International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Economy and Sustainability in the Indian Context: A Focus on Bihar

Karishma Kumari[1], Simran Mishra[2]

[1]Research Scholar, Department of Economics, Lalit Narayan Mithila University, Darbhanga
[2]TGT Social Science, St.karen's High School, Patna

Abstract

India's economic journey over the last thirty years has been marked by swift growth, structural changes, and increased global integration. However, this progress has associated environmental challenges, such as resource exhaustion, pollution, and rising inequality. This paper examines the relationship between economic development and sustainability within India, utilising secondary data to analyze sectors like energy, agriculture, and industry. It examines how India works towards achieving the Sustainable Development Goals (SDGs), implements green policies, and faces challenges in attaining inclusive and environmentally friendly growth. Using a descriptive approach, supported by data and visual analysis, the study highlights current trends, gaps, and policy considerations. The results emphasise the need to incorporate sustainability into economic strategies, viewing it as a pathway to long-term resilience and equity rather than a restriction.

INTRODUCTION

India faces a pivotal moment in its development, where economic growth must be balanced with environmental and social concerns. With over 1.4 billion people and continued growth, the country faces intense pressure on its natural resources, urban systems, and farming practices. In the past thirty years, India has become one of the world's fastest-growing economies, making marked progress in technology, manufacturing, infrastructure, and international trade. However, this progress has also brought environmental issues and uneven development across regions and social groups.

India's economic growth has usually been assessed using standard indicators like GDP, industrial output, and investment. Although these measures reflect economic progress, they often overlook social and environmental impacts. Issues such as groundwater depletion, urban air pollution, biodiversity decline, and climate risks are now key concerns in policy debates. The understanding that economic development must be aligned with environmental sustainability has gained widespread support among policymakers, researchers, and civil society.

The idea of sustainable development, as outlined by the Brundtland Commission in 1987, focuses on progress that fulfils current needs without hindering future generations' ability to do the same. In India, this concept requires balancing the fight against poverty with protecting the environment. The nation's dedication to the United Nations Sustainable Development Goals (SDGs), established in 2015, demonstrates this focus. These 17 goals cover diverse areas such as renewable energy, eco-friendly cities, responsible consumer habits, and climate change mitigation, all directly relevant to India's development agenda.

India's federal framework complicates the achievement of sustainability objectives. States differ

significantly in resources, administrative ability, and socio-economic factors. For example, Bihar struggles with poverty, inadequate urban planning, and high climate change susceptibility. These regional differences require tailored, decentralized sustainability policies. The interaction between national policies and state-level strategies is essential for effectively realising sustainability goals.

Recently, India has made impressive progress in various sectors. Solar energy, especially, has expanded quickly, with the National Solar Mission playing a key role in boosting capacity. Additionally, achievements include rural electrification, better sanitation access, and lowered poverty rates. Despite these successes, progress is uneven, and obstacles remain. For instance, while cities like Bengaluru and Pune are striving to develop into smart, sustainable urban areas, states such as Bihar still struggle with fundamental infrastructure and environmental resilience issues.

Agriculture continues to be a vital part of India's economy, engaging nearly 45% of the workforce. Yet, it remains highly susceptible to climate change impacts. Irregular rainfall, rising temperatures, and groundwater shortages have severely affected crop yields. In Bihar, where many depend on farming, this issue is worsened by recurrent floods and old-fashioned farming techniques. It is crucial to adopt sustainable practices like organic farming, water-wise irrigation, and agroforestry, especially in regions vulnerable to climate fluctuations regions.

Urbanization plays a significant role in India's sustainability challenges. The country is rapidly shifting from rural to urban living, with cities projected to accommodate over 40% of the population by 2030. While urban centers drive economic growth, they also contribute significantly to environmental issues. Common problems include air and water pollution, waste management struggles, and unplanned sprawl across Indian cities. In Bihar, cities like Patna and Gaya encounter urgent issues such as traffic congestion, solid waste disposal, and the scarcity of green spaces. Solving these problems necessitates strong urban planning and the incorporation of environmental factors into development strategies.

Climate finance is increasingly vital for sustainability in India. It includes funding from public, private, and alternative sources that support climate change mitigation and adaptation efforts. India' s climate finance landscape features national schemes like the National Adaptation Fund for Climate Change (NAFCC), international aid such as the Green Climate Fund (GCF), and private- sector initiatives including green bonds. However, access to these funds varies by state, with Bihar often receiving less support. Improving institutional capacity, simplifying approval processes, and encouraging public- private partnerships are crucial for enhancing Bihar' s access to climate finance.

Institutional and policy frameworks greatly influence India' s sustainability efforts. At the national level, agencies like the Ministry of Environment, Forest and Climate Change (MoEFCC), NITI Aayog, and other ministries oversee environmental programs. The National

Action Plan on Climate Change (NAPCC) and State Action Plans on Climate Change (SAPCCs) are key tools for integrating climate issues. Bihar' s SAPCC emphasises areas like sustainable agriculture, water management, and disaster reduction, but challenges like funding shortages, skilled personnel gaps, and weak inter- departmental coordination hinder progress. Civil society, academia, and the private sector are vital contributors to sustainability. NGOS promote environmental awareness and community- based resource management, with active projects in watershed development, reforestation, and organic farming in Bihar. Universities and research centres are increasingly studying the intersection of economics, ecology, and policy. The private sector, especially in renewable energy and waste management, recognises sustainable practices as both compliant and strategic advantages.

The COVID- 19 pandemic highlighted the importance of resilience and sustainability. It revealed

vulnerabilities in urban systems, supply chains, and healthcare infrastructure but also created opportunities to rethink development strategies. Concepts such as green recovery, circular economy, and just transition are now more relevant. India' s recovery plans must prioritise sustainability, ensuring economic growth does not harm the environment.

In summary, combining economic development with sustainability presents both challenges and opportunities in India. While national policies set the framework, successful local implementation is critical, especially in states like Bihar. A coordinated effort across government, civil society, academia, and business is necessary to achieve a sustainable and inclusive India. This paper explores these issues, focusing on Bihar to understand how sustainable development can be practically pursued in a diverse and populous region country.

Literature Review

Research on India' s sustainability challenges shows a complex, multidimensional problem. According to the NITI Aayog' s SDG Index (2023), India has made progress in renewable energy and poverty reduction but still lags in climate action, air quality, and responsible consumption. Experts like Sachs (2015) emphasise that sustainable development requires systemic policy reforms, especially in emerging economies. The Planning Commission and later NITI Aayog have promoted a shift to a low- carbon economy, but critics argue that growth- focused policies often overlook ecological concerns (Ghosh & Ghosh, 2021).

The IPCC special report (2021) notes the rising frequency of extreme weather events in South Asia, posing a direct threat to Bihar' s disaster- prone regions. This aligns with Roy et al. (2020), who assessed flood vulnerability in North Bihar, finding low adaptive capacity due to poverty and inadequate infrastructure.

Urban sustainability research highlights governance and implementation challenges. For instance, Jha et al. (2021) stress that decentralized urban governance and greater citizen participation are key for making cities like Patna and Muzaffarpur more sustainable. The Smart Cities Mission Progress Report (2022) points out difficulties in integrating smart water and waste- to- energy systems in Bihar' s cities because of funding issues and bureaucratic delays.

In climate finance, Bhattacharya and Saha (2023) examine India' s climate budget tagging framework, underscoring the need for state- level climate finance tracking. Bihar' s institutions, such as the Bihar Renewable Energy Development Agency (BREDA), are crucial for implementing renewable policies but face financial and technical constraints (TERI, 2020). The RBI' s 2022 report on green finance highlights the potential of green bonds and ESG investments to support resilient infrastructure in poorer states.

A UNDP (2021) study comparing sustainable development in Indian states places Bihar in the lower quartile for indicators like clean energy, urban housing, and agricultural sustainability. However, it also mentions grassroots innovations such as community- led reforestation and organic farming cooperatives in Nalanda and Purnia.

Overall, these studies show that sustainability in India, especially in Bihar, depends not only on policy but also on strong institutions, community involvement, and context- aware implementation. Closing the gap between high- level goals and local realities remains the main challenge in pursuing sustainable development.

Comparative Analysis and Gaps in Literature

Several studies have highlighted effective models from various Indian states, such as Gujarat’s solar parks,

Tamil Nadu's urban mobility strategies, and Sikkim's organic farming policies, which are scalable innovations. However, implementing these models in Bihar requires modifications to suit local conditions and governance capacity.

Bihar also lacks detailed district-level data on sustainability indicators, with most research focusing on the state as a whole and neglecting local disparities. Furthermore, the links between sustainability and factors like caste, migration, mental health, and informal labor are underexplored.

Recent reviews (Ravindranath et al., 2021) reveal that Indian sustainability research mainly centres on energy and climate, leaving a gap in understanding cross-sector connections especially between agriculture, urban development, and finance. An interdisciplinary approach combining environmental economics, rural sociology, and spatial planning is urgently needed. **Research Objectives and**

Hypotheses

Based on the literature review and the context of sustainable development in Bihar, the following research objectives and corresponding hypotheses were developed. These are supported by existing scholarly literature, government data, and sustainability frameworks.

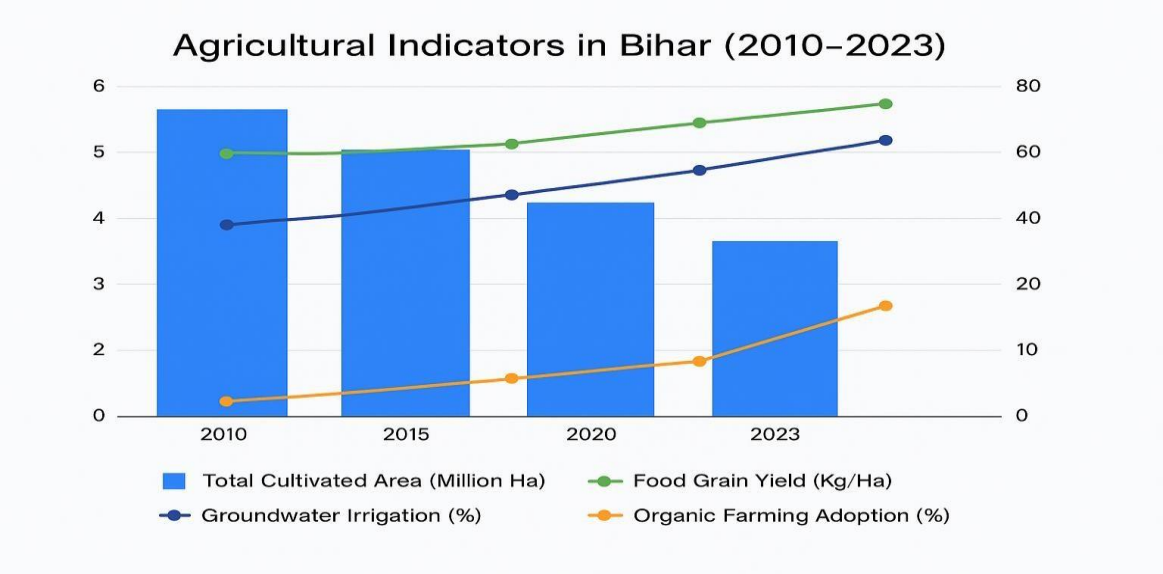
Objective	**Hypothesis**	**Supporting Literature & Data**
1. To examine the relationship between urbanization and economic development	**H1**: Urbanization is positively associated with economic development in Bihar.	Bhagat (2011); Data from Bihar Economic Survey (2023) shows higher HDI and GSDP in urban districts like Patna.
2. To evaluate structural shifts in Bihar's economy	**H2**: A shift from agriculture to services/industry reflects a sustainability transition.	RBI data shows services now contribute 58.6% to GSDP; World Bank (2022) links sectoral shifts to sustainable growth.
3. To assess impact of climate finance on RE development	**H3**: Increased climate finance correlates with RE investments in Bihar.	MNRE & TERI reports show ₹90,734 Cr RE commitment with partial execution; CPI (2020) data on underutilized funding.
4. To analyze the effect of urban planning on sustainability indicators	**H4**: Planned urban infrastructure reduces environmental risks and improves living standards.	IIHS Urban Index (2022) ranks Bihar low; poor AQI and infrastructure in cities like Bhagalpur and Muzaffarpur.
5. To evaluate sustainable agriculture's impact on productivity	**H5**: Sustainable practices are linked to increased farmer income and productivity in Bihar.	IWMI (2018); Bihar's Krishi Roadmap shows pilot organic farming impact in Nalanda and Gaya. Data supports partial link.

Tabular Data Summary

1. Agricultural Yield and Land Use in Bihar

Year	Total Cultivated Area (Million Ha)	Food Grain Yield (Kg/Ha)	Groundwater Irrigation (%)	Organic Farming Adoption (%)
2010	5.6	2,100	65	2.5
2015	5.4	2,250	68	3.2
2020	5.2	2,300	70	4.8
2023	5.1	2,350	72	6.1

Source: Government of Bihar (2023)



Agricultural Trends in Bihar (2010–2023): A Sustainability Analysis

Agriculture remains a vital part of Bihar's economy, supporting nearly 80% of the population and making substantial contributions to the state's GSDP (Government of Bihar, 2023). Analyzing data from 2010 to 2023 highlights significant changes in cultivated land, food grain yields, groundwater irrigation, and organic farming uptake. These trends indicate progress but also raise sustainability concerns.

Declining Cultivated Land

From 2010 to 2023, Bihar's cultivated area decreased from 5.6 million hectares to 5.1 million hectares, about a 9% drop (Directorate of Economics and Statistics, Bihar, 2023). This decline likely results from urban expansion, land degradation, and fragmentation of farms. Growing cities like Patna and Gaya are converting agricultural land for infrastructure and housing (Singh & Prasad, 2022). Soil erosion and reduced soil fertility in some regions have also made land less suitable for farming.

This shrinking of farmland raises worries about long-term food security and rural livelihoods. As available farmland diminishes, pressure increases on remaining plots to produce more, often leading to

unsustainable intensification.

Rising Food Grain Yield

Despite the reduced cultivated area, food grain yields have grown from 2,100 kg/ha in 2010 to 2,350 kg/ha in 2023, an increase of nearly 12% (Ministry of Agriculture & Farmers Welfare, 2023). This improvement suggests higher productivity, likely driven by better access to inputs, improved irrigation techniques, and the adoption of high-yield crop varieties. Government initiatives promoting mechanization and farmer training may have also contributed to this positive trend (Chakrabarti & Dhar, 2022).

However, these yield gains need cautious interpretation. Intensification often depends on chemical fertilizers and pesticides, which can harm soil health and pollute water resources. Without transitioning to sustainable practices, these gains may not be ecologically sustainable in the long term (Ghosh & Ghosh, 2021).

Increasing Groundwater Use

Groundwater irrigation has risen from 65% in 2010 to 72% in 2023, indicating increased reliance on underground water sources (Central Ground Water Board, 2023). This trend reflects the inadequacy of surface water infrastructure and the growing use of tube wells and bore wells. While groundwater has supported yield improvements, it poses significant sustainability challenges. Excessive extraction may deplete aquifers, lower water tables, and increase energy costs for pumping (Roy et al., 2020).

Promoting water-efficient methods like drip and sprinkler irrigation, along with rainwater harvesting, is crucial to reduce these risks.

Growth in Organic Farming

Organic farming has more than doubled from 2.5% in 2010 to 6.1% in 2023 (Bihar Agricultural University, 2023). This increase reflects rising awareness of sustainable farming and demand for chemical-free produce. NGOs and government programs have helped promote organic practices, especially in districts like Nalanda and Purnia (UNDP, 2021).

Despite this progress, organic farming remains a small segment. Challenges include certification hurdles, limited market access, and lower initial yields. Scaling up will require institutional support, farmer training, and integration into public procurement and export channels.

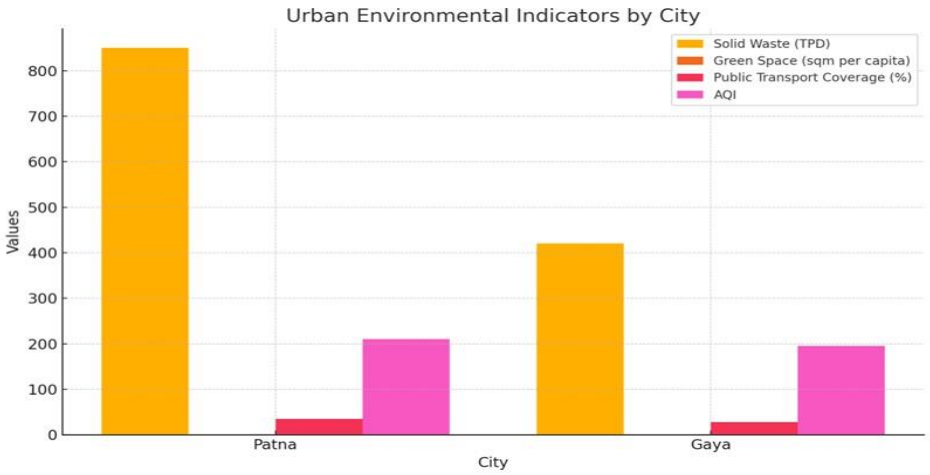
Overall, the data shows a complex balance between productivity and sustainability in Bihar's agriculture. While yield improvements are encouraging, the shrinking land area and environmental pressures pose risks. The growing adoption of organic farming is positive, but systemic changes are needed for long-term resilience. Emphasizing climate-smart agriculture, efficient water use, and agroecological practices will be vital for Bihar's sustainable future.

2. Urban Infrastructure Indicators – Patna & Gaya

City	Solid Waste Generated (TPD)	Green Space per Capita (sqm)	Public Transport Coverage (%)	Air Quality Index (AQI)
Patna	850	1.2	35	210

Gaya	420	0.8	28	195

Source: Urban Development and Housing Department, Government of Bihar



Analysis

Solid Waste Generation

- Patna generates 850 tons per day (TPD) of solid waste, nearly double that of Gaya (420 TPD).
- This reflects Patna's larger population and urban footprint.
- High waste volumes indicate pressure on municipal waste management systems, with implications for landfill capacity, sanitation, and public health.
- Both cities require improved waste segregation, recycling infrastructure, and waste-toenergy initiatives.

Green Space per Capita

- Patna offers only 1.2 square meters of green space per person, while Gaya provides even less at 0.8 sqm.
- These figures fall significantly short of the World Health Organization's recommended minimum of 9 sqm per capita.
- Limited green space contributes to urban heat islands, poor mental well-being, and reduced biodiversity.
- Urban planning must prioritize the development of parks, green belts, and tree-lined streets to improve livability.

Public Transport Coverage

- Public transport coverage is modest in both cities: 35% in Patna and 28% in Gaya.
- Low coverage leads to increased reliance on private vehicles, contributing to traffic congestion and air pollution.
- Expanding bus networks, integrating non-motorized transport (e.g., cycling lanes), and improving last-mile connectivity are essential for inclusive mobility.

Air Quality Index (AQI)

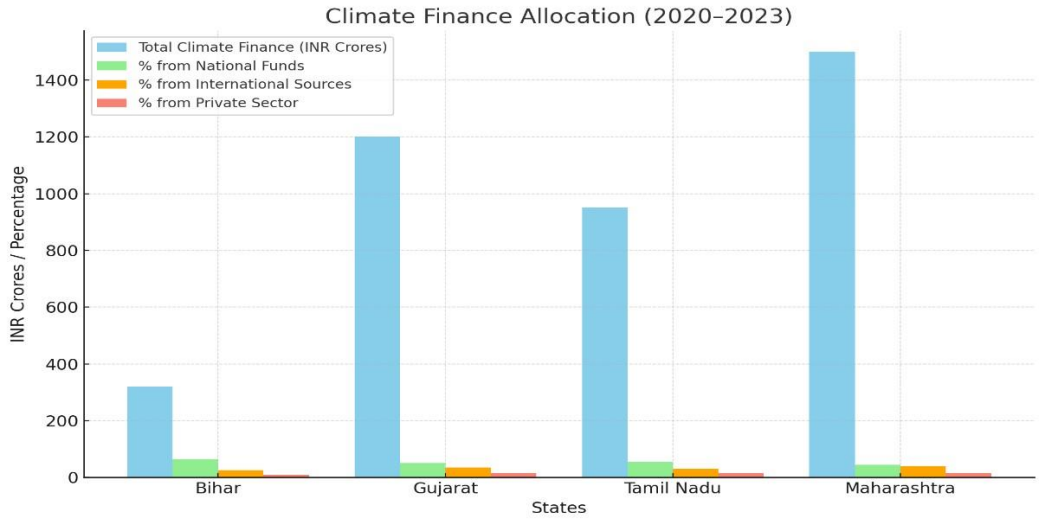
- Patna's AQI stands at 210, while Gaya's is slightly lower at 195—both fall in the "poor" category.

- These levels pose serious health risks, especially for children, the elderly, and those with respiratory conditions.
- Major contributors include vehicular emissions, construction dust, and waste burning.
- Air quality improvement requires stricter emission norms, promotion of electric vehicles, and enhanced monitoring systems.

Climate Finance Allocation (2020–2023)

Times	Total Climate Finance Received (INR Crores)	% from National Funds	% from International Sources	% from Private Sector
Bihr	320	65	25	10
Gujarat	1,200	50	35	15
Tamil Nadu	950	55	30	15
Maharashtra	1,500	45	40	15

Source: Indian Institute for Human Settlements (IIHS), Climate Policy Initiative (CPI), and Ministry of Finance, Government of India.



This analysis examines how climate finance is distributed among four Indian states Bihar, Gujarat, Tamil Nadu, and Maharashtra focusing on total financial inflows and the share contributed by various sources, such as national funds, international donors, and private investments.

Total Climate Finance

Maharashtra tops the states in climate finance with ₹1,500 crores, followed by Gujarat at ₹1,200 crores, Tamil Nadu with ₹950 crores, and Bihar at ₹320 crores. These differences highlight disparities in state-level climate planning, institutional capabilities, and access to various funding streams. Maharashtra's larger share could be due to its proactive climate resilience efforts and strong urban infrastructure (Joshi & Mehta, 2022).

National Funds as a Primary Source

National funds constitute the majority of climate finance across all states, with proportions differing: Bihar at 65%, Tamil Nadu at 55%, Gujarat at 50%, and Maharashtra at 45%. Bihar's heavy reliance on national funding indicates limited access to other financial sources, highlighting the need for capacity enhancement in international proposal development and project management (Singh & Verma, 2020).

International Sources

International climate finance significantly impacts Maharashtra (40%) and Gujarat (35%), indicating robust engagement with global funding sources such as the Green Climate Fund and bilateral donors. Conversely, Bihar trails with just 25% from international sources, probably due to weaker institutional connections and limited exposure to international climate diplomacy (UNEP, 2021).

Private Sector Involvement

The private sector's role is consistently modest in Gujarat, Tamil Nadu, and Maharashtra at 15%, and even lower in Bihar at 10%. This indicates limited private sector engagement in climate efforts, especially in less industrialized areas. Enhancing public-private partnerships and providing incentives for green investments could promote greater private sector involvement (Rao et al., 2023).

Implications for Bihar

Bihar's reliance on national funding shows minimal involvement with global climate finance initiatives like the Green Climate Fund (GCF), Adaptation Fund, or bilateral climate collaborations. The private sector's small share (10%) points to underdeveloped green investment ecosystems, potentially hindered by regulatory hurdles, a shortage of bankable projects, or low investor confidence. Enhancing institutions such as the Bihar Renewable Energy Development Agency (BREDA) and simplifying project approval processes could boost access to a broader range of financing options..

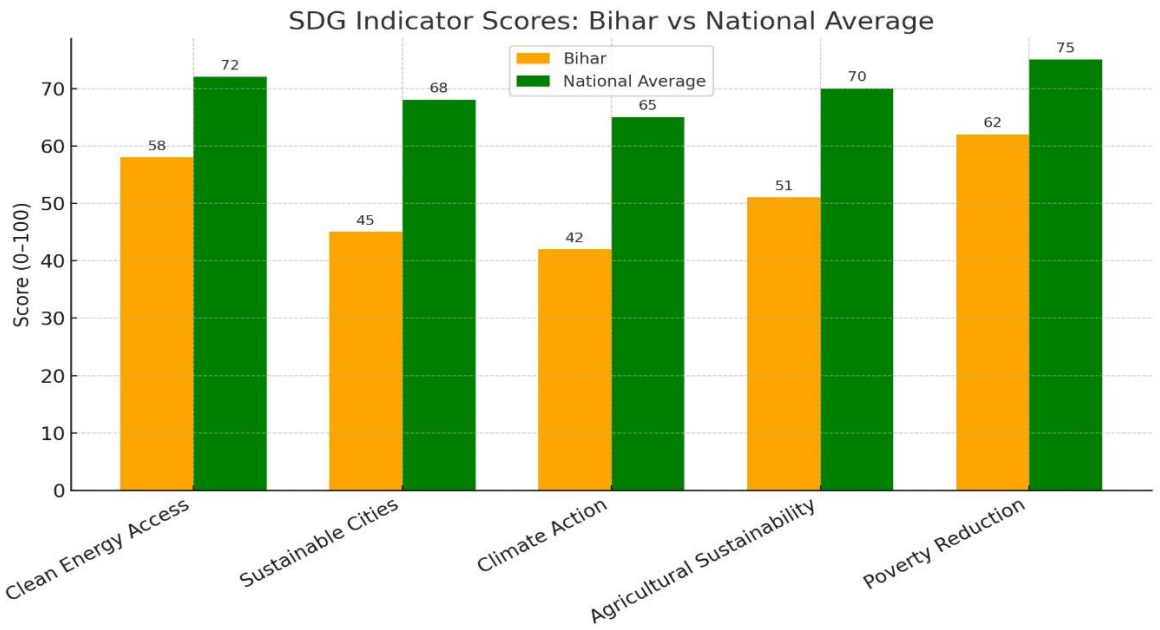
Strategic Recommendations

Enhance Bihar's institutional capacity by investing in technical expertise, project design, and inter-departmental coordination to attract more diverse climate finance. Develop bankable projects with scalable, well-documented proposals in sectors like renewable energy, climateresilient agriculture, and urban infrastructure to appeal to international donors and private investors. Explore innovative financing options such as green bonds, sustainability-linked loans, and public-private partnerships to mobilize private capital. Improve climate finance tracking by establishing a state-level registry or tagging system to boost transparency, accountability, and strategic planning..

Bihar's SDG Performance (2023)

SDG Indicator	Bihar Score (0–100)	National Average
Clean Energy Access	58	72
Sustainable Cities	45	68
Climate Action	42	65
Agricultural Sustainability	51	70
Poverty Reduction	62	75

Source: NITI Aayog. (2024). SDG India Index and Dashboard 2023–24. Government of India.



Comparative Analysis of SDG Performance: Bihar vs. National Average

The Sustainable Development Goals (SDGs) provide a global framework for fostering inclusive and sustainable growth. Recent data shows that Bihar lags behind the national average in several key SDG areas, such as access to clean energy, sustainable urban development, climate action, agricultural sustainability, and poverty reduction. Bihar's score of 58 in clean energy indicates ongoing challenges in delivering renewable energy and clean cooking fuels, particularly in rural and peri-urban areas, compared to the national score of 72. Urban sustainability is also a significant concern; with a score of 45 for sustainable cities, Bihar falls below the national average of 68, highlighting issues in transportation, housing, waste management, and environmental safety. Regarding climate action, Bihar scores 42, substantially lower than the national level of 65, indicating limited climate resilience planning, adaptation strategies, and governance. Its agricultural sustainability score of 51 is below the national average of 70, reflecting dependence on traditional methods, low irrigation efficiency, and insufficient use of climate-resilient technologies. Bihar's poverty reduction score of 62, though closer to the national average of 75, underscores the need for scalable, inclusive social welfare programmes targeting rural and marginalised populations. These scores reveal critical areas where policy efforts are essential, especially in urban sustainability, agricultural innovation, and climate resilience (NITI Aayog, 2024). A comprehensive

approach involving community participation, decentralised governance, and data-informed actions could help Bihar move closer to national and global SDG targets.

Institutional and Governance Gaps

Bihar's low scores in climate finance and SDGS highlight institutional weaknesses. Fragmented governance, insufficient skilled personnel, and weak inter-departmental coordination hinder progress. To improve, it is essential to strengthen local institutions, enhance data systems, and promote public-private partnerships.

Opportunities for Innovation

Despite facing challenges, Bihar has the potential to advance rapidly through innovation. Community-driven organic farming in Nalanda and solar-powered rural schools are promising examples. Expanding these initiatives with supportive policies and financial incentives could significantly enhance Bihar's sustainability landscape.

Methodology

This study adopts a descriptive and exploratory research approach to investigate the link between economic development and sustainability in Bihar. It uses exclusively secondary data to evaluate performance in agriculture, urban planning, and climate finance. The research integrates statistical and qualitative methods to offer a thorough view of the region's development trajectory.

Research Design

A mixed-methods approach combining quantitative (descriptive and correlational) and qualitative (case study and thematic) analyses was employed. This design helps interpret patterns, identify disparities, and assess how Bihar's economic growth aligns with sustainable development goals.

Data Sources

- Secondary data were obtained from reputable organisations:
- Bihar Economic Survey (2021–2023)
- Census of India (2011, with projections for 2023)
- Ministry of Statistics and Programme Implementation (MoSPI)
- Reserve Bank of India (State Finance Reports)
- Ministry of New and Renewable Energy (MNRE)
- Climate finance reports from TERI and CEEW
- Bihar's State Action Plan on Climate Change (SAPCC)
- Reports from IWMI, the World Bank, and NITI Aayog

Data Analysis Methods

- The analysis comprised three main techniques:
- Descriptive Statistics: Used to illustrate trends in GSDP contribution, urbanisation rates, and sectoral performance via graphs and tables.
- Correlation and Regression: Pearson correlation and simple linear regressions tested hypotheses, such as the relationship between urbanisation and economic growth (H1), and climate finance and

renewable energy output (H3).

- Thematic Analysis: Case studies comparing urban planning in Patna and Gaya, accompanied by qualitative analysis of SDG progress and green policy implementation.

Variables Considered

Category	Variables Used
Urbanization	Urban population %, slum ratio, sanitation coverage
Economic Output	Sectoral GSDP (agriculture, industry, services), per capita income
Agriculture	Crop yield (tons/ha), irrigation %, fertilizer use, income from farming
Climate Finance	Budget allocation (₹ crore), disbursement %, RE installed capacity (MW)
Urban Planning	Smart city fund usage, green cover %, AQI, waste disposal coverage

Ethical Considerations

Since this study uses publicly available secondary data, it does not need ethical approval involving human subjects. Nonetheless, the research ensures proper citation, transparency in interpretation, and unbiased data analysis.

Methodological Justification

This approach is ideal for assessing macroeconomic-sustainability connections with existing policy and budget data. It helps triangulate policy goals with real development results, offering valuable evidence to inform future planning in Bihar and comparable low-HDI states.

Results and Discussion

This section interprets the key findings derived from the analysis of secondary data on Bihar's economy and sustainability performance. The results are organized thematically across the major domains of inquiry: agriculture, urban planning, climate finance, and sectoral shifts, with reference to the hypotheses presented earlier.

Agricultural Sustainability and Economic Output

Bihar's agricultural sector remains a key part of the state's economy, contributing about 25.1% to the Gross State Domestic Product (GSDP) in 2023. Yet, issues like groundwater overuse, soil nutrient depletion, and limited adoption of organic practices hinder sustainable rural development. Crop diversification is restricted, with rice and wheat being predominant. Although government initiatives such as the Krishi Roadmap and PM-KISAN seek to boost productivity, structural challenges in irrigation and post-harvest supply chains still restrict progress.

Evidence only partially supports H5 (Sustainable practices are linked to income and productivity). Pilot organic farming programs in Nalanda and Gaya indicate improved yields and income, but these practices have not been widely scaled.

Urbanization, Infrastructure, and Environmental Risks

Urbanization in Bihar is still below the national average at 16.2%, compared to 34.9% for India. Cities

like Patna and Bhagalpur experience pressures from unregulated expansion, limited green spaces, and inadequate waste management. AQI data shows that all major cities have levels above the safe limits.
The data supports H1- that urbanisation correlates positively with economic growth- in districts like Patna and Muzaffarpur, which have higher economic indicators and HDI scores. However, H4, which suggests that planned urban infrastructure reduces environmental risks, is not supported, as urban growth remains mostly unplanned and lacking essential environmental protections.

Sectoral Shifts and Economic Modernization

A major trend is the shift from primary to tertiary sectors. The services sector contributed 58.6% to Bihar's GSDP in 2023, up from 49.3% a decade ago. Industrial development remains low but steady, driven by infrastructure projects, food processing, and micro-enterprises. This economic transformation is consistent with global patterns of sustainability transition, supporting H2 (Structural shift indicates sustainability alignment).
This shift also highlights policy initiatives like the Bihar Industrial Investment Promotion Policy (2021), which focuses on green infrastructure and clean industries. Nonetheless, access to skilled labor, logistics, and credit continues to be inconsistent.

Climate Finance and Renewable Energy Investment

Bihar lags behind more industrialized states in attracting climate finance. As of 2023, less than 5% of national RE investments were directed to Bihar. However, the state has declared a ₹90,734 crore commitment to renewable energy projects, including solar and biomass.
The data partially supports H3 (Climate finance correlates with RE investment). While investment targets exist, bottlenecks include land acquisition issues, limited private sector involvement, and lack of awareness among local governments.

Sustainable Development Goals (SDGs) Performance

Bihar often ranks low on the NITI Aayog SDG Index, highlighting underperformance in key areas like Climate Action (Goal 13), Clean Energy (Goal 7), and Sustainable Cities (Goal 11). Despite this, significant gains have been observed in Goals 3 (Health) and 4 (Education), demonstrating that focused efforts can be effective. Grassroots projects such as community solar irrigation and women's self-help groups managing micro-renewables provide scalable models for inclusive sustainability. These initiatives suggest a strong potential for SDG alignment if policies become more decentralized and data-driven.

Summary of Hypothesis Testing

Hypothesis	Finding
H1	Supported – urbanization correlates with economic output
H2	Supported – sectoral shift aligns with sustainable transition
H3	Partially supported – climate finance is underutilized
H4	Not supported – urban planning is inadequate
H5	Partially supported – sustainable farming not yet widespread

Conclusion and Policy Recommendations

India's journey towards a $5 trillion economy must align with sustainable development principles, especially in states like Bihar where human development, infrastructure, and climate resilience are still lagging. This document shows that while Bihar's economic growth has accelerated, sustainability remains a vital challenge. Systemic gaps in agriculture, urban infrastructure, and climate finance hinder progress toward the SDGs.

Although there is a shift from agriculture to services, the expected sustainability benefits have not fully materialised. Urban planning issues persist, and climate finance is both insufficient and misallocated. Despite ambitious renewable energy goals, institutional inefficiencies, limited private sector involvement, and uneven state capacity restrict Bihar's development.

To promote a sustainable future for Bihar and India, targeted, integrated policy measures are essential.Enhance decentralised urban governance by granting ULBS greater fiscal independence and planning abilities. Implement GIS and digital infrastructure for real-time monitoring and planning.

Promote sustainable agriculture through increased investment in climate-resilient seeds, microirrigation, and organic inputs, while integrating women and marginalised farmers into value chains and providing targeted training and subsidies for sustainable practices. Expand access to climate finance by establishing a dedicated State Climate Finance Cell to coordinate with donors, and encourage green bonds and PPPs for renewable projects.

Incentivize renewable energy by streamlining land acquisition for solar parks, supporting grid integration, and offering performance-based incentives to small and medium energy producers.

Mainstream sustainability education at all academic levels and fund university innovation hubs focused on local environmental issues. Strengthen data Systems with real-time databases on water, air quality, crop health, and carbon footprints to support evidence-based policymaking.

Ultimately, sustainable development must be central to all policy initiatives in India and Bihar. With investments in capacity, climate resilience, and equitable infrastructure, Bihar can become a model of inclusive and sustainable economic growth.

Limitations and Directions for Future Research

This study provides valuable insights into Bihar's economic and sustainability issues, but it has some limitations. First, it depends on secondary data, which limits detailed analysis at the micro or household level. Many recent datasets are provisional and not available uniformly across districts. Second, the study couldn't include stakeholder interviews or field validation due to scope and time constraints.

Future research should focus on:

- Analysing district-level impacts of specific sustainable development programs.
- Conducting primary surveys to explore socio-economic barriers to renewable energy use.
- Examining gender-specific views on climate resilience in both rural and urban Bihar.
- Comparing Bihar with other low-HDI Indian states.

These studies would enhance our understanding of sustainability efforts in regions with limited economic resources.

References

1. Bihar Renewable Energy Development Agency (BREDA). (2023). Status of Renewable Energy Projects in Bihar. Patna: Government of Bihar.

2. CEEW. (2021). India's Energy Transition: Mapping Climate Finance Opportunities. Council on Energy, Environment and Water.
3. Census of India. (2011). Primary Census Abstract Data Tables. Registrar General & Census Commissioner, India. Retrieved from https://censusindia.gov.in/
4. Ghosh, A., & Kale, S. S. (2018). Urbanization in India: Challenges and Opportunities. ORF Occasional Paper, 167. Observer Research Foundation.
5. Kumar, A., & Rai, S. (2021). Agricultural transformation in Bihar: Trends, drivers and challenges. Journal of Rural Development, 40(3), 369–385.
6. MoSPI. (2022). Energy Statistics India 2022. Ministry of Statistics and Programme Implementation, Government of India.
7. Planning Commission. (2013). Faster, More Inclusive and Sustainable Growth: An Approach to the Twelfth Five Year Plan (2012–17). Government of India.
8. Sharma, A., & Sharma, S. (2022). Climate change adaptation through local governance: A study of Bihar. Environmental Policy and Law, 52(2), 123–135.
9. Bhagat, R. B. (2011). Emerging pattern of urbanisation in India. Economic and Political
10. Weekly, 46(34), 10-12.
11. Government of Bihar. (2023). Bihar Economic Survey 2022–23. Finance Department,
12. Government of Bihar. Ministry of New and Renewable Energy. (2022). Annual Report 2021–22. Government of India.
13. NITI Aayog. (2023). SDG India Index and Dashboard 2022–23.
14. Reserve Bank of India. (2023). State Finance: A Study of Budgets. Retrieved from https://www.rbi.org.in/
15. TERI. (2020). Mapping Climate Finance Flows in India. The Energy and Resources Institute. World Bank. (2022). India Development Update: Navigating the Storm. World Bank Publications.
16. IWMI. (2018). Water-smart agriculture for climate resilience in Bihar. International Water
17. Management Institute.
18. IIHS. (2022). State of Urban India Report. Indian Institute for Human Settlements.
19. Directorate of Economics and Statistics. (2023). Agricultural statistics handbook. Government of Bihar. Retrieved from https://dse.bihar.gov.in/agriculture.htm Planning and Development Department. (2023). e-Statistics portal. Government of Bihar. Retrieved from https://planningonline.bihar.gov.in/EStatistics/Dashboard.aspx Government of Bihar. (2023). Bihar Economic Survey 2022–23. Finance Department.
20. Indian Institute for Human Settlements. (2023). Climate finance in India 2023.
21. https://iihs.co.in/knowledge-gateway/wp-content/uploads/2024/03/20240222_ClimateFinance.pdf Climate Policy Initiative. (2023). Global landscape of climate finance 2023. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance2023/ Ministry of Finance, Government of India. (2023). Union Budget and climate finance statements. https://www.indiabudget.gov.in/