For Discussion on
26 May 2020

Legislative Council Panel on Development

Government's Preparedness for Increasing Landslide Risk due to Climate Change

PURPOSE

This paper briefs Members on the Government's effort on addressing the landslide risk brought about by more frequent extreme rainfall events due to climate change.

SLOPE SAFETY AND LANSLIDE RISK IN HONG KONG

2. The Hong Kong Government set up the Geotechnical Engineering Office (GEO)[1] in 1977 to develop and systematically implement the Hong Kong Slope Safety System[2]. After years of efforts, the overall landslide risk has been remarkably reduced to less than one-fourth of the risk level in 1977, and the number of landslides has reduced substantially. Casualties due to landslides have also dwindled significantly in recent years.

3. However, given its hilly terrain and dense population, there is still a risk that landslides with serious casualties and consequences may occur should Hong Kong be hit by an extreme rainfall event. Concerted efforts of the Government and the public are crucial in enhancing the preparedness and resilience against landslide disasters and reducing the potential loss of life and damage to property.

4. The potential of a rainstorm in triggering landslides depends on various factors including the rainfall intensity, the rainfall distribution and the number and condition of slopes hit by the rainstorm. In this regard, we have

[1] Geotechnical Engineering Office (GEO) is under the Civil Engineering and Development Department.
[2] GEO has developed a comprehensive slope safety management system, covering setting of standard, technical development, design, construction, maintenance, management as well as public education and publicity, etc. to make Hong Kong a safer place to live. This system is comprehensive, reasonable and effective and has gained wide recognition by geotechnical professionals worldwide.

developed the "Landslide Potential Index[3]" (LPI) to indicate the potential of a rainstorm in triggering landslides. When the LPI of a rainstorm is greater than 100, the landslide risk associated with the rainstorm is classified as "Extremely high". According to the LPI of every rainstorm that prompted Landslip Warnings in the past 35 years (Figure 1 refers), there have been three rainstorms falling into the category of "Extremely high" risk since 1985. The last rainstorm that resulted in an LPI greater than 100 occurred in June 2008, of which the LPI value is 126. This record-breaking rainstorm struck western Lantau, resulting in many natural terrain landslides, 2 fatalities and havoc in western Lantau.

5. In the past 12 years, Hong Kong has fortunately neither experienced a landslide risk level reaching "Extremely high" nor any fatal landslide. Nevertheless, the Hong Kong Observatory (HKO) has pointed out that although it used to take several decades to break a rainfall record in the past, the hourly rainfall record in Hong Kong was broken several times in the last few decades. HKO has also predicted that climate change would bring about more frequent and intense extreme rainfall events. Therefore, despite that the Hong Kong Slope Safety System has successfully reduced the overall risk of landslides in Hong Kong to an "as low as reasonably practicable" level, there is no room for complacency, but a need for in-depth studies on the potential impact of extreme rainfall on landslide risk due to climate change.

IMPACT OF CLIMATE CHANGE ON LANDSLIDE RISK

6. In recent years, extreme weather exacerbated by climate change has brought about many disasters worldwide, causing significant casualties and economic losses. According to the assessment of GEO, if the above-mentioned June 2008 severe rainstorm were to strike the densely urbanized area of Hong Kong, a large number of severe landslides including debris flows on natural hillside would occur. The landslides could block roads, damage buildings and affect other important facilities, and the occurrence of severe landslides resulting in significant casualties and economic losses could not be ruled out. Worse still, if an extreme rainfall event like those that affected other

[3] Based on the number of landslide reports, which includes landslides on both man-made slopes and natural hillside, we established a statistical model between rainfall intensity and landslide frequency, and regularly review and embrace the latest data to optimize the model and improve the accuracy of the estimates.

parts of the world in recent years (e.g. Typhoon Morakot[4] that hit Taiwan in 2009) hits Hong Kong, much larger scale and severe landslides could occur.

7. From scientific angle, the landslide threat brought about by extreme rainfall cannot be entirely avoided. Thus it is vital to stay vigilant and acquire relevant experience and technologies at home and aboard, so as to establish proper tackling strategy and preparedness, thus bringing the potential loss of lives and properties to a minimum.

PREPAREDNESS FOR INCREASING LANDSLIDE RISK DUE TO CLIMATE CHANGE

8. The Government has formulated strategies to prepare Hong Kong for the threat of extreme rainfall brought about by climate change, which covers three aspects viz prevention, preparedness and education. Key measures include:

(a) Strengthening slopes against extreme rainfall to prevent landslides
(b) Enhancing emergency preparedness and response to cope with severe landslide events
(c) Improving the community resilience against landslide risk

Strengthening Slopes against Extreme Rainfall to Prevent Landslides

9. We launched the Landslip Prevention and Mitigation Programme (LPMitP) in 2010 to manage the landslide risk of both natural hillside and man-made slopes in a holistic manner. Under the LPMitP, the Government upgrades 150 man-made slopes and constructs mitigation measures for 30 vulnerable natural hillside catchments each year[5].

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[4] Typhoon Morakot hit Taiwan in 2009, with a maximum rainfall of 1400 mm in 24 hours, brought a total rainfall of 3,000 mm to the southern Taiwan, equivalent to 75% of its average annual rainfall. The low pressure trough, which swept across western Lantau on 7 June 2008, had brought about a maximum rainfall of 623 mm in 24 hours and a total rainfall of 672 mm, which amounted to about 25% of the average annual rainfall in Hong Kong.

[5] The Panel on Development was briefed on the progress and target of the Landslip Prevention and Mitigation Programme vide LegCo Brief (ref: CB(1)105/15-16(04)).

10. We also endeavor to enhance the prevailing slope engineering design standard and preventive measures to strengthen the slopes against extreme rainfall events, in order to reduce the probability of occurrence of severe landslides. These measures include: (i) enhancement of slope drainage design standard and improvement of slope surface drainage system to cater for the possible increase in precipitation due to extreme rainfall events; (ii) use of soil nails to enhance the robustness of slope; (iii) construction of flexible and rigid barriers to contain debris flow and thus minimizing the impact to adjacent facilities; (iv) use of unmanned aerial hydroseeding technique to revegetate landslide scars on natural hillside as well as identification of landslides on aerial photographs using artificial intelligence in order to enhance the effectiveness of evaluating landslide risk; and (v) use of innovative technology to regulate the regional groundwater.

Enhancing Emergency Preparedness and Response to Cope with Severe Landslide Events

11. From technical viewpoint, the forecast of climate change effects bears many uncertainties. We cannot rely solely on engineering solutions to manage the landslide risk brought about by extreme rainfall events. Enhancing the Government emergency preparedness and response is equally important. In order to collect real-time rainfall data to support the operation of the Landslip Warning System, we adopt advanced computer facilities and software to manage and record the abundant rainfall data from a network of about 120 automatic raingauges covering the whole territory. In addition, based on the data, we established a statistical model between rainfall intensity and landslide frequency to facilitate the estimation of number of landslides induced by a rainstorm. With the aid of this rainfall-landslide correlation model and the rainfall forecast from the HKO, the Government is able to determine the appropriate timing of issuing or cancelling a Landslip Warning.

12. We also proactively make use of new technology to enhance our emergency preparedness and response. We have developed and put on trial a novel landslide detection system *"Smart Barrier"*, applying modern information technology for monitoring the condition of landslide debris-resisting barriers. Many barriers are located at natural stream course or hillside, where accumulation of landslide debris behind the barriers may easily go unnoticed. The "Smart Barrier" allows all-weathered and non-stop monitoring of the barriers' conditions and provides alerts via mobile

application in the event of any accumulation of landslide debris, thus forewarning the occurrence of major debris flow. This enables relevant Government departments to arrange timely emergency evacuation of nearby residents and minimize any possible casualties.

13. The Government has also put in place a contingency plan for natural disasters. Where situation warrants, the Emergency Command System (ECS) will be triggered to pool together resources within the Government for well-coordinated and prompt response in dealing with severe landslide incidents. The GEO also assists in developing and managing the "Common Operation Picture" to facilitate real-time sharing of emergency information (such as on landslide, flooding, etc.) among various departments. In addition, we maintain a 24-hour year-round landslide emergency service to advise various departments on actions to be taken in case of danger arising from landslides. Where necessary, our geotechnical engineers would join relevant departments to inspect landslide sites and provide expertise advice on appropriate mitigation measures or emergency works, so as to ascertaining public safety. Besides, we conduct training events and operational drills to ensure adequacy and effectiveness of the Plan. We have also introduced virtual reality trainings to empower our colleagues in dealing with severe landslide incidents.

Improving the Community Resilience against Landslide Risk

14. Another important initiative is to raise community resilience against natural disasters such as extreme rainfall and severe landslide events. The Government has been promoting personal precautionary measures under emergency situations. When natural disaster occurs and before the arrival of rescue teams, the public may follow pragmatic self-help tips to protect themselves, minimize damages and avoid casualty.

15. We have a proactive strategy to educate the public on the precautionary measures that they should take when Landslip Warning is in force. Besides, we raise public awareness of slope safety through public education, publicity events and public information services. Our safety messages to the public are simple but crucial, which include (i) the public should always stay vigilant about warning and advice issued by the Government during adverse weather; (ii) when Landslip Warning is in force, or during heavy rainfall, the public should stay away from slopes, watch out

and report for signs of landslide danger; and (iii) the public must strictly follow the instructions of the rescue personnel and act promptly.

16. Our public education activities include organizing slope safety roving exhibitions, talks, broadcasting announcements of public interests on television and radio, and promoting slope safety messages through media and online platforms. In 2019, we organised a yearlong inter-departmental public education campaign, the "Safer Living 2.0", which aims to enhance public understanding of natural disasters, such as typhoons, landslides, storm surge and flooding.

17. For private slopes, we continue to implement community education programme to promote the importance of slope maintenance in preventing landslides. We have set up a Community Advisory Unit to proactively provide community advisory services to owners and help them fulfil their slope maintenance responsibilities.

CONCLUSION

18. Although severe landslides arising from extreme rainfall cannot be totally avoidable, with the concerted efforts of the Government and the public to get the community well-prepared, we will be able to enhance our resilience against landslide disasters and bring the loss of life and properties down to a minimum.

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Civil Engineering and Development Department
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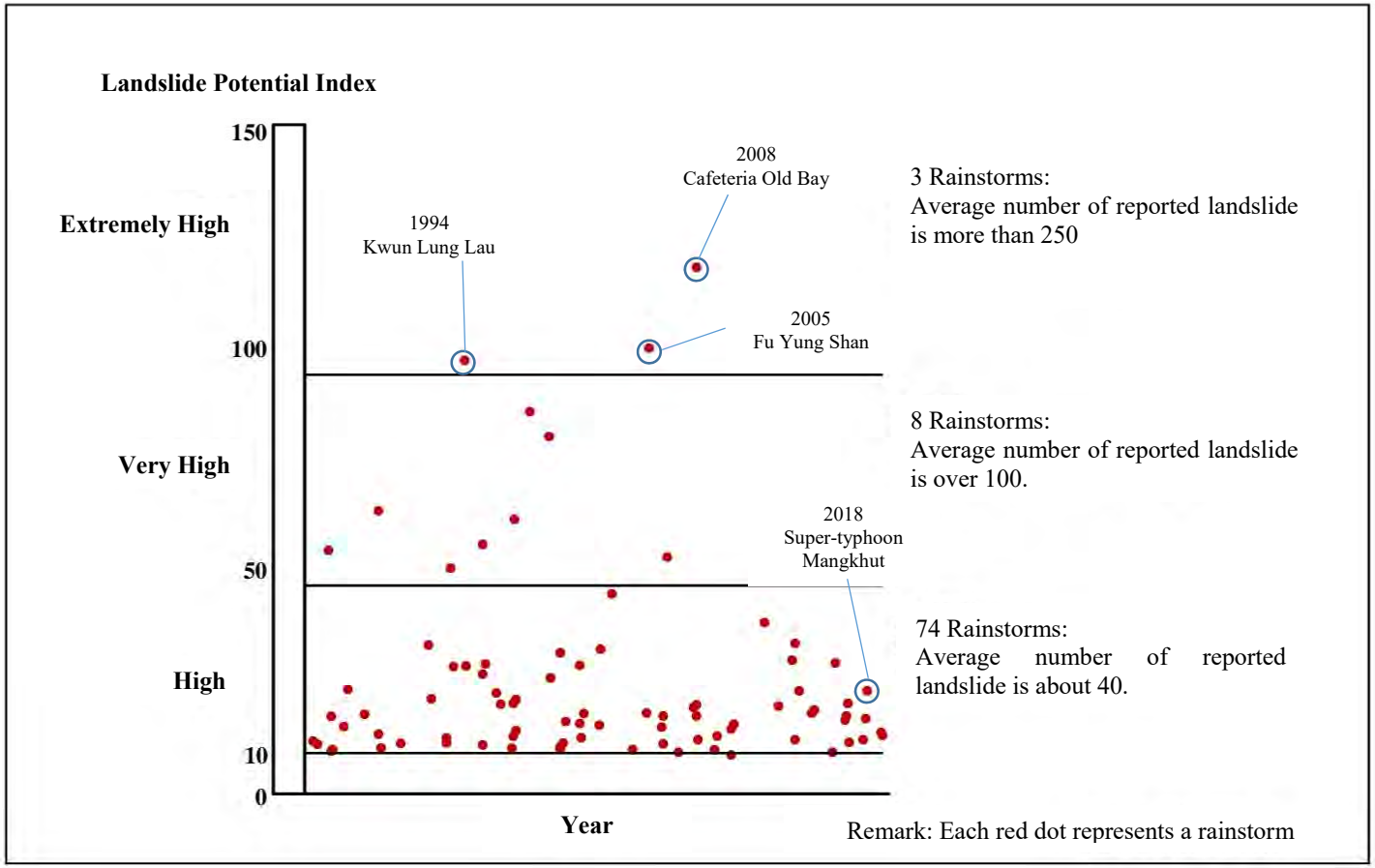

Figure 1 – Landslide Potential Index of Past Rainstorms that prompted Landslip Warning (1985-2019)