Engineering geological investigation for landslide hazard zonation in the Sino-Nepal road corridors

*[1,2]Basanta Raj Adhikari, [1]Bingwei Tian, [1]Feiyu Chen, [1]Xiaoyun Gou, [3]Suraj Gautam, [4]Samir Ghimire, [2]Suman Chapagain, [5]Akash Acharya
*Email: bradhikari@ioe.edu.np

Introduction:

Road construction in the Trans-Himalaya is always challenging task because of fragile and rugged topography with the strong influence of monsoon. The road connectivity between China and Nepal has a long history which continues till now. There are 6 major Trans-Himalayan region. However, this study focuses on three main road corridors namely: Kaligandaki (Pokhara-Jomsoom-Zhongba), Trishuli (Kathmandu-Trishuli-Gyirong) and Bhotekoshi rivers (Kathmandu-Tatopani-Nyalam), which cross the Himalaya with different geological discontinuities i.e., South Tibetan Detachment System (STDS) and Main Central Thrust (MCT). The Himalayan range is acting a topographic barrier resulting different climate in the southern and northen part. People have been living in these road corridors for a long time. After a road construction, people living along this road corridors are facing different engineering geological problems. Therefore, this study attempts to analyze these past events and their impact.

Study area::

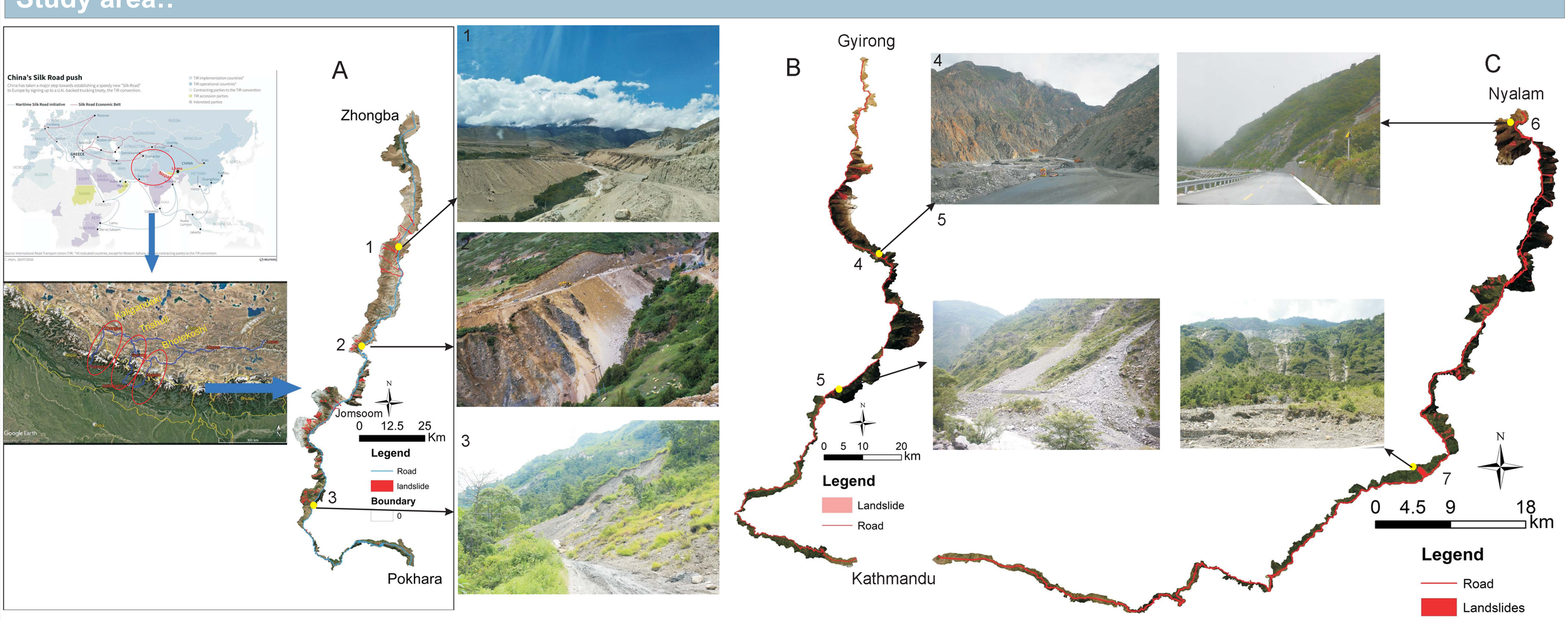

Fig. 1: Location map of the study area. (A) Kaligandaki (Pokhara-Jomsoom-Zhongba); (B) Trishuali (Kathmandu-Trishuli-Gyirong) ; (C) Bhotekoshi rivers (Kathmandu-Tatopani-Nyalam). (1) Debris flow at Lo-Manthang Khola, Mustang, Nepal; (2) Slope modification near Samar village due to road construction, Mustang, Nepal; (3) Rainfall triggered landslide near Baisari, Myagdi, Nepal; (4) Rock slide near Gyirong, China; (5) Debris flow near Betrabati, Nuwakot, Nepal; (6) Rock slide near Nyalam, China; (7) Jure landslide, Sindhupalchowk, Nepal

Large scale mass movements:

Fig. 2: Baisari landslide: Gorkha earthquake -2015 has triggered this landslide and destroyed the road. This landslide has dammed the Kaligandaki River for more than 12 hours.

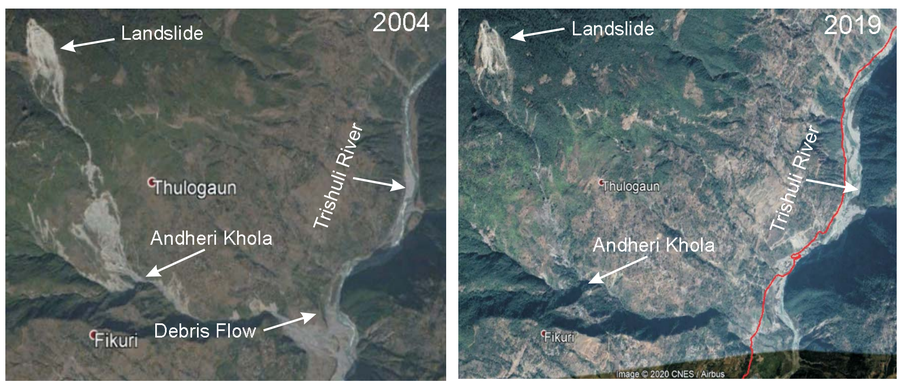

Fig. 3: Andheri Khola debris flow: Landslide and debris flow occurred in the Andheri Khola, Nuwakot in 2003. The newly built Kathmandu-Gyirong road passes through the foot of the past debris flow. Poor engineering geological and geomorphological consideration will bring devastation in this road.

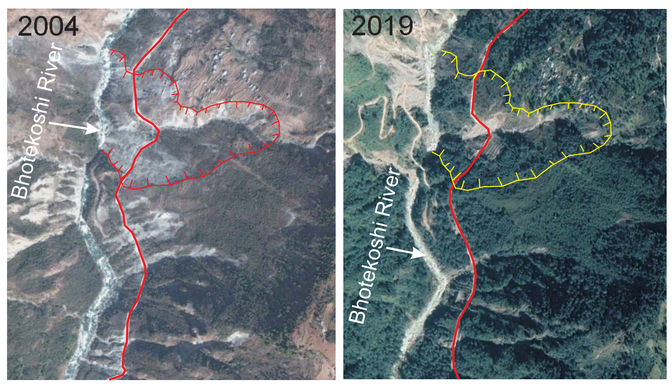

Fig. 4: This landslide occurs every year sliding down the Kathmandu-Nyalam road. New track has to be built every year after the monsoon due to poor drainage management and geotechinal investigations.

Kinematic analysis:

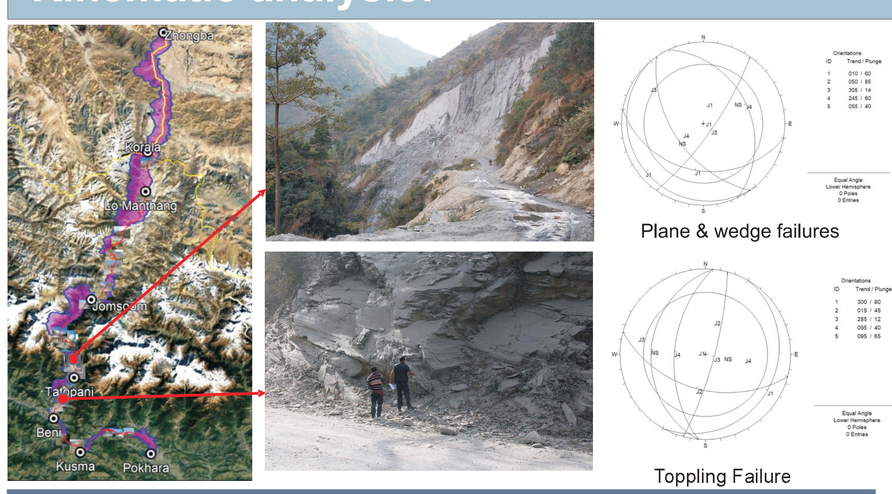

Fig. 5: Kaligandaki road corridors

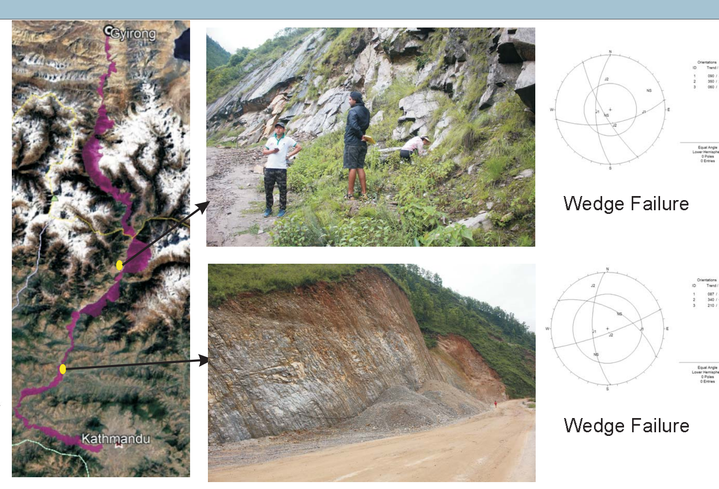

Fig. 6: Trishuli road corridors

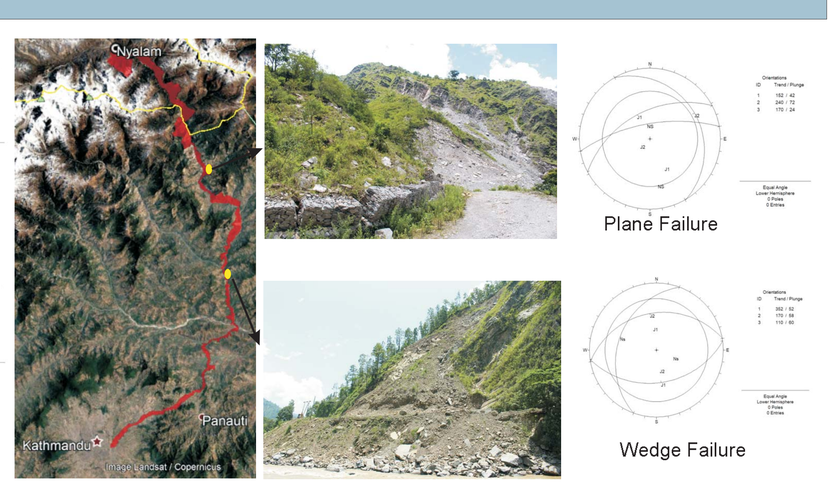

Fig. 7: Bhotekoshi road corridors

Mitigation practices:

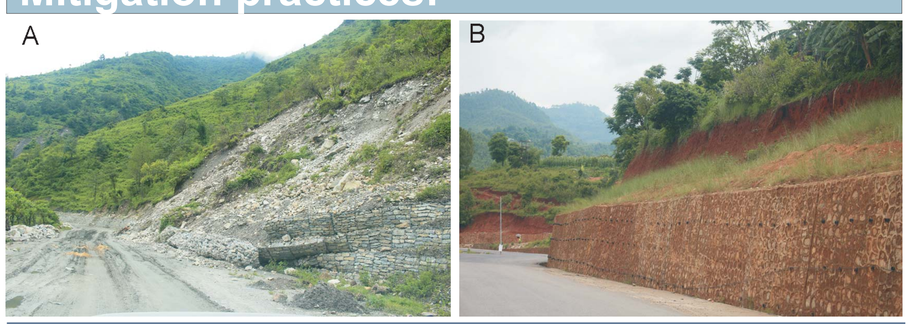

Fig. 8: (A) Gabion walls are destroyed by moving mass during monsoon in the Kaligandaki Road corridor; (B) Good practice of slope modification and construction of retaining wall with bio-engineering in the Trishuli road corridor.

Conclusions:

All roads have landslides on either sides of the Himalaya, however, souther slope is more vulnerable than northern part.

Reactivation of paleo-landslide and river toe cutting coupling with strong monsoon are responsible for landslide generation.

Poor consideration of geomorphological and engineering geological parameters are the major threats.

Kinematic analysis shows that many slopes are unstable.

Acknowledgment:

National Natural Science Foundation of China
Grant no: 71841027

Affiliations:

1. Institute for Disaster Management and Reconstruction, Sichuan University, China.
2. Department of Civil Engineering, Tribhuvan University, Nepal
3. Institute of Himalayan Risk Reduction, Nepal
4. Central Department of Geology, Tribhuvan University, Nepal
5. Trishuli Jal Vidhyut Company Limited, Nepal