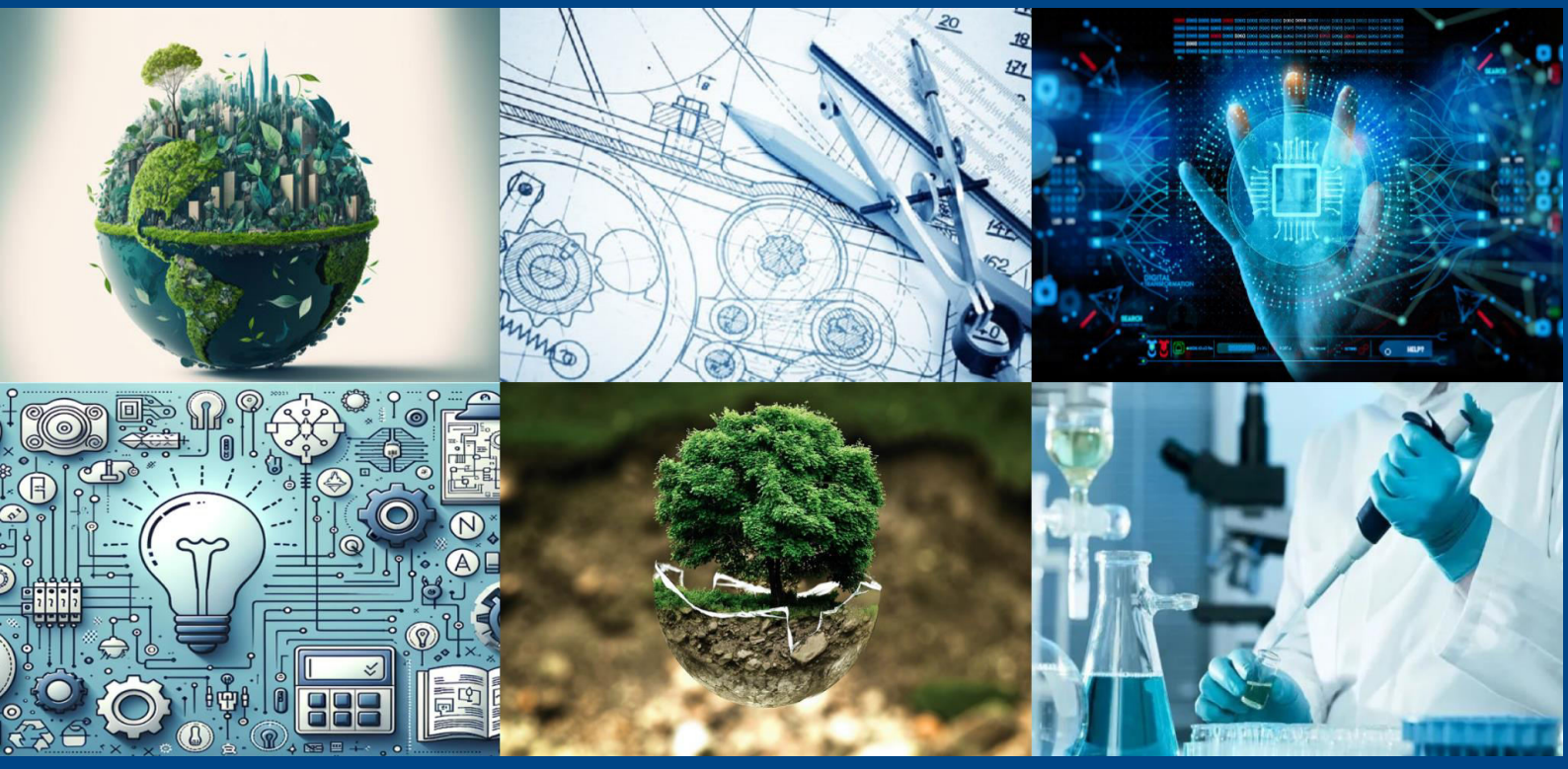
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206 **Volume 8, Issue 3, March 2025**

© 2025 IJMRSET | Volume 8, Issue 3, March 2025| DOI: 10.15680/IJMRSET.2025.0803316

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

A Study of Relationship between Economic Development and Environmental Changes in India

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ABSTRACT: India's economic development has led to environmental changes, including air and water pollution, and climate change. However, India has also taken steps to reduce emissions and promote sustainable development. Environmental changes-Air pollution: India's rapid economic growth has led to increased air pollution from the combustion of fossil fuels. This pollution has serious health consequences. Water pollution: India's economic growth has contributed to water pollution. Land pollution: India's economic growth has contributed to land pollution. Climate change: India's economic growth has contributed to climate change through greenhouse gas emissions. Steps to reduce emissions-Economic restructuring: Economic restructuring has helped to reduce energy- related carbon dioxide emissions. Local environmental protection: Local environmental protection has helped to reduce emissions. Technological change: Technological change has helped to reduce emissions. Renewable energy incentives: Renewable energy incentives and development programs have helped to reduce emissions. Carbon trading market: The 2022 Energy Conservation (Amendment) Bill sets in motion the creation of a domestic market for carbon trading. Clean infrastructure assets: Investments in clean infrastructure assets can help to reduce emissions.

KEYWORDS: Economic, development, environmental, changes, India

I. INTRODUCTION

One of the key environmental problems facing India is that of particle pollution from the combustion of fossil fuels. This has serious health consequences and with the rapid growth in the economy these impacts are increasing. At the same time, economic growth is an imperative and policy makers are concerned about the possibility that pollution reduction measures could reduce growth significantly. This paper addresses the tradeoffs involved in controlling local pollutants such as particles. Using an established Computable General Equilibrium model, it evaluates the impacts of a tax on coal or on emissions of particles such that these instruments result in emission levels that are respectively 10 percent and 30 percent lower than they otherwise would be in 2030. The main findings are as follows: (i) A 10 percent particulate emission reduction results in a lower gross domestic product but the size of the reduction is modest; (ii) losses in gross domestic proudct from the tax are partly offset by the health gains from lower particle emissions; (iii) the taxes reduce emissions of carbon dioxide by about 590 million tons in 2030 in the case of the 10 percent reduction and 830 million tons in the case of the 30 percent reduction; and (iv) taken together, the carbon dioxide reduction and the health benefits are greater than the loss of gross domestic product in both cases.[1,2,3]

India’s commitment to achieving net-zero emissions by 2070 is not just a climate goal but a cornerstone of its economic growth strategy. By targeting a 45 per cent decrease in the emission intensity of its GDP and aiming for 50 percent non-fossil fuel power generation by 2030 [1], India is aligning environmental sustainability with economic prosperity. Central to this transition are the comprehensive policy reforms to be undertaken across various cross-cutting aspects to ensure resource availability such as land, manpower, water etc. From ambitious renewable energy targets to innovative land use planning and the nascent but promising hydrogen economy, India’s policy landscape is evolving rapidly to address the challenges of climate change and energy security.

India has also implemented various financial mechanisms to foster its clean energy transition, including feed-in tariffs, tax incentives, subsidies, green bonds, and renewable energy certificates, incentivising investment and promoting the adoption of sustainable energy sources. India has made notable progress in green financing like the sovereign green bonds showcase India’s commitment to expanding renewable energy production and reducing its carbon intensity by supporting expenditures for renewable energy and electrification of transport systems. Indian green bond issuances have reached a total of $21 billion as of February 2023 [2]. Further, the Reserve Bank of India concluded four

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sovereign green bonds auctions of INR 20,000 crore (vs INR 16,000 crore in FY23), whose proceeds may be used to finance/refinance eligible green projects [3]. Alongside policy reforms, adopting an analytical economy-wide approach to understand the entire economic landscape of a country rather than focussing on specific sectors in isolation is crucial for India's economic growth. Let's discuss some of the key strategies that can be adopted for fostering enhanced economic growth and sustainable development in India.

Promoting Renewable Energy Capacity

India has made significant progress in renewable energy, with 71% of the 26 GW of new power generation capacity in FY 2023-2024 coming from renewable sources, bringing the total renewable energy capacity to 144 GW (33% of the total). Solar power dominated this growth, contributing 15 GW (81% of new renewable capacity), and wind energy additions nearly doubled to 3.3 GW. Additionally, RE auctions reached a record 41 GW, with a notable shift towards including energy storage components [4]. To further align with India's climate objectives, a substantial expansion of renewable fuel capacity, alongside the promotion of technological solutions and fostering innovation, will be a positive step to expand current installed base. This approach will help in economic growth, diversification of the country's energy mix, and increase the use of renewable fuel. Clear targets, streamlined processes for community engagement, infrastructure development, etc., investment in robust policies, and financial incentives can be crucial in further boosting renewable energy capacity in India. Additionally, investments in research and development (R&D) and grid integration technologies can play a vital role in this transition[4,5,6]

Diversifying Economic Opportunities

Exploring economic diversification is one of the essential factors for growth. While renewable energy is crucial for sustainable development, relying solely on it may not be viable. States in India vary in resources, requiring alternative approaches. For instance in states, initiatives like the promotion of renewable energy, energy efficiency in industries, green manufacturing, crop diversification, the promotion of green fuels like green hydrogen, and the encouragement of electric vehicles can stimulate innovation and job growth. In addition, green jobs can certainly play a crucial role in diversifying economic opportunities in India and enhancing economic growth. With India emerging as one of the world leaders, it has the potential to create 35 million green jobs by 2047 [5]. There is a need to boost the prevalence of green skills across all sectors undergoing green transitions. This can be essential to cultivate the workforce needed to meet the demand and achieve net- zero transitions effectively. From a sustainability perspective, fostering economic diversification should include initiatives promoting regenerative agriculture, eco-tourism, and sustainable practices across industries to ensure long-term resilience against environmental challenges.

Prioritising Complimentary Areas of Focus

Sectoral interventions, such as nature-based solutions that include afforestation, watershed management, and ecosystem restoration, alongside investments in agriculture, infrastructure, tourism, and manufacturing, can generate employment opportunities, foster green innovation, and contribute to Gross Domestic Product (GDP) growth. These interventions play a significant role in boosting economic growth and sustainable development. For example, advancements in agricultural technologies and infrastructure improvements can enhance productivity, ensure food security, attract investment, and bolster rural livelihoods. [7,8,9]Similarly, prioritising manufacturing and industrial development can creates avenues for capital absorption, resulting in job creation and technological innovation.

Establishing a Robust Governance Mechanism for Sub-National Climate Actions

Given the critical role of sub-national actors in advancing India's low-carbon development goals, a robust governance mechanism at this level can be imperative for effective implementation of the clean energy transition. Strong local governance can ensure that regional efforts align with national objectives, facilitates efficient resource allocation, and enables timely policy execution. Incorporating diverse governance structures, including cities and panchayats, will help in driving India's clean energy transition. This involves implementing localised solutions, setting policies, and fostering collaboration between stakeholders at various levels.

Strengthening the Financing Mechanism

A robust financing mechanism is vital for fostering India's economic growth and sustainable development. It ensures adequate investment in renewable energy, infrastructure, and green technologies, while mobilising private sector participation and supporting innovation adoption. Such a mechanism can promote inclusive growth and resilience to

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climate change. Strong policy and regulatory frameworks can be considered essential to create a favourable investment climate and direct funds towards economic development. Solutions like concessional loans, grants, subsidies, and carbon pricing can further help facilitate economic growth. This comprehensive approach can certainly assist India in its ambitious targets for prosperity and environmental sustainability.

Institutionalising Climate Change Capacities[10,11,12] Institutionalising capacities on climate change is another crucial factor for fostering economic growth and sustainable development through resilience, innovation, and informed decision-making. By building expertise within institutions, India can better understand and mitigate climate-related risks, attract investment in green technologies and infrastructure, and capitalise on emerging opportunities. Collaborating with relevant institutions and stakeholders (such as academic training institutes (ATIs), Bankers Institute of Rural Development who are providing periodic training to government officials to mainstream climate change into sectoral development plans) , government organisations, civil societies, and think tanks, to integrate climate considerations into policies and initiatives across sectors, can be key to ensuring resilience to climate change impacts and contributing to holistic planning for sustainable development.

A multifaceted approach is incontrovertibly one of the crucial steps for achieving economic growth and sustainable development in India. Promoting renewable energy, diversifying economic opportunities through policy reforms across various aspects such as land, water, and labour, and expanding focus on complimentary areas (such as nature based solutions and ecosystem restoration) are the strategies that will go a long way towards this goal. While establishing robust governance mechanisms, strengthening the financing mechanism, and institutionalising capacities on climate change, can play a pivotal role towards implementation. Through collaborative efforts to climate-proof sectoral actions, India can pursue holistic planning, propelling itself towards improved economic growth and sustainable development.

II. DISCUSSION

India occupies an intriguing position in the context of climate change and economic development. Blessed with enormous resources (Forests, solar energy, etc.), but short of the capital and technical know-how, India's journey to a net-zero carbon economy is a marathon. Immediate climate change policies like COP26 often meet reluctance and stress the economy. Climate change has inevitably started altering the climatic dimensions and is now causing substantial damage to the Indian economy. Yet, not aspiring an emission-less economy will hamper the development of the future. The energy demands often clash with climate-change policies. Agriculture too is affected by climate change, making half of the Indian population vulnerable. This paper presents an empirical study on the above-mentioned issues. The material and methods involve theoretical data extracted from the "Assessment of Climate Change over the Indian Region report 2020" issued by the Indian government and several other esteemed research papers. The objective of this paper is to highlight the climatic variations and how they leave an impact on the economy. At the same time, it presents suggestions to channel the climatic adversities and boost the economy. Adopting green goals and gradually shifting to a clean and green economy will hold the key with respect to India.

This study extends prior research and takes a robust account of the effects of economic growth on environmental quality in India, using several single-equation and system estimators and considering multiple structural breaks over 'long' as well as 'short' time periods. The long-run model is estimated on annual data for the period 1951–52 to 2015–2016. The results provide robust support for the positive and significant effects of gross domestic product and financial development and for the negative effects of trade openness and domestic investment on carbon dioxide emissions. The presence of structural breaks challenges the validity of smooth and continuous relationship between income and emissions postulated in previous research. Policy intervention, in terms of the imposition of Pigouvian tax, allocation of carbon quotas and promotion of carbon 'cap-and-tax' and/or 'cap-and-trade' systems, is needed to correct market failure, to cover the external cost of pollution and to curtail the emission of carbon. It is worth subsidizing alternative sources of energy, adopting carbon-efficient technologies and switching to carbon-neutral substitutes.[13,14,15]

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III. RESULTS

Concerns about the incessant rise in emissions and their attendant effects on climate change, which is ravaging the globe, are on the ascendency. The literature has almost concluded that economic activities and growth contribute significantly to environmental degradation. Despite the plethora of studies on the effect of economic growth on environmental degradation, empirical studies examining the reverse – i.e., how environmental degradation affects economic growth – are limited. However, the associated literature postulates that attaining economic growth is accompanied by increased environmental degradation. To guide the development of non-conflicting environmental and structural policies, this study examines whether the rise in environmental degradation is associated with economic growth. It also examines the potential channels through which environmental degradation could affect economic growth. Using a global panel comprising 140 countries from 1980 to 2021 and the two-step dynamic system-generalized method of moment technique to control endogeneity, the findings generally indicate a retarding effect of environmental degradation on economic growth. Further analysis, however, reveals that emissions exhibit an inverted U-shaped relationship with economic growth. However, ecological footprint indicators of environmental degradation have a U-shaped relationship with economic growth. Pathway analysis highlighted that health, foreign direct investment, and technological innovation are the potential channels through which environmental degradation could retard economic growth.

Preliminary calculations using data from the World Bank show that gross domestic product has a direct, proportional relationship with the extent of carbon dioxide (CO2) emissions in India, and the relationship is even stronger after the introduction of the liberalization policy in the 1990s. However, trade seems to have an inversely proportional relationship, consistent with the view that India's imports are mostly manufactured items that may involve polluting production process and are currently being produced outside India.[16,17,18]

We believe more specific research is needed to assess the overall environmental impact of patterns of production and consumption. Recent scientific analysis focuses on better scientific measures of the damage and impact of climate change and its effect on inequality. Clearly, warmer regions around the globe, including India and many developing Asian countries, will be affected more than their northern counterparts due to global warming. In fact, recent estimates show that climate change has increased inequality in the United States between the north and the south. Patterns of production are generally induced by the conditions of global trade and investment and by physical infrastructural support and local resources. India and the People's Republic of China (PRC), the two largest countries in Asia, have very different GDP compositions. This poses the question of whether excessive industrialization coupled with the usual transboundary and climate concerns make the PRC more vulnerable than India, which thrives on service sector growth and in turn benefits from the low pollution content of growth. This also calls for serious exploration of green accounting and the preparation of databases with better environmental indicators.

It will be worthwhile to explore the effect of liberalization on other climatic aspects, such as water pollution and land salinity, with the help of large scientific databases. But only through trade can countries replace the local production of pollution-intensive goods with imports and reduce CO2 emissions. Countries that can replace the production of pollution-intensive goods by imports will reduce CO2 emissions on this count. The growth effect, however, will go the other way. Countries with different trade patterns may suffer on both counts. India is possibly a mixed case and more detailed analysis is needed to examine the hypothesis.

IV. CONCLUSION

One of the key environmental problems facing India is that of particle pollution from the combustion of fossil fuels. This has serious health consequences and with the rapid growth in the economy these impacts are increasing. At the same time, economic growth is an imperative and policy makers are concerned about the possibility that pollution reduction measures could reduce growth significantly. This paper addresses the tradeoffs involved in controlling local pollutants such as particles. Using an established Computable General Equilibrium model,[19] it evaluates the impacts of a tax on coal or on emissions of particles such that these instruments result in emission levels that are respectively 10 percent and 30 percent lower than they otherwise would be in 2030. The main findings are as follows: (i) A 10 percent particulate emission reduction results in a lower gross domestic product but the size of the reduction is modest; (ii)

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