Public Disclosure Authorized
Public Disclosure Authorized
Public Disclosure Authorized

World Bank Disaster Risk Management Hub, Tokyo

Road Geohazard Risk Management

Supporting countries to build disaster resilient roads

Solutions Brief
FEBRUARY 2017

Japan's experience in road geohazard risk management by addressing the challenges in an integrated manner ensuring institutional coordination, and applying structural and non-structural measures, offers key lessons for the developing countries.

Geohazards: A frequent and growing risk to roads globally

Geohazards are the most common type of natural hazards faced globally. Geohazards affecting road infrastructure are the geological and environmental conditions, and include most hazards, such as slope slides and collapse, earth/debris flows, flooding, and erosion. Most related disasters are triggered by phenomena, such as earthquakes or heavy rains. Human factors can also impact the severity of geohazards on roads. This is often due to unsuitable highway planning, a lack of geological surveys, and inappropriate gradients of engineered slopes, among factors (figure 1 on next page).

The lack or absence of road geohazard risk management is becoming an important issue not only for road network management but also for socio-economic development. Where there may be some system, there is often an emphasis on emergency response rather than proactive measures.

Japan is geohazard-prone and is at risk from typhoons, heavy rainfall, earthquakes, tsunami, and other hazard events. Led by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT), the country has learned from dealing with frequent road geohazard events to make systematic improvements in its road geohazard risk management procedures.

A knowledge base on reducing road geohazard risk to reduce costs and save lives

The World Bank Disaster Risk Management Hub, Tokyo has supported the development of the

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

GFDRR
Global Facility for Disaster Reduction and Recovery

Road Geohazard Risk Management Handbook and Operational Toolkit to help practitioners address the risk. Road geohazard risk management is technically challenging and needs to be addressed in an integrated manner at the landscape level ensuring institutional coordination, and applying both structural and non-structural measures.

Mitigation can help:

- Minimize the risks and impacts of geohazards on roads, road users, and people in the landscape area where a road network is located;
- Support the alignment decisions of new roads or re-alignment of existing roads to avoid hazardous locations, which can result in significant savings in construction costs, subsequent maintenance costs including the restoration of locations damaged by geohazards, and losses caused by traffic disturbances/interruptions due to geohazard; and

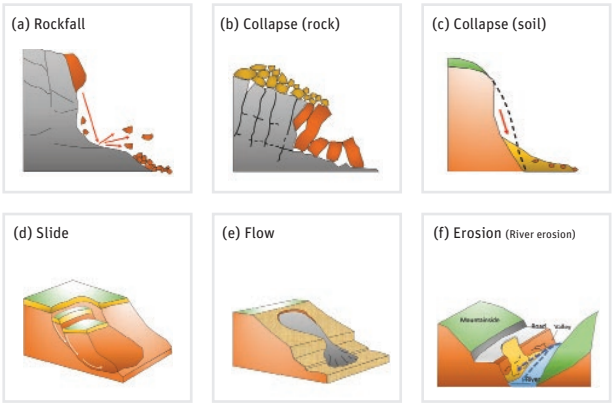
Additionally, if a geohazard risk event may occur, proactive measures should be installed:

- The safety and reliability of existing roads;
- Precautionary measures such as early warning systems and precautionary road closures are used to better safeguard road users; and
- Contribute to the speedy recovery/reconstruction of a road after geohazard events and the mitigation of future geohazard events.

The handbook offers a unique framework for managing the risks of geohazards on new and existing roads:

- It approaches geohazard risk management from a landscape approach. While road design traditionally has looked only at the specific site where a road will be built, this handbook examines both factors that could cause geohazards from further upstream and assesses possible impacts downstream.
- It goes beyond solely adopting a technical approach to geohazard risk management and covers a gamut of issues from institutional arrangements, policy, conceptualization, design, to operations and maintenance. It also provides relevant sample TORs and Operational Manuals for practitioners to easily apply in their existing program.

Figure 1: Classification of Geohazards for Roads



Illustrated by Kenichi Tanaka of Nippon Koei. Co., Ltd.

referring U.S. Geological Survey 2004

These efforts can result in a significant decrease in loss of life and livelihoods, as well as savings in construction, maintenance, or reconstruction costs. While there is typically a high level of complexity associated with most activities on road geohazard management, the aforementioned handbook outlines a simple but effective step-by-step approach applied to each of the stages of road development: institutional arrangements, road planning, design, construction, operations and maintenance and post-disaster. The aim is to help developing countries manage the serious risks posed from these events the related impact on human lives, property, and the natural and built environment.

A framework for road geohazard risk management:

The Handbook presents five key aspects for road geohazard risk management:

1. Establishing an adequate institutional framework. This includes supporting appropriate laws and regulations; national and local government management plans and strategies; and developing needed institutional, technical coordination, and funding mechanisms.

2. Conducting risk assessment of geohazards and planning for both new and existing roads.
The handbook suggests conducting a series of risk assessments, such as hazard mapping and evaluating exposure levels, and determining potential impacts on the local social environment. The handbook provides guidance on how to determine potential economic loss due to loss of road access and also conduct a cost-benefit analysis of potential investments to mitigate geohazards. The results of these assessments will help identify and prioritize endangered locations, and plan risk reduction measures.

3. Implementing structural measures to reduce the risk of road damage. Structural measures can increase the resilience of roads. They include:

- Reduce risk of road damage due to geohazards.
- Reduce road maintenance costs.
- Ensure connectivity during and after disasters.
- Contribute to the speedy recovery/reconstruction of a road after geohazard events and to the mitigation of future geohazard events.

Structural measures which include bio-engineering, are usually implemented during the road construction and operation and maintenance stages, based on prioritization of the countermeasures required on endangered locations. An environmental and social impact assessment is needed during the concept design phase of a new road construction or for the planning of structural measures for existing roads.

The design of structural measures requires investigation and analysis of the relevant geographical, geological, geotechnical, hydrological, and hydraulic conditions of a particular location. The investigation methods depend on the geohazards types and the type of planned structural measures, such as “Sabo” landscape ecosystem management or ground surface drainage.

4. Making additional non-structural risk reduction measures. It is critical to adopt methods for risk avoidance to prevent the loss of human life, reduce damage and loss to vehicles and roads, and improve the efficient maintenance of structural measures. These are generally less expensive than structural measures and easier set up.

Non-structural measures include the following:

- Supporting early detection and emergency information collection to help prevent problems and avoid damages for road users. Additionally, a road condition emergency information system is effective in sharing information such as geohazard damage occurrences and traffic conditions including road closures, giving road users the ability to minimize their losses in adverse conditions.
- Developing and implementing an emergency preparedness and response plan.
- Engaging stakeholders to reduce geohazard risk and increase road disaster awareness. Human activities such as irrigation or deforestation often trigger road geohazard disasters. It is important to raise public awareness and develop partnerships among road sector authorities, local stakeholders, and the private sector to enhance information sharing and increase the possibility of road disaster prevention.

5. Conducting post-disaster activities. After a disaster strikes, the emergency inspection and post-disaster assessments should be conducted together with non-structural measures. A comprehensive process with a series of procedures needed for resilient recovery, rehabilitation, and reconstruction should be laid out and followed in case of emergency. Emergency traffic regulation and public notification should be conducted if road users are endangered.

Looking forward

To support longer-term efforts, the concepts of road geohazard risk management planning can be mainstreamed within government strategies and development plans. It considers, for example, the contributions of a road as an emergency transport and evacuation route, or the possible use of a road embankment as a flood control dike.
A case study has been developed that captures Japan's experience in road geohazard risk management and offers a way forward for the developing countries.

Figure 2: Framework and Workflow for Road Geohazard Risk Management

Institutional setup: Law and regulation, Upper-level plan/strategies, Road geohazard management plan/strategies, Technical standard, Institutional and technical coordination mechanisms, Funding mechanisms

Stage	New road	Existing road
Pre-concept	Risk evaluation of geohazard for new road	Risk evaluation of geohazard for existing road
Concept	Geohazard management planning for new road	Geohazard management planning for existing road
Design and construction	Structural measures • Design • Construction	
Operation and maintenance	Nonstructural measures • Operation • Management of structural measures	
	Post-disaster actions and reactive measures • Emergency interventions • Emergency inspection, damage assessment, and post-disaster needs assessment • Recovery from road geohazard events	

Charted by Mikihiro Mori, Nippon Koei. Co., Ltd.

The reports includes:

- Significant issues Japan had to overcome, such as an initially narrow scope of road management authorities and expanding the mandate and planning of geohazard risk management in road sector across various technical Ministries and local government;
- Turning points in geohazard risk management, such as the 1968 Hida River Bus Fall Incident;
- The development of critical institutional frameworks, such as passing key legislation and creating funding mechanisms;
- Steps MLIT took to identify hazardous locations, conduct risk evaluations, and make needed interventions;
- Non-structural measures Japan took, such as developing early warning systems, precautionary road closures, and emergency preparedness plans.

Additional resources

Development of Practical Road Disaster Management System Based on Risk Management Techniques, Keiichi Tamura, Journal of JSCE VOL.1 2013

Disaster Risk Management in the Transport Sector: A Review of Concepts and International Case Studies (2015). The World Bank.

Field Guide on Soil Bioengineering for Slope Stabilization to Timor-Leste, Dr. Bashir Hussain Shah (World Bank), May 2012

Muzira, Stephen, Martin Humphreys and Wolfhart Pohl. Geohazard Management in the Transport Sector (Transport Note No. TRN-40) (2010). Roads & Highways Thematic Group, the World Bank.

Guidelines for Construction Technology Transfer Development of Warning and Evacuation System against Sediment Disasters in Developing Countries (2004). Ministry of Land, Infrastructure and Transport Infrastructure Development Institute - Japan

The Japan-World Bank Program for Mainstreaming Disaster Risk Management (DRM) helps developing countries drive large-scale investment to increase their disaster resilience. Through the Global Facility for Disaster Reduction and Recovery, the World Bank DRM Hub in Tokyo connects officials, practitioners, and development professionals with leading Japanese and global DRM expertise and solutions.

Contact:
World Bank Disaster Risk Management Hub, Tokyo
Phone: +81-3-3597-1320
Email: drmhubtokyo@worldbank.org
Website: http://www.worldbank.org/drmhubtokyo