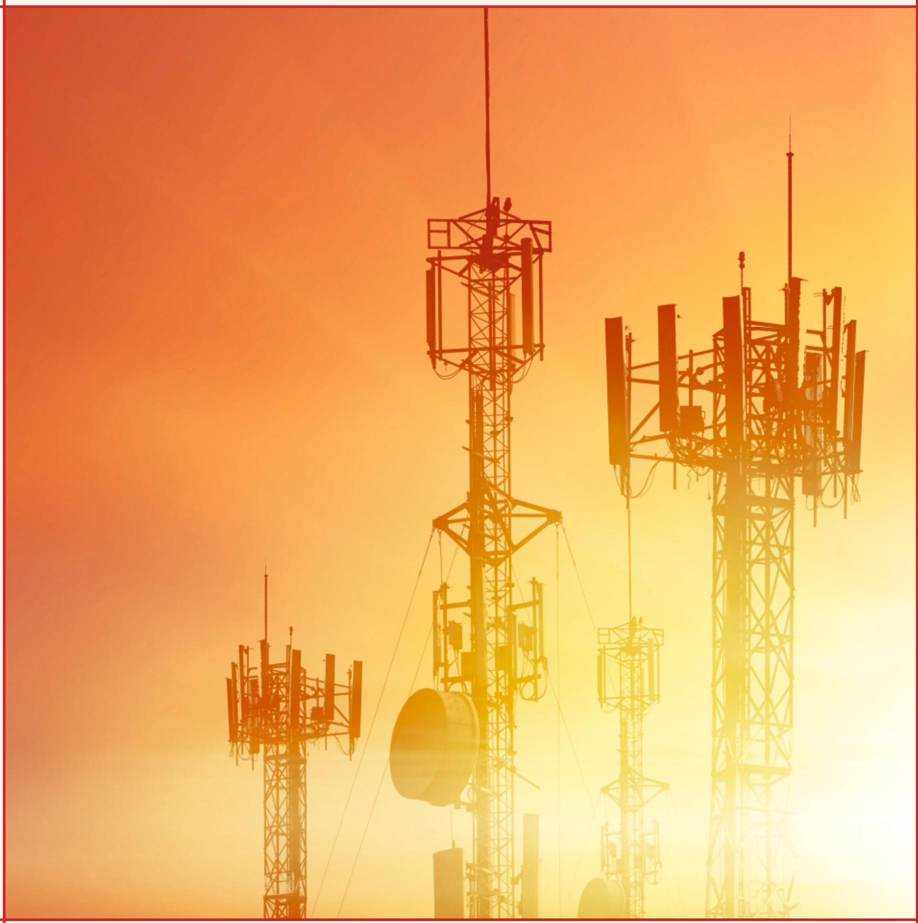
pwc

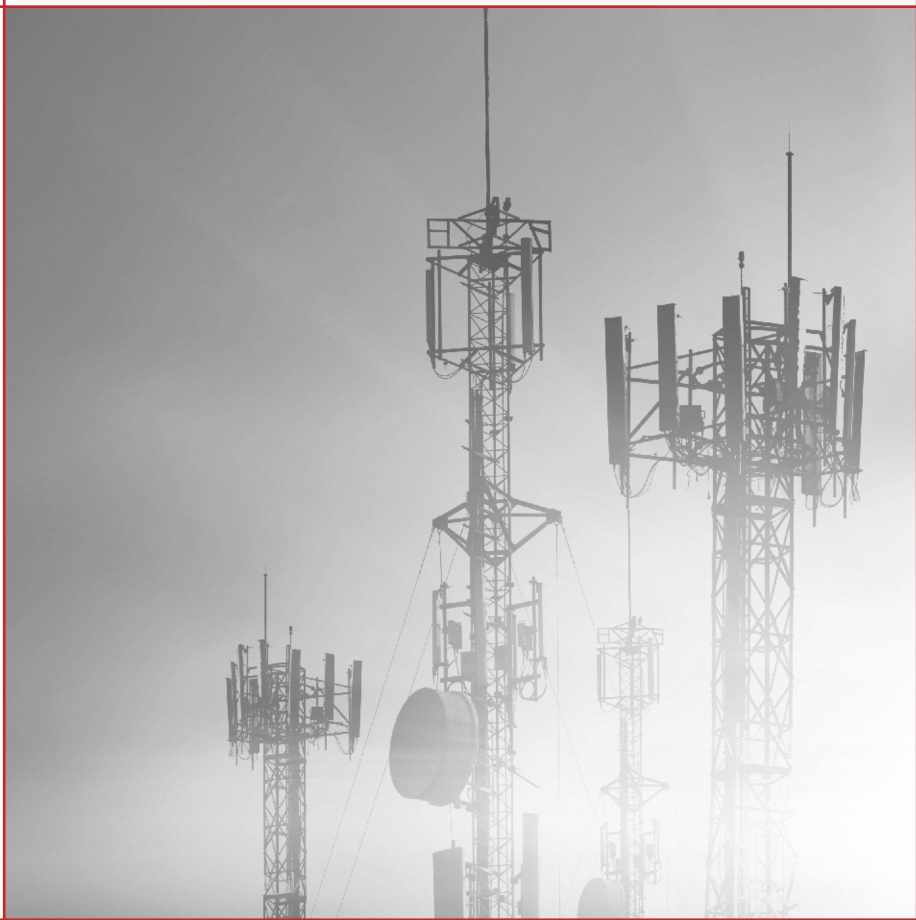
भारत दूरसंचार
DOT
INDIA TELECOM

CDRI
Coalition for Disaster Resilient Infrastructure



Policy Brief

National and Sub-national Disaster Risk and Resilience Assessment Framework and Roadmap for the Telecommunications Sector



Policy Brief

National and Sub-national Disaster Risk and Resilience Assessment Framework and Roadmap for the Telecommunications Sector

Section 1
Introduction

Disaster risks to infrastructure are on the rise globally, with some disasters occurring more frequently and others becoming more severe. According to the United Nations INFORM risk index, India is ranked 35th out of 191 countries in 2024-25.[1] In India, over 58 percent of the land is vulnerable to earthquakes, 12 percent to floods, 15 percent to landslides, and more than 10 percent to forest fires. Of India's 7,516 km of coastline, nearly 5,700 km is at risk from cyclones and tsunamis. Telecommunications, a critical infrastructure spread throughout the country, is susceptible to these hazards. Over the past decade, the telecommunications sector has contributed approximately 15 percent to global GDP and by 2030, the sector is projected to reach US$2.8 trillion, with a Compound Annual Growth Rate (CAGR) of about 6.2 percent between 2024-30. The expansion of the digital economy underscores the urgent need to protect this infrastructure from an increasing threat of natural hazards. Moreover, post-COVID-19 and with the United Nations' goal of delivering last-mile warnings by 2027, enhancing the disaster resilience of telecommunications infrastructure nationwide is increasingly vital.

To address this, the Coalition for Disaster Resilient Infrastructure (CDRI), in partnership with the Department of Telecommunications (DoT) and the National Disaster Management Authority (NDMA), Government of India has conducted a comprehensive study at both national and sub-national levels. This study aims to develop a Disaster Risk and Resilience Assessment Framework (DRRAF) specifically tailored to the telecommunications sector, along with an actionable roadmap for stakeholders at these levels. The project takes a system scale approach, encompassing first, middle and last-mile connectivity, interconnected infrastructure systems and a variety of technological options across different geographical areas (mountains, plains and coastal regions). The study proposes disaster resilience measures across five dimensions: Technical Planning & Design, Operations & Maintenance, Policy, Institutions & Processes (PIPs), Financial Arrangements and Expertise. These measures aim to achieve key outcomes such as reducing physical damage and financial losses, ensuring quick service restoration, enhancing disaster response capabilities, improving emergency connectivity, promoting peer-to-peer knowledge exchange and strengthening sectoral capacity.

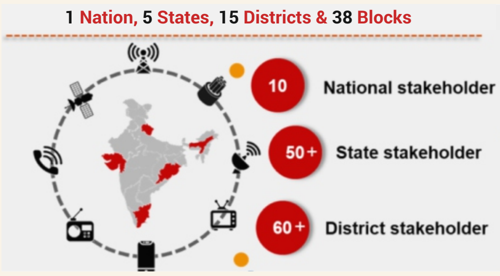


Figure 1:

Damaged telecommunication tower in Ganjam district, Odisha

[1] https://drmkc.jrc.ec.europa.eu/inform-index

Section 2

A. Project approach and methodology

The project adopts a 3E approach—Explore, Evaluate and Execute to understand existing disaster risk challenges on ground and assess the nature of risk and degree of vulnerability to comprehensively recommend optimal resilience interventions which are cost-effective, technically feasible, socially acceptable and nature-friendly. The detailed steps under 3E approach are outlined in the figure below:

Step 1: Explore

1. Stakeholder mapping and consultation
2. Desk research
3. Identify 3 most vulnerable districts across 5 states based on KPIs a) Population Density, b) Rural & Urban population share, c) Number of industries
4. Field consultation through Focused Group Discussion (FGD) & Key Informative Interview (KII)

Step 2: Evaluate

1. Multi-hazard risk mapping of telecom infrastructure
2. Assess disaster risk and resilience of telecommunication & its interdependent / interconnected infrastructure system
3. Identify the weakest element across all miles
4. Cost Benefit analysis of selected resilience intervention

Step 3: Execute

1. Develop disaster risk and resilience index for 5 selected states
2. Design comprehensive Disaster Risk & Resilience Assessment Framework (DRRAF) for the telecommunications sector
3. Develop actionable roadmap (short, medium and long term) for India and five states
4. Information dissemination

Figure 2:

Methodology envisaged for the study

Section 2

B. Key Outputs

B.1 Multi-hazard risk mapping:

A comprehensive multi-hazard risk mapping of telecommunication towers across India has been conducted, focusing on five selected states: Assam, Gujarat, Odisha, Tamil Nadu and Uttarakhand. This assessment analyses the exposure of the towers to eight natural hazards such as landslides, floods, cyclones, storm surges, lightning, forest fires, flash floods and earthquakes. Approximately 0.77 million telecommunication towers (data collected from the DoT) have been mapped on the GIS platform. The key findings are presented in Table 1.

1.1 National

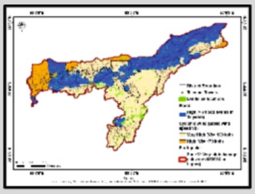
Hazard	Telecommunication towers exposed to hazards (in %)		
	Very High	High	Total
Flood	6	11	17
Cyclone	26.82	30	56.82
Earthquake	6.4	20.6	27
Landslide	2.23	1.96	4.19
Storm surge	3	1	4
Lightning	30	45	75

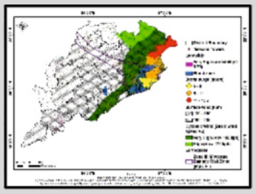
Table 1: Percentage of telecommunication towers exposed to various hazards at national scale

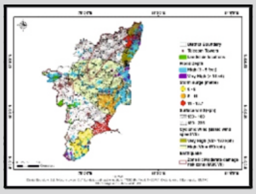
1.2 Five selected states

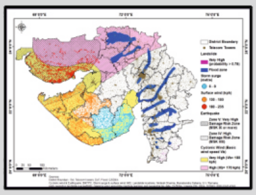
State & Telecommunication towers (in numbers)	Telecommunication towers exposed to hazards (in %)			
Assam (18388)	Flood (43)	Cyclone (83)	Landslide (5)	Earthquake (100)
Odisha (26919)	Flood (13)	Cyclone (57)	Storm surge (14)	Earthquake (36)
Tamil Nadu (48416)	Flood (33)	Cyclone (57)	Storm surge (14)	Landslide (1)
Gujarat (45249)	Flood (12)	Cyclone (28)	Storm surge (5)	Earthquake (12)
Uttarakhand (9756)	Flash Flood (<1)	Forest fire (<1)	Landslide (10)	Earthquake (100)

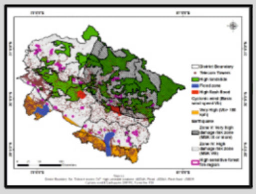
Table 2: Percentage of telecommunication towers across five selected states


Assam


Odisha


Tamil Nadu


Gujarat


Uttarakhand

B. 2 Disaster Risk & Resilience Index for five selected states

The Disaster Risk and Resilience Index is a comprehensive index developed to understand the disaster risk profile of telecommunication towers based on four key parameters—intensity, frequency, duration and spatial extent for different geographical regions (mountain, plain and coast). It helps to understand the spatio-temporal risk profile of the infrastructure. The diagram below presents the Disaster Risk Index for the five selected states:

State/Hazard	Risk Index for telecommunication assets						
	Earthquake	Cyclonic wind	Flash flood	Flood	Landslide	Storm surge	Forest fire
Assam							
Uttarakhand							
Gujarat							
Odisha							
Tamil Nadu							

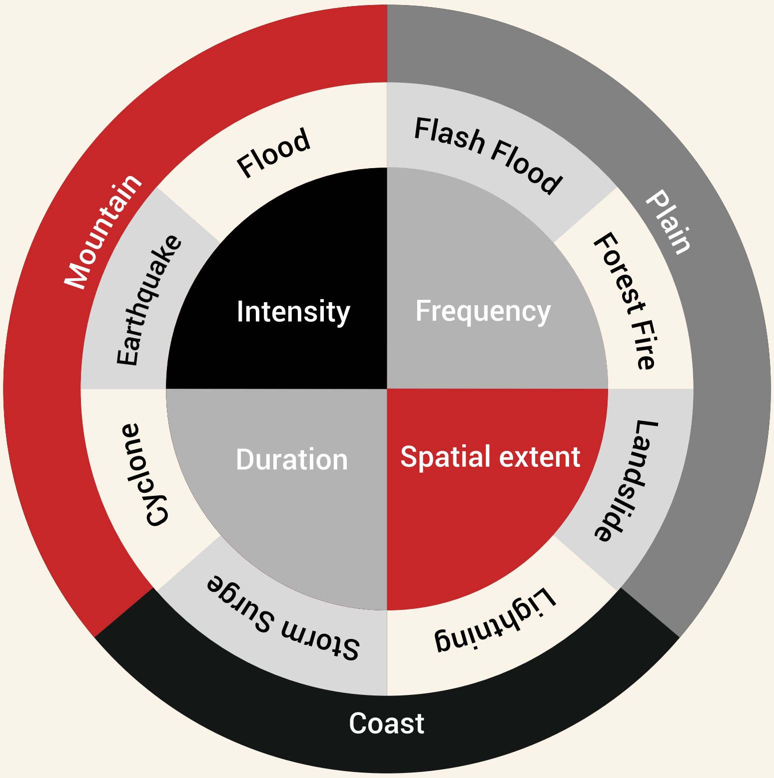
Figure 3: Disaster Risk Index for five selected states

The Disaster Resilience Index serves as a vital matrix for guiding required changes in policy, infrastructure planning and design, operational procedures, maintenance strategies, capacity building and financial investments. The index incorporates ten key indicators, including good governance, learning capacity, resourcefulness, flexibility, responsiveness, redundancy, robustness, information flows, safe failure and interdependency. The index helps to monitor the system's ability to respond, manage and adapt effectively to disasters. The diagram below presents the Disaster Resilience Index for the five selected states:

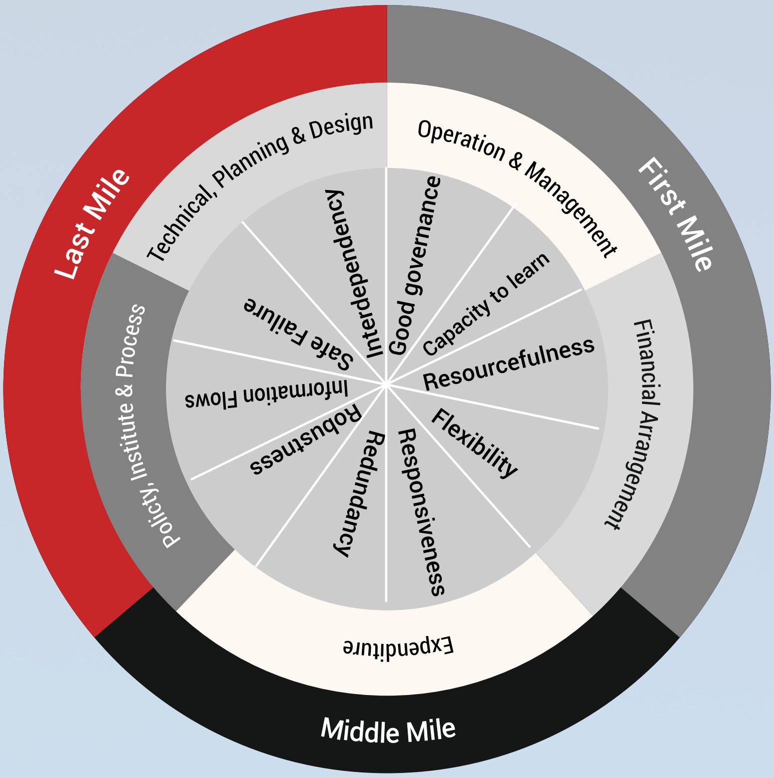
Resilience KPIs	Assam	Gujarat	Tamil Nadu	Odisha	Uttarakhand
Good governance					
Capacity to learn					
Resourcefulness					
Flexibility					
Responsiveness					
Redundancy					
Robustness					
Information Flows					
Safe Failure					
Interdependancy					

Figure 4: Disaster Resilience Index for five selected states

Exposure of assets (%)	Risk score	Hazard severity
0	0	No hazard / Data not available
1-20%	1	Very low
21-40%	2	Low
41-60%	3	Moderate
61-80%	4	High
81-100%	5	Very High



Resilience score	
0	No data
1	Rare, very low
2	Low, sometimes
3	Often, moderate
4	Likely, high
5	Always, very high



B.3 Disaster Risk and Resilience Assessment Framework

The study has developed a Disaster Risk and Resilience Assessment Framework (DRRAF) to help stakeholders understand, identify and address existing and emerging risks through optimal resilience interventions. The framework aligns with various global resilience frameworks, ensuring a cohesive approach towards integrated disaster risk management and resilience building. Some of the unique features of the framework are listed below:

Unique features of the framework

- **Intersectionality with global infrastructure resilience frameworks**
- **Considers multi-hazard cascading and compounding impacts at both asset and system scale**
- **Strengthens resilience at system levels, identifying the weakest element across the system**
- **Learns from periodic and event-based changes to adapt to dynamic vulnerabilities**
- **Peer-to-peer knowledge exchange on managing disaster impact**

The DRRAF elaborates on two integrated layers—risk and resilience layers. These layers act as a feedback loop for each other and include an integrated monitoring and evaluation mechanism that guides stakeholders to learn, take corrective actions and adapt to emerging disaster risks. The figure below presents the comprehensive DRRAF for the telecommunications sector.

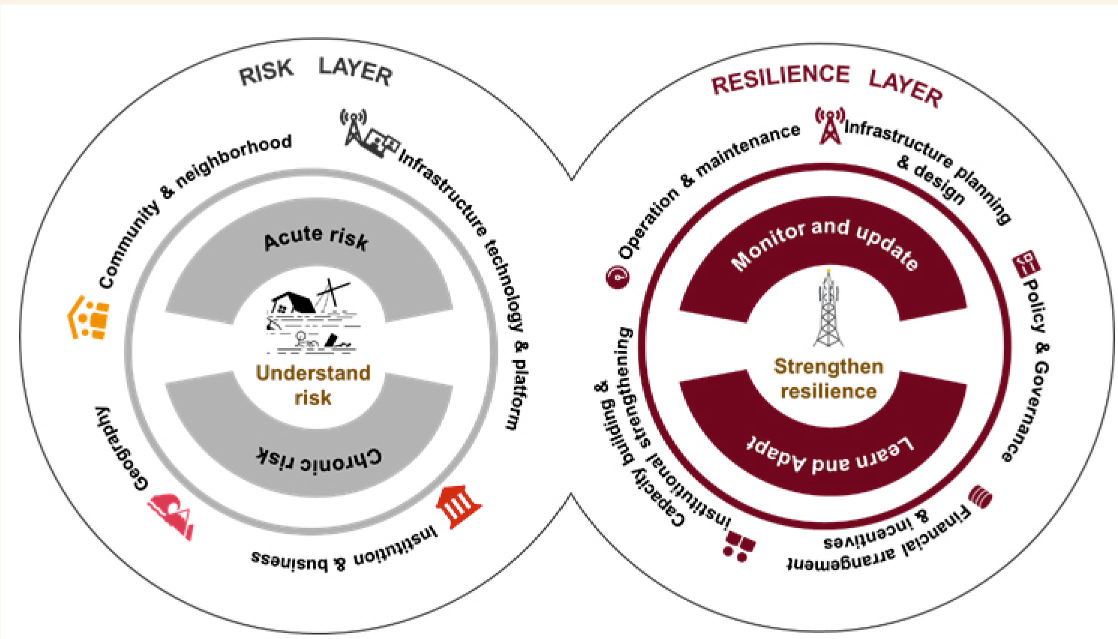


Figure 5:

Disaster Risk and Resilience Assessment Framework (DRRAF)

Section 3
Policy recommendations

This section outlines several recommendations for national and sub-national stakeholders across five domains: Policy, Planning & Institutions, Technical Planning and Design, Operation and Maintenance, Financial Arrangements & Incentives, and Expertise. These recommendations may guide the stakeholders in developing short, medium and long-term roadmaps to strengthen disaster resilience across the sector at system scale. Key recommendations are listed below.

Recommendation 1: Enhance technical planning and design to withstand disaster impacts

- There is an increasing issue with service availability across highly disaster vulnerable regions and rural areas due to inadequate redundancy in network planning and limited availability of emergency communication devices.
  There is a need to carry out a comprehensive need assessment for adding redundancy in the network, pre-positioning of Cell on Balloon, Cell on Truck, Cell on Ship & Boat, High Altitude Platform System (HAPS), procuring emergency communication devices and restoring landline phones based on historical & forecasted hazard risk information.
- There is an increasing disaster threat of submarine cable cuts due to erosion at the coast and high-intensity coastal hazards.
  There is a need to plan for multiple cable landing zones across coastal states to ensure better redundancy at first-mile network.
- There are limited Cells on Wheels (CoW) available across states and with operators.
  DoT may maintain an appropriate number of CoWs centrally and may deploy them as per the requirements across the country.
- 27 percent of telecommunication towers are vulnerable to high earthquake hazards across the country.
  There is a need to ensure sufficient seismic resilience of these assets.
- There is an interoperability issue across different generations of telecommunication devices.
  There is a need to provision for low latency (10-20ms from the existing 250ms) wireless communication to sync with next-generation LEO satellite communication technologies (having latency between 2 and 27 ms).
- Data Centre requires a large amount of uninterrupted power throughout the year. Frequent damage to power infrastructure due to disasters may have a cascading impact on the Data Centre operation.
  It is required to plan for a captive power supply in the Data Centre through two feeder lines falling under different hazard-vulnerable zones.
- There is insufficient dedicated duct available along district/sub-district road networks for laying telecommunication cables which leads to frequent damage of these cables.
  The provision of a common duct across these regions on a cost-sharing basis with operators may help reduce the frequent damage of OFC cuts.

Recommendation 2: Develop robust multi-hazard information repository for the sector

- ➔ The reporting format of State Disaster Response Fund funding does not include the telecommunications department's damage & loss information, and there is limited historical multi-hazard damage & loss information available for the sector.
  Mainstreaming disaster data collection using updated data format may help develop a robust multi-hazard data repository for the sector.

- ➔ There are limited multi hazard zonation maps available across states and at sub-district scale, and these maps have limited information on hazard intensity, frequency and duration.
  There is a need to develop standard and updated multi-hazard zonation maps across all states up to sub-district scale.

- ➔ There is no comprehensive assessment to identify the critical telecommunication assets that may provide minimum service connectivity during disaster.
  There is a need to carry out a comprehensive assessment to identify such critical infrastructure at sub-district scale that may provide required connectivity.

Recommendation 3: Risk-informed governance across the sector

- ➔ Due to limited disaster risk information available at local scale, there is inadequate disaster preparedness.
  Increasing the accuracy and scale of hazard forecasting and mainstreaming disaster risk modelling for location-specific risk understanding may help in risk-informed governance across the sector.

- ➔ Building susceptibility to multi-hazard often leads to damage of Roof Top Towers (RTT).
  Ensuring the building codes consider multi-hazard impacts may help reduce the vulnerability of RTT due to building failure.

- ➔ There is a limited mechanism to validate telecommunications asset damage loss information provided by the operators.
  It is required to form a disaster task force at each Licensed Service Area (LSA) level to validate damage loss information.

- ➔ There is a limited understanding of disaster vulnerability and risk of telecommunications infrastructure system among the stakeholders, which restricts effective preparedness and impacts restoration activities at the local scale.
  A disaster resilience lab should be set up at the national level under the guidance of the National Communication Academy (NCA) to support robust decision-making.

- ➔ There is an increasing risk of community violence due to poor network and service availability during disasters.
  There is a need to upgrade the "Sanchar Saathi" portal to register and address consumer grievances online during disasters.

Recommendation 4: Develop risk-sharing instruments for telecommunication operators

- ➔ There is no risk-sharing instrument available for derisking the telecommunication operators.
  Parametric Insurance model may extend the risk financing support to the operators.

Recommendation 5: Develop a cross-sectoral framework and leverage partnerships for stakeholder collaboration

- There is no knowledge-sharing platform that can guide stakeholders in improving collaborations to better manage the disaster collectively.
  There is a need to establish a countrywide knowledge platform to exchange disaster management learnings.
- Power outage has a significant cascading impact on telecommunications service continuity.
  Developing a framework to ensure uninterrupted power supply to critical telecommunication sites through alternate power arrangements such as RE and microgrids can help manage the disaster and restore the services effectively.
- There is a lack of dedicated telecommunications infrastructure at critical industrial locations/parks/zones and multipurpose disaster shelters across the country.
  Developing a framework to establish a dedicated telecommunications infrastructure system at these locations may help establish better connectivity during a disaster. For the dedicated telecommunications services, a premium tariff may be charged from the consumers.

Recommendation 6: Increase financial arrangements for strengthening infrastructure resilience

- There is limited financing support available for strengthening the resilience of infrastructure systems across the country.
  Assessing the need for resilience building and provisioning the budget for the financial planning of the line departments may help reduce infrastructure damage & loss and consequent economic loss.
- There is limited terrestrial network bandwidth availability in the mountainous regions.
  Extend financial support through USOF/Digital Bharat Nidhi to establish a Satellite Earth Station Gateway for providing connectivity to the mountainous region through LEO satellite constellation in future.

Recommendation 7: Promote last-mile connectivity and information access

- There is insufficient communication channel for sending disaster warnings/alerts and restoration updates to the last-mile residents in remote locations.
  It is required to make a provision to provide each "Aapda Mitra" volunteer, village heads, Anganwadi leaders, postmen etc., with alternate communication devices, such as shortwave radio communication devices, to establish last-mile connectivity and support information access to them.
- There is limited bandwidth available for disaster communication in remote areas.
  Extending the inter-band spectrum sharing for such regions may improve emergency communication.
- There is a limited connectivity provision in non-feasible regions.
  DoT may provide funding support to operators for setting up an asset in the non-feasible regions through bidding or nomination process. Other operators may latch based on the tariffs defined by TRAI. Additional spectrum may be allocated during emergency situations.

Recommendation 8: Leverage collaborative and digital efforts to strengthen service restoration activities

- There is limited logistic support available to the telecommunication operators from the local administration.
  Priority support and arrangement of fuel, power and transportation may help strengthen better restoration activities.
- There is a cumbersome approval process for telecommunications service restoration activities.
  Making a provision for a single-window digital permission system may expedite the restoration activities.
- There is limited spatial information available about the optical fiber network damage.
  GIS mapping of countrywide Optical Fiber Cable network and integrating it with real-time fault management system may help restore the services faster.
- There is a significant delay in submarine cable repair due to a multi-stage approval process. This may result in major connectivity blackouts in future.
  There should be a provision of specialized Indian shipping vessels for repair of the submarine cables to expedite the restoration activities.

Recommendation 9: Upscale institutional capacity and improve last-mile expertise

- There is a consumer knowledge gap at the last mile for ICR service activation.
  A community awareness programme may help improve the last-mile capacity to avail these services.
- There is insufficient manpower in rural areas for preventive maintenance and restoration work.
  Upscaling institutional capacity through comprehensive resource need assessment for these activities at block/district level may improve the operational resilience of the system.
- Availability and usage of satellite phones across line departments are limited due to their high cost, complex handling and limited function in indoor/denser regions.
  It is required to provide user-friendly, cost–effective satellite phones for line departments supporting disaster management activities.

Recommendation 10: Improve the service quality through precise monitoring mechanism

- There is a frequent issue of poor call connectivity and network congestion during the golden hour of a disaster. There is also limited information available with DoT on the number of call attempts made by the telecommunications subscribers in the impacted regions.
  Daily/weekly monitoring of call traffic, Dropped Call Rate (DCR), and cell-bouncing busy hour at district scale rather than LSA scale may help assess the service quality across the disaster impacted regions.
- Assessments of telecommunication faults are carried out monthly, which does not precisely account for the restoration efficiency during a disaster.
  Mean Time to Repair (MTTR) should be accounted on a weekly basis rather than monthly to assess the fault repair comprehensively.

By jointly undertaking these steps, India and its states can enhance their collective disaster resilience efforts in the telecommunications sector. This collaborative approach will contribute to fostering sustainable development and encourage inter-state collaboration at all levels.

Coalition for Disaster Resilient Infrastructure

Coalition for Disaster Resilient Infrastructure
4th & 5th Floor, Bharatiya Kala Kendra, 1, Copernicus Marg,
New Delhi–110001, India
Tel.: +91 11 40445999

www.cdri.world
info@cdri.world
cdri_world
coalition-for-disaster-resilient-infrastructure