Intergovernmental Ninth Regional EST Forum in Asia

(EST for Resiliency – Building Safe, Smart, Low-carbon and Resilient Cities in Asia)

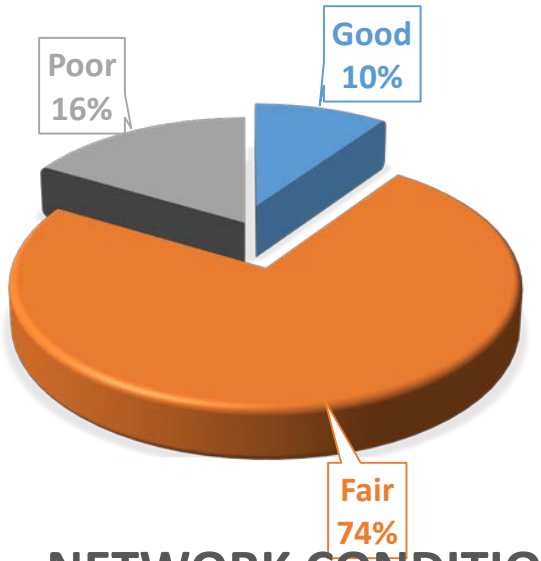
Climate and Disaster Resilient Transport System and Infrastructure Development for Nepal

Kamal Pande

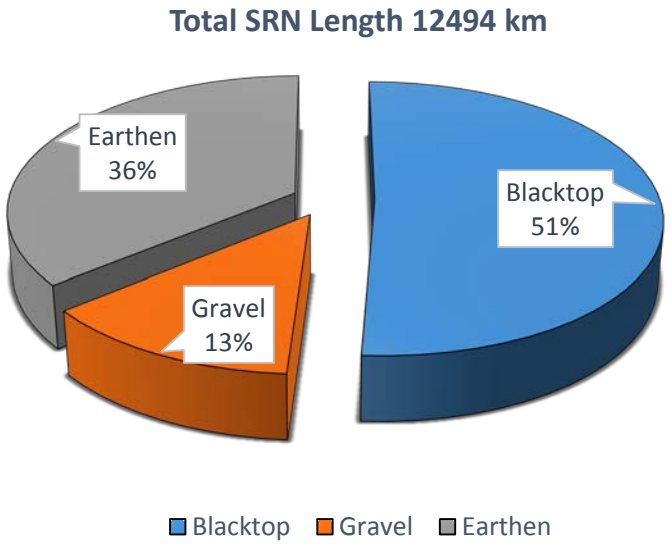
Infrastructure Development Specialist

18-20 November 2015
Hyatt Regency, Kathmandu, Nepal

Nepal Road System

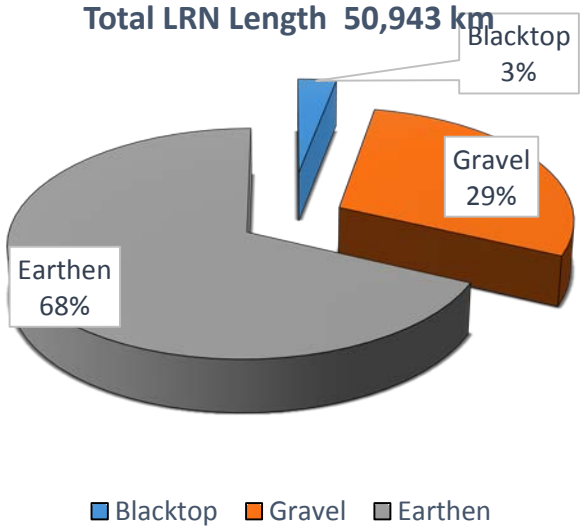


NETWORK CONDITION



- **Local Road Network**
  - **District Roads**
  - **Village Roads**
  - **(Municipal Roads not accounted)**

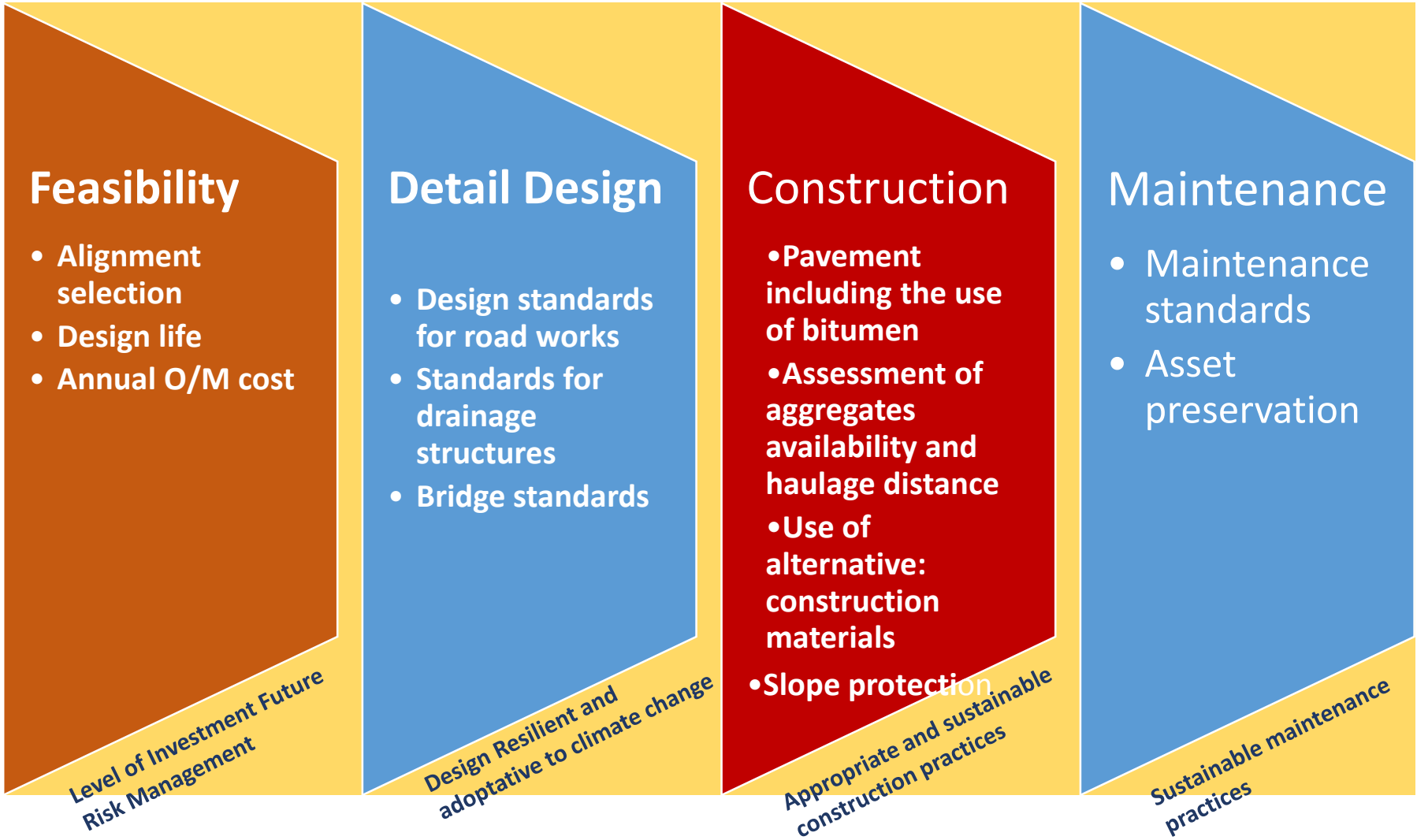
<u>District Road Core Network</u>:
29,000 km (approx.)
(incl. 6,000 km of new construction)



Issues & Challenges

- Increasing Trend in Vehicle Population
- High share of Unpaved in Road System
- Condition of Road: Road Maintenance
- Fuel Consumption – Per Capita/Consumption Trend
- Transport Sector Vulnerability to Climate Threats/Challenges
  - It is susceptible to the impacts of rapid climate change.
  - The traditional way of designing and implementing transport infrastructure is not adequate for long-term sustainability.

Stages of Transport Infrastructure Dev. & Linkage to Disaster Threats



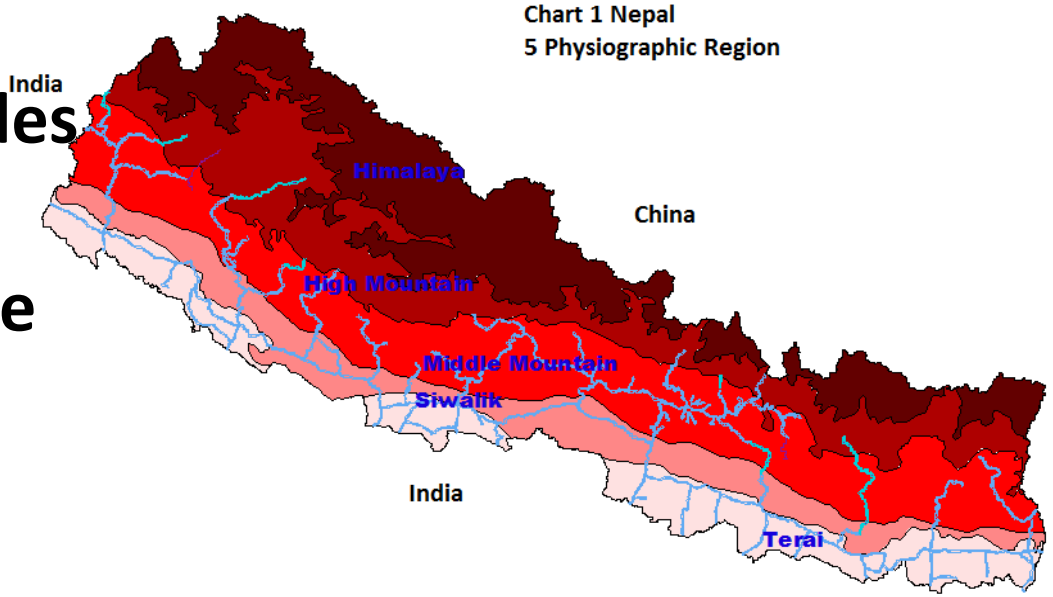
Assessment of Disaster Impact on Road Infrastructure

Nepal Experience of early impacts of Climate Change:

- Unprecedented heavy rain and massive floods followed by long spells of drought.
- Rise in maximum temperature by 1.8^0C between 1975 and 2006.
- Rapid depletion of glaciers: regions -Dudh Koshi basin, Imja Glacier, etc.
- The heavy rains followed by flood in 1974, 1981, 1988, 1993, 2004, 2012, 2013, 2014, 2015 have caused a substantial damage to the road assets.
- Increased vulnerability of the road due to frequent landslides and toe cutting.
- 39 flooding instances recorded in between 1970 and 2015 damaging road and disrupting traffic lasting several days.
- Significant economic and social loss due to road closures

Impact to Road Infrastructure in Different Physiographic Region

- The Terai region: floods and landslides
- Hills: Heavy Rains vulnerable to landslides
- High Mountains & Himalayas: glacial lake outbursts and landslides
- Disasters are severe threats in all physiographic regions



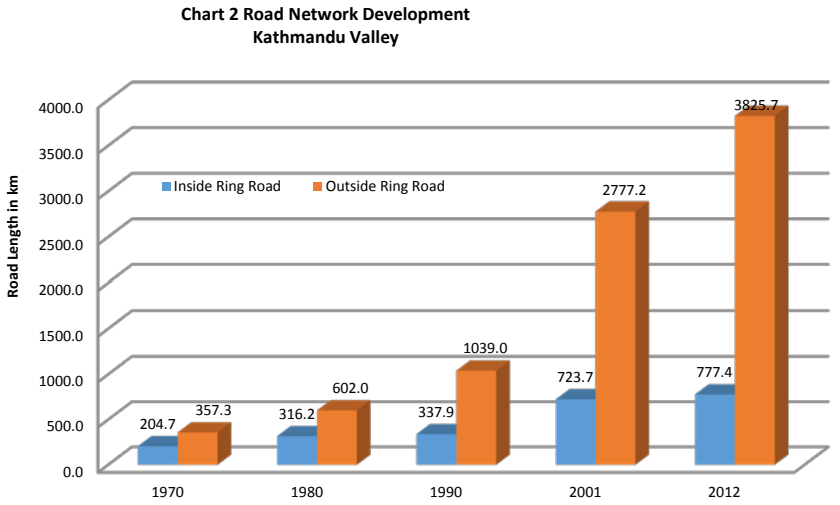
Recent Earthquake Damage Assessment

Summary of Damages and Losses on Transport Sector (NRs. Million)

Subsectors	Component	Estimated Damage	Estimated Loss
1. Strategic Road Network (SRN)	Highways and Feeder Roads	1,660	526
	Bridges	2,676	0
	Government Buildings	253	0
Subtotal		4,589	526
1. Local Road Network (LRN)	District Road Core Network (DRCN)	8,858	2,674
	Village Road Core Network	3,627	1,600
Subtotal		12,485	4,274
1. Civil Aviation	Airports	95	130
	CAAN HQ, Academy, Safety, Fire Building	19	0
Subtotal		114	130
Total for Transport Sector (2.1% of total effect)		17,188 USD 171.88 million	4,930 USD 49.30 million

Road System in Kathmandu Valley

- The total road length in the valley stands at 4,603 km in 2012.
- Out of total valley roads, only one third is paved and rest are either in gravel or earthen condition.
- Around 39% of total vehicle registered in Nepal in Bagmati Zone
- 78 % of motorcycle
- Over the period of 1971 – 2011, the disaster (earthquake, flood and landslide) has caused 160 deaths and 235 injured.
- Earthquake Damage Loss of 1213 houses and damaged 2261 houses



	SRN Rs. million		VRCN Rs. million	
	Damage	Recovery	Damage	Recovery
Lalitpur	3.7	6.0	345	518
Bhaktapur	56.0	79.9	30	45
Kathmandu	44.9	70.5	415	618

Road Network in Valley

Road Network	Nature of traffic demand	Institutional Responsibility	Funding source	Road length in km (as of 2012)
Strategic Urban	Highly, Strategic, long distance trade haulage,	Department of Roads	Central Government	482.83 (incl. 18.75 km in VDCs.)
Municipal Urban	Core area of vehicle dominance especially within the ring road. Outside ring road and highly dominated by pedestrian movement. Presence of non-motorized traffic	Respective Municipalities	Government grant and Municipalities internal resources	4526.09
Rural	High presence of non-motorized traffic,	Respective VDCs	Government grant	29.32

Source: DoR and satellite photo

Impact of Climate Change on Road Transport Infrastructure

Temperature Increase

- **Road Investment**
  - Road investment marginalized by excessive migration due to water scarcity (local roads)
- **Bridges**
  - Thermal expansion of bridges
  - Buckling of joints of steel structure
  - Higher corrosion activity at locations with high humidity.
- **Pavement**
  - Increased fatigue needing additional maintenance cost
  - Deterioration of gravel surface: moisture loss leading cycle of resurfacing.

Temperature Decrease

- **Pavement**
  - Exposure to snow condition
  - Affect road transport operations
  - Increased OM costs

Impact of Climate Change on Road Transport Infrastructure

High rainfall/flooding

- **Pavement**
  - Deterioration of gravel surface due to excessive moisture.
  - Deterioration of bituminous pavement with faster deterioration trend calling for early intervention for periodic maintenance or overlay.
- **Road Embankment & Drainage Structures**
  - Damage to road drainage structures including foundation resulted due to high runoff.
  - Breaching of road embankments resulting loss of road section.
  - Submersion of road
  - Landslides and road blocks
  - Erosion
- **Bridges**
  - Scouring of bridge foundation
  - Submersion of bridge
  - Bridge washout

Impact of Climate Change on Road Transport Infrastructure

Earthquake

- **Road Embankment & Drainage Structures**
  - Failure of embankment and drainage structures.
  - Bridges
  - Damage to bridge bearing & column

Landslides

- **Road Embankment & Drainage Structures**
  - Failure of embankment and drainage structures.

Adaptation of Road Infrastructure to Climate Change and Disaster Impacts

- Adaptation through making changes in the structural design (engineering) such as specifying materials, having standard dimensions, constructing effective drainage systems, etc or through non-engineering methods such as planning for maintenance, alignment, land use and environmental management.
- In addition, there are two types of responses that can be planned by the government:
  - Pre-disaster response: include policy, resilience design, quality of material use, regular inspection and maintenance (I/M), research and institutional development, etc
  - Post-disaster response: includes how to make the people and infrastructure adapt during and after the disasters. This part mainly covers management, maintenance, medical facilities, and public awareness, etc. for the resilience society.

Adaptation of Road Infrastructure to Climate Change and Disaster Impacts

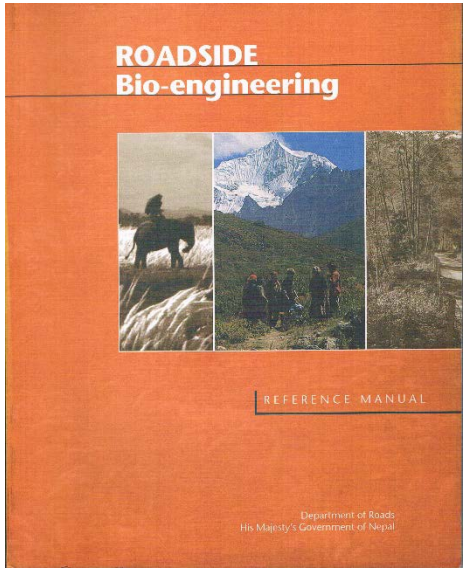
- Identification of roads that are most prone to extreme climate conditions and disasters
  - Project screening and scoping
- Risk analysis and impact assessment
  - Vulnerability assessment – vulnerability assessment even after the program has been implemented.
  - Adaptation assessment – future adaptation practices are incorporated into the roads and the population accessing it.
- Planning the response to the risks present.
  - In the context of LAPA, in this stage, the local adaptation plans are developed.
- Life cycle costing – Criteria in assessing the feasibility including adaptation measures into the road structures.
- Design of infrastructure
- Implementation and construction
- Monitoring and Evaluation

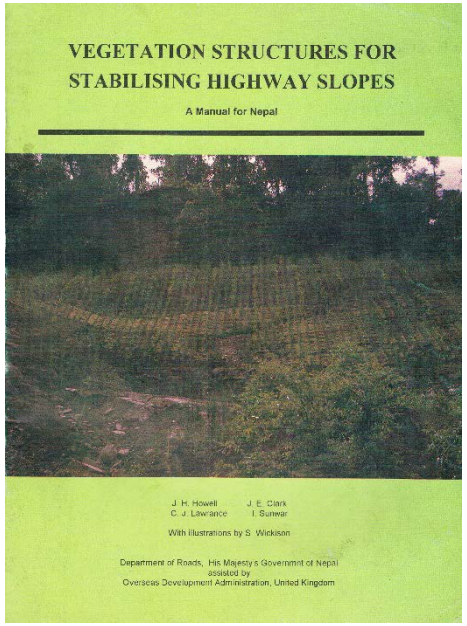
Success Story

Box 1: Example of Bioengineering to reduce impact of landslides on roads.

"Bio-engineering is the use of living plants for engineering purposes in conjunction with civil engineering structures to reduce shallow-seated instability and erosion on slopes."

- **Extensive research and trials carried out in Dharan-Dhankuta Road and Lamusangu-Jiri Road (1980-1993)**
- **Proven cost effective technique now widely applied in road slopes**
- **Extensive use of local resources and skills**
- **Knowledge gained disseminated and shared**





Opportunities: Transport Infrastructure Climate & Disaster Resilient

- Promoting
  - clean energy-based alternate transport system;
  - mode that improve the transport sector's efficiency and to demonstrate modal shifts;
- Converting public utility vehicles to liquid petroleum gas and renewable energy sources and introducing an efficient mass transport system;
- Ensuring the movement of vehicles at optimum speed of fuel consumption;
- Promotion of non-motorized transport;
- Educating the public on the need for and advantages of clean energy transport; and,
- Creating awareness among the local and national stakeholders in addressing the issues of climate change and its impacts on the transport infrastructure.

Strategic Component

- Awareness-raising among key stakeholders at local and central level
- Developing and mainstreaming project screening guidelines for selecting and assessing climate and disaster resilient transport infrastructures. – for local and strategic roads
- Integrating the strategy of “Avoid – Shift – Improve” in formulating and designing transport mode in Nepal into National Transport Policy.
- Classification of road system based on location and the degree of vulnerability to the disaster and climate change impact.

Strategic Component

- Developing design standards to incorporate, adapt and accommodate to the climate change impact
- Operationalization of road maintenance practices to minimize secondary impact caused by disaster or climate change.
- Environmental and social safeguards
- Enhance institutional capacity and undertake reform

Conclusion

- The Climate Change Vulnerability Mapping of Nepal under NAPA has been established as a tool to help identify the areas that are the most vulnerable to different kinds of disasters in Nepal.
- Direct and indirect impacts of climate change on transport infrastructure prompts the need for careful consideration on planning and designing resilient infrastructure.
- Addressing investment needs of transport projects including railway - economic opportunities and positive impacts- integration of adaptation measures into the design and implementation phase - extremely necessary.
- Adaptation of these infrastructures to climate change - positive impact on the social, environmental as well as economic aspects of the country.
- The development of EST primarily requires awareness among the key stakeholders in understanding climate change as well as its consequences on the livelihood of the people.
- Investment needs in the initial years is high. Life cycle costs to be considered in order to assess the difference in building roads with and without the adaptation measures.

Thank You

erkrpande@gmail.com