

## Management of Natural Terrain Landslide Risk

**Key Messages:** Government’s strategy is to keep the natural terrain landslide risk to a level that is as low as reasonably practicable. Study and mitigation of natural terrain landslide hazards affecting existing developments are systematically carried out under the Landslip Prevention and Mitigation Programme (LPMitP), following the “react-to-known-hazard” principle. Landslide risk to new developments is controlled through avoidance of development in hazardous areas as far as possible, and study and mitigation of hazards as part of new developments where required.

### Introduction

Natural terrain landslides include slope failures, debris flow and boulder falls from natural hillsides that are not significantly modified by human activities. These natural hillsides cover about 60% of the land area of Hong Kong, and landslides occur on them as part of the landform evolution. As with other landslides, the locations and timing of landslides on natural hillsides cannot be predicted with precision.

Some relevant statistics are as follows:

- From a review of aerial photographs taken between 1924 and 2019, about 111 400 landslides on natural terrain were identified. An inventory of landslides (the Enhanced Natural Terrain Landslide Inventory) has been compiled from the review and is available for public viewing in the Civil Engineering Library and on the Hong Kong Slope Safety Website (<http://hkss.cedd.gov.hk>).
- Most of the natural terrain landslides occur in relatively remote areas but some affect existing developments. Between 1982 and 2020, about 1 430 natural terrain landslides affecting developed areas were reported to the GEO. Most of these landslides were small-scale failures affecting open spaces, minor roads and footpaths, and other less important facilities.
- Since 1980, natural terrain landslides have caused 16 fatalities, 13 of which were in squatter areas<sup>1</sup>.

The historical natural terrain landslide data provide an indication of the scale of the problem, and may give an impression that landslide risk from natural hillsides is lower than that from man-made slopes in Hong Kong. However, the data may not have fully reflected the inherent landslide risk to the community. Some landslides were “near-miss” incidents that could well

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<sup>1</sup> Since the mid-1980s, the GEO has been undertaking a programme to recommend safety clearance of squatter structures that are identified as being especially vulnerable to landslide risk, based on geotechnical studies and inspections. The programme has proved to be effective in reducing the number of landslide fatalities in squatter areas, from 27 fatalities in the 1980s to two fatalities in the 1990s.

have resulted in much more serious consequences. This situation will be aggravated as more new developments encroach on the steep natural hillsides.

The severe rainstorm of 7 June 2008 highlights the potential vulnerability of developments located close to natural terrain. This rainstorm caused several hundreds of reported landslides, including many debris flows that affected developed areas. The significant scale of these natural terrain landslides appears to be related to the severity of the rainfall, which reached a maximum of 380 mm in a four-hour period, corresponding to a theoretical statistical return period of 1 100 years, and an estimated Landslide Potential Index of 1262. Importantly, the intense rainfall was concentrated in areas of steep natural hillsides.

### **Management of Natural Terrain Landslide Risk**

The Government's strategy for management of natural terrain landslide risk aims at keeping the natural terrain landslide risk to the as low as reasonably practicable level. It entails the following general principles:

- (i) The Government adopts a "react-to-known-hazard" principle in dealing with natural terrain hazards affecting existing developments, i.e. to carry out studies and mitigation actions where significant hazards become evident. Under the LPMitP which commenced in 2010, about 30 natural hillside catchments with known hazards to existing buildings or important transport corridors are to be systematically dealt with annually.
- (ii) For new developments, the Government aims to contain undue increase in natural terrain landslide risk. This is implemented through judicious land-use and project planning to avoid development in hazardous areas, and requirement for study and mitigation of natural terrain landslide hazards as part of new developments in close proximity to natural hillsides. The GEO uses a set of criteria to determine where the natural terrain would require further studies (see Appendix A).

### **Technical Approach for Dealing with Natural Terrain Landslide Hazards**

The Government's strongly preferred approach is not to carry out stabilization works to large areas of natural terrain, which would be both impractical and environmentally unfriendly if hard engineering measures, such as shotcrete, are used extensively, but to mitigate the risk through adjustments to the layout of new developments and provision of buffer zones and defence measures (e.g. debris-resisting barriers).

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<sup>2</sup> Risk description based on Landslide Potential Index: > 100 = extremely high; 51 – 100 = very high; 10 – 50 = high; and < 10 = low.

Natural hillsides do not require maintenance. Where hazard mitigation measures are provided to a natural hillside, it is only necessary to maintain the physical integrity and continued functionality of the measures. The recommended good practice for maintenance of natural terrain hazard mitigation measures is provided in Geoguide 5.

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**Criteria Used by GEO  
for Determining the Need for Natural Terrain Hazard Study for New Development**

For new developments involving occupied buildings, major infrastructure facilities, busy roads, densely-used open areas, etc., natural terrain landslide hazards need to be studied when the following condition is satisfied:

“Where there is natural terrain outside the site, but within the same catchment, which is at an angular elevation of 20° or more from the site, and where there is natural terrain sloping at more than 15° within 50 m horizontally upslope of the site, provided that there is a credible flowpath to the site.”

There are occasionally cases where a natural terrain landslide hazard study may also be required for development sites which do not meet the above criteria, for example for development sites which are either intersected by or adjacent to a natural drainage course.