



From Natural Hazard to Psychological Impact: An Integrative Conceptual Model of the Role of Geographical Determinants in Psychological Vulnerability to Natural Disasters in Libya

Abtisam Ali Mohammed Raqeem¹, Amira Ibrahim Ahmed Aqjam²

¹Department of Psychology, Al-Zahra College of Education, Aljafara University, Libya

²Physical Geography Department, Higher Institute of Science and Technology – Zaltan, Libya

ebtisam@aju.edu.ly¹, amiraamira1009as@gmail.com²

<https://orcid.org/0009-0002-6711-8938>¹

Received: 01/9/2026 Revised: 10/9/2026 Accepted: 30/9/2026 Publication: 27/10/2026

Abstract

The psychological fallout of natural disasters is rarely a direct function of the event's physical severity. Instead, it emerges from a complex interplay between hazard characteristics, localized spatial conditions, institutional efficacy, and the psychosocial resources accessible to affected populations. This paper seeks to construct an integrative conceptual model that elucidates how geographical determinants shape psychological vulnerability to natural disasters within the Libyan context. Employing a conceptual model-building methodology, this study conducts a narrative and analytical review of theoretical literature, recent systematic reviews, and localized Libyan studies focusing on the 2023 Derna floods. Core constructs were refined, relational dynamics were derived, and testable theoretical propositions were formulated. The proposed model delineates three interconnected domains: geographical hazard determinants that dictate exposure and intensity; institutional and built-environment factors that moderate the trajectory from hazard exposure to tangible losses; and mediating mechanisms such as displacement, livelihood disruption, and the erosion of social support that translate physical exposure into psychological distress. Furthermore, psychosocial resources (e.g., self-efficacy, coping mechanisms, social cohesion) are posited to moderate these pathways. The model introduces "place identity" as a distinct pathway, illustrating how prolonged displacement and the obliteration of familiar landmarks exacerbate psychological vulnerability. Psychological vulnerability to disasters is a multifaceted spatial, social, and psychological construct. The proposed framework lays the groundwork for future empirical validation, spatial vulnerability mapping, and the integration of mental health and psychosocial support (MHPSS) into disaster risk reduction (DRR) strategies in Libya.

Keywords: Psychological vulnerability; spatial vulnerability; geographical determinants; natural disasters; place identity; Libya; mental health.

من المخاطر الطبيعية إلى الأثر النفسي: نموذج مفاهيمي تكاملي لدور المحددات الجغرافية في القابلية للتأثر النفسي تجاه الكوارث الطبيعية في ليبيا

ابتسام علي محمد بالرقم ، كلية التربية الزهراء جامعة الجفارة

اميرة إبراهيم أحمد قجام ، المعهد العالي للعلوم والتقنية- زلطن

ملخص

نادراً ما تكون التبعات النفسية للكوارث الطبيعية نتيجة مباشرة لشدة الحدث المادية؛ بل تنشأ عن تفاعل معقد بين خصائص الخطر، والظروف المكانية المحلية، وفعالية المؤسسات، والموارد النفسية والاجتماعية المتاحة للسكان المتضررين. تسعى هذه الورقة إلى بناء نموذج مفاهيمي تكاملي يوضح كيف تشكل المحددات الجغرافية القابلية للتأثر النفسي تجاه الكوارث الطبيعية في السياق الليبي. ومن خلال منهجية بناء النماذج المفاهيمية، تقدم الدراسة مراجعة تحليلية ونقدية للأدبيات النظرية، والمراجعات المنهجية الحديثة، والدراسات المحلية الليبية التي ركزت على فيضانات درنة عام 2023. وقد جرى تنقيح المفاهيم الأساسية، واستنباط الديناميكيات العلائقية، وصياغة فرضيات نظرية قابلة للاختبار. يحدد النموذج المقترح ثلاثة مجالات مترابطة: المحددات الجغرافية للمخاطر التي تملئ مستوى التعرض وشدة؛ والعوامل المؤسسية والبيئة العمرانية التي تؤثر في مسار التحول من التعرض للخطر إلى وقوع خسائر ملموسة؛ وآليات وسيطة—مثل النزوح، وتعطل سبل العيش، وتآكل الدعم الاجتماعي—التي تحول التعرض المادي إلى معاناة نفسية. علاوة على ذلك، يُفترض أن الموارد النفسية والاجتماعية (مثل الكفاءة الذاتية، وآليات التكيف، والتماسك الاجتماعي) تلعب دوراً معيّلاً في هذه المسارات. والأهم من ذلك، يطرح النموذج مفهوم "هوية المكان" كمسار مستقل، موضحاً كيف يؤدي النزوح المطول وتدمير المعالم المألوفة إلى تقاوم القابلية للتأثر النفسي. إن القابلية للتأثر النفسي تجاه الكوارث هي مفهوم متعدد الأبعاد، يجمع بين الجوانب المكانية والاجتماعية والنفسية. ويضع هذا الإطار المقترح أساساً للتحقق التجريبي المستقبلي، ورسم خرائط القابلية للتأثر المكاني، ودمج خدمات الصحة النفسية والدعم النفسي الاجتماعي (MHPSS) ضمن استراتيجيات الحد من مخاطر الكوارث (DRR) في ليبيا.

الكلمات المفتاحية: القابلية للتأثر النفسي؛ القابلية للتأثر المكاني؛ المحددات الجغرافية؛ الكوارث الطبيعية؛ هوية المكان؛ ليبيا؛ الصحة النفسية.

1. Introduction

Libya's geographical tapestry exposes it to a diverse array of natural hazards, ranging from flash floods and wadi inundations in the coastal and mountainous regions to prolonged droughts, land degradation, and severe dust storms in the semi-arid interiors. The catastrophic floods that struck eastern Libya in 2023 laid bare a sobering reality: a natural disaster is never merely an isolated meteorological event. Rather, it is the culmination of acute natural hazards intersecting with a geographical, urban, and institutional landscape primed to amplify their destructive potential. Historically, geographical literature has predominantly focused on the physical mechanics of these phenomena precipitation patterns, surface runoff, watershed dynamics, and the structural integrity of mitigation infrastructure. Conversely, psychological literature has concentrated on quantifying the clinical symptoms among survivors, such as post-traumatic stress disorder (PTSD), anxiety, and depression. However, the nexus between these two domains remains underexplored. There is a distinct scarcity of models that articulate how the specific characteristics of a place translate into divergent psychological responses among its inhabitants. This paper operates on the premise that the psychological impact of a disaster is not dictated solely by the event itself, but by the pre-existing spatial, social, and psychological conditions that render certain individuals and communities disproportionately susceptible to harm. Consequently, this study aims to construct a conceptual model that bridges geographical hazard exposure, institutional factors, mediating mechanisms, psychosocial resources, and ultimate psychological outcomes.

2. Research Problem and Questions

The core research problem is anchored in the following primary question: How can the variance in the psychological impact of natural disasters among individuals and communities in Libya be explained through the lens of geographical determinants, and what mechanisms translate spatial hazard exposure into psychological vulnerability?

To unpack this, the study addresses the following sub-questions:

- What specific geographical characteristics elevate the probability and intensity of natural hazard exposure within the Libyan context?
- Which institutional and urban factors moderate the relationship between hazard presence, exposure levels, and subsequent losses?
- What mediating mechanisms bridge the gap between geographical exposure and psychological outcomes?
- Which psychosocial resources buffer or exacerbate the strength of these impacts?
- How can these multifaceted relationships be synthesized into a testable conceptual model?

3. Significance and Limitations

The theoretical significance of this paper lies in its pioneering effort to fuse physical geography with disaster psychology, offering a unified framework for understanding spatially induced psychological vulnerability. Practically, the model provides a blueprint for identifying regions and demographic cohorts most in need of psychosocial interventions, thereby informing early warning systems, shelter planning, and post-disaster recovery protocols. It is imperative to acknowledge the study's boundaries. This paper is strictly a theoretical construct; it does not introduce novel empirical field data. Furthermore, while the model is tailored to the Libyan context and encompasses both rapid-onset and slow-onset natural disasters, it does not claim generalizability to anthropogenic crises or conflict zones. Finally, this work does not assert absolute primacy in exploring the geography-mental health nexus in Libya; rather, its contribution is the synthesis of fragmented literature into a cohesive, testable framework.

4. Core Concepts

To ensure conceptual clarity, the following constructs are defined:

- **Natural Hazard:** A natural process or event that poses a potential threat to human life and property, which only metamorphoses into a disaster when it intersects with a vulnerable and poorly equipped society.
- **Hazard Exposure:** The degree to which populations and infrastructure are situated within the hazard zone, spatially defined by proximity to wadis, steep gradients, coastlines, and floodplains.
- **Psychological Vulnerability:** A pre-existing individual or collective predisposition to develop psychological distress or maladaptation following a disaster. It represents a latent susceptibility rather than an active pathology.
- **Social Vulnerability:** The societal characteristics such as income, housing quality, service accessibility, and community cohesion that dictate a community's capacity to prepare for, confront, and recover from a hazard.
- **Spatial Vulnerability:** The uneven geographical distribution of hazard exposure and coping capacity, emerging from the intersection of physical, social, and institutional variables.
- **Psychological Resilience:** The dynamic process of positive adaptation and recovery in the wake of adversity, heavily contingent upon the availability of individual and collective resources rather than being a static trait.
- **Place Identity:** The cognitive and emotional bond individuals share with their environment, wherein the place serves as a repository of memory, belonging, and meaning. The destruction or forced abandonment of such places can act as an independent source of psychological distress.

5. Literature Review

The existing literature concerning the September 2023 Derna floods bifurcates into two primary streams. The first comprises geographical and hydrological investigations that reconstructed the event's chronology using hydrological modeling and satellite telemetry. For instance, Armon et al. (2025) demonstrated that Storm Daniel deposited unprecedented rainfall over the Derna watershed, and the subsequent failure of two earthen dams amplified the devastation by a factor of twenty compared to a no-dam scenario, highlighting severe institutional deficits in risk assessment. Similarly, Nemnem et al. (2025) revealed that the storm's total runoff exceeded the dams' combined capacity sevenfold, generating a catastrophic surge that was further exacerbated by urban encroachment into the wadi pathway.

The second stream consists of descriptive and correlational psychological studies conducted among Derna survivors. These studies primarily measured PTSD or depression and linked them to demographic variables or psychosocial support. Notable examples include Ajaal's (2025) study of 674 affected individuals, Elzawam's (2025) research on 100 survivors using the Arabic Davidson Trauma Scale, and a cross-sectional study by Almabrouk et al. (2025) on medical students at the University of Derna, which found a significant correlation between internal displacement and elevated anxiety and depression.

Recent systematic reviews corroborate that natural disaster exposure elevates the risk of psychiatric disorders, with displacement, social support erosion, and income loss acting as primary risk factors (Santomauro et al., 2023; Zhong et al., 2024).

The Research Gap: While geographical studies elucidated the physical genesis and magnitude of the disaster, and psychological studies quantified the clinical outcomes among survivors, a critical disconnect remains. Existing research has failed to integrate spatial exposure variables with psychological outcomes or test the mediating mechanisms between them. The gap is not a lack of data in either discipline, but the absence of an integrative model that bridges the spatial and the psychological.

6. Methodology of Theoretical Construction

This study utilizes an integrative conceptual model-building approach. Rather than collecting primary field data, this methodology synthesizes concepts and relational dynamics from disparate literature streams into a novel, testable theoretical architecture (Jaakkola, 2020). The review encompassed foundational theories of vulnerability and risk, disaster psychology, social support dynamics, alongside localized Libyan studies on the Derna flood and recent systematic reviews. Sources were selected based on direct relevance to the model's constructs and verifiable publication data. As a comprehensive PRISMA-guided systematic review was not conducted, this is characterized as a narrative analytical review. The construction followed a systematic progression: delineating the boundaries of physical geography and disaster psychology; cataloging relevant local and international literature; harmonizing the definitions of shared constructs; deducing relational pathways based on established theories; formulating falsifiable propositions; and evaluating the model for internal consistency, testability, and boundary clarity (Whetten, 1989).

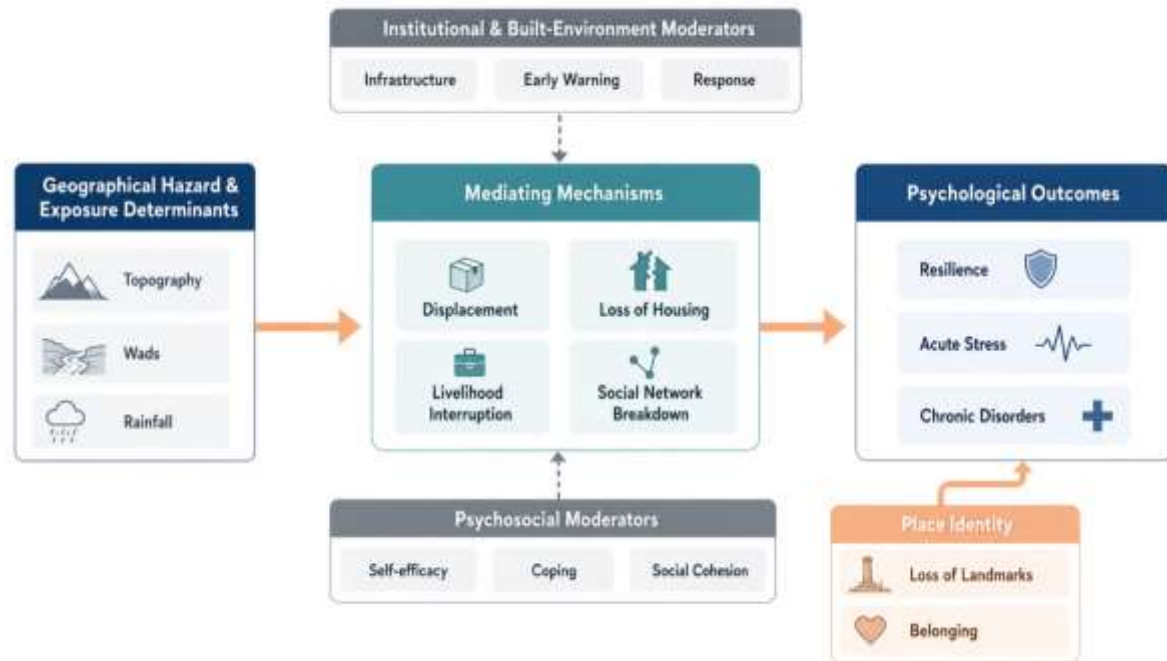


Figure 1 the research workflow

Figure 1 above illustrates the study's novel integrative framework, which transcends traditional linear models by mapping how physical geographical determinants translate into psychological outcomes through specific mediating losses. The moderating roles of institutional infrastructure and psychosocial resources, while uniquely introducing "Place Identity" as an independent, parallel pathway. This distinct pathway demonstrates that the erosion of spatial belonging and landmarks contributes directly to psychological distress, offering a comprehensive, multi-layered understanding of disaster vulnerability in the Libyan context.

7. Theoretical Foundations

The model is anchored in several established theoretical paradigms:

- **Vulnerability and Hazard Literature:** Conceptualizes disasters as the intersection of hazard, vulnerability, and limited coping capacity, rather than mere acts of nature (Blaikie et al., 1994; Wisner et al., 2004; Cutter et al., 2003).
- **Conservation of Resources (COR) Theory:** Explains psychological distress as a response to the threat or actual loss of valued resources, illustrating how cumulative losses compound trauma (Hobfoll, 1989).
- **Transactional Model of Stress and Coping:** Highlights the mediating role of cognitive appraisal how an individual evaluates the threat and their capacity to manage it (Lazarus & Folkman, 1984).
- **Ecological Systems Theory:** Situates the individual within nested, interacting systems ranging from the immediate family to the broader natural environment (Bronfenbrenner, 1979).
- **Post-Disaster Social Support Literature:** Demonstrates that while social networks are crucial for recovery, large-scale disasters often precipitate the deterioration of these very support systems (Kaniasty & Norris, 1993; Norris et al., 2002).

8. Theoretical Contribution and Scientific Originality

The primary theoretical contribution of this paper is the development of an explanatory framework that links geographical hazard determinants to institutional pathways, subsequent losses, and psychosocial resources, while uniquely positioning "place identity" as a critical lens for understanding psychological variance. The originality does not lie in inventing entirely new concepts, but in orchestrating existing constructs into a context-specific, testable model tailored for Libya.

This model diverges from traditional frameworks in three key ways:

- Traditional vulnerability models explain disaster genesis but rarely map the micro-level translation of physical losses into specific psychological outcomes.
- Disaster psychology often treats "exposure" as a monolithic variable, neglecting the nuanced spatial characteristics and their specific mediating pathways.
- The proposed model integrates both domains by distinguishing between variables that dictate exposure, institutional factors that moderate loss, mechanisms that mediate psychological impact, and resources that buffer the outcome. It also isolates place identity as an independent pathway to understand the unique trauma of displacement and spatial dislocation.

9. The Proposed Conceptual Model

The model rejects a simplistic, linear causal pathway in favor of a multidimensional architecture that assigns distinct roles to various variables: determining exposure, mediating impact, and moderating outcomes.

Table 1: Components and Proposed Relationships of the Conceptual Model

Role in Model	Components	Proposed Relationship
Hazard & Exposure Determinants	Topography, gradient, wadi networks, rainfall regimes, proximity to floodplains.	Dictate the probability, intensity, speed of onset, and warning window of the event.
Institutional & Urban Moderators	Infrastructure quality, floodplain zoning, early warning systems, emergency response efficacy.	Moderate the translation of hazard presence into actual exposure and tangible loss.
Mediating Mechanisms	Human/material casualties, housing destruction, displacement, livelihood interruption, collapse of social networks.	Channel physical exposure and resource loss into psychological distress.
Psychosocial Moderators	Self-efficacy, coping strategies, meaning-making, community cohesion, prior trauma.	Buffer or exacerbate the relationship between loss and psychological outcomes.
Place Identity Pathway	Loss of landmarks, spatial belonging, and environmental mastery.	Acts as an independent source of psychological stress, particularly during prolonged displacement.
Outcomes	Adaptive resilience, transient acute stress, chronic psychiatric disorders.	Represents the spectrum of psychological responses post-disaster.

Logic of the Relationships:

- **Direct Pathway:** Rapid-onset hazards with narrow warning windows maximize the likelihood of life-threatening situations and acute trauma.

- **Mediating Pathway:** Physical losses translate into psychological distress via the depletion of resources (housing, community, income), which shatters the foundational sense of safety.
- **Institutional Moderation:** Robust early warning and effective governance mitigate the hazard-to-loss trajectory; institutional failure amplifies it.
- **Psychosocial Moderation:** High levels of internal and external resources attenuate the impact of losses on mental health.
- **Place Identity Pathway:** The destruction of a place is not merely the loss of physical assets; it is the erasure of memory and belonging, constituting a distinct psychological wound.
- **Geographical Variance within Libya:**

The model anticipates regional variations in vulnerability. In coastal and mountainous wadis, rapid-onset flash floods likely precipitate acute trauma and PTSD due to the suddenness and lethality of the event. Conversely, in the semi-arid peripheries, slow-onset hazards like drought and land degradation may foster chronic anxiety, learned helplessness, and prolonged distress related to livelihood erosion. These are hypothesized patterns awaiting empirical validation.

10. Theoretical Propositions and Testing Indicators

To facilitate future empirical research, the model yields the following testable propositions:

- **Proposition 1:** The velocity of hazard onset and the constriction of warning windows positively correlate with the incidence of acute psychological symptoms. (Indicators: Warning time, exposure duration, reports of direct life threat).
- **Proposition 2:** Resource depletion (housing, livelihood, social support) mediates the relationship between geographical exposure severity and psychological distress. (Indicators: Housing loss, income interruption, displacement).
- **Proposition 3:** Psychosocial resources (self-efficacy, social cohesion) negatively moderate the relationship between disaster exposure and adverse psychological outcomes. (Indicators: Standardized scales for self-efficacy, coping, and perceived support).
- **Proposition 4:** The quality of institutional response (early warning, evacuation, relief) moderates the relationship between hazard presence and tangible losses. (Indicators: Warning lead-time, evacuation efficiency, shelter adequacy).
- **Proposition 5:** Prolonged displacement exacerbates psychological vulnerability through the mediating mechanism of place identity loss. (Indicators: Displacement duration, loss of landmarks, place attachment scales).
- **Proposition 6:** Slow-onset hazards produce a distinct, chronic pattern of psychological distress compared to the acute trauma associated with rapid-onset events. (Indicators: Exposure duration, event frequency, chronic anxiety/burnout metrics).

11. Scientific Contribution

This paper facilitates a paradigm shift from merely describing the correlation between geography and mental health to explicating the underlying mechanisms. It rigorously differentiates the roles of variables (determinants, moderators, mediators), distinguishes between hazard typologies (rapid vs. slow onset), and introduces place identity as a vital spatial-psychological construct. While not claiming absolute precedence in the Libyan context, its contribution lies in its integrative synthesis and the provision of a robust, testable architectural framework.

12. Application of the Model and Future Research

Empirically, the model can be validated through cross-sectional studies across diverse Libyan geographical zones, integrating spatial exposure metrics with psychometric assessments of symptoms and resources, utilizing structural equation modeling to test mediation and moderation. Longitudinal designs could track the evolution of symptoms in relation to displacement duration and resource recovery.

Practically, the model informs:

- The development of psycho-social vulnerability maps that overlay geographical hazard data with community resilience indicators.
- The integration of Mental Health and Psychosocial Support (MHPSS) into early warning, shelter, and relief protocols.
- The targeted pre- and post-disaster allocation of resources to the most vulnerable cohorts.
- The design of reconstruction interventions that consciously preserve place identity and foster community healing.

13. Discussion

The proposed conceptual model advances a critical paradigm shift in disaster psychology by conceptualizing psychological vulnerability not as a mere clinical byproduct of physical trauma, but as a spatially mediated, institutionally moderated, and psychologically processed phenomenon. By integrating geographical hazard determinants with the micro-level dynamics of disaster psychology, this framework addresses the persistent disconnect between physical exposure metrics and clinical outcomes (Dalla et al., 2024); (A. F. Zaid et al., 2026). The discussion that follows synthesizes the theoretical pathways of the model, contextualizes them within the specific geographical and institutional realities of Libya, and outlines the implications for both empirical research and public health policy. The first major theoretical contribution of this model lies in its explicit delineation of how geographical determinants and institutional factors jointly dictate initial exposure (Ben Dalla et al., 2026). Hydrological and geographical reconstructions of the 2023 Derna floods demonstrate that the catastrophe was not solely a meteorological anomaly; rather, it was a systemic failure where extreme rainfall intersected with compromised infrastructure and unregulated urban encroachment into wadi pathways (Armon et al., 2025; Nemnem et al., 2025). Our model extends these physical findings by positing that such institutional deficits act as critical moderators. When early warning systems fail and floodplain zoning is ignored, the geographical hazard is amplified into acute, life-threatening exposure. This aligns with foundational vulnerability literature, which asserts that disasters are born at the intersection of natural hazards and societal fragility, rather than from the natural event alone (Blaikie et al., 1994; Wisner et al., 2004; Cutter et al., 2003). Consequently, the psychological trauma experienced by survivors is inextricably linked to the preventable, spatially concentrated nature of their exposure.

Moving beyond the initial exposure, the model elucidates the mediating mechanisms that translate physical destruction into psychological distress. Drawing upon the Conservation of Resources (COR) theory (Hobfoll, 1989), this research conceptualize the disaster aftermath as a cascading depletion of valued resources. The geographical reality of the flood characterized by the sudden obliteration of homes and the severing of community ties forces a rapid and involuntary loss of material, social, and psychological resources. Empirical evidence from Derna strongly supports this pathway; studies indicate that internal displacement, loss of housing, and the disruption of

daily livelihoods are primary drivers of elevated anxiety and depression among affected populations (Almabrouk et al., 2025; Elsaid & Boshaala, 2025). Furthermore, the model incorporates the well-documented phenomenon of social support deterioration. While communities often rally immediately following a crisis, the prolonged stress of displacement and resource scarcity frequently leads to the erosion of the very social networks required for recovery (Kaniasty & Norris, 1993; Norris et al., 2002). Thus, the psychological impact is mediated not just by the initial shock, but by the chronic, grinding loss of the environmental and social scaffolding that sustains mental well-being.

A novel dimension introduced by this framework is the conceptualization of "place identity" as an independent pathway to psychological vulnerability. Traditional disaster psychology often treats the physical environment merely as a backdrop or a collection of material assets. However, through the lens of ecological systems theory (Bronfenbrenner, 1979), the environment is an active, nested component of human development and identity. When a disaster obliterates familiar landmarks, ancestral neighborhoods, and communal spaces, it inflicts a distinct psychological wound the erasure of spatial belonging and autobiographical memory. Field reports from Derna highlight severe mental health crises driven not only by the loss of life and property but by the profound disorientation and grief associated with returning to unrecognizable, altered landscapes (Médecins Sans Frontières, 2023). Prolonged displacement exacerbates this, as individuals are severed from the physical anchors of their identity, leading to chronic distress that standard trauma models, which focus primarily on acute life-threat, may fail to fully capture (Galea et al., 2005).

The model also accounts for the significant variance in psychological outcomes by integrating psychosocial moderators. The trajectory from resource loss to chronic psychiatric disorders, such as post-traumatic stress disorder (PTSD), is not deterministic. The transactional model of stress and coping (Lazarus & Folkman, 1984) informs this research proposition that an individual's cognitive appraisal of the disaster, coupled with their internal resources like self-efficacy and meaning-making, critically buffers the psychological impact. Local studies in Derna reveal that demographic variables and pre-existing psychosocial support systems significantly influence the severity of PTSD and depression (Ajaal, 2025; Elzawam & Aisha, 2025). Furthermore, the concept of psychological resilience is framed not as a static trait, but as a dynamic capacity to adapt, heavily contingent upon the availability of both internal coping strategies and external community cohesion (Bonanno, 2004). In the Libyan context, where formal mental health infrastructure may be strained by broader systemic challenges, informal social cohesion and cultural meaning-making systems become the primary moderators of psychological survival and recovery.

Additionally, the proposed framework distinguishes between the psychological signatures of rapid-onset and slow-onset hazards. While the Derna floods exemplify the acute, high-arousal trauma associated with sudden, rapid-onset events characterized by narrow warning windows, the model hypothesizes a different psychological trajectory for slow-onset hazards prevalent in Libya's semi-arid regions, such as drought and land degradation. Systematic reviews indicate that prolonged exposure to environmental degradation fosters chronic anxiety, learned helplessness, and pervasive uncertainty, contrasting sharply with the acute PTSD profiles typical of flash floods (Santomauro et al., 2023; Zhong et al., 2023). By delineating these pathways, the model provides a more nuanced psychosocial topography of vulnerability across Libya's diverse geographical zones, moving beyond a monolithic view of disaster trauma. The theoretical integration achieved by this model carries profound practical implications for disaster risk reduction and public health policy. The Sendai Framework for Disaster Risk Reduction emphasizes the necessity of

understanding disaster risk in all its dimensions, including vulnerability, exposure, and capacity (UNDRR, 2015). This research model operationalizes this mandate by demonstrating that mental health and psychosocial support (MHPSS) cannot be treated as an afterthought or a purely clinical intervention deployed after the physical debris is cleared. Instead, MHPSS must be spatially informed. Early warning systems, evacuation protocols, and shelter placements must be designed with an acute awareness of how they impact place identity and social cohesion. Interventions that inadvertently fracture community networks during displacement may accelerate the deterioration of social support, deepening psychological vulnerability (Kaniasty & Norris, 1993). Therefore, geographical mapping of hazard exposure must be directly coupled with the mapping of social and psychological resources to identify cohorts requiring targeted pre- and post-disaster interventions. This discussion underscores that psychological vulnerability to natural disasters in Libya is a deeply socio-spatial construct. The physical geography dictates the parameters of the threat, institutional efficacy determines the magnitude of the exposure, and the subsequent depletion of resources and place identity drives the psychological toll. By mapping these intricate, multi-layered relationships, the proposed conceptual model moves the discipline beyond descriptive correlations. It offers a robust, testable architecture for future empirical research, fulfilling the criteria for a substantial theoretical contribution (Jaakkola, 2020; Whetten, 1989), and paving the way for targeted, geographically sensitive mental health policies that address the root spatial and social drivers of psychological distress.

14. Conclusion

The psychological aftermath of a natural disaster is not an inevitable byproduct of the physical event; it is constructed through a sequential pathway originating in the spatial environment, filtered through institutional efficacy, mediated by tangible and intangible losses, and ultimately buffered by the psychosocial resources of the individual and community. The proposed model conceptualizes psychological vulnerability as a complex socio-spatial-psychological construct. By bridging the divide between physical geography and disaster psychology, this framework offers a vital foundation for collaborative empirical research and the design of more empathetic, effective, and spatially aware disaster preparedness and recovery policies in Libya.

References

- A. F. Zaid, L. O. F. B. Dalla, Ö. Karal, S. Mumin, M. Essgaer, and A. A. Shlibak, . (2026). "RHYTHMIQ: A low-cost portable ECG monitoring system with on-device multimodal feedback and clinical validation," in 2026 International Conference on Circuit, Systems and Communication (ICCSC), Fez, Morocco, 2026. doi: 10.1109/ICCSC71566.2026.11650392.
- Ajaal, F. S. S. (2025). Post-traumatic stress disorder among a sample of Storm Daniel affected individuals in Derna in light of some variables. *Journal of Sebha University for Human Sciences*, 24(1). <https://doi.org/10.51984/JOHS.V24I1.3778>
- Almabrouk, A., et al. (2025). The psychological impact of Storm Daniel on medical students at the University of Derna in Libya: A cross-sectional study. *Cambridge Prisms: Global Mental Health*. <https://doi.org/10.1017/gmh.2025.10007>
- Armon, M., Shmilovitz, Y., & Dente, E. (2025). Anatomy of a foreseeable disaster: Lessons from the 2023 dam-breaching flood in Derna, Libya. *Science Advances*, 11(13), eadu2865. <https://doi.org/10.1126/sciadv.adu2865>

- Ben Dalla L., Jetlaweib S.S., Karal Ö., EL-sseid M., Medeni T.D. (2026). Informal Economy Dynamics in Central Africa and the Mediterranean: A Machine Learning Approach. *Economy: strategy and practice*. 2026;21(2):6-22. <https://doi.org/10.51176/1997-9967-2026-2-6-22>
- Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At risk: Natural hazards, people's vulnerability and disasters*. Routledge.
- Bonanno, G. A. (2004). Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist*, 59(1), 20–28.
- Bronfenbrenner, U. (1979). *The ecology of human development*. Harvard University Press.
- Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly*, 84(2), 242–261.
- Dalla, L. O. B., Medeni, T. D., & Medeni, İ. T. (2024). Evaluating the Impact of Artificial Intelligence-Driven Prompts on the Efficacy of Academic Writing in Scientific Research. *Afro-Asian Journal of Scientific Research (AAJSR)*, 48-60.
- Elsaid, S., & Boshaala, A. (2025). Post-traumatic stress disorder and depression among the survivors of the Derna flood 2023. *Libyan Journal of Medical Research*, 19(1).
- Elzawam, M. A., & Aisha. (2025). Post-traumatic stress disorder among a sample of Derna flood survivors. *Al-Qalaa Journal*, 24.
- Galea, S., Nandi, A., & Vlahov, D. (2005). The epidemiology of post-traumatic stress disorder after disasters. *Epidemiologic Reviews*, 27, 78–91.
- Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Psychologist*, 44(3), 513–524.
- Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, 10, 18–26.
- Kaniasty, K., & Norris, F. H. (1993). A test of the social support deterioration model in the context of natural disaster. *Journal of Personality and Social Psychology*, 64(3), 395–408.
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer.
- Médecins Sans Frontières. (2023). *Libya: Mental health support needed after Storm Daniel destroys Derna*.
- Nemnem, A. M., Tanim, A. H., Nahian, A., Khan, S., Goharian, E., & Imran, J. (2025). How extreme rainfall and failing dams unleashed the Derna flood disaster. *Nature Communications*, 16(1), 4191. <https://doi.org/10.1038/s41467-025-59261-9>
- Norris, F. H., Friedman, M. J., Watson, P. J., et al. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry*, 65(3), 207–239.
- Santomauro, D. F., et al. (2023). Mental health disorders due to disaster exposure: A systematic review and meta-analysis. *Cureus*, 15(4).
- UNDRR. (2015). *Sendai framework for disaster risk reduction 2015–2030*. United Nations Office for Disaster Risk Reduction.
- Whetten, D. A. (1989). What constitutes a theoretical contribution? *Academy of Management Review*, 14(4), 490–495.
- Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk: Natural hazards, people's vulnerability and disasters* (2nd ed.). Routledge.
- Zhong, S., et al. (2023). Mental health of vulnerable groups experiencing a drought or bushfire: A systematic review. *Cambridge Prisms: Global Mental Health*, 10, e24. <https://doi.org/10.1017/gmh.2023.24>