

## **Landslide Potential Index**

**Key Messages:** The Geotechnical Engineering Office of the Civil Engineering and Development Department has developed an index, called the Landslide Potential Index (LPI), to describe the severity of a rainstorm with respect to its potential to cause landslides. The LPI values of rainstorms in recent years are relatively small.

### **Introduction**

Landslides on man-made slopes are common in Hong Kong. The majority of landslides are caused by rainfall. While some past rainstorms have caused many landslides, others have caused relatively few. The occurrence of only a small number of landslides might be either because the rainstorm is not severe, because slopes have performed well, or some combination of both factors. A severe rainstorm is one that is intense and falls over an area of many man-made slopes, and hence could potentially cause a lot of landslides.

This note examines the traditional means of describing severity of rainstorms, and proposes a Landslide Potential Index specifically for the purpose.

### **Measurement of Rainstorm Severity by Return Period**

The severity of a rainstorm is traditionally described by its return period, i.e. the average time until the next occurrence of a rainstorm of equal magnitude. The longer the return period, the more intense the rainstorm is. However, the return period is not an ideal measure of rainstorm severity for the following reasons:

- The rainfall-return period relationship derived from statistical analysis of rainfall data collected at a certain raingauge station may not be valid for other locations. The rainfall-return period relationship used in Hong Kong is based on the historical rainfall data recorded at the Hong Kong Observatory Headquarters at Tsim Sha Tsui. The relationship, if applied to rainfall recorded at Tai Mo Shan, for example, would over-estimate the return period because rainfall of the same intensity occurs more frequently at Tai Mo Shan than at Tsim Sha Tsui.

- Return period is often reported for the rainfall recorded at a raingauge station, i.e. point rainfall. This does not give a full picture of how severe the rainstorm is in terms of its potential to cause landslides because the areal coverage of the storm is not represented.
- The area affected by a given rainstorm is usually much smaller than the total land area of Hong Kong. Hence, the chance of a given rainstorm occurring anywhere within Hong Kong is likely to be much higher than the chance of its occurrence at a specific locality. This explains why rainfall of 50-year return period can occur in Hong Kong rather frequently (but at different locations within the territory). An analogy to this is traffic accidents. The chance of a traffic accident occurring at a particular location is much smaller than the chance of it occurring anywhere in Hong Kong.
- The return period of a rainstorm depends on the combination of rainfall intensity and duration. For a given return period, the rainstorm could be intense for a short duration or less intense for a longer duration. The type and number of landslides that two rainstorms of the same return period could cause could be different.
- An intense rainstorm affecting an area with few slopes will have lower potential to cause landslides. This is not reflected in the return period of the rainstorm.

### **Landslide Potential Index**

A more direct measure of the severity of a rainstorm in terms of specific consequences is the number of landslides it could cause. Using historical rainfall and landslides records, a statistical relationship between rainfall intensity and landslide frequency has been obtained. When the rainfall intensity of a rainstorm and the number of man-made slopes covered by the rainstorm are known, the number of landslides that could be triggered by the rainstorm can be estimated.

The Geotechnical Engineering Office of the Civil Engineering and Development Department has developed an index, called the Landslide Potential Index (LPI) that is based on the probable number of landslides that could be caused by a given rainstorm. The well-known rainstorm of late July 1994 that led to the landslide at Kwun Lung Lau with five deaths and three serious injuries is set at an LPI of 10. A rainstorm with an LPI of 5 could be half as severe as the Kwun Lung Lau rainstorm in causing landslides. A rainstorm with an LPI value greater than 10 is possible. The LPI of a rainstorm is not a predictive index. It helps to analyse the severity of a rainstorm after the event.

The table below gives the LPI value and information on consequences of those rainstorms occurring since 1984 which led to landslides causing fatalities. The LPI of rainstorms that resulted in the issue of the Landslip Warning since 1984 are presented in the chart attached. The LPI values of rainstorms in recent years are all relatively small.

#### Fatal Landslides since 1984

Landslide Location	LPI	Date	Landslide Consequence
Kwun Lung Lau, Kennedy Town	10	23 July 1994	5 fatalities and 3 injuries
Sham Tseng San Tsuen	8	23 August 1999	1 fatality, 13 injuries, a squatter dwelling was demolished and several other dwellings were severely damaged
Ten Thousand Buddhas' Monastery, Shatin	6	2 July 1997	1 fatality, 1 injury and a building known as "Kun Yam Din" was damaged
Shum Wan Road, Aberdeen	6	13 August 1995	2 fatalities, 5 injuries, 3 shipyard and a factory were damaged
Fei Tsui Road, Chai Wan	6	13 August 1995	1 fatality and 1 injury
Lion Road Lower Village	6	21 May 1989	2 fatalities, 3 injuries, 2 squatter huts were damaged and another 16 huts were permanently evacuated
Milestone 14½ Castle Peak Road	3	7 August 1994	1 fatality and 17 injuries
Baguio Villas, Pokfulam	3	8 May 1992	2 fatalities
Kennedy Road below Wah Yan College, Wan Chai	3	8 May 1992	1 fatality
Kau Wa Keng Upper Village	2	4 June 1997	1 fatality, 5 injuries and 1 squatter hut was damaged
Cheung Shan Estate, Kwai Chung	1	16 June 1993	1 fatality and 5 injuries

#### Announcement of the LPI

The LPI of a rainstorm that results in the issue of the Landslip Warning would be uploaded onto the Hong Kong Slope Safety Website (<http://hkss.cedd.gov.hk>) within a week of cancellation of the Warning. The information will be kept in a running list for that year.

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Chart Showing Rainstorms since 1984 that Resulted in the Issue of Landslip Warning

