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## Disaster Recovery Guidance Series

# Transport Sector Recovery: Opportunities to Build Resilience



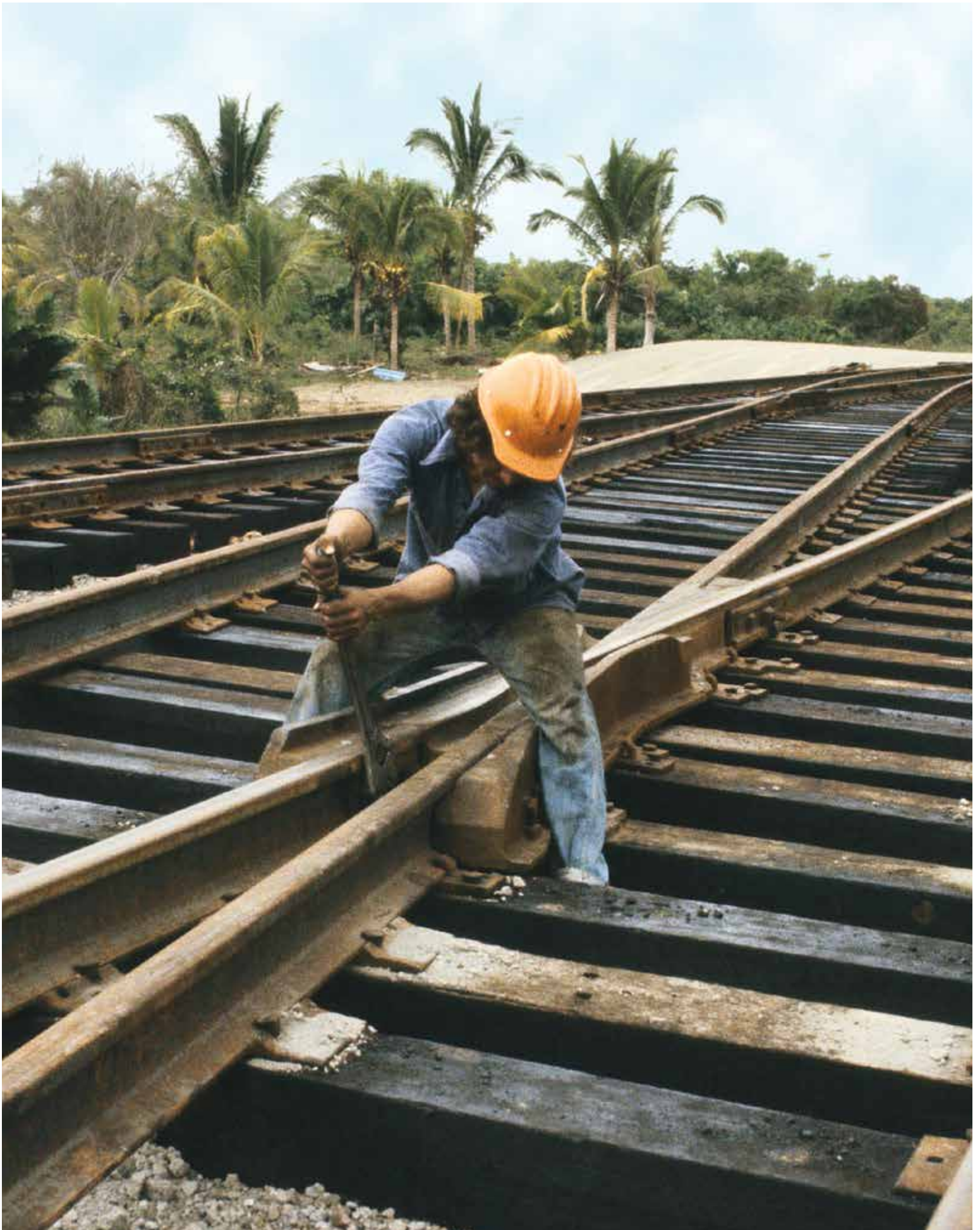


# Acknowledgments

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Mexico—Man fixing railroad tracks. Photo: Curt Carnemark / World Bank

## Introduction: Restoring the Transport Sector after a Disaster

Transport infrastructure and services underpin the economic growth and social development of any country. When the transport network is disrupted, from a natural disaster or other event, the consequences can be widespread, including halting the productive sector and thus increasing the cost of goods; preventing people from accessing critical services, such as health care; delaying the restoration of key sectors, such as water and energy supply; and stalling reconstruction. Damages may be sustained to physical assets, such as roads and vehicles, leading to economic losses for owners and operators of transport assets and services, as well as losses to other sectors when breakdowns in transport links lead to higher costs and reduced economic activity. Disruptions in transport links for any extended period of time affect local communities and their ability to recover, as well as more broadly a country's economic health. For this reason, restoring the transport sector after a disaster is essential to the overall recovery<sup>1</sup> process in the aftermath of a disaster.

Disasters pose a real threat to the viability of the transport network, yet in their aftermath, they also present an opportunity to reduce risks, strengthen resilience, and eventually build back better (BBB).<sup>2</sup> This may include relocating transport infrastructure outside of flood zones or designing structures so that they are better able to endure the next storm or river flow, thereby enabling faster recovery

from future disruptions. While disasters can highlight shortcomings in planning, design, and materials used to construct assets, they also present an important opportunity to rectify deficiencies and move toward more proactive risk management and lifecycle maintenance of transport assets and infrastructure. Transport systems that are built well the first time and are well maintained are likely to sustain less damage from natural disasters or climate change impacts. When the transport network incurs less damage, the costs of rebuilding the structure is reduced, making more resources available for investment in

**The Transport Network is made up of the transport infrastructure, assets, and systems—aviation, maritime, inland waterways, and surface transport (public transit, roads, commuter and freight rail, trucking, bus and metro passenger transport, and bicycle and pedestrian paths)—required for the successful operation of a society and its economy.**

more stable and adapted systems. If a disaster strikes, a still-functioning transport system can be the lifeline to allow for the protection and revitalization of people and other sectors, like telecommunications, energy, and other essential service delivery.

This Guidance Note is intended to provide action-oriented guidance to government officials facing post-disaster recovery challenges related

<sup>1</sup> The International Recovery Platform defines the recovery phase as “the restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. The recovery task of rehabilitation and reconstruction begins soon after the emergency phase has ended, and should be based on pre-existing strategies and policies that facilitate clear institutional responsibilities for recovery action and enable public participation. Recovery programs with heightened public awareness and engagement after a disaster, afford a valuable opportunity to develop and implement disaster risk reduction measures and to apply the ‘build back better’ principle.”

<sup>2</sup> BBB enhancements, if thought out well, can reduce maintenance costs for a transport asset or system and, in the event of a disaster, result in lower damages, losses, and recovery needs. In some cases, BBB enhancements can also require significant resources, time, effort, and design and may not be able to happen during the recovery period, as transport authorities are focused on restoring the network to basic levels of service. In this case, transport officials can begin to think about what is possible and needed going forward and incorporate these into development plans.



Photo: Ekipaj

to the transport sector. The Guidance Note frames the scope of recovery work, including the administrative elements for setting up a planned and organized recovery of the transport sector, the implementation activities required to restore the transport network, and recommendations for investing in systems preparedness and physical asset resilience. The Guidance Note offers best practices, case studies, and tools that can help transport officials identify entry points for building resilience and building back better, as well as guidance for how to undertake a more effective and better-coordinated recovery of

the transport sector. The Guidance Note is not meant to be prescriptive nor represent actions that are appropriate across all disaster scenarios or cultural, governmental, and socioeconomic contexts. Rather, it is meant to offer critical considerations along with guidance and best practices from which an appropriate response may be formulated.

This note is accompanied by an extensive reading list that is available on the Global Facility for Disaster Reduction and Recovery's (GFDRR) Recovery Hub website,<sup>3</sup> under the Transport section.

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<sup>3</sup> <https://www.gfdrr.org/recovery-hub>.

## Principles for Transport Sector Recovery

The following overarching principles should guide the recovery and reconstruction of the transport sector. They are meant to aid transport officials in thinking through how to use recovery and reconstruction processes to promote transport infrastructure, assets, and services that can better withstand future shocks, as well as better meet the economic and social needs in communities where the transport network operates.

- **Mitigate risks:** Relocate transport structures located in high-risk areas to reduce hazard exposure; where relocation is not possible, structurally retrofit or strengthen critical assets to reduce vulnerability.
- **Improve access and mobility<sup>4</sup>:** For example, enhance walking, bicycling, and public transport facilities in urban areas. This can reduce poverty and facilitate participation in economic, social, and political processes.
- **Apply green and climate-smart solutions:** Identify opportunities to decrease the environmental footprint of the transport sector to combat climate change and pollution.
- **Innovate low-cost, high-impact solutions:** Intelligent transport systems, for example, enable users and operators to make safer, coordinated, and smart use of transport networks.
- **Be future oriented:** Align recovery outcomes with development goals (e.g., land use plans and national development objectives), anticipated future community needs, and maintenance costs.



- **Equity and inclusivity:** Help enable access to jobs and markets for everyone through good-quality transport regardless of economic or social status.<sup>5</sup>
- **Efficiency:** Meet transport demand effectively to promote seamless movement of people and goods.
- **Promote safety across all modes of transport:** This can involve implementing measures to reduce fatalities, injuries, and crashes from transport mishaps.
- **Build Back Better:** Recovery and reconstruction present an opportunity to address structural deficiencies in transport infrastructure and enhance resilience to future hazard impacts.

Tanzania—Young mother carries child on her back. Photo: Scott Wallace / World Bank

<sup>4</sup> The World Bank's Sustainable Mobility for All (SUM4ALL) Initiative provides more information on how to foster efficient, inclusive, green, and safe mobility. See <https://sum4all.org/>.

<sup>5</sup> This includes considering the impacts on gender, disability, and social issues; getting vulnerable individuals effectively engaged in consultation, information sharing, and decision making around recovery efforts; and enabling programs or plans to better prepare the poor and vulnerable to absorb the impact of future hazards and shocks.

## Overview: Transport Sector Recovery and Reconstruction

In the immediate aftermath of a disaster, during the emergency relief and response phase, the highest priority is to carry out life-saving emergency services, including providing medical attention, food, water, and shelter. To do this, vital transport and supply routes, including roads, ports, and airports, need to be cleared of debris so that evacuations can take place and life-sustaining services can be implemented.

*Immediate recovery* activities occur in parallel with emergency response activities. Transport officials need to be well coordinated with relevant response agencies to maximize public safety, to protect and preserve transport facilities as much as possible, and to reopen the transport system as quickly as possible, while transport sector recovery planners undertake the estimation of post-disaster recovery and reconstruction needs by assessing the value of destroyed assets and of transport production flows.

During the *short-term recovery phase*, transport sector recovery planners use the results of the post-disaster needs assessment (PDNA) to

develop a Recovery Plan, begin to prioritize recovery needs against limited resources, and mobilize the required financing to rebuild the transport network and services in a way that better serves community and nationwide needs now and in the future. Transport officials must work with affected communities to integrate their concerns and needs into these plans. Consider that short-term recovery decisions have long-term implications. For instance, decisions about materials and labor procurement affect the local economy, while locations for debris removal sites can limit longer-term options.

During the *medium- to long-term recovery phase*, transport officials need to continually assess recovery progress against objectives via a monitoring and evaluation (M&E) framework (established during immediate or short-term recovery) that can incorporate new information and be adapted accordingly. Transport officials need to begin to think about future land use planning and investments in preparedness that will make recovery faster and more effective in future disaster events.

### The following sections outline:

<b>Governance and Financial Foundations of Transport Sector Recovery</b>	The administrative and institutional components to set up the Transport Sector Recovery (e.g., conduct the PDNA, establish a Recovery Plan)
<b>Implementation Activities and Considerations</b>	The critical activities and considerations to return the transport sector back to the new normal (e.g., restore critical infrastructure and services, debris removal, support community recovery)
<b>Forward Outlook: Investment in Preparedness</b>	Next steps for investing in preparedness of the transport sector going forward



## Governance and Financial Foundations of Transport Sector Recovery

Shortly after a disaster has occurred, transport officials must accurately identify transport sector recovery needs and use them to inform a well-organized and planned restoration of the sector. This section outlines the institutional and administrative components for setting up recovery of the transport sector.

### Transport Sector Recovery within the Overall Recovery

After a major disaster, recovery of the transport sector should be part of the overall national Recovery Framework. All recovery activities need to be in line with the government's overarching strategy. Keep in mind that various sectors will compete for available resources. Since the transport sector cuts across all other sectors (social, production, and infrastructure), transport officials need to address interdependencies and work with other sectors to optimize recovery outcomes.

### Identify Post-Disaster Damages, Losses, and Needs

The transport sector may sustain destruction of its physical assets—infrastructure and vehicles—and changes in its production flows, that is, losses may be incurred when products cannot reach the intended markets in time due to damage to their normal routes of transport or higher costs of operation when vehicular traffic must utilize alternative, longer, and lower-quality routes. The lead transport agency, likely the Ministry of Transport<sup>6</sup> (or equivalent regional or local-level agency), needs to conduct a transport sector PDNA to estimate the magnitude of recovery and reconstruction needs.

The PDNA process should include civil, transport, and structural engineers in the estimation of



the value of destruction (damages) and should include transport economists in the estimation of (negative) changes in the production flows (losses) of transport services. Accurately assessing economic losses due to transport infrastructure damages can be particularly difficult and complex. The transport sector assessment team should ideally be fully knowledgeable about the possible modifications of traffic flows that may arise after a disaster, the possible shift of cargo and persons between transport modes or subsectors, and the methodology of estimating the value of transport costs. In the aftermath of hurricanes Irma and Maria, critical access via secondary roads was severely hampered in many parts of the Caribbean, causing significant economic losses in the agricultural and tourism sectors, as well as in the livelihoods of the affected population.

Access to reliable and updated information on transport assets, such as location, condition, and

China—After years of rapid urbanization, rising incomes, and transport investment that focused on automobiles, streets in cities such as Beijing are packed with cars. Photo: Li Lou / World Bank

<sup>6</sup> The responsible agency may be a Ministry of Public Works; a National Transport Authority; or a state, provincial, or local

### Box 1. Case Study: Supplementing Assessment Data after Christchurch Earthquake in New Zealand

After the 2011 Christchurch Earthquake in New Zealand, the Canterbury Earthquake Recovery Authority used cell phone tower data to provide insights into where people were moving, both immediately after the disaster and in the following months during recovery. These additional assessment data helped transport

planners understand land use changes as people moved out of their homes or businesses and into new areas, as well as how they were getting from point to point, which helped identify which infrastructure repairs would have the most benefit.

criticality, is desirable for conducting a PDNA. The sheer number of assets and their geographical distribution can make it difficult to collect, analyze, and understand their status in real time. The transport sector assessment team needs to identify any missing baseline information on the transport network to assess traffic flows and additional operational costs, which translate into economic losses. These information gaps may need to be filled with additional assessments to make future decisions. See **Boxes 1** and **2** for examples of how to supplement information gaps.

#### Guidance

The PDNA methodology for the transport sector<sup>7</sup> can support the effective assessment of damages and losses and their corresponding needs for recovery and reconstruction. For example, in the aftermath of Hurricane Maria in 2017, the use of this methodology helped identify that Dominica's transport sector damages were dominated by severe washouts at critical river crossings, and losses were composed of the costs of restoring road access, clearing debris, and restoring river capacity,

as well as traffic delays and income losses to transport service providers.

#### Tools

Using smart technologies, such as remote sensing tools, artificial intelligence, drones, and satellite imagery, can be valuable to support the remote assessment of damages—particularly in remote areas or conflict hot spots. These tools help speed up assessments, provide real-time accuracy, and reduce the safety risks associated with having personnel on the ground.<sup>8</sup> For example, when telecommunications are operational, RoadLab Pro,<sup>9</sup> a free smartphone app, can be used to evaluate road conditions, map road networks, detect major road bumps, and report safety hazards. The app helps identify critical links in a road network and generate real-time data. For a more detailed list of innovative technology tools that can be applied to recovery of the transport sector, please see the Recovery Hub.

authority. Depending on the country, different government-level organizations may be responsible for undertaking the construction, maintenance, and operational needs for primary, secondary, and/or tertiary road networks. For example, primary roads may fall within the purview of the central government, while secondary roads are commonly built and maintained by provincial governments, and tertiary roads are often built and maintained by district or municipal governments.

<sup>7</sup> More information on assessing damages and losses in the transport sector can be found at: [https://gfdrr.org/sites/gfdrr/files/WB\\_UNDP\\_PDNA\\_Transport\\_SP\\_FINAL.pdf](https://gfdrr.org/sites/gfdrr/files/WB_UNDP_PDNA_Transport_SP_FINAL.pdf).

<sup>8</sup> For more information on GFDRR's methodology for conducting a Global RApid post-disaster Damage Estimation (GRADE) approach, see <https://www.gfdrr.org/en/publication/methodology-note-global-rapid-post-disaster-damage-estimation-grade-approach>.

<sup>9</sup> More information on RoadLab Pro can be found at: <https://www.softteco.com/projects/roadlab>

## Box 2. Case Study: Addressing Post-Disaster Information Gaps in Belize

To address the information gap challenge, the Government of Belize introduced the use of an information management tool, “SpatialEdge,” tailored to the country’s needs. The tool has a user-friendly interface to facilitate data collection, management, access, and analytics, and uses geospatial technology that enables the

use of smartphone apps, like RoadLab Pro, to track road location and provide a proxy for road roughness using the acceleration functions in a smartphone. This helps assess the condition of transport assets, and its ease of use facilitates timely updates and reduces costs associated with recurring data collection.

## Set Up a Transport Recovery Plan

A transport sector Recovery Plan<sup>10</sup> to direct the design and implementation of the sector recovery process should be overseen and led by the Ministry of Transport (or other relevant national, regional, or local authority charged with leading the recovery of the transport sector). The results of the PDNA and any overarching government Recovery Strategy or Recovery Framework will be important reference points for the development of a sector-based Recovery Plan.<sup>11</sup> The purpose of the Recovery Plan should be to provide clear, specific, and timely guidance to achieve intermediate, short-, and longer-term recovery and reconstruction of the transport sector and to foster sustainable and resilient recovery of the affected communities. It should help articulate a vision for transport sector recovery; define a recovery strategy, objectives, and expected outcomes; prioritize actions; fine-tune planning; clarify roles and responsibilities, as well as mechanisms for coordination;

provide a framework for internal and external communications; and provide guidance on financing, implementing, and monitoring recovery.<sup>12</sup> The transport sector Recovery Plan facilitates the planning, prioritization of actions, and sequencing of activities, which informs funding decisions.

The Ministry of Transport needs to engage technical agencies, public sector agencies, private sector owners and operators, and local implementers, as well as civil society and community organizations, to contribute their technical expertise and local knowledge of community needs. During this process, trust and transparency by the government is critical to the development and implementation of a plan that will yield good outcomes. Once stakeholders have been engaged, the Recovery Plan will need to be formally approved by the government to ensure legitimacy and to guarantee resources.

While developing a Recovery Plan, there will be uncertainty about future disasters and climate

<sup>10</sup> The U.S. Department of Transportation’s (DOT) National Transportation Recovery Strategy for recovering from disasters may be a useful resource.

<sup>11</sup> A transport sector-specific Recovery Plan should serve as a repository of updated assessment information, from which to prioritize recovery needs (including priorities for geographical and asset repairs/reconstruction), clarify implementation arrangements and time frames, and reconfirm funding needs (met and unmet). This will pave the way for a consolidated recovery framework. The Recovery Framework builds on the PDNA for detailed sequencing, prioritization, financing, and implementation of the recovery. For more information on PDNAs and Recovery Frameworks see the Recovery Hub website at [https://www.gfdrr.org/recovery-hub?sector=541#attachment\\_5](https://www.gfdrr.org/recovery-hub?sector=541#attachment_5)

<sup>12</sup> A disaster recovery framework can be a helpful tool to build off a transport sector PDNA for detailed sequencing, prioritization, financing, and implementation of the recovery, which can support the effective development of a transport sector Recovery Plan.

change impacts. Uncertainties arise both due to the challenges of modeling complex hazards and levels of exposure and from uncertainty around policy actions and human behavior. The transport sector Recovery Plan needs to be risk-informed and to reduce the vulnerability of people to climate change and future disaster impacts. Investing in a risk-based asset management approach<sup>13</sup> can support the development of a Recovery Plan that considers the cost of preventive maintenance of an asset versus the cost of emergency maintenance or replacement. Applying a risk-based asset management methodology to the development of a Recovery Plan can support transport officials in planning for the unexpected, prioritizing investments, thinking about long-term outcomes, and maximizing the service life of transport assets.

Transport sector recovery planners should also take the following steps:

***Address existing policy, regulatory, or planning procedures already in place:***

- Link post-disaster recovery objectives to long-term development objectives, as well as existing national and local transport management plans and policies, to help align recovery measures with ongoing sustainable development. See **Box 3** for an example of how a recovery effort allowed the review of the long-term plan to better meet development objectives.
- Identify streamlined policy and regulatory decision-making or delivery procedures. For example, adjust existing planning, consenting, and regulatory systems to fast-track permits for transport network repairs and rebuilding in areas that can be rebuilt under existing policies, plans, or regulations.

- Use this opportunity to encourage city or local transport officials to develop their own Recovery Plans following the guidelines of the national transport Recovery Plan.

***Address inclusivity:***

- Prioritize and plan for the mobility of women, who often have different travel patterns than men, as they also care for the home, the children, and the elderly.
- Quantify the value of resilience measures in economic terms, as well as on their environmental, social, and cultural aspects, for a truly holistic and sustainable solution.

Make it clear that effective recovery of the transport network enables and supports community, economic, and environmental recovery. Mobilizing key stakeholders, including environmental and social specialists, and engaging cross-transport sector experts will help such solutions.

- Engage public support and participation<sup>14</sup> by using a community-driven and locally managed process that promotes local decision making and ownership of the recovery planning and implementation effort.
- Ideas and goals for a community's future vision may already exist in a community's development plan, annual report, or urban planning guidance, or may be available through community association minutes. Hosting town hall meetings where the public is free to provide ideas and have them considered in the recovery planning process is a good way to encourage community involvement and align recovery objectives with community objectives.

<sup>13</sup> DOT provides further guidance for how to manage external threats through risk-based asset management of transport assets at: <https://www.fhwa.dot.gov/asset/pubs/hif12050.pdf>

<sup>14</sup> For Recovery Plans to address a community's demographic and socio-cultural needs and preferences, all representative community groups must be involved, including businesses, religious, and civil society organizations; emergency managers; representatives from various government agencies; public advocacy groups; and the media. By involving all these stakeholders, a highly organized recovery operation that maximizes lessons learned, best practices, and efficiency of labor is possible.

### Box 3. Case Study: Addressing Community Needs in Recovery Planning in Kansas, USA

After a 2007 tornado destroyed the town of Greensburg, Kansas, USA, the Kansas Department of Transportation reconsidered the long-term plan for a freeway based on the community recovery goals because

the location of the future freeway affected community rebuilding plans. A relocated route was developed because it provided the most desirable mix of visibility, access, and economic development opportunities for the community.

#### ***Develop recovery objectives that are appropriate and monitor progress toward their implementation:***

- Develop transport network recovery goals and outcomes that are clear, measurable, and time bound, with clearly articulated activities and milestones (that can be adapted as new information becomes available) to achieve a successful recovery.
- As implementation of the Recovery Plan progresses, continually assess the recovery and reconstruction needs, identifying any challenges and working with stakeholders to resolve them.

#### **Prioritize Recovery Needs**

Transport officials need to draw on the defined transport sector recovery vision and plan to prioritize recovery and reconstruction needs, objectives, and the corresponding activities to implement the recovery. When prioritizing activities in the Recovery Plan, transport officials need to account for anticipated service delivery drops, due to recovery and reconstruction, and the consequences of these inadequacies (e.g., people unable to get to their job, reduced tourism revenue, higher costs to transport goods, and increased travel times to do business). Transport officials need to balance these considerations with actions to mitigate such adverse impacts when making prioritization decisions.

Transport officials should continually examine the defined priorities by asking:

- Are the originally identified recovery objectives and desired outcomes still applicable?
- Have any new recovery needs been identified?
- What recovery activities will have the greatest daily impact on livelihoods?
- Are the current recovery priorities aligned with the affected community's transport needs?
- How can transport sector recovery activities promote the recovery of businesses and economic development?
- Are there redundancies in the transport network to allow linkages between communities and hospitals, fire stations, schools, shelters, etc. in the event of a future disaster?

#### **Guidance**

The International Recovery Platform developed an “Infrastructure Guidance Note” that outlines key factors to consider when prioritizing infrastructure reconstruction and recovery.

These factors are:

1. The criticality of services provided by each infrastructure component in relation to life safety, national security, economic stability and commerce, and quality of life and community function
2. Proposed or determined movements of populations

3. The need for additional study to determine hazard risk, hazard mitigation options, modernization options, longer-term development goals, and expansion opportunities, among other operations
4. The availability of reconstruction funding, materials, labor, and expertise
5. The settlement of legal constraints, such as land ownership and reconstruction responsibility (in the case of privately owned infrastructure).<sup>15</sup>

### **Tip**

Using an agreed-upon list of prioritization criteria supports the evaluation and communication of transport infrastructure asset needs in relatable terms. For example, a 1 (low) to 10 (high) scale of “recovery need” may be used to prioritize transport infrastructure asset needs. This means that if a bridge is at a Level 8, the magnitude of its recovery need is greater than a segment of road with a Level 6. Prioritization is not necessarily based on extent to which an asset is damaged. It needs to be based on the level of service that asset offers, and how crucial it is to the community and economy. A lifecycle cost management mechanism<sup>16</sup> can help identify whether a specific asset should be temporarily fixed, fully repaired, retrofitted, or demolished.

## **Identify Institutional Arrangements for the Transport Sector**

The transport sector is vast and complex. Depending on a country’s size and governmental structure, several governmental bodies—ministries or other offices at the national or subnational levels—may be involved in the recovery process. This note assumes that the Ministry of Transport (or equivalent

regional or local-level agency) will take the lead role in coordinating, planning, and overseeing the implementation of transport sector recovery.<sup>17</sup> For the Ministry of Transport to create effective institutional arrangements, it should have a clear legal mandate for recovery that clarifies roles and responsibilities, and should be supported by effective political and technical leadership. The Ministry of Transport needs to:

- Appoint a senior transport official to lead the sector’s recovery
- Facilitate continuity between humanitarian emergency response and recovery work
- Clarify the role of international organizations and development partners
- Coordinate recovery efforts across other sectors (e.g., housing, health, education) with relevant stakeholders
- Clarify the roles and responsibilities of civil society, municipal government agencies, the private sector, owners and operators of transport assets, facilities and services, communities, and nongovernmental organizations in the recovery process
- Clarify post-disaster financial responsibilities of the national and local governments
- Identify appropriate human resources and maximize their availability throughout the recovery
- Define what components of the overall recovery the transport sector is leading on or collaborating on
- Support decentralized implementation of recovery activities by empowering local ownership and decision making

<sup>15</sup> Exposure and vulnerability to natural disasters should also be a factor.

<sup>16</sup> The International Facility Management Association has an asset lifecycle model that may be applied. See [http://www.ifma.org/docs/default-source/knowledge-base/asset\\_lifecycle\\_model.pdf](http://www.ifma.org/docs/default-source/knowledge-base/asset_lifecycle_model.pdf).

<sup>17</sup> However, in some cases, a mandate may need to come from the highest executive office to appoint a lead that will develop an intergovernmental plan for the recovery that includes the transport sector.

- Develop an appropriate framework and implement resources for robust M&E to identify where recovery progress has and has not been made for the sector

### Tip

If there is no clear legal mandate to define the institutional arrangements, consider what decision-making structures, policies, and processes need to be put in place so that there is clear oversight, implementation, and funding of recovery and reconstruction activities.

## Coordinate the Recovery

Giving responsibility to a specialized coordination unit or project management mechanism within the lead transport agency will help keep track of all transport sector recovery and reconstruction activities in two key capacities: leadership coordination among key transport stakeholder partners and technical advisory. To effectively engage transport stakeholders, build on existing coordination mechanisms within the transport sector and optimize how they can be used to lead transport recovery decisions and activities. If not evident, form a transport recovery coordination group, composed of representatives from critical stakeholder groups<sup>18</sup> to support the development and implementation of the Recovery Plan. While much of the recovery delivery is likely to occur at the local level, managed by local officials, the transport recovery coordination group could ensure proper distribution of resources, issuance of technical assistance, internal and external financial assistance, and transparency, and could support other special programs that will fuel recovery. Tonga and Fiji use national cluster systems<sup>19,20</sup> for disaster management by

sector; these systems support strong emergency and recovery coordination by sector. To effectively coordinate the recovery, the transport recovery coordination group should:

- Appoint a leader of the transport recovery coordination group who will be connected and engaged at the highest level with the lead agency of the overall recovery
- Collaborate with other sectoral recovery planning and implementation operations
- Serve as a central repository of transport sector recovery information
- Establish a public information office to disseminate pertinent information to the affected population
- Minimize duplication, redundancy, or inefficiencies in transport sector recovery
- Adjudicate complaints, grievances, and other concerns of affected individuals and groups, feeding them back into the recovery planning process

### Tips

- Align the transport recovery coordination group with the wider national recovery coordination mechanism, convening daily meetings at first, then weekly, etc., as appropriate, to support implementation of the Recovery Plan. An example of a reconstruction committee in Japan after the 1995 Great Hanshin Earthquake is outlined in **Box 4**.
- Eventually, business as usual will be reestablished. There may be a decrease in recovery pace and funds may be diverted, leading to competition for resources. Expect and plan for this decrease of pace, political interest, and funding. It is often around the

<sup>18</sup> Including transport and other relevant government agencies at the national, local, and regional levels; civil society; community-based organizations; the affected community; disaster risk management professionals; the private sector; donors; transport service delivery officials; construction teams; environmental organizations; building officials; zoning administrators; economic development officers; regional planning organizations; and public information officers.

<sup>19</sup> For more information on Tonga's emergency clusters, see <https://reliefweb.int/sites/reliefweb.int/files/resources/clustersdrmc.pdf>.

<sup>20</sup> For more information on Fiji's emergency clusters see [http://www.ndmo.gov.fj/images/NDMO%20OLD/Fiji\\_National\\_Cluster\\_System\\_for\\_Disaster\\_Management.pdf](http://www.ndmo.gov.fj/images/NDMO%20OLD/Fiji_National_Cluster_System_for_Disaster_Management.pdf).

#### Box 4. Case Study: Recovery Coordination after the 1995 Great Hanshin Earthquake in Japan

One month after the 1995 Great Hanshin Earthquake in Kobe, Japan, the national government formed a “reconstruction committee” to organize recovery efforts. The body was created through national legislation that required the participation of numerous national, prefectural, and local agencies, as well as governmental organizations. The prime minister personally managed the committee, and the chief cabinet secretary and the minister

of the national land agency served as deputy managers, with representation from other high-ranking government officials. The participation of such prominent leaders encouraged stakeholders involved in the reconstruction committee to collaborate and come to agreement on recovery goals, and it brought national attention to recovery issues. Through the committee, a national plan of action for recovery was collaboratively developed.

one- and three-year points of recovery efforts where funding and coordination support halts and recovery is waylaid—leaving communities feeling abandoned.

### Mobilize and Allocate Funding

A key challenge for transport network recovery and reconstruction is mobilizing additional funding resources over and above normal development funding. Rebuilding transport infrastructure assets can be very costly. Further, investing in resilient transport measures often requires more upfront costs of time and resources, including better engineering design, data collection, and capacity development. Post-disaster recovery relies on effective fast-track funding that makes use of available sources of financing, both public and private, domestic and international. However, for transport infrastructure, the responsibility for repair and reconstruction most likely sits within the public domain, where the bulk of normal development funding arises.

Transport sector recovery implementation needs to be supported by the mobilization of funds and coordination mechanisms that channel funds to the implementation entities

in a timely manner. Clear rules on resource allocation will help maintain fiduciary control and will hold beneficiaries to account. Utilizing coordination mechanisms, for example, linking a Transport Sector Assessment Subcommittee (see **Box 5**) with a Finance Subcommittee is a good practice that supports the allocation of resources based on actual damages incurred in what is an inherently political process. The Transport Sector Assessment Subcommittee should quantify funding needs based on PDNA findings and provide transparency on the use of funds. Local governments should bear part of the disaster losses, balanced with their financial capacities, to have the right incentives to invest in risk reduction and prevention measures and to purchase appropriate insurance coverage.

Some funding sources might include:

- **Regular budget:** Allowances for diversion of funding for existing projects to urgent repair work in the case of disasters.
- **Sector-specific financing mechanisms,** including the use of transport-specific funds (e.g., highway maintenance fund, airport/port improvement funds) and road taxes, port charges, and airport fees to build back better.



## Box 5. Case Study: Convening Technical Advice for a Successful Earthquake Recovery in California

It is also important not to convene critical stakeholder inputs too late. In the aftermath of the 1989 Loma Prieta Earthquake, in California, disputes over the cost of repairs and the expected levels of repairs caused significant recovery delays. A peer review panel was established to review aspects of

the reconstruction; however, they were not able to convene until several months after the earthquake. As a result, many repairs that had already begun had to be redone or abandoned, resulting in substantial delays and economic waste.

- **Budget-sharing mechanisms between local and central governments** that allow local authorities to apply for additional funding for reconstruction works. The procedures should be negotiated in advance and cover the procedures for applying for a subsidy from the central government, the cost-sharing ratio of rehabilitation works, and the criteria for the types and severity of disasters. Such criteria should require the establishment of a body of experts and organizations to the central government level and team formulation and procedures for damage assessment.
- **Public-private partnerships** so that policy incentives can be used to promote private sector investment to share reconstruction costs. Public-private partnerships are often used to procure funds for infrastructure improvement, as it is relatively low risk and suitable for long-term fund operation by pension and insurance institutions. Promoting private sector recovery can promote collaboration in repair and operation of transport infrastructure, devolving responsibility and releasing resources. Infrastructure repair may rely on private sector

resources, and providing support to these private enterprises can facilitate recovery.

- **Additional funds or diverting existing funds from international partners.** For example, the following instruments may be considered:
  - Catastrophe Deferred Drawdown Option (Cat DDO),<sup>21</sup> a World Bank product, provides countries with a preapproved credit line that can be accessed when a national emergency is declared following a natural disaster, provided the country commits to developing an integrated Disaster Risk Management Strategy.
  - Contingency Emergency Response Component (CERC)<sup>22</sup> allows for rapid reallocation of uncommitted funds in an investment project financing toward urgent needs in the event of a crisis or emergency physical, economic, and social recovery.
- **Insurance:** Sufficient coverage of transport systems to catastrophic risks is an important resiliency strategy. Insurance protection helps ensure that when a disaster occurs, capital from insurance claims can be made rapidly

<sup>21</sup> The Development Policy Loan with a Cat DDO is a contingent credit line that provides immediate liquidity to International Bank for Reconstruction and Development member countries in the aftermath of a natural disaster. It is part of a broad spectrum of risk financing instruments available from the World Bank Group to help borrowers plan efficient responses to natural disasters. See [http://treasury.worldbank.org/bdm/pdf/Handouts\\_Finance/CatDDO\\_Product\\_Note.pdf](http://treasury.worldbank.org/bdm/pdf/Handouts_Finance/CatDDO_Product_Note.pdf).

<sup>22</sup> For more information on CERCs and other International Development Association financial mechanisms, see [http://siteresources.worldbank.org/PROJECTS/Resources/40940-1365611011935/Guidance\\_Note\\_IRM.pdf](http://siteresources.worldbank.org/PROJECTS/Resources/40940-1365611011935/Guidance_Note_IRM.pdf).

## Box 6. Case Study: Mexico's National Disaster Risk Management Fund for Time Efficient Disbursement of Funds

To ensure the time-efficient allocation and disbursement of funds, set the time frame for the PDNA to be completed. In Mexico, the Operating Rules of the national disaster risk management (DRM) fund allow for a maximum of 20 working days for subcommittees to carry out all steps of a PDNA (e.g., complete a site visits,

document and photograph the types of damages with GPS-integrated devices, itemize recovery and reconstruction transport sector needs and related costs). Based on the assessment results, resources from the national DRM fund are allocated for specific activities and never for the recipient entity to spend at its discretion.

available compared to national mechanisms, which are often delayed. Further, depending on whether the government has signed onto an insurance scheme, a regional insurance facility may be utilized. For example, the Caribbean Catastrophe Risk Insurance Facility (CCRIF)<sup>23</sup> and the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)<sup>24</sup> offer hurricane and earthquake coverage to participating governments in the Caribbean and Central American region and in the Pacific region, respectively.

- **Loans:** It may be possible to obtain emergency loans, including from the World Bank, though this may affect the future fiscal position of the country or province.
- **New taxes:** Levies, taxes, or surcharges can be used to raise additional funds for reconstruction.
- **Policy incentives for boosting domestic trade and commerce:** Adopting changes to policy for commerce can promote investment and help inject liquidity into affected areas.

### Tip

A good fund-tracking mechanism, along with a strong public financial management system, can

enhance donor confidence and help mobilize additional funds for recovery. Pre-agreement and maintenance of financial mechanisms in anticipation of a disaster are the best ways to ensure rapid access to resources.

## Establish a Communications Plan

The lead recovery agency should set an overarching communications strategy that informs sector-specific communication strategies. Aligned with the overarching strategy, transport officials should establish a transport communications plan<sup>25</sup> that communicates the goals of the Recovery Plan, recovery decisions, activities, and progress on a regular basis. Messaging should be coordinated with the overarching communications strategy and communication plans from the other sectors so that local communities receive consistent and accurate information. Community and sector stakeholders need to be kept aware of shifting priorities and recovery progress by providing timely and accurate information about local routes, damages, and closures, and what is planned next. Dissemination of this information requires assistance from a broad range of stakeholders,

<sup>23</sup> <http://siteresources.worldbank.org/PROJECTS/Resources/Catastrophicriskinsurancefacility.pdf>.

<sup>24</sup> <http://pcrafi.spc.int/>.

<sup>25</sup> This is an important tool for keeping recovery decision makers and the public informed from the early stages and throughout the recovery process.

including the media, elected officials and their staff, the private sector, volunteers, and community organizations.

A transport sector communications focal point should coordinate the flow of all disaster-related information internally (within the Ministry of Transport) and externally (to the public and media). This person should have oversight of who communicates what and when. Key decision makers need to be informed of recovery and reconstruction progress to maintain and build their confidence. This is essential if programs are to continue to run uninterrupted. The communications plan needs to define how regularly (e.g., daily, weekly, monthly) status reports are distributed to key decision makers; state, regional, and local officials; and the public.

### Tips

- Identify a public information officer who will schedule interviews, issue press releases, and gather and verify information. Implementing an effective and coordinated public information operation can play a role in the success of any recovery.<sup>26</sup>
- Keep members of the affected population informed about the steps that they can take to better protect themselves and their communities from disaster impacts, routes that are available and will soon become available, detours, and plans for the transport network going forward.
- Communication needs to be two-way. There should be a feedback mechanism that allows beneficiaries to be engaged, identify new opportunities, raise issues or grievances, identify corruption, and propose alternatives for transport reconstruction investments and programs.
- Utilize shared databases, message boards, and satellite links to improve information



flow and focus communication channels on keeping those working on the recovery, as well as the public, informed.

Fiji—Suva Airfield. Photo: Kszymek

## Build Capacity

Strengthen recovery systems in national and local governments by assessing the training needs of transport officials and other relevant sector agencies or stakeholders. Address skill gaps, particularly at the local, regional, and institutional levels. A knowledge platform can support the sharing of best practices, technical publications, and other knowledge materials relevant to recovery and reconstruction, thereby bolstering the capacity of transport officials to effectively conduct present and future recovery efforts.

## Establish a Monitoring and Evaluation Framework

A government-wide M&E framework should be developed to support the creation of the overarching recovery strategy. Within this

<sup>26</sup> Having point persons in different parts of the country with satellite communication devices can allow information to more easily flow in from parts of the country that may lack all communications.

framework, transport sector-specific outcomes need to be monitored by the transport recovery lead agency. To achieve this, transport officials should identify reporting time frames for the ministry, the cabinet, stakeholders, and the public—including for financial audits if additional ones are required outside regular ministerial reporting. Transport officials can promote transparency and accountability in resource execution by requiring regular submission of progress reports from contractors and service suppliers implementing the activities. Making these submissions public can support trust-building with the population, giving individuals transparency into such decisions.

Continually assess progress toward recovery objectives defined in the Recovery Plan, take on new information, and adapt accordingly, using the wider recovery M&E framework designed by the lead recovery agency and the transport recovery M&E framework.

**Tip**

Investments in data collection, archiving, analyzing, and sharing information systems

with partners will support a comprehensive and effective M&E framework and process for the transport sector recovery.

## Develop Contingency Programming

Transport officials should think about how to develop or strengthen contingency programming to enable effective institutional coordination and communication in a future disaster event. Use the learnings from a disaster to begin programming for contingencies, increasing the likelihood that, when failures do occur, they can be addressed in a way that limits negative impacts. For example, design evacuation routes, ports, and airports with strong resilience so that they can continue to operate during a disaster. Additionally, develop contingency plans for when they are not operative by putting in place the necessary policy and institutional frameworks, communications protocols, and investments to support emergency preparedness and response for future events.

### Box 7. Case Study: Tonga Develops Contingency Programming to Rapidly Deploy Goods and Services Post-Disaster

In Tonga, contingency programming has been addressed through investments in emergency response systems and procurement regulations. Aware of its high exposure to natural disasters, Tonga established provisions in its legal framework and institutional arrangements to manage disaster preparedness, response,

and rehabilitation. Additionally, the country has identified the need for an advanced procurement system (compatible with that of international donors) to enable a timely, efficient, and transparent acquisition and deployment of goods and services related to emergency response.

## Implementation of Transport Sector Disaster Recovery

The institutional components outlined above will help in the development of a well-organized and planned recovery. These components form the basis from which to effectively implement activities, outlined below, to return transport to the new *planned* normal.

### Restore Critical Transport Infrastructure

Based on the recovery and reconstruction needs identified in the PDNA and any other supplementary assessment information, identify which transport assets, modes, and routes need to be restored as a priority and initiate that work. For example, reestablish lifelines, including evacuation routes, hospital routes, and main corridors, so that response functions may take place and recovery can proceed. Consider that, while great effort and resources must be given to recovering primary roads, secondary and tertiary roads may also be vital connections between communities and social and economic resources.

When restoring critical transport infrastructure and services, transport officials need to consider how to effectively manage traffic, which will be important to a successful disaster recovery. This will require significant coordination with affected and adjacent jurisdictions. Convening an emergency transport relief task force to manage damaged or affected transport lifelines will support the implementation of immediate traffic control measures, such as using detours or alternate routes that may have been previously developed for other hazards or high-traffic event scenarios.

Identify and initiate interim transport sector accommodations for airports, ports, rail, etc. For example, establish an alternative site that can conduct air traffic control so that shipments and supplies can enter the country. Transport



officials need to provide temporary services that replace disrupted services in the short term to mitigate economic impacts. Communicate alternative arrangements to affected populations and develop an exit strategy for temporary accommodations. Keep in mind that temporary structures often become permanent.

As recovery and reconstruction progress, efforts should shift toward implementing measures to reduce future infrastructure damages and losses by strengthening and retrofitting vital lifeline connections within the transport system and implementing pre-mitigation strategies. For example, developing a risk-based asset management system can help identify optimal investment strategies to reduce a roadway's risk and vulnerability to hazards and maintain its functional performance at an acceptable level in the event of a disaster.

#### **Tip**

Readily available and accurate traffic data are

Vietnam—Woman holding a bicycle, Mekong River Delta. Photo: Hadynyah

very helpful in developing emergency detours and making informed decisions about which modes and routes need to be established as a priority. Smartphone apps, such as Google Maps and Waze, communicate road closures and detours in real time in many countries around the world.

## Manage Labor and Material Needs

Recovery of the transport sector requires intensive use of labor and materials. During recovery, there is a high demand for these resources, which can create either a surplus or a deficit of labor and materials. There is a complex trade-off between bringing in large numbers of workers to complete the infrastructure repairs quickly, which further adds to the pressures on housing stock (pushing up prices and forcing lower socioeconomic families out of their rental accommodation or taking up tourist accommodation), and taking a slower pace to rebuild, relying on local labor and thereby placing less pressure on other infrastructure, like housing, and allowing some labor to be directed to support the restoration of other sectors. Transport officials need to minimize the downsides of the changing labor and materials markets on the local communities and the economy. There is a high demand on limited labor and materials, which can cause a shock to local markets that may result in a spike in labor and construction costs. Alternatively, a market glut can occur due to excessive donation of materials and labor, which can eliminate all demand for local products and labor and

put local companies and laborers out of work. Preexisting relationships with private sector construction companies, transport infrastructure asset owners, transport providers, and materials suppliers are key to understanding the existing labor force capacity and capabilities, anticipating any incoming labor force and materials challenges, and identifying additional costs associated with supplying materials.

### Tips

- Have a transparent and managed pipeline of work that carefully releases work out into the market to avoid the effect of overstressing construction companies or artificially driving up prices.
- Support those undertaking an increased workload due to recovery and reconstruction demands and make sure health and safety guidelines and standard operating procedures are up to standard and adhered to.

## Debris Removal and Demolition

Make transport infrastructure functional and safe by removing debris and identifying infrastructure, including buildings that support transport, that may need to be demolished because they are beyond repair or no longer needed or reside in a hazard zone. In some cases, a partially damaged structure may need to be demolished without causing further damage to the remaining structure. Transport officials should work in close coordination with those charged with making demolition

### Box 8. Case Study: Restoring the Road Network within 20 Hours in Japan

In the aftermath of disaster events, Japan's Nippon Expressway Company (NEXCO) prioritizes road clearance to restore the road network within 20 hours for emergency vehicle passage. Further, NEXCO employs several strategies to facilitate the rapid response

and recovery of transport systems. One such strategy is the “eight-directions strategy,” which aims to reestablish accessibility to Tokyo from eight directions within 48 hours after the disaster by maintaining at least one route in each direction.

## Box 9. Case Study: Private Sector Transport Companies Supplementing the Workforce in New Orleans

In the aftermath of Hurricane Katrina in 2005, many families in New Orleans, USA, were displaced, which resulted in a lack of workers to support restoration of transport services and reconstruction of the transport network. Almost a year after the storm, the population

of New Orleans was nearly half its pre-Katrina total. As a result, major transport companies, such as CSX, brought in workers from throughout its system and provided them with food and accommodations for months to staff reconstruction projects.

decisions in other sectors, as this may require road closures to make a given area safe. Further, since debris removal is a cross-cutting recovery need, regulation on landfills requires coordination with authorities beyond the transport sector.

Debris removal can be costly and take months or even years due to the need for appropriate disposal sites, the cost of collection and transport to those sites, the routes available to designated sites, and the need for heavy vehicles and tools to execute the debris removal operation. Plan to accommodate the oversize and overweight vehicles needed to remove debris to minimize subsequent damage to infrastructure, which can be caused from heavy vehicles carrying debris. Test for contamination or other hazardous substances prior to demolition. If harmful contaminants are identified, appropriate storage plans need to be developed and environmental management needs to take place. Resist tactics to manage debris removal, such as landfilling, incineration, or waste-to-energy tactics, that further contribute to poor air quality and can exacerbate climate change.

### Tip

To determine if the transport asset in question should be repaired or demolished and replaced, ask:

- What options are there for repairing the infrastructure? Should the infrastructure be relocated? Is it economical to repair or more

affordable to demolish and replace? Are there historic preservation or environmental concerns that need to be addressed?

## Procurement

Procuring personnel and equipment to help remove debris or repair roads and bridges, as well as make temporary repairs to important public transport facilities, requires dedicated time and human resources, as well as specific technical knowledge. Doing this well is critical for securing high-quality, cost-effective external contractors who deliver effective recovery of the transport sector. Keep in mind that the scale of construction required by a destructive natural disaster can offer an opportunity to improve and adapt procurement methods, as well as to develop alliances. Some activities to consider for improved procurement practices are:

- The increase in the volume of transactions and the urgency with which they need to be completed can overwhelm transport officials. Simplified procurement procedures can allow for the hiring of contractors under existing contracts in the region. This is the most direct way for mobilizing resources for reconstruction.
- In addition to simplified procedures, simple forms of contracts may also be considered, such as time-based contracts, or reimbursable cost-plus fee contracts for emergency repairs

### Box 10. Case Study: Expediting the Issuance of Construction Permits after the Northridge Earthquake, USA

After the 1994 Northridge Earthquake in California, USA, the governor exercised emergency powers to significantly reduce the time required to issue construction permits. The lead official of the California transport agency empowered districts to approve emergency contracts, which expedited the recovery efforts.

Note that though emergency powers can be an important tool for expediting administrative processes, it is important to emphasize the need for transparency and accountability. Otherwise, opportunities may arise for corruption, approving projects that may be controversial or have negative environmental or social impacts.

### Box 11. Case Study: Performance Incentivized Cost Reimbursable Works Contract Model in Australia

In Queensland, Australia, the Department of Transport and Main Roads developed a Performance Incentivized Cost Reimbursable Works Contract model that allowed the state to issue work to the market without first defining the scope of the work. The department would

work with the contractor to refine the scope of work and use a pain share/gain arrangement. This allowed the state to get projects out to the market faster, minimized disputes, and ensured that the focus is on getting work done rather than administering contracts.

where no design is prepared. In small countries, the transport authority may also consider establishing a framework agreement with the local contractors to reduce the time of the procurement process following a disaster.

## Inventory, Map, and Analyze

Severe disaster impacts should prompt the inventorying of transport assets and the risk assessment of their vulnerability. The mapping and assessment of these assets can clarify which disaster scenarios require the greatest analysis, which in turn provides an informative feedback loop for disaster and climate forecasters. For example, in the aftermath of Hurricane Sandy, New York State Department of Transportation officials said that more-accurate sign inventories would have been very helpful after the hurricane in accelerating repair contracts. Understanding how at-risk assets

may be affected can influence long-term asset maintenance, repair, and replacement strategies in an asset management plan. Some assets could be strengthened, some relocated to less-exposed areas when their economic lifecycle ends, and others may need to be abandoned.

## Engineering, Design, and Construction

Limit future asset losses and reduce exposure of assets by investing in stronger protective infrastructure, such as seawalls and appropriate drainage systems, using materials that increase the resilience of transport assets or applying “softer” or “nature-based” solutions, such as beach nourishment, coral reefs protection, and mangrove preservation.

Understand the sources of vulnerability to the transport network so that the engineering and



design process can reduce or even eliminate vulnerabilities (e.g., retrofitting, making roads earthquake resistant). Adapt engineering design practices for resilient, reliable, efficient, and effective transport infrastructure. Use innovative materials and design specifications that enhance the robustness and flexibility of transport infrastructure. Design infrastructure technical standards and guidelines to inform rebuild design to the levels of service that are appropriate and affordable, taking betterment into account where possible. Options to increase resilience of roads include the use of positive drainage techniques, permeable pavements, epoxy modified open graded porous asphalt, and waterproof solutions for thin chip seals or sprayed seals. Other options include the following:

- Geocell pavements are effective in spreading load and can do without the aggregate base course and subbase layers of traditional pavements, relying instead on load transfer between blocks. The resulting composite structure serves as a flexible but impermeable pavement surface.
- Rock, geosynthetic container and concrete masonry block revetment provide efficient coastal protection solutions that make use of local materials.

### **Tips**

- Implement quality control and safety measures to reduce challenges during and after reconstruction.

- A “dig once” policy can help reduce the number and scale of repeated excavations for the installation and maintenance of transport infrastructure facilities. Such policies save both time and cost, with concurrent economic, social, and environmental benefits.
- Consider interdependencies between projects. Fixing one bridge may simply result in thousands of cars being fed onto substandard roads that cannot cope. A transport peer review panel of engineers and planners can help vet some of these decisions.
- To make decisions under uncertainty, identify the most exposed transport links to natural hazards by overlaying the network with hazard data, factoring in different parameters of their vulnerability, such as flood depth and duration, traffic rerouting, and structural damage. By running scenarios of possible events and their impacts, a robust decision-making approach can be applied to guide an analysis of policy options available when the transport network is exposed to unpredictable climate or geological events.
- New solutions must be tested and their robustness assessed through stress-testing under a wide range of plausible conditions. It may be useful to choose low regret design and engineering solutions that can withstand a variety of climate conditions. Another option is to increase the flexibility

## **Box 12. Case Study: Legislation Can Help or Hinder the Design and Engineering Process**

Following the 1989 Loma Prieta Earthquake in California, legislation both hindered and helped reconstruction. For example, after the earthquake, existing legislation contributed to challenges faced by reconstruction crews. Existing laws favored repairing facilities back to their pre-earthquake condition. This

condition was not always the safest. Several existing structures were not designed to endure seismic loads. Yet, a legislation plan that was implemented in the aftermath of Loma Prieta supported the retrofitting of 122 bridges, none of which were damaged in the subsequent 1994 Northridge Earthquake.

of investments, for example, by choosing engineering designs that have a reduced lifetime or that are easy to retrofit in the future once additional information is known on the direction, magnitude, and speed of climate change or disaster risks and on the performance required.

- There will be pressure to quickly reinstate transport infrastructure and services to the way they were before a disaster, but decision makers need to balance this with the elimination of risks in the transport network. Simply rebuilding to conditions that existed prior to an event will likely ensure that risks are retained going forward.

## Plan for Land Use

Transport systems may have been developed decades or even centuries ago to meet a capacity that has long since been exceeded. Urban growth and its associated space restrictions often stand in the way of efforts to expand and meet modern demand. The aftermath of a disaster presents an opportunity to better align a community and its projected needs with transport infrastructure that will better serve its residents going forward. Transport officials should identify where changes in the landscape may present opportunities to alter land use patterns to support social and economic development objectives, to increase accessibility, and to attract new residents or businesses.

Planning and rebuilding often proceed in parallel rather than in a linear process. Transport officials need to work closely with the national and local government recovery policy makers to get decisions made about future land use, to mitigate the risk that rebuilding permanent transport infrastructure is counterproductive and creates poor land use outcomes in the future, and to put in place appropriate land use regulations that have sufficient support to be enforced. Transport officials should examine the appropriateness

of pre-disaster land use planning objectives by questioning:

- Where can transport and land use planning be improved to reduce vulnerabilities and better meet the needs of the current population?
- Are there amended land use plans that should be accounted for in the Recovery Plan?

### *Tool*

Georeferenced hazard maps can be overlaid on the transport network to identify vulnerabilities and facilitate new infrastructure being built in a risk-informed manner. If such maps do not yet exist, transport officials should begin inventorying and mapping the transport network to better understand where transport assets and risk are located to inform future decision making.

### *Tips*

- Promote land use policies that address congestion, pollution, road crashes, and exclusion and that offer more transport options, as well as make schools, work, and markets closer together.
- A geohazard risk management perspective that incorporates people, the environment, hydrology, geology, and the transport infrastructure should be adopted in land use planning for a more resilient transport network going forward. A standardized geohazard risk index can support the identification of problem areas and the specification of risk mitigation methods.
- Disasters can drastically alter the landscapes they affect, which can result in the loss of land use that may have been previously used for roads, bridges, etc. This results in the need for new land to be located for infrastructure reconstruction. This can be a complicated process. When transitioning to longer-term development processes, consider the implications of recovery decisions for future land use planning and development.

- Post-disaster contexts often present unique planning powers that may allow a host government to acquire or rezone land that may allow routes to be developed for rail when in normal business-as-usual environments it would be near impossible to acquire all required lands.

## Address Economic Losses

Develop programs to assist local businesses to relocate to new or temporary facilities or address economic losses. Factor in economic conditions in the context of tangible issues, like lost revenue from reduced taxes and job loss, to intangible issues, such as lost business opportunities from transport network failures, when making related decisions. Keep in mind that improvement of transport infrastructure, such as sea ports and airports, can help draw commerce to the area, resulting in a net improvement in local business capacity, in spite of the disaster that occurred.

## Reduce Inequalities and Support Community Recovery

Inequalities are exacerbated in the aftermath of disasters. Planners must account for such inequalities, including unequal access to repaired, reconstructed, or upgraded infrastructure, in the planning process to mitigate their perpetuation in recovery and reconstruction. Prioritize areas that are low income and/or have minority communities in planning, as wealthier areas tend to have

stronger links politically with local institutions and organizations that bolster their ability to recover faster. Ensuring a grievance mechanism is in place to address community concerns can support transport officials in mitigating and addressing unequal access issues. For example, after the Northridge Earthquake, in California, disputes and decisions on project sites were settled in hours. Hotlines were established to expedite answers and responses to contractors in the field and helped reduce paperwork.

The impact on communities of restoration works should not be underestimated. The social and economic impacts of ongoing roadworks, detours, and extended repair times can add to both economic costs (travel times, etc.) and social costs (additional stress and frustration). A functioning transport network supports an affected population's ability to rebuild asset stocks, enables the delivery of scalable social protections, increases access to the financial system, and supports the buying and selling of goods. Factor in economic conditions in the context of tangible issues, such as lost revenue from reduced taxes and job loss, to intangible issues, such as lost business opportunities from transport network failures, when making related decisions. Consider how the community could be included in transport network recovery and reconstruction activities to bolster their livelihoods, for example, cash for work. Also consider what programs may be needed to assist local businesses to relocate to new or temporary

### Box 13. Case Study: Bringing Back Displaced Workers to New Orleans to Support Transport Sector Recovery

Recovery planners should be mindful of the need to provide temporary services that replace disrupted service in the short term to mitigate economic impacts. After Hurricane Katrina, in New Orleans, USA, a new transport service that brought displaced workers back to New Orleans

for work was established to help the city recover economically. The service was funded by the U.S. Federal Emergency Management Agency and coordinated with the Federal Transit Administration, the State of Louisiana, and New Orleans Regional Transit.

### Box 14. Case Study: Transport Recovery through Disaster-Responsive Safety Nets in Comoros

In Comoros, the government is building resilience through disaster-responsive safety nets. One of the key programs provides short-term post-disaster cash for work, including debris removal and road clearing. The

program both provides immediate benefits for households through creation of labor opportunities and leaves communities with lasting benefits (such as improved community facilities and transport access).

facilities or mitigate economic losses, given breakdowns in transport connectivity.

#### **Tool**

The *Modeling the Economics of Resilient Infrastructure Tool* (MERIT) was developed by the Government of New Zealand to understand the types of businesses that can be affected by different hazards and how those impacts can take shape. MERIT is an economic evaluation tool and may be used to assess the economic impacts associated with major infrastructure outages, such as gross domestic product disruptions. MERIT is a dynamic, multiregional, and multisectoral economic model that contains core features of a computable general equilibrium model.<sup>27</sup>

### Transition to the New Normal

Anticipate what the new “normal” will look like and consider how recovery objectives and activities will interact with ongoing development objectives. Eventually, there will be an interest by the government to transition from recovery arrangements to business-as-usual scenarios and longer-term development planning. As the recovery operations begin transitioning toward business as usual, recovery activities will compete with other development demands.

Develop a Transition Plan, in consultation with key stakeholders, that appropriately prioritizes recovery objectives. This plan will

guide the Ministry of Transport and other key stakeholders to identify when and how recovery activities for the transport sector not completed can be integrated into normal land use and development plans and processes. Account for ongoing recovery and reconstruction activities and funding needs. Clarity on which agencies will be responsible for carrying forward transport recovery activities and associated costs will be important.

### Lessons Learned

As the recovery process closes out and there is a transition to the new normal (or ideally during the recovery process, if there is resource capacity for it), interview key decision makers, stakeholders, partners (including private sector implementing partners), and members of the affected communities to identify key lessons from the transport recovery process, including what worked, what did not work, and how resilience can be improved now and in anticipation of a future disaster.

#### **Tip**

Work with relevant local, regional, national, and international stakeholders to develop lessons learned that future disaster recovery efforts can benefit from. Integrate learnings into wider sustainable development planning, to inform preparedness measures in anticipation of a future event. Move toward local self-sufficiency, sustainability, and resilience.

<sup>27</sup> For more information, see <https://www.merit.org.nz/merit/>.

## Forward Outlook: Investment in Preparedness



To bolster resilience to future disasters or climate change impacts, governments need to systematically invest in preparedness measures and infrastructure strengthening, which in the long run will prove to be more cost-effective than addressing transport infrastructure failures as they happen. As transport officials conduct recovery and reconstruction activities, disaster impacts will be fresh in institutional memory. Now is the time to build on momentum to mitigate vulnerabilities, develop the capacity of relevant stakeholders, implement appropriate risk mitigation and adaptation measures, and integrate lessons

learned into pre-disaster recovery planning. Transport officials can do this by:

- Increasing knowledge of risk exposure and vulnerabilities of the transport sector<sup>28</sup> so that transport officials can reduce those risks and undertake the appropriate preparedness measures
- Defining a disaster risk financing and procurement strategy<sup>29</sup>
- Mobilizing resources ex-ante through a disaster risk management fund or disaster risk financing and insurance strategy

Tanzania—Dar es Salaam's new bus transit system.  
Photo: Hendri Lombard / World Bank

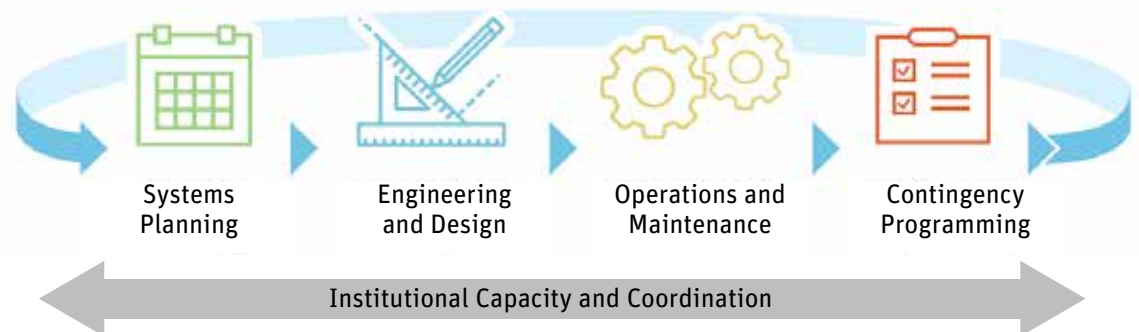
<sup>28</sup> Georeferenced hazard maps can be overlaid on the transport network to identify vulnerabilities and to build new infrastructure in a risk-informed manner.

<sup>29</sup> For example, early contract involvement can help improve the quality and innovation of large and complex projects

- Developing an ex-ante transport sector Recovery Framework
- Developing comprehensive and function-specific emergency plans pre-disaster
- Establishing relevant partnership agreements between neighboring states
- Maintaining a system of trained supplemental personnel (e.g., volunteer engineers)
- Mandating regular simulated training exercises, or emergency simulations, to evaluate emergency response plans, test weaknesses of existing lifeline systems, better prepare citizens so that they are able to respond immediately in the event of a disaster

Government authorities should use the transport infrastructure lifecycle model<sup>30</sup> as a practical framework to think more holistically and proactively about the lifetime of transport assets (Figure 1). The framework helps institutions think about budgeting, defining priorities, rehabilitation schedules, and investments to reduce future damages and losses in the transport sector. Strengthening these operations through risk-based asset management and the infrastructure lifecycle approach will help reduce overall maintenance costs and bolster the long-term resilience of transport systems.

Figure 1. Transport Infrastructure Lifecycle Model



<sup>30</sup> *Systems Planning* can involve analysis to better understand which infrastructure is critical and vulnerable, as well as measures to shift the deployment of long-life infrastructure away from disaster prone areas, or plan for the use of transport infrastructure as part of disaster risk management. *Engineering & Design* relates to measures that enhance the resilience of infrastructure through improvements in design and engineering standards and construction materials specifications to ensure these can withstand the impacts of natural disasters and climate change. *Operations & Maintenance* interventions can add a new level of resilience by securing economic and social developments and reducing recurrent reconstruction costs due to frequent disasters. *Contingency Programming* means planning for a quick and effective response, with protocols and financing, following a disaster event to mitigate post-disaster impacts.





The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change. Working with over 400 local, national, regional, and international partners, GFDRR provides grant financing, technical assistance, training and knowledge sharing activities to mainstream disaster and climate risk management in policies and strategies. Managed by the World Bank, GFDRR is supported by 34 countries and 9 international organizations.