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## Climate variability, livelihood diversification, and migration patterns: An integrated analysis of Bundelkhand region, India

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### Abstract

Climate variability has emerged as a major driver of rural livelihood instability in semi-arid regions of India. This study analyzes the relationship between climate variability, livelihood diversification, and migration patterns in the Bundelkhand region. Using secondary data from national and international sources, the study applies a regression-based analytical framework to assess the determinants of migration. The findings reveal that rainfall variability and declining agricultural productivity significantly increase migration, while livelihood diversification and institutional support reduce migration pressure. The study emphasizes the importance of climate-resilient agriculture, rural employment generation, and policy integration to ensure sustainable development.

**Keywords:** Climate variability, migration, Bundelkhand, livelihood diversification, rural development, regression analysis

### 1. Introduction

Migration has become a defining feature of rural transformation in developing economies. In regions such as Bundelkhand, characterized by erratic rainfall, drought conditions, and limited irrigation facilities, migration is often a response to livelihood insecurity rather than opportunity. Climate variability has intensified these vulnerabilities, affecting agricultural productivity and rural income stability.

This study examines migration not only as an economic phenomenon but also as an adaptive strategy influenced by environmental stress and institutional factors. Understanding these dynamics is crucial for designing effective development interventions.

### 2. Review of Literature

The study draws upon multiple theoretical frameworks. The Sustainable Livelihood Framework highlights the role of assets and institutional support in shaping livelihood outcomes. The New Economics of Labour Migration (Stark & Bloom, 1985) <sup>[5]</sup> conceptualizes migration as a household risk management strategy. The Harris-Todaro model (1970) <sup>[3]</sup> explains migration as a response to expected income differentials.

Empirical studies suggest that climate variability negatively impacts agricultural productivity, leading to increased migration (World Bank, 2020) <sup>[6]</sup>. Similarly, Deshingkar and Akter (2009) <sup>[2]</sup> emphasize that lack of rural opportunities and infrastructure accelerates migration in vulnerable regions.

### 3. Study Area

Bundelkhand spans parts of Madhya Pradesh and Uttar Pradesh, including districts such as Chhatarpur, Tikamgarh, Sagar, Panna, and Damoh. The region is characterized by semi-arid climatic conditions, low soil fertility, and high dependence on rain-fed agriculture. Frequent droughts and declining groundwater levels contribute to persistent livelihood challenges and migration.

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#### 4. Data and methodology

The study is based on secondary data collected from Census of India, NSSO, Indian Meteorological Department (IMD), NITI Aayog, and World Bank reports.

A descriptive and analytical research design has been adopted. Trend analysis is used to examine rainfall variability and agricultural productivity, while regression analysis is applied to identify the determinants of migration.

#### 5. Model specification

the study employs a multiple linear regression model:

$$[MIG = \beta_0 + \beta_1 RFV + \beta_2 AGP + \beta_3 LVD + \beta_4 INS + \epsilon]$$

Where:

MIG = Migration rate

RFV = Rainfall variability

AGP = Agricultural productivity

LVD = Livelihood diversification

INS = Institutional support

#### 6. Results and Discussion

The regression results indicate that rainfall variability has a statistically significant positive effect on migration, confirming that climate stress acts as a major push factor. Agricultural productivity shows a negative relationship with migration, suggesting that improved farm output reduces the need to migrate. Livelihood diversification, particularly non-farm employment, significantly lowers migration pressure by providing alternative income sources. Institutional support, including employment schemes and irrigation facilities, also plays a mitigating role, although its impact varies across districts.

The model demonstrates a good explanatory power, indicating that climate and livelihood factors jointly influence migration decisions in the region.

#### 7. Policy implications

The findings suggest that reducing distress migration requires a multi-dimensional approach. Investment in climate-resilient agriculture, such as drought-resistant crops and water management systems, is essential. Promotion of rural non-farm employment and skill development can enhance livelihood diversification. Strengthening institutional support through effective implementation of government schemes can further reduce migration pressures.

#### 8. Conclusion

Migration in Bundelkhand is a complex phenomenon driven by climate variability, economic constraints, and institutional factors. While migration provides short-term coping mechanisms, long-term solutions require sustainable rural development strategies. Integrating climate adaptation with livelihood diversification can significantly reduce migration and improve regional resilience.

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