EXPLORING THE LINK BETWEEN CLIMATE VARIABILITY, DROUGHT, AND INTERNAL MIGRATION IN PURULIA DISTRICT, WEST BENGAL, INDIA

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1. Introduction

Due to rising temperatures and shifting precipitation patterns, many regions worldwide are facing prolonged droughts and aridification trends (Burrell et al., 2020), with significant consequences for food and water security, agricultural productivity, and human health. Migration, whether permanent or temporary, is significantly influenced by climate change and the ensuing environmental degradation (Black et al., 2011). When other adaptation strategies are exhausted, households might opt for or be compelled to migrate from the impacted areas (Hunter et al., 2015). Although climatic factors are often cited as a major driver of large-scale international migration in public discussions, empirical research, and meta-analyses suggest a more pronounced effect on short-distance, internal migration within countries rather than across borders (Borderon et al., 2019). Local economic, sociopolitical, and demographic factors play a crucial role in shaping climate-related mobility patterns and outcomes (Cai et al., 2016). While the impact of climate change on migration has garnered extensive public and scientific interest, there is a lack of comparative data on its influence on internal migration at the local level and how contextual factors may moderate this impact (Hoffmann et al., 2024).

2. Need for the study

Droughts significantly affect India, with projections indicating an increase in their severity, frequency, duration, and spatial coverage under climate-warming scenarios(Gupta & Jain, 2018). A considerable part of India is now either at risk of drought or already affected by it, as droughts are becoming more frequent and widespread. Nearly 68% of the entire growing region is at drought risk (Bageshree et al., 2022). High poverty levels, extensive borrowing, limited crop diversity, reliance on agriculture for income, and inadequate agricultural insurance exacerbate the vulnerability of the population to drought (Panda, 2017). Droughts led to reduced grain yields (Kumar et al., 2020), impacting the economy, environment, and society. Approximately one-fifth of India's population lives below the international poverty line (UNDP, 2020), and half depend on agriculture, heightening their susceptibility to drought conditions. The socio-economic effects of droughts include disruptions in rural communities, increased indebtedness, decreased cereal consumption, higher school dropout rates, psychological and health issues, loss of social status for vulnerable groups, heightened social tensions,

and the erosion of social capital, including the migration of people from drought-stricken areas (Government of India, 2017). In 2020, it was estimated that around 3,856,000 people were internally displaced in India due to disasters, including droughts (GRID, 2021).

The intensity and frequency of droughts in the Gangetic Plains and the adjoining regions of Eastern India have increased significantly over the past 50 years (Nath et al., 2017).The western region of West Bengal is severely impacted by drought (Roy & Hazra, 2020), with Purulia among the hardest-hit districts (Bhunia et al., 2020).

Agriculture in Eastern India largely depends on monsoon rains. Any significant deviation from the normal monsoon pattern, compounded by other environmental factors that reduce soil moisture, can directly impact the state's GDP. West Bengal, a major agricultural centre, has regions, particularly in the west, that are drier and thus require thorough investigation to assess the potential risk of socio-economic losses due to drought. There appears to be no comprehensive study in Purulia, one of West Bengal's most drought-prone districts, that integrates climate variability, drought, social vulnerability, and internal migration. While various methods have been employed to gauge drought severity in Purulia, no research has yet determined if regions affected by drought coincide with areas of social vulnerability, and whether this prompts migration among the marginalized communities.

3. Hypothesis

The hypothesis for the current study, based on the understanding above, was established as follows:

Internal migration is prompted by drought and a range of socio-economic factors.

4. Research questions

The current study was primarily conceived and executed to explore answers to the subsequent questions:

- How do climate variations and meteorological drought affect agriculture in Purulia?
- How does social vulnerability to drought affect communities at the sub-district level?

- What strategies did households use to cope with the drought?

5. Objectives of the study

1. To examine climate variability and drought in the district
2. To assess the impact of drought on agriculture
3. To conduct a social vulnerability analysis at the sub-district level.
4. To identify the controlling factors influencing the decision to migrate internally.
5. Find out different ways of coping and adapting

6. Research Methodology

The research is grounded in a descriptive and explanatory framework, utilizing quantitative and qualitative measurement techniques. It relies on primary and secondary data sources. Analyses of climate variability, drought, the impact of drought on crop yield, and social vulnerability have been conducted using secondary data from sources such as the Indian Meteorological Department, the District Statistical Handbook, and the Census of India. Various demographic, environmental (drought, etc), and socio-economic indices have been gathered through household surveys. These household survey data have been used to find out the relationship between climate variability, drought and internal migration. Results were analysed using binary logistic regression, Kruskal–Wallis H, and the Wilcoxon signed-rank test. Additionally, life histories and case studies were collected using an ethnographic approach.

Research methodology for the study of climate variability and drought

The study utilized linear regression, the Precipitation Concentration Index (PCI), the Rainfall Anomaly Index (RAI), and the Standardized Precipitation Index (SPI) to assess significant shifts in climate variables, including precipitation, maximum and minimum temperatures, and drought conditions, across the study area for 50 years (1970-2020). Additionally, the perceptions of smallholder farmers regarding changes in rainfall, temperature over time, and the incidence of drought were incorporated, following an ethnographic approach through case studies.

Research methodology for studying the impact of drought on agriculture

To achieve this objective, yield variability was assessed using the coefficient of variation (CV), defined as the standard deviation divided by the mean. The inter-annual variability of crop yields was calculated with CV, and the results were graphically presented to illustrate the extent of variability. The study analysed rice crop yield trends through linear regression analysis, which indicates changes in yield values over time. Using multiple regression, crop yields were regressed against climate parameters—maximum and minimum temperatures, and precipitation. This analysis calculated the impact of both average annual and monsoon-induced variability on crop yields. Thus, the study established the correlation between precipitation, temperatures, and crop yields. The resulting coefficients indicate the average change in yield (kg/hectare) per unit change in the climate variable. The coefficient of determination (R^2) from the regression elucidates the proportion of yield variation explained by climate variability. Furthermore, the statistical significance of each climate variable's effect on rice yields was evaluated with a 95% confidence interval. The crop failure index was also used in this study.

Research methodology for assessing drought and social vulnerability at the sub-district level

The social vulnerability index was derived using principal component analysis. This study analyzed social vulnerability at the sub-district (block level) spatial scale. Socioeconomic variables such as household structure, education, occupation, household assets, provision of irrigation, housing, access to basic services, and the rural/urban proportion were included in this assessment. The vulnerability analysis was conducted for the years 2001 and 2011.

The research methodology used for the analysis of drought and internal migration in two sub-districts of Purulia

This work is based on a primary survey which began by examining the socio-economic and demographic backgrounds of migrant households. Subsequently, the nature, pattern, distance, duration, and characteristics of internal migrants were analysed. The study then explored how these households cope with drought, the adaptation strategies they employ at both household and institutional levels, and their reasons for migrating. A migrant is defined here as an individual from a rural household who relocates due to climatic factors, specifically drought. Drought is pinpointed as the cause, with migration as the direct result. This phenomenon is assessed at the sub-district level in Purulia, specifically in

Baghmundi and Man Bazar 1. The selection of Man Bazar 1 and Baghmundi was based on their social vulnerability and frequent droughts. A multi-stage sampling method was employed for the survey, which is a process of drawing samples from progressively smaller groups at each stage, also known as multistage cluster sampling. Households were randomly selected from each village using the simple random sampling method. A semi-structured questionnaire was utilized for the survey. The most effective formula for calculating sample size is size = $pqZ^2 \div E^2$ (Payne, G., & Payne, J., 2004).

e is the desired level of precision (i.e., the margin of error),

p is the (estimated) proportion of the population that has the attribute in question q is 1 – p. Based on this formula; the sample size required for each of the two sub-districts amounts to 400 households.

Parametric methods like binary logistic regression and non-parametric methods like the Kruskal–Wallis H test and the Wilcoxon signed-rank test were used to analyse field data.

6. Findings / Discussions

Migration is a strategic response for households experiencing climate shocks. This study utilizes climate indicators and comprehensive household survey data to explore the link between droughts and outmigration in two sub-districts of Purulia. It examines the varied effects of drought and extreme climate conditions on the socio-economic aspects of households, uncovering an increasing migration trend due to the frequency and timing of droughts. When migration costs are high, households may first turn to local coping strategies, such as borrowing money or selling assets. The binary logistic model has pinpointed factors like household size, education and age of migrants, marginalized social groups, outstanding family debts, low household income, drought, and delayed monsoons as key determinants in migration decisions. Primary coping methods include crop management, the use of native rice varieties, pond digging, hapa, ditch construction, livelihood diversification, and borrowing funds. Migration often emerges as a choice when other options have been depleted. As an adaptive measure, internal migration offers advantages to migrants and their families through remittances, serving as a buffer for those affected by climate shocks, despite the long-term costs and risks associated with migration. Nonetheless, recent trends indicate a growing preference for migration, especially among younger household members. Established labour migration pathways

may also sway the immediate choice to migrate following climate shocks. Research indicates that a series of successive and repeated droughts may increase the likelihood of individuals migrating in the short term. Individuals who have faced consecutive drought conditions over the past two years are more likely to migrate. Moreover, severe droughts, such as the one in 2010, have resulted in permanent migration.

Research indicates that the district is experiencing diminished monsoon rainfall, escalating temperatures, and a rise in the frequency and severity of droughts. Since the year 2000, there has been an increase in drought occurrences in the study region. Despite an overall reduction in precipitation and an increase in dry years, the precipitation concentration index indicates episodes of heavy rainfall. However, this heavy rainfall cannot support agriculture because of its delaying nature and Purulia's hard rock terrain causing run-offs. Drought years correspond with lower rice yields, which is the staple food of the region. Although rice production has increased over time, it remains unstable due to climatic extremes. There is a notable correlation between rice yield patterns and drought events. Recurrent droughts and inadequate irrigation have led to crop failures. The year 2010, characterized by severe drought, had a profound impact on Purulia, especially its southern (Bandwan, Man bazaar I and II, Puncha) and western (Baghmundi, Joypur, Jhalda II) sub-districts, which also endured intense drought from 2000 to 2015. Ongoing droughts, lack of sufficient irrigation, and continuous crop failures have resulted in enduring unemployment, deepened poverty, and increased social vulnerability. The analysis shows that the Baghmundi and Man bazaar I sub-districts suffer from high drought prevalence and vulnerability. With less than half of their land irrigated, these areas find it challenging to counteract the intensifying droughts. Socio-economically, they encounter challenges with a predominantly rural population reliant on natural resources, which amplifies their vulnerability to climatic extremes such as drought. High population growth, restricted access to assets, lack of irrigation, and a higher percentage of non-labourers add to their susceptibility to drought.

7. Recommendations for further research

Initiatives such as MGNREGA may help reduce temporary migration by offsetting some of the economic benefits gained from it. While rainfed crops typically suffer yield declines during droughts, irrigation plays a vital role in lessening these losses. Improving irrigation systems can ensure a consistent water supply for crops during droughts and

reduce reliance on unpredictable rainfall, thus mitigating the negative impact on agricultural output and food security, especially in regions with erratic weather patterns. It would allow farmers to maintain crop growth during dry periods and achieve stable production levels. Additionally, there should be a focus on developing crops that are resistant to drought, such as millet.

8. Limitations of the study

This research relies on demographic data from 2011 due to the absence of more current figures. The study's scope is further limited to 2015, as this is the latest year for which agricultural data is available for the district. Assessing the impact of drought on crop yields and social vulnerability is essential and requires up-to-date data to identify socially vulnerable populations in affected areas. Additionally, resource constraints hindered surveying the destination region of migrants. The study utilizes reports from women about their husbands' migration, which could introduce recall bias

9. Conclusions

Despite its limitations, this study significantly enhances our understanding of the climate-migration nexus by providing substantial evidence that out-migration is a response to climate shocks, especially droughts. It also supports the notion that migration decisions are heavily influenced by the economic, social, and migratory contexts of the origin communities, in addition to climate shocks or hazards (Black et al., 2011). In my particular context, where the economy is dominated by subsistence agriculture with inadequate irrigation, limited resource access, and a scarcity of local alternative employment options, migration emerges as a relatively appealing immediate strategy for households coping with the effects of climate shocks.

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