Geo-hazard Risk Reduction: Understanding the Risks and Management Options in the Roads Sector

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Outline

• What are Geo-hazards?
  – Definition
  – Examples

• What are the impacts of Geo-hazards on Roads?

• What solutions are available?
  – Non-Structural
  – Structural

• Conclusion
What are Geo-Hazards?

• Definition

• Major Examples:
  – Landslides / Slope failure
  – Glacial Lake Outburst Flooding (GLOF)
  – Volcanoes
  – Combined risk phenomena
Bridge collapse by a rockslide due to the 2008 Iwate-Miyagi Nairiku Earthquake (Iwate Prefecture, Japan) (Takami et al, 2014)
Retreat of glaciers and increase in number and area of glacial lakes (photo: Yamada, 1998)

Increase in Glacial Lake Outburst Flood (GLOF) hazards by Global Warming, Nepal (photo: Umemura)
Landslides triggered by GLOF in 1985 (Nepal) (WECS, 1987)

Erosion and sedimentation are the GLOF associated hazards along the stream.
Unstable deposits originating from an active volcano induce sediment disasters

left above: **Pyroclastic flow** (Mt. Unzen, Japan) (photo by Shimabara City)

Left below: **Debris flow** (Mt. Unzen, Japan) (photo by Shimabara City)

Right above: **Slope failure and subsequent debris flow** (Izu-Oshima, Japan) (Photo G. Sato)
How Do Geo-hazards Impact the Roads Sector?

Physical impacts include:

• Road blockage
• Inundation (upstream)
• Outburst flood risks due to landslide dam (downstream)

These damages cause significant economic and livelihood impacts.
A landslide causes road blockage, inundation (upstream), outburst flood risks due to landslide dam (downstream) (after Shinjo River Work Office, MLIT, Japan)
Solutions to be Considered

• Non-Structural
  – Risk Identification
  – Early Warning

• Structural
  – Check Dams
  – Road Planning and Design
Identification of Landslide Hazardous Slopes

by aerial photos, satellite images and high resolution topographical maps

Landslide topographies, Tegucigalpa, Honduras (Contours from the 2m resolution AW3D DSM) (JICA, Teikyo Hiese Univ., data supported by JAXA/RESTEC)
Monitoring of ground displacement often supports prediction of collapse time of a slow movement landslide. (after Shinjo River Work Office, MLIT, Japan)

Increasing trend of displacement by an extensometer

Early Warning System as a Non-structural Measure

Monitoring of ground displacement often supports prediction of collapse time of a slow movement landslide. (after Shinjo River Work Office, MLIT, Japan)
A concrete check dam to reduce debris flow and sediment hazards in downstream
(Mt. Murapi, Java, Indonesia)

Dry masonry check dam constructed in 1835
(Hiroshima Pref., Japan)
Better to reduce erosion and sedimentation risks by road alignment selection

Distribution of landslides induced by the Nepal Gorkha Earthquake in 2015 (Chigira et al, 2016)
Conclusion

• Identification of geo-hazards distribution and possible phenomena location-wisely and catchment-wisely and causes as well
• Identification of Socio-economic conditions
• Combination of structural and non-structural measures including alignment planning
• Combination of indigenous and advanced technologies
• Establishment and dissemination of knowledge data base – Hand book and tools
Knowledge dissemination

Structural measures

Non-structural measures