissions growth, with carbon emission at an all-time high, mostly happening in China, India, United States and countries of the European Union. With Carbon Dioxide being emitted at a large scale, it is the most important cause of global warming. With such huge amounts of CO_2 emissions, it is very evident that mostly all the countries are in carbon intensive economy stage. Climate Change is at peak high, with its effects being witnessed by nearly all parts of the world. There has been increasing sea levels, global temperature rise, increase in the frequency of droughts, cyclones and much more. To understand the adversity effects happening due to climate change, it's very vital that the energy sector needs to change its ways of occurrence. Electricity generation, transmission, distribution and consumption, all these need to be revised and laid out with a new outlook. 'Decarbonization' of the global energy systems is the need of the hour, with all countries across the globe have to take responsible ways to tackle this challenge. With decarbonisation happening, countries need to look into energy transition and sustainable energy development. The International Renewable Energy Agency (IRA) defines 'Energy Transition' as "the pathway in the transformation of the global energy sector from fossil-dominated mix to zero-carbon by the second half of the 21st century". Sustainability and Energy are intertwined, with the development and growth in one automatically leads the growth in other. With all these happening simultaneously, it will result in the growth and development of a nation. Group of 20 (G20) being the rich, technologically advanced, independent, democratic economies should lead the way forward in energy transition and sustainable energy development. India is rising to be an economic superpower, with any country's progression, there's always been a significant rise in energy demands and that's happening in India as well. In this perspective, this paper analysed the different aspect of adversities it may cause into the economy due to climate change. This paper also tried to find the path for energy transition policy measures and the role of G20 economies for Sustainable Energy Development. In this process, the key role played by India in respect of climate change and clean energy transition were also discussed.

Keywords: Climate Change, Carbon dioxide (CO_2), Decarbonisation, Sustainable Energy, G20 Economies

Introduction

Carbon dioxide emissions, primarily from the combustion of fossil fuels, have risen drastically since the beginning of the industrial revolution. Most of the world's greenhouse gas emissions come from a relatively fewer number of countries such as United States, China, Russia, India, Japan, countries of European are s ome of the major emitters of carbon dioxide gases.

Associate Professor PG Department of Commerce ,College of Commerce, Arts & Science PPU, Patna

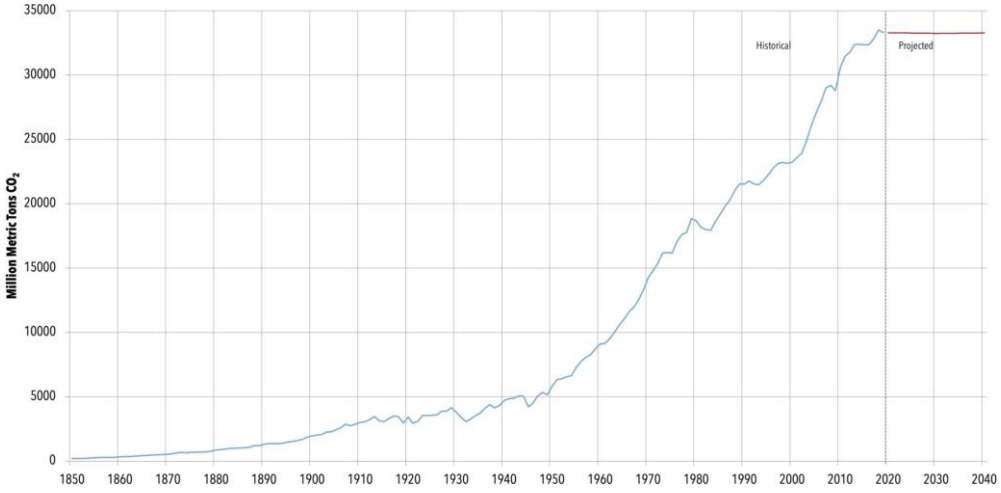


Figure 1 : Level of production of Carbon Dioxide (CO2) per decade

Source: International Energy Agency

The graph projected here (Source: International Energy Agency) depicts the level of production of Carbon Dioxide (CO2) per decade by all the nations. It can be very well noticed that over the past 50 years or so, the level of carbon dioxide emissions have increased exponentially. These production levels are projected to remain more or less similar as they are of now over the next few decades as well. Also, the other greenhouse gases such as methane, nitrogen based gases also are expected to have a rise over the next few decades owing to high intensive industrialization, machining & production processes with the countries across the world intensifying their growth and development.

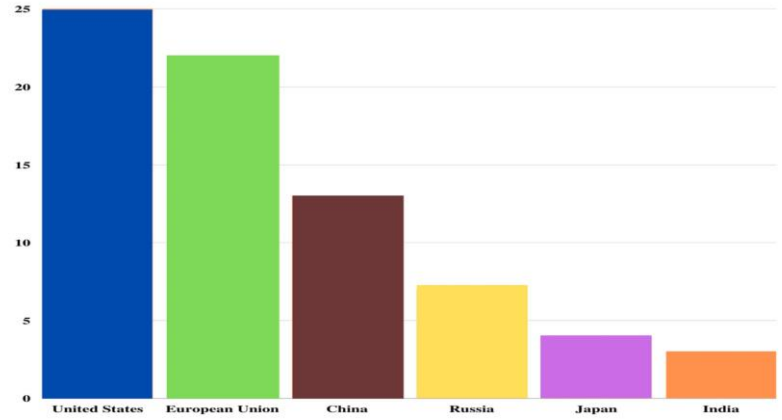


Figure 2 : Global Carbon Emission across (1751-2017) by different countries

Source: International Energy Agency

This chart (Source: International Energy Agency) depicts the Global Carbon Emission across (1751-2017) by different countries. It can be clearly understood that most of the carbon emission produced till date is from the most advanced and highly developed countries and from the recent developing nations. The reason being these countries focused highly on industrial processes, manufacturing, electricity production, automotive & transport etc. and different other sectors.

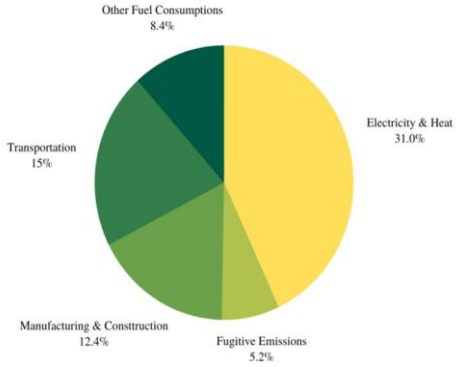


Figure 5 : Percentage production of carbon by different components of the energy sector
Source: World Resources Institute

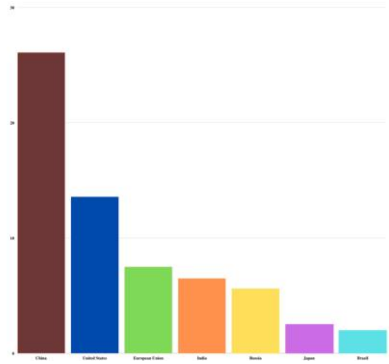


Figure 3 : Global Carbon Emissions by the different countries in 2018
Source: International Energy Agency

This Chart (Source: International Energy Agency) depicts the percentage of Global Carbon Emissions by the different countries in 2018. China which is now a highly industrialized economy has surpassed the earlier top carbon emitting countries by a huge margin, and has gained the top spot in production of carbon emissions accounting for around 26.1% of the total global carbon emissions. United States, Russia, Japan, countries of European Union which are highly developed countries have maintained their spots in the carbon production. India, also hosting a lot of different industries and manufacturing units also emits a lot of carbon based gases accounting for around 4.5% of the total global carbon emissions.

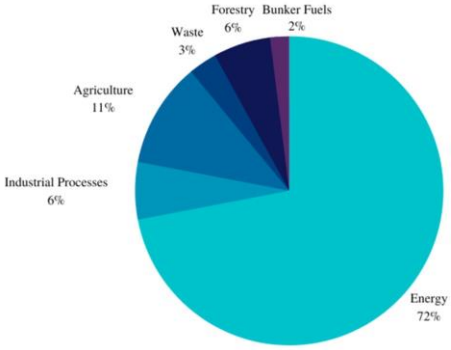


Figure 4 : Percentage production of carbon by the different sectors globally
Source: World Resources Institute

This Pie Chart (Source: World Resources Institute) represents the percentage production of carbon by the different sectors globally. Energy sector is the primary carbon emitting sector accounting for 72% of the total global emissions. The other sectors include Agriculture: 11%, Industrial Processes: 6%, Forestry: 6%. Waste Management: 3% and others.

There are different components in the energy sector - Electricity & Heat: 31.0%, Transportation: 15%, Manufacturing & Construction: 12.4%, Fugitive Emissions: 5.2% and others which account for 8.4%. (Source: World Resources Institute)

The Global Energy related CO_2 emissions in 2020 was 31.5 Giga tons, which contributed to CO_2 reaching its highest ever average annual concentration in the atmosphere of 412.5 parts per million which is around 50% higher than when the industrial revolution began.

Problem Statement

Most of the electricity generated globally is by the usage of fossil fuels. They have been used since time immemorial but with industrialization there has been a rapid use of such resources, they now been used on an extensive scale. The combustion of fossil fuels produces greenhouse gases like carbon dioxide

(CO_2), Sulphur dioxide (SO_2), Nitrous oxides (NOx). With Carbon dioxide dominating the role here, it is the main cause of global warming, which is now felt and faced in every part of the world. With such huge amounts of CO_2 emissions across the nations, throughout the world, it can be said that presently most of them are still in a carbon intensive economy stage. The energy sector is vital in tackling the climate change since it accounts for about two thirds of global carbon dioxide emissions. To realize the adversity of climate change, there is a dire need for a global transition in electricity generation, transmission, distribution as well as consumption. Decarbonization of the global energy systems is one of the greatest and most important challenges faced by humans in the 21st Century. It is very important right now to strike a balance between developmental needs and environmental conservation and protection. The main challenges facing renewable energy sources is resource availability, resource access, resource location, security of supply, sustainability, and affordability. With several steps and measures need to be set up and introduced by the governments of different countries, will it allow to transform their economies into clean energy economies.

Objectives:

- To know the adversity of Climate Change
- To realize the need for Global Energy Transition in Energy Sector
- To understand the process of Decarbonisation of Global Energy Systems
- To understand the path of Energy Transition in Global Energy Sector
  To understand the concept of Sustainable Energy Development.

Methodology

This paper is conceptual and based on secondary data, referred and collected from various sources. Published articles, journals, national newspapers, government websites and different network websites were used to substantiate and authenticate the objectives of the study. Different graphical representation methods like pie chart, bar diagram, percentage methods were also used and taken as references.

The path for Energy Transition

Energy transition refers changes undertaken in fundamental processes in human societies evolution that are driven by technical, economic, and social changes. It is a new path for economic development and innovation that does not compromise the environmental integrity and sustainability motivated by challenges faced around. It calls for changes in existing policies, technology as well as supply and demand patterns for electricity and other energy resources. Till date the world has faced three energy transitions already, the first transition involved replacement of wood with coal as the main energy source. In the second transition, oil replaced coal as the main energy resource. In the third transition, it was asked to replace fossil fuels with renewable energy. The main objective of this fourth transition, that's being developed, is to fight the global climate change through decarbonization of the energy supply and usage. Kabeyi, M. et. Al., talks about developing a sustainable energy transition system which is driven by the climate change agenda, technology developments and innovation, increased energy efficiency, enhanced energy security, deployment of affordable energy solutions and measures and modernization of the energy sector from traditional energy systems.

Energy efficiency and Renewable Energy are the two major components for energy transition. Together they can provide most of the energy-related CO_2 emission reductions which is required, using technologies that are safe, reliable, affordable and widely available. The total share of renewable energy should be raised for this pathway to succeed. With most of the world's population using renewable energy, it will automatically improve the energy efficiency.

With the use of renewable energy resources increasing mostly through growth in solar and wind power generation it will lead to decarbonisation in the power sector, since it was dominated by non-renewable sources like oil, natural gas and coal till now. But this transformation isn't so easy. It will require a meticulous approach for power distribution planning, system and market operations, and regulation and public policy. With most of energy produced being renewable sources there will be a significant change in the transportation and automotive industry with Electric vehicles becoming a common part of the households. Apart from the renewable electricity producing sources, other renewable energy sources like thermal, geothermal energy and bioenergy, should also be introduced and utilized.

Sustainable Energy Development

Sustainable Energy development is the most important aspect when talked about global energy transition. Sustainable development and energy are closely related and interconnected. With one occurring at a progressive rate, the other automatically happens gradually. With the policies being laid out about decarbonisation, usage of carbon low fuels, efficient energy sources, it will lead to the growth and development of a nation.

Sustainable Development

It is defined by a lot of people in different ways ; 'socio-economic growth that delivers the traditional positive progress and targets in an ecologically acceptable manner and with due regard of the future generations welfare and rights' by Kabeyi and Olanrewaju or 'Sustained growth or sustained change where the developments happening are successful' by Lele and in a lot of other ways by many others.

Sustainability is very important when talked about energy resources production and usage, since humans exploits these resources to meet their everyday growing energy demand. With this happening, people forget about the future generations to meet their energy needs and a stable environment to live in. Right now, there is a very much necessity to develop a balance between economic growth and the social wellbeing of the society as a whole, now as well as in future for sustainability to stay which revolves around a number of factors including technical, political and economic which are different from one country to another. Therefore, the concepts of sustainable development and sustainability have the framework for achieving economic advancement and progress while at the same time conserving the environment.

Relationship between Sustainable Development and Energy

Energy is one of the most important factors which influences the rate of progress as well development of any nation. Right now, most countries are using fossil fuel based resources to satisfy their energy demands. These fuels have a lot of carbon content, causes pollution and release of greenhouse gases. There is need for a new energy paradigm for the transformation from fossil fuel-based energy systems to low carbon based fuels. Sustainability is an important factor in the global energy transition where policies for production and utilization of energy resources are developed. It also includes the methods for planning, operation and implementation. Issues which affect sustainability are energy research and development, technological innovations, formulation of policies, promoting benefits of usage and making the society ready to accept the changes being made.

Characteristics of Sustainable Energy

For energy sources and systems to contribute to sustainable development, they should possess the following characteristics:

- Energy resources and systems are sustainable if they are renewable in nature.

- They should be readily accessible, available, and affordable.
- The Energy sources should be diverse and easy to secure.
- The Energy systems should be economically and financially viable.
- The energy production should be associated with minimal environmental impacts.
- During the production of energy, there should be minimum resource wastage.
- Energy produced using the sources should be of low carbon content The energy production should be done efficiently.
- Energy development and usage should bring positive social impacts.
- Transport and transfer of energy from source to users should be made easy and economical.

Goals of Sustainable Energy

- Improving Energy Efficiency – It is related with improvement in economic and the technical efficiency of energy systems in terms of energy generation, distribution and usage. This can be made possible through improvement of existing technologies, research and development and putting good energy management practices.
- Improving Energy Security – It is related to supply of energy resources. It is to be ensured that the energy at all times, in sufficient quantities and at fair prices is made available for the supply.

Some common problems of energy security includes: power distribution, price instability, supply instability, power blackout, theft of electricity etc.

- Reduce Environmental Impact – It can be achieved through reduction in the environmental impact of energy systems of production or generation. Waste recycling, treatment, adoption of clean technologies, safe disposal of wastes, usage of low carbon technologies, decarbonisation of energy supply and integration of the whole electric system are all a part of energy system's relation with the environment.
- Expand Access, Availability, and Affordability – Energy provided should be reliable in supply and access, and should made available at affordable price or cost and quality.

Dimensions of Energy Sustainability

Kabeyi, M. et. Al., defines the selection criteria for development sustainable energy transition should consider the environmental, technical, social, institutional, and economic dimensions of sustainability.

Figure 6 : Dimensions of Energy Sustainability

Source: Kabeyi, M. et. Al., Frontiers in Energy Research

- Technical – It relates to the meeting of the current and future demands in a safe and efficient manner with usage of clean sources of energy and technology.

- Social – It is concerned with the rights of the whole community and is measured by the level of social acceptance and their access to the energy resource and systems.
- Economic – It refers to the ability for meeting demand in a cost-effective manner. It also relates with all the financing required for energy resource development.
- Institutional – The development of new energy technologies, new business models, and new policy priorities and frameworks need market participation, control models, rules and regulations which require intensive political and government participation.
- Environmental – It is related with managing the negative impact of energy production. It should be ensured that the environment should never be allowed to absorb more than it can contain.

Policy Measures for the Energy Transition

There are various strategies, measures and technologies that can be used to improve sustainability. They include :

- Promoting and practicing methods for energy efficiency
- Increasing the contribution of renewable energy in electricity generation
- Use of Carbon Capture and Storage (CCS) in fossil and biomass power plants
- Discouragement and putting penalty for usage of fossil fuels Use of low carbon based fuels and clean carbon technologies
- Use of hydrogen in the transportation sector
- Reductions in the demand for energy
- Promote usage of biofuels and biomass resources in transport services and other related sectors
- Usage of high efficient conversion technologies
- Better energy distribution and providing energy to all parts
- Provision and development of cheap and efficient energy production units

Role of G20 Economies

There is a striking relationship between freedom and greenness, the world's richest and largest economies – the Group of 20 (G20). These countries have greater political rights and civil liberties and also have greener policies and economies. What happens in G20 economies has important implications for the future of the world economy, as the other nations revolves around these economies

A report by B Barbier, E. mentions that a clean energy transition led by major economies is essential for attaining net-zero carbon emissions by 2050, as subjected by the oath taken at the United Nations Climate Change Conference held at Paris in 2015 and any delay in the process over the coming years could make this target unattainable.

The transition as talked about primarily consists of three main elements:

- The large democracies have to agree to end the underpricing of fossil fuels, which is the most important factor for preventing the clean energy transition. These democracies of G20 should commit to phase out cost and tax breaks for the production and consumption of fossil fuels. They should also phase in more efficient pricing of fossil fuels through taxes and trade permits to cover the costs of air pollution, global warming, and other economic damages.

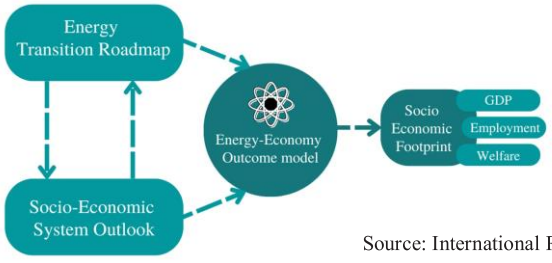
- G20 democracies impose a tax on carbon-intensive imports to reduce the risk of use of such industries which have a higher carbon footprint. It would also induce other economies to reform their policies of carbon emission.
- Major democracies need to recycle the revenues earned through reforming fossil fuel markets to fund additional green innovation and development. Research & Development is needed in major democracies to fund for more innovative methods of energy transition.

Focus areas where policies need to be developed:

(i) Make a synergy between energy efficiency and renewable energy
(ii) Development of power sector based on renewable sources of energy
(iii) Decarbonisation of the transport, industrial, manufacturing sectors through electrification
(iv) Technological innovation for the development of renewable energy methods
(v) Aligning the socio-economic system with the transition requirements
(vi) Ensuring that the transition costs and benefits are fairly distributed amongst all

Constraints in global energy transformation

This global energy transformation as talked about won't be possible without spending a huge sum of money. Every country has a huge budget for its energy requirement purposes for different sectors, but with transitioning to a more cleaner and non-carbon based economy would require more of their allocated percentage of their budget in the development of the energy sector. Comparing with the current policies, there will be a lot of additional investments in low-carbon technologies for the development of the energy sector for the transition to take place since most countries policies on energy sector are based on using carbon intensive technologies. A report by the International Energy Agency says that the 'Cumulative investment in the energy system between 2015 and 2050 will need to increase around 30%, from USD 93 trillion according to current and planned policies, to USD 120 trillion to enable the energy transition. In total, throughout this period, the global economy would need to invest around 2% of the average global GDP per year in decarbonisation solutions, including renewable energy, energy efficiency, and other low carbon energy technologies.' The financial system of every country should be aligned with sustainability and energy transition requirements. Every country has its own financial constraints which will inhibit the capital required for the energy transition process. However the cost-savings from reduced air pollution, better health and lower environmental damage would far outweigh these costs. In addition to this, the energy transition would significantly improve the energy sector's socio-economic footprint, will help in increasing the Gross Domestic Product (GDP) of a country, will create a lot of jobs, thus increasing employment opportunities, will provide a cleaner and more healthier environment and also will aid in improving global welfare.



Source: International Renewable Energy Agency

Figure 7 : Socio-Economic Footprint

India and Energy Transition

India's economic growth has been among the highest in the world over the past two decades, with huge increase in industry, manufacturing, research & development sector. But with increasing technologies and increasing size of economy comes the demand for energy consumption. There has been a rapid growth in the country's fossil fuel consumption which means that the net carbon emissions will also rise significantly and with this, it has placed India in the third spot for the highest carbon emission in the world. But with all this happening India also has made its place in the clean energy transition, with different changes in policies or the energy sector and their implementation. As mentioned by Birol, F. et.

Al., India has overachieved its commitment made at Climate Change Conference - Paris Summit (2015) by already meeting 40% of its power capacity from non-fossil fuels - almost nine years ahead of its commitment and the share of solar and wind as India's energy sources have grown significantly. Renewable electricity is growing at a faster rate in India than any other major economy and also India boasts itself as one of the leading producers in bio mass energy. India is well placed to become a global leader in renewable batteries and green hydrogen technologies. However, there are certain problems when it comes to the energy transitioning in India, like energy security issues, lack of reliable electricity supply and distribution, importing energy resources, reliance on traditional fuels. Taking all these into consideration, India has already brought in numerous policies for the development, growth and usage of renewable energy sources and low carbon based technologies. If they are fully implemented, they could limit the potential trade-offs between affordability, security and sustainability and boost the country's economy a lot, taking it to newer heights. 'India's ambition to reach net zero emissions by 2070 and to meet fifty percent of its electricity requirements from renewable energy sources by 2030' is a very significant note for the global fight against climate change, and to turn this into reality requires significant contribution and participation from both the government's as well as the residents of the country.

Conclusion

The global energy system has to be transformed. The current energy supply system of most of the world is largely based on fossil fuels - carbon intensive economies, this need to be changed to be based on renewable energy sources. With the ongoing rate of carbon emissions the world is facing a series of disastrous events in the coming future, melting of glaciers and polar ice caps, global warming, increasing frequency of droughts, increasing sea levels, tsunamis occurring, climate change is real. These all occurring in a way or other relates with carbon emissions, and thus its reduction should be at the center of global environmental policy. For this to happen, the energy system needs to be transitioned, decarbonisation needs to be done, high energy efficiency and renewable energy sources needs to be used. It is therefore important to understand the relationship between economic development and energy consumption, and effectively improve energy efficiency for a better relationship and sustainable development. Usage of renewables makes energy supply more sustainable and will make energy available at a lower cost and with greater socio-economic benefits. Energy sustainability or energy for sustainable development is a challenge for many countries developed and developing countries. The process is unique to different countries because the transition is affected by local social and economic conditions. The complexity and comprehensiveness of the energy transition is influenced by the diversity of factors involved in their interests which are often in conflict interest with one another. The current policies of the governments across the world needs to changed and aligned so that countries focus more on carbon free, clean energy technologies. A significant sum of budget is required, to be dedicated for developing carbonfree economies. Eyeing the situation around, rapid and positive actions are required to remove this transition barrier and ensure that the introduction of clean, modern energy sources and low carbon usage technologies. It should be made sure that the

implementation of policies for energy transition is not further delayed. This will thus create a world that is both more prosperous and exposed to fewer longterm risks.

References

AAYOG, N. Towards A Clean Energy Economy, NTI Aayog and Rocky Mountain Institute

B Barbier, E. 2022. Transitioning to green energy is key to both tackling climate change and creating sustainable economies., World Economic Forum, Advance Access published 7 November 2022

Birol, F. and Kant, A. India's clean energy transition is rapidly underway, benefiting the entire world

Dechezlepretre, A., Kozluk, T., Elgouacem, A., and Kruse, T. 2020. COVID-19 and the low-carbon transition: Impacts and possible policy responses, Working Paper 1 on Macroeconomic and Structural Policy Analysis, Advance Access published 2020

Energy and Climate Change. 2022. European Environment Agency, Advance Access published 3 October 2022

Evans, S. 2017. Solar, wind and nuclear have 'amazingly low' carbon footprints, study finds, Carbon Brief, Advance Access published 12 August 2017

Five ways to jump-start the renewable energy transition now. 2022. United Nations, Advance Access published 2 October 2022

Gielen, D. 2017. Perspectives for the energy transition investment needs for a low-carbon energy system, International Renewable Energy Agency, Tech. Rep, Advance Access published 2017

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., and Gorini, R. 2019a. The role of renewable energy in the global energy transformation, Energy Strategy Reviews, Advance Access published 2019

Gielen, D., Gorini, R., Wagner, N., Leme, R., Gutierrez, L., Prakash, G., Asmelash, E., Janeiro, L., Gallina, G., and Vale, G. 2019b. Global energy transformation: a roadmap to 2050, Advance Access published 2019

global emissions. 2022. center for climate and energy solutions center for climate and energy solutions, Advance Access published 3 October 2022

Global Energy and CO2 Status Report 2018. 2018. International Energy Agency, Advance Access published 2018

Kabeyi, M. and Olanrewaju, O. 2022. Sustainable Energy Transition for Renewable and Low Carbon Grid Electricity Generation and Supply. Front, Energy Res, vol. 9, 743114

Perspectives for the clean energy transition- The critical role of buildings. 2019. International Energy Agency, Advance Access published 2019

Transitions to low carbon electricity systems: Key economic and investments trends. 2021.

International Atomic Energy Agency, Advance Access published June 2021

Factor Market Interlinkages In Marine Fishery Sector Of Odisha

[1]Nispesita Manjari Jena

Abstract

With more than two-third of India jutting into the sea, our country has a long enviable sea-coast yet to be explored. The fishing sector in India supports the livelihood of one-fourth of its population especially from the marginalized and undefended communities. Presently, India is ranked 2nd in aquaculture and 3rd in fisheries production in the world. Fishery contributes 1.07% to the national GDP and 5.30% to the agriculture GDP of India. Odisha is ranked 4th largest fish cultivating state of the country. Fish is one of its most popular and favorite food and nutrition supplement, with annual produce of 8.73 lakh metrictons during the financial year 2020-21, contributing 2.33% to the economy as claimed by the fisheries and animal husbandry department of Odisha. This study is of qualitative aspect and data are collected from secondary sources like articles, magazines and Directorate of fisheries, Odisha. The motive of this study is to explore the concept of the nature of factor market interlinkages in marine fishery sector of Ganjam district. It also helps to identify different issues and challenges in terms of availing infrastructure and better marketing linkages in marine fishery sector.

Key Words: interlinkages, factor market, marine fisheries

INTRODUCTION:

Fisheries sector is one of the most important sectors in the context of socio-economic development of the state. India contributes 7.7% to global fish production and ranks 4th in global export of fish products. However, Odisha ranks 8th in marine fish production and 6th in inland fish production in India. Marine fisheries constitute an important subsector of the Indian economy both at the national and state level. This is an important contribution to the state as well as to the country in the form of employment and livelihood, supplement of nutrition and food security, domestic consumption and income from foreign exchange earnings. Factor market is a huge linkage effect in the state economy with the negative linkage operating through investment, employment and development in boat/craft, trawler and net making machine and the positive linkage working within ice plants, cold storage, processing, transportation, marketing and selling etc. In Ganjam district, both Kaibarta (Keuta) and Nolia communities are treated as backward and poor communities. Their whole life totally depends on middle man and money lenders for factor inputs. The boat owner is always indebted to the trader and the boat owner forced to sell his fish at the fixed rate demanded by the trader. They may have lack of knowledge about market and price decided by them. They would have problem of non-availability of infrastructure facilities and proper marketing system.

Review of Literature:

Kundu(2020) highlights that labor market flexibility accompanied by trade liberalization helps in building complementary relationship between formal and informal sector in India. They found that there is no direct relation is established between the labor market flexibility and trade liberalization with respect to inter- and intra-sectoral movement of labor.

Lebbe (2018) attempted to analyzed interlock factor market in agriculture sector and that explain in theoretical aspect. The study again found that the poor farmers are exploited by middlemen, money

[1] Research Scholar,Department of Analytical and Applied Economics, Utkal University, Bhubaneswar.

lenders and traders in terms of cash or other kind of help. Further it found a suggestion that policy makers should give more focus on plan and give subsidies to the poor, to provide easy marketing facilities etc.

Singh and Patnail (2014) examined the status of marine fishery in India as well as Odisha specially to explore the socio and economic condition of marine fishermen in reference to the targeted policies of government. They found that appropriate design and implementation of development programs are the key to improve the socio and economic condition of the community in Odisha. It is focused on inclusive growth and sustainability. They noticed that, without inclusive growth and improvement in their socio economics, the growth of fishing industry shall not be at the desired level.

Koriakose et al. (2014) identified that economic sustainability of marine fishery in India and it showed total factor productivity is a measure of the productivity of all fish factor inputs in the form of their combined effect on output and is often accounted for by technological change or more efficient method of producing output. It again found that 76% of the fuel requirement in the fishing industry was in trawl sector followed by dolnetters, gillnetters and others. Further the study showed a positive growth of 1.7 percent during 2000 to 2010 period showed a growth rate of 3.4 percent.

Objective:

To identify different issues and challenges in terms of availing infrastructure and better marketing linkages among fisherman communities of Ganjam District.

Research Problem:

The research problem revolves around the various issues and challenges faced by the fishing communities in terms of accessing better marketing linkages, weather condition, small scale operation, and investment in boat and storage facility, bargaining with traders and distress selling etc. Hence, the research problems of the study is given as

a. What are the different socio-economic factors affect fisherman communities?
b. What are the issues and challenges faced by fisherman communities?
c. What are the possible interventions for enhancing livelihood of fisherman communities?

Methodology and Analysis:
The study is based on secondary data collected from different journals, articles and reports that links with interlinkage factor market. It is qualitative in nature. This study examines the nature of factor market interlinkage in marine sector of Odisha.

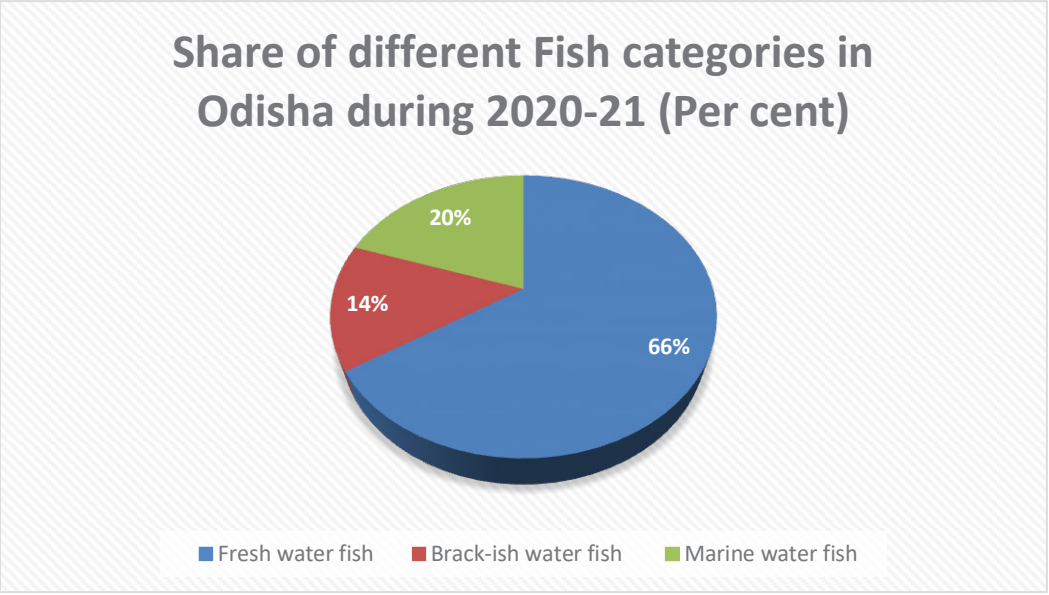
Status of Fish productioninOdisha (000' MT) from2013-14 to 2020-21;

Table.1

Year	Inland fish production		Marine fish	Total	Growth rate of fish production (per cent)	Per capita consumption of Fish (kg.) per year
	Fresh water	Brack-ish water				
2013-14	263.86	30.01	120.02	413.89	0.91	9.66
2014-15	300.96	35.37	133.21	469.54	13.45	11.06
2015-16	336.22	40.31	144.75	521.28	11.02	12.24
2016-17	393.73	61.27	153.10	608.10	16.66	13.49
2017-18	454.19	79.94	150.84	684.97	12.64	14.42

2018-19	506.61	94.03	158.32	758.96	10.80	15.38
2019-20	543.05	116.10	157.31	816.46	7.58	16.24
2020-21	574.98	125.52	172.47	872.97	6.92	16.34

Source: Directorate of Fisheries, Odisha



The above table shows the share of different fish categories in Odisha from 2013-14 to 2020-21. It shows that out of the total fish production, brackish water constitute 14 % and marine fishery is 20 % where as fresh water fish is 66 % in the year of 2020-21(table.1). The source of fresh water fish production from rivers, lakes andponds, etc. The share of fresh water fish and brackish water fish is continuously increased.

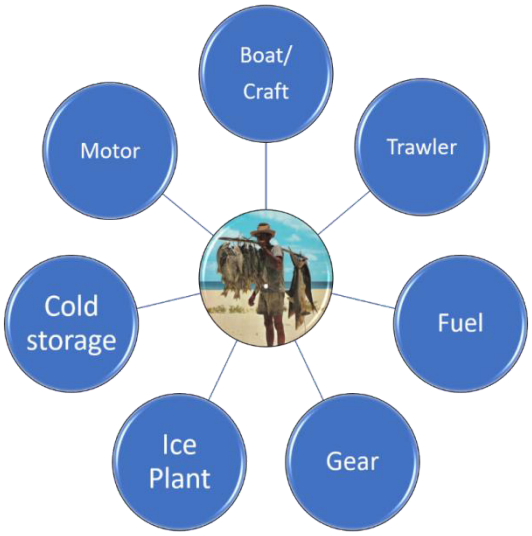
The key constraints of factor market interlinkages:

The issue of resource constraints is a major threat faced by the fishing community of Ganjam District. The traders or middlemen charge exorbitant interest rates which is anywhere between 36% to 50% per annum.

This affects the price they receive in the short-term and overall profitability in the long run. At the start of the season, the fishermen are already debt ridden. They are not sure about the profitability of the expedition to the sea and the sale is made through middlemen in a largely formalized system which cannot be avoided by the fishermen. The supply of fish from landing center to reginal market is through agents and middlemen.

The access to ice, which is the most critical ingredient in post-production stage, is controlled by traders, thus making fishermen dependent upon them and settling for lesser price. This study shows the fishermen in marine sector are exploited by money lenders and middlemen in terms of money or other kind of help etc. The findings examine interlinked loan or financial transaction, lack of knowledge may cause decline in fish production in rural areas of Ganjam District.

Factorsof marine fish production:



Interlinked Factor market can broadly be classified into various types, namely those involving linkage of land, labor(Fishermen), inputs and output(Fish catch) of farm households. From the above figure shows that fishermen always live with these factors like Boat/craft, Trawler, fuel, cold storage, ice plant and motor etc. These factors are very much essential for fish catching. A fisherman is incomplete without factor input and factors are always important in their daily life. Fishermen always depend on factors and these inputs are linkages with market at a high price. So, fishermen need money for factor and directly contact with moneylenders and traders for loan. Moneylenders always wait for time and situation for forwarding loan to fishermen and earn profit from fishermen.

1.3 Cost of Operation:

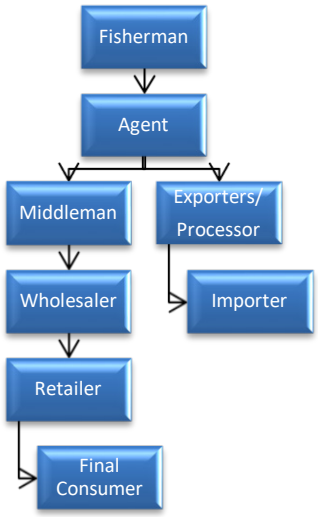
Fixed cost	Variable cost
Boat /Craft	Fuel
Net	Repair
Motor	Insurance
License fees	Renewal license

In marine fishery production, there are two types of factorscost that is fixed cost and variable cost. Fixed factor remain fixed and variable factor change with time and situation. Fixed factor such as boat, Net, motor, and license fees. Variable cost like Fuel, and renewal license. Fixed factor are like one time investment and need some repairs with time and situation. Variable factors are increase with increase in output. The cost of factor is high in Boat, Net, Motor and license fees as compared to variable factors.

Many factor inputs are influenced in marine fishery that is insufficient fishing equipments, lack of cold storage, and low standard post harvest handling and low price at the time of landing. Lack of knowledge about factor market and their interlinkages in marine fishery sector.Inaccessibility of transport system reduce fishermen negotiations on price. The supply of fish from landing center to regional market is through agents and middlemen. Fishery in Ganjam district is restricted to only a few regional markets like Berhampur, Bhubaneswar and Cuttack. These is some movements to Delhi, Mumbai, and Bhubaneswar markets too. But the potential of other markets is yet to be explored.

Product movement in marine fishery:

The following flow chart explains the market inter linkages or the movement of product from fishermen to the final customer(Household) and in the process the number of intermediaries involved. The following chart represent the factor market inter linkage in Ganjam district.



Flow chat of factor market interlinkage

Recommendations based on the study of marine fisheries:

i) Procurement:

The fishermen need to developed the post- harvest storage technology at the local level market to other market. Providing adequate and timely credit is the most important intervention because credit is the main source to make the most required difference to all groups of people in the fishing sector.

ii) Processing:

To improve their bargaining capacity with the traders and money lenders the fisher folk organization needs to develop a quality process for post-harvest primary processing. Technological infrastructure required to develop.

iii) Policy and institution:

Setting up group-based cooperatives with help the fishermen to bargain for good prices and bypass the intermediate links. The government must provide incentives to the fishermen and easy loan for investment at favorable terms and condition.

iv) Marketing:

The gap in the linkages lies in decreasing production of marine fishes, initial processing and quality issues, large supply and demand gap and distribution linkage. product and process innovation need to be the key areas of intervention.

Conclusion:

Marine fish is highly nutritional food,it requires perfect catching, processing and distribution, if it is to be utilized in a cost effective and efficient way.This study is relevant to conduct factor market interlinkages to have an understanding of markets, factor inputs, and the difficulty constraints that reduce the growth of fish cultivation and competitiveness of small fisher folk. Therefore, policy makers should focus more on this problem. They should come up with a triumphant plan with many subsidies to the poor and invest in rural areas to boost easy marketing facilities.

Reference:

Ahamed Lebbe, S. M. (2018). Interlocked factor market in agrarian sector: an overview of theoretical concept.

Anneboina, L. R., & Kumar, K. K. (2017).Economic analysis of mangrove and marine fishery linkages in India. *Ecosystem Services*, *24*, 114-123.

Korakandy, R. (1994). *Technological change and the development of marine fishing industry in India: a case study of Kerala*. Daya Books.

Krishnan, M., &Birthal, P. S. (2002). Aquaculture development in India: An economic overview with special reference to coastal aquaculture. *Aquaculture Economics & Management*, *6*(1-2), 81-96.

Salagrama, V. (2006). *Trends in poverty and livelihoods in coastal fishing communities of Orissa State, India* (No. 490). Food & Agriculture Org.

Swain, M. (2000). Agricultural development and interlocked factor markets. *Indian Journal of Agricultural Economics*, *55*(3), 308-316.

"Use of electric vehicle and its adoption as alternative fuel vehicle in India"

Poonam Kumari
Priyanka Kumari Prasad

Abstract

Nowadays a variety of option is available for the fuelling of vehicles. The tendency has enabled the world to choose the fuel for the vehicles which they consider safe and economically suite their pocket. This paper consider the use and adoption of electric vehicles as an alternative fuel vehicle in India. Basically, it has been considered an option to discontinue the use of Internal Combustion Engine Vehicles i.e ICEV which is considered as the main source of carbon release in the world at present. The main source of air pollution is the fuel that is procured from the petroleum, which are the origin of power for the ICEV. Moreover, the traditional automobile has become an expensive phenomena because of the rise in prices of fossil fuels. The automobile manufacturers and the policy makers all over the world are thinking about electric vehicles for the coming generations as an option for ICEV for the sake of bringing down the emissions from vehicles to achieve energy safety, to battle with the increasing fossil fuel prices and to accomplish environmental sustainability. As an alternative to traditional vehicle the electric vehicles are being introduced as an innovative green product in the market place. The study is based on system dynamic approach. In understanding policy resistance behaviour of people in relation to the new initiatives, the system dynamic approach is very useful. The paper aims to study the behaviour of people and manufacturers in the use and adoption of electric vehicles with the help of system dynamic approach.

Introduction

The rising level of pollution is alarming the world and making the human kind tensed and worried. Use and adoption of electric vehicles can be considered as one of the solution for the concern all over the world. According to the study, the electric passenger vehicles could comprise 30% by 2030 and 75% of new vehicle sales in India by 2050. Moreover, the Council on Energy, Environment and Water (CEEW) stated that half of new two wheelers and over a quarter of 3 and 4 wheelers sold in 2030 could be electric. The government is trying it's best to encourage the use and adoption of electric vehicles in India. The government has launched FAME (Faster Adoption and Manufacturing of Electric Vehicle) Scheme 1 and 2. In India, the rate of adoption of electric vehicles is very low. However, the high prices, lack of awareness, lack of infrastructure and the limit range of driving are some of the reasons for the poor adoption rate of electronic vehicles in India.

The government is striving hard for green modes of transportation. The government is attempting to discontinue the use and manufacture of petroleum vehicles so as do reduce the pollution caused by emission of Petroleum based fuels.

However, there are various government policies which encourage and motivate to use electric vehicles they are

1) The GST has been slashed from 12% to 15% for cleaner vehicles.

2) There is no requirement of permit for the vehicles operated by battery.

3) The government has not proposed any registration fees for electric vehicles.

4) The purchase of electric vehicles can give tax exemptions to the customers.

In-Charge Principal, T. M. N. S.+2 School, Tekari, Gaya
Ramdayalu, Atardah, Mujaffarpur

5) The government has released to the policy guidelines for reduction in the rate of electricity charge and for the charging, the framework at offices and residential societies.

6) On all categories of EVs the custom duty is also reduced.

7) For the provision of charging stations in building for electric vehicles, the building code and town planning rules has been amended by Housing and Urban Affair Ministry.

8) The scrap policy for ICEV is also introduced.

The adoption rate of electric vehicles in India is very disappointing in spite of several initiative taken by the government, as compared to the other developing economies of the world. However, a slight increase in the adoption was experienced in 2020, still the rate is very disappointing. In India, the demand for electric two wheelers and three wheelers is far more than that of four wheelers. Moreover, the electric two wheelers (62%) is dominating electric vehicle market, whereas, electric three wheelers (37%). But the fact is there is negligible adoption in case of four wheelers or personal cars. For further promoting the electric vehicles in India, vehicles owned by central agencies is converted into electric vehicles.

The adoption of Evs through system dynamics model is the main objective of this paper study. In the 1950s, Jay forrester, created the field of system dynamics at Massachusettes Institute of Technology. The structure and dynamics of the complex system is drafted to assist us learn them. For sustained improvement, it designed high average policies and translate victorious implementation and change. In this study, we could try to learn the process of adoption of electric vehicles in our country by system dynamics model. This model is adopted, as it is very complex to study the automobile industry. However, there is a lot of variety of stakeholders who gave their feedbacks at different time resulting into time lags between the response given by different users.

A whole system approach is offered by system dynamics for transport planning with those different opinions offered by different stakeholders and those late and lagged feedbacks are revealed to the policy makers for decision making. The most relevant approach to a bundle of issues that are faced by automobile industry in India right now is the holistic approach of system dynamics. The whole ecosystem of the transport sector in India will be changed due to the transformation of the automobile sector from ICEV to electric vehicles, which will also affect a lot of people in the country. In this paper, we would emphasize the dynamics of electric vehicles adoption and the challenges connected to it. In this study, we would favour the system dynamics approach to clarify the relationship among different variables or factors related with it.

2. Literature review

An extensive literature review has been done before framing this research paper on different theories of consumers, various factors that affect the adoption of electric vehicles and the consequences of different schemes launched by the government for the consumers and manufacturers in the adoption of electric vehicles. The diffusion of innovation (DOI) is the most widely used theory in the adoption of electric vehicles propounded by Rogers in 1962. According to this theory, if the government provides financial incentive to the people for the adoption of any scheme or innovative product this resulted in the easy adoption of that product. Moreover, for the diffusion in the society, the acceptance of the innovative product should be done at mass level. Recently, various researchers conducted the study to figure out the effect of government policies and financial incentives for the consumers adoption of the innovative product in the society. In this section, the culmination of some most important work in the stream of the use and adoption of electric vehicles and their uncovering and detections are listed as below

Freg B (2018) Today and coming future is all about Internet. Moreover, it is rightly said that the internet enabled cars and social commerce is the electric vehicles future. The availability of internet cars which

boost the adoption of electric vehicles all over the world. This fact is well elaborated by fuggy logic and system dynamics modelling.

Gallagher et al(2014) Adoption of electronic vehicles in US is mainly due to the rising prices of gasoline. Social preference can be the other reason for the adoption. The US government initiated various policy measures among them, the sales tax incentives have the greatest impact on the adoption of electric vehicles in US.

Kang et al(2015) The reasons for adoption of electric vehicles varies with every market. The reason in case of US market is the manufacturers setting high vehicle price which result in high price sensitivity in the market. Moreover, in case of China, it is the number of charging stations and their pricing.

Lane and Potter(2007) The theory of planned behaviour can assist in the adoption of electric vehicles according to the end users point of view. According to the theory, the human beings make decisions based on some rational impulses and the feasible outcome of their decisions. Moreover, as per the theory, if the consumer presumes the behaviour to be the social norm, there are more chances of his performing the behaviour. Moreover, the consumers awareness regarding the benefit of using electric vehicles for the social environment is the cause for the adoption of electric vehicles among them.

Skippon and Garwood(2011) According to the research Scholars the symbols and self identity plays very important character in intentions and adoption behaviour of the consumers.

Lane and Potter(2007) Egbue and long(2012) The electric vehicles are environmental friendly which can help the world to reduce the pollution caused by the smoke released by transportation vehicles and can minimise and solve the issues of transportation sector are the assumptions for the adoption of electric vehicles by consumers.

Fakhra Jabeen et al(2013) According to the studies done the electric vehicle have very distinct characteristics as compared to petroleum vehicles. Electric vehicles don't spread pollution they are noise free and the cost of a running an electric vehicle is far less than that of Petroleum vehicle. The main reason for such a distinct feature is that it uses electricity as a source to run the engine. However, it has limitations of short range of driving and limited number of charging stations which needs at least 20 to 30 minutes to recharge the electric vehicle are some of the obstacles in the adoption of electric vehicle. Moreover, every new electric vehicle is sold with home charging station but there is limited charging infrastructure for the public in the Western Australia.

Anshuman et al(2018) the greatest opportunity is presented by millennials but there is need to serve some specific sub segments by the auto makers in order to boost electric vehicles adoption. In the coming future, a sudden change is expected in the technology which would pressurize the automobile manufacturers to maintain sustainability. Despite of the great launch of offerings such as Nissan's leaf and the Tesla Model S, the adoption of electric vehicles is much slow then expected. The reasons for slow adoption are said to be lack of public infrastructure for charging stations and the limit range of distance. Moreover, inspite of the various opportunities available, the Indian automobile industry is not able to reap the opportunity due to many reasons.

Bansal et al(2021) the consumers are free to pay more so as to increase electric vehicles capacity. According to the study which was based on 1000 respondents from India stated that, the consumers are ready to pay 10 to 34 US dollars extra to lesson the fast charging time by 1 minute, 7 to 40 US dollars extra per kilometre so as to increase its driving range at 200 km.

3. Research methodology

The present research work is descriptive in nature. The sample is taken as 180 respondents. The data is collected through a primary source. An online questionnaire is send to the respondents in the Delhi and

NCR region. The sample size of 180 respondents is traked who commute to their office daily by public or private transport. The students, corporate employees and academicians are the target population who travel to their offices and colleges daily. The researcher uses convenience sampling method to collect the data. Along with the demographic profile questions were asked to give their opinion on a likert scale of 1 to 5. The literature reviews help the researcher to identify the variables of the study. The variables of these descriptive study are analysed with the help of SPSS. However, the variables are the infrastructure for electric vehicle, charging station, the ownership cost, product and environmental awareness of electric vehicles.

To study the relationship between cause and effect among the factors, system dynamic approach is useful. System dynamics is a methodology to understand complex issues which are termed as dynamic problems and involve feedback too. The system dynamic approach is very useful as once developed, solves the management problems by assessing the impact of strategy in the coming future of the strategy proposed. There are many complex inter related subsystems making automobile industry as complex and dynamic. So, to understand, the relationship between manufacturers, consumers, government policies and suppliers, system dynamic approach is used. The interaction of various elements in the micro environment can be clearly studied by system dynamics.

The Causal Loop Diagram (CLD) and stock flow diagram are the tools used in system dynamics to analyse the data. The Stella architect is a software used for system dynamics modelling.

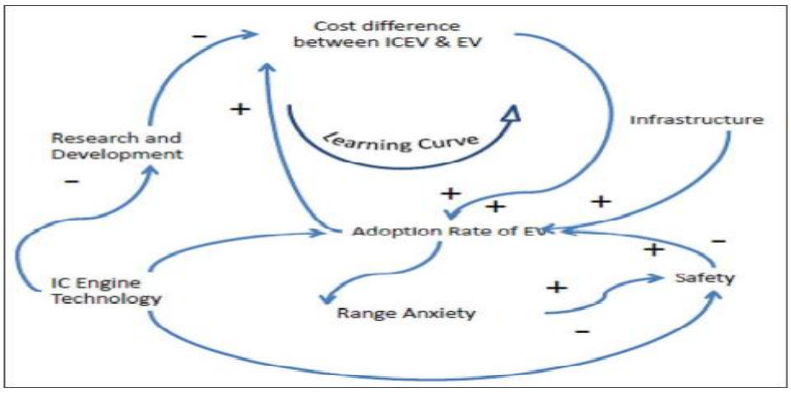
4. Data analysis and interpretation

To acknowledge the process of electric vehicles adoption in our country on the ground of literature review, theoretical framework has been developed. On the cornerstone of the system dynamic concept, the model has been developed. Causal Loop Diagram represents the variables affecting the adoption of electric vehicles.

4.1 Causal Loop Diagram

In the previous section, we studied the various variables that affected the adoption of electric vehicles and the descriptive statistics of the study helped to determine the effect on the behavioural intension. In the CLD figure-1, the items with strong correlation were put accordingly. As per the CLD, the items affecting each other positively are connected by + sign and those affecting negatively are connected by us sign. The dynamics of the electric vehicle adoption and the factors affecting it are represented by CLD.

Figure 1



Currently, range issues, safety issues and the infrastructure for electric vehicles are some of the causes limiting the adoption of electric vehicles in India. However, if these limitations are eliminated and worked upon, they will definitely influence positively in the adoption of electric vehicle and that the reason they are connected by positive loops. The cost difference in the electric vehicles and ICEVs, directly influence the electric vehicle adoption shown in the another loop. Since, the cost of purchase of electric vehicles is much higher than the petroleum based vehicles, it also affects the adoption of electric vehicles.

Lack of research in the area of electric vehicle as it is totally a new zone and the mechanics is also not that developed as compared to vehicles used traditionally, represents one more loop and reason for high cost difference among the two. However once people start adopting the electric vehicles, the cost difference will be minimized due to large manufacture of electric vehicles and hence shown by a positive arrow in the Causal Loop Diagram. Hence, it can be said that option of electric vehicles is a very complex procedure which can be understood by system dynamics approach.

4.2 Reinforcing and Balancing Loops

To analyse the causal relationship between infrastructure, adoption and government policies reinforcing(R) and balancing(B) loops are developed in the figure-2. The value of the stock is increased by positive reinforcing loop which is a causal loop reinforces itself. The number of electric vehicles adopters will increase if the government policies favour the adoption environment. The government will be able to impel the cleaner mode of transportation, if the number of adopters increase, which will ultimately increase their production too.

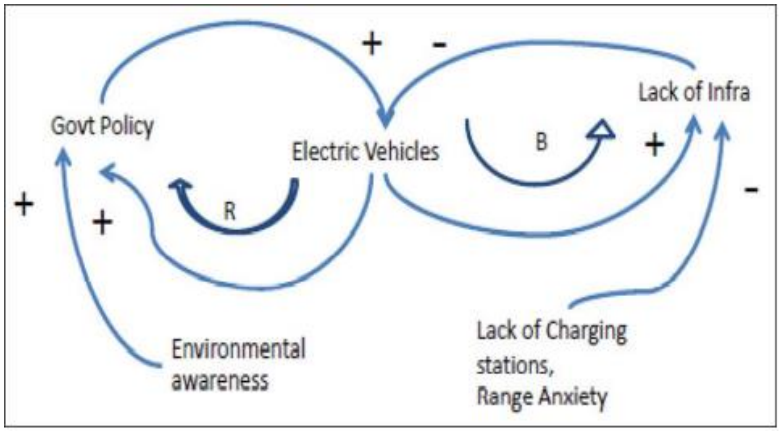


Figure 2

This loop is a positive loop which will benefit both the customers and the government policies. The people are showing concerns regarding the increasing pollution. They have become more aware regarding the environment which is compelling the companies to change their policy and in turn inspiring people to adopt electric vehicles, this is represented in the causal reinforcing loop.

The effect of range anxiety and infrastructure of electric vehicles is shown in the balancing loop. Here the infrastructure of electric vehicle means the charging stations availability at public places, offices and at home etc. Moreover, range anxiety can be termed as the concern regarding the distance that electric vehicle will cover at a stretch once charged. These are represented through balancing loops as these are the factors affecting negatively in the adoption of electric vehicles.

5. Conclusion

System dynamics is a field which is considered relevant at the national level strategic policy issues involving delays and feedbacks such as transport sector. Development of CLDs is involved in this approach. To explore the problem and its nature, understanding the system dynamics is important. The parameters which are considered important in the stability and response of the system can be tested by the system dynamics model. According to the results of the study, the adoption of electric vehicles is dependent on many factors such as infrastructure for electric vehicles, range anxiety, price of electric vehicles and environmental awareness and policy of the government. Using CLD, the effect of different correlated variables that affect the adoption of electric vehicles is identified. In the coming future, this model can be used to understand the various determinants of electric vehicles adoption and its forecast. The paper provides an understanding of the topic with the help of system dynamics approach. By analysing cause and effect relationship dynamics approach give more empirical application in solving the real life situations.

References

Ajzen, I. (1991). The theory of planned behavior. Organizational Behav., Human Decision Processes, 50, 179- 211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ankit Kumar, Choudhary, S. K., & Chethan, K. N. (June 2018). Commercial viability of electric vehicles in India. International Journal of Mechanical Engineering and Technology (IJMET).

Bansal Prateek, Kumar Rajeev Ranjan, Raj Alok, Dubey Subodh, & Graham Daniel. (2021). Willingness to pay and attitudinal preferences of Indian consumers for electric vehicles, Elsevier, 100, 105340. https://doi.org/10.1016/j. eneco.2021.105340

Bo Feng, Qiwen Ye, & Brian J. Collins. (2018). A dynamic model of electric vehicle adoption: The role of social commerce in new transportation, Information & Management. https://doi.org/10.1016/j.im.2018.05.004.

Egbue, Ona & Long, Suzanna. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy. 48, 717–729. https:// doi.org/10.1016/j.enpol.2012.06.009.

Forrester, J. W. (1961). Industrial dynamics, MIT press: Cambridge, MA.

Jabeen, Fakhra & Olaru, Doina & Smith, Brett & Braunl, Thomas & Speidel, Stuart. (2013). Electric Vehicle Battery Charging Behaviour: Findings From A Driver Survey.

Kang, N. Ren, Y. Feinberg, F.M., & Papalambros, P. Y. (2015). Public investment and electric vehicle design: A model-based market analysis framework with application to a USA-China comparison study. Des. Sci., 2(e6). https:// doi.org/10.1017/dsj.2016.7.

Lane and Potter. (2007). The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. J. Cleaner Prod.. 15(11–12), 1085-1092. https://doi. org/10.1016/j.jclepro.2006.05.026

Mohamed, M., Tamil Arasan G., & Sivakumar, G. (Feb 2018). Study on electric vehicles in India opportunities and challenges. International Journal of Scientific Research in Environmental Science and Toxicology.

Mohd, Sahil Ali, & Rahul Tongia. (May 2018). Electrifying mobility in India: Future prospects for the electric and EV ecosystem, Brookings India IMPACT Series No. 052018.

Morton, C., Anable, J., & Nelson, J. D. (2017). Consumer structure in the emerging market for electric vehicles: Identifying market segments using cluster analysis. International Journal of Sustainable Transportation, 11(6), 443-459. https://doi.org/10.1080/15568318.2016.1266533.

Ning Wang, & Yafei Liu. (2015). Key Factors Influencing Consumers' Willingness to Purchase Electric Vehicles in China, Research Paper from School of Automotive Studies, Tongji University, Shanghai.

Paul, D. Larson, Jairo Viáfara, Robert V. Parsons & Arne Elias. (2014). Consumer attitudes about electric cars: Pricing analysis and policy implications, Transportation Research Part A: Policy and Practice. 69, 299-314. ISSN 0965-8564

Pritam K. Gujarathi, Varsha A. Shah, & Makarand M. Lokhande. (Jan 2018). Electric vehicles in India: Market analysis with consumer perspective, policies and issues. Journal of Green Engineering.

Rachana Vidhi, & Prasanna Shrivastava. (2018). A review of electric vehicle lifecycle emissions and policy recommendations to increase EV penetration in India, Energies, 11, 483. https://doi.org/10.3390/en11030483.

Rogers E. M. (2018). Diffusion of Innovations (5th ed.). Free press: New York.

Sharma, R. P., & Namrata Maheshwari. (2018). A study on the customer"s Awareness and perception level towards green cars. International Journal of Technology Enhancements and Emerging Engineering Research, 2(5).

Shikha Juyal, Harkiran Sanjeevi, Abhishek Saxena, Shweta Sharma, Aakaash Singh, Seethapathy Chander, & Ashok Jhunjhunwala. (2018). NITI Aayog & World Energy Council. Zero Emission Vehicles (ZEVs): Towards a Policy Framework.

Skippon, Stephen & Garwood, Mike. (2011). Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. Transportation Research Part D-transport and Environment. 16, 525-531. https://doi. org/10.1016/j.trd.2011.05.005.

Municipal Solid Waste Management & Disposal: Impact on Income & Employment Level of Sanitation Workers

Ram Pd. Chandra
Ravindra Brahme

ABSTRACT:

In this paper, we have discussed Management, Disposal and impact on Income & Employment level of sanitation workers of MSW in Ambikapur. The aim of the study to explain and describe of used methods for MSW of Ambikapur Municipal Corporations (AMC) and Impact of SLRM on employment and economic condition of sanitation workers. Municipal solid and liquid waste is a one of the biggest territory of concern in the all world. In growing countries like India, where is fastly rising in population growth and urbanization; and the improvement of people's standard of living; and the amount of MSLW is also increasing. SPSS 'version 20' and Jamovi '2.2.2' has been used for processing of the data and paired sample t-test and chi square test have been performed to test the relationship. Study result shows that AMC used of door to door waste collection is happening in hundred percent of all wards; and hundred percent used of waste management practices for collected waste and hundred percent disposal of municipal solid and liquid waste through bio-compost, biogas and vermicomsting. SLRM is a job oriented programme; whereby sanitation works, employment generations, income generation, increase of income level of the workers and appreciable type's impact of their economic conditions; and that is a faction of financial stability for AMCs; and sanitation workers looks this programme as a factor of generating employment and as a helpful in solving the economic problems.

Keyword: Municipal solid waste; Waste management; Waste disposal; Door-to-door waste collection; Income; Employment generation

JEL Classification: Q53, C12

Introduction

Municipal Solid Waste (MSW) has become a serious environmental problem in major cities all over world (Pamnani, 2014; Choudhury et al., 2017), and Economic development, urbanization and improving living standards of cities, have lead to an increase in the amount and complication of generated waste (Rathi S., 2006). Solid waste management is something that every city government provides to its residents. Although service levels, environmental impacts, and costs vary dramatic; and solid waste management is arguably the very important municipal service and serves as a condition for other municipal practices (Daniel et al., 2012). In developing countries, recent urbanization has increased the concentration of people resulting in accumulation of waste that needs to be properly managed and disposed (Ferri et al., 2015). With this in mind, it is necessary to determine the factors that influence solid waste management specific to each country context (Wilson, 2007). Integrated approach, Improving Solid Waste Management (Joseph et al., 2012; Kashyap, 2018), and the problem of solid waste management and its impact towards health and environmental problems is increasing and issue of SWM is one of the problems that need an improvement (Kassie, 2016). A sustainability approach takes into account the three pillars defined in the Johannesburg Plan of Implementation of the World Summit on Sustainable Development of 2002 (UN, 2002). The philosophy of the "Waste Management Hierarchy" (prevention/minimisation, materials recovery, incineration and landfill) has been adopted by most industrialised nations as the menu for developing municipal solid waste (MSW) management strategies (Sakai et al., 1996).

Asst. Dept. of Economics, Govt. MLS PG College Seepat, Bilaspur (CG), India
Associate Professor, School of Studies in Economics, Pt. RSS University Raipur (CG), India

The all world, MSW production were estimated at 1.6 billion tonnes in 2002 (Pappu et al., 2007); and it is estimated that by the year 2025 and 2050, solid waste production will reach respectively 2.2 and 4.2 billion tons/year (Saifullah, 2016). India's municipal population generated 114,576 tons/day of municipal solid waste in 1996, which is predicted to rise from four-times with regards to 440,460 tons/day by the year 2026. The maximum city ranges from 0.20 Kg to 0.6 Kg among the per capita waste production (Phapal et al., 2017). The typical rates of growth of MSW generation in the Indian cities are about 1.3% per annum (Bhide, 1998, Imura et al., 2005, Shekdar 2009) and municipal solid waste disposal is a common problem in most third world countries (Patrick, 2015). Researcher will be find out of the present study are use methods for waste management and disposal included (waste generation, waste collection, segregation, processing of waste) in AMC and Impact of the solid and liquid resource management (SLRM) Centre on employment and economic condition of the sanitation workers.

Review of Literature

(Saifullah and Islam) discussed Municipal solid waste management in Dhaka City Corporation (DCC). The aims of the study to explore current MSWM scenario in DCC; and find out the MSW production in the city is 4634.52 tons/day. Operational and collection efficiency of DCC MSWM is respectively 45% and 60%. Open dumping is a most serious issue for groundwater, air pollution and environmental pollution and greenhouse gas emissions. (Choudhury M., Dutta J., 2017), conducted a research on A comparative study of the status of municipal solid waste management for three major cities in Upper Assam India. Researcher major factors identified that Riparian ecosystem, Vermicomposting, Biogas and need advanced technological measures. Study shows that there is a good scope of biogas production and vermicomposting from waste dumping areas as 90% on average the waste is bio-degradable. (Contreras et al., 2010), researcher studies an issues factors analytical model to evaluate the current, last and to-be, municipal solid waste management strategic for the cities of Boston and Yokohama; and considered four factors who legal, socio-economic, technology development and institutional, inter-regional and international factors. (Zaman U.A., 2013), conducted a research on identification of waste management development factors and potential emerging waste treatment technologies in the Swedish context. Social, economic and environmental factors were considered. (Shekadar A.V., 2009), evaluated conceptual issues surrounding the sustainability of solid waste management. Despite all these researches, a number of developing countries are still facing recycling waste management related challenges. (Garnett et. al., 2017), conducted a research on explored attitudes towards greater levels of public involvement in waste management decision-making. Studies focused on factors perception, interests, the decision context, the means of engagement and the necessary resources and capacity for adopting a participatory decision. (Patrick A.N., 2015), evaluated conceptual issues management and disposal of municipal solid waste in Abakaliki metropolis, Nigeria; and result find that poor waste management and disposal system of Abakaliki metropolis and suggested that improve waste management services.

A Brief Review of the Study Area

Ambikapur is a city and headquarters of Surguja District. This district is one of the oldest districts in the state of Chhattisgarh in east-central India. Ambikapur is also the divisional headquarters of the Surguja Division, which consists of five districts Surjua, Jashpur, Korea, Balrampur and Surajpur. Ambikapur was the capital of the princely state of Surguja before Indian independence. The city derives its name from the Hindu goddess Mahamaya (Ambika Devi). Ambikapur is one of the largest cities in Chhattisgarh. Sarguja (Ambikapur) district is resplendent with natural aesthetic. Hence, the tourism possibilities of the place are bright enough to earn a pretty amount of revenue the year. Wealthy with several surround natural treasure and with a culture of its own, Ambikapur city of Chhattisgarh stands a prosperous platform of the state that exudes positive prospects. Sarguja (Ambikapur) generate income

for the regional people through farming and animal husbandry too. In AMCs started Solid and Liquid Resource Management Centre (SLRM) in 2014-15 and involve this campaign in AMCs Officers/employee, Public representatives and female self-help group of Ambikapur city. SLRM works basis of totally female self-help and it is a greatest example of woman empowerment. In swachh survekshan (SS) 2020, AMCs has been India's cleanest city no. 1 (in 10 Lakh Population range). SS 2019, AMCs has been adjudged 'India's Cleanest City No. '2' and SS 2018, SS 2017 rank respectively '11' and '15' at the National level swachh survekshan report (Swachh survekshan report 2017, 2018, 2019 and 2020).

Figure 1: Map of Ambikapur Municipal Corporation Area

Source: Prepared by chips DIS division and first Author Ph.D. Thesis (http://nagarnigamambikapur.co.in/municipal_boundries.php)

Objective of the Study

Two main objective of the study are:

- To study used methods for waste management and disposal of the AMCs.
- To analyses Impact of SLRM on employment and economic level of sanitation workers.

Methodology and hypothesis

The study based on primary data and Interview-schedule method used for the data collection. 40 samples choose through random sampling for study out of 400 SLRM workers from 4 areas (East-100, West-100, South-100 and North-100). AMCs is divided by 4 core areas (East, West, South and North) of the municipal Corporation area and total 18 SLRM Centre established for management and disposal of door-to-door collected householders solid and liquid waste. SPSS 'version 20' and Jamovi 'version 2.2.2' statistical software has been used for processing of the data and Paired sample T-test and Chi square test have been performed to test the relationship (Nagar and Mittal, 2012; Shukla and Sahai, 2013).

χ^2 Chi Square test:

χ^2 Chi Square test formula is following extract:

$$\chi^2 = \sum \left\{ \frac{(f_o - f_e)^2}{f_e} \right\}$$

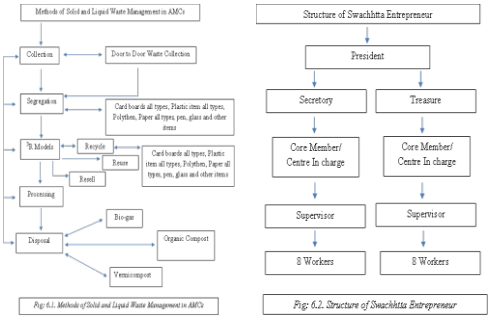
Where: χ^2 = Chi square test; f_o = Observed frequency; f_e = Expected frequency

1. H_{01}: There is no significant difference between Income before and after start SLRM Programme of the SLRM workers.
   Ha_1: There is significant difference between Income before and after start SLRM Programme of the SLRM workers.
2. H_{02}: There is no significant impact of SLRM on employment level of the SLRM workers.
   Ha_2: There is a significant impact of SLRM on employment level of the SLRM workers.
3. H_{03}: There is no significant impact of SLRM on economic condition of the SLRM workers.
   Ha_3: There is a significant impact of SLRM on economic condition of the SLRM workers.

Methods of Waste Management and Disposal

AMC is used waste management techniques are door to door collection method for collect the householder's generated waste in hundred percent of wards. Segregation of collected waste in SLRM center in category wise (card board all types, new paper, plain paper, glossary paper, pen, plastic item, all types of glasses and other items). The dry waste is Recycle, Reuse and Resell (^{3}R Model), and used biogas, organic composting and vermicomposting for disposal of collected waste; thus hundred percent used of waste management practices and disposal methods. AMCs claim hundred percent of a dumping

yard free city of the state; and claim hundred percent of bin free city validate on-ground level and the city's damp waste are getting treated at the waste treatment plant. AMCs is also use techniques ICT based monitoring system; the city comes to displaying of information, education and communication messages through hoarding, paintings and banners/writings in all commercial and public areas and sanitation awareness programs organized in school and college level; and main characteristics of the SLRM Centre are works forces totally basis of the female self-help groups; and in this way, a good example of women empowerment is being presented. Fig: 6. shows that Waste Management and Disposal Methods of AMCs and structure of Swachhta Entrepreneurs.



Source: First Author Ph.D. Thesis

Figure 2: Waste Management and Disposal Methods of AMCs; and Structure of Swachhta Entrepreneur

Condition of Ambikapur Municipal Corporation (AMC) before and after start SLRM Program

Source: First Author Ph. D. Thesis

Figure 3: Condition of AMC before and after start SLRM Program

Condition of Dumping Yard before and after Start SLRM Program

Source: First Author Ph. D. Thesis

Figure 4: Condition of Dumping Yard before and after Start SLRM Program

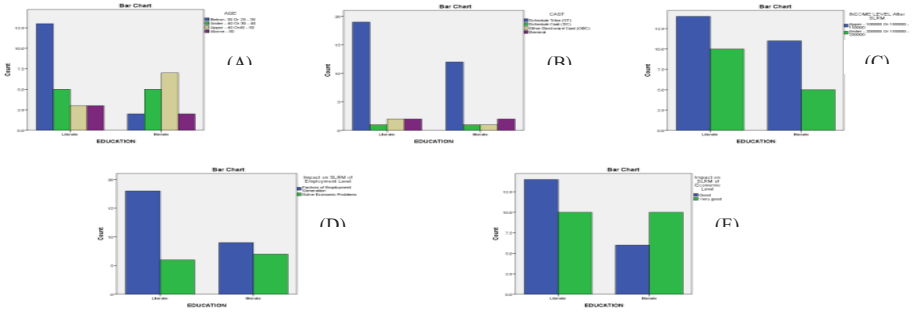
Data Analysis

Table 1: Descriptive statistics

Variable	Description	Education		Statistics				
		Lit.	Illt.	$\bar{X}$	SE*	M	Z	SD
Age Groups	1= Below- 30 (20 – 30)	13 (54.2)	2 (12.5)	2.13	.169	2.0	1.0	1.067
	2= Under - 40 (30 – 40)	5 (20.8)	5 (31.2)					
	3= Upper - 40 (40 – 50)	3 (12.5)	7 (43.8)					
	4= Above - 50	3 (12.5)	2 (12.5)					
Cast	1= Schedule Tribe (ST)	19 (79.2)	12 (75.0)	1.15	.092	1.0	1.0	.580
	2= Schedule Cast (SC)	1 (4.2)	1 (6.2)					
	3= Other Backward Cast (OBC)	2 (8.3)	1 (6.2)					
	4= General	2 (8.3)	2 (12.5)					
Income level after start SLRM	1= Upper - 100000 (100000 – 150000)	14 (58.3)	11 (68.8)	2.38	.078	2.0	2.0	.490
	2= Under - 200000 (150000 – 200000)	10 (41.7)	5 (31.2)					
Impact of SLRM on Employment level	1= As a factor of generating employment	18 (75.0)	9 (56.2)	1.33	.075	1.0	1.0	.474
	2= As a helpful in solving economic problems	6 (25.0)	7 (43.8)					
Impact of SLRM on economic condition	1= Very Good	10 (41.7)	10 (62.5)	1.50	.080	1.5	1.0	.506
	2= Good	14 (58.3)	6 (37.5)					
							Total Observation- 40	

Source: Author's calculated from primary data; Lit. = Literate; Illt. = Illiterate

Note: () = percentage, $\bar{X}$ = Mean, SE* = Standard error of Mean, M= Median, Z = Mode, SD = Standard deviation



Source: First Author's Ph.D. thesis

Figure 5: (A) Age group; (B) Cast distribution; (C) Income level after start SLRM; and (D) Impact of SLRM on employment generation and (E) Economic level of the SLRM workers.

Table 2: Testing of hypothesis

Testing of hypothesis					
Used test	variable	F-value	p-value	result	remarks
Paired sample T-test	Income level before & Income level after start SLRM	7.00	0.001*	H_0 Reject	Significant
χ^2 test	Impact of SLRM on Employment level	4.57	0.033*	H_0 Reject	Significant
χ^2 test	Impact of SLRM on Economic conditions	9.60	0.002*	H_0 Reject	Significant

Source: Author Calculated from Primary data; Note: * = p-value < .05, (result significant and null hypothesis rejected)

Interpretation and Discussion

Respondents are two groups considered literate and illiterate based on their education level. Table 1 presents that descriptive statistics of age group wise distribution of the SLRM works in this analysis. In term of age distribution, respondents extreme are 37.5% in age group 20-30; moderate are 25.0% in 30-40, 40-50 age groups and least are 12.5% in above-50 age groups; thus the literate and illiterate respondent are extreme and least respectively 54.2% (20-30), 12.5% (40-50 & above-50) and 43.8% (40-50), 12.5% (20-30 & above-50). Age wise of descriptive statistics mean, SE, median, Z (mode) and SD respectively shows are 2.13, 0.169, 2.0, 1.0 and 1.067. It is found that the extremely high respondents are age groups 20-30 between other age groups. Figure 5(A) shows that distribution of the education and age group. Table 1 show that descriptive statistics of cast wise distribution of the SLRM works in this analysis. In term of cast distribution, respondents extreme are 77.5% in ST; moderate are

10.0% in general and least are 5.0% SC; thus the literate and illiterate respondent are extreme and least respectively 79.2% in ST, 4.2% in SC and 75.0% in ST, 6.2% in SC & OBC. Cast wise of descriptive statistics mean, SE, median, Z and SD respectively shows are 1.15, 0.092, 1.0, 1.0 and 0.580. It is found that the extremely high respondents are ST cast between other cast. Figure 5(B) shows that distribution of the education and cast.

Table 1 presents that descriptive statistics of distribution of Income level after start SLRM programme of the SLRM works in this analysis. In term of Income level after start SLRM programme, respondents extreme are 62.5% in level 100000 – 150000 and least are 37.5% in Under - 200000; thus the literate and illiterate respondents are extreme and least respectively 58.3% in level 100000 – 150000, 41.7% in Under – 200000 and 68.8% in level 100000 – 150000, 31.2% in Under - 200000. It is found that the extremely high respondents are belonging to 100000 – 150000 Income level between other income level groups; and descriptive statistics of Income level mean, SE, median, Z and SD respectively shows are 2.38, 0.078, 2.0, 2.0 and 0.490. It is clear that respondent's income increasing after start SLRM programme. Figure 5(C) shows that Income level after start SLRM programme.

Table 1 presents that descriptive statistics of Impact of SLRM on employment level of SLRM works in this study. In term of Impact of SLRM on employment level, respondents extreme are 67.5% in As a factor of generating employment; least are 32.5% in As a helpful in solving economic problems; thus the literate and illiterate respondents are extreme respectively 75.0% and 56.2% in As a factor of generating employment and least respectively 25.0% and 43.8% in As a helpful in solving economic problems; and descriptive statistics of employment level mean, SE, median, Z and SD respectively shows are 1.33, 0.075, 1.0, 1.0 and 0.474. It is found that SLRM Programme the extremely high respondents are as a factor of generating employment. Figure 5(D) shows that highly Impact of SLRM on employment level of SLRM works. Table 1 show that descriptive statistics of types of Impact on economic level of the SLRM works in this study. In term of types of impact, respondents extreme and least average are 50.0% in good and 50.0% in very good; thus the literate and illiterate respondents extreme of good impact on economic level are 58.3% and 62.5% very good impact on economic level; and least of very good impact on economic level 41.7% and 37.5% good impact on economic level; and descriptive statistics of employment level mean, SE, median, Z and SD respectively shows are 1.50, 0.080, 1.5, 1.0 and 0.506. It is found that SLRM programme the extremely high respondents are a very good impact on their economic level. Figure 5(E) shows that Impact of SLRM on economic level of the SLRM workers.

Result and Hypothesis testing

Table 2 presents that Paired sample t-test of Income level before & Income level after start SLRM. T-test is statically significant and it is understood that the t- value = 7.00 at 5% level of significant and 39*df*, p-value = 0.001 < 0.05. Hence the alternative hypothesis (Ha_1) is accepted and rejects the null hypothesis (H_{01}). It is clear that there is significant difference between Income level after and before start SLRM Program; and income level increasing of the sanitary works after start SLRM.

Table 2 presents that chi square test of Impact of SLRM on Employment level. Chi square test is statically significant and it is understood that the χ^2 value = 4.57, 5% level of significant and 1*df*, p-value = 0.033 < 0.05. Hence the alternative hypothesis (Ha_2) is accepted and rejects the null hypothesis (H_{02}). So it is clear that there is significant Impact of SLRM on employment generation level of the SLRM workers and helpful of generating the employment.

Table 2 presents that chi square test of Impact of SLRM on Economic conditions. Chi square test is statically significant and it is understood that the χ^2 value = 9.60, 5% level of significant and 1*df*, p-value = 0.002 < 0.05. Hence the alternative hypothesis (Ha_3) is accepted and rejects the null hypothesis

(H_{03}). It is clear that there is significant Impact of SLRM on economic condition of the sanitary works; and helpful of solving their economic problems.

Conclusion

This paper presents current status of management and disposal of solid waste; and woman empowerment, employment generation & economic condition of the sanitary workers in AMC Chhattisgarh India. Municipal solid and liquid waste is a one of the biggest territory of concern in the all world. In growing countries like India, where is fastly rising in population growth and urbanization and with the improvement of people's standard of living; and the amount of MSLW is also increasing. Study result shows that AMC used door to door collection is happening in hundred percent of all wards, and hundred percent used of waste management practices for collected waste and hundred percent disposal of municipal solid and liquid waste; therefore AMC claim hundred percent of a dumping yard free city of the state; and claim hundred percent of bin free city validate on-ground level and the city's damp waste are getting treated at the waste treatment plant. Researcher observed that the main characteristics of the SLRM center are works forces totally basis of the female self-help groups; and it is appreciable example for woman empowerment. AMC used other methods of information education and communication messages (IECM) in the shape of wall writings, paintings, and banners/hoardings in all commercial and public areas displaying for people and householders awareness of the city. SLRM programme is a job oriented programme; whereby sanitation works, employment generations, income generation, increase of income level of the works and appreciable type's impact of their economic conditions; and that is a faction of Financial Stability for AMCs; and sanitation workers looks this programme as a factor of generating employment and as a helpful in solving economic problems.

Compliance with ethical standards

Declaration of Competing Interest: All Author's disclosed that No Competing Interest.

Funding Sources: All Authors' disclosed that not received any types of grant, Fellowship, Organization Contribution or Government Funding during the data survey and study.

Author's Contributions: Ram Pd. Chandra formulated its design, coordinated with the conduct of the study including data collection, performed the statistical analysis and interpreted the data, and drafted the manuscript; Ravindra Brahme conceived the study, participated in the design of the study, assisted in interpreting the data and helped to draft the manuscript; both the authors read and approved the final manuscript.

Acknowledgement: The author is thankful to the Dr. Ravindra Brahme, Professor, School of Studies in Economics, Pt. Ravishankar shukla University Raipur (C.G.) India for their cooperation and supports during the study. Author is also thankful to SLRM workers voice of environment for their support and cooperation during the data collection and survey.

References

Bhide, A.D., Shekdar, A.V. (1998). Solid waste management in Indian urban centers. International Solid Waste Association Times (ISWAT), 1, 26–28.

Choudhury, M., Dutta, J. (2017). A Comparative Study of Municipal Solid Waste Management Status for Three Major Towns of Upper Assam India. Int. J Waste Resources, Volume 7, Issue 3, 1-8.

Cuartas, M., López, A., Pérez, F., Lobo, A. (2018). Analysis of landfill design variables based on scientific computing. Waste Management, 71, 287–300.

Daniel, H. and Perinaz, B.T. (2012). WHAT A WASTE: A Global Review of Solid Waste Management. Urban Development Series, World Bank, March, No. 15. www.worldbank.org/urban

Ferri, L.G., Chaves, L.G., Ribeiro, M.G. (2015). Reverse logistics network for municipal solid waste management: The inclusion of waste pickers as a Brazilian legal requirement. Waste Management 40, 173-191.

Garnett, K., Cooper T., Longhurst, P., Jude, S., Tyrrel S. (2017). A conceptual framework for negotiating public involvement in municipal waste management decision-making in the UK. Waste Management 66, 210–221.

Imura, H., Yedla S., Shinirakawa H., Memon, M.A. (2005). Urban Environmental Issues and Trends in Asia – An Overview. International Review for Environmental Strategies, Vol. 5, pp. 357-382.

Joseph, K., Rajendiran S., Senthilnathan R., Rakesh M. (2012). Integrated approach to solid waste management in Chennai: an Indian metro city. J. Mater Cycles Waste Management 14, 75 – 84.

Kashyap, V. B. (2019). Improving Solid Waste Management for Barshi City. International Journal of Science and Research (IJSR), Volume 8, Issue 9, September, pp. 1112-1115.

Kassie, K. E. (2016). The problem of solid waste management and people awareness on appropriate solid waste disposal in Bahir Dar City: Amhara region, Ethiopia. ISABB Journal of Health and Environmental Sciences Vol. 3(1), May, pp. 1-8.

Nagar, K.N. and Mittal, S. N., (2012). Fundamental elements of Statistics, Minakshi Prakashan Merath, pp. 816-847.

Pamnani, A. and Srinivasarao, M. (2014). Municipal solid waste management in India: A Reveiw and some new results. International Journal of Civil Engineering and Technology (IJCIET), Volume 5, Issue 2, February, pp. 01-08.

Pappu, A., Saxena, M., Asolekar, S.R. (2007). Solid wastes generation in India and their recycling potential in building materials. Building and Environment, 42, 2311-2320.

Patrick A.N., (2015). Management and disposal of municipal solid waste in Abakaliki metropolis, Nigeria. International journal of scientific research in environmental science, 3(3), pp. 0107-0118. http://dx.doi.org/10.12983/ijsres-2015-p0107-0118

Phapal, T., Bhosle, S.M. and Kulkarni A. (2017). Municipal Solid Waste Management in Various Cities: A Literature Review. International Journal of Civil, Structural Environmental and Infrastructure Engineering Research and Development (IJCSEIERD), Vol. 7, Issue 2, April, 33-40.

Rathi. S. (2006). Alternative approaches for better municipal solid waste management in Mumbai, India. Waste Management 26, 1192-1200.

Saifullah, A.Z.A., Islam Md. T., (2016). Municipal solid waste (MSW) management in Dhaka City, Bangladesh, American Journal of Engineering Research (AJER), Volume-5, Issue-2, pp-88-100. www.ajer.org

Saifullah, A.Z.A., Islam, Md. T. (2016). Municipal solid waste (MSW) management in Dhaka City, Bangladesh. American Journal of Engineering Research (AJER), Volume-5, Issue-2, pp-88-100.

Sakai, S., Sawell, S. E., Chandler, A.J., Eighmy, T.T., Kosson, D. S., Vehlow, J., Sloot van der, H.A., Hartlen, J., Hjelmar, O. (1996). World Trends Municipal solid waste management. Waste Management, Vol. 16, No. 5/6, pp. 341-350.

Shekadar A.V., (2009). Sustainable SWM: an integrated approach for Asian countries. Journal of Waste Management 24, 1438-1448.

Shekdar, A.V. (2009). Sustainable solid waste management: an integrated approach for Asian countries. Waste Management 29, 1438-1448.

Shukla, S.M. and Sahai S.P., (2013). Quantitative Method, Sahitya Bhavan Publications, Agra, pp. 603-630.

Swachh Survekshan Report 2017, 2018, 2019 and 2020 Govt. of India.

United Nations (UN) (2002). Report of the World Summit on Sustainable Development. Johannesburg, South Africa, 26 August – 4 September 2002. http://www.unmillenniumproject.org/documents/131302

Wilson, D.C. (2007). Development Drivers for Waste Management. Waste Management Res., 25, 198-207.

Zaman, U.A. (2013). Identification of waste management development drivers and potential emerging waste treatment technologies. Int. Journal Env. Sci. Techno., 10, 455–464.

An Analysis of the Impact of Covid-19 on the Environment

Seema R

Abstract:

Corona virus (COVID-19) which was originated from Wuhan, Hubei province in China has been spreading across different parts of the globe and more so in India, in spite of nation-wide lockdown and social distance. COVID-19 pandemic has not only infected and killed millions of millions people, but it has also negatively impacted the economy with varying degrees across the globe and in India as the economic activities were completely stopped during the lockdown period. Given the data availability, the paper attempts to examine the impact of COVID-19 on different key sectors of the Indian economy and offer policy suggestions to push the Indian economy on V-shaped recovery. The present study is based on secondary data. These data analyzed into before and after COVID-19 period The policy measures taken by various authorities like lockdown, social distancing, isolation in their home, quarantine, closure of films, industries, businesses, institutions, public facilities, restrictions on the movement of people and vehicles, announcing infected area as buffer zone and seal downs and many other measures taken by the governments at different levels towards containment of the disease resulted in a drastic reduction in carbon emissions, nitrogen oxides emissions, deforestation, Poaching , greenhouse gases, global temperature, melting glaciers and sea levels and other environmental degradation caused by human activity which may save a thousands of lives over the period of lockdown.

Key Words: Covid-19, Pandemic, Environment, Impact, Lockdown

Introduction:

The Covid-19 pandemic is a global health crisis that affected everyone and most countries of the world. The entire world is facing health related emergency like speeding human suffering, infecting the global economy and upending people's lives. The transmission of diseases like the Novel Coronavirus Covid-19, between animals and humans (Zoonoses) threatens ecosystem integrity. According to the UN's environment chief, Inger Andersen and other environmental experts that "Nature is sending us a message with the ongoing climate crisis." Many economists and various financial institutions have made predictions on the huge decline in the trade which will have impact on global GDP and also every nation will face a heavy loss on its economy. Economists also have made predictions that if the lockdown continues further, developing countries like India will fall far back to 20 years which will be a great challenge to tackle in the post lockdown period. The spread of the virus is continuing day by day even after the lockdown, and the government has now announced the Second round of lockdown since April 1. The vaccine is yet not developed which is the prime reason for extending the lockdown. In such a situation its each ones responsibility rather only choice is to maintain social distancing and stay at home. (Pujari and Suppannavar 2020). Therefore, Indian economy faced many problems related to economy which are results of nationwide lockdown.

Dev and Sengupta (2020) in this paper they described the state of the Indian economy in the pre-Covid-19 period and assess the potential impact of the shock on various segments of the economy. the study finally, analyse the policies that have been announced so far by the central government and the Reserve Bank of India to ameliorate the economic shock and put forward a set of policy recommendations for specific sectors. Study Conducted by Sherwani and Gupta (19, May 2020) Corona Virus pandemic may wreck the Indian economy and the level of GDP may further fall, more so when India is not immune to the global recession.

Asst professor Dept of Studies in Economics, Sir MV College of arts and commerce, Bhadravathi- Karntaka

Study explored that India is more vulnerable, since its economy has already been ailing and in a deep-seated slowdown for several quarters, much before the COVID-19 outbreak became known. The paper reveals the the Prime Minister of India has already spoken of setting up an Economic Task Force to devise policy measures to tackle the economic challenges arising from COVID 19. the paper concluded that as the disruption from the virus progresses globally as well as within India, it is for us to forget, at least for the time being, all talking only about economic recovery, and instead join hands whole heartedly to tackle the outcome of COVID-19. Tiwari (April 19, 2020) said that the central government and most of the state governments passed their budget for the financial year 2020- 21 during February-March 2020, before the lockdown. The central government estimated a 10% growth in the country's nominal GDP in 2020-21, and more than half of the states estimate their nominal GSDP growth rate in the range of 8%-13%. Due to the unforeseen impact of the lockdown on the economy, the 2020-21 GDP growth rates are expected to be lower than these estimates. As a result, the tax revenue that the central and state governments will be able to generate is expected to be much lower than the budgeted estimates, during the period of lockdown.

OBJECTIVES OF THE STUDY

- ❖ To analyze the impact of COVID-19 on environment and economic growth.
- ❖ To examine the factors contributing to the environmental degradation
- ❖ To offer policy prescriptions to ensure V-shaped recovery of the Indian economy.

RESEARCH METHODOLOGY:

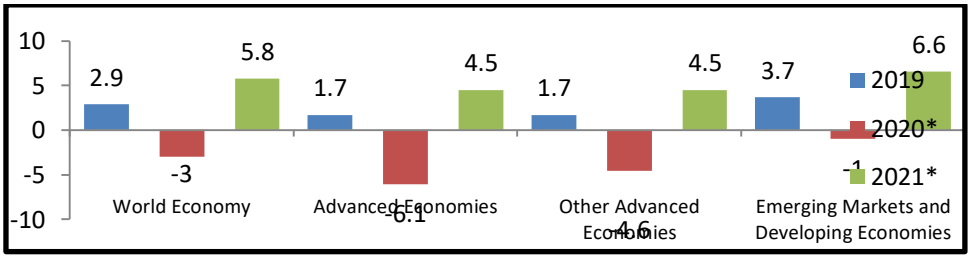
The present study is based on secondary data. The data such data are related to environment and covid-19, and economic growth and so collected. These data analyzed before and after COVID-19 period. Suitable statistical tools such as percentage, Growth rate and GDP ratio will be used to analyze the data. The data collected Ministry of Statistics and Program Implementation Government of India, Central Statistical Office, Controller General of Accounts (CGA), Ministry of Commerce and Industry,

RESULTS AND DISCUSSIONS

Impact of COVID-19 on World Economic Growth

Tab-1 1 below makes the analysis of the economic growth of three cumulative periods from 2019; the world economy shows a 3 percent negative growth posing a very perturbed condition for all the countries. The top nine advanced countries have also got into a huge economic breakdown of about -6.1 percent negative in 2020 from 1.7 percent growth in 2019. The other advanced economies show a -4.6 percent negative growth for the same period followed by the developing economies with -1 percent growth rate. The below three tablesexplored that the advanced countries have suffered a higher loss than compared to that of the developing economies.

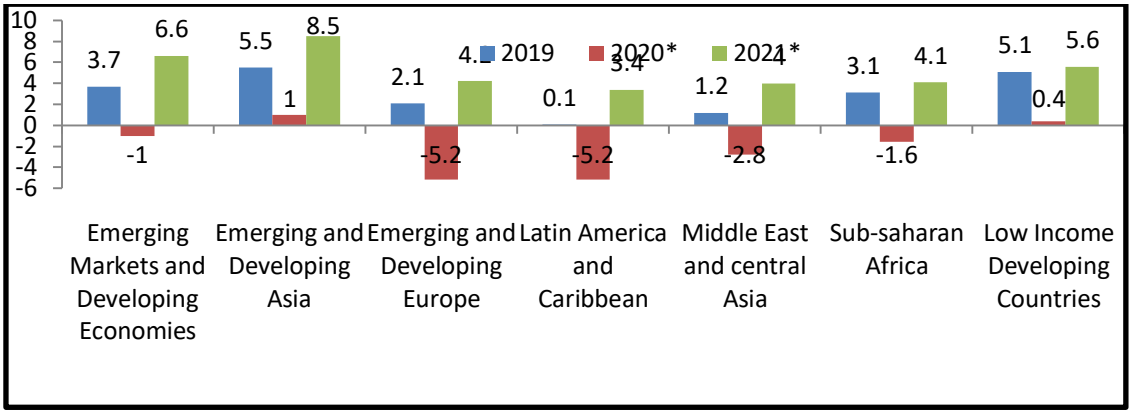
Tab 1: Impact of COVID-19 on GDP Growth Rates of World and Major Economies (%)



Source: IMF Note: * Forecasting

In tab-2 it is seen that accept for developing Asia and low income developing countries other all group of countries have negative growth during the year 2020. Also in Fig 3 shows the negative growth rate of the major countries and yet can see China and India having a very low but positive growth rate for the same period. In summary we can say that all the countries together have a declining trend in the economic growth rates which ultimately has pulled down the global growth rate and the sole reason is the unpredictable spread of the novel Virus all over the world. The forecasts made for 2021 in all the three figures is based on the hope to discover vaccine against the virus which would bring back the economy back to normal.

Tab-2 Impact of COVID-19 GDP Growth Rate in Emerging Markets and Developing Economies (%)



Source: IMF Note: * Forecasting

Environmental Impact- positive and Negative

The document conducted by the UNEP 2020 includes the 2030 agenda, the SDGs and the Paris agreement on climate change and that these are the best chance for a brighter future. The report further informs that the new normal situation does not provide a silver lining for the environment; however, it provides the impetus to revisit one relationship with nature and build a better world. For this reason, the direct impact of the virus on the environment has been analysed.

Prior to the Covid-19 pandemic, increase in the amount of greenhouse gases produced since the beginning of the industrialisation era in general and LPG Era in particular caused average global temperature on the earth to rise, causing the meltdown of glaciers, rising sea levels, greenhouse effect, ozone depletion, acid rain and threat to biodiversity including flora and fauna. In one or the other way, the human activity prior to corona virus pandemic caused environmental pollution and degradation. In order to combat environmental degradation, researchers, experts and officials argued that reduced economic activity would help to reduce global warming as well as environmental pollution which expected to allow environment to slowly flourish. Environmentalists and earth scientists also called for biodiversity protections.

The impact is shown below in the form of positive and negative. the fig-1 below indicates a situation by regions.

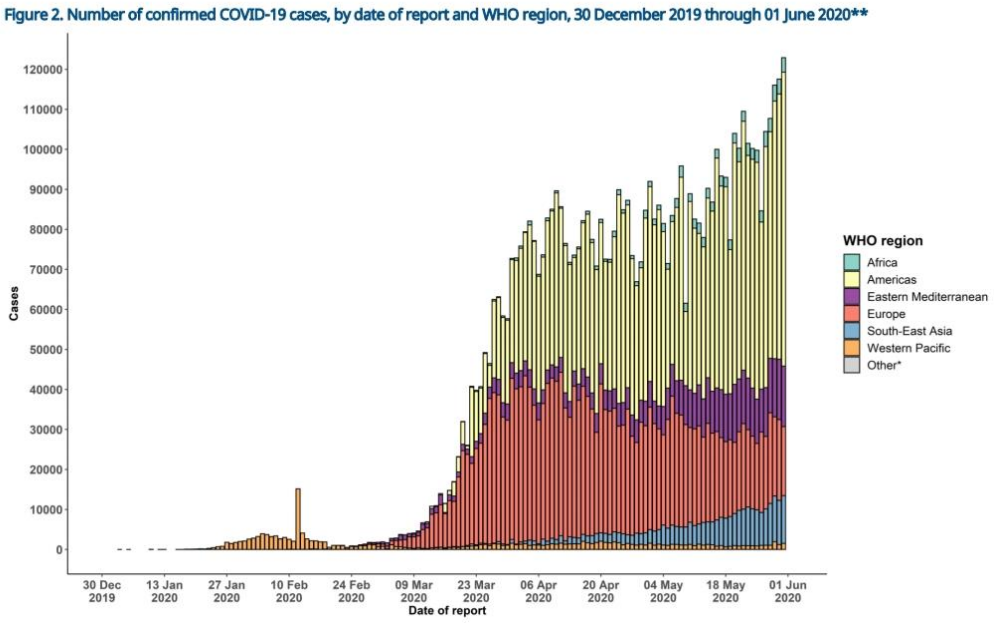
Situation in Numbers (by WHO region) **Total as of 01-06-2020**

Situation in numbers (by WHO Region)

Total (new cases in last 24 hours)

Globally	6 057 853 cases (122 917)	371 166 deaths (4 000)
Africa	104 242 cases (3 632)	2 638 deaths (84)
Americas	2 817 232 cases (73 439)	160 514 deaths (2 812)
Eastern Mediterranean	520 137 cases (15 136)	12 627 deaths (274)
Europe	2 159 791 cases (17 244)	180 594 deaths (509)
South-East Asia	272 512 cases (11 933)	7 743 deaths (312)
Western Pacific	183 198 cases (1 533)	7 037 deaths (9)

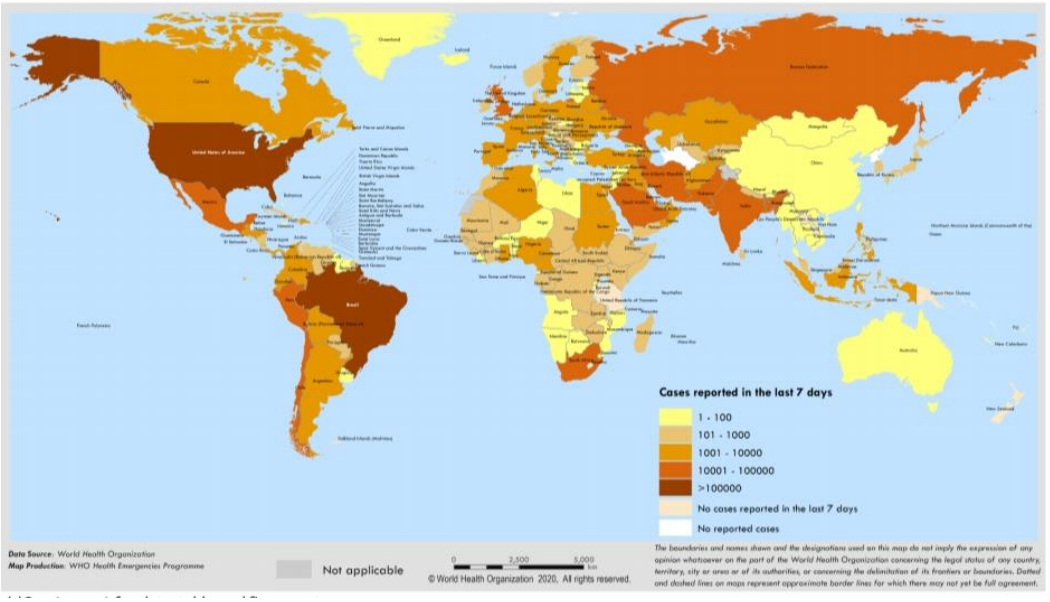
Source: WHO data as received- 01 June 2020



Source: WHO data as received- 01 June 2020

Surveillance

Figure 1. Number of confirmed COVID-19 cases reported in the last seven days by country, territory or area, 26 May to 01 June**



Source: WHO data as received- 01 June 2020

Positive impact:

The most of the countries of the world have tried to fight against the spread of the virus with massive Covid-19 lockdowns, social distancing and isolation at their homes resulted in drop of GHG emissions to proportions never before seen since World War II, drastic reduction in the concentration of nitrogen dioxide(NO_2) and particular matters, air pollution has drastically reduced in countries such as China, France, Germany, Italy, and Spain many beaches around the world to get cleaned up, noise levels have fallen significantly in most countries. These are positive indirect impact of Covid-19 on the environment due to the policy measures that were taken by various governments such as:

1) Massive Covid-19 screening tests
2) Public policy of social distancing
3) Shut down of power plants and industrial activities.
4) Decreased use of vehicles.
5) Government ordered citizens to stay at home.
6) Regular activities have ground to a halt
7) Reduced use of cars and other private vehicles.
8) Reduction in waste generated by tourists who visit the beaches.

Negative impact:

There are also negative secondary aspects of Covid-19 on the environment such as the reduction in recycling of waste, increase in domestic waste, endangering the contamination of physical spaces like water and land. Apart from these effects, the global economic activity is expected to return in the coming months in most of the countries and decreasing concentration of GHG during a short period is not a sustainable way to clean up our environment. Some of the case studies on negative effects of Covid-19 related to some countries have proved the case.

1) In USA, some cities have suspended recycling programmes because authorities have been concerned about the risk of spreading the virus in recycling centres.
2) The European nations have been resorted to restrict sustainable waste management in fear of spreading infection from the recycling centres.
3) Italy has prohibited infected residents from sorting their waste.
4) Some industries have seized the opportunity to expel disposable bag bans and
5) Increased online food ordering has increased the growth of domestic waste both organic and inorganic.

An Analysis:

After analysing the positive and negative indirect effects of the Covid-19 on the environment, the following analysis can be done. The present situation is healing the planet in a way never before in living history of human beings.

1. Decreased concentrations of NO_2 and PM 2.5

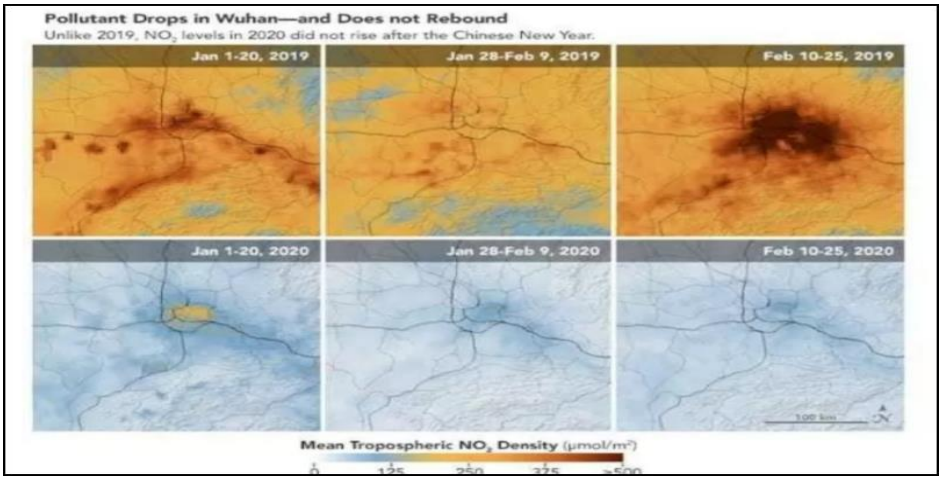
The 2016 WHO reports indicates that air pollution contributes to a significant percentage of global mortality each year (8%). The most affected countries being those found in Africa, Asia and part of Europe. However, 91% of the world population lives in places where poor air quality exceeds the permissible limits. The consequences of air quality degradation are manifested in poor health and death of mankind.

Due to Covid-19 controlling measures implemented by various governments such as strict traffic restrictions and self-quarantine measures resorted to changes in air pollution. The concentration of NO_2 and PM reduced to new low levels in various metropolitan cities. It is evident from the reading from the Copernicus Sentinel-5 P satellite show a significant reduction in NO_2 concentrations (CAMS 2020).

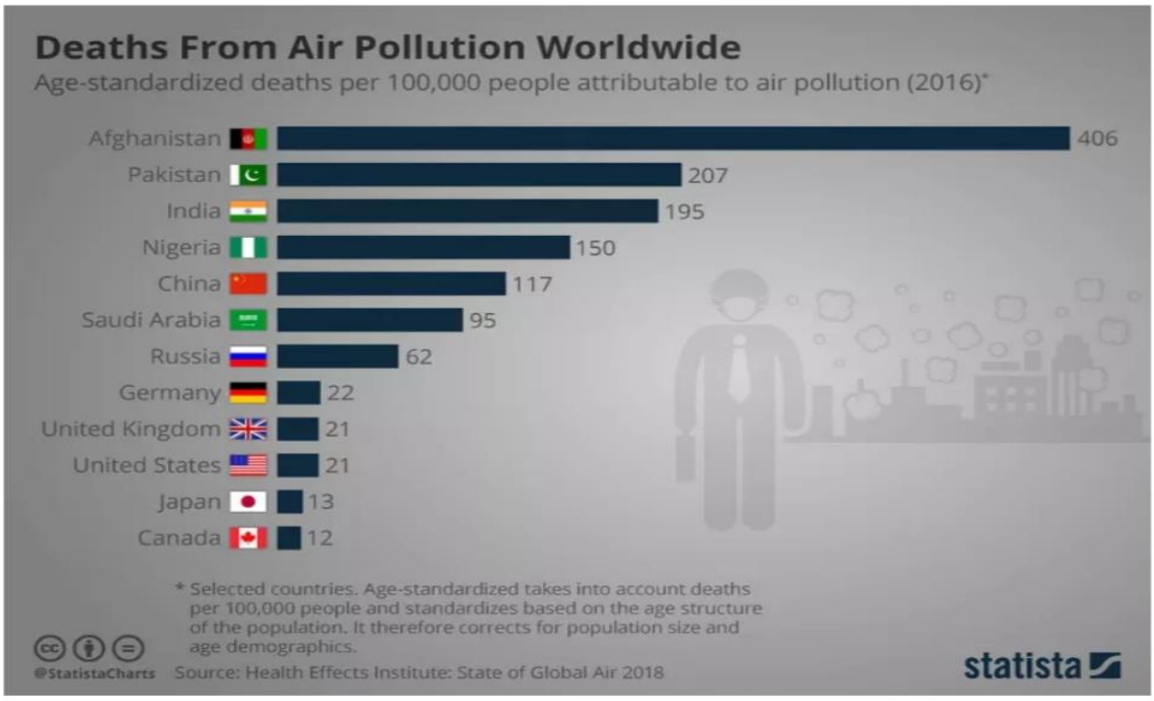
Area –wise reduction in concentration of NO_2 and

Country	**NO_2 concentrate**	**PM 2.5 concentrate**
Wuhan	22.8 ug/m^3	1.4 ug/m^3
China	12.9 ug/m^3	18.9 ug/m^3
India/Delhi	158 ug/m^2	-

Source: CAMS, 2020



Source: NASA Image



Source: Statistica

All of these air quality improvements generated human health benefits that have outnumbered confirmed Covid-19 deaths so far.

2. Clean beaches

The non-responsible use by people has caused many beaches in the world to present pollution problems. The lack of tourists, as a result of the social distancing measures and restrictions on private as well as public transport facilities mainly aviation has caused a notable change in the appearance of many beaches in the world like Acapulco(Mexico), Barcelona (Spain) and Salinas (Ecuador).

3. Reduction of Noise pollution

Environmental noise is one of the main sources of discomfort for the population and the environment, causing health problems and altering the natural conditions of the ecosystems. The imposition of quarantine measures have caused people to stay at home and decreased use of private and public transportation. All these changes have caused the noise level to drop considerably in most cities in the world.

4. Increased waste

The generation of organic and inorganic waste is indirectly accompanied by a wide range of environmental issues such as air and water pollution, soil erosion, deforestation. The quarantine policies have led consumers to increase their demand for online shopping for home delivery. Consequently, organic waste generated by households has increased. Online food purchase also increased the concentration of inorganic waste. Medical waste is also on the rise. Hospitals produced tons of medical wastes per day in the form of gloves, masks, medical kit during the outbreak. Also, there has been an increase in garbage from personal protective equipment.

5. Reduction in waste recycling

Waste recycling has always been a major environmental problem to all countries in the world. As a result of the pandemic, many countries have stopped recycling programs in the fear of Covid-19 spreading in recycling centres and waste management has been restricted. Many industries have grabbed the opportunity to use the disposable bag bans.

6. Other effects

Some countries have resorted to treatment of waste water by using chlorine and waste water treatment plants to strengthen their disinfection routines. The excess of chlorine in water could generate harmful effects on people's health.

Indian Experience

The novel coronavirus disease pandemic poses a crucial choice to the world; the society, economy and environment. India emerged with strict measures to save the lives of the people. We accepted the problem and responded in such a serious manner that a less damaging impact of the disease on the society.

India is facing some of the vital environment changes after the covid-19 lockdown. The present epidemic caused a drastic reduction in human activity, industrial and transport emissions, effluents and pollutants in the atmosphere, soil and water. This type of effect is also in the form of reduction in carbon emissions.

In India, the results are similar to that of other countries. India is facing with the most vital environmental changes seen after the covid-19 lockdown.

1. After the announcement of Janatha curfew and the following lockdown measure caused a significant dip in air pollution levels was measured across the country. Cities like Delhi, Bengaluru, Kolkata and Lucknow saw their average Air Quality Index (AQI) staying within two digits.

2. Water bodies have been clearing and the rivers Yamuna and Ganga have seen significant improvements.

3. Critically endangered South Asian River Dolphins also known as Ganges Dolphins have seen spotted back in the Ganga Ghats of Kolkata after 30 years due to the reduced pollution in water.

4. A lots of Flamingos, the birds normally migrate to the city of Navi Mumbai every year, have gathered and there is a massive increase in their numbers never before.

5. The Uttarakhand pollution Control Board tested water in Haridwar and test results revealed that the water is classified as fit for drinking after chlorination for the first time in decades.

6. The lockdown has seen a decline in fishing which means that the fish biomass will increase. Apart from that animals have been spotted moving out freely and even sea turtles have been spotted returning to areas they once avoided.

7. Plants are growing better because there is cleaner air and water. They are allowed to thrive, grow and produce more oxygen and coverage.

In conclusion, though there has been a positive impact on the environment due to lockdown policy, there is a fear that once people start travelling again or go back to doing what they have been doing, all the positive impacts will also disappear.

Conclusion

This paper aims to discuss the effects of the new coronavirus has had on the environment. The positive and negative indirect effects are highlighted. The positive effects revolve around the reduction of NO_2 and PM 2.5 concentrations in most of the cities of the countries. The quality improvement of beaches and reduction of environmental noise were highlighted. On the contrary, the negative effects triggered around increase in domestic and medical waste and restriction on recycle systems.

It is essential to highlight that emission of some GHGs have decreased as a result of the covid-19. This reduction could have little impact on the total concentration of GHGs in the atmosphere for decades on the one hand and on the other, the decrease in GHGs emissions is only temporary. Since, once the pandemic ends, the countries will revive their economies and GHGs emission will increase.

Finally, it could be concluded that the covid-19 will produce both positive and negative indirect effects on the environment, but the strength of the latter is more. Reduction in GHGs concentrations during short period is not a sustainable way of cleaning our environment. Further, the virus crisis brings other environmental problems that may last longer and may be more challenging to manage if countries neglect the impact of the epidemic on the environment.

REFERENCES:

Adelekan, I. O. (2005). Gender, economic policy and domestic energy use in Nigeria. Ibaden Journal of the Social Sciences, 3(1), 1–16.

Akinwale, A. A. (2010). The menace of inadequate infrastructure in Nigeria. African Journal of Science, Technology, Innovation and Development, 2(3), 207–228.

Basu P (2004), "Providing better access to finance for SMEs in India", access finance, issue 2. December, 2004.

Duragesh Pujari and Shreya Suppannavar (2020): *"Our Plan Towards Supplementing Government's Efforts To Slow Down, Eliminate the Further Spread of Covid19 and in Smooth Delivering Of Essentials to the Needy in India".*

Faisal Sherwani and Achal Gupta (19, May 2020): *"Coronavirus (Covid-19) and Indian Economy",* L&L Partners Law Offices, New Delhi. https://www.mondaq.com/india/operational-impacts-and-strategy/936014/coronavirus-covid-19-and-indian-economy

R. Vani, M. C. (2013). The impact of globalization on micro, small and medium enterprises with special reference to India. Innovative Journal of business and management, 2(05) September,-October, 2013. Retrieved from

S. Mahendra Dev and Rajeshwari Sengupta (2020): *"Covid-19: Impact on the Indian Economy",* Working Papers 2020-013, Indira Gandhi Institute of Development Research, Mumbai, India.

Suyash Tiwari (April 19, 2020) *"Impact of Lockdown on Government Revenue"* Published on PRS India.

Indian Renewable Energy Sector: Problems And Prospects

D Subrahmanya Prasad,

ABSTRACT

The energy crisis could be a turning point for accelerating clean sources and for forming a sustainable and secured energy system, Birol, the head of the International Energy Agency (IEA) said recently during the Singapore International Energy Week. "Energy security is the number one driver (of the energy transition)," said Birol, as countries see energy technologies and renewables as a solution. According to him, tightening markets for liquefied natural gas (LNG) the world over and major oil producers cutting supply have resulted in "the first truly global energy crisis**".[1]**

The impact of climate change on environment and overall economy is widely acknowledged. Many countries across the globe are making all out efforts to switch over from conventional energy sources to non-conventional or renewable energy sources. Countries in both the developing and developed world have started taking necessary measures to rapidly and significantly increase the share of non-conventional energy in the overall energy mix.

Energy sector plays a pivotal role in any country's economic and industrial development. The Government of India (GOI), in the past years, had taken major initiatives to bring about a sea transformation of the country from power deficit to power surplus status. Universal access to affordable power in a sustainable manner has been the guiding principle for the Power sector and towards this end the Ministry of New and Renewable Energy (MNRE), GOI has been in the forefront in initiating and implementing several measures aimed at achieving a sustainable energy framework, which fosters India's growth. The electricity energy generation from Renewable Energy Sources (Solar, Wind, Hydro & Bio Power) has shot up from 193.5 Billion Units during 2013-14 to 306.3 Billion Units during 2020-21 at a CAGR of 6.8%. India is fully geared to meet the formidable challenges related to climate change through several energy transition initiatives which will enable it to honour the commitments made by the country on the global arena. The targets are daunting, thanks to the timely initiatives and the multi-pronged approach adopted by the GOI, the clean energy transition in India is already well underway. India has achieved tremendous success in its recent energy development efforts, but a plethora of challenges still confront us including the Covid-19 pandemic which has been a major disruption. Strong government support and the increasingly favorable economic climate have helped India to achieve a dominant position in the world's renewable energy markets. The steps taken by the GOI have resulted in increased FDI in RE sector of India over the years and increased investments have in turn resulted in creation of great employment opportunities in this sector.

This paper attempts to review the present Renewable Energy scenario of India, the progress made by the nation in achieving the much needed shift from fossil fuel to non-fossil fuel based energy generation in the backdrop of commitments made by the GOI in various international fora and the issues and challenges which lie ahead and require interventions at appropriate levels on war footing. The suggestions made based on the review outcomes, it is hoped, will provide useful information to policymakers, investors, industries, practitioners and researchers alike.

Keywords: *India, Sustainable, Renewable energy, Achievements, Initiatives, Challenges, Recommendations, Investment, Employment, Policymakers, Investors*.

Associate Professor,ICFAI Business School (IBS),IFHE University,Hyderabad (Telangana State)

INTRODUCTION

India, has been a major player in the global energy economy and ranks fourth behind China, USA and the European Union (EU), thanks to rising purchasing power and continuously improving standards of living. The Energy consumption of India use has almost doubled since 2000, with a lion's share of the demand (around 80%) still being met by coal and oil. On a per capita basis, India's energy consumption and greenhouse gas (GHG) emissions are less than half the world average. As India recovers from the economic ills caused by Covid -19 pandemic, it is expected to come out of the slump and progress into a growth–oriented and dynamic period in its energy development programme. Over the coming years, millions of Indian households are set to buy new appliances, air conditioners and vehicles. India is set to become the world's most populous country (India's population is set to rise to 1.515 billions) by the end of the decade, overtaking China, according to the World Economic Forum's report dated the 11th August,2022 on United Nations' World Population Prospects.

Renewable energy sources, like solar energy, wind energy, bio-energy, also referred to as non-conventional sources of energy, are sources that are continuously replenished by nature. A renewable energy system operates by transforming energy from the sun, wind, falling water, sea waves, geothermal heat, or biomass into heat or electricity useful for human consumption. The sun and wind, either directly or indirectly, account for the lion's share of renewable energy. The Indian renewable energy (RE) sector is the fourth most attractive RE market globally. India was ranked fourth, fifth and fourth in wind power, solar power and renewable power installed capacity, as of 2020.

INDIAN ADVANTAGE			
DEMAND SCENARIO	**INVESTMENT PATTERN(FDI INFLOWS)**	**GOVERNMENT SUPPORT**	**COMPETITIVE ADVANTAGE**
1.As per the estimates provided by the Central Electricity Authority(CEA) India's power requirements are expected to reach a level of 817 GW by 2030,real estate and transport sectors accounting for lion's share.	1. Non-conventional energy sector received FDI inflow of US$ 11.62 billion between April, 2020 and March, 2022.	1. In the Union budget 2022-23, the Government of India (GOI) allocated a huge sum of Rs.19, 500 crore for a Productivity Linked Incentive (PLI) scheme to boost manufacturing of high efficiency solar modules.	1. Globally, India ranks fourth in renewable energy capacity and wind power and fifth in solar power capacity.
2. The renewable energy capacity in India increased by 250% between 2014 and 2021. By 2030, 50 per cent of India's energy production will be met by non-fossil fuel, and by 2070 it plans 'Net	2. Rising foreign investments in the renewable energy sector like the US$ 75 billion investment from UAE is expected to	2. India launched the Mission Innovation CleanTech Exchange, a global initiative that will help accelerate clean energy innovation.[**16**]	2. In October, 2021 India retained its third rank on the EY Renewable Energy Country Attractive Index 2021.

Zero'.-Prime Minister Shri Narendra Modi.	pave the way for more such investments in the country.		
3. Renewable energy is set to play a crucial role, as India aims to meet its energy demand, which is expected to be of the order of 15,820 TWh by 2040, on its own.	3. Investment in renewable energy in India reached a record level of US$ 14.5 billion in FY22, an increase of 125% over FY21.	3. India's largest floating solar power plant under the National Thermal Power Corporation (NTPC) with a total installed capacity of 100 MW became fully operational in Ramagundam, Telangana on 30th July, 2022.	3. Indira Gandhi International Airport (IGIA), Delhi has made a great beginning by becoming the first Indian airport to run entirely on hydro and solar power.

Literature review

The renewable energy sector has attracted considerable attention of researchers during the last two decades. The research done so far unequivocally points out that there exists an enormous scope of enhancing and exploiting the resources lying untapped in India.
India's announcement that it aims to reach net zero emissions by the year 2070 and to meet fifty percent of its electricity requirements from renewable energy sources by 2030 has far reaching consequences for the global effort against climate change. India is following a new model of economic development that could avoid the carbon-intensive approaches followed by many countries in the past – and provide a blueprint and an alternative path for other developing economies **[2].** A Significant shift in energy scene had been observed since 2008 in Solar and wind power sectors. Despite these advances which have contributed in no small measure to the economic and industrial development of India, the country continues to experience increased demand for energy for meeting its various developmental needs. A major demand and supply gap of energy is anticipated in the near future if the various energy related studies are any indication in this regard.

India ranks 3rd in renewable energy country attractive index in 2021 and 3rd largest energy consuming country in the world. India has an ambitious target to achieve a capacity of 175 GW worth of renewable energy by the end of 2022, which escalates to 500 GW by 2030. This is the world's largest expansion plan in renewable energy sector **[3].**

Energy sector forms one of the crucial elements of any nation's economic and industrial development. The Government of India (Ministry of Power), in the past years had taken several significant measures to bring about a major transformation of the country from power deficit to power surplus nation, connecting the whole nation into one grid, strengthening & deepening the distribution system and achieving universal household electrification apart from encouraging vital investments in conventional and renewable energy capacity. The GOI's endeavors through implementation of energy efficiency programmes have resulted in reduction of energy intensity and avoidance of CO2 emission **[4].**

Over 80% of India's energy needs are met by three fuels: coal, oil and solid biomass. While Coal remains the largest single fuel in the current

energy mix, Oil consumption and imports have grown on account of fast rising vehicle ownership and extensive use of road transport network. Biomass, primarily fuelwood, though its use is on the decline, it is still widely used as a cooking fuel. Despite recent success in expanding LPG coverage in rural areas, 660 million Indians are yet to switch to modern, clean cooking fuels or related technologies **[5].**

India is the third largest global emitter of CO2, despite low per capita CO2 emissions. The carbon intensity of its power sector in particular is well above the global average. Additionally, particulate matter emissions are a major factor in air pollution, which has emerged as one of India's most sensitive social and environmental issues: in 2019, there were well o ver one million premature deaths related to ambient and household air pollution **[5]**.

The growth of India's energy consumption will be the fastest among all significant economies by 2040, with coal meeting most of this demand followed by renewable energy. The demand for renewable sources of energy in India is expected to show a mammoth increase from 17 Mtoe(Million Tonnes of Oil Equivalent) in 2016 to 256 Mtoe in 2040, with an annual increase of 12% approximately.(Kumar and Majid,2020).[6]

Objectives of the study:

1. To review and analyze the current Renewable Energy Scenario of India.

2. To identify the problems faced by the Government and various associated agencies in providing energy sourced from renewables.

3. To suggest possible solutions for the development of Renewable Energy Sector of India and the way forward.

Emphasis on Renewable Energy

During the annual Conference of Parties (COP)-21 in Paris, India too committed that it would achieve 40 per cent of its installed power generation capacity from non-fossil fuel sources by 2030. Further, in COP-26 at Glasgow, UK, Hon'ble Prime Minister of India made five major commitments to address climate change related issues which include (i) Achieving the net-zero emissions target by 2070(ii) Stepping-up India's non-fossil energy capacity to 500 GW by 2030, (iii)Bringing down India's carbon intensity to 45% by 2030(iv) India will meet 50 per cent of its energy requirements using renewable resources of energy 2030 and (v) curtail carbon emissions to the extent of 1 billion tonnes from the total projected emissions.

To achieve these laudable objectives, the Government of India took several policy initiatives to strengthen the renewable energy sector and to reduce carbon emissions, The significant initiatives are presented below (**Chart 1**):

Sl No	**Chart 1: Major Initiatives of the GOI to augment the Renewable Energy Sector of India**
1	The allocation in the Union Budget 2022-23for the Solar Energy Corporation of India(SECI),the nodal organization for the development of the Indian renewable energy sector, stood at Rs.1,000 crore approximately.
2	The GOI has allocated an amount of Rs. 19,500 crore for a PLI scheme which envisages manufacturing of high-efficiency solar modules.
3	Permission accorded for FDI (Foreign Direct Investment) up to 100 percent under the automatic route.
4	Provision of renewable repurchase obligation (RPO) under the National Tariff Policy up to 2022.
5	Qualification Standards developed for deployment of solar photovoltaic devices.
6	Schemes such as PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme which aims to provide energy security to consumers and Solar Rooftop phase-II introduced.
7	Green Team Ahead Market (GTAM) launched to facilitate procurement of Renewable Energy (RE) power through the country's power exchange.
8	Waiver of inter-state transmission system charges for projects to be commissioned by 30th June, 2025.
9	The GOI has announced plans to kick-start a US$ 238 million National Mission on advanced ultra-super critical technologies for cleaner coal utilisation.
10	In August 2021, the Government proposed norms for green energy purchase and consumption.
11	In July, 2021 the Ministry of New and Renewable sources of Energy (MNRE) approved NTPC's plan to set up a 100% subsidiary of NTPC to build a 4,750 MW RE park (India's largest solar park) at the Rann of Kutch in Khavada of Gujarat.

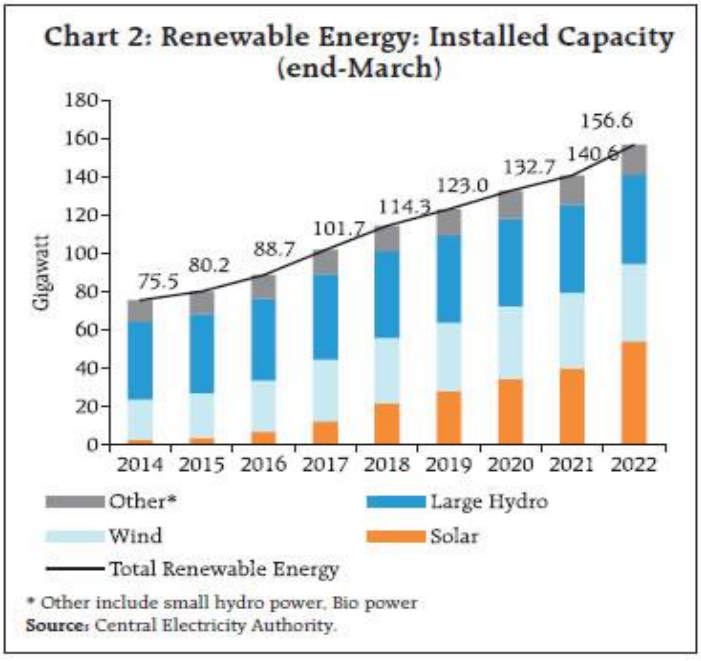
MARKET SIZE (STRUCTURE)

As per the Annual Report 2021-22 of the Ministry of Power, Government of India, India has achieved the truly ambitious target of generating 40% of energy from non-fossil fuel sources in November 2021 - the first country to have achieved its Nationally Determined Contributions(**NDCs),** nine years ahead of committed time line. The report also adds that India's total installed capacity was 395 GW as on 31.01.2022, out of which 235.9 GW is fossil fuel based (Coal/gas etc.) and 159.1 GW is non-fossil fuel (RE + Nuclear) based. The installed capacity is close to double the peak demand and India has become a power exporting nation, exporting power to neighbouring countries like Nepal, Bangladesh and Myanmar As per the Central Electricity Authority (CEA), as on March 2022, installed capacity of renewable energy (including nuclear-based) is around 163 GW, accounting for 41 percent of the total installed capacity.**[4]**

India has a target of about 450 Gigawatt (GW) of installed renewable energy capacity by 2030 – about 280 GW (over 60%) is expected to come from solar energy, a significant source with lot of promise and potential. The addition to renewable energy capacity stood at 8.2 GW (an increase of 240%) for the first eight months of FY22 against 3.4 GW for the first eight months of FY21.The installed capacity in solar power segment has gone up by more than 18 times, i.e from 2.63 GW in March 2014 to 49.3 GW at the end of 2021.

Progress in Renewable Energy Sector

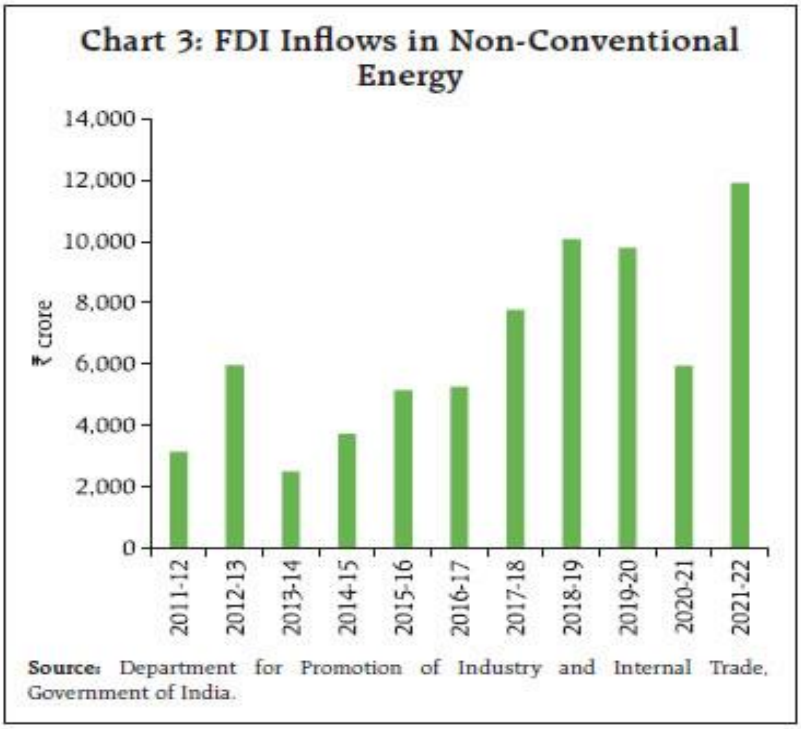
Total installed capacity increased significantly over the period since 2014, from 75.5 GW as on March 2014 to 156.6 GW as on March 2022.Though the economy was plagued by supply chain disruptions caused by Covid-19 pandemic followed by Russia-Ukraine conflict which caused sudden spurt in prices of wind and solar energy components, Indian Renewable Energy Sector was able to add about 15 GW capacity during the financial year 2021-22, resulting in 11.4 per cent increase in total installed capacity as at the end of March 2022 over March 2021. As per the Renewables Global Status Report (REN21), India was ranked third after China and United States in net capacity addition in 2021 in Solar PV capacity. Also, India was ranked third in the world in terms of new capacity addition as at the end of December, 2021 after China, United States and Brazil [**7**].The share of installed solar capacity in total installed capacity also increased substantially from 3.5 per cent in March 2014 to 28.5 per cent in March 2021 and further to 34.5 per cent in March 2022. **(Chart 2).**



Among the states, as on April 2022, Rajasthan was ranked No.1 with a share of 15.7 per cent in total installed capacity. Of the total installed capacity, the top 5 states, viz., Rajasthan, Gujarat, Tamil Nadu, Karnataka and Maharashtra together accounted for a share of around 70 per cent approximately.

Investment in Renewable Energy Sector

During April 2000 to March 2022, non-conventional energy sector received FDI equity inflows to the tune of ₹75,000 crore, which accounts for around 2 per cent of total FDI inflows in India. FDI equity inflows in non-conventional energy sector increased substantially in recent years. In 2021-22, the sector attracted an all-time high FDI equity inflows of ₹11,905 crore **(Chart 3)[9].**



ROAD AHEAD

It is expected that, in about two decades, i.e by 2040, around 49% of the total electricity will be generated by renewable energy sources following the use of more efficient batteries to store electricity. This will further reduce the solar energy cost by around 66% in comparison to the present cost.Further,the use of renewable sources of energy replacing coal will result in an annual cost savings of Rs. 54,000 crore (US$ 8.43 billion) for India. The Central Electricity Authority (CEA) estimates that by the year 2029-30, the share of renewable energy generation would increase from 18% to 44%, while the share of thermal will come down from 78% to 52%.**[8]** India, which has an installed renewable energy (RE) generation capacity of a little .over 150GW aims to reach 175GW (Break-up: Solar: 100GW, Wind: 60GW, Bio-power: 10GW and Small hydro power projects: 5 GW): in 2022.In 2022, India's renewable energy sector is expected to get a shot in the arm with a likely investment of US$ 15 billion, as the government directs its attention towards electric vehicles, green hydrogen, and manufacturing of solar equipment**. [10**

India's installed Renewable Energy (RE) capacity stood at 150.54 GW (the break-up of which is given below) as on November, 2021

Source of RE	Installed Capacity(in GW)
Solar	48.55
Wind	40.03
Small-hydro power	4.83

Bio-power	10.62
Large-hydro power	46.51
Nuclear power	***6.78***

It can be seen from the above table that the non-fossil based installed energy capacity is 157.32 GW accounting for a little over 40% of the total installed electricity capacity of 392 GW. India has a target of 500 GW of installed renewable energy (RE) capacity by 2030. **[11]**
The installed solar energy capacity has increased by 19.3 times in the last 8 years, and stands at 56.6 GW as of 1st June 2022. The installed Renewable energy capacity (including large hydro) has increased from 76.37 GW in March 2014 to 159.95 GW in May 2022, i.e. an increase of around 109.4%.
At the Paris Conference of the Parties (COP 21), India,(as a party to the conference) as part of its Nationally Determined Contributions (NDCs) committed to achieving 40 percent of its installed electricity capacity from non-fossil energy sources by 2030. India has achieved this goal in November 2021 itself, well before the target date set.
From 2014 to November, 2021, the Ministry of Power, GOI have added power generation capacity of 160.8 GW consisting of 83,920 MW from Fossil Fuel and 76,900 MW from Non-Fossil Fuel Capacity making India power surplus. The total installed capacity was 395 GW as on 31.01.2022, out of which 235.9 GW is fossil fuel based (Coal/gas etc.) and 159.1 GW is non-fossil fuel (Renewable Energy + Nuclear) based. The installed capacity is now close to double the peak demand and India is exporting power to Nepal, Bangladesh and Myanmar. [**12**].
Most recently, the Covid19 pandemic brought unprecedented disruptions to our societies and economies , with major consequences across the energy world. The damage to lives and livelihoods and to the energy sector – will last for years to come. **[14]**
Against this backdrop, to re-energize India and overcome the roadblocks to Renewable success the following measures are suggested [**13**]:

Improving the investment climate for RE capacity creation

During the 2014-2019 period, renewable energy programmes and projects in India attracted investments of USD 64.4 billion.[**15**]. The COVID-19 pandemic had impacted implementation of RE projects as the country imposed .several precautionary restrictions to prvent the spread of the infection. However in 2021 new opportunities emerged as Indian companies like ReNew Power (first Renewable Company to list on NASDAQ) started exploring foreign markets scouting for funds for investment in RE sector. The Government should create an enabling environment by initiating appropriate policy measures so that more Indian corporates engaged in RE could come forward and raise funds on a much larger scale in future. Introduction of Sovereign Green Bonds in public sector projects through the recent central budget will pave the way for similar investment forays in RE sector in future.

Indian Renewable Energy sector received about USD 7.27 billion as FDI from 2014-15 to June 2021 out of which the year 2020-21 alone accounted for USD 797 million (nearly 11 %) .To encourage more FDI in the RE sector the Government should put in place major regulatory and procedural changes to enhance the ease of doing business in India and make it an attractive destination for the purpose.

According to the Union Minister for Power and New and Renewable Energy, R K Singh, the Government has opened the gates for installation of RE capacity and selling it through open access which means anybody can setup RE capacity and sell it wherever it wants. This step goes a long way in improving the investment climate in RE sector.

Role of solar power

The Government of India has introduced the production linked incentive scheme (PLI), National Programme on High Efficiency Solar PV Modules involving a mammoth outlay of Rs.4, 500 crores to support and promote manufacturing of high efficiency solar photovoltaic (PV) modules. This initiative of the GOI will help in adding an additional capacity of 55GW of solar PV module manufacturing capacity to the existing capacity of around 11GW.Similar investments of this nature and magnitude could help improve the contribution of solar power to the existing energy mix in India substantially.

52 solar parks have been sanctioned with a cumulative capacity of 37.92 GW in 14 states and solar power projects have already been commissioned in some of these parks. It is necessary to mention in this context that under the rooftop solar programme phase-II, an allocation of 3.4 GW has already been made to various states/ UTs and a capacity of 1.07 GW has already been installed. This is one of the most significant ways of adding RE capacity across the country rapidly and in an equitable manner.

Role of Wind power

India ranks 4th in wind power capacity in the world. The Government has put in place the offshore Wind Energy policy to exploit the potential of offshore wind energy along India's coastline. More research is called for in this area to fully exploit the country's wind power potential.

Strengthening the domestic manufacturing ecosystem

Efforts have been undertaken to create, strengthen and expand the domestic manufacturing eco-system. Schemes namely PM-KUSUM, Solar Rooftop etc have a precondition of Domestic Content Requirement, directly creating a domestic demand of more than 36 GW solar PV (cells & modules). Further, the Government has decided to impose Basic Customs Duty (BCD) on import of solar PV modules @40% and on import of solar PV cells @25% with effect from 01.04.2022.

National Hydrogen Mission

Hon'ble Prime Minister Shri Narendra Modi announced the launch of the National Hydrogen Mission in his independence speech on 15th August 2021. The goal of this mission is to aid the government in meeting climate targets and make India a global hub for green hydrogen production and export. Such measures could go a long way in helping the country in achieving success in its RE related efforts.

Issues/Challenges ahead

RE capacity creation on a massive scale is not an easy task and faces several challenges in its implementation. The following are some of the major issues/challenges ahead.**[15]**

- **Mobilization of the necessary finance and investment on competitive terms**: This calls for changes in the rules and regulations governing the banking sector for financing RE efforts on a wider scale, arranging long-term funding and developing suitable mechanisms for risk management/mitigation by considering both the relevant financial and technical bottlenecks.

- **Funds mobilization**: PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana) was a scheme launched by the Government of India to augment the income of farmers and provide sources for irrigation and de-dieselising the agricultural sector through installation of Solar Pumps and Grid connected solar and other RE Power Plants (REPP). The scheme provides farmers a window of opportunity to become entrepreneurs. This calls for large scale mobilisation of funds on attractive terms which in turn requires mitigating investment risks and easing approval processes.

- **Land acquisition**: is one of the major challenges in renewable power generation, Identification of land with RE potential, its conversion and development, clearance from Land Ceiling Act and other departments of state Governments like revenue department are time consuming and long drawn-out processes. State governments have to play a key role in acquisition of land for RE projects.
- **Integrating** larger share of renewables with the grid;
- **Enabling** supply of firm and dispatchable power from renewables;
- **Enabling** penetration of renewables in the so called hard to decarbonize sectors.

References:

https://www.weforum.org/agenda/2022/10/world-is-in-its-first-truly-global-energy-crisis-ieas-birol#:~:text=drives%20renewables%20growth-,The%20energy%20crisis%20could%20be%20a%20turning%20point%20for%20accelerating,and%20renewables%20as%20a%20solution.

https://www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world.

https://www.investindia.gov.in/sector/renewableenergy#:~:text=India's%20installed%20renewable%20energy%20capacity,as%20on%2031st%20March%202022.

MOP_Annual_Report_Eng_2021-22.pdf

India Energy Outlook 2021(published by the International Energy Agency)

Kumar. J and Majid, Energy Sustainability and Society (2020)

REN 21 THE RENEWABLES

Central Electricity Authority, Ministry of New and Renewable Energy, Media Reports and Press Releases

Department for Promotion of Industrial and International Trade, GOI.

https://energy.economictimes.indiatimes.com/news/renewable/indias-renewable-energy-investment-likely-to-cross-15-billion-in 2022/88468080#:~:text=New%20Delhi%3A%20After%20witnessing%20cloudy,the%20ambitious%20175%20GW%20renewable)(Energyworld.com

Energyworld.com

1. Ministry of Power, 2021-22 report
2. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1785808
3. REN21, Renewables 2020 Global Status Report
4. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1785808)(Ministry of New and Renewable Energy)
5. www.ibef.org

@@@@@@@@@@@@@@@@@@@@@@

Solid Waste Management in India

Pragati Krishnan
Ravindra Brahme

Abstract

In recent years, the exponential growth in human population, enhanced density of urban and rural areas, miscellaneous culture, varying eating habits and livelihood have raised an important yet continuously neglected problem which is "waste or garbage". Not only in our country but this problem is pertinent all around the globe. The increasing growth in solid, wet, reusable, single used materials, electronic waste (e-waste) have arisen a major ecological anxiety. These wastes generated from any sources have continued as a raising tenacious environmental problem. The objectives of this paper are to study the solid waste management in global as well as in Indian perspectives.

Keywords: Environmental Economics, Environmental Sustainability, Municipal Solid Waste, Waste Management.

Introduction

In recent years, there is rapid spurt in the amount of waste all around the globe. The main factors behind this are seen in the form of rise in the community standard of living, urbanization and increase in population. In this parlance, Waste Management is emerged as a pivotal environmental issue in many developing countries including India. By Wastes, we mean the by-products of human activities in the form of production, consumption and distribution of various goods by the society. It has both the positive and negative effect on the environment. The positive effect is witnessed in the form of recycling and reuse of the biodegradable products into manures. But, on the other hand the negative effects particularly when we talk with respect to the present context is the drastic increase in the medical wastes and e-wastes which poses big challenges for efficient and sustainable management (Krishnan,2021).

In a large parlance, the waste is a substance which is labeled as waste by its owner. However, it is truth that, if one person sees a substance as a garbage, it could surely be a treasure for someone else. It is also said "someone's garbage, others treasure". Besides that, it was argued that there is a necessity to visibly describe what creates wastes as this form the foundation for guideline (Amasuomo & Baird, 2016). Simply, a waste is unwanted or unstable material (Mor, et al., 2021).

The quality of the environment in many developing countries, particularly in the urban areas is rapidly deteriorating day by day. Owing to population explosion industrialization, increased urban housing and economic prosperity, there has been a significant spurt in municipal solid waste (MSW) generation throughout the country. There is a positive correlation between municipal waste generation in kg / person / day and global economic development. Urbanization is on massive scale resulted in accelerated industrial growth and the displacement of people from villages to cities. However, it has been observed that the amount of waste generated increases annually in relation to population growth and urbanization. Since then, the per capita generation of municipal waste has also increased enormously with the improvement of the lifestyle and social status of urban inhabitants (Sharholy et al., 2007).

The non-management of all the waste generated by the municipalities from the cities is the main reason for the decline in the quality of the environment. The disposal of waste in cities is usually done by the municipalities; the major challenge before them is the lack of a proper system of waste disposal.

Assistant Professor (Guest), School of Studies in Economics, Pt. Ravishankar Shukla University, Raipur, Chhattisgarh, India
Professor & Head School of Studies in Economics, Dean, Faculty of Social Sciences, Pt. Ravishankar Shukla University, Raipur, Chhattisgarh, India

Municipalities are faced with many challenges in the management of waste from cities such as lack of financial resources, lack of infrastructure etc (Sujauddin et al., 2008). Most municipalities do not have the capacity to properly address the various problems associated with waste disposal (Burntley, 2007).

Economists face many problems in decision making regarding solid waste disposal because of the collection and availability of data related to waste generation, waste collection, transportation of waste and segregation and disposal of waste with municipalities are not available (Balasubramanian,2015).The availability of various data related to waste management can be extremely useful for local policy makers in making economic decisions such as building a framework for managing waste, charging citizens fees or taxes, and providing grants or subsidies (Nahman, 2011).

The objectives of this paper are to study the solid waste management in global as well as in Indian perspectives. For this the data has been collected from secondary sources which includes the World Bank, annual reports of various years of solid waste management in India, Central Pollution Control Board, New Delhi.

2. Solid Waste Management in Global Perspectives

Waste generation and resource shortages have long been recognized as two of the greatest challenges human society is facing (Hou et al ,2012). The solid waste management includes disposal, recovery, recycling, reuse and prevention. Current global Municipal Solid Waste (MSW) generation level is 1.3 billion tons per year, and is expected to increase to approximately 2.2 billion tons per year in 2025. This amount may result in significant health, environmental, aesthetic, land-use resources, and economic concerns if not managed properly. Waste to Energy (WTE) is a viable option for disposal of MSW and energy generation (Ouda & Raza, 2014).

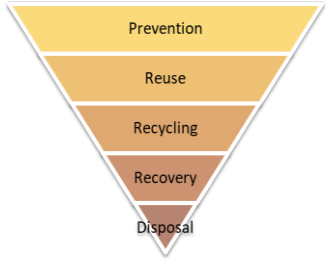


Fig1. The waste management hierarchy

Table 1: Projected Waste Generation and Urbanization Rate by Income

Income Level	2010		2025	
	Urban Population (million)	Waste (kg/capita/day)	Urban Population (million)	Waste (kg/capita/day)
Low-income	343	0.6	676	0.86
Lower-middle income	1296	0.78	2080	1.3
Upper-middle income	572	1.16	619	1.6
High-income	774	2.13	912	2.1

Source: https://openknowledge.worldbank.org/handle/10986/30317

The projected waste generation and urbanization rate by income is shown in table 1 which exhibits that in the higher income level the urban population is 774 million in 2010 and they produce 2.13 kg/capita/day waste. By 2050 it is projected that the population of urban lower -middle income would reach 2080 million and the urban high income would reach 912 million and their waste generation would expect to be 1.3 kg/capita/day and 2.1 kg/capita/day respectively.

Table 2: Projected Global Waste Generation

Year	Billions of Tonnes
2016	2.01
2030	2.59
2050	3.40

Source: https://openknowledge.worldbank.org/handle/10986/30317

Projected Global Waste Generation has been mentioned in table 2 which shows a very striking figure that the world is forecasted to generate 2.59 billion tonnes of waste annually by 2030 which is further predicted to reach 3.40 million tonnes annually all around the globe by 2050.

Table 3: Projected Waste Generation by Region (Millions of tonnes per year)

Region	Year		
	2016	2030	2050
Middle East and North Africa	129	177	255
Sub-Saharan Africa	174	269	516
Latin America and Caribbean	231	290	369
North America	289	342	396
South Asia	334	466	661
Europe and Central Asia	392	440	490
East Asia and Pacific	468	602	714

Source: https://openknowledge.worldbank.org/handle/10986/30317

The region wise projected waste generation has been illustrated in table 3. It exhibits that by 2030 Middle East and North Africa is expected to generate 177 million tonnes of per year waste which is projected to increase by 255 million tonnes per year by 2050. Similarly, Europe and Central Asia is anticipated to generate 440 million tonnes of waste by 2030 and 490 million tonnes of waste by 2050. 602 million tonnes per year and 714 million tonnes per year of waste have been expected to produce by East Asia and Pacific by 2030 and 2050 respectively.

3. Solid Waste Management in Indian Perspective

Municipal waste is recognized as, “the household wastes, commercial and market area waste, slaughter house waste, slit from drainage, wastes from road sweeping and treated biomedical wastes”. The rapid spurt in population followed by rise in income, unplanned urbanization and gradual changing lifestyles leads to greater volume and composition of municipal solid waste in India. As a consequence of this, India confronts many ecological challenges connected with generation, collection, transportation, treatment and disposal of waste. Also, in the current scenario India is not in a position to cope up with these challenges and henceforth it simultaneously impacts environment and public health.

In 2019 unstarred question was also asked by DR. (Prof) Kirit Premjibhai Solanki to our honorable Minister of Environment, Forest and Climate change regarding “the state/ UT- wise total quantum of annual waste generated in the country”, “the total quantum of wastes recycled or reused and deposited in the landfills”. He also questioned with regard to “the steps implemented by the government to encourage

the recycling of waste or to reduce the quantum of waste generated". In response to all these questions our honorable minister has been very beautifully answered that –

- "According to the annual report of Ministry of Housing and Urban Affairs for the year 2016-17, the total solid waste generated is estimated to be 1,50,000 T/day approximately."
- "For effective management of various types of wastes, the government has revised and notified various waste management rules in 2016 hazardous waste, E-waste, plastic waste and bio-medical waste."
- "CPCB ha published guidelines for environmentally recycling of commonly recyclable hazardous wastes and also it has prepared 52 Standard Operating procedures for utilization of 40 different types of hazardous wastes after conducing trial runs."
- Furter "the CPCB in its norms prescribed technological solutions for collecting segregating and disposing plastic wastes.

Table 4: Year wise Solid Waste Management Status

Year	Solid Waste Management Status			
	Solid waste generated (TPD)	Collected (TPD)	Treated (TPD)	Landfilled (TPD)
2015-16	1,01,066	86,531	20,288	37,953
2016-17	1,19,140	1,16,685	24,045	49,836
2018-19	1,52,076	1,49,748	55,759	50,161
2019-20	1,52,847	1,46,053	70,973	40,863
2020-21	1,60,038	1,52,749	79,956	29,427

Source: Annual Report on Solid Waste Management of various years, CPCB, Delhi

The year wise solid waste management status in the country is highlighted in the table 4 which shows that the total quantity of solid waste generated is 1,60,038 TPD in 2020-21 which is only 1,01,006 TPD in the year 2015-16. Likewise, in the year 2018-19 there is maximum landfilled with 50,161 TPD, followed by 49,836 TPD in 2016-17. There is also an increasing trend in the solid waste collected and treated in these five years.

Table 5: State Wise Solid Waste Management Status (2020-21)

Sl. No	State	Solid waste generated (TPD)	Collected (TPD)	Treated (TPD)	Landfilled (TPD)
1	Andhra Pradesh	6898	6829	1133 205	205
2	Arunachal Pradesh	236.51	202.11	Nil	27.5
3	Assam	1199	1091	41.4	0
4	Bihar	4281.27	4281.27	Not provided	No
5	Chhattisgarh	1650	1650	1650	0
6	Goa	226.87	218.87	197.47	22.05
7	Gujarat	10373.79	10332	6946	3385.82
8	Haryana	5352.12	5291.41	3123.9	2167.51
9	Himachal Pradesh	346	332	221	111
10	Jammu and Kashmir	1463.23	1437.28	547.5	376
11	Jharkhand	2226.39	1851.65	758.26	1086.33

12	Karnataka	11085	10198	6817	1250
13	Kerala	3543	964.76	2550	Not Provided
14	Madhya Pradesh	8022.5	7235.5	6472	763.5
15	Maharashtra	22632.71	22584.4	15056.1	1355.36 (Unscientif ically disposed= 6221.5)
16	Manipur	282.3	190.3	108.6	81.7
17	Meghalaya	107.01	93.02	9.64	83.4
18	Mizoram	345.47	275.92	269.71	0
19	Nagaland	330.49	285.49	122	7.5
20	Odisha	2132.95	2097.14	1038.31	1034.33
21	Punjab	4338.37	4278.86	1894.04	2384.82
22	Rajasthan	6897.16	6720.476	1210.46	5082.16
23	Sikkim	71.9	71.9	20.35	51.55
24	Tamil Nadu	13422	12844	9430.35	2301.04
25	Telangana	9965	9965	7530	991
26	Tripura	333.9	317.69	214.06	12.9
27	Uttarakhand	1458.46 -	1378.99	779.	85
28	Uttar Pradesh	14710	14292	5520	0
29	West Bengal	13709	13356	667.6	202.23
30	Andaman and Nicobar Island	89	82	75	7
31	Chandigarh	513	513	69	444
32	DDDNH	267	267	237	14.5
33	Delhi	10990	10990	5193.57	5533
34	Lakshadweep	35	17.13	17.13	Nil
35	Puducherry	504.5	482	36	446
	Total	160038.9	152749.5	79956.3	29427.2

Source: Annual Report on Solid Waste Management (2020-21), CPCB, Delhi

The table 5 shows the state wise solid waste management status for the year 2020-21. The total quantity of Solid waste generated in the country is 160038.9 TPD of which 152749.5 TPD of waste is collected at a collection efficiency of 95.4%. 79956.3 TPD (50 %) of waste is treated and 29427.2 (18.4%) TPD is landfilled. 50655.4 TPD which is 31.7 % of the total waste generated remains un-accounted.

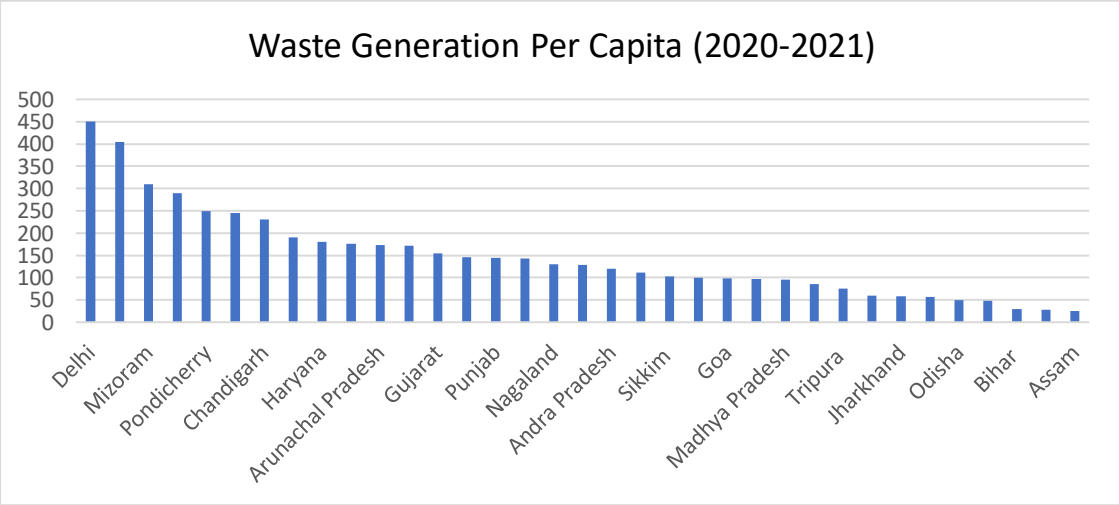
Table 6: Solid Waste Generation Per Capita

Year	Solid Waste Generation Per Capita (gm/day)
2015-16	118.68
2016-17	132.78
2018-19	121.54
2019-20	119.26
2020-21	119.07

Source: Annual Report on Solid Waste Management (2020-21), CPCB, Delhi

The Per capita solid waste generation has been calculated for the last five years and is given in Table 6. The Marginal decreasing trend is observed in per capita solid waste generation over the last five years.

Figure 2: State wise Solid Waste Generation Per Capita 2020-21



Source: Annual Report on Solid Waste Management (2020-21), CPCB, Delhi

The figure 2 highlights the state wise per capita solid waste generation for the year 2020-21. It reflects that Delhi has maximum per capita solid waste generation of 450 TPD, followed by Lakshadweep (400 TPD), Mizoram (310 TPD) where as Chhattisgarh has 57 TPD per capita solid waste generation, followed by Odisha (49 TPD), Himachal Pradesh (48 TPD), Bihar (30 TPD) respectively. Meghalaya (28 TPD) and Assam (25 TPD) have witnessed minimum per capita solid waste generation.

Table 7: Projected Population Growth and Overall Impact on Waste Generation.

Year	Population ($x10^6$)	Per capita generation (kg per day)	Total waste generation ($x10^6$ Tonnes per year)
2001	197.3	0.439	31.63
2011	260.1	0.498	47.30
2021	342.8	0.569	71.15
2031	451.8	0.649	107.01
2036	518.6	0.693	131.24
2041	595.4	0.741	160.96

Source: Report on sustainable solid waste management in India. Waste-to-Energy Research and Technology Council (WTERT)

The table number 7 exhibits the sustainable solid waste management in India which indicates that 366 cities in India were generating 31.6 million tons of waste in 2001 and in 2011, it was generating 47.3 million tons, a 50% increase in one decade. It is estimated that these 366 cities will generate 161 million tons of MSW in 2041, a five-fold increase on in four decades. At this rate the total urban MSW generated in 2041 would be 230 million TPY (630,000 TPD). Further in 2021 the per capita generation is 0.569 kg/day which is projected to increase by 0.649 kg/day, 0.693 kg/day and 0.741 kg/day in 2031, 2026 and 2041 respectively.

4. Conclusions

In most of the developing countries among several municipal communities, there are very few primary studies on the economics of managing solid wastes. However, in the present chapter the economics of managing solid waste discusses about economics of waste, overview of waste at global and national level, economic instruments, e-waste, issues and constraints of waste management etc.

Furthermore, the introduction of economic means possesses great threats. Therefore, there is an urgency to reinvigorate the institution and governance at local levels. In many developing countries including India, economists are grappling with a number of difficulties in evaluating the cost effectiveness of waste management on account of paucity of data on generation, disposal and recycling of wastes (Balasubramanian, 2015, 2018,2019, Balasubramanian and Birundha, 2012). The Solid Waste Economic estimate provides information to local policy makers to help formulate healthy urban planning for sustainable cities.

The developing countries undergoes financial and technological deprivations to enhance the effective waste management system. Therefore, the economics of waste management would gradually be emerged as a sound mechanism for waste management, primarily the cost-benefit aspects at the local and regional level (Defra, 2011). The economic estimation of solid waste is also very useful in helping decision makers to develop taxes / fees or other economic means to efficiently allocate financial and technical resources in a productive manner at the city level (Kinnaman and Fullterton, 1999).

References

Aleluia, J. and Ferrão, P., 2017. Assessing the costs of municipal solid waste treatment technologies in developing Asian countries. Waste Management, 69, pp.592-608. https://doi.org/10.1016/j.wasman.2017.08.047

Amasuomo, A. E., Baird, J. (2016) The Concept of Waste and Waste Management, J. Manag. Sustain. 6 (2016) 88–96. https://doi.org/10.5539/jms.v6n4p88

Annepu, R. K. (2012). Report on sustainable solid waste management in India. Waste-to-Energy Research and Technology Council (WTERT), 1-189.

Annual Report on Solid Waste Management of various years, CPCB, Delhi.

Burntley, S.J., (2007). A review of municipal solid waste composition in the United Kingdom. *Journal of Waste Management* 27 (10), 1274–1285. https://doi.org/10.1016/j.wasman.2006.06.018

Balasubramanian, M. and Birundha, V.D., 2012. An economic analysis of solid waste management in Madurai District, Tamil Nadu. Applied Journal of Hygiene, 1(1), pp.1-7. doi: 10.5829/idosi.ajh.2012.1.1.55156

Balasubramanian, M., 2015. Economics of solid waste in India. Economic and political Weekly, 50(25), pp.17-20.

Balasubramanian, M. (2020). Economics of Solid Waste Management: A Review. Strategies of Sustainable Solid Waste Management.

Casado, M.R., Serafini, J., Glen, J. and Angus, A., 2017. Monetizing the impacts of waste incinerators sited on brownfield land using the hedonic pricing method. Waste Management, 61, pp.608-616

Defra (2011) The Economics of Waste and Waste Policy, Department for Environment, Food and Rural Affairs, London.

Hou, D., Al-Tabbaa, A., Guthrie, P., & Watanabe, K. (2012). Sustainable waste and materials management: national policy and global perspective.

https://openknowledge.worldbank.org/handle/10986/30317

Kinnaman, T.C. and Fullterton, D. (1999). The economics of residential solid waste management (No. w7326). National Bureau of Economic Research. doi10.3386/w7326

Krishnan,P.(2021) "The Covid-19 Pandemic: From a Bird's Eye on Environment and Ecology." *The Central chronicles*, Raipur edition,08.

Mor. R., Sangwan K. S., Singh. S., (2021) E-waste Management for Environmental Sustainability: an Exploratory Study, Procedia CIRP. 98 (2021) 193–198. https://doi.org/10.1016/j.procir.2021.01.029

Nahman, A., 2011. Pricing landfill externalities: Emissions and disamenity costs in Cape Town, South Africa. Waste Management, 31(9-10), pp.2046-2056.

Ouda, O. K., & Raza, S. A. (2014, May). Waste-to-energy: solution for municipal solid waste challenges-global perspective. In 2014 International Symposium on Technology Management and Emerging Technologies (pp. 270-274). IEEE.

Report on sustainable solid waste management in India. Waste-to-Energy Research and Technology Council (WTERT).

Sharholy, M., Ahmad, K., Vaishya, R., Gupta, R., 2007. Municipal solid waste characteristics and management in Allahabad, India. Waste Management 27 (4), 490–496.

https://doi.org/10.1016/j.wasman.2006.03.001

Sujauddin, M., Huda, M.S., Rafiqul Hoque, A.T.M., 2008. Household solid waste characteristics and management in Chittagong, Bangladesh. Journal of Waste Management 28, 1688–1695.

Analyzing The Linkage Between GDP, Energy Consumption And Carbon Emission: Evidence Form Major Economies

Abhishek Anand
Dhiresh Kulshrestha
S.R. Sagar
Narinder Kumar

Abstract:

Energy, growth and environmental degradation is the major topic of debate globally and an important aspect for every economy. Globally it has been a major challenge to adhere with the sustainable development goals along with the development of the economy. In the aspect the study is being undertaken to see the correlation and the adherence of the major economies of the world compared to India towards sustainable development goals. Energy has been the major source of manufacturing sector which has led to growth in production and GDP of the country. Countries considered industrial revolution as a benchmark for the development and fulfil the demand of the population in the economy. However, these instances also came with negative impact such as – degradation of environment, depletion of natural resources, health issues, etc. The study is undertaken to analyse the variables- energy consumption, per capita GDP and CO_2 emission in respect of the top 3 GDPs of the world (United States, China and Japan) and comparing it with India. The study will analyse the level and trend of the variables and their correlation in different economies. The trends will analyse whether the countries are adhering or will be able to achieve SDG goals of United Nations.

Keywords: energy, degradation, sustainable development, growth

Introduction

Developing country have boundations and limitation due to the characteristic in attaining economic growth and development. Each country wants to follow and adopt the strategy which focusses to increase productivity, efficiency, job creation, income, better standard of living, etc. which consider all socio- economic outputs of an individual and an economy.

Along with labour and capital, energy has become today an important source of production and development of the economy. Natural resource is an important source of energy and in ease of rapid development and competition globally, economies has exploited natural sources of energy at all the possible. Energy has been the major source of manufacturing sector which has led to growth in production and GDP of the country. Countries considered industrial revolution as a benchmark for the development and fulfil the demand of the population in the economy. However, these instances also came with negative impact such as – degradation of environment, depletion of natural resources, health issues, etc. These competition of producing more and more by the economies has led to the concern for environmental degradation and path for unsustainable growth. In 21st century the greater concern and global discussion is sustainability, CO_2 emission and environment. Establishment of United Nation Environmental Programme (UNEP) and the United Nation Development Programme (UNDP) are the result of United Nation Conference on Human Environment in 1972 which came up with the notion of sustainable development. The empirical literature such as EKC has also brought attention, discussion and research to find the linkage between growth of an economy and its environmental degradation.

The study is undertaken to analyse the variables- energy consumption, per capita GDP and CO_2 emission in respect of the top 3 GDPs of the world (United States, China and Japan) and comparing it with India. The study will analyse the level and trend of the variables and their correlation in different economies. The trends will analyse whether the countries are adhering or will be able to achieve SDG goals of United Nations.

Assistant Professor, department of Economics, Chitkara Business School, Chitkara University, Punjab
Professor and Dean Economics, Chitkara Business School, Chitkara University, Punjab
Guest faculty, T.M. Bhagalpur University, Bihar
Assistant Professor, department of Economics, Chitkara Business School, Chitkara University, Punjab

Past Literature

The study on the relationship between economic growth and consumption of energy was undertaken in 1978 by Kraft and Kraft who analysed the data of United States from 1947 – 174 and concluded that energy consumption increases due to increase in GNP. In 2000, Granger causality test was done by Asafa- Adjaye between consumption of energy and income taking into consideration four developing countries of Asia. The analysis and the results concluded that there is not a neutral relationship between energy and income. In 2004 an attempt was made by El- Sakka to study thew relationship between energy consumption and growth of output in Canada. He studies concluded that for Canada, the limiting factor for growth was energy. In 2006, Sari and Soytas analysed the data of G7 countries to see the relation between consumption of energy and income in the sector of production. The study concluded that the causality runs in both directions for Canada, Italy, Japan and United Kingdom for United States and France the causality test shows that runs from the usage of energy to income and for Germany the causality runs from income to consumption of energy.in 2008, Narayan and Smith analysed the relation between real GDP, consumption of energy and formation of capital, using Granger causality. The study concluded that the major factor influencing economic growth is energy consumption. According to the study undertaken by Swan and Halemburg in 2009 and 2012 respectively has concluded that industrial sector as the largest sector consuming energy which is being followed by household and transportation sector respectively. Lee and Chang in 2007 through concluded for the developed and developing countries through the panel analysis that main source of energy s on fossil fuel and there is very less or marginal investment on renewable source of energy. The study also found that almost energy consumption of the developing countries in the world account for about 40% is globally by the developing countries.

Purpose of the Study

Purpose of the study being undertaken is to analyze the relation between energy consumption and economic growth, along with relation of CO_2 emission to the economic growth. The study analyzes and compares the energy consumption and CO_2 emission of 3 top GDPs of the world compared to India on the basis of their GDP. The study will analyze the trends of consumption of energy along with CO_2 emissions. Paper is designed to see whether there is any significant role of energy in the development of Indian economy and its impact on and CO_2 emissions. The study will help the policymakers for framing the appropriate policy in the context of energy sector so as to promote inclusive growth of the country with sustainability of environment.

Objective of the study

- To analyze the energy consumption of top 3 GDPs of the world compared to India.
- To analyze relation between consumption of energy (per capita) of India and its development (GDP per capita).
- Analyze the and CO_2 emissions in India compared other major countries of world in GDP.
- To analyze whether there is any relation between and CO_2 emissions in India and its development (per capita GDP).

Research Methodology

For the study to be undertaken we have taken following four hypotheses to analyze the role of consumption of energy and its impact on environment degradation and growth in GDP along with the development of an economy.

1. The null hypothesis H_0 taken is: Annual energy consumption of top 3 GDPs of the world is more as compared to India. For which the alternative hypothesis is taken as H_1 is: Annual energy consumption in India is not more as compared to top 3 GDPs of the world.

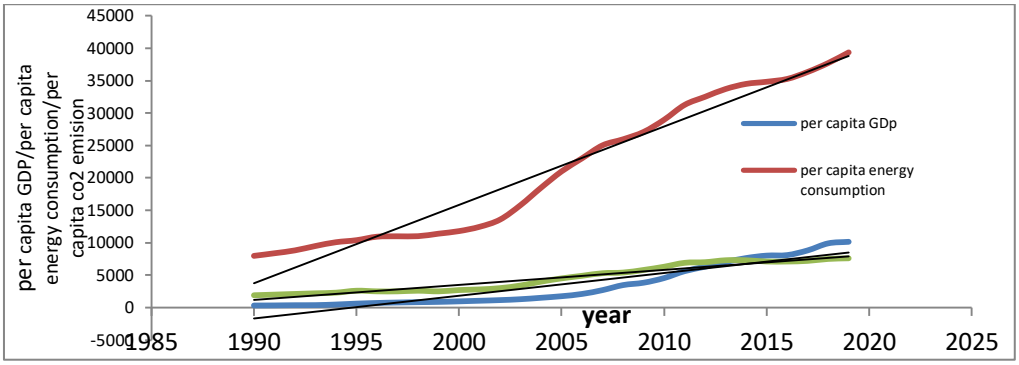
2. The null hypothesis H_0 taken is: Consumption of energy per capita in India increased with a rise in GDP (per capita). In this regard the alternative hypothesis is taken as H_1**: C**onsumption of energy per capita in India have not increased with a rise in GDP per capita.
3. The null hypothesis H_0 taken is: Per capita CO_2 emission of top 3 GDPs of world is more compared to India. The alternative hypothesis H_1 taken is: Per capita CO_2 emission of top 3 GDPs of world is not more compared to India.

For the analysis of data ANOVA, correlation and time series data analysis has been applied to for the interpretation and their relation. Variables being undertaken are energy consumption, per capita energy consumption, GDP per capita and CO_2 emission by top 3 GDPs of the world. The test will analyze graphically and empirically the consumption of energy, CO_2 emission and impact of GDP per capita of India on energy and CO_2 emission.

Data Analysis Relationship between per capita GDP, per capita energy consumption and CO_2 emission by different countries

China

Figure: 1



In the above figure we see that by analysing the data for last 30 years GDP per capita, energy consumption per capita and emission of CO_2 per capita is increasing.

Table: 1

GDP per capita		Per Capita Energy consumption	Per Capita CO_2 emission
Mean	3385.733333	21271.0802	45433.333
Standard Error	603.1679946	1992.182983	388.858
Standard Deviation	3303.687166	10911.63559	2129.89
The correlation between GDP per capita and energy consumption per capita = 0.9576		The correlation between energy consumption per capita and CO_2 emission per = 0.99456	The correlation between per capita GDP and CO_2 emission per capita = 0.944
$r^2 = 0.917$		$r^2 = 0.9890$	$r^2 = 0.88736$
T = 17.556		T =50.07	T =14
D. f = 28		D. f =28	D. f =28
$T_{0.05}$= 2.05		$T_{0.05}$=2.05	$T_{0.05}$=2.05

By the above analysis we can say that there is a significance relation between per capita GDP, per capita energy consumption and per capita CO_2 emission.

In Chinese economy there is high correlation found in the variables of GDP per capita, energy consumption.

Japan

Figure: 2

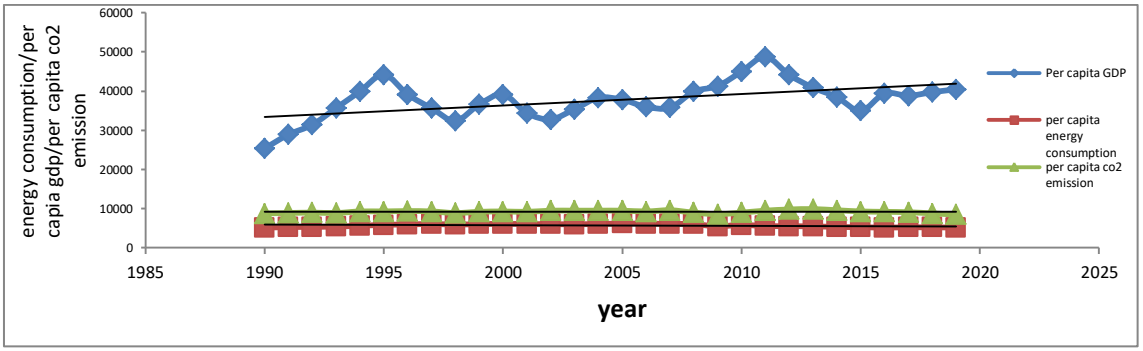


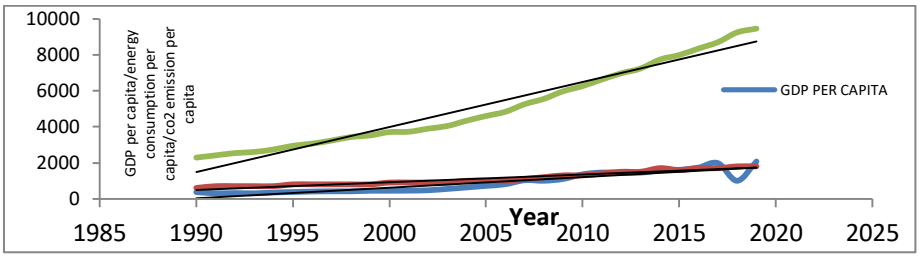
Table:2

	GDP Per capita	consumption of energy per capita	CO_2 emissions per capita
Mean	37693	5708.049	9223.333
Standard Error	879.574436	67.93536	61.34195
Standard Deviation	4817.627596	372.0973	335.9837
	The correlation between GDP per capita and energy consumption per capita = 0.047401436	The correlation between GDP per capita and CO_2 emission per capita = 0.3250	The correlation consumption of energy per capita and emission of CO_2 per capita = 0.3783
Coefficient of determination (r^2)	0.002227	0.1056	0.141
Calculated t Value (T)	17.556	50.07	14
Degree of freedom (d.f)	28	28	28
Significance value($T_{0.05}$)	2.05	2.05	2.05

From the above analysis of Japan there is found to be no correlation between the variables, i.e., per capita GDP, pe capita energy consumption and emission of CO_2 per capita, but there is low degree relation between energy consumption per capita and CO_2 emission per capita. It is because the calculate value t is greater than te tabulated value of t. therefore, the relation between energy consumption per capita and CO_2 emission per capita is significant.

India

Figure: 3



There is significant relation between per capita GDP, per capita energy consumption and per capita CO_2 emission. There is high degree of correlation as t calculated is more than the t tabulated. Therefore, the relation is significant.

Table:3

	GDP Per capita	emission of CO_2 per capita	per capita energy consumption
Mean	884.8333333	1120	5111.334
Standard Error	102.0870497	70.53164	410.0828
Standard Deviation	559.1537993	386.3177	2246.116
	The correlation between GDP per capita and consumption of energy per capita = 0.939960459	The correlation between GDP per capita and emission of CO_2 per capita = 0.938521723	The correlation between consumption of energy per capita and emission of CO_2 per capita = 0.994082524
Coefficient of determination	$r^2 = 0.881721$	$r^2 = 0.91973$	$r^2 = 0.988036$
Calculated t Value (T)	2.3	17.69	23.19
Degree of freedom (d.f)	28	28	28
Significance value($T_{0.05}$)	2.05	2.05	2.05

USA

Figure: 4

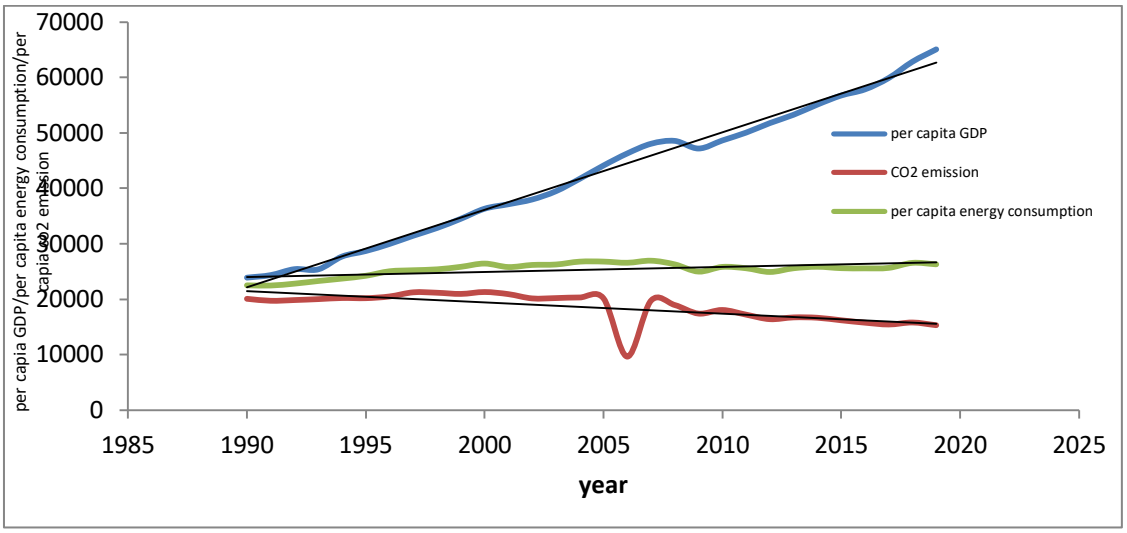


Table: 4

	GDP per capita	CO2 emission	per capita energy consumption
Mean	42418.57	18535.33	25362.81
Standard Error	2257.788	476.9143	232.047
Standard Deviation	12366.41	2612.167	1270.974
Correlation	The correlation between consumption of energy per capita and GDP per capita = 0.648191152	The correlation of CO_2 emissions per capita and GDP per capita = -0.694125054	The correlation between consumption of energy per capita and CO_2 emissions per capita = -0.251423444
Coefficient of determination	$r^2 = 0.4199$	$r^2 = 0.4096$	$r^2 = 0.0625$
Calculated t Value (T)	4.887	- 4.73	- 1.364
Degree of freedom (d.f)	28	28	28
Significance value ($T_{0.05}$)	2.05	2.05	2.05

There is moderate degree of correlation between per capita GDP, energy consumption and CO_2 emission; and correlation among GDP, energy consumption and CO_2 emission are significant.

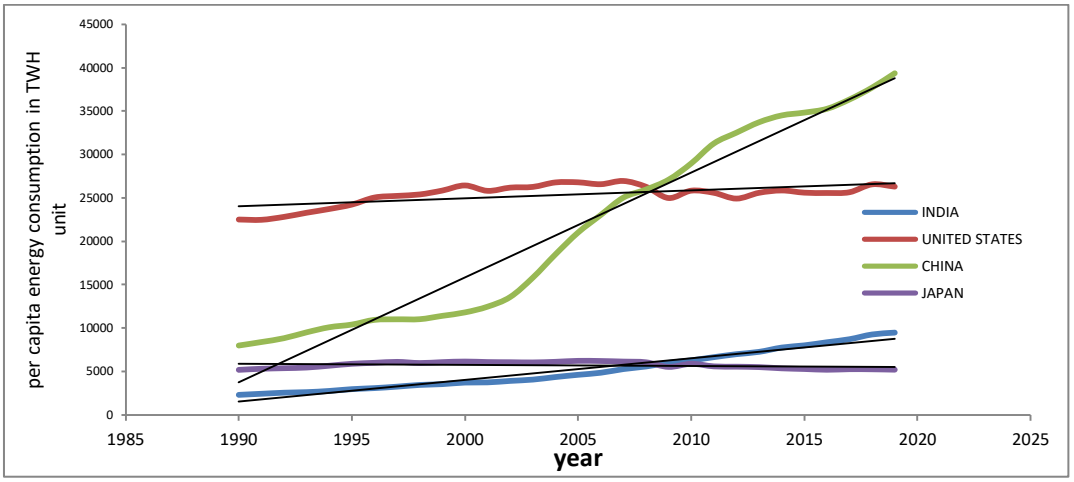
Here, $T_{cal.} > T_{tab.}$

4.887 > 2.05 at degree of freedom = 29.

so, their relation is significant.

Comparative study of energy consumption in TWH Unit

Figure: 5



In the figure we see that energy consumption per capita of India and China is increasing, energy consumption of United States per capita and Japan is constant.

Table: 5

S.N.	Country	Per capita energy consumption (Average in last 30 years) in TWH unit
1.	India	1120
2.	Chinese	21271.0802
3.	Japan	5708.049
4.	USA	18535.33

Comparative study of per capita GDP in US$

Figure: 6

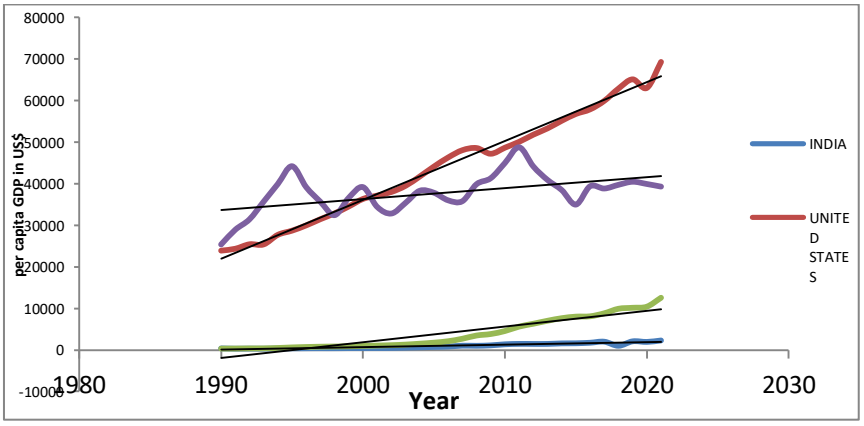


Table: 6

S.N.	Country	Per capita energy consumption (Average in last 30 years) in TWH unit
1.	India	884.8333333
2.	Chinese	3385.733333
3.	Japan	37693
4.	USA	42418.57

According to the above analysis GDP per capita of China and United States is increasing, India's is constant or increasing at a very slower rate. Whereas, in case of Japan tendency of growth can be seen.

Comparative study of per capita CO_2 emission

Figure: 7

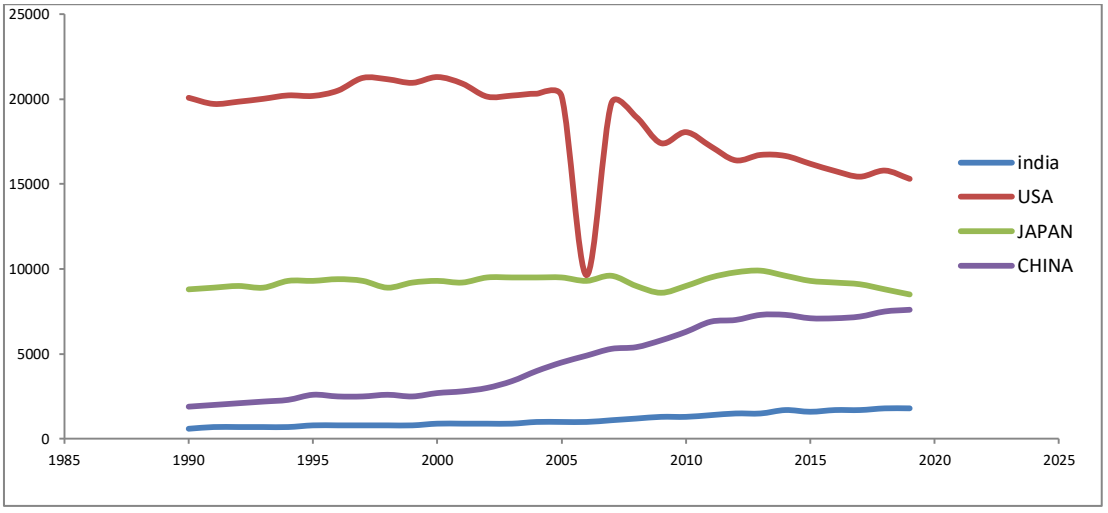


Table: 7

Sl.No.	Country	Per capita CO_2 emission (Average in last 30 years) in kg unit
1.	India	1120
2.	Chinese	4543.33
3.	Japan	9223.33
4.	USA	18535.33

From the above analysis we can say that there has been rapid increase in CO_2 emissions of China. In India and Japan, it is almost constant. Whereas, there is long term tendency of decline in CO_2 emission for United States

Conclusion

The study undertaken has analysed the study of three variables which are per capita GDP, per capita energy consumption and per capita carbon emission by the top 3 GDP countries of the world and

compare it with India. The study concludes that the per capita energy consumption is increasing for India along with the China. In context of per capita GDP, we can see that it is increasing for United States and China but the increase in India and Japan is at a slower rate. In the comparative analysis of CO_2 emissions, it is seen that the emissions have increased for India. whereas, it has a decreasing tendency for United States.

From the analysis we can say that correlation between GDP per capita and consumption of energy per capita is lower in Japan and United States as compared to India. In the correlation between GDP per capita and emission of CO_2 is also higher in India. The study concludes that the countries taken for the study countries taken for the comparative study, China's correlation is higher along with India compared to United States and Japan. It is the need for Indian government to frame the policy makers adopt the clean source of energy for the development purpose, so as to adhere to the sustainable development goals.

References

Asafu-Adjaye, J. (2000), "Th e relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries", Energy Economics, 22(6): 615-625.

Kraft, J., and Kraft, A. (1978), "On the relationship between energy and GNP", Journal of Energy and Development, 3(2): 401-403.

Narayan, P.K., and Smyth, R. (2008), "Energy consumption and real GDP in G7 countries: New evidence from panel cointegration with structural breaks", Energy Economics, 30(5): 2331-2341.

Soytas, U., and Sari, R. (2006), "Energy consumption and income in G-7 countries", Journal of Policy Modeling, 28(7): 739-750.

Ghali, K.H., and El-Sakka, M.I.T. (2004), "Energy use and output growth in Canada: a multivariate cointegration analysis", Energy Economics, 26(2): 225-238.

Abhishek Anand, (2019), "Sustainable Development a Global Challenge

" IJRAR, Issue 2, 341z – 346z.

Kasperowicz R., Štreimikienė D. (2016), Economic growth and energy consumption: comparative analysis of V4 and the "old" EU countries, Journal of International Studies, Vol. 9, No 2, pp. 181-194. DOI: 10.14254/2071-8330.2016/9-2/14

Lee, C. C., & Chang, C. P. (2007). Energy consumption and GDP revisited: a panel analysis of developed and developing countries. Energy Economics, 29(6), 1206-1223.

Swan, L. G., & Ugursal, V. I. (2009). Modeling of end-use energy consumption in the residential sector: A review of modeling techniques. Renewable and sustainable energy reviews, 13(8), 1819-1835. [3] Holmberg, K., Andersson, P., & Erdemir, A. (2012). Global energy consumption due to friction in passenger cars. Tribology International, 47, 221-234.

https://data.worldbank.org/

https://ourworldindata.org/energy-production-consumption

https://www.statista.com/statistics/263455/primary-energy-consumption-of-selected-countries/

Stern, D. I. (1997). Limits to substitution and irreversibility in production and consumption: a neoclassical interpretation of ecological economics. Ecological economics, 21(3), 197-215.

Stern, D. I., Burke, P. J., & Bruns, S. B. (2019). The impact of electricity on economic development: a macroeconomic perspective.

Wang, W., Zhang, M., & Li, P. (2014). Exploring temporal and spatial evolution of global energy production and consumption. Renewable and Sustainable Energy Reviews, 30, 943-949.

Wrigley, E. A. (2013). Energy and the English industrial revolution. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 371(1986), 20110568.

The sustainable development goals in Developing and underdeveloped countries

Devendra Vishwakarma

Abstract :

Sustainable Development Goals (SDGs) proposed by United Nations (UN) in 2015 comprising a universally acceptable worldwide development agenda which each country of the world has to achieve till 2030. The main challenges to sustainable development which are global in character include poverty and exclusion, unemployment, climate change, conflict and humanitarian aid, building peaceful and inclusive societies, building strong institutions of governance and supporting the rule of law. To save the planet from extreme poverty, hunger, malnutrition, equitable access to modern technology improved education and health for all human beings. The Developed Countries should give at least one percent of their Gross National Product (GNP) in the form of development assistance to poor countries. The study suggests that good governance that could undertake and implement structural reforms are necessary to deal with the challenges confronting to countries in achieving the targets these stipulated goals. More importantly, the Developed Countries (DCs) started to implement their strategies to view Sustainable Development Goals targets. Now need that Developed Countries should assist the Under Developed Countries (UDCs) and help them from their experience in identifying the transformational challenges which they possibly have to face in achieving Sustainable Development Goals targets. Otherwise, it looks impossible for the Under Developed Countries to come up with these targets till 2030.The study outcomes can prove very much helpful for Developing and Under Developed Countries for achieving these targets and devising thriving economic policies generous to attaining their targets till 2030.

Keywords :-Sustainable Development Goals (SDGs), Gross National Product (GNP), Developed Countries, Developing and Under Developed Countries (UDCs).

Introduction :

The **Sustainable Development Goals**, also known as the **Global Goals**, are a call from the **United Nations** to all countries around the world to address the great challenges that humanity faces.The Sustainable development encompasses the achievement of three interconnected objectives are economic development, social inclusion, and environmental sustainability which are necessary for the well-being of individuals and societies. A set of 17 goals and 169 targets adopted by countries to end poverty and hunger, ensure healthy lives, promotion of well-being, inclusive and quality education for all, achievement of gender equality by empowering all women and girls, ensuring access to safe water and sanitation, energy, information and technology, reduce inequality within, and among countries, make cities safe and sustainable, ensure sustainable consumption and production patterns, take urgent action to combat climate change, conserve and sustainably use the oceans and seas, manage forests to protect biodiversity, promote just, peaceful and inclusive societies, and revitalize the global partnership for sustainable development.

UNDP-UNRISD report reviews recent trends in six areas that are fundamentally important to achieving the 2030 Agenda. These six 'mega-trends' relate to (i) poverty and inequalities, (ii) demography, (iii) environmental degradation and climate change, (iv) shocks and crises, (v) development cooperation and financing for development, and (vi) technological innovation. Some of the trends are positive, including on the reduction of absolute poverty and several technological innovations. Yet negative trends in several of the others pose a significant risk to the realization of the SDGs.

MA Economics, MA Rural Development, MSW, MBA, LLB, Ph.D& D-litt in Economics ,EC Member of Indian Economic Association & In charge of Madhya Pradesh , Professor Radiant college & senior consultants bhoj open university

The challenge of sustainable development is the challenge of achieving environmental conservation and resource management without compromising the targets of growth and development. It is therefore a process of making human and environmental regeneration not only an end of economic growth but also a means. It redefines wealth and restructures qualitative development in economic growth policies. Sustainable development is in itself revolutionary since it replaces exchange value by intrinsic value, market regulation by self-regulation and capital accumulation with de-accumulation. It is an effort and a design to raise poor countries of the world from social decadence, exploitation, global inequity and waste.

Developing and under developed countries are on a sustained growth path, they will be able to address a wide range of needs, including environmental protection and the eradication of poverty. The countries has performed persistent sustained economic growth since the introduction of open door policy in 1986, particularly after holding a full membership of ASEAN in 1997, it is questionable whether economic growth is of benefit to the reduction of either poverty or social inequality, or whether the economic growth produces negative impacts on environmental condition. The interaction of these determinants is considered to be a primary concept of sustainable development, which remains a major challenge for current and future development of developing and under developed countries. Poverty eradication has become the objective of the government's economic and social policy in many developing countries. In these countries, although the Government has reported that the average proportion of poverty has decreased significantly, this issue remains very important, particularly, in rural areas. In addition, the inequality level of income distribution is increasing, hence, it is questionable whether economic growth is distributed throughout the population or not, and an increase in the level of inequality is assumed to reduce the level of sustainable development. Moreover, an increase in the amount of industrial and manufacturing factories increases in the volume of pollution and produces negative impacts on environmental systems. Therefore, the environmental issue has become an important topic among the policy makers in developing and under developed countries. Three major issues will be discussed in this research. The first one is to identify the determinants influencing economic growth, the second one is to examine the impacts of economic growth on poverty and income distribution, and the last one is to investigate the impacts of economic growth on environmental conditions. These three issues are identified in order to find reasonable evidences to provide some suggestions for sustainable development for current and long run development for developing and under developed countries.

Objectives :-

The strong commitment of the Governments of developing and under developing countries is to achieve the Millennium Development Goals (MDGs), while exiting the ranks of the Least Developed Countries (LDCs) by the year 2020. With this specific target to achieve, a high rate of economic growth is considered as a necessary condition for economic development but it is not a panacea for socioeconomic development. The impact of economic growth factors such as social development, particularly, poverty and income distribution which remains a challenge for economic development of developing and under developed countries. The other one is the impact of economic growth on the environmental factors such as deforestation and environmental degradation. Economic growth is considered as a key factor to achieve the national development goal of developing and under developed countries; however, if the government's policies are focused only on economic growth as to reach a minimum income to graduate, without considering their impacts on the other aspects, such as social, cultural, and natural sustainability, this could mean that the envisaged development mechanisms and processes would prove inadequate for country's long term development perspective. For this reason, to achieve successfully the goals of the various economic development plans, the government needs to consider both the development potential to increase the wealth of people in the countries and also to preserve the sustainability of development that would ensure lasting benefits for the country's future generations.

Literature Review :-

Sustainable development (SD) refers to a mode of human development whereby resources use aims to meet human needs while ensuring the sustainability of natural systems and the environmental conditions (Smith et al., 1998). The concept of SD is related to different issues of socio-economic development, which aims to determine the needs for societies to be sustained. The term SD is largely used; the Brundt land Commission introduced the idea that the next generation should access to have the same degree well-being opportunities as the current generation. In other words, sustainable development is described as "non-decline" in time of human welfare, which can be estimated, based on the type of analysis, through the level of human utility, earnings, and consumption (United Nations, 1987)

Disano (2001), the underlying theme of SD is the integration of economic, social, and environmental issues in decision and policy making at all levels of development dimensions. This helps the understanding of the various dimensions of sustainable development and their complex interactions and the facilitation of policy decisions aimed at achieving sustainable development goals. The integration implies the involvement of virtually all traditional sectors of economic and government activity, such as economic planning, agriculture, health, energy, water, natural resources, industry, education, and the environment. Several studies show that the wealthy benefit from growth and the remainder of the population is affected by the costs of resource depletion, social stress, environmental degradation, and other problems (Bo Gao, 2001; Greiner, 2010; Limskul et al., 2013). Referring to the World Commission on Environment and Development (2011), sustainable development contains two key concepts: (1) the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and (2) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet the present and future needs.

David (1996) states that SD is about achieving the economic growth needed to meet human needs, improve living standards, and provide the financial resources that make environmental protection possible. There are two major aims of SD, including a sustainable economy that equitably meets human needs without extracting resource inputs or expelling waste in excess of the environment's renewing capacity and sustainable human institutions that assure both security and the opportunity for social interaction and spiritual growth.

The impact of foreign aid on the economic growth process of developing countries has been a topic of intense debate. The impact of foreign aid on economic growth is supported by several studies, such as Gomanee et al. (2003), Dalgaard et al. (2004), and Karras (2006). However, there are two major contrasting views in this debate. One argues that aid has a positive effect on economic growth, with an even greater impact in countries with sound economic and trade policies. The other contends that foreign aid causes corruption, encourages rent-seeking behaviour, and erodes bureaucratic institutions (Dollar and Burnside, 2000; Anup Shah, 2012).

Growth theory has mainly developed from the neoclassical model, such as by Solow (1956), Cass (1965), and Koopmans (1965). The neoclassical model has an aggregate approach. 51 Solow's model19 of economic growth allows the determinants of economic growth to be separated out into increases in inputs (labour and capital) and technical progress. Economic growth studies begin with the neoclassical production function which has the form: (1) where Y represents the total production in an economy, A denotes total factor productivity which is usually known as technology level (and its change in time), K is capital, and L is labour and α is elasticity of output to capital. Please note that the technology in the general Solow Growth Model is contained in the residual term A, and is meant to represent societal factors that are not taken into account in Capital (K) or Labour (L) The theory of Solow (1956) essentially argues that when production takes place under neoclassical conditions and constant returns to scale, there will no opposition between natural and unwarranted rates of growth. The system is self-

adjusting to any given rate of growth in the labour force and eventually approaches a state of steady proportional expansion. The main innovation introduced by Solow is the ability to allow for factor sustainability, so that stable equilibrium growth could be attained. One characteristic of this model is the convergence property. Many studies remark that a country that begins with a lower level of GDP per capita is expected to achieve a higher growth rate in the long term. This could imply the assumption that if all economies were basically the same, except for their initial capital intensities, poor economies would grow faster than rich ones.

However, this theory has not been completely proved by the empirical analysis, since the economic systems of different countries differ in various features, including the government policy, access to work, international cooperation, willingness to work, and access to technology. The widespread use of the neoclassical model focuses on the roles played in coordinating and integrating various factors in macroeconomics, public finance, and international economics. Due to the dependence of growth on exogenous technical progress in the neoclassical growth model and the evident inconsistency of the "unconditional convergence", the hypothesis led to a renewed search for alternative models that can generate economic growth endogenously. According to the endogenous growth theory, economic growth is primarily the result of endogenous and not external forces. This theory maintains that investment in human capital, innovation, and knowledge is a significant contribution to economic growth; therefore, the endogenous theory emphasizes education, on-the-job training, and the development of new technologies, accounting for their increasing relevance (Lucas 1988).

Romer (1990), who identifies four basic preconditions for growth: (1) capital-measured in units of consumption goods; (2) labour skills available from a healthy human body; (3) human capital-activities such as formal education and on-the-job training, which is person-specific; and (4) an index of the level of technology. However, this model specification is less clear about the technical progress and the factors influencing growth are hard to measure.

Kottaridi and Stengos (2010) examined the relationship between FDI and economic growth by contrasting past empirical evidence and conventional wisdom and arriving at some interesting new results. Applying non-parametric methods, and taking into account non-linear effects of initial income and human capital on economic growth, they explored the FDI effect on growth in much greater detail than previous studies. Their findings not only confirm the non-linear effect of human capital in the presence of FDI inflows but also suggest that FDI inflows are growth 59 enhancing in the middle-income countries while there is a 'two-regime' FDI effect for high income countries.

Chansomphou and Ichihashi (2011) examined the impact of foreign aid and foreign direct investment on the long-run and short-run per capita income growth of Laos. Using time-series data for the period 1970-2008 and modified Solow's growth model, they find that foreign aid has a strong positive impact and it is considered to be a main contributor to income growth in Laos, while FDI has a negative impact on income per capita. They concluded that the negative impact of FDI might be due to its concentration in few economic sectors and its extreme rises and falls in some periods.

Easterly (2001) states that countries with positive income growth had a decline in the proportion of people below the poverty line, and the fastest average growth was associated with the fastest poverty reductions. In Indonesia, for example, which had average income growth of 76 percent from 1984 to 1996, the proportion of Indonesians beneath the poverty line in 1993 was one-quarter of what it was in 1984, (a bad reversal came with Indonesia's crisis over 1997- 1999, with average income falling by 12 percent and the poverty rate shooting up to 65 percent, again confirming that income and poverty move together.

Dollar and Kraay (2001) explored this question by studying the experiences of a group of developing countries that have significantly opened up to international trade during the past two decades. They provide evidence that, contrary to popular beliefs increased trade has strongly encouraged growth and poverty reduction and has contributed to narrowing the gaps between rich and poor worldwide. The persistent problem of poverty in the developing world has led to frequent questions about the effectiveness of economic growth in influencing poverty reduction. The persistence of poverty may also lead to pessimism about the impacts of market-oriented policies and outward looking development strategies. However, the programs launched by many developing countries for the reduction of poverty seek to evaluate the factors that are important to identify the exact 61 relationship between economic growth and poverty. Therefore, a large body of scientific literature on this topic has empirically examined the important independent variables.

Kuznets (1955) analysed the relationship between economic growth and income inequality using the "inverted U" hypothesis. He suggested that in the early stages of economic growth, income distribution tends to worsen, while in the next stage it improves as a wider segment of the population participate in the rising national income. This implies that the positive effect of this linkage depends on the level of economic development.

Grossman and Krueger (1991) state that the impact of economic growth on environmental quality is categorized through three different channels: (1) the scale effect, (2) the composition effect, and (3) the technique effect. By definition, the scale effect happens as pollution increases 65 with the size of the economy, the explanation being that if the structure of the economy and technology does not change, it is assumed that an increase in the scale of economic activity leads to an increase in pollution and environmental degradation. The composition effect refers to the change in production structure of an economy from agriculture-based to industry and service. In the first stage of the development process, pollution increases as the economic structure changes from agriculture to resource-intensive heavy industries. The last effect is the technique effect, which captures improvements in the technique of production and adaption of cleaner technologies and hence a reduction in pollution. Several studies have considered the impact of growth on environmental conditions.

Smyth et al. (2008), who conducted an analysis of the relationship between growth and environmental issues in China, finding that together with the high rate of economic growth, it also produces a high rate of pollution. Many cities in China are now suffering from a high level of pollution and natural disasters, as well as a traffic congestion problem. Those problems are becoming a major challenge for the future development of China.

Conclusion :-

This study investigated the determinants growth in developing and under developing countries. Finding from the study shows that high economic development promotes sustainable development and economic growth, which is in line with the assumption that countries with high GDP per capita possess adequate resources to support growth incentives. This implies the need to adopt economic development policies, which leads to increase GDP since it is a determinant of achieving growth goals and sustainability goals.

On the other hand, trade openness was found to exert a negative and significant relationship with growth and foreign direct investments having a negative but insignificant relationship with growth foreign direct investments having a negative relationship with growth. This implies that increased international activities such as trade and foreign investments may deter or slow countries goals. Therefore, it is important to ensure prompt restrictions and monitoring of foreign investments and movements to ensure the economic growth effect of FDI and trade is accompanied by environmental quality. The government and regulatory agencies of developed and particularly developing countries should be deliberate in their

sustainability goals to ensure growth. Meanwhile, the institutional quality is an insignificant determinant of growth, i.e., considering the role of government and institutional policies in the success of economic goals such as growth, the quality of environmental institutions in determining the growth achievement is insignificant. Findings further show that high energy consumption leads to a decrease in growth; however, renewable energy use improve growth. This shows that despite en mix contributes positively to growth and environmental sustainability.

The internationalization determinants of growth, trade openness, and FDI relationship with growth are insignificant for developing and under developing countries. The effect of trade openness and FDI on developing and under developed countries is negative and significant, causing FDI and trade openness to be detrimental to growth. However, the effect of institutional quality in determining growth increase is insignificant for both developing and under develop countries.

According to the IMF report, trade and technology are famous for promoting GDP growth and GDP per capita. Hence, countries can gear up their policies towards the promotion of GDP per capita through technological innovations.

Second, governments and policymakers should carefully choose international business policies because the foreign direct investment is often not targeted towards growth. For instance, international business contract host countries often are at a disadvantage because of the transfer of pollution – intensive operations from one country to the other, thereby creating pollution. We suggest the employment of minimal foreign investment with strict supervision in order not to give room for exploitation by foreign counter parts.

Third, able energy sources make efficient and effective use of natural assets in general production and consumption that any other energy sources. As such, it is more likely to promote growth than other sources of energy. For these reasons, we encourage governments and policymakers to promote renewable energy by offering grants and loans to investors in those areas. Also, a tax holiday could be another option to promote investment in renewable energy. With that more users are likely to increase, thereby lowing the level of CO2 emissions and consequently achieving growth.

References :-

Birdsall N, Wheeler D (1993) Trade policy and industrial pollution in Latin America: where are the pollution havens? J Environ Dev 2:137–149.

Chang CP, Hao Y (2017) Environmental performance, corruption, and economic growth: global evidence using a new data set. Appl Econ 49:498–514.

Bailis R, Ezzati M, Kammen DM (2005) The role of technology management in the dynamics of greenhouse gas emissions from household energy use in Sub-Saharan Africa. J Environ Dev 14(1):149–174.

Transforming our world: the 2030 Agenda for Sustainable Development. (n.d.). Retrieved April 23, 2020, from https://sustainabledevelopment.un.org/post2015/transformingourworld

Griggs, D., & Stafford-Smith, M. (2013). Sustainable development goals for people and planet. Nature, 495, 305–307. doi: https://doi.org/10.1038/495305a.

Pradhan, P., Costa, L., Rybski, D., Lucht,W., &Kropp, J.P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions, Earth's Future, 5, 1169–1179 https://doi.org/10.1002/2017EF000632.

David, M. P. C. (2018). Sustainable Development Goals (SDGs)-Challenges for India. Indian Journal of Public Health Research & Development, 9(3), 1. doi: 10.5958/0976-5506.2018.00172.9.

Peng YS, Lin SS (2009) National culture, economic development, population growth, and environmental performance: the mediating role of education. J Bus Ethics 90:203–219.

Rahman MM, Saidi K, Mbarek MB (2020) Economic growth in South Asia: the role of CO2 emissions, population density, and trade openness. Heliyon 6:03903.

Salman M, Long X, Dauda L, Mensah CN (2019) The impact of institutional quality on economic growth and carbon emissions: evidence from Indonesia, South Korea, and Thailand. J Clean Prod 241:118331.

Shahbaz M, Gozgor G, Adom PK, Hammoudeh S (2019) The technical decomposition of carbon emissions and the concerns about FDI and trade openness effects in the United States. Int Econ 159:56–73.

Walter I, Ugelow JL (1979) Environmental policies in developing countries. Ambio:102–109.

Sustainable Development Goals. (n.d.). Retrieved April 23, 2020, from https://en.wikipedia.org/wiki/Sustainable_Development_Goals

Choudhuri, S. (2019). A Research on Sustainable Development in India. International Journal of Recent Technology and Engineering Special Issue, 8(2S3), 1210–1215. doi: 10.35940/ijrte.b1226.0782s319.

Dhar, S. (2018). Gender and Sustainable Development Goals (SDGs). Indian Journal of Gender Studies, 25(1), 47–78. doi: 10.1177/0971521517738451Background on the goals. (n.d.). Retrieved April 23, 2020, from https://www.in.undp.org/content/india/en/home/sustainable-development-goals/background/

MDGs to SDGs: Top 10 Differences. (2014, August 8). Retrieved April 23, 2020, from https://advocacy.thp.org/2014/08/mdgs-to-sdgs/

NITI Aayog. (n.d.). Sdg India Index & Dashboard 2019-20. Retrieved from https://niti.gov.in/sites/default/files/2019-12/SDG-India-Index-2.0_27-Dec.pdf

Beradovic M (2009) the role of FDI and openness of trade in economic growth: a study of Africa and Asia. Unpublished Bachelor Thesis Submitted to JonkopinIntenational Business School, Jonkopin University.

Discloser of Origins of Genetic Resources under TRIPs and CBD

Debottam Chakraborty
Niladri De

Abstract

Plant genetic resources form the very backbone of the underdeveloped countries as the country's majority of population depends on the agriculture. Any law regulating the access to the genetic resources of these countries is of utmost importance to the people at the grassroots as well as the policy makers. As the two most important international norm (CBD and TRIPs) are seem to be contradictory, we will look into the aspects where this contradictions may have implications and how they can be made consistent if that can be done at all. In this context we will also look into the possibility of other international provisions which has been framed over the time.

Keywords: Discloser norms, CBD, TRIPs

JEL Classification: Q56, Q34, Q37

Introduction

Plant genetic resources form the very backbone of the underdeveloped countries as the country's majority of population depends on the agriculture. Any law regulating the access to the genetic resources of these countries is of utmost importance to the people at the grassroots as well as the policy makers. As the underdeveloped countries are the hotspot of biodiversity, the international norms and regulations on the genetic resources have severe implications for the people of these countries. The national governments of these countries have also tried to enact laws, which most of the time reflects the ideology in the international arena. The recent developments in this front are numerous. The paper is an attempt to capture those developments and their consistencies in case of discloser norms for genetic resources.

The first international norm, which address the issue of genetic resources and the ownership rights over that, famously known as Convention on Biological Diversity (CBD, 1992). On the one hand when it seeks to ensure the sovereign rights of the states over the natural resources, on the other hand it makes mandatory to disclose the origin of genetic resources. The issues of Benefit Sharing and Prior Informed Consent have been mentioned in the text.

The other important international development, which has taken place in the arena of trade in intellectual property, is named as Trade Related Aspect of Intellectual Property Rights (TRIPs) under the umbrella of World Trade Organisation (WTO).It provides for the free access to the genetic resources by any party, for commercial exploitation or any research activities. The discloser of origin of genetic resources is not mandatory for this case.

As the two most important international norm are seem to be contradictory, we will look into the aspects where this contradictions may have implications and how they can be made consistent if that can be done at all. In this context we will also look into the possibility of other international provisions which has been framed over the time.

Discloser Requirement under CBD

Discloser of Origins requirements can be traced to two provisions in the Convention on Biological Diversity: Article 1established the basis for access and benefit sharing (ABS) agreements. Article 8(j) required Parties to protect traditional knowledge.

Assistant Professor of Economics ,Sundarban Hazi Desarat College,Pathankhali, Gosaba, 24 PGS. (S), West Bengal
Assistant Professor of Economics ,Narasinha Dutt College ,Howrah, West Bengal

The provisions of prior informed consent and benefit sharing under CBD have ensured the sovereign rights of the communities over traditional knowledge. Many countries have promulgated laws or regulations that specify requirements that must be fulfilled by people seeking access to genetic resources before they will be permitted to do so. The Bonn Guidelines provided voluntary guidelines for improving ABS agreements to facilitate the process of implementation,and recommended that Parties encourage disclosure of origin as a mechanism to track compliance with ABS requirements. Committees of World Trade Organization (WTO) and the World Intellectual Property Organization (WIPO) are currently considering such mechanisms.

2.2 TRIPs in the Context

Although there has been much discussion on the discloser norms in the TRIPs forum, however;no consensus has been reached on whether these requirements should take the form of simple formalities ora component of the disclosure requirement should be added as an additional requirement of patentability. There was no consensus on whether these requirements should be mandatory or facultative, or about the consequences of non-compliance with these requirements (for example, denial or rejection of the application, invalidation or revocation of the patent, unenforceability of the patent).

Any decision is yet to be reached how these requirements should be discharged (via a statement, submission of evidence, submission of a certificate of origin), how far the applicant of a patent should go in order to comply with these requirements, or how the patent office should proceed in order to verify compliance with these requirements.

Most importantly no decision has been made on the meaning and definition of disclosure requirements, or in which cases these requirements should apply (inventions directly based on biological resources or traditional knowledge, inventions developed using biological resources or traditional knowledge).

2.3 Synergies between the Two

Lot of Discussions has been taken place to create synergies between the TRIPs Agreement and the CBD since mid 90's.The debate has also been undertaken in the fora of the international intellectual property system more broadly, including some of the Conventions under the World Intellectual Property Organization (WIPO) and more specifically the Patent Cooperation Treaty, the Patent Law Treaty and the potential Substantive Patent Law Treaty.

Regarding the relationship between TRIPs and CBD we may notice that the theme of Access and Benefit sharing and that of patent filing processes are completely different; each system has a purpose and they do not match. They are incompatible in objectives and mechanisms of implementation. There is also a certain level of overlap in the subject matter of both agreements in the sense that there is an overlap over the material subject to access under the CBD and the material used or incorporated in a particular invention subject to a potential patent. So, some suitable adjustment has to be made in the patent regime so as to avoid cases where the genetic resources being used or incorporated in inventions without respecting national access laws and to promote the creation of synergies.

The submissions made by the different groups so far have sought to incorporate disclosure requirements in the TRIPs Agreement as a mechanism that allows the verification that any genetic resource or associated traditional knowledge have been obtained in a legitimate manner and that the legal requirements of the country of origin have been fulfilled as anintegral part of the patent filing process. Many countries like Brazil, the Andean Community countries, Costa Rica, India, Nepal, Norway, Belgium, Denmark and the European Union has already incorporated these requirements through different modalities. Some other countries like Switzerland, Thailand and the Dominican Republic are also evaluating their legislative provisions for this.

The proposals presented by various countries to address the biodiversity related mandates indicate that the TRIPs Council needs to reform the TRIPs Agreement, specifically Article 9, with the purpose of incorporating an obligation for patent applicants to disclose all biological resources and associated traditional knowledge that have been directly or indirectly incorporated in an invention. In these submissions it has been stated by theproponent countries that the disclosure requirement would be a condition for granting of patent and would have to specifically include the disclosure of the country of origin and legal source of the biological recourses and traditional knowledge used or incorporated in the invention; the evidence of prior informed consent and approval by national authorities in relation to traditional knowledge and evidence of fair and equitable benefit-sharing in accordance with national laws.

In order to move debates forward, basic agreements need to be reached. Let us form some ideas, which may contribute to attaining certain levels of consensus. Firstly, the aspectsof discloser norms may be considered formal or substantive, but they should be mandatory and there should be a sanction for non-compliance with these requirements before and after the grant of a patent. The agreements should be reached between the patent applicant or patent holder and the holders of rights to the genetic resources or traditional knowledge, before sanctions are applied, which could contribute to a win-win situation. Clear rules have to be chalked out about when this requirement would apply (the relationship between the invention and the resource or knowledge) and about what is required (disclosure of the country of origin or of the source or both).Simplicity as well as practicability should be a paramount consideration when defining how these requirements are to operate and to be verified.

Given that the TRIPs Agreement is broadly recognised as the most important international instrument on intellectual property – establishing a set of minimum principles which all WTO Members are required to implement – it is natural to identify it as the primary instrument to be modified in order to include the disclosure mechanism and therefore facilitate coherence with the CBD. The TRIPs Agreement is currently under a specific and complete review under articles 7.3(b) (on the patentability of life forms) and 71.1. Also, the current negotiations on an international regime on access and benefit-sharing in the CBD will need to establish the adequate links between the mechanism and the future regime so as to facilitate the generation of relevant evidence of prior informed consent and fair and equitable benefit-sharing.

3. Provisions under other International Norms

Several international forums have played host to discussions and activities related to disclosure requirements.WIPO's Intergovernmental Committee on Intellectual Property and Genetic Resources, TraditionalKnowledgeand Folklore has contributed significantly to the understanding of protection of traditionalknowledge and access to genetic resources from an intellectual property perspective.

The initial focus on harmonizing procedural aspects of patent laws by the Standing Committee of Patents (SCP) of the WIPO led to the conclusion of the Patent Law Treaty (PLT) in June 2000. Prior to the conclusion of the PLT, the Columbian delegation in 1999 submitted a paper on 'Protection of Biological and Genetic Resources' which argued that the PLT should comprise of provisions linking filing of patent applications with access and benefit sharing regulations. The basic demands made in the proposal were that: (i) 'All industrial property protection shall guarantee the protection of the country's biological and genetic heritage. Consequently, the grant of patents or registrations that relate to the elements of that heritage shall be subject to their having been acquired legally;' and (ii) Every document shall specify the registration number of the contract affording access to genetic resources and a copy thereof where the goods or services for which protection is sought have been manufactured or developed from genetic resources or products thereof, of which one of the member countries is the country of origin.

This proposal was supported by several developing countries, but was staunchly opposed by United States, European Union and Japan, on the ground that this was an element of substantive patent law and had no place under the PLT. As it turned out, the PLT was concluded without any reference to the Columbian proposal. However, this led to further meetings within the WIPO and consensus was reached that the 'WIPO should facilitate the continuation of consultations among Member States in coordination with the other concerned international organizations, through the conduct of appropriate legal and technical studies and through the setting up of an appropriate forum within WIPO for future work.

However, the WTO remains the most relevant forum for discussion of disclosure requirements, and theinclusion of disclosure requirements in the TRIPs Agreement is vital. Although the progress achieved indifferent international forums such as WIPO and CBD should not be overlooked and these organizations should continue to address these issues, such discussions should not be taken as an excuse not to advocatefor progress in the WTO context.

As a matter of fact, even if WIPO had a mandate for leading negotiations, developed countries maychoose not to sign an instrument which includes an obligation for disclosure. Therefore, the objectiveof making the disclosure requirements mandatory at an international level would not be achieved. Thischoice would not be possible in the WTO context. If the TRIPs Agreement was modified to include mandatory disclosure requirements, this would legally bind all its member states.

4. India's Current Stand

Brazil, China, Cuba, Dominican Republic, Ecuador, India, Pakistan, Peru, Thailand, Venezuela, Zambia and Zimbabwe had made a submission in the TRIPs Council on the relationship between the TRIPs Agreement and the CBD and the protection of Traditional Knowledge in June 2002. The submission was made under paragraphs 12 and 19 of the Doha Ministerial Declaration.

The submission was made with the objective to highlight and strengthen the principal arguments for inserting a provision in the TRIPs Agreement that mandates patent applicants for inventions, that use biological resources and traditional knowledge, to disclose the source of origin of such resource and knowledge, as well as provide evidence that they have obtained the necessary prior informed consent (PIC), and complied with national laws on benefit sharing. This type of provision is very essential to ensure TRIPs Agreement and CBD are implemented in a mutually supportive manner.

Disclosure of the source and the country of origin and evidence of PIC and fair and equitable benefit sharing in a patent application would play a significant role in preventing biopiracy and misappropriation and in some cases, prevent the issue of 'bad patents' awarded without due regard to the prior use and knowledge with regard to the resource. There has been extensive documentation of patents being sought over resources and knowledge freely appropriated from biodiversity rich countries, as well as patents on the resources as they exist, without any further improvement or where the value addition does not appear to fully conforms to the accepted benchmarks for inventiveness. Some of these examples include patents granted on quinoa and ayahusca, and on products based on plant material and knowledge developed and used by local communities such as the cases of turmeric, neem, kava, barbasco, endod and bitter gourd.

To judge the genuineness of an invention, it is crucial to disclose the source of origin of the resources on what the invention is based. This is especially important when the traditional knowledge used in the invention is undocumented and exists in oral form, or is documented in a local language. Disclosure of origin of the resource and traditional knowledge would enable a better assessment by the patent examiner of the novelty and inventive step involved in the invention, as well as enable those having knowledge about the oral/undocumented knowledge to supply the necessary evidence of prior art to the patent examiners, at least in those patent regimes having pre-grant opposition procedures. It is expected that the disclosure of origin of the resource and associated traditional knowledge, and evidence of PIC

and benefit sharing will reduce the instances of bad patents and enable the patent office to ascertain more effectively the 'inventive step' claimed in a particular patent application.It should also improve the compliance with the national laws on PIC and fair and equitable benefit sharing prior to accessing a biological resource/associated traditional knowledge. This would also increase the credibility of the patent system, as well as contribute to achieving the principal objectives of the TRIPs Agreement. Placing the onus on a patent applicant to disclose the basis of its claims is a step that can pre-empt any misuse of patent laws and thereby prevent misappropriation of knowledge and resources.

5. Conclusion and Recommendations

The followings may be concluded and recommended:

Grant of patent should include Disclosure of the country of origin and legal source of the biological recourses and traditional knowledge used or incorporated in the invention

The discloser requirements for granting patents should be mandatory and there should be a sanction for non-compliance with these requirements before and after the grant of a patent

The current negotiations on an international regime on access and benefit-sharing in the CBD will need to establish the adequate links between the mechanism and the future regime.

Clear specification has to be made on the meaning and definition of disclosure requirements, or in which cases these requirements should apply (inventions directly based on biological resources or traditional knowledge, inventions developed using biological resources or traditional knowledge).

References:

Berglund, M. (2005),The Protection of Traditional Knowledge Related to Genetic Resources: The Case for a Modified Patent Application Procedure, SCRIPT, 2(2):108.

Correa, C.M. (2005), The politics and practicalities of a disclosure of origin obligation, Occasional Paper No. 16, Geneva: QUNO.

Gebru, A. (2019), Patents, Disclosure, and Biopiracy, Denver Law Review, Cardozo Legal Studies Research Paper No. 560.

Kieff, F.S. (2001), Property rights and property rules for commercializing inventions, Minnesota Law Review 85:697.

Long, C. (2002), Patent Signals, University of Chicago Law Review 69:625.

Tobin, B. (1997), Certificates of origin: a role for IPR regimes in securing prior informed consent, In: Access to Genetic Resources – Strategies for Benefitsharing, Nairobi: ACTS Press.

Influence of Covid-19 on Air Quality in India

D.B. Usharani
M.Suganthi

ABSTRACT

The spread of COVID-19 has challenged most countries worldwide. A nationwide lockdown was imposed in India on 24 March 2020 and extended till 30 May 2020 in various phases. During that period, the movement of people and economic activities that cause air pollution slowed down. Researchers attempted to investigate the effect of those changes on air quality. Multiple researches have shown that lockdown led to a temporary reduction in the air pollution throughout the world. This paper highlights on the risks associated with air pollution in general and the impact of Covid-19 on air quality.

Introduction

The introduction of toxins into the environment that have a negative impact on it is known as pollution. Anything that humans introduce into the atmosphere that has a negative impact is considered air pollution. The combustion of fossil fuels in vehicles, aircraft, and for the generation of power is the largest contributor to air pollution. When substances such as chemicals or biological matter that can endanger people or other living things are released into the atmosphere, air pollution results. Carbon dioxide, carbon monoxide, sulphur dioxide, and microscopic particles produced by the burning of various materials, particularly coal, are among the pollutants in the air. These pollutants damage the ecosystem by accelerating global warming in addition to harming people by spreading disease. All people are impacted by pollution, but children are more vulnerable than adults because they spend more time outside and breathe in more air, especially while they are exercising.

Objectives

- To estimate the risk associated with air pollution.
- To study the impact of Covid-19 on air quality in India.

Air Pollution and Health Effects

The World Health Organization (WHO) estimates that air pollution kills 7 million people annually. The WHO also estimates that nine out of ten individuals breathe dirty air, which has been related to heart disease, lung cancer, and strokes. The issue affects more cities in Asia than any other region in the world.

India is severely burdened with the hazardous effects of air pollution. In a recent study, a mortality of 1.2 million and 38.7 million disability-adjusted life-years (DALYs) has been found to be associated with air pollution in India (Balakrishnan et al., 2019). As per the 'World Air Quality report-2019' on the basis of particulate matter (PM2.5), India ranks the fifth most polluted country in the world and dominated the list of the smoggiest urban areas, where 21 of the top 30 most polluted cities were from India (IQAir, 2019). Owing to increasing industrialization across the country, progressive worsening of ambient air pollution remains a great challenge for sustainable development and public health reforms (Gordon et al., 2018).

Deteriorated air causes long- and short-term health effects such as chronic obstructive pulmonary disease (COPD), asthma, respiratory mortality, cancer, cardiovascular mortality, etc. among humans (Kim et al. 2015; Ghorani-Azam et al. 2016; Maji et al. 2017; Cohen et al. 2017; Landrigan et al.

Associate professor, dept.of Economics, ethiraj college for women
Assistant professor, dept.of Economics, ethiraj college for women

2018). This global threat is considered as one of the leading cause for mortality and accounts for 7 million lives every year, estimating a total cost of more than 4% of the GDP (WHO 2020).

Environmental campaign group Greenpeace South-east Asia and air quality technology company IQAir measured pollution levels across 28 cities. They found that, air pollution caused about 160,000 deaths and economic losses totalling about US$85 billion in the five most-populated cities, that is, New Delhi, Mexico City, Sao Paulo, Shanghai and Tokyo. Delhi had the highest death toll among the five biggest cities. The study also found that some 54,000 people died due to high levels of tiny pollution particles, known as PM2.5, which can cause lung and heart diseases.

Top 10 Countries with the Worst Air Pollution - PM2.5 exposure (µg/m³) - IQ Air 2020

S. No	Country	AQI Value
1	Bangladesh	77.10
2	Pakistan	59.00
3	India	51.90
4	Mongolia	46.60
5	Afghanistan	46.50
6	Oman	44.40
7	Qatar	44.30
8	Kyrgyzstan	43.50
9	Indonesia	40.70
10	Bonsia & Hezegovina	40.60

The table below shows India's position in the Climate Change Performance Index, 2020

	G20 Rank	Global Rank
Overall	2	9
GHG Emissions	2	11
Renewable Energy	6	26
Energy Use	2	9
Climate policy	12	15

Source: Centre for Science and Environment, based on Jan Burck, Ursula Hagen, Niklas Hohne, Leonardo Nascimento and Christoph Bals 2019, Climate Change Performance Index, Germanwatch, Bonn.

Air Pollution and Life Expectancy

Air pollution cuts life expectancy for every man, woman and child on earth by nearly two years, according to data released on 28 July 2020. The Air Quality Life Index (AQLI) said that air pollution would continue to cause billions of people to lead shorter and sicker lives across the globe. In countries

such as India and Bangladesh, air pollution was so severe that it now cuts average lifespans in some areas by nearly a decade. Authors of the research said the quality of the air many humans breathe constituted a far higher health risk than Covid-19. Nearly a quarter of the global population lives in just four south Asian countries that are among the most polluted - Bangladesh, India, Nepal and Pakistan. AQLI found that these populations would see their livespan cut by five years on average, after being exposed to pollution levels 44 per cent higher than 20 years ago. Some 89 per cent of the region's 650 million people live in areas where air pollution exceeds the World Health Organisation's recommended guidelines. While places such as the United States, Europe and Japan have succeeded in improving air quality, pollution still takes an average of two years of life expectancy worldwide, AQLI said. Bangladesh was found to have the worst air quality of any country, and around 250 million residents of India's northern states will lose eight years of life on average unless pollution is brought under control.

Air Pollution and COVID-19

The novel corona virus, also known as COVID-19, which was first discovered in the Chinese city of Wuhan in December 2019, has influenced more than 200 nations. On March 11, 2020, the World Health Organization (WHO) designated it a global pandemic. Many nations have chosen a total lockdown, as advised by the WHO. India, France, Italy, New Zealand, Poland, and the UK decided to implement one of the most stringent lockdowns ever seen. On April 25, 2020, India began a three-week lockdown and further extended it until May 3, 2020. Now that the illness had been treated as an endemic and almost all nations had loosened the limitations.

Cleaner skies over South Asia that resulted from pandemic lockdowns affected the timing of snowmelt in the Indus River basin of Pakistan and India, researchers reported on 26 April 2021. Anecdotal reports also suggested that the air over much of the subcontinent was cleaner. In Kathmandu, Nepal, for example, residents reported being able to see Mount Everest, 100 miles distant, for the first time in decades. By analysing satellite remote-sensing images, researchers found that concentrations of soot and other particles on snow and ice in the Indus basin decreased by 30% in 2020 compared with the 20-year average.

National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) reported that the level of Nitrogen Dioxide has imperatively diminished up to 30%, and there is a significant improvement in environmental quality. In India, Delhi and Mumbai noted a 40–50% reduction in Nitrogen Dioxide emission as compared to the previous year. During the lockdown period, a reduction in PM2.5 levels have been observed in major cities in India. Delhi reported 35–39% reduction, Kolkata 30–40% and 14–43% in Mumbai due to the lockdown. It is evident from several pieces of research that the nationwide lockdown in India improved the air quality (Singh and Chakraborty, 2020).

Conclusion

Studies found that the lockdown measures imposed to contain the spread of COVID-19 infection were found to be very effective in improving the air quality. It not only restricted the spread of infection rate, but also has given a scope to realize the restoration ability of environment and health with reduced ambient air pollutants levels leading to improved air quality.

References

A. Garg, S. Bhattacharya, P.R. Shukla, V.K. Dadhwal, Regional and sectoral assessment of greenhouse gas emissions in India, Atmospheric Environment, 35 (2001)

K.S. Sridhar, Carbon emissions, climate change and impacts in Indian's cities. India Infrastructure report, 2010.

T.V. Ramachandra, Shwetmala, Decentralised carbon footprint analysis for opting climate change mitigation strategies in India.

Census of India, Provisional population totals – 2011. Paper-II, Vol. II. Census of India, New Delhi, 2011

Ministry of Environment and Forests (MoEF), India, India's GHG emissions profile, Climate Modeling Forum, MoEF, GoI, 2009

A Step towards Sustainable Society: The Awareness of Carbon Dioxide Emissions,Climate Change and Carbon Capture in North Chennai Region of Tamil Nadu

A. Thaha Sahad
M. Abdul Jamal
M. Fakir Ismail
S. Mohamed Nazeer

Abstract

Climate change is rapidly spreading across the globe. The ever-increasing levels of greenhouse emissions from various economic activities have resulted in an increase in temperature and, ultimately, global warming. The human race may face even more dangerous consequences as a result of such rising levels of global warming, particularlyin terms of rising sea levels, water scarcity, and ultraviolet radiation, among other things. CO2 emissions are rapidly increasing as a result of man-made activities such as coal combustion, various fossil fuel combustion, deforestation, biomass combustion, and cement production. Several studies have looked at the impact of renewable energy use, economic growth, and technological innovation energy on CO2 emissions, according to the literature review. Compared to previous studies that used CO2 emissions as a proxy for environmental degradation, this study goes a step further in attempting to gain a better understanding of public perceptions of climate change, CO2 emissions, and carbon capture and storage in developing countries. The current study combined the two arms of research, vis-à-vis qualitative and quantitative techniques of data collection and analysis. The objective of the current study is to examine the level of public awareness regarding the CO2 emissions, climate change and carbon capture and storage in Chennai City of Tamil Nadu. The empirical evidence provides a basis for the formulation of strategic actions, pro-public and governmental decisions. This study is useful to formulate strategic decisions towards CO2 emissions and climate change and projects implementation in Chennai City. It is highly recommended to examine mitigation strategies to increase the level of the general public awareness with respect to climate change in particular. The findings offer significant implications for environmental policies and strategies in curbing the negative environmental impacts of CO2 emissions in Chennai city as a whole.

Keywords: Public Awareness, Carbon Dioxide Emission, Climate Change, CarbonCapture and Storage, North Chennai Region of Tamil Nadu.

Introduction

Climate change is rapidly spreading across the globe. The ever-increasing levels of greenhouse emissions from various economic activities have resulted in an increase in temperature and, ultimately, global warming. The human race may face even more dangerous consequences as a result of such rising levels of global warming, particularlyin terms of rising sea levels, water scarcity, and ultraviolet radiation, among other things. CO2 emissions are rapidly increasing as a result of man-made activities such as coal combustion, various fossil fuel combustion, deforestation, biomass combustion, and cement production. According to an analysis published in Nature Climate Change, India's percentage carbon dioxide emissions rose slower in 2016-19 than in 2011-15, but were still significantly higher than the global average of 0.7 percent. In 2016-19, China increased emissions by 0.4 percent, while the United States decreased emissions by 0.7 percent, both of which dwarf India's emissions in absolute numbers. Lockdowns to combat the COVID-19 pandemic in 2020 reduced global CO2 emissions by 2.6 billion tonnes, or 7% less than in 2019.

Assistant Professor, PG & Research Department of Economics,Presidency College, (University of Madras), Chennai, Tamil Nadu.
Assistant Professor, PG & Research Department of Economics, TheNew College (University of Madras), Chennai, Tamil Nadu
Assistant Professor, PG & Research Department of Economics, The NewCollege (University of Madras), Chennai, Tamil Nadu.
Assistant Professor, PG & Research Department of Economics, TheNew College (University of Madras), Chennai, Tamil Nadu.

Lockdowns are "neither a sustainable nor desirable solution" to the climate crisis, according to the researchers, and 2020 was a "pause button" that could not realistically continue while the world relied heavily on fossil fuels. China, for example, emitted about 10 billion tonnes of carbon dioxide in 2018, while the United States emitted 5.41 billion tonnes. During the same period, India produced 2.65 tonnes of CO2. When the pandemic slowed economic growth in 2020, India's emissions fell 9.7%, slightly higher than the global average of 9.6%. The percentage changes are based on information provided by the countries. It comes ahead of a "global stock take" that reveals that how far countries have come since signing the Paris Agreement in 2015, which commits the world to reducing emissions to keep global warming below 0.5-1 degrees Celsius by the end of the century.

Countries are expected to gather in Glasgow, Scotland later this year for the United Nations Climate Summit to report on their progress and future plans. Researchers from the University of East Anglia (UEA), Stanford University, and the Global Carbon Project in the United Kingdom found that 64 countries reduced their fossil CO2 emissions between 2016 and 2019, but the rate of reduction needed to increase tenfold to meet the Paris Agreement's climate change goals (The Hindu, 2021).

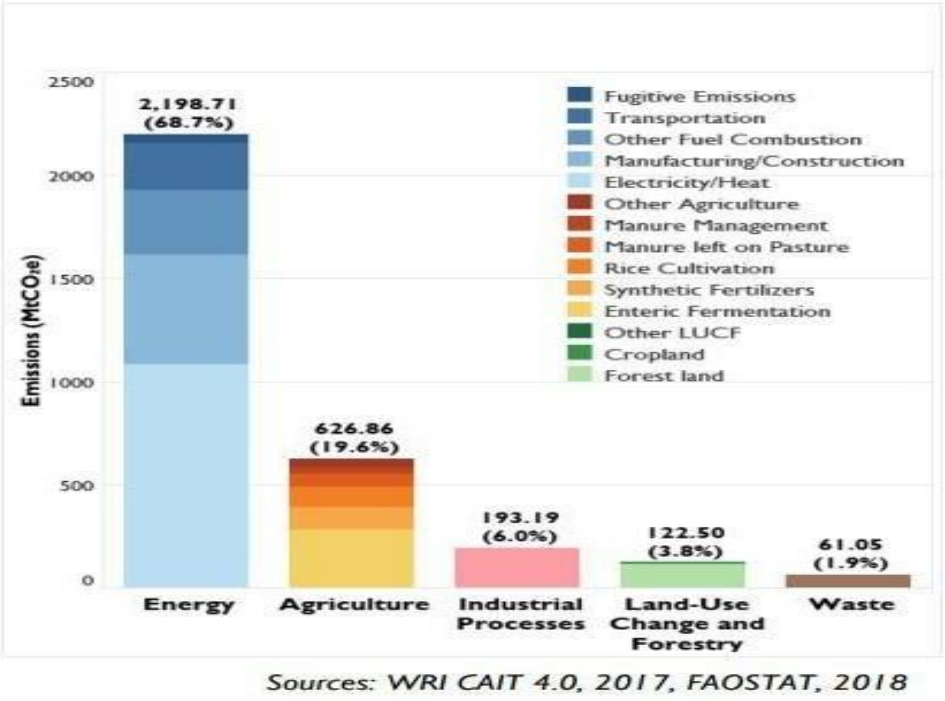
Sectoral Carbon Dioxide (CO2) emissions

In 2014, India's total GHG emissions were 3,202 million metric tonnes of carbon dioxide equivalent (MtCO2e), accounting for 6.55 percent of global GHG emissions. The energy sector accounts for 68.7% of GHG emissions in India, followed by agriculture, industrial processes, land-use change and forestry, and waste, which contribute 19.6%,

6.0 percent, 3.8 percent, and 1.9 percent, respectively. Between 1990 and 2014, India's GDP increased by 357 percent, while GHG emissions increased by 180 percent. India emits twice as many greenhouse gases as the global average when measured by GDP. Emissions from the energy sector accounted for 68.7% of total emissions, according to the World Resource Institute Climate Analysis Indicators Tool (WRI CAIT). Electricity and heat generation accounted for 49 percent of emissions in the energy sector, while manufacturing and construction accounted for 24 percent. Agriculture was the second- largest source of emissions (19.6% of total), with enteric fermentation accounting for 45 percent of all agriculture emissions. 6.0 percent, 3.8 percent, and 1.9 percent of total emissions in 2014 came from industrial processes (IP), land use change and forestry (LUCF), and waste, respectively. India's First Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC) was submitted in 2015 and includes a GHG inventory for 2010 as well as GHG trends from 2000 to 2010.

According to the BUR, LULUCF (land use, land use change, and forestry) was a net carbon sink in 2010, absorbing 252.53 MtCO2e more than was emitted in that year. WRI CAIT shows LUCF as a net sink from 2000 to 2010, but from 2011 to the most recent year for which data are available, 2014, CAIT shows LUCF as an emissions source. From 2011 onwards, the BUR does not provide data. The GHG Platform – India, on the other hand, has released GHG emission estimates for 2005 to 2013, which include agriculture, forestry, and other land uses (AFOLU). It shows that between 2005 and 2013, the land subsector was a growing carbon sink, with removals increasing from 134.0 MtCO2e in 2005 to 177.7 MtCO2e in 2013 (Dhingra, S. Mehta, R. 2017). Because different estimation methodologies and data sources are used, direct comparison of findings from multiple sources can be difficult. According to the BUR and WRI CAIT, energy is India's highest GHG emitting sector, followed by agriculture.

Figure -1



Greenhouse Gas (GHG) Emissions by Sector

Review of Literature

People's knowledge, values, attitude, and practises are all linked to a better- quality environment, according to studies (Oskamp and Schultz, 1996). Individuals must have a basic understanding of what the environment is all about and how important it is. Individuals' attitudes toward the environment are influenced by their understanding and awareness of the importance of environmental protection (Ahmad et al., 2012). The terms "awareness" and "understanding" are synonymous. Understanding comes after awareness. Individuals may be aware of certain facts, but they may not comprehend the significance of the information. As a result, knowledge is accompanied by understanding. The public's support is critical to the success of CO2 emission reductions and the adoption and implementation of CO2, carbon capture and storage technologies (CCS). They must be aware and understand that carbon capture and storage (CCS) can significantly reduce CO2 emissions released into the atmosphere. The combustion of fossil fuels contributed to the emission. If CCS is not available and widely deployed after 2020, the cost of achieving desired climate stabilisation by 2050 will be at least 70% higher, according to the International Energy Agency (EU, 2011). Public opinion, technical, and economic considerations are all equally important in the development and deployment of CCS, according to the literature. It is necessary to recognise the factors that

influence public perceptions of CCS in order to comprehend public opinion and concerns (De Best-Waldhober et al., 2011). Unfortunately, previous studies have revealed that the public has mixed feelings about CO2 emissions and carbon capture and storage. This was due to a lack of awareness and comprehension (Wallquist et al., 2009). Some people associate carbon capture and storage with nuclear waste, while others believe CO2 causes lung cancer. CCS is a new technology, but the vast majority of the public is unaware of it, and their understanding of it is limited (de Best-Waldhober and Daamen, 2008). As a result, any new piece of information can easily sway their opinions (De Best-Waldhober et al., 2011).

Chunshan Zhou et al. (2017) conducted a national survey in China to gauge public awareness of CCUS technology's environmental impact and management. The survey's main findings can be summarised as follows: (1) Although CCUS technology has some positive environmental benefits, public acceptance is hampered by public awareness of high environmental risks; (2) Government departments with high expectations to play a key role in environmental management; (3) Information about CCUS projects in traditional and electronic media, as well as from expert lectures and government departments, can reduce perceived risk and improve public acceptance of CCUS. The study by YuriiVasilev et al. (2021) focused on increasing public awareness of carbon capture and storage technologies in Russia. The paper reviews the key findings of several recent studies on the subject, including a study of environmental consciousness among St. Petersburg students, a content analysis of Russian school textbooks, a study of environmental groups on Russian social media, and an experimental study on using eco-comics and posters as educational tools to promote environmental awareness.

Among the available studies in India, Sarma et al (2001) examined the Emission of Carbon Dioxide from a Tropical Estuarine System, Goa, India, among the studies available in India. An experimental study found that the soil-water interaction may be a key determinant of pCO2 abundance in estuarine waters. Due to higher wind speeds and non-SW monsoons, the calculated water-to-air average fluxes were 67 and 11 mmol m2 d1, respectively, in the SW monsoon. This research strongly suggests that, in addition to biological processes, pH regulation by soil-water interaction is important in river and estuarine systems. The carbon dioxide emissions from coal-fired power generation in India were studied by Shiv Pratap Raghuvanshi et al (2006). Carbon dioxide emitted as a result of coal combustion (fossil fuels) currently accounts for more than 60% of the increased greenhouse effect. The purpose of this communication is to provide a quick overview of CO2 emissions from coal-fired power generation in India.

Anant Yadav et al. (2016) conducted a study to capture CO2 using either Chlorella sp. microalgae or a consortium of microalgae. The harvested biomass was used to produce biogas through anaerobic digestion. The carbonation column was able to reduce the average 34 percent CO2 in the vent gas to 15 percent CO2 in the carbonation column's outlet gas. According to a study by Danish et al. (2021), increasing nuclear energy reduces pollution instantly, indicating that more nuclear energy power in the Indian energy system would be beneficial for climate change mitigation. The findings also show that the IPAT equation's overarching effect of population density stimulates carbon emissions. The study by Kirikkaleli et al. (2021) examines the impact of renewable energy consumption and energy investment by public-private partnerships on consumption-based carbon dioxide emissions in India between 1990Q1 and 2015Q4, while controlling for technological innovation and economic growth. The findings of this study show that there is a long-run cointegration equation between consumption-based carbon dioxide emissions and their possible determinants; (ii) while renewable energy consumption is beneficial for lowering consumption-based carbon dioxide emissions, public-private partnership investment in energy contributes to consumption-based carbon dioxide emissions in the long run; and (iii) public-private partnership investment in energy makes a positive contribution to consumption-based carbon dioxide emissions in the long run. Several studies have looked at the impact of renewable energy use, economic growth, and technological innovation energy on CO2 emissions,

according to the literature review. Compared to previous studies that used CO2 emissions as a proxy for environmental degradation, this study goes a step further in attempting to gain a better understanding of public perceptions of climate change, CO2 emissions, and carbon capture and storage in developing countries. This study adds additional insight into the public awareness regarding climate change, CO2 emissions, and CCS in the context of developing country. Most of the prior studies have focused on developed countries, while studies related to developing countries are still relatively limited. It has also been widely acknowledged that one cannot generalize the findings of studies on developed countries to the developing countries. Thus, this study provides empirical evidence on the level of awareness of CO2 emissions (characteristics, importance, negative impacts and sources), climate change (importance and causes) and CCS (benefits, concerns regarding location and way forward) among the general public of Chennai City of Tamil Nadu.

Objectives

1. To assess the environmental impact of Carbon Dioxide (CO2) emissions and public awareness regarding the climate change in Chennai City of Tamil Nadu.

2. To examine the level of public awareness regarding the Carbon capture andstorage (CCS) in Chennai City of Tamil Nadu.

Methodology

The current study combined the two arms of research, vis-à-vis qualitative and quantitative techniques of data collection and analysis. The objective of the current study is to examine the level of public awareness regarding the CO2 emissions, climate change and carbon capture and storage in Chennai City of Tamil Nadu. The empirical evidence provide a basis for the formulation of strategic actions, pro-public and governmental decisions. For the purpose of exploring the public perceptions / awareness regarding CO2 emissions, and climate change, the present study conducted in north Chennai that includes Manali (50 samples), Ennore (50 samples) and Tiruvottiyur (50 Samples) areas. These areas is chosen due to high concentration of heavy industries in various industrial areas namely TANGEDCO's North Chennai Thermal Power Station (NCTPS), NTECL Vallur power plant, Chennai Petroleum Corporation Ltd (CPCL), Tamil Nadu Petro products Ltd (TPL), Manali Petrochemicals Ltd (MPL) and Madras Fertilizers Ltd (MFL). These heavy industries used large volume of coal, natural gas and also electricity that resulted in large volume of CO2 emission. In this study multi-stage sampling design was adopted. In the first stage the areas of study is restricted to the north region of Chennai city. In the second stage the sampling units selected by convenience sampling with proportionate to number of population based on heavy industries. The study employed convenience sampling method. In order the avoid biasness in opinion, the respondents involved in this study were from various background, education level and age. Self-administered questionnaire was used to obtain feedback from the public. The questionnaire has two versions: English and Tamil. The first section of questionnaire includes demographic information of respondents such as gender, age, education, and occupation. The second section was designed to examine respondents' awareness and knowledge towards CO2 emissions. The third section is about respondents' awareness and knowledge towards climate change and CCS.

Results & Discussion

It was noted that while 20% of respondents said they had heard of CO2 but knew nothing about it, 80% of respondents said they had heard of it and knew a little about it. The respondents' knowledge of CO2 emissions and their accurate perception that CO2 is unhealthy were both supported by the two percentages. When asked about the negative effects of CO2 respondents overwhelmingly stated that " CO2 influences the climate,"

with the highest mean value of 4.0. This indicates that the respondents understand the significance of CO2 and that they need it for the growth of plantsand trees.

The high means indicate that the respondents were aware of potential climate change effects. They believed it to be the cause of the altered weather patterns and higher risk of droughts, fires, and floods. As a result, it demonstrates their awareness of and familiarity with climate change. The respondents chose "emissions from power stations/factories and industries (means value = 4.42) and cutting down rainforest (mean value = 4.31)" in response to the question about the causes of climate change. They agreed, in response to the final question in the section on climate change, that the earth is getting warmer, with a mean value of 4.27, and that CO2 emissions from human activity are also to blame, with a mean value of 4.12.

The majority of respondents (60%) confirmed that they had never heard of carbon capture and storage (CCS), which is a rather low level of knowledge in this area. The second-highest response was that 3%2 of respondents have only heard of it (CCS) and have no knowledge of it. When asked if they were aware of the CCS implementation, the majority of respondents said they had never heard of it.

Among the respondents who were aware of CCS, 20% indicated that they learned about it from print media and 8.5% from social media, while the remaining respondents said they learned about it from other sources, such as friends and family. The majority of respondents needed to be briefed on the CCS because, as was previously mentioned, they were not familiar with it. As a result, following a brief introduction on the data collection site, respondents were asked to weigh in on the advantages of the CCS implementation.

As evidenced by the 3.42 mean value, the respondents indicated that they have serious concerns about CCS storage locations. They were concerned, among other things, about the security of CO2 transportation to the storage site, the risk of leaks while the site is in use, the risk of building damage and ground motion due to an increase in underground pressure during CO2 injection, the potential risk of sabotage to the site, and the potential decline in the local real estate market. The respondents, on the other hand, expressed conflicting opinions about the possibility of a decrease in electricity costs with the installation of CO2 capture technology in power generation, the minimal inconvenience that CO2 storage will cause in the neighbourhood, the inadequacy of the assurances regarding the safety of CO2 storage for the environment, and the excessivehealth risks associated with CO2 storage.

The respondents provided a wealth of insightful information on how to move CCS adoption and implementation forward. In general, respondents concurred that CCS will lead to an improvement in the sustainability of the environment for future generations (mean value 3.82). However, they vehemently advocated that the public's views be seriously taken into account when making decisions regarding the implementation of CCS (mean value 3.65). If CCS is to be implemented, the welfare of the public cannot be ignored (mean value 3.85). They also believe that the government must provide adequate financial support in order for the implementation of CCS to prevent a corresponding increase in the cost of electricity.

Conclusion

According to the study's findings, most people are aware of the harmful effects of CO2 emissions and climate change. However, they don't know a lot about CCS. They obviously know about CO2 emissions and climate change, but they don't know about CCS. Therefore, it is crucial to make an effort to raise public awareness of CO2 emissions, climate change, and CCS. The public becoming aware of these issues is regarded as the first step. As a result, those with high levels of awareness are eager to adopt more environmentally friendly habits in order to mitigate the effects of climate change. Therefore, it is crucial to inform and educate the general public using all forms of media. This study is helpful in developing strategic decisions regarding CO2 emissions, climate change, and the

adoption of CCS technology and projects in Chennai City. It is strongly advised to look into mitigation measures to raise public awareness of climate change in general and the implementation of CCS in particular.

References

Ahmad, A.L., Rahim, S.A., Pawanteh, L., Ahmad, F. (2012), The understanding of environmental citizenship among Malaysian youths: Astudy on perception and participation. Asian Social Science, 8(5), 85-92.

Bui, M., Adjiman, C. S., Bardow, A., Anthony, E. J., Boston, A., Brown, S., ... & MacDowell, N. (2018). Carbon capture and storage (CCS): the way forward. Energy & Environmental Science, 11(5), 1062-1176.

de Best-Waldhober, M., Paukovic, M., Brunsting, S., Daamen, D. (2011), Awareness, knowledge, beliefs, and opinions regarding CCS of the Dutch general public before and after information. Energy Procedia, 4, 6292-6299

EU. (2011), Special Eurobarometer 364: Public Awareness and Acceptance of CO2

Capture and Storage. p185. Available from: http:// www.ec.europa.eu/public_opinion/archives/ebs/ebs_364_en.pdf.

Ghazali, Z., Zahid, M. (2015), Environmental sustainability: Carbon emission reduction strategies and reporting among Malaysian construction companies. In: International Symposium on Technology Management and Emerging Technologies (ISTMET). p417-421.

Ghazali, Z., Zahid, M., Kee, T. S., & Ibrahim, M. Y. (2016). A step towards sustainable society: The awareness of carbon dioxide emissions, climate change and carbon capture in Malaysia. International Journal of Economics and FinancialIssues, 6(3), 179-187.

Ghosh, S. (2018). Carbon dioxide emissions, energy consumption in agriculture: a

causality analysis for India. Arthaniti: Journal of Economic Theory and Practice,17(2), 183-207.

Kirikkaleli, D., & Adebayo, T. S. (2021). Do public-private partnerships in energy and renewable energy consumption matter for consumption-based carbon dioxide emissions in India?. Environmental Science and Pollution Research, 28(23), 30139-30152.

Lee, Z.H., Sethupathi, S., Lee, K.T., Bhatia, S., Mohamed, A.R. (2013), An overview on global warming in Southeast Asia: CO2 emission status, efforts done, and barriers. Renewable and Sustainable Energy Reviews, 28, 7181.

Li, Q., Liu, G., Leamon, G., Liu, L. C., Cai, B., & Chen, Z. A. (2017). A national survey of public awareness of the environmental impact and management of CCUS technology in China. Energy Procedia, 114, 7237-7244.

Masud, M.M., Akhtar, R., Afroz, R., Al-Amin, A.Q., Kari, F.B. (2013), Pro- environmental behavior and public understanding of climate change. Mitigation and Adaptation Strategies for Global Change. Netherlands: Springer. p1-10.

Oskamp, S., Schultz, P.W. (1996), Using psychological science to achieve ecological sustainability. In: Donaldson, S., Berger, D., Pezdek, K, editors. AppliedPsychology: New Frontiers and Rewarding Careers. Mahwah, NJ: Erlbaum. p81- 106

Ozcan, B., & Ulucak, R. (2021). An empirical investigation of nuclear energyconsumption and carbon dioxide (CO2) emission in India: Bridging IPAT and EKChypotheses. Nuclear Engineering and Technology, 53(6), 2056-2065.

Raghuvanshi, S. P., Chandra, A., & Raghav, A. K. (2006). Carbon dioxide emissions from coal based power generation in India. Energy Conversion and Management, 47(4), 427-441.

Sarma, V. V., Kumar, M. D., &Manerikar, M. (2001). Emission of carbon dioxide from a tropical estuarine system, Goa, India. Geophysical Research Letters, 28(7),1239-1242.

Selma, L., Seigo, O., Dohle, S., & Siegrist, M. (2014). Public perception of carbon capture and storage (CCS): A review. Renewable and Sustainable Energy Reviews, 38, 848-863.

Vasilev, Y., Cherepovitsyn, A., Tsvetkova, A., &Komendantova, N. (2021). Promoting Public Awareness of Carbon Capture and Storage Technologies in the Russian Federation: A System of Educational Activities. Energies, 14(5), 1408.

Wallquist, L., Vivianne, H.M., Visschers, M.S. (2009), Lay concepts on CCS deployment in Switzerland based on qualitative interviews. International Journal of Greenhouse Gas Control, 3(5), 652-657.

Xuan, Y., Wang, Z. (2012), Carbon capture and storage perceptions and acceptance: A survey of Chinese university students. International Proceedings of Computer Science Information Technology, 38, 100.

Yadav, A., Choudhary, P., Atri, N., Teir, S., &Mutnuri, S. (2016). Pilot project at Hazira, India, for capture of carbon dioxide and its biofixation using microalgae. Environmental Science and Pollution Research, 23(22), 22284-22291.10

Glimpses of Clean Energy : Indian Perspective

Harindra Kishor Mishra

Abstract

Energy is the basic element of human activity and an indispensable input of socio-economic development. Without energy we cannot expect the universe. Solar system is the sole source of energy in this universe. The nature had provided energy sources first as the basic requirement for the development and existence of living organism. Energy is the only mover of life line. It facilitates human activities and increases productivity of man power through agricultural, industry as well as in services. In order to sustain the growth, uninterrupted supply of energy is essential.

India offers a conducive atmosphere for the growth and application of renewable energies. When utilised in the right manner and with the right technology, India can become a world leader in the field of renewable energy. Globally, India is one of the leaders in the production of renewable energy and is playing an important role in contributing to a global green economy. There is a need to raise awareness of using renewables as a source of energy. Renewables including solar, wind, hydro, biodiesel and green hydrogen are the major sources of energy that lead to a low-carbon economy. The challenge before India is how to meet its requirements without compromising the ecology of the country. In addition, we have to be mindful of the looming danger of climate change. But just moving to renewable electricity won't be sufficient. We require a renewable electricity future that is affordable and accessible to all. Scientists, Engineers and Technologists have accepted the challenge. It is high time that thinking people and policy planners sit together and take account of what we are heading for and what we should do about it so that the efforts of the scientific community are not wasted.

In the beginning the problem of energy was its availability and cost of procuring it but later on qualitative changes took place and eco-friendly energy was the demand of the time due to ecological damage and environmental destruction. All over the world demands were raised for eco-friendly energy compatible with human survival which should also be sustainable on the long term basis. Rat race and consumerism devoid of values have spoiled the whole system, posing a threat to mankind and human civilization. Now situation warrants that bold and timely actions are highly desirable if future of the mankind is safe and secure not for the present but also for the future generation. Hence, intergenerational equity is to be maintained for sustainable future.

Key Words:- Universe, Existence, Technology, Green Economy, Environment, Survival

Scientists gave energy the romantic name of "The Queen of the world". The word 'energy' seems to appear for the first time in the works by Aristotle. The term energy has originated from the Greek Word "Energia" which means capacity to work. By work we mean moving something against resistance. When an object is moved against a force, work is done and energy is expended in the process by the agency responsible for movement. The world of living and non-living things alike are brimful of energy.

In ancient Indian texts the concept of energy as **"**Shakti has been almost at the focus of philosophic, scientific and metaphysical thought from time immemorial. Shakti causes the great universal movements of the stars and planets, and, on our own earth, the great natural movements of wind and waters. Shakti is also at the origin of fire, heat, and light, and the power to enable mankind, animals and plants to grow and work. In ancient Indian literature the concept of Shakti is also sometimes made synonymous with the Supreme Being**" (Dayal, 1989, P.1).**

The development of any country depends also on its natural resources. It has been seen that the country richer in mineral wealth has developed fast in comparison to the country lacking in mineral wealth.

H.O.D. of Economics, Nagendra Jha Mahila College, Laheriasarai, Darbhanga

As the economy attains the higher stages of economic development, it requires more energy for maintaining its stage of development and moving towards higher stage of its growth. The energy resources of any country vary with time, technology, economic condition and new discoveries, the quantity of available energy resources can be assessed only at a particular time, under prevailing conditions.

The challenge before mankind is one of finding abundant energy and of simultaneously reducing the terrifying degree of pollution associated with the combustion of huge quantities of fossil fuels. The world is in serious danger of approaching an energy famine within a few decades unless sources of long-term salvation are developed. There are of course other green resources available, of which hydropower is perhaps very important. Then there is solar energy-inexhaustible and abundant. Present government has rightly focussed its attention on harnessing the huge renewal energy potential that mother nature has gifted us in the form of sunlight, wind, water streams and biomass. Benefits of renewable energy are immense but not without challenges.

It would scarcely be an exaggeration to say that tomorrow sources such nuclear energy and hydrogen energy may well become the best hopes for the survival of the human civilisation.

Solar Energy

Solar energy is direct and perennial sources of energy, unpolluting and freely abundantly available. The energy from sun can be used in meeting the energy requirement in almost all the temperature ranges. The sun produces energy by converting mass into energy at a rate of million of tons per second. **"**The solar radiation falling on the surface of the earth is equal to 170 trillion kilo watts. It means eight days of sunshine is equal to the total available sources of energy in the world put together for a period of about one year**".**

Solar energy is considered to be of considerable important for the future energy supply and, as one of the factors of rural development. Parikh has described the potential of solar energy as follows: **"**A large amount of solar radiation falls in India, and for most of the country, very few days are without sunshine. The annual average intensity of solar radiation in India is 600 calories per square centimetre per day……. even the minimum available radiation in the month of December is also quite large and for most cities, it is 500 calories per square centimetre per day. Thus, solar energy is an attractive source of energy in India**" (Parikh, 1976, P.42).**

In June, 2008, a National Action Plan on climate change was announced, which included eight major national missions with the one on solar energy being the centre piece. This mission envisages a major step up in the utilization of solar energy for power generation and other purposes. The Jawaharlal Nehru National Solar Mission (JNNSM) was launched by the Prime Minister of India in January 2010, with a target of 20,000 MW grid Solar power (based on solar thermal power generating systems and solar photovoltaic (SPV) technologies), 2000 MW of off-grid capacity including 20 million solar lighting systems and 20 million sq. m. solar thermal collector area by 2022. The Mission will be implemented in three phases. The first phase will be of three years (upto March, 2013), the second up to March 2017 and the third phase will continue until March, 2022.The target for phase-I is to set up 1,100 MW grid connected solar plants including 100 MW of roof top and small solar plants and 200 MW capacity equivalent off-grid solar applications and 7 million sq. m. solar thermal collector area **(Garg, 2012, PP.14-15).**

According to Wikipedia, "Solar Power in India is a fast developing industry. The country's solar installed capacity was 59.302 GWAC as of 31 August 2022. Solar Power generation in India, ranks fourth globally in 2021. The Indian Government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule".

The NSM so far is a domestically funded Policy. Yet the Ministry of Environment and Forests (MOEF), on October 18, 2011, announced that the NSM would be shortlisted in application for funding from Clean Technologies Fund (CTF). The CTF is backed by World Bank and a variety of international banks, including the Asian Development Bank.

The MNRE has launched a Scheme on 'Development of Solar Cities' under which a total of 60 cities/ towns are proposed to be supported for development as 'Solar/Green Cities'. At least one city in each state to a maximum of five cities in a State may be supported by the Ministry. The cities may have population between 0.5 to 50 lakh. There is a provision that relaxation could be considered for special category states including North-Eastern States. The growing emphasis on solar energy utilisation to achieve energy security as well as to combat the menace of climate change and global warming has resulted in the formulation of one of the world's most ambitious solar missions in India for cooking, water heating, water dissimilation, space heating, crop drying, air-conditioning and refrigeration, etc.

Achievement of 100 GW of solar power will lead to abatement of 170.482 million tonnes of CO_2 over its life cycle. With an enhanced target of 100,000 MW, upto 1 million jobs will be created. More employment and investment opportunities will enhance income. Higher soar power targets will augment power generation in India improving energy security and energy access. Solar manufacturing will also pick up after visibility on this investment opportunity to support these targets. Power generation through solar will offset conventional power generation, reducing the need to import coal and gas and lead to foreign reserve savings. Revenue to the government through taxes and duty, etc., from plants in power generation and manufacturing will also increase and solar projects will provide a productive use of abundant wastelands **(Tripathi, 2016, P. 46).**

Wind Energy

Wind energy is an indirect form of solar energy. Air temperature difference causes winds and it contains kinetic energy. This energy of motion gives the wind its ability to perform work. It is a renewable energy and poses no major environmental problems. Wind energy has been used to propel boats and ships, and for pumping water and grinding grain since time immemorial. Wind energy was used to propel sail boats even before Christ. It is believed that windmills were first used in Persia in the 7 century AD. Reports reveal that in the year 1840, there were about 10,000 windmills working in England & Wales and about 8000 in Holland. The first big wind generator was installed in 1941 at the top of Mount Grandpass Nobe. It could generate about 1,250 KW power.

As of 31 July 2022, the total installed wind power capacity was 40.893 GW, the fourth largest installed wind power capacity in the world. Wind Power capacity is mainly spread across the Southern, Western, Northern and Western regions. Windmills or wind turbines provide energy which is used in homes, farms and industries. Their numbers are gradually increasing in India as wind energy is a clean, non-polluting source of energy. Moreover, it is inexhaustible, since winds blow everyday and can never be used up! Also, this energy is free- the fuel is provided free of cost by nature.

Wind energy is set to become more important across the globe. By 2050, wind energy could avoid the emission of 12.3 gigastonnes of green gases. Wind energy preserves water resources. By 2050, wind energy can save 260 billion gallons of water-the equivalent to roughly 400,000 Olympic-size swimming pools- that would have been used by the electric power sector. Today wind energy represents more than 50% of all renewable energy capacity in the world. The new open access measures will further spur the growth of wind power. The market is picking up but there is more potential. The future looks green and bright for wind.

Today, all eyes in the industry are set at the widening horizons of the wind energy programme. However, an unspoken question hangs in the air. No one is certain as to what may happen if, at some time in the future, the offered concessions are revoked. Some may even argue that even within the

existing structure itself, there is a large gap between the set targets and actual achievements. But, optimism is the theme song of the believers of renewable energy technologies, of which wind energy is an important component. They say that, given an increasing gap between the demand and supply of conventional power, wind energy can show its might. Significantly, the Ministry of Non-conventional Energy sources together with the Indian Renewable Energy Development Agency are also quite hopeful of seeing the wind get that extra punch of power soon **(Deambi, 2003, P.25).**

Global scientific research has highlighted the impact of windmills on wildlife. For example, in the first few months of 2018 alone, published papers have shown that in the Pacific Islands, that activity is as much as 20 times lower in areas with windmills. And in Texas, there has been a staggering 77% decease in redhead docks in coastal ponds within windfarms. The situation may not be different in India. In fact, it may be worse considering the high levels of biodiversity in every square kilometre of forest. In Rajasthan, for instance, transmission lines and spinning blades have reportedly led to increasing mortalities of the critically- endangered Great Indian Bustard. In studies of wind farms from Kutch to Andhra Pradesh, direct collisions have been reported. In Karnataka, where over 6,000 acres of forest land have been diverted for windmills, anecdotal evidence suggests that many species could be affected **(Rao, 2018, P.8).**

Ocean Energy

Ocean is one of the important potential renewal sources of energy. Research and development regarding the use of this energy source is being carried out. Ocean energy does not require any fossil fuel and is pollution free. Energy from the ocean is available in several forms such as ocean thermal energy, wave energy, tidal energy, salinity gradients, ocean currents, ocean winds and marine energy.

We all know that oceans cover about 70 percent of the Earth's surface. But that they have a potential to offer an important alternate source of energy is not known to many of us. Oceans are a rich source of thermal energy, as it has been estimated that on an average day, 60 million sq. kms of tropical ocean waters absorb solar radiation equivalent in heat content to that of about 170 billion (1 billion=10^9) barrels of oil. Theoretically, removal of this much heat from the ocean would not significantly alter its temperature, but would permit generation of about 10 million megawatts of electricity on a continuous basis. If even an insignificant fraction of this stored solar energy could be converted into electric power, it would supply more than the total amount of electricity consumed in the world. The oceans are thus a vast prospective renewable energy resource with the potential to produce enormous amount of power **(Mezumder, 2003, P.52).**

Evidently there are several scientific discoveries which give us clues for their use in serving the needs of society. Since ancient times oceans have served the mankind in countless ways. The seas around India constitute a natural frontier of our country. Since time immemorial, the inhabitants of India used the seas for transport and communication, for trade and food. Recent developments in the field of oceanography have convinced everyone that some of the biggest treasures of the world lie hidden in the sea. Oceans are, therefore, known as **"**our last frontier.**"** One of the areas of science in which the most spectacular advances are expected to be made is the ocean sector. Coastal and offshore activities are on the increase and technological advances are on the way to harness some of the hitherto untapped resources of the sea **(Qasim, 1991, P.12).**

According to Wikipedia, **"**India has a long coastline of 7517 Km marked along by numerous estuaries and gulfs which makes it attractive for the development of marine energy projects. India's wave power potential is around 40-60 GW. However, compared to the developments in other renewable energy technologies, ocean energy technologies like wave and tidal are in their nascent stages of development in India.**"** According to a study by IIT Madras and CRISIL, wave energy technologies would require about 10 GW of cumulative capacity to become cost competitive.

Ocean thermal energy is generated by making use of the temperature difference between the ocean surface and deeper depths. A temperature difference of about 20℃ exists between the ocean surface and depth of more than the 500 m. This temperature difference is converted to work and then into electricity. This is done using certain gases (Viz. Ammonia, Propane, etc.) which become liquid at not very low temperature but become gas at slightly higher temperatures. Ammonia (NH_3) becomes liquid at the lower temperature of deeper depths. When liquid NH_3 comes in contact with the higher temperature at the ocean surface, it becomes gas and the pressure increases. This high pressure NH_3 rotates the turbine. From the turbine, gaseous NH_3 is taken to lower depth for liquification. The first ocean thermal energy conversion (OTEC) plant was installed in 1920, some of the best sites in the world for OTEC plants are located of the Indian mainland near Lakshadweep and Andaman-Nicobar islands **(Alappat & Dikshit, 1999, P. 42).**

Keeping in view the need for 'green energy' in this century, the OTEC systems promise full exploitation of the marine renewable energy sources. The Economics of power generation form the sea in terms of investment, maintenance of the systems, serving etc. will have to be taken into account in such a way that the cost of power generation is comparable with the conventional sources. The oceans are a vast-store house of renewable energy which is waiting to be unlocked. This is very important for India. Our seas are a source of endless energy inviting us to be tapped. The question arises whether we have determination enough to tap it.

Small Hydro Energy

Hydro Power is perhaps the oldest renewable energy technique known to mankind for mechanical energy version as well as electricity generation. India is amongst the countries including China where water wheels were first developed. India has a century old history of hydro power and the beginning was from small hydro. Small hydro is the development of hydroelectric power on a scale suitable for local community and in industry, or to contribute to distributed generation in a regional electricity grid. Hydro power projects are generally categorised in two segments i.e. small (less than 25 MW) and large hydro (more than 25 MW). While Ministry of New and Renewable Energy is responsible for small hydro projects, the large hydro power is dealt by Ministry of Power. Small hydro power projects are further classified as Micro Hydro (up to 100 KW), Mini Hydro (101 to 2000 KW) and Small Hydro (2001 to 25000 KW). Small hydro power is one of the most attractive renewable source of grid quality power generation.

It has been recognised that small hydro power projects can play a critical role in improving the overall energy scenario of the country and in particular for remote and inaccessible areas. MNRE is encouraging development of small hydro projects both in the public as well as private sector. Though, the SHP programme is now essentially private investment driven. Projects are normally economically viable and private sector is showing lot of interest in investing in SHP projects. The viability of these projects improves with increase in the project capacity.

MNRE runs a special Small Hydro Power (Capacity up to 25 MW) Programme to meet power requirements of remote and isolated areas in a decentralised manner. Such projects also create employment opportunities to local people and enhance livelihood opportunities in rural areas. Special emphasis is being laid to north-eastern states which are beleaguered by large energy deficits and poor quality of energy services. SHP projects have been found effective in generating sufficient electricity to power domestic households, schools and clinics in rural areas and catalyse entrepreneurship activities. Against the target of 5,000 MW aggregate capacity by the year 2022, an aggregate capacity of 4,750. 46 MW has been achieved (up to 31.12.2020). Under the PM's special package for Arunachal Pradesh, over 150 micro-hydel and small hydel projects have been installed in the region, that are pushing rural transformation activities. Several SHP projects have been completed in Ladakh and Kargil areas, where grid-connectivity is technically difficult **(Saxena, 2022, P.34)**

Biogas Energy

The Biogas technology is a proven technology now and is well known all over the world. **"**Biogas is the term used to describe the mixture of gases produced during anaerobic digestion. The mixture mainly consists of methane (CH_4) and Carbon dioxide whose ratio ranges from 1-2:1. The term gas/biogas has been frequently used in the text and refers to combustible gas containing 50 percent or more of methane**" (Chawla, 1986, P.132).**

Since in our county only gobar is used, hence it is called gobar gas or biogas produced form the digestion of dung (gobar). Biogas is a clean, unpolluted and cheap source of energy in rural areas. It contains 55 to 70 percent methane which is inflammable. Biogas is produced from cattle dung in a "Biogas Plant", commonly known as "gobar gas plant" through a process called "digestion". The manurial value of the dung is enhanced in the process.

Biogas plants are reliable source of decentralised Renewable Energy for heating, cooking as well as generating electricity/ power generation and thermal energy application alternatives in our country. Biogas Potential in India is very large. At present more than 5 million biogas plants are operational in the country. Maharashtra, Gujarat, Karnataka, Uttar Pradesh and Madhya Pradesh are India's major biogas plant operating states. The state of Maharashtra had the largest number of biogas plants in India, with over 931 thousand plants as of March 2021. Karnataka ranked second with nearly 513 thousand plants.

The Gobar-Dhan Yojana will help in keeping the village clean while increasing the income of farmers and cattle herders. Replacement of fossil fuels with agricultural solid biomass by clean fuel like biogas for cooking, lighting and electricity generation would also help in curtailing the Green House Gas (GHG) emissions as well as indoor air pollution. According to the United Nations Food and Agriculture Organization (FAO), the animal waste on this planet produces around 55-65 percent methane, which upon release in the atmosphere can affect global warming 21 times higher than the rate CO_2 does **(Ganesan, 2018, p.46).**

Biogas is the first clean and renewable source of energy that was developed specifically for rural areas and was promoted by union government during 1980s. Currently, MNRE is running a comprehensive 'New National Biogas and Organic Manure Programme' (NNBOMP) for dissemination and deployment of biogas plants in remote, rural and semi-urban areas of the country. Under the programme, Central subsidy is provided for installing biogas plants in the size range varying from one cubic metre to 25 cubic metre. Besides financial support is also extended to beneficiaries for construction, supervision etc.

Ministry of New and Renewable Energy, Govt. of India is contemplating National Biogas Mission for setting up of 1 crore biogas plant by 2022. Already a task force has been constituted by the Ministry, which is working on preparation of Mission Document. This will be an initiative for utilising all kind of bio-waste for biogas production for cooking, power generation and automotive fuel, for providing energy security and promoting organic agriculture in the country.

Biomass Energy

Biomass has always been an important energy source for the country considering the benefits it offers. It is renewable, widely available, carbon neutral and has the potential to provide significant employment in the rural areas. Approximately 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. MNRE has realised the potential and role of biomass energy in the Indian context and has started various programmes for promotion of appropriate technologies for its use in various sectors of the economy to ensure derivation of maximum benefits. For proper utilisation of biomass, bagasse based cogeneration in sugar mills and biomass power generation have been taken up under biomass power and cogeneration

programme. As on 30.06.2021, a total capacity of 10170 MW has been installed in Biomass Power and Cogeneration sector.

Power and renewable energy minister R.K. Singh has said, India can generate around 18,000 Megawatt (MW) of renewable energy using biomass and an additional 7000-8000 MW from bagasse cogeneration in sugar mills. He also said in a written reply in Parliament, MNRE has launched a scheme to support biomass-based cogeneration in sugar mills and other industries up to March 2020. "Under this scheme, biomass cogeneration Projects are being provided Central Financial Assistance at the rate of Rs. 25 Lakh per MW of surplus exportable capacity and Rs. 50 Lakh per MW of installed capacity depending on the type of fuel used." He quoted a study by Indian Institute of Science, Bangalore, which estimated surplus biomass availability in the country at around 120 to 150 million tonnes per annum covering agricultural residues.

Energy production is possible using fast growing tree species like Eucalyptus, Prosopis, Lencaena, Acacia, etc. These trees are planted for the sole purpose of power generation and are called energy plantation. Usually energy plantations maintain a 5-year crop cycle. For a 10 MW Power Station, about 5,500 hectares will have to be brought under energy plantation if it is to run only on plantation wood. Gasifiers are generally installed to recover energy from biomass resources (agricultural residues/wastes, biowastes from industries, bagasse of sugar mills, etc) for power generation.

The biomass energy sector presents ample opportunities for job creation in India. As per MNRE'S Human resource development strategy for Indian RE sector report, estimated that 35,000 people were engaged in employment through biomass on-grid systems in 2009. The report also projected employment of 60,000 and 1 Lakh people by 2020 in biomass on-grid under moderate and high growth scenarios respectively. It further projected employment of 63,000 people by 2020 in the biomass gasification sub-sector. However, biomass gasification based electricity generation and distribution companies in rural areas have been facing acute skills crunch. While there are ITI level Courses for solar energy in India, there, isn't any curriculum recommended by the government for biomass gasifier sector. To address this challenge, Bihar based Husk Power Systems (HPS) has set-up Husk Power University, a captive institution for skills building of local youth **(Shardul, et al, 2016, P. 37)**

Prices of bagasse corncobs, coconut shells that are used as fuel for biomass power projects have risen over five times since 2005 while there has been no major rise in the tariffs. Besides, uncertainties in supply due to unorganised suppliers and unpredictable climatic conditions have sharply dented economics of biomass projects.

While 80% of the plants have already ceased functioning, the rest are also on the verge of closure. According to the Indian Biomass Power Association secretary general D.Radhakrishna, of the 1,100-MW installed capacity in the country only about 200-MW is operational, that too in heavy losses. A few of the projects have defaulted in loan repayment and are likely to be taken over by the banks.

Such projects have Power purchase agreements with state distribution utilities to sell power at fixed tariffs. "The tariffs were set when the price of biomass fuel was very low. Unless government policy is amended to allow power purchase agreements to be renegotiated to reflect the recent sharp rise in fuel costs, the long term viability of biomass projects will be threatened," Fitch Rating said in its recent report **(Jai & Singh, 2011, P. 11)**

In India, 400 million people, of which 90% are women, are exposed to indoor air pollution from inefficient cookstoves. This results in respiratory, pulmonary and vision problems. In addition, inefficient cookstoves mean that women spend five to eight hours per day on cooking activities, 20% of that time collecting fuel. This is time that could be spent on educational or other activities. Searching for fuel also puts women and children at risk of sexual violence. The government of India is taking action. The National Programme on Improved Cookstoves has been successful at the State level. The National

Biomass Cookstoves Initiative (NBCI) is providing improved cookstoves, which directly help the weakest and most vulnerable sections of society **(Verma, 2013, P.7).**

Biodiesel

India faces increasingly difficult challenges in ensuring energy security. Among all end-uses, the scope for fuel substitution is highly restricted in the transport sector, which is a very vital one because of its role in ensuring the mobility of goods and people. There has been a worldwide search for alternative renewable fuels to mitigate the problem of energy insecurity and India has been exploring the feasibility of developing biofuels that can reduce the dependence on petroleum products for transport. However, the use of biotic resource may involve some change in the land use pattern if it is derived from a cultivated crop, as in the case of bioethanol and biodiesel, from sugarcane and oilseeds respectively. Since changes in land use may threaten the security of food or other agrarian supplies **(Singhal & sengupta, 2012, P. 66).**

Biodiesel is non-toxic; biodegradable diesel fuel made from vegetable oils, animal fats and used or recycled oils and fats. Biodiesel could be an excellent renewable fuel for diesel engines. It is derived from vegetable oils that are chemically converted into biodiesel. The chemical process is called Transesterification. The process was developed as early as 1853 by scientists E.Duffy and J.Patrick. Transesterification is the process of using methyl alcohol in the presence of a catalyst such as sodium hydroxide or potassium hydroxide to chemically break the molecule of the raw renewal oil into methyl ester (Biodiesel) of the renewable oil with glycerol as a bio-product. Biodiesel when used as a pure fuel it is known as B100. However, it is often blended with petroleum-based diesel fuel and when this is done, the blend is designated "BXX" where xx is the percentage of biodiesel in the blend. For example, B20 is a blend of 20% biodiesel and 80% petroleum diesel fuel. Biodiesel can be used in the pure form, or blended in any amount with diesel fuel for use in compression ignition engines **(Senapati, 2014, P.28)**

Biodiesel is an environment friendly fuel which has almost no Sulphur, no aromatics, and has about 10% built in oxygen. Biodiesel needs no separate infrastructure for storage and dispensing, the existing tanks and dispensation station of conventional diesel can be used. It is safe to handle and moreover, flash point of biodiesel is higher than the conventional diesel and needs no engine modification upto a blending of 15% **(Sarmah & Bordoloi, 2008, P.4).**

Several plants found in India, including pongamia pinnata, neem, rubber, and castor bear seeds with non-edible oils that can be used to produce biodiesel. But the plant that is arousing great enthusiasm for this purpose is Jatropha curcas. Jatropha is the first choice since it can be grown in both saline and alkaline soils, arid and semi-arid conditions, low slopes of hilly areas, and degraded and abused soils- **(Raj, 2006, P.10).**

Experts say biodiesel production has huge employment potential. In India, the fuel is made from Jatropha, a plant grown in the semi arid-arid regions of Rajasthan, where otherwise cultivation is sparse **(Choudhary, 2011, P.11).** India has vast stretches of degraded land, mostly in areas with adverse agro-climatic conditions, where species of Jatropha can be grown easily. Considering 10 million plantation on both sides along the railway tracks, 1,26,000 hectares can be cultivated with jatropha. Use of 11 million hectares of waste land for Jatropha cultivation can lead to generation of a minimum of 12 million jobs **(Biswas, 2006, P. 15).**

Hydrogen Energy

Hydrogen is the ultimate clean energy carrier. Unlike our current energy sources such as nuclear or fossil fuels, combining hydrogen and oxygen in a fuel cell produces nothing but electricity and pure, clean water. That is the reason hydrogen is used in fuel cells on the Space Shuttle to provide electricity and water for the astronauts to drink. Hydrogen is not an energy source, however, like electricity,

hydrogen must be generated from another energy source. If hydrogen is made from fossil fuels, then some greenhouse gases may be generated, although often less than using fossil fuels directly for transportation. But if hydrogen is made from renewable energy sources such as algae, biomass, wind, or solar energy, there will be zero or near-zero emissions. Hydrogen-powered fuel cell vehicles will eliminate local air pollution, significantly reduce green house gas emissions and eliminate our dependence on imported oil **(Kumar, et al, 2007, P.15).**

In India considerable progress has been made in the field of harnessing hydrogen as fuel. India's hydrogen energy programme is part of what the Ministry of Non-conventional Energy Sources (MNES) calls it's New Technologies Initiative. The strategy has been to help laboratories acquire expertise in the production, storage, and utilization of hydrogen as an alternative fuel. A major outcome of this programme is a hydrogen-powered motorbike that uses a novel metallic hydride hydrogen storage system that could also be used in cars **(Datta, et al, 2003, P. 13).**

"National Hydrogen Mission**"** was announced in August 2021 to produce carbon-free fuels from renewable resources and to make India a global hub of production as well as export of green hydrogen. The ultimate aim of this mission is to attain self-reliance in energy production and to achieve the set target by 2047 so as to celebrate the 100 years of independence. This is to increase the usage of natural gas in the economy from renewable sources. To achieve this target, a roadmap has been set for making India self-reliant in energy sector for which a Pan-India network of CNG and piped-natural gas is laid out which will help in achieving 20% ethanol blending target. National Hydrogen Mission will bring drastic changes in the energy sector and will contribute in gas-based cleaner economy **(Mohapatra & Mohapatra, 2021, P.30).** The production of green hydrogen will support in making India self-reliant and will help government companies, and other production units to fulfil their long-term growth potentials without compromising on the set targets of carbon-free economy.

Considerably work has been going on in India on harnessing hydrogen as a fuel. But much more still needs to be done. The hydrogen economy is within sight but there is still a long road ahead. The sooner we got there the better it would be.

Nuclear Energy

"Jain philosophers have been speaking about non-violence in olden days when nobody knew about power from atoms. Mahatma Gandhi put non-violence into practice in modern times and its power was soon known to the world. The power derived from atoms in equally non-violent. Talking of non-violence today, therefore, sounds useless, it is very much in the system,**"** observed Raja Ramanna, country's eminent nuclear scientist. He also said, "Nuclear power is the only diversified unlimited energy source which is quasi-indigenous, does not emit green house gases and has largely favourable and slightly unfavourable economics. Should the climate-change threat become a reality, the only available technology that can replace coal in base load is nuclear technology". **(Mahalanobis, 2002, P.8.).**

Homi J Bhabha had also said in 1943, "……when nuclear energy has been successfully applied for power production, in say about a couple of decades from now, India will not have to look abroad for its experts but will find them ready at hand.

India needs to diversify its energy sources. One of the best options is nuclear energy- a non-carbon emitting resources. India has plenty of Thorium, but Uranium is scarce. India's uranium resources- about 0.8% of the world- cannot contribute to any significant improvement in the situation if Uranium is to be used on once-through basis and then disposed off a waste. However, with a carefully planned programme, the available Uranium can be used to harness the energy contained in non-fissile Thorium, of which India possesses 32% of the world's resources.

The Indian nuclear power programme, launched in 1954, envisaged a three stage development of nuclear power generation from country's Uranium and thorium resources. The first stage of this programme involves using indigenous Uranium in Pressurised Heavy Water Reactors (PHWRs), which efficiently produces energy as well as Plutonium. In the second stage, by reprocessing the spent nuclear fuel and using recovered plutonium in Fast Breeder Reactors (FBRs), the non-fissile depleted Uranium and Thorium can breed additional fissile nuclear fuel, Plutonium and Uranium-23, respectively. In the third stage, Thorium and Uranium - 233 based nuclear reactors can meet long-term energy demands **(Bose, 2006, P.10)**

India has seven nuclear power plants, which produce a combined 6.78 gigawatts of atomic energy. The government has said that it plans to triple its nuclear power capacity to 22.48 gigawatts by 2031 to make up 5% of the country's power production, from just over 3% now.

Jitendra Singh, Minister of state for Earth Science and Atomic Energy, told Parliament in March, 2022, "Nuclear power has huge potential and can provide long-term energy security to the country in a sustainable manner. A nuclear capacity expansion programme is one of the means to achieve the country's transition in meeting the goal of a net-zero economy."

"There is the problem of secrecy. There has been no disclosure of how much heavy water leaked or of the rise in the radiation levels within the reactor complex. Secrecy, again, is not conducive to safety. With plans for a large expansion of nuclear power in the country, it is vital that the nuclear establishment makes safety it highest priority, not at the verbal but operational level" **(Editorial, 2016, P. 8.)**

If nuclear engineers can overcome the technical hurdles involved in building the next generation of reactors then mankind will have energy that is safe, abundant, reliable, inexpensive and proliferation resistant. For nuclear power to undergo a renaissance, engineers agree that reactors will need to be a lot cheaper to run. And to sway a nuclear averse public, the next generation of reactors will need to produce much less radioactive waste at terrorist- proof facilities. Such technological challenges are too great for one country alone. In 2001, the founding nations of GIF (The Generation IV International Forum) consisting of the united states, Argentina, Brazil, Canada, France, Japan, South Korea, South Africa, Switzerland and the United Kingdom decided to pool their resources and expertise for developing the nuclear reactors of tomorrow **(Biswas, 2007, P.10).**

Hence, in the modern age, the importance of nuclear energy for economic development is so vital that the Nobel laureate, atomic physicist F. Joliot-curie believed that "It is not so much atomic energy as the mass synthesis of molecules similar to chlorophyll that will be responsible for the real revolution in world power engineering" **(Alekseev, 1986, P. 200).**

Conclusion

Mahatma Gandhi had said that his object in life was to wipe tear from every eye. The Integrated Energy Policy too, needs to keep this sage advice of Mahatma Gandhi in mind by making it a guiding principle. Only when sustainable energy security is assured to the poorest of the poor and the disadvantaged sections of our society can India hold its head high and get its rightful place in the comity of nations in the 21st century.

In India the population is growing at an alarming rate. It has put an excess pressure on fossil fuels. The treasure of fossil fuel is fast depleting. In India the reserves of fossil fuels are being consumed at a very fast rate. For the survival of mankind the enormous use of energy, we may have to shift our dependence from fossil fuel based techniques of production to renewable energy based techniques. Though the country has vast potential for renewable source of energy, their commercial exploitation at present is minimal. There is an urgent need of concrete energy planning to generate more and more energy from renewable sources to meet the present demand. If the earth has to survive in a decent enough form

innumerable such innovations will have to harness the power of nature to provide cheap and clean energy for the future. Apart from supporting jobs and entrepreneurship with better power supply, renewable energy has vast potential to address critical issues such as energy poverty, agro-productivity, food security, health and climatic variability. In one stroke, we can make renewable electricity the main source of energy, solve the challenges related to energy poverty, address climate change, build local economies and move towards a secure energy future for India. There can be many solutions to a problem but to reveal the hidden answers what is required is determination, dedication, will to achieve the goals, a well defined policy, and political and financial support.

The energy problem is not going to be solved overnight rather it will be aggravated in the time to come due to various factors which have not received the proper attention of the policy makers. Multipronged attack on this front is required. Right from increasing production and generation, shift in the use pattern is also important. It is not the energy that matters today rather it has got to be eco-friendly as well. Now the environmentalist have come to the conclusion that generation and consumption of energy irrespective of its ecological impact will be damaging and finally suicidal in the long run. Hence, these vital aspects of energy scenario are to be kept upper most in the mind while deciding energy policy on the long term sustainable basis.

References

1	Alekseev, G.N.	(1986),	"Energy And Entropy," Mir Publishers Moscow.
2	Alappat, B.J. & A.K. Dikshit	(1999),	"The Non-Conventional Alternatives," Yojana, Vol. 43, No. 12, December.
3	Bose, Mrityunjay	(2006),	"A Deal For India," Science Reporter, Vol. 43, No. 4, April.
4	Biswas, Soumitra, G. Srikanth & Nirmala Kaushik	(2006),	"Biodiesel : Fuel Of The Future," The Hindu, Delhi, August 3.
5	Biswas, Rathindra Nath	(2007),	"The Challenge Of Green Power." Science Reporter, Vol. 44, No. 6, June.
6	Chawla, O.P.	(1986),	"Advances In Biogas Technology," Published by Publication and Information Division, Indian Council Of Agricultural Research, New Delhi.
7	Choudhary, Shruti	(2011),	"CCI To Probe Govt-OMC Role In Bio-diesel," The Economic Times, Pune, December 28.
8	Dayal , Maheshwar	(1989),	"Energy Today And Tomorrow," Publication Division, Ministry of Information and Broadcasting, Government of India.
9	Deambi, Suneel,	(2003),	"The Winds Of Change," Science Reporter , Vol. 40, No. 6, June.
10	Datta, Dr. Sukanya, Parvinder Chawla, Hasan Jawaid Khan and Dr. B.C. Sharma	(2003),	"Hydrogen-The Ultimate Fuel," Science Reporter, Vol. 40, No.6, June.
11	Editorial,	(2016),	"Once Again A Nuclear Reactor Leak," Economic & Political Weekly, Vol. L1, No. 14, April 2.
12	Garg, P,	(2012),	"Energy Scenario And Vision 2020 In India," Journal of Sustainable Energy and Environment.
13	Ganesan, Dr. K.,	(2018),	"Gobar Dhan : Waste To Wealth," Kurukshetra, Vol. 66, No. 6, April.
14	Jai, Shreya & Sarita C singh,	(2011),	"Biomass Projects Tripping On Funds And Fuel Crunch," The Economics Times, Pune, December 28.
15	Kumar Naveen, Rajni Singh, Sarika Saxena & Ashwani K. Srivastava	(2007),	"Green Algae : Future Power Plants," Science Reporter, Vol. 44, No. 6, June.
16	Mahalanobis, Surojit,	(2002),	"Harnessing Nuclear Energy," The Times Of India, New Delhi, April 23.
17	Mazumder, Subhjit Mitra,	(2003),	"Magnificent Oceans-Source Of Rich Energy," Science Reporter, vol. 40, No. 6, June.
18	Mohapatra, Dr. Amiya Kumar,	(2021),	"Self-Reliance In Energy Sector," Yojana, Vol. 65, No. 12, December.
19	Parikh, Kiriti,	(1976),	"Second India Studies : Energy," Macmillan Co. Of India Ltd, Delhi.
20	Qasim, Prof. S.Z.	(1991),	"Sea : Store House Of Renewable Energy," Yojana, Vol. 35, Nos. 1&2, January 26.
21	Raj, N. Gopal,	(2006),	"Prospecting For Green Diesel," The Hindu, Delhi, May 22.

22	Rao, Mohit M.,	(2018),	"Rethinking Wind Energy," The Hindu, Patna, May 10.
23	Sarmah, Etali & Bedanga Bordoloi,	(2008),	"Biodiesel- The Cornucopia Of Fuel In Future," Kurukshetra, Vol. 56, No. 4, February.
24	Singhal, Robin and Ramprasad Sengupta,	(2012),	"Energy Security And Biodiesel : Implications For Lad Use And Food Security," Economic & Political Weekly, Vol. XLVII, No. 40, October 6.
25	Senapati, Dr. Manas Ranjan,	(2014),	"Biodiesel-The New Power," Kurukshetra, Vol. 62, No. 9 July.
26	Shardul, Martand, Shilpa Mohan, Mohd. Asim Mirza, Devender Singh and M.K. Pande,	(2016),	"Biomss Energy : Scope In India," Kurukshetra, Vol. 64, No. 07, May.
27	Saxena, Dr. Jagdeep,	(2022),	"Renewable Energy : Transforming The Face Of Rural India," Kurukshetra, Vol. 70, No. 03, January.
28	Tripathi, Arun Kumar,	(2016),	"The National Solar Mission : Marching Ahead In Solar Energy," Yojana, Vol. 60, August.
29	Verma, Sandip,	(2013),	"Clean Energy Can Light Up Lives," The Hindu, Kolkata, September 3.

Practices of Rural Waste Management in Karnataka

Wajeeda Bano

Abstract

Waste generation in India has increased tremendously in the last few decades. In recognition of the rapid urbanization and the growing population, there is an urgent need for effective and efficient solid waste management practices in urban as well as rural areas. The present study is based on a project undertaken in rural areas of Dakshina Kannada district with the following major objective::

- To assess the waste collection services and practices in Konaje Gram Panchayat
- To examine people's awareness of the management and segregation of household waste,
- To analyze waste management attitude, knowledge, and practice,
- To assess people's willingness to pay for a hygienic environment, &
- To suggest strategies for improvement of rural solid waste management practices.

Methodology The present study is undertaken in Konaje Gram Panchayat in Mangalore taluk of Dakshina Kannada district in Karnataka for an in-depth analysis of waste management practices at the grass root level. By keeping a 5 % margin of error and 95% confidence level we selected the required sample size of 334. **The study is based on both primary and secondary sources of data.** Modeling of the logistic and multinomial models are employed to analyze the determinants of knowledge in waste management, willingness to pay for a hygienic environment, and attitudes towards waste management. Results reveal that in the study area, there are places that urgently require attention due to the littering of waste materials, the divergence between solid waste management practices, and the solid waste regulations of 2016. The attitudes, knowledge of waste management, and willingness to pay for a hygienic environment have statistically significant influencing factors. The study provides various strategies to improve the waste management situation.

Keywords: Waste, segregation, management, field study

Introduction

Waste management is also termed as waste disposal defined as the assemblage of systematic processes that aim at transferring waste to selected locations, treating it to detoxify or changing to a riskless form, and reforming it to be reused, or simply a way through which produced waste is controlled. Waste management classifies methods of handling waste to minimize and remove waste areas/places where its unwanted, reduce the effects that can be caused due to the presence of waste and changing of waste to a usable form, starting from waste collection and ending at efficient safe disposal. How wastes are disposed of and managed differs from place to place depending on the responsible authority in designing a system of waste collection.

Review of Literature

On the need for waste management the studies conducted by (Lal, 2007), (Kaushal, 2012) (Narayana, 2009) revealed that the necessity of waste management to reduce health related risk revealing aesthetic effect of solid and liquid waste. According to them nearly 60% of reported illnesses are linked to poor waste management causing diseases like skin infections, dengue fever, diarrhea and gastrointestinal illness among residence. These studies also pointed out that waste treatment reduces the cost that could be used or incurred in disposing the municipal waste. Compost can provide cheaper renewable energy and provide nutrient essential for plant growth and also reduce waste. Poor people can be employed in

the waste management system through recycling and collection of waste material. Transformation of the waste in to usable products creates business opportunities that can be undertaken (Kaushal (2012).

Reducing dependence on collection of municipal waste by citizen will help to make each individual to be accountable for the waste he or she generates. Manual decomposing is easily merged into socio-economic conditions providing employment opportunities; manual decomposing is environmentally viable and can be a good source of income with less effort (Narayana, 2009). Waste management is very important in ensuring ecological and sustainable development, a clean and healthy environment, maintaining the health of the citizens, conserving resources, ensuring the quality of healthy life, utilization of renewable resources, generating and utilizing energy from waste, convert harmful waste to useful and usable substances, prevent contamination of toxic and harmful substances from not harmful, treating garbage and sewage water and economic viability of industries will be achieved (Sharma H.D (1995). Nunan F. (2000) explains how revenue to municipalities from the sale of organic waste which is collected from the waste bins, can be useful and used to water vegetables consumed in the local market, livestock farmers earning income from the sale of dung as organic manure to plant growers in the informal market and environmentally efficient practices that are compatible for a healthy environment.

Studies related to Waste Management Practices at international level such as by Zeng (2015) reveal the prevalent of popular ways of waste collection by specific collection containers from the local authorities in china. (Meallem, 2010) Employing both qualitative and quantitative approach to the study of patterns of environmental waste management in Um Batim village showed how poor waste management practices are dominant in rural areas posing health risks to the villagers. Han, Z (2015) identified that the presence of waste management problems in rural Tibet that result from burning domestic wastes in unorganized manner, free open dumping and wastes being burned randomly, increase in per capita waste generation. (Guan, 2015) employed a quantitative study of present and historical data of Zihejiang province concerning domestic waste management in the rural areas underpinning environmental challenges that were faced by the poor in waste management in the rural areas and suggested a cost effective means that will be sustainable in the long run, this can be through upgrading from sanitary landfill waste treatment to composting and landfill that is preceded by source segregation of rural domestic waste.

While examining waste management issues in Romanian cities Mihai, F., &Grozavu, A. (2018) found that there was an increase in banned waste disposal practices before the implementation of EU accession. Taghipour, H (2016) Study of Khosrowshah district in Iran reveals that there is absence of people awareness on undesirable solid waste disposal posing risk their health and the environment, no systematic program for solid waste separation was followed. Wath S.B (2011) Says India has neither formal nor systematized E-waste management practice to ensure environmental safety. The study reveals that a large amount of E-waste is being dumped as municipal solid waste and the practices for recovering and recycling E-waste in India are traditional and unhealthy. Gupta, N (2015) opines that authorities should establish competent plans for solid waste management so that conditions for hygiene and sanitary are adequately maintained. Kaushall (2012) Study reveals that most of the urban areas in India are lacking storage municipal solid waste management. Uncontrolled dumping leads to pollution of water and soil, rising threat to threat on public and environmental health. (Shah, 2012). Prevailing practices of uncontrolled dumping of waste increases problems to human and environmental health, therefore the mitigation strategies such as door to door waste collection, scientific designated landfills, implementation of polluter pay principle, community participation and proper planning need to be adopted (Vij, D. (2012)

Waste management studies at regional level by Velsivasakthivel, S et al (2014), Chanakya, H. N (2008) Narendra, M et al (2013, Thirumala, S. (2013) Sudhakar, V., &Chandrashekar, J. (2008) Guptha, C. N et al (2009) Lakshmikantha, H et al (2007) Chanakya, Han Z (2009) Ramachandra (2007) have discussed solid waste and biomedical waste disposal problems and how these are handled at different areas.

Similarly several **Waste management studies at district level like** Sequeira, V et al (2015), Bhaskar, B. (2011) Pullishery, (2014) Andrade,(2011) Rani, R. (2006) Ismail, I.(2013) Sushma, M. K (2010) Purushothama, K. V. (2018) Kumar, P (2007) discussed about solid waste and medical waste generated in Mangaluru per day and discussed waste management problems faced in urban areas in Mangaluru.

Research Gap

The review of literature reveals that majority of the studies have been undertaken in the urban areas and very few studies have been conducted in the rural areas. Particularly studies available in Darkshina district have majority been centered on management of biomedical waste and very few on the management of solid waste. Therefore this study has been conducted in the rural areas of Darkshina District to analyze and asses the status of solid waste management

Objectives

Following are the important objectives of the present study:

1. To assess the waste collection services and practices in Konaje Gram Panchayat.
2. To examine people's awareness in management and segregation of household waste.
3. To analyze waste management attitude, knowledge and practice.
4. To assess peoples willingness to pay for hygienic environment.
5. To suggest strategies for improvement of rural solid waste management practices.

Methodology

The present study is undertaken in Konaje Gram Punchayat in Mangalore taluk of Dakshina Kannada district in Karnataka for in-depth analysis of waste management practices at grass root level. By keeping 5 % margin of error and 95% confidence level we selected required sample size of 334. **The study is based on both primary and secondary sources of data.** Collection of primary data stratified sampling was employed in distribution of questionnaires. The total respondents were divided in to three groups namely Institutions, commercial establishment and households. Apart from primary data the direct interview was conducted at the Gram Panchayat office, to obtain various information and operations that the Panchayat performs in dealing with waste management.

Discussion

Dakshina Kannada district (also known as Managlore) remained one among top five district of the Karnataka state. The district houses many industries, refineries and urban infrastructure. In Dakshina Kannada district Mangalore City Corporation is responsible for handling municipal solid waste. The total waste material generated per day is 220 tons; the total waste collected per day in the city is 210 tons.

Konaje Gram Panchayat is located in Mangalore Taluka of Dakshina Kannada District. Total population in Konaje Gram Panchayat is 11368 of which 5613 are male, 5755 are female population. Konaje Gram Panchayat has eleven wards in total which are under the jurisdiction area of the Panchayat. As per Rule 15 of Solid waste management 2016 act gram panchayats have duties and responsibilities to manage the waste generated in their villages and also preparation of waste management plan as per state policy and strategy.

The result of the collected data and analysis shows following demographic characteristics of the respondents like the Age, Income, Level of education, Marital status, size of family, and religion.

Table 1: Social and demographic characteristics of respondents

Social demographic variable	Frequency	Percentage	Cumulative percent
Total number of respondents	334	100	100
Age			
< 20	32	9.6	9.6
20-29	142	42.5	52.1
30-39	75	22.5	74.6
40-49	46	13.8	88.3
50-59	29	8.7	97
60>	10	3	100
Gender			
Male	176	52.7	52.7
Female	158	47.3	100
Marital			
Single	140	41.9	41.9
Married	183	54.8	96.7
Divorced	3	0.9	97.6
Widowed	8	2.4	100
Family Size			
Less 3	40	12	12
3—5	212	63.5	75.4
Above 5	82	24.6	100
Education level			
No School	16	4.8	4.8
Basic	52	15.6	20.4
Secondary	113	33.8	54.2
Tertiary	153	45.8	100
Religion			
Hindu	220	65.9	65.9
Muslim	83	24.9	90.7
Christian	26	7.8	98.5
Other	5	1.5	100
Av Monthly income			
<1000	45	13.5	13.5
1000-5000	67	20.1	33.5
5000-10,000	102	30.5	64.1
10,000>	120	35.9	100

Source: Field data

Knowledge in Waste Management : Respondents were asked about their knowledge in waste management and they responded either adequate knowledge or inadequate knowledge, those who had adequate knowledge in waste management were 66.2% of the total sample respondents and those with inadequate knowledge 33.8%. Responses of respondents from institutions, shops and households are presented in table 2.

Table 2: Knowledge: responses of respondents from institutions, shops and households

No.	Respondent Category	Adequate	Not Adequate
1	Institutions	68.60%	31.40%
2	Households	61.20%	38.80%
3	Shops	68%	32%

Source: field study

Logistic regression of knowledge in waste management

Since the dependent variable of knowledge in waste management is a binary dependent variable to the chosen independent variables a logistic regression was used to capture the relationship and the model was estimated by the maximum likelihood (ML) method was used this was done through a statistical package (STATA) and the results of the estimated model are summarized in the table 3.

Table 3: STATA Output of Logistic regression on knowledge determinants

Iteration 0: log likelihood = -213.73231

Iteration 1: log likelihood = -149.56859

Iteration 2: log likelihood = -148.96639

Iteration 3: log likelihood = -148.96444

Iteration 4: log likelihood = -148.96444

	Number of obs =	334
Logistic regression	LR $chi^2(6)$ =	129.54
Dependent variable: KnWg	Prob> chi^2 =	0.0000
Log likelihood = -148.96444	Pseudo R^2 =	0.3030

Variable	Coefficients	Std. Error	Prob.
Age	0.168709	0.1356358	0.2140
Edu	0.6270511	0.1861782	0.0010
Info	0.332636	0.102227	0.0010
WstP	0.5434498	0.1644716	0.0010
VscWst	-1.977137	0.3370092	0.0000
AwStm	0.5204996	0.1670656	0.0020
Cons	-2.978011	1.161542	0.0100

Significance level indicator (*) at 1%, (**) at 5%, (***) at 10%

The likelihood ratio (LR) statistic has a value of 129.54 tests the null hypothesis that all the coefficients are simultaneously zero it follows the χ^2 distribution which in our model at six degrees of freedom the *p-value* is 0.000 thus refutes the null hypothesis that the six covariates are zero as showing a very highly statistically significant, practically signify that all six covariates are decisive determinants of knowledge in waste management. The Pseudo R^2 of 0.3030 implies that 30.3% of the adequacy or inadequacy of knowledge in waste management is explained by the variables included in the model, however, this R^2 is not meaningful for binary regression models (Gujarati, 2012). In assessing the factors influencing knowledge in waste management all chosen factors were found to be statistically significant with exception of the age of the respondent which was statistically insignificant as seen in its *p* value in table 3.

Those who indicated to have a more satisfactory attitude had a higher level of knowledge than those with a lesser satisfactory attitude, as indicated in the table above the positive relation of the coefficient of Awstm. Attitude reveals the readiness to use acquired knowledge in waste management, but with unsatisfactory attitude even knowledge in waste management cannot be taken into consideration as people can have ignorance and thus indicate inadequate knowledge through practice of waste management activities. This can also be interpreted in terms of the Odds ratio see table 4.

Table 4. Odds ratio of knowledge in waste management

Logistic regression — Number of obs = 334; LR chi2(6) = 129.54; Prob > chi2 = 0.0000; Log likelihood = -148.96444; Pseudo R2 = 0.3030

knwg	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	1.183776	.1605623	1.24	0.214	.9074361	1.544268
edu	1.872082	.3485408	3.37	0.001	1.29972	2.696497
info	1.394639	.1425699	3.25	0.001	1.141422	1.704032
wstp	1.721937	.2832098	3.30	0.001	1.247437	2.376927
vscwst	.1384651	.046664	-5.87	0.000	.0715282	.2680421
awstm	1.682868	.2811494	3.12	0.002	1.212952	2.334837
_cons	.050894	.0591155	-2.56	0.010	.0052235	.4958752

Table 4 can be interpreted that an additional level of education increases the odds infavor of adequate knowledge by 87%, while receiving information on waste management increases the odds of having adequate knowledge by 39%. Attending program related to waste management increases the odds infavor of adequate knowledge by 72%, an increase in the view on people who dispose waste everywhere decreases the odds ratio by 14% and an increase in satisfactory attitude towards waste management will increase the odds in favor of adequate knowledge by 68%.

Practices of waste management: In trying to understand the waste management practices the respondents were asked to indicate the most preferred waste management practice with choices such as burning, disposing of, reusing, and recycling. The results reveal that about 38.6% of the respondents selected burning waste materials, 28.4% indicated that they prefer disposing of waste, 9% of the respondents practice reuse and 24% recycle the waste materials. Though village gram panchayat has to

ensure management of waste as according to rule 15 of the Solid Waste Management Rules 2016. However, the local government efforts are lagging behind and Konaje Gram Panchayat have no any waste management plan.

Attitude in waste management: Respondents attitude towards waste management was determined by the respondent's response on the question "How do you consider your attitude towards waste management?" the response by the respondents was as displayed in table 5. The table reveals that those with satisfactory attitude are 39.2%, somewhat satisfactory 44.6%, somewhat not satisfactory 9.3% and those not satisfactory attitudes are 6.9%, these responses are being assessed to see the relationship with selected determining variables by use of a multinomial logit model

Multinomial logistic regression of determinants of attitude in waste management

Using the maximum likely hood technique the multinomial logistic model was estimated using STATA software the results are presented in table 5.

Table 5 : STATA output of multinomial logit of attitude determinants

Iteration 0: log likelihood = -378.11227
Iteration 1: log likelihood = -334.90016
Iteration 2: log likelihood = -329.0293
Iteration 3: log likelihood = -328.90786
Iteration 4: log likelihood = -328.90754

Iteration 5: log likelihood = -328.90754

Multinomial logistic regression — Number of obs = 334
Outcome Variable: AwStm — LR chi^2 (33) = 98.41
Log likelihood = -328.90754 — Prob> chi^2 = 0.0000
Pseudo R^2 = 0.1301

Choice	Variable	Coefficients	Std. Error	Z statistic	Prob.
Not satisfactory at all	Edu	0.0822828	0.2985347	0.28	0.783
	Gen	0.5601330	0.5430223	1.03	0.302
	Income	0.0985189	0.2642706	0.37	0.709
	KnWg	-1.0455340**	0.5400854	-1.94	0.053
	SatWms	-1.5444150*	0.4759415	-3.24	0.001
	UgcSv	-1.1944810**	0.5874063	-2.03	0.042
	Rol	0.4340230	0.4213598	1.03	0.303
	LgEf	-0.1897936	0.2699964	-0.7	0.482
	SwCs	-0.1109794	0.2825309	-0.39	0.694
	QwCs	-0.1377584	0.3544757	-0.39	0.698
	DwSmp	0.5076561	0.5219216	0.97	0.331
	Cons	0.7582989	1.9385000	0.39	0.696

Somewhat not satisfactory	Edu	0.3057363	0.2682253	1.14	0.254
	Gen	0.5424575	0.4565801	1.19	0.235
	Income	0.1207576	0.2148243	0.56	0.574
	KnWg	-0.9657261**	0.4649889	-2.08	0.038
	SatWms	-0.6169857	0.4052191	-1.52	0.128
	UgcSv	-0.2441735	0.4475405	-0.55	0.585
	Rol	-0.3150978	0.3098128	-1.02	0.309
	LgEf	0.1446484	0.2259215	0.64	0.522
	SwCs	-0.1834814	0.2413231	-0.76	0.447
	QwCs	-0.0963735	0.3005811	-0.32	0.748
	DwSmp	0.420736	0.4382252	0.96	0.337
	Cons	-0.4259428	1.5585990	0.27	0.785
Somewhat satisfactory (Base outcome)					
Satisfactory	Edu	-0.2970509**	0.1525024	-1.95	0.051
	Gen	-0.1603544	0.2546812	-0.63	0.529
	Income	0.2300667***	0.1331351	1.73	0.084
	KnWg	0.0090137	0.3052824	0.03	0.976
	SatWms	0.0962560	0.2476517	0.39	0.698
	UgcSv	-0.4661792***	0.2763290	-1.69	0.092
	Rol	0.6356203**	0.2633562	2.41	0.016
	LgEf	-0.0247329	0.1250013	-0.2	0.843
	SwCs	-0.1706003	0.1591368	-1.07	0.284
	QwCs	0.4014967***	0.1960577	2.05	0.041
	DwSmp	-0.9437153**	0.3215827	-2.93	0.003
	Cons	-1.6198930	1.0769340	-1.5	0.133
Significance level indicator (*) At 1%, (**) at 5%, (***) at 10%					

As seen in table5 the results of the multinomial logistic regression the LR statistic following a chi square distribution at 33 degrees of freedom rejects the null hypothesis that all the coefficients are zero in showing the p value of 0.000 which is statistically significant, thus we can say all the control variables are important determinants of attitude towards waste management.

To know the willingness to pay for hygienic environment the respondents were asked if they are willing to pay for hygienic environment. 77.5% responded were willing to pay for hygienic environment while the rest 22.5% were not willing to pay for hygienic environment.

This willingness was assessed with various determinants to understand the relationship the results are presented in Using the maximum likely hood technique the logistic regression model was estimated using STATA software the results are presented in table.6

Table 6: STATA Output of Logistic regression on determinants of willingness to pay

Iteration 0: log likelihood = -177.89102
Iteration 1: log likelihood = -133.15587
Iteration 2: log likelihood = -128.88955
Iteration 3: log likelihood = -128.84591
Iteration 4: log likelihood = -128.84588
Iteration 5: log likelihood = -128.84588

	Number of obs =	334
Logistic regression	LR chi2(8) =	98.09
Controlled variable: WpHe	Prob> chi2 =	0.0000
Log likelihood = -128.84588	Pseudo R2 =	0.2757

Variable	Coefficients	Std. Error	Prob.
Edu	0.397209	0.181018	0.0280
Gen	0.1460482	0.321514	0.6500
Income	0.6481235	0.157524	0.0000
ImPh	0.9578952	0.469816	0.0410
Wstes	0.711291	0.1743177	0.0000
SatWms	0.9694295	0.2823424	0.0010
Rol	0.6567034	0.2498468	0.0090
LfgPro	0.5994635	0.1808476	0.0010
Cons	-9.81048	1.469531	0.0000

The table 6 reveals that the model is significant with the LR of 98.09 and following a chi-square value that is highly significant, remaking that the variables are important determinants of the model as the significance revoke the null hypothesis that the coefficients are simultaneously equal to zero.

The table 6 shows that education has a statistically significant impact on willingness to pay for a hygienic environment as the level of education increases the respondents are 1.5 times($e^{0.397209}$=1.487667) willing to pay than those with a lower level of education. Pham Thi Thuy Trang *et al* (2017)Boateng*et al* (2016), Ramadhan Rajab (2015), and Aggrey&Douglason, (2010) also have obtained similar results signifying that those who are more educated understand the need for a hygienic environment and the consequences that a person can in case if the environment is unhygienic.

Gender was found to be statistical insignificance in the willingness to pay for a hygienic environment where a male is 1.2 times ($e^{0.1460482} = 1.157252$) willing to pay than a female.

Income was found to have statistically positive significance where an increase in income increases the willingness to pay by 2 times ($e^{0.6481235}$=1.91195) than a lower income. Similar results have been obtained in previous studies by Boateng et al (2016) and Awunyo-Vitor*et al*. (2013). Thus individuals with higher incomes cover basic human needs and will be willing to have a healthy life in ensuring the welfare of their living conditions hence will be more willing to pay as a feeling of responsibility for

one's own health and welfare. This coincides with the results obtained that have been obtained by other studies such as Ramadhan Rajab (2015)

Respondents who perceived waste materials are found to be 3 times ($e^{0.9578952}$=2.606205) willing to pay for a hygienic environment than respondents who perceived that waste materials have no impact on human health.

For an improvement in the waste situation, the respondents are 2 times ($e^{0.711291}$=2.036619) willing to pay for a hygienic environment than if they regard the waste situation is poor.

Satisfaction with waste situation has a significant positive impact on the willingness to pay. Respondents who were more satisfied with waste situation were 3 times ($e^{0.9694295}$=2.63644) willing to pay than those whose satisfaction was less.

An increase in perception of having a very important role to play is 2 times ($e^{0.6567034}$=1.928425) higher willing to pay than those who perceive to have a lesser role

An increase in the agreement by the respondents that the government is not doing enough to fix garbage problem are 2 times ($e^{0.5994635}$=1.821142) willing to pay than if they disagree that the government isn't doing enough to fix garbage problem. For more details of the odds ratio see table 13

Table 13: Odds ratio of willingness to pay for a hygienic environment.

```
Logistic regression                             Number of obs     =        334
                                                LR chi2(8)        =      98.09
                                                Prob > chi2       =     0.0000
Log likelihood = -128.84588                     Pseudo R2         =     0.2757
```

wphe	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
edu	1.487667	.2692944	2.19	0.028	1.043333	2.121233
gen	1.157252	.3720727	0.45	0.650	.6162468	2.173207
income	1.91195	.3011779	4.11	0.000	1.40408	2.603521
imph	2.606205	1.224437	2.04	0.041	1.037769	6.545106
wstes	2.036619	.3550187	4.08	0.000	1.447206	2.866086
satwms	2.63644	.7443788	3.43	0.001	1.51596	4.585093
rol	1.928425	.4818107	2.63	0.009	1.181769	3.146826
lfgpro	1.821142	.3293491	3.31	0.001	1.277632	2.595861
_cons	.0000549	.0000806	-6.68	0.000	3.08e-06	.0009778

General findings

The Konaje gram panchayat waste management can be properly stated by dividing its areas into four categories i.) Institutions ii.) Open lands, iii.) Home areas and iv.) Shopping areas. The present study found the situation of waste management very encouraging at residential areas. But situation at shops, institutions, and open areas revealing a very alarming situation due to bad waste situation.

The waste management practices that exist in Konaje gram panchayat are not much efficient and effective. All the stakeholders i.e panchayat, households, institutions, shops have not been much successful in creating public awareness and proper management of generated waste materials.

Feeling of responsibility in waste management was also barely seen among the panchayat office and the households. All stakeholders are involved in passing on responsibility to one another no one wants to takeup initiative and lend the process of proper sustainable waste management.

Specific findings

- Waste burning which has been heavily discouraged in the waste management rules of 2016 is adopted.
- Among sustainable waste management practice it was found that decomposing which is allowing the biodegradable waste to decompose and mix with the soil was being practiced for kitchen waste.
- Littering of waste along BC road and in open lands was observed.
- The poor waste management practices have led to health effects where some of the people have been infected with various diseases like stomach ache, diarrhea, typhoid fever, dengue fever, malaria, and cholera.
- The majority of the respondents are willing to pay.

Suggestions and recommendations

Konaje gram panchayat should strategically adopt corrective and long-term plans to manage the waste in the areas. Without workable and effective plans the situation in the near future will worsen, therefore it is better to involve various stakeholders (i.e. households, shops, and local government offices) in handling waste management. A sense of responsibility should be created for each stakeholder so that all participate in sustainable practices. Location of official disposal site is important to enable those who do not know where to dispose their waste materials to transport them to located official areas. Without official location of disposal site it is easy for the people to continue with the habit of random throwing of waste materials. Discouraging and limiting the use of plastic bags; the panchayat can also verily control the use of plastic bags by putting various measures to control businesses and households who use plastics that are non-biodegradable.

This project also suggest further areas of research which could have valuable contribution in ensuring clean and healthy environment, this include; choice of waste disposal options, factors influencing reuse and recycling behavior, alternative options to use of plastic bags, impact of level of education on waste management behavior, determinants of random throwing of waste materials, factors for reuse of plastic bags.

Conclusion

Waste may be dangerous (such as biomedical and hazardous)or not dangerous need attention since they may be breeding place for carriers of parasites or viruses that cause diseases (i.e malaria, dengue fever), can also lead to having bad smell if not well managed. Waste is being generated daily and waste materials keep on increasing thus should be managed in a way causing no further harm to the environment or human welfare. Sustainable practice to manage the waste must be adopted so that all can have healthy environment. Practices such as recycle enable not only reveal creativity by individuals but also generate income from cheap materials or resource. Reducing the creation of waste materials help in bringing disciplined about unnecessary expenditures for things that are not actually needed.

References

Boateng, S. &. (2016). Household Willingness to Pay for solid Waste Disposal Services in Urban Ghana: The Kumasi Metropolis Situation. *Ghana Journal of Geography* , Vol. 8(2), Pages 1-1.

Chanakya, H. N. (2008). Nitrogen pool, flows, impact and sustainability issues of human waste management in the city of Bangalore. . *Current Science* , 1447-1454.

Chanakya, H. N. (2009). Towards a sustainable waste management system for Bangalore. . *In 1st International Conference on Solid Waste Management (IconSWM), Kolkata.*

Gowda, K. ((2014)). Planning strategies for municipal solid waste management in the city of Hassan, Karnataka. *IJITR* , 2(3), 948-958.

Guan, Y. Z. (2015). Rural domestic waste management in Zhejiang Province, China: Characteristics, current practices, and an improved strategy . *Journal of the Air & Waste Management Association* , 65(6), 721-731.

Guan, Y. Z. (2015). Rural domestic waste management in Zhejiang Province, China: Characteristics, current practices, and an improved strategy. *Journal of the Air & Waste Management Association* , 65(6), 721-731.

Guptha, C. N. (2009). Electronic Waste Management System in Bangalore. *A Review. JK Journal of Management & Technology* , 1(1), 11-24.

Han, Z. D. (2015). Characteristics and management of domestic waste in a rural area of the Tibetan Plateau. *Journal of the Air & Waste Management Association* , 65(11), 1365-1375.

Hans, V. &. (2011). Women and Domestic Violence: Indian Scenario . *UGC Sponsored National Seminar on Violence and Violence Around, Besan Besant Women's College in association with D.K. District Legal Services Authority* . Mangalore .

Ismail, I. M. (2013). Knowledge, attitude and practice about bio-medical waste management among personnel of a tertiary health care institute in Dakshina Kannada,. *Al Ameen Jounal of Medicall Science, Karnataka* , Vol 6- 376-80.

Kaushal, R. K. (2012). Municipal solid waste management in India-current state and future challenges: a review. *International Journal of Engineering Science and Technology,* , 4(4), 1473-1489.

Kaushal, R. K. (2012). Municipal solid waste management in India-current state and future challenges: a review. . *International Journal of Engineering Science and Technology* , 4(4), 1473-1489.

Kumar, P. &. (2007). Estimation and material flow analysis of waste electrical and electronic equipment (WEEE)–a case study of Mangalore City, Karnataka, India. . *In Proceedings of the International Conference on Sustainable Solid India.*

Lakshmikantha, H. &. (2007). Household hazardous waste generation-management. . *In Proceeding of The International Conference on Sustainable Solid Waste Management* , pp. 5-7.

Lal, P. T. (2007). Economics of rural waste management in the Rewa Province and development of a rural solid waste management policy for Fiji. *Apia, Samoa: SPREP* .

Lal, P. T. (2007). Economics of rural waste management in the Rewa Province and development of a rural solid waste management policy for Fiji. *Apia, Samoa: SPREP* .

Maaike J. Bruins, P. V. (2019). The Role of Nutrients in Reducing the Risk for Non communicable Diseases during Aging. *Nutriets* , Vol- 11(1).

Madhavi Bhargava, S. D. (2014). A comparative study of mid-day meal beneficiaries and private school attendees. *Indian Journal of Community* .

Meallem, I. G. (2010). Environmental Hazards of Waste Disposal Patterns—A Multimethod Study in an Unrecognized Bedouin Village in the Negev Area of Israel. *Archives of environmental & occupational health* , 65(4), 230-237.

Narayana, T. (2009). Municipal solid waste management in India: From waste disposal to recovery of resources? . *Waste management* , 29(3), 1163-1166.

Narendra, M. K. (2013). Assessment of Biomedical waste of various hospitals in Mysore City Karnataka, India. *Int. J. Curr. Microbiol. App. Sci* , 2(3), 1-5.

Shah, R. S. (2012). Sustainable solid waste management in rural areas. *International Journal of Theoretical Applied Sciences* , 4, 72-75.

Sushma, M. K. (2010). Biomedical dental waste management and awareness of waste management policy among private dental practitioners in Mangalore city, India. *Tanzania Dental Journal* , 16(2), 39-43.

Taghipour, H. A. (2016). Journal of Material Cycles and Waste Management. *Characterizing and quantifying solid waste of rural communities.* , 18(4), 790-797.

Thirumala, S. (2013). Study of bio-medical waste generation and management in various hospitals in Davangere city of Karnataka, India. *Nitte University Journal of Health Science* , 3(3), 22.

Velsivasakthivel, S. &. (2014). Airborne multiple drug resistant bacteria isolated from concentrated municipal solid waste dumping site of Bangalore, Karnataka, India. . *International Research Journal of Environmental Sciences* , 3(10), 43-46.

Wath, S. B. (2011). E-waste scenario in India, its management and implications. *Environmental monitoring and assessment* , 172(1-4), 249-262.

Zawawi, E. M. (2015). Important criteria for manageming Disaster Waste in Malaysia. *Jurnal Teknologi,* , 75(9). https://doi.org/10.11113/jt.v75.5240.

Zeng, C. N. (2015). A comprehensive overview of rural solid waste management in China. *Front. Environ. Sci. Eng* , 9, 949–961 https://doi.org/10.1007/s11783-015-0816-8.

Cost of Adoption of Electric Vehicles: A Case Study of India

Bhartendu Kumar Chaturvedi
Atri Nautiyal
Mohammed Yaqoot

Abstract

Globally, electric vehicles (EVs) are being promoted to phase out polluting petroleum fuel (oil and gas) powered vehicles. In India, these petroleum fuels are generally imported leading to huge import bills. Through taxes and duties, these fuels generate significant amount of revenue for federal (central) and state governments in India contributing about 18-20% and 7-8% of their total revenue receipts respectively. Large scale adoption of EVs and consequent reduction in consumption of petroleum fuels would lead to reduced import bills and revenue having mixed results on economy that is worth studying. This paper assesses the cost of large scale adoption of EVs in India.

Applying scenarios of 20% and 30% reduction in annual consumption of petroleum fuels indicate revenue losses of ₹ 66,863 Crore and ₹ 1,00,295 Crore respectively with negligible monetary benefit on account of reduced import bill. Comparing the loss of revenue receipts with expenditure of ₹ 93,628 Crore by central government on high priority Core of the Core Schemes during 2019-20 , it can be inferred that the transition to EVs is going to hamper government expenditure on its priority areas. Additional expenditure by government agencies for promotion of EVs would further add to the fiscal burden of government.

Keywords: Electric vehicle; Adoption; Cost

Introduction

At the UN Sustainable Development Summit in September 2015, 17 Sustainable Development Goals (SDGs) were adopted by member countries. Apart from ending poverty, achieving gender equality and improving quality of life, one of the main aim of these SDGs is to address climate change concerns through global collaborative efforts [1]. Subsequently, at COP 21 in Paris during December 2015, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to combat climate change through sustained efforts aimed at low carbon future. Paris Agreement is aimed at strengthening the world response to climate change by maintaining the global temperature rise this century well below 2 ℃ above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 ℃ [2]. To achieve these objectives, the Paris Agreement encourages member countries to reduce their greenhouse gas (GHG) emissions and make sustained efforts towards a cleaner and greener world [2]. Both SDGs and Paris Agreement advocate adoption of renewable and cleaner energy technologies, improvement in energy efficiency, and afforestation for reducing global GHG emissions. Considering the amount of pollutant gases and GHG emissions contributed by combustion of oil and gas in conventional motor vehicles during transportation, many cities and countries have started making transition to electric vehicles (EVs).

EVs are of two types: full battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). In addition to an electric motor, a PHEV has a gasoline engine. During last few years, global market of EVs have witnessed rapid growth due to multiple environmental, societal and health benefits of EVs over internal combustion engines (ICEs) [3]. These benefits include:

a) Reduced air pollution and GHG emissions: Emissions from vehicles can be categorized into direct emissions and life cycle emissions. Direct emissions include tailpipe emissions, and emissions due to evaporation from the vehicle fuel system, and emissions during fueling process.

Associate Professor, School of Business, University of Petroleum and Energy Studies Kandoli Campus, Dehradun, Uttarakhand
Associate Professor, School of Liberal Studies, University of Petroleum and Energy Studies Kandoli Campus, Dehradun, Uttarakhand
Professor, School of Business, University of Petroleum and Energy Studies Kandoli Campus, Dehradun, Uttarakhand

b) Direct emissions involve smog-forming pollutants (such as nitrogen oxides), GHG emissions, and other air pollutants that are harmful to human health. Life cycle emissions for vehicles include all emissions related to: vehicle manufacturing, distribution, usage and recycling; and fuel production, processing, distribution, usage. Like direct emissions, life cycle emissions also include a variety of harmful air pollutants and GHGs.

As BEVs have oil and gas free operations, it has zero direct emissions. However, as a PHEV has a gasoline engine in addition to an electric motor, it leads to evaporative emissions as well as tailpipe emissions while operating on gasoline. Nonetheless, most PHEVs have higher efficiency than comparable conventional vehicles. Thus, PHEVs result in fewer tailpipe emissions even when operating on gasoline [4]. Regarding life cycle emissions, it is important to notice that all vehicles produce substantial life cycle emissions and estimating it is often complex. However, EVs (both BEVs and PHEVs) result in lesser life cycle emissions than conventional vehicles because electricity is a comparatively cleaner energy source than gasoline or diesel [3]. With zero tailpipe emissions, BEVs have significant potential to reduce air pollution and GHG emissions in surface transportation sector.

Reduction in emissions would be more pronounced in urban areas with high concentration of vehicles operating on conventional ICEs. It is quite obvious that usage of EVs in cities and towns would lead to reduction in pollution and GHG emissions locally but there are concerns about source of electricity and associated emissions near the power plants located in areas far from cities and towns. If the electricity used for EV charging is generated through combustion of fossil fuels such as coal or natural gas, there would be emissions at the location of power plant contributing to climate change. However, if the electricity used for EV charging is sourced from renewable energy, there would be zero emissions both at the place of EV usage and at the site of power generation. Hence, it can be inferred that the usage of EVs in urban areas is going to reduce emissions in cities and towns but its overall impact on global GHG emissions would be more pronounced if the electricity used for EV charging is sourced from renewable energy such as solar, wind, hydro, etc.

c) Higher energy efficiency: With three-to-five times higher energy efficiency than conventional ICE vehicles, EVs are going to improve the energy efficiency of surface transportation significantly [3].

d) Improved energy security: EVs would enable the transition of surface transportation from oil and gas (often imported from other countries) to electricity generated from domestic/indigenous resources. This would substantially reduce dependence on other countries for energy needs, resulting in improved energy security.

e) Noise reduction: EVs have much lesser moving parts compared to conventional ICE vehicles. Hence, EVs have much quitter operation and their large scale adoption would substantially reduce noise pollution [3]. EVs have so quiet operation that the pedestrians often fail to notice its presence by sound. To reduce pedestrian risk, European Union vehicle regulators have recently mandated all EVs to have noise emitting device to alert nearby pedestrians [5].

f) Development of clean energy industry: Battery is an integral part of an EV and mass adoption of EVs is dependent on rapid technological developments in batteries making them more competitive in efficiency and cost. Thus, global policy and institutional support to EVs would also propel the growth of batter industry. Batteries are also critical for large-scale integration of variable renewable energy large (solar and wind) to the grid and any improvement in battery technology would enable the clean energy transition. Hence, growth of EV industry would aid the development of clean energy industry [3].

Considering the above merits, EVs are being promoted in many parts of the world. In some countries, the transition to EVs are at quite nascent stage. However, in many big auto markets, EVs are experiencing mass adoption. In year 2019, there was 40% increase in global stock of electric cars taking the total stock to around 7.2 million units [6]. Worldwide, the market share of electric cars in the car industry registered an all-time high of 2.6% during 2019, from 1.5% in 2017 and 2.4% in 2018 [6].

India, with a large and vibrant economy, has been following global trend on transition to electric mobility. However, compared to global leaders in EV industry, India is still at a nascent stage. By the

end of 2019, India reported a cumulative diffusion of 11,200 electric cars with 0.1% market share [6]. With the launch of National E-Mobility Programme, India aims to accelerate the diffusion of EVs in the country and propel the share of EVs to more than 30% by 2030 [7]. This is a testimony of India's commitment to EV30@30 Campaign through which member countries aim to achieve cumulative goal of 30% EV sales by 2030 (only buses, trucks and cars to be considered for attainment of goal). India has planned to achieve its goal of 30% EV sales through ensuring cumulative sale of 31% electric cars, 24% electric buses and 72% electric two-wheelers by 2030 (sale of two-wheelers would not be considered for attainment of goal under EV30@30) [3].

As road transportation sector is one of the major consumers of oil and gas in India, the transition to electric mobility in India is going to have a significant impact on oil and gas consumption in the country. India is heavily dependent on imports for meeting its oil and gas needs. During 2019-20, India fulfilled about 85% of its crude oil (petroleum) consumption and 52.8% of its natural gas consumption through imports [8]. For petroleum imports (including crude oil) and import of natural gas during 2019-20, India spent $ 119.1 Billion and $ 9.5 Billion respectively [8]. Thus, reduction in oil and gas consumption through migration to electric mobility would reduce India's dependence on imports, consequently improving energy security of the country. However, as both federal and state governments in India generate a large amount of revenue through various taxes and duties levied on oil and gas (a total of ₹ 5,55,370 crore revenue was received by the governments during 2019-20), mass adoption of EVs may adversely affect their revenue receipts (Figures 1-2) [8]. With such contrasting impact on import bills and revenue receipts, it appears that the transition to EVs in India may have mixed impact on the economy of the country. Hence, this necessitates an in-depth study of the economic impact of large-scale adoption of EVs in India and the same has been conducted in this paper.

Figure 1: Price buildup of petrol at Delhi on 1st February, 2021 in ₹/litre [8]

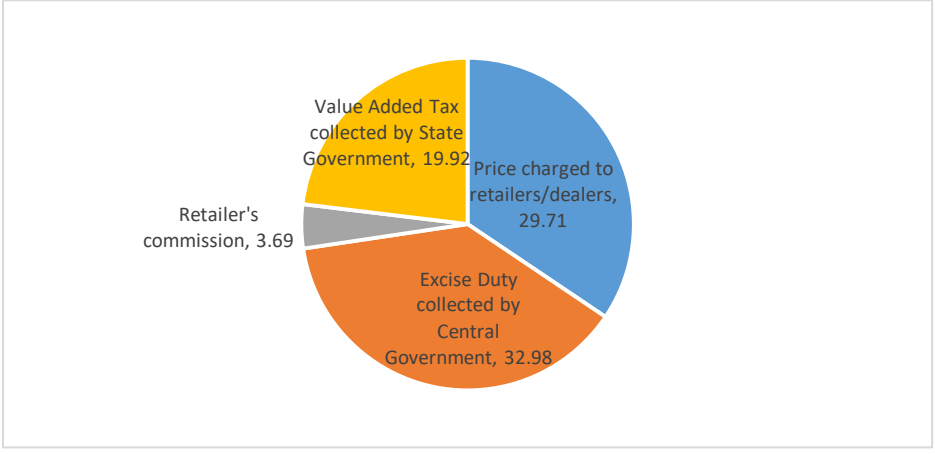
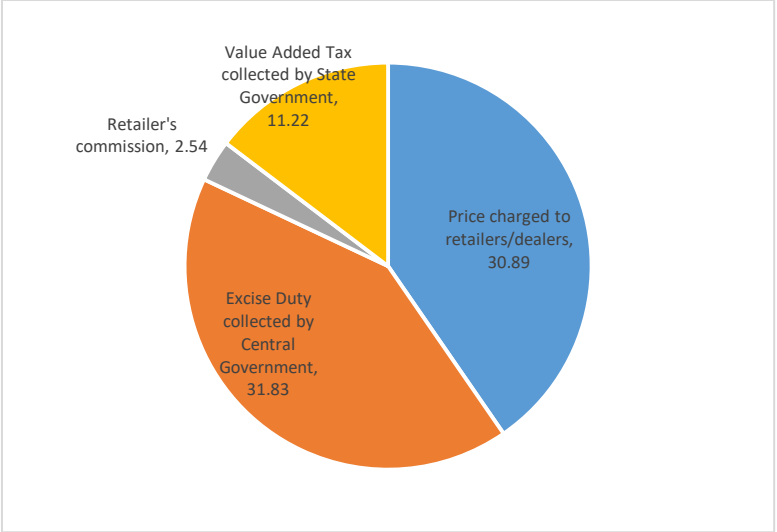


Figure 2: Price buildup of diesel at Delhi on 1st February, 2021 in ₹/litre [8]



1. Trends in Global EV Market

As per Global EV Outlook 2020, about 40% increase in global stock of electric cars was registered during the year 2019, taking the total stock to around 7.2 million units (Table 1). Among the new electric car additions during the year 2019, BEVs had a share of 67% and PHEVs the remaining 33%. The share of BEVs in annual electric car sales has been consistently on rise from 50% in 2012 to 67% in 2019. This is majorly due to domination of BEVs in China which is the biggest electric car market. In China, BEVs enjoy a share of 79%. Similar trend has been noticed in USA where the share of PHEVs dropped from 34% to 26% between 2018 and 2019. China maintained the leadership position in global electric car stock with about 47% share. During 2019, electric car stock in China registered a growth of 46% with its stock reaching 3.4 million electric cars (Table 1). With 1.7 million and 1.5 million electric cars, Europe and USA registered 25% and 20% share in global stock by the end of 2019. Globally, 2.1 million electric cars were sold during 2019. China, Europe and USA registered a sale of 1.06 million, 0.561 million and 0.327 million electric cars during 2019. China alone accounted for more than 50% share of global electric car sales during 2019 [6].

The global market share of electric cars in the car industry registered an all-time high of 2.6% during 2019, from 1.5% in 2017 and 2.4% in 2018. Most of the countries having highest shares of electric cars in overall car sales are in Europe. In terms of market share of electric cars, Norway is at the top with 55.9% followed by Netherlands and Sweden with 15.1% and 11.4% market shares respectively (Table 2).

Similar trend was observed in the case of electric light commercial vehicles (LCVs). During the year 2019, the sale of electric LCVs (BEV and PHEV) was around 69,710 with China alone accounting for 42,650 electric LCVs. In terms of market share of electric LCVs, Norway, Sweden and China were the leaders during 2019 with 5.1%, 2.4% and 2.2% market shares respectively.

During 2019, even though the annual sales and market shares of electric cars registered new records, a slowdown was experienced in year on year growth in annual sale of electric cars. As per Global EV Outlook 2020 [6], the reasons for the slowdown are: a) contracting vehicle markets; b) cuts in electric car purchase subsidies in some key regions; c) and consumer expectations of further technology improvements and new EV models.

In several key passenger car markets such as China and India, overall car sales recorded lower sales in 2019 compared to 2018. In China, sale of cars dropped 4% in 2018 followed by 8% drop in 2019. Similarly, in India, car sales registered a drop of 13% during 2019. Similarly, USA experienced a dip of 2% in car sales volume. However, Europe bucked the trend with a jump of 1% in car sales volume during 2019. Hence, due to this general trend of sluggish growth in overall sale of cars during 2019, the share of electric cars increased significantly even with lower growth in its annual sales [6].

Initially, from year 2010 onwards, incentives in the form of purchase subsidies and tax reductions were the key drivers in almost all electric car markets. These incentives were primarily targeted at reduction of upfront cost to the adopter of EV. Generally, such incentives are introduced in nascent markets to promote the technology for larger good. However, when the market matures
and the technology learning and economies of scale have reduced the cost significantly resulting in mass adoption, the incentives are gradually withdrawn. During early part of year 2019, China reduced subsidies for EV purchases by about 50% and the market reaction was instantaneous leading to immediate slump in sales. The effect was so significant that the Chinese government had to reverse its decision and announce that the subsidy scheme would continue up to 2022. Similarly, a legislation to phase out federal tax credits for automakers was introduced in USA that would impact the subsidies applicable to EVs [6].

During last decade or so, the attractiveness of electric cars has increased significantly for the consumers. Battery costs, charging times and designs have experienced consistent improvements and the process is still on. This puts the consumer in the dilemma that whether to buy the EV now or to wait for a new and improved EV. The dilemma tends to be quite complex when the improvements in EV parameters are by leaps and bounds in a year.

In spite of the challenges, market prospects for EV industry looks bright. Several big auto markets joined as signatories to EV30@30 Campaign that was launched at the Eighth Clean Energy Ministerial in 2017. Under EV20@30 Campaign, the signatory countries namely Canada, China, Finland, France, India, Japan, Mexico, Netherlands, Norway, Sweden and United Kingdom aim to collectively reach 30% market share for electric vehicles (excluding two/three-wheelers) by 2030. Currently, by the end of 2019, the global market share of electric cars is around 2.6% and the market share of electric LCVs is even lower [6]. So, the efforts toward attainment of a cumulative target of 30% market share in the signatory countries of EV30@30 by year 2030 is expected to create huge business opportunities for all stakeholders of global EV industry.

Table 1: Electric car stock (BEV and PHEV) (thousands of vehicles) [6]

Country	***2005[1]***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***
Australia								0.3	0.6	1.9	3.7	5.1	7.3	10.9	20.1
Brazil										0.1	0.1	0.3	0.7	1.1	3.0
Canada							0.5	2.5	5.7	10.7	17.7	29.3	45.9	90.1	141.1
Chile											0.1	0.1	0.2	0.4	0.7
China					0.5	1.9	7.0	16.9	32.2	85.3	292.7	628.7	1207.7	2288.8	3349.1
Finland							0.1	0.2	0.5	0.9	1.6	3.3	7.2	15.5	29.4
France					0.1	0.3	3.0	9.3	18.9	31.5	54.5	84.0	118.8	165.5	226.8
Germany				0.1	0.1	0.2	1.9	5.3	12.2	24.9	48.1	72.7	109.6	177.1	258.8
India				0.4	0.5	0.9	1.3	2.8	2.9	3.4	4.4	4.8	7.0	9.1	11.2
Japan					1.1	3.5	16.1	40.6	69.5	101.7	126.4	151.2	205.3	255.1	294.0

[1] Calendar year

Korea						0.1	0.3	0.8	1.4	2.7	6.0	11.0	25.7	60.6	92.4
Mexico								0.1	0.1	0.2	0.3	1.0	2.2	4.0	4.7
Netherlands					0.1	0.3	1.1	6.3	28.7	43.8	87.5	112.0	119.3	146.7	214.8
New Zealand								0.1	0.1	0.4	0.9	2.4	5.9	11.4	17.7
Norway				1.7	1.8	2.7	3.9	8.4	15.7	35.4	69.2	114.1	176.3	249.0	328.6
Portugal						0.7	0.9	1.0	1.1	1.3	2.5	4.3	8.7	17.0	29.7
South Africa											0.3	0.7	0.9	1.0	1.2
Sweden							0.2	1.1	2.7	7.3	15.9	29.3	49.7	78.6	97.0
Thailand										0.1	0.4	0.4	0.4	9.0	19.4
United Kingdom	0.2	0.5	1.0	1.2	1.4	1.7	2.9	5.6	9.3	24.1	48.5	86.4	133.7	184.0	259.2
United States	1.1	1.1	1.1	2.6	2.6	3.8	21.5	74.7	171.4	290.2	404.1	563.7	762.1	1123.4	1450.0
Others	0.5	0.5	0.5	0.6	0.7	1.0	3.4	7.8	13.2	26.5	51.0	83.4	142.3	213.5	319.0
Total	1.8	2.1	2.6	6.6	8.9	17.0	64.3	183.6	386.3	692.6	1235.7	1988.2	3136.8	5111.9	7167.8

Table 2: Market share of electric car (BEV and PHEV) (%) [6]

Country	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***
Australia										0.1	0.2	0.1	0.2	0.4	1.1
Brazil															0.1
Canada								0.1	0.2	0.3	0.4	0.7	1.0	2.6	3.0
Chile															0.1
China								0.1	0.1	0.4	1.0	1.4	2.3	4.6	4.9
Finland								0.1	0.2	0.4	0.6	1.2	2.5	4.7	6.9
France							0.1	0.3	0.5	0.7	1.2	1.4	1.8	2.2	2.8
Germany								0.1	0.2	0.4	0.7	0.7	1.6	2.0	3.0
India							0.1					0.1		0.1	0.1
Japan						0.1	0.3	0.5	0.6	0.7	0.6	0.6	1.2	1.1	0.9
Korea										0.1	0.2	0.3	0.9	2.3	2.1
Mexico													0.1	0.1	0.1
Netherlands							0.2	1.0	5.4	3.9	9.7	5.9	2.5	6.3	15.1
New Zealand										0.1	0.2	0.6	1.2	2.1	2.8
Norway				1.5	0.1	0.7	0.9	3.2	5.7	14.5	21.1	26.6	33.6	49.1	55.9
Portugal						0.3	0.1	0.1	0.2	0.1	0.6	0.8	1.9	3.7	5.7
South Africa												0.1	0.1		0.1
Sweden							0.1	0.3	0.5	1.4	2.4	3.4	5.2	7.0	11.4
Thailand														0.9	1.7
United Kingdom							0.1	0.1	0.1	0.6	1.1	1.4	1.8	1.9	2.8
United States							0.2	0.4	0.7	0.8	0.7	1.0	1.3	2.3	2.1
Others								0.1	0.1	0.3	0.5	0.6	0.8	1.0	1.5

2. Status of EV Industry in India and Market Outlook

India, with a large and vibrant economy, has been following global trend on transition to electric mobility. For promotion of electric vehicles in India, policymakers launched a scheme titled Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME-India) in 2015. The Phase-I of FAME-India scheme was initially applicable for two years commencing from April 1st, 2015 that later got extended up to March 31st, 2019. Phase-I of FAME-India, with a budget of ₹ 895 crore

focused on four areas for development of EV market in the country: technology development, demand creation, charging infrastructure and pilot projects [9]. After the completion of Phase-I of FAME-India, Phase-II has been implemented from April 1st, 2019 with a coverage period of 3 years and a budgetary support of ₹ 10,000 crore. Much like Phase-I, Phase-II is focused on demand creation (through capital subsidy), charging infrastructure and publicity/awareness campaigns for the development of EV industry in India [9]. In spite of the initiatives for promotion of EVs in India, the transition to electric mobility in the country is still at an early stage. By the end of 2019, India has reported a cumulative diffusion of 11,200 electric cars with 0.1% market share [6]. However, there are about 1.26 million electric two-wheelers [10] and 1.5 million electric three-wheelers in India [11]. There is hardly any adoption of electric LCVs in India [6].

With the launch of National E-Mobility Programme in 2018, India aims to accelerate the diffusion of EVs in the country and propel the share of EVs to more than 30% by 2030 [7]. This is a testimony of India's commitment to EV30@30 Campaign through which member countries aim to achieve cumulative goal of 30% EV sales by 2030 (only buses, trucks and cars to be considered for attainment of goal). India has planned to achieve its goal of 30% EV sales through ensuring cumulative sale of 31% electric cars, 24% electric buses and 72% electric two-wheelers by 2030 (sale of two-wheelers would not be considered for attainment of goal under EV30@30) [3]. Recently, National Electric Mobility Mission Plan (NEMMP) 2020 was launched providing the vision and roadmap for accelerated adoption of EVs and their manufacturing in the country [12].

During last few years, many states in India such as Delhi, Telengana, Gujarat, Karnataka, etc. have declared their EV policy. Upfront capital subsidies, exemption from road tax and registration fee, and fiscal support for charging infrastructure and charging services are common among these state EV policies [13, 14]. In addition, federal government of India has extended income tax benefits to individual taxpayers on purchase of EVs [15]. For all startups (including startups related to EV industry and energy storage batteries), the federal government has extended tax holiday till 31st March, 2022 [16]. All these initiatives have started creating a favorable environment for adoption of EVs in India and the EV industry is expected to follow sustained growth trajectory in India.

3. Oil and Gas Consumption for Road Transport in India

Globally, road transportation sector is one of the major consumers of oil and gas. As per Statistical Year Book India 2018 [17] that has reported the latest data available on number of road transport vehicles in India, the country has 23,00,30,598 registered vehicles including 13,84,740 buses, 16,89,75,300 two-wheelers, 2,79,76,199 cars (private and commercial), 22,65,488 jeeps, 1,69,08,166 light and heavy commercial vehicles, etc. With India at a very early stage of EV adoption, most of the road transport vehicles in the country are running on fossil fuels (oil and gas).

Petrol/gasoline, diesel, natural gas and LPG are the energy resources used for road transportation in India (Table 3). As per a study conducted by M/s Nielsen (India) Pvt Ltd for Petroleum Planning and Analysis Cell (PPAC) of Petroleum Ministry [26], 99.61% of petrol is consumed by road transport sector in India through two-wheelers, three-wheelers, cars and utility vehicles. In all annual reports published by Ministry of Petroleum and Natural Gas, Government of India, most of the diesel consumed in India has been put under non-specified or retail/reseller category without indicating their end-use. However, as per the study conducted by M/s Nielsen (India) Pvt Ltd for Petroleum Planning and Analysis Cell (PPAC) of Petroleum Ministry [26], 70% of diesel consumed in India is used in transportation sector with road transport (passenger and commercial vehicles) using 66.28%, railways 3.24% and aviation/shipping 0.48%. Based on the study report [26], for those years during which segregated data for petrol and diesel consumption for road transport is not available, this study considers 99.61% and 66.28% of total annual petrol and diesel consumption for energizing road transport in India respectively (Table 3).

Apart from huge consumption of petrol and diesel for road transportation in India, natural gas and LPG are also used to energize road transport vehicles but to a much smaller extent (Table 3). However, there is hardly any electricity consumption data for road transportation in India (Table 3). This is quite interesting as the country has significant numbers of electric vehicles (11,200 cars, 15,00,000 three-wheelers and 6,00,000 two-wheelers) [6]. This could be due to the fact there is hardly any network of commercial charging stations for electric vehicles in India and most of these EVs are charged at homes or offices [6]. Consequently, electricity consumption for charging of EVs is accounted in the energy bills of those homes or offices without any segregation. Thus, there is hardly any segregated data regarding consumption of electricity for road transport in India. However, electricity as an energy source for road transport has been included in Table 3 to put usage of EVs for road transport in perspective.

From Table 3, it is quite evident that consumption of petrol and diesel in India is largely driven by road transport sector. Natural gas also plays a significant part in road transport with about 15% of its consumption powering road transport vehicles. Thus, with such large number of motor vehicles used for road transport in India and their heavy dependence on petroleum sector, any transition towards electric mobility is going to have significant impact on the consumption of petroleum fuels in the country. Consequently, mass adoption of EVs is going to affect the economics of petroleum sector in India including import bills, subsidy expenditures and revenue receipts.

4. Petroleum Sector - Import Bills, Subsidy Expenditure and Revenue Receipts for Government of India

India is heavily dependent on imports for fulfilling its petroleum sector needs. During year 2019-20, India imported around 85% of its crude oil (petroleum) consumption and 52.8% of its natural gas consumption [8]. To protect the consumers and oil marketing companies from uncertainties in international oil and gas market (variations in international oil and gas prices and currency exchanges rates), Government of India used to offer subsidies to consumers and under-recoveries to oil companies. Under-recoveries to the oil companies are indirect subsidies that are compensated by two mechanisms: a) cash assistance is provided to the oil companies by the government; b) government devises a burden-sharing formula varying from year to year by which oil exploration companies and oil marketing companies share the under-recoveries [27]. Both the subsidies and under-recoveries were huge burden on the government finances and in some cases encouraged inefficient operations. Realizing the same, Government of India deregulated the pricing of petrol in 2010 and diesel in 2014 [28]. This allowed oil marketing companies to determine the prices of petrol and diesel in line with international market prices and revise them fortnightly. The deregulation of petrol and diesel prices resulted in the reduction of their associated subsidies and under-recoveries to zero (Table 4). This was extended further and from June 16, 2017 there has been dynamic pricing in which prices for petrol and diesel are revised on a daily basis that allows capturing almost every variation in global oil prices so that the same can be transmitted to the consumers [28]. Thus, from Table 4, it is quite clear that from year 2015-16, there are no subsidies and under-recoveries on account of petrol and diesel consumption in India. This indicates that even though Government of India's dollar reserves get impacted due to high import bills but the value is recovered fully through dynamic pricing of petrol and diesel. Table 4 also indicates that though there are subsidies/under-recoveries related to natural gas, these subsidies are only applicable to natural gas consumption in northeastern part of India. Northeastern part of India is primarily hilly terrain with limited commercialization and industrialization, and it has just 3.76% share in India's population [31]. Thus, as reflected in Table 4, subsidies/under-recoveries for natural gas applicable to north-eastern part of India has been less than 1% of the total revenue receipts during last several years and hence insignificant. So, like petrol and diesel, natural gas is also almost free of subsidies/under-recoveries in India. Any decrease in consumption of petrol, diesel or natural gas is surely going to reduce India's import bills. However, as there are almost zero subsidies/under-recoveries associated with petrol, diesel and natural gas in India since 2015-16 due to deregulation, almost all import bill expenditures are recovered through sale of these fuels. Hence, apart from improving energy security and maintaining dollar reserves, any reduction in consumption of these fuels and subsequent decrease in import bills is not going to bring any monetary gain to Government of India. Federal (Central) and State governments in India earn huge revenue from sale of petrol, diesel and natural gas through taxes, duties, royalty, cess, etc. [8, 24, 25]. Table 4 highlights the revenue receipts of Central and State governments in India

through sale of petrol, diesel and natural gas. Central Government of India earns about 18-20% of its total revenue receipts from petroleum sector whereas the state governments earn about 7-8% of its total revenue receipts from the same. Thus, both central and state governments in India earn significant revenue from sale of petrol, diesel and natural gas, and any reduction in their consumption (and sale) due to increased adoption of electric vehicles is going to have significant economic impact on India.

Table 3: Consumption Pattern of Energy Sources used for Road Transport in India [7, 18-25]

Energy Source	***Parameter***	***2014-15[2]***	***2015-16***	***2016-17***	***2017-18***	***2018-19***
Petrol/Gasoline	*Total consumption ('000 metric tonne)*	19075	21847	23765	26174	28284
	Consumption for road transport ('000 metric tonne)	DNA	DNA	DNA	26174	28284
	Percentage of consumption used for road transport (%)	99.61*	99.61*	99.61*	100	100
Diesel	*Total consumption ('000 metric tonne)*	69781	75054	76476	81597	84126
	Percentage of consumption used for road transport (%)	66.28*	66.28*	66.28*	66.28*	66.28*
Natural Gas	*Total consumption (MMSCM)*	51300	52517	55697	59170	60798
	Consumption for road transport (MMSCM)	5416	5464	7350	8585	9206
	Percentage of consumption used for road transport (%)	10.56	10.40	13.20	14.51	15.14
LPG	*Total consumption ('000 metric tonne)*	18000	19623	21608	23342	24907
	Consumption for road transport ('000 metric tonne)	165	172	168	185	181
	Percentage of consumption used for road transport (%)	0.92	0.88	0.78	0.79	0.73
Electricity	*Total consumption (GWh)*	948522	1001191	1061183	1123427	1158310
	Consumption for road transport ('000 GWh)	0	0	0	0	0
	Percentage of consumption used for road transport (%)	0	0	0	0	0

DNA – Data not available

*Data as per the study conducted by M/s Nielsen (India) Pvt Ltd for Petroleum Planning and Analysis Cell (PPAC) of Petroleum Ministry [26]

Table 4: Import Bill, Subsidies/Under-recoveries and Revenue Receipts associated with Oil and Gas in India [7, 24, 25, 29, 30]

Particulars	***Unit***	***2014-15***	***2015-16***	***2016-17***	***2017-18***	***2018-19***	***2019-20***
Import bill	₹ Crore	7,62,060	4,81,940	5,41,725	6,54,824	8,96,848	8,42,743
Import bill as percentage of India's gross imports (in value terms)	%	27.9	19.4	21.0	21.8	24.9	25.1
Subsidy/Under-recovery on Petrol	₹ Crore	0	0	0	0	0	0
Subsidy/Under-recovery on Diesel	₹ Crore	10,935	0	0	0	0	0
Subsidy/Under-recovery on Natural Gas (applicable only for North East region of India)	₹ Crore	765	781	498	435	557	574

[2] Financial year followed in India e.g. 2014-15 implies 1st April, 2014 – 31st March, 2015.

Revenue receipts for Central Government from petroleum sector	₹ Crore	1,72,066	2,53,615	3,34,534	3,36,162	3,48,041	3,34,315
Revenue receipts for Central Government from petroleum sector as percentage of total revenue receipts of Central Government	%	16	21	24	23	20	18
Revenue receipts for State Government from petroleum sector	₹ Crore	1,60,554	1,60,209	1,89,770	2,06,864	2,27,591	2,21,056
Revenue receipts for State Government from petroleum sector as percentage of total revenue receipts of State Government	%	9	8	8	9	8	7
Total revenue receipts from petroleum sector	₹ Crore	3,32,620	4,13,824	5,24,304	5,43,026	5,75,632	5,55,371

5. Economic Analysis of Mass Adoption of EVs in India

As established in the previous section, the transition to EVs in India is going to significantly impact the revenue receipts of central and state governments in the country. The importance of the revenue receipts from petroleum sector can be gauged by comparing it with expenditure of central or state governments of India on priority areas while maintaining a fiscal deficit of around 3.5% [32]. In India, 'Core of the Core Schemes' are the highest priority areas for central government [33-37]. Table 5 reflects the year-wise expenditure on these Core of the Core Schemes. For assessing the economic impact of transition to EVs, this study considers India's commitment to EV30@30 Campaign of achieving 30% EV sales by 2030. Let us assume that 30% EV sales would lead to 30% reduction in oil and gas consumption and subsequently 30% reduction in revenue receipts from petroleum sector. Applying this 30% reduction on the revenue receipts of central government during 2019-20 indicates a loss of ₹ 1,00,295 Crore revenue to the central government. As this loss of ₹ 1,00,295 Crore revenue is significantly higher than the total expenditure of ₹ 93,628 Crore by central government on Core of the Core Schemes during 2019-20 , it can be inferred that the loss of revenue receipts due to transition to EV is going to hamper India's ability to spend on its priority areas resulting in significant economic impact. Considering a different scenario, even a reduction of 20% of revenue receipts of central government during 2019-20 would have resulted in a loss of ₹ 66,863 Crore revenue. If not lost, this revenue would have been good enough to almost finance the budget outlay of ₹ 71,687 Crore for Mahatma Gandhi National Rural Employment Guarantee Programme which is one of the flagship schemes of Government of India (Table 5). Similar to central government, the state governments are also going to feel the impact on their revenue receipts due to the mass adoption of EVs.

Table 5: Expenditure by Central Government of India on Core of the Core Schemes (₹ Crore) [33-37]

Core of the Core Scheme	***2015-2016***	***2016-17***	***2017-2018***	***2018-19***	***2019-20***
National Social Assistance Progamme	8,616	8,854	8,694	8,418	8,692
Mahatma Gandhi National Rural Employment Guarantee Programme	37,341	48,215	55,166	61,815	71,687
Umbrella Scheme for Development of Schedule Castes	4,201	4,863	5,061	7,574	5,591
Umbrella Programme for Development of Scheduled Tribes	2,934	3,319	3,573	3,781	4,205
Umbrella Programme for Development of Minorities	3,810	2,790	3,948	886	1,742
Umbrella Programme for Development of Other Vulnerable Groups	1,240	1,507	1,574	1,564	1,711
Total Expenditure on Core of the Core Schemes	58,142	69,548	78,016	84,038	93,628

In addition to the loss of revenue receipts, transition to EV would demand significant expenditure by central and state government in manufacturing of EV components, development of charging infrastructure, incentives to EV adopters and in awareness campaigns. For example, Phase-II of FAME-India scheme has been implemented by central government from April 1st, 2019 for a period of three years. This phase has a budgetary support of ₹ 10,000 crore and it is focused on demand creation (through capital subsidy), charging infrastructure and publicity/awareness campaigns for the development of EV industry in India [9]. In addition, several states in India such as Delhi and Telengana are promoting EVs in their states through upfront capital subsidies, exemption from road tax and registration fee, and fiscal support for charging infrastructure and charging services [13, 14]. Road tax and registration fee levied on road transport vehicles contribute significantly to the revenue of state governments in India (Table 6). As several state governments are exempting registration fee and road tax for promotion of EVs in their states, this would reduce their revenue and could hamper their capability to spend on schemes of socio-economic importance. Also, central government of India has extended income tax benefits to individual taxpayers on purchase of EVs that allows a deduction for interest payments up to ₹ 1.5 lakhs under Section 80EEB [15]. For all startups (including startups related to EV industry and energy storage batteries), the federal government has extended tax holiday till 31st March, 2022 [16].

From the above, it can be inferred that mass adoption of EVs in India will have double impact of loss of revenue receipts from petroleum sector and pressure of expenditure for promotion of EVs. In totality, it is going to be fiscally challenging for both central and state governments. The situation would demand budgetary provisions ensuring fine balance between expenditure on priority areas and keeping the fiscal deficit in check.

Table 6: Revenue Received by all States in India through various Fee/Taxes levied on Road Transport Vehicles *(₹ Crore)* [38]

Parameter	***2017***	***2018***	***2019***	***2020***
New Vehicle Registration Fee	854	962	907	667
Motor Vehicle Tax / Road Tax	40,001	55,168	42,548	36,012
Total Revenue from Road Transport Vehicles (including other Fee and Taxes)	46,505	62,845	50,538	41,619

This study has policy implications for India and other countries that have: a) deregulated oil and gas market with dynamic pricing; and b) significant earnings from sale/consumption of petrol, diesel or natural gas through taxes, duties, etc. In these countries, mass adoption of EVs will not only reduce their revenue receipts but also add the burden of expenditure for promotion of EVs and charging infrastructure. In spite of these challenges, as EVs offer several vital benefits, the transition seems imminent. Countries such as India could plan the transition in phased manner and identify additional products and services on which taxes and duties could be levied. For example, green tax could be levied on consumption of fossil fuels such as coal or pollution tax could be imposed on all construction activities. This would allow the governments to generate additional revenue to not only compensate for the loss of revenue receipts due to the transition but also make sure that the governments have sufficient funds to promote EVs and development of charging infrastructure.

Conclusion

Most of the road transport vehicles in India are powered by petroleum fuels (petrol, diesel or natural gas). Mass adoption of EVs in India is going to reduce the consumption of these petroleum fuels in the country. During last few years, federal (central) and state governments in India have earned about 18-20% and 7-8% of its total revenue receipts respectively from sale of petroleum fuels (petrol, diesel and natural gas) through taxes, duties, royalty, cess, etc. During year 2019-20, central and state governments earning from petroleum sector were ₹ 3,34,315 Crore and ₹ 2,21,056 Crore respectively. Mass adoption of EVs and consequent reduction in consumption of petrol, diesel and natural gas would reduce these earnings for central and state governments. As these earnings are quite significant, any reduction in these due to the adoption of EVs would affect the capability of both central and state governments to fund their schemes for socio-economic development. Additionally, budgetary allocations made by government agencies for promotion of EVs and development of charging infrastructure, and incentives for promotion of EVs such as revocation of road tax and registration fee, income tax benefits, tax holiday for electric vehicle startups, etc. are going to add to their fiscal burden. Hence, mass adoption of EVs is going to be fiscally challenging for central and state governments in India.

References

[1] United Nations. The 17 Goals. https://sdgs.un.org/goals (last accessed on 13th March, 2021)

[2] United Nations Framework Convention on Climate Change. What is the Paris Agreement? https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement (last accessed on 17th February, 2021)

[3] International Energy Agency. Global EV Outlook 2019. June, 2019.

[4] International Energy Agency. Global EV Outlook 2017. June, 2017.

[5] BBC News. Electric cars: New vehicles to emit noise to aid safety. 30th June, 2019. https://www.bbc.com/news/business-48815968 (last accessed on 12th March, 2021)

[6] International Energy Agency. Global EV Outlook 2020. June, 2020.

[7] Press Information Bureau, Government of India. Shri RK Singh launches National E-Mobility Programme in India; congratulates EESL for installation of 50 lakh LED street lights. 7th March, 2018. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1523123 (last accessed on 30th January, 2021)

[8] Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. PPAC's Snapshot of India's Oil and Gas Data. January, 2021.

[9] Press Information Bureau, Government of India. Implementation of National Electric Mobility Mission Plan. 8th July, 2019. https://pib.gov.in/newsite/PrintRelease.aspx?relid=191337#:~:text=The%20National%20Electric%20Mobility%20Mission,their%20manufacturing%20in%20the%20country (last accessed on 25th January, 2021)

[10] Wadhwa N. EV sales in India cross 7.5 lakh mark in FY2019. 1st May, 2019. https://www.autocarindia.com/car-news/ev-sales-in-india-cross-75-lakh-mark-in-fy2019-412542 (last accessed on 27th January, 2021)

[11] Bhatia S. What is driving electric three-wheelers to a competitive market in India? 20th March, 2020. https://auto.economictimes.indiatimes.com/news/commercial-vehicle/lcv/what-is-driving-electric-three-wheelers-to-a-competitive-market-in-india/73261874 (last accessed on 28th January, 2021)

[12] Press Information Bureau, Government of India. National Electric Mobility Mission Plan. 2nd July, 2019. https://pib.gov.in/PressReleasePage.aspx?PRID=1576607 (last accessed on 24th January, 2021)

[13] Transport Department, Government of National Capital Territory of Delhi, India. Delhi Electric Vehicles Policy, 2020. https://transport.delhi.gov.in/sites/default/files/All-PDF/Delhi_Electric_Vehicles_Policy_ 2020.pdf (last accessed on 30th January, 2021)

[14] Telangana State Renewable Energy Development Corporation Ltd., Government of Telengana, India. Telengana Electric Vehicle and Energy Storage Policy 2020-2030. https://tsredco.telangana.gov.in/Updates_2020/Telangana_EVES_policy_2020_30.pdf (last accessed on 30th January, 2021)

[15] Ministry of Finance, Government of India. Budget Speech, Union Budget 2019-2020. https://www.indiabudget.gov.in/budget2019-20/doc/Budget_Speech.pdf (last accessed on 30th January, 2021)

[16] Ministry of Finance, Government of India. Budget Speech, Union Budget 2021-2022. https://www.indiabudget.gov.in/doc/Budget_Speech.pdf (last accessed on 3rd February, 2021)

[17] Ministry of Statistics and Programme Implementation, Government of India. Motor Vehicles - Statistical Year Book India 2018.

[18] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2015.

[19] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2016.

[20] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2017.

[21] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2018.

[22] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2019.

[23] Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Energy Statistics 2020.

[24] Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. PPAC's Snapshot of India's Oil and Gas Data. June, 2016.

[25] Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. PPAC's Snapshot of India's Oil and Gas Data. July, 2018.

[26] Press Information Bureau, Government of India. All India Study conducted by M/s Nielsen (India) Pvt Ltd for Petroleum Planning and Analysis Cell (PPAC) on sale of Diesel and Petrol. 28th January, 2014. https://pib.gov.in/newsite/PrintRelease.aspx?relid=102799 (last accessed on 28th February, 2021).

[27] Yaqoot M, Diwan P, Kandpal TC. Public financing of solar lanterns versus subsidizing kerosene for domestic lighting in India: A feasibility assessment. Renewable Energy 2015; 80: 564-72.

[28] International Energy Agency. India 2020 Energy Policy Review. January 2020.

[29] Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. Subsidy-Petroleum. https://www.ppac.gov.in/content/150_1_Subsidy.aspx (last accessed on 25th January, 2021)

[30] Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India. Import/Export. https://www.ppac.gov.in/content/212_1_ImportExport.aspx (last accessed on 26th January, 2021)

[31] Dikshit KR, Dikshit JK. North-East India: Land, People and Economy. Springer, 2014.

[32] Ministry of Finance, Government of India. Budget at a Glance, Union Budget 2020-2021.

[33] Ministry of Finance, Government of India. Outlay on Major Schemes, Union Budget 2016-2017.

[34] Ministry of Finance, Government of India. Outlay on Major Schemes, Union Budget 2017-2018.

[35] Ministry of Finance, Government of India. Outlay on Major Schemes, Union Budget 2018-2019.

[36] Ministry of Finance, Government of India. Outlay on Major Schemes, Union Budget 2019-2020.

[37] Ministry of Finance, Government of India. Outlay on Major Schemes, Union Budget 2020-2021.

[38] Ministry of Road Transport and Highways, Government of India. Vahan Dashboard. https://vahan.parivahan.gov.in/vahan4dashboard/ (last accessed on 20th February, 2021)

Social and Solidarity Economy and Goals of Sustainable Development in India.

Kirti Dubey
Vivek Birla

The United Nations approved the Sustainable Development Goals (SDGs), in the year 2015 as a worldwide call to battle the problem of poverty, safeguard the atmosphere, and make certain that all and sundry lives in tranquility and opulence by 2030.

The 17 SDGs can be enumerated as the goals of no poverty, zero hunger, good health and well being for all , quality education for the children of the world, gender equality and sensitization ,clean water and sanitsisation, affordable and clean energy, decent work and economic growth ,Investment in infrastructure and innovation , reduced income inequalities ,Sustainable development of cities , communities and urban areas,responsible ways of production and consumption of nation's resources , Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries,life below water, life on land, sustainable development in the world through peace, stability, human rights and effective governance, based on the rule of law and last but not the least the goal of realization of the need for development with strong global partnerships and cooperation

The 17 SDGs are interconnected;and the responsible bodies are aware that actions in one area will have an impact on outcomes in others, and that development must create equilibrium in the arenas of social, economic, and environmental sustainability.

Countries have pledged to prioritise progress for those who are the most disadvantaged. To achieve the SDGs in any context, all of society must contribute their portions of innovative uniqueness,competence, technical expertise, and monetary assets.

Social economy and social innovation help to construct more comprehensive, ingenious, and enduring societies and economies, and such nations tend to develop novel solutions to improve the quality of life and well-being of individuals, communities, and places while addressing socioeconomic and environmental challenges, such as the COVID-19 pandemic crisis.

To support the expansion and internationalization of the social and solidarity economy, the OECD launched the Global Action "Promoting Social and Solidarity Economy Ecosystems" in 2020, funded by the European Union's Foreign Partnership Instrument. The Action focuses on dual critical policy levers that can assist in unlocking the potential of the SSE, namely legal frameworks and social impact measurement, while taking the entire policy ecosystem into account as a framework.

Although the term "solidarity economy" is not commonly used in India, grassroots organisations are increasingly engaging in lobbying activities with government officials. On a global scale, the United Nations Inter-Agency Task Force on SSE was formed to address this growing interest.

Main paper

The SDGs are the culmination of decades of effort by countries and the UN, including the UN Department of Economic and Social Affairs. At the Millennium Summit in September 2000 at UN Headquarters in New York, member nations unanimously adopted the Millennium Declaration. The Summit resulted in the establishment of eight Millennium Development Goals (MDGs) intended at plummeting extreme poverty by 2015.

At the United Nations Conference on Sustainable Development (Rio+20) in June 2012 in Rio de Janeiro, Brazil, Member States adopted the outcome document

Assistant Professor, Teerthankar Mahaveer University, Moradabad
Assistant Professor, Teerthankar Mahaveer University, Moradabad

"The Future We Want," in which they agreed, among other things, to launch a process to develop a set of SDGs to build on the MDGs and to establish the UN High-level Political Forum

on Sustainable Development. Other measures for implementing sustainable development were also included in the Rio+20 outcome, such as mandates for future programmes of work in development financing, small island developing states, and other areas.

In2015, 195 countries agreed with the United Nations that they could improve the world. The United Nations approved the Sustainable Development Goals (SDGs), in the year 2015 as a worldwide call to battle the problem of poverty, safeguard the atmosphere, and make certain that all and sundry lives in tranquility and opulence by 2030.

Shri Narendra Modi, honorable Prime Minister of India pinned down his views on SDG as follows in his speech at the United Nations Sustainable Development Summit in September 2015–*"Just as our vision behind Agenda 2030 is lofty, our goals are comprehensive. It gives priority to the problems that have endured through the past decades. And, it reflects our evolving understanding of the social, economic and environmental linkages that define our lives... The sustainable development of one-sixth of humanity will be of great consequence to the world and our beautiful planet."*

Mr. António Guterres, honorable United Nations Secretary-General set down his views as follows-*"The 2030 Agenda and its 17 Sustainable Development Goals (SDGs), adopted in 2015, provide a coherent, holistic framework for addressing these challenges and their interconnections. (...) They require member states to address the social, economic and environmental dimensions of sustainable development in a balanced manner. Their implementation must embody the principles of inclusiveness, integration and 'leaving no one behind'."*

The 17 SDGs can be enumerated as the goals of no poverty, zero hunger, good health and well being for all , quality education for the children of the world, gender equality and sensitization ,clean water and sanitsisation, affordable and clean energy, decent work and economic growth ,Investment in infrastructure and innovation , reduced income inequalities ,Sustainable development of cities , communities and urban areas,responsible ways of production and consumption of nation's resources , Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries,life below water, life on land, sustainable development in the world through peace, stability, human rights and effective governance, based on the rule of law and last but not the least the goal of realization of the need for development with strong global partnerships and cooperation

The Division for Sustainable Development Goals (DSDG) of the United Nations Department of Economic and Social Affairs (UNDESA) now provides substantive support and capacity-building for the SDGs and related thematic issues such as water, energy, typical weather, oceans, urbanisation, transportation, science and technology, the Global Sustainable Development Report (GSDR), partnerships, and Small Island Developing States.

"India played a key character in the expansion of the United Nations Sustainable Development Agenda 2030, and the Sustainable Development Goals emulate much of India's National Development Agenda (SDGs). The world's step forward toward achieving the SDGs is principally reliant on India's accomplishment of the same. However, the SDGs may be difficult to soak up and comprehend, with 17 goals, 169 targets, and 306 national indicators, and defining and quantifying progress may be hard-hitting.

The NITI Aayog has taken the initiative by releasing the SDG India Index - Baseline Report 2018, which demonstrates how the SDGs will be monitored in India. The NITI Aayog has released the Baseline Report of the Sustainable Development Goals (SDG) India Index, which details the advancement made by India's states and union territories in achieving the 2030 SDG targets.

The SDG India Index was created by NITI Aayog and covers 13 of the 17 SDGs (leaving out Goals 12, 13, 14 and 17) The SDG India Index is designed to give a comprehensive picture of the country's social, economic, and environmental conditions, as well as those of its states and union territories. Its goal is to track India's and its states' progress toward the 2030 Sustainable Development Goals.

The Niti Ayog strives to accelerate the adoption, implementation, and monitoring of the SDG framework and related activities at the national and sub national levels by employing a cooperative and competitive federalism strategy.

The officials in credited with the task of looking over the SDG are striving hard To accelerate the country's achievement of the SDGs, the government, civil society, commercial sector, university, think tanks, research organisations, and multilateral organisations collaborate closely.

Although the term "solidarity economy" is not commonly used in India, grassroots organisations are increasingly engaging in lobbying activities with government officials. On a global scale, the United Nations Inter-Agency Task Force on SSE was formed to address this growing interest.

Despite historical, cultural, political, economic, and social variations, SSE is seen as an important tool for addressing poverty and the need to produce revenue for certain segments of the population. The Indian experience adds to the discussion of participation of the cooperative societies already existent in India scenario in the mechanisms that provide job possibilities and money.

Collective action in India was set aside or took on new paradigm through NGO networks, cooperative societies and identity politics. After two decades, recruits, producers, and patrons are seeing a huge augment in shared action. Old and new forms are on the climb in reaction to global crises (financial and food), structural conditions of unstable employment, and new-fangled options for inventive expression and group correlation set by the internet era..

The phrase "social and solidarity economy" (SSE) is more and more being used to refer to a broad spectrum of organizations that are at variance from conventional for-profit businesses, entrepreneurship, and the informal economy by two key distinctive features . For starters, they have clear economic and social (and often environmental) goals. Second, they demand various co-operative, associative, and solidarity relationships. Cooperatives, mutual associations, income-generating NGOs, women's self-help groups, community forestry and other organisations, informal sector worker associations, social entrepreneurship and fair trade organisations and networks are just a few examples.

.According to ILO 2011 report , it has been reported that .Over 30 million people (mostly women) are organised in 2.2 million self-help groups in India, while Amul, the country's largest food marketing firm, has 3.1 million producer members and $2.5 billion in annual sales.

Thus , keeping in view the need for driving towards the attainment of sustainable development goals the need for accepting and incorporating the theme nature of SSE becomes ardent as such an approach can be a major machinery for disadvantaged or disempowered individuals in society to achieve more authority over the capital and decision-making processes that affect their life.

India had roughly 84,000 Joint Forest Management organisations by the early 2000s, including 8.4 million people and 22.5 percent of its forest acreage. Cooperatives, mutual health and insurance associations, certain types of foundation and service-delivery NGO, microfinance or solidarity finance groups, self-help groups, community-based organisations, and new forms of social enterprise that produce goods and services that address unmet needs, mobilise unused resources, engage in collective provisioning, and manage common pool resources are all examples of SSE. Fair trade organisations and informal sector workers' associations are also included.

Recently, the topic has broadened to encompass businesses and forms of sharing made possible by new digital resources and technology like carpooling and crowd funding.

The Amul cooperative organisation, India's largest food marketing firm, with 3.1 million producer members and a $2.5 billion yearly turnover.

Over 30 million people (mostly women) are organised in 2.2 million self-help groups across India.

The Kudumbashree poverty eradication scheme in Kerala, which aims to improve local economic growth as well as women's social status and capacities, has grown to include approximately 4 million women.

The Self-Employed Women's Association (SEWA) is a non-profit organisation headquartered in India that represents disadvantaged, self-employed women. In India, unprotected informal workers account for more than 94 percent of the female labour force. SEWA had 1.4 million dues-paying members by 2012, and they were working to improve income, food, and social security.

Various methods have been developed to make urban housing more affordable for low-income people.

Tenant-owned housing cooperatives, cooperative land societies, mutual home ownership housing societies administered by big service cooperatives, and community land trusts are examples of these cooperatives.

The local land trust movement in India was the inspiration for this piece.

Cities have the capacity to provide human beings with access to infrastructure, services, and employment, allowing them to meet their basic requirements while also realising their dreams and aspirations. Cities, on the other hand, can be overwhelming, particularly when prosperity is scarce or unequally distributed. 52 Cities' ability to become sustainable is hampered by inefficient use of public resources and unequal access to them. 53 Other major parts of the sustainability problem are crime, waste, pollution, and high carbon production and consumption patterns linked with cities; thus, the need for integrative and sustainable city development models.

In India, the majority of working-age people work in the informal economy, which is characterised by unstable employment and severe decent-work shortages. In India, the presence of informal work not only affects people's current living conditions, but it's also a major impediment to households and businesses raising their production and finding a way out of poverty.

However, income, job status, economic sector, kind and size of business in which they work, location, and social and employment protection vary greatly among workers in the informal economy.

In this aspect, SSE holds a lot of promise. It provides another approach of addressing precarious employment and bridging the gap between the informal and formal economies under fair working conditions. SSE, along with its constituent parts of job creation, social discourse, and labour standards connected with both workers' rights and social protection, can play a vital role in fulfilling the objective of decent work in an enabling policy and institutional framework. Workers and producers in the informal economy might band together in various types of associations and cooperatives to solve market problems. Such groups can improve producers' ability to negotiate higher prices and revenue by facilitating access to money, market knowledge, inputs, technology, support services, and markets. While While SSE projects may not be suitable for the lowest segments of the community, they can help to minimise power and information imbalances within the people. As well as Increase the amount and consistency of incomes on labour and product marketplaces.

This is especially crucial in industries like food and agriculture, which have high levels of volatility, Insecurity and global competition keeping in mind the The small amount of money required to start a Certain cooperatives can be advantageous for unemployed workers looking for a regular source of income .

The fundamental driver of agricultural growth, development, and transformation of national socio-economic and agro-ecological milieus has been a large ecosystem of science, technology, and innovation, which is evolving dynamically to suit the fast changing development goals.

In the middle of the unprecedented COVID-19 epidemic, the globe faces new and developing health and nutrition needs, as well as the United Nations' Sustainable Development Goals - Agenda 2030. (UN, 2015) The increase in the number of hungry and malnourished individuals in India is the most significant challenge to face. India accounts for about a quarter of the world's hungry, a third of the world's stunted children, and half of the world's wasting children.

In light of SSE, organisations must end the coexistence of food abundance and waste, as well as high rates of hunger and malnutrition; check high inequities, trade, and market distortions; and Stop the relentless loss of natural resources; slow the spread of infectious diseases and pests; and, of course, minimise the ever-increasing climate change volatility that is posing huge problems to Indian agriculture today.

The scope of SSE organizations in India can tend to identify with the ideas of decent work, which frequently come naturally to organisations that involve associative work that incorporates both the labour and capital elements.

In India frequent upheavals of Issues of labour norms and rights at work appear prominently in SSE organisations due to participatory decision-making and workplace democracy. Such activities also enable the workers and producers involved to articulate and argue for their common demands, which they may then direct at relevant economic actors and government officials.

. The SSE have the preview framework for planning the activities as per the SDG india Index 2020-21 whiuch is developed in collaboration with The United nation's in Indiawhere the achievement levels of all the Indian states and union territories arre adjudicated on115 indicators thata are in line with MoSPI's National indicator Framework(NIF)The New index is more full-bodied than the preceding editions as the indicators incorporate 16 out of 17 SDG with the qualitative assessment on Goal 17 and cover70 SDG targets

The latest report of 2020-21 has been released and maximum achievement of SDG has been attained by Kerala with 75 points followed by Himachal Pradesh and Tamil Nadu at 74, Andhra Pradesh , Goa < Karnataka , Uttarakhand at 72 Sikkim at 71 and Maharashtra at 70 points .Chandigarh bags maximum points of 79 amongst the Union territories followed by Delhi at 69 points.. The bottom five states that need dire attention `and the assistance of SSE are Chhattisgarh, Nagaland, Odisha , Arunachal Pradesh , Meghalaya , Rajasthan , Uttar Pradesh , Assam, Jharkhand and Bihar.

Thus we see that there is a lot of scope of the role and importance of Social and Solidarity economy in the attainment of SDG for India till 2030 Social economy and social innovation help to construct more comprehensive, ingenious, and enduring societies and economies, and such nations tend to develop novel solutions to improve the quality of life and well-being of individuals, communities, and places while addressing socioeconomic and environmental challenges, such as the COVID-19 pandemic crisis.

References

http://www.un.org/sustainabledevelopment/news/communications-material/

2011 ILO report:

United Nations General Assembly. 2012. The Future We Want. UN Doc. No. A/RES/66/288. 27 July. http://www. un.org/ga/search/view_doc.asp?symbol=A/ RES/66/288&Lang=E

United Nations. 2013. A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development. Report of the High Level Panel of Eminent Persons on the Post2015 Development Agenda. New York: United Nations. http://www.un.org/sg/ management/pdf/HLP_P2015_Report.pdf

ILO. 2014. Op.cit. 17

Fonteneau et al. 2011. Op. cit. 18

OECD. 2013. Job Creation Through The Social Economy And Social Entrepreneurship. Paris: OECD.

ICA. 2013. "Co-operative Facts and Figures". Accessed March 25. http:// ica.coop/en/whats-co-op/co-operativefacts-figures; ICA. 2012. "90th ICA International Day of Co-operatives – 7th July 2012". Accessed March 25. http:// ica.coop/en/media/news/90th-icainternational-day-co-operatives-7thjuly-2012

Agarwal, Bina. Forthcoming. "Demonstrating the Power of Numbers: Gender, Solidarity and Group Dynamics in Community Forestry Institutions." In Utting. Op. cit

7 ILO. 2007. Cooperatives and Rural Employment, Fact Sheet. Geneva: ILO.

Agarwal, Bina. Forthcoming. "Demonstrating the Power of Numbers: Gender, Solidarity and Group Dynamics in Community Forestry Institutions." In Utting. Op. cit

For concrete examples see the MBM Initiatives Report: http://www.rencontresmontblanc.coop/en/page/mbm-initiativesreport.

Amul. N.d. "Organisation". Accessed March 31. http://www.amul.com/m/organisation

WIEGO, 'Events Help Sewa Celebrate 40 Years.' Accessed May 28. http://wiego.org/wiego/events-help-sewacelebrate-40-years

Mukherjee-Reed, Ananya. 2013. " Taking Solidarity Seriously: Analyzing Kerala's Kudumbashree as a Women's Social and Solidarity Economy Experiment." In Utting.

Lewis, Michael and Pat Conaty. 2012.

UN-Habitat. 2012-2013. State Of The World's Cities 2012/2013. Prosperity of Cities. Nairobi: UN-Habitat. 53 UN- DESA. 2013.

World Economic and Social Survey. Sustainable Development Challenges. UN Doc. No. E/2013/50/Rev. 1

An initial draft of this paper was prepared by UNRISD and subsequently revised on the basis of extensive inputs and comments from other Task Force members and observers.

Muradian, Roldan. Forthcoming. "The Potential and Limits of Farmers' Marketing Groups as Catalysts of Rural Development." In Social and Solidarity Economy: Beyond the Fringe, edited by Peter Utting. London: Zed Books. Diop, Amadou, Isabelle Hillenkamp, and Jean-Michel Servet. 2007. "Poverty Versus Inequality." In Microfinance and Public Policy. Outreach, Performance and Efficiency, edited by Bernd Balkenhol. 27-46. New York: Palgrave MacMillan. 15 Birchall, Johnston. 2011. "The Comparative Advantages of Memberowned Businesses." Review of Social Economy 70, no. 3: 263-294.

https://wgz.short.gy/SDGIndiaIndex

http://sdgindiaindex.niti.gov.in

NATIONAL DIALOGUE INDIAN AGRICULTURE TOWARDS 2030 Pathways for Enhancing Farmers' Income, Nutritional Security and Sustainable Food Systems

http://www.fao.org/state-of-food-security-nutrition-in-the-world

Blue Carbon Market Integration Into Natural Resource Regenerative Practice In India

Yogita K S
Sagar Srinivas
Duragesh Pujari
R.R. Biradar

Abstract

The enormous volumes of carbon dioxide that Earth's oceans take up from the atmosphere are referred to as "blue carbon." Important carbon sinks include coastal ecosystems like kelp beds, salt marshes, and mangrove swamps. These crucial wetlands are being protected as part of the fight against climate change. Wetland restoration can be profitable with the implementation of carbon markets as part of the Paris Agreement on Climate Change. Carbon markets enable restoration projects to sell carbon offsets, easing the financial load on state and federal budgets. Recognize India's potential for development and carbon trading as a result. This study relied on secondary data from numerous review articles, journals, scientific blogs, and websites. SWOT framework used in this study to evaluate natural-based solutions and develop strategic planning.

Key Words: Blue carbon, Paris Agreement, Coastal Ecosystem, Climate change.
JEL: Q4, Q43, Q54, Q57, C1.

Introduction:

Carbon that is stored in coastal environments including salt marshes, mangroves, and seagrass beds is known as coastal blue carbon. Similar to terrestrial forests, coastal ecosystems take in and store atmospheric carbon dioxide in the form of vegetation and soil. But coastal ecosystems do so on a far bigger scale than forests do. According to research, mangroves and salt marshes sequester (remove) carbon from the atmosphere at a rate that is ten times higher than that of tropical forests. On average, they also store three to five times as much carbon as tropical forests. This is due to the fact that soil, as opposed to above-ground vegetation, stores the majority of coastal blue carbon. Because they absorb more carbon than they emit, coastal blue carbon ecosystems are sometimes frequently referred to as "carbon sinks." In order to combat climate change and ensure positive social, economic, and environmental results, these ecosystems are crucial. Compared to terrestrial forests, coastal blue carbon ecosystems may sequester two to four times more carbon (Murray et al, Nicolas Institute, 2011). Through carbon sequestration, better management of these ecosystems may help deliver Nationally Determined Contributions to the Paris Agreement on Climate Change, improve food security, safeguard livelihoods, and build resilience. Coastal blue carbon habitats have the potential to significantly increase emissions when they are damaged or destroyed. Up to 10% of global emissions from deforestation are thought to be caused by mangrove destruction (Donato et al, Nature Geoscience 2011). In their Nationally Determined Contributions to the Paris Agreement, more than 50 nations have already acknowledged the importance of blue carbon, but much more work has to be done.

2. What is Carbon Market/Carbon Credit?

Since the late 1990s, when carbon credits first appeared, it has been feasible to offset emissions from events like you're wedding in California by purchasing carbon credits from the planting of trees in the Amazon. Along with Verra, other NGOs like the Geneva-based Gold Standard and the Edinburgh-based Plan Vivo have emerged to create the rules and maintain registers of carbon credit projects. In the past, there have been issues with the carbon market in general, including double counting of carbon reductions, failing to distribute funds to local communities, or producing unintended collateral harm along the route, such as destroying one crop to grow another for credits. The approaches presented by organizations like Verra aim to prevent these problems. The Taskforce on Scaling Voluntary Carbon

Markets, established in September of last year, is making great efforts to guarantee that all future carbon credits, including blue ones, are reliable. And experts concur that before turning to offsets for their residual emissions, both corporations and countries need to work hard to decarbonize.

2.1 Types of Carbons

Brown Carbon	Black Carbon	Blue Carbon	Green Carbon
CO2 emissions from industrial and human energy consumption.	Soot produced by incomplete fuel and biomass combustion	55% of the carbon in living things is stored in the ocean.	Carbon is stored in soils and terrestrial ecosystems.

25 percent of all GHG emissions are made up of green and blue carbon emissions. Stopping them also improves food security, livelihoods, and biodiversity (IPCC. 2007; Nelleman et, al. 2009).

3. Empirical Evidence from Review of Literature:

This study articulated that trading permits has migrated from the environmental economics textbook to the political and policy agendas as a strategy of reducing pollution. The multiple studies have found how the assumptions of economic theory are very different from how the permit market actually operates. It is clear that manipulation can be used to get rich while paying little attention to the effects on the environment or society. As of now, it seems that carbon trading and offset programs are ineffectual at lowering GHGs. The same individuals and organizations would control a brand-new, multi-billion-dollar industry under the ETS ideas. Government regulation is required to uphold norms, but it also needs to address the kinds of institutions that are best suited to bringing about the necessary behavioural change. An ETS's main weakness in comparison to other policies is that an excessive baseline or regulatory loophole in any one country or sector eliminates the need for genuine reductions elsewhere. National carbon markets allow 38poorly regulated sectors to benefit, just as international carbon markets reward countries with lax regulations and poor enforcement. The billions of dollars now generated by carbon trading and offsets have created a powerful institutional structure with many vested interests whose opportunities for profit rely on maintaining GHG emissions rather than reducing them. It's difficult to imagine how politicians will cut the market by 80% once it's been created, even in the 40 years they've given themselves**. (Spash, 2009)** Blue carbon ecosystems (BCEs) boost fisheries and preserve coastlines while also storing carbon. Over 185 million acres, BCEs are estimated to store more than 30,000 Tg of carbon. Emissions of 304 (141-466)Tg carbon dioxide equivalent (CO2e) annually might be avoided by conservation. To provide more useful information for policy and other activities trying to integrate blue carbon into climate change mitigation measures, future studies should concentrate on producing new spatial products with comparable resolutions, especially for seagrasses and tidal marshes. Land tenure, project borders, and carbon rights are just a few examples of the legislative and governance hurdles that demonstration projects will assist to identify and address. In order to integrate ocean-based natural climate solutions (BCEs) into national development goals (NDCs) for climate change mitigation, the Blue Carbon Strategy (BCS) is being coupled with the UN Decade of Ocean Science and Ecosystem Restoration (2021–2030)**.(Macreadie et,al., 2021).** This study analyses carbon trading prospects and examines greenhouse gas (GHG) emissions trading schemes. It claims that an extension of carbon trading appears to be on the horizon due to the introduction of new schemes, the steady growth of the existing ones, and a desire to link existing and planned schemes. Links between emission trading systems and markets can be built for no conceptual reason. However, there are a number of significant practical challenges as well as a number of technological and non-technical problems that may impede this growth. The growth of carbon trading schemes is seriously questioned in light of the current state of the world economy and the absence of a worldwide climate agreement. **(Perdan et.al.2011).** This paper articulated a significant ecosystem, mangroves offer beneficial social, economic, and environmental benefits. In order to manage this environment sustainably, Indonesia has made mangroves a national priority. In order to comprehend the advantages, disadvantages, opportunities, and risks associated with mangrove management in Indonesia, a SWOT analysis was

conducted. To improve the management of mangrove ecosystems, research, technology, and information systems are required**. (Arifanti et.al. 2022)** Improved methods to measure the size of Blue Carbon ecosystems and establish their origin are sought after by scientists. It was of utmost importance to comprehend how climate change influences carbon build-up in mature BC ecosystems. The function of carbonate and macrophytes in BC cycling were contentious issues. One of the most important concerns that must be answered in order to adequately restrict the BC paradigm is the influence of climate change and the net balance of Greenhouse gases from BC ecosystems. There is plenty of room for important experiments to be planned and carried out, for existing hypotheses to be confirmed or rejected, and for fresh concepts and ideas to emerge. (**Macreadie et, al. 2019)**

4. Objectives:

- To evaluate the inclusion of blue carbon in India using SWOT analysis,
- To Study Dynamic analysis of carbon retention services in India and state wise.
- To estimate impact of factors on total carbon stock and value of carbon retention services in India.

5. Materials and Methods:

The study is based on secondary data, and researcher developed a plan for incorporating blue carbon in India before identifying two external (opportunities and threats) and internal (strengths and weaknesses) and positive and negative strategic components that arose from the state and status of the mangrove forests, tidal salt marshes and seagrass. The purpose of a SWOT analysis is to carefully identify different elements that go into creating a strategy by highlighting present strengths and opportunities while simultaneously minimizing weaknesses and threats. For assessing the whole situation and attaining the goals, a SWOT analysis is helpful. Based on the characteristics of blue carbon and the socio-economic circumstances of the people residing in the blue carbon area, we created a SWOT analysis. Author applied qualitative components of regression and dynamic analysis of state-by-state carbon retention in India in addition to theoretical SWOT analysis. using the software programs QGIS and EViews.

6. Results and Discussions

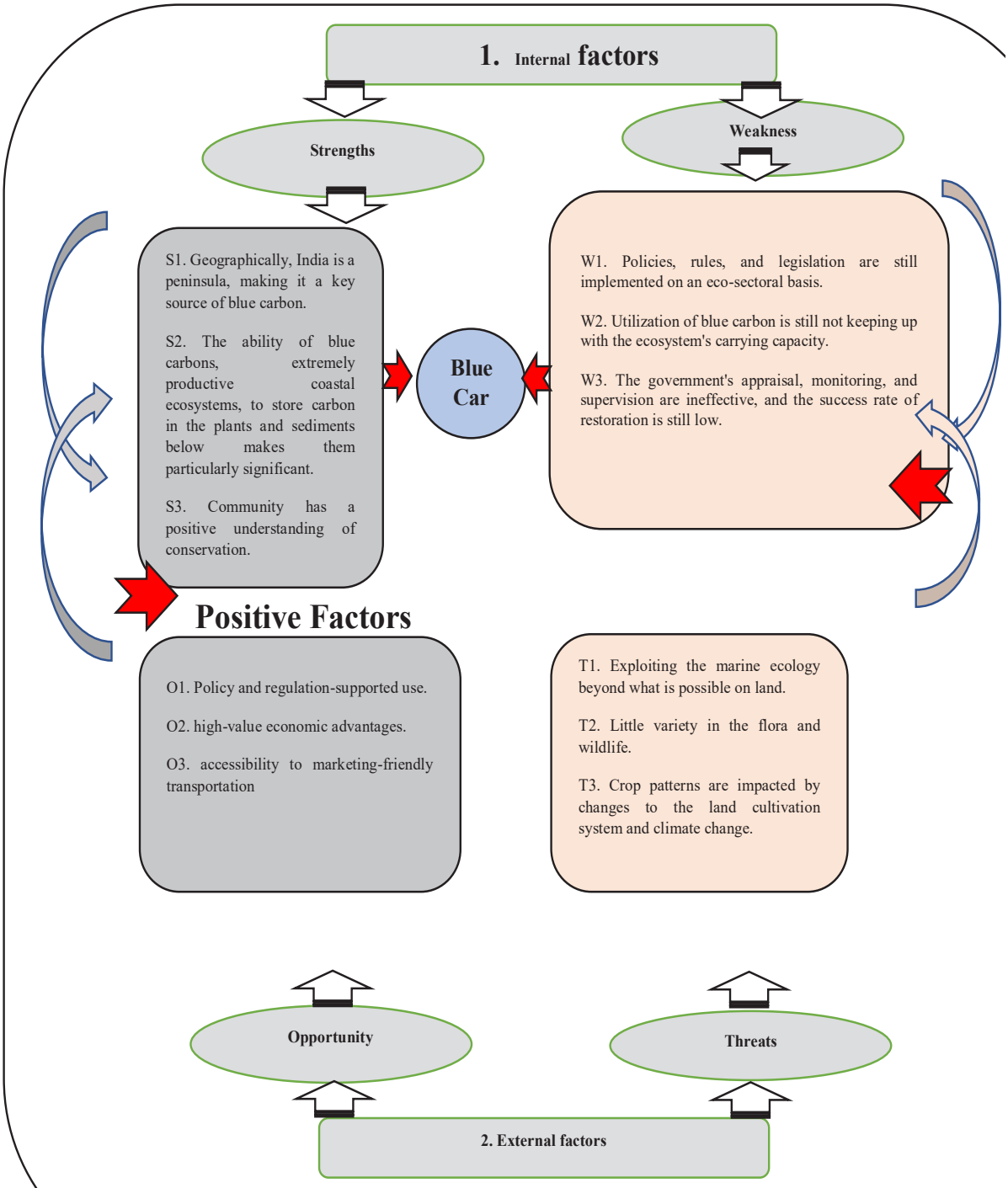
6.1 Strategies for developing blue carbon market in India

Ocean carbon sinks are being studied more in-depth than forest carbon sinks when it comes to the use of SWOT in carbon trading. This ground breaking project combines blue carbon trading with climate regulation services as part of the progressive assetization of blue carbon. The theoretical logic of this technology was improved by reviewing the study on SWOT applications in numerous sectors. It was looked at whether it would be possible to use natural solutions in transactions involving ecological goods (such carbon sinks). The SWOT model for the blue carbon international trade market was built using a conceptual model technique, and the benefits of merging the two were illustrated. It is helpful for lowering transaction costs and increasing productivity, this has the result of universal oversight, allowing businesses to uphold their social and environmental obligations and aiding in the achievement of carbon neutrality.

Figure 1 illustrates ways for how future external elements like opportunities and dangers as well as internal characteristics like strength and weakness will affect both positive and negative outcomes. Because of this technique, developing nations like India can benefit. India is in the early stages of development and has abundant natural resources. By adopting sustainable or natural solutions, we may lessen environmental pollution and carbon emissions. Only the quota and carbon credit types of voluntary carbon offsets are offered by blue carbon. India has three different types of coastal ecosystems: estuarine on the west coast, deltaic on the east, and Andaman Nicobar-type islands. Therefore, reducing the weak points of bad regulation, lack of oversight, and harm-free land cultivation

using scientific methods will improve the blue carbon market, a brand-new and crucial centre for economic growth.

Figure 1. Stages of developing a plan utilizing a SWOT analysis.



			Manipur Meghalaya Mizoram Nagaland Rajasthan Uttar Pradesh West Bengal		
Low			Tripura	Bihar Chandigarh Daman and Diu and Dadra and Nagar Haveli Delhi Goa Haryana Ladakh Lakshadweep Odisha Puducherry Punjab Sikkim	**13**
Total	**4**	**8**	**12**	**12**	**36**

NOTE: Red indicates High Carbon emission; Green shows less carbon emission; yellow shows No changes in carbon emission.
Source: Authors calculation.

6.2 Dynamic Analysis of Carbon Retention Services in India

Figures 2 and 3 attention on how forests store carbon to maintain environmental balance. Carbon value in ecosystem services is accounted for by SEESA. The study divided the states into four categories based on their carbon holdings: high, low, moderate, and extremely high. Non-Available is indicated with NA (Table 1). Here are two maps that display state-by-state carbon retention data for the years 2015–16 and 2017–18. Andhra Pradesh, Jammu, Jharkhand, Kerala, Tamil Nadu, Telangana, and Uttarakhand are among the states with a high carbon value. Bihar, Chandigarh, Daman and Diu, Delhi, Goa, Haryana, Ladakh, Lakshadweep, Odisha, Puducherry, Punjab, Sikkim, and Tripura are low carbon value regions. Andaman and Nicobar, Assam, Gujarat, Himachal Pradesh, Meghalaya, and Mizoram are members of the moderate category. In the years 2015–16, states with exceptionally high carbon values include Arunachal Pradesh, Chhattisgarh, Karnataka, Madhya Pradesh, and Maharashtra. Some states, like Karnataka, had a very high to High level movement in their carbon levels during the second assessment years of 2017–18. Telangana and Jharkhand went from high to moderate. Tripura causes a low value to become moderate. Himachal Pradesh and Assam go from moderate to high. Because decrease in forest carbon stock during the previous two years despite an increase in forest cover. A decrease in carbon stock indicates that there is less biomass in the forest, which is caused mostly by destruction of thick forests and tree shrinkage due to drought and wild fire. The forest carbon stock absorbs and stores atmospheric carbon dioxide. Its decrease means more greenhouse gases in the atmosphere (Table1, Fig 2 and Fig 3).

Fig. 2: Assessment of The Value of Carbon Retention Services in India (2015–16).

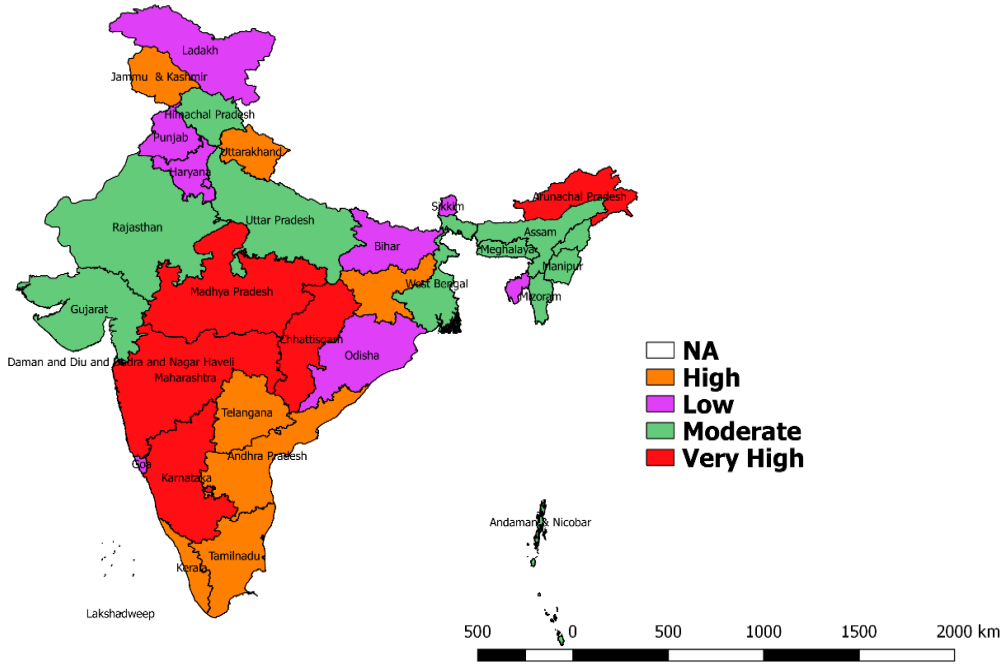
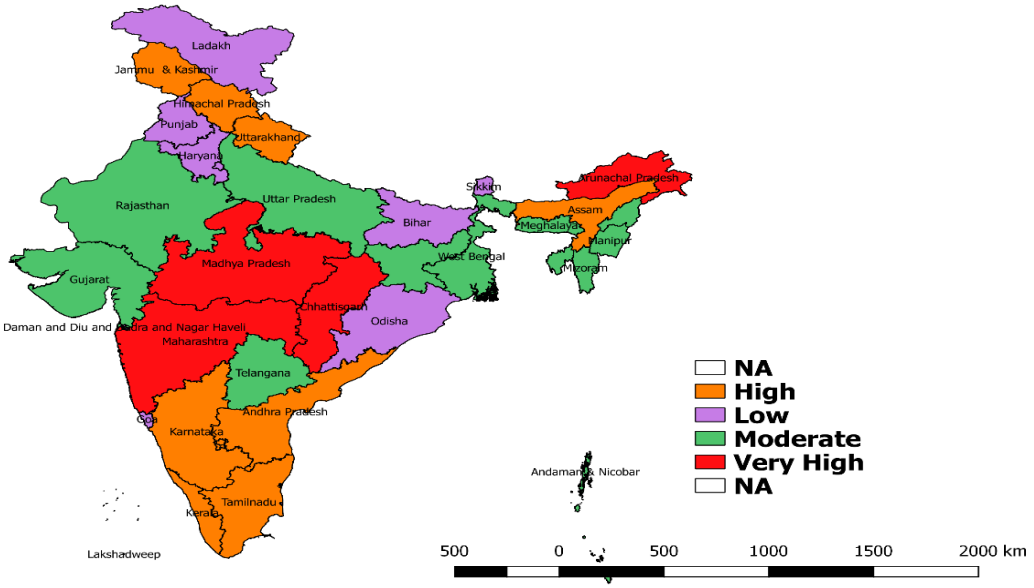


Fig. 3.: Assessment of The Value of Carbon Retention Services (2017-18).



6.3 Impact Assessment of Total Carbon Stock and Value of Carbon Retention Services in India.

Equation 1 Indicates that Functional relationship of total carbon stock depends on Above ground biomass. Below ground biomass, Dead woods, litters, soil organic, value of carbon retention services.

Above ground biomass is all living matter above the earth, such as stems, branches, seeds, and leaves. and below ground biomass is all living biomass derived from live roots. Fine roots with diameters less than 2mm (country specific) are frequently omitted since they cannot be separated experimentally from soil organic materials or litter which is also called living biomass. Dead woods are any non-living woody biomass that is not included in litters. upright or laying down on the ground Dead wood also comprises dead roots and stamps with a diameter more than or equal to 10 cm or any other diameter employed by the nation. Litters contain all live biomass lying dead in various degrees of decomposition above the mineral or organic soil with a diameter smaller than a minimum diameter determined by the nation (FSI 5cm). Soil organic carbon in mineral and organic soils (including peat) to a depth determined by the nation (for FSI 30cm) and administered consistently over time VCRS is the value of carbon retention services determined from a constant 3 percent of carbon in the formulae. When the equation is run using Alfa and Beta using natural log data from India's Envisat 2020 carbon retention services, equations 3 and 4 are obtained from equations 1 and 2. This is an estimated equation for predicting total carbon by its determinates.

$$lnTC = f\,(lnAGB + lnBGB + lnDW + lnL + lnSO + a) \quad \ldots\ldots\ldots\ldots Eq\ (1)$$

$$lnVCRS = f\,(lnCS + \beta) \quad \ldots\ldots\ldots\ldots Eq\ (2)$$

Were,
TC= Total carbon stock
AGB = Above ground biomass
BGB= Below ground biomass
DW= Dead woods
L= Litters
SO= Soil Organic
VCRS = value of carbon retention services
a & β = Alpha and Beta (constant)
Ln= Natural log

The study used cross section data and regresses Above ground biomass, Below Ground Biomass, Dead woods, litters, soil organic, value of carbon retention services on total carbon stock (Eq1). The R^2 of the first equation is 0.99. The OLS empirical result shows that AG, BG. DW, L, SO are positively impact on TC. Instead of Soil organic all other independent variables are Insignificant (Eq 3).

The analysis regressed carbon stock on the value of carbon retention services (Eq 2). The R2 of the second equation is 0.99. The OLS empirical finding reveals that carbon stock has a positive impact on the value of carbon retention services at one percent level of statistical significance. (Eq 4).

$$lnTC = 0.2092(lnABG) + 0.1441(lnBGB) + 0.0109(lnDW) + 0.0852(lnL) + 0.5673(lnSO)^{***} + 1.1542 \quad \ldots\ldots\ldots Eq\ (3)$$

$$lnVCRS = 1.01642(lnCS)^{***} + 0.3054 \quad \ldots\ldots\ldots Eq(4)$$

7. Conclusions and policy suggestions:

This study differs from earlier research in three ways: (i) from a qualitative standpoint, it develops a conceptual framework for applying SWOT in blue carbon trading; (ii) it combines regulatory bodies of government departments to participate in the virtual economy industry in environmental governance;(iii) it uses the marketization and reimbursement of blue carbon sinks to achieve a balance between environmental and socio-economic interests of the whole ecosystem, and helps to achieve natural resource based market in Indian blue economy create green carbon markets. This study finds Carbon

neutrality has progressively gained acceptance as a means of limiting global warming. Some nations have established national and regional carbon trading markets, and focus is growing on ties to global carbon markets. Blue carbon, a crucial element of nature-based solutions (NBS), is still unconnected to the carbon trading market and has not obtained the attention it merits. The empirical evidences reveal that AG, BG. DW, L, SO are positively impact on TC, but not significant. Instead of Soil organic all other independent variables are Insignificant. Hence suggest that suggesting that the government develop a new environmental budget in order to increase live biomass such ABG, BGB, DW, and soil organic. It strengthens the forest cover in India and provides a natural antidote to pollution. It might also serve as a new blue carbon marketing centre in the future, strengthening the functions of coastal ecosystems. The empirical finding reveals that carbon stock has a positive impact on the value of carbon retention services at one percent level of statistical significance. Hence, study recommended that the value of carbon preserving services is increased by environmental intelligence or green cover. approach can aid in the achievement of sustainable goals. SWOT application for carbon trading, has the result of universal oversight, allowing businesses to uphold their social and environmental obligations and aiding in the achievement of carbon neutrality.

References:

Alongi, D.M. (2009) The Energetics of Mangrove Forests; Springer: Dordrecht, The Netherlands,

Alongi, D.M.; Sasekumar, A.; Tirendi, F.; Dixon, P. (1998). The Influence of Stand Age on Benthic Decomposition and Recycling of Organic Matter in Managed Mangrove Forests of Malaysia. J. Exp. Mar. Bio. Ecol. 225, 197–218. [CrossReff]

Anderson, K. & Peters, G. (2016). The trouble with negative emissions. Science 354, 182–183

Arifanti, V.B.; Kauffman, J.B.; Hadriyanto, D.; Murdiyarso, D.; Diana, R. (2019) Carbon Dynamics and Land Use Carbon Footprints in Mangrove-Converted Aquaculture: The Case of the Mahakam Delta, Indonesia. For. Ecol. Manage. 432, 17–29. [Cross Ref]

Arifanti, V.B.; Novita, N.; Subarno; Tosiani,(2021). A. Mangrove Deforestation and CO2 emissions in Indonesia. In Proceedings of the The 6th INAFOR 2021 Stream 3, Bogor, Indonesia, 8 September; Volume 874, p. 012006.

Arifanti, V.B.; Sidik, F.; Mulyanto, B.; Susilowati, A.; Wahyuni, T.; S.; Y.; Yuniarti, N.; Aminah, A.; Suita, E.; et al. (2022) Challenges and Strategies for Sustainable Mangrove Management in Indonesia: A Review. Forests 2022, 13, 695. https://doi.org/10.3390/ f13050695

Barbier, E. B. et al. (2011). The value of estuarine and coastal ecosystem services. Ecol. Monogr. 81, 169–193

Chausson, A. et al. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. Glob. Chang. Biol. 26, 6134–6155

Donanto, D.C. Kauffman J. B. Murdiyarso,D, (2011) Mangroves among the most carbon rich forest in tropics Nature 4 (5) 293-297.

Duarte, C. M., Losada, I. J., Hendriks, I. E., Mazarrasa, I. & Marbà, N. (2013). The role of coastal plant communities for climate change mitigation and adaptation. Nat. Clim. Chang. 3, 961–968

Duarte, C. M., Middelburg, J. J. & Caraco, N. (2005) Major role of marine vegetation on the oceanic carbon cycle. Biogeosciences 2, 1–8

Friess, D. A. et al. (2020) in Oceanography and Marine Biology Vol. 58 Ch. 3 (CRC)

Giesen, W.; Wulfrrat, S.; Zieren, M.; Schoten, L. (2007) Mangrove Guidebook for Southeast Asia; Dharmasarn Co., Ltd.: Bangkok, Thailand,

Himes-Cornell, A., Grose, S. O. & Pendleton, L. (2018). Mangrove ecosystem service values and methodological approaches to valuation: where do we stand? Front. Mar. Sci. 5, 376

Hochard, J.P.; Hamilton, S.; Barbier, E.B. (2019) Mangroves Shelter Coastal Economic Activity from Cyclones. Proc. Natl. Acad. Sci. USA 116, 12232–12237. [CrossRef]

IPCC, Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 p

Kanchan Srivastava (2020): Green cover of many Indian states rises but carbon stock declines. Green cover of many Indian states rises but carbon stock declines (mongabay.com)

Kathiresan, K.; Bingham, B.L. (2001). Biology of Mangroves and Mangrove Ecosystems. Adv. Mar. Biol. 40, 81–251. [CrossRef]

Lovelock, C. E. & Duarte, C. M. (2019). Dimensions of blue carbon and emerging perspectives. Biol. Lett. 15 https://doi.org/10.1098/rsbl.2018.0781

Macreadie P I et al. (2019) The future of Blue Carbon science. **Nature communications** 10: 3998

Macreadie P I**,** Costa MD, Atwood TB, Friess DA, Kelleway JJ, Kennedy H, Lovelock CE, Serrano O and Duarte CM, 2021. Blue carbon as a natural climate solution. pp.1-14.

Macreadie Peter, I., Serrano, O., Maher Damien, T., Duarte Carlos, M. & Beardall, J. Addressing calcium carbonate cycling in blue carbon accounting. Limnol. Oceanogr. Lett. 2, 195–201 (2017). Argued that calcium carbonate cycling has been ignored in blue carbon offset schemes, but warrants serious attention

McLaren, D. A (2012). comparative global assessment of potential negative emissions technologies. Process Saf. Environ. Prot. 90, 489–500

Mitsch, W.; Gosselink, J. Wetlands, (2007) 4th ed.; John Wiley & Sons, Inc.: Hoboken, NJ, USA,

Nellemann C, Corcoran E, Duarte CM, et al. (Eds). 2009. Blue carbon. A rapid response assessment. GRID-Arendal: United Nations Environment Programme. ISBN: 978-82-7701-060-1.

Nellemann, C. et al. (2009) Blue Carbon — The Role of Healthy Oceans in Binding Carbon (UN Environment,)

Nesshöver, C. et al. (2017). The science, policy and practice of nature-based solutions: an interdisciplinary perspective. Sci. Total Environ. 579, 1215–1227

Perdan S, And Adisa Azapagic (2011) Carbon trading: Current Schemes and Future developments. Energy policy 39.6040-6054.

Pires, J. C. M. (2019). Negative emissions technologies: a complementary solution for climate change mitigation. Sci. Total Environ. 672, 502–514

Ramsar Convention on wetlands (2018). Global wetland out: State of the world's wetlands and their Services to people, Gland, Switzerland: Ramsar Convention Secretariat.

Salampessy, M.L.; Febryano, I.G.; Martin, E.; Siahaya, M.E.; Papilaya, R. (2015) Cultural Capital of the Communities in the Mangrove Conservation in the Coastal Areas of Ambon Dalam Bay, Moluccas, Indonesia. Procedia Environ. Sci. 23, 222–229. [CrossRef]

Spash, Clive L (2009) The brave new world of carbon trading. Munich personal RePec Archive. MPRA paper no. 19114

Thomas, S. Blue carbon: knowledge gaps, critical issues, and novel approaches. Ecol. Econ. 107, 22–38 (2014)

Virtual Expert Forum on SEEA Experimental Ecosystem Accounting (2020): valuation of carbon retention services in India

https://seea.un.org/sites/seea.un.org/files/carbonretentionindia.

Digital Banking: A Paradigm Shift in key to the competitiveness of Indian Banking Sector

Ajit Kumar

INTRODUCTION:

In digital era banking industry today had shifted to a new dimension, with technology aiding globalisation and integration of world's financial markets there has been a quantum jump in the expectation of customers for newer products and alternative delivery channels. The range of financial products and services should be offered at the lowest cost to both institutional and individual consumers, namely, borrowers, investors, depositors and risk managers. In this regard, improvement in productivity and higher returns on assets for the financial institutions will need to be realized through greater penetration of efficient and low cost delivery channels, access to scale advantages in processing, procurement and other back-office functions, and leveraging on world-class skills.

The motivation behind the present research study is to bring out really important and fundamental issues which bank officials generally fail to fully appreciate and or implement while selecting or developing their IT infrastructure for their banking organisations. Till about half a decade ago, banks used a large number of IT system for different purposes. The results of the use of the IT systems were mixed, some of them made a good impact on the health and vibrancy of the organisation. These good systems had achieved the planned objectives and even were a positive influence in the next generation. For instance, the database used by an initial system could be used with minor modifications for a later system. Hence the use of such systems not only improved the quality of the computing environment but also saved the organization of huge investments down the years.

Many of the other information Systems that were implemented did not have the good fortune of the above systems. Many of them were found unsuitable for the banking environment after implementation. Others remained unused by the end users for various reasons. Some of them remained a liability for the organization, remaining in the books of account consuming huge amount of resources but not adding any value.

A fact that should be of great concern to IT infrastructure & system planners is the results of such implementations. Often, results of a technology implementation are thought to be sufficiently complicated toward off questions related to accountability. The main reasons for this complication are manifold: There are several hidden factors that impact a technology implementation in banks. There are hidden impacts for information systems including hidden benefits like improvement in the quality and skill level of staff and acquisition of know-how for the IT department.

Information technology would be the key to the competitiveness of banking and finance sector. India will keep pace with global leaders in the use of banking technology. In such a scenario, on-line accessibility will be available to the customers from any part of the globe; 'Anywhere' and 'Anytime' banking will be realized in true sense. At the same time traditional banking will co-exist with 'on-line' banking to cater to the specific needs of different customers.

Indian banking sector has played a crucial role in the socio-economic development of the country. This system is expected to continue with the growth and development needs of all the segments of the society**.** The banking system, that will evolve after the use of IT will be transparent in its dealings, adoption of global best practices in accounting and disclosures driven by the motto of *value enhancement* for all stakeholders. Information technology will bring fundamental shift in the functioning of banks. It would not only help them to bring improvements in their internal functioning but also enable them to provide better & efficient customer service. Technology will break all boundaries and encourage cross border banking business.

(2.) The Model Shift in Business Process Re-Engineering

Banks would have to undertake extensive Business Process Re-Engineering (BPR) and tackle issues like -

a) How best to deliver products and services to customers

b) Designing an appropriate organizational model to fully capture the benefits of technology and business process changes brought about.

c) How to exploit technology for deriving economies of scale and how to create cost efficiencies,

d) How to create a customer - centric operation model.

Entry of ATMs has changed the profile of front offices in bank branches. Customers no longer need to visit branches for their day to day banking transactions like cash deposits, withdrawals, cheque collection, balance enquiry etc. E-banking and Internet banking have opened new avenues in *"convenience banking"*. Internet banking has also led to reduction in transaction costs for banks to about a tenth of branch banking. Technology solutions would make flow of information much faster, more accurate and enable quicker analysis of data received. This would make the decision making process faster and more efficient in banks. For the Banks, this would also enable development of appraisal and monitoring tools which would make credit management much more effective.

The result would be a definite reduction in transaction costs, the benefits of which would be shared between banks and customers. While application of technology would help banks reduce in their operating costs in the long run, however the initial investments in IT would be sizeable. IT expenditure of banking and financial services industry in USA is approximately 7% of the revenue as against around 1% by Indian Banks. With greater use of technology solutions, we expect IT spending of Indian banking system to go up significantly. One area where the entire banking system can reduce the investment costs in technology applications is by sharing of facilities between them.

We are already seeing banks coming together to share ATM Networks. Similarly, in the coming years, we expect to see banks and FIs coming together to share facilities in the area of payment and settlement, back office processing, data warehousing, etc. While dealing with technology, banks will have to deal with attendant operational risks. This would be a critical area where the bank management will have to deal with in future.

The time period within which the impact is profound is a matter of debate in the system. The impact of continuous change in information systems has not been sufficiently studied. There are many contextual (organisational and environmental) variables that prevent generic. global models from being suitably implemented for evaluating information system effectiveness.

In India, only a few banks are offering E-banking services, though the Internet connections have crossed 4.5 million. These facilities are used largely by corporations and a new generation of professionals. The *Institute for Development Research in Banking Technology (IDRBT)*, RBI launched its *Electronic funds Transfer (EFT)* and *Real-time Gross Settlement Systems (RTGS)* with services available throughout India. Liberalization and de-regulation process started in 1991-92 has made a sea change in the banking system. From a totally regulated environment, we have gradually moved into a market driven competitive system. Our move towards global benchmarks has been, by and large, calibrated and regulator driven.

The pace of changes gained momentum in the last few years. Globalization would gain greater speed in the coming years particularly on account of expected opening up of financial services under WTO regime. Four trends of change can be seen in the banking industry world over, viz.

1) Consolidation of players through mergers and acquisitions,

2) Globalisation of operations,

3) Development of new technology

4) Universalisation of banking.

With technology acting as a catalyst, we expect to see great changes in the banking scene in the coming years. It entails emergence of an integrated and diversified financial system. The move towards universal banking has already begun. This will gather further momentum by bringing in IT into an integrated financial system. Indian banking sector is driving business through technology. India had displayed an explosive economic growth over the last decade. The banking sector in particular has expanded rapidly, emerging unscathed from the economic downturn due to its robust and well regulated nature in a highly competitive market; Indian banks are now aiming to capture the market share by increasing operational efficiency through investments in technology.

India's IT expenditrue in the banking sector through *public private partnerships(PPP)* is nearing US $10 billion with several projects going to private software companies. Banks are also being pushed to participate in financial inclusion and are looking for cost-effective banking solutions to achieve this goal. Meanwhile, the phenomenal growth in the mobile subscription base has resulted in banks trying to leverage this technology to provide banking facilities in rural areas. While new banks have been very adeptive in acquiring core banking services and innovative IT infrastructure, challenges still exist in integration of IT security and compliance. Technological advancements to enrich customer experience are being evaluated by most banks and a shift from legacy systems is occurring at moderate pace.

Indian banks had invested heavily in technology and set up a core banking facilities and IT infrastructure to boost efficiency, and to offer convenient access and services to their consumers. As a first step, banks will have to defend this franchise against competition from private and foreign banks by offering customers conveniences such as tele- banking, ATMs, and Internet banking. channels they can provide these facilities by investing into the right technology. Finally, banks should aggressively put in place mechanisms to cross-sell investments, insurance, credit cards, mortgages, and other asset products that are growing at a far faster pace than deposits. Banks have two options. The first is to build the IT skills required to introduce the new IT platform.

This would help in building robust credit assessment skills, marketing savvy, strong technology-enabled processing capabilities, and a retail credit recovery system. The alternative is to ally with global players who can provide the technology and expertise. A revamp of operations and strategy has to be accompanied by radical restructuring and the implementation of performance management. High-performance of foreign banks and their potential to become universal banks or large-scale national bank. They been ahead to pack in profitably, capturing emerging opportunities in the banking sector. While, the majority of foreign banks operate in a limited capacity through a single branch that serves businesses from their home country.

Banks will need to look for ways to optimize resources for technology applications. In this regard, global partnerships on technology and skills sharing may help. Human resources development would be another key factor in defining the characteristics of a successful banking institution. Employing and retaining skilled workers and specialists, re-training the existing workforce and promoting a culture of continuous learning would be a challenge for the banking institutions. This type of competition will become the order of the day as ,banks seek to enlarge their customer base and at the same time to realize cost reduction and greater efficiency. Several new IT opportunities are available to establish a presence in high-growth areas of the banking sector, where we want to outsource operational and product expertise from global players

. (2.) AIMS AND OBJECTIVES:-

1.. To identify the IT skill and capabilities of the employees, because customer satisfaction is greatly affected by the performance of the bank personals.

2.. To analyze the potentials of the different delivery channels like branches, ATMs, Internet and Mobile banking and Call Centers

3. To elaborate the inter-relationship between the IT infrastructure of these two banks also its usefulness and productivity in the banking sector of the economy.

(3.) REVIEW OF LITERATURE:

The reasons for research on the IT infrastructure of banks are many and varied. The IT infrastructure of a bank is the application of computing and communication technology to meet the challenges that is faced in business in the emerging and strengthening economy. Information technology systems are developed using IT to aid an individual in performing a task in an organization. The number and variety of applications that have been deployed is tru1y amazing. There is a plethora of utilitarian IT system used in organizations, such as decision support systems.

Computer- mediated communications, e-commerce and knowledge management systems. Research in IT infrastructure has been active right since the inception of this young discipline. Research covered wide and varying topics and this has led to several debates on the identity of the field. Some of the best researchers analyzed the growth in the IT infrastructure area and tried to identify the problems associated with research in the area. IT infrastructure research is a dynamic and ever changing field. Novel technologies and management trends have emerged, evolved, and departed over the years since the discipline first formed in the late 1960s. Others worked on the various themes around which the information technology systems scholarship is concentrated. IT scholars research and teach a set of diverse topics associated with information technologies

IT infrastructures and IT -enabled business solutions and the immediate antecedents and consequences of these information systems e.g.; managing, planning., designing, building, modifying, implementing, supporting, or assessing IT -based systems that serve, directly or indirectly, practical purposes.

Often information system development and implementation occurs so suddenly without proper planning. IT infrastructure evaluation has been an area of active research right from the initial use of computer-based information systems in organisations. However, very few researchers have thought it necessary to undertake an in depth study of the reasons why information systems lacked effectiveness. Where such studies were done, they did not consider it essential to include the impact of the legacy systems used by the organization. In the absence of this historical perspective, it seems that the actual context in organizations differed from those in the research and the findings were not implementable Different key words were used by researchers at different parts of the globe:

1. Information Technology Success

2. Information Technology Effectiveness

3. Information Technology Evaluation

4. Information Technology Evaluation

Enterprise-wide IT infrastructure was part of Indian banks way back in the last decade of the 20^{th} century. Despite severe resistance in the initial period to the use of IT infrastructure in banks, banks were able to steadily grow with the use of information technology and hence, several generations of IT infrastructure of banks can be clearly identified in the Indian banks. For instance, starting with the

Advanced Ledger Posting Machines(ALPM) to the present core banking solutions, there are clearly differentiated IT infrastructures used industry-wide, with just a few exceptions. Over the years, great improvements have occurred in the quality of the IT infrastructure used.

However, the impact of IT infrastructure and the impact of the changes in the IT infrastructure of banks on the organization have not been clearly understood, despite immense research in related areas. Each time an IT infrastructure is selected to be deployed, an elaborate exercise is followed to ensure that the system suits our needs. But post-deployment, no evaluation is done to ensure that the system works as we planned. No instrument exists for the measurement of IT infrastructure of banks effectiveness in Indian banks.

They developed a framework to assess IT-enabled resources at both the front end and the back end. We enrich the discussion by incorporating insights from transaction costs economics.

Transaction cost economics (TCE), Explicitly recognizing the costs of coordination among economic entities in markets, TCE stresses that a firm's central task is to coordinate transactions efficiently *(Williamson1985)*. IT can lower coordination costs, and in supply chain contexts, digitally enabled integration capability can substantially improve transactional efficiencies through increased information sharing and communications capabilities, resulting in improved supply chain performance.

Furthermore, TCE sheds light on the role of the digitally enabled supply chain management(SCM) in competitive environments. An important feature of a competitive environment is the extensive competitive actions in the markets, such as competitive entry, price change, supplier alliances and new product introduction.

It is of the view that improvements in the growth rate can be effected through three exclusive channels: ,i.e;improving productivity of capital, through investments in human capital and raising *total factor productivity (TFP)* technology He however, the '*technological penetration*' in India has been quite modest.

It is evident from the literature review that some of the prominent themes like - IT effectiveness, IT success and IT impact have lion share of the works. All other themes like. Customer satisfaction, Value creation, etc are very important aspect in the study of IT infrastructure efficiency. Hence, there is still much being discussed about the issues faced by organizations in evaluating their IT systems. Little seems to be done towards improving the systems and procedures used for IT evaluation. It is hoped that through this research work, at least some improvement can be made in the state of affairs in the discipline.

(4.) Conclusion

This study is based on operational issues of IT infrastructure The choice is influenced by the importance in India banking arena." It indicates how it is being done; how effectively and efficiently the man-power, money and materials, as these are the principle resources of an organisation are being utilized. The primary aim of any organisation is to properly harness and handle these resources.

One of the important aspects of this study is to identify the major issues between deficient IT infrastructures of SBI and efficient IT infrastructure of Citibank. For a successful organisation technology and business strategy must go hand in hand, Information technology has become an essential element of firm capability and a source of sustainable competitive advantage. Although it is widely accepted that IT resources contribute to performance and future growth potential of the firm, the empirical results of the relationship between IT capability and firm performance is still to be explored. The unavailability of publicly available data, the accelerated pace of IT innovation. The possible interactive effects between IT and human resources, and the intangible nature of IT capability are among the obstacles that hinder an understanding of whether and how IT can create value for a firm.

REFERENCES

Bharadwaj,A.S; *A resource-based perspective on information technology and capability performance: an emprical investigation*. MIS Quartly 2000:241(1) Pp. 169-96.

Joshi, V.C.; *e-finance Log into the future*; Response books, New Delhi (2004); P. 26

Kaptan, S.S.; *New Concepts in Banking*, Sarup & Sons; New Delhi (2002); Pp. 28-30.

Heritage, Arnold; *Innovation, Technology and Finance*; Basil Blackwell Inc., New York (1988); pp. 2-6.

Szanto B.; *The unconventional challenges of Information Tech*nology; The journal of Technovation 2005:25(5):469 P. 76.

Thatcher ME, Oliver JR; *The impact of technology investments on a firm's production efficiency, product quality, and productivity.* Journal of Management & Information System2001:18(2) Pp.17-45.

Bakos JY, Brynjolfsson E.*; From vendors to partners: information technology and firm performance: an emprical investigation*. MIS Quartly 2000:241(1) Pp. 169-96.

Bagchi, Amiya Kumar; *The Evolution of the SBI-Vol. I (the roots 1806-1876)*; Sage Publication, New Delhi, (2003); pp.1-20.

Bhaisn, Niti; *Banking Developments in India (1947-2007) growth, reform and outlook*; New Century Pub., New Delhi (2006); p.187.

10. Bharadwaj,AS; Bharadwaj, SG; Konsynski, BR.; *Information technology effects on firm performance as measured by Tobin's Q* ; Management Science Journal 1999; 45(7): 1008 P. 24.

Bower, Tab; Gibb, Greg and Wong, Jeffrey; *Banking in Asia -Acquiring a Profit Mindset*; John Wiley &Sons (Asia) Pvt. Ltd. New Delhi (2003); pp.83-87

A Cross-Country Analysis of Carbon Dioxide (CO_2) Emission and Economic Growth

Yasmeen Sultana H.
Ajmal Faiz V

ABSTRACT

Covid -19 has adversely impacted everything on earth, including economic growth, especially in the global south. It has been compelling nations to adopt policies with more growth-generating power to overcome the economic losses created by the pandemic. This paper attempts to reveal the risk behind overemphasis on economic growth without understanding the hidden environmental challenges that follow it. This study analyses relation between economic growth (GNI) and pollution indicators (CO_2 emission) in India as a proxy to China and United States of America and tests the environmental Kuznets curve for the same. The study focuses on the changes between the economic and environmental costs of covid-19 in the light of geopolitical differences. To examine the relationship between environmental degradation and economic growth, the study employed annual time series data from world bank data base, our world in data, and global carbon atlas for period ranging from 1990 to 2018. The main variables used in the study are Carbon dioxide emissions in kiloton and metric tonnes, Gross national income Descriptive statistics have been used for analysis part. Variables have been expressed both in the form of total as well as per capita values. The study analysed three countries, India, China, and the USA for finding out the difference in economy environment interactions. This study offers suggestions and policies that help the countries as a whole to overcome these issues in the light of the common necessity to curtail environmental hazards. In the long-term individual failures in this field would result in global turmoil. In short, it's essential to have cooperation amongst both south and north in this matter.

Keywords: Environmental costs, Geopolitical differences, Global South, Environmental Kuznets Curve.

Introduction

Men are moving towards a new world order with the covid 19 pandemic and its variants. The world is facing one of the difficult times ever since the pandemic was established, especially in southern countries like developing ones, which have a more negative impact. The new world order demands people to be more connected or globalized in economic growth, pandemic preventive measures like a vaccine, global cooperation on environmental protection and sustainable development, and national security matters. At the same time, countries are not identical in terms of their economic, demographic, and geographic backgrounds. Most developing countries need more wealth to normalize the entire economic system that is not up to the mark till now. They face the main issues: technological divide, underdeveloped infrastructure, poor environmental quality, and economic inequality. Regarding environmental issues and how the production procedures impact the ecology, it is more important to analyse the trends and past experiences in the same. With the urge of covid 19, India's entrepreneurial activities, especially Total early-stage Entrepreneurial Activity (TEA), have declined to 5.34 per cent in 2020-21 from previous years 15%. According to the Global Entrepreneurship Monitor (GEM), India survey conducted by Entrepreneurship Development Institute of India (EDII), the entrepreneurship intention among individuals has declined due to the setback caused by the pandemic. According to the report of Japanese brokerage Nomura's yearly outlook, the current growth cycle being witnessed in the country is not durable and will peak by the first half of 2022.

Assistant professor, Department of Economics, School of Management, Pondicherry University, Puducherry
Research scholar, Department of Economics, School of Management, Pondicherry University, Puducherry

Higher inflation, wider current account deficit, and side effects of loose policies adopted to push growth during the pandemic will come into play, forcing RBI to act even as the scaring results cast doubt on growth's durability. According to official data, India's industrial production rose 3.2 per cent in October. As per the Index of Industrial Production (IIP) data by the National Statistical Office (NSO), the manufacturing sector's output grew 2 per cent in October 2021. In October, the mining output climbed 11.4per cent, and power generation increased 3.1per cent. The IIP had grown by 4.5 per cent in October 2020. All these reports and data show the need for good progress in economic activities and uplifting the economy back to the pre-corona state by the authorities.

Literature Review

Numerous studies have looked at the connection between CO_2 emissions, energy use, and economic expansion. Dinda and Coondoo (2006) investigated the income-emission relationship's short-term dynamics in 88 different countries. The findings demonstrated that in North America, South America, Asia, and Oceania, CO_2 emission and GDP per capita are cointegrated. According to Soytas et al. (2007), carbon emissions are eventually brought on by energy use. According to Warr and Ayres (2010), there is a one-way causal relationship between GDP and energy. Although increased output does not result in increased energy consumption, it does have both short- and long-term effects on the energy supply. According to the researchers, a short-term increase in energy inputs can sufficiently stimulate output growth. Meanwhile, over a number of years, GDP adjusts back to the long-term equilibrium relationship as a positive response to increased energy and useful work inputs. Recently, the fixed and random effects model was used by Borhan, Ahmed, and Hitam (2013) to examine the relationship between pollution and economic growth.

Humans are faced with a dilemma that requires them to choose between economic development and environmental protection. Ecosystems are altered by global warming. According to several studies, human-caused CO_2 emissions are directly related to global climate warming (Azomahou et al., 2006; Dinda and Coondoo, 2006; Lee and Lee, 2009; Jaunky, 2011; Al-mulali, 2012; Liddle, 2012). Additionally, a number of ecological economics studies have revealed a link between environmental deterioration and economic expansion (Coondoo and Dinda, 2002; Hill and Magnani, 2002; Soytas et al., 2007). As a development of the literature on connection between environment, economy and its interactions with each other, the environmental Kuznets curve has gained notable popularity. The EKC explains that as economic growth rises, at the beginning environmental degradation increases, but after a threshold level of income achieved, the pollutants declines. EKC has an inverted U shape. The proper conceptual framework has been introduced by G Grossman and A Krueger. Increases in GDP may be associated with worsening environmental conditions in very poor countries, air and water quality appear to benefit from economic growth once some critical level of income has been reached (Grossman & Krueger, 1995). According to the study the point may vary with different pollutants and countries. (Mandal & Chakravarty, 2016) observed that as compared to sample of high-income nations, studies using sample of low income have more probability of finding an EKC. This refutes the claim made by early literature where it was suggested that high income nations are more probable of exhibiting EKC. (Horii et al., n.d., 2014) explained 'poverty-environment trap' which depicts the mutual causation of environmental degradation and poverty in least developed countries. Lack of proper education followed by poverty leads to dirty technologies which will again cause further pollution. (Arouri et al., 2013) used data from 1971 to 2010 to test EKC 0 by implementing the ARDL bounds test approach in the presence of structural break stemming in the series to examine a long run relationship and found that the variables are cointegrated. That means energy consumption, and trade openness worsens the environment via increasing CO2 emissions. (Stern, 1998) found that the poorest countries struggle more than the richest countries to reduce the environmental impacts as income grows. (Culbertson, 1990) stated that environmental degradation and pollution are existing with the systematic impact of economic individualism. That is unless the economic system posits value for future as highly as the present it is

difficult to curtail environmental degradation. (Seppälä et al., 2001) has tested EKC with direct material flow for the USA, Germany, Japan, the Netherlands, and Finland. The study found that the EKC doesn't work in these industrialized countries. (Plassmann & Khanna, 2006) found that the connection between consumer behaviour and reduction in pollution can either be fostering or preventing. That is consumer behaviour can work in both directions.

Research Method

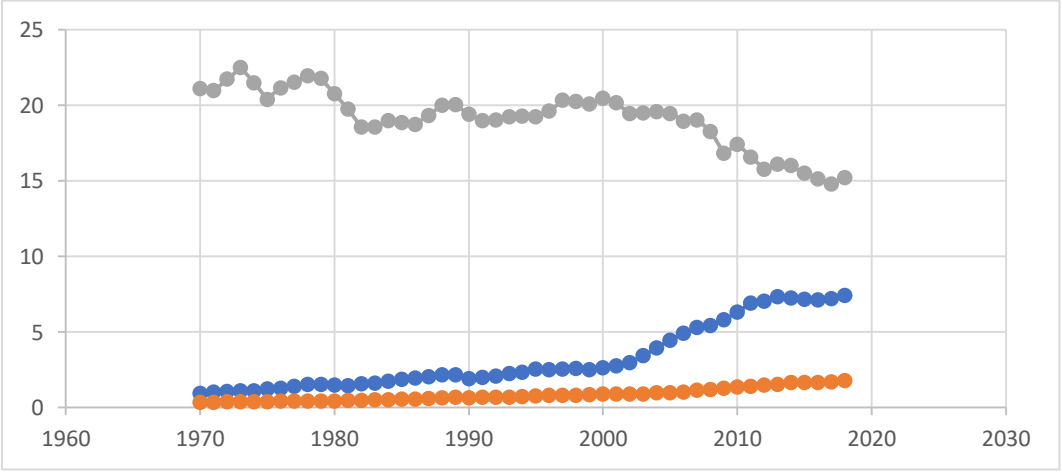
To examine the relationship between environmental degradation and economic growth, the study employed annual time series data from world bank data base, our world in data, and global carbon atlas for period ranging from 1990 to 2018. The main variables used in the study are CO_2 Carbon dioxide emissions in kiloton and metric tonnes, Gross national income Descriptive statistics have been used for analysis part. Variables have been expressed both in the form of total as well as per capita values. The study analysed three countries, India, China, and the USA for finding out the difference in economy environment interactions.

Results and Discussion

The comparison between India, China and, the United States of America, in Figure 1 shows that Indian and Chinese yearly per capita emissions of Carbon Dioxide have been increasing. In contrast, the USA shows a decline in per capita emissions after 2000. The year 2000 indicates a drastic change in all three countries' emissions. Even though India and China are increasing, the USA's CO_2PC is much higher than the other two countries.

Figure 1

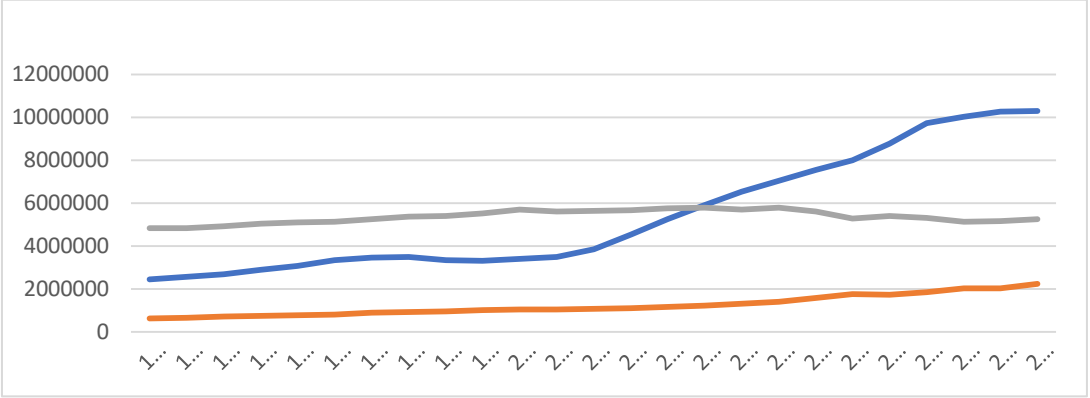
CO_2 Per Capita Emission of India, China, and United States of America



In contrast with per capita analysis, the total emission country-wise indicates that China is producing much higher Carbon Dioxide Kiloton (CO_2KT) than India and USA.in the year 1990, China recorded an emission of 2442431.019 KT of CO2 and then coming to 2014 that rose to 10291926.88 CO_2KT, that is 7849495.861 more production is happening every year. China is the largest producer of CO_2 in the world. At the beginning of the twenty-first century, China started bouncing its CO_2 production because it has started producing more and more goods and became a production hub for many products. China could able to make the production process cheaper.

Figure 2

CO_2 Kilo Ton emission of India, China, and United States of America



It was finding out the relation and trend in CO_2 per capita emission and gross national income per capita of India from 1990 to 2018 shows a direct relationship between the two variables. They are positively related to each other with the passing of time; both the variables have increased. In the year 1990, India's per capita income was approximately 1790, and CO_2PC was 0.644. Still, in 2018 it reached 1.799, which is around three times more than the production at the beginning of the observation, and the per capita income also increased to somewhat the same proportion (6449). We can infer from the above data that India is in the first stage of the EKC in terms of CO_2 emissions. According to EKC, that means in the Indian scenario, there will be a reduction in the environmental pollution in the later stage.

Figure 3

CO_2 Per Capita Emission and Gross National Income Per Capita of India

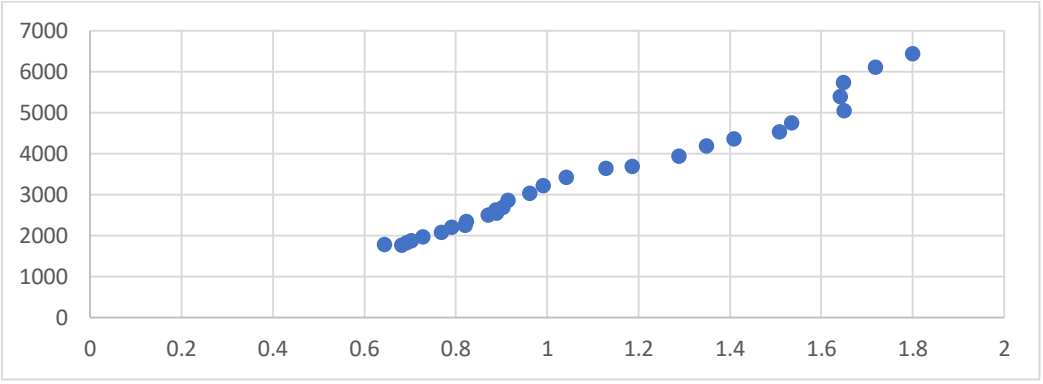
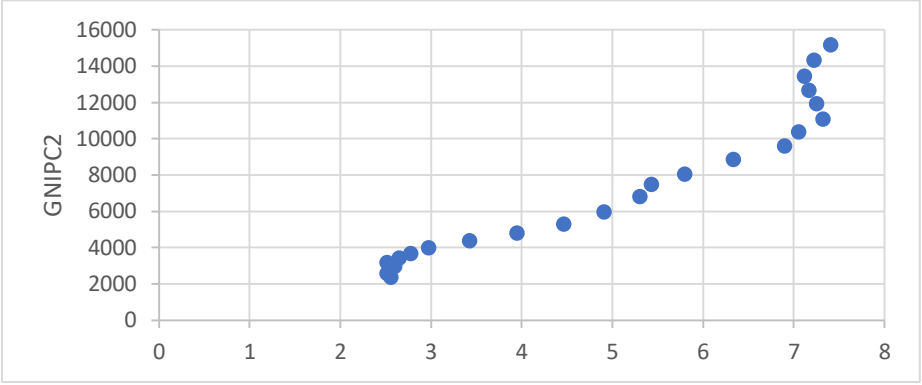


Figure 4 shows the relation between CO_2PC and the GNIPC of China. It shows exciting results, especially in the first and last six years of the observations, that is from 1990- 1995 and from 2013-2018, and in between it is showing a different trend. Both in the first and last six years with a per capita income increase of 2000 units and with achieving that amount of rising in income, the amount of CO_2PC has increased by 0.5 units. And the period in between shows the speed of achieving more 2000 per capita income has increased from 6 years to 4 years. And with that time period, the CO_2PC has increased from 3 units to 5 units. The marginal increase is two units per 2000 units of additional per capita income gained. Now the overall results show that China is entering the second stage of EKC.

China is at the peak of carbon production compared to any other country. And hopefully, it might be getting reduced in the coming years with the help of better technologies and tools.

Figure 4

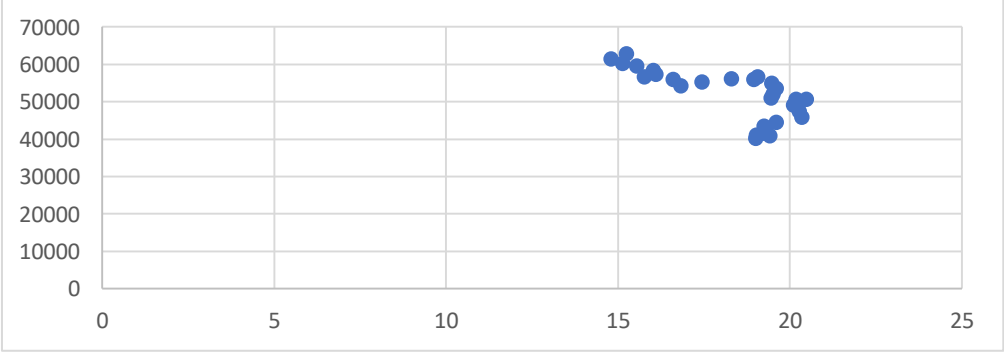
CO_2 Per Capita Emission and Gross National Income Per Capita of China



The interaction between carbon emission per capita and gross national income per capita is shown in Figure 5. In the USA, at the beginning of the observations, the CO_2PC was around 19 units, and the per capita income was 4000. Even though both the carbon emission per capita and national income per capita are much higher than the other two countries, it still shows an overall decline in CO_2 per capita with an increase in per capita income. There was a slight increase of 0.11 units of CO_2PC from 1990 to 1999and after that there was a continuous decline in the CO_2 per capita emissions of USA. Comparing the three countries from data from 1990 to 2018 on CO_2 per capita emission and GNI per capita reveals that India and China have increased the carbon emissions along with the increase in per capita income. In contrast, the USA shows an opposite trend of decline in CO_2 emission per capita. Indian and Chinese emissions per capita have increased by 1.15 and 4.9 units, respectively. And USA shows a decrease of around 4 units of CO_2 emissions per capita. And United States of America is in the final stage of EKC, which is a decrease in environmental degradation with increasing growth and development.

Figure 5

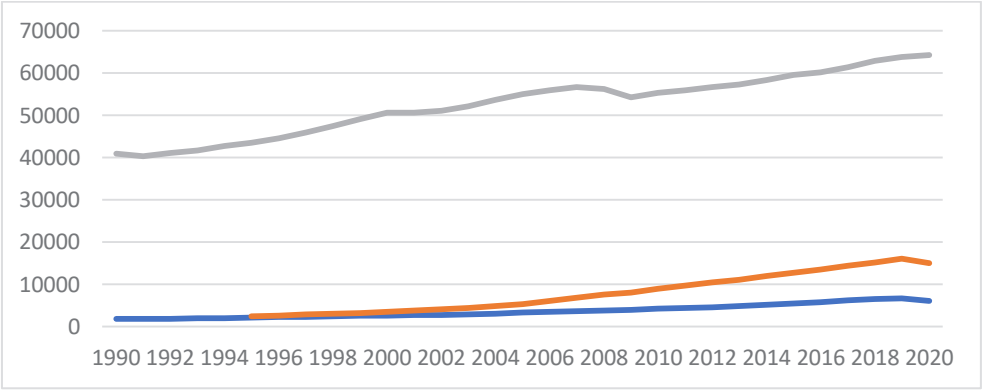
CO_2 Per Capita Emission and Gross National Income Per Capita of United States of America



Data from 1990 to 2020 on the gross national income of India, China, and the USA suggests that, during these thirty years of the time period, all the three countries in the study have shown an increase in their national income per capita. From 1990 to 2011, both India and China's income per capita was below 10,000, and India shows the same till now. In contrast to India, the other two countries' GNI per capita

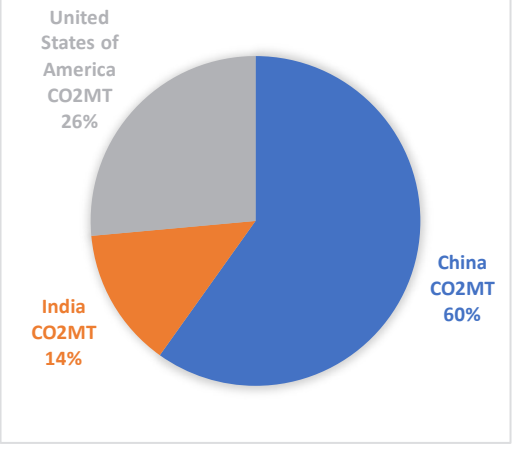
indicates almost the same amount of slope in the time series line provided in Figure 6, which means these country's income per capita increases at the same pace. Even though they have the same marginal increase in income per capita, still the actual GNIPC is much higher for the USA than in China. USA recorded approximately 40,000 GNIPC in 1990, and at the end of the observations (2020), that is reached 64,000 approx. While observing the national income per capita of China in the year 2020, it records 14,936.82, and the same for India is 6072.61.

Figure 6
Gross National Income of India, China, and United States of America



The pie Figure 7 three countries' total emissions of CO_2 in metric tones of India, China, and the USA in the year 2020. The total emission of these three countries is accounted as 17,822.44 CO_2MT, which is 52.73 per cent of the total world CO_2 emissions. At the same time, the rest of the world emits only 47.27 per cent, which is less than that of the three countries' total emissions. Out of these, china produces the most CO_2MT with a quantity of 10667.88 MT CO_2, which is 31.56 per cent of total world emissions and 60 per cent of three countries total, and which is almost one by third of total world emission with nearly 18 per cent or one by a fifth of the population of the world. India and USA emit 2441.79, 4712.77metric tonnes of CO_2, respectively, which are 7.22 percent and 13.94 per cent of total world CO2MT emissions in 2020.

Figure 7
CO_2 Emission Pie Chart 2020



According to OECD's definition of green growth, it is said that along with economic growth and development, natural assets also should provide the resources and environmental services, which is vital for our well-being. According to the world bank definition, green growth is growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. And this growth needs to be inclusive

Conclusion

This study was mainly focused on the environmental impact of economic growth of three countries, India, China, and the USA. China and USA are related to India in economic, political, security, and trade aspects. The USA is one of the full-fledged developed countries in the world, whereas the other two countries are on the way to development. Amongst India and China, China shows a high-speed development with an average GDP growth rate of 7.17 in the last ten years. The study used CO_2 as environmental degradation and GNI to represent growth and development. At the same time, comparing the growth and development of these three countries, In the light of sustainability and environmental hazards, which is visible that environmental degradation always existed as the by-product of development. The study found that there is a positive relationship between economic growth and environmental degradation in the case of India and China, but which is negative or inversely related to the USA's. With the analysis of the Environmental Kuznets Curve, it is clear that both India and China are in the first stage of EKC, which means with per capita income increase, environmental degradation also increases. The USA shows that it has already reached the third stage of EKC, which means more economic growth leads to less environmental degradation. The reason for this is that more sophisticated technology in production, increased value for the environment, changed preferences, and so forth. As we observed in the analysis, it is obvious that developing countries need more money and wealth to come out of the vicious circle of poverty and to achieve many necessary goals like better infrastructure and better standards of living, and they are compelled to give less preference to the environmental issues. Developed countries total environmental hazards are far above the developing ones. The developed countries have utilized the fruit of industrialization and have reached the top. Now the question is how to convince the developing countries to reduce pollution and related hazards. It could be done through, cooperation of both north and south countries. Due to the pressure for growth and development and associated things like the national debt and interest repayment pressure, south countries fall into the trap where they can't concentrate on improving their environmental standards. So better cooperation and planning are needed for solving these issues. To protect our environment and ecology comes under the common need. And different nations have individual agendas as well. Making both the common and individual interests go in the same direction will sort the problem out, and the hope is not yet over.

References

Arouri, M., Shahbaz, M., Onchang, R., & Teulon, F. (2013). Environmental Kuznets Curve in Thailand: Cointegration and causality analysis. In Source: The Journal of Energy and Development (Vol. 39, Issue 1). Autumn. https://www.jstor.org/stable/24812900

Azomahou, T., Laisney, F. and P. Nguyen Van, P. 2006. Economic development and CO2 emissions: A nonparametric panel approach, Journal of Public Economics, 90, 1347-1363.

Dinda, S. and Coondoo, D. 2006. Income and emission: A panel data-based cointegration analysis, Ecological Economics, 57, 167-181.

Soytas, U., Sari, R., and Ewing, B.T. 2007. Energy consumption, income, and carbon emissions in the United States, Ecological Economics, 62, 482-489.

Warr, B. S. and R. U. Ayres. 2010. Evidence of causality between the quantity and quality of energy consumption and economic growth, Energy, 35, 1688-1693.

Borhan, H., Ahmed, E. M., and Hitam, M. 2013. CO2, Quality of Life and Economic Growth in East Asian 8, Journal of Asian Behavioural Studies, 3, 13-24.

Coondoo, D. and S. Dinda. 2002. Causality between income and emission: a country group-specific econometric analysis, Ecological Economics, 40, 351-367.

Culbertson, J. M. (1990). "Economic Growth," Population, and the Environment (Vol. 11, Issue 4). https://about.jstor.org/terms

Dinda, S. and Coondoo, D. 2006. Income and emission: A panel data-based cointegration analysis, Ecological Economics, 57, 167-181.

Hill, R. J. and E. Magnani. 2002. An Exploration of the Conceptual and Empirical Basis of the Environmental Kuznets Curve, Australian Economic Papers, 41, 239-254.\

Horii, R., Ikefuji, M., Eni, F., & Mattei, E. (2014). Environment and Growth. https://about.jstor.org/terms

Grossman, G. M., & Krueger, A. B. (1995). Economic Growth and the Environment. In Source: The Quarterly Journal of Economics (Vol. 110, Issue 2).

Jaunky, V. C. 2011. The CO2 emissions-income nexus: Evidence from rich countries, Energy Policy, 39, 1228-1240.

Lee, C. C. and J. D. Lee. 2009. Income and CO2 emissions: Evidence from panel unit root and cointegration tests, Energy Policy, 37, 413-423.

Mandal, S. K., & Chakravarty, D. (2016). Is environmental kuznets curve a universal phenomenon? – an econometric analysis of the existing studies, The Journal of Developing Areas, 50(6), 261–276. https://doi.org/10.2307/26415665

Plassmann, F., & Khanna, N. (2006). Preferences, Technology, and the Environment: Understanding the Environmental Kuznets Curve Hypothesis. In American Journal of Agricultural Economics (Vol. 88, Issue 3).

Seppälä, T., Haukioja, T., & Kaivo-oja, J. (2001). The EKC Hypothesis Does Not Hold for Direct Material Flows: Environmental Kuznets Curve Hypothesis Tests for Direct Material Flows in Five Industrial Countries. In Sustainability (Vol. 23, Issue 2). https://about.jstor.org/terms

Stern, D. I. (1998). Progress on the environmental Kuznets curve? (Vol. 3, Issue 2). https://about.jstor.org/terms

Soytas, U., Sari, R., and Ewing, B.T. 2007. Energy consumption, income, and carbon emissions in the United States, Ecological Economics, 62, 482-489.

Global Warming and Climate Change: An Analysis

Rajiv Kumar Ranjan
Himanshu Kumar

Abstract

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas. "Global warming" refers to the long-term warming of the planet. Global temperature shows a well-documented rise since the early 20th century and most notably since the late 1970s. Worldwide since 1880, the average surface temperature has risen about 1 °C (about 2 °F), relative to the mid-20th century baseline (of 1951-1980). This is on top of about an additional 0.15 °C of warming from between 1750 and 1880.

"Climate change" encompasses global warming, but refers to the broader range of changes that are happening to our planet. These include rising sea levels; shrinking mountain glaciers; accelerating ice melt in Greenland, Antarctica and the Arctic; and shifts in flower/plant blooming times. These are all consequences of warming, which is caused mainly by people burning fossil fuels and putting out heat-trapping gases into the air. Scientists use observations from the ground, air, and space, along with computer models, to monitor and study past, present, and future climate change. Climate data records provide evidence of climate change key indicators, such as global land and ocean temperature increases; rising sea levels; ice loss at Earth's poles and in mountain glaciers; frequency and severity changes in extreme weather such as hurricanes, heat waves, wildfires, droughts, floods, and precipitation; and cloud and vegetation cover changes.

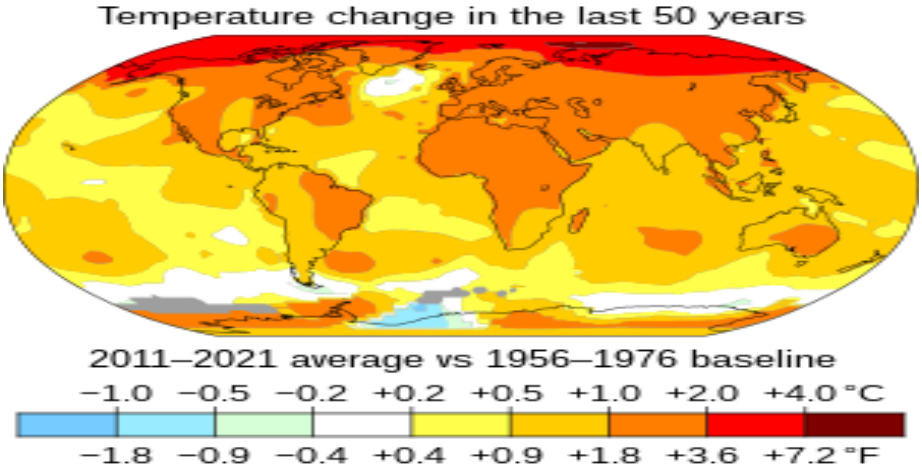
Introduction

The planet is warming, from North Pole to South Pole. Since 1906, the global average surface temperature has increased by more than 1.6 degrees Fahrenheit (0.9 degrees Celsius) even more in sensitive Polar Regions. And the impacts of rising temperatures aren't waiting for some far-flung future the effects of global warming are appearing right now. The heat is melting glaciers and sea ice, shifting precipitation patterns, and setting animals on the move. Many people think of global warming and climate change as synonyms, but scientists prefer to use "climate change" when describing the complex shifts now affecting our planet's weather and climate systems. Climate change encompasses not only rising average temperatures but also extreme weather events, shifting wildlife populations and habitats, rising seas, and a range of other impacts. All of these changes are emerging as humans continue to add heat-trapping greenhouse gases to the atmosphere. Climate change is a significant variation of average weather conditions say, conditions becoming warmer, wetter, or drier over several decades or more. It's the longer-term trend that differentiates climate change from natural weather variability. Record floods. Raging storms. Deadly heat. Climate change manifests itself in myriad ways and is experienced by every living being, although not equally. Throughout the world, the economically disadvantaged and people of color those who have contributed the very least to the root causes of climate change are the most likely to suffer from its worst impacts. Here are the basics on what causes climate change, how it's affecting the planet and its people, and what we can do about it.

Assistant Professor, Department of Economics, Murarka College, Sultanganj, T.M. Bhagalpur University, Bhagalpur
Research Scholar, Department of Economics, T.M. Bhagalpur University, Bhagalpur

Global Warming

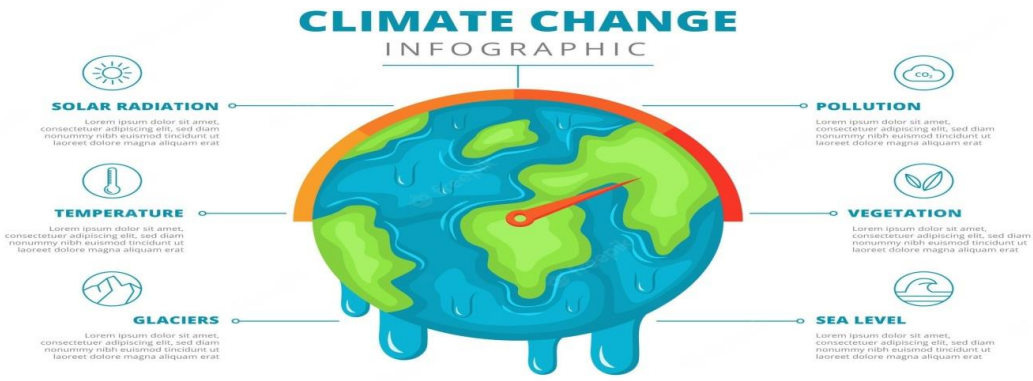
Since the Industrial Revolution, the global annual temperature has increased in total by a little more than 1 degree Celsius, or about 2 degrees Fahrenheit. Between 1880 the year that accurate recordkeeping began and 1980, it rose on average by 0.07 degrees Celsius (0.13 degrees Fahrenheit) every 10 years. Since 1981, however, the rate of increase has more than doubled: For the last 40 years, we've seen the global annual temperature rise by 0.18 degrees Celsius, or 0.32 degrees Fahrenheit, per decade.



The result A planet that has never been hotter. Nine of the 10 warmest years since 1880 have occurred since 2005 and the 5 warmest years on record have all occurred since 2015. Climate change deniers have argued that there has been a "pause" or a "slowdown" in rising global temperatures, but numerous studies, including a 2018 paper published in the journal *Environmental Research Letters*, have disproved this claim. The impacts of global warming are already harming people around the world.

Climate Change

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term. Changes observed in Earth's climate since the mid-20th century are driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere, raising Earth's average surface temperature.



Natural processes, which have been overwhelmed by human activities, can also contribute to climate change, including internal variability and external forcing e.g., volcanic activity, changes in the Sun's energy output, variations in Earth's orbit. Scientists use observations from the ground, air, and space,

along with computer models, to monitor and study past, present, and future climate change. Climate data records provide evidence of climate change key indicators, such as global land and ocean temperature increases; rising sea levels; ice loss at Earth's poles and in mountain glaciers; frequency and severity changes in extreme weather such as hurricanes, heat waves, wildfires, droughts, floods, and precipitation; and cloud and vegetation cover changes.

Effects of Global Warming and Climate Change

Each year scientists learn more about the consequences of global warming, and each year we also gain new evidence of its devastating impact on people and the planet. As the heat waves, droughts, and floods associated with climate change become more frequent and more intense, communities suffer and death tolls rise. If we're unable to reduce our emissions, scientists believe that climate change could lead to the deaths of more than 250,000 people around the globe every year and force 100 million people into poverty by 2030. Global warming is already taking a toll on the United States. And if we aren't able to get a handle on our emissions, here's just a smattering of what we can look forward to:

1. Disappearing glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and continue to increase the risk of wildfires in the American West.

2. Rising sea levels will lead to even more coastal flooding on the Eastern Seaboard, especially in Florida, and in other areas such as the Gulf of Mexico.

3. Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All of these can damage or destroy agriculture and fisheries.

4. Disruption of habitats such as coral reefs and alpine meadows could drive many plant and animal species to extinction.

5. Allergies, asthma, and infectious disease outbreaks will become more common due to increased growth of pollen-producing ragweed, higher levels of air pollution, and the spread of conditions favorable to pathogens and mosquitoes.

Though everyone is affected by climate change, not everyone is affected equally. Indigenous people, people of color, and the economically marginalized are typically hit the hardest. Inequities built into our housing, health care, and labor systems make these communities more vulnerable to the worst impacts of climate change even though these same communities have done the least to contribute to it.

Impacts of Climate Change and Global Warming

A rise of 2°c

- Severe storms and floods in many countries, particularly impacting coastal areas, with droughts also affecting many parts of the world
- Seas become more acidic, coral and krill die, food chains are destroyed
- Little or no Arctic sea ice in summer – which not only means less habitat for polar bears, but also means the global climate warms faster, as there is less polar ice to reflect sunlight

Beyond 2°c:

- Rainforests dying
- Unthinkable loss of ancient ice sheets of Greenland and Antarctica, causing dramatic sea level rises
- Mass displacement of people and widespread species loss and extinction

Effects of Global Climate Change

According to the World Economic Forum's Global Risks Report 2021, the failure to mitigate and adapt to climate change is "the most impactful" risk facing communities worldwide ahead of even weapons of mass destruction and water crises. Blame its cascading effects: As climate change transforms global ecosystems, it affects everything from the places we live to the water we drink to the air we breathe. And though climate change affects everyone in some way, it's indisputable that its most negative impacts are borne disproportionately by certain groups: women, children, people of color, Indigenous communities, and the economically marginalized. Climate is a human rights issue. As the earth's atmosphere heats up, it collects, retains, and drops more water, changing weather patterns and making wet areas wetter and dry areas drier. Higher temperatures worsen and increase the frequency of many types of disasters, including storms, floods, heat waves, and droughts. These events can have devastating and costly consequences, jeopardizing access to clean drinking water, fueling out-of-control wildfires, damaging property, creating hazardous-material spills, polluting the air, and leading to loss of life.

Challenge and Solutions

Many climate change solutions can deliver economic benefits while improving our lives and protecting the environment. We also have global frameworks and agreements to guide progress, such as the Sustainable Development Goals, the UN Framework Convention on Climate Change and the Paris Agreement. Three broad categories of action are: cutting emissions, adapting to climate impacts and financing required adjustments. Switching energy systems from fossil fuels to renewable like solar or wind will reduce the emissions driving climate change. But we have to start right now. While a growing coalition of countries is committing to net zero emissions by 2050, about half of emissions cuts must be in place by 2030 to keep warming below 1.5°C. Fossil fuel production must decline by roughly 6 per cent per year between 2020 and 2030. Adapting to climate consequences protects people, homes, businesses, livelihoods, infrastructure and natural ecosystems. It covers current impacts and those likely in the future. Adaptation will be required everywhere, but must be prioritized now for the most vulnerable people with the fewest resources to cope with climate hazards. The rate of return can be high. Early warning systems for disasters, for instance, save lives and property, and can deliver benefits up to 10 times the initial cost.

Conclusion

According to the U.S. Environmental Protection Agency, the term climate change is often used interchangeably with the term global warming, but according to the National Academy of Sciences, the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are other changes in addition to rising temperatures. Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period. Breathing is life. We know that we will survive without food for several weeks and without water for few days, but without oxygen, we will die in a matter of minutes. The oxygen, the air we breathe sustains us. So, let us make today and everyday a good day for everyone. Allow the earth to have more clean air. Help control pollution. Otherwise, Earth will eventually have an atmosphere incompatible with life.

References

Anup S. (2015) Climate Change and Global Warming Introduction, Retrieved on 05.05.2015.
Crucifix, Michel (2016). "Earth's narrow escape from a big freeze". Nature. 529 (7585): 162–163.
Hausfather, Zeke (19 April 2018). "Explainer: How 'Shared Socioeconomic Pathways' explore future climate change". Carbon Brief. Retrieved 20 July 2019.
Mukherjee, Manju Mohan. 1997. Community Empowerment through Panchayati Raj in Rajnagar block of West Bengal (A case study of three villages), Ambala City: Associated Publishers.
Ritchie, Hannah; Roser, Max (15 January 2018). "Land Use". Our World in Data. Retrieved 1 December 2019.
NOAA via Shah A. (2015) Global issues Retrieved on 05.05.2015 fromhttp://www.globalissues.org/arcticle/ 233/climate-change-and-global-warming- introduction.
"State Renewable Portfolio Standards and Goals". National Conference of State Legislators. 17 April 2020. Retrieved 3 June 2020.
World Health Organization. November 2015. Archived from the original on 3 January 2021. Retrieved 2 September 2020.

Role of Green Economy In Sustainable Development And Poverty Alleviation

Rakesh Kumar

Abstract

COVID-19 and climate change have exposed the interdependence of economies of all countries and people around the world. All economic activities are based on ecosystem services that depend on natural resources. In such a situation, environmental imbalance and ecological crisis will have an impact on economic activities. Adoption of green economy seems to be the most suitable option for its solution. The concept of green economy has emerged in front of the world in the early years of the 21st century to avoid these side effects and for sustainable development. Today, the concept of green economy is flourishing in the global perspective. The objective of which is to reduce environmental risks and ecological hazards and to develop eco-friendly.

In today's era of globalization, green economy can prove to be an effective step in solving challenges like sustainable development and global poverty. The purpose of the presented article is to consider the problems like environmental crisis and social disparity emerging at the global level from the present model of rapid industrialization and development and the importance of sustainable development and green economy to solve these problems.

Keywords: Sustainable development, poverty alleviation, green economy, global poverty, environmental imbalance, climate change

Introduction

The concept of green economy is becoming a popular global concept in the early years of the 21st century. There is also a main reason behind this. It is estimated that the green economy has the potential to solve all the problems that the world is currently facing such as: climate, food and economic. Along with economic development, it also guarantees the protection of the earth's ecological system. The decade following the 2009 global financial crisis saw increasing structural weaknesses in developing countries. The pandemic of COVID-19 and climate change, rising poverty and inequality have further aggravated this problem. These weaknesses of developing countries include declining investment, productivity, employment and weak efforts to reduce poverty; mounting debt; and accelerating the pace of destruction of natural capital. The pandemic has already pushed more than 100 million people into extreme poverty and inequality. It is believed that the impact of climate change will push 130 million more people into extreme poverty by the year 2030. Covid-19 and climate change have clearly exposed the interdependence of the planet, its economy and humanity. All economic activities are based on ecosystem services. In such a situation, the natural resources providing these services will be less, and then definitely it will affect the economic activities. Research by Oxford University, the World Economic Forum and the Observer Research Foundation all show that, if green options to get growth back on track are adopted, they will not only help combat climate change, but governments will do what they can to do it. Will spend the amount, on that they will also get the best financial benefit?

To deal with the complex challenges facing the world today, and to deal with the weaknesses that have come to the fore in its structure, and also for economic development, for the balance between natural resources and economic activity, for future development, to deal with climate change. The best solution lies in adopting a green, resilient and inclusive growth approach, which approaches the goals of poverty eradication and shared prosperity from a long-term perspective of sustainable development. This approach also keeps an eye on the long-term goals of development while regaining the rate of economic growth; one who believes that this earth, the human beings and the economy on it are related to each other; and deals with risks in an integrated manner. Research by Oxford University, the World Economic Forum and the Observer Research Foundation all show that, if green options to get growth back on track are adopted, they will not only help combat climate change, but governments will do what

they can to do it. Will spend the money, on that they will get the best economic benefits and will also get good results of development.

In this perspective, exactly 20 years after the 1992 conference in Rio de Janeiro, Brazil, under the auspices of UNEP, the Rio $20 conference in June, 2012, under the name of 'Green Economy in the Context of Sustainable Development and Poverty Alleviation'. The United Nations Environment Conference was held.

Today, discussions, meetings and conferences are being organized on the green economy at the global level. This means that as sustainable development has been the main global topic of discussion in the past decade, similarly green economy is going to become a similar topic in the coming decades. According to the United Nations Environment Programme, green economy promotes enhanced human well-being and social equity on the one hand and reduces environmental risks and ecological hazards on the other. The simplest expression of a green economy is a low carbon, resource efficient and socially inclusive economy.

Meaning of sustainable development

The Brundtland Commission Report defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development has four dimensions – society, environment, culture and economy – which are interconnected, not separate. Sustainability is a paradigm of thinking about the future in which environmental, social and economic considerations are balanced in the pursuit of a better quality of life. For example, a prosperous society depends on a healthy environment to provide food and resources, safe drinking water, and clean air for its citizens.

Meaning of Green Economy

Green economies are low carbon, resource efficient and socially inclusive. Employment and income growth in a green economy is driven by public and private investment in activities, infrastructure and assets that reduce carbon emissions and pollution, improve energy and resource efficiency, and protect biodiversity and reduce the loss of ecosystem.

Broadly speaking, a green economy is an economy in which growth in income and employment is driven by public and private investment that reduces carbon emissions and pollution, increases energy and resource efficiency, and preserves biodiversity and prevents loss of ecosystem resources.

It is about sustainable energy, green jobs, low carbon economy, green policies, green buildings, agriculture, fisheries, forestry, industry, energy efficiency, sustainable tourism, sustainable transport, waste management, water efficiency and all other resource efficiency. All these elements are required for the successful implementation of a green economy.

These investments need to be catalysed and supported by targeted public spending, policy reforms and regulatory changes. It is essential to maintain and strengthen this growth trajectory and, where necessary, rebuild natural capital as vulnerable economic assets and sources of public benefits. Especially poor people whose livelihood and security are largely dependent on nature. Our life and development is influenced by green economies in almost every way.

Principles of Green Economy

The following are the principles of green economy –

1. Public Welfare

2. Good Governance

3. Prosperity and Abundance

4. Justice

5. Planetary Boundaries

Objective of Green Economy

- The aim of the green economy is to create wealth that supports well-being. In addition to financial wealth, there is also human, social, physical and natural capital.
- All people can prosper with investment in and access to sustainable natural systems, infrastructure, knowledge and education.
- These investments provide opportunities for green and decent livelihoods, enterprises and employment.
- The system relies on collective action for public goods, but individual choices are allowed.

Green Economy Measurement Factors

Different organizations have been adopting different methods to measure the green economy. Many indicators have been used for this. The United Nations Environment Program is discussing several factors with the OECD and the World Bank to measure this. Mainly the factors which have emerged are the following-

- **Economic indicators:** share of investment or share of production or employment in sectors that meet sustainability standards, such as green GDP
- **Environmental indicators:** resource use efficiency or pollution intensity at either a sectoral or economic level. like energy use/GDP or water consumption/GDP
- An integrated indicator of progress or well-being.

Apart from UNEP, many organizations have also given their analysis on the components of green economy. Karl Bukart has given six components of green economy namely: renewable energy, green building, clean transport, water management, waste management and land management.

The Global Citizens Center has identified three pillars of a green economy which it calls the 'Triple Baseline'. These three pillars are sustainable development, social justice and localism. Which can be understood through the following picture.

Global Green Economy which is published annually by Dual Citizen Inc. For this it takes the help of four indicators –

- To what extent the national leadership provides leadership on green issues in local and international fora.
- The success of the policy framework and domestic policies that have successfully promoted the use of renewable energy sources in the domestic market.
- Clean technology investment climate in each country
- Commitment to green tourism and promotion of sustainable tourism through Govt.

Role of Green Economy in Sustainable Development

Sustainable development is that which, while meeting the needs of the present, does not compromise with the needs of future generations. It was recognized internationally in the year 1980 by the Brundtland Report named 'Our Common Future' and then in 1992 at the First International Earth Conference in Rio de Janeiro, it was recognized as the main guiding principle of international cooperation for development. Achieving sustainable development requires the advancement and strengthening of three interdependent and mutually reinforcing pillars. These three pillars are environmental protection, social development and economic development. Moving towards a green economy can be an important effort in achieving these goals. Instead of being a passive recipient of wastes generated by economic activities, the green economy treats the environment as an economic

driver for economic output, price stability and long-term prosperity, which in turn is a driving force for growth and innovation. In a green economy, the environment is the enabler of economic development and human well-being. In addition, the poor are the most dependent on the natural resource base for their livelihoods and the least shielded from environmental degradation, so a green economy movement can promote equitable development. Thus orientation towards green economy is a way of sustainable development. Also it can be seen as a journey rather than a destination. Although the nature of green economy may differ between developed and developing countries on the basis of geographical extent, natural resource base, human and social capital and stage of economic development, but its main principles such as: enhanced human well-being, social equality, There is no difference between reducing environmental risk and ecological degradation, etc.

Green Economy and Poverty Alleviation

Economic wealth today, defined as gross domestic product, is usually created by over-exploitation and pollution of our common natural resources essential to life, such as clean fresh water, forests and air. Such economic development has led to high economic and social costs, especially for the poor who are entirely dependent on these resources for their livelihoods. The existing economic activities have resulted in the degradation of biodiversity and ecosystems on a large scale. As a result, sectors such as agriculture, animal husbandry, fishing and forestry have been particularly affected, on which the livelihood of most of the world's poor population depends. On the other hand, the orientation towards green economy aims at access to basic services and basic infrastructure to eradicate poverty and improve the overall quality of life. This includes - ensuring access to electricity and modern energy services to those populations of the world who are still deprived of these services. In addition, the green economy also provides an important opportunity to eliminate subsidies that promote environmental risk. According to an estimate, governments around the world currently spend about $700 billion annually to ensure the availability of fossil fuels. This amount is five times the expenditure on development aid worldwide. Much of this subsidy is allocated by governments in developing countries to shield the poor from sudden increases in commodity prices. But many studies have proved that the real benefit of fossil fuel subsidy does not reach the real needy and people with higher income take advantage of it. Eliminating environmental risk subsidies and adopting an approach like cash transfers to the needy can reduce the fiscal deficit as well as achieve social protection goals. At the same time, it will also improve the environmental performance.

Suggestions and Conclusion

Even though the green economy is running with the aim of promoting employment generation, poverty alleviation and sustainable development etc. and the leaders of the world are optimistic about it, but its concerns are no less and this concern is mainly of the developing countries. Developing countries believe that green economy can negatively affect their economic development. According to him, misuse of the concept of green economy will only increase the disparity between the rich and the poor, which can block the development of the poor. The main concern of the developing countries is protectionism and grants given by the developed countries to their industries for technology so that those industries can make themselves eco-friendly. The challenge before developing countries is to promote growth as well as sustain it. While the developing countries have reached the peak of economic development, they only have to maintain the level of development and not increase the development. Developing countries will be at loss in such competition. But in order to face the emerging global challenges, all countries will have to take cooperative steps, only then the goal of environment-friendly global order based on justice and equity can be achieved.

References

Banerjee, P. and Sood, A. (April, 2012): 'The Political Economy of Green Growth in India', United Nations Research Institute for Social Development (UNRISD), Occasional Paper-5.

Barbier, E. (2011): 'The policy challenges for green economy and sustainable economic development', Natural Resources Forum 35, United Nations.

BRICS nations discuss road map to turn into green economies', Economic Times, April 23, 2015

Development Alternatives (December, 2014): 'Lessons for India's Transition to a Greener EconomyInputs to the Global Transition Report'

Dutta, S. (October, 2015): 'Climate Change and Indian Agriculture', Vol-XXXVI, No.-10, World Focus,

Green Economy Roadmap". Archived from the original on 5 May 2016. Retrieved 11 May 2016.

Gupta, H. (June 2015): 'Low Carbon Pathways', Working Paper 305, Indian Council for Research on International Economic Relations.

Guttikunda, S.; Puja J. and Debi G. (2015): 'Regulating Air Pollution from Coal-Fired Power Plants in India', Economic & Political Weekly, Jan. 3, 2015 Vol. L No. 1.

International Institute for Sustainable Development (2014): Trade and Green Economy – A Handbook IUCN: 'Transitioning to a Green Economy - Building on Nature', Position Paper.

Khor, M. (July 2011): 'Risks and uses of the green economy concept in the context of sustainable development, poverty and equity', Research Paper, South Centre.

UN: The System of Environmental-Economic Accounts (SEEA) - Measurement Framework in Support of Sustainable Development and Green Economy Policy

UNCTAD (2013): Are there downwards to a green economy?

UNEP (2011): Towards a Green Economy – Pathways to Sustainable Development and Poverty Eradication, A Synthesis for Policy Makers. www.unep.org/greeneconomy

UNEP (2011): Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. www.unep.org/greeneconomy

World Bank to lead economic push on nature protection. BBC News. Retrieved 11 May 2016.

Causes And Consequences Environmental Degradation In India

Marri Babu Rao [1]

Environment can be defined as the physical surrounding of man/woman of which he/she is a part and on which he/she is dependent for his/her activities like physiological functioning, production and consumption. His physical environment stretches from air, water and land to natural resources like energy carriers, soil and plants, animals and ecosystems. The relationship between physical environment and the well-being of individuals and societies is multi-fold and multi-faceted with a qualitative as well as a quantitative aspect to it. Health risks are mainly linked to space heating, cooking and lighting: low grade fuels, insufficient ventilation are often the main problems. Additionally, there may be problems connected with moisture, light, incidence, hazardous substances from building materials, lacquers and paints. Problems with drinking water, sewage and waste are not linked to the dwelling as such but rather to lack of appropriate infrastructure.

The sustainable administration of the earth and natural resources is essential for financial development and human prosperity. At the point when overseen well, inexhaustible characteristic assets, watersheds, profitable scenes and seascapes can give the establishment to supported comprehensive development, sustenance security and poverty reduction. natural resources give vocations to a huge number of individuals and create sizeable assessment income. There are many environmental issues in India. Air pollution, water pollution, garbage, and pollution of the natural environment are all challenges for India.

CAUSES OF ENVIRONMENTAL DEGRADATION

The major causes of the environmental degradation are modern urbanization, industrialization, over-population growth, deforestation etc. Environmental pollution refers to the degradation of quality and quantity of natural resources. Various types of the human exercises are the fundamental reasons of environmental degradation. These have prompted condition changes that have turned out to be hurtful to every single living being. The smoke radiated by the vehicles and processing plants expands the measure of toxic gases noticeable all around. The waste items, smoke radiated by vehicles and ventures are the fundamental driver of contamination. Spontaneous urbanization and industrialization have caused water, air and sound contamination. Urbanization and industrialization help to expand contamination of the wellsprings of water. So also, the smoke discharged by vehicles and ventures like Chlorofluorocarbon, nitrogen oxide, carbon monoxide and other clean particles dirty air. Neediness still remains an issue at the base of a few ecological issues.

SOCIAL FACTORS

Population

The rapid population growth and economic development in country are degrading the environment through the uncontrolled growth of urbanization and industrialization, expansion and intensification of agriculture and the destruction of natural habitats. One of the significant reasons for environmental degradation in India could be ascribed to quick development of population which is antagonistically influencing the natural resources and condition. The developing population and the ecological weakening face the test of maintained improvement without natural harm. The presence or the nonattendance of ideal characteristic assets can encourage or hinder the procedure of economical development.

Poverty

Poverty is said to be both cause and effect of environmental degradation. The round connection mongst poverty and environment is a to a great degree complex marvel. Imbalance may cultivate un sustainability in light of the fact that poor people, who depend on normal assets more than the rich, drain

[1] Lucturer, Gvsm Govt Degree College, Vulavapadu, Prakasam District, Ap

characteristic assets quicker as they have no genuine prospects of accessing different kinds of assets. Moreover, degraded environment can accelerate the process of impoverishment, again because the poor depend directly on natural assets.

Urbanization

Urbanization in India started to quicken after freedom because of the nation's reception of a blended economy which offered ascend to the advancement of the private area. Urbanization is occurring at a quicker rate in India. Population living in urban territories in India, as per 1901 statistics, was 11.4%. This tally expanded to 28.53% as indicated by 2001 enumeration, and intersection 30% according to 2011 evaluation, remaining at 31.16%. As indicated by a review by UN State of the World Population report in 2007, by 2030, 40.76% of nation's population is required to dwell in urban zones. According to World Bank, India, alongside China, Indonesia, Nigeria, and the United States, will lead the world's urban population surge by 2050. Lack of opportunities for gainful employment in villages and the ecological stresses is leading to an ever increasing movement of poor families to towns. for example, vitality, lodging, transport, correspondence, instruction, water supply and sewerage and recreational pleasantries, along these lines exhausting the valuable ecological asset base of the urban areas. The outcome is the developing pattern in decay of air and water quality, age of squanders, the expansion of ghettos and bothersome land utilize changes, all of which add to urban poverty.

Economic Factors

Environmental degradation, to a large scale, is the result of market failure, namely the non-existent or poorly functioning markets for environmental goods and services. In this unique situation, environmental degradation is a specific instance of utilization or generation externalities reflected by uniqueness amongst private and social costs/benefits. Absence of very much characterized property rights might be one reason for such market disappointment. Then again, showcase contortions made by value controls and endowments may irritate the accomplishment of environmental goals.

Institutional Factors

The Ministry of Environment & Forests (MOEF) in the Government is responsible for protection, conservation and development of environment. The Ministry works in close coordinated effort with different Ministries, State Governments, Pollution Control Boards and various logical and specialized establishments ,colleges, non-Governmental associations and so on. The greater part of the State Government organizations are moderately little experiencing deficiency of specialized staff and assets. Although overall quality of Environmental Impact Assessment (EIA) studies and the effective implementation of the EIA process have improved over the years, institutional strengthening measures such a straining of key professionals and staffing with proper technical persons are needed to make the EIA procedure a more effective instrument for environment protection and sustainable development. Land Degradation Land degradation is any change or disturbance to the land perceived to be undesirable. All these practices are causing degradation and depletion of environment.

Air Pollution

Air pollution in India is a serious issue with the major sources being fuel wood and biomass burning, fuel adulteration, vehicle emission and traffic congestion. Air pollution is also the main cause of the Asian brown cloud, which is causing the monsoon to be delayed. India is the world's largest consumer of fuel wood, agricultural waste and biomass for energy purposes. greenhouse emissions contributing to climate change.

Effects

There are very adverse effects of environmental degradation. These effects can be enumerated as:

Impact on Human Health

The greatest effects on the health of individuals and populations result from environmental degradation. Human health might be at the receiving end as a result of the environmental degradation. The main

factors account to urban air quality deterioration are growing industrialization and increasing vehicular pollution, industrial emissions, automobile exhaust and the burning of fossil fuels kills thousands and lives many more to suffer mainly from respiratory damage, heart and lung diseases. In the countryside, nitrates from animal waste and chemical fertilizers pollute the soil and water, and in the cities, the air is contaminated with lead from vehicle exhaust. In India's largest cities - Mumbai and Delhi - about one-half of children under age 3 show signs of harmful exposure to lead, defined as to or more micrograms of lead per deciliter of blood.

Loss of Biodiversity

Biodiversity is important for maintaining balance of the ecosystem in the form of combating pollution, restoring nutrients, protecting water sources and stabilizing climate. The main cause of loss of biodiversity are deforestation, global warming, overpopulation and pollution are few of the major causes for loss of biodiversity. In fact human beings have deeply altered the environment, and have modified the territory, exploiting the species directly, for example by fishing and hunting, changing the biogeochemical cycles and transferring species from one area to another.

Ozone Layer Depletion

Ozone layer is responsible for protecting earth from harmful ultraviolet rays. The most important reason for ozone layer depletion is the production and emission of chlorofluorocarbons (CFCs). ozone depleting substances remain stable in the lower atmospheric region, but as they reach the stratosphere, they get exposed to the ultra violet rays. This leads to their breakdown and releasing of free chlorine atoms which reacts with the ozone gas, thus leading to the depletion of the ozone layer. Global warming is another result of environmental degradation.

CONCLUSION

The primary causes of environmental degradation in India are attributed to the rapid growth of population in combination with economic development and overuse of natural resources. Major environmental calamities in India include land degradation, deforestation, soil erosion, habitat destruction and loss of biodiversity. Economic growth and changing consumption patterns have led to a rising demand for energy and increasing transport activities. Air, water and noise pollution together with water scarcity dominate the environmental issues in India.According to World Bank estimate, India has made one of the fastest progresses in the world, in addressing its environmental issues and improving its environmental quality. Still, India has a long way to go to reach environmental quality similar to those enjoyed in developed economies.

REFERENCES

CSO. (2003). Compendium on Environmental Statistics in India. New Delhi: Ministry of Statistics and Programme Implementation, GOI.

Gogoi, L. (2013). Degradation of Natural Resources and its Impact on Environment: a Study in Guwahati City, Assam, India. International Journal of Scientific and Research Publications, 3(12).

GOI. (1997-98). Economic Survey. New Delhi: Planning Commission.

Lakshmana, C. M. (2013). Population, development, and environment in India. Chinese

Journal of Population Resources and, 11(4).

Nagdeve, D. A. (2006). Population, Poverty and Environment in India. IIPS Mumbai, ENVIS

center, 3(3).

Ray, S., & Ray, I. A. (2011). Impact of Population Growth on Environmental. Journal of

Economics and Sustainable Development, 2(8).

Saarangapani , B., & Sripathi, K. (2015). Environmental Degradation in India - Dimensions

and Concerns: A Review. Prabandhan Indian Journal of Management, 8(4).

Tyagi, S., Garg, N., & Paudel, R. (2014). Environmental degradation: Causes and

Consequences. European Researcher, 81(8-2).

India's Climate Change Mitigation Strategies

Madhubanti Dutta

Abstract

The developing world did not trigger the global warming crisis, but it has had a significant impact on them. The time to avoid an increase in global temperatures of more than 1.5 degrees Celsius is quickly closing. It is improbable that the objectives set at the international conference held in Glasgow in 2021 will be accomplished. At the 27th Conference of Parties (COP), India submitted its Long-Term Low Emission Development Strategy to the UNFCCC. "The strategy will put a strong emphasis on the prudent use of domestic resources while taking into account energy security. The phase-out of fossil fuels will be done in a fair, easy, sustainable, and inclusive way. India is to become a green hydrogen hub according to the National Hydrogen Mission, which was established in 2021. Along with the overall development of the power sector, other milestones planned include the quick expansion of green hydrogen generation, and a tripling of nuclear capacity by 2032. The effort to boost the adoption of electric vehicles and the growing use of green hydrogen fuel are expected to propel the low carbon development of the transportation sector. The plan will support increased use of biofuels, especially ethanol blending in gasoline. There will be a number of costs associated with the development of new technologies, new infrastructure, and other transitional costs as we move toward low-carbon development. Although there are numerous estimates that vary amongst studies, they are all in the trillions of dollars by 2050 range. In order to ensure scale, scope, and speed, mostly from public sources, the provision of climate finance by developed countries will play a very significant role and needs to be significantly increased, in accordance with the principles of the UNFCCC. Here in this paper, the mitigation and adaptation strategies of India, wrt climate change is discussed in detail, focusing on India's initiatives to promote a green economy.

Introduction

Climate change is the most significant threat to humanity, which has been the subject of discussion for almost a decade. The World Health Organization's (WHO) evaluation of climate change indicates that environmental issues affect people's lives and health. A UN expert claims that human-induced climate change is the biggest, most pervasive threat to the planet's ecosystems and society and those developing countries are the most affected ones. According to the IPCC report and local reports on the Climate Vulnerability Index (CVI), India is one of the world's hotspots for geographical and socioeconomic vulnerabilities. Global climate change is a severe problem. The Earth's climate is changing due to increased human emissions of heat-trapping greenhouse gases, and these changes are already having a substantial effect on the environment. For instance, ice sheets and glaciers are melting more quickly; lake and river ice is breaking up sooner; the ranges of plants and animals are changing, and flowers and leaves are beginning to bud earlier. Whether or not the world quickly decarbonizes, current trends in emissions and atmospheric greenhouse gases would make some catastrophic climatic impacts unavoidable through 2040—one of the country's most at risk from climate change is India. India must therefore map out every district-level sensitive area, industry, and population segment. The topography and geography of India are varied enough to necessitate different strategies depending on the location. An efficient framework for climate action rests on planning and implementation. Establishing a regular monitoring system to evaluate progress is crucial, as is having a research and knowledge committee regularly update on new scientific resources and parameters. India has already started to feel the effects of climate change, including sea level rise, glacier retreat Himalayas, intense tropical storm floods, irregular rainfall patterns, excessive heat stress, desertification, urban flooding, and forest fires. Unless its policies forgo all other development goals in favour of mitigating climate change, India, like the rest of the nations, would fall short of the IPCC criteria despite its efforts. India, meanwhile, is already in a precarious position, according to both the IPCC study and regional studies from the country. Among the

states most vulnerable to climatic disasters, including floods, droughts, and cyclones, are Assam, Andhra Pradesh, Maharashtra, Karnataka, and Bihar.

India's Developments Under its Nationally Determined Contributions (NDC) Targets

India's historical utilization of carbon space during the period 1850-2019 is 51.94 Gt, which is merely 1.8% of total carbon space. Moreover, the country has made significant developments under its NDC targets, such as-

Reduced emission intensity of GDP by 24% between 2005 and 2016

✓ 100% village electrification achieved in Jul'22[1] and next goal is to deliver uninterrupted, 24x7 power for all[2]

✓ 41.5% (around 167 GW) of total cumulative electric power installed capacity is non-fossil based as of June'22[3]

✓ Forest and tree cover increased to ~80.9 million sq km (24.62% of total geographical area)

✓ Total carbon stock in country's forest is estimated to be 7,204 million tons; an increase of 79.4 million tonnes from 2019

✓ Only G-20 country whose NDCs are 2°C compliant

✓ Has reached 10% of ethanol blending as in June'2022 and is on track to achieve the 20% target by 2025

✓ 30 projects are being implemented under the National Adaptation Fund for Climate Change which includes sectors such as livestock, water conservation, climate change adaptation, sustainable livelihoods, resilient agriculture, etc. and are worth around USD 105.18 Million[4].

Present Scenario

On a worldwide basis, cities are in charge of the majority of carbon emissions and energy use. Cities make about 3% of the planet's surface area, but they produce more than 70% of its emissions. Buildings, energy consumption, and transportation all contribute significantly to emissions in cities. 54% of the world's population currently resides in cities, which use 78% of the world's primary energy. Additionally, up to 68% of the world's population is anticipated to live in the metropolis by the year 2050. The demand for housing, energy use, and transportation will all climb along with the population. According to the IPCC, in order to keep global warming at 1.5°C, the Paris Agreement's goal, global net human-caused carbon dioxide emissions would need to decrease by about 45% from 2010 levels by 2030 and reach "net zero" around 2050. Most nations committed to reducing global carbon emissions by 70% and were working on plans to reach the net-zero aim (UN-Net Zero Coalition). To reach net-zero, especially after 2030, increased energy efficiency, widespread electrification, and the bulk of energy coming from renewable sources are all necessary. Depending on the situation, CCUS, nuclear, hydrogen, and biofuel all make a substantial contribution. Therefore, we want a highly energy-efficient and intelligent energy infrastructure for everything from manufacturing to consumers.

Significance of COP27

[1] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/jul/doc202272774301.pdf
[2] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1811047
[3] https://powermin.gov.in/en/content/power-sector-glance-all-india
[4] https://www.nabard.org/content.aspx?id=585

The 27th edition of the Conference of the Parties on Climate Change (COP27), a crucial occasion in the battle against climate change, will take place in Egypt's Sharm el-Sheikh from November 6–18, 2022. For this yearly summit, the 198 convention members have come to work together to combat the harmful effects of climate change. The world is not on track to keep global warming to 1.5C, and recent developments have made it increasingly harder to reach this goal. The success of COP27 is crucial for maintaining international climate cooperation and will help developing countries deal with the loss and harm caused by climate change. Rich nations might provide more money to help less developed nations adapt their economies and deal with climate change's effects. Following the COP26, which was held in Glasgow, Scotland, last year, many countries committed to "scale down" unabated coal power and to eliminate inefficient fossil fuel subsidies by signing the Glasgow Climate Pact. The Paris rulebook, often known as Article 6, was completed during COP26, opening the door to selling carbon emissions. Based on COP26's outcomes, COP27 will see progress in several areas that are essential for addressing the climate emergency, such as reducing greenhouse gas emissions quickly, promoting resilience, preparing for climate change's inevitable effects, and meeting commitments to finance climate action in developing countries. Despite a worsening energy crisis, record greenhouse gas concentrations, and increased extreme weather disasters, nations are urged to come together at COP27 to fulfil the historic Paris Agreement for people and the environment[5].

The Need for Adaptation Measures

Assessment of losses made by the Government incurred in agriculture and other sectors due to the climate change during the last twenty years. The Intergovernmental Panel on Climate Change (IPCC) and other organizations have conducted studies using climate models to simulate potential connections between climate change and the frequency and severity of weather-related events. It is challenging to show a causal relationship between climate change and loss of life, property, or financial resources.

The National Action Plan on Climate Change (NAPCC) is being implemented by the government through eight national missions in the areas of solar energy, improved energy efficiency, water, agriculture, Himalayan eco-system, sustainable habitat, green India, and strategic knowledge on climate change. Their respective nodal Ministries institutionalise and carry out their missions. Thirty-three (33) States and UTs have created State Action Plans on Climate Change under the general framework of the NAPCC (SAPCC). Additionally, the government is establishing the National Adaptation Fund for Climate Change to fund adaptation measures in States and UTs in regions that are especially vulnerable to the negative effects of climate change (NAFCC). 29 projects have been approved under NAFCC for adaptation in agriculture, water, forestry, etc. in 27 States and UTs. The National Action Plan on Climate Change (NAPCC) is being implemented by the government through eight national missions in the areas of solar energy, improved energy efficiency, water, agriculture, Himalayan eco-system, sustainable habitat, green India, and strategic knowledge on climate change. Their respective nodal Ministries institutionalise and carry out their missions. Thirty-three (33) States and UTs have created State Action Plans on Climate Change under the general framework of the NAPCC (SAPCC).

Additionally, the government is establishing the National Adaptation Fund for Climate Change to fund adaptation measures in States and UTs in regions that are especially vulnerable to the negative effects of climate change (NAFCC). 29 projects have been approved under NAFCC for adaptation in agriculture, water, forestry, etc. in 27 States and UTs. India's GDP emission intensity decreased by 24% between 2005 and 2016 thanks to domestic efforts, exceeding the pre-2020 voluntary target of a reduction of 20–25% from 2005 levels by 2020. This shows that we are still working to disconnect growth from emissions. Between the Forest Survey of India's 2015 and 2019 assessments, there has been an increase in forest and tree cover of about 1.3 million acres. 15% of the nation's carbon dioxide emissions were offset in 2016 by the Land Use and Land-Use Change sector, which includes forests and tree cover, for a

[5] https://pib.gov.in/PressReleasePage.aspx?PRID=1873661

net removal of around 307.82 million tonnes of CO2 equivalent, improving its position as a sink by 2.2% from 20146.

India Initiatives to Promote Green Economy

A green plan for economic recovery and sustainable development should encourage innovation with a supportive policy framework and desired initiatives.

- ✓ National Green Hydrogen Mission
- ✓ Self-reliance in energy production by 2047
- ✓ 100% electrification of Indian Railways by 2024/Net Zero by 2030[7]
- ✓ 20% Ethanol blending target advanced to 2025
- ✓ 5% blending of biodiesel in diesel by 2030[8]
- ✓ 5,000 compressed bio-gas plants
- ✓ FAME-2 scheme launched in 2019
- ✓ Promoting circular economy in key sectors
- ✓ Scrappage Policy
- ✓ National Solar Mission, 2010
- ✓ National Offshore Wind Energy Policy, 2015
- ✓ National Wind-Solar Hybrid Policy, 2018
- ✓ National Biofuel Policy, 2018
- ✓ Sustainable Alternative Towards Affordable Transportation (SATAT) Programme
- ✓ PLI Schemes for Advanced Chemistry Cell (ACC) Battery
- ✓ High Efficiency Solar PV Modules
- ✓ LED bulb campaign is reducing emissions by 40 million tonnes annually

Sustainable Funding For Green Economy

We expect that India's climate action investments from 2022 to 2030 will total USD 1.01 trillion, an average of USD 112 billion annually. This investment gap is consistent with the emissions target India has set for 2030.

Sustainable funding covers a range of activities, from putting cash into green energy projects to investing in companies that demonstrate social values such as social inclusion or good governance by having, for example, more women on their boards. It will embed and meld environmental, social and governance (ESG) practices within finance and will serve as a framework in which the related International Standards for green finance can be developed.

Sustainable Finance, in the recent times, has assumed immense significance and visibility in the financial world. According to the European Union, sustainable finance is "financing that supports

[6] https://loksabhaph.nic.in/Questions/QResult15.aspx?qref=27486&lsno=17
[7] https://pib.gov.in/PressReleseDetail.aspx?PRID=1806617
[8] https://pib.gov.in/PressReleseDetailm.aspx?PRID=1777219

economic growth while lowering environmental constraints and taking into account social and corporate governance issues."

India initiatives

1. **Hon'ble PM launched Green Grids Initiative**— The first international network of globally interconnected solar power grids is called One Sun One World One Grid (GGI-OSOWOG). It aspires to lower energy costs, lower carbon footprints, and open up new channels for international cooperation.

2. **Green bonds** - After China, India has the second-largest emerging green bond market. With a Certified Climate Bond valued at US$650 million, the SBI joined the market. In order to increase investments in ecologically sustainable projects, India also joined the International Platform on Sustainable Finance (IPSF) in 2019. Sovereign Green Bonds will be issued in 2022–2023 as part of the government's overall market borrowings to raise money for green infrastructure. The funds raised will be used for government initiatives that lower the economy's carbon footprint.

3. The International Financial Services Centres Authority (IFSCA) was established in 2019 by an Act of Parliament and given the dual mandate of developing and also regulating financial products, financial services, and financial institutions within IFSCs in India. This marks India's first International Financial Services Centre (IFSC) and is located in the Multi-service SEZ in GIFT City, Gujarat.

4. **Sustainable Finance Scheme** – The Sustainable Finance Scheme is a brand-new programme from the Small Industries Development Bank of India (SIDBI) for financing sustainable development initiatives that promote energy efficiency and cleaner production but are not covered by foreign or bilateral lines of credit. For the purposes of this plan, all sustainable development initiatives are acceptable, including those involving renewable energy, the Bureau of Energy Efficiency (BEE) star grading system, green microfinance, environmentally friendly structures, and eco-friendly labelling.

5. 5. Sustainability Linked Bonds (SLBs), a more recent category of financial instruments in India, are similar to other bonds except that their structural or financial characteristics are dependent on whether the issuer achieves specified Sustainability Performance Targets ('SPT').

6. **Blended finance**: The government will encourage the use of thematic funds for blended finance, with the government's contribution being capped at 20% and the funds being managed by private fund managers for significant up-and-coming industries.

Suggestions for Sustainable Model

For domestic capital flows, this would entail actions like promoting deeper bond markets, green infrastructure investment trusts (invits), and innovation in green finance products. India will require actions to lower hedging costs, adjust external commercial borrowing standards, and make practical use of innovation and de-risking mechanisms to assist more projects in reaching expected risk in order to facilitate global capital flows. -

Planning, innovation, public budgeting, financial systems, development finance, and cities are six transformative sectors that are crucial for coordinating financial flows with climate and development goals.

- ✓ Plan infrastructure for a low-emission and resilient future
- ✓ Unleash innovation to accelerate the transition
- ✓ Ensure fiscal sustainability for a low-emission, resilient future
- ✓ Reset the financial system in line with long-term climate risks and opportunities
- ✓ Rethink development finance for climate, by ensuring that development finance institutions have the resources,
- ✓ Empower city governments to build low-emission and resilient urban societies,

Green Hydrogen: The Key to India's Energy Future

- At the Glasgow COP26, India announced its goal of becoming net-zero by 2070 and intent to increase its non-fossil fuel energy capacity to 500 gigawatts (GW) by 2030. India needs to concentrate on developing non-fossil power sources, new mobility options, and industrial green hydrogen in order to combat climate change and increase its energy self-sufficiency.
- Currently, most of India's 6 MMTPA hydrogen production is grey, generated using natural gas in the refineries and fertilizer industries. India's hydrogen demand is predicted to reach 12 MMTPA by 2030, which means green hydrogen will have to supply 80–100% of the new demand.
- To accelerate energy transition and scale up the production of green hydrogen, a framework needs to be put in place that brings together six key enablers – affordable and abundant renewable electricity and water supply, demand, transmission and distribution infrastructure, technology and innovation, policy, and finance.
- The task of setting up a flourishing hydrogen economy will require urgent and critical **policy** interventions around electrolyser manufacturing and associated components through Production Linked Incentive (PLI) schemes. The introduction of a certain amount of mandatory consumption by fertilizer and refineries could also boost production of green hydrogen.
- To achieve the ambitious targets, **funding** will need to be secured through grants, sovereign green bonds, and global climate finance commitments.

The Following Steps Can Help Accelerate the Energy Transition Journey of Indian Enterprises:

- Energy transition roadmap: Industries specifically oil and gas, cement, iron and steel among others, require a strong alignment of their energy transition roadmap with their strategy, so that green hydrogen adoption is embedded in their business growth plans.
- Capital efficiency: Companies should evaluate their investments in renewable projects with detailed technology and commercial risk assessment. Effective capital project management through digital technologies can help optimise both time and budget. Companies should adopt a 'set-measure and track' approach, commencing from the design stage itself.
- Pricing: An 'internal carbon price' strategy will help companies make effective capital allocation decisions toward building their renewable energy portfolio and green hydrogen projects.

At the "city level," there is an urgent need for a zero-energy system that will aid in the creation of strategic pathways for the decision-makers to develop and put into place net-zero carbon emission systems. Numerous international, national, and regional energy systems models exist, but an instrument for an integrated energy approach at the municipal level is needed. (Fattahi and others, 2020) At the city level, there needs to be more guidance on how to build these systems and assess their environmental, economic, and social repercussions. The federal or state-level governments' decision-making for achieving net-zero targets is only sometimes clear to local government officials. According to the data, creating and implementing an integrated Net-Zero energy carbon system at the city level is urgently needed. India is experiencing tremendous urbanisation, which will result in enormous energy consumption in the future. The nation consumes 6% of the world's primary energy and has 18% of the world's population. By 2050, India's urban population is projected to increase from 31.6% to 57.7%, affecting energy consumption patterns and GHG emissions. Therefore, controlling the carbon dioxide emissions from metropolitan areas is crucial. To ensure an integrated approach to energy management, we need to find a strategic strategy that balances the various sectors.

There are some future scenarios that climate change is anticipated to affect, but they are not inevitable. Many problems and potential solutions are already well-known, and ongoing research keeps revealing new ones. There is still time to avoid the worst-case scenario by reducing warming and bringing emissions near zero. To reduce our emissions of greenhouse gases, it will be necessary to invest in new infrastructure and technology, which will create jobs.

The revised N.D.C[9]. states that India is now committed to generating roughly half of its installed electric power capacity from sources other than fossil fuels and reducing the G.D.P.'s emissions intensity by 45 per cent from 2005 levels by 2030. To protect the weak and vulnerable from the harmful effects of climate change, the Honorable Prime Minister has advocated for sustainable lifestyles and climate justice. To promote and spread a healthy, sustainable way of life founded on the customs and principles of moderation and conservation, mainly through a large-scale "LIFE" (Lifestyle for the Environment) movement that serves as a pillar for combating climate change. At C.O.P. 26, the Hon. Prime Minister of India introduced the "One-Word Movement" to the world to acknowledge lifestyle's crucial role in climate change. One sentence to sum up life...Lifestyle for Environment is the abbreviation for L.I.F.E. The goal of LiFE is to coexist without harming the Environment. And those that follow such a lifestyle are known as "Pro-Planet People." Mission LiFE is influenced by the past, operates in the present, and considers the future. Reduce, use, and recycle are values that permeate every aspect of our daily lives. The citizen-centric approach to addressing climate change is also emphasised in India's revised N.D.C. India's choice to adopt more N.D.C.s demonstrates its dedication to completely separating economic growth from greenhouse gas emissions[10].

[9] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812
[10] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1831364

Global Warming and Climate Change: Challenges for Sustainability of Economy

Shailesh kumar
Assistant Professor Dept. of Economics, Bharti college, University of Delhi

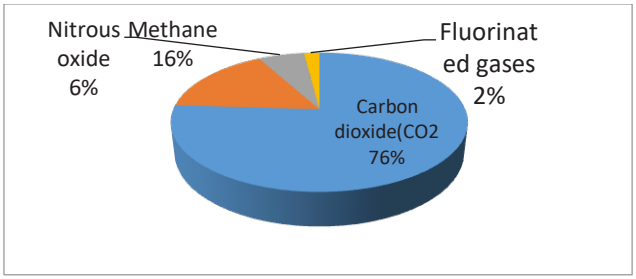
Introduction

Climate change affects our economy through impacts on different social, cultural, and natural resources. It is apprehended to affect virtually every sector of society, including water resources, food production, energy use, ,human health, infrastructure, transportation systems, energy, food, water supplies , commerce, recreation, education , tourism and agriculture and even national security. While some of these effects could be beneficial, particularly in the short run, many of the impacts could be costly, far-reaching, and damaging to local communities and society as a whole in the long term . The aim of this paper is to explain the Challenges of global warming and climate change on sustainability Economy. Climate is directly to have impacts on agricultural sustainability and crop productivity. Sustainability of agricultural production is the key to ensure food and livelihood security. The changing climatic conditions affect agricultural system at three levels: the crop (or livestock) level, the farm (or cropping system) level and at the food system level. Negative impact includes more frequent droughts and floods, heat stress, increased outbreaks of diseases and pests, shortening of crop growing periods and in coastal region increasing flooding and Salinization due to sea level rise and impeded drainage. The adverse impact of climatic variability on agriculture production at farm level gets aggregated to the level of the food system in terms of food shortages and rising prices which can affect food security.

Status of CO_2 Emission in the Major Countries

The greenhouse effect include carbon dioxide, methane, nitrous oxide, and water vapor, and fluorinated gases . Greenhouse gases have different chemical properties and are removed from the atmosphere, over time, by different processes. Carbon dioxide is important greenhouse gas because it currently accounts around 76 per cent of total GHG . In February 2007, the Intergovernmental Panel on Climate Change (IPCC) reported to the United Nations that the Earth's climate system is undoubtedly getting warmer. According to the Climate Impacts Group at the University of Washington, the average annual temperature in the Pacific Northwest rose by 1.5° F in the 20th century and is expected to rise by 0.5° F per decade in the first half of the 21st century. Carbon dioxide gas traps solar heat in the atmosphere, partly in the same way as glass traps solar heat in a sunroom or a greenhouse. For this reason, carbon dioxide is sometimes called a "greenhouse gas."(Thakur and Kumar, 2012) . . The mean sea level rise along the Indian Coasts is estimated to be about 1.33 mm/year on an average and global average sea level rose at an average rate of 1.8 mm/ year over 1961-2003 (Dalip Kumar 2013). Combination of greenhouse can be seen in Chart-1.

Chart-1
Greenhouse Gas Emission by Gases



The trends in per capita CO_2 emissions can be seen in Table-1. The figure of USA , Japan ,EU ,Russia show declining trends but other countries like China and India emitting more than in 2020 in terms of per capita emission. USA per capita CO_2 emissions was 19.6 MT in 1990 and it was reduced up to 13.68 MT in 2020. Same trends was also in Japan. But China , per capita CO_2 emissions trends is gradually increased. People's Republic of China is the world's largest emitter of CO_2 due to fossil-fuel use and cement production. China is the world's largest hydraulic cement producer.

Table-1

Trends of CO_2 Emission in Major Countries

Countries	CO_2 Emission in per capita(in metric ton)						CO_2 Emission in 2017 (Million Metric ton)	CO_2 Emission in 2020 (Million Metric ton)	Change in 1990 to 2020
	1990	2000	2010	2015	2017	2020			
USA	19.6	20.6	17.6	16.1	15.7	13.68	5,107	4,535	-5.92
EU	9.2	8.4	7.7	6.9	7.0	6.4	3,114	2,550	-2.80
CHINA	2.1	2.8	6.2	7.7	7.7	8.2	10,877	11,680	6.10
JAPAN	9.5	10.2	8.9	9.9	10.4	8.39	1,321	1,031	-1.11
RUSSIA	16.5	11.3	11.8	12.3	12.3	11.64	1,765	1,674	-4.86
INDIA	0.8	1.0	1.7	1.9	1.8	1.74	2,455	2,411	0.94
World Average	3.9	3.8	4.5	4.5	4.4	4.5	35,93,000	34,81,000	0.60

Sources:- World Bank, Climate Watch. 2020. GHG Emissions. Washington, DC: World Resources Institute

Climate change is projected to have mostly negative and adverse health impacts on many population groups, especially the poorest, in large areas of India. These could include direct health impacts such as heatstroke, and indirect impacts such as increased diarrhea risk due to water contamination via flooding, or higher risk of mortality leading to large-scale loss of livelihoods (MOEF-2010).

Table-2
Share of CO_2 Emission in 2020 (Million Matric Tonnes)

Sr. No	Countries	Percentage	Million Matric Ton
1	USA	13%	4535
2	EU	7%	2550
3	CHINA	34%	11680
4	JAPAN	3%	1031
5	RUSSIA	5%	1674
6	INDIA	7%	2411
7	Others Countries	31%	10929
8	World CO2 Emission	100%	3481000

Sources:- https://www.statista.com/statistics/486073/co2-emissions-south-africa-fossil-fuel-and-industrial-purposes

Climate Change Effects on Primary Sector

Climate change is also affecting the natural systems like forest, river, land, ponds, tanks etc. Agricultural sustainability is also depends on forest, river, land, ponds, tanks etc.. Agriculture has to adapt to significant impacts of climate change, while at the same time providing food for a growing population. Our societies depend on food, fuel, fiber , water and other services which are available in the natural system. Climate Change will make future water resources less predictable and complicated. Sustainable agriculture is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species. Sustainable agriculture seeks to provide more profitable farm income, promote environmental stewardship, and enhance quality of life for farm, families and communities. As a more sustainable agriculture seeks to make the best use of nature's goods and services, technologies and practices must be locally adapted and fitted to places. Hasna Vancock explains the sustainability as a process which tells of the development of all aspects of human life affecting sustenance (Hansa-2007). Climate change will depress agricultural productivity. It will add several conflicting pressures on agricultural production. Climate Change will affect agricultural sector in the Indian sub-continent in many ways (Babu and Bhalachandran, 2009). Impacts on agriculture due to climate change have received considerable attention in India as they are closely linked to the food security and poverty status of a vast majority of the population (Kumar, 2009). It will affect agriculture productivity directly through higher temperatures, greater crop water demand, more variable rainfall, cold spells and extreme climate events such as floods and draughts. Most of developing countries have reducing global average productivity. (World Bank, 2010). Climate-smart agriculture (CSA) is an integrated approach to managing landscapes—cropland, livestock, forests and fisheries

Climate Change and Effects on Secondary and Tertiary Sector

Climate change also affects the secondary and tertiary sector. Flood, drought, sea level rise and Cyclone are the major climatic events which affect industry, health and education sector. In the coastal areas industry and infrastructure are destroyed by cyclone and high storm. On the one hand they destroy the Industries, building, machineries and on the other they destroy the roads, communication network, transportation, power supply and drinking water supply lines. Tourism industries are also affected by

coastal erosion, cyclone and storms. Human health also suffers from climate change especially due to flood, drought and cyclone. Ocean acidification is an emerging issue with potential for major impacts in coastal areas. Coastal erosion severely affects infrastructure facilities such as the railway, road system and that ultimately disturbs economic activities along the coast such as fishing, recreational and other coast-related activities. Floods, landslides, cyclones, droughts, wind storms, coastal erosion, tsunami, sea surge, and sea level rise are the main natural hazards that cause disasters. As climate change causes the ocean to rise, increase atmospheric carbon dioxide and that will change ocean chemistry. When carbon dioxide dissolves in water, it makes water more acidic. This harmful effects on natural ecosystems, affects fish that people eat, coral reefs that tourists visit, and the whales, dolphins, sharks, and other marine life.

Climate change directly affects the energy sector. Running the air conditioning in a car reduces its fuel efficiency at highway speeds during the very hot seasons. A warmer climate implies increase in the demand for water in irrigated agriculture and use of energy. Climate change can affect fossil and nuclear energy production. Direct climate impacts related to power plants are cooling and water availability. Climate change directly affects the renewable energy. Renewable energy depends directly on ambient natural resources such as hydrological resources, wind power production patterns and intensity, and solar energy radiation etc. Evaporation of water from the surface of reservoirs is another important part of the water cycle that may be affected by climate change. Climate change also affects the Photovoltaic (PV) electricity generation system, solar water heating, solar radiation, and lastly impacts on solar energy production. In 2005, climate extremes accounted for a 13 per cent variation in energy productivity in developing countries (World Bank, 2010).

Climate Change and effect on Transportation Systems

Climate change directly affects both the rural and urban transportation systems. IPCC identified "increases in hot days and heat waves, arctic temperatures, sea level, intense precipitation events and hurricane intensity" as the climate change characteristics having the most significant adverse impacts on transportation (IPCC-2007). Climate change effects are most relevant to the highway system. These effects can be seen in three ways i.e. Land-based transportation system, Airways transportation system and Marine transportation system. Transportation system affected by Sea level rise, high speedy storm, and heavy rains in coastal areas, high and low temperature, dense fog and high tides are caused due to climate change. Heavy rains may result in flooding, which could disrupt traffic, delay construction activities, and weaken or wash out the soil and culverts that support roads, tunnels, and bridges. High speedy Storms physically damage roads and rail networks and vehicles from high winds and wind-driven rain and debris. These changes could increase the risk of delays, disruptions, damage, and failure across our land-based, air, and marine transportation systems.

Incidents of Cloudbursts and landslides in Northern India states had led to the rise in death tolls to more than 1000 in the region. Increasing levels of water in two main rivers of the State, namely Alakhnanda and Bhagirathi, have also resulted in the collapse of bridges, and damaging and washing away of property which is yet to be estimated. Local villagers are complaining of fever, diarrhea and vomiting, high temperature and gastro-intestinal infections in Kedarnath valley. They are infested with diseases due to contamination of water resources in the area and to hundreds of decaying bodies spread across the valley. Water-borne diseases /air borne or direct contact diseases have been spreading in the valley. Many roads connecting the pilgrim centers like Kedarnath , Badrinath, Gangotri, Yamonitri and Govindghat have been damaged. Around 400 roads have been damaged making communication and transportation difficult in Uttarakhand. The massive loss of lives (around 6000 persons), property and infrastructure was due to landslides and floods in Uttarakhand.

Government Initiatives

Many initiatives are being taken to mitigate climate change and face to adaptation challenges. Some of these are Jawaharlal Nehru National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustainable Agriculture, National Mission for Sustaining the Himalayan Ecosystem:, National Mission for a Green India, National Mission on Strategic Knowledge for Climate Change etc.

At the 26th Conference of Parties (CoP_{26}), Indian Prime Minister Narendra Modi declared a five-fold strategy — termed as the *PANCHAMRITA* — to achieve this feat.

These five points include:

- India will get its non-fossil energy capacity to 500 gigawatt (GW) by 2030
- India will meet 50 per cent of its energy requirements from renewable energy by 2030
- India will reduce the total projected carbon emissions by one billion tonnes from now onwards till 2030
- By 2030, India will reduce the carbon intensity of its economy by less than 45 per cent
- So, by the year 2070, India will achieve the target of Net Zero.

Union Environment Minister Bhupender Yadav, who is representing the Indian delegation at the COP_{27} in Egypt, said that the world should not burden farmers with mitigation responsibilities. He also welcomed the inclusion of "transition to sustainable lifestyles and sustainable patterns of consumption and production in our efforts to address climate change. (PTI, 2022). In COP_{27}, India demanded that only coal could not be singled out and that the phase out of all fossil fuels should be addressed. That did not happen. But India could at least hold on to the status quo. (Basu, 2022).

For Adaptation needs following strategies -

a. Crop adaptation strategies of Planting of drought and flood resistant varieties of crops, Knowledge about changing rainfall pattern, Crop diversification, Change in cropping pattern system, Mixed cropping, enhanced irrigation efficiency, conservation and conserve soil moisture, afforestation and agroforestry.

b. Livestock adaptation strategies can be done by encouraging Breeding strategies, Livestock management systems and Capacity building for livestock keepers.

c. Others adaptation Strategies includes Labour migration and Income diversification, river basin management for efficient irrigation and prevention of water logging, soil erosion and nutrient - leaching; water – harvesting, soil moisture; preservation and efficient water- transportation .

d. It also need s income diversification through integration of activities like cattle- rearing and fish production along with rice cultivation.

e. Adaption strategies in agriculture requires integrated pest and pathogen management, using varieties of seeds, climate forecasting for risk management, change in pasture rotation, , modification of grazing pattern, altering catch size to improve environment by reducing the level of fishing in order to sustain yield of fish stocks.

f. Introducing forest conservation, agroforestry and forest-based enterprises for Diversification of rural incomes(.Kumar &Jha,2017)

Summing Up

Agriculture sustainability there is need to manage both climate mitigation and adaptation techniques. If the emissions are not controlled, that will result in the severe climate change crisis in the current century. There is a need to adopt mitigation strategy to achieve the goal of stabilization of atmosphere. It needs reduced deforestation, sustainable forest management and forest reforestation. In agriculture there is need to reduce non-CO_2 gases through improved crop and livestock management agro- forestry practices, biomass restoration etc. There is a need to monitor and disseminate information related to climate change to farmers and the masses so that they may respond to new danger like pests, disease and other factors that affect production system. It needs investment in new technical or management strategies and imparting training for new jobs based on new land uses, industrial relocation and human migration. There is need to revisit new infrastructure policies that may enable in adapting to climate change and their costs and benefits. There is need for research and outreach of new technologies required for adaptation to climate change. The threatening climate change and its adverse impacts need a series of coherent and integrated development strategies in the areas of safeguarding food security and rural livelihoods and implementation of adaptation and mitigation measures to address the impacts of climate change. Electric vehicles, as well as solar and wind power, are growing Heat tolerant crop varieties. It also requires global efforts with focus on internal cooperation and coordination between exporting and importing nations within the context of sustainability of economy.

Reference:-

Babu, Suresh Chandra and G. Balachandran (2009),” Three Programms that could Effectively Reduce Poverty and Malnutrition”, The Hindu, Survey of Indian Agriculture 2009, pp 111-114.

Basu Jyanta, (2022), COP27: India happy with loss and damage outcome; wary on agriculture, hints Centre, Published in *Down to Earth*, 20 November.

Hasna, A. M. (2007). "Dimensions of Sustainability". Journal of Engineering for Sustainable Development: Energy, Environment, and Health 2 (1): PP-47–57.

Kumar Dalip (2013), Climate Change and Watershed Management: Impacts on Agricultural Productivity and Food Security, in Anil K Thakur and Dalip Kumar,(Ed.),Dimensions of Climate Change in India: A Development Perspective, Regal Publications, New Delhi , PP.3-23.

Kumar Dalip & Anjami Kumar Jha, ed. (2017), Climate Adaptation and Mitigation: Challenges and Opportunities in Agriculture Sustainability, in Book on *Doubling Farmers' Income: Agriculture Sustainability and Policies,* edited by Falendra K. Sudan, Jammu University, Jammu, PP, 81-105.

MOEF(2010),Climate Change and India: A 4x4 Assessment, A Sectoral and Regional Analysis for 2030s, Ministry of Environment and Forest, Government of India, Indian Network for Climate Change Assessment(INCCA), November.

PTI (2022), COP27 Climate Submit: ‘World has waited for long…’, says India on compensation fund approval, Mint, 20 Nov 2022,

Thakur Anil Kumar and Dalip Kumar ed. (2013), Sustainable Development in India: Issues and Approaches. Regal Publication, New Delhi.

World Bank (2010), World Development Report, 2010, Development and Climate Change, The World Bank, Washington DC, Pp-40.

Renewable Energy: It's Role In Our Indian Economy

Imteyaz Hassan
Shah Ali Adnan
Md. Danish Shabbir

ABSTRACT:
Now more than ever, the globe needs clean, renewable energy sources. Instead of using carbon-based fossil fuels, which contribute significantly to greenhouse gas emissions, switching to renewable energy sources has many social and economic benefits. Fossil fuels that burn carbon are one of the main causes of climate change. India's rising reliance on renewable energy sources is the key to meeting the country's soaring energy needs, which are only projected to increase at an exponential rate in the years to come. The need for these things is expected to keep rising at an exponential rate. There will be tremendous development in the renewable energy industry thanks to the "Make in India" project and other initiatives of the Indian government that encompass Solar Energy, Wind Energy, and other types of renewable energy sources. As a consequence of this expansion, many new employment will open up throughout the nation, in cities and towns alike. Use of renewable energy sources in India would be very beneficial to the country's youth since it would provide stable employment opportunities. In this piece, we'll talk about how important renewable energy is, how it's changed India's economy and society, and what the government in India is doing to promote and expand renewable energy use there.

Keywords: Renewable energy, Fossil fuels, Indian economy, Government effort.

INTRODUCTION:

In every field, the most fundamental need is access to sufficient sources of energy. The bulk of the world's energy originates from a mix of renewable and non-renewable sources. Now, most of our efforts are being put towards developing renewable energy sources. It is possible that the supply of renewable energy, which comes from the earth, will never run out. We use the term "renewable" to describe this kind of power source. Some of the numerous potential applications of renewable resources include electricity production, transportation, and a broad variety of other functions. Several diverse methods for harnessing renewable energy have emerged in the contemporary period. Technology such as solar cells, windmills, and turbines all qualify as instances of this. Renewable energy may be generated from many different resources, such as the sun, the wind, the tides, the waves, and biomass. The current trend toward renewable energy might be attributed to the fact that it is simple to implement and readily available in the natural environment. Indeed, this is currently happening right now. Coal was the primary fuel of the nineteenth century. However, renewable energy has begun to overtake coal, petroleum, and other fossil fuels as the most important energy source in recent years. It's anticipated that this tendency will keep going. The rapid expansion of this company has resulted in a rise in the number of available jobs.[1]

2. DEMAND OF ENERGY IN INDIA DUE TO INCREASE IN POPULATION:

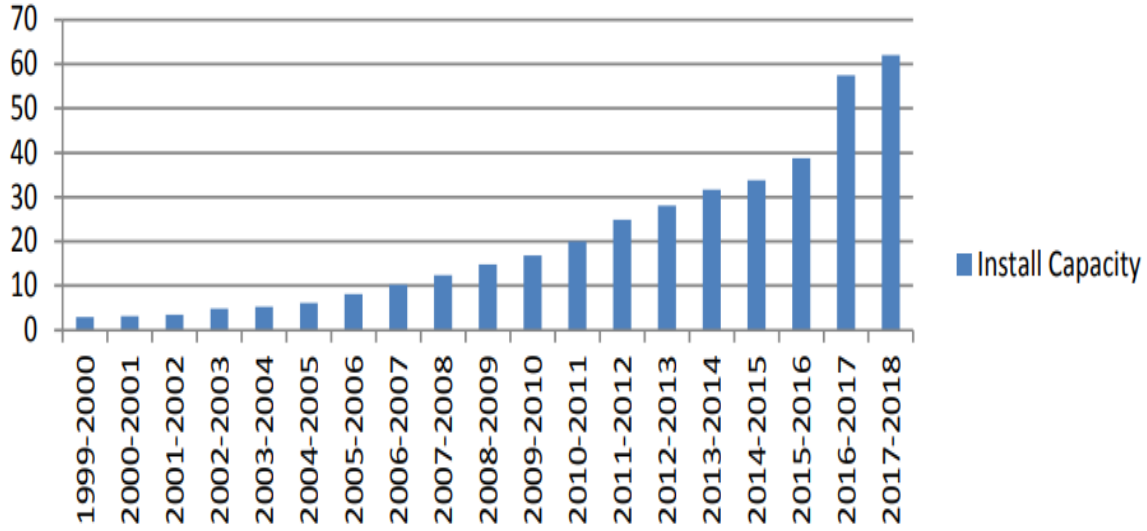
It is well-known that India has the second-largest population and the fastest-growing population in the world. You may find relevant data in statistical as well as anecdotal literature. If current projections hold, India's population will have exceeded China's by 2025. It is anticipated that this will occur. Our expectation is based on current patterns. India is the third biggest user of electricity, yet it has the lowest per capita energy consumption (Unit) among both developed and developing nations. Even though India is the third-biggest power consumer, this is the case. Although India is the world's third largest power consumer, this continues to be the case. As a result of the country's efforts to meet the rising demand for energy brought on by the rapid growth of its population, India is presently the third biggest user of

power worldwide. India should have little problems meeting its growing energy demands in the not-too-distant future due to the country's large youth population and extremely low median age of around 27 years. It is also important to remember that India is a participating member of the Paris Climate Agreement. India hopes that its participation in this endeavour would lead to a decrease in greenhouse gas emissions and the promotion of socioeconomic growth in the nation by increasing the usage of renewable energy sources. It is expected that the share of thermal energy in total installed capacity will decrease in the near future as a result of the Indian government's efforts to advance policies that promote the use of renewable energy sources. These policies include the Jawaharlal Nehru National Solar Mission and the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME) programmes. This is due to the fact that the government of India is actively pushing for regulations that support the expansion of renewable energy production. That's because the Indian government has promised to actively promote laws that boost renewable energy use. The bulk of India's foreign reserves are used for the purchase of fossil fuels, thus investing in renewable energy would not only provide a financial return, but also reduce this burden. Investment in renewable energy would not only pay off for India, but will also help the country's dwindling foreign currency reserves. Renewable energy investments would not only be financially beneficial, but will also improve India's foreign reserves. It will also provide a large number of secure jobs for India's young population, which is expanding at a pace very close to exponential. India's strategic location is conducive to the development of renewable energy sources; the country has a coastline of 7500 Km, making it ideal for the construction of wind energy farms, and enjoys over 300 days per year with favourable solar radiation. In India, the solar energy business, this is a godsend. All of India's solar energy workers will benefit from this good news. These positive developments are good news for the solar energy industry in India. The solar energy industry in India has expanded greatly because to this donation. There is a good chance that the vast majority of India's population, which lives in rural regions, would be able to contribute to the country's effort to meet its growing energy demands by finding work in biogas plants. A rise in India's per capita power consumption (Unit) would be indicative of a brightening trend in the country's socioeconomic environment, and this rise is expected to arise from the equal distribution of energy output made possible by the use of renewable energy sources. Assuming this is true, the socioeconomic environment in India seems to be improving. As a result of incorporating numerous renewable energy sources, this objective was within reach.

3. RENEWABLE ENERGY IN INDIA:

In the wake of the energy crisis of 1979, several nations quickly set out to investigate the potential of renewable energy sources more thoroughly. Following the founding of The Commission on Additional Sources of Energy (CASE) in 1981, India set up the Department of Non-conventional Energy Sources (DNES) in 1982. As a result, CASE was established in 1982, only two years later. This event marked India's entry into the renewable energy industry. The Indian Renewable Energy Development Agency (IREDA) was established in 1987 with the goal of managing the country's investments in renewable energy. In 1992, a new ministry was established to oversee alternative energy sources; it was first known as the Ministry of New and Renewable Energy Sources (MNES). A Minister of State position will now oversee the Ministry. After China and the United States, India is the third most prolific country in terms of electricity generation in 2016, and the fifth most prolific nation in terms of wind energy output, with a potential wind energy capacity of 102.8 gigawatts (GW). It can produce 19.7 GW of hydro-power, 22.5 GW of bio-power, and 6 GW of solar-power, and it's expected to produce 22,000 MW of solar-power by 2022. [3]

Fig 1: Renewable Energy Installed Capacity Growth for 18 Year to Year (in GW)[4]



Source:Ministry of Renewable Energy Report on Renewable Energy Installed Capacity Growth.

4. GOVERNMENT EFFORTS TO DECREASE POLLUTION AND TO DEVELOP THE ATTITUDE OF RENEWABLE ENERGY:

Through the use of renewable energy sources, India has made great strides in recent years toward its objective of removing pollution from the environment. Indian authorities have already made many measures in this direction. The car industry, a major source of environmental pollution, has been chosen as the starting point for these initiatives. One of the initiatives taken by the government to reduce environmental pollution is to encourage the use of battery-powered autos. These and similar initiatives, such as the Jawaharlal Nehru Solar Mission[5], Faster Adoption and Manufacturing of Electric Vehicles (FAME), and others, are serving as the area of renewable energy's epochal precedent. As a result, efforts have been made to shift focus toward renewable resources in order to reduce reliance on conventional fuels, particularly coal. It's because more attention is being paid to sustainable energy sources that we've seen this change occur, which increases the value of renewables [6]. Currently, there is a great deal of opportunity for investors in the real estate market in India. The new Union Government under Prime Minister Narendra Modi in particular has prioritised the expansion of our country's physical infrastructure. Prime Minister Modi is directing this endeavour. This industry, which includes manufacturing, is expected to be the primary driver of economic growth during the next five years. The target for renewable energy production set by the Ministry of New and Renewable Energy (MNRE) has increased from 50 GW to 175 GW by the year 2022 respectively. Because of this in particular, the ministry was able to fulfil its purpose. Renewable energy sources, such as the sun and the wind, will make up the bulk of this book's discussion of electricity respectfully.

5. EMPLOYEMENT CREATION:

The number of accessible positions in the renewable energy industry has increased dramatically because to the sector's esoteric foundation. These job openings are crucial to addressing power outages and provide a great platform for the promotion of young Indian professionals in the energy sector. India has a large young population, therefore this is very essential. There is no economic sector that can function without access to energy, since all mechanical devices and machinery need it for proper functioning

(except manual machines). Because of this, the roustabout is being used by both commercial firms and the government to generate electricity. The Indian government has made a number of initiatives under the "Make in India" programme to increase the use of renewable energy throughout the country. Companies like Tata Power Solar Systems and Waaree Solar, among others, have cornered the market in India's solar energy industry. These companies are competing with one another to win the contracts, and the stakes are high. Some of the most significant enterprises that are fueling the expansion of India's wind energy industry include Vestas India and Inox Wind, among others. Several prominent Indian businesses, like Institutional & Domestic Biogas Plant and FRD Biotech, are driving the growth of the country's biogas energy market.

6. CONCLUSION:

Even though there hasn't been a significant labour shortage in the sector, the government of India is keen on increasing the number of available jobs in the electrical industry. Still, India relies on oil imports from other countries to power its industrial and transportation sectors. All the foreign currency that India earns from its exports goes straight into these sectors. With year-round sunshine over most of India, solar power offers a fantastic opportunity for expanding the country's energy infrastructure. Since this is the case, solar power is an excellent means of generating electricity. India's 7,500 kilometres of coastline make it a prime location for the generation of wind power. More than 69 percent of India's population lives in rural areas and works in agriculture or livestock, according to a census taken the same year. Although each of these three forms of renewable energy is still relatively new to the Indian market, it has the potential to provide a large number of jobs in the production, installation, and upkeep of renewable goods in specific locations. The Indian government places a high priority on this area of the economy since it does not contribute to the production of greenhouse emissions, helps keep the environment clean, and has a limitless supply.

REFERENCES:

Narula, K., Reddy, B. S., Pachauri, S., & Dev, S. M. (2017). Sustainable energy security for India: An assessment of the energy supply sub-system. Energy Policy, 103, 127-144.

PLANNING COMMISSION of India, 2002, Indian Goverment Report.

Ramachandra, T. V., Jain, R., & Krishnadas, G. (2011). Hotspots of solar potential in India. Renewable and Sustainable Energy Reviews, 15(6), 3178-3186.

Ministry of New and Renewable Energy Report on Renewable Energy Installed Capacity Growth (2015), http://mnre.gov.in/file-manager/annual-report/2014- 2015/EN/Chapter%201/chapter_1.htm.

Tripathi, L., Mishra, A. K., Dubey, A. K., Tripathi, C. B., & Baredar, P. (2016). Renewable energy: an overview on its contribution in current energy scenario of India. Renewable and Sustainable Energy Reviews, 60, 226-233.

Bajpai, S., & Kidwai, N. R. (2017). Renewable Energy Education in India. Comparative Professional Pedagogy, 7(4), 103-113.

Krishnamurthy, S., Joseph, S., Pradhan, V., & Rao, P. (2017). Empowering Women of Rural India for Renewable Energy Adoption–An Exploratory Factor Analysis. Indian Journal of Science and Technology, 10(37).

Rehman, S., & Hussain, Z. (2017). Renewable energy governance in India: challenges and prospects for achieving the 2022 energy goals.

[9] Sindhu, S., Nehra, V., & Luthra, S. (2017). Solar energy deployment for sustainable future of India: Hybrid SWOC-AHP analysis. Renewable and Sustainable Energy Reviews, 72, 1138- 1151.

[10] Sawle, Y., Gupta, S. C., & Bohre, A. K. (2018). Socio-techno-economic design of hybrid renewable energy system using optimization techniques. Renewable Energy, 119, 459-472

Impacts of Covid-19 on SDGs

Shashi Kiran Kujur
Rashmi Priya Toppo

ABSTRACT

In 2015 the united Nations General Assembly adopted the 2030 agenda for sustainable development. 193 member countries, including India, got committed to 17 sustainable development Goals. The SDG India Index released by NITI Aayog and the united nation shores that the Nations has score of 66 in 2020-21 and Kerala and Himachal Pradesh and Tamilnadu are front summers in states category while Chandigarh is front runes in VT5 category. With 2030 Agenda and the sustainable development Goals with Five P's Theory SDSN and UN has been proposed a initiative of SDG Transformation with 6 main Transformation which Coues entire 17 SDG5

Introduction

In 2015 the United Nations General Assembly adopted the 2030 agenda for sustainable development. 193 member countries, including India, got committed to the 17 sustainable development Goals that require efforts to end all forms of poverty, fight inequalities and tackle climate change while ensuring that no one was lift behind.

India played a significant role in making that declaration and its progress in achieving these goals are social for the world as it is home to about 17% of the world population the SDG India Index released by NITI Aayog and the United Nations, shows that the Nation has a score of 58, a little beyond halfway mark in meeting the target set for 2030.

"Development which meets the needs of the present without compromising the ability of future generations to meet their own needs." This most widely accepted definition of sustainable development was given by the Brundtland commission in its report our common future (1987). Sustainable development (SD) calls for concerted efforts towards building an inclusive, sustainable and resilient future for people and planet.

SDG Transformation

With the 2030 Agenda and the sustainable development Goals hour committed themselves to time-bound targets for prosperity, people planet, peace and partnership (United Nations 2015) known as the five p's. many governments how asked the SDSN and members of its leadership council how they might organize the implementation of the SDG.

In response and drawing on the work of the world in 2050 initiative SDG implementation be organized in broad SDG Transformations that each describe major societal changes that inter alia transform resource use, institutions, technology and social relations.

Leave no one behind

1. Education, Gender and Inequality SDGs (1, 5, 7-10, 12-15, 17)
2. Health, wellbeing and Demography SDGs (1, 2, 3, 4, 5, 8, 10)
3. Energy Decarburization and sustainable Industry SDGs (1-16)
4. Sustainable food, land, water and oceans SDGs (1-3, 5, 6, 8, 10-15)
5. Sustainable cities and communities SDGs (1-16)
6. Digital Revolution for Sustainable Development SDGs (1-4, 7-13, 17).

Assistant Professor, Department of Economics, Govt.G.N.A.P.G.College,Bhatapara (C.G.)
Assistant Professor, Department of Economics, Govt. College, Bagicha, Jaspurnagar (C.G.)

Circularity and Decoupling

1. Education, Gender and Inequality – Involving ministers of education, science and technology, Gender primary and secondary education, vocational training and higher education, social protection systems and labor standards and R&D. It directly target SDGs 1,2,3,4,5,8,9 and 10 and rain forces and other SDG outcomes.
2. Health, wellbeing and Demography Group interventions to ensure universal Health courage (VHC), promote health behaviors, and address social determinants of health and wellbeing it directlytargets SDGs 2,3 and 5 with strong synergies, into many need to be led by ministries of health.
3. Energy decarbonization and sustainable Industry – this transformation groups investment in energy access the decarbonization of power, transport, buildings and Industry and curbing Industrial pollution it directly targets SDGs 3, 6, 7, 9, 11-15 and reinforce several other goal.
4. Sustainable food, land water and oceans Interventions to make food and other agricultural or forest production systems more productive and resilient to climate change must be coordinated with efforts to conserve and restore biodiversity and promote healthy diets alongside major reduction in food waste and losses. This broad transformation directly promotes SDGs 2, 3, 6 and 12-15.
5. Sustainable cities and communities – Cities towns and other communities require integrated investments in infrastructure, urban services as well as resilience to climate change. These interventions target of course SDG 11 and they also contribute directly to goals 6, 9 and 11.
6. Harnessing the Digital Revolution For sustainable development – If managed well, digital technologies, such as artificial intelligence and modern communication technologies can make major contributions towards virtually all SDGs.

India's STEPS TO IMPLEMENT SUSTAINABLE DEVELOPMENT GOALS

- MANREGA is being implemented to provide jobs to unskilled laboures and improve their living standards.
- (NFSA) is being enclosed to provide subsidized food grains.
- The government of India make India open defecation free under its flagship programme. Swachha Bharat Abhiyan
- Renewable energy generation target have been set at H5GW by 2022 to exploitsolar energy, wind energy and other such renewable sources of energy efficiency and reduce the dependence, on fossil fuels.
  Eg- International Solar Alliance
- AMRUT and HRIDAY Schemes have been launched for improving the infrastructure aspects.
- India has expressed its intent to combat climate change by ratifying the Paris agreement.

India's performance

- As per sustainable development Report

Year	Score	Rank	Regional score
2021	60.1	120/165	65.7
2020	61.9	117/166	67.2
2019	61.1	115/162	65.7

Source - SSDN

- As per SDG India Index

Year	Score
2020	66
2019	60
2018	58

Source- NITI AAYOG

- As per Global Hunger Index Report

Year	Score	Rank
2021	27.5	101/116
2020	27.2	94/107
2019	30.3	102/117

Source – concern world wide welt hunger life

- As per Gender Gap Report (IFPRI)

Year	Score	Rank
2021	0.625	140/156
2020	0.668	112/153
2018	0.665	108/149

Source – WEF

In 2015 the united Nations General Assembly adopted the 2030 agenda for sustainable development. 193 member countries, including India got committed to 17 SDG5. "Development which meets the needs of the present without compromising the ability of future generation to meet their our needs." This definition was given by "Brundtland commission" in its Report of "our common future" 1987.The SDSN and UN has been proposed initiative of SDG Transformation that each describe major societal changes that inter technologies and Social relations.

The Covid-19 is the biggest Impediment accomplish the all IT SDG5. However, government has taken various steps to reduce the negative impact of Covid-19 such as MGNREGA, NESA, International solar alliance, Swachha bharat abhiyan and digital infrastructure, such as e-education, e-health, e-governance, e-pay etc. there is some positive impact of covid-19 is low level of pollution, low level of carbon commission, less traffic Accidents, clean environment, increase in O2 level.

Due to various initiative of Governments the score of India sustainable development Report 2021 is 60.1 which is further started to getting better in SDG India Index Report 2020 score is 66 which is highest till now with Kerala at top position followed by Himachal Pradesh and Tamilnadu and in V ts Chandigarh is in top Rank. This we can say the India is still in path towards achieve 17 SDG5 of 2030 Agenda.

Conclusion

In 2015 the united Nations General assembly adopted the 2030 agenda for sustainable development. 193 countries including India got committed to the IT sustainable development goals. India also started SDG India Index report since 2018 measure the performance and initiative taken by states and VTs There is huge impact of Covid-19 not only in India but all over the world this various initiatives and schemes are launched to tackle the consequences and maintain the path towards achieving 17 SDG.

The main 6 transformations are

1) Education, Gender, and Inequality SDG_5 (1, 5, 7-10, 12-15, 17)
2) Health wellbeing and Demography SDG_5 (1, 2, 3, 4, 5, 8, 10)
3) Energy decarbonization and sustainable Industry SDG_5 (1-16)
4) Sustainable food, land, water and oc SDG_5 (1-3, 5, 6, 8, 10-15)
5) Sustainable cities and communities SDG_5 (1-16)
6) Digital revolution for sustainable Development SDG_5 (1-4, 7-13, 17)

By involving various minister such as health, education, science & Tech, R&Detc. with cooper groups, NGO, Industrial corpora in various initiative to achieve SDG is really necessary because these are part of Entire Journey to accomplish 2030 Agenda the pandemic Covid-19 has greater impact in the results of the initiative taken by government the impacts are positive as well as negative such as there is a highly negative impact on SDG-1, 2, 3, 8 and 10 while mixed and moderately impact on SDG – 4, 5, 6,

7, 9, 11, 16, 17 and for SDG – 12, 13, 14, 15 the impacts are still not clear the positive impacts are clean energy, less greenhouse gas emission, clean water resources, less pollution various invention in IT sector and Biotechnology sector e-health, e-education, e-governance, e-pay etc.

To reduce the Negative Impact of Covid-19 Govt has been taken various initive time to time such as-NESA, MGNREGA, International solar alliance, swachha Bharat Abhiyan, AMRUT, HRIDAY etc. To maintain the path to accomplish SDG-17 of 2030 Agenda.

REFERENCES

Sustainable development report 2019,2020,2021.

Study report on sustainable development available on (www.drishtiias.com).

SDG India index report 2018,2019,2020.

Study report on global hunger index available on (www.globalhungerindex.org).

Study report on sustainable development goals available on (https://byjus.com).

Study report on impact of covid on sustainable development goals available on (https://www.unsdsn.org).

Study report on sustainable development goals available on (https://www.ifpri.org).

Study report on sustainable development goals available on (https://www.weforum.org).

Study report on sustainable development goals available on (https://www.niti.gov.in).

The sustainable development goals report 2021

India's Path to Green Growth

Yashika Sharma

Abstract

It has been twenty years after the first Rio Summit, and the world continues to face a twin challenge: expanding economic opportunities for all and addressing environmental pressures which, if left unaddressed, could challenge our ability to seize these opportunities. Green growth is where these two challenges come together, and it is for us to exploit the opportunities that can help to realise them together.

Although the past decade of swift economic growth has brought many profits to India, the environment has suffered, revealing the population to grave air and water pollution. Poverty remains both a cause and consequence of resource degradation: agricultural yields are lower on degraded lands, and forests and grasslands are depleted as livelihood resources decline. To survive, the poor are forced to mine and overuse the limited resources available to them, creating a downward spiral of poverty and environmental degradation. In response to this, Indian government has launched various initiatives to direct India's economic journey to a path of Green Growth. This paper attempts to examine India's performance in the last decade on the Green Growth indicators while also setting the OECD average as a benchmark.

Green growth: Definition and Importance

Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. Green growth is not an alternate for sustainable development. Rather, it provides a practical and flexible approach for achieving concrete, measurable progress across its economic and environmental pillars, while taking full account of the social consequences of greening the growth dynamic of economies. The focus of green growth strategies is to ensure that natural assets can deliver their full economic potential and are also sustained for future generations. Natural resources are not completely substitutable and green growth policies take consideration of that.

In May 2011, the OECD delivered its Green Growth Strategy to Heads of State and Ministers from over forty countries, who greeted it as a valuable tool for expanding economic growth and job creation through added sustainable use of natural resources, efficiencies in the use of energy, and valuation of ecosystem services. Green growth policies are an integral part of the structural reforms needed to foster strong, more sustainable and inclusive growth. They can unlock new growth engines by:

- Enhancing productivity by creating incentives for greater efficiency in the use of natural resources, reducing waste and energy consumption, unlocking opportunities for innovation and value creation, and allocating resources to the highest value use.
- Boosting investor confidence through greater predictability in how governments deal with major environmental issues.
- Opening up new markets by stimulating demand for green goods, services and technologies.
- Contributing to fiscal consolidation by mobilising revenues through green taxes and through the elimination of environmentally harmful subsidies. These measures can also help to generate or free up resources for anti-poverty programmes in such areas as water supply and sanitation, or other pro-poor investments.
- Reducing risks of negative shocks to growth due to resource bottlenecks, as well as damaging and potentially irreversible environmental impacts.

Strategies for greener growth need to be tailored to fit specific country circumstances. They will need to carefully consider how to manage any potential trade-offs and best exploit the synergies between green growth and poverty reduction. The OECD is working to identify the policy mixes and measurement tools that countries in different situations can adopt to implement green growth in a way that contributes to poverty eradication, employment opportunities, and a strong and sustainable economy. Green growth strategies also recognise that focusing on GDP as the main measure of economic progress generally overlooks the contribution of natural assets to wealth, health and well-being. They therefore need to rely on a broader range of measures of progress, encompassing the quality and composition of growth, and how this affects people's wealth and welfare.

A number of other international organisations, think tanks and academics have also turned their attention to green growth, including the World Bank and the Green Growth Leaders. In February 2012, the World Bank along with UNEP, OECD and the GGGI launched a new international knowledge-sharing platform in Mexico - the Green Growth Knowledge Platform (GGKP) - bringing together under the same roof the major international organizations supporting and promoting both green growth and green economy. The GGKP aims to enhance and expand efforts to identify and address major knowledge gaps in green growth theory and practice, and to help countries design and implement policies to move towards a green economy.

India's overall performance in comparison to OECD Estimates

The Organisation for Economic Co-operation and Development is an intergovernmental organisation with 38 member countries, founded in 1961 to stimulate economic progress and world trade. While these member countries are developed economies, India is a developing economy. Thus, there are significant differences in the implementation for Green Growth strategies between India and OECD countries. However, this also presents huge opportunities to India as a growing economy for an early adaptation of green measures. We examine all indicators suggested by OECD to measure Green growth for India while keeping OECD countries average as a benchmark target in the paper below.

Air Pollution

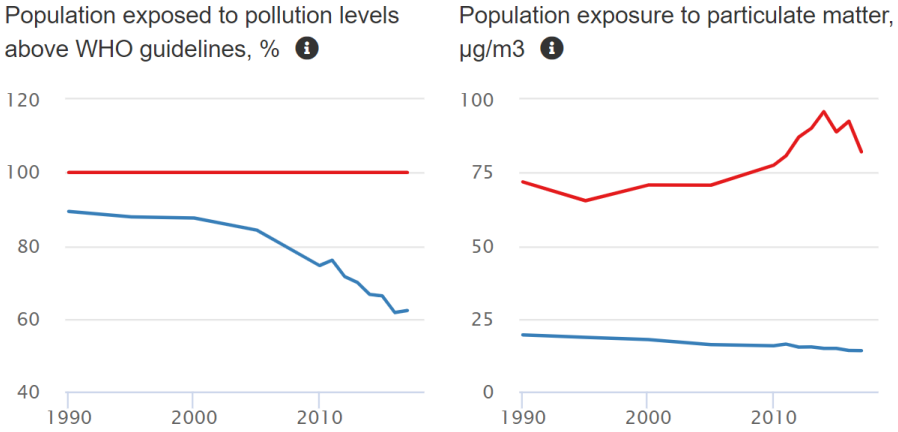
Clean air is a fundamental human right. Yet, air pollution continues to pose a significant threat to people worldwide. The World Health Organization's Air quality guidelines (AQG) serve as a global target for national, regional and city governments to work towards improving their citizen's health by reducing air pollution. The Guidelines apply worldwide to both outdoor and indoor environments and are based on expert evaluation of current scientific evidence for:

- particulate matter (PM)
- ozone (O3)
- nitrogen dioxide (NO2)
- Sulphur dioxide (SO2).

The green growth indicators collect data on the percentage of population in each country that is exposed to air pollution and particulate matter above the levels indicated by WHO guidelines. As per the first indicator, OECD countries overall have improved in the performance. The percentage of population exposed to pollution above WHO guidelines has decrease from 89% (1990) to 62% (2017). On the other hand, India has seen no improvement in air quality and 100% of its population is exposed to pollution significantly above the levelsrecommended by WHO.

India's performance has also worsened on the second indicator, i.e., percentage of population exposed to particulate matter. While the OECD countries have improved from 19% (1990) to 14% (2017), India's performance has worsened from 72% (1990) to 82% (2017). This peaked at an alarming 96% for India in the year 2014.

Source:



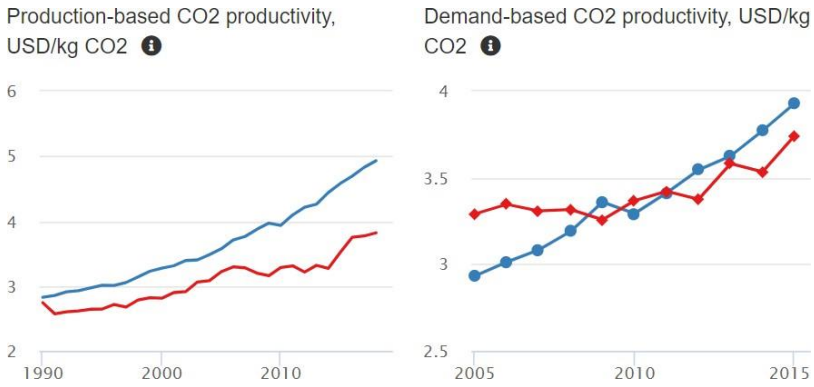
https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

Carbon Productivity

Carbon dioxide (CO2) emissions from the combustion of fossil fuels and biomass accounts for 90% of total greenhouse gas (GHG) emissions. It is thus a key factor in India's ability to deal with climate change. The stabilisation of GHG concentrations in the atmosphere depends on implementation of articulate national and state policies that aim at structural and technological changes.

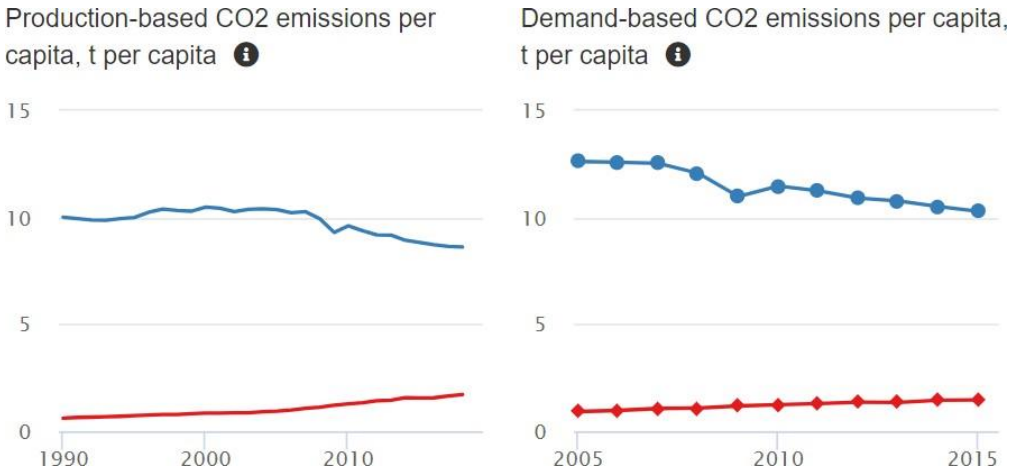
Accounting on multiple efforts by the state and national governments in India post 2010, we have seen improvements in India's carbon emission patterns. However, it is still lagging when compared to other OECD countries. Let's examine the trend in India's performance as compared to OECD countries with respect to each indicator separately.

1. Production based CO2 productivity $/kg CO2 –India's is performing on similar lines as OECD in terms of improvement however, the absolute numbers still have a significant difference. India witnessed a growth in Carbon productivity from 2.74 (1990) to 3.82 (2018). While the OECD countries have improved from 2.82 (1990) to
4.93 (2018). The period between 2006-2014 marks as a phase of stagnancy for India.
2. Demand based CO2 productivity $/kg CO2- Though India has witnessed an improvement in this indicator over time, the growth rate is not comparable to OECD countries. OECD countries surpassed India's level post 2011 and has seen a steep growth overall. OECD's performance improved from 2.93 (2005) to 3.93 (2015). On the other hand, India's improvement has been rather slow from 3.29 (2005) to 3.74 (2015).



Source: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

3. Production-based CO2 emissions per capita –OECD countries have seen a slight reduction in production-based CO2 emissions per capita from 10 tonnes (1990) to 9 tonnes (2018). India on the other hand witnessed increased per capita emissions from1 tonne (1990) to 2 tonnes (2018).
4. Demand-based CO2 emissions per capita - OECD countries have seen a slight reduction in demand-based CO2 emissions per capita from 13 tonnes (2005) to 10 tonnes (2015). India's demand-based CO2 emissions have been stagnant since 2005 at a level of 1 tonne of CO2 per capita.



Source: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

Land Resources

"Built-up Area" refers to buildings, excluding all other types of urban land use such as paved surfaces (roads, parking lots), commercial and industrial sites (ports, landfills) and urban green spaces (parks, gardens). India has witnessed an enormous increase in its built-up area amounting to 96.3% between 1990-2014 while the overall population growth in this period has been around 45.9% .This indicates infrastructural development for building needs other than housing. On the other hand, for OECD the overall population growth rate has been 18.4% between 1990-2014 while the change in built-up area was 31.6%. The huge difference in the growth rate of built area accounts for the fact that India is a

developing economy while most of the OECD countries are already developed. A high growth rate for India is thus a positive sign for its competence in infrastructural development. However, the key concern in this is to avoid excessive use of land resources for human needs and preserve the natural ecosphere.

This data also points out to the alarming population growth rate in India as compared to the developed OECD countries. To ensure green growth and equitable development India also needs an action plan to reduce the growth rate of population in coming years.

Country	Change in built-up area, %, 1990-2014	Change in population, %, 1990-2014
India	96.3	45.9
OECD	31.6	18.4

Source: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

Green Innovation

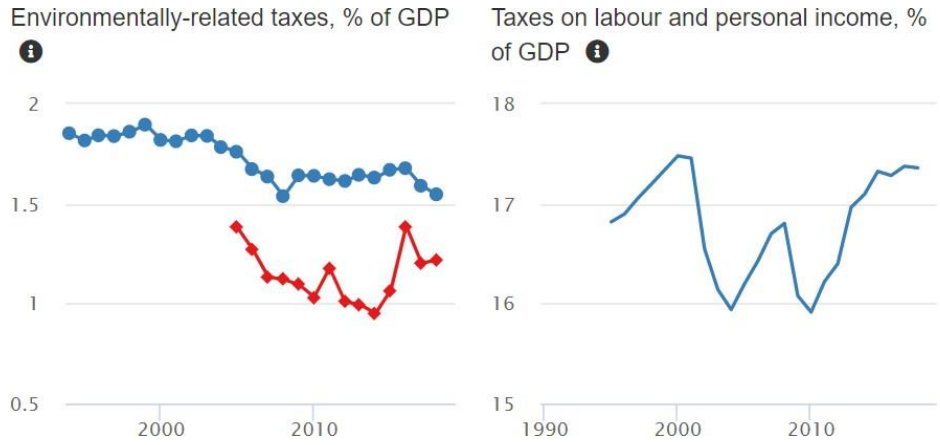
Green innovation is not only driving sustainability but is also boosting the Indian economy and encouraging consumers to use green technology products. The progress in green technology has also accentuated India's ranking on Global Innovation Index. India has moved from 81st rank in 2015-16 to 40th in 2022. A lot of this has to do with the number of green patents filed by India in the last few years. While we see a similar share of environmental patents as a percentage of total patents for India and OECD countries, there is a huge difference in absolute terms. This highlights a huge opportunity area for India to improve on its journey towards green growth. Science, technological innovations, and data systems can help identify solutions and can provide conclusive contributions to address the major challenges for India. These call for increased and continued investments in statistical capacities, Research & Development, Education and Skill development.

Country	Share of environmental patents, % of all patents, 2014-2016 average	Number of environmental patents, thousand patents, 2014-2016 average
OECD	10.25	29 400.66
India	9.02	438.7

Source: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

Environmental Taxes

Environmental Taxes as a percentage of GDP are total tax revenues from taxes on energy products, motor vehicles and transport, and other specific taxes (waste, ozone-depleting substances, measured emissions to air or water, etc.), as a share of GDP. By putting a price on pollution, taxes and tradable permit systems, the government incentivises emissions abatement at the lowest possible cost. The OECD's work on tax and the environment investigates to what extent countries harness the power of taxes and tradable permit systems for environmental and climate policy. While OECD has no data on share of labour and personal income tax for India, we can examine its efforts in the light of implementation of Environmental related taxes. Environmental related taxes are new to India as compared to the OECD countries. They were introduced as an effort to achieve green growth in 2005. While we see slight decrease in environmental taxes as a percentage of GDP over the last years from 1.85% (1994) to 1.55% (2018), the rate for India has been varying significantly in this period. The latest estimate available is for 2018 at 1.22% of GDP.



Source: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default

Discussion

Environmental sustainability could become the next major challenge as India surges along its projected growth trajectory. A low-emission, resource-efficient greening of the economy should be targeted at a very low cost in terms of GDP growth. While a more aggressive low-emission strategy comes at a slightly higher price tag for the economy it ensures to deliver greater benefits. For an environmentally sustainable future, India needs to value its natural resources, and ecosystem services to better inform policy and decision-making. Green growth can be considered as a subset of sustainable development. It is narrower in scope, entailing an operational policy agenda that can help achieve concrete, measurable progress at the interface of the economy and the environment. It fosters the necessary conditions for innovation, investment and competition that can give rise to new sources of economic growth that are consistent with resilient ecosystems. Green growth strategies need to pay specific attention to many of the social issues that can arise as a direct result of greening the economy. Green growth strategies should be implemented in parallel with initiatives focusing on the broader social pillar of sustainable development.

References:

OECD, Green Growth and Sustainable Development, available at: https://www.oecd.org/greengrowth/
United Nations Sustainable Development Goals Knowledge Platform, Green Growth, available at: https://sustainabledevelopment.un.org/index.php?menu=1447
OECD, Data on Green growth Indicators, Retrieved from: https://www.compareyourcountry.org/green-growth-indicators/en/4/all/default
OECD, What is Green Growth and how can it help deliver Sustainable Development, available at: https://www.oecd.org/greengrowth/whatisgreengrowthandhowcanithelpdeliversustainabledevelopment.htm#:~:text=Green%20growth%20means%20fostering%20economic,which%20our%20well%2Dbeing%20relies.

India's Performance on Sustainable Develoment Goals

Yashika Sharma

Abstract

This paper reflects on India's performance in achieving the Sustainable Development goals as a universal call of action to ensure economic growth along with sustaining natural resources and ecosystem services on which the economy and society depend. At the core of sustainable development, are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries in a global partnership. They recognize that ending poverty and other deprivations must go together with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests. These goals were adopted in 2015 and are targeted for the year 2030. Since the world is already half-way in this journey, it is a great time to retrospect and analyse the performance on the target indicators for these SDGs so far. A deep dive on India's performance on these indicators will also help to indicate the high priority and critical action items that are needed to achieve these goals. This paper takes the opportunity to examine all indicators under the 17 SDGs one by one and access India's performance so far.

Sustainable Development Goals

The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. It is a set of 17 SDGs which recognize that that development must balance social, economic, and environmental sustainability. The SDGs are intended to end poverty, hunger, AIDS, and discrimination against women.

Postgraduate, Department of Economics, Delhi School of Economics, University of Delhi.

India's overall performance on SDGs

As per the global Sustainable Development Report, 2022, India was ranked 121 out of the 163 countries having a score of 60.3 while the regional average score was 65.9. It was ranked 117 in 2020 and 120 in 2021.India is not well prepared to achieve the United Nations- mandated Sustainable Development Goals (SDG) and its preparedness has worsened over the years in comparison with other countries. India continues to face huge challenges in achieving 11 of the 17 SDGs, which has hard-pressed its global ranking on SDG preparedness. According to the report, India is on track to achieving SDG 13 on climate action. However, The State of India's Environment, 2022 highlighted that the country was facing major challenges in this area and India's performance on climate action(SDG) 13 has deteriorated from 2019-2020.This decline in India's performance is largely due to eight states: Bihar, Telangana, Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh, Punjab, and Jharkhand. On the other hand, the progress in around 10 of these sustainable development goals is similar to those in 2021.These include SDG 2 on ending hunger, SDG 3 on good health and wellbeing and SDG 6 on clean water and sanitation. Going forward, we will examine each of these goals in detail and how India is performing in each of them.

SDG 1: No poverty

The goal is to end poverty in all its forms everywhere. Though India's Score is moderately improving, it is insufficient to attain goal by 2030. Significant challenges remain for India in this area.

Indicators:

Indicator	Target	India (2022)	Trend
Poverty Head count ratio at $1.90 per day	0%	5.91%	A significant improvement from theestimated HCR of 23.06 in 2011
Poverty Head Count ratio at $3.20 per day	0%	35.70%	a significant improvement from the estimated HCR of 60.99% in 2011

SDG 2: Zero Hunger

The goal is to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. India's Score is stagnating or increasing at less than 50% of required rate. Major challenges remain in India's journey.

Indicators:

Indicator	Target	India	Trend
Prevalence of undernourishment (%)	0%	15.3% (2019)	Little or no improvement in this goal as the percentage of population under this indicator has remained almost stagnant from 15.6% in 2011 to 15.3% in 2019
Prevalence of stunting in children under 5 years of age (%)	0%	34.7% (2017)	A significant improvement from the estimated value of 45.32% in 2010

Prevalence of wasting in children under 5 years of age (%)	0%	17.3% (2017)	Little or no improvement in this goal as the percentage of population under this indicator has remained almost stagnant from 18.66% in 2010 to 18.18% in 2019
Prevalence of obesity, BMI ≥ 30 (% of adult population)	2.8	3.9 (2016)	India achieved this target in 2010 and now the percentage has increased to 3.9% as measured in 2016
Human Trophic Level (best 2–3 worst)	2.04	2.2 (2017)	India's score has been stagnant for 20 years at an approximate value of 2.20.
Cereal yield (tonnes per hectare of harvested land)	7	3.2 (2018)	Gradually improving from 2.68 in 2010 to 3.2 in 2018
Sustainable Nitrogen Management Index (best 0–1.41 worst)	0	0.9 (2015)	Stagnant score at 0.89 for last 5 years
Exports of hazardous pesticides (tonnes per million population)	0	0.5 (2019)	Goal achieved

SDG 3: Good Health and Well-Being

The goal is to ensure healthy lives and promote well-being for all at all ages. Score is moderately improving but it is insufficient to attain goal. Major challenges remain in this area.

Indicators:

Indicator	Target	India	Trend
Maternal mortality rate (per 100,000 live births)	3.4	145 (2017)	A significant improvement from the estimated value of 210 in 2010
Neonatal mortality rate (per 1,000 live births)	1.1	20.3 (2020)	A significant improvement from the estimated value of 31.8 in 2010
Mortality rate, under-5 (per 1,000 live births)	2.6	32.6 (2020)	A significant improvement from the estimated value of 58.2 in 2010
Incidence of tuberculosis (per 100,000 population)	0	188.0 (2020)	A significant improvement from the estimated value of 247 in 2010. However, this is still insufficient to attain the goal.
New HIV infections (per 1,000 uninfected population)	0	0.0 (2020)	Goal Achieved
Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30–70 years (%)	9.3%	21.9% (2019)	Score has been stagnant at >20% since 2010. Significant challenges remain in achievement of this goal.
Age-standardized death rate attributable to household air pollution and ambient air	0	184 (2016)	Trend information unavailable

pollution (per 100,000 population)			
Traffic deaths (per 100,000 population)	3.2	15.6 (2019)	Little or no improvement. From a score of 17.18 in 2010, the score initially increased till 2012 and then it has been stagnant at around 16.
Life expectancy at birth (years)	83	70.8 (2019)	Slow but steady improvements. From 67.23 in 2010 to 70.8 in 2019
Adolescent fertility rate (births per 1,000 females aged 15 to 19)	2.5	12.2 (2018)	A significant improvement from the estimated value of 37.2 in 2010
Births attended by skilled health personnel (%)	100%	81.4% (2016)	A significant improvement from the estimated value of 52.3% in 2008
Surviving infants who received 2 WHO-recommended vaccines (%)	100%	85% (2020)	A significant improvement from the estimated value of 79% in 2010. The highest score was achieved in 2019 (91%). The preparedness has worsened post 2019. This could be an effect of the pandemic
Universal health coverage (UHC) index of service coverage (worst 0–100 best)	100	61 (2019)	A moderate improvement from the estimated value of 48 in 2010. However, this is insufficient to attain the goal.
Subjective well-being (average ladder score, worst 0–10 best)	7.6	3.6 (2021)	The score has been decreasing from 5 in 2010. This is a major challenge as the data suggests that India will not be able to achieve this goal.

SDG 4: Quality Education

The goal is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Score is stagnating or increasing at less than 50% of required rate as challenges remain in this area.

Indicators:

Indicator	Target	India	Trend
Participation rate in pre-primary organized learning (% ofchildren aged 4 to 6)	100%	85.2% (2020)	Trend information unavailable
Net primary enrollment rate (%)	100%	94.6% (2020)	Little or no improvement. From a score of 96.12% in 2010, the score initially increased till 2013 and then it has dropped.
Lower secondary completion rate (%)	100%	84.6% (2020)	A moderate improvement from the estimated value of 76.27% in 2011. However, this is insufficientto attain the goal.
Literacy rate (% of population aged 15 to 24)	100%	91.7% (2018)	Slow but steady improvements. From 86.15% in 2010 to 91.7% in 2018

SDG 5: Gender Equality

The goal is to achieve gender equality and empower all women and girls. India's score is stagnating, and the preparedness is worsening.

Indicators:

Indicator	Target	India	Trend
Demand for family planning satisfied by modern methods (% of females aged 15 to 49)	100%	72.8% (2016)	A moderate improvement from the estimated value of 70.9% in 2010. However, this is insufficient to attain the goal.
Ratio of female-to-male mean years of education received (%)	100%	62.1% (2019)	A moderate improvement from the estimated value of 50% in 2010. However, this is insufficient to attain the goal.
Ratio of female-to-male labor force participation rate (%)	100%	26.8% (2020)	The score has been decreasing from 32.75% in 2010. This is a major challenge as the data suggests that India will not be able to achieve this goal.
Seats held by women in national parliament (%)	50%	14.4% (2020)	A moderate improvement from the estimated value of 10.83% in 2010. However, this is insufficient to attain the goal.

SDG 6: Clean Water and Sanitation

The goal is to ensure availability and sustainable management of water and sanitation forall. India's score is moderately improving but it is insufficient to attain the goal.

Indicators:

Indicator	Target	India	Trend
Population using at least basic drinking water services (%)	100%	90.5% (2020)	A moderate improvement from the estimated value of 85.68% in 2010. However, this is insufficient to attain the goal.
Population using at least basic sanitation services (%)	100%	71.3% (2020)	A significant improvement from the estimated value of 42.42% in 2010. However, this is still insufficient to attain the goal.
Freshwater withdrawal (% of available freshwater resources)	12.5%	66.5% (2018)	Trend information unavailable
Anthropogenic wastewater that receives treatment (%)	100%	2.2% (2018)	Trend information unavailable
Scarce water consumption embodied in imports (m3 H2O eq/capita)	100%	97.4 (2018)	Goal achieved

SDG 7: Affordable and Clean Energy

The goal is to ensure access to affordable, reliable, sustainable, and modern energy for all.India's score is moderately improving but it is insufficient to attain the goal.

Indicators:

Indicator	Target	India	Trend
Population with access to electricity (%)	100%	97.8% (2019)	A significant improvement from the estimated value of 76.3% in 2010. India is on track to attain the goal.
Population with access to clean fuels and technology for cooking (%)	100%	64.2% (2019)	A significant improvement from the estimated value of 35.2% in 2010. India is on track to attain the goal.
CO2 emissions from fuel combustion per total electricity output (MtCO2/TWh)	0	1.7 (2019)	The score has been stagnant at 1.6-1.7 since 2010. Major challenges remain in achieving this goal.
Share of renewable energy in total primary energy supply (%)	51%	23.1% (2019)	On track or maintaining SDG achievement

SDG 8: Decent Work and Economic Growth

The goal is to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. India's score is moderately improving but it is insufficient to attain the goal.

Indicators:

Indicator	Target	India	Trend
Adjusted GDP growth (%)	5%	3.6% (2020)	Trend information unavailable
Victims of modern slavery (per 1,000 population)	0%	6.1 (2018)	Trend information unavailable
Adults with an account at a bank or other financial institution or with a mobile-money-service provider (% of population aged 15 or over)	100%	79.9% (2017)	A significant improvement from the estimated value of 35.23% in 2011. India is on track to attain the goal.
Unemployment rate (% of total labor force)	0.5%	5.4% (2022)	The score has been stagnant at ~5% for India. Though it peaked to 8% in 2020, it returned to normal in 2022.
Fundamental labor rights are effectively guaranteed (worst 0–1 best)	0.85	0.5 (2020)	India is on track to attain the goal.
Fatal work-related accidents embodied in imports (per 100,000 population)	0	0.1 (2015)	Goal Achieved

SDG 9: Industry, Innovation, and Infrastructure

The goal is to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. India's score is moderately improving but it is insufficient to attain the goal.

Indicators:

Indicator	Target	India	Trend
Population using the internet (%)	100%	43% (2020)	A significant improvement from the estimated value of 7.5% in 2010. India is on track to attain the goal.
Mobile broadband subscriptions (per 100 population)	100%	47 (2019)	A significant improvement from the estimated value of 0 in 2010. India is on track to attain the goal.
Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1–5 best)	3.8	2.9 (2018)	No improvement from the estimated value of 2.91 in 2010. This is insufficient to attain the goal.
The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0–100 best)	50	45.7 (2022)	Goal Achieved
Articles published in academic journals (per 1,000 population)	1.2	0.1 (2020)	A moderate improvement from the estimated value of 0.06 in 2010. However, this is insufficient to attain the goal.
Expenditure on research and development (% of GDP)	3.70%	0.65% (2018)	The score has been decreasing from 0.79% in 2010. This is a major challenge as the data suggests that India will not be able to achieve this goal.

SDG 10: Reduced Inequalities

The goal is to reduce inequality within and among countries.

Indicators:

Indicator	Target	India	Trend
Gini coefficient	27.5	35.7 (2011)	No improvement from the estimated value of 35.4 in 2009. This is insufficient to attain the goal.
Palma ratio	90.00%	3.1 (2011)	Trend information unavailable

SDG 11: Sustainable Cities and Communities

The goal is to make cities and human settlements inclusive, safe, resilient, and sustainable.India's score is decreasing, and the preparedness has worsened in the past years.

Indicators:

Indicator	Target	India	Trend
Proportion of urban population living in slums (%)	0.00%	34.8% (2018)	The performance is worsening. From a value of 29.4% in 2010, the percentage of people living in slums has increased
Annual mean concentration of particulate matter of less than 2.5 microns in diameter (PM2.5) (µg/mt)	6.3	90.6 (2019)	There has been slight improvement from 95.85 (2010). It is insufficient for India to attain this goal.
Access to improved water source, piped (% of urban population)	100%	65.9% (2020)	The performance is worsening as compared to a value of 69.97% in 2010.
Satisfaction with public transport (%)	82.60%	68% (2021)	Little or no improvement. From a score of 66% in 2010, the score initially increased and then dropped after 2020.

SDG 12: Responsible consumption and production

The goal is to ensure sustainable consumption and production patterns. India has achievedthe target score and is on track to maintain this achievement.

Indicators:

Indicator	Target	India	Trend
Municipal solid waste (kg/capita/day)	0.1	0.4 (2018)	Goal Achieved
Electronic waste (kg/capita)	0.2	2.4 (2019)	Goal Achieved
Production-based SO2 emissions (kg/capita)	0	7.6 (2018)	Goal Achieved
SO2 emissions embodied in imports (kg/capita)	0	0.2 (2018)	Goal Achieved
Production-based nitrogen emissions (kg/capita)	2	8.0 (2015)	The score has been stagnant at 7-8. On track to achieve the SDG.
Nitrogen emissions embodied in imports (kg/capita)	0	0.4 (2015)	On track to achieve the SDG.
Exports of plastic waste (kg/capita)	0	0 (2021)	Goal Achieved

SDG 13: Climate Action

The goal is to take urgent action to combat climate change and its impacts. India hasachieved the target score and is on track to maintain this achievement.

Indicators:

Indicator	Target	India	Trend
CO2 emissions from fossil fuel combustion and cement production (tCO2/capita) 1.8 2020 L	0	1.8 (2020)	On track to achieve the SDG.
CO2 emissions embodied in imports (tCO2/capita) 0.1 2018 • L	0	0.1 (2018)	On track to achieve the SDG.
CO2 emissions embodied in fossil fuel exports (kg/capita) 1.4 2020	0	1.4 (2020)	Trend information unavailable

SDG 14: Life Below Water

The goal is to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. India's score is stagnating, and the preparedness is worsening.

Indicators:

Indicator	Target	India	Trend
Mean area that is protected in marine sites important to biodiversity (%)	100%	19.2% (2020)	No improvement from the estimated value of 19.18% in 2010. This is insufficient to attain the goal.
Ocean Health Index: Clean Waters score (worst 0–100 best)	100%	29.5 (2020)	Little or no improvement from the estimated value of 28.54% in 2012. This is insufficient to attain the goal.
Fish caught from overexploited or collapsed stocks (% of total catch)	0%	7.4% (2018)	On track to achieve the SDG.
Fish caught by trawling or dredging (%)	1%	54.9% (2018)	The performance is worsening as compared to a value of 46.96% in 2010.
Fish caught that are then discarded (%)	0%	4.9% (2018)	On track to achieve the SDG.
Marine biodiversity threats embodied in imports (per million population)	0	0 (2018)	Goal Achieved

SDG 15: Life on Land

The goal is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. India's score is stagnating, and the preparedness is worsening.

Indicators:

Indicator	Target	India	Trend
Mean area that is protected in terrestrial sites important to biodiversity (%)	100%	20.7% (2020)	No improvement from the estimated value of 20.65% in 2012. This is insufficient to attain the goal.
Mean area that is protected in freshwater sites important to biodiversity (%)	100%	18.9% (2020)	No improvement from the estimated value of 18.9% in 2012. This is insufficient to attain the
			goal.
Red List Index of species survival (worst 0–1 best)	1	0.67 (2021)	The performance is worsening as compared to a value of 0.71 in 2010.
Permanent deforestation (% of forest area, 5-year average)	0%	0% (2020)	Goal Achieved
Terrestrial and freshwater biodiversity threats embodied in imports (per million population)	0	0.1 (2018)	Goal Achieved

SDG 16: Peace, Justice and Strong Institutions

The goal is to promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. India's score is stagnating and there are multiple challenges in India's path to achieve these targets.

Indicators:

Indicator	Target	India	Trend
Homicides (per 100,000 population)	0.3	3 (2020)	There has been slight improvement from 3.76 (2010). It is insufficient for India to attain this goal.
Unsentenced detainees (% of prison population)	7%	69.1% (2019)	The performance is worsening as compared to a value of 65.7 in 2010.
Population who feels safe walking alone at night in the city or area where they live (%)	90%	62% (2021)	The performance is worsening.
Property Rights (worst 1–7 best)	6.3	3.7 (2020)	The performance is worsening as compared to a value of 4.81 in 2018.
Birth registrations with civil authority (% of children under age 5)	100%	79.7% (2020)	Trend information unavailable
Corruption Perception Index (worst 0–100 best)	88.6	40 (2021)	There has been slight improvement from 36 (2012). It is insufficient for India to attain this goal.
Children involved in child labor	0%	NA	Trend information unavailable

(% of population aged 5 to 14)			
Exports of major conventional weapons (TIV constant million USD per 100,000 population)	0	0 (2020)	Goal Achieved
Press Freedom Index (best 0–100 worst)	10	46.6 (2021)	The performance is worsening as compared to a value of 40.34 in 2013.
Access to and affordability of justice (worst 0–1 best)	0.75	0.4 (2020)	There has been slight improvement from 0.31 (2014). It is insufficient for India to attain this goal.

SDG 17: Partnership for the goals

The goal is to strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development. India's score is stagnating and there are multiple challenges in India's path to achieve these targets.

Indicators:

Indicator	Target	India	Trend
Government spending on health and education (% of GDP)	15%	4.4% (2019)	No improvement from the estimatedvalue of 4.24% in 2010. This is insufficient to attain the goal.
For high-income and all OECD DAC countries: International concessional public finance, including official development assistance (% of GNI)	NA	NA	Trend information unavailable
Other countries: Government revenue excluding grants (% of GDP)	40%	13.2% (2018)	There has been slight improvement from 13.18 (2010). It is insufficient for India to attain this goal.
Corporate Tax Haven Score (best 0–100 worst)	40	0 (2019)	Goal Achieved
Statistical Performance Index (worst 0–100 best)	100	70.4 (2019)	There has been slight improvement from 67.39 (2016). India is on track to attain this goal.

Discussion

We must restate the importance of sustainable development for achieving the true potential of growth without disturbing the environmental equilibrium. Over the past two decades in particular, economic growth has come at the expense of the environment. Earth's natural resources have been used in ways that are environmentally inefficient and uneconomical, with dangerous consequences such as decreased air quality and overall climate change. Sustainable development is a carefully planned strategy to embrace growth while using resources more efficiently, with utmost consideration of immediate and long-term benefits for our planet and the mankind.

The examination of India's performance on sustainable development goals suggests that there is a long and difficult path ahead in this journey. The country continues to face major challenges in achieving 11

of the 17 SDGs, which hard-pressed its global ranking on SDG preparedness. The progress in around 10 of these goals is similar to those in 2021. While India has performed well on SDG 12 and 13, there are major challenges that remain to achieve other goals.

We need to reformulate some strategies and prioritize the critical action items. New partnerships and innovations that emerged recently, including scientific cooperation should be scaled-up to support the SDGs. Science and technological innovations can help identify solutions and can provide decisive contributions to address the major challenges. These call for increased and prolonged investments in statistical capacities, Research &Development and education. Achieving the SDGs is fundamentally an investment agenda in physical infrastructure (including renewable energy, digital technologies) and human capital (including health, education).

References:

Sustainable Development Report 2022
United Nations Department of Economic and Social Affairs, Retrieved from: https://sdgs.un.org/goals
Sustainable Development Report, Data on SDG Dashboards and Trends, Retrieved from: https://dashboards.sdgindex.org/profiles/india
Ministry of Environment, Forest and Climate Change, Policies to achieve sustainable Development goals, Available at: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1843400
Media Reports, Press Release, Ministry of Environment, Forest and Climate change

India Water Resource Information Systems (India-WRIS): Managing water resourcesinformation for better strategies and policies

Mahendra Singh
Pragyan Pushpanjali
Nagapavan Chintalapati
Nitesh Bhatia
RajkiranPrabhakar

Abstract

The greatest civilizations of the world are all closely related to the availability of water. Water is the most essential element, a resource for the people to survive and grow as individuals and also as a civilization. Water is needed for the purpose of agriculture (irrigation), human survival (drinking water), logistics (water ways), energy (hydro electricity), etc. The availability of water for these various needs has to be ensured in a timely and optimum manner by the state through various technologies and interventions. Optimization of any resource is not possible without an understanding of the demand and supply challenges related to the resource. A system for understanding the demand and supply challenges is the development of Information Systems. Thispaper examines the information systems in the context of water; benefits of the system and identifies challenges hindering the maximization of information systems contribution for optimization of water resources use towards the economy, livelihood, food supply, logistics, etc.

Key words: Water Resource Information Systems, Water management, Supply of water,

Introduction

India is blessed with many rivers. India has a rich wealth of water resources. The fresh water sourcein India is approx 4%. The rainfall in India is one of positive additions to the water resources. Thecountry wide network of rivers, lakes, ponds and other water resources are numerous. The wide number of water resources results in complex and varied data. Information management of water resources emerged as major challenge in managing water resources, environment and allied areas.Water policy adoption, policy revisions are major areas (Tinashe Lindel Dirwai et. al, 2017) recent development is the area of information technology that has been successfully used in all domains of our life and so is the area of natural resources management. The current trends in Managementinformation systems (MIS) shows that water resources can be well managed with the help of efficient information management (Nepfumbada, Braune, & Madikizela, 2005), (Kong, Yang, & Shi, 2012). MIS is a system used for data collection, warehousing, analysis, reporting, and visualization used for decision making.

Water resource management involves a number of hydrological elements. These elements are sources of various data. Managing such data emergence sources has become important for policy framing and decision making. Simple decisions like forecasting of flood situation increase or decrease in water level is simple examples where MIS of water resources played a key and pivotal role. Present day situation suggests a unified system for planning and managing information related to the country's water resources. Efficient water governance requires an efficient information management system.

There are many complexities in water data like – multiplicity of sources of data, varyingapplication and requirements of data, incomplete and highly dispersed nature of data. Water data in most countries lack the basic statistical feature of (India-WRIS.). At the same time it becomes quite difficult to compare these data.

Department of Business Administration, Central University of Jharkhand, Ranchi, India
Assistant Professor, Department of Business Administration, Central University of Jharkhand, Ranchi, India
Institute of Management Studies, Banaras Hindu University, Varanasi, U.P. India
Department of Business Administration, Central University of Jharkhand, Ranchi, India
Institute of Management Studies, Banaras Hindu University, Varanasi, U.P. India

The need for data is highlighted by the conflicts for water. The availability of water is not consistent in all the rivers across the entire year. Some of the rivers originate in India whereas others originate outside India. This poses International Challenges in distribution of water equitably and Information systems are central to rational resolution of the conflicting claims (Satyanarayana& Sharma, 2009). The same is true for the interstate disputes for water distribution for the purposes of drinking water, irrigation and industries.

Figure 1: Few important facts about water availability in India

1	Average water rainfall	1160 mm
2	Range of rainy days	5-150 days
3	Per capita water availability	1588 M^3
4	Average annual potential flow in rivers	1879 KM^3
5	Estimated utilizable water resources	1123 KM^3

Source: *Resources at a Glance 2011 Report, CWC, New Delhi, (http://www.cwc.nic.in)*

The following research is carried out to address the Information needs, Information systems and challenges in the context of Water Resource Information in India.

Research Question

1. What are the actions taken by the government to keep track of water resources in thecountry?
2. What is the current status of the information system developed by the government?
3. Evaluate the information systems.

Research Objectives

i. To describe the water resource information system

ii. Identify the strengths and weaknesses in data collection, storage, analysis, predictabilityand dissemination to decision makers of Water resources

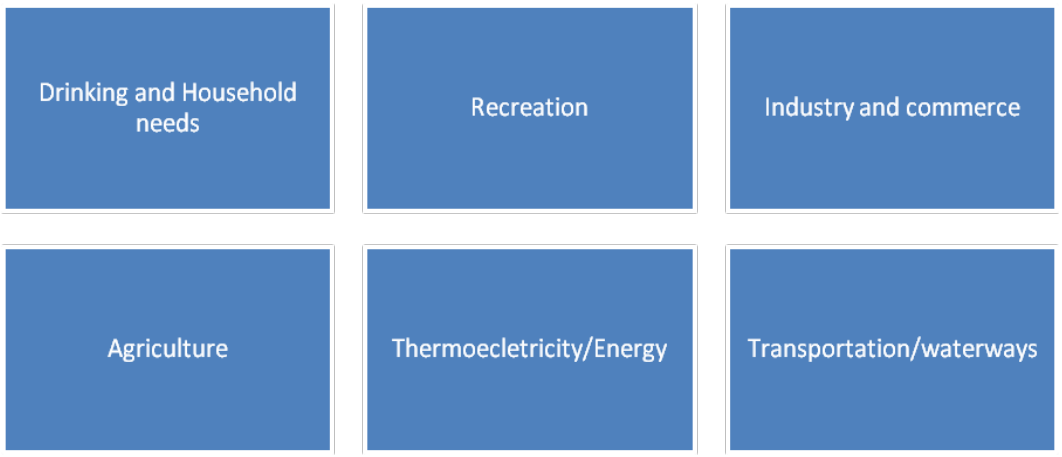
iii. Suggest the areas where additional focus needs to be provided for more efficient andeffective Information Systems.

2. Review of water resources information and WRIS

2.1. Uses of Water (Water – The elixir of life on Earth)

Water is used for Agriculture (Irrigation), Drinking Water, Industries, Energy Production and Transportation. India has well developed infrastructure for storage of water in Dams, and also has hydro electric power generation facilities. Drinking water availability to every household is a challenge in many places and tap water to every home is one of the focus areas of the Government of India. The economic growth of India has been driven by Service industries but with more and more people shifting out of Agriculture jobs, the need for manufacturing industries is higher and that will increase the demand for water. The cost of transportation through rivers is considerably less than road / rail transport and the government has developed National Water Way as one of the to improve the movement of goods and people using Rivers across the country.

Figure 2: General uses of water (CDC, 2021)



The state governments have been managing the water resources for agriculture and drinking water for many years with modicum of success. The balancing of water resources supply with demand has been ensured through a combination of initiatives. However, even a cursory review of the newspapers will show the protests, demands by farmers and citizens during most years for supply of water for irrigation and drinking water. This clearly exhibits a failure in the predictability of demand and the logistics strategy for supply of water resources.

The excessive focus on irrigation and drinking water has forced Industries to adjust their demand for water resources from public sources and depend on groundwater and processed water for their requirements. There is a need for this to change as India needs massive industrialization with heavydemand for water in the next decade as the Youth moves from agriculture to industries. The ability of service industries to support the ever growing youth population is reducing and excessive human resources in GIG economy businesses may not be beneficial in the long term for the society.

Government in the recent decade has come out with the plan to use rivers for transport of goods / people. The water way is a cost effective, efficient and effective way to address the logistics of transport of goods from one place to another. The success of the waterway will be only ensured if the water levels of sufficient depth are available in the entire route of journey. Infrastructure needs to be developed to ensure availability of water for transport needs ("Home _ Department of Water Resources, RD & GR _ GoI,"2022.). The dams also help in hydro electricity generation, which have helped the country in ensuring power supply. Hydro electricity is an important element of the energy security of the country. Water has to be flowing for Hydroelectricity and optimum use is only possible if the water flow aids in the other domains of use like Irrigation, drinking water, transportation and industry.

The entire discussion posits the need for having a real time information system regarding water resources. The paper discusses the existing water resources information system developed by the Government of India and then evaluates the existing system and data to identify the challenges in the above five domains for water usage

2.2 Water Information Management – the Indian Initiative

Keeping in mind the need of MIS for water resources, a joint effort of Central water commission (CWC) Ministry of water resources and Indian Space research Organization (ISRO) led to the generation of database and implementation of web enabled water resources information system of India' short (India-WRIS WebGIS). It is claimed as a single window solution with respect to water resources India for stakeholders, government agencies, departments, state water resources departments, research institutions and others (Satyanarayana & Sharma, 2009). It is a web enabled MIS with comprehensive data on different areas of hydrology and water resources in India. Consistency in data is maintained with addition and updating of data at different levels. The major areas in MIS, Data management in area of water resource management include-data governance organization, data production process, procedures for integrating data management, data processing and most important is dissemination of information for decision making (Filali- Meknassi et al., 2018)

2.3. Application of water data

There are 20 major water basins in India. An assessment by CWC in 2019 has reported that the average annual water resources of 20 basins is 1999, 20 Billion Cubic Meters (BCM). Data collection mechanisms for many other water resources are slowly getting built up by the state and central governments for the augmentation, conservation and efficient management of water resources ("India-WRIS," 2022.).

Water resource planners and decision makers are in need of reliable, up to date and relevant data for their different needs. Water resources planning include benefits to people and economies (Loucks, D.P., van Beek, E. 2017). The data related to water is used in many more areas of planning, decision making and forecasting. The major areas of application of water data as discussed in (Filali-Meknassi et al., 2018) may be summarized as-

Figure 3: Major areas of application of water data

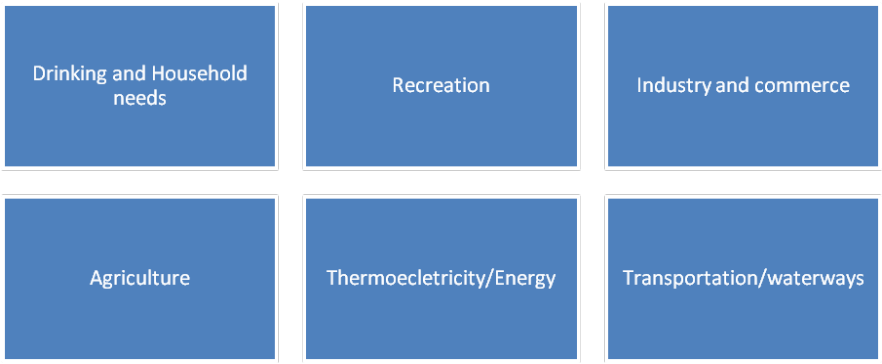


Figure 2: General uses of water (CDC, 2021)

3. The architecture of WRIS

The key elements of any MIS as per definition by Ralph Stair and George Reynolds (Stair &Reynolds, 2010) a computer-based information system (CBIS) as a "single set of hardware, software, databases, telecommunications, people, and procedures configured to collect, manipulate, store, and process data into information.

1. Hardware
2. Software
3. Data
4. Procedure
5. People

On the basis of basic structure of MIS, The India WRIS is having key four elements(Satyanarayana & Sharma, 2009)

1. Data- Input, entry and collecting system
2. Data Storage, analysis, transformation in user friendly manner
3. Interactive system for geo visualization and temporal analysis
4. Information dissemination system in public (used by public, downloads and tools)(Singh, Kaur, Litoria, & Das, 2021)

The present portal contains 12 major info systems, 36 sub info systems having 95 spatial layersalong with large attribute data of the water resources assets and temporal data of 5-100 years ("India-WRIS," 2022)

3.1. India Web WRIS web GIS timeline-

Time line/Version	Time/Year	Remarks
0	MoU in 2008	CWC, Ministry of Jalshakti, ISRO
1	December 10, 2009	Execution
2	December 7, 2010	
3	March 22, 2012	Designed for multi-users
4	December 4,2012 and March 28, 2014	
Revamped version/ currentversion	30 July 2019	Revised version

India WRIS is managed by the National water informatics center (NWIC). There are different data agencies in NWIC. The data for web based GIS is taken from various Indian agencies. These agencies work as multiple elements/systems of MIS where data input, processing, warehousing, analyzing and reporting are done. Various agencies included in India WRIS also works as a platform for data usage by public and other stakeholders. The major agencies for data of NWIC have been discussed below. At present the NWIC includes 49 agencies including nine central agencies, 35 state agencies, three rivers basin agencies and 2 Union territories agencies. The tableprovides important data agencies.

Figure 4: Various data agencies for water information systems

Agency	Web address	Major data availability
Central WaterCommission	http://www.cwc.gov.in/	Rainfall, reservoir level, reservoir live storage, data onriver level information on river flow and surface water quality. The source is having facility of web editor module (by state water resources departments)
National RemoteSensing Centre	https://www.nrsc.gov.in/	Having gridded daily data on rainfall, soil moisture content,land degradation maps, ground water potential maps etc. vast resources available for downloading
National Institute of Hydrology	http://www.nihroorkee.gov.in/	Provides data with respect tolive rainfall. Updated Data regarding river gauge level.
Central Water and Power research station	http://cwprs.gov.in/	Data in the form of technical reports, publication and otherswith respect to water and power.

Central ground waterboard	http://cgwb.gov.in	Seasonal groundwater leveldata for different states, districts and station wise. Data on fluctuations of ground water level. Data on water quality of groundwater.The CGWB also provides data on aquifer system of India
Survey of India	http://www.surveyofindia.gov.in/	Data with respect to international boundaries, state, district and station wiseboundaries.
Central PollutionControl Board	https://www.cpcb.nic.in/	Data source for ground water quality, surface water quality, integration is in progress.

Source: Compiled by Authors

Apart from the above major central agencies there are various state agencies for data in NWIC platforms. The long list of these agencies indicates how good integration of state water resources bodies, departments, units has been done for increasing the efficiency, cost effectiveness, availability and speed of data for various decision making with respect to policies for water resources management in the country.

3.2. The MIS (WRIS)

Water data management as we are discussing is complex and challenging. Keeping in view the vastness and dispersed nature of water data, its management has specific requirements. The water data management should be focused around the five major areas (Filali-Meknassi et al.,2018).

1. Governance of water data and related policies, sharing of the water information and usageby decision making bodies.
2. The point of data emergence should be kept in mind for data production at differentlevels
3. Integration of different levels of data (nationals, regional, state level, district level, stationlevel)
4. Efficient methods of data processing, and generating useful reports
5. Reporting and making it available to the users, use of different digital tools forinformation dissemination (websites, Smartphone apps, e books, social media)

The MIS (India WRIS) works on advanced software, computer technology, high end processing tools and web technology. In general water resource information systems are designed keeping in mind the developing water resources database useful for various stakeholders and users. Availability of real time and efficient data is key in MIS. Advanced internet, intranet technology platforms are useful in such designs (Wang, 2021). Application of database management system (DBMS), server database, web services and map services and spatial data services are major contributors to the WRIS.

The India WRIS is a well planned, designed, structured and executed MIS. The design of India WRIS is done keeping in mind the requirements of the users. The comprehensive and clarity in information availability is another good feature of the India WRIS. There are a total of 12 main information systems. The first one is the Base data information system which includes information regarding administration, region, infrastructure and terrain (“India-WRIS,” 2022). The second main information system is surface

water info systems including water resource divisions, basin surface water bodies, Canal River, water resource projects and other information (Satyanarayana & Sharma, 2009). The third main information system is groundwater information system of ground water level, aquifer etc. The fourth information system is Hydro-met information system including meteorological, climate flood forecasting related information. The fifth information system including surface and ground water quality is the water quality information system. The sixth main information system is the snow cover /glacier information system. Seventh main information system is the inland navigation waterways system. The eighth main information system details the information on inter basin transfer links. Ninth main information system covers hydro-met extremes of flood, drought and extreme events. Land resource info system regarding land use, land degradation, soil and water land is the tenth main information system. Water tourism information system is one the main information systems of India WRIS. Twelfth main information system includes socio-economic data in two major sub information systems (rural and urban) ("India-WRIS,"2022.). In total there are 12 main information systems, 36 sub information systems. The India WRIS includes 87 layers and more than 4500 layers. The data coverage is of 5-100 years.

4. The major tools and technologies used in architecture of India WRIS

The web application and user interface technology is used to disseminate information to users. Data visualization, analysis are used for generating various reports. Adobe flex is used for rich internet application. India WRIS uses Oracle 11g (relational database Management System) for enhancing support in multi user systems. For web GIS and front end 2D adobe flex, HTML and PHP are used. For 3D the use of Arc explorer, .NET and Arc Globe has been done. For the purpose of publishing and geo data services ARC GIS server is used (Satyanarayana& Sharma, 2009). For geo data base and back end Oracle 11g and My SQL are used. For database storage and web hosting a strong hosting architecture is located and replicated at three places (Satyanarayana& Sharma, 2009). Public usage and reach is ensured by designing the interface in a user friendly manner. The home page has a main toolbar with six modules, these various modules are provide with graphic user interface facility do easy access. Another module is about information discovery and data catalog. Third core module is for the purpose of data explorations and viewing the data using various tools.

5. Role & benefits of India WRIS in Water resource information management

The India WRIS is powerful MIS which serves many benefits in water resource management. It provides graphical presentation and availability of time series data. Data on telemetry of different stations and basin level are provided. Map view on portal is one of the important features which provide easy access to information. Colour based mode are helpful in understanding of the different information. Different layers of India WRIS provide information on more than 100 user areas. Information on irrigation related infrastructure is provided with the help of national remote sensing organization (ISRO). Information on hydro structures with help of Cartosat satellite data is available. Separate layer on beacon indicates the location and inland navigation of waterways. The information based on coastline is useful for various decisions and policies. Ground water quality and locations are available in a separate layer on groundwater quality, where origin of data is from CPCB. District wise culturalable areas for minor irrigation related information are useful for various policies. The detailed information on listed dams of India based on national register on large dams is quite useful water resource information. Information with respect to earthquakes, drought, and rainfall are major useful information available for various forecasting, decision making and policy framing. Information available for hydro meteorological, hydroelectric basins is related with hydroelectric regions of India. Information son minor irrigation, dug wells, deep tube well, shallow tube well, canals are another area of information useful in agricultural usage. Information available on river polygons, river inland navigations, river line are provides major information on river system in India. Water bodies' data of mapping of surface water bodies of India, water tourism spots related information are integral part of information used.

Figure 5: Major water data available on India WRIS

Surface water	Storage, River, snow glacial lake, surface water quality,wetlands
Ground water	Ground water exploration, Groundwater behavior, Ground water resource estimation, GW prospects study, Artificial recharge structure, Ground water quality
Land Resource	Land degradation, Land use-Land cover, soil type, waterlogging , soil salinity, wasteland study
Hydro meteorological	Rainfall, Evapo-transpiration, Soil moisture, Agro-climatic/ ecological region
Allied themes	Inland waterways navigation, storm surge study, socio- economic census, flood inundation, drought affected areas, reported extreme temperature rainfall & earthquake events.
Projects	Water resources projects, inter-basin transfer links, minor irrigation census

Source: (India-WRIS, 2022)

Figure 6: Important WRIS tools, publications and Utilities

Tools	Online web editor, Artificial recharge structure, data entry
Publications	Atlas, Basin reports, Compendium, Pre-generated maps, Project Documents, Research & development, wasteland distribution atlas, water logging and salinity assessment.
Utilities	Data availability, Data /report downloads District report at glance,Geo viewer, meta data, PMP atlas, Surface water audit, WRIS wiki.

Source (India-WRIS, 2022).

Information on waterways, waterways limits and waterways navigation are of importance in logistics and international transportation. Usefulness of India WRIS is more in the area of visualization of different available data, mapping, and downloading related information and reports. India WRIS helps in maintaining water data on web portals like information on past and real time rainfall. Information on surface water reservoir, groundwater are another type of most used information. Different available reports in downloadable formats are useful for policy makers.

6. Conclusion

WRIS is the need of the hour as the demand for water is ever increasing and the sources dwindling. The paper has highlighted the salient points of the current system and has provided a foundation for the debate on the way forward. The conflicts of water are a reality of the day and governance of water resources will help in ensuring equitable distribution of water resources. In the above paper, we have highlighted the uses of water – agriculture, industry, energy production, drinking and household uses, etc. Need based prioritization methods used currently are not satisfying the demands of various users. A real time water resource information system will provided trustable data to all stakeholders and allow for resolution of conflicts in an amicable fashion. The WRIS will help in preservation of water resources, improve storage mechanisms of water in centralized river systems and decentralized lakes and tanks,

and optimize distribution of water in a timely fashion for various purposes. The WRIS will improve the predictability of demand for water resources and help in prioritization of the demands of water resources. The WRIS is a tool for policy makers to manage the water resources better and the need for collecting data from other sources is highlighted in the above study.

7. References:

Dirwai TL, Kanda EK, Senzanje A, Busari TI (2021) Water resource management: IWRM strategies for improved water management. A systematic review of case studies of East,West and Southern Africa. PLoS ONE 16(5): e0236903. https://doi.org/10.1371/journal.pone.0236903

CDC. (2021).Other Uses and Types of Water | Healthy Water. Retrieved from https://www.cdc.gov/healthywater/other/index.html

Filali-Meknassi, Y., Murray Argent, R., Haener, P., Verbist, K., Meyer, C., Berod, D., …Abrate,

T. (2018). *The Handbook on Water Information Systems. Administration, Processing andExploitation of Water-Related Data*. Retrieved from www.inbo-news.org

Home _ Department of Water Resources, RD & GR _ GoI. Retrieved from http://jalshakti-dowr.gov.in/.

India-WRIS.2022. Retrieved from https://indiawris.gov.in/wris/#/

Kong, D., Yang, G., & Shi, C. (2012). Design of water resource management information systembased on Web GIS. *Proceedings - 2012 International Conference on Computer Science andInformation Processing, CSIP 2012*, 1419–1422. http://doi.org/10.1109/CSIP.2012.6309130

Loucks, D.P., van Beek, E. (2017). Water Resources Planning and Management: An Overview.

In: Water Resource Systems Planning and Management. Springer, Cham.https://doi.org/10.1007/978-3-319-44234

Nepfumbada, M., Braune, E., &Madikizela, B. (2005). Information Needs for Integrated Water Resources Management, (November).

Satyanarayana, P., & Sharma, J. R. (2009). Web Enabled Water Resources Information System for India, (January). Retrieved from https://www.researchgate.net/profile/Pondari_Satyanarayana/publication/296675244_web_enabled_water_resources_information_system_of_india_india-wris_webgis/links/56d7d62508aebabdb4030d22/web-enabled-water-resources-information-system-of-india-india-wris-we

Singh, B., Kaur, S., Litoria, P. K., & Das, S. (2021). Development of web enabled water resource information system using open source software for Patiala and sasnagar districts of Punjab, India. *Water Practice and Technology*, *16*(3), 980–990. http://doi.org/10.2166/wpt.2021.050

Stair, R., & Reynolds, G. (2010). Principles of Information Systems, A Managerial Approach,705. Retrieved from https://drive.uqu.edu.sa/_/fbshareef/files/principles of information systems 9th -stair, reynolds.pdf

Wang, F. (2021).Water resources information management system based on agent model.*Journalof Physics: Conference Series*, *2066*(1), 0–7. http://doi.org/10.1088/1742- 6596/2066/1/012036

The Role and Benefits of Natural Resources of Kaziranga National Park in Supporting the Economic Well-Being, Physical and Mental Health, and Positive Perception Towards Protected Area Conservation of Local Communities

Shashank Shekhar
Ruchi Badola
Pragyan Pushpanjali
Anand Mishra

Abstract

The current study deals with the (1) perspectives of and (2) benefits to local communities neighbouring the Kaziranga National Park to various aspects of ecosystem services. The study involved interviewing participants to know their perspective on utilities of services provided by the protected area in their daily living, health, psychology, and livelihood. The above-mentioned investigation was carried out between the years 2018 and 2021. It consisted of 749 semi-structured interviews carried out in 21 different villages in the Bokakhat and Kaliabor Circle adjacent to Kaziranga National Park. Every household served as a sampling unit. The villages were chosen based on how likely they were to use non-timber forest products and how dependent they were on the ecosystem services of the forest to support their livelihood. Through group discussions and semi-structured interviews, the eldest members of the household provided most of the information on the use of NTFP extraction and perceptions of the benefits of ecosystem services. The respondent's demographic information was also recorded. Results showed a very positive attitude of locals towards protecting and conserving the protected area for better livelihood, health, and psychological benefits. Based on this study, this paper also discusses the role of Provisioning and Cultural Ecosystem Services of Kaziranga National Park in supporting human health and well-being.

Keywords: *Provisioning services, cultural services, medicinal plants, ethnomedical use,mentalhealth, perception towards*

OVERVIEW

Ecosystem Services (ES) are significant contributors to the health and well-being of human beings. It is broadly categorized as Provisioning Services, Regulating Services, Supporting Services, and Cultural Services (MEA, 2005) with the majority being offered by forest variations. Provisioning services such as NTFPs (food, seeds, fruits, fodders, fuel wood, medicine, natural fibres, etc.) and timbers delivered by the forest act as a resource to local communities to sustain a livelihood, whereas cultural services (such as spiritualism, entertainment, aesthetics, etc) improve the quality of life of the communities. Regulating services supports humans by regulating the key components or processes of the ecosystem such (as carbon sequestration, climate modulation, water cycle, amelioration of infectious diseases, etc.) while forests also provide supporting services that significantly support humans by promoting production and/or maintenance of all other ecosystem services. These are the fundamental processes that support the services and functioning of any ecosystem. Forest ecosystem services (FESs) promote natural ecosystem health and improve the health and well- being of the human population residing in the vicinity.

Although, forests are spread across all terrestrial biomes of the earth, *viz*., Tropical Forest Biomes, Savanna, Desert, Grassland, Temperate Deciduous Forest Biome, Mediterranean Climate Biomes, Northern Coniferous Forest Biome, and Tundra (Forseth, 2010), yet,

Department of Ecodevelopment Planning & Participatory Management, Wildlife Institute of India, Dehradun
Scientist-G, Department of Ecodevelopment Planning & ParticipatoryManagement, Wildlife Institute of India,
Assistant Professor, Department of Business Administration, Central University of Jharkhand
Finance Officer, Dr. Shyama Prasad Mukherjee University, Morabadi Maidan, Ranchi

Tropical forests are known to be major contributors of forest ecosystem services (FES), specifically, genetic resources and water cycling (Anderson and Bojo, 1992). Briefly, it may be stated that all four types of ES are vital for the functioning of the ecosystem and maintain the health and well-being of local communities. (MEA, 2005)

Threat to Forests

Besides, forests account for 2/3rd of the gross primary production of the terrestrial biome (MEA, 2005) providing not only oxygen for respiration but various provisions to sustain life on earth. It is alarming that in 2010 the global forest cover was 30% (3.92Gha) of the earth's land mass, with 93% natural forest and only 7% plantation, which depleted by 6.3% between 2002-2020 (FAO, 2010; TEEB, 2010; Hansen et al., 2013; UMWRI, 2021). According to the Sustainability Consortium (SC), from 2001-2020 annually 411Mha of tree cover vanished globally. Commodity-driven deforestation was reported as the dominant driver of global annual tree cover loss in 2001-2019 among others as urbanization, shifting agriculture, and wildfire (SC, 2021). This depleting forest cover in the recent climate change scenario is expected to drastically affect FES and human livelihood and well-being. This is a pressing concern as it is well established that any change in the basics of land (such as forest cover, habitat alterations, water balance, etc) directly affects the capacity of the ecosystems to deliver FES and ecosystem functions (Costanza et al., 1997; Lambin et al., 2001, Balthazar et al., 2015) which would not only impact human wellbeing and health but also the entire biodiversity and production of the landscape. Thus, to maintain the well-being and health of local communities it would be mandatory to conserve forest cover and reduce dominantdrivers causing permanent loss of forest and tree cover, globally.

Protected areas in support of Forest ecosystem services

Protected areas have the potential to support all categories of ecosystem services although provisions of services and functions may vary with different types of ecosystems. Conservation of protected areas directly preserves FES of the landscape as evident from numerous studies globally (Antonio et al., 2015; Manolaki and Vogiatzakis 2017) but entails upgrading traditional conservation approaches. Preserving provisioning and cultural FES to protect the benefits derived for human health and well-being gets complicated, in today's scenario, as the traditional conservation plans were not designed to preserve regulating services (such as pollination, decomposition, disease control, climate regulation, air, and water decontamination, soil erosion, flood control, and carbon storage, etc.) (Kremen and Ostfeld, 2005; Zorrilla-Miras et al., 2014) but rather focused on species and habitat conservation. This also poses a challenge to the integrated conservation of ecosystem services. Additionally, most of the studies conducted worldwide tend to explore individual ecosystem services studied at wide scales (Naidoo et al., 2008; Tang et al., 2011) rather than considering the entire system at lessened spatial resolution. Very few studies have represented spatial-scale ecosystem services as protected areas (Duran et al., 2013). Few studies as one in a semi-arid ecosystem of Spain showed carbon stocking and groundwater recharge to be the most delivered and supported FES of protected areas networks (Antonio et al., 2015). The current study also resonates similarly and enlists the most important FES used by neighbouring communities of Kaziranga National Park. Briefly, the protected area benefits local communities with major livelihood opportunities that support them in sustaining life.

Protected areas control air quality

The average air quality index (AQI) (2021), the protected area had a satisfactory air quality index value of 100 with PM_{10} as the main pollutant and CO of 950.0 μg/m³ (AQI 47) (CPCB, 2021). This is comparatively healthier than cities such as Delhi (AQI 215-500), Kolkata (AQI 100-255), Mumbai (AQI 108-500), etc where forest cover is comparatively low. Besides with the closure of seventy industries in the "non-developmental zone" of the protected area as per the National Green Tribunal (NGT) the air quality and habitat quality are expected to improve with a reduction in pollution from sulphur and untreated effluents discharges (Down to Earth, 2012).

Protected areas in psychological wellbeing

Protected areas preserve and conserve natural habitats with occasional restoration activity that support the recovery of natural habitats and forest succession. This helps maintain the ecological balance by increasing overall forest and tree cover. Human benefits in economy, health, psychology, and various other aspects from these green lungs of nature. However, environmental conditions have been proven to have a differential effect on the attitude of individuals in forested and urban areas (Park et al., 2011). Urban life brings along with loads of stress involving work pressure, pollution, interpersonal relationships, and various other stressors while also limiting people to closed rooms and clumped-up spaces irritating the state of mind, as observed in daily life. All these drives the urge of urban citizens to escape into the wilderness for therapeutic health benefits and relief from anxiety and strain (Knopf, 1983; Ulrich et al., 1991; Kaplan, 1995; Frumkin, 2001; Lee et al., 2011, 2019; Mao et al., 2012; Tsunetsugu et al., 2013; Ochiai et al., 2015; Bang et al., 2017; Velarde et al., 2007; Neff et al., 2018; Song et al., 2018; Yu et al., 2018; Lyu et al., 2019; Kim at al., 2020). Natural environments also provide an improved physiological and emotional environment improving human attitude or mood than urban scapes (Hartig & Staats, 2003; Morita et al., 2006). Chiang et al. (2017) reported a positive response of human psychology to landscape locality and forest density. It has also been reported to improve the work performance of individuals and even on the automatic nervous system of hypersensitive people (Shin, 2007; Song et al., 2015). Even progresses in mental health in psychologically challenged or disturbed patients have also been seen in numerous studies (Poulsen et al., 2016; Bielinis et al., 2020) alongside boosting immunity (Li et al., 2008; Park et al., 2010)) promoting the therapeutic utility of aesthetic profits of natural sites in psychological treatments. Also, Kobayashi et al. (2021) have recently reported an increase in vigour and a reduction in fatigue, depression, dejection, anxiety, tension, and confusion with walking and viewing forests. Summarising, it may be stated that forests or natural habitats have positive psychological assistance to human well-being both in virtual and first-hand experience. Thus, as also evident from the current study, conserved forests or protected areas have a high potential of delivering psychological bonuses or acting therapeutically to the well-being of local communities and people visiting the landscape.

Nature's pharmacy

Forests have traditionally served as reservoirs of herbal medicines globally with 70-95% of the population in developing countries relying on traditional medicines for primary healthcare (Robinson and Zhang, 2011). Herbal medicinal therapy, also known as Ayurveda, has been practiced in India and globally for ages. It is known to have originated in India more than 3000 years back and still remains a commendable healthcare source in the eastern world, specifically in Asia (Britannica,2019). Herbal medicines are widely practiced among Indian ethnic communities (Silambarasan et al., 2017; Singh et al., 2017) even in the modern era of allopathic and advanced medicine. According to Senthilkumar and Murugesan et al. (2012), almost 44% of known species in India are used in traditional medical practices. Manifold approaches in the conservation of medicinal plants and their habitats are also practiced in India (Udayakumar et al., 2020). Research on ethnomedicines in Western Ghats, south India, North-eastern India, and other parts of India has revealed the potential of new drug developments and economic benefits to the livelihood of the local community from natural plant resources (Balamurugan et al., 2018; Raj et al., 2018; Tripathi & Mall, 2018; Silambarasan et al. 2017; Jaganmohan et al., 2018; Archana 2019; Hussain et al., 2019; Tamang et al., 2019; Zameer, 2021). Numerous studies in Assam similarly showcase the rich resource of medicinal plants in the wilderness of the region specifically in the protected areas (Baro et al., 2017; Yadav et al., 2018; Borah et al., 2020). Some of the studies also emphasize on ethnomedical utilization of medicinal plants among indigenous tribes such as Karbi, Sonowal Kachari, etc. (Swargiary et al., 2019; Baidya et al., 2020; Dutta & Barooah, 2021). Briefly, medicinal plant resources of forests in and outside protected areas are significant for the derived medicinal and economic benefits besides contributing to the traditional and cultural integrity of the local communities. It is crucial that biodiversity conservation and management approaches are integrated

with planning for the conservation of FES to carefully maintain the ecosystem functions and services of nature while benefiting human health and wellbeing.

OBJECTIVES OF THIS STUDY

The objective of this paper are to study

NTFPs (Non-Timber Forest Products) and fuelwood derived from the forests andadjoining areas that are of economic benefit to local people.

The attitude and perception of people towards mental health and other benefitsfrom protected areas.

The ethnomedical utility in disease control, health, and well-being of localcommunities.

STUDY AREA

The current study was conducted in Kaziranga National Park and adjoining landscape in the state of Assam in India. It is a UNESCO world heritage site (Bhaumik, 2007) and a major attraction for national park visitors to the region. It is a major conservation site for great one- horned rhinoceroses housing two-thirds of the world population of the species (Dutt, 2018).

Forest ecosystem services of Kaziranga National Park and the adjoining landscape are documented through a few studies focusing on ecosystem goods and services (Hussain at al., 2012; Das & Hussain, 2016; Geethaljani, 2017; Hazarika et al., 2019). Though, as per IIFM- NTCA reports the protected area generated a revenue of INR 9.8 billion (INR 0.95 lakh/hectare) annually with some vital ecosystem services such as wildlife habitat and refugia generating INR 5.73 billion per year and gene-pool protection yielding INR 3.49 billion per year; it has a recreation value of INR 21 million per year, a biological control value of INR 150 million per year and carbon sequestration worth INR 17 million per year. This supports the conservation funding of the park and the economic well-being of its local communities while also contributing to the state's gross domestic demands.

METHOD

Participatory survey

The current study was conducted from 2018 to 2021 with 749 semi-structured interviews conducted in 21 selected villages in Bokakhat and Kaliabor Circle adjoining Kaziranga National Park.

Table 1 List of villages surveyed in Bokakhat Circle with the number of households pervillage

Name of Village	Number of households
Haldibari	27
Kaziranga N.C.	23
Hatikhuli T.E.	39
No. 2 Silidubi	30
No. 1 Silidubi	25
Halowa N.C.	15
No. 1 Kohora	27
No. 2 Kohora	24
Mohpora	25
Halowa Gaon	30

Table 2 List of villages surveyed in Kaliabor Circle with the number of households pervillage

Name of Village	Number of households
Sakmuthi T.E. No. 1	28
Sakmuthi T.E. No. 2	27
Sakmuthi T.E. No. 3	19
Sakmuthi T.E. No. 4	30
Kalangmukh N.C.	24
Hatimura No. 2	25
Seconee T.E. No. 1	27
Seconee T.E. No. 3	36
Seconee T.E. No. 4	25
Bihdubi No.1	24
Bihdubi No.3	29
Dakhin Deopani N.C.	25
Baghmari	24
Malini Grant T.E.	23
Harmoti No. 1	19
Kuthari Na-Basti	17
Rangaloo	29
Hathoukhat	26
Bamunigaon	27

Information and opinion of respondents were collected using a semi-structured questionnaireregarding the objectives mentioned above viz.

NTFPs (Non-Timber Forest Products) and fuelwood derived from the forests andadjoining areas that are of economic benefit to local people.

The attitude and perception of people towards mental health and other benefits from protected areas.

The ethnomedical utility in disease control, health, and well-being of local communities.

Each household was a sampling unit. The villages were selected based on their potential usage of non-timber forest products and dependency on forest ecosystem services in sustaining livelihood. During the survey, 749 households were surveyed with 1-2 respondents per household. Information on NTFP extraction use and perceptions of ecosystem service utilities were mostly collected from the eldest members of the household through group discussions and semi-structured interviews. The demographic data of the respondents were also noted. Suitable statistical tools were used to derive the conclusions.

FINDINGS

Dependency on Forest Ecosystem Services (FES)

The current study focused on the human well-being and health of the local communities of Kaziranga National Park. The study revealed fuel wood, fodder, leaf litter, wood (construction material), medicinal plants, and tourism to be the direct benefits of provisioning and recreational services to locals, provided

by the protected area. Also, indirect services were summarised as water retention, nutrient retention, air purification, prevention of land erosion, wild genetic resource, aesthetics, and spiritual and religious worth. Information gatheredthrough surveys revealed that neighbouring communities' livelihood and finance depended on FESs.

Fuelwood and Non-Timber Forest Products extracted from the forest by neighbouringcommunities of Kaziranga National Park

Fuelwood

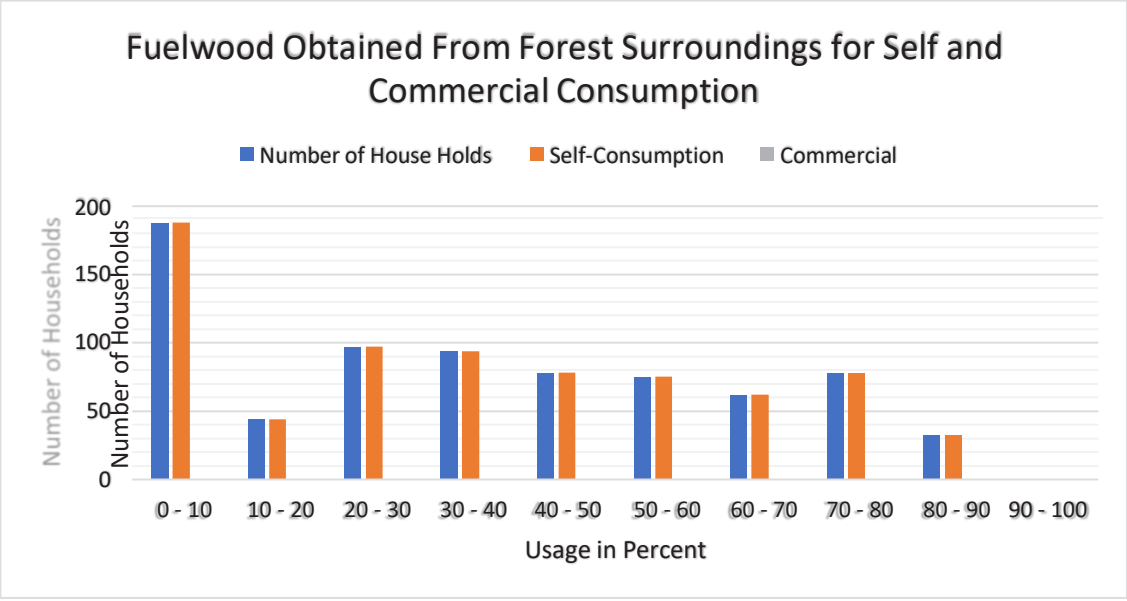


Figure 1 Household-wise fuelwood usage from the surrounding of Kaziranga National Park

Fodder

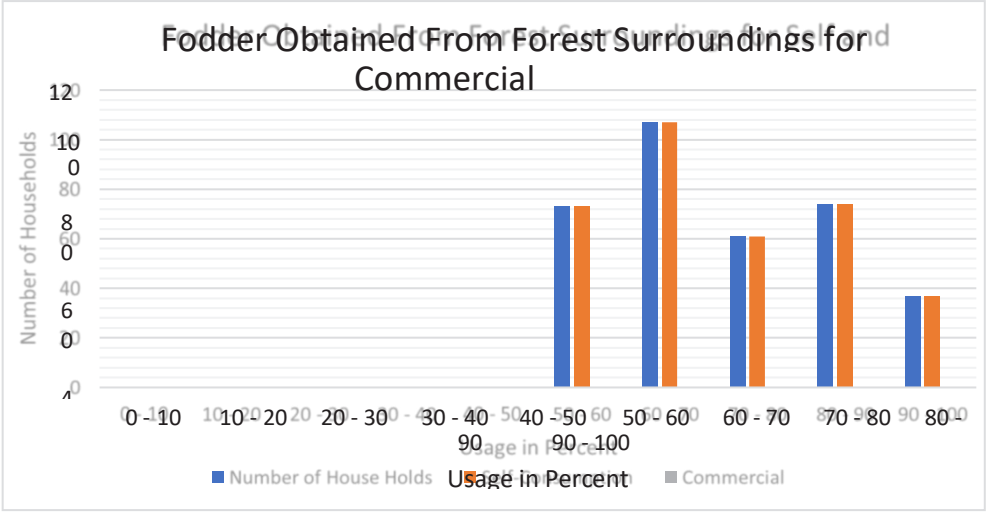


Figure 2 Fodder obtained from the surrounding of Kaziranga National Park

Grazing

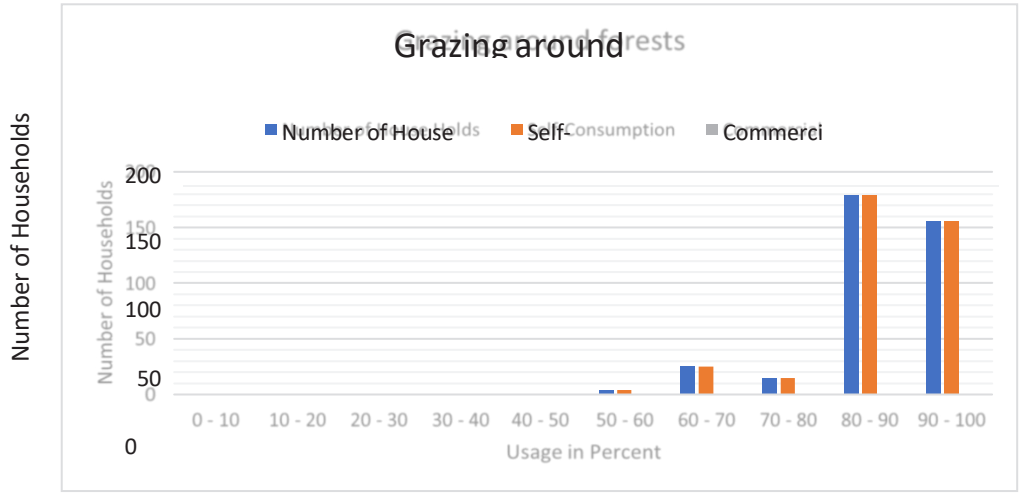


Figure 3 Grazing livestock around Kaziranga National Park

Thatching

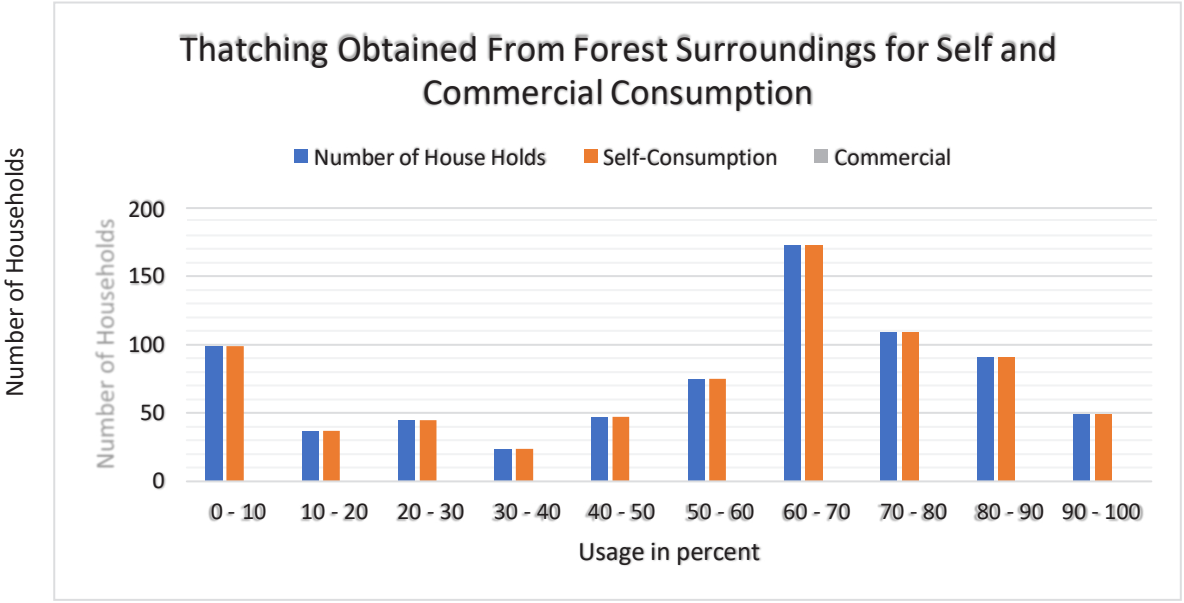


Figure 4 Thatching materials obtained from the surrounding of Kaziranga National Park

Fruits

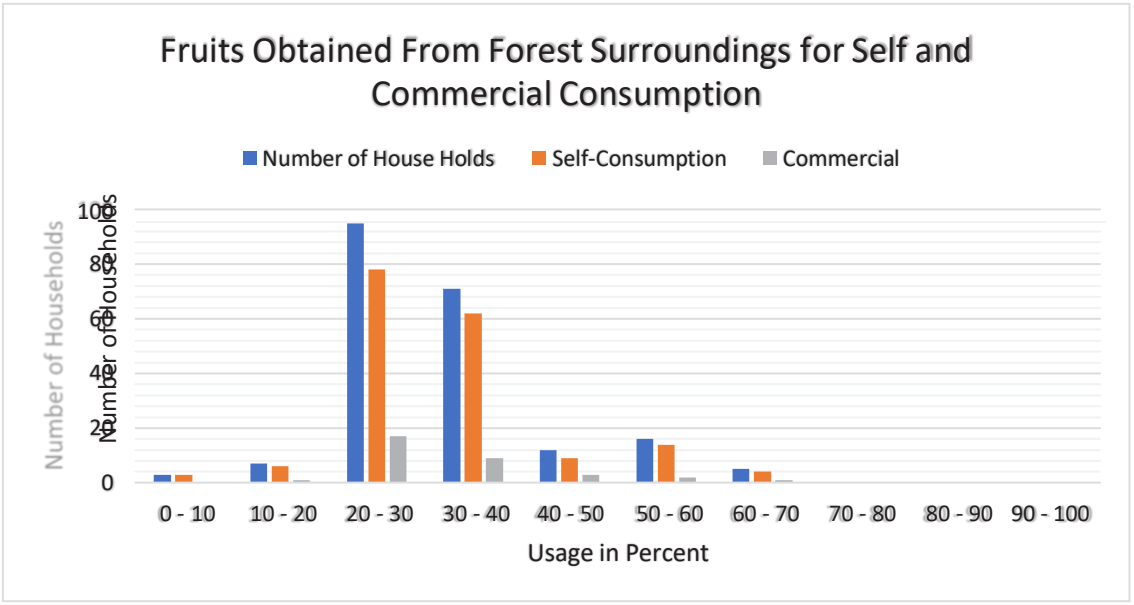


Figure 5 Fruits obtained from the surrounding of Kaziranga National Park

Vegetables

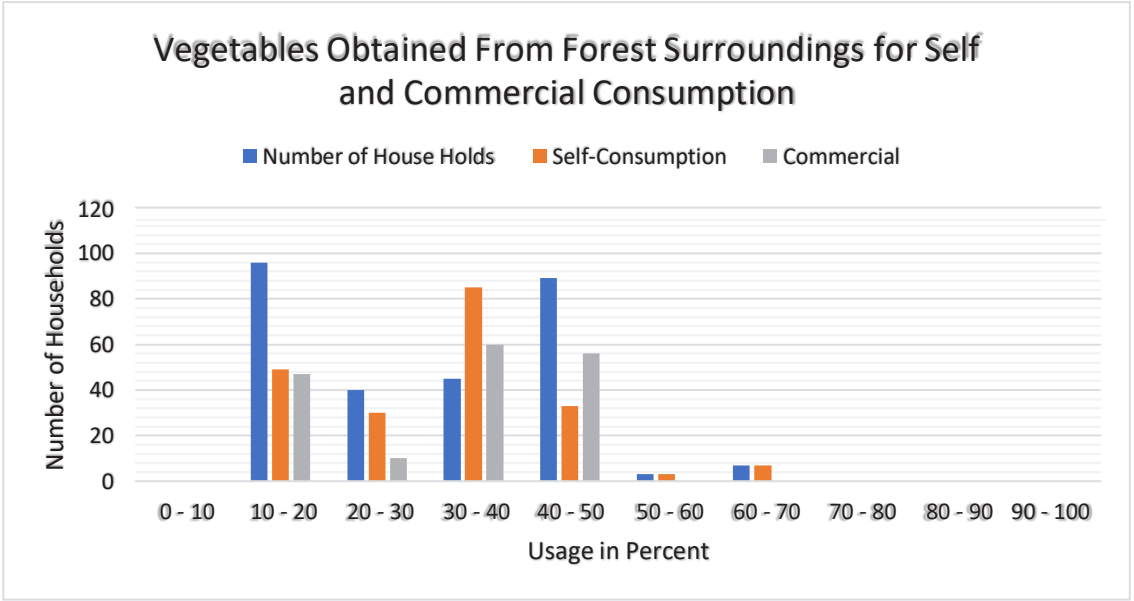


Figure 6 Vegetables obtained from the surrounding of Kaziranga National Park

Medicinal Plants

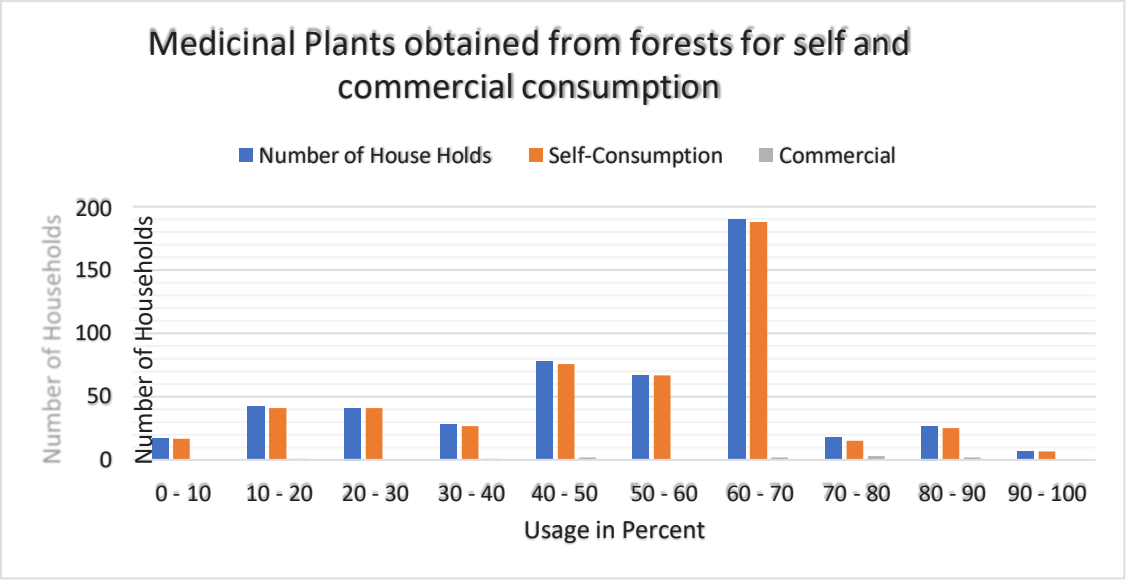


Figure 7 Medicinal plants obtained from the surrounding of Kaziranga National Park

Table 3 Weighted average of the NTFPs used by the neighbouring communities ofKaziranga National Park

Forest Product	**Percent Extracted Per Household (Weighted Average*)**	**Remarks**
Fuelwood	55.27	Used for domestic purposes
Fodder	50.70	
Grazing	66.01	
Thatching	82.13	
Fruits	Self-Consumption-11.32	Used for both domestic and commercial purposes
	Commercial-2.13	
Vegetables	Self-Consumption-13.13	
	Commercial-11.5	
Medicinal plants	Self-Consumption-51.82	In general, not used forfinancial gain
	Commercial- 1.33	

***The weighted average was calculated using the formulae-**

$$Weighted\ average = \square\{frequency * mid\ of\ \%\ range\}/\square\{mid\ of\ \%range\}$$

Table 4 Primary-income-source-wise distribution of households

Source	Number of households generating income (main source)
Agriculture	525
Selling of NTFPs	157
Tourism	143

As seen from the above table 525 out of 749 households i.e., approximately 70% of the households depended primarily on agriculture as their primary source of income.

Local community perception of Mental health benefits of living in the vicinity of Protected Area (Kaziranga National Park)

The local community near the Kaziranga National Park had a very positive attitude and perception toward the protection of the national park and the environment in general. 89% of total respondents agreed to have positive psychological feedback or mood on visiting, viewing, or witnessing the natural environment and greenery of the national park. Only <10% of people had no views or negative views on the same, although, life stage, lifestyle, and livelihood demands may be speculated to be behind such responses. 93% of respondents agreed to have experienced the positive role of forests and natural habitats in maintaining a healthy environment and human well-being. Besides, 91% of the respondents were in favor of the protection and conservation of the natural environment. Most of the respondents felt that living near the vicinity of the park and visiting natural areas had a positive impact on their minds and they benefitted from it.

Table 5 Attitude and perception of people living in the vicinity of Protected Areas towards benefits from Protected Area

Psychological Health Benefits	Number of Households Reporting Positive Benefits	Percentage
Attitude towards the Protection of nature andprotected areas	682	91
The mood on visiting, viewing, or witnessing the natural environment of the national park	667	89
Perception on the positiverole of forests in human well-being	697	93

Ethnomedical utility in disease control, health, and wellbeing

20% of total NTFPs extracted from forests per household were plants of medical value used for treating general and daily ailments such as dysentery, diarrhoea, pain, cramps, open wounds, inflammations, sprains, cough-cold, asthma, fatigue, blood pressure, diabetes, mild skin conditions, microbial or fungal infections, etc. Respondents used medicinal plants for daily mild to chronic ailments. Some of the frequently used medicinal plants and their common use in the daily life of the respondents are mentioned in **Table 6**. Ethnomedical use of wild herbs and plants was reported to be very common among the respondent households although they resorted to modern medicine as applicable and affordable. Respondents, in general, used more than 90% of medicinal plants extracted from forests for maintaining personal health and well-being.

Table 6 List of Medicinal Plants extracted from forests and adjoining areas with reportedutility

Local Name	**Scientific Name**	**Medicinal utility (as reported by the local residents)**
Mani Muni (Indian Pennywort)	*Centella asiatica*	Gastrointestinal disorders, relieve menstrualpain. memoryenhancement, anti-convulsant, anti- depressant, wound healing, anti- bacterial activity
Neem	*Azadirachta indica*	Immune-modulatory, anti-inflammatory, antihyperglycemic, antifungal, antibacterial, antiviral
Tulsi (Basil)	*Ocimum tenuiflorum*	Fever, cough-cold, skin disease,insect bites, respiratory problems,indigestion, ear infection, Immune-modulatory
Pudina (Mint)	*Mentha spicata*	Stomach pain, acidity, flatuation
Dupor bon tenga (Goethe plant)	*Bryophyllum pinnatum*	Kidney stones treatment, earache,burns, abscesses, ulcers, piles,diarrhoea, Lithiasis, insect bites, killing head lice, gastric ulcers, urinary issues, cholesterol
Doron bon	*Leucas aspera*	Snakebite, common cold, intestinal worm infection, asthama, malaria,Sinusitis, pharyngitis, decay of tooth, loss of appetite, headache, body ache,
		influenza
Jilmil saak (White goosefoot)	*Chenopodium album*	Supplements for Protein, Vitamin A, Calcium, Phosphorus, Potassium, blood iron; constipation, arthritis, rheumatism, enlargement of the spleen and bile related diseases
Brahmi saak	*Bacopa Monnieri*	Improve cognition, reduces depression-anxiety
Tengesi tenga	*Tengesi tenga*	Vitamin C supplement, insect bites, lower back pain, urinary tract infections, high blood pressure, diabetes, dysentery, fever, headache and loss of appetite
Musondori saak	*Hottuynia cordata*	Gastrointestinal problems, strengthens muscles

Mati Kanduri	*Alternanthera sessilis*	Diuretic, laxative, improves lactation, skin problems, night blindness
Bhedailota (Stink vine)	*Paederia foetida*	Gastrointestinal problems,rheumatism pain, infertility, paralysis, urinary bladder stones, urinary retention
Narasingha (CurryLeaves)		Vitamin A, B, C, B2, Calcium, iron supplement; dysentery, diarrhoea, diabetes, morning sickness,
		queasiness, boost digestion, bloodcirculation
Bhatou Phul	*Vanda coerulea*	Glaucoma, cataract
Red Vanda	*Renanthera imschootiana*	Gonorrhoea, optical sore
Chota chand	*Rauvolfia serpentina*	Anxiety, sedation
Agarwood	*Aquilaria mallaccensis*	Snake bite, diarrhoea, constipation, astringent
Usipak	*Hibiscus manihot*	Tuberculosis, diabetes
Talishpatra	*Abies spectabilis*	Asthma, bronchitis
Bon Khopa	*Abroma augusta*	Headache, diabetes
Pera-petari	*Abutilon indicum*	Diuretic,anti-inflammatory, astringent
Mukuta-manjari	*Acalypha indica*	Burns, scabies, syphilis, centipede bites
Hati-huria	*Achyranthes aspera*	Dysentery, piles ulcer,
Bos	*Acorus calmus*	Chronic diarrhoea, dysentery

DISCUSSION

It was found that 55.27% of fuelwood per household was extracted from the vicinity ofthe protected area.

It was noted that 50.70% of the fodder requirement of every household was fulfilled bythe protected area.

66.01% of the grazing requirement per household's livestock was fulfilled by theprotected area.

82.13% of the thatching requirement per household was met by the protected area.

For self-consumption 11.32% of households relied on forests for fruits, while 2.13% ofhouseholds sell fruits derived from the vicinity of forests.

13.13% of households depended on the protected area for vegetables for self- consumption, while 11.5% of households sold the vegetables for commercial gains.

51.82% of households used medicinal plants from the vicinity of the protected area for treating their own ailments, while 1.33% of households sold it for commercial gains. Medicinal plants extracted from the adjoining areas of the Kaziranga National Park were found to be used for treating a number of ailments such as anti-depressant, anti- inflammatory, fever, stomach pain, earache, snake bites, vitamin and mineral supplements, high blood pressure, etc.

It was found that 525 or approximately 70% of household income was dependent on agriculture, 157, or approximately 21% of household income was dependent on the selling of NTFPs (Non-Timber Forest Products), and 143, or approximately 19% of household's income was dependent on tourism from

Kaziranga National Park.

91% of the household had a positive attitude towards the protection of nature and natural resources. 89% of the household reported having positive effects on their mood after visiting, viewing, or witnessing the natural environment of the National Park. Around 93% of the household held a positive perception of the role of forests in humanwell-being.

CONCLUSION

The people living around The Kaziranga National Park were enjoying the Provisioning and Cultural ecosystem services provided by the Protected Area.

The Provisioning services that the people obtained from the surrounding of Kaziranga National Park were fuelwood, fodder, grazing, thatching, fruits vegetables, and medicinal plants.

The Provisioning Ecosystem Services also helped the people generate income. 21% of household income was dependent on the selling of Non-Timber Forest Products. 19% of household income was found to be dependent on the tourism of Kaziranga National Park. 70% of households' income was dependent on agriculture, fishing, poultry farming, etc.

The study showed that locals were particularly aware of and dependent on wild bees for honey, bee wax, and agricultural pollination. Also, awareness of their dependency on rain for agriculture and water source was also very evident through the surveys. Locals were reliant on wild plants for aesthetic, medicinal, and nutritional values, although, the use of modern medicines is as well in practice. Based on user reports, on average, households of respondents were mostly dependent on forests for medicinal plants, fuelwood, fodder, thatching, and grazing of livestock

The Cultural Ecosystem Services of the protected area provided positive psychological well-being to the people.

The Provisioning and Cultural ecosystem services of Kaziranga National Park were found to have a positive role in supporting human health and well-being.

References

Bhaumik, Subir (17 April 2007). "Assam rhino poaching 'spirals'". BBC News. Archived from the original on 22 November 2008. Retrieved 10th September 2021.

Dutt, Anonna (30 March 2018). "Kaziranga National Park's rhino population rises by 12 in 3 years". *Hindustan Times*. Retrieved on 20th August 2021.

IIFM-NTCA reports 2015. https://web.archive.org/web/20160826050803

/http://www.iifm.ac.in/sites/default/files/Newspdf/IIFM-NTCA-REPORT.compressed- min.pdf Retrieved form original on10th September 2021.

Das, D., & Hussain, I. (2016). Does ecotourism affect economic welfare? Evidence from Kaziranga National Park, India. *Journal of Ecotourism*, *15*(3), 241-260.

Hazarika, A. K., & Kalita, U. (2019). Conservation and Livelihood Conflict of Kaziranga National Park: A World Heritage Site of Assam, India. *Space and Culture, India*, *7*(3), 224-232.

Hussain, S. A., Barthwal, S. C., Badola, R., Rahman, S. M. T., Rastogi, A., Tuboi, C., & Bhardwaj, A. K. (2012). An analysis of livelihood linkages of tourism in Kaziranga National Park, a natural world heritage site in India. *Parks*, *18*(2), 32-43.

Geethanjali, M. (2017). Ecosystem Goods and Services Provided by'Beels' in Kaziranga. *Indian*

Forester, *143*(12), 1249-1254.

Anderson, T and J Bojo. 1992. 'The Economic Value of Forests' *in* Anil Agarwal (edt.), *The Price of Forests,* CSE, New Delhi.

Archana, G. R. (2019) Traditional herbal remedies for management of female reproductive disorders by tribes of Aryankavu forests of Kollam district, Kerala. "*Rescue and Restoration of Selected RET Medicinal Plants of Western Ghats"*,107.

Baidya, S., Thakur, B., & Devi, A. (2020). Ethnomedicinal plants of the sacred groves and their uses by Karbi tribe in Karbi Anglong district of Assam, Northeast India.

Balamurugan, S., Vijayakumar, S., Prabhu, S., & Yabesh, J. M. (2018). Traditional plants used for the treatment of gynaecological disorders in Vedaranyam taluk, South India-An ethnomedicinal survey. *Journal of traditional and complementary medicine*, *8*(2), 308-323.

Balthazar, Vincent; Vanacker, Veerle; Molina, Armando; Lambin, Eric F. (2015). *Impacts of forest cover change on ecosystem services in high Andean mountains. Ecological Indicators, 48(), 63–75.* doi:10.1016/j.ecolind.2014.07.043

Bang, K. S., Lee, I., Kim, S., Lim, C. S., Joh, H. K., Park, B. J., & Song, M. K. (2017). The effects of a campus forest-walking program on undergraduate and graduate students' physical and psychological health. *International journal of environmental research and public health*, *14*(7), 728.

Baro, D., & Borthakur, S. K. (2017). Climbing Angiosperms of Manas National Park, Assam: Diversity and Ethnobotany. *Bioscience Discovery*, *8*(2), 158-165.

Borah, D., Tangjang, S., Das, A. P., Upadhya, A., & Mipun, P. (2020). Assessment of non-timber forest products (NTFPs) in Behali Reserve Forest, Assam, Northeast India. *Ethnobotany Research & Applications*, *19*(43), 1-15.

Britannica, The Editors of Encyclopaedia. "Ayurveda". *Encyclopedia Britannica*, 15 Nov. 2019, https://www.britannica.com/science/Ayurveda. Accessed 26 September 2021.

Castro, A. J., Martín-López, B., López, E., Plieninger, T., Alcaraz-Segura, D., Vaughn,

C. C., & Cabello, J. (2015). Do protected areas networks ensure the supply of ecosystem services? Spatial patterns of two nature reserve systems in semi-arid Spain. *Applied Geography*, *60*, 1-9.

Chiang, Y. C., Li, D., & Jane, H. A. (2017). Wild or tended nature? The effects of landscape location and vegetation density on physiological and psychological responses. *Landscape and Urban Planning*, *167*, 72-83.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R., Sutton, P., van den Belt, M. (1997) The value of the world's ecosystem services and natural capital. Nature 387, 253–260.

Downtoearth (2012) https://www.downtoearth.org.in/news/polluting-units-shut-in-kaziranga-39094).

Dura´n AP, Casalegno S, Marquet PA, Gaston KJ (2013) Representation of Ecosystem Services by Terrestrial Protected Areas: Chile as a Case Study. PLoS ONE 8(12): e82643. doi:10.1371/journal.pone.0082643

Dutta, M., & Barooah, M. S. Consumption and Utilisation of Indigenous Herbal Plants among the Sonowal Kachari Tribes of Assam–A Review.

E. Bielinis, A. Jaroszewska, A. Łukowski, N. Takayama (2020) The effects of a forest therapy

programme on mental hospital patients with affective and psychotic disorders. Int. *J. Environ. Res. Public Health*, 17 (1), p. 118

EEB. 2010. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, London and Washington: Earthscan.

FAO. 2010. Global Forest Resources Assessment-2010, Forestry Paper 163, FAO, Rome.

Forseth, I. (2010) Terrestrial Biomes. *Nature Education Knowledge* 3(10):11

Frumkin, H. (2001). Beyond toxicity human health and the natural environment. American Journal of Preventive Medicine, 20(3), 234–240. doi:10.1016/S0749- 3797(00)00317-2

Gogoi, S. (2020). ETHNOMEDICINAL PRACTICES AMONG THE LOCAL COMMUNITIES IN DIBRUGARH DISTRICT OF ASSAM. *Journal Of Natural Remedies*, *21*(8), 65-68.

H.J. Lee, Y.H. Son, S. Kim, D.K. Lee (2019) Healing experiences of middle-aged women through an urban forest therapy program. *Urban For. Urban Gree.*, 38 (2019), pp. 383-391

H.J. Lee, Y.H. Son, S. Kim, D.K. Lee (2019) Healing experiences of middle-aged women through an urban forest therapy program. *Urban For. Urban Gree.*, 38 (2019), pp. 383-391.

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Hartig, T., & Staats, H. (2003). Restorative environments. Journal of Environmental Psychology, 23(2), 103–107. doi:10.1016/S0272-4944(02)00108-1 [special issue]

Hussain, J., Zhou, K., Akbar, M., Raza, G., Ali, S., Hussain, A., ... & Ghulam, A. (2019). Dependence of rural livelihoods on forest resources in Naltar Valley, a dry temperate mountainous region, Pakistan. *Global Ecology and Conservation*, *20*, e00765.

Jaganmohan, M., Vailshery, L. S., Mundoli, S., & Nagendra, H. (2018). Biodiversity insacred urban spaces of Bengaluru, India. *Urban Forestry & Urban Greening*, *32*, 64- 70.

Kaplan, S. (1995). The restorative benefits of nature. Journal of Environmental Psychology, 15(3), 169–182. doi:10.1016/0272-4944(95)90001-2

Kim, J. G., Khil, T. G., Lim, Y., Park, K., Shin, M., & Shin, W. S. (2020). The psychological effects of a campus forest therapy program. *International journal of environmental research and public health*, *17*(10), 3409.

Knopf, R. C. (1983). Recreational needs and behavior in natural settings. In I. Altman, & J. F. Wohlwill (Eds.), Behavior and the natural environments (pp. 205–240). New York: Plenum.

Kobayashi, H., Ikei, H., Song, C., Kagawa, T., & Miyazaki, Y. (2021). Comparing the impact of forest walking and forest viewing on psychological states. *Urban Forestry &Urban Greening*, *57*, 126920.

Kremen, C., & Ostfeld, R. S. (2005). A call to ecologists: measuring, analyzing, and managing ecosystem services. *Frontiers in Ecology and the Environment*, *3*(10), 540- 548.

Lambin, E.F., Turner, B.L., Geist, H., Agbola, S., Angelsen, A., Bruce, J.W., Coomes, O., Dirzo, R., Fischer, G., Folke, C., George, P.S., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E.F., Mortimore, M., Ramakrishnan, P.S., Richards, J.F., Skånes, H., Steffen, W., Stone, G.D., Svedin, U.,

Veldkamp, T., Vogel, C., Xu, J., 2001. The causes of land-use and -cover change: moving beyond the myths. Glob. Environ. Change 11, 261–269.

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public health*, *125*(2), 93-100.

Lyu, B., Zeng, C., Deng, S., Liu, S., Jiang, M., Li, N., ... & Chen, Q. (2019). Bamboo forest therapy contributes to the regulation of psychological responses. *Journal ofForest Research*, *24*(1), 61-70.

Manolaki, P., & Vogiatzakis, I. N. (2017). Ecosystem services in a peri-urban protected area in Cyprus: a rapid appraisal. *Nature Conservation*, *22*, 129.

Mao, G. X., Lan, X. G., Cao, Y. B., Chen, Z. M., He, Z. H., Lv, Y. D., ... & Jing, Y. A.

N. (2012). Effects of short-term forest bathing on human health in a broad-leaved evergreen forest in Zhejiang Province, China. *Biomedical and Environmental Sciences*, *25*(3), 317-324.

MEA (Millennium Ecosystem Assessment). 2003. *Ecosystems and Human Well- Being: A Framework for Assessment,* Island Press, Washington, DC

Morita, E., Fukuda, S., Nagano, J., Hamajima, N., Yamamoto, H., Iwai, Y., et al. (2006). Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. Public Health, 121(1), 54–63. doi:10.1016/j.puhe.2006.05.024

Naidoo R, Balmford A, Costanza R, Fisher B, Green RE, et al. (2008) Global mapping of ecosystem services and conservation priorities. Proceedings of the National Academy of Sciences of the United States of America 105: 9495–9500.

Neff, K. D., Long, P., Knox, M. C., Davidson, O., Kuchar, A., Costigan, A., ... & Breines, J. G. (2018). The forest and the trees: Examining the association of self- compassion and its positive and negative components with psychological functioning. *Self and Identity*, *17*(6), 627-645.

Ochiai, H., Ikei, H., Song, C., Kobayashi, M., Miura, T., Kagawa, T., ... & Miyazaki,

Y. (2015). Physiological and psychological effects of a forest therapy program on middle-aged females. *International journal of environmental research and public health*, *12*(12), 15222-15232.

Park, B. J., Furuya, K., Kasetani, T., Takayama, N., Kagawa, T., & Miyazaki, Y. (2011). Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning*, *102*(1), 24-32.

Park, B. J., Kasetani, T., Tsunetsugu, Kagawa, T., & Miyazaki, Y. (2010) The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest

bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, 15(1), 18–26. doi:10.1007/s12199-009-0086-9

Poulsen, D. V., Stigsdotter, .. K., Djernis, D., & Sidenius, U. (2016). 'Everything just seems much more right in nature': How veterans with post-traumatic stress disorder experience nature-based activities in a forest therapy garden. *Health psychology open*, *3*(1), 2055102916637090.

Raj, A. J., Biswakarma, S., Pala, N. A., Shukla, G., Kumar, M., Chakravarty, S., & Bussmann, R. W. (2018). Indigenous uses of ethnomedicinal plants among forest- dependent communities of Northern Bengal, India. *Journal of ethnobiology and ethnomedicine*, *14*(1), 1-28.

Ramachandra T. V., Divya Soman, Ashwath D. Naik and M. D. Subash Chandran, 2017. Appraisal of

Forest Ecosystems Goods and Services: Challenges and Opportunities for Conservation, Journal of Biodiversity, 8(1): 12-33 (2017), DOI: http://10.1080/09766901.2017.1346160

Robinon, M. R. & Zhang, X. (2011). The World Medicine Situation (TraditionalMedicines: Global Situation, Issues and Challenges). Geneva. World Health Organization, Geneva, Switzerland.

SC (The Sustainability Consortium), World Resources Institute, and University of Maryland. "Tree Cover Loss by Driver." Accessed through Global Forest Watch on 10/09/2021. www.globalforestwatch.org.

Senthilkumar, N. & Murugesan, S. (2012). Bioprospecting the renewable forest resources, an overview. Curr Biotica, 5, 522-540.

Silambarasan, R., Sureshkumar, J., Krupa, J., Amalraj, S., & Ayyanar, M. (2017). Traditional herbal medicines practiced by the ethnic people in Sathyamangalam forestsof Western Ghats, India. *European Journal of Integrative Medicine*, *16*, 61-72.

Singh, R. S., Ansari, I., Singh, R. K., Singh, S. K., & Debjit, P. A. L. (2017). Ex-situ conservation of medicinal Plants and its therapeutic in mine impacted lands in dry tropical forests of Jharkhand, India. *Eurasian Journal of Forest Science*, *5*(2), 44-69.

Song, C., Ikei, H., Kobayashi, M., Miura, T., Taue, M., Kagawa, T., ... & Miyazaki, Y. (2015). Effect of forest walking on autonomic nervous system activity in middle-aged hypertensive individuals: A pilot study. *International journal of environmental research and public health*, *12*(3), 2687-2699.

Song, C., Ikei, H., Park, B. J., Lee, J., Kagawa, T., & Miyazaki, Y. (2018). Psychological benefits of walking through forest areas. *International journal of environmental research and public health*, *15*(12), 2804.

Swargiary, A., Roy, M. K., & Daimari, M. (2019). Survey and documentation of ethnobotanicals used in the traditional medicines system of tribal communities of Chirang district of Assam against helminthiasis. *Biomedical and Pharmacology Journal*, *12*(4), 1923-1935.

Tamang, B., Sarkar, B. C., Pala, N. A., Shukla, G., Patra, P. S., Bhat, J. A., ... & Chakravarty, S. (2019). Uses and ecosystem services of trees outside forest (TOF)-A case study from Uttar Banga Krishi Viswavidyalaya, West Bengal, India. *Acta Ecologica Sinica*, *39*(6), 431-437.

Tang Z, Fang J, Sun J, Gaston KJ (2011) Effectiveness of protected areas in maintaining plant production. Plos One 6.

Tripathi, S. C., & Mall, T. P. (2018). Potent Nutrimental and Ethnomedicinal Horticultural Flora from North Central Terai Forests Of UP, India. *Sustainable Horticulture,* Volume 2*: Food, Health, and Nutrition*, 369.

Tsunetsugu, Y., Lee, J., Park, B. J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013).Physiological and psychological effects of viewing urban forest landscapes assessed bymultiple measurements. *Landscape and Urban Planning*, *113*, 90-93.

Udayakumar, M., Selvan, B., & Sekar, T. (2020). Density, population structure and ethnobotanical uses of a medicinally important vulnerable tree (IUCN) in tropical forests of Javadhu hills, South India. *Medicinal Plants-International Journal of Phytomedicines and Related Industries*, *12*(2), 290-300.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology, 11(3), 201–230. doi:10.1016/S0272-4944(05)80184-7.

UMWRI (University of Maryland and World Resources Institute). "Global Primary Forest Loss". Accessed through Global Forest Watch on 10/09/2021 from www.globalforestwatch.org.

Velarde, M. D., Fry, G., & Tveit, M. (2007). Health effects of viewing landscape— Landscape types in environmental psychology. Urban Forestry & Urban Greening, 6(4), 199–211. doi: 10.1016/j.ufug.2007.07.001

Yadav, A., Verma, P. K., Chand, T., & Bora, H. R. (2018). Ethno-medicinal knowledge of Clerodendrum L. among different tribes of Nambor reserve forest, Assam, India. *Journal of Pharmacognosy and Phytochemistry*, *7*(5), 1567-1570.

Yu, C. P., Lee, H. Y., & Luo, X. Y. (2018). The effect of virtual reality forest and urban environments on physiological and psychological responses. *Urban forestry & urban greening*, *35*, 106-114.

Zameer, M. (2021). Tribal Life and the Environment of Jammu and Kashmsir, India. *Asian Journal of Sociological Research*, 10-14.

Zorrilla-Miras, P., Palomo, I., Gomez-Baggethun, E., Martín-L opez, B., Lomas, P. L., & Montes, C. (2014). Effects of land-use change on wetland ecosystem services: a casestudy in the Donana marshes in southwestern Spain. ~ Landscape and Urban Planning, 122, 160e174.

CPCB (2021). https://cpcb.nic.in//upload/Downloads/AQI_Bulletin_20211022.pdf

The age of Azadi Ka Amrit Mahotsav and Development of Indian Economy: An analysis

Manjari Nath

Introduction:

The year 2021 holds a special place for all Indians, as it marks the 75th year of India's independence. Since 1947, India has achieved tremendous all-round progress taking giant strides in terms of infrastructure, industry, health, education, and socio-economic development. To celebrate and commemorate 75 years of progressive India and the glorious history of its people, culture, and achievements, the Government of India launched the 'Azadi Ka Amrit Mahotsav',an embodiment of all that is progressive about India's sociocultural, political, and economic identity. The Azadi Ka Amrit Mahotsav is based on five pillars- Freedom Struggle, Ideas at 75, Achievements at 75, Actions at 75 and Resolve at 75. The Mahotsav is dedicated to the people of India who have been instrumental in transforming the country into a global force. In this significant year, Prime Minister Shri Narendra Modi launched the Gati Shakti National Master Plan that envisages developing an efficient, seamless multi-modal transport network and will play a critical role in transforming the infrastructure framework of the country.

The idea of self-reliant nation in every aspect is being achieved by the pioneering vision of our Hon'ble Prime Minister. During the pandemic, India has demonstrated that it can cope up with dire situation. Aatmanirbharta also gives a financial cushion to several businesses and encourage entrepreneurs to produce maximum goods and services within the country. Within this year, India has not only started the world's largest self-made vaccination drive, it is in fact exporting it to different nations as well. The whole concept of self-reliance will reduce unemployment at many levels. India is a big and the fast growing market for a majority of the product categories and with the mantra of 'vocal for local', the promulgation of local brands, manufacturing and supply chain will provide a big boost to India's economy. 75th years of free India are replete with stupendous achievements. These become more remarkable because the country had to make a 'Tryst with Destiny' bringing out an exploited 1/6th of the humanity from the vagaries of the colonial yoke. The major challenges at the time of independence in 1947 included socio-economic development and nation-building through education and industrial development, eradication of poverty, and food self-sufficiency in a drought-hit era with a divided nation by the colonial masters who were forced to lift their colonial shackles by the Gandhian non-violent movements. This was even more difficult as the world was divided into Cold War adversaries and bloc politics which India could not have subscribed to. Hence, India not only stood and helped in the emancipation of a large number of colonised countries but also created a third way with a more equitable force in the form of NAM (Non-Aligned Movement) to serve national interest and cause of peace and development, especially for the developing and underdeveloped world. It became a champion for the rights of oppressed people at the international fora while discharging its obligations as a responsible international actor and a voice of reason.

India, before the advent of the colonial powers, contributed to over a quarter of the global GDP which went down to less than 4% when they left with her industry decimated and an administrative system that was geared to serve the interests of the colonial masters. In the last over seven decades, India has engineered Green, Yellow and White Revolutions with continuous upgradation in technology in the agricultural and food processing areas not only to meet the demand of a burgeoning population but has also emerged as a net exporter and helper to the world. India has also emerged as credible nuclear and space power in the world- the tools it intends to employ for the global good.

Asst. Professor, Department of Economics, A.N.D. College, Shahpur Patori, Samastipur

Objectives:

The 'Azadi Ka Amrut Mahotsav' is a series of activities organized by the Government of India to mark India's 75th anniversary of independence. The Azadi Ka Amrit Mahotsav, held in the 75th year of India's independence, is an opportunity to re-energize and re-emphasize India's marine moorings.

- A vast number of actions have been performed by the various departments in this regard during the previous year, both within the nation and overseas.
- Commemorative ship visits to 75 Indian ports (https://testbook.com/ias- preparation/major-ports-inindia/) in 2021-22, President's Fleet Review aligned with India's 75th year of independence, Lokayan 2022 (sail ship expedition)
- Swachh Technology Challenge
- 'Har Dhadkan Hai Swachh Bharat Ki'
- Announcement of PMAY-U Awards: 150 Days Challenge
- 'Lakshya Zero Dumpsite' Campaign
- 'Swachhatam Connect' Campaign, etc.
- A cultural event will also be arranged to commemorate the country's tenacious spirit. There will be music, dance, recitation, and a reading of the Preamble (https://testbook.com/iaspreparation/preamble-to-the-indian-constitution/) (each line in a different language, representing the different regions of the country).
- There will be 75 voices in the choir and 75 dancers in the event, representing young strength as the future of India.

Prime Minister Narendra Modi while speaking at the inaugural of curtain raiser activitiesof the Azadi Ka Amrit Mahotsav reiterated and reaffirmed that "We are proud of our Constitution. We are proud of our democratic traditions. The mother of democracy, India is still moving forward by strengthening democracy. India, rich in knowledge and science, is leaving its mark from Mars to the Moon. Today, India's startup ecosystem has become a centre of attractionin the world. Today, India is moving out of the darkness of scarcity to meet the aspirations ofmore than 130 crores (1.3 bn) people." India has the largest young aspirational population andthe fastest growing market economy which is ready to cater to the needs of teeming billion-plus people who take pride in the Indian story.

As a result of umpteen initiatives by the present government, hundreds of archaic lawshave been dispensed with. India's global ranking for DBI (Doing Business with India) has moved up significantly even as more needs to be done. India has become a favourite investment destination garnering the highest annual FDI inflow of $83.57 billion in FY21-22 despite the Pandemic.

Computer Software and Hardware became the top recipient sector of FDI Equity inflow with a share of around 25% which indicates that India figures prominently for the investors as the AI-driven Industrial Revolution 4.0 moves to a higher orbit. India also boasts of fast growth in billionaire Unicorns globally. Moreover, the FDI equity inflows in Manufacturing rose by 76% in FY 2021-22 well supported by the Indian policy framework and 'Make in India' and PLI(Performance Linked Initiative) schemes. This is a remarkable achievement and a testament to Indian economic and political resilience.

Likewise, for the first time, Indian exports of goods and services reached over $600billion in 2021-22 despite the global problems and supply constraints due to the pandemic and the ongoing Eurasian war. India has always been a trading nation and is working hard to reclaim that status yet again. Along with

this, India is also focusing on self-reliance with a global footprint – 'Atmanirbhar Bharat', especially in the manufacturing sector and to be an integral part of alternate value and supply chains that are resilient and reliable for the national interestand the global good.

In this context, India's participation in the I2U2, Quad, Indo-Pacific Economic Framework (IPEF) and other regional and sub-regional connectivity-oriented frameworks acquires a renewed salience and focus. Likewise, vigorous move to expeditiously implement INSTC (North-South Transport corridor), strategic connectivity projects like Chabahar in Iran to Afghanistan to Central Asia and Europe or North-Eastern India to ASEAN corridors aim at providing crucial trade and economic linkages for India's centrality in global supply chains.

As India wishes to lead through the AI-driven Industrial revolution 4.0, its Digital India, Innovate, Start Up and Stand Up India campaigns have become the hallmark of a unique digital footprint. Some initiatives like access to the internet, banking at the doorstep and direct payment into accounts to nearly a billion Indians are the game changer and are providing the leadership position to India in the comity of nations. PM Modi recently, while speaking at the inaugural of the first bullion exchange, claimed that India already accounts for 40% of global digital payments. India's foreign policy has become more robust and confident with impeccable credentials as the country pursues a value-based foreign policy clearly driven by strategic autonomy to subserve her own national interests which are aligned with the global welfare andhas emerged as a voice of reason at the global stage. India at the UNSC no longer pleads for a place on the horseshoe table but claims it on the basis of her credentials. Meanwhile, India continues to play the global leadership role as a voice of the developing and underdeveloped countries be it for the waiver of Intellectual Property Rights for Vaccines or at the WTO negotiations on fishing and agriculture and on the reforms for the multilateral institutions.

India is also at the forefront of the fight against Climate Change. The International Solar Alliance (ISA), Coalition of Disaster Resilient Infrastructure (CDRI) and 'One Planet One Health' are the initiatives that India has launched with and for the global community as it has emerged as a first responder in crisis situations from natural disasters to the pandemic. With a clear focus on multilateralism and primacy of the UN Charter, India navigates her foreign and security policy with dignity and confidence as she engages with diverse partners across various groupings like the Quad, BRICS, SCO, G20 and Indo-Pacific Economic Framework (IPEF)where India becomes a pivot. Her Neighbourhood First, Act East and Link West and Africa for Africans policies provide her with the effective fulcrum for mutually beneficial partnerships.

India's capacity-building assistance under the ITEC (Indian Technical and EconomicCooperation) to over 160 countries and supply of essential medicines, medical supplies anddeputing professionals and paramedics during the pandemic have given it unparalleled heft as aresponsible global-centric power always rising to the occasion. India has emerged as a firstresponder during the crises with the 'Share and Care' attitude, immensely adding to its SoftPower which has translated into unprecedented support for India at the international foraincluding at the declaration of June 21 as the International Yoga Day. As a new global orderemerges out of the current churn and transition, India is all set to take up a benign leadership roleduring the 'Amrit Kaal' – next 25 years with a strong polity, stronger economy and efficientforeign policy which is robust, resilient and result oriented and with the global good at the core. **Atmanirbhar Bharat**

During the pandemic, as a nation, India has shown the entire world its resilience andcapability to deal with extreme adversities. India has not only started the world's largest self - made vaccination drive, but it is also exporting it to many other countries. Aatmanirbharta provides financial support to several firms, encouraging entrepreneurs to produce goods and services within the country. This will help the country to focus on the tagline of 'vocal for local,' the promotion of local brands, manufacturing, and supply chains that will provide a significant boost to India's economy. This will ultimately help India to become Atmanirbhar Bharat in every aspect.

Digital India

In July 2015, the Indian government launched the 'Digital India' initiative to improve online infrastructure and increase internet accessibility among citizens (for example, linking rural areas to high-speed internet networks); thereby, empowering the country to become more digitally advanced.

The initiative encompasses the following three key objectives:

- Establish a secure and stable digital infrastructure
- Deliver digital services
- Ensure that every citizen has access to the Internet

The government's increased focus to create a digitally empowered economy is forecast to benefit all sectors, wherein core digital sectors such as information technology & business process management, digital communication services and electronics manufacturing are likely to double their GDPs to US$ 355-435 billion by 2025. In another report, McKinsey highlighted that the 'Digital India' initiative is expected to boost the country's digital economy to US$ 1 trillion by 2025, up from US$ 200 billion in 2018.

Banking Network in India

As per the Reserve Bank of India (RBI), India's banking sector is sufficiently capitalised and well-regulated. The financial and economic conditions in the country are far superior to any other country in the world. Credit, market and liquidity risk studies suggest that Indian banks are generally resilient and have withstood the global downturn well. The Indian banking industry has recently witnessed the rollout of innovative banking models like payments and small finance banks. In recent years India has also focused on increasing its banking sector reach, through various schemes like the Pradhan Mantri Jan Dhan Yojana and Post payment banks. Schemes like these coupled with major banking sector reforms like digital payments, neo-banking, a rise of Indian NBFCs and fintech have significantly enhanced India's financial inclusion and helped fuel the credit cycle in the country. The digital payments system in India has evolved the most among 25 countries with India's Immediate Payment Service (IMPS) being the only system at level five in the Faster Payments Innovation Index (FPII). India's Unified Payments Interface (UPI) has also revolutionized real-time payments and strived to increase its global reach in recent years. The Indian banking system consists of 12 public sector banks, 22 private sector banks, 46 foreign banks, 56 regional rural banks, 1485 urban cooperative banks and 96,000 rural cooperative banks in addition to cooperative credit institutions As of September 2021, the total number of ATMs in India reached 213,145 out of which 47.5% are in rural and semi urban areas.In 2020-2022, bank assets across sectors increased. Total assets across the banking sector (including public and private sector banks) increased to US$ 2.67 trillion in 2022. In 2022, total assets in the public and private banking sectors were US$ 1,594.51 billion and US$ 925.05 billion, respectively. During FY16-FY21, bank credit increased at a CAGR of 0.29%. As of FY21, total credit extended surged to US$ 1,487.60 billion. During FY16-FY21, deposits grew at a CAGR of 12.38% and reached US$ 2.06 trillion by FY21. Bank deposits stood at Rs. 165.74 trillion (US$ 2.11 trillion) as of May 20, 2022. According to India Ratings & Research (Ind-Ra), credit growth is expected to hit 10% in 2022-23 which will be a double digit growth in eight years. As of July 29, 2022 bank credit stood at Rs. 123.69 lakh crore (US$ 1,553.23 billion). As of July 29, 2022 credit to non-food industries stood at Rs. 123.36 lakh crore (US$ 1.54 trillion). **Development in Agriculture:**

Agricultural productivity has also marked an upward trend during the plan period. The production of food-grains which was 510 lakh tones in 1950-51 increased to 176.4 million tones in 1990-91 and further to 211.9 million tones in 2001-02. Similarly, the production of cotton was 21 lakh bales in 1950-51 and it was expected to be 908 million bales in 1990-91 and further 10.0 million tones in 2001- 02. In

the same, the production of sugarcane was expected to be 241.0 million tones in 1990-91 against the 69 lakh tones in 1950-51. It rose to 298.4 million tones in 2001-02.

Development of Industry:

In the first five year plan much of the capital was invested to develop the industry and defence. About fifty per cent of the total outlay of the plans was invested for their development. As a result, industrial production has increased to a great extent. For instance, the production of cotton cloth which was 4215 million sq. metres in 1950-51. It was 31.1 million tones in 2001-02. In the same fashion, the production of sugar was recorded to be 12047 thousand tones in 1990-91 against 1100 thousand tones in 1950-51. It further rose to 15520 thousand tones in 2000-01.

Development of Transport and Communication:

During the planning period, much attention has been paid towards the development of transport and communication. In the first two plans, more than one-fourth of the total outlay was invested on the development of transport and communication. In 1990-91, the total length ofroads increased to 19.92 lakh kms which increased to 252.2 lakh kms in 1998-99. Similarly route of railway was 63.1 thousand kms in 2001-02 against 53.6 thousand km in 1950-51. The Ninth Plan outlay was 19.6%. .

Self Reliance:

During the last five decades, considerable progress seems to have been made towards the achievement of self reliance. We are no longer dependent on other countries for the supply of food-grains and a number of agricultural crops. In the same fashion, we have made substantial investment in basic and heavy industries. We are in a position to produce all varieties of basic consumer goods. The emphasis was extended was lord on the development of basic industries like steel, power and chemical fertilizer. Similar stress was given on achieving self sufficiency in different sectors.

Employment Generation:

In India, the problem of unemployment is most crucial. During the first Nine plans much emphasis was laid on the creation of larger employment opportunities, such as, emphasis on the establishment of small and cottage industries, spread of technical education, development of self- employment schemes, creation of larger industries, improvement of agriculture and service sectors etc. During the first two plans employment opportunities were generated for about 16 million people. Again during 1961-71 about 20 million people got fresh job opportunities. Again during 1981-91, about 28 million people were provided job opportunities. But with the huge growth of number of working population, the backlog of unemployment at the end of each planis increasing at a rapid rate. Total backlog which was 5.3 million at the end of first plan gradually rose to 106 million by the end of Ninth Plan. This backlog on employment front is likely to further increase during the Tenth Plan Period.

Power:

Total installed capacity (including non-utility), which was only 2,301 MW in 1950, increased to 97,899 MW (including non-utility of 12,079 MW) by the end of March, 2000. The cumulative capacity in the public utilities as on March, 2000 in the country has reached 97,837 MW (provisional) comprising 23,816 MW as hydro, 70,186 MW as thermal, 2,680 MW as nuclear and 1,155 MW as wind energy. A capacity addition of 40,245 MW in the public utilities has been targeted for the Ninth Five Year Plan period (1997-2002) and against this achievementso far during the first three years of the Plan period were 3,226 MW, 4,242 MW and 4,507 MW respectively.

Price Stability:

Attaining economic stability has been considered as one of the major objective of economic planning

throughout the entire plan period. But unfortunately, the country has been subjected to series of economic fluctuations and instability in the price level. Instability and rising prices has been considered the biggest failure of economic planning in India. The average of inflation in terms of the Wholesale Price Index (WPI) increased significantly from 3.3% in 1999-2000 to 7.1% in 2000-2001 due to substantial rise in administered prices of petroleum products. During 2001-2002, the inflation declined in terms of WPI.

Conclusion

'Azadi Ka Amrit Mahotsav' festival celebrates the rapid strides that India has taken in the past 75 years. This festival encourages us to rediscover our hidden strengths and prompts us to take sincere, synergistic action to regain our rightful place in the comity of nations.

References:

https://delhicustoms.gov.in/pdf/Reeti%20-%20191021_compressed.pdf

https://www.abplive.com/business/india-became-fastest-growing-economy-changes- made-on-economic-front-in-75-years-2192316

https://www.amarujala.com/columns/opinion/azadi-ka-amrit-mahotsav-indian-economy- journey-of-independent-india-in-the-world-of-economics

https://zeenews.india.com/hindi/business/azadi-ka-amrit-mahotsav-independence-day-15- august-gdp-and-per-capital-income-1947-to-2022/1298942

Public Distribution System in India

Sanjeev kumar Singh

The Public Distribution System (PDS) evolved as a system of management of scarcity through distribution of foodgrains at affordable prices. Over the years, PDS has become an important part of Government's policy for management of food economy in the country. PDS is supplemental in nature and is not intended to make available the entire requirement of any of the commodities distributed under it to a household or a section of the society.

PDS is operated under the joint responsibility of the Central and the State/UT Governments. The Central Government, through Food Corporation of India (FCI), has assumed the responsibility for procurement, storage, transportation and bulk allocation of food grains to the State Governments. The operational responsibility including allocation within State, identification of eligible families, issue of Ration Cards and supervision of the functioning of Fair Price Shops (FPSs) etc., rest with the State Governments. Under the PDS, presently the commodities namely wheat, rice, sugar and kerosene are being allocated to the States/UTs for distribution. Some States/UTs also distribute additional items of mass consumption through the PDS outlets such as pulses, edible oils, iodized salt, spices, etc(.NFHS, Report GOI)

History Of Public Distribution System

Public Distribution System in 1960s:

The public distribution of essential commodities was in existence in the country during the inter-war period. However, PDS, with its focus on distribution of foodgrains in urban scarcity areas, had emanated from the critical food shortages of 1960s. PDS had substantially contributed to the containment of rise in food grains prices and ensured access of food to urban consumers. As the national agricultural production had grown in the aftermath of Green Revolution, the outreach of PDS was extended to tribal blocks and areas of high incidence of poverty in the 1970s and 1980s.

Revamped Public Distribution System (RPDS):

The Revamped Public Distribution System (RPDS) was launched in June, 1992 with a view to strengthen and streamline the PDS as well as to improve its reach in the far-flung, hilly, remote and inaccessible areas where a substantial section of the poor live. It covered 1775 blocks wherein area specific programmes such as the Drought Prone Area Programme(DPAP), Integrated Tribal Development Projects (ITDP), Desert Development Programme (DDP) were being implemented and in certain Designated Hill Areas (DHA) which were identified in consultation with State Governments for special focus. Food grains for distribution in RPDS areas were issued to the States at 50 paise below the Central Issue Price. The scale of issue was up to 20 kg per card.

The RPDS included area approach for ensuring effective reach of the PDS commodities, their delivery by State Governments at the doorstep of FPSs in the identified areas, additional ration cards to the left out families, infrastructure requirements like additional Fair Price Shops, storage capacity etc. and additional commodities such as tea, salt, pulses, soap, etc. for distribution through PDS outlets.

Targeted Public Distribution System (TPDS):

In June, 1997, the Government of India launched the Targeted Public Distribution System (TPDS) with focus on the poor. Under the PDS, States were required to formulate and implement fool proof arrangements for identification of the poor for delivery of foodgrains and for its distribution in a transparent and accountable manner at the FPS level.

Assistant Professor, Dept. of Economics, sahibgang College Sahibganj, S.K.M.university Dumka , Jharkhand

The scheme, when introduced, was intended to benefit about 6 crore poor families for whom a quantity of about 72 lakh tonnes of food grains was earmarked annually. The identification of the poor under the scheme was done by the States as per State-wise poverty estimates of the Planning Commission for 1993-94 based on the methodology of the "Expert Group on estimation of proportion and number of poor" chaired by Late Prof Lakdawala. The allocation of food grains to the States/UTs was made on the basis of average consumption in the past i.e. average annual off-take of food grains under the PDS during the past ten years at the time of introduction of TPDS.

The quantum of food grains in excess of the requirement of Below Poverty Line (BPL) families was provided to the State as 'transitory allocation' for which a quantum of 103 lakh tonnes of food grains was earmarked annually. Over and above the TPDS allocation, additional allocation to States was also given. The transitory allocation was intended for continuation of benefit of subsidized food grains to the population Above the Poverty Line (APL) as any sudden withdrawal of benefits existing under PDS from them was not considered desirable. The transitory allocation was issued at prices, which were subsidized but were higher than the prices for the BPL quota of food grains.

Keeping in view the consensus on increasing the allocation of food grains to BPL families, and to better target the food subsidy, Government of India increased the allocation to BPL families from 10 kg to 20 kg of food grains per family per month at 50% of the economic cost and allocation to APL families at economic cost w.e.f. 1.4.2000. The allocation of APL families was retained at the same level as at the time of introduction of TPDS but the Central Issue Prices (CIPs) for APL were fixed at 100% of economic cost from that date so that the entire consumer subsidy could be directed to the benefit of the BPL population. However, the CIPs fixed in July and December, 2000 for BPL & AAY respectively and in July, 2002 for APL were not revised upwards since then even though procurement cost have gone up considerably.

The number of BPL families was increased w.e.f. 1.12.2000 by shifting the base to the population projections of the Registrar General as on 1.3.2000 instead of the earlier population projection of 1995. With this increase, the total number of BPL families came to 652.03 lakh as against 596.23 lakh families originally estimated when TPDS was introduced in June 1997.

Under the TPDS, the end retail price was fixed by the States/UTs after taking into account margin for wholesalers/ retailers, transportation charges, levies local taxes etc. The States were earlier requested to issue food-grains at a difference of not more than 50 paise per kg over and above the CIP for BPL families. However, since 2001, flexibility was given to States/UTs in the matter of fixing the retail issue prices by removing the restriction of 50 paise per kg over and above the CIP for distribution of food grains under TPDS.

Antodaya Anna Yojana (AAY)

AAY was a step in the direction of making TPDS aim at reducing hunger among the poorest segments of the BPL population. A National Sample Survey Exercise pointed towards the fact that about 5% of the total population in the country sleeps without two square meals a day. This section of the population could be called as "hungry". In order to make TPDS more focused and targeted towards this category of population, the "Antyodaya Anna Yojana" (AAY) was launched in December, 2000 for one crore poorest of the poor families.

AAY involved identification of one crore poorest of the poor families from amongst the number of BPL families covered under TPDS within the States and providing them food grains at a highly subsidized rate of Rs.2/- per kg. for wheat and Rs.3/- per kg for rice. The States/UTs were required to bear the distribution cost, including margin to dealers and retailers as well as the transportation cost. Thus the entire food subsidy was passed on to the consumers under the scheme.

The scale of issue that was initially 25 kg per family per month was increased to 35 kg per family per month with effect from 1st April 2002.

The AAY Scheme has since expanded to cover 2.50 crore poorest of the poor households as follows:

1. First Expansion

The AAY Scheme was expanded in 2003-04 by adding another 50 lakh BPL households headed by widows or terminally ill persons or disabled persons or persons aged 60 years or more with no assured means of subsistence or societal support. Order to this effect was issued on 3rd June, 2003. With this increase, 1.5 crore (i.e. 23% of BPL) families were covered under the AAY.

2. Second Expansion

As announced in the Union Budget 2004-05, the AAY was further expanded by another 50 lakh BPL families by including, inter alia, all households at the risk of hunger. Order to this effect was issued on 3rd August 2004. In order to identify these households, the guidelines stipulated the following criteria:-

a) Landless agriculture labourers, marginal farmers, rural artisans /craftsmen, such as potters, tanners, weavers, blacksmiths, carpenters, slum dwellers and persons earning their livelihood on daily basis in the informal sector like porters, coolies, rickshaw pullers, hand cart pullers, fruit and flower sellers, snake charmers, rag pickers, cobblers, destitute and other similar categories in both rural and urban areas.

b) Households headed by widows or terminally ill persons/disabled persons/ persons aged 60 years or more with no assured means of subsistence or societal support.

c) Widows or terminally ill persons or disabled persons or persons aged 60 years or more or single women or single men with no family or societal support or assured means of subsistence.

d) All primitive tribal households.

3. Third Expansion

As announced in the Union Budget 2005-06, the AAY was expanded to cover another 50 lakh BPL households thus increasing its coverage to 2.5 crore households (i.e. 38% of BPL). Order to this effect was issued on 12th May, 2005.

In a country, in which there is a rapid growth of population demanding for an increase in consumption of food grain. The agricultural production (including food) which has been increasing at a lower rate though merit-less attention of the consumption which is largely depended on distribution assumes greater significance.

The marketing channel of wheat and Rice are having differing prices. In privet market its usual demand and supply have determined the prices of these commodities. Therefore, the usual market model and its recapitulation here is of little use. Whereas, in the public distribution system the fixed (determined) prices for commodities distribution to the consumers. The consumers here are no other than the card holders. Therefore a separate non-competitive market for specific segment of consumers (cardholders) is being created. It is to this extent is parallel to the private market. Therefore the difference in price determination motives of sale and consumption differs significantly. As a theoretical gesture, therefore there is lead for the two tier competitive and complimentary markets within the agricultural markets.

Thus PDS is an important instrument of ensuring food security through the market mechanism. Food security has to do with both availability to reasonable price and hence can guard against food in security caused by the stability in food price and production. Therefore it require an extensive study. Similarly,

the study is important for the reason that two tier system of markets and price would increase the consumption level of the poor people. The supply of staples (wheat and Rice) is considered to be an essential step even to mitigate the efforts of famine and maintain the consumption level of the people. This is what has been the view help by Prof. Amartya Sen, Besides the leaner expenditure system analysis and its application India has demonstrated that the inter independence consumption of the people was low and it was much low for below poverty line households. However, the better result could be found it applied for special area such as Which will help in formulating PDS and other marketing policies and further more the wheat and rice supplied through PDS. In Davangere are not the common have different effect on the magnitude of consumption. The rice different are also very significant. The truth of the matter is that the Jawar is the staple grains with a mixed nutritional contest consumed by high and low, Muslims, Brahmins, Christians, Urban and rural SC and ST other section of people in Davangere.

The basic objective of the public distribution system in India is to provide essential consumer goods at cheap and subsidized prices to the consumers so as to insulate them from the impact of rising of these commodities and maintain the minimum nutritional status of our population.

OBJECTIVES OF THE STUDY:

The important objectives of the study of marketing channel for wheat and Rice in public distribution system: A .

1. To examine the marketing channels of food grains in India with special reference to wheat and rice issue.

2. To study the working of PDS in India.

HYPOTHESIS:

The important Hypothesis is to be tested in the present study have broadly stated in the following.

1. The public Distribution system, which has chalked to ensure minimum intuitional standard to the poor is successful in achieving its objectives.

As a mark of improvement in the present empirical study to arrive at ground realities in our household survey the control group analysis will adopt separate data non-PDS consideration.

Targeted Public Distribution System(TPDS) IN INDIA

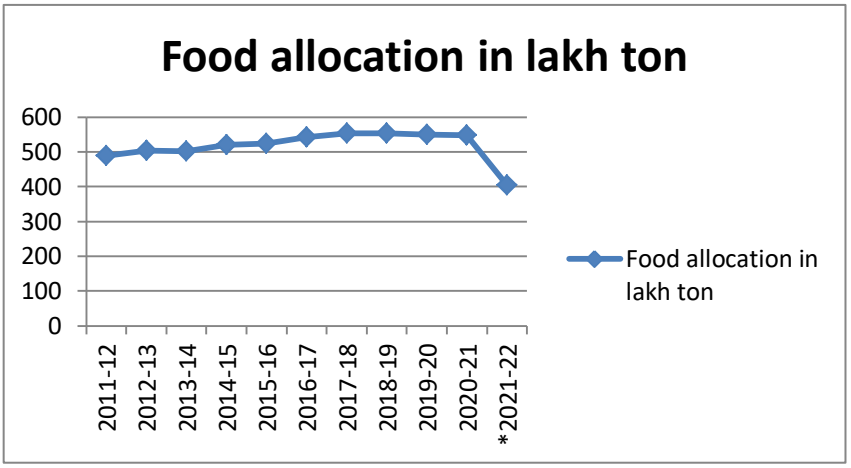
Till the year 1997, the public distribution system was of universal nature, however the government implemented the "Targeted Public" distribution system (TPDS) from June 1997 to focus on the poor. Coverage of TPDS with two estimates of poverty. The relationship was under categories i.e. Below Poverty Line (BPL) and Above Poverty Line (APL). After that, in December 2000, the government had implemented the "Antyodaya Anna Yojana (AAY)" to make the Targeted Public Distribution System more focused and targeted to the poor and poorest.

Presently, the TPDS is operated in the country under the joint responsibility of the Central and the State/UT Governments as per the provisions of the National Food Security Act 2013 wherein the Central Government is involved in the procurement of food grains in the country, storage allocation and distribution of Indian food. Transports these to the FPS depots of the Corporation, while the State/UTs identify eligible families/beneficiaries under the Act, issue and manage ration cards/beneficiaries, allot food grains to all fair price shops and deliver food grains at the doorstep. If we look at the eligible beneficiaries currently covered under TPDS, there has been a significant increase from the past years to the present, as by jan 2020, about 8.7 crore families have been covered under AAY in the country, while

70.94 crore in PHH. Families are covered. While talking about the year 2011, under AAY, 2.5 crore families are covered under BPL (8.33 crore), 13.23 crore families are covered under APL.

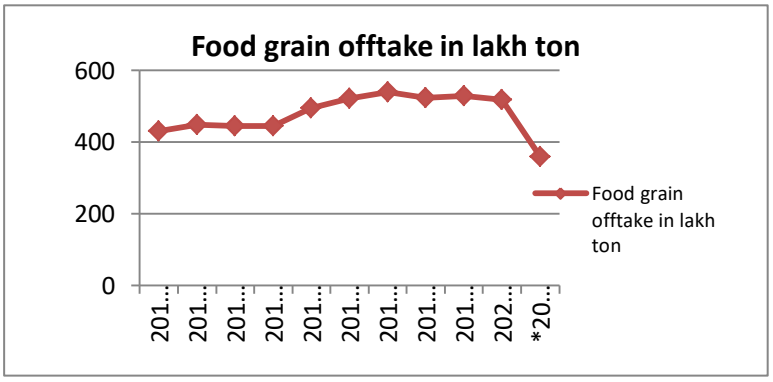
In the current year (2021-22), we will discuss about the allocation of food grains to the eligible beneficiaries under TPDS and if we look at the lifting of food grains in relation to that, then we can say that in some states the allocation and lifting of food grains is more as compared to other states. Like Maharashtra (964.546 thousand tons), Uttar Pradesh (1573.145 thousand tons), Bihar (962.885 thousand tons), Tamil Nadu (717.871 thousand tons), West Bengal (632.075 thousand tons) etc.

Looking at the trend of allocation of food grains under TPDS/NFSA in India since the year 2011, there has been an increase in the allocation of food grains, but there has been a fluctuation in the offtake relative to the allocation.



Trend of allocation of food grains under TPDS/NFSA since 2011 to present year

*till December 2021



Trend of lifting of food grains under TPDS / NFSA from the year 2011 to the present year

*Till December 2021

Looking at the above figures, we can say that the allocation of food grains under TPDS has increased in the last years, but if we looking at the off-take of food grains, it has decreased instead of increasing. Due to which the problems prevailing in the public distribution system.

Problems in PDS

1) Identification of BPL families – Targeting mechanisms such as TPDS are prone to large inclusion and exclusion errors. This means that eligible beneficiaries are not getting food grains while those who are ineligible are getting food grains. The biggest problem remains. Despite the best efforts made by the government in identification of BPL families, this problem still persists.

2) Leakage in PDS- The problem of leakage is more when food grains have to be taken away from the transport, like during the transportation of food grains from Punjab state to north-east states, there are large leakages, because the distance between them is more. The most recent data on food leakages is not publicly available. The latest data is for 2011-12, according to which NSS (2011-12) in the assessment of TPDS found 46.7 per cent leakage of rice and wheat in PDS at all India level.

3). Fake Ration cards in circulation - Food grains are distributed through ration cards, and FPSs themselves pick up rations using fake ration cards and sell them in the open market. Due to which there is a shortage of food grains and poor and Food grains do not reach the needy people. According to the Parliament, till the year 2014-21, about 4.4 crore bogus ration cards have been suspended in the states/UTs. In which the most bogus ration cards were found in Uttar Pradesh, Maharashtra, West Bengal, Madhya Pradesh, Rajasthan, Karnataka and Telangana etc.

4). Illegal practice in food distribution – There are many FPS owners of the state who provide less food grains to the beneficiaries at the rate fixed by the government and sell the foodgrains they save at open market prices, due to which BPL Families do not get the food they deserve, nor do they get enough nutrition. Due to which poverty and hunger increase instead of reducing.

5). Deterioration of the quality of food grains - The quality of food items is a very important thing. If the quality of food items is bad, then where will the nutrition come from. Tampering with the quality of food grains takes place at several stages like while moving food grains from FCI to FPS, then from FPSs to beneficiaries, but most of all tampering happens only on FPSs.Good quality food grains are sold in the open market at good prices by the owners of FPSs and instead poor quality food items are distributed among the beneficiaries, due to which there is a lack of nutrition in the children. And they become victims of malnutrition.

Table 1

Comparison of existing TPDS with the National food Security act

Provisions	Current TPDS	National Food Security Act 2013
The implication for "right to food"	Set up under administrative order; no legal backing	Provides statutory backing for the right to food
Coverage	90.2 crore beneficiaries =18.04 crore families x 5(average no.of members in a family)	Up to 75% of rural and upto 50%of the urban population ,about 81.34 crore beneficiaries32
Categories	AAY, BPL, and APL	AAY , priority, and excluded
Entitlements per category	BPL and AAY:35kg/family/month APL:15-35kg / family/month	Priority:5kg/person/month AAY:35kg/family/month
Prices of food	AAY: Rs 3/kg for rice, Rs 2/kg	All categories :Rs 3/kg for rice, Rs 2/kg for wheat

–grains	for wheat,and Re 1/kg for coarse grains Other Categories : differs across states	,and Re 1 /kg for coarse grains
Identification of beneficiaries	Centre: releases state- wise estimates of the population to be covered under TPDS Creates criteria for identification States: identify eligible households	Centre :release state- wise estimated of the covered population to be covered under the Act States Create criteria for identification identify eligible households
Centre-state responsibility	Centre: procurement ; state wise allocation; transport of grains up to state depots; storage States; delivery of grains from state depots to ration shop to the beneficiary	Same as the current system with some additions Centre: provides food security allowance to pass on the beneficiaries Centre and states : not responsible for failure to supply food grains during force majeure conditions, e.g. war, flood, drought
Grievance redressal mechanism	State governments responsible for ensuring monitoring ;vigilance committees to be set up at state ,districts, block and ration shop levels	Appoints district grievance redressal officers; establishes State Food Commissions; vigilance committees at state, districts, block and ration shop levels

CONCLUSION

In this study we see that there are several problems in the PDS that act as a barrier to TPDS achieving its goals. The biggest problem in TPDS is identifying BPL families, high diversion of food grains, increasing food subsidy, poor storage system etc. Due to this problem in TPDS, 100% lifting of food items is not possible, as we can see in Figure (2), and the government needs to improve TPDS. For example, the policy currently being run by the government needs to be strengthened further, so that TPDS can work better.

REFRENCES

www.nfsa.gov.in

www.dfpd.gov.in

Article in Asian Journal of Agriculture extension economic and sociology.February 2019 (Table 2)

Article under the CC BY-NC-ND License,AdityaVermaAyush Singh Rathore,A CharanKumari, (an automated approach to PDS using IoT)

Department of food and public distribution ,yearly report 2020-2021

The PDS and Food security in India. 3 September 2019, Neetu Abey George and Fiona H.McKay,International journal **of Environmental research and public health.**