Infrastructure climate change resilience: a review of resilience assessment frameworks

Introduction: Research overview

The study highlights the importance of developing a practically applicable, multi-scale, multi-hazard, forecasting-based framework for infrastructure resilience in the face of climate change. It examines whether existing frameworks, or elements of them, can be used as or combined into a holistic resilience assessment framework (RAF).

Why the research is needed?

Infrastructure systems in the UK (and globally) are increasingly vulnerable to climate change hazards such as floods, storms, droughts, heat, and sea level rise. Existing RAFs are fragmented, most focus on one scale (site, community, city, or national) or one sector, and do not account for interdependencies between infrastructure systems.

The UK Government, NIC, and National Resilience Strategy (NRS) call for resilience standards that anticipate shocks, drive adaptation, and reduce risks of cascading infrastructure failures. Without a holistic RAF, adaptation may result in overcapitalisation, resource overconsumption, or maladaptation.

Research questions

1. Do any existing resilience frameworks, or components of them, meet the requirements set out by the NIC, MOD, and NRS for infrastructure climate change resilience?
2. Can existing RAFs be combined or adapted into a holistic, practically applicable framework capable of cross-scale, multi-hazard forecasting?
3. What gaps in the literature and practice remain, and what components are available as building blocks for a new framework?

Methodology

Approach: Scoping review with Thematic Analysis.

Data sources:
Academic databases (Google Scholar, Scopus), RAF taxonomies (Resilience Toolbox, Sustainable Infrastructure Tool Navigator), grey literature, and industry practice.

Inclusion criteria:
RAFs addressing climate change-related hazards and resilience across economic, social, and environmental infrastructure.

Exclusion criteria:
Frameworks unrelated to climate change (e.g., earthquakes, volcanic eruptions).

Analysis method:
Thematic analysis to categorise RAFs into seven typologies (academic, government, NGO, industry standards, financial models, industry-led tools, international development tools).

Evaluation dimensions:
Scale of application (national, city, community, site), hazard scope (single/multi-hazard), orientation (formative vs. summative), and whether frameworks assess resilience retrospectively (ex-ante) or forecast future resilience (ex-post).

Results

No existing framework meets the NIC's requirements for a dynamic, multi-scale, multi-hazard, forecasting-based RAF.

110 frameworks were reviewed, and many valuable components were identified.

The research identified the following gaps:

1. Lack of integration across scales (site, community, regional, national).
2. Weak treatment of infrastructure interdependencies ("panarchy" issues).
3. Heavy reliance on either theoretical academic models (hard to apply) or narrowly focused industry tools (too specific).
4. No agreed benchmark or universal standard for resilience.
5. Existing frameworks are often sector-specific, location-limited, or temporally static.

Conclusion

A holistic, dynamic, multi-scale, and forecasting-based resilience assessment framework does not yet exist, but components identified in current RAFs could serve as building blocks for developing such a tool, which is urgently needed to meet national and global climate resilience goals.

Find out more about the research by reading the full article here.

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