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Approach Paper

Climate and Natural Disaster–Resilient Transport: Evaluation of the World Bank Group's Support, 2016–25

January 28, 2026

1. Background and Context

1.1 The Independent Evaluation Group (IEG) is conducting an evaluation of the World Bank Group's transport interventions to improve resilience to climate and natural disasters and ensure reliable, accessible transportation. This evaluation will respond to the Bank Group's Evolution Roadmap, which places greater focus on infrastructure, service delivery, and climate adaptation (World Bank Group 2022), and the Update to Governors entitled "Foundations for Growth and Jobs," which commits to providing "reliable, affordable, and resilient…roads, ports…[as] key enablers of job creation" (World Bank and IMF 2025, 3). For this evaluation, *resilience* is defined as the capacity of the transport sector to cope with hazardous events in a way that maintains its essential function, whereas *adaptation* refers to the process of adjustment to such events and their effects (Adapted from IPCC 2021). This evaluation will cover the most common shocks—from climate change (for example, extreme temperatures, abnormal precipitation, storms, strong winds, flooding, heatwaves, sea level rise, and so on) to natural disasters (for example, earthquakes and volcanic activity). Addressing those shocks together is logical because they are interconnected and often require similar adaptation measures. The evaluation will also seek to highlight successful practices and areas for improvement and provide examples of effective adaptation activities that can be scaled up and replicated for the benefit of reliable and accessible transportation.

1.2 Climate change and natural disasters are responsible for substantial damage to transport infrastructure and disruption of transport services and cause significant economic and social losses. It is estimated that 3.3–3.6 billion people live in highly climate- and disaster-vulnerable conditions (IPCC 2023). Households and firms in low- and middle-income countries incur significant annual costs—between US$391 billion and US$647 billion—because of disruptions to essential infrastructure, such as transport, energy, and water and sanitation services (Hallegatte, Rentschler, et al. 2019). The cost can reach almost 9 percent of a combined GDP of lower-middle-income countries (US$7.44 trillion; World Bank 2023). Climate change substantially alters the baseline conditions of transport systems as extreme temperatures and precipitations, sea level rise, and so on cause damage to infrastructure, disrupt operations, and increase safety risks. Direct damage from natural hazards to global transport infrastructure is calculated at approximately US$15 billion annually, with more than half of it (about US$8 billion) occurring in low- and middle-income countries (Rozenberg et al. 2019). Changing

precipitation patterns create significant structural risks to transport. In a scenario in which global temperatures rise by four degrees Celsius, 70 percent of transport assets worldwide will face a sharp increase in flood risk because of a reduction of more than 25 percent in the rainfall design return periods—that is, a 1-in-10-year event becomes a less than 1-in-7.5-year event (Liu et al. 2023).

1.3 Reliable transport infrastructure and services play a pivotal role in the economic and social development of any country and in the emergency response and recovery. With land transport carrying about 90 percent of passengers and 80 percent of freight in low- and middle-income countries, mobility is the lifeblood of communities and economies because it is essential for daily life, social and economic activities, and overall well-being of communities and businesses. All-weather roads improve access to markets and enhance food security as they enable people and firms to take goods to markets and access supplies more efficiently, reducing costs and boosting competitiveness (World Bank and IMF 2025). Reliable transport access is essential for sustaining economic development and access to jobs, markets, schools, and health-care services, as well as for development and growth of businesses. Damage to transport infrastructure and disruptions to transport services can have widespread consequences resulting in social and economic losses; reduced economic activities; increased costs of goods and living; constrained access to critical services, such as health care and social assistance; and delayed restoration of other essential infrastructure, such as water and energy supply, which adversely affect the well-being of communities and economic growth of the country (GFDRR 2018). A reliable and resilient transport network is critical to enabling the transportation of emergency responders, equipment, supplies and aid to affected areas, evacuation of the affected people, and delivery of materials and labor to restore the damaged infrastructure and rebuild communities, essential social services, and economic activities.

1.4 Investing in adaptation measures increases resilience to climate and natural disasters and helps reduce the overall infrastructure provision and maintenance costs. Disasters can undo years of economic growth and development in a moment if infrastructure designs have not been climate-informed and investments in adaptation and preparedness have not been undertaken. Adaptation measures—such as adhering to resilient construction and maintenance standards, implementing flood protection systems, and stabilizing slopes—are critical to strengthening and safeguarding transport infrastructure against climate change and natural disaster impacts and avoiding or reducing service interruptions. Such measures can have higher up-front costs than traditional measures, wide variation in returns across contexts, and predominance of social over financial benefits. Nevertheless, investing in adaptation measures is cost-effective: over the lifetime of infrastructure assets, every dollar invested in natural

disaster resilience is estimated to yield a return of US$4 (Hallegatte, Rentschler, et al. 2019; Hallegatte, Rozenberg, et al. 2019).

1.5 Since 2006, the Bank Group has focused on helping client countries manage and reduce natural disaster impacts. This effort was strengthened by establishing the disaster risk management (DRM) unit and the Global Facility for Disaster Reduction and Recovery (GFDRR), a global multidonor partnership. The DRM unit aids client countries in identifying, reducing, and managing risks from natural disasters and climate change. DRM is integrated into investments in transport, energy, housing, health, education, and urban development. The GFDRR's main mission is to help low- and middle-income countries understand, manage, and reduce their vulnerabilities to natural hazards and climate change. Since 2015, GFDRR-funded technical assistance has helped mobilize about US$35 billion for climate and disaster resilience interventions led by the Bank Group, national governments, and other development partners.

1.6 Since FY 2016, the World Bank's Transport Global Practice started increasing its attention to enhancing the resilience of road infrastructure to natural disasters and climate change. The Transport Global Practice joined the World Bank's commitment to climate finance, including climate adaptation finance that would address climate change impacts. This initiative facilitated stronger collaboration between the transport sector and the DRM team and efforts to secure grant funding from the GFDRR, supporting both analytical studies and the preparation and implementation of lending projects. Initial activities primarily focused on engineering aspects of road projects, such as identification and implementation of adaptation solutions for roads and highways. By 2017, the GFDRR and the Transport Global Practice jointly advocated for transport project teams to move away from reactive responses to crises to adopting proactive strategies. This approach aimed to ensure that transport infrastructure remains resilient in the face of changing risks and hazards and maintains reliable performance throughout its lifetime by addressing every phase—from planning, design, and construction to operations and maintenance (GFDRR 2018).

1.7 In its 2021–25 Climate Change Action Plan (CCAP), the Bank Group committed to significantly scaling up climate financing for both mitigation and adaptation, with the Transport Global Practice specifically focused on enhancing resilience in the transport sector. Under this plan, the Bank Group pledged to allocate an average of 35 percent of its total financing to climate action. That was an increase from the average of 26 percent achieved during the implementation of the 2016–20 CCAP. In addition, the 2021–25 CCAP emphasized the importance of adaptation by setting a goal for at least 50 percent of the International Bank for Reconstruction and Development–International Development Association climate financing to support adaptation efforts (World Bank Group 2021a). To enhance resilience in transport, the Bank Group proposed to use the following tools and

approaches: (i) upstream sectoral and strategic spatial planning informed by assessments of risk and vulnerability; (ii) resilient infrastructure solutions, which include investments in physical infrastructure, new technologies, and community-based adaptation; (iii) improvement of the enabling environment through institutional and capacity support, awareness raising, and finance to enhance the capabilities of the relevant stakeholders at the policy and regulatory levels; and (iv) postdisaster risk and recovery support so that climate change risk and resilience are integrated into rebuilding efforts (World Bank Group 2021).

1.8 Beginning July 1, 2023, the Bank Group reiterated its commitment to aligning all its new financing flows with the climate mitigation and adaptation goals of the Paris Agreement. In parallel, the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA) pledged to align 85 percent and 100 percent of Board of Executive Directors–approved real sector projects[1] starting July 1, 2023, and July 1, 2025, respectively. At COP28, in December 2023, the Bank Group made a commitment to increase its climate finance from 35 percent to 45 percent of the total finance in its 2021–25 CCAP, with a goal of half of the World Bank's public sector financing—IBRD and IDA—to support adaptation and half to support mitigation. In 2025, the same CCAP was extended without any changes until June 30, 2026.

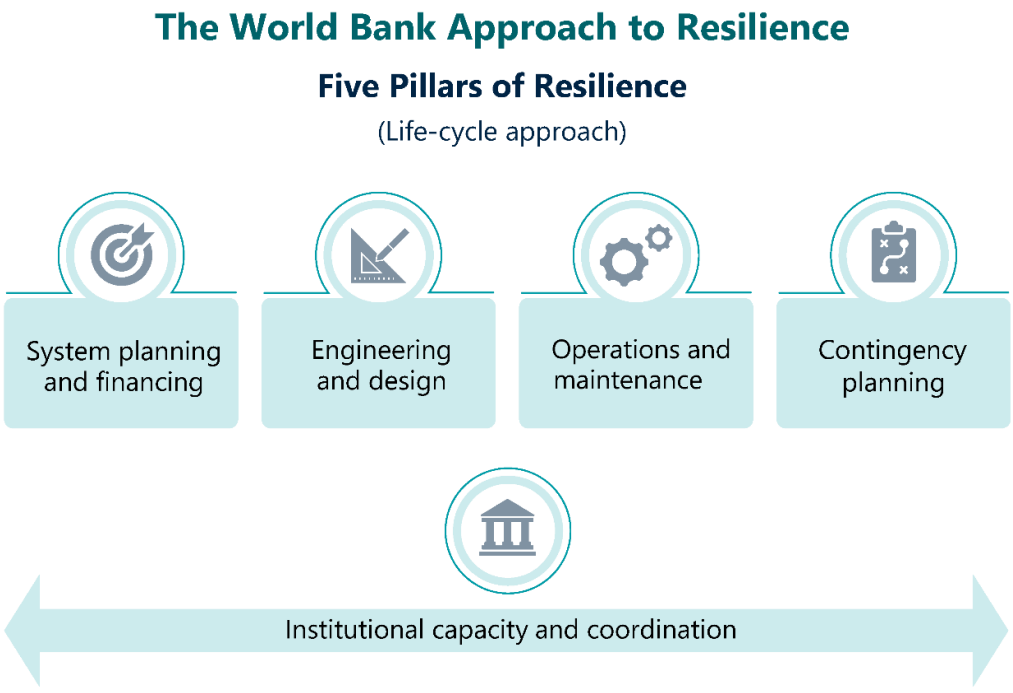
1.9 In 2025, the World Bank's Transport Global Practice reaffirmed its commitment to resilient transport by releasing *Disaster and Climate-Resilient Transport Guidance Note*. The Guidance Note promotes a life-cycle approach (figure 1.1) to integrating climate resilience and natural disaster consideration into every stage of the transport infrastructure life cycle—that is, (i) system planning and financing, (ii) engineering and design, (iii) operation and maintenance, (iv) contingency planning, and (v) institutional capacity and coordination. Building on this life-cycle approach and the results of the Transport Global Practice's review of a sample of transport projects, the Guidance Note advises World Bank staff and clients to focus on four priorities: (i) system thinking (moving from asset-focused investments to systemwide resilience); (ii) enhanced risk governance and disaster financing for long-term climate and natural disaster adaptation; (iii) innovative technologies; and (iv) cross-sectoral coordination, which integrates emergency response, meteorological services, and transport planning for better disaster preparedness and response (Keou et al. 2025).

1.10 The World Bank initially concentrated its efforts on building resilience within the road sector but expanded this focus to other transport subsectors over time, whereas IFC and MIGA began prioritizing adaptation and resilience at a later stage. In FY24, climate

[1] The real sector includes nonfinancial industries, such as energy, manufacturing, transport, telecommunications, mining, and agribusiness.

adaptation included 36 percent of the Transport Global Practice's commitments (US$1.8 billion); in FY25, this share was 30 percent (US$2.1 billion), representing about 20 percent of the Bank Group's total climate adaptation finance. Road projects—making up more than half of the transport portfolio—were initially the primary focus of climate adaptation finance, with 133 of the 158 rural and interurban road projects incorporating climate adaptation finance during FY16–25. Urban transport was the next largest subsector, with 35 of the 53 projects integrating climate adaptation finance. IFC and MIGA began prioritizing climate adaptation and resilience in FY23, after the mandatory adoption of the Paris Alignment, although their contributions to adaptation finance remain limited. IFC increased its adaptation finance from US$153 million in FY23 to US$550 million in FY25. In FY25, IFC's adaptation finance represented 3 percent of all its commitments from its own account. Specifically for the transport sector (excluding logistics and warehouse subsectors), in FY25, two IFC transport projects included port and airport adaptation activities of US$2 million.

Figure 1.1. Five Pillars of the Life-Cycle Approach to Climate and Natural Disaster Resilience of Transport



Sources: GFDRR 2018; Keou et al. 2025.

1.11 The World Bank Group has recently started to more systematically incorporate resilience in its cost-benefit analyses for transport projects. IEG's evaluation that covered urban transport found that the identification of resilience risks, as an integral part of a project's economic analysis, had risen from 49 percent to 68 percent and that the

incorporation of those risks into cost-benefit analysis had increased from 30 percent to 37 percent between 2007 and 2017 (World Bank 2019). A preliminary portfolio review shows that more recent transport projects are actively considering the additional costs and benefits of implementing adaptation measures to get a more accurate assessment of the projects' viability. In addition, the Transport Global Practice is partnering with the Transport Research Laboratory to update the Highway Development and Management Model 4, version 2.0 (HDM-4), which will enable to systematically integrate climate and resilience considerations into asset deterioration modeling and incorporate the costs and benefits of resilience. HDM-4 is a specialized software tool used by road agencies around the world to plan, analyze, and manage their road networks.

1.12 Previous IEG evaluations have provided some insights into the World Bank's recent efforts to strengthen resilience to climate change and natural disaster risks and recommended further assessments. IEG evaluations—such as *Mobile Metropolises: Urban Transport Matters—An IEG Evaluation of the World Bank Group's Support for Urban Transport*; *Building Urban Resilience: An Evaluation of the World Bank Group's Evolving Experience (2007–17)*; and *Reducing Disaster Risks from Natural Hazards: An Evaluation of the World Bank's Support, Fiscal Years 2010–20*—covered various aspects of the urban transport subsector or resilience within the transport sector to some extent (World Bank 2017b, 2019, 2022a). However, given the overarching objectives of those evaluations, the recommendations of *Building Urban Resilience* and *Reducing Disaster Risks from Natural Hazards* evaluations were generally geared toward DRM rather than specific transport issues. The *Mobile Metropolises: Urban Transport Matters* evaluation excluded recommendations related to resilience in transport projects because it focused on the overall design and implementation of urban transport projects. These evaluations did not assess the effectiveness of adaptation measures in enhancing resilience to climate and natural disasters within the transport sector, nor did they cover MIGA and IFC projects largely because of a lack of sufficient evidence at that time.

1.13 Between 2008 and 2016, the World Bank had a limited climate adaptation portfolio, mostly in environment, agriculture, and DRM. At that time, the World Bank predominantly focused its efforts on climate mitigation, especially on renewable energy. Since then, a more substantial number of transport projects with adaptation activities have emerged. This increase creates a timely opportunity to assess whether the adaptation measures have been effective in strengthening the resilience of the transport infrastructure and operation and maintenance.

2. Objectives and Audience

2.1 The objective of this evaluation is to assess the Bank Group's performance in supporting client countries in strengthening resilience within the transport sector to

climate and natural disasters and derive recommendations to enhance future engagements. The evaluation will assess the relevance and effectiveness of the Bank Group's interventions and identify the factors that lead to addressing resilience in project design and implementation from an infrastructure life-cycle and system thinking perspective. This means considering resilience not only from an engineering point of view but also in terms of capacity, institutional aspects, operation and maintenance, emergency preparedness, and contingency planning. It also means shifting from an asset to a system thinking focus by considering the transport asset not in isolation but as part of a network or system. Drawing on evidence-based findings about what works, why, under which circumstances, and for whom, the evaluation will identify practical recommendations for the World Bank, IFC, and MIGA to inform future engagements.

2.2 This evaluation is intended for the Bank Group's Board of Executive Directors, management, and staff involved in advancing resilient transport initiatives. The audience includes task teams working on transport projects or on projects in other sectors that incorporate transport investments. The evaluation will also target client countries seeking to strengthen transport resilience, development partners, the private sector, and academic institutions that play various roles in building or strengthening resilience in the transport sector.

2.3 Given the importance of this evaluation for transport managers and task teams, the evaluation team will consult with them throughout the process but will keep IEG's independence to arrive at sound conclusions and recommendations. To maximize the evaluation's operational relevance for the Bank Group and gather the relevant data and information, the evaluation team will maintain ongoing communications and exchanges with management and staff involved in transport projects, partnerships, knowledge work, and other aspects of support in the client countries. The team will also engage with trust funds that support resilience of transport to climate or natural disasters in countries, such as the GFDRR, the Korea Green Growth Trust Fund, the Quality Infrastructure Investment Partnership, the Public-Private Infrastructure Advisory Facility, and the Global Facility to Decarbonize Transport. The evaluation team will discuss critical issues and share early findings. This continuous dialogue will help inform the ongoing work and facilitate the interpretation of evidence.

3. Evaluation Questions and Scope

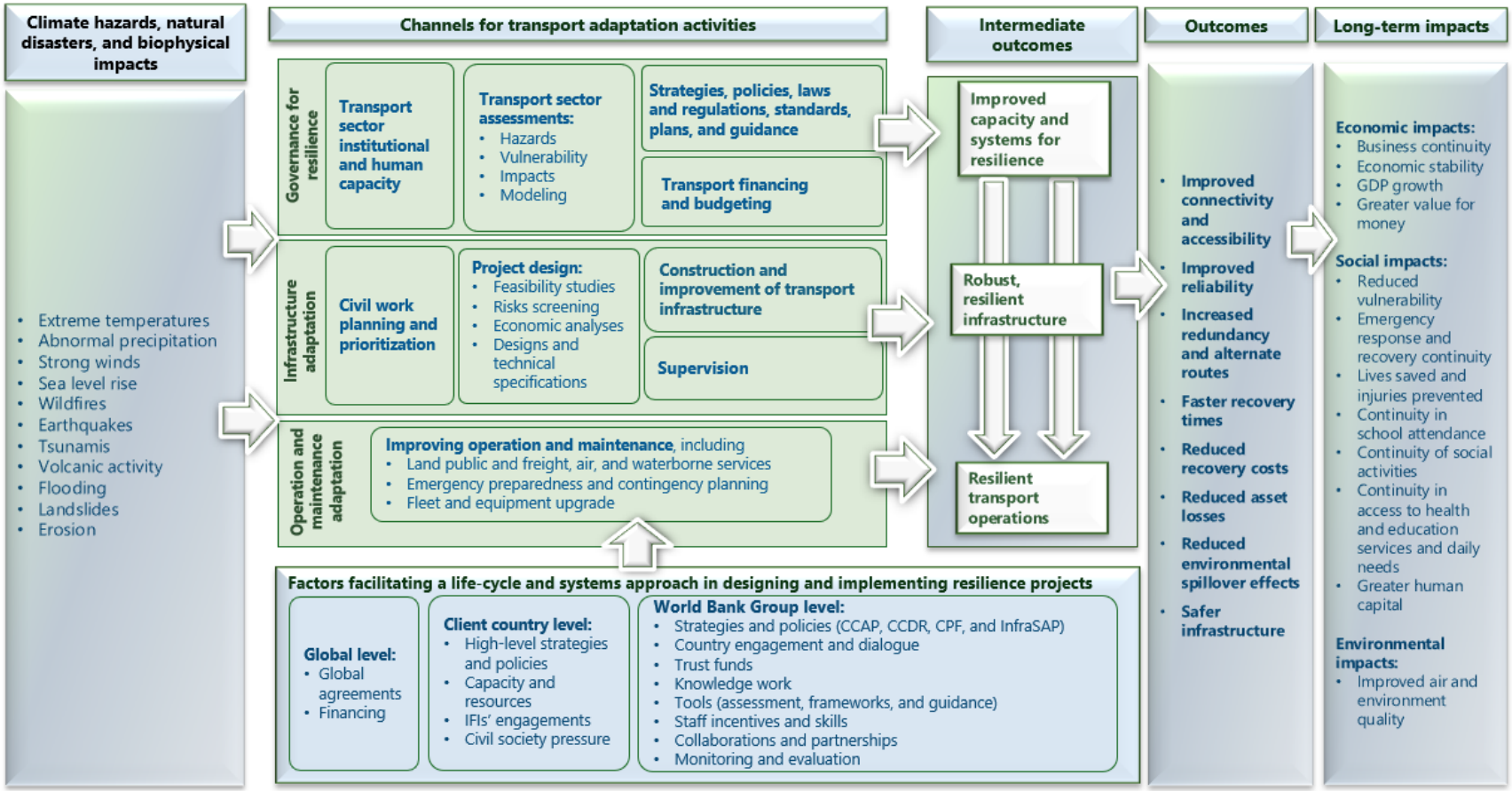
3.1 IEG has developed a conceptual framework to evaluate how the Bank Group supports clients in integrating adaptation activities to address climate and natural disasters into transport interventions, with the goal of enhancing resilience. This framework identifies the most prevalent shocks from climate change and natural disasters, along with their biophysical impacts, which necessitate targeted adaptation

activities (figure 3.1). These include flooding, landslides, erosion, extreme temperatures, abnormal precipitations, sea level rises, strong winds, wildfires, earthquakes, tsunamis, and volcanic activities.

3.2 The framework outlines three primary channels through which transport adaptation activities can contribute to resilience by (i) strengthening governance, capacity, and systems, including transport planning and financing; (ii) constructing and upgrading transport infrastructure; and (iii) improving transport operation and maintenance (which covers the daily management and long-term maintenance of infrastructure and vehicles) and emergency preparedness and contingency planning. Each channel is associated with specific intermediate outcomes—the first leads to improved governance, capacity, and systems for resilience; the second results in robust, resilient infrastructure; and the third ensures resilient transport operations. Implementation of adaptation activities contributes to a range of outcomes, such as improved connectivity and accessibility, reliability, and redundancy and alternate routes; reduced recovery costs, asset losses, and spillover effects on environment; faster recovery times; and safer infrastructure. These adaptation activities are expected to help maintain continuity in school attendance, social activities, access to health care, emergency response and recovery, and business activities. They can also contribute to delivering greater value for money, improved air and environmental quality, saved lives, and prevented injuries. Ultimately, these benefits support greater human capital, economic stability, and GDP growth.

3.3 Until recently, the Bank Group's support has concentrated on resilient infrastructure. Effectively delivering resilience requires an infrastructure life-cycle and systems approach that supports adaptation activities across all three channels—that is, sector governance and capacity, infrastructure and operation and maintenance, and adaptation of a systems approach in transport planning and management. Successful implementation of the infrastructure life-cycle and systems approach depends on many internal and external factors. Some of those factors have been preliminary identified by the IEG team during the consultations with operational staff at the design stage of this evaluation and are summarized in figure 3.1.

Figure 3.1. Conceptual Framework for Climate and Natural Disaster–Resilient Transport Guiding the Evaluation



Source: Independent Evaluation Group.

Note: CCAP = Climate Change Action Plan; CCDR = Country Climate and Development Report; CPF = Country Partnership Framework; IFI = international finance institution; InfraSAP = Infrastructure Sector Assessment Program.

3.4 This evaluation seeks to answer the overarching question: How well have the Bank Group's efforts enabled public and private sector clients to develop transport resilience to climate and natural disasters? For this evaluation, Bank Group*'s efforts*, *support*, and *contribution* are defined to include financing to public and private sector clients, technical assistance, policy dialogue with public sector client agencies, and the Bank Group's due diligence through its comprehensive risk and impact assessments for projects. In addition, where relevant, the evaluation will examine how effectively Bank Group interventions have leveraged the private sector to enhance resilience and identify opportunities for deeper private sector engagement in the transport sector. As noted in chapter 1, *resilience* is defined as the capacity of the transport sector to cope with a climate or natural hazard event in a way that maintains its essential function. The main evaluation questions (EQs) are the following:

- EQ 1: Relevance. How well has the Bank Group supported transport resilience that is responsive to climate and natural disaster risk profiles?
- EQ 2: Effectiveness. How well and in what way has the Bank Group's support contributed to the following:
    a. Strengthening the clients' transport sector governance for resilience to climate and natural disasters?
    b. Building transport infrastructure that is resilient to climate and natural disasters?
    c. Ensuring transport operation and maintenance that is resilient to climate and natural disasters?

3.5 EQ 1 will assess the relevance of transport resilience activities that are responsive to climate and natural disasters with a stepwise analysis. These steps are as follows: (i) identifying the main categories of hazards and their biophysical impacts in the project intervention area; (ii) assessing the quality of the hazard identification and risk assessments that were used to design the project's adaptation activities; (iii) identifying and classifying the adaptation activities included in projects; and (iv) for projects with adequate hazard identification, matching the adaptation activities to the main climate and natural hazards and their biophysical impacts to identify gaps if any. This question will be addressed through the portfolio review and analysis (PRA) of a stratified representative sample of the projects. The evaluation will not treat climate finance as a separate funding source but will rather focus on transport-related interventions that support resilience to climate change and natural disasters with information on climate co-benefits used as an input in certain analyses.

3.6 EQ 2 will assess the effectiveness of adaptation activities in road infrastructure, and sector governance and capacity building in different contexts. First, EQ 2 will examine whether the adaptation activities, planned during project approval, have been implemented. This assessment will be based on the PRA of sampled projects and, for select projects, interviewing the Bank Group's teams and clients. Second, EQ 2 will explore the extent to which the Bank Group's support to improving sector governance for resilience has led to the strengthening of the clients' institutional capacity. This assessment will be performed, on a sample basis, through content analysis of project and other documents, complemented by client and task team interviews, when necessary, to assess whether outputs have been used and intermediate results that demonstrate improved governance, capacity, and systems have materialized. The evaluation will review the quality of cost-benefit analyses and, where data permits, quantify costs and benefits of selected resilience interventions. In addition, IEG will examine how the Resilience Rating System and the disaster and climate risk stress test methodology (with the accompanying Risk Stress Test tool) developed by the Climate Change Group have been applied in practice and will use this to inform recommendations on strengthening the integration of resilience in the cost-benefit analyses for transport projects. IEG will also take stock of different instruments used in the transport portfolio to mobilize private capital for resilience in the transport sector.

3.7 EQ 2 will also explore whether the transport infrastructure and operation and maintenance delivered with the Bank Group's support have become more resilient to climate and natural disasters. For a list of potential intermediate outcome indicators and data sources, see appendix F. EQ 2 will further attempt to explore whether the Bank Group's support for resilience contributed to resilience outcomes, such as improved connectivity, accessibility, safer infrastructure, and reduced asset losses. A list of potential outcome indicators and data sources is provided in appendix G. This analysis will be done through the following tasks for case studies: (i) assessing the extent to which the design of projects focuses on the infrastructure life-cycle approach and integrates system thinking, (ii) evaluating the fidelity of implementation of the design, (iii) capturing results and contributions to transport resilience, (iv) attempting to capture contributions to resilience outcomes, and (v) identifying enabling and hindering factors for the adoption of the life-cycle and systems approach.

3.8 Contribution of adaptation activities to resilience of transport infrastructure and operation and maintenance and possibly resilience outcomes will be assessed through a combination of the PRA of the sampled projects and case studies, that include field observations, and geospatial analysis. This analysis will identify key factors that have either facilitated or hindered the Bank Group's efforts to incorporate an infrastructure

life-cycle and system thinking approach in project design and those influencing the fidelity of implementation.

3.9 The evaluation period will cover the activities of the World Bank, IFC, and MIGA from FY16 to FY25, encompassing lending, investment, guarantees, and related technical assistance, as well as analytical and advisory services approved during this time frame. The activities may be either completed or ongoing. This timeline is intentionally proposed because it is around FY16–17, when the roads portfolio started receiving climate adaptation finance, according to the Climate Change Group dashboard. This time frame will enable the evaluation team to assess how past support has helped mainstream resilience aspects over time in the key areas of the conceptual framework and identify key trends of the Bank Group's support. IEG's preliminary portfolio analysis has identified 619 lending, investment, and guarantee projects delivered by the World Bank, IFC, and MIGA in the transport sector or transport-related activities, with or without climate adaptation finance during FY16–25. The portfolio includes 544 lending projects of the World Bank, specifically 288 active and 256 closed projects delivered by the Transport and other Global Practices; 61 IFC investments (46 active and 15 closed) in the transport sector; and 14 transport projects (all are active) with MIGA guarantees during FY16–25. The World Bank lending portfolio under review includes projects mapped not only to the Transport Global Practice but also to other Global Practices, such as Agriculture and Food; Urban, Disaster Risk Management, Resilience, and Land; Water; and others if those projects include transport-related activities or components.

3.10 This evaluation will have an in-depth analysis for subsectors in which the Bank Group has been more actively and extensively supporting climate and natural disaster resilience–related activities. In particular, the roads and highways subsector, which represents more than half of the World Bank portfolio, was a leading subsector among all transport subsectors to prioritize resilience. For closed roads and highways projects, the evaluation will examine the relevance of project designs, outcomes achieved, and factors that influenced those efforts. Lessons learned from the roads and highways subsector will inform recommendations for improving resilience strategies in other transport subsectors. The evaluation will also assess the extent to which the life-cycle and system thinking approach was applied in the designs of recent projects prepared in other transport subsectors, especially in projects where ports, airports, rail, and other modes are critical for resilience, connectivity, and emergency response. It will also assess the relevance of the project designs, given the climate and disaster hazards affecting the projects.

3.11 A few topics will be outside the scope. This evaluation will exclude geopolitical and socioeconomic shocks, such as civil conflicts, geopolitical tensions, economic and

trade policies, cybersecurity attacks, and pandemics. The main reason for the exclusion is that these types of shocks differ substantially from climate and natural hazards in terms of their drivers and implications for transport sector resilience. Including them could dilute the focus and coherence of this evaluation and would require distinct methodological approaches to assess the Bank Group's support in this area. IEG intends to carry out a Learning Engagement in partnership with the Transport Global Practice to review transport logistics interventions that are supported in response to those geopolitical and socioeconomic shocks. While geopolitical and socioeconomic shocks are excluded, the evaluation will note where climate-related transport disruptions have indirect spillover effects (for example, on migration, food security, or trade logistics), where relevant, while maintaining the defined scope.

4. Evaluation Design

Design Principles

4.1 The evaluation will assess the relevance and effectiveness of the Bank Group's support for resilient transport. It will cover the resilience approaches of all the Global Practices of the World Bank, IFC, and MIGA during 2016–25. The evaluation design matrix in appendix A provides details.

4.2 This evaluation will aim to use data-driven methods as extensively as possible. IEG's preliminary literature review suggests that such methods are better suited to capture results of adaptation measures for resilience and develop scalable, interpretable, and real-time resilience assessment frameworks (Yang et al. 2025). Traditional resilience modeling approaches frequently use simplified assumptions and static system behaviors, which may not adequately reflect the complex and dynamic nature of real-world transport systems. The resilience assessments of transport systems conducted in mid-2010 and earlier tend to rely more on surveys, case studies, conceptual and theoretical work, mathematical modeling, and simulation, with mathematical modeling and simulation being the predominant ones. Most studies used simulations to validate mathematical models (Wan et al. 2018). More recent resilience assessments of transport tend to rely on numerical analysis, optimization models, simulation techniques, and data-driven methods. The literature also recommends adopting a full life-cycle approach to resilience assessment that encompasses all stages—that is, planning and design, emergency response, infrastructure repair, postrecovery enhancement, and daily operations (Yang et al. 2025).

4.3 Accordingly, this evaluation will use a mixed methods approach to generate, triangulate, and validate findings and evaluative evidence. The evaluation will apply both qualitative and quantitative methods to provide a comprehensive and nuanced understanding of the complexities involved in the Bank Group approaches to develop,

maintain, and operate climate- and natural disaster–resilient transport. The evaluation will combine PRA, structured literature review, and case studies. Case studies will use multiple methods, including content analysis of documents, field observations, semistructured interviews with project teams and clients, and geospatial analysis. Where feasible, they may also incorporate modeling and simulation. Triangulating evidence from different methods of data collection and analysis will strengthen the validity of findings and minimize biases that could arise from relying on a single source of information. It will also help overcome the limitations of a particular method. For EQ 1, the evaluation will primarily rely on a PRA of a stratified random sample of all lending, investment, and guarantee projects approved during FY16–25, complemented by advisory services and analytics, as well as a rapid, semistructured review of Bank Group documents (for example, Country Partnership Frameworks, Country Climate and Development Reports, and so on) in sampled projects' countries and external literature. These methods will establish how well the Bank Group's support has aligned with country transport sector hazard risks and needs, identify trends or patterns in the relevance of project designs, and provide the basis for selecting cases for in-depth analysis under EQ 2. For EQ 2, the evaluation will rely on PRA and two sets of case studies.

Building Blocks

4.4 The main methodological blocks are as follows (summarized in appendix B):

1. Rapid literature review (EQ 1 and EQ 2). The evaluation team will conduct a rapid literature review of the external scientific literature and internal research and analytical reports to identify (i) transport adaptation activities for each type of climate and natural hazards, (ii) benefits and impacts of implementing adaptation activities, and (iii) enabling and hindering factors that play a role in design and implementation of adaptation activities and in adoption of life-cycle and systems approaches. The review team will use a search strategy with specific keywords, follow expert recommendations, and, to the extent possible, track citations to identify relevant literature.

2. PRA (EQ 1 and EQ2). The evaluation team will first identify all lending, investment, and guarantee projects that have sector and thematic codes related to transport and that were approved during FY16–25. The portfolio will include both active and closed projects. The analysis will be conducted separately for investment project financing and Program-for-Results projects and development policy financing projects, given their different nature. The analysis for investment project financing and Program-for-Results will include the identification of climate and natural hazard risks and categorize adaptation

activities from project documents using a coding scheme. The portfolio analysis will separately identify transport resilience activities, objectives, and indicators to distinguish between projects that include resilience-related activities and those that also demonstrably contribute to resilience outcomes, such as improved reliability or reduced recovery costs. Furthermore, the review will facilitate an assessment of which adaptation measures proposed at project appraisal have been implemented and which have not, as well as determine the achievement status of resilience-related indicators. The evaluation will examine whether project designs failed to account for any climate or natural disaster risks as well as whether projects faced other more severe hazards than they had been projected and designed for. Regional projects might require slightly different treatment. For development policy financing, the analysis will focus on resilience-related prior actions, objectives, and indicators. The trends or patterns identified from PRA may also help identify potential factors that facilitated or hindered the integration of resilient considerations into project design and implementation. Preliminary identification suggests that the portfolio has 474 investment project financing and Program-for-Results projects and 70 development policy financing projects. For a detailed analysis within the available resources, the evaluation will select a representative sample of projects from the identified portfolio. The evaluation team will use stratified random sampling strategy with transport subsectors (roads, railways, waterways, and so on) as strata for proportionate representation of all subsectors. The evaluation will also ensure that the sampled projects are representative of the portfolio on multiple variables of interest such as Global Practices, Regions, and brownfield or greenfield projects to name a few.

3. For the selection of case studies to support an in-depth analysis to answer EQ 2—that is, the effectiveness of adaptation activities for resilience of transport infrastructure and operation and maintenance—the PRA will identify completed projects in the roads and highways subsector with high exposure to climate and natural hazards, different levels of adaptation interventions, and high disbursement rates. Projects with high disbursement rates are likely to have had most of their adaptation activities implemented and, hence, are good candidates for assessing effectiveness. In addition, the PRA will identify completed projects with activities to strengthen the sector governance for resilience. A sample of these projects will be selected to explore the extent to which the Bank Group support to improve sector governance for resilience has led to the strengthening of the clients' institutional capacity.

4. Stakeholder interviews (EQ 1 and EQ 2). For EQ 1 and EQ 2, semistructured interviews with project task team leaders (TTLs) or project team members will be carried out to complement information that is not available in project documents. For EQ 2, additional semistructured interviews with TTLs or project team members, clients, and other relevant stakeholders will be conducted in the framework of the case studies. Explanatory interviews with TTLs and clients will also take place to refine the case study methodologies.

5. Case studies (EQ 2). In addition to the PRA, EQ 2 will be answered using two distinct sets of case studies that will use multiple methods, including content analysis of project and other documents, semistructured interviews with TTLs and clients, field observations, and geospatial analysis. Where feasible, the evaluation might also explore modeling and simulation techniques within case studies. In addition, wherever feasible, the team will analyze the project-level data on cost overruns, delays, or backlogs because of climate or disaster events to enhance the operational relevance of the evaluation's findings. The evaluation team will conduct the analysis of two sets of case studies that (i) are based on completed and mature projects that have experienced climate or natural disaster impacts, and (ii) focus on design aspects of projects that have used the recently adopted life-cycle and systems approaches and the ones that have not. For the first set, the unit of analysis will be a project, and for the second one the starting point will be a project, but it will also include a related set of projects and activities that are part of the same transport system. The latter set will also define the case boundaries that extend beyond the projects and take a cluster approach (described further in this section). The main methods for the case-based approach are as follows:

a. Case selection. For the first set of case studies, the evaluation team will purposively sample 8–10 closed projects that meet the following criteria to the extent feasible: (i) projects are from the roads and highways subsector, which was an early leader of resilience activities within the transport sector, and from other subsectors, if those projects have available data; (ii) they are closed or their infrastructure constructed is matured to observe operation and maintenance effectiveness; (iii) they experienced climate or natural disaster impacts right before or after the projects were closed; and (iv) in one or two cases, projects have geospatial data that are available before and after the disaster. To the extent possible, the evaluation will also attempt to have case studies with a good mix of different Regions, Global Practices, brownfield and greenfield projects, and countries with varying disaster risk levels, including, where feasible, Small Island Developing States. For the second set of case studies, to assess design aspects, the evaluation team will purposively select 6–8 active or closed projects, half of which employ the life-cycle and systems approach in the design and the remaining half do not. Because this is a relatively new approach emphasized in the more recent Bank Group strategies, the evaluation will consider both active and closed projects. The aim of these case studies is to assess design aspects; hence, completion of the project is not a necessary condition for selection of this set of case studies. Similarly, whether the project has experienced natural disasters or climate events or not is not a selection criterion for this set of cases. This second set of case studies will consider including nonroad subsectors to capture the broader application of resilience design principles.

b. Content analysis of documents that will extend beyond the typical project documents, such as Project Appraisal Documents and Implementation Completion and Results Reports. The review will also encompass hazard, vulnerability, and exposure analyses; engineering designs; bidding and contract documents; and progress or performance reports for road and highway projects completed. Most of these reviews will be desk-based. However, field-based reviews may be undertaken for documents that are not accessible through the Bank Group systems or from the Bank Group task teams.

c. Semistructured interviews will be conducted with TTLs and clients for case study projects to complement the evidence obtained during the project document review. Those interviews will take place virtually or in person during field visits.

d. Field observations will be conducted after the initial desk-based review of the project documents and interviews with TTLs. The field visits would assess whether the infrastructure observed in the field is constructed according to its designs, whether designs are prepared with the consideration of climate and natural disaster risks, whether resilience features are sustained during the operation and maintenance phase, and whether contingency planning and institutional arrangements are in place to sustain the infrastructure resilience. The field visits will also help obtain the documentation that cannot be obtained through desk correspondence with the Bank Group task teams or clients.

e. Geospatial analysis will be conducted for selected cases for which geospatial data are available. The latter is essential because geospatial analysis requires precise geographic identification of each intervention. Identifying these locations usually starts with a careful review of project documents and may be supplemented by field verification. This process is labor-intensive and time-consuming, yet essential for ensuring accurate and reliable results. In addition to location information, the geospatial analysis will draw on two additional categories of data sources: (i) data on climate and natural disasters (for example, ThinkHazard! and EM-DAT—both World Bank resources) and (ii) remote sensing imagery (for example, satellite imagery, radar imagery, and drone imagery). The objective is to assess the effectiveness of each intervention by comparing project infrastructure affected by climate events or disasters before and after implementation (for example, landslides and floods). Modeling approaches will be selected on a case-by-case basis, depending on data availability and intervention characteristics, and may include nature-based solutions, engineering-based approaches, or hybrid models that combine nature-based solutions and engineering measures. The specific modeling approach will be determined once the precise geolocation of the interventions is established because model selection depends—among other factors—on the type of disaster, local climatic conditions, and the overall area of the intervention (which are not currently known). The results of the geospatial analysis will be used to triangulate the evidence obtained from project document reviews and interviews and make the findings more credible and less biased. Subject to data availability and identification assumptions being met, counterfactual analysis may be used to complement the geospatial assessment and support causal interpretation. For details on the geospatial analysis methodology, see appendix C.

f. Cluster approach. The second set of case studies will focus on identifying key factors facilitating or hindering the life-cycle and systems approach in the design and implementation of the projects. These case studies will also be informed by the structured literature review and will adopt a cluster perspective, in which the case boundaries extend beyond the individual projects to include all other relevant Bank Group–supported transport activities in the same country or within the same transport network. Data sources will include project-, sector-, and country-level document reviews.

Risks and Mitigation Measures

4.5 The team anticipates the following risks and proposes several mitigation measures to meet the evaluation's objectives:

a. Assessing the effectiveness of adaptation activities in achieving resilience ex ante presents a challenge because definitive assessment is only possible once a disaster has occurred. To address this risk, IEG will assess potential bias in the selection of the EQ 2 case studies to ensure that the projects affected by disasters are representative of the ones not yet affected by disasters.

b. Project Implementation Completion and Results Reports (ICR) include limited results information and outcome-level indicators (World Bank 2022a). IEG will complement its document reviews with a case-based approach to reduce this risk, which will include the review of additional documents such as vulnerability assessments, feasibility studies, engineering designs, supervision reports, road agency annual reports, and financial data; field observations; interviews with TTLs, client transport agencies, and project beneficiaries; geospatial analysis; and possibly modeling and simulations.

c. Urban transport, railways, ports and waterways, and air transport projects have only recently started incorporating climate adaptation activities, as they have traditionally emphasized climate mitigation. Thus, the evaluation will focus on these transport subsectors in EQ 1 and in the part of EQ 2 on the assessment of key factors facilitating or hindering the life-cycle and systems approach in the design and implementation of the projects. The part of EQ 2 on results and contributions to the resilience of infrastructure and operation and maintenance against climate and natural disaster impacts will cover only the roads and highways subsector, but this will be done in a way that keeps possibilities open for generalizing the recommendations from the roads and highways subsector evaluation to other subsectors.

d. IFC and MIGA have begun reporting on climate adaptation in transport projects approved since FY23, and, as mentioned in chapter 1, only two IFC projects in FY25 directly financed airport and port adaptation activities. These projects are likely ongoing; hence, the effectiveness of their adaptation activities cannot be assessed yet. However, mature and closed IFC and MIGA transport projects approved before FY23 may have addressed risks from climate and natural hazards. Therefore, such projects, if identified, will be considered for inclusion in the case studies under EQ 2. MIGA operations typically do not focus on improving client governance, capacity, and systems for resilience; IFC advisory services might address some of them. Therefore, in the part of EQ 2 on the assessment of key factors facilitating or hindering the life-cycle and systems approach in the project design and implementation, the case study selection will consider countries with World Bank, MIGA, and IFC operations. The case studies will explore whether IFC and MIGA projects could benefit from collaboration with the World Bank to strengthen client governance, capacity, and systems for resilience and how these projects might include an infrastructure life-cycle and system thinking perspective.

5. Quality Assurance Process

5.1 The quality and usefulness of the evaluation's findings and recommendations will be assessed through IEG's quality assurance processes, including internal IEG and Bank Group management review, one-stop review meeting, and peer review. IEG will have regular interactions with the World Bank, IFC, and MIGA to discuss preliminary findings, ensure factual accuracy, and maximize utility. IEG's evaluation team will use several advisers for specific topics (for example, climate adaptation for road infrastructure), where specialized expertise is needed. The one-stop review meetings for the Approach Paper and the evaluation report will benefit from advice on both evaluation methodology and technical aspects. The evaluation will be peer-reviewed by three independent external peer reviewers: Claudia Adriazola-Steil (deputy global urban mobility director and director of health and road safety at the World Resources Institute Ross Center for Sustainable Cites); Henry Kerali (senior transport adviser, former World Bank country director in several Regions, former transport practice manager, and former professor at the University of Birmingham); and Dr. Satish Ukkusuri (professor of civil engineering at the College of Engineering, Lyles School of Civil and Construction Engineering, Purdue University, and campus director at the US Department of Transportation National Center for Transportation Cybersecurity and Resiliency).

5.2. Together, they bring diverse experience in building and strengthening climate and natural disaster resilience of transport, public and private sector perspectives, global

and regional perspectives, academic and research depth, and practical implementation and impact evaluation expertise to this evaluation.

6. Expected Outputs, Outreach, and Tracking

6.1 The main output will be an evaluation report that will be delivered to the Bank Group Board's Committee on Development Effectiveness. The team will also share its intermediate findings and results with its technical counterparts in the World Bank, IFC, and MIGA.

6.2 Upon the completion of the evaluation, the IEG team will develop an outreach plan together with IEG's Knowledge and Communications unit. This team will consult on the proposed outreach plan with the key counterparts in the Bank Group, including IFC and MIGA. This plan may include internal and external dissemination through regional workshops in collaboration with partner organizations and online outreach tools.

7. Timeline and Resources

7.1 The evaluation draft and IEG management review are planned for the first quarter of FY27. The Bank Group management review and e-submission are planned for the first and second quarters of FY27, respectively.

7.2 The budget for the evaluation is approximately US$1.15 million, inclusive fixed and variable costs. The budget estimate is driven by the large scale and scope of the evaluation, with many complex technical issues in the roads and highways and other transport subsectors managed by the World Bank, IFC, and MIGA. Therefore, IEG will engage a team of several senior technical transport and geospatial experts, economists, and local consultants for case studies and field visits. In addition, EQ 2 requires field visits to cross-validate the results of the evaluation of the effectiveness of the adaptation measures for transport infrastructure resilience.

7.3 The team conducting the evaluation will be composed of evaluation specialists, sector experts, and data scientists. Natalya Stankevich (senior evaluation officer) and Elisabeth Goller (senior evaluation officer) will jointly lead the evaluation and provide the necessary sector and evaluation expertise. The core team members include Fang Xu (lead evaluation officer/adviser); Amit Patel (senior evaluation officer/Methods); Izlem Yenice (senior evaluation officer/IFC); Yulia Krylova (MIGA evaluation officer, extended-term consultant, ETC); Virginia Ziulu (data scientist and remote sensing specialist); Chikako Miwa (evaluation analyst); James Markland (senior highways adviser, short-term consultant, STC); Aline Eloyse Lang (senior transport specialist, STC); Adriana Ormazabal Caballerom (transport specialist, STC); Dawn Roberts (senior evaluation specialist, STC); Victor Hugo Abreu (adviser on the EQ 1 methodology and

professor of civil engineering at the Federal University of Rio de Janeiro); Xiaoyi Lu (data analyst, ETC); and Charles Allegar (data analyst, STC). International consultants with technical subsector expertise may be recruited for case studies, if the evidence is available in projects addressing resilience in other nonroad subsectors. Local consultants will be recruited for road case studies and missions. Jean-Jacques Alain Ildevert Ahouansou will provide administrative support. The work will be conducted under the leadership and guidance of Sabine Bernabè (Director General, Evaluation); Carmen Nonay (director, Finance, Private Sector, Infrastructure, and Sustainable Development); Avjeet Singh (manager, Infrastructure and Digital), and Estelle Raimondo (head, Methods Advisory Function).

8. Use of Artificial Intelligence

8.1 In line with the Bank Group guidance on artificial intelligence, the authors of this Approach Paper declare that they used artificial intelligence (AI) tools, specifically Microsoft Copilot and mAI (World Bank Group ChatGPT), for editorial purposes. These tools were used to condense the text and enhance the language; the authors reviewed and selectively incorporated AI-generated suggestions as appropriate. The evaluation team may also use AI to summarize and synthesize the findings of the project document reviews, ensuring that all outputs are verified by the team for accuracy and quality before inclusion in the final evaluation report.

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Appendix A. Evaluation Design Matrix

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
EQ 1: How well has the World Bank Group supported transport resilience that is responsive to climate and natural disaster risk profiles?	Evidence that the design of the Bank Group's support for resilient transport is responsive to the project's natural disasters and climate impacts	PADs, PPs for World Bank lending, and IFC and MIGA Board documents	Content analysis to identify climate and natural disaster risks reported in PADs, PPs, and IFC and MIGA Board documents and evaluate the quality of the hazard and risk assessment against a list of criteria	Especially older PADs and PPs might report disaster/climate hazards less comprehensively. The analysis might split the evaluation period in subperiods to establish trends and achieve better comparisons or exclude projects with poor risk assessments from further analysis. If climate and disaster risk assessments are incomplete, secondary sources, such as CCDRs and the European Commission's INFORM, will be used to triangulate.
		Existing Bank Group and external disaster and climate risk data (for example, ThinkHazard!, Germanwatch, and IFC climate risk system)	Content analysis of databases and documents to identify the disaster and climate hazards for the project area. Comparison of the results of the hazard identification in the PAD and other sources	Data on transport-related climate and disaster hazard may not be available at the project area level for all projects. The analysis will be adjusted based on the available data, for instance, using the sources with the most available data.
		Rapid literature on disaster and climate adaptation activities for different climate and natural disaster risks for each subsector in transport	Categorization of literature review findings by hazard type and validation of the categorization by expert judgment	Extensive literature on transport infrastructure resilience activities exists for roads and ports. For other modes and governance for climate and natural disaster resilience, the literature might be more limited and scattered. However, the Transport Global Practice has recently produced a Guidance Note with key adaptation activities for task teams.
		PADs, PPs for World Bank lending, Concept Notes for ASA, IFC and MIGA Board documents, and IFC advisory	Content analysis (manual coding supported by keyword search) to identify and categorize the	Adaptation activities are difficult to identify because they are context specific, which will require more resources for coding. Data sources might also exclude

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
		services project data sheet approval documents	adaptation activities included in projects and ASA Matching diagnostic of the projects' climate and natural disaster risks with the adaptation activities for specific hazards identified in literature and in projects and ASA	adequate details; hence, additional documents will be reviewed, such as project preparation aide-mémoire, or task teams involved in project preparation will be interviewed. Projects, for which adequate information cannot be found, might have to be excluded from certain analyses as appropriate. It might also be difficult to systematically identify all ASA aimed at transport adaptation and resilience, so we might have to work with the main types of ASA, clearly document the choice of ASA, and consider this choice in the interpretation of findings.
		TTL interviews	Analysis of TTL interviews to complement the information on adaptation activities included in projects and ASA, if necessary	This method is possible for a limited number of projects only given time and cost constraints. We will select projects for additional data collection based on criteria such as valuable learning opportunities.
	Evidence that projects have resilience-related PDOs and indicator targets	PADs and PPs	Content analysis of documents to identify PDOs and indicators; assessing whether adaptation activities and resilience-related PDOs and indicators have clear line of sight	Many projects might lack resilience-related PDOs and indicator targets, which is a finding per se.
EQ 2a. How well and in what way has the Bank Group's support contributed to strengthening the clients' transport sector governance for resilience to climate and natural disasters?	Evidence that clients used the Bank Group–supported outputs on transport sector governance for resilience and on the intermediate outcomes of this use	ICRs, ICRRs, ISRs, and aide-mémoire, completion summaries of ASA	Content analysis to identify evidence about the use and intermediate outcomes of World Bank–supported resilience governance activities	Data sources might exclude adequate details. TTLs will be interviewed to complement the information from project documents.
		Client and TTL knowledge	Interview data analysis to complement project document content analysis	This method is possible for a limited number of projects only given time and cost constraints. We will select

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
				projects for additional data collection.
EQ 2b. How well and in what way has the Bank Group's support contributed to building transport infrastructure that is resilient to climate and natural disasters?	Evidence that clients carried out adaptation activities	Project evaluation documents (for example, ICRs, ICRRs, PPARs, XPSRs, and Evaluative Notes)	Content analysis to assess what project documents report on the implementation of adaptation activities carried out	Adaptation activities are difficult to identify because they are context specific, so more coding resources will be necessary. Adaptation activities might also not or inadequately be reported, which is a finding per se.
EQ 2c. How well and in what way has the Bank Group's support contributed to ensuring transport operation and maintenance that is resilient to climate and natural disasters?	Evidence that resilience results are achieved	Project evaluation documents (for example, ICRs, ICRRs, and PPARs)	Content analysis to assess the extent to which resilience-related targets have been achieved and the quality of results measurement	Project evaluation documents might exclude indicators and evidence on resilience outcome, which is a finding per se.
	Case studies on results and contributions to climate and natural disaster resilience of infrastructure and operation and maintenance, including the following:			
	Evidence that civil work planning and prioritization focused on resilience	PADs and PPs, IFC investment Board documents, studies and reports on the selection of infrastructure for financing, project preparation aide-mémoire and ISRs, and clients' investment selection procedures	Content analysis against standardized checklist to understand whether resilience played a role in selecting project activities for the Bank Group's support (for example, in prioritizing roads to be intervened)	PADs and PPs generally include limited information on infrastructure planning and prioritization; therefore, the analysis will be complemented with the review of additional documents and appraisal TTL or client interviews.
	Evidence that the infrastructure design focused on resilience	Infrastructure design documents, construction standards, bid documents, draft contracts, and risk and vulnerability analysis assessments	Content analysis against standardized checklist to understand whether civil work designs adequately reflect the risk and vulnerability assessments	The risk analysis for projects might be generic, which is a finding per se. The analysis will be supplemented with evidence of TTL or client interviews.
	Evidence that resilience features are discussed during project supervision	Client supervision reports for road construction, ISRs, and aide-mémoire	Content analysis to understand whether resilience is important in civil work supervision	Supervision reports might not be regularly filed in the Bank Group's filing system, and it might be time-consuming to get them from clients; thus, we will complement the analysis with evidence of TTL or client interviews. Supervision consultants might not be as independent as they are

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
				expected to be, so evidence from supervision reports will mainly be used for triangulation.
	Evidence that civil works were planned, designed, constructed, and supervised with resilience in mind	TTL and client knowledge	Interview data analysis to complement project document content analysis	This information will be used for triangulation.
	Evidence that the infrastructure was built to adequate resilience levels and that resilience-focused maintenance is carried out	Field observations	Field observations against a checklist; compare what is built against what was designed and check quality shortcomings in what was built (for example, absence of protection in landslide-prone location)	Field observations only partially reveal construction quality and maintenance shortcomings; thus, evidence will be triangulated with evidence on resilience planning and design.
	Evidence of less physical damage to infrastructure and service interruption	Data on climate events and natural disasters (for example, EM-DAT, and World Bank resources)	Analysis of data on the occurrence and severity of climate events and natural disasters in project intervention areas	Data may be limited, incomplete, or outdated. DRM and Data unit from Development Impact Evaluation will be approached for the missing data.
		Data on project type and location of interventions	Content analysis to identify closed projects affected by climate events and natural disasters after project completion	Project documents might not contain sufficiently detailed project intervention data, and TTLs might also lack these data. Therefore, we will limit the analysis to projects with case studies for infrastructure resilience.
		Remote sensing images (for example, satellite, radar, and drone)	Geospatial analysis and modeling to compare project infrastructure affected by climate events or disasters before and after (for example, landslides and floods)	Each analysis is context specific, so we must target the model to each context. Detailed images require high-resolution data, which are only commercially available. We might need additional computational resources.
			Simulation and modeling	It is expensive and will be used if absolutely needed and feasible.
	Evidence that the Bank Group's efforts	ICRs, ICRRs, XPSRs, and Evaluative Notes	Content analysis to identify Bank Group–	Project documents may provide limited details on

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
	contributed to emergency preparedness and response mechanisms for the transport sector		supported outputs and results related to emergency preparedness and response	emergency preparedness and response outcomes and results. Therefore, the analysis will be complemented by TTL and client interviews.
		Client and TTL knowledge and interviews	Interview data analysis to better understand emergency preparedness and response mechanisms put in place and evaluate how the Bank Group supported them and what difference they made, if any	It may be time-consuming to identify the right people to interview and set up interviews, which might require limiting this analysis to a sample.
		Past IEG evidence on maintenance (IEG evaluations, including PPARs and ICRRs)	Content analysis to examine existing evidence on the Bank Group's support to clients' maintenance efforts and challenges	From past IEG evidence, it might be difficult to distinguish between routine and resilience enhancing maintenance. However, it is important to understand whether the Bank Group supports maintenance in general.
		ISRs, aide-mémoire, and other documents, such as output- and performance-based road contracts or other maintenance contracts	Content analysis to identify policy dialogue and Bank Group support to climate-focused maintenance	Most documents, especially for older projects, might discuss maintenance in general and not with a focus on resilience to climate or natural hazards, which is a finding per se.
		Client knowledge	Interview data analysis to understand to what extent and how clients adapted their maintenance efforts to climate and natural hazards	Interviews can be done only for a small sample, given the difficulty in identifying the right people on the client side and scheduling interviews. Information will be used for triangulation.
	Evidence of factors that facilitate (or hinder) the Bank Group's support to designing transport projects that enhance resilience to climate and natural hazards	Literature on factors that play a role in facilitating or hindering an infrastructure life-cycle and system thinking perspective	Categorization of rapid literature review findings to design the case studies and develop the theory of change, including rival theories (pre-case study work)	The available literature on the topic might be limited. Therefore, we will complement it with TTL interviews.

Evaluation Questions	Judgment Criteria and Evidence Threshold	Data Sources and Data Collection Methods	Data Analysis Methods	Risk and Mitigation Strategies
	with a greater focus on an infrastructure life-cycle and system thinking perspective and ensuring project implementation according to the design	TTL and client knowledge	Interview data analysis to design the case studies and develop the theory of change, including rival theories (pre-case study work)	The TTLs to be interviewed will not be rigorously selected. We will interview only a small number of people. We will use this information jointly with other findings.
		Bank Group and reliable external reports with country context variables and project characteristics, such as client development status, involvement of DRM staff in Bank Group projects, and availability of trust funds	Coding of variables for each project (not manually) and comparison of these variables for projects with and without a focus on an infrastructure life-cycle and system thinking perspective	The comparison will be carried out for the complete portfolio, so the country context and project characteristics variables might be limited because of data constraints. We will explore additional variables or factors in case studies.
		Case studies on design aspects based on projects that have used recently adopted life-cycle and systems approaches and the ones that have not, including the following:		
		Bank Group staff knowledge; client knowledge; Bank Group documents and ASA; Country Climate and Development Reports; client adaptation documents, such as adaptation strategies; and Country Partnership Frameworks, ISRs, and aide-mémoire	Virtual case studies, including document reviews and interviews with Bank Group staff (especially TTLs) and clients to understand the key factors for a greater focus on an infrastructure life-cycle and system thinking perspective to resilience	We will be able to conduct only a limited number of case studies given their cost. We will carefully select the cases to achieve adequate rigor. The case study unit is not yet defined.

Source: Independent Evaluation Group.
Note: ASA = advisory services and analytics; DRM = disaster risk management; ICR = Implementation Completion and Results Report; ICRR = Implementation Completion and Results Report Review; IEG = Independent Evaluation Group; IFC = International Finance Corporation; ISR = Implementation Status and Results Report; MIGA = Multilateral Investment Guarantee Agency; O&M = operation and maintenance; PAD = Project Appraisal Document; PDO = project development objective; PP = project paper; PPAR = Project Performance Assessment Report; TTL = task team leader; XPSR = Expanded Project Supervision Report.

Appendix B. Summary of Methods to Be Used to Address the Main Evaluation Questions

Methods	EQ 1. How well has the World Bank Group supported transport resilience that is responsive to climate and natural disaster risk profiles?	EQ 2. How well and in what way has the World Bank Group's support contributed to (a) strengthening the clients' transport sector governance for resilience to climate and natural disasters, (b) building transport infrastructure that is resilient to climate and natural disasters, and (c) ensuring transport operation and maintenance that is resilient to climate and natural disasters?
Rapid literature review	Yes	Yes
Portfolio review and analysis	Yes	Yes
Development of risk and resilience profiles	Yes	
Stakeholder interviews	Yes	Yes
Case studies[a]		Yes
Content Analysis of Documents		Yes
Field observations		Yes
Geospatial analysis		Yes
Stakeholder interviews and surveys		Yes
Simulation and modeling (if needed and feasible)		Yes

Source: Independent Evaluation Group.
Note: EQ = evaluation question.
a. Case studies use multiple methods.

Appendix C. Methodological Details for Geospatial Analysis

Georeferencing of Project Interventions

For the geospatial analysis to be meaningful, it must be tied to the geographic locations of project implementation sites—in this case, the roads supported by the selected projects. Crucially, "identifying" a road goes beyond simply naming it; it requires establishing its precise, geographically referenced location so that it can be accurately integrated into spatial analyses. This precise identification is also essential for estimating the area of analysis for each case, which, in turn, guides decisions about the appropriate spatial resolution of imagery data needed for the reliable assessment.

Precisely identifying roads is a challenging and time-consuming process because this information is not captured in any standardized data repository. Obtaining accurate geospatial data typically requires a combination of approaches:

- Reviewing project documents for location information, such as maps that can be re-referenced or detailed descriptions (for example, specific city names at key points along the road);
- Consulting operations task team leaders to determine whether they have existing geospatial files, such as shapefiles or other formats containing usable location data;
- Conducting field visits to obtain or verify location data (for example, using GPS-enabled devices to capture points that allow the road to be accurately delineated); and
- Verifying the information, if needed, using high-resolution satellite imagery to ensure accuracy and consistency.

Preliminarily Identified Indexes and Analytical Methods for Quantifying Natural Disasters

The geospatial analysis will use a range of remote sensing indexes and analytical methods to quantify the extent or intensity of various natural disasters—such as floods, landslides, and heat events—occurring during the evaluation period along the identified roads and their surrounding areas.

In addition to the precise identification of the roads, the selection of specific indexes and analytical methods will depend on multiple factors, including the type of disaster to which each road is susceptible, terrain and topographic characteristics, spatial extent, underlying causes of the natural disaster, and prevailing weather patterns.

Tables C.1, C.2, and C.3 provide examples of indexes and analytical methods that could potentially be used in the geospatial analysis. These lists are not exhaustive but rather illustrative of the types of measurements that may be applied.

Table C.1. Indicative Indexes and Analytical Methods to Measure Floods

Index and Method	Purpose and Interpretation
Spectral indexes	
NDWI (Normalized Difference Water Index)	Detects surface water and flooded areas, especially in vegetated regions
MNDWI (Modified Normalized Difference Water Index)	Enhances water detection in urban or built-up areas
AWEI (Automated Water Extraction Index)	Suppresses shadows and dry soil, improving automated water extraction
NDMI (Normalized Difference Moisture Index)	Indicates surface moisture and flood extent on vegetated terrain
NDFI (Normalized Difference Flood Index)	Highlights inundated vegetation and mixed water and land pixels
Other methods	
SAR backscatter change	Identifies flooded areas from a drop in radar backscatter
SAR coherence change	Detects surface change from flooding
DEM-based flow accumulation	Locates potential flood zones and drainage paths
Machine learning–based flood mapping	Integrates multiple predictors for improved flood delineation

Note: DEM = digital elevation model; SAR = synthetic aperture radar.

Table C.2. Indicative Indexes and Analytical Methods to Measure Landslides

Index and Method	Purpose and Interpretation
Spectral indexes	
NDVI (Normalized Difference Vegetation Index)	Monitors vegetation cover and stress after landslides
NBR (Normalized Burn Ratio)	Detects burned or disturbed vegetation, including landslide scars
NDMI (Normalized Difference Moisture Index)	Indicates soil and canopy moisture; linked to slope stability
SAVI (Soil Adjusted Vegetation Index)	Adjusted NDVI reducing soil influence
Other methods	
Slope, aspect, curvature	Quantify steepness and terrain form controlling landslide potential
TWI (Topographic Wetness Index)	Reflects soil moisture accumulation areas prone to instability
SPI (Stream Power Index)	Represents erosive power; related to landslide triggering
TRI / TPI (Terraine Ruggedness Index / Topographic Position Index)	Quantifies microrelief and relative position that relate to instability
InSAR (Interferometric Synthetic Aperture Radar) Deformation Mapping	Detects ground displacement and precursors to failure
Coherence Change Detection	Identifies landslide events and disturbed surfaces
ML (Machine Learning) Susceptibility Mapping	Predicts probability of landslides based on terrain and environment

Landslides often cause abrupt changes in surface cover, especially vegetation loss, soil exposure, and moisture shifts. Therefore, spectral indexes that track vegetation, soil, or water serve as indirect indicators of slope instability or its aftermath.

Table C.3. Indicative Indexes and Analytical Methods to Measure Extreme Heat Events

Index and Method	Purpose and Interpretation
Spectral indexes	
NDBI (Normalized Difference Built-up Index)	Highlights built-up and impervious surfaces that retain heat
UI (Urban Index)	Combines the Normalized Difference Built-up Index and the Normalized Difference Vegetation Index to distinguish urban from vegetated areas, supporting UHI analysis
NDVI (Normalized Difference Vegetation Index)	Indicates vegetation cover, which mitigates surface heating; used in combination with land surface temperature to assess vegetation–heat relationships
Other methods	
LST (Land Surface Temperature)	Quantifies surface heat; core metric for UHI studies
SUHI (Surface Urban Heat Island)	Measures UHI intensity and persistence
Albedo mapping	Estimates surface reflectivity, affecting energy absorption and local heating
Heat anomaly detection	Identifies unusually hot areas relative to long-term baseline or expected seasonal temperatures

Effectiveness Analysis

Remote sensing measurements will provide quantifiable, descriptive information on the extent and intensity of natural hazards affecting the roads and surrounding areas. These measurements will enable a detailed understanding of spatial and temporal patterns of exposure and impact, offering an important contextualized perspective on the effectiveness of the interventions.

In addition to this descriptive quantitative analysis, geospatial data can be incorporated into econometric models—such as difference-in-differences or counterfactual approaches—provided that the necessary methodological assumptions are met. These models will allow for a rigorous assessment of whether the roads supported by the projects experienced measurable improvements in resilience relative to appropriate comparison groups or preintervention baselines.

By combining descriptive remote sensing observations with econometric inference, the analysis aims to generate robust evidence on the projects' effectiveness in reducing vulnerability to natural disasters.

Appendix D. Terminology

The following definitions have been adapted for the purpose of this evaluation:

- Adaptation is the process of adjustment to actual or expected climate or natural hazard events and their effects (Adapted from IPCC 2021).
- Climate change is a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC 2021).
- Climate co-benefits refer to the share of financing dedicated to climate change adaptation or mitigation in operations financed by the World Bank Group.
- Climate extreme (extreme weather or climate event) is the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable (IPCC 2021).
- Disaster is a serious disruption to a society or community that is triggered by a hazardous event (either natural or human-made) and involves widespread human, material economic or environmental losses and impacts, which exceed the ability of the society or community to deal with using its own resources (UNDRR 2017).
- Disaster risk is a consequence of the interaction between a hazard and the characteristics that make people and places vulnerable and exposed (UNDRR 2017).
- Exposure is the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas (UNDRR 2017).
- An extreme weather event is defined as "an event that is rare at a particular place and time of year" (IPCC 2021).
- An extreme climate event is defined as "a pattern of extreme weather that persists for some time, such as a season" (IPCC 2021).
- Natural hazards are natural or environmental events, such as a hurricane, earthquake, or flood, that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (UNDRR 2017).
- Vulnerability is the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (UNDRR 2017).
- Resilience is the capacity of the transport sector to cope with a hazardous event in a way to maintain its essential function (Adapted from IPCC 2021).

- Transport sector governance for resilience encompasses capacity, systems, policies, and practices necessary to ensure that transport infrastructure or services are climate and disaster resilient.
- Infrastructure life-cycle perspective to project design considers the infrastructure life cycle when deciding on the adaptation measures to include in a project. This life cycle includes, among others, the governance arrangements and capacity for resilience, transport planning, resilience financing, engineering and design, operation and maintenance, and emergency preparedness and contingency planning.
- System thinking perspective to project design means a focus on the transport as a network when defining adaptation measures.

Reference

IPCC (Intergovernmental Panel on Climate Change). 2021. *Climate Change 2021: The Physical Science Basis*. Working Group I Contribution to the Sixth Assessment Report, IPCC.

United Nations Office for Disaster Risk Reduction (UNDRR). 2017. "Disaster Risk." In *The Sendai Framework Terminology on Disaster Risk Reduction*. UNDRR.

Appendix E. Initial Stakeholder Analysis

Stakeholder	Level of Influence	Level of Interest	Issues of Interest	Potential Focus of Engagement and Outreach
Board members	High	High	One World Bank Group coherence	
World Bank Group management, MIGA, IFC, and World Bank	High	High	The Independent Evaluation Group's overall evaluative judgments	CODE and pre-CODE meetings
Technical staff at MIGA, IFC, and World Bank	Medium	Medium-high	Specific technical issues depending on work program and areas of specialization	Engagement in design and case selection process
Trust funds, other MDBs, and bilateral agencies	Low	High	Findings on collaboration and specific technical issues	Outreach target for knowledge-sharing events
Case study country client transport agencies	Low	Medium	Findings on their country, entity, and project implemented	Engagement in data collection process and dissemination for country-specific outreach
Private sector clients	Low	Low	Findings on their subsector, capacity, and technical or investment issues	Engagement in dissemination for their specific subsector outreach
Research institutes and academia	Low	Low	Overall findings, including on their areas of specialization	Outreach target for knowledge-sharing events

Source: Independent Evaluation Group.
Note: CODE = Committee on Development Effectiveness; IFC = International Finance Corporation; MDB = multilateral development bank; MIGA = Multilateral Investment Guarantee Agency.

Appendix F. Possible Intermediate Outcome Measures to Explore

Intermediate Outcomes	Intermediate Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
Improved governance capacity and systems for resilience	Adaptation plans prepared	ICR and aide-mémoire	Medium	High	Low
	Risk-informed prioritization and design choices	Road and transport agency reports	Medium	High	Low
	Climate and disaster risks assessed	Interviews with road and transport agency staff	High	High	Medium-high
	Climate clauses in performance-based contracting and public-private partnerships				
	Road asset management system with climate module				
	Resilience standards in place				
	Emergency contracts in place				
	Resilience planning carried out				
Robust, resilient infrastructure	No, less debris, or material on transport infrastructure	Road and transport agency reports	Low–medium	High	Low
		ICR and aide-mémoire	Low	High	Low
	Water on roads or other infrastructure	Interviews with road and transport agency staff	High	Medium	Medium-high
	Less erosion	Interviews with communities	High	Low	High
	Improved drainage	Media sources	Low	Medium	Low
	Stabilized slopes	Crowd feeds	Medium	High	Medium-high
		Geospatial	Medium	Medium	High
	Less infrastructure damage from water, wind, heat, cold, and storms	Road and transport agency reports	Low	High	Medium
		Damage assessment reports	Medium	High	Medium

Intermediate Outcomes	Intermediate Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
		Geospatial	Medium	Medium	High
		Interviews with road and transport agency staff	High	Medium	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low
		Crowd feeds	Medium	High	Medium-high
	Higher-return period designs	Road and transport agency reports	Low	High	Medium
		ICR and aide-mémoire	ont	High	Low
		Interviews with transport agency staff	High	High	Medium-high
Resilient operations	Maintenance carried out	Road and transport agency reports	Medium	High	Low–medium
	Resilience considered in maintenance	Reports from contractors doing maintenance	Medium	High	Low–medium
	Early-warning system integration	Worklogs of workers doing maintenance	Medium	High	Low–medium
	Emergency protocols in place	Finance system data	Medium	Medium	Low–medium
		Interviews with road and transport agency staff	High	High	Medium-high
		ICR and aide-mémoire	Low–medium	High	Low

Source: Independent Evaluation Group.
Note: ICR = Implementation Completion and Results Report.

Appendix G. Possible Outcome Measures to Explore

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
Road and transport infrastructure closure	Number of closures per year	ICR and aide-mémoire	Low	High	Low
		Road and transport agency reports	Low	High	Medium
		Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds (for example, Waze)	Medium	High	Medium-high
		Geospatial	Medium	Medium	High
		Modeling and simulation	Low	Medium	High
	Average duration of each closure	ICR and aide-mémoire	Low	High	Low
		Road and transport agency reports	Low	High	Medium
		Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds	Medium	High	Medium-high
		Travel time recovery curves (econometric model to calculate the recovery, based on disaster information)	Low	Medium	High
		Geospatial	Medium	Medium	High

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
		Modeling and simulation	Low	Medium	High
Rebouncing back period	Days to restore road or transport infrastructure to functionality	Road and transport agency reports	Low	High	Medium
		Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low
		Worklogs of workers restoring the infrastructure	Low	High	Medium
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds	Medium	High	Medium-high
		Travel time recovery curves (econometric model to calculate the recovery, based on disaster information)	Low	Medium	High
		Geospatial	Medium	Medium	High
		Modeling and simulation	Low	Medium	High
Redundancy	Availably of alternative route or service	Road and transport agency reports	Medium	High	Medium
		Google maps and geospatial	High	High	Medium
		Multimodality analysis	Medium	High	Medium
		Modeling and simulation	Low	Medium	Medium
Cost to repair infrastructure	Dollars spent per year on repairs of infrastructure due to events	Road and transport agency reports	Low	High	Medium
	Dollars spent on repairs per specific event	Finance system data	Low	High	Low

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
		Interviews with transport agency staff	High	Low	Medium-high
		Damage assessment reports	Medium	Medium	Medium
		Modeling and simulation of costs	Low	Low–medium	High
		Damage curves (simulation of average impacts of events using transport and economic model)	Low	Low–medium	High
		Media sources	Low	Medium	Low
	Dollars spent on emergency repair contracts per year (before and after comparison)	Road agency reports	High	Low	Medium
		Finance system data	High	Low	Low
		Interviews with transport agency staff	High	Low	Medium-high
Cost to clear infrastructure	Dollars spent per year to clear infrastructure due to events	Road and transport agency reports	Low–medium	High	Medium
	Dollars spent to clear infrastructure per specific event	Finance system data	Low	High	Low
		Interviews with road and transport agency staff	High	Low	Medium-high
		Worklogs of workers clearing the infrastructure	Low	High	Medium-high
		Damage assessment reports	Low	Medium	Medium
Transport emergency response budgets	Yearly budgets for transport emergency response	Road and transport agency reports	Medium	Medium	Medium
		Interviews with road and transport agency staff	Low–medium	Low	Medium-high
		Finance system data	Medium	Low–medium	Low

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
Monetary value of damaged infrastructure	Replacement cost of transport assets	Replacement cost model	Medium-high	Low–medium	Medium
		Calculation based on cost of cleaning and repair	Low	High	Low
		Asset management data and inventory	Low	High	Low
		Economic models and estimation	Low	Low–medium	High
		Insurance analysis	Low	Medium	Low
		Damage assessment reports	Medium	Medium	Medium
Service delays	Number of days with service delays	ICR and aide-mémoire	Low	Medium	Low
	Number of days with service cancellations	Transport agency reports	Medium	High	Low
		Transport company reports	High	High	High
		Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Medium	Medium	Low
		Geospatial	Medium	Medium	High
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds	Medium	High	Medium
		Modeling and simulation	Low	Medium	Medium
	Excess travel time	ICR and aide-mémoire	Low	Medium	Medium
	Vehicle-hours of delay	Transport agency reports	Low	High	Low
	Passenger-hours of delay	Transport company reports	High	High	High
	Tonne-hours of delay	Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
		Media sources	Low	Medium	Low
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds	Medium	High	Medium
		Modeling and simulation	Low	Medium	High
Water quality	Turbidity	Water treatment data	Low	High	Low
	pH	Media sources			
	Oxygen levels		Low	Medium	Low
	Minerals, metals, and coliforms				
	Water taste and quality	Interviews with communities	Medium	Low	High
Soil erosion	Vegetation cover	Road agency reports	Low	High	High
		Interviews with road and transport agency staff	High	Low	Medium-high
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low
		Geospatial	Medium	Medium	High
Air quality	Particulate matter	Meteorological data	Medium	High	Low
Habitat destruction	Land cover change	Satellite image (Sentinel)	Medium	Medium	High
	Habitat loss area	Wildlife and environmental monitoring (environmental agency)	Low	High	Medium
	Loss of vegetation	Modeling and simulation	Low	Medium	High
Accidents	Crash statistics	Road agency reports	Low	High	Medium
		Police reports	Medium	High	Low
		ICR and aide-mémoire	Low	High	Low
		Interviews with communities	High	Low	High
		Media sources	Low	Medium	Low

Outcomes	Outcome Indicators	Data Sources	Likely Data Availability	Data Reliability	Data Collection and Processing Difficulty
		Geospatial	Medium	Medium	High
		Data from speed detectors, CCTV, and hydrosensors	Low	High	Low
		Crowd feeds	Medium	High	Medium

Source: Independent Evaluation Group.
Note: CCTV = closed-circuit television; ICR = Implementation Completion and Results Report.