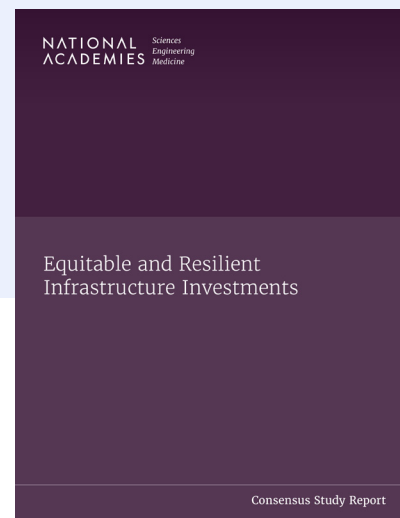


Equitable and Resilient Infrastructure Investments

Communities across the United States are experiencing increased human and financial impacts from disasters caused by extreme weather events and other natural hazards. These events are amplified in frequency and intensity by climate change. According to the National Oceanic and Atmospheric Administration, there were 20 weather disaster events in 2021 with losses exceeding \$1 billion each, and 323 weather and climate disasters, including wildfires and drought, since 1980 in which overall damage and costs reached or exceeded \$1 billion each. While media coverage sometimes paints these disasters as affecting rich and poor alike and suggests that natural disasters do not discriminate, the reality is that they do. As reiterated at the National Academies of Sciences, Engineering, and Medicine (the National Academies) March 17, 2022, workshop, there have been decades of discriminatory policies, practices, and embedded bias within infrastructure planning processes.¹ Among the sources of these policies and practices are the agencies that promote resilience and provide hazard mitigation and recovery services, and the funding mechanisms they employ. These practices have resulted in low-income communities, often predominantly Indigenous people and communities of color, bearing a disproportionate share of the social, economic, health, and environmental burdens caused by extreme weather and other natural disasters. It remains unclear which research strategies can ensure that infrastructure investments help increase resilience and improve equitable decision-making—and do not inadvertently impact—vulnerable and disadvantaged communities.

¹ For further information about the workshop see: <https://www.nationalacademies.org/event/03-17-2022/hazard-mitigation-and-resilience-applied-research-topics-workshop-1-equitable-and-resilient-infrastructure-investments>



The Resilient America Program of the National Academies convened two committees on applied research topics for hazard mitigation and resilience to assist the Federal Emergency Management Agency (FEMA) in reducing the immense human and financial toll of disasters caused by natural hazards and other large-scale emergencies. FEMA asked the National Academies committees to identify applied research topics, information, and expertise that can inform action and collaborative priorities within the natural hazard mitigation and resilience fields.

APPLIED RESEARCH TOPICS FOR HAZARD MITIGATION AND RESILIENCE

The 2021–2022 committee, convened by the Resilient America Program, selected two largescale themes within which to identify applied research topics. This year’s themes are Equitable and Resilient Infrastructure Investments, and Compounding and Cascading Events. Two workshops were planned for these two themes to gather information for identifying priority applied research topics.

On the theme of Equitable and Resilient Infrastructure Investments the committee chose three applied research topics as being particularly important for natural hazard mitigation and resilience, especially in motivating local action to address climate impacts and build resilience:

1. Partnerships for equitable infrastructure development,
2. Systemic change toward resilient and equitable infrastructure investment, and
3. Innovations in finance and financial analysis.

The committee selected these topics based on information gained from a one-day public workshop, which took place on March 17, 2022, as well as committee members’ backgrounds and experience with hazard mitigation and resilience.

I. Partnerships for Equitable Infrastructure Development

Targeted equitable public infrastructure investments can generate enormous community benefits in terms of reducing disparities in the quality of and access to services before and after hazard events. Based on this, the committee identified two areas of research that would improve equitable community involvement:

1. Partnerships for knowledge transfer and promoting action research

Based on the presentations, examples, and research opportunities discussed in the workshop, as well as on discussions with the Resilient America Roundtable and among the committee members, the following applied research questions were identified regarding partnerships for knowledge transfer and promoting action research for equitable infrastructure services and access:

- How can applied research on resilient and equitable infrastructure services and access be advanced by using participatory action research concepts and principles where the process begins and ends with local communities?
- What are compensation models that value local expertise and how can they be modified to enable greater community participation by those affected by inequitable infrastructure services and access so as not to create additional undue burden on marginalized community members?
- How can community-to-community knowledge transfer of resilience and equity assessment and planning processes for infrastructure services be facilitated?
- What institutional processes would better enable community members to participate in action research?
- What mechanisms would ensure that community input and public participation in action research is actively reflected in equitable and resilient

infrastructure planning and development rather than just “heard” and how can we verify/validate the success of such processes and mechanisms?”

2. Building trust to enable productive and equitable community participation

The committee identified the following applied research questions pertaining to trust as it related to equitable and resilient infrastructure development based on the workshop:

- What role does trust play in the development and provision of resilient and equitable infrastructure?
- What role does trust play in the recovery of functions and services of resilient and equitable infrastructure?
- What strategies and tactics can be deployed at the institutional level to regain and grow trust where it has been frayed, especially during times of change resulting from stressors and acute disruptive events?

II. Systemic Change Toward Resilient and Equitable Infrastructure Investment

Inequity can be hard-wired into mature and stable institutions, such as federal and state agencies, city officials, public planners, and the entities that develop infrastructure. Too often, however, institutions do not recognize they have a problem, and even when they do, they may have difficulty bridging the gap between awareness of inequity and substantive change, which in turn, can contribute to failed outcomes in building resilient and equitable infrastructure.

During the process of reaching consensus, the committee identified six areas of research that would inform institutional efforts to put equity at the center of their infrastructure investments:

1. Catalyze and support systemic change in the institutions involved in infrastructure development

Under this research topic, the committee identified several applied research questions including:

- What models of system change are most useful for institutions to achieve equitable infrastructure investments?
 - How can infrastructure providers and investors stimulate their institutions into meaningful and lasting change to address inequitable outcomes? How can these institutions make equity an explicit goal and hold themselves accountable for achieving or advancing equity?
2. Develop effective community resilience hubs

On resilience hubs, four research questions are identified including the following:

- What are the policy and regulatory barriers in different states and jurisdictions that limit resilience hub deployment, and how may these be overcome?
- How do we create replicable community engagement strategies for resilience hub design and shift decision-making to those most affected by disasters?

3. Engage in community resilience planning

On community resilience planning, the committee pointed out some applied research questions including:

- What measures and indicators are needed to help communities track progress toward improving resilience and equity and prioritize infrastructure plans and investments?
- What planning and funding strategies are needed for local, state, and federal stakeholders to ensure that affordable housing is not disproportionately located in neighborhoods or communities at higher risk of damage and loss of services?

4. Incorporate integrated multi-benefit solutions into resilient and equitable infrastructure planning

On this topic, the committee identified several applied research topics including:

- How can communities use broad-based and inclusive planning to maximize economic, environmental, and social value by working together at the pre-design phase to make infrastructure investments address historic disinvestment in BIPOC communities?
 - How do we broaden project funding streams to ensure that they can provide multiple community benefits?
5. Link the built and natural environments to benefit communities

Several research topics are pointed out by the committee on interdependency of the built and natural environments including:

- How can we investigate, understand, and apply function and design relationships between neighborhood housing and access to natural areas and open space?
 - How can we measure interrelationships between the built and natural environments to foster investment that brings about optimal and equitable conditions for underserved communities?
6. Identify the role minimum code requirements that can play in developing resilient and equitable infrastructure

Based on the workshop, the committee identified several applied research questions on minimum building codes including:

- What incentives exist to encourage communities to specify requirements beyond code-minimum performance?

- What is the role of performance standards versus prescriptive code requirements for achieving resilient and equitable outcomes?

III. Innovations in Economic and Financial Analysis

Traditionally, public funds finance infrastructure investments, but public deficits, the inability of the public sector to deliver efficient investment spending, and a lack of political will have in many communities led to governments reducing the level of public funds they allocate to infrastructure. The workshop discussions made it clear that research needs to develop new analytical tools that can demonstrate the benefits of public investment in resilient and equitable infrastructure development and that would lead to developing new mechanisms for financing resilient and equitable infrastructure.

1. Innovative financing for equitable infrastructure development

Based on the workshop, the committee identified many applied research questions pertaining to innovative financing for equitable infrastructure development. Some of the questions include:

- What is the range of public finance for climate-resilient infrastructure that includes mechanisms, incentives, or other measures including equity requirements to ensure that projects it supports are equitable?
- How are these public financing programs supporting climate objectives in addition to equity and community resilience, if defined more broadly than climate resilience?
- What is the role of wrap-around funding—a collaborative, team-based funding approach to service and support planning—and financing in mitigation, recovery, and other aspects of risk reduction?

2. Benefit–cost analysis

The committee listed several applied research questions related to benefit–cost analysis as applied to resilient and equitable infrastructure development. Some of the questions include:

- How can we include distributional considerations in benefit–cost analysis to analyze equity, social justice and other broad societal goals?
- How can we adapt benefit–cost analysis to account for difficult–to–monetize outcomes, such as resilience, public health, and equity?
- Are there alternative decision analysis approaches to benefit–cost analysis to evaluate resilient infrastructure investments?
- What adjustment to benefit–cost analysis would better incorporate benefits to future generations?

CONCLUSION

The consensus study report *Equitable and Resilient Infrastructure Investments* identifies activities in each of the three particularly important applied research topics that are indicated. The report also includes specific questions to consider when undertaking this research. The Committee on Hazard Mitigation and Resilience Applied Research Topics took a broad view of applied research and those involved in that research, ranging from researchers in academia to small community groups exploring and testing approaches for addressing climate impacts. The three primary applied research topics frame three important components of resilient and equitable infrastructure investments. Tying the three together is the fact that equitable, inclusive, and trusted processes and leaders are essential for accepted and sustainable decisions, which are particularly important for challenges such as climate impacts that do not have short–term solutions.

The workshop presentations and discussions demonstrated an existing base in the academic literature, as well as experience in resilient and equitable infrastructure investment, and they presented important lessons from work developing resilience hubs and dealing with housing needs and transportation infrastructure and services. Academic and applied research is needed to collect and expand this knowledge to better inform equitable and resilient infrastructure investments and motivate further local action on resilience.

With this report, the committee hopes to inspire researchers and communities. Research findings from these topics should bolster and extend attention and activities that strengthen capacities for community resilience through inclusive work at the local, regional, national, and global levels for robust and equitable action.

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