The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 2 | Issue 11 | November 2024
ISSN: 2583-973X (Online)
Website: www.theacademic.in

Environmental Sustainability and Disaster Management in Bihar

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ARTICLE DETAILS

Research Paper

Keywords:
Climate Change, Disaster Management, Forest Resources, Bihar, Sustainable Development

DOI:
10.5281/zenodo.14328547

ABSTRACT

The intricate relationship between environment, climate change, and disaster management is increasingly significant in Bihar, a state vulnerable to various natural disasters. This paper examines the impact of climate change on environmental degradation and its subsequent influence on disaster frequency and intensity, particularly in the context of floods and droughts. In 2022-23, Bihar experienced severe flooding affecting 17 districts and drought conditions impacting over 72 lakh people. The state's forest resources, comprising deciduous sal forests and moist deciduous forests, play a crucial role in its economy, contributing approximately 8% to the agricultural Gross State Domestic Product (GSDP) in 2021-22. However, the Department of Environment, Forest, and Climate Change faces financial challenges, with revenues increasing by 22.2% to ₹53.82 crore while expenditures reached ₹631.37 crore. This study emphasizes the necessity for integrated disaster management strategies that promote community engagement and sustainable forest management practices. By prioritizing adaptive management and leveraging technological advancements, the government can enhance resilience against climate-related disasters while fostering sustainable development. Ultimately, addressing the nexus between environment, climate change, and disaster management is vital for safeguarding human lives and preserving ecological integrity in Bihar.

1. Introduction

The interplay between environment, climate change, and disaster management has emerged as a critical area of concern for policymakers globally, particularly in regions like Bihar, India, which are highly susceptible to natural disasters. Climate change, primarily driven by human activities such as deforestation, industrialization, and unsustainable agricultural practices, exacerbates environmental degradation and increases the frequency and intensity of disasters such as floods, droughts, and heat waves. In Bihar, the socio-economic impacts of these disasters are profound, affecting millions of lives and livelihoods. For instance, in the fiscal year 2022-23 alone, floods impacted 17 districts while drought conditions affected over 72 lakh people across 11 districts. Such statistics underscore the urgent need for a comprehensive approach to disaster management that integrates environmental sustainability with effective risk reduction strategies. Bihar is characterized by its diverse forest resources, including deciduous sal forests in the south and moist deciduous forests in the north. These forests play a vital role in the state's economy by providing essential products such as timber, fuel wood, and non-timber forest products (NTFPs), contributing approximately 8 percent to the agricultural Gross State Domestic Product (GSDP) in 2021-22. However, the state's forest cover faces significant challenges due to increasing urbanization and climate change impacts. The financial trends of the Department of Environment, Forest, and Climate Change reveal a mixed picture; while revenue has increased by 22.2% to ₹53.82 crore in 2022-23, expenditures have surged to ₹631.37 crore. This highlights the need for efficient resource allocation to support sustainable forestry practices while addressing the pressing demands of climate change mitigation. The government of Bihar has initiated several programs aimed at enhancing environmental resilience and promoting sustainable development. Initiatives such as the Hariyali Mission and Jai-Jeevan-Hariyali Abhiyan focus on afforestation and water conservation efforts that are crucial for maintaining ecological balance. Additionally, the establishment of eco-tourism projects aims to generate revenue while fostering community engagement in conservation efforts. However, despite these positive steps, there remains a critical need for integrated disaster management frameworks that encompass community participation and adaptive management practices. By prioritizing these strategies, Bihar can not only mitigate the adverse effects of climate change but also promote sustainable economic growth that benefits its vulnerable populations. In summary, addressing the nexus between environment, climate change, and disaster management is essential for safeguarding human lives and preserving ecological integrity in Bihar. As this paper explores various dimensions of this interconnectedness, it aims to provide insights into effective strategies that can be adopted by the

government to enhance resilience against climate-related disasters while promoting sustainable development. The findings will contribute to a deeper understanding of how integrated approaches can better equip communities to face the challenges posed by an increasingly unpredictable climate.

2. Review of Literature

Kumar, S., Singh, S. K., Kanga, S., Meraj, G., Farooq, M., & Nathawat, M. S. (2024). The reviewed literature emphasizes that environmental degradation significantly exacerbates disaster risks by reducing the functionality of vital ecosystems that mitigate natural hazards. It highlights the interconnectedness of unsustainable development practices, poverty, and environmental deterioration, which collectively heighten vulnerability to disasters. Research underscores the necessity for environment-sensitive policies and practices to reduce disaster risks while fostering resilience. Strategies like integrated resource management, elimination of harmful subsidies, renewable energy adoption, and biodiversity conservation have proven effective across regions when tailored to local contexts. Case studies from the Asia-Pacific region reveal how these approaches can simultaneously address environmental challenges and disaster risks. Thus, building resilience requires a holistic framework combining long-term environmental sustainability with immediate disaster risk reduction measures.

Dai, J., & Azhar, A. (2024). The review by Jiapeng Dai and Aisha Azhar examines the outcomes of collaborative governance in disaster management and its alignment with the United Nations Sustainable Development Goals (SDGs). The study emphasizes the importance of partnerships (SDG 17) and aligns the Sendai Framework with goals such as poverty eradication, climate action, and urban resilience. Highlighting global case studies, including those from the USA, the review delves into key areas like non-profit roles, policy frameworks, and specific disasters such as Hurricanes Katrina and Rita. It identifies gaps in existing research and calls for studies from diverse contexts, emphasizing a comprehensive framework for integrating disaster management and sustainable development under the SDG agenda. The research underscores the critical role of collaboration in achieving resilient and sustainable communities globally.

Sargiotis, D. (2024). Dimitrios Sargiotis's study explores the transformative impact of digital technologies like Artificial Intelligence (AI), Machine Learning (ML), and Information and Communication Technology (ICT) on civil engineering, disaster management, and sustainable urban development. The paper emphasizes the use of AI for predicting and managing natural disasters, ICT for enhancing urban resilience, and virtual simulations in education to bridge theory and practice. Through case studies such as AI-powered applications and advanced materials engineering, the research

underscores the potential of digital transformation in building resilient infrastructure, improving public health, and promoting sustainable urban planning. The study also addresses the challenges of integrating digital innovation into traditional civil engineering practices, contributing valuable insights for a sustainable and resilient future.

Ghermandi, A., Langemeyer, J., Van Berkel, D., Sinclair, M., Venohr, M., & Wood, S. A. (2023). The review underscores the transformative potential of social media (SM) data in advancing environmental sustainability and achieving UN Sustainable Development Goals (SDGs). SM data enables researchers to analyze human-nature interactions, monitor social-ecological changes, and develop sustainable urban and ecosystem management strategies. However, the field faces challenges like restricted data access, privacy concerns, and lack of ethical frameworks, which hinder its growth. The authors advocate for fostering a virtuous cycle through transparent data sharing, collaboration between stakeholders, and ethical commitments by researchers to build trust and inclusivity. This approach aims to maximize the public benefits of SM data while safeguarding user privacy. Overall, the literature emphasizes the need for coordinated efforts by researchers, SM companies, and policymakers to unlock the potential of SM data for sustainability science.

Wang, J.-J., & Tsai, N.-Y. (2022). The study highlights the importance of contemporary integrated community planning that addresses sustainability, disaster resilience, and intergenerational inclusivity. By tackling challenges such as aging populations, low birth rates, and environmental safety, the research provides a comprehensive framework for developing sustainable and disaster-resilient communities. The proposed system of intergenerational planning includes five dimensions and 26 indicators, emphasizing safety, health care, education, employment, and environmental conservation. The findings underscore the need for community-centered strategies, such as disaster management mechanisms, intergenerational interaction, and holistic economic models, to drive sustainable development. This framework serves as a valuable reference for adapting communities to societal changes and promoting resilience in the face of emerging challenges.

3. Objective of the Study

The objective of this study is to explore the intricate relationship between environment, climate change, and disaster management in Bihar, with a focus on identifying effective strategies for enhancing resilience and sustainability. By analyzing the current trends and challenges faced by the state, this research aims to provide insights that can inform policy decisions and promote sustainable development practices.

a) Assess the impact of climate change on natural resources and disaster frequency in Bihar, particularly in relation to floods and droughts.

b) Evaluate the role of forest resources in supporting the state's economy and their contribution to agricultural GSDP.

c) Identify effective disaster management strategies that integrate community engagement and sustainable environmental practices.

d) Recommend policy measures that enhance financial efficiency in environmental initiatives while addressing the challenges posed by climate change.

4. Methodology

The methodology of this research paper primarily relies on secondary data collected from various reputable sources to analyze the interplay between environment, climate change, and disaster management in Bihar. The data was sourced from key government departments, including the Directorate of Economics and Statistics, the Department of Environment, Forest and Climate Change, and the Department of Disaster Management, among others. These sources provide comprehensive statistics on forestry, rainfall patterns, and disaster impacts over recent years.

Additionally, specific reports such as the Bihar Economic Survey and data from the Meteorological Centre in Patna were utilized to gather insights into climatic trends and their implications for agricultural productivity and disaster resilience. The study also references initiatives like JEEVIKA to understand community engagement in environmental sustainability efforts. By synthesizing this secondary data, the research aims to identify effective strategies for enhancing disaster management frameworks while promoting sustainable development practices in the context of Bihar's unique environmental challenges.

Result and Discussion

5. Environment, Climate Change, and Disaster Management

The interconnection between environment, climate change, and disaster management has become increasingly critical in contemporary discourse. Climate change, driven by anthropogenic activities, is exacerbating environmental degradation and increasing the frequency and intensity of natural disasters such as floods, hurricanes, and wildfires. This dynamic poses significant challenges for disaster management strategies, necessitating a comprehensive approach that integrates environmental sustainability with effective risk reduction measures. By prioritizing adaptive management practices that

enhance ecosystem resilience, policymakers can mitigate the impacts of climate-related disasters while promoting sustainable development. Furthermore, engaging communities in disaster preparedness and response initiatives is essential for fostering resilience and ensuring that vulnerable populations are equipped to cope with the adverse effects of climate change. Thus, addressing the nexus between environment, climate change, and disaster management is vital for safeguarding human lives and preserving ecological integrity in an era of unprecedented environmental challenges.

6. Forest Resources in Bihar

Bihar is characterized by two distinct types of forests: the deciduous sal forests located in the southern regions, including Kaimur, Rohtas, Aurangabad, Gaya, Jamui, Munger, and Banka, and the moist deciduous forests found in the northern area of West Champaran. These forests are vital for the state's economy as they provide a range of forest-based products such as timber, fuelwood, and non-timber forest products (NTFPs) like bamboo and medicinal plants. In the fiscal year 2021-22, forestry and logging contributed approximately 8 percent to Bihar's agricultural Gross State Domestic Product (GSDP), reflecting a steady growth rate of 3.7 percent per annum over the past five years (2018-19 to 2022-23). This highlights the importance of sustainable forest management and conservation efforts in supporting both economic development and ecological balance in the region.

Table 01 : Share of Forestry and Logging in Agriculture GSDP (2018-19 to 2022-23)

(Rs. in Crore) (at constant prices)

Sector	2018-19	2019-20	2020-21	2021-22 (P)[1]	2022-23 (Q)[2]
Crops	39266 (55.2)	37041 (51.5)	39928 (51.3)	41051 (50.6)	43057 (49.8)
Livestock	20444 (28.7)	22773 (31.7)	25192 (32.4)	26365 (32.5)	28621 (33.1)
Forestry & Logging	5807 (8.2)	6084 (8.5)	6222 (8.0)	6473 (8.0)	6756.0 (7.8)
Fishing & Aquaculture	5670 (8.0)	6037 (8.4)	6434 (8.3)	7173 (8.8)	7970 (9.2)
Agriculture, Forestry and Fishing	71186 (100.0)	71936 (100.0)	77776 (100.0)	81062 (100.0)	86403 (100.0)

Source : *Directorate of Economics and Statistics, GoB*

Table 01 presents the share of forestry and logging in Bihar's agricultural Gross State Domestic Product (GSDP) from 2018-19 to 2022-23, expressed in crores of rupees at constant prices. The data indicates

[1] P = Provisional estimate
[2] Q=Quick estimate

that while the overall GSDP for agriculture, forestry, and fishing has shown a steady increase from ₹71,186 crore in 2018-19 to ₹86,403 crore in 2022-23, the contribution of forestry and logging has slightly fluctuated. Specifically, the forestry and logging sector contributed ₹5,807 crore (8.2%) in 2018-19 and increased to ₹6,473 crore (8.0%) in 2021-22, before rising to ₹6,756 crore (7.8%) in 2022-23. This trend reflects a relatively stable but diminishing percentage share within the agricultural GSDP, indicating that while the sector's absolute value is increasing, its proportionate contribution compared to crops and livestock is declining. In contrast, livestock and fishing & aquaculture sectors have shown a more significant increase in both absolute terms and percentage share during this period, highlighting a shift in agricultural dynamics within the state.

7. Revenue and Expenditure of Forest Department

The Department of Environment, Forest, and Climate Change has experienced mixed financial trends over the past five years, with its revenue increasing by 22.2%, reaching ₹53.82 crore in 2022-23. However, its expenditure was significantly higher at ₹631.37 crore for the same period, reflecting substantial investments in initiatives such as the Ja1-Jeevan-Hariya1i afforestation program. This disparity highlights the ongoing challenges in balancing revenue generation with the financial demands of environmental conservation and climate change efforts.

Table 02 Revenue and Expenditure of the Department of Forest (2018-19 to 2022-23)

(Rs. crore)

Year	Revenue	Expenditure		
		Plan	Non-Plan	Total
2018-19	24.13	223.75	122.86	346.61
2019-20	20.31	560.51	132.41	692.92
2020-21	14.99	398.69	280.29	678.98
2021-22	30.34	227.90	166.28	394.18
2022-23	53.82	429.54	201.83	631.37
CAGR (%)	22.21	4.13	12.98	6.56

Source : *Department of Environment, Forest and Climate Change, GoB*

The table 02 showcases the financial performance of Bihar's Forest Department from 2018-19 to 2022-23. Revenue has steadily grown at a CAGR of 22.21%, but expenditure has also increased significantly, reaching Rs. 2,743.16 crore over the period. The 'Plan' expenditure, likely for projects and initiatives,

has been a major component, alongside 'Non-Plan' expenditure for operational costs. While revenue growth is positive, the substantial expenditure underscores the need for efficient resource allocation and cost-effectiveness in the department's operations.

Area under Different Types of Forest

Bihar's forest landscape is primarily dominated by Open Forests, covering over half of the total forest area. Moderately Dense Forests constitute a significant portion, while Very Dense Forests comprise a relatively smaller area. The data highlights the need for balanced forest management to preserve biodiversity and ecological health.

Table 03: Area under Different Types of Forest in Bihar (2011 to 2021)

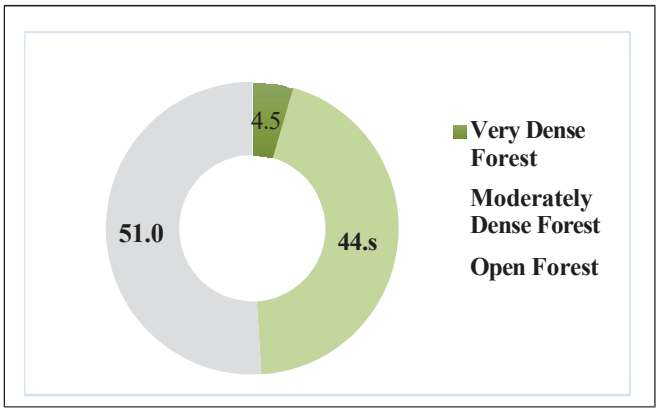
(Area in sq. km)

Type of Forest	2011	2013	2015	2017	2019	2021
Very Dense Forest (VDF)	231 (3.4)	247 (3.4)	248 (3.4)	332 (4.5)	333 (4.6)	333 (4.5)
Moderately Dense Forest (MDF)	3280 (47.9)	3380 (46.4)	3346 (46.1)	3260 (44.7)	3280 (44.9)	3286 (44.5)
Open Forest (OF)	3334 (48.7)	3664 (50.3)	3664 (50.5)	3707 (50.8)	3693 (50.5)	3762 (51.0)
Total	6845 (1.00)	7291 (100.0)	7258 (100.0)	7299 (100.0)	7306 (100.0)	7381 (100.0)

Source : *Department of Environment, Forest, and Climate Change, GoB*

Bihar's forest landscape is dominated by Open Forests, covering 51% of the total forest area in 2021, spanning 3,762 sq km. Moderately Dense Forests follow at 44.5% (3,286 sq km), while Very Dense Forests constitute a smaller portion at 4.5% (333 sq km). Between 2011 and 2021, Open Forests saw a slight increase, while Very Dense Forests experienced a more significant growth. However, Moderately Dense Forests witnessed a decline over the same period. This data provides insights into the changing dynamics of Bihar's forest cover and highlights the need for effective forest management practices to maintain ecological balance and biodiversity.

Classification of Different Types of Forest in Bihar (2021)



Source : *Department of Environment, Forest, and Climate Change, GoB*

8. Rainfall Patterns in Bihar

Rainfall is a crucial resource for Bihar, driving agriculture, tourism, and other sectors. The state's annual average rainfall during 2001-22 was 1009.4 mm, but 2022-23 saw a significant decrease to 849.1 mm. The south-west monsoon is the primary source of rainfall, contributing over 81.7% of the annual total in 2022-23. Rainfall distribution across districts is uneven, with Kishanganj receiving the highest annual rainfall in 2022-23, while Jehanabad, Buxar, and Arwal recorded the lowest.

Table 04 - Season Annual Rainfall (2001-02 to 2022-23)

(Rainfall in mms)

Year	Winter Rain	Hot-Weather Rain	South-west Monsoon	North-west Monsoon	Annual
2001	20.9 (138.6)	86.7 (98.7)	908.2 (104.8)	192.2 (309.8)	1208 (117.1)
2002	48.9 (324.3)	66.8 (76)	896.9 (103.5)	33.2 (53.5)	1045.8 (101.4)
2003	19.2 (127.3)	93.0 (105,9)	767.6 (88.6)	128.9 (207.8)	1008.7 (97.8)
2004	23.7 (157.2)	41.4 (47.1)	906.1 (104.6)	60.1 (96.9)	1031.3 (100.0)
2005	0.1 (0.7)	89.5 (101.9)	777.6 (89.7)	30.2 (48.7)	897.4 (87.0)
2006	0.1 (0.7)	90 (102.4)	925.9 (106.8)	27.8 (44.8)	1043.7 (101.2)
2007	28.3 (187.7)	76.4 (87.0)	1360 (156.9)	40.5 (65.3)	1506.1 (146.0)
2008	30.6 (202.9)	61.8 (70.3)	1084 (125.1)	19.3 (31.1)	1196 (115.9)
2009	0.1 (0.7)	98.2 (111,8)	699.2 (80.7)	71.1 (114.6)	868.6 (84.2)
2010	0.7 (4.6)	49.3 (56.1)	584.4 (67.4)	43.4 (70)	677.9 (65.7)
2011	5.2 (34.5)	79.4 (90.4)	1028 (118.6)	0.5 (0.8)	1113.1 (107.9)
2012	11.2 (74.3)	31.3 (35.6)	704.2 (81.3)	51.2 (82.5)	797.9 (77.3)

2013	17.1 (113.4)	73.8 (84)	518.4 (59.8)	164.3 (264.9)	773.6 (75.0)
2014	33.3 (220.8)	96.1 (109.4)	788.3 (91.0)	41.9 (67.5)	959.6 (93.0)
2015	11.7 (77.6)	89.3 (101.6)	690.7 (79.7)	4.3 (6.9)	796 (77.2)
2016	7.5 (49.7)	72.6 (82.6)	936.9 (108.1)	54.5 (87.9)	1071.6 (103.9)
2017	0.4 (2.7)	103.1 (117.4)	843.2 (97.3)	47.6 (76.7)	994.4 (96.4)
2018	0.1 (0.7)	65.5 (74.6)	689.9 (79.6)	25.4 (40.9)	780.9 (75.7)
2019	28.2 (187.3)	56.9 (64.8)	968.3 (111.7)	41 (66.0)	1094.4 (106.1)
2020	28.8 (191.2)	172.5 (196.4)	1159.7 (133.8)	24 (38.8)	1385 (134.3)
2021	0.5 (3.4)	251.2 (286.0)	960.8 (110.9)	201.3 (324.5)	1413.9 (137.1)
2022 (Up to September)	35.0	81.2	606.1	0.0	7223
Average (2001-21)	15.1	87.9	866.6	62.0	1031.6

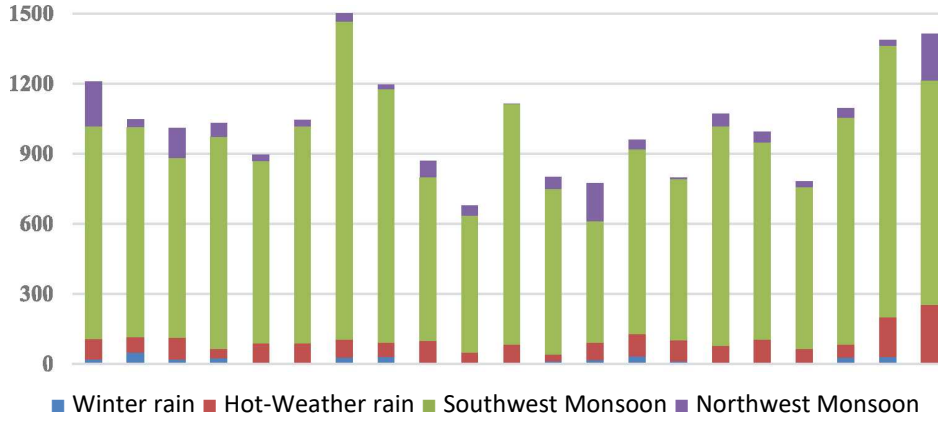
Note : Figures in parentheses denote actual rainfall as the percentage of long-run average rainfall

Source : *Directorate of Economics and Statistics, GoB*

This table 04 presents the season-wise rainfall data for Bihar from 2001 to 2023 (up to September). The annual average rainfall during this period was 1009.4 mm. The south-west monsoon is the primary source of rainfall, contributing over 80% of the annual total. In 2022-23, the state received 849.1 mm of rainfall, significantly below the long-term average.

The table also shows that rainfall distribution varies across seasons and years. While the south-west monsoon dominates the rainfall pattern, the hot-weather season and winter rain also contribute to the overall rainfall. The north-west monsoon, however, contributes minimally to the state's rainfall.

Trends in Season-wise Distribution of Rainfall in Bihar (2001 to 2021) **(mms.)**

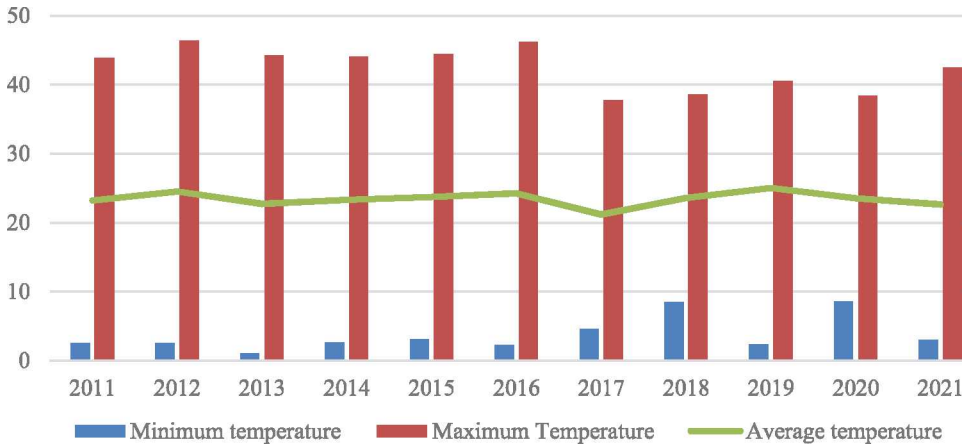


9. Temperature

Bihar experiences a sub-tropical climate with extreme temperature variations. Between 2011 and 2021, the state witnessed a slight increase in both minimum and maximum temperatures compared to the long-term average. The impact of global warming is evident in the rising frequency of heatwaves, with maximum temperatures often exceeding 45 degrees Celsius. This trend necessitates adaptive strategies to mitigate the adverse effects of climate change and protect public health.

Trends in Annual Temperature in Bihar (2011-12 to 2021-22)

(In degree Celsius)



Source : Meteorological Centre, Patna

10. **Bihar's Environmental and Forestry Initiatives**

Hariyali Mission : The Hariyali Mission, a flagship initiative of the Bihar government, aims to expand the state's green cover through diverse plantation schemes. Key components include the Krishi Vaniki Scheme, planting 11.75 lakh plants with farmers' assistance, and Kisan Nurseries, fostering 100 lakh plants by JEEVIKA SHGs. The Mukhya Mantri Niji Paudhshala (Poplar) Yojana also promotes the growth of poplar plants, with 2.7 lakh ETP stump plants cultivated in 27 nurseries during 2022-23.

Agro Forestry- Poplar (ETP) Scheme : Operational since 2012-13, this scheme encourages farmers to plant poplar species as short-duration trees. Saplings are sold at nominal rates, and farmers are incentivized for plant maintenance. In 2022-23, 0.70 lakh ETP poplar plants were planted, furthering agroforestry adoption among farmers.

Agro Forestry- Other Species Scheme : This scheme facilitates the plantation of species like teak, mahogany, and eucalyptus on farmers' fields. Saplings are distributed at affordable rates, and farmers receive financial incentives for maintaining them. In 2022-23, 11.75 lakh plants were planted under this initiative, promoting biodiversity and sustainable forestry.

Chief Minister Private 'Poplar Nursery' Scheme : To ensure a steady supply of poplar saplings, this scheme provides free poplar cuttings to selected farmers for nursery establishment. The government buys back the saplings at predetermined rates based on plant survival. In 2022-23, 2.7 lakh ETPs were raised across 27 nurseries under this program.

Chief Minister Private Nursery - Other Species Scheme : Focusing on diversifying plantations, this scheme supports raising saplings of various species. Beneficiaries are aided in establishing nurseries, and plants meeting quality standards are bought by the Department. In 2022-23, around 100 lakh saplings were raised, contributing significantly to afforestation goals.

Compensatory Afforestation Fund Management Planning Authority (CAMPA) : CAMPA addresses ecological losses caused by the diversion of forest land for non-forestry purposes. It emphasizes afforestation, wildlife habitat improvement, and infrastructure development. In 2022-23, 1.53 lakh plants were planted under this initiative, with a target of 18.89 lakh plants for 2023-24.

Jai-Jeevan-Hariyali Abhiyan (JJHA) : Launched in 2019, JJHA promotes water conservation and afforestation. It aims to enhance green cover, minimize pollution, and increase farmer incomes. Between 2019-23, over 1205 lakh plants were planted under this program, integrating environmental sustainability into Bihar's development framework.

Namami Gange : Part of a national mission to rejuvenate the Ganga, Namami Gange focuses on afforestation along the river and its tributaries. With 7.51 lakh saplings planted in previous years and 3.67 lakh planned for 2023-24, the initiative ensures ecological restoration while addressing the state's vulnerability to floods and droughts.

11. **Sustainable Forestry and Environmental Initiatives in Bihar**

Harit JEEVIKA Harit Bihar : JEEVIKA's Harit JEEVIKA Harit Bihar initiative empowers communities to combat climate change through extensive tree plantations and low-cost models. With over 30.5 million saplings planted and 789 nurseries established, this initiative significantly enhances air quality and promotes environmental sustainability across Bihar.

Green Budget : Bihar introduced the Green Budget in 2020-21 to align government expenditures with environmental goals. It includes measures for climate change mitigation, afforestation, pollution control, and water conservation. Eco-tourism projects like Rajgir Zoo Safari are being developed, while agroforestry and private nurseries provide employment opportunities alongside ecological benefits.

Integrated Forest Management Plan : This plan aims to protect natural forests through structural strengthening, involving a budget allocation of ₹1,631.9 lakh (state and central shares) for 2023-24. The initiative focuses on conserving forest resources and improving ecosystem resilience.

Development of Natural Forests : This program focuses on soil and water conservation, maintenance of earlier plantations, and garland trenching in forest areas. A budget of ₹9,989.97 lakh has been allocated for these activities in 2023-24, ensuring sustainable management of forest lands.

Management of Biological Diversity : The Gram Sabhas are central to managing biodiversity under this initiative. The Vriksha Mitra Scheme educates schoolchildren about flora and fauna, fostering community engagement in environmental conservation efforts.

Scheme for Garland Trenching : Targeted at water harvesting in southern Bihar's forest areas, this scheme has created over 6.69 lakh cubic meters of rainwater storage capacity. It supports biodiversity conservation by improving groundwater levels.

Bamboo Mission : Under the National Bamboo Mission, bamboo plantations are promoted on government and private lands. Nurseries have been established, and farmers are supported with ₹103.5 lakh allocated in 2023-24 for nursery development and bamboo plant distribution.

Bihar Heritage Tree App : The app facilitates the conservation of heritage trees over 50 years old, cataloging rare and culturally significant species. This initiative underscores Bihar's commitment to preserving its natural and cultural heritage.

State Action Plan on Climate Change (SAPCC) : Adopted in 2015, SAPCC outlines strategies to mitigate climate change effects through energy efficiency, natural resource conservation, and improved water management. With UNEP's support, the plan emphasizes a Low Carbon Development Pathway tailored to Bihar's needs.

Climate Change Learning Lab : Established in 2022 with GIZ's support, the Climate Change Learning Lab is a platform for raising awareness and educating communities about climate change challenges specific to Bihar, fostering informed action at local levels.

Plant Tissue Culture Lab : This lab focuses on producing high-quality plants for afforestation. A budget of ₹200 lakh for 2023-24 supports its development, enabling large-scale tree plantation initiatives with robust plant varieties.

Development of Eco-tourism and Parks : Eco-tourism and park development are prioritized to attract visitors and promote biodiversity. A ₹10,000 lakh budget for 2023-24 funds the maintenance and enhancement of these sites, offering both ecological and economic benefits.

12. **Disaster Management in Bihar**

Bihar's geographic and climatic conditions make it highly vulnerable to a range of natural disasters, including floods, droughts, thunderstorms, lightning, and cyclones. These disasters have significant socio-economic impacts, causing loss of life, property, and livelihoods. Floods and droughts remain the most recurring challenges, with devastating effects on agriculture and infrastructure. In 2022-23, floods impacted 17 districts, while drought affected over 72 lakh people across 11 districts. Lightning and thunderstorms also pose a significant risk, with hundreds of fatalities reported annually. To address these challenges, the state has adopted a multi-faceted disaster management approach, including relief operations, infrastructure repairs, community engagement, and policy development. Over ₹430 crore was allocated for disaster management in 2022-23, reflecting Bihar's commitment to minimizing disaster-related losses and building resilience.

Table 05 : Loss and Damage to Life and Property during Natural Disasters (2022-23)

Type of natural calamity	Districts affected	Lives Lost	People affected (in lakh)	Crop Area affected (lakh ha)	Crop Production Loss (Rs. Lakh)	Livestock Affected (lakh)
Flood	17	0	4.51	0.57	5257.69	0.38
Drought	11	0	72.20			

Source : *Department of Disaster Management, GoB*

In 2022-23, Bihar faced significant impacts from natural disasters, including floods and droughts. Floods affected 17 districts, impacting 4.51 lakh people, damaging 0.57 lakh hectares of crops, and causing a crop production loss of ₹5,257.69 lakh. Additionally, 0.38 lakh livestock were affected. Droughts impacted 11 districts, affecting 72.2 lakh people, highlighting the severe challenges posed by natural calamities in the state.

Table 06 : Assessment of Flood Vulnerability in Bihar (2018-2022)

Year	Districts	No. of Families affected (in lakh)	Houses affected

2018	Supaul, Bhagalpur, Khagaria	0.38	1074
2019	Sheohar, Sitamarhi, East Champaran, Madhubani, Araria, Kishanganj, Supaul, Darbhanga, Muzaffarpur, Saharsa, Katihar, Purnea, West Champaran, Buxar, Bhojpur, Bhagalpur, Khagaria, Samastipur, Lakhisarai, Begusarai, Munger, Patna, Nalanda, Nawada, Jehanabad, Arwal, Madhepura	37.36	45161
2020	Madhubani, Khagaria, Supaul, West Champaran, Kishanganj, Bhagalpur, Sheohar, Muzaffarpur, Darbhanga, East Champaran, Samastipur, Saharsa, Begusarai, Gopalganj, Vaishali, Sitamarhi, Siwan, Saran, Madhepura	25.06	18775
2021	Patna, Nalanda, Bhojpur, Buxar, Kaimur, Gaya, Jehanabad, Saran, Siwan, Gopalganj, Muzaffarpur, East Champaran, West Champaran, Sitamarhi, Sheohar, Vaishali, Darbhanga, Madhubani, Samastipur, Begusarai, Munger, Sheikhpura, Lakhisarai, Khagaria, Saharsa, Supaul, Madhepura, Purnea, Araria, Katihar, Kishanganj, Bhagalpur	20.64	12289
2022	Purnea, Kishanganj, Araria, Sitamarhi, Bhagalpur, Saharsa, Katihar, Khagaria, Bhojpur, Lakhisarai, Begusarai, Patna, Buxar, Vaishali, East Champaran, West Champaran, Supaul	1.12	1744

Source : *Department of Disaster Management, GoB*

This table 06 shows how many families and houses were affected by floods in Bihar from 2018 to 2022. It lists the districts that were hit the hardest during each year. You can see that in 2019, the highest number of families and houses were affected, followed by 2020. This indicates that these years were particularly bad for floods in Bihar. The table also shows that many districts were affected multiple times during this period, highlighting the recurring nature of flooding in the state. **In essence, the table reveals the extent of flood damage in Bihar over the past few years and underscores the need for effective flood management strategies in the state.**

13. JEEVIKA's Role in Disaster Management

JEEVIKA, in collaboration with various agencies, has been actively involved in disaster management initiatives in Bihar. Through training programs and capacity building, JEEVIKA has trained a significant number of its members in disaster preparedness and response. The organization has also established Disaster-Health Help Desks and identified disaster volunteers to support relief efforts. Additionally, JEEVIKA has collaborated with UNICEF to provide Flood Response Support Kits and conduct training on their installation and maintenance. These initiatives aim to enhance community resilience and minimize the impact of disasters in Bihar.

Table 07 : Progress of different activities under Disaster Management

Sl. No.	Activities undertaken by JEEVIKA	Progress

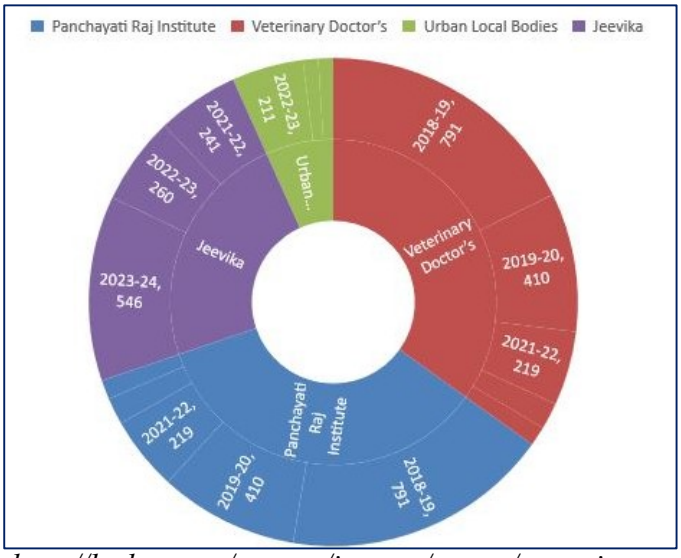
1	JEEVIKA Master Trainers trained in Natural Disaster (Module 1) in convergence BSDMA	304
2	JEEVIKA trainers trained in Natural Disaster (Module 1)	2136
3	Total number of trained JEEVIKA cadres in Natural Disaster (Module 1)	28632
4	Number of JEEVIKA Didis on two or more components of Natural Disaster	3691008
5	Number of active JEEVIKA Disaster-Health Help Desk Centres (in public hospitals and medical college hospitals)	45
6	Number of active JEEVIKA Disaster-Health Assistants/ Swasthya Sakhi	135
7	Number of identified disaster volunteers	128163

Source : *JEEVIKA, Government of Bihar*

JEEVIKA has trained a significant number of its members in disaster management, including 304 Master Trainers and over 28,000 cadres. Additionally, over 3.6 million JEEVIKA Didis have been sensitized to disaster risks. The organization has also established 45 Disaster-Health Help Desks and identified over 128,000 disaster volunteers, demonstrating its commitment to building community resilience.

Flood Preparedness and Management : JEEVIKA has been actively involved in flood preparedness and management in Bihar. In collaboration with UNICEF, JEEVIKA has trained over 37 lakh community members, including JEEVIKA staff and community professionals, on flood preparedness and management. Additionally, JEEVIKA has received 15 Flood Response Support Kits from UNICEF to provide safe drinking water in flood-affected areas. Training has been provided to CLF office bearers on the installation, functioning, and maintenance of these kits.

Disaster Risk Reduction : JEEVIKA, in partnership with the Bihar State Disaster Management Authority, has conducted training programs for Master Trainers in Disaster Risk Management and Mitigation. These trained Master Trainers will now cascade this knowledge to community members, project staff, and CBOs in their respective districts. Additionally, 245 JEEVIKA trainers have been trained in Module-2 of Disaster Risk Management and Mitigation across all 38 districts.



Source : *http://bsdma.org/assests/images/yogna/capacity_graph.JPG*

14. Recommendations for the Government of Bihar

Enhance Community Engagement: Strengthen community involvement in disaster preparedness and response initiatives by implementing training programs and awareness campaigns. This will empower local populations to effectively manage risks associated with climate change and natural disasters.

Sustainable Forest Management: Prioritize sustainable management of forest resources to enhance biodiversity and ecological balance. Implement policies that promote afforestation and reforestation, particularly in areas with declining forest cover, to support both environmental sustainability and economic development.

Investment in Technology: Leverage advanced technologies such as GIS and remote sensing for better monitoring of environmental changes and disaster management. This will improve data collection, risk assessment, and resource allocation during emergencies.

Climate Resilience Strategies: Develop comprehensive climate resilience strategies that integrate various sectors, including agriculture, forestry, and water management. This should include adaptive measures to mitigate the impacts of extreme weather events on vulnerable populations.

Promote Eco-Tourism: Invest in eco-tourism initiatives to generate revenue while promoting conservation efforts. This can create job opportunities and raise awareness about the importance of environmental protection among local communities.

Disaster Risk Reduction Framework: Establish a robust disaster risk reduction framework that includes regular assessments of vulnerabilities and the implementation of mitigation measures. Allocate sufficient resources for infrastructure improvements to withstand natural disasters.

Public Awareness Campaigns: Launch public awareness campaigns focused on climate change, its impacts, and the importance of sustainable practices. Educating the population about environmental conservation can foster a culture of sustainability across the state.

15.

16. **Conclusion**

In conclusion, the interrelationship between environment, climate change, and disaster management is increasingly critical for Bihar, as evidenced by the state's vulnerability to natural disasters such as floods and droughts. With floods impacting 17 districts and drought affecting over 72 lakh people in 2022-23, it is essential for the government to adopt comprehensive strategies that integrate environmental sustainability with effective disaster risk reduction measures. The on going efforts in afforestation and sustainable forest management, which contributed approximately 8 percent to the agricultural Gross State Domestic Product (GSDP) in 2021-22, underscore the importance of these initiatives in bolstering both ecological health and economic stability. The financial trends of the Department of Environment, Forest, and Climate Change reveal a mixed picture; while revenues have increased by 22.2% to ₹53.82 crore in 2022-23, expenditures have surged to ₹631.37 crore, indicating a need for improved resource allocation and efficiency. The substantial investment in programs like the Ja1-Jeevan-Hariya1i afforestation initiative highlights the government's commitment to enhancing green cover, yet it also emphasizes the necessity for sustainable financial planning to support these vital environmental initiatives without compromising fiscal health. Furthermore, the diverse array of programs aimed at promoting eco-tourism, community engagement in biodiversity management, and the development of climate resilience strategies are commendable steps towards fostering a sustainable future for Bihar. By continuing to prioritize these initiatives and ensuring that they are effectively implemented and funded, the government can mitigate the adverse impacts of climate change while promoting economic growth and community well-being. In doing so, Bihar can not only protect its natural resources but also enhance the resilience of its communities against the challenges posed by a changing climate.

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