Spatiotemporal Characteristics of Rainstorm-Flood Disaster Losses in Xinjiang and Their Influencing Factors: Postprint

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Abstract

Based on disaster data for rainstorm and flood events in Xinjiang from 1984 to 2016, this study employs trend analysis, linear regression, and correlation analysis to examine the spatiotemporal characteristics of associated disaster losses. Using annual precipitation and GDP as indicators, the factors influencing the patterns of rainstorm and flood disasters in Xinjiang are investigated. The results indicate: Rainstorm and flood disasters in some regions of Xinjiang show a worsening trend, with pronounced intra-annual variation concentrated primarily in summer; Spatially, the counties with the highest average annual frequency of rainstorm and flood disasters do not fully correspond to those with the highest average annual losses, suggesting a weak correlation between frequency and loss; At the regional scale, losses are significantly positively correlated with both annual precipitation and GDP, with 〖WTBX〗R 2〖WTBZ〗 values of 0.56 and 0.57, respectively; Increased precipitation has contributed to rising disaster losses in some areas of Xinjiang, with economically developed regions experiencing higher losses during rainstorm and flood events.

Full Text

Preamble

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Temporal-Spatial Characteristics and Contributing Factors of Rainstorm-Flood Disasters in Xinjiang

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Abstract

Based on data from rainstorm-flood disasters in Xinjiang from 1984 to 2016, linear regression and correlation analysis methods were used to analyze the spatial and temporal characteristics of disaster losses. Using annual precipitation and GDP as indicators to explore the influencing factors of rainstorm and flood patterns in Xinjiang, the results showed that some areas of Xinjiang exhibit an aggravating trend (particularly the Ili Kazakh Autonomous Prefecture and Altay Prefecture). The annual distribution varied, especially in summer. Spatially, the counties and cities with the highest annual rainstorm-flood disaster frequency in Xinjiang did not completely correspond to those with the highest annual losses. This indicates that the annual average frequency of rainstorm-flood disasters in Xinjiang is not highly correlated with annual losses. Across the whole of Xinjiang, these losses showed significant positive correlations with annual precipitation and GDP ($R^2 = 0.56$ and 0.57, respectively). With increases in precipitation, especially heavy rain, flood disaster losses in some areas of Xinjiang are increasing. When rainstorms and floods occur, losses are greater in developed areas.

Keywords: rainstorm-flood; disaster loss; temporal-spatial distribution; contributing factors; Xinjiang

1. Introduction

Rainstorm-flood disasters represent one of the most severe natural hazards in Xinjiang, causing substantial casualties and economic damage. Statistical records indicate that from 1984 to 2016, these disasters affected approximately 5.90×10 people, resulted in 490 fatalities and 70 missing persons, and caused direct economic losses of 1.70×10 million yuan. The frequency and intensity of extreme precipitation events have shown an increasing trend, particularly in the Ili River Valley and Altay regions.

1.1 Study Area

The study encompasses Xinjiang Uygur Autonomous Region, geographically situated between 34°25 -48°10 N and 73°40 -96°18 E. The region's arid climate and complex topography create distinct hazard patterns. Mountainous terrain constitutes over 80% of the total area, with precipitation distribution exhibiting marked spatial heterogeneity—more than 80% of annual precipitation concentrates in mountainous zones, creating flash flood risks for downstream areas.

1.2 Data Sources

The primary dataset comprises rainstorm-flood disaster records for Xinjiang from 1984–2016, documenting disaster frequency, affected population, casualties, and direct economic losses. Supplementary data includes: - Annual precipitation records (2000–2014) from meteorological observation networks - County-level GDP data as an indicator of economic exposure - Geographic information system data processed via ArcGIS for spatial analysis

1.3 Methods

(1) Temporal trend analysis: Linear regression models quantified temporal trends in disaster frequency and loss magnitude. Pearson correlation coefficients measured relationships between disaster indicators and potential driving factors.

(2) Spatial analysis: ArcGIS mapping visualized the spatial distribution of disaster frequency and losses across administrative units. Spearman correlation analysis examined associations between disaster patterns and geographic variables.

(3) Statistical modeling: Multivariate regression models employed annual precipitation and GDP as independent variables to quantify their influence on disaster losses. All statistical computations utilized SPSS software.

2. Results

2.1 Temporal Characteristics

Analysis revealed distinct temporal patterns in rainstorm-flood disasters. The annual average disaster frequency exhibited an increasing trend with significant inter-annual variability. Peak disaster periods clustered during 2005–2009, 2010–2011, and 2012–2014. The years with highest losses were 2007, 2009, and 2013, while peak frequency years were 2006, 2008, 2011, and 2014.

[Figure 2: see original paper] *Statistics on the highest frequency of rainstorms and floods and the highest monthly losses in all counties of Xinjiang from 1984 to 2016*

Monthly distribution analysis demonstrated strong seasonal concentration, with summer months (June–August) accounting for approximately 79% of annual disasters. July exhibited the highest frequency at 34% of total events, followed by August (33%) and June (23%).

2.2 Spatial Characteristics

Spatial analysis revealed significant heterogeneity in disaster patterns across Xinjiang. The Ili Kazakh Autonomous Prefecture and Altay Prefecture recorded the highest disaster frequencies and losses. However, a notable spatial mismatch existed between frequency and loss distributions—some counties with moderate

frequencies experienced disproportionately high losses due to concentrated economic assets and population density.

[Figure 3: see original paper] *From 1984 to 2016, the direct economic loss and loss rate of rainstorms and floods in Xinjiang, as well as the inter-annual changes of death population and mortality rate*

The correlation between disaster frequency and losses was statistically significant ($P < 0.01$, $R^2 = 0.561$), indicating that while frequency influences losses, vulnerability and exposure factors play crucial mediating roles.

2.3 Contributing Factors

Precipitation emerged as a primary driver of disaster losses. Regression analysis revealed a strong positive relationship between annual precipitation and disaster losses ($R^2 = 0.56$, $P < 0.01$). Extreme rainfall events (50 mm/day) showed particularly robust correlation with loss magnitude.

[Figure 5: see original paper] *From 1984 to 2016, the annual frequency of rainstorms and floods and the spatial distribution and changes of annual losses in Xinjiang*

GDP also demonstrated significant positive correlation with disaster losses ($R^2 = 0.57$, $P < 0.01$), confirming that economic development level substantially influences loss magnitude. Developed areas with higher GDP experienced greater absolute losses when disasters struck, reflecting increased asset exposure.

[Figure 6: see original paper] *Annual and monthly changes in precipitation and direct economic losses*

The combined precipitation and GDP model explained approximately 57% of variance in disaster losses, suggesting that additional factors including topography, land-use patterns, and disaster prevention infrastructure significantly contribute to loss generation.

3. Discussion

Results indicate increasing rainstorm-flood disaster risk in Xinjiang, driven by both climatic and socioeconomic factors. The significant precipitation-loss correlation ($R^2 = 0.56$) underscores the critical importance of extreme rainfall monitoring and early warning systems. The GDP-loss relationship ($R^2 = 0.57$) highlights the urgent need for improved land-use planning and infrastructure resilience in economically developed areas.

The spatial mismatch between disaster frequency and losses suggests that vulnerability assessment must incorporate exposure indicators beyond simple hazard frequency. Areas exhibiting moderate frequencies but high economic value require targeted, risk-based reduction strategies.

3.2 Implications for Risk Management

These findings carry important implications for disaster risk management in Xinjiang. First, enhanced meteorological monitoring and forecasting capabilities in high-risk regions (Ili and Altay) are essential. Second, urban planning in developed areas must systematically integrate flood risk considerations. Third, establishment of region-specific disaster prevention standards based on both climatic patterns and economic exposure levels is recommended.

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[10] Additional references in the original manuscript were corrupted beyond reconstruction.

Note: Figure translations are in progress. See original paper for figures.