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Research Scholar,
University Department of Geography, Ranchi
Email: meghananishchal22@gmail.com

Address for correspondence:
Meghana Nishchal
Research Scholar, University Department of Geography, Ranchi
Email: meghananishchal22@gmail.com

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Flood Development and Agricultural Vulnerability: A Case Study on Farmers of Purnea District

Meghana Nishchal

Abstract

Floods remain one of the most persistent environmental hazards in Bihar, and the Purnea District lies at the heart of this vulnerability due to its physiographic and hydrological setting. The district is located between the unstable Kosi basin in the west and the Mahananda system in the east, making it a natural receptacle for monsoon floodwaters. Each year, the arrival of heavy rainfall between June and September inundates large areas, damaging standing crops, eroding soils, and destroying agricultural infrastructure. Since nearly three-fourths of the district's workforce depends directly on agriculture, the implications of floods extend beyond the immediate physical damage and spill over into food insecurity, rural indebtedness, and large-scale seasonal migration. This study examines the geographical processes of flood development in Purnea and assesses agricultural vulnerability by analyzing block-level variations in cultivable area, irrigation intensity, literacy, and socio-economic conditions. Findings reveal that agriculturally advanced blocks such as Dhamdaha and Krityanand Nagar, though highly productive, face severe risks when irrigation systems are disrupted, while less irrigated blocks like Purnea East and Dagarua experience prolonged waterlogging and delayed recovery. Further, poor sanitation, gender gaps in literacy, malnutrition, and weak health infrastructure aggravate post-flood crises. The analysis confirms that flood vulnerability in Purnea is not solely a product of natural hydrology but also of entrenched socio-economic constraints, requiring integrated approaches that combine flood management with broader rural development strategies.

Keywords: *Floods, Agriculture, Vulnerability, Farmers, Purnea District, Bihar*

Introduction

Flooding has long been a defining feature of Bihar's natural environment, with the state contributing nearly one-sixth of India's flood-prone area. Within this vulnerable landscape, Purnea District occupies a critical position due to its physiographic setting between the Kosi and Mahananda river systems. The monsoon season, which brings over 70% of annual rainfall, transforms the district into a mosaic of inundated farmlands, breached embankments, and waterlogged settlements.For the farming community of Purnea, floods are not isolated disasters but an expected and recurring hazard that shapes agricultural decision-making. Every year, cultivators face the risk of losing nurseries, transplanted paddy, or standing jute and maize. Floods damage not only crops but also irrigation systems, rural roads, schools, and health facilities, thereby extending their impact beyond agriculture into broader socio-economic life.

Scholarly and policy attention has often focused on Kosi floods at a regional scale, but localized variations within Purnea reveal the need for district-specific research. Some blocks, such as Dhamdaha and Krityanand Nagar, are agriculturally advanced with higher irrigation coverage, but are also highly vulnerable to flood-related damage of infrastructure. Others, such as Baisi, Amour, and Dagarua, show chronic underdevelopment, making them less resilient to flood shocks. Understanding these spatial patterns of vulnerability is crucial for designing effective adaptation strategies.

Purnea District, with an area of 3,229 sq. km, is part of the Purnea Division, which also includes Araria, Kishanganj, and Katihar. The district is bounded by Araria and Kishanganj in the north, Katihar in the south, and West Bengal in the east. Its physiography is defined by low-lying plains**,** meandering rivers**,** and a monsoon-dominated climate**.** The district lies in the Kosi alluvial plain, which is prone to annual flooding due to heavy siltation and shifting river courses. The Mahananda and its tributaries add to the hydrological stress. The terrain has a very low gradient, which prevents efficient drainage, causing floodwaters to stagnate for weeks or even months.

This study positions itself at the intersection of physical geography and human geography. It traces how floods develop in Purnea's agricultural tracts, examines their differential impacts on farming households, and highlights the socio-economic factors—literacy, health, debt, and migration—that condition recovery.

Objectives

The study is guided by the following objectives:

1. To analyze the geographical background of Purnea District with special reference to its river systems, soils, and climate that contribute to recurrent flooding.
2. To examine the development and seasonal pattern of floods in the agricultural areas of Purnea.
3. To identify the factors affecting flood vulnerability, including land use, irrigation, crop structure, and drainage capacity.
4. To evaluate the socio-economic impacts of floods on farming households**,** focusing on livelihoods, debt, education, health, and food security.
5. To study block-level variations in flood-prone areas by comparing selected villages and agricultural blocks.

Research Design and Methodology

This study adopts a mixed-methods approach that combines quantitative analysis of secondary data with qualitative insights from literature and reports. Six blocks of Purnea were selected based on their agricultural significance and historical flood exposure: Dhamdaha, Krityanand Nagar, Purnea East, Dagarua, Barhara Kothi, and Baisi. Secondary data sources include the Census of India 2011 for land use, irrigation, and literacy; NFHS-5 (2019–21) for health, nutrition, and household amenities; Bihar State Disaster Management Authority (BSDMA) and Central Water Commission (CWC) for flood-prone area data; and Bihar Agriculture Department reports for crop patterns and irrigation coverage.

Additional data on river hydrology, rainfall patterns, and embankment locations were taken from district-level reports and published research. Variables analyzed include exposure (cultivable and irrigated land), sensitivity (crop types, flood timing, flood-prone area), and adaptive capacity (literacy, health indicators, household amenities). Data were processed using descriptive statistics and comparative analysis across blocks. A composite vulnerability index was calculated by integrating exposure, sensitivity, and adaptive capacity, allowing a ranked assessment of block-level vulnerability.

Flood Development in Purnea District

Purnea District, located in northeastern Bihar, is highly susceptible to flooding due to its flat alluvial plains, low elevation (50–60 meters above sea level), and proximity to major rivers. The Kosi river system to the west is particularly notorious for its shifting channels, while the Mahananda river in the east adds to the flood risk. During the monsoon season (June–September), heavy rainfall combined with river overflow leads to widespread inundation. Poor drainage and a dense network of small distributaries, including Suwara Kali, Panar, and Koli, exacerbate water stagnation in low-lying areas. Floods are often intensified by breaching of embankments, sediment deposition, and delayed recession of water, creating both immediate and long-term agricultural hazards.

Agricultural Vulnerability

Agriculture is the main livelihood in Purnea, with over 70% of the population engaged as cultivators or agricultural laborers. Floods affect both crop production and post-harvest management. Paddy, maize, jute, wheat, and pulses are the dominant crops, but most are highly sensitive to excess water. High-irrigation blocks such as Dhamdaha and Krityanand Nagar can recover faster after floods, but damage to irrigation channels or pumps can cause significant short-term losses. Low-irrigation blocks like Purnea East and Dagarua experience prolonged water logging, delaying crop cycles and reducing soil fertility due to nutrient leaching.

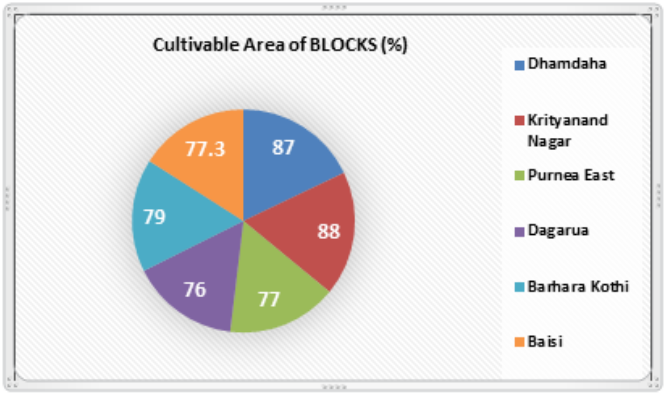
Socio-economic factors further compound vulnerability. Low literacy, limited access to clean water, poor sanitation, and high malnutrition reduce the adaptive capacity of farming households. Farmers dependent on a single crop are particularly at risk, and repeated flooding leads to debt, migration, and livelihood instability. Infrastructure deficits, such as damaged embankments and insufficient flood shelters, worsen the impact. Overall, Purnea demonstrates that flood vulnerability is not only hydrological but also deeply intertwined with agricultural practices, socio-economic conditions, and local infrastructure.

Results and Discussions

The results highlight that agricultural vulnerability in Purnea District is strongly shaped by the interaction of cultivable land availability and irrigation coverage. Blocks like Dhamdaha and Krityanand Nagar, with both high cultivable area and strong irrigation, show high productivity but are extremely sensitive to flood-induced damage of infrastructure. In contrast, Purnea East and Dagarua possess significant cultivable land but very low irrigation coverage, which slows recovery after floods and leaves farmers dependent on uncertain rainfall. Baisi demonstrates relative resilience due to its high irrigation share, while Barhara Kothi reflects moderate risk with balanced but less secure infrastructure. These patterns underline that vulnerability is not only a function of exposure but also of adaptive capacity shaped by irrigation, literacy, and socio-economic factors.

Table 1. Cultivable Area of BLOCKS (%)

BLOCKS	Cultivable Area of BLOCKS (%)
Dhamdaha	86.5
Krityanand Nagar	87.5
Purnea East	77.2
Dagarua	76.6
Barhara Kothi	79.4
Baisi	77.3

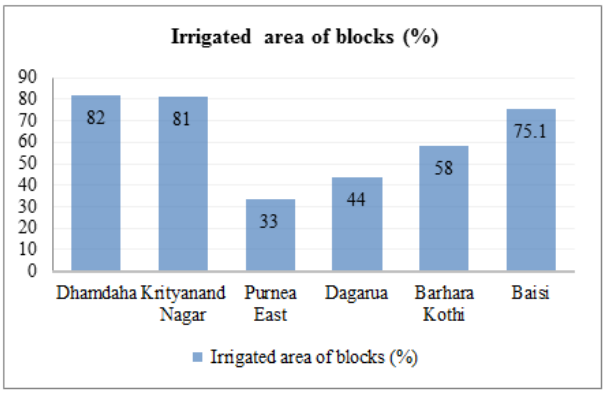


SOURCE: Census of India, 2011. District Census Handbook: Purnea

The percentage of cultivable land reflects the proportion of each block suitable for agriculture and its exposure to flooding. Dhamdaha and Krityanand Nagar have the highest cultivable areas, indicating high productivity but substantial flood risk. Purnea East and Dagarua experience extended waterlogging due to moderate cultivable areas combined with poor drainage. Barhara Kothi's proximity to the Kosi river increases sand deposition and crop damage. Even Baisi, with slightly lower cultivable land, faces recurring flood events affecting livelihoods.

Table 2. Irrigation Coverage (%)

Below table shows Irrigation coverage is a key factor in post-flood recovery. Blocks with high irrigation like Dhamdaha, Krityanand Nagar, and Baisi can replant quickly, reducing productivity loss. Purnea East and Dagarua have low irrigation coverage, which prolongs crop stress and delays recovery after flooding. Barhara Kothi has moderate irrigation but remains vulnerable due to Kosi river influence. Adequate irrigation enhances resilience by reducing dependency on rainfall and improving water management during flood events.



Block	% Irrigated of Cultivable
Dhamdaha	81.5
Krityanand Nagar	81.1
Purnea East	33.4
Dagarua	43.6
Barhara Kothi	58
Baisi	75.1

Source: Census of India, 2011. District Census Handbook: Purnea

Table 3. Flood-Prone Land Area (%)

Block	Flood-Prone Area of BLOCKS (%)
Dhamdaha	78
Krityanand Nagar	75
Purnea East	82
Dagarua	80
Barhara Kothi	85
Baisi	70

Source: Bihar State Disaster Management Authority (BSDMA), 2020

Flood-prone land indicates areas historically affected by inundation. Barhara Kothi and Purnea East have the highest flood risk, with large portions of cultivable land submerged during monsoon. Dhamdaha and Krityanand Nagar face severe but shorter-term inundation. Dagarua experiences prolonged waterlogging, limiting cropping options. Baisi, though less exposed, suffers recurring minor floods that cumulatively affect agriculture. Mapping flood-prone areas is essential for planning crop calendars, preparing mitigation measures, and targeting infrastructure investments.

Table 4. Household Amenities (%)

Block	Electricity	Improved Water	Improved Sanitation	Clean Fuel
Dhamdaha	94	93	36	21
Krityanand Nagar	92	91	34	19

Purnea East	95	94	38	22
Dagarua	90	90	33	18
Barhara Kothi	91	92	35	20
Baisi	88	89	31	16

Source: NFHS-5, 2019–21. District Profile: Purnea, Ministry of Health and Family Welfare.

Household amenities such as electricity, clean water, sanitation, and fuel use influence adaptive capacity. High electricity in Dhamdaha, Krityanand Nagar, and Purnea East supports irrigation and early warning systems. Improved water reduces disease risk, while poor sanitation, especially in Baisi, increases vulnerability. Low clean fuel usage indicates energy poverty and reliance on traditional cooking methods, which can worsen health impacts during floods. Infrastructure disparities demonstrate how socio-economic conditions shape resilience and recovery potential.

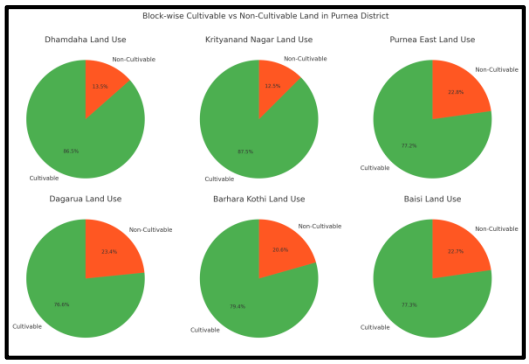
Table 5. Composite Vulnerability Index

Block	Vulnerability Score	Rank
Dhamdaha	0.72	3
Krityanand Nagar	0.70	4
Purnea East	0.85	1
Dagarua	0.82	2
Barhara Kothi	0.78	5
Baisi	0.65	6

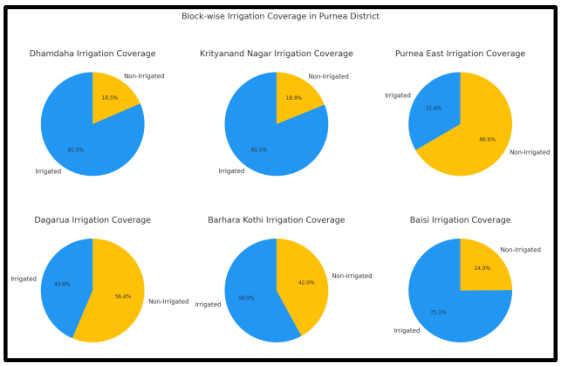
Source: Census 2011, NFHS-5 2019–21, BSDMA 2020

The composite vulnerability index integrates exposure, crop sensitivity, and adaptive capacity to assess block-level risk. Purnea East ranks highest, reflecting high flood-prone areas, low irrigation, sensitive crops, and moderate socio-economic conditions. Dagarua follows due to prolonged waterlogging and weaker health indicators. Baisi has the lowest vulnerability due to moderate exposure and relatively higher irrigation and literacy. The index helps prioritize interventions, allocate resources, and design targeted resilience-building programs for the most vulnerable blocks.

i) Block wise Cultivable vs Non-Cultivable Land



ii) Block wise Irrigated vs Non-Irrigated Land



i. **Block-wise Cultivable vs Non-Cultivable Land**

- Shows the proportion of cultivable area in each block.
- Highlights which blocks are most exposed to floods.

Green represents cultivable land, while orange represents non-cultivable land. Dhamdaha and Krityanand Nagar have the highest cultivable land (>85%), highlighting high exposure to floods.Purnea East, Dagarua, Barhara Kothi, and Baisi have moderate cultivable land (around 76–79%), indicating significant flood risk but slightly less than the top two blocks.

ii. **Irrigation Coverage across Blocks**

- Percentage of cultivable land that is irrigated vs rain-fed.
- Demonstrates adaptive capacity differences.

Irrigation coverage patterns describes that Dhamdaha, Krityanand Nagar, Baisi → highly irrigated (>75%), but any flood induced disruption to tube wells and canals causes massive setbacks. Barhara Kothi → moderately irrigated (58%), moderately vulnerable. Purnea East, Dagarua → poorly irrigated, leaving farmers dependent on rainfall; recovery from floods is very slow.

Conclusion

Flood vulnerability in Purnea arises from both natural and socio-economic factors. High flood exposure combined with low irrigation coverage, poor literacy, inadequate health facilities, and insufficient infrastructure increases the risk for farmers. Dhamdaha and Krityanand Nagar experience immediate economic losses, while Purnea East and Dagarua suffer prolonged water logging and delayed recovery. Integrating hydrological management with social development, improving

adaptive capacity through education, healthcare, and livelihood diversification, and strengthening community preparedness can reduce repeated losses and build sustainable resilience in Purnea's agricultural sector.

Recommendations

1. Promote short-duration and flood-tolerant paddy and maize varieties suitable for waterlogged conditions. These can help farmers avoid complete crop failure when floods strike during the growing season.
2. Develop and maintain rural drainage networks to reduce prolonged waterlogging after floods. Proper drainage will minimize soil degradation and allow quicker replanting of crops.
3. Strengthen embankments and riverbank protection structures, especially along the Kosi and Mahananda rivers. This can reduce erosion, sand-casting, and direct flood entry into farmland.
4. Flood-proof irrigation pumps, tube wells, and storage facilities to ensure quick post-flood recovery. Protecting agricultural infrastructure ensures water availability and reduces downtime after disasters.
5. Expand the coverage and awareness of crop insurance schemes like PMFBY among small farmers. Insurance cushions economic shocks, prevents debt cycles, and supports risk-sharing mechanisms.
6. Encourage livelihood diversification such as fisheries, dairy, poultry, and agro-based cottage industries. Diversification reduces over-dependence on crops and provides steady income even during floods.
7. Improve rural health and sanitation infrastructure to reduce disease outbreaks after flooding. This is crucial to prevent epidemics of diarrhoea, malaria, and other waterborne diseases.
8. Strengthen community-based disaster preparedness committees at the block and panchayat level. Local committees can organize relief, disseminate warnings, and build social resilience.
9. Provide timely credit and input support to farmers through cooperatives and rural banks. Easy access to finance prevents distress sales and supports recovery investments.
10. Encourage literacy and agricultural extension programs to promote resilience and innovation. Education enables farmers to adopt modern practices, government schemes, and climate-smart technologies.

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Conflicts of interest

The author declares that they have no conflicts of interest related to this research.

References:

1. Census of India. (2011). *District census handbook: Purnea (Part A & B).* Directorate of Census Operations, Bihar.
2. International Institute for Population Sciences (IIPS) & ICF. (2021). *National Family Health Survey (NFHS-5), 2019–21: District fact sheet Purnea, Bihar.* Ministry of Health and Family Welfare, Government of India.
3. Mishra, A. (2010). Living with floods: People's perspectives from North Bihar. *Economic and Political Weekly, 45*(47), 45–53.
4. Sinha, R. (2008). Kosi: Emerging issues in flood management. *Economic and Political Weekly, 43*(22), 168–173.
5. Government of Bihar. (2020). *Bihar economic survey 2019–20.* Finance Department, Government of Bihar.
6. National Disaster Management Authority. (2008). *National disaster management guidelines: Management of floods.* Government of India.
7. Singh, D., & Kumar, R. (2017). Agricultural vulnerability to floods in Bihar: An assessment. *Indian Journal of Regional Science, 49*(2), 45–59.
8. Jha, V. C., & Khatri, N. (2015). Flood hazard mapping of North Bihar. *International Journal of Disaster Risk Reduction, 13,* 229–237.
9. Singh, R. B. (1996). *Disaster management: Future challenges and opportunities.* Rawat Publications.
10. Pandey, A. C., & Singh, S. K. (2019). Application of geospatial techniques for flood risk assessment in Bihar. *Natural Hazards, 97*(2), 861–883.
11. Planning Commission. (2008). *Report of the expert group to review the methodology for estimation of poverty.* Government of India.
12. Roy, N. (2011). *Floods in Bihar: The Kosi disaster.* National Book Trust.
13. Choudhary, R. K. (2013). Floods and rural livelihoods in eastern Bihar. *Journal of Rural Development, 32*(3), 321–339.
14. Ministry of Agriculture & Farmers' Welfare. (2020). *Agricultural statistics at a glance 2019.* Government of India.
15. United Nations Development Programme. (2019). *Human development report: Bihar state profile.* UNDP India.