

IWDRI 2019

Second International Workshop on Disaster Resilient Infrastructure

Workshop Summary

19th – 20th March, 2019 | New Delhi

Organised by



In collaboration with



Our partners



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Acknowledgements

We thank our partners, the UN Office for Disaster Risk Reduction (UNDRR), the United Nations Development Programme (UNDP), the World Bank Group and the Global Commission on Adaptation (GCA) for contributing their technical expertise and for helping in bringing together a diverse range of experts and participants.

We are grateful to all the speakers for sharing their knowledge and expertise. Their contributions have helped to expand the collective knowledge base on infrastructure resilience.

Finally, we thank all the participants who shared their views and experiences during the two days. The quality of discussions and engagement demonstrated a global commitment to building resilient infrastructure.

This report has been prepared by the
Interim Secretariat @ CDRI
Coalition for Disaster Resilient Infrastructure
National Disaster Management Authority
A-1, Safdarjung Enclave, New Delhi, India - 110029
E: cdri@ndma.gov.in, O: +91-11-26701700
<https://resilientinfra.org/iwdri/>



Delegates at the opening ceremony

Introduction

The Second International Workshop on Disaster Resilient Infrastructure (IWDR I) was held in New Delhi on 19th and 20th March 2019. The workshop was organized by the National Disaster Management Authority (NDMA), Government of India, in collaboration with the United Nations Office for Disaster Risk Reduction (UNDRR), and in partnership with the United Nations Development Programme (UNDP), the World Bank Group and the Global Commission on Adaptation (GCA). The event brought together more than 270 participants from 34 national governments, multilateral development banks, United Nations agencies, the private sector, policy think tanks, and academia.

The workshop was held in the context of the Government of India's proposal to establish a global Coalition for Disaster Resilient Infrastructure (CDRI). As a crucial milestone in this process, the IWDR I 2019 explored ways of advancing and implementing some of the ideas generated at the first IWDR I, held in 2018. More specifically, it looked at the contours that such an inter-country knowledge partnership requires, to be an effective instrument of enhancing the resilience of infrastructure worldwide. It looked at concrete action plans for collaboration amongst partner countries, international organisations, development banks, and the private sector, to assist countries to upgrade their capacities and practices with regard to infrastructure development in accordance with their risk context and economic needs.

The CDRI is envisioned as a platform for knowledge generation and exchange. It will bring together countries and key stakeholders to work on the common challenge of enhancing the resilience of infrastructure systems, particularly in the context of increasing disaster risk in the face of climate change.

Three main objectives that guided the discussion at IWDR I 2019:

1. Advancing discussion on the thematic pillars identified under CDRI: IWDR I 2019 advanced discussions on the four key thematic pillars that were identified during IWDR I 2018. These were (1) Risk assessment; (2) Standards and regulations; (3) Financial mechanisms for managing risks; and (4) Recovery and reconstruction. Gaps in knowledge and practice in the above thematic areas are known to constrain the creation of resilient infrastructure. Apart from these, the workshop explored the cross-cutting aspects of policy context-specific issues in which infrastructure is being created and the role of multilateral development agencies and technology in the resilience building process.

2. Identifying areas of collaboration: Three technical sessions and three working sessions helped identify areas where countries and agencies could potentially work together and share knowledge and resources to improve practices in specific sectors, thematic areas of general policy and governance landscape around DRI.

3. Determine the “form’ and “function” of CDRI: A diverse gathering of technical experts and national representatives provided the opportunity to deliberate upon CDRI’s functional framework, possible governance arrangements, role of different stakeholders, alignment with other important global initiatives, financing mechanisms and thus, chart a work plan for the next year.

Overview

The workshop consisted of three technical and three working sessions along with one featured event. The two days saw 45 presentations from 60 speakers on 14 topics. The sessions were divided as follows over the two days:

Technical Session 1: Thematic pillars driving the CDRI

- T1-A: Risk assessment methodologies and metrics
- T1-B: Standards and regulation
- T1-C: Reconstruction and recovery

Technical Session 2: Policy and governance landscape for DRI

- T2-A: Large investments in new infrastructure
- T2-B: Focus on refurbishment and replacement of infrastructure
- T2-C: Small Island Developing States (SIDS) and Landlocked Countries (LLDC)

Technical Session 3: Financing for Disaster Resilient Infrastructure

Working Session 1: Perspectives from multilateral agencies

Featured Event 1: Emerging Technologies and Innovation

- FE1-A: Digital Technologies
- FE1-B: Engineering and nature based solutions

Working Session 2: Resilience of Key Infrastructure Sectors

- WS2-A: Ports, Rail and Freight
- WS2-B: Airports, Energy and Telecom
- WS2-C: Water

Working Session 3: Form and function of the CDRI

The list of participants can be found on page 33.

The speaker profiles and their session-wise presentations can be found online at <https://resilientinfra.org/iwdri/presentations.php>.

Key Insights from the Workshop

This section presents the session-wise key insights derived from the workshop.

T1 - The thematic pillars

Gaps in both knowledge and practice in these thematic areas act as barriers to the creation of resilient infrastructure. While these gaps are reflective of the global status, countries have had varying amounts of success in addressing each theme. This session brought together experts working at the forefront of the three pillars that are aiding better decision making for infrastructure resilience.

T1A - Risk assessment methodologies and metrics

- Risk, in the context of infrastructure, manifests in three ways: direct damage of infrastructure assets, the impact of damaged infrastructure on surrounding communities and other infrastructure systems, and the indirect social and economic losses arising out of the loss of infrastructure services. There is an urgent need to move from assessing the risks to the safety of single assets to assessing the risks to the performance of assets and entire infrastructure systems. National governments can provide the institutional basis for the 'system of systems' approach to building infrastructure resilience.
- National infrastructure can be thought of in two categories: Strategic Infrastructure – like deep-sea ports, international airports, oil/gas pipelines, usually managed by national authorities and Local Infrastructure – like roads, power transmission, sanitation, that are managed by local governments and communities. Needs of both strategic and local infrastructure must be understood and addressed differently at the required scales through appropriate forms of governance, financing mechanisms, and incentives.
- Risk data is a public good. Governments need to ensure that this information is collected accurately and regularly, and made widely available in the public domain. Hazard and asset-wise risk, to and due to infrastructure, needs to be understood from micro to macro scales and in a timely manner, in order to enable effective risk reduction policies and actions.
- Accounting for the effects of unpredictable changes in climate interacting with complex infrastructure systems creates a situation of 'deep uncertainty' about the future. This requires us to move from a 'past-based' robust design strategy to an adaptive design strategy that allows for flexibility in future actions and minimises regret in the long term.

Action point for CDRI: *Develop metrics and methodologies to measure the resilience of infrastructure and produce a comparative report on the 'Status of Infrastructure Resilience' around the world.*

Country in focus : PERU

Peru's National disaster management centre carries out local level assessments of hazards, identifies susceptible exposed elements, analyses vulnerabilities, and calculates risk levels, in order to control risk and increase the resilience of public infrastructure.

Such risk assessment reports allow the authorities of the national, regional, and municipal governments to propose structural and non-structural measures at a detailed scale to reduce disaster risk and implement corrective and prospective management of disaster risks for local and territorial planning.

This entire process is supported by SIGRID (Geographic Information System for Disaster Risk Management) – a web based interactive platform that articulates and contains geo-referenced technical-scientific information to support decision making for disaster risk management.



T1B - Standards and regulation

- National building codes and land-use regulations have been shown to be the most effective tools for building the resilience of infrastructure systems and communities. Developing, updating, and implementing building codes and land-use regulation is an iterative process. It requires nations to develop national level frameworks, legislation and institutional capacities to learn from past events and drive future resilience. Experience from successful countries shows that this costs approximately 1% of the total value of infrastructure built annually.
- Codes and standards are useless if not implemented at the time of planning, design, and construction. Effective implementation requires a few streams of action:
 - Outreach to a wider public on the need for standards and building safely.
 - Transparent development and updating of standards taking into account local-level capacities.
 - Free and wide distribution of codes and standards, along with training and guidance on their implementation.
 - Strict regulation of professionals and stakeholders involved in infrastructure creation and maintenance.
- There is a clear need for performance-based resilience standards that take a systems perspective to maximise the life-cycle of infrastructure assets while minimising their impacts on the surrounding environment. Having a collaborative national process for all stakeholders to agree on resilience measures and codes would encourage ownership amongst stakeholders and ensure smoother and wider adoption.

Action point for CDRI: *Develop 'Resilient Infrastructure Standards' for various sectors and different risk contexts. These could be coupled with an independent certification mechanism to promote their world-wide adoption.*

Country in focus : United Kingdom

UK's National Infrastructure Commission is an executive agency of the UK Treasury, set-up to provide impartial, expert advice and make independent recommendations to the government on economic infrastructure. Part of its remit is to produce a National Infrastructure Assessment (NIA) once in every parliament, setting out the NIC's assessment of the UK's long-term infrastructure needs over a 30-year horizon and providing recommendations to address those needs.

In 2018, the Commission has taken up the task to examine the resilience of UK's infrastructure and consider what action government should take to ensure that infrastructure can cope with future changes, disruptions, shocks and accidents.



T1C - Recovery and reconstruction

- Pre-disaster recovery planning and arrangements are the most effective ways to ensure building back better (BBB). Building back better includes:
 - BBB stronger – includes risk informed building standards, smart spatial planning, pre-approved designs and technical assistance.
 - BBB faster – includes ex-ante contracts for debris removal and construction, contingent financing, rapidly scalable social protection, and streamlining the allocation of recovery funding using pre-developed templates for livelihoods, industry, and infrastructure recovery.
 - BBB inclusive – includes social protection, programs, ensuring reconstruction doesn't overlook low - income communities.
 - These three measures can reduce global annual losses by 12% (USD 65 bn), 14% (USD 75 bn) and 9% (USD 52 bn) respectively. This can free up funds for future development.
 - Blended finance options and mechanisms that combine central government support with the use of debt and insurance instruments can provide capital for faster recovery and reconstruction. These need to be supported by capacities and institutional mechanisms to manage recovery planning and implementation in order to ensure that opportunities for building back better are harnessed.

- Recovery processes need to be more inclusive of local communities and the most vulnerable. The business as usual practices of assessing post-disaster damage and loss often do not account for infrastructure that is not a pre-defined asset class (e.g. village roads, community spaces, etc.). No assessments lead to no recovery plans, and hence it is left to communities to self-invest. There is a need, therefore, for baseline assessments of local systems, building local capacities through skill transfer to communities, and enhancing political and financial commitment to enable inclusive recovery processes.
- Recovery needs for both intensive and extensive disasters must be addressed. This includes the identification of affected critical infrastructure, decisions on the allocation of funds, and building knowledge over time.

Action point for CDRI: Support nations affected by disasters to assess damages to strategic and local infrastructure and to develop strategies for stronger, faster and inclusive recovery and reconstruction.

Country in focus : JAPAN

Japan has a pre-defined recovery framework that allows local governments to access funds from the central government to recover from the impacts of a disaster. The Package Programme to Support Recovery Livelihoods and Industry was applied in the wake of the Torrential Rains of July 2018 and the Hokkaido Eastern Iburi Earthquake of September 2018. It aims to coordinate a programme focusing on issues to be addressed immediately for the recovery of livelihoods and industry in the affected area and to use the reserve fund to smooth the implementation of the Programme. The Programme makes reserve fund available, as appropriate, so that the affected people are reassured, and the affected local governments can take actions for recovery and reconstruction without financial concern.

The program also aims to expedite the emergency recovery, considering the details of local circumstances caused by the disaster and to pursue the recovery of local economy in the affected area and provide support to it with close communication with the aims to encourage affected SMEs to continue their business with predictability and hope.





Dr. Krishna Vatsa from UNDP moderating the session on 'Finance for disaster resilient infrastructure'

T2 - Policy landscape

Infrastructure resilience needs to be looked at in a system of systems perspective. National governments will have to provide the institutional basis for the implementation of a systems approach. Three typologies of development contexts helped to unpack the issues and challenges faced by countries at different levels of infrastructure growth, economic development, and geographical characteristics. While these contexts present a large diversity of challenges, the sessions brought together countries with similar characteristics to identify common issues and to discuss the institutional arrangements required to build disaster resilient infrastructure in each context.

T2A - Emerging nations with large investments in new infrastructure

- Rapid urbanisation, steady economic and population growth, and a growing middle class are driving the demand for large long-term investments in infrastructure in emerging economies. There is an urgent need to address the structural issues that underpin this development and put in place risk estimation, standard development, and governance arrangements, to ensure that all new infrastructure development is resilient to climate

change and disasters impacts. This will require these nations to take sustainable and climate resilient pathways rather than continuing with the business as usual practices from the past; and to act immediately to address future uncertainties despite capacity gaps and financial constraints.

- Government departments regulating various types of infrastructure usually work in silos. The lack of an overarching strategy for resilience building leads to a lack of coordination between the departments and across levels of government. The systems of systems approach points to the need for a national level strategy that understands the interactions between various infrastructure systems and harmonises policies and plans for national resilience building.
- The lack of regularly updated accurate local level data on hazards, vulnerability, exposure, and impacts of disasters is a primary constraint to decision making for infrastructure resilience. Governments need to provide systems, frameworks, formats, and platforms for sharing risk data to aid proper decision making.

Country in focus : ARGENTINA

Argentina has a national platform for national, territorial and local level management. This platform uses geo-referenced data from local levels to map and plan for, and implement local and national actions for sustainable development. Their Plan-Project-Work-Impact model allows them to identify areas with least achievement of development indicators and target them with the appropriate interventions in a regionally integrated manner. Since 2017, the National System of Integrated Risk Management (SINAGIR) has been integrated into the Territorial Planning System and supports risk-informed development planning in the country in line with the Sendai Framework for action.



T2B - Advanced economies with a focus on refurbishment and replacement of infrastructure

- Advanced economies face the two-fold challenge of building new infrastructure while simultaneously rebuilding or upgrading aging infrastructure assets to respond to the challenges posed by climate change and urbanisation. Countries like Canada and the UK have begun the task of revising standards for critical infrastructure assets in light of new hazard profiles.

- Advocating for investments in upgrading and retrofitting of existing assets can be enabled by the development of ‘Resilience Standards’ supported by a rating system. Such a system will help policy-makers to justify higher upfront costs and prioritise expenditures that improve infrastructure resilience in the long-term.
- Advocating for resilience through a purely economic lens may not yield results. There is a need to reconsider how these issues are communicated to non-technical stakeholders who may not be convinced by technocratic words. It may be more effective to use ‘hearts and minds’ arguments and to explain how the issues affect people and communities.

Country in focus : CANADA

Canada has initiated its Climate-Resilient Buildings and Core Public Infrastructure Initiative in order to develop decision support tools, including codes, guides and models for the design of resilient new buildings and critical public infrastructure (CPI) and rehabilitation of existing buildings and CPI in key sectors to ensure that existing and future climate change and extreme weather events are addressed. This 5-year project under the Pan Canadian Framework on clean growth and climate change, has been initiated with \$42.5M in funding from Infrastructure Canada, a federal department responsible for public infrastructure in the country. The program is currently working on understanding how critical services are behaving under the changing climate hazards in order to develop guidelines on adaptation of existing infrastructure.



T2C - Small Island Developing States (SIDS) and Landlocked Developing Countries (LLDCs)

- These nations are vulnerable to shocks and slow onset stresses experienced domestically as well as in neighbouring countries. This is due to their narrow resource base, smallness of their markets, geographical location, dispersion, remoteness, and population density. SIDS and LLDCs, due to their poor economic growth, struggle to put in place policies and finances to build infrastructure resilience. Building disaster resilient infrastructure is a major challenge in both these contexts. Leveraging of technologies like remote sensing, robotics and Artificial Intelligence may help in overcoming human resource constraints.
- Resilient telecommunications infrastructure is a key consideration for developing nations to leverage their intellectual capital and improve their international exposure and competitiveness. Both SIDS and LLDCs also face challenges with regards to data and energy

connectivity. Their lack of access to major internet backbone connections limits their sources for internet connectivity and limits their capacity to upgrade the capacity of those connections. Information Technology is also an important component of infrastructure resilience.

- These nations face the need to strengthen their institutional setup for enforcing implementation of disaster resilient standards at all levels. This may include the creation of an apex body at the regional level, harmonization of regulatory systems, and pooling technical expertise to make up for the gap in available capacities. They also need to strengthen institutional arrangements for the collection, collation, analysis, and sharing of risk data. Risk assessments, considering the dynamic nature of risks, need to be incorporated as a continuous process and not a one-off exercise.
- The establishment of partnerships at international, regional, national levels between their ministries, agencies, private sector and other key stakeholders in the areas of risk assessment, climate change resilience, disaster risk reduction and insurance are essential to the developing the resilience of infrastructure in these nations.

Country in focus : TRINIDAD AND TOBAGO

Trinidad and Tobago has implemented a Critical Facility Protection Policy Framework since 2010. This framework aims to make critical facility networks resilient to existing and emerging threats by integrating the continuous protection of these facilities with routine public and private sector business practice. They use a top-down process to decision making which includes political and administrative involvement, budgetary allocation & financing packages, multi-level, intra and inter-sectoral linkages and bottom-up which includes buy-in, participatory and need-based approach.



T3 - Financing disaster resilient infrastructure

- While context-specific challenges may not allow for generalizable best practices that are applicable around the world, the alignment of the global governments and the private sector to achieving the Sustainable Development Goals (SDGs) presents a great opportunity to build partnerships that can direct infrastructure investments into resilient pathways.

- The lack of dependable risk data is the main hurdle to incorporating disaster and climate risks onto the balance sheets of infrastructure investors. There is a need for governments to continue investing in public goods like risk assessments and early warning systems to support disaster risk mitigation and enable the integration of risk reduction in infrastructure systems.
- There is a need for promoting a political will to invest in higher upfront costs in the short-term to achieve lower-life cycle costs in the long-term. Public and private sector can come together and understand how to balance investment and risk and also how much of the risk to be shared in the private sector and how much of this risk is to be retained by the public sector. There is a further need to improve commitments to invest significantly in mitigation funds at the national and regional level.
- Financing systems need to be strengthened to invest in the project design and embed resilience aspects into projects from the design stage. There is a need for a pipeline of bankable resilient infrastructure projects and enabling the integration of risk reduction in infrastructure systems design and operation.
- While insurance experts are familiar with disaster risks, there is a need to educate the wider financial sector audience on disaster risk considerations by improving risk communication to better target the banking, investment and financial regulators. The aim would be to get the private and public sector investors to hold disaster and climate risks as contingent liabilities on their balance sheets on an annualized basis.

Action point for CDRI: *Work towards the development and recognition of a new asset class for 'Resilient Infrastructure' in order to promote demand side uptake and incentivise investments in resilient infrastructure.*

WS 1- Perspectives of Multilateral organisations

- Multilateral and bilateral banks and development organizations have been at the forefront of working towards the 2030 agendas – SDGs, Sendai Framework and the Paris accord. They have been involved in all stages and aspects of risk reduction and have access to the latest knowledge, methodologies, and skills and can offer a wide range of approaches, products, and services to countries to upgrade their systems and capacities to help nations to implement the resilience agenda.
- There is a need for a multi-dimensional, multi-stakeholder approach for nuanced implementation across all sectors. There is a clear need to increase accountability to build the stakeholders' trust in risk information, regulatory governance, and professionals, in order to achieve better compliance and results.

- Investments to strengthen disaster resilience remain low, partly due to a lack of information on the direct and indirect socio-economic impact of disasters, as losses and damages are often not fully recorded. It also reflects the insufficient understanding of public investment processes and possible opportunities to integrate risk reduction measures into development planning.
- Multi-lateral organizations have the capacity to support the development of a data ecosystem that can be leveraged to influence paradigm changes and actions towards building the resilience of infrastructure systems.

FE - Emerging technologies

Digital Technologies

- Digital technologies include integrated sensors, IoT devices, drones, wireless communications, satellites, RADAR/LIDAR, APIs, cloud storage and computing, block-chain, machine learning and artificial intelligence. These can be used to build infrastructure resilience through supporting – assessments, mapping, monitoring, diagnostics, communication, analysis, forecasting, early warning, design, scheduling, prioritization, scaling up, automation, consumer interfaces, risk data sharing and advocacy.
- Digital technologies can be used in conjunction with participatory methods, like crowd-sourcing and hack-a-thons, to harness and multiply the potential of big data. This can be used to understand complex patterns of risk and to generate innovative solutions to resilience problems.
- Many companies are working on developing full-fledged decision support systems for pre and post-disaster infrastructure planning and prioritization. Governments, NGOs and communities need to work together to utilise these technologies in a responsible manner for building disaster resilience.

Engineering and nature based solutions

- Modern construction technologies provide a substantial improvement of the durability of concrete structures, but also of the seismic resistance of infrastructure. The recent improvement in concrete technologies can significantly improve the durability of concrete, while new materials, carbon and other types of fibers are being used for seismic upgrading of existing infrastructures.
- Engineering solutions are expensive and effective but have a high environmental impact, on

the other hand, nature based solutions (NBS) are cheaper and less effective but help to preserve the environmental assets. Planners must use hybrid solutions that balance the cost, effectiveness and environmental impacts to improve the resilience.

- Application of digital technologies cannot substitute proper design and construction of hard infrastructure, but can greatly improve the life-cycle resilience of an asset.

Way Forward

Need for discussions around the world

One of the key insights cutting across all the sessions was the need for a global discussion on the disaster and climate resilience of infrastructure systems. Improving disaster resilience is an iterative process where each failure exacts a tragic cost. Opportunities to learn and improve are relatively rare and inordinately expensive for individual nations. For some nations facing frequent extensive and intensive risks, these costs may have severe implications on their national economies and consequently on their attainment of the SDGs. It is clear that accelerating the pace of improving the resilience of infrastructure systems worldwide will require a concerted global effort.

Small Island Developing States (SIDS) are on the frontlines in terms of experiencing the impacts of climate change. Their small size, limited resources, geographic dispersion and isolation from markets; place them at an economic disadvantage, including challenges to develop economies of scale. Similarly the **Landlocked Developing Countries (LLDCs)** dependence on the resilience of their neighbours' infrastructure systems for the smooth functioning of their own economy makes them unable to build domestic resilience through their efforts alone. It is evident that these nations are severely constrained in their capacity to address the challenges of building climate and disaster resilience by themselves. They increasingly rely on the support of and partnership with the international community to realize their sustainable development objectives.

The **emerging economies** of some developing countries are in the process of building the foundational physical infrastructure that will serve as the basis of growth and development for decades to come. This situation presents a unique opportunity to 'get it right'. To ensure that this growth builds in 'resilience' instead of 'risk' requires urgent actions to develop the requisite capacities and systems. The current time presents an opportunity for emerging nations to learn from the past experiences of advanced nations and in a way 'tunnel to the end' to adopt solutions that have proven results.

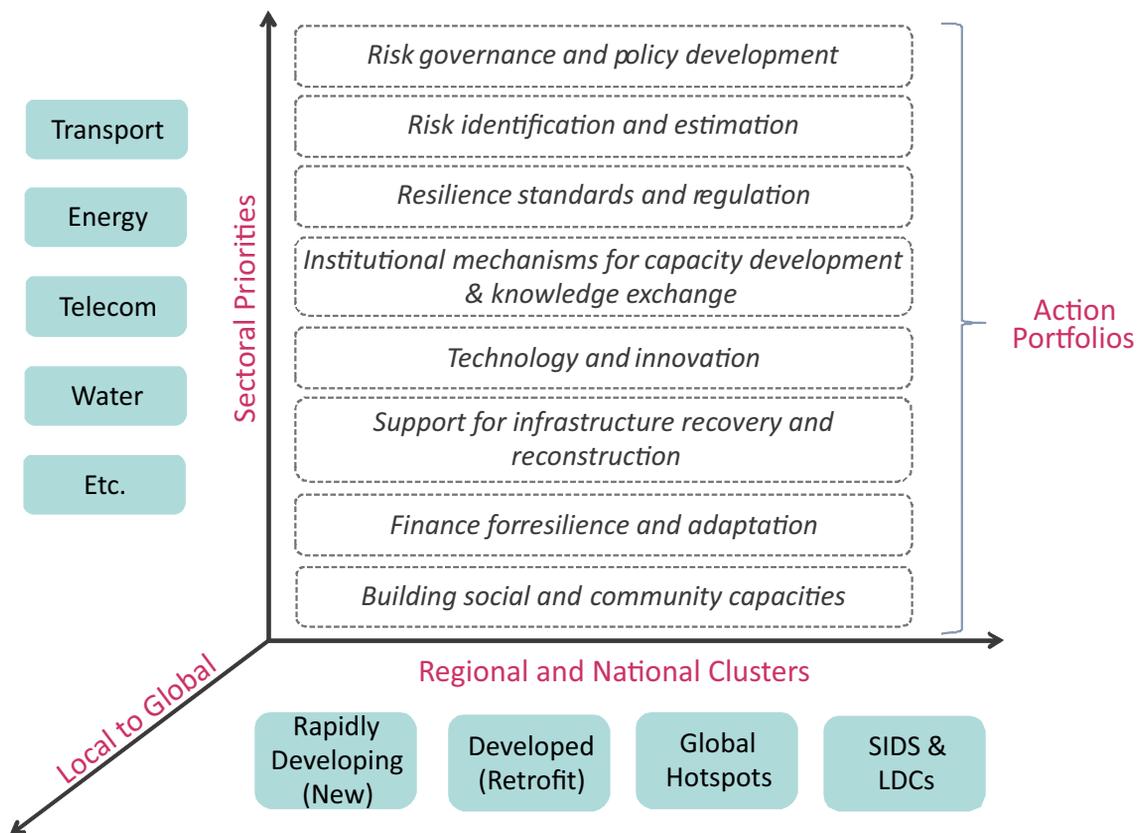
By virtue of the size of their capital stock, technologically and economically **advanced nations** face the maximum economic losses in absolute terms due to impacts of disasters. They face the challenges of reinforcing, protecting, and upgrading existing infrastructure in light of an increasingly uncertain hazard profile. Pooling together knowledge and resources with other advanced nations can help them to proliferate scientific knowledge and best practices that can ensure the climate and disaster resilience of an increasingly global and interconnected infrastructure system.

The niche for CDRI

Physical infrastructure underpins the achievement of all 17 Sustainable Development Goals and about 92% of their targets. This infrastructure will be at threat from natural hazards, the profile of which will change with the changing climate during its long life-cycle. Thus the concept of disaster resilient infrastructure and the tasks of CDRI lie at the intersection of all three global 2030 agendas, i.e. The Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction and the Paris Climate accord. There are many initiatives on different aspects of disaster

risk reduction and many initiatives on infrastructure development in different sectors. However, few significant ones address the notion of disaster resilience for infrastructure in a range of countries with different disaster risk and development contexts. There are fewer concrete initiatives that work at the intersection of Sendai Framework, Sustainable Development Goals (SDGs) and, Climate Change Adaptation with a focus on infrastructure. The CDRI is aimed at addressing this niche.

Emerging areas of collaboration



The outcome document (page no. 29) circulated at the workshop envisioned that the CDRI would follow the principle of 'form follows function' and co-create a fit-for-purpose organisation. In line with this, it identified 8 thematic areas around which the CRDI could be developed. These have been identified as 'Action Portfolios' in the above diagram. These portfolios are placed within the three dimensions of scale, sector and region. These dimensions and portfolios have been elaborated on below.

The three dimensions :

Sectoral priorities

While there is a need for a 'system of systems' perspective to planning and managing risk to and due to infrastructure, the implementation of infrastructure projects is usually carried out in sectoral silos. Actions taken towards improving resilience will flow through these silos and hence must be customized to the characteristics of the sector and its comprising infrastructure. Each sector has its sector-specific needs and forms of governance that need to be addressed in that context. The role of the CDRI would also be to find interconnected relationships of cause and effect between these sectors and to direct and priorities investments for focused outcomes, in line with the system of systems approach.

Regional and national clusters

National governments will have to provide the institutional basis for the implementation of a systems approach. Governments will have to consider mechanisms for mainstreaming of disaster risk management considerations at all levels and a harmonisation of policies to build national and regional resilience. All nations have different characteristics of infrastructure growth, economic development, and geographical characteristics. While these contexts present a large diversity of challenges, the typologies attempt to bring together countries with similar contexts so as to help identify the institutional arrangements required to build disaster resilient infrastructure in their context. The additional role of the CDRI would be to enable cross-learning between these regions and promote financial and technological flows, in line with the global climate commitments and sustainable development agenda.

Global to local and vice-versa

Actions will have to be taken at all levels to be effective. Global discourses can provide guidance and alignments for national priorities. Nations will have to balance local and national priorities through effective engagement with all stakeholders in the infrastructure construction and maintenance process. Infrastructure resilience should support the resilience of local communities.

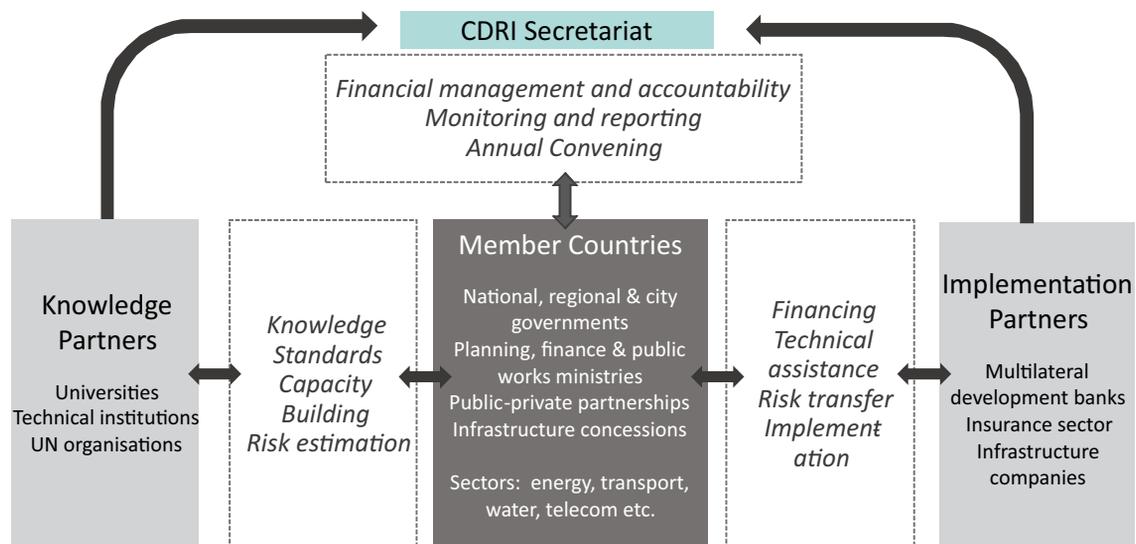
Action portfolios :

The following action portfolios will function across the three dimensions described above:

- 1. Risk governance and policy development:** The development of governance and policy arrangements required to enable the integration of disaster and climate resilience concepts in all infrastructure creation.
- 2. Risk identification and estimation:** The identification and estimation of risk to and from infrastructure from large and small hazards, from the macro to micro scales.
- 3. Resilience standards and regulation:** Adoption of mechanisms required for developing, enforcing, and updating scientific standards and regulations for infrastructure resilience in light of changing technology and risk profile.

- 4. Institutional mechanisms for capacity development and knowledge exchange:** Enabling the exchange and spread of scientifically accurate knowledge enabling the contribution of all stakeholders to building the resilience of infrastructure systems.
- 5. Technology and innovation:** Harnessing and leveraging the power of technology to address constraints on accuracy, scale, reach and capacity in constructing, operating and recovering infrastructure systems.
- 6. Infrastructure recovery and reconstruction:** Ex-ante development and adoption of mechanisms for assessing losses, estimating needs, and channelling adequate funds to disaster-affected areas in a timely manner.
- 7. Financing resilience and adaptation:** Risk financing strategies for each nation will depend on its capacity, risk appetite, resources, and willingness to manage risk. Appropriate financing can incentivise the resilience of infrastructure systems.
- 8. Building social and community capacities:** Building the capacities of local communities to participate in the process of creating and sustaining small and large scale infrastructure, so as to enhance disaster and climate resilience of the community and its surrounding infrastructure.

Proposed preliminary form of the coalition



As depicted in the figure above, member countries, supported by a Secretariat, will work with implementation and knowledge partners to deliver on the vision of the CDRI. The Member countries will play the central role in decision-making and setting priorities at national, regional and local scales, as well as across key sectors. They will be aided by Knowledge Partners in creating standards, estimating risk and building capacity. The Implementation Partners will provide technical support for financing, procuring, and risk transferring. The CDRI Secretariat will help enable the coordination between all these pools of actors, apart from providing support for financial accountability, monitoring, and knowledge management and dissemination. The CDRI Secretariat will also promote the visibility of the needs of DRI at various global forums to gain from the existing momentum, as well as create new partnerships and innovative financing solutions across multiple actors and regions.

Connections with other global initiatives

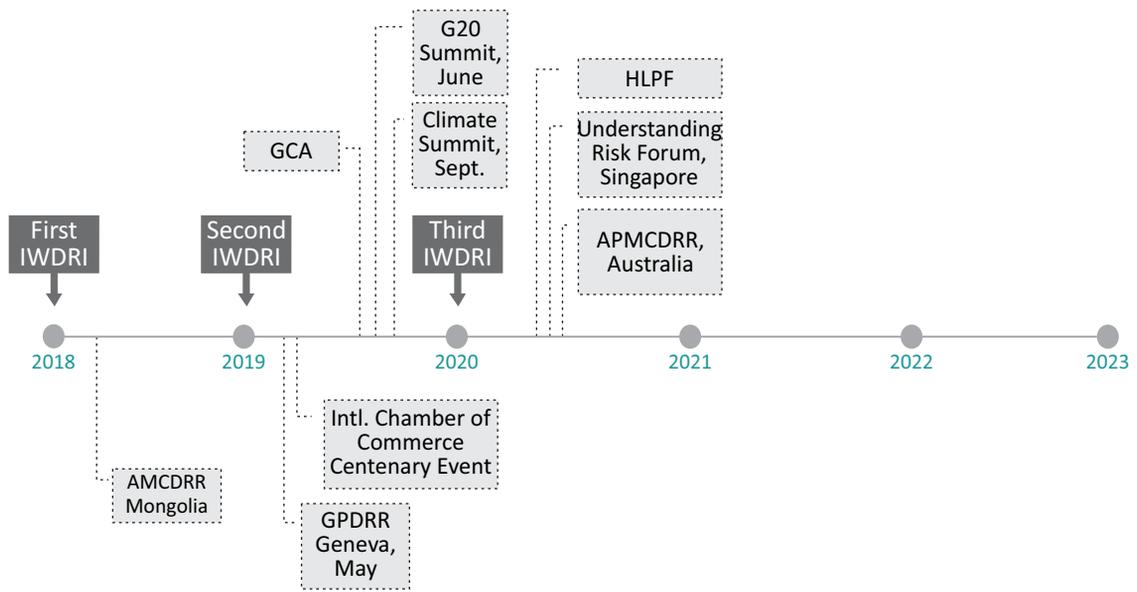
As an initiative that aims to address resilient growth of infrastructure, in the face of climate change, the CDRI finds potential lines of synergies with agendas of most important global forums. While other forums address the broader perspective of bringing in sustainable growth, the CDRI can help bring an intellectual and practical “connectedness” in the area of resilience, specifically relating to large infrastructure systems that demand a heavy long-term investment.

The urgency of mindful, climate-aware investment in infrastructure is being brought to the forefront at global forums such as the G20 Summit. The G20 Leaders' Declaration at Buenos Aires 2018 recognised, "the importance of comprehensive adaptation strategies, including investment in infrastructure that is resilient to extreme weather events and disasters." It supported actions and cooperation in developing countries, especially those that are particularly vulnerable, including small island states [Point 19]. Through various working groups, mainly the “Development Working Group (DWG)” and “Climate Sustainability Working Group”, the G20 Presidency is encouraging collaboration in the areas of "Quality Infrastructure Investment" and better financial regulations for infrastructure. The CDRI can work to bring in aspects of climate and disaster resilience under these areas.

The UN Climate Summit 2019 has “Resilience and Adaptation” as one of its six key action portfolios to take transformative steps to mitigate climate impact. The recently launched Global Commission on Adaptation (GCA), overseen by former UN Secretary-General Ban Ki-moon, aims to enhance the political visibility of adapting to climate change, focussing upon on solutions, catalysing the global adaptation movement and accelerating action. The Commission will present a flagship report at the UN Climate Summit in September 2019, which will include a chapter on the adaptation of infrastructure systems, a consultative workshop to gather specialised stakeholders inputs on this chapter on infrastructure was organised by GCA on the margins of IWDR1 2019.

By bringing on board potential country and agency partners, post-workshop engagements of the IWDR1 will be pursued in various capacities at the following forums. These will also serve as channels of pursuing collaborative projects under the institution of the CDRI:

1. Global Platform for Disaster Risk Reduction (GPDRR), 2019
2. UN General Assembly Special Thematic Session on Water and Disasters, June 2019
3. UN Climate Summit 2019
4. Asian Ministerial Conference for Disaster Risk Reduction 2020



Timeline of Global Events and CDRI development

Appendix



Prof. Jim Hall of the Environmental Change Institute, Oxford University, presents the keynote address

Outcome Document

1. The Second International Workshop on Disaster Resilient Infrastructure (IWDR I) was held in New Delhi on 19-20 March 2019. The workshop was organized by the National Disaster Management Authority (NDMA), Government of India, in collaboration with the United Nations Office for Disaster Risk Reduction (UNISDR), and in partnership with the United Nations Development Programme (UNDP), the World Bank Group and the Global Commission on Adaptation (GCA). The event brought together more than 270 participants from 34 national governments, multilateral development banks, United Nations agencies, the private sector, policy think tanks and academia. The workshop was held in the context of the Government of India's proposal to establish a global ***Coalition for Disaster Resilient Infrastructure (CDRI)***.
2. Over two days, the participants deliberated on the importance of facilitating disaster and climate resilient infrastructure including through risk assessments, standards and regulation, recovery and reconstruction and appropriate financial, governance and institutional arrangements. The workshop addressed policy challenges related to disaster and climate resilient infrastructure in countries that need to make large investments in infrastructure; others where existing infrastructure stock is completing its life cycle and needs to be replaced or refurbished; and other contexts, including small island developing countries and landlocked countries.

The workshop discussed the supportive role of the financial sector, multilateral development banks, UN agencies, technical organizations and the private sector in strengthening the capacities of local and national governments to deliver resilient infrastructure. Opportunities and challenges in achieving disaster and climate resilience were

presented across key infrastructure sectors, including water, energy, rail, ports, freight corridors, and aviation. The workshop also discussed the role of emerging technologies and innovation in the development of resilient infrastructure networks.

3. The workshop participants took note of the fact that infrastructure losses from disasters and climate events are escalating worldwide. At the same time, unprecedented growth of investment in infrastructure sectors is expected in the coming years. Climate change will add another level of complexity and uncertainty in the design of infrastructure systems for the long-term. It will also pose multiple challenges in the adaptation of existing systems. The infrastructure systems of the 21st century are unprecedented not only in terms of scale but also in terms of their local to global interconnectedness. Infrastructure system disruptions in one location can now disrupt global supply chains, creating impacts that are difficult to predict.
4. This presents both a challenge as well as an opportunity. The opportunity is that if these massive investments in new and refurbished infrastructure are made resilient, then this will make an important contribution to the reduction of disaster and climate risk, and the achievement of the Global Targets of the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals and the Paris Climate Agreement. ***The challenge is that a transformation is now required in how infrastructure is designed, constructed, operated and maintained, and in the financial incentives, standards, governance arrangements and capacities that are required to facilitate resilient infrastructure, and the commitment to leave no one behind.***
5. No country can address this challenge alone. It requires a framework of collaboration that engages countries from all regions and with different infrastructure challenges as well as other organisations that can facilitate the required transformation. ***The Coalition for Disaster Resilient Infrastructure (CDRI) is proposed to provide that framework.***
6. The Coalition will serve as ***a platform where knowledge is generated and exchanged on different aspects of disaster and climate resilience of infrastructure.*** It will bring together technical expertise from a multitude of stakeholders and in doing so, it will create a mechanism to assist countries to upgrade their capacities and practices with regard to infrastructure development in accordance with their risk context and economic needs. The Coalition will be co-created by countries at all stages of development to access and disseminate knowledge and resources to from other members to make their infrastructure resilient and thus, contribute to each other's economic growth and sustainable development.
7. The CDRI must be inclusive of the range of stakeholders involved in the design, development, maintenance, operations and regulation of infrastructure systems. While governments have a leading role in setting policies and establishing the regulatory environment for infrastructure, private investments are playing an increasingly larger role in infrastructure design, development and operation. Financing institutions, multilateral banks and the insurance sector have a critical role in providing both finance as well as technical assistance and capacity

building. Specialised technical and research organisations are developing risk and resilience metrics, standards, knowledge products, technologies, and innovative approaches to develop disaster and climate resilient infrastructure that should be harnessed. Community-led processes and networks are taking the lead in community-based climate adaptation and disaster risk reduction.

CDRI must play the role of ***a knowledge, innovation and institutional development platform*** that connects these resources with regional and sectoral demands for resilience, including provision of resilient economic infrastructure (transport, telecom, energy, water), social infrastructure (health, education) and ecological infrastructure (that provide critical ecosystem services like clean water, air, food, biomass and waste management) which are critical for securing humanitarian and development services for all, in particular the most vulnerable.

8. The CDRI will complement the 'Quality Infrastructure' initiative. This will promote a deeper understanding of issues of mutual interest such as addressing the infrastructure financing gap, enhancing connectivity, greater interoperability and will also enable meeting the SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation) and SDG 11 (Make cities and human settlements inclusive, safe, resilient and sustainable).
9. The vision, mission, goal and objectives of the CDRI should be explicitly linked to the post- 2015 development agenda including the achievement of the Sustainable Development Goals, the Paris Climate Agreement and the Sendai Framework.
10. In the development of the CDRI, the form must follow function, and a fit for purpose institutional design must be co-created. The functions of a global Coalition for Disaster Resilient Infrastructure (CDRI) could be developed around the following thematic areas: ***(a) Risk governance and policy development; (b) Risk identification and estimation; (c) Resilience standards and regulation; (d) Institutional mechanisms for capacity development, and knowledge exchange; (e) Technology and innovation for disaster and climate resilience; (f) Support for infrastructure recovery and reconstruction; (g) Finance for resilience building and climate adaptation; and (h) Building social and community capacities to enhance disaster and climate resilience.***
11. Following the IWDR 2019, a Secretariat of the CDRI will be established in New Delhi, with support from the Government of India, UNISDR and other interested Governments and partner organisations to facilitate the development of the CDRI in the short term.
12. The Secretariat will undertake wide-ranging consultations with interested countries and other partners on the final form and functions of the CDRI.
13. The Secretariat will define the scope of the CDRI and propose appropriate governance arrangements that could facilitate the participation of governments, multilateral

development banks, organisations of the United Nations, and specialised technical and research organisations with the CDRI. This would include financing mechanisms for the CDRI and a resource mobilization plan.

14. In parallel, it would facilitate a number of collaborative start-up activities for the CDRI in order to generate momentum and produce short-term results. These could include, inter alia, the development of knowledge products and platforms, national and sector-specific case studies, best development of knowledge products and platforms, national and sector-specific case studies, best practices and a global review of disaster and climate risk and resilience for infrastructure. These could provide a baseline for the CDRI and the discussion around the development of standards, financial and compliance mechanisms and appropriate governance arrangements.
15. The Government of India and the CDRI Secretariat will continue to consult with interested countries and other relevant partners on the structure and financing of the Coalition with a view to a formal launch of the CDRI later in 2019. At the same time, the CDRI has the unique opportunity to align with the infrastructure resilience related elements of ongoing regional and global initiatives such as the High Level Political Forum (HLPF), the Climate Summit 2019, Global Platform on Disaster Risk Reduction, G20 Summit and Infrastructure Working Group meetings, the Asia-Pacific Ministerial Conference on Disaster Risk Reduction and the GCA.
16. There is value in conducting a focused workshop on disaster and climate resilient infrastructure as a platform for tracking progress, knowledge exchange, innovation and to foster collaborative initiatives. In the future, IWDRR could be hosted by India and other partner countries by rotation.

List of Participants

Country Representatives :

1. Afghanistan
2. Argentina
3. Australia
4. Bhutan
5. Canada
6. Chile
7. China
8. Fiji
9. France
10. India
11. Indonesia
12. Italy
13. Jamaica
14. Japan
15. Malaysia
16. Maldives
17. Mauritius
18. Mexico
19. Mongolia
20. Myanmar
21. Nepal
22. Netherlands
23. Nigeria
24. Peru
25. Russia
26. Saudi Arabia
27. South Africa
28. South Korea
29. Sri Lanka
30. Switzerland, SBB AG
31. Thailand
32. Trinidad and Tobago
33. UK
34. USA

International Organisations :

35. 100 Resilient Cities
36. Asia Air Survey Co. Ltd.
37. Asia Disaster Preparedness Centre
38. Asian Development Bank
39. Asian Infrastructure Investment Bank
40. Challenge Co. Ltd. (alarm systems)
41. DFID
42. EU
43. European Investment Bank
44. Facebook
45. GIZ
46. Global Commission on Adaptation
47. Google
48. Green Climate Fund
49. Hoover Institution, Stanford University
50. IBM
51. Insurance Development Forum
52. International Code Council
53. Ishigaki Japan
54. Japan Bosai Platform
55. JICA
56. Keio University, Japan
57. KFW
58. Kokusai Kogyo
59. New Development Bank
60. Risk Nexus Initiative
61. Sacertis
62. SARMAP, Switzerland
63. Swiss Development Corporation (SDC)
64. Swiss RE
65. Tonichi Engineering Consultants
66. U.S. Forest Service International Programs
67. UNDP
68. UNESCAP
69. UNICEF
70. UNISDR
71. University of Oxford
72. UNOPS
73. US SIF: The Forum for Sustainable and Responsible Investment / Oppenheimer Funds
74. USAID
75. Weather News Inc.
76. World Bank Group

Government of India Institutions :

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| 77. | Prime Minister's Office | 87. | Ministry of Shipping |
| 78. | 15th Finance Commission of India | 88. | Central Water Commission |
| 79. | NITI Aayog (National Institution for Transforming India) | 89. | Airports Authority of India |
| 80. | Principal Scientific Advisor | 90. | State: Uttarakhand |
| 81. | Ministry of External Affairs, India | 91. | State: Tamil Nadu |
| 82. | Ministry of Home Affairs | 92. | State: Sikkim |
| 83. | Ministry of Railways | 93. | State: Odisha |
| 84. | Ministry of Science and Technology/DST | 94. | Andhra Pradesh State Disaster Management Authority |
| 85. | Ministry of Communications (Department of Telecommunications) | 95. | Bihar State Disaster Management Authority |
| 86. | Ministry of Power | 96. | National Disaster Management Authority |

Domestic Institutions India :

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| 97. | AECOM | 115. | Insurance Institute of India (III) |
| 98. | Bureau of Indian Standards | 116. | International Commission on Irrigation and Drainage |
| 99. | CBRI Roorkee | 117. | International Medical Corporation |
| 100. | Central Public Works Department | 118. | National Disaster Response Force |
| 101. | Central Road Research Institute | 119. | National Institute of Disaster Management |
| 102. | Council On Energy, Environment and Water | 120. | National Institute of Public Finance and Policy |
| 103. | Dedicated Freight Corridor Corporation of India Ltd | 121. | National Institute of Urban Affairs |
| 104. | Geohazards Society | 122. | National Insurance Academy |
| 105. | Geological Survey of India | 123. | NHPC (National Hydroelectric Power Corp.) |
| 106. | IIT Bombay | 124. | PricewaterhouseCoopers (PwC) |
| 107. | IIT Delhi | 125. | Ramboll India |
| 108. | IIT Gandhinagar | 126. | Research Design & Standards Organisation |
| 109. | India Meteorological Department | 127. | RMSI |
| 110. | Indian Institute of Human Settlements | 128. | SEEDS India |
| 111. | Indian Institute of Tropical Meteorology, Pune | 129. | Tandon Consultants Private Limited |
| 112. | Indian Road Congress | 130. | Tata Sustainability Group |
| 113. | Indian Space Research Organization | 131. | The Energy and Research Institute (TERI) |
| 114. | Indus Towers | | |

This report has been prepared by the

Interim Secretariat @ CDRI

Coalition for Disaster Resilient Infrastructure

National Disaster Management Authority

A-1, Safdarjung Enclave, New Delhi, India - 110029

E: cdri@ndma.gov.in, O: +91-11-26701700

<https://resilientinfra.org/iwdri/>