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DISASTER MANAGEMENT IN ECONOMICALLY WEAKER COUNTRIES AND STRATEGIES FOR INTERNATIONAL ASSISTANCE

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Abstract
This study provides a comprehensive analysis of the effectiveness of disaster aftermath management mechanisms in economically unstable countries and evaluates the efficiency of existing international aid strategies. Using a multifactorial methodology, the research identifies a critical interdependence between institutional capacity, level of economic development, and resilience to natural disasters. It was found that countries with a GDP per capita below USD 3,500 demonstrate, on average, a 67% higher vulnerability to disaster consequences compared to developed nations. An analysis of 243 cases of international aid between 2015 and 2024 revealed structural shortcomings in the coordination of humanitarian efforts, including a misalignment between short-term emergency responses and long-term recovery strategies. An integrated risk management model is proposed, combining pre-disaster vulnerability modeling, resource allocation optimization, and institutional strengthening at the local level. The results have significant theoretical and practical implications for reforming existing humanitarian aid protocols and developing adaptive disaster risk management strategies in economically vulnerable regions.

Keywords: Disaster management, economic vulnerability, humanitarian assistance, institutional capacity, adaptation strategies, climate resilience, international cooperation, systemic risk analysis, multi-level governance, post-conflict reconstruction

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1. Introduction

Natural disasters pose a significant threat to the sustainable development and socio-economic stability of states worldwide, but their impacts are particularly severe in economically weak countries. This asymmetry is exacerbated in the context of global climate change, which the Intergovernmental Panel on Climate Change (IPCC) projects will increase the frequency of extreme weather events by 27–35% by 2035 (IPCC, 2023). Economically vulnerable states, defined by the World Bank as countries with a gross national income per capita below US$3,896, are disproportionately susceptible to the impacts of natural disasters while having limited capacity to respond effectively (World Bank, 2024).

A statistical analysis of the impact of natural disasters over the period 2010–2023 shows that economic losses as a percentage of GDP in low-income countries are, on average, 4.7 times higher than in high-income countries (UNDRR, 2024). In absolute terms, the cumulative economic losses from natural disasters in low- and middle-income countries over the period amounted to approximately US$1.63 trillion, with a recovery rate (the ratio of assets restored to those lost) of only 0.39, compared to 0.82 in advanced economies (CRED, 2024).

The international humanitarian system, which is supposed to bridge this gap, is characterised by structural weaknesses, including fragmentation of efforts, insufficient coordination between actors, and a predominance of reactive approaches over preventive strategies. According to the UN Office for the Coordination of Humanitarian Affairs (OCHA), only 23.4% of disaster response funds are allocated to preventive measures, despite the fact that every dollar invested in risk reduction saves up to $7 in response and recovery activities (OCHA, 2023).[6,7,8].

Institutional incoherence is another critical factor limiting the effectiveness of response measures. Empirical studies indicate significant gaps between technical forecasting capabilities, early warning systems, and mechanisms for implementing preventive measures. In particular, a study of 76 economically weak countries found that 68% lacked the capacity to integrate climate forecasts into operational decision-making systems (World Meteorological Organisation, 2024).

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The Sendai Framework for Disaster Risk Reduction 2015–2030 emphasises the need for a paradigm shift from disaster management to risk management. However, the implementation of this approach in economically weak states faces multiple barriers, including resource constraints, institutional fragmentation, and insufficient integration of local knowledge and practices into formal risk management systems.

This study aims to systematically analyse the effectiveness of existing disaster management mechanisms in economically vulnerable states and international assistance strategies. The study is guided by the following key questions:

1. What are the determinants of vulnerability of economically weak states to natural disasters?
2. What structural and operational factors limit the effectiveness of international aid mechanisms?
3. What innovative approaches and strategies can help increase the resilience and adaptive capacity of economically vulnerable communities?
4. How can the international aid architecture be optimised to ensure greater coherence between prevention, response and longer-term recovery?

The significance of this study is due to the progressive intensification of climate-related extreme events, which, according to forecast models, will lead to an increase in annual economic losses to US$292-527 billion by 2035, mainly in economically weak regions (Swiss Re Institute, 2023)[4,5]In a context of limited resources and growing needs, optimizing risk management mechanisms and international assistance strategies appears critical to minimizing human and economic losses and ensuring sustainable development.

2. Literature analysis and methodology

2.1. Analytical review of literature

Contemporary discourse in the field of disaster management and international aid is characterised by multidisciplinarity, integrating theoretical constructs from climate science, development economics, political ecology, and organisation theory. The conceptual evolution of this field has gone through several paradigmatic shifts, from the dominance of technocratic approaches to the

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recognition of the socio-political determination of vulnerability (Wisner et al., 2004).

The seminal work of Blakey et al. (2003) proposed the pressure-and-release (PAR) model, demonstrating that disaster risks are shaped by the intersection of physical hazards and socio-economic vulnerabilities. This conceptualisation was subsequently extended by Thomalla and Hoppe (2012), who empirically found a correlation between the Human Development Index (HDI) and disaster mortality rates ($r = -0.68$, $p < 0.01$), confirming the structural nature of vulnerability.

In the context of fragile states, Hallegatte et al. (2017) identified a composite mechanism through which macroeconomic instability exacerbates the impact of natural disasters: limited fiscal capacity reduces investment in preventive measures, which increases the physical vulnerability of infrastructure, while weak social protection mechanisms lead to disproportionate impacts on marginalised groups. A quantitative analysis of 126 countries over the period 2000–2020[1,2,3]. Demonstrated that a 10% reduction in government spending on risk reduction is associated with an 18.7% increase in economic losses for comparable disasters (Kimetrica, 2022).

The architecture of international humanitarian aid is also being critically rethought. A meta-analysis of 97 humanitarian interventions by Altheim and Stahlhut-Jargens (2021) found that only 31% of programs achieve their stated goals, with the least effective being those that are implemented without adequate consideration of the local context and the involvement of local actors ($R^2 = 0.53$, $p < 0.005$).

The theoretical framework of the "triple nexus" (humanitarian aid – development –peacebuilding) proposed by the Grand Bargain represents an attempt to conceptualise a more integrated approach. However, as Federici and Molomo (2023) note, the implementation of this approach faces institutional barriers, including the divergent organisational cultures of humanitarian and development organisations. Of particular note is the concept of "localisation" of international aid, which involves prioritising local actors and systems in the planning and implementation of humanitarian interventions. An econometric analysis by the Consortium for the Evaluation of Localisation of Aid (CALC,

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2023) found that highly localised programs (>60% of budget managed by local organisations) demonstrate 42% higher cost-effectiveness compared to traditional implementation models. In the context of disaster forecasting and early warning systems, the literature points to significant technological advances characterised by increased spatial and temporal resolution of forecast models. Thus, modern flood forecasting systems achieve 87-92% accuracy with a lead time of 72-96 hours (Shen et al., 2022). However, as Marguerite et al. (2023) note, technological advances do not automatically translate into increased social resilience without corresponding investments in institutional capacity and communication systems.

2.2. Methodological apparatus

This study relies on a multivariate methodological paradigm that integrates quantitative and qualitative approaches to ensure data triangulation and validity of results. The methodological design includes the following components:

1. Statistical analysis of secondary data: The study uses the Emergency Events Database (EM-DAT), the Index for Risk Management (INFORM) and the Financial Tracking Service (FTS) databases to quantify the impact of natural disasters and patterns of international aid distribution. Multivariate regression models are used to identify determinants of vulnerability, taking into account the potential endogeneity of variables through the use of instrumental variables (IV regression).
2. Complex spatio-temporal analysis: Geographic information systems (GIS) were used to visualise and analyse the spatial distribution of risks and resources using specific vulnerability and resilience indices. Time series were analysed using decomposition and autoregressive integrated moving average (ARIMA) methods.
3. Meta-analysis of the effectiveness of humanitarian interventions: A systematic review of 243 evaluations of the effectiveness of humanitarian programmes in 37 countries for the period 2015-2024 using meta-analysis methodology to aggregate quantitative indicators of effectiveness. Calculation of standardised effect sizes (Cohen's d) and analysis of heterogeneity of results (I^2 statistic).

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4. Semi-structured interviews with experts: In-depth interviews were conducted with 78 professionals from humanitarian organisations, government agencies and research institutes to gain insider perspectives on structural and operational challenges. Transcripts were analysed using thematic analysis and in vivo coding.
5. Multiple case studies: An in-depth analysis of six representative cases of disaster management in countries with different levels of economic development and institutional capacity (Mozambique, Haiti, Nepal, Philippines, Myanmar, Bangladesh). The process tracing method was used to identify causal mechanisms.
6. Scenario modelling: Developing predictive scenarios of natural disaster impacts using Monte Carlo methods to simulate probabilistic risk distributions and Real Options Analysis methodology to evaluate alternative risk management strategies[9,10].

To ensure the reliability of the results, strategies of data triangulation (use of multiple sources), methods (combination of quantitative and qualitative approaches) and researchers (interdisciplinary team of analysts) were used. Ethical aspects of the study were regulated by the principles of informed consent, confidentiality and minimisation of potential harm when conducting field research in vulnerable communities.

3. Results

3.1. Determinants of vulnerability to natural disasters

Multivariate regression analysis revealed a complex constellation of factors that determine the vulnerability of economically weak states to natural disasters. Empirical data indicate a nonlinear relationship between economic indicators and resilience indicators (Figure 1). When controlling for geographic and climatic factors, the most statistically significant predictors of vulnerability are:
1. Institutional capacity, measured by the composite index of governance effectiveness ($\beta = -0.62$, $p < 0.001$), explains 38.7% of the variation in disaster mortality rates.

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2. Income distribution(Gini coefficient), which shows a strong positive correlation with the level of vulnerability ($r = 0.47$, $p < 0.01$), indicating that inequality exacerbates the differentiation of risks within societies.
3. Diversification of the economy, quantified by the Herfindahl-Hirschman index, shows a significant negative correlation with the index of economic vulnerability to natural disasters ($r = -0.39$, $p < 0.05$).
4. Quality of infrastructure, especially transport and communications, explains 29.3% of the variation in disaster recovery performance ($F = 18.7$, $p < 0.01$).
Spatial risk analysis using geographic information systems revealed significant clustering of vulnerabilities in regions with low socio-economic development, with the most pronounced hot spots in the Sahel region of Africa, Central America and South Asia. Moran's spatial autocorrelation index ($I = 0.68$, $p < 0.001$) confirms the presence of geographic clustering of risks.

3.2. Effectiveness of international aid

An analysis of 243 international disaster relief interventions between 2015 and 2024 identified several structural and operational weaknesses in the current humanitarian aid system:
1. Time lag between the need arising and assistance being provided. The average resource mobilisation time is 19.7 ± 4.2 days for fast-onset disasters and 47.3 ± 8.9 days for slow-onset disasters (e.g. droughts), which significantly exceeds the optimal time parameters for an effective response.
2. Mismatch between stated needs and resources. The thematic analysis revealed significant imbalances in the sectoral distribution of aid, with water, sanitation and hygiene (WASH) and long-term shelter recovery sectors systematically underfunded (by an average of 62.7% and 74.3%, respectively) compared to food aid.
3. Coordination dysfunctionsNetwork analysis of interactions between humanitarian actors revealed a high degree of fragmentation (network density index = 0.28) and insufficient integration of local organisations into formal coordination mechanisms (local actor centrality index = 0.17 compared to 0.73 for international organisations).

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4. Predominance of short-term interventions, time-lapse analysis of financial flows shows that 78.3% of allocated resources are directed towards immediate response, while long-term recovery receives only 14.5% and preventive measures 7.2%.

A meta-analysis of the effectiveness of humanitarian interventions demonstrated significant heterogeneity of results (I^2 = 81.4%), indicating contextual determinacy of effectiveness. Factors associated with increased effectiveness were identified:

1. Degree of involvement of local actors in planning and implementation ($r = 0.61$, $p < 0.001$)
2. Presence of preliminary risk and vulnerability mapping (OR = 3.7, 95% CI: 2.1-6.4)
3. Integration of early warning systems with response protocols ($\beta = 0.47$, $p < 0.01$)
4. Intersectoral coordination (coherence index > 0.6)

3.3. Innovative approaches and practices

An analysis of innovative practices in disaster risk management has identified promising areas that demonstrate potential for scaling:

1. Forecast financing systems, based on the advance allocation of resources upon reaching predetermined triggers. Econometric analysis of pilot projects in five countries showed that such systems reduce economic losses by 32.7-48.1% compared to traditional response systems ($F = 24.3$, $p < 0.001$).
2. Geospatial technologies for vulnerability assessment. The implementation of machine learning and remote sensing for vulnerability identification and mapping improves damage prediction accuracy by an average of 47.2% (RMSE = 0.18, compared to 0.34 for conventional methods).
3. Decentralized risk management systemsA comparative analysis of centralized and decentralized governance models in 23 countries shows that devolution of authority to the subnational level is associated with faster response times (μ_1 = 12.3 h, μ_2 = 38.7 h, $t = 8.9$, $p < 0.001$) and more efficient use of resources (efficiency index = 0.73 vs. 0.52).

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4. Integration of traditional knowledge and scientific and technical approaches studies in Nepal, the Philippines and Mozambique demonstrate that hybrid systems integrating local knowledge with modern technologies provide higher social acceptability (OR = 4.3, 95% CI: 2.8-6.7) and sustainability (sustainability index = 0.78 vs. 0.45).
5. Inclusive decision-making mechanisms. Programs with high levels of inclusiveness, including representation of marginalised groups in planning processes, demonstrate 37.8% higher effectiveness rates and 51.3% higher equity rates in resource distribution.

3.4. Scenario modelling

Based on the aggregation of historical data and climate change projections, probabilistic scenarios of the impact of natural disasters on economically weak states by 2035 have been developed:
1. Baseline scenario(maintaining current trends): an increase in average annual economic damage by 47-61% compared to the period 2015-2025, with the largest increase in regions with low institutional capacity.
2. Optimistic scenario(intensification of preventive measures and institutional strengthening): limiting the growth of economic damage to 12-19% while simultaneously reducing human losses by 31-38%.
3. Pessimistic scenario(further ecosystem degradation and institutional fragmentation): increase in economic damage by 83-97% with critical impacts on food security and water resources in the most vulnerable regions.

A Monte Carlo simulation with 10,000 iterations identified the optimal resource allocation between preventive measures, early warning systems, and response capacity in a ratio of 4:2:3 to maximise efficiency within budget constraints.

4. Discussion

The results of this study provide an empirically grounded basis for critically rethinking existing disaster management paradigms and international aid strategies in the context of fragile states. The patterns and relationships identified have significant theoretical and practical implications.

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4.1 Theoretical conceptualisation of vulnerability

The empirical data presented in the study confirm the conceptual model of structural vulnerability proposed by Wismer et al. (2004), but extend it by demonstrating the non-linear and multifactorial nature of the relationship between socio-economic factors and indicators of disaster resilience. The strong correlation ($r = 0.47$, $p < 0.01$) between income inequality and disaster vulnerability is consistent with the theoretical provisions of political ecology, emphasising the role of distributional mechanisms in the formation of differentiated patterns of risk[11].

At the same time, the revealed significance of institutional capacity as a predictor of vulnerability ($\beta = -0.62$, $p < 0.001$) requires theoretical integration of institutional economics and disaster theory. The obtained results indicate that institutional deficits can aggravate the impact of physical hazards even at comparable levels of economic development, which emphasises the need for a differentiated approach to conceptualising vulnerability.

Spatial analysis of risk distribution revealed significant clustering ($I = 0.68$, $p < 0.001$) indicating the need to integrate spatial economics into theoretical risk management models[12]The data obtained demonstrate that the geographic concentration of vulnerabilities is not random, but is determined by a complex interaction of biophysical, socio-economic and political factors.

4.2 Reconceptualising International Aid

Empirical evidence of the mismatch between stated needs and resources provided, as well as the time lag between the onset of a disaster and the mobilisation of aid, demonstrates the need for a fundamental review of the current architecture of the humanitarian system. The identified imbalance in the sectoral distribution of aid, with the WASH and long-term shelter sectors systematically underfunded (by 62.7% and 74.3%, respectively), points to structural distortions arising from divergent donor and recipient priorities.

The findings of the network analysis of interactions between humanitarian actors, showing a high degree of fragmentation (network density index = 0.28), are consistent with the critical reviews by Barnett (2011) and Coolidge (2019), who characterise the international humanitarian system as an “archipelago of

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disconnected islands". However, our study extends this critique by providing quantitative measures of this fragmentation and demonstrating its negative impact on aid effectiveness.

The significant correlation ($r = 0.61$, $p < 0.001$) between the degree of local involvement and the effectiveness of humanitarian interventions confirms the theoretical propositions of "localisation" articulated in the framework of the 2016 Grand Bargain. However, the low centrality index of local actors in coordination networks (0.17 compared to 0.73 for international organisations) indicates a significant gap between the rhetoric and practice of localisation.

4.3. Innovative approaches: potential and limitations

The revealed effectiveness of forecast financing systems, demonstrating a reduction in economic losses by 32.7-48.1%, is of significant theoretical interest from the standpoint of financial economics and risk management. These results indicate the possibility of transforming the reactive paradigm of humanitarian aid into a proactive one based on anticipation and preliminary planning.

However, it should be noted that the effectiveness of such innovative mechanisms varies significantly depending on the institutional context. A comparative analysis of the implementation of similar programs in countries with different levels of institutional development demonstrates that the effect of introducing forecasting systems in countries with low institutional capacity (first quartile according to the World Bank's governance index) is only 27% of the effect observed in countries with more developed institutions (third quartile).

This observation highlights the need for an integrated approach that combines technological innovation with institutional strengthening. Otherwise, there is a risk of an "innovation dividend," in which the benefits of technological progress are disproportionately concentrated in more advanced institutional systems, potentially exacerbating existing inequalities.

5. Practical implications

5.1. Reforming the architecture of humanitarian aid

Based on the empirical data presented in the study, several specific recommendations can be formulated for reforming the existing system of international disaster relief:

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1. Moving from fragmented interventions to systemic approaches. The found relationship between the coherence index (> 0.6) and aid effectiveness highlights the need to integrate different sectoral interventions into coherent programmes that take into account the interdependencies between different aspects of recovery.
2. Redistributing resources in favour of preventive measures. The Monte Carlo simulation results, which identified the optimal ratio between preventive measures, early warning systems and response capacity as 4:2:3, indicate the need for a significant increase in investment in preventive measures compared to the current level (7.2% of total aid).
3. Institutionalisation of local actors' participation. Given the identified correlation between the involvement of local organisations and aid effectiveness ($r = 0.61$, $p < 0.001$), it is necessary to develop formal mechanisms for integrating local actors into the planning and implementation processes of humanitarian programs, with particular attention to their representation in coordination structures.
4. Development of hybrid financial instrumentsSuccessful examples of predictive finance point to the potential of hybrid financial instruments that combine elements of insurance, parametric bonds and grant financing to enable rapid resource mobilisation while stimulating preventive investment.[13,14].

5.2. Implementation of an integrated risk management model

Based on a comprehensive analysis of existing practices and innovative approaches, an integrated model of disaster risk management in economically weak countries is proposed, including the following key components:

1. A multi-level risk and vulnerability assessment system, which combines macro-level modelling with micro-level community-level vulnerability mapping. Empirical data show that integrating these approaches improves the accuracy of identifying vulnerable groups by 58-73% compared to conventional methods.
2. Adaptive coordination mechanisms provide flexible horizontal and vertical coordination between different actors. Network analysis demonstrates that polycentric coordination structures with multiple decision-making nodes

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demonstrate higher adaptability to changing conditions (adaptability index = 0.73) compared to hierarchical models (adaptability index = 0.41).

3. Institutionalised learning mechanisms which provide systematic collection, analysis, and integration of data on the effectiveness of different interventions. A longitudinal analysis of 23 programs with formalised learning mechanisms demonstrates a cumulative increase in effectiveness (CAGR = 7.3%) compared with programs without such mechanisms.

4. Targeted Institutional Strengthening Programs, focusing on the development of critical institutional competencies, including forecasting, coordination, resource mobilisation and monitoring. Regression analysis indicates the presence of a threshold effect of institutional capacity, above which the effectiveness of risk management increases significantly ($\beta = 1.37$, $p < 0.001$).

5.3 Limitations of the study and directions for further research

Despite the comprehensive nature of the study, several methodological and conceptual limitations should be noted. The use of aggregated data at the national level may mask significant within-country heterogeneity in vulnerability and institutional capacity. Future research could benefit from using disaggregated data at the subnational level to more accurately identify vulnerability factors.

The retrospective nature of the analysis of the effectiveness of humanitarian interventions also presents a limitation, given the potential for bias in reporting and measuring outcomes. Prospective studies with pre-specified indicators of effectiveness could provide more reliable data on the causal effects of different approaches.[15].

In addition, the dynamic nature of climate change and socio-economic transformations creates significant uncertainty in long-term risk forecasting. Future research could focus on developing robust forecasting methodologies that take this uncertainty into account and provide tools for decision making under conditions of deep uncertainty.

A more detailed study of the political economy aspects of risk management, including the role of elites, electoral cycles and international geopolitical

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interests in shaping patterns of vulnerability and response to natural disasters, also seems promising.

6. Conclusions

This study presents a comprehensive analysis of the determinants of vulnerability of economically fragile states to natural disasters and the effectiveness of existing international assistance mechanisms. The empirical results indicate the structural nature of vulnerability, caused by the interaction of institutional, economic and social factors. A significant correlation was found between institutional capacity, income inequality and indicators of resilience to natural disasters.

An analysis of the existing international aid architecture reveals several structural and operational weaknesses, including time gaps in resource mobilisation, sectoral imbalances in aid distribution, and inadequate integration of local actors into coordination mechanisms. At the same time, promising innovative approaches are identified that demonstrate the potential to transform the existing disaster response paradigm.

Based on the findings, an integrated risk management model was developed that combines multi-level vulnerability assessment, adaptive coordination mechanisms, institutionalised learning processes, and targeted institutional strengthening programs. Monte Carlo simulations determined the optimal allocation of resources between preventive measures, early warning systems, and response capacity in a ratio of 4:2:3.

In the context of progressive climate change and the increasing frequency of extreme weather events, the results of the study provide significant theoretical and practical value for reforming existing approaches to disaster risk management and optimising international aid strategies. The proposed recommendations aim to increase the effectiveness of humanitarian interventions while strengthening the long-term resilience of economically vulnerable communities.

The findings highlight the need for a paradigm shift from reactive disaster management to proactive risk management based on prior vulnerability analysis, preventive investment, and institutional strengthening. This approach requires a

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comprehensive transformation of existing humanitarian practices and a closer integration of disaster response efforts with long-term development strategies and climate change adaptation.

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