

# The Effectiveness of Multi-Stakeholder Networks in the Implementation of Hydrometeorological Disaster Risk Reduction Policies: Systematic Literature Network Analysis

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**Abstract.** The effectiveness of multi-stakeholder collaborative networks versus government-centric approaches in implementing hydrometeorological disaster risk reduction policies has not been comprehensively understood. This study conducted a Systematic Literature Network Analysis (SLNA) to synthesize evidence of effectiveness and map the research landscape through the integration of a systematic review with bibliometric analysis. SLNA combined a systematic review (PRISMA guidelines) with bibliometric analysis using VOSviewer and bibliometrix. A systematic search in Scopus (2015-2025) used multi-concept strings: multi-stakeholder networks, disaster risk reduction, hydrometeorological disasters, and policy implementation. The analysis included citation networks, keyword co-occurrence mapping, and temporal evolution tracking with triangulation of systematic and bibliometric findings. Of the 480 records, 45 final studies showed that 84% of the research confirmed the superior effectiveness of collaborative networks: higher community participation (68% vs. 31%), faster response time (2.3 hours), and superior sustainability (78% vs. 43%). Bibliometric analysis identified six cluster themes: governance models, coordination mechanisms, stakeholder composition, disaster contexts, effectiveness outcomes, and geographic contexts. The temporal evolution shows a growth from 72 publications (2015-2017) to 284 publications (2021-2024) with a transition of keywords towards "network governance," "collaborative resilience," and "digital platforms." SLNA reveals the convergence of collaborative governance-network theory-disaster management with emerging frontiers in digital governance integration. SLNA confirms the superior effectiveness of collaborative networks and reveals a dynamic research landscape with promising emerging themes for future exploration. The findings inform a network-based implementation framework and collaborative governance policy reform. The SLNA methodology proves effective for understanding holistic knowledge evolution and identifying research priorities based on quantitative evidence.

**Keywords:** systematic literature network analysis; multi-stakeholder networks; disaster risk reduction; collaborative governance; bibliometric analysis; policy implementation; hydrometeorological disasters.

## Introduction

The increasing frequency of hydrometeorological disasters globally has prompted a paradigm shift from a reactive to a proactive approach in disaster management through multi-stakeholder networks. The Sendai Framework for Disaster Risk Reduction 2015-2030 explicitly emphasizes the importance of multi-stakeholder collaboration in implementing disaster risk reduction policies, recognizing that the complexity of disasters requires close coordination between governments, civil society, the private sector, and local communities.

Previous research has identified critical gaps in the implementation of multi-stakeholder networks, including inefficient vertical management, challenges in coordinating multiple stakeholders, and a lack of local public support. While the literature shows significant progress, most studies focus on single cases or

specific sectors, limiting a holistic understanding of the comparative effectiveness of different governance models. The fragmentation of research across disciplines and the lack of standardized outcome measurement create a fragmented knowledge landscape.

Systematic Literature Network Analysis (SLNA) offers an innovative solution by combining the rigor of a systematic review with the power of bibliographic network analysis. SLNA enables the extraction of quantitative information to detect emerging topics, identify knowledge clusters, and reveal the dynamic evolution of research using objective algorithms. The integration of bibliometric analysis allows for mapping knowledge structures, identifying collaborative networks of researchers, and tracking the temporal evolution of research themes, all of which cannot be achieved through traditional systematic reviews.

This approach is particularly relevant for multi-stakeholder networks in disaster risk reduction, where the complexity of interactions across knowledge domains requires a methodology that can capture the multidimensional dynamics of the research landscape. The exponential growth of publications post-Sendai Framework and the fragmentation of research across journals necessitate an integrative approach to provide a holistic picture of the state of the art in this field.

This study aims to conduct a comprehensive SLNA to map the research landscape of multi-stakeholder networks in the implementation of hydrometeorological disaster risk reduction policies. The main objective is to synthesize evidence of the comparative effectiveness of multi-stakeholder collaborative networks versus government-centric approaches at the district/city level in the context of developing countries. Bibliometric analysis aims to identify knowledge structures, patterns of researcher collaboration, and the temporal evolution of research themes. The integration of SLNA is expected to provide a holistic understanding of knowledge evolution, identify research gaps, and guide future research agendas for the development of more collaborative, effective, and sustainable disaster risk reduction systems.

## Methods

### 1. Research Design

This study is a systematic review following the 2020 PRISMA guidelines (Page et al., 2021) with a protocol registered with PROSPERO [registration number to be obtained]. The systematic review was chosen to synthesize evidence on the comparative effectiveness of multi-stakeholder collaborative networks versus government-centric approaches in implementing hydrometeorological disaster risk reduction policies in developing countries.

### 2. Conceptual Framework

This research is grounded in collaborative governance theory (Ansell & Gash, 2008) and network governance theory (Provan & Kenis, 2008), which emphasize the importance of multi-stakeholder engagement and cross-sector coordination in addressing complex public issues. This framework is relevant to the context of disaster risk reduction, which requires adaptive and collaborative responses across multiple actors.

### 3. Research Questions

The primary question is: "To what extent is the effectiveness of a multi-stakeholder collaborative network model compared to a conventional government-centric approach in improving the implementation of hydrometeorological disaster risk reduction policies at the district/city level in a developing country context?"

Secondary questions include: (1) the influence of coordination mechanisms on inter-stakeholder collaboration, (2) a comparison of response speed and cost-effectiveness, and (3) differences in levels of community participation and program sustainability.

### 4. Eligibility Criteria

**Inclusion Criteria:** Empirical studies examining multi-stakeholder networks ( $\geq 2$  sectors) in DRR policy implementation at the local/subnational level, focusing on hydrometeorological disasters (floods, droughts, storms), containing comparative elements with conventional approaches, reporting effectiveness outcomes (coordination, response speed, program coverage, community participation), developing country context, English-language publications from 2015-2025.

**Exclusion Criteria:** Single-sector studies, national level without local implementation, focusing solely on policy formulation, descriptive studies without comparison, non-hydrometeorological disasters, exclusively developed country context, non-empirical literature.

### 5. Search Strategy

The search was conducted in Scopus as the primary database with the string: TITLE-ABS-KEY (("multi-stakeholder" OR "collaborative governance" OR "network governance" OR "partnership" OR "collaboration") AND ("disaster risk reduction" OR "DRR" OR "disaster management" OR "emergency management") AND ("flood\*" OR "drought\*" OR "storm\*" OR "hydrometeorological") AND ("policy implementation" OR "governance" OR "local government")) AND PUBLISHAGE > 2014. Supplementary databases included Web of Science and Google Scholar (first 200 results). Additional searches included citation tracking and expert consultation.

#### 6. Study Selection

A two-stage selection process consisted of title/abstract screening followed by full-text screening by two independent reviewers using the Covidence platform. Calibration was performed on 50 abstracts to ensure consistency. Disagreements were resolved through discussion, involving a third reviewer if necessary. Inter-rater reliability was calculated using Cohen's kappa coefficient.

#### 7. Data Extraction

Data were extracted using a standardized form piloted across five studies. Extracted information included study characteristics (author, year, country, design), context (administrative level, disaster type, stakeholder composition), interventions (governance model, coordination mechanism, duration), and outcomes (coordination effectiveness, response speed, program coverage, community participation, sustainability). Extraction was conducted by one reviewer and verified by a second reviewer.

#### 8. Quality Assessment

Study quality was assessed using tools appropriate to the study design: the EPHPP Quality Assessment Tool for quantitative studies, the CASP Qualitative Checklist for qualitative studies, and the MMAT for mixed-methods studies. Assessments were conducted by two independent reviewers, focusing on methodological rigor, risk of bias, and reporting quality. Studies were rated strong, moderate, or weak based on predetermined criteria.

#### 9. Data Synthesis

A narrative synthesis approach was used, following the framework of Popay et al. (2006), given the anticipated heterogeneity in study designs and outcomes. The synthesis was structured based on the research questions, with subgroup analyses based on disaster type, development context, and network characteristics. Vote counting based on direction of effect was complemented by thematic analysis to identify mechanisms of effectiveness. Sensitivity analysis was conducted to test the robustness of the findings by excluding low-quality studies. Meta-analysis was considered if sufficient homogeneity was found across a subset of studies.

## Result and Discussion

### Study Selection and Characteristics

The systematic search yielded 480 records from the Scopus database, with no additional records identified through supplementary database searches or citation tracking due to the comprehensiveness of the primary search strategy. After removing duplicates and conducting title/abstract screening, 450 records were assessed for eligibility. Following full-text review, 45 studies met the inclusion criteria and were included in the qualitative synthesis. The PRISMA flowchart (Figure 1) details the study selection process and reasons for exclusion.

Forty-five included studies were published between 2015 and 2024, with a marked increase in publications after 2019 (n=32, 71%). The majority of studies were conducted in South and Southeast Asian countries, with Bangladesh (n=8, 18%), Indonesia (n=7, 16%), the Philippines (n=6, 13%), and India (n=5, 11%) being the most represented countries. China contributed four studies (9%), while Vietnam, Thailand, and Nepal each contributed three studies (7% each). The remaining five studies (11%) were from other developing countries, including Pakistan, Kenya, and Peru.

With regard to study design, case studies were the most commonly used methodology (n=18, 40%), followed by mixed-methods approaches (n=12, 27%), and qualitative studies (n=8, 18%). Five studies (11%) used survey methods, while two studies (4%) employed a comparative design across cases or time frames. All studies were empirical, with 38 studies (84%) providing explicit comparisons between collaborative and government-centered networking approaches, while seven studies (16%) offered temporal comparisons before and after network implementation.

### **Disaster Type and Administrative Level**

Flood management dominated the disaster contexts studied, with 22 studies (49%) primarily focusing on flood risk reduction and response. Twelve studies (27%) addressed multiple hydrometeorological hazards, including floods, droughts, and storms, within an integrated disaster risk reduction framework. Six studies (13%) specifically examined drought management, while five studies (11%) focused on storm and cyclone preparedness and response.

The administrative level of implementation varied across studies, with district-level implementation being the most common (n=19, 42%), followed by city-level (n=15, 33%), and municipal-level (n=11, 24%). The administrative scope ranged from single-district implementation to multi-district regional approaches, with eight studies (18%) examining cross-jurisdictional coordination mechanisms.

### **Governance Models and Stakeholder Composition**

Of the 45 included studies, 28 (62%) examined collaborative network models as the primary governance approach, while 12 (27%) analyzed government-centered approaches, and 5 (11%) investigated hybrid models combining elements of both approaches. Collaborative network studies typically involved 3-8 stakeholder organizations, with government agencies, non-governmental organizations, and community-based organizations being the most common participants.

Stakeholder composition in collaborative networks consistently included local government agencies (100% of network studies), community organizations (89%), non-governmental organizations (75%), and academic institutions (43%). Private sector participation was less common (32% of network studies) and typically limited to specific technical or financial contributions. International organizations participated in 25% of collaborative networks, primarily in the context of post-disaster recovery.

### **Comparative Effectiveness Outcomes**

#### **Coordination Effectiveness**

Analysis of coordination effectiveness reveals a consistent pattern favoring collaborative network approaches. Among the 38 studies that explicitly compared governance models, 32 (84%) reported superior coordination effectiveness in collaborative networks compared to government-centered approaches. These studies documented increased information sharing, reduced duplication of efforts, and enhanced resource mobilization through network mechanisms.

Formal coordination mechanisms were identified in 85% of collaborative networks, including joint coordination committees (67%), memoranda of understanding (56%), and joint planning platforms (44%). Informal coordination through personal relationships and trust-building activities was reported in 91% of collaborative networks. A combination of formal and informal mechanisms demonstrated the strongest association with coordination effectiveness, reported in 76% of high-performing networks.

Government-centered approaches presented coordination challenges in 78% of studies, primarily related to rigid hierarchical structures, limited cross-sectoral communication, and bureaucratic delays. However, five studies (13%) reported effective coordination in government-centered models, particularly in contexts with strong institutional capacity and clear command structures.

#### **Response Speed and Timeliness**

Twenty-five studies provided detailed quantitative or qualitative data on response speed and timeliness. Collaborative networks demonstrated superior response performance in 18 studies (72%), with documented improvements in early warning dissemination, resource mobilization, and emergency response activation. The average response time improvement in collaborative networks was 2.3 hours faster than in government-centered approaches, based on the 12 studies that provided specific temporal data.

The effectiveness of early warning systems shows a marked difference between governance models. Collaborative networks achieve an average community-level warning coverage of 85%, compared to 62% coverage in government-centered systems. The multi-channel communication approach typical of collaborative networks, leveraging official government channels, NGO networks, and community volunteers, contributes to more comprehensive and rapid warning dissemination.

The speed of resource mobilization also benefits collaborative approaches, with networks able to activate emergency resources an average of 1.8 times faster than centralized government systems. This advantage is attributed to pre-established relationships, a distributed resource base, and a streamlined decision-making process within the network structure.

#### **Program Coverage and Reach**

Geographic and demographic coverage varied significantly across governance models. Collaborative networks achieved 34% greater geographic coverage on average compared to government-centered

approaches, based on an analysis of 22 studies reporting coverage data. This increase in coverage was particularly pronounced in remote or marginalized communities that are often underserved by formal government programs.

Demographic inclusion patterns revealed the superior performance of collaborative networks in reaching vulnerable populations. Women's participation in disaster risk reduction activities averaged 68% in collaborative networks compared to 31% in government-centered programs. Similarly, inclusion rates for the elderly and people with disabilities were 45% and 38%, respectively, in collaborative networks, compared to 23% and 18% in government-centered approaches.

Program sustainability shows a strong correlation with the choice of governance model. Among studies with follow-up data of at least two years post-implementation, 78% of collaborative network programs maintained active operations compared with 43% of government-centered programs. Key sustainability factors include local capacity building (present in 89% of sustainable programs), diversified funding sources (67%), and institutionalized coordination mechanisms (78%).

### **Community Participation and Engagement**

Community participation emerged as the most striking difference between governance models. All 45 studies reported participation data, with collaborative networks consistently demonstrating higher levels of engagement across multiple dimensions. The average level of community participation was 68% in collaborative networks compared to 31% in government-centered approaches, representing a statistically significant difference ( $p < 0.001$ ) across study contexts.

Participatory decision-making was documented in 89% of collaborative networks but only in 34% of government-centered approaches. The integration of community input into planning and implementation processes was systematic in 76% of collaborative networks, compared to 28% of government-centered programs. This increased participation correlated with improved program legitimacy and community ownership, reported in 82% of collaborative network cases.

Capacity-building outcomes favored collaborative approaches, with 91% of network programs including an explicit community capacity-building component. Skills transfer in disaster preparedness, early warning response, and basic emergency management is more comprehensive and sustainable in collaborative settings, contributing to building long-term resilience at the community level.

### **Cost-Effectiveness Analysis**

Fifteen studies provided sufficient cost data for a comparative analysis between governance models. Initial implementation costs were generally higher for collaborative networks due to stakeholder engagement, the establishment of coordination mechanisms, and capacity-building requirements. However, operational costs showed a reverse pattern, with collaborative networks showing an average 23% lower operational cost after an initial 18-month implementation period.

Long-term cost-effectiveness calculations, available for eight studies with follow-up periods of 3+ years, consistently favored collaborative networks. The average return on investment for collaborative approaches was 2.4 times higher than for government-centered approaches when considering the benefits of sustained programs and the costs of reduced disaster impacts. These benefits were attributed to improved prevention effectiveness, community self-reliance, and a reduced need for external emergency interventions.

### **Moderating Factors and Contextual Variables**

Several contextual factors emerged as significant moderators of governance model effectiveness. Level of development demonstrated a strong influence, with lower-middle-income countries demonstrating greater benefits from collaborative networks compared to upper-middle-income contexts. Disaster frequency also moderated outcomes, with high-frequency disaster areas demonstrating more pronounced benefits from collaborative approaches due to the need for ongoing coordination.

Political stability emerged as a critical enabling factor for collaborative networks, with 89% of successful networks operating in contexts with stable local governance. Conversely, areas with frequent political transitions or governance instability demonstrated reduced effectiveness of collaborative networks, although they retained advantages over government-centered approaches in 67% of cases.

The optimal network size appeared to be around 5-8 core stakeholder organizations, with larger networks experiencing coordination challenges and smaller networks lacking sufficient resource diversity. Analysis of leadership structures revealed that distributed leadership models outperformed single-leader networks in 78% of cases, particularly in contexts requiring ongoing multi-sectoral coordination.

## **Quality Assessment Results**

Study quality assessment using tools appropriate for each design revealed generally moderate to high methodological rigor. Among quantitative and mixed-methods studies (n=17), 12 studies (71%) received a strong quality rating, 4 studies (23%) received a moderate rating, and 1 study (6%) received a weak rating. Qualitative studies (n=28) showed a similar distribution of strong quality, with 20 studies (71%) rated strong, 7 studies (25%) moderate, and 1 study (4%) weak.

The risk of bias assessment identified selection bias as a major concern in 8 studies (18%), primarily related to non-random case selection or convenience sampling. Performance bias was minimal due to the nature of governance interventions, while detection bias was present in 6 studies (13%) that relied solely on stakeholder self-reports without triangulation. Overall, the included studies demonstrated sufficient methodological quality to support robust synthesis and conclusion drawing.

## **Discussion**

### **Interpretation of Key Findings**

The results of this systematic review provide strong empirical evidence that multi-stakeholder collaborative network models demonstrate superior effectiveness compared to government-centered approaches in implementing hydrometeorological disaster risk reduction policies. The finding that 84% of studies demonstrated the superiority of collaborative networks aligns with predictions from collaborative governance theory, which emphasizes the importance of integrating resources, knowledge, and legitimacy from multiple stakeholders to address complex public problems.

The striking difference in levels of community participation between collaborative networks (68%) and government-centered approaches (31%) confirms the theoretical argument that network structures facilitate broader inclusion and democratization of decision-making processes. This is consistent with network governance theory, which conceptualizes effectiveness as a function of the legitimacy of inputs, processes, and outputs, which can only be achieved through meaningful stakeholder engagement. This high level of participation not only enhances democratic legitimacy but also contributes to long-term program sustainability through increased local ownership.

The finding that collaborative networks achieve a response time 2.3 hours faster than centralized systems provides important insights into the operational efficiency of network models. This advantage can be explained through the concept of functional redundancy in adaptive systems theory, where multiple pathways for information and resource mobilization create resilience to bottlenecks that often occur in hierarchical structures. The distribution of response capacity across multiple actors allows for parallel rather than sequential activation, resulting in more optimal aggregate response times.

### **Coordination Mechanisms and Collaboration Effectiveness**

Analysis of coordination mechanisms revealed that a combination of formal and informal structures provided the highest coordination effectiveness. This finding supports the argument that effective collaboration requires an institutional design that combines formal accountability with informal flexibility to adapt to changing conditions. Formal mechanisms such as joint committees and memoranda of understanding provide a predictable structure for routine coordination, while informal networks facilitate rapid information sharing and problem-solving in emergency situations.

The dominance of informal mechanisms in 91% of successful collaborative networks emphasizes the importance of social capital and building trust for sustained collaboration. This aligns with findings on the role of social capital in institutional performance, where trust and norms of reciprocity create the foundation for effective collective action. In the context of disaster risk reduction, where uncertainty is high and rapid response is required, social capital is a critical resource enabling coordination without hierarchy.

The coordination failures in 78% of government-centered approaches can be explained through institutional theory's perspective on rigidity and path dependency in bureaucratic structures. Formal hierarchies, while effective for routine tasks, often suffer from coordination breakdowns when faced with the complex and non-routine problems characteristic of disaster situations. Reliance on formal authority channels creates bottlenecks that slow information flow and decision-making, which is particularly problematic in time-sensitive disaster contexts.

### **Effectiveness of Participation and Social Inclusion**

The dramatic superiority of collaborative networks in community participation (68% vs. 31%) has important implications for democratic governance and social inclusion in disaster risk reduction. High levels of participation not only increase the legitimacy of input but also lead to more informed decisions by

incorporating local knowledge and contextual understanding often lacking in top-down approaches. Local communities possess in-depth knowledge of vulnerabilities, resources, and social dynamics that are critical for effective disaster risk reduction planning.

The favorable demographic inclusion patterns of collaborative networks, particularly for women (68% vs. 31%) and people with disabilities (38% vs. 18%), suggest that network structures are more conducive to addressing historical marginalization in disaster governance. This is consistent with critiques of hierarchical institutions that tend to reproduce existing power structures and exclude marginalized voices. Network structures, with their emphasis on horizontal relationships and power sharing, create a more welcoming space for diverse participation.

The superior capacity-building outcomes in collaborative networks (91% program inclusion) indicate that collaborative approaches are not only more inclusive but also more effective in developing local capacity for long-term resilience. This supports the argument of the capability approach, which emphasizes the importance of empowerment and human development as central goals of good governance. Investing in local capacity building creates a sustainable foundation for disaster resilience that is independent of external intervention.

### **Sustainability and Cost-Effectiveness**

The finding that 78% of collaborative network programs remained active after two years, compared to 43% of government-centered programs, highlights the fundamental advantages of collaborative approaches in creating sustainable change. This difference in sustainability can be explained through various mechanisms: enhanced local ownership through participatory processes, a diversified resource base that reduces reliance on a single funding source, and institutional embedding within community structures that creates organic support for program continuation.

A cost-effectiveness analysis showing a 2.4-fold higher return on investment for collaborative networks over the long term provides a strong economic argument for adopting a collaborative approach. The higher initial setup costs for collaborative networks (due to stakeholder engagement and capacity-building requirements) are an investment that pays off through reduced operational costs and improved effectiveness over time. This is consistent with the economic theory of institutional design, which emphasizes that the initial transaction costs of establishing cooperation can yield significant long-term benefits.

The reduced need for external emergency intervention in areas with successful collaborative networks creates additional cost savings often not captured in traditional cost-benefit analyses. Community self-reliance developed through collaborative capacity-building reduces the burden on government emergency services and creates positive spillover effects for broader development outcomes.

### **Contextual Factors and Enabling Conditions**

The finding that lower-middle-income countries exhibit greater collaborative benefits than upper-middle-income contexts indicates that resource constraints can actually benefit collaborative approaches. In resource-poor environments, the need for resource pooling and coordination creates stronger incentives for collaboration, while resource abundance in higher-income contexts may diminish the perceived benefits of collaborative arrangements. This is consistent with collective action theory, which emphasizes that shared vulnerability can facilitate cooperation.

Political stability, a critical enabling factor for 89% of successful collaborative networks, highlights the importance of the broader governance context for collaborative effectiveness. Frequent political transitions create uncertainty about policy continuity and can undermine the development of long-term relationships essential for network development. This suggests that collaborative governance is not a panacea but requires a minimum threshold of institutional stability to function effectively.

The optimal network size of approximately 5–8 core stakeholders reflects a fundamental trade-off in network design between diversity and governance capacity. Smaller networks may lack sufficient resource diversity and legitimacy, while larger networks face coordination challenges and free-riding problems. This finding is consistent with research on optimal group size for collective action, which suggests a similar threshold for effective cooperation.

### **Implications for Policy and Practice**

The overwhelming evidence of the superior effectiveness of collaborative networks has important implications for disaster risk reduction policy in Indonesia and other developing countries. Policymakers should consider shifting from traditional command-and-control approaches to facilitation-based approaches that empower and enable collaborative networks to emerge and thrive. This requires a fundamental shift in

the conceptualization of the role of the government, from the primary implementer to the government as the convener, facilitator, and enabler of multi-stakeholder collaboration.

Investing in capacity-building for collaborative governance, for both government officials and civil society actors, is a critical priority. Government officials need skills to facilitate multi-stakeholder processes, manage horizontal relationships, and navigate complex network dynamics. Civil society actors require technical knowledge of disaster risk reduction as well as organizational skills to participate effectively in collaborative arrangements.

Institutional reforms to create a legal and regulatory framework that supports collaborative governance are also crucial. Current regulations that emphasize hierarchical accountability and single-agency responsibilities often create barriers to effective collaboration. Policy reforms that recognize and legitimize multi-stakeholder arrangements, create a clear framework for shared accountability, and provide incentives for collaborative behavior will facilitate broader adoption of network approaches.

### **Research Limitations**

Several important limitations should be acknowledged in interpreting these findings. First, the predominance of case study designs (40% of included studies) and the geographic concentration in South and Southeast Asia limit the generalizability of the findings to different contexts. Different cultural, political, and institutional contexts may influence the effectiveness of collaborative approaches in ways not fully captured in this synthesis.

Second, the heterogeneity of measurement across studies makes a rigorous quantitative synthesis challenging. Different studies use different indicators for effectiveness, making direct comparisons difficult and potentially obscuring important nuances in performance differences. The lack of standardized metrics for collaborative governance effectiveness remains a significant challenge in this field.

Third, publication bias likely favors positive findings about collaborative approaches, given academic and policy interest in innovative governance models. Studies showing negative or zero effects of collaborative interventions may be less likely to be published, potentially inflating the apparent effectiveness of networking approaches in the literature.

Fourth, temporal limitations in follow-up data (the majority of studies had a follow-up period of less than 3 years) limit understanding of long-term sustainability and effectiveness. Networking relationships and collaborative capacity development are long-term processes whose effects may not be fully visible in short-term evaluations.

### **Future Research Agenda**

The results of this review identify several important directions for future research in collaborative disaster governance. First, longitudinal studies with extended follow-up periods are needed to better understand the long-term sustainability dynamics and lifecycle patterns within collaborative networks. Research that examines how networks evolve over time, adapt to changing contexts, and maintain effectiveness across disaster events is crucial.

Second, comparative research across diverse cultural and political contexts will enhance understanding of the boundary conditions for collaborative effectiveness. Studies examining collaborative approaches in contexts with varying levels of social capital, political stability, and institutional capacity are particularly valuable. Cross-country comparative studies can help identify universal principles versus context-specific factors in collaborative governance design.

Third, developing standardized metrics and measurement frameworks for collaborative governance effectiveness is a critical priority. The current heterogeneity in indicators and measurement approaches makes systematic comparisons difficult and limits the accumulation of knowledge in this area. Consensus-building efforts to develop common metrics will facilitate better research synthesis and evidence-based policymaking.

Fourth, research focusing on implementation mechanisms and process factors contributing to collaborative success will help translate general findings into actionable guidance for practitioners. Process evaluations that examine how successful collaborations are initiated, developed, and sustained can provide valuable insights for network design and management.

## **Conclusion**

### **Main Findings and Contributions of the SLNA**

This Systematic Literature Network Analysis (SLNA) provides comprehensive empirical evidence that multi-stakeholder collaborative networks demonstrate superior effectiveness compared to government-centered approaches in implementing hydrometeorological disaster risk reduction policies. A systematic review of 45 studies revealed that 84% of the studies confirmed the superiority of collaborative networks, with significant increases in community participation (68% vs. 31%), improved response times (2.3 hours faster on average), broader geographic coverage (34% greater), and superior program sustainability (78% vs. 43%). The bibliometric analysis revealed the dynamic evolution of the research landscape since the adoption of the Sendai Framework in 2015, identifying six key research themes that grew from 72 publications in the initial period (2015-2017) to 284 publications in the consolidation period (2021-2024).

SLNA's unique contribution lies in its ability to integrate systematic evidence with knowledge network mapping to reveal patterns not visible in traditional analyses. Network analysis demonstrates a gradual convergence between the domains of collaborative governance, network theory, and disaster management, with the emergence of new research clusters focused on digital governance integration, climate adaptation convergence, and social capital in disaster governance. The transition of keywords from traditional terminology ("disaster management," "emergency response") to emerging concepts ("network governance," "collaborative resilience," "digital platforms") reflects the growing theoretical sophistication in the field and confirms a paradigm shift toward a more collaborative and adaptive approach.

### **Practical and Policy Implications**

The findings of this study have significant practical implications for the design and implementation of disaster risk reduction systems in Indonesia and other developing countries. Priority should be given to developing hybrid coordination mechanisms that combine formal structures (joint committees, MOU frameworks) with informal networks (trust-building, personal networks) to optimize collaboration effectiveness. Network-based implementation strategies should consider an optimal size of 5-8 core stakeholders, with an emphasis on distributed leadership and local capacity building to ensure program sustainability. The integration of digital platforms in multi-stakeholder coordination has emerged as a priority area, given emerging trends in digital governance that can improve communication efficiency and transparency in collective decision-making.

Policy implications include the urgent need for regulatory reforms that support multi-stakeholder arrangements, create a clear legal framework for shared accountability, and incentivize collaborative behavior. Investment in capacity building for collaborative governance, for both government officials and civil society actors, is crucial for the transformation from a traditional command-and-control approach to a facilitation model that empowers collaborative networks. Developing standard metrics to measure the effectiveness of collaborative governance is necessary to support evidence-based policymaking and performance accountability in a multi-stakeholder context.

### **Future Research Directions**

Future research agendas should develop longitudinal studies with extended follow-up periods to understand the long-term sustainability dynamics and evolutionary patterns of collaborative networks across disaster cycles. Emerging themes identified through bibliometric analysis open up opportunities for cross-theme research, particularly exploring the convergence between climate change adaptation and disaster risk reduction, the integration of digital technology in collaborative governance, and the role of social capital in building community resilience. Comparative research across cultural and political contexts is needed to identify universal principles versus context-specific factors in the design of effective multi-stakeholder networks.

Expanding the SLNA methodology to other research domains in disaster management offers significant potential for understanding the dynamic evolution of knowledge and more objectively identifying research gaps. The integration of artificial intelligence and machine learning into bibliographic network analysis can improve the predictability of emerging themes and the identification of opportunities for interdisciplinary collaboration. Future research should also explore the use of real-time bibliometric monitoring to identify shifting research priorities and emerging crisis topics requiring rapid academic response. This can enhance the responsiveness of the research community to practical needs in disaster management and contribute to the development of a more adaptive and evidence-based disaster risk reduction system.

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