

Factors influencing community flood resilience: Delphi insights

Item Type	Conference contribution
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Citation	Olatunji, E., Pathirage, C., Proverbs, D., Suresh, S. and Ekundayo, O. (2025) Factors influencing community flood resilience: Delphi insights, in Subashini, S., Pillai, P. & Morgan, J. (eds.) Beyond Futures - Festival of Research & Innovation 2025. Wolverhampton, University of Wolverhampton, pp. 300-307.
Publisher	University of Wolverhampton
Download date	2026-04-14 06:20:13
License	https://creativecommons.org/licenses/by-nc-nd/4.0/
Link to Item	https://wlv.openrepository.com/handle/2436/626084

B11: Factors Influencing Community Flood Resilience: Delphi Insights

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Abstract

Purpose

This research sought out to develop valid indicators influencing community flood resilience (CFR) in socially diverse communities, drawing on a combination of evidence from the body of knowledge and from a Delphi process involving key flood risk stakeholders.

Methodology

Recognising the conceptual ambiguity and measurement challenges surrounding resilience, the research adopts a participatory, iterative design to generate and validate meaningful indicators. A modified Delphi method was employed, beginning with a synthesis of 79 indicators across six dimensions and followed by three structured rounds involving community leaders, practitioners, and experts. The approach combined semi-structured interviews and Likert-based surveys to prioritise indicators through statistical consensus and qualitative justification.

Findings

Findings reveal 17 new indicators (See Table 2) generated from the Delphi phase 1 semi-structured interview. While consensus was achieved on majority of these new indicators, five indicators (E4, E5, G1, H1, and I2) failed to meet the consensus threshold of mean ≥ 3.0 and variance ≤ 0.9 at the Delphi phase 2. At the third and final phase, only one indicator (E5) still failed to meet the consensus requirement. The process highlighted divergent views around wealth, migration trend, and community approval, affirming the importance of local context in resilience assessment.

Originality/value

Integrating community perspectives with expert input, the research offers a replicable, co-produced approach for generating and validating CFR indicators that is both rigorous and adaptable.

Link to themes

It advances inclusive resilience planning aligned with Sustainable Development Goal 11, contributing to the broader themes of green innovation, sustainability, and socially inclusive policy design.

Keywords: Resilience, Indicators, Community, Flood Resilience, Delphi

Introduction

The increasing frequency and severity of climate-induced hazards, particularly flooding, present urgent challenges to community safety, infrastructure integrity, and long-term sustainability. Between 2000 and 2019 alone, floods constitute nearly 44% of global natural disasters, impacting 4.03 billion people and causing 1.2 million fatalities (UNDRR, 2020). As urban areas continue to grow and climate risks intensify, flood risk management strategies must address not only hazard exposure but also social vulnerability and community-level capacity to respond (Zhong et al., 2022).

Governments, policy makers, and practitioners have increasingly prioritised the development of frameworks to support community resilience (Campos et al., 2017), introducing interventions intended to mitigate or adapt to the adverse impacts of climate change (Gillard et al., 2017). However, despite a growing body of literature (Summers et al., 2017), the concept of community resilience remains elusive, with evolving interpretations and contested definitions (Manyena et al., 2019; Ogah et al., 2015). This ambiguity presents both epistemological and methodological challenges, especially in efforts to operationalise resilience within policy and research frameworks (Manyena et al., 2019). In the absence of a shared understanding or consistent means of measurement, assessing the outcomes of resilience-focused initiatives becomes difficult (Ogah et al., 2015). Without robust methods for evaluation and learning, progress in building resilience becomes inconsistent.

Various approaches have been explored to address these gaps, including participatory frameworks that enable communities and stakeholders to articulate their own understandings of resilience (Olatunji et al., 2024a, 2025). This study adopts the Delphi technique as a means of synthesising expert insights through a deliberative and iterative process. While traditionally used for forecasting and strategic foresight (Ribeiro & Quintanilla, 2015), the Delphi method is well suited to complex, multi-scalar challenges such as Community Flood Resilience (CFR) (Flood et al., 2023). By adapting the technique to include inclusive interactions, this research presents how the Delphi method can support the development of valid, context-specific indicators for assessing CFR.

Literature Review

The concept of CFR has been examined through various frameworks and methodologies, with many studies adopting a dimension- and indicator-based approach to its assessment. Olatunji et al. (2024b) identify six key dimensions often used in such assessments: infrastructural, human, environmental, economic, governance, and social. Each dimension encompasses a broad set of indicators that collectively reflect a community's ability to anticipate, withstand, and recover from flood events without obscuring the interdependencies that shape resilience in practice.

Definitions of resilience in the literature also vary widely. It is commonly regarded as a system's capacity to absorb, adapt, or transform in response to external shocks (Robinson, 2019; Glass et al., 2022). However, there is a tendency to conflate resilience with rapid recovery or 'bouncing back', which may neglect deeper structural issues or power relations that influence a community's ability to act and adapt (Chuang et al., 2018; Zhong et al., 2022). This raises concerns about whether current models sufficiently address the underlying conditions that either constrain or enable adaptive capacity. Community

resilience itself is broadly understood as the capacity of a group of people, often situated within a shared geographic location, to withstand disturbances, adapt, and transform in response to external shocks (Robinson, 2019; Glass et al., 2022). Communities that can swiftly return to normal operations after a flood and take pre-emptive actions to reduce future losses are recognised as exhibiting high resilience (Zhong et al., 2022).

Public participation is widely endorsed as a necessary component of climate adaptation and resilience planning. However, it is often treated as a procedural formality rather than a substantive element of governance. Participation tends to be confined to specific stages of the policy process- either upstream in agenda-setting or downstream in implementation- seldom spanning both (Pallett et al., 2019; Flood et al., 2023). This compartmentalisation weakens its transformative potential. Moreover, the dominant forms of engagement frequently privilege institutional or technical actors, marginalising alternative knowledge systems and community voices (Glass et al., 2022). A truly inclusive and deliberative process would require not only transparency and accessibility but also a rebalancing of power dynamics and recognition of epistemic diversity (Reed et al., 2018).

Various methodologies have been proposed to operationalise resilience indicators. Among these, the Delphi method (Alshehri et al., 2015), Analytic Hierarchy Process (Spiliotis and Skoulikaris, 2019), and Analytic Network Process (Zhang, 2017) are prominent. While these techniques offer systematic approaches to expert-based evaluation, they also risk reinforcing technocratic perspectives if not accompanied by community input. Furthermore, the reliance on expert consensus may obscure contested interpretations of resilience or overlook localised understandings. Although integrated models have improved the measurement of multi-layered community resilience systems (Parkouhi and Ghadikolaei, 2017; Jordan and Javernick-Will, 2013; Zhong et al., 2022), significant gaps remain in reconciling quantitative or qualitative rigour with the complexity of resilience.

Despite the proliferation of frameworks assessing Community Flood Resilience (CFR), a key gap remains in the contextual relevance and validity of existing indicators. Most models' use expert-defined, top-down measures, often excluding the perspectives of communities who live with flood risk. This study addresses that gap by applying a modified Delphi method that integrates expert and community insights to co-produce indicators from the outset, to generate and agree on valid CFR indicators as a way of strengthening the framework's applicability in real-world resilience planning (Olatunji et al., 2024a). The next section demonstrates how this was done while maintaining scientific rigour.

Methodology

The Delphi method is an iterative technique used to generate structured consensus on complex issues (Dalkey et al., 1969). Its anonymity, controlled feedback, and reflective rounds support rigorous co-production of frameworks and nuanced resolution of disagreements. In this research, modified Delphi technique was employed which began with literature synthesis of existing indicators (Olatunji et al., 2025). Drawing from Olatunji et al., (2024b), 79 indicators were synthesized: infrastructural (12), human (17), environmental (9), economic (12), governance (14), and social (15). A purposive sampling strategy which identified 10 participants (Table 1) covering community leaders and stakeholders. The selection emphasized interest, experience, and influence on resilience, ensuring diverse and informed inputs.

Table 1: Demographics of Participants

Participant ID	Gender	Education	Current Role	Years of Exp
Participant 001	Male	Masters	Founder / Chair of Flood Action Group	5 - 10
Participant 002	Male	Masters	Emergency Planning Lead	5 - 10
Participant 003	Female	Bachelors	Flood Engagement Officer	< 5
Participant 004	Female	PhD	FRM Research Fellow	11 - 20
Participant 005	Male	Masters	Researcher	< 5
Participant 006	Male	PhD	FRM Research Fellow	11 - 20
Participant 007	Female	Masters	Deputy Head of Water Management	> 20
Participant 008	Male	Bachelors	Area Flood Risk Team Leader	> 20
Participant 009	Female	PhD	Climate and Sustainability Consultant	11 - 20
Participant 010	Female	Bachelors	CFR Engagement Advisor	< 5

Three rounds were conducted: semi-structured interviews (Phase 1) and two online surveys (Phase 2 and 3). Before the interview, the members of the Delphi panel were sent the existing indicators from literature in advance of the interview, and this was also displayed for them to think through during the interview. The semi-structured interview covered the question:

Considering the community flood resilience dimensions and indicators displayed, are there any additional practicable/important indicators that should be included?

The survey collected 5-point Likert-scale data (Strongly Disagree to Strongly Agree- 1 to 5) which were analysed using the consensus definition. Consensus followed thresholds identified in literature, items with mean ≥ 3.0 , and variance ≤ 0.9 were retained (Keeney et al., 2011). Items with mean ≤ 3 or variance ≥ 1 were reassessed in subsequent rounds. For further reading on this participatory assessment of CFR (see Olatunji et al., 2024a, 2025).

Results And Discussion

This section covers only the findings related to the new indicators generated by the Delphi panel members. The Delphi panel consisted of an equal number of male and female participants (Table 1). After analysing the interviews, the following indicators (Table 2) were generated by the members of the Delphi panel.

Table 2: Newly Suggested Indicators during the interview (Delphi Phase 1)

Dimension	Indicator	Rationale
Economic (E1)	Availability/access to cheap credit	Availability/access to cheap credit enhances flood resilience.
Economic (E2)	Alternative livelihoods	With diversified livelihoods, community members have options when a climate-sensitive livelihood is affected by flooding.
Economic (E3)	Proximity to small retail outlets	This ensures essential supplies and services when routes to large businesses are blocked.
Economic (E4)	Financial know-how	Communities with a knowledgeable leader who can access government flood funding.
Economic (E5)	Wealthy areas	Homes valued above a certain threshold often indicate higher socio-economic status.

Governance (G1)	Community approval or satisfaction	Community satisfaction can indicate successful organizational decisions that strengthen relationships.
Governance (G2)	Clear responsibility	When communities understand each organization's responsibility, it strengthens their overall flood resilience.
Governance (G3)	Simple and Effective Reporting	Clear instructions on how to report a flood improve flood resilience.
Governance (G4)	Community Involvement	Strong two-way involvement, where community members have a voice enhances overall community resilience.
Human (H1)	Migration Trend	New migrants from outside the local area which then puts more stress on existing flood infrastructure.
Human (H2)	IT Literacy	Being able to use some digital tools and understand or interpret flood information (e.g. flood warnings) .
Infrastructure (I1)	Data Infrastructure	The presence of operational monitoring equipment like sensors that collects data needed to implement warning systems.
Infrastructure (I2)	Design standard	The return period considered during infrastructure design (e.g. flood wall) could affect its reliability during flood events.
Infrastructure (I3)	Public Services Buildings	Availability of community centres like halls and libraries enhance CFR
Social (S1)	Active community communication platform	Community platforms like WhatsApp/ Facebook help tailor flood risk information to the understanding of members.
Social (S2)	Disposable Time	Proportion of community members with some disposable time to attend multi agency and flood group meetings.
Social (S3)	Community connectedness	Connectedness between the most vulnerable and those who can support them is a key indicator of CFR.

After the Phase 1 interview, the CFR indicators were sent to the Delphi panel on a 5-point Likert scale for each member to rate. Table 3 presents the mean and variance of CFR Indicators after the first survey. At this phase, five indicators (E4, E5, G1, H1, and I2) failed to meet the consensus threshold of mean ≥ 3.0 and variance ≤ 0.9 . These were resent to panel members in the next phase using the same scale. However, this time, members were also asked to justify their ratings to add rigour and clarity on why an indicator should be excluded from the final CFR framework. Indicators that satisfied the consensus criteria were excluded from the second round to streamline the process, but they were retained for inclusion in the final CFR framework.

Table 3: Mean and Variance of CFR Indicators after the first survey (Delphi Phase 2)

Dimension	E1	E2	E3	E4	E5	G1	G2	G3	G4	H1	H2	I1	I2	I3	S1	S2	S3
Mean	3.5	3.3	3.9	4.1	3.7	4.1	4.8	4.8	4.7	3.5	4.4	4.7	4.1	4.3	4.5	4.4	4.1
Variance	0.9	0.9	0.5	1.0	1.8	1.0	0.2	0.2	0.2	1.2	0.3	0.2	1.0	0.5	0.3	0.3	0.5

Table 4 presents the mean and variance of CFR Indicators after the second survey. At this stage, only one indicator (E5) still failed to meet the consensus requirement of mean ≥ 3.0 , after which the study was concluded.

Table 4: Mean and Variance of CFR Indicators after the second survey (Delphi Phase 3)

Dimension	E4	E5	G1	H1	I2
Mean	4.10	3.90	4.00	3.70	4.10
Variance	0.30	1.20	0.90	0.50	0.30

Participant 005 was the only respondent to highlight financial literacy (E4), linking it to household income and broader economic resilience. This suggests that financial know-how- though often overlooked- may be a critical soft skill in enhancing adaptive capacity, especially in low-income settings. Regarding migration trend (H1), responses were mixed. Participant 005 viewed migration as potentially enriching communities or overburdening infrastructure if unplanned, while Participant 001 dismissed its relevance due to lack of direct experience. The divergent views point to the context-dependent nature of this indicator and the importance of local policy readiness.

Design standards (I2) prompted similarly contrasting perspectives. Participant 005 emphasized how poor infrastructure design directly increases vulnerability to flooding, whereas Participant 001 argued that even well-designed structures can fail without routine maintenance. This contrast reveals that resilience depends not only on engineering quality but also on continuous operational oversight. Community approval (G1) was broadly dismissed as a weak indicator. Participant 009 questioned its relevance, and Participant 002 saw no influence on resilience, suggesting that approval metrics may reflect unrelated indicators. Meanwhile, Participant 005 also pointed out that wealthier communities (E5) are generally more flood-resilient due to stronger economic buffers. Despite aligning with wider resilience literature, "wealthy areas" was the only newly generated indicator dropped for lack of consensus- unlike others that were retained and integrated into the framework. Collectively, these insights highlight the importance of both structural and socio-economic dimensions in assessing and enhancing CFR.

Conclusion

This research addressed a critical gap in Community Flood Resilience (CFR) research: the lack of context-sensitive and community-validated indicators within existing assessment frameworks. Integrating both stakeholder and community perspectives through a modified Delphi approach, the study developed a co-produced set of indicators that better reflect the complex social, infrastructural, and economic realities influencing resilience. While consensus was reached on most indicators, variations in perspectives on issues such as wealth and community approval highlighted the need for adaptable frameworks that respond to local conditions. Despite methodological challenges, including time intensity, the study successfully achieved its objective of generating a robust, participatory indicator set. These findings provide a practical tool for enhancing local flood resilience planning and offer a foundation for future research focused on operationalising resilience in diverse, at-risk communities.

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