

# DISASTER RESILIENCE PLANNING IN THE NATIONAL INFRASTRUCTURE PIPELINE

**Study Brief** Coalition for Disaster  
Resilient Infrastructure (CDRI)  
January 2025

KNOWLEDGE PARTNER

**CDRI**   
Coalition for Disaster Resilient Infrastructure



16th Edition  
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Empowering Utilities:  
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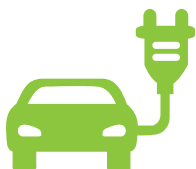
## ABOUT WUS 2025

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The World Utility Summit (WUS) has been at the forefront of empowering utilities to navigate the future with resilience and transformation. The 2025 edition marks the 5th iteration of this prestigious summit, which will focus on the cutting-edge technologies that will reshape the utility industry. In this Edition - Regulators, Tech Companies, Consultants, Government Officials, and Utility Leaders will all be there to share their perspectives on the challenges and opportunities that lie ahead. This gathering offers unparalleled opportunities for networking, knowledge sharing, and collaboration in

## SUMMIT TRACKS:

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### ■ **Energizing a Greener Grid: Decarbonization Meets Distributed Solutions**

This theme will explore the ongoing shift towards renewable energy sources and distributed generation models (e.g., rooftop solar) to achieve net-zero emissions. Sessions could discuss:

- Transition to Renewable energy sources & its integration
- Advancements in Energy Storage Technologies
- Policy & economic implications of decarbonization
- Innovation in Renewable Energy: advancements in solar, wind, geothermal, Hydrogen and other renewable energy technologies



### ■ **Bytes & Breakers: Navigating the Digital Revolution in Utilities**

This theme will delve into the impact of digital technologies on the utility industry. Sessions could address:

- Connecting to the cloud & the data landscape: Discuss how utilities can leverage cloud computing and big data for better decision-making
- Leveraging big data and analytics for optimizing grid operations and maintenance
- The changing customer experience in a digital utility environment
- Smart storage: Explore solutions for integrating energy storage into the grid to optimize renewable energy usage
- A smarter energy system: examining the risks, unlocking resilience: Explore how digitalization can build a more resilient grid
- Blockchain for Utilities amid the Energy Transition
- Big Data, Blockchain, IOT & Analytics for Grid
- Accelerated use of AI & Cloud
- Growing adoption of Modernization and Automation with Cybersecurity



### ■ **Investing in Future: Building Climate Resiliency in the Energy Ecosystem**

This theme will focus on strategies for building climate resilience into utility infrastructure to withstand extreme weather events like storms and floods. Sessions could explore:

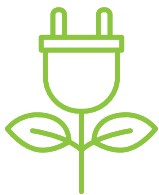
- Strengthening and modernization grid infrastructure for improved resilience & to withstand extreme weather events
- Early warning systems and emergency response plans for utilities
- The role of distributed generation in enhancing grid resilience
- Adapting utility business models to account for climate risks
- Emergency preparedness and response: Developing robust plans for responding to and recovering from extreme weather events
- Expedited the development & deployment of new technologies for managing extreme weather events
- Make Climate resilience a central part of policy framework and system planning



### ■ **Harmonizing Grid Horizons: Evolving Regulatory & Policy Landscape**

This theme will examine the evolving regulatory environment for the utility sector, considering the need for innovation and investment. Sessions could discuss:

- Policy frameworks for encouraging renewable energy development and distributed generation
- Regulatory reforms to promote grid modernization and digitalization
- The role of regulators in ensuring fair competition and consumer protection in the changing utility landscape
- Policy approaches for achieving national and international climate goals
- Regulation for the future: Explore how regulations can incentivize innovation in renewable energy and grid modernization
- Changing regulatory landscape: Discuss the ongoing regulatory changes impacting the utility sector



### ■ **MegaWatts to MegaBytes: Confluence of Utilities and Emerging Technologies**

This theme will explore the potential of emerging technologies (e.g., blockchain, Internet of Things) to revolutionize the utility sector. Sessions could address:

- Financing the Future: Unlocking the Financing for Renewable & Efficiency Projects
- Workforce Transformation: Skill & Training for Renewable Energy Economy?
- Key disruptive energy technologies: Explore technologies like small modular reactors, advanced battery storage, and hydrogen fuel cells



### ■ **Session with eTECHnxt: Energy Storage – Enabling RTC Renewable Energy**

- Enhancing Grid Efficiency and Reliability by Integration of Battery Storage with Renewable Energy Forecasting and Scheduling
- Role of Battery Storage in Enabling Round-the-Clock Renewable Energy Systems: Challenges, Opportunities, and Policy Implications
- Roadmap for Utilities & Industries to achieve Flexibility, Resilience, and Decarbonization



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## INTRODUCTION

With the frequency and intensity of disasters increasing amidst climate change, the average annual loss (AAL) for global infrastructure is estimated to be between US\$ 732 and US\$ 845 billion. This is roughly 14% of the 2021-2022 global gross domestic product (GDP) growth. In India, the increasing frequency and severity of natural hazards pose a significant threat to crucial infrastructure investments. Disasters in India account for 2% of its GDP and can reduce central government revenue by up to 12% annually.

Globally over the last 50 years, the number of disasters has increased rapidly by a factor of five because of climate change including extreme weather event. With an increase in such events, vulnerabilities and the risk associated with hazards have also increased simultaneously. There is an upward trend in annual disaster events from 1980-2013 (Figure 1).

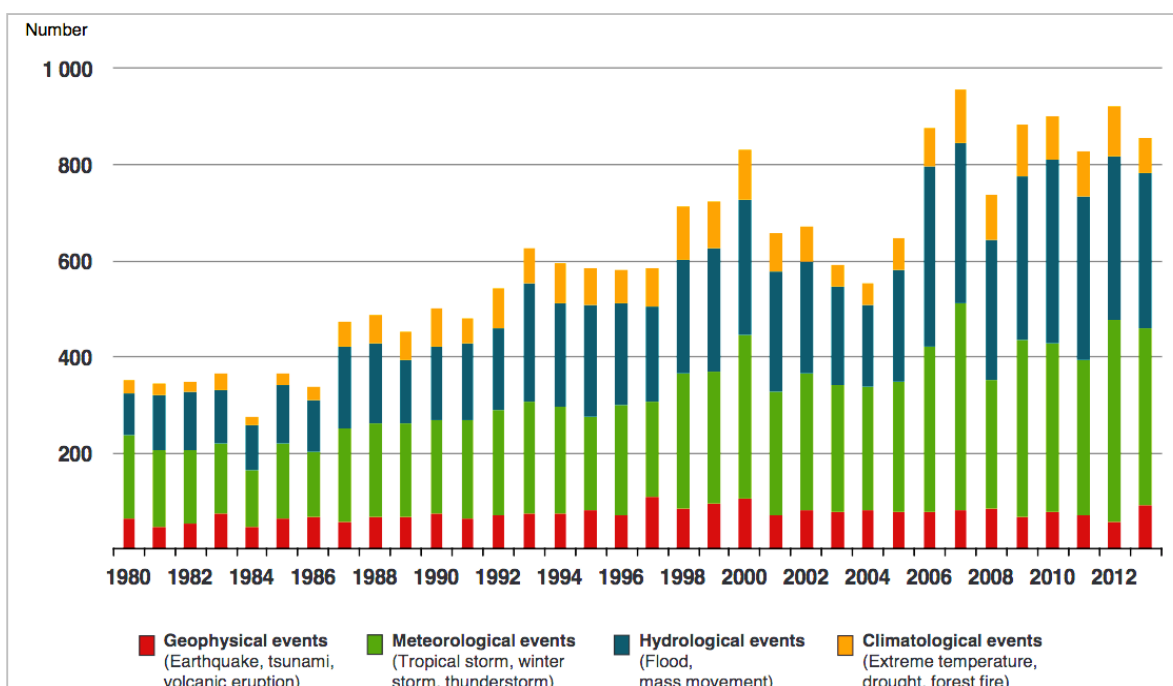


Figure 1: Annual number of disasters associated with natural events around the world from 1980-2013 (Source: NatCatSERVICE, Munich Re, 2014)

Coalition for Disaster Resilient Infrastructure (CDRI), as an international organization, aims to address the disaster risks affecting the critical infrastructure. It seeks to mainstream resilience considerations with the support of concerned stakeholders. In line with its objective, CDRI advocates for investing in infrastructure resilience during early project phases and recommends measures through this study titled, 'Appraisal of Standard Agreements and Contractual Documents for Projects under National Infrastructure Pipeline to Achieve Disaster Resilience Goals'.

## Scope of The Study

The study focuses on mainstreaming disaster resilience in the three most invested infrastructure sectors: roads, railways and power. It identifies existing gaps from the resilience perspective in key areas: policy and institution, infrastructure development process, infrastructure development projects and financing. Action points are suggested to address the gaps in disaster

resilience. To aid in addressing these gaps, the study developed the Resilience Cost-Benefit Analysis (RCBA) tool, which analyses the benefits of investing in resilience. Additionally, it provides a toolkit designed to incorporate disaster resilience that helps incorporate resilience considerations into infrastructure projects.

- Global Infrastructure Resilience Report, CDRI, 2023
- Handbook on Disaster Management for Nodal Officers, NIDM, 2019
- World Meteorological Organization (2021)  
NatCatSERVICE, Munich Re, 2014).

The RCBA tool comprises an interactive Excel-based application and a user guide. It utilizes project-level data as inputs, overlays it with a disaster risk catalogue, and assists the key stakeholders in making informed decisions for investing in resilience measures at initial project phases. The toolkit for disaster resilience comprises four components: a) a checklist of resilience measures that suggest modifications to standard contractual documents to ensure sectoral resilience, b) a checklist of design options for infrastructure sectors to increase the resilience of assets against predominant hazard impacts, c) a guidance document for line ministries on incorporating disaster resilience considerations during the project identification and appraisal phases and, d) a guidance document for potential bidders to guide them prepare project proposals that include disaster resilience goals. Together, these resources aim to assist the line ministries in incorporating disaster resilience aspects into the project identification and appraisal phases and enable private sector bidders to effectively plan and budget for disaster resilience while developing and submitting their project proposals.

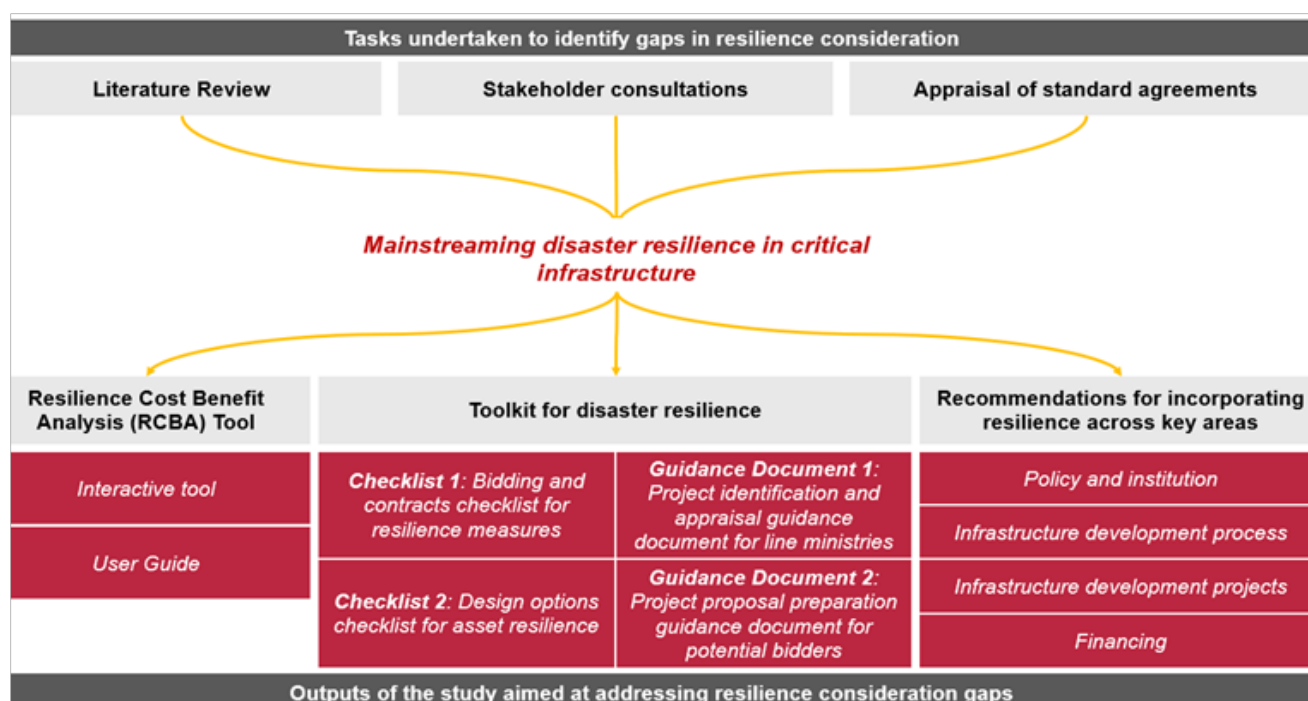


Figure 2: Methodology and output of the study

Resilience frameworks, indices and methodologies drafted by esteemed organizations such as the World Bank, Asian Development Bank, ARUP etc. have been developed in the context of infrastructure resilience. The frameworks reviewed under the study are as follows:

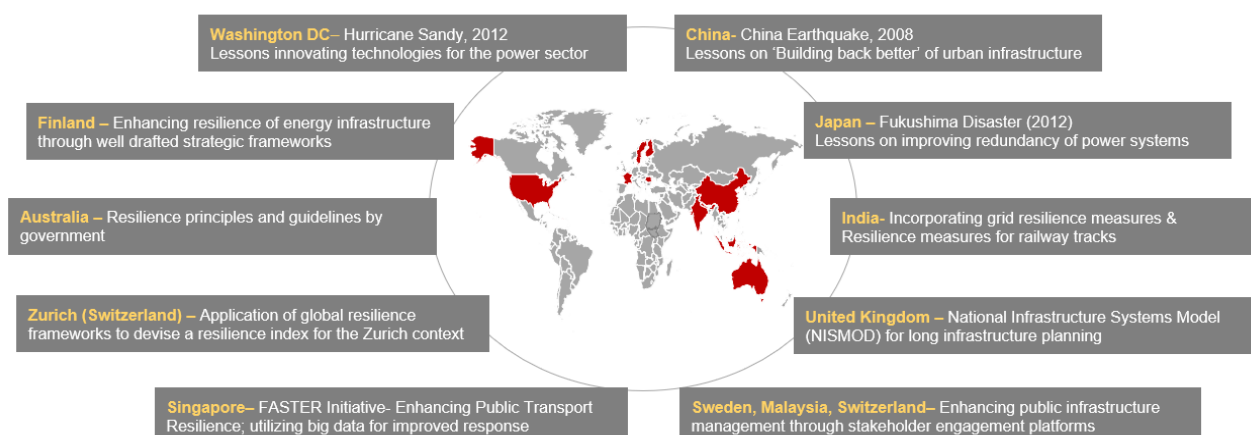
- i. Resilience Measurement Index (2013)
- ii. Measuring critical infrastructure resilience, ETH Zurich (2015)
- iii. Critical Infrastructure Resilience Index (CIRI) (2016)
- iv. Resilience Rating System (RSS), World Bank Group (2021)
- v. Energy Resilience Framework, ARUP (2022)
- vi. Infrastructure Resilience Planning Framework (IRFP), Cybersecurity and Infrastructure Security Agency (CISA) (2022)
- vii. EU- Circle Resilience Framework, National Center for Scientific Research “Demokritos” (2018)
- viii. Physical Climate Risk Assessment Methodology (PC RAM), Coalition for Climate Resilient Investment (CCRI) (2021)
- ix. Global Infrastructure Risk and Resilience Model and Index (GIRI), Coalition for Disaster Resilient Infrastructure (CDRI) (2022)
- x. Guidelines for Climate Proofing Investment in the Transport Sector- Road Infrastructure Projects, Asian Development Bank (2011)

The infrastructure resilience frameworks examined demonstrate wide-ranging applicability throughout various stages of a project's life cycle. From the initial planning phases to implementation, operation, and maintenance, these frameworks provide strong methodologies and strategies to improve infrastructure resilience.

### International Good Practices

Several countries across the world have taken significant measures to enhance the resilience of their infrastructure, including power, roads, and railways. Good practices and learnings of different countries are categorized under the following two heads:

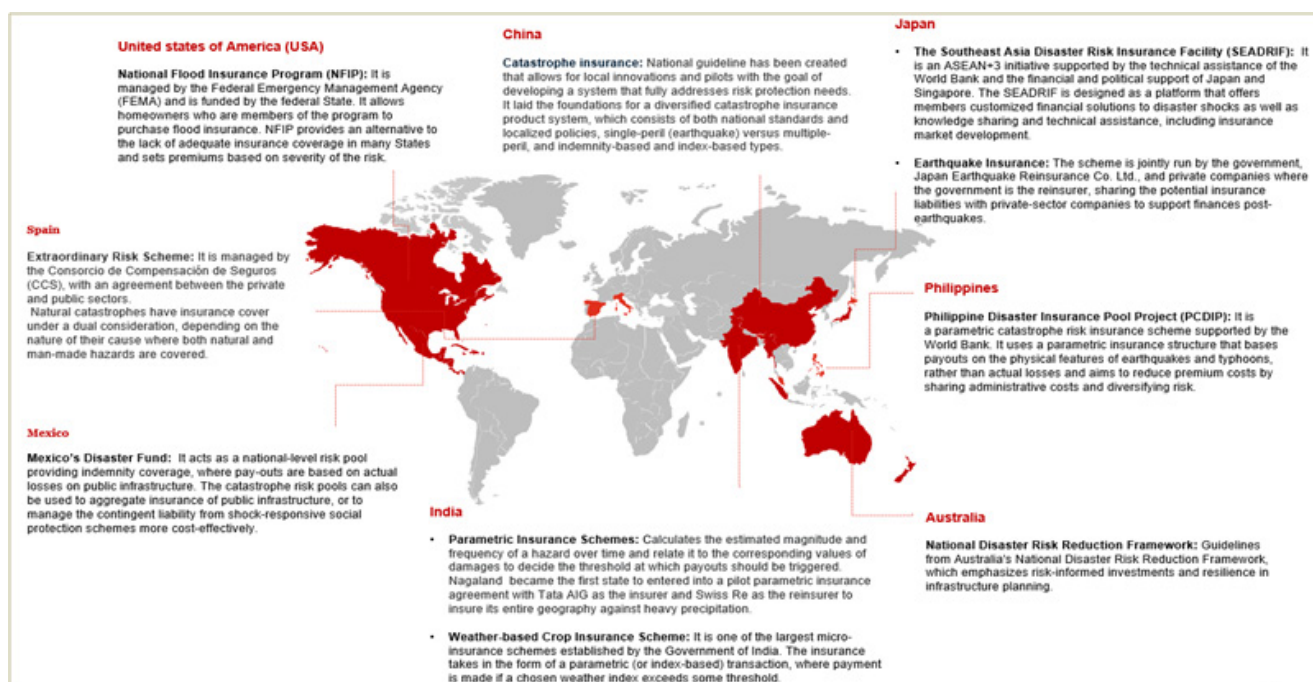
- **Structural:** a) Design & construction standards b) Retrofitting and Upgrades c) Redundancy & Back-up systems d) Innovative technologies
- **Non-structural:** a) Policy and Regulation b) Emergency planning and management c) Data and monitoring systems d) Community and stakeholder management.



*Figure 3: Snapshot of global best practices on structural resilience measures*

- Lifelines-The Resilient Infrastructure Opportunity, WB Report (2019)
- Building Resilience, OECD Report (2019)

Developed countries has started addressing financial liabilities in cases of natural disasters. Countries of Asia Pacific region, facing higher number of natural hazards are increasingly incorporating resilience clauses in their PPP contracts and other procurement documents.



*Figure 4: Good practices for integrating resilience considerations in standard agreements & contractual documents (non-structural measures)*

A literature review was conducted to capture key insights from the global best practices on critical infrastructure resilience. At the same time, stage-wise stakeholder consultations were conducted to understand the current state of incorporating disaster resilience into infrastructure projects. An appraisal of sector-specific standard agreements and contractual documents for the roads, railways and power sectors was also conducted to identify gaps in mainstreaming resilience considerations. Based on the literature review, stakeholder consultations, and appraisal of standard agreements, several gaps were identified across four focus areas: policy and institutional aspects, infrastructure development processes, project-level strategies, and financing.

In terms of policy and institutional aspects, a lack of comprehensive data structures and database inconsistency were noted, leading to issues with hazard damage and the loss of data. Additionally, resilience considerations are absent in the existing sectoral policies, along with gaps in capacities and expertise.

Regarding the infrastructure development processes, there is an absence of well-defined natural hazard scales and risks in existing model documents and disaster resilience considerations are limited throughout the project life cycle. The need for more adaptive contractual frameworks and stringent qualification criteria for experts at the detailed project report (DPR) stage was also identified.

At the project level, there are gaps in assessing natural hazard risks during the infrastructure planning and design phase. There is a shortfall in implementing additional provisions that exceed the minimum design codes and a lack of effective enforcement mechanisms for existing codes and standards.

Lastly, there is a lack of dedicated resilience financing sources for infrastructure projects and limited insurance coverage for hazard risks across different project phases. Stakeholders, including the National Disaster Management Authority (NDMA), have suggested creating a risk pool. In contrast, multilateral development banks (MDBs) and development finance institutions (DFIs) have suggested a cost-benefit methodology and a tool to justify investments in resilience.

## Key Actions For Stakeholders

### Governments

1. Integrate resilience considerations within sectoral policies.
2. Create institutional mechanisms for disaster risk data management and dissemination.
3. Ensure equitable responsibility allocation and cross-sectoral collaboration.
4. Create an enabling environment for the private sector to enhance resilience investments.
5. Mandate regular monitoring and evaluation of resilience measures incorporated.
6. Mandate risk and vulnerability assessment during project initiation.
7. Enhance technical expertise and capacity-building initiatives.
8. Update design standards with the evolving hazard scenario.



9. Establish thresholds for hazard parameters contextual to the site and project and include them in Force Majeure clauses.
10. Include provisions to allocate and transfer risk among stakeholders.
11. Appoint independent engineers to proof-check project design and safety consultants to check compliance with resilience measures.
12. Extend the defect liability period.
13. Make existing public-private partnerships (PPP) and engineering, procurement, and construction (EPC) policies flexible to incorporate resilience measures
14. Establish risk pools at regional and national level

### Private Sector

1. Ensure incorporation of resilience measures in all project stages.
2. Incorporate resilience considerations during the project proposal development and submission.
3. Incorporate resilience considerations during project investment.

### Institutional Development Partners and Financial Institutions

1. Develop capacity-building programmes, training modules and guidance documents, and toolkits to build knowledge on resilience investment, disaster risk reduction (DRR) and disaster risk financing and insurance (DRFI) and implement it.
2. Make provisions to expand insurance coverage to all the project phases.
3. Explore parametric insurance models and risk retention programmes.

### Recommendations for Mainstreaming Disaster Resilience in Infrastructure

#### A. Policy- and institutional- level interventions for improving infrastructure resilience

India's disaster management policy framework is anchored by the Disaster Management Act (2005), which established the NDMA to oversee disaster management efforts nationwide, along with state disaster management authorities for regional coordination. The National Policy on Disaster Management (2009) emphasized integrating disaster risk considerations across various sectors to mitigate impacts effectively. Building on this, the National Disaster Management Plan (2019) aimed to enhance preparedness and reduce vulnerabilities. Despite these disaster risk reduction (DRR) efforts, there remain significant gaps, particularly in integrating resilience strategies within critical infrastructure sectors. To identify these gaps, policies, action plans, and programmes from India and six other countries – the UK, Australia, Japan, the USA, Finland, and Bulgaria -were reviewed. Based on the policy review, the gaps within key focus areas were identified, and recommendations were formulated:

## 1. Integrate resilience considerations within sectoral policies

The Disaster Management Act (2005) and the National Policy on Disaster Management (2009) have encouraged sectoral disaster management plans, but only a few sectors, like the power sector, emphasize resilience while suggesting mitigation measures. While policies like the National Action Plan on Climate Change (NAPCC) mention resilience, they tend to focus more on mitigation. *To effectively address disaster risks, line ministries must integrate resilience into their critical infrastructure policies. This should include clear regulations and investment plans. Furthermore, standard agreements should also incorporate resilience measures at all project stages to ensure accountability. These design standards need to be regularly updated to incorporate evolving hazard scenarios and new construction technologies. It should be flexible to keep provision for additional resilience measures beyond minimum codal requirements.*

*The line ministries can utilize the toolkit for disaster resilience to understand the existing resilience gaps within the standard documents and contractual agreements. They can then develop provisions to standardize incorporating resilience measures within sectoral policies.*

## 2. Create institutional mechanisms for data management and dissemination

The National Policy on Disaster Management (2009) and the National Geospatial Policy (2022) emphasise using GIS databases such as National Database for Emergency Management (NDEM) and National Spatial Data Infrastructure (NSDI) to improve data access. However, challenges remain due to data standardisation and dissemination issues. There is a need for *an institutional mechanism to create, maintain, and update comprehensive data on hazard damages and losses, which should be housed within an agency like the NDMA. Additionally, a common platform/directory should be developed to access all available and updated design standards related to resilience for each line ministry.*

## 3. Create mechanisms for cross-sector collaboration

Existing sectoral policies, including the National Disaster Management Plan (2019), outline the roles of government, the private sector, and community organisations in DRR. However, these policies fall short of equitable responsibility allocation and cross-sector collaboration. *It is crucial to clearly define the roles and responsibilities of various ministries and other stakeholders while encouraging cross-sector collaboration. Additionally, establishing a platform for sharing information and best practices across sectors is crucial for enhancing these collaborative efforts.*

## 4. Enhance technical expertise and capacity-building initiatives

Strengthening capacity building and awareness for DRR and resilience is essential. The National Disaster Management Plan (2019) and organisations like NDMA and NIDM conduct trainings and workshops for various stakeholders, these efforts need scaling and consistency with a central focus on resilience. *Enhancing technical expertise and disaster resilience capacity across line ministries and stakeholder-specific capacity-building initiatives on responsibilities, data sharing, and monitoring of resilience measures can improve mainstreaming disaster resilience into infrastructure projects. Capacity-building programmes on DRR and Disaster Risk Financing and Insurance (DRFI) should also be conducted to encourage private sector investments in resilience.*



## 5. Mandate risk and vulnerability assessment during project initiation

The National Disaster Management Plan (2019) underscores the need to conduct risk assessments in disaster preparedness. However, resource constraints and limited data hinder their integration into critical infrastructure projects. While some projects, like the Mumbai Coastal Road and Chennai Metro, conduct these assessments, they are often considered optional. *Concerned ministries should mandate detailed risk and vulnerability assessments for infrastructure projects based on database and site investigations to identify disaster risks and incorporate resilience measures.*

## 6. Create an enabling environment for enhancing financial incentives

India's Nationally Determined Contribution under the Paris Agreement (2021–2023) points to the need for investment in climate-vulnerable sectors but lacks a focus on resilience. Existing funds like national and state disaster risk management prioritise relief efforts over resilience. Moreover, financial incentives for resilient infrastructure are inadequate. *Policies should incorporate mandates or regulations to enhance financial incentives for public and private investments in resilience, thus creating an enabling environment. Additionally, the RCBA tool can encourage investments in infrastructure projects that focus on building resilience and enhancing financial incentives.*

## 7. Strengthening infrastructure development processes for sectoral resilience

Rapid infrastructure development and increasing geographical coverage inherently increase exposure to hazard risks. India's existing infrastructure development processes do not emphasise the disaster resilience of assets, whereas large recurring damages and losses are incurred due to natural hazards. There is an immediate need to integrate resilience considerations within the existing development processes at each project life cycle phase. The following action points have been identified to address gaps and enhance resilience considerations in infrastructure development processes.

## 8. Standardise hazard risk assessment

The current infrastructure development process lacks a comprehensive assessment of natural hazard risks despite adhering to governmental flood-levels and geo-technical investigations. *There is a need to standardize the hazard risk assessment process in infrastructure planning and design stages derived from past impacts by natural hazards on various asset classes.*

## 9. Determine hazard thresholds

Developing a disaster risk management framework based on risk assessment and hazard thresholds is crucial. It will help determine asset risks and allocate them among parties effectively. *The government needs to establish common definitions and metrics for risk. At the same time, local authorities should establish site- and project-specific thresholds for hazard parameters.*

## 10. Embed resilience in contractual obligations

Integrating disaster resilience measures to enhance project sustainability, is important, as is incorporating specific ‘disaster resilience’ clauses in standard contracts. This ensures stakeholder accountability and incorporates these measures throughout the planning, design, construction, operation, and maintenance phases. To mainstream disaster resilience, standard bidding documents and contracts should clearly define natural hazard risks and responsibilities with disaster risk reduction and maintenance clauses incorporated. *Force majeure clauses need to specify hazard types and thresholds tailored to each project’s asset type and location to determine damage and contingent liabilities of the authority and party responsible for the design.*

In the EPC mode, short defect liability periods (3-5 years) lead to quality and maintenance challenges. *Extending this period under a ‘Modified EPC’ contract would incentivise better materials and construction practices, as contractors account for longer liabilities, thus enhancing asset durability and resilience.*

Equitable risk allocation among stakeholders should be facilitated to ascertain liabilities in cases of hazard impacts. *The allocation should be based on hazard thresholds established by the local authority regarding parameters such as intensity, frequency and duration among others. An iterative approach can also be adopted for the private sector to allocate and transfer risk based on insurance and PPP market maturity.*

*An empaneled list of resilience experts should be created under line ministries to proof-check project design.* If the safety consultant/resilience expert highlights any gaps in design that make the asset unsafe and suggests mitigations to address the gaps in the design, it should not cause any change in the project’s scope.

## 11. Include resilience expertise in the project to ensure compliance with resilience measures

*A resilience expert should be involved in the project to ensure compliance with disaster resilience measures at various design, construction and operation and maintenance (O&M) stages.* An empaneled list of resilience experts should be created under the line ministries. The implementing authorities can involve them in supervision and monitoring. A detailed checklist of resilience considerations for the type of infrastructure asset should be developed, which will further equip the expert to evaluate and monitor infrastructure at various stages of its life cycle. The resilience toolkit should include a checklist (non-exhaustive) that line ministries can enhance, and experts can use.

## 12. Project-level interventions for resilient assets

A uniform approach to resilience is ineffective as different regions are vulnerable to a range of hazard risks. Project-level interventions allow for localised risk assessments, which will ensure that specific vulnerabilities are addressed. Project-level structural and non-structural resilience measures must be incorporated within the key activities in the infrastructure development phases. The following gaps and action points have been suggested for building resilience

### 13. Explore historic and probabilistic data

The country does not have credible datasets on hazards, vulnerabilities, and exposures in a common and standardised format. Additionally, data are absent for assessing disaster resilience at sub-national levels. Hence, using *historical and probabilistic hazard data when designing the asset need to be explored.*

### 14. Conduct detailed risk and vulnerability assessment of assets

The current infrastructure development process is inadequate in assessing natural hazard risks, as standardised datasets on hazards and vulnerabilities are lacking. To enhance *resilience, it is crucial to standardise hazard risk assessments using historical impact data and conduct detailed vulnerability assessments to prioritise resilience interventions and design upgrades.*

### 15. Design assets with additional resilience provisions

*Infrastructure designs should exceed the existing standards by incorporating protective measures, redundancies, and local adaptations.* Employing new technologies and integrating indigenous resilience practices can further enhance resilience.

Incorporating additional resilience provisions into the project design will entail certain costs. *To ensure the viability of the investment, comparing the quantifiable benefits of incorporating additional resilience measures is crucial. This can be carried out using the RCBA tool.*

### 16. Develop project-level disaster risk management framework

A project-level disaster risk management framework is needed, grounded in a comprehensive risk assessment with site-specific hazard thresholds. *The framework will identify potential disaster risks and evaluate the vulnerability and exposure of projects, thus guiding the design and implementation of mitigation measures.*

### 17. Ensure regular quality checks and monitoring

Currently, project monitoring is restricted to the construction phase in India. The operation and maintenance phase of the project does not have active monitoring and regular quality checks. Further, real-time monitoring at the operational phase is present only in select sectors like transmission. *Regular quality checks and monitoring should be conducted for all the project phases. A decision support system (DSS) can also be proposed for asset tracking, managing data and providing weather alerts and warnings.*

### 18. Incorporate 'Build Back Better' principles in the operation and maintenance phase

Integrating the 'Build Back Better' principle is vital for post-disaster repair and reconstruction to strengthen infrastructure for withstanding future hazards. *Along with integrating the 'Build Back Better' principle, early warning systems should be implemented during the operation and maintenance phase. This will ensure prompt maintenance and minimise disaster impacts.*

## 19. Bridging the financing gap in infrastructure resilience

India's financing landscape for resilience is evolving, involving the government, institutional investors, MDBs, DFIs, and the private sector. The 15th Finance Commission emphasised a shift from disaster response to risk mitigation by creating the National Disaster Mitigation Fund. Public finance, guided by the Ministry of Finance, strongly supports infrastructure projects. Despite initiatives like the National Infrastructure Pipeline and investments from the National Investment and Infrastructure Fund (NIIF) and the Green Growth Equity Fund (GGEF), challenges in financing resilient infrastructure persist. This paves the way for allocating a portion of the funds to infrastructure resilience initiatives. Further, the MDBs and DFIs such as Asian Development Bank (ADB), World Bank Group (WBG), KfW, Japan International Cooperation Agency (JICA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the UK's Foreign, Commonwealth & Development Office (FCDO) are major contributors in funding infrastructure resilience projects and interventions in India through grants, loans, and bonds. However, there is currently a lack of specific resilience criteria used by funding agencies to qualify resilient projects. The private sector companies are also key players in developing climate-resilient infrastructure, especially in renewable energy, through PPPs and models like the Hybrid Annuity Model. However, challenges are leading to limited participation, which includes inadequate localised climate risk data for assessing risks and returns, low or uncertain financial returns in resilience projects, regulatory and policy barriers, and a lack of awareness about resilience investment benefits. The following recommendations aim to create opportunities for future investment and to mainstream resilience for various stakeholders.

## 20. Create a dedicated infrastructure resilience fund to strengthen public infrastructure resilience against natural hazard

Raising awareness, building capacity around investment in resilient infrastructure, and developing a comprehensive infrastructure resilience fund are crucial. *The proposed India Infrastructure Resilience Fund (IIRF) would enhance infrastructure durability and adaptability while easing government financial burdens by reducing long-term maintenance costs. It can attract domestic and international investors by showcasing a commitment to resilience, thus boosting infrastructure confidence. The fund would also align national and regional policies, fostering collaboration among government, private sector, and development agencies, while encouraging innovative, sustainable infrastructure solutions.*

*The RCBA Tool can be integrated to evaluate asset resilience options, aid informed fund allocation decisions, and serve as an eligibility criterion for accessing the resilience fund.*

## 21. Standardise definitions for “resilient infrastructure investment”

*It is important to standardize the definition of ‘infrastructure resilience investments’ such as the taxonomies like the Climate Bonds Resilience Taxonomy (CBRT) to enhance market transparency and confidence. It will help assist the government, MDBs, DFIs, and private sector by providing clear guidelines for identifying and evaluating resilience infrastructure projects.*

## 22. Establish resilience criteria for project screening and evaluation

*MDB/DFIs can establish strict resilience criteria for their project screening and evaluation processes.* It will ensure that funds are directed towards infrastructure capable of withstanding and adapting to disaster impacts, thereby safeguarding long-term investments.

## 23. Mainstream use of RCBA tool during project evaluation and screening process

*The RCBA tool can be utilised by various stakeholders, such as MDBs/ DFIs, in their project screening and evaluation processes to enhance the assessment of projects from a resilience perspective.* This will help stakeholders in achieving the effectiveness and sustainability targets of infrastructure investments.

*Similarly, the private sector should utilise the RCBA tool for design and cost estimation.* Based on the values of return on investment (RoI) and internal rate of return (IRR), it will provide insights into the benefits of resilience investments and help them make viable investment decisions.

## 24. Create a risk pool at regional and national levels

As the entire burden of absorbing the financial risk of natural hazards lies with the government; leveraging disaster risk transfer mechanisms and establishing risk pools at the national level or among multiple countries can also effectively manage the financial impacts of natural hazards. *Establishing national and regional risk pools can effectively manage the financial impacts of natural hazards by sharing risks and resources. A 'South Asian Risk Pool,' similar to Southeast Asia Disaster Risk Insurance Facility (SEADRIF), could enhance regional resilience by enabling collaboration among South Asian countries. Also, several risk pools operate nationally in various countries, such as the Philippine City Disaster Insurance Pool (PCDIP). A similar national-level risk pool can be created where individual states within India can participate. Reinsurers and insurers would also join as members, with insurance companies retaining some risk and transferring the balance to the internal market.*

## 25. Create a sovereign risk capacity for pooling and diversifying risk

*Creating an India Risk Insurance Facility (IRIF) should be proposed to reduce the financial burden of absorbing risks solely by the government.* In this, individual states within the country can participate. Reinsurers and insurers would also join as members, with insurance companies retaining some risk and transferring the balance to the internal market.

## 26. Support development of insurance and reinsurance markets

Developing robust insurance and reinsurance markets is essential to mitigate financial losses associated with natural hazards and enhance infrastructure resilience. *The government can promote the development of insurance and reinsurance markets to create effective risk transfer options while assuming some key risks in the interim to avoid placing excessive disaster risk on the private sector.*

## 27. Utilise products for transferring disaster risk



*Some key products that may be available and can be utilised to transfer disaster risks are catastrophe bonds (also known as cat bonds), resilience bonds, weather derivatives, parametric insurance, and captives.* Some donor-funded contingent lines of credit can also provide immediate liquidity when a disaster occurs.

## **28. Prepare mechanisms to make funds available to cover the costs of emergency response and reconstruction**

*Developing a risk retention programme (that may include specialised government reserves, a contingency budget, or reconstruction funds) and related access mechanisms can enable private operators to attain the funding needed to restore assets and operations.* It will assist in covering the overall costs associated with emergency response and reconstruction efforts. Additionally, a regulatory framework can be created to facilitate swift insurance claim settlements to enable quick post-disaster recovery and reconstruction.

## **29. Expand infrastructure insurance coverage to all project phases**

In India, the insurance policies procured by contractors or other consultants are typically limited to the contract duration with a predominant focus on the construction phase., which results in the O&M phase with coverage gaps. The insurance protection against natural catastrophe risks is low, with 93% of exposure being uninsured. Additionally, the government is responsible for absorbing the financial risk of natural hazards. Hence, there is a need to mandate insurance coverage across all the phases. *Expanding insurance coverage across all the project phases (including O&M) with a provision to cover hazard risks is essential.*

### **Applicability of RCBA Tool and Toolkit for Infrastructure Resilience**

The identified gaps in policies, infrastructure development processes, infrastructure projects and finance will guide key stakeholders such as line ministries, implementing agencies, and private sector investors, to strategically address the drawbacks in the existing systems at their respective levels. It will help mainstream disaster resilience from the policy level to development processes and project levels. It would further enhance investment domains for the private sector and other stakeholders to effectively contribute towards building resilience for the infrastructure sector.

The RCBA tool developed for assessing the benefits of resilience investment can create an enabling environment for investing in infrastructure resilience and encourage increasing financial incentives as stated in Recommendation 6. As per Recommendation 14, the RCBA tool can be utilised to evaluate the benefits of the additional resilience measures within infrastructure design. Similarly, for Recommendation 20 the RCBA tool can be integrated to evaluate resilience options aiding informed fund allocation and serves as an eligibility criterion for accessing the resilience fund. In Recommendation 22, the RCBA tool can be utilised by the MDBs/DFIs for project screening and evaluation and the private sector can use it for both design and cost estimation of infrastructure projects.

The line ministries can also utilize the toolkit for disaster resilience to identify the existing resilience gaps within the standard documents and contractual agreements and develop provisions to standardise the incorporation of resilience measures within sectoral policies as highlighted in Recommendation 1. At the project level, both line ministries and the private

sector bidders can utilise the toolkit during project identification, appraisal phase, and proposal development, ensuring the incorporation of resilience in all project stages. Likewise, the toolkit can help tackle financing gaps by guiding equitable risk sharing while developing contractual agreements that incorporate resilience considerations.

## Key Forward Actions

The study outlines a series of immediate and short-term actions emerging from the findings and recommendations which are essential for mainstreaming resilience. It requires collaboration between CDRI and government stakeholders such as the Department of Economic Affairs (DEA), relevant line ministries, implementing agencies, and the NDMA. The DEA needs to ensure robust funding and approval mechanisms for resilience projects, while line ministries must integrate resilience into their documents, improve disaster impact documentation, and update codes and standards. As key beneficiaries of the RCBA tool and toolkit, the implementing agencies should focus on local-level capacity building and knowledge dissemination. The NDMA will be crucial in managing hazard data governance and establishing a risk insurance facility. This coordinated effort aims to effectively address existing disaster risks and embed resilience across critical infrastructure. Emerging from the overall study, the following forward action points have been suggested:

1. Scaling up of RCBA tool through additional data and beta testing.
2. Collaboration with international governments for applicability and synergies.
3. Modification of the standard bidding documents (SBDs) /model concessional agreements (MCAs) based on suggested changes.
4. Appraisal of model documents for other asset types and implementation modalities.
5. Standardisation of hazard data capturing and documentation with a defined governance mechanism.
6. Development of communication and decision support system with real data sharing from localised early warning systems.
7. Creation of IIRF with identified sources and governance and ensuring intended utilisation through blockchain technology.
8. Housing of IIRF in consultation with NDMA and Insurance Regulatory and Development Authority of India (IRDAI).
9. Study of international and Indian insurance and reinsurance markets for disaster risks in infrastructure.
10. Risk mapping of Indian states and selected countries for diversified risk portfolios to establish a risk pool





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## STRATEGIC PARTNERS



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