



土木工程拓展署
土力工程處
Geotechnical Engineering Office
Civil Engineering and
Development Department

香港斜坡安全 HONG KONG SLOPE SAFETY



前言

教育局於2005年公布，三年新高中學制將於2009年9月在中四級實施。地理科是其中一個重點的選修科目。

新高中地理科課程是根據2005年教育局出版的一份文件和課程發展議會《高中課程指引》(2007)的建議而制訂。在此課程中，地理被視為一門學科讓學生可以從空間的角度了解自身所處的地球。

土木工程拓展署轄下的土力工程處應教育局的請求，在天然災害及地球科學兩個新高中地理科課程內容上製備了一份「教學支援教材套」。其中有關香港岩石及礦物的資料亦適用於部份化學科的課程。

「教學支援教材套」包括了14本小書冊、4張海報、3片光碟及其他一些補充資料。此教材套在香港的斜坡安全、山泥傾瀉、地質及地貌等課題上提供了合適及最新的資料並同時符合新高中地理科課程的水平。

土力工程處的「香港地質調查組」負責編寫有關香港地質及地貌方面的內容，而「斜坡安全部」則負責香港斜坡安全及山泥傾瀉的部份，「斜坡安全部」的同事亦負責整個項目的策劃與安排。我謹向各位參與這項工作的同事致謝。

我相信這教材套對各位負責新高中地理科目的老師在擬備教材時能提供合適的參考。此教材套亦給予有興趣於這些課題的廣大讀者一些有用的資料。



陳健碩
土木工程拓展署
土力工程處處長
2008年12月

Foreword

In 2005, the Education Bureau (EDB) announced that a three-year New Senior Secondary (NSS) curriculum would be implemented at Secondary 4 in September 2009. Geography is one of the elective subjects under the NSS curriculum.

The NSS curriculum has been developed on the basis of the recommendations made by an EDB document in 2005 and a Senior Secondary Curriculum Guide of 2007. Within the curriculum, geography is seen as a key educational discipline that provides students with a spatial understanding of the Earth on which we live and work.

At the request of the EDB, the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department have prepared support teaching materials for the NSS Geography curriculum under the topics of Natural Hazards and Earth Science. The materials written on rocks, minerals and ores in Hong Kong are also suitable for part of the Chemistry curriculum.

The "Teaching Support Materials Kit" consists of 14 booklets, 4 posters, 3 CDs and other supplementary information sheets. This teaching kit contains pertinent and up-to-date information on slope safety, landslides, geology and geomorphology in Hong Kong, written at a level that is suitable for the NSS Geography curriculum.

Hong Kong Geological Survey of GEO have compiled the teaching materials that describe the geology and geomorphology of Hong Kong. The Slope Safety Division of GEO have prepared the teaching materials on Hong Kong slope safety and landslides. Colleagues in the Slope Safety Division are also responsible for the overall planning and coordination of this project. Their contributions are gratefully acknowledged.

I am confident that, for years to come, secondary school geography teachers will find the kit invaluable for preparing their classroom teaching materials. The contents will also be of interest to the more general readers who may wish to learn more about these topics.

Raymond K S Chan
Head, Geotechnical Engineering Office
Civil Engineering and Development Department
December 2008

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引言 Introduction

香港的土地總面積約1,100平方公里，當中逾百分之六十的土地位處於傾斜度超過15°的天然斜坡之上(圖1及2)。隨著城市急速發展，香港的人口越見稠密，由1950年的二百萬迅速增長至2009年的近七百萬(圖3)。為增加土地以興建大廈及基礎建設，天然山坡便被切割而成為大量人造斜坡(圖4、5及6)。早期由於不注重土力工程技術，而政府對此等工程亦欠缺監管，加上香港每年平均降雨量高達2,300毫米(圖7)，令人造斜坡易受山泥傾瀉威脅。這種問題正好解釋了香港為何有嚴重的山泥傾瀉歷史。

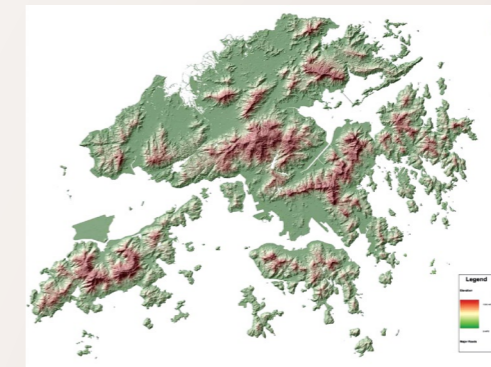


圖1. 香港的地形—香港陸地面積約1,100平方公里(60%是天然山坡)。
Figure 1. The topography of Hong Kong - Hong Kong has a total land area of about 1,100km² (60% of which are nature slopes).



圖2. 香港山多平地少。
Figure 2. Hong Kong's hilly terrain.

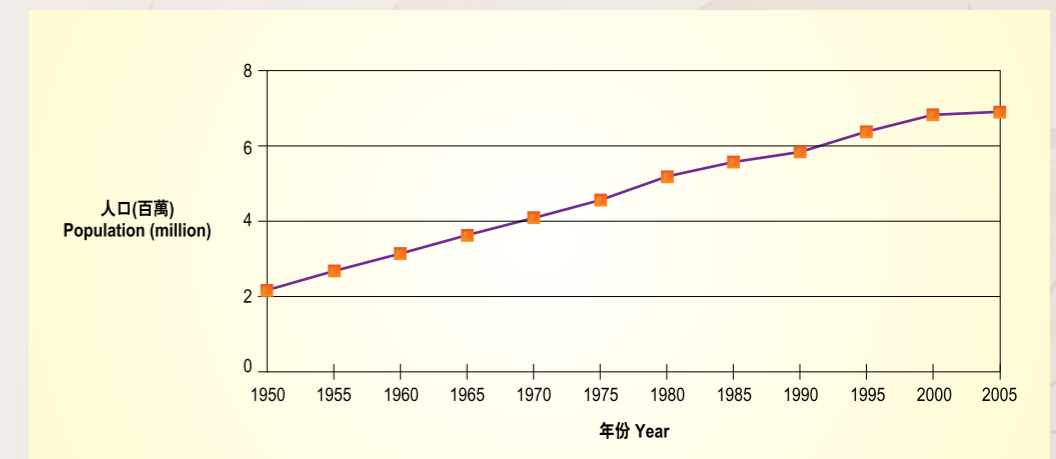


圖3. 香港的人口。
Figure 3. Population of Hong Kong.



圖4. 建造樓宇時要切割大量山坡。
Figure 4. Building platforms are formed by cutting into the hillside.



圖5. 建設道路網時亦需切割山坡。
Figure 5. Cut slopes are formed for highway network.



圖6. 樓宇及道路設施非常接近斜坡。
Figure 6. Buildings and roads are constructed close to steep slopes.



圖7. 過去20年接獲山泥傾瀉數目及全年雨量(1988-2007)。
Figure 7. The total number of reported landslide and annual rainfall in the past twenty years (1988-2007).

自1947年起的過去60年內，有超過470人死於山泥傾瀉(圖8)。兩次嚴重災難於1972年的同一天發生，導致138人死亡(圖9及10)。四年後的1976年，另一宗嚴重山泥傾瀉亦導致18人喪生(圖11)(詳情請參閱香港的山泥傾瀉一書)。當時的港督麥理浩特別委派由國際專家組成的獨立小組進行研究。建議之一是設立監管山坡發展的機構，監督香港斜坡的設計、建造及維修工程，土力工程處於1977年因而成立。

Hong Kong has a total land area of about 1,100km², of which more than 60% is on natural slope steeper than 15° (Figures 1 & 2). The population in Hong Kong has grown rapidly from about 2 million since the 1950s to almost 7 million in 2009 (Figure 3). In order to make space for building and infrastructure development, large number of man-made slopes have been formed by cutting into the natural hillsides (Figures 4, 5 & 6). In the early days, there was little geotechnical engineering input and regulatory control by the Government on these site formation works. The slopes formed were therefore susceptible to landslides, given that Hong Kong has an average annual rainfall of as high as 2,300mm (Figure 7). These all explain why Hong Kong has a history of tragic landslides.

In the past 60 years since 1947, more than 470 people have died in landslides (Figure 8). Two major disasters took place on the same day in 1972 and killed 138 people (Figures 9 & 10). Four years later in 1976, another severe landslide killed another 18 people (Figure 11) (see the Booklet on Landslides in Hong Kong for more details). In response, the Governor Sir Murray MacLehose appointed an independent review panel of international experts to study the problem. One of the recommendations was to establish a control organization to regulate hillside developments and oversee the design, construction and maintenance of Hong Kong's slopes. This led to the formation of Geotechnical Control Office within the Government in 1977 (renamed as Geotechnical Engineering Office in 1991).

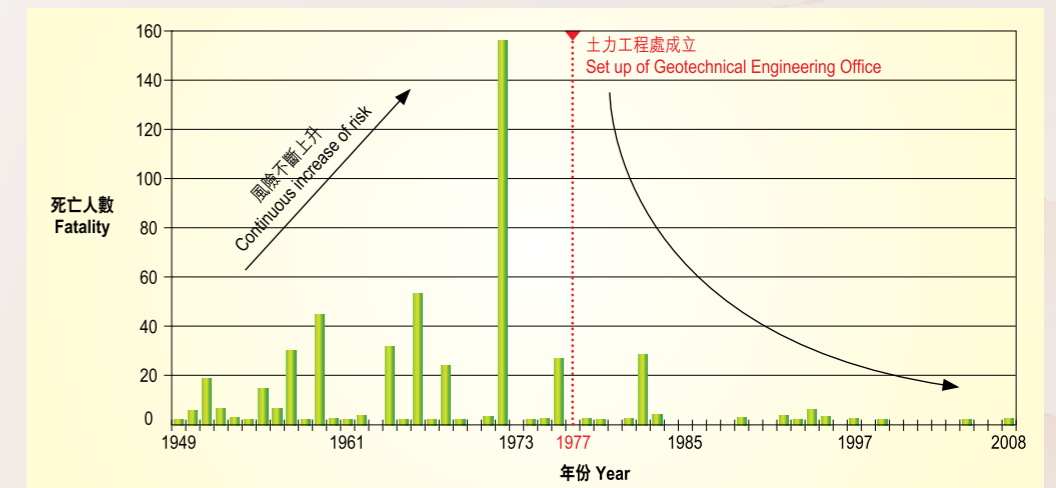


圖8. 因山泥傾瀉而導致死亡的人數。
Figure 8. Number of landslide fatalities.



圖9. 1972年寶珊道山泥傾瀉導致67人喪生。
Figure 9. 1972 Po Shan Road landslide (67 fatalities).



圖10. 1972年秀茂坪山泥傾瀉導致71人喪生。
Figure 10. 1972 Sau Mau Ping landslide (71 fatalities).



圖11. 1976年秀茂坪山泥傾瀉導致18人喪生。
Figure 11. 1976 Sau Mau Ping landslide (18 fatalities).

斜坡紀錄冊

香港的斜坡可以劃分為天然山坡或人造斜坡(圖12及13)。人造斜坡如削土坡、填土坡、石坡、擋土牆等(圖13)皆統稱為「斜坡」。

為提供香港特別行政區內較大型人造斜坡的詳細資料，土力工程處於一九九四年七月展開為期四年的「有系統鑑定及登記斜坡計劃」。在該項計劃下，土力工程處有系統地鑑定、分類及登記了香港較大型的人造斜坡和擋土牆(統稱斜坡)。為了確保斜坡紀錄冊的資料完整和不斷更新，土力工程處調派了一組專業及技術人員，負責日常的系統管理及資料更新，以配合處理各政府斜坡維修部門及私人機構岩土專業人士所提供的更新資料。

香港共有約57,000幅較大型人造斜坡(圖14)登記於政府的斜坡登記冊，包括(圖15)：

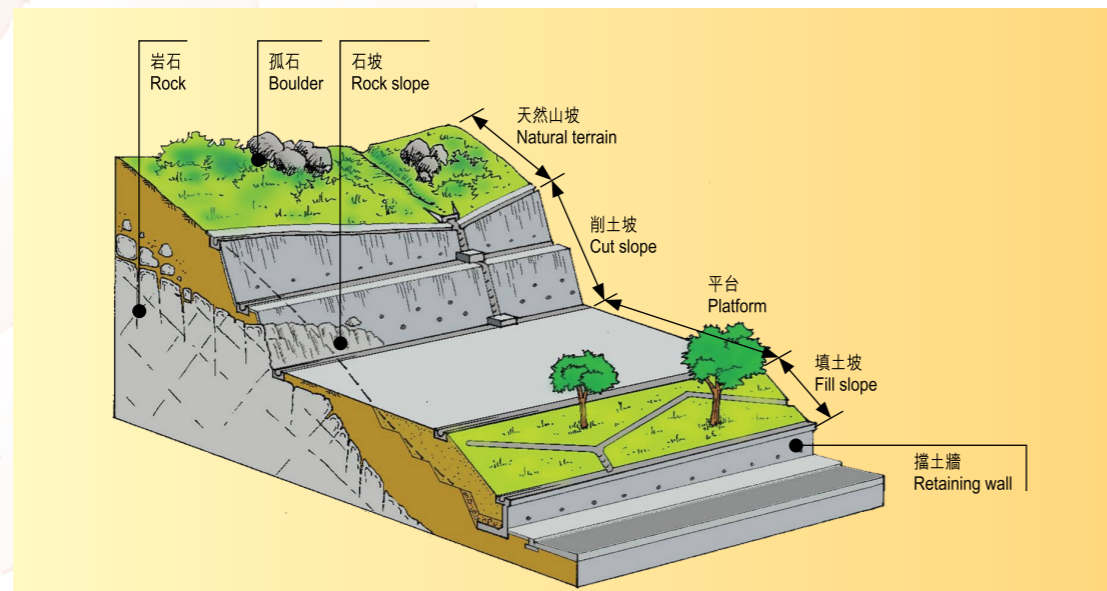


圖13. 斜坡的類別。
Figure 13. Types of slope.

- ▶ 約18,000幅1977年後的斜坡，這些斜坡已按當時的安全標準及檢查要求設計及建造；
- ▶ 約39,000幅1977年前的斜坡，大部份均未必符合目前的安全標準；

或，以擁有權計算：

- ▶ 約39,000幅屬政府斜坡；及
- ▶ 約18,000幅屬私人斜坡。

圖16顯示由不同部門或組織維修的私人斜坡及政府斜坡。

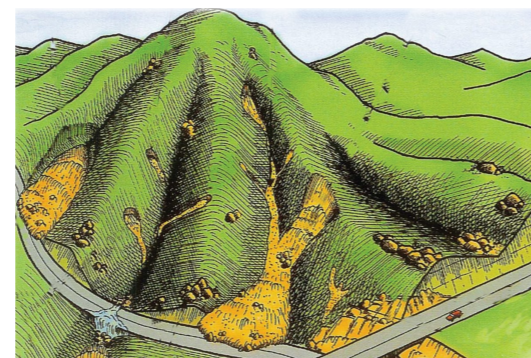


圖12. 天然山坡。
Figure 12. Natural terrain.

Slope Catalogue

Slopes in Hong Kong may be classified as natural hillside or man-made slopes (Figures 12 and 13). Man-made features such as cut slopes, fill slopes, rock slopes, retaining walls, etc (Figure 13) are collectively known as "slopes".

To provide comprehensive information on the sizable man-made slopes in the Hong Kong Special Administrative Region (HKSAR), the Geotechnical Engineering Office (GEO) started a 4-year project - "Systematic Identification and Registration of Slopes in the Territory (SIRST)" in July 1994. Under the SIRST project, the GEO systematically identify, catalogue and register sizeable man-made slopes and retaining walls (collectively termed slopes) in the HKSAR. To ensure that the slope catalogue information is comprehensive and up-to-date, a dedicated team of professional and technical staff has been deployed to administer, maintain and update the catalogue with the latest slope data provided by various parties including government maintenance departments and geotechnical practitioners in the private sector.

There are about 57,000 sizeable man-made slopes in Hong Kong (Figure 14) registered in the Government's Catalogue of Slopes, comprising (Figure 15) :

- ▶ About 18,000 post-1977 slopes which have been designed and constructed under the safety standards and checking requirements introduced since that time;
- ▶ About 39,000 pre-1977 slopes, many of which may not meet the current safety standard.

or, in terms of ownership :

- ▶ About 39,000 government slopes; and
- ▶ About 18,000 private slopes.

Figure 16 shows the distribution of private slopes and government slopes maintained by different parties.

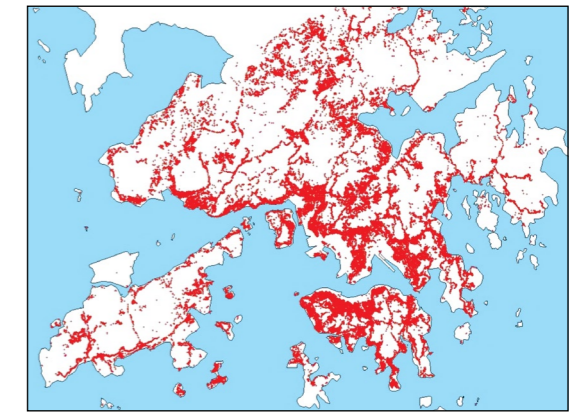


圖14. 香港57,000幅登記人造斜坡的分佈。
Figure 14. Distribution of 57,000 registered man-made slopes in Hong Kong.

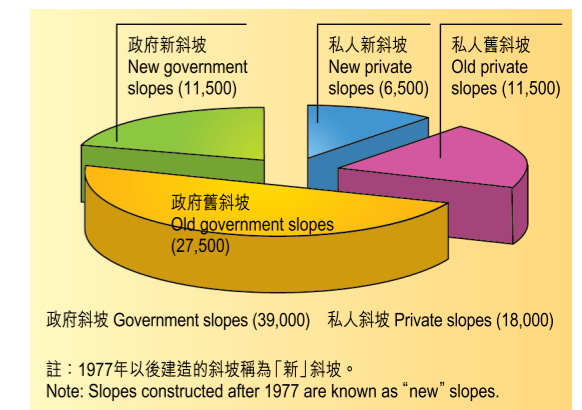


圖15. 57,000幅人造斜坡的分類。
Figure 15. Classification of the 57,000 man-made slopes.

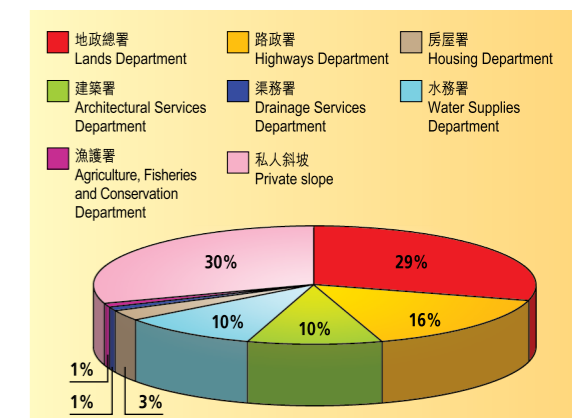


圖16. 維修責任——私人斜坡及政府斜坡之分佈。
Figure 16. Maintenance responsibility - The distribution of private slopes and government slopes.

香港斜坡安全系統

建立香港斜坡安全系統的目的是在斜坡安全方面達至最高標準以配合社會的需要。它由下列七個主要工作範疇(KRA)組成：

KRA1: 提高斜坡安全的標準和賴以達致更高安全標準所需的技術水平，並改善有關的行政和規管架構；

KRA2: 確保新建斜坡符合安全標準；

KRA3: 鞏固不符合標準的政府斜坡；

KRA4: 維修所有政府人造斜坡；

KRA5: 確保業主負責物業範圍內斜坡的安全；

KRA6: 通過公眾教育、宣傳、資訊服務和發佈警告，提高市民對斜坡安全的意識，並鼓勵他們作出回應；

KRA7: 改善斜坡的外觀。

圖17顯示香港斜坡安全系統的主要工作如何有效減低山泥傾瀉風險。從圖中可見這個系統採用了三個主要策略：

- ▶ 停止風險上升；
- ▶ 提高斜坡安全從而減低風險；
- ▶ 減低後果從而減低風險。

圖18說明山泥傾瀉「風險」的簡化概念。

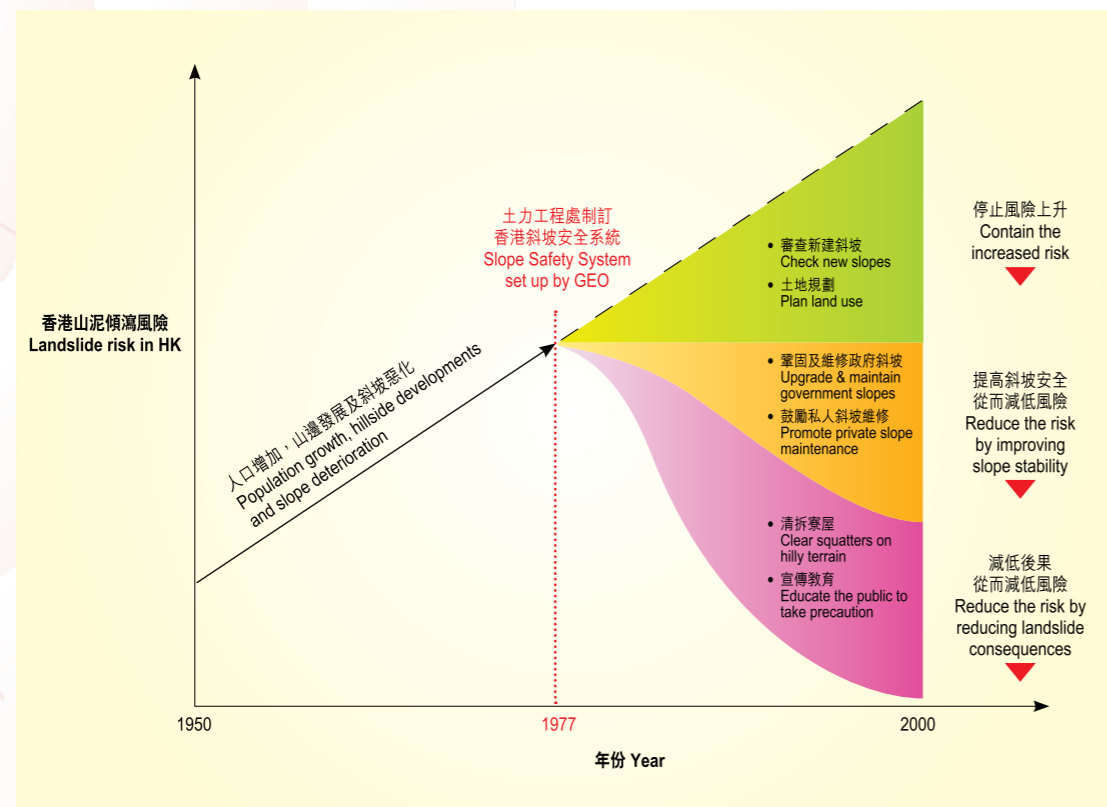


圖17. 減低山泥傾瀉風險的主要策略。
Figure 17. Major strategies to reduce the landslide risk.

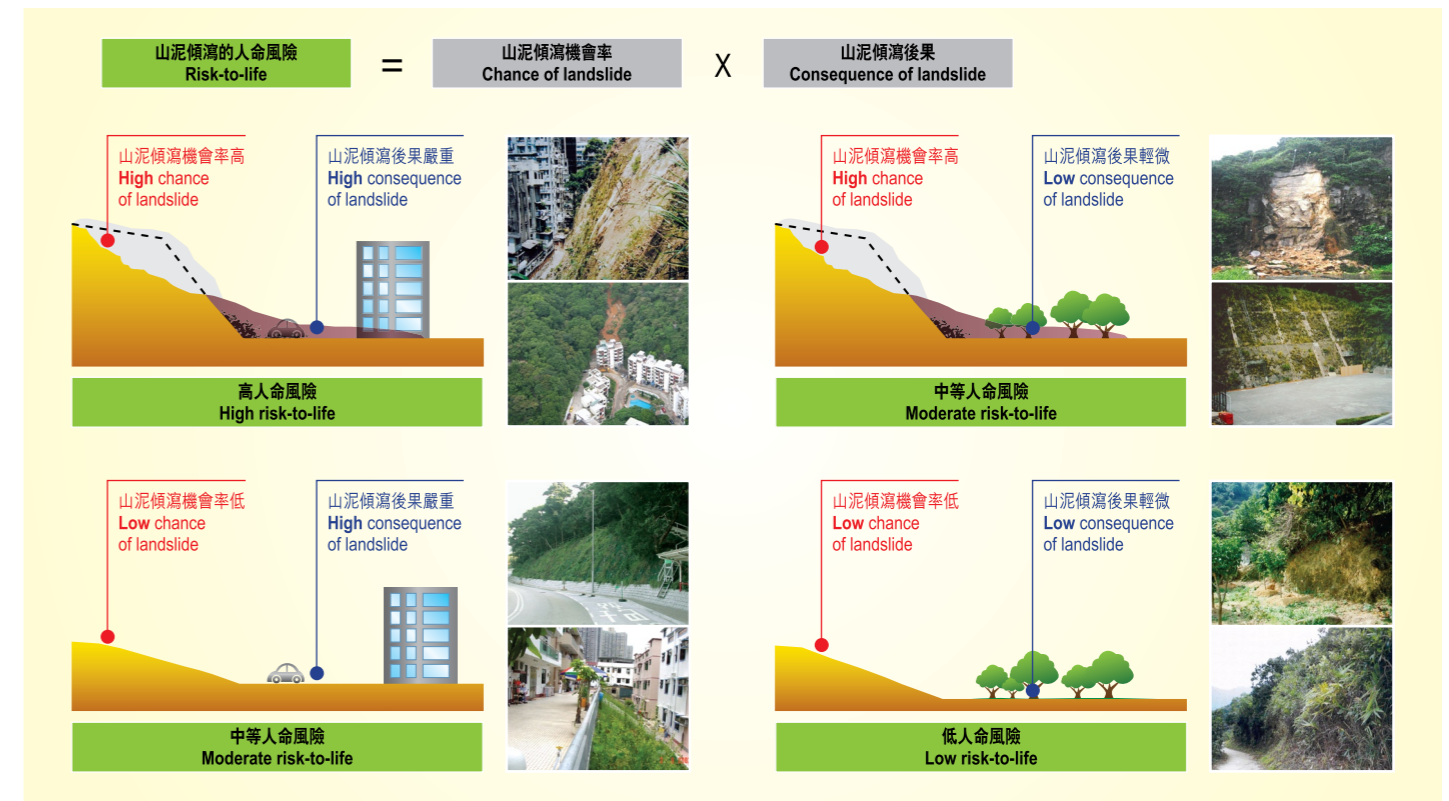


圖18. 山泥傾瀉「風險」簡化概念。
Figure 18. Simplified concept of landslide "risk".

The Hong Kong Slope Safety System

The Hong Kong Slope Safety System (HKSSS) was established with the aim to meet Hong Kong's needs for the highest standards of slope safety. It comprises seven key results areas (KRA):

KRA1: Improve slope safety standards, technology, and administrative and regulatory frameworks;

KRA2: Ensure safety standards of new slopes;

KRA3: Rectify substandard government slopes;

KRA4: Maintain all government man-made slopes;

KRA5: Ensure that owners take responsibility for slope safety;

KRA6: Promote public awareness and response in slope safety through public education, publicity, information services and public warnings;

KRA7: Enhance the appearance and aesthetics of slopes.

Figure 17 shows how the major elements of HKSSS effectively reduce the landslide risk. The figure shows that three major strategies are employed:

- ▶ Stop the increasing trend of the landslide risk;
- ▶ Reduce landslide risk by improving slope conditions;
- ▶ Reduce landslide risk by reducing landslide consequence.

The simplified concept of landslide "risk" is illustrated in Figure 18.

以下闡述圖17的部份主要內容：

審查新建斜坡及完善土地規劃 (參閱KRA 2)

香港的私營及公營項目岩土工程會由土力工程處分別以屋宇署及政府行政框架的法定權力機構進行定期監管。目的是確保大眾安全。

香港法例第123章，建築物條例(及三項相關法例)為私人發展的岩土工程管制的法律基礎。主要參與人士如圖19所示。

不同的政府部門會於初期計劃階段，就未來土地用途聽取岩土工程的建議，這是減低

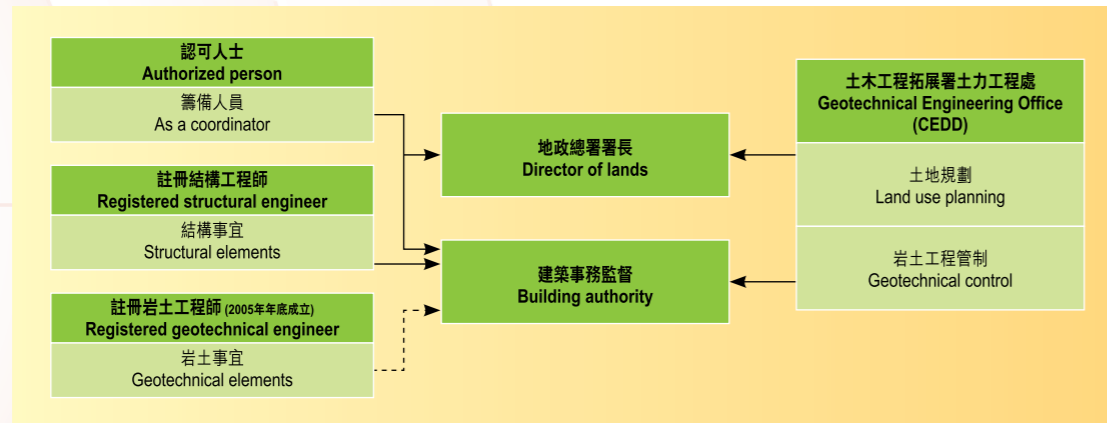


圖19. 監管私人發展之主要參與部門。
Figure 19. Key parties involved in control of private developments.

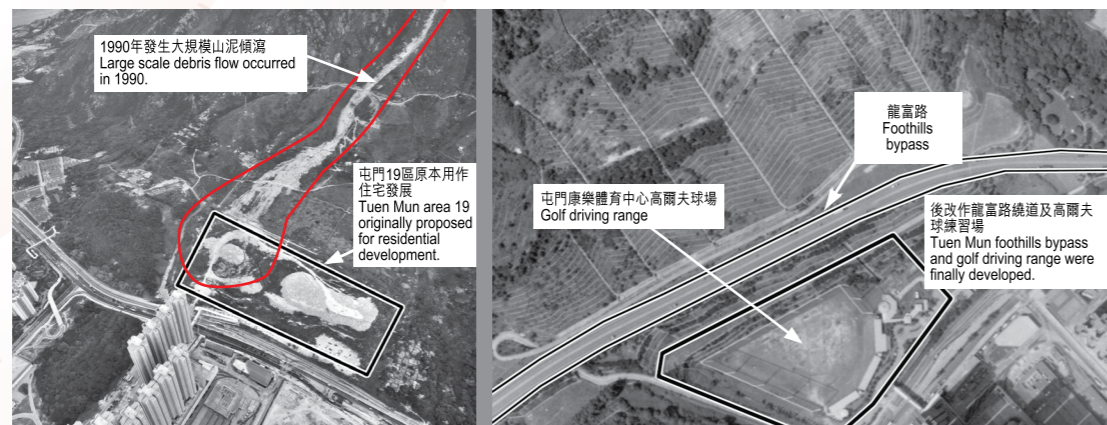


圖20. 完善土地規劃實例—屯門19區在80年代本來規劃用作住宅發展，但土力工程處認為附近山坡有潛在風險，不適合用作住宅發展用途，原建議被擱置。1990年該地段發生大規模山泥傾瀉。其後，該地區只用作興建龍富路及高爾夫球練習場等較為低風險的發展。
Figure 20. Example of effective planning in land use - Tuen Mun area 19 was originally proposed for residential development in 1980s. However, GEO advised that the area was not suitable for the development due to unstable hillsides nearby and the proposal was subsequently dropped. Large scale debris flow occurred in 1990 and area 19 was affected. Later, low risk-to-life facilities such as foothills bypass and golf driving range were built in this area.

潛在天然災害最有成本效益的方法。圖20所示便是一個真實的案例。

鞏固及維修政府斜坡 (參閱KRA 3及4)

對於在1977年土力工程處成立前建成的39,000幅斜坡，政府已推行防止山泥傾瀉計劃，以便有系統地鞏固未符合標準的政府斜坡(圖21)。在這項計劃之中，政府根據風險排列系統排列的優先次序選出未符合標準的斜坡進行鞏固工程，用成本效益最高的方法減低山泥傾瀉的風險。圖22及23顯示已鞏固的政府斜坡數目及防止山泥傾瀉計劃的開支。

Some salient details of Figure 17 are discussed below:

Check New Slopes and Plan Land Use (see KRA 2)

Regulatory control over geotechnical works of both private and public developments in Hong Kong is exercised by the GEO through the statutory authority of the Buildings Department and the Government's administrative framework respectively. The objective is to ensure public safety.

The legal basis for geotechnical control of private developments is the Buildings Ordinance, Chapter 123, Laws of Hong Kong (with 3 related Regulations). The key parties involved are shown in Figure 19.

Geotechnical advices are given to various government departments at the early planning stages regarding the future land use. This is a highly cost-effective way in reducing potential natural hazards. A real case example is given in Figure 20.

Upgrade and Maintain Government Slopes (see KRA 3 & 4)

For the 39,000 slopes formed before the set up of GEO in 1977, the Government has implemented an ongoing Landslip Preventive Measures (LPM) Programme to systematically upgrade those government man-made slopes which are found to be substandard (Figure 21). A risk-based priority classification system was developed for the systematic selection of substandard slopes for upgrading such that landslide risk could be reduced in the most cost-effective way. The number of government slopes upgraded and cost spent under LPM Programme are shown in Figures 22 and 23.



圖21. 在政府斜坡上進行防止山泥傾瀉工程。
Figure 21. Landslip preventive works on a government slope.

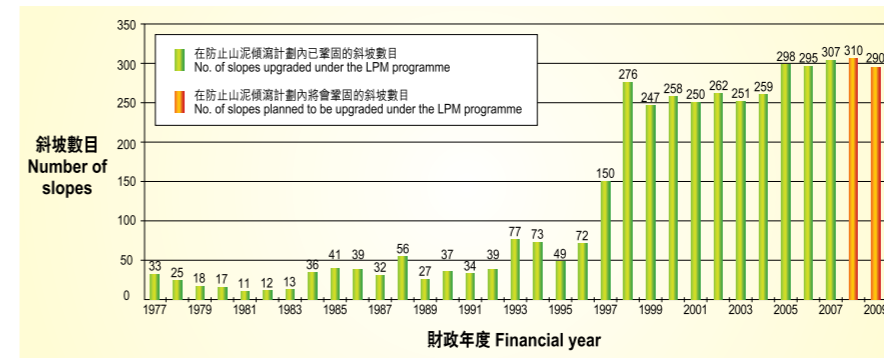


圖22. 在防止山泥傾瀉計劃下已鞏固/將會鞏固的政府斜坡。
Figure 22. No. of government slopes upgraded / planned to be upgraded under the LPM programme.

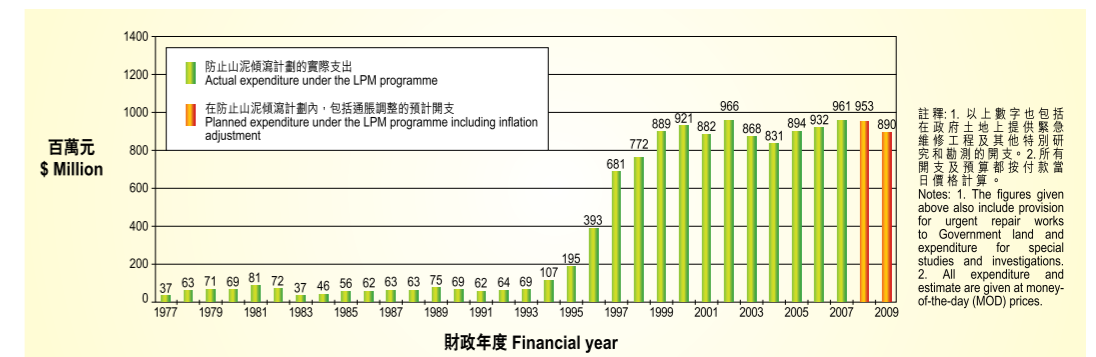


圖23. 防止山泥傾瀉計劃的開支(由1977-1978至2009-2010)。
Figure 23. Annual LPM expenditure / estimate (From 1977-1978 to 2009-2010).

人造斜坡需定時維修，缺乏維修是本港許多山泥傾瀉事故的主要成因。政府七個負責斜坡維修的部門(圖24)有系統地按照規定的維修計劃，對所有政府人造斜坡進行所需的維修工作。政府每年在斜坡維修上的支出約為六億元。

推動維修私人斜坡 (參閱KRA 5)

如上所述，任何斜坡需定時維修。在香港的氣候環境下，一個缺乏保養的斜坡，狀況會日漸變壞，甚至會變得不穩或倒塌，因而造成人命傷亡，財物損失及干擾日常生活。若發生這類意外，市民會蒙受損害，業主亦可能需要支付大筆費用來修葺斜坡，使它符合安全。

土力工程處向公眾(尤其是斜坡業主)提供公眾教育及資訊服務，指引他們如何維修人造斜坡(圖25)及按照香港法例第344章《建築物管理條例》之《大廈管理及維修工作守則》履行其斜坡維修責任。

若有任何現存的私人斜坡被認為有危險或有潛在危險，建築事務監督會發出危險斜坡修葺令，業主便有法律責任去勘察和施行必需的斜坡工程，以改善情況。

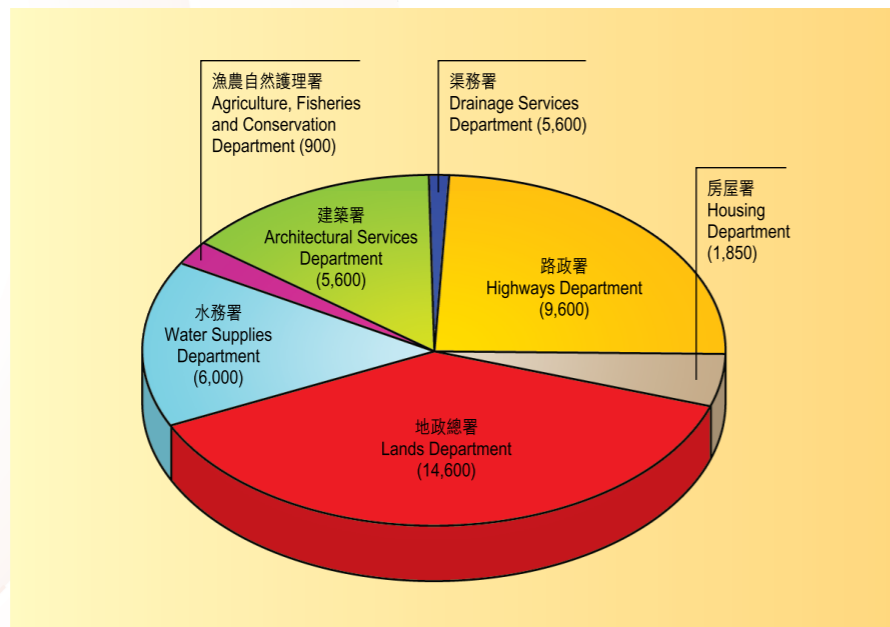


圖24. 由各部門維修的政府斜坡數目。
Figure 24. Number of government slopes maintained by departments.

Man-made slopes need regular maintenance, and lack of slope maintenance has been a major contributory factor to many of Hong Kong's landslides in the past. The Government systematically maintains all its slopes through the slope maintenance programmes of 7 departments (Figure 24). The annual expenditure on slope maintenance is around 600 millions.

Promote Private Slope Maintenance (see KRA 5)

As discussed above, regular maintenance is essential for all slopes to avoid deterioration. Under the Hong Kong climatic conditions, if slopes are not properly maintained, in time it may become unstable and collapse, causing injury to persons, damage to property and disruption to normal life. If this happens, suffering and hardship may result and great expense may be incurred in reinstating the ground and making it safe.

Public education and guidance information are provided to general public, especially slope owners, telling them how to maintain man-made slopes (Figure 25). Through public education, private slope owners are also informed to discharge their slope maintenance duties as imposed under the Code of Practice on Building Management and Maintenance produced in accordance with the Building Management Ordinance, Chapter 344, Laws of Hong Kong.

If any existing private slope is considered to be dangerous or liable to become dangerous, the Building Authority will serve a Dangerous Hillside Order on its owners. The owners will then have the legal obligation to investigate the slope and propose any remedial works as necessary.



圖25. 土力工程處製備有關斜坡維修的公眾教育刊物及資訊。
Figure 25. Public education and guidance information on slope maintenance prepared by GEO.

清拆山邊寮屋

「寮屋居民」是指房屋署在一九八二年所登記居住在暫准寮屋的居民(圖26)。政府的政策是透過推行寮屋區安全清拆計劃，而不在只影響寮屋安全的山坡上進行防止山泥傾瀉工程，致力減低山泥傾瀉對寮屋居民的威脅。這是因為若要進行這些工程，必須先拆卸寮屋，以騰出通道和工作場地(圖27)。此外，由於寮屋靠近山坡，施工安全難以保證，將來的斜坡維修亦構成問題。因此，清拆受威脅的寮屋，並為受影響的寮屋居民提供安置，是保障他們免受山泥傾瀉威脅的最佳良策。清拆這些寮屋亦可減少寮屋區的其他問題(圖28)。

截至一九九二年，共有64,200名寮屋居民因斜坡安全理由而按提出的清拆建議獲安排搬遷，其中不少寮屋清拆後騰出用地作房屋發展用途。該64,200名寮屋居民中，58,000人來自港島及九龍市區。自一九九二年以來，政府以斜坡安全理由，建議遷置約21,000名寮屋居民；截至二零零五年十二月，其中約10,100人選擇留居原處。

當山泥傾瀉警報發出後，民政事務處便會開放臨時庇護站，收容有需要的寮屋居民或公眾人士(圖29)。此外，每年的雨季初，民政事務處會在寮屋區派發土力工程處印製的單張，通知居民採取預防措施。這些單張載有斜坡安全指引，並呼籲寮屋居民在有山泥傾瀉風險時立刻撤離居所，前往臨時庇護站。



圖26. 山邊寮屋。
Figure 26. Squatters on hilly terrain.



圖27. 用一般工程方法不能有效處理寮屋斜坡問題。
Figure 27. Engineering works approach is normally not an effective way to deal with slopes with squatters.

Clear Squatters on Hilly Terrain

'Squatters' are those persons who live in tolerated squatter structures surveyed by Housing Department in 1982 (Figure 26). It is Government policy to reduce the landslide hazards to squatters through clearance of the concerned squatter structures and not through carrying out of landslip preventive works on slopes affecting only such structures. This is because such works often cannot be carried out without first demolishing the structures, in order to provide road access and working space (Figure 27). Due to the close proximity of squatter structures to the slopes, there are problems associated with construction safety and subsequent maintenance of the slopes. Therefore, clearance of the concerned squatter structures and offer of rehousing to the occupants at risk is the best solution to safeguard them from the landslide hazards. The clearance of these structures also reduces other problems associated with squatter areas (Figure 28).

By 1992, 64,200 squatters who were recommended to be cleared on slope safety grounds were cleared, many of which were cleared to release land for housing developments. Of these 64,200 squatters, 58,000 were from the Hong Kong and Kowloon urban areas. Since 1992, about 21,000 squatters were recommended to be cleared on slope safety grounds. However, about 10,100 squatters have chosen to stay put as of December 2005.

When the Landslip Warning is issued, temporary shelters are provided by the District Offices to accommodate squatters or any members of the public in need (Figure 29). Additionally, the District Officers have been distributing warning leaflets,

produced by GEO, in squatter areas at the start of the wet season every year. These leaflets contain guidance on slope safety and urge squatters to evacuate immediately and seek temporary shelter at times when landslide risk is of concern.



圖28. 寮屋清拆實例。
Figure 28. Example of squatters clearance.



圖29. 山邊寮屋附近放置警告牌勸喻寮屋居民在山泥傾瀉警報發出後或大雨期間應該採取的預防措施。
Figure 29. Warning signal is erected in squatter areas on hilly terrain to advise people the precautionary measures to be observed when landslide warning signal is in force or during heavy rain.

公眾教育及資訊服務 (參閱KRA 6)

單靠政府的努力並未能解決所有的斜坡安全問題，因為在57,000幅人造斜坡中，約有三分之一屬私人擁有，因此，社區的參與是不可或缺的。土力工程處不斷進行有關斜坡安全的宣傳及公眾教育活動，致力減低山泥傾瀉風險。圖30便是一些公眾教育的宣傳活動。

公眾教育對加強本港的斜坡安全發揮著兩大功能：

- ▶ 透過提醒業主定期維修斜坡，減低發生山泥傾瀉的機會；
- ▶ 藉著宣傳在暴雨期間應採取的個人預防措施，減少山泥傾瀉帶來的後果。

在大學及研究組織的協助下，土力工程處每年進行公眾意見調查，用以評估效果及制定策略。截至2008年的調查結果如圖31所示。



圖30. 各類公眾教育的宣傳活動。
Figure 30. Various kinds of promotion activities for public education.

Public Education and Public Information (see KRA 6)

Government alone cannot solve the whole slope safety problem as about one third of the 57,000 sizeable man-made slopes are of private responsibility. Therefore, community involvement is essential. The GEO undertakes ongoing public education on slope safety to reduce the landslide risk in Hong Kong. Some public education activities are shown in Figure 30.

Public education plays two key roles in enhancing slope safety:

- ▶ To reduce the probability of landslides by reminding the owners to maintain their slopes regularly;
- ▶ To reduce the consequences of landslides by promoting personal precautionary measures during heavy rain.

With the assistance of the universities and research organizations, the GEO has been conducting annual public opinion surveys to gauge the effectiveness of the campaign and to formulate appropriate strategies. The survey results up to 2008 are shown in Figure 31.

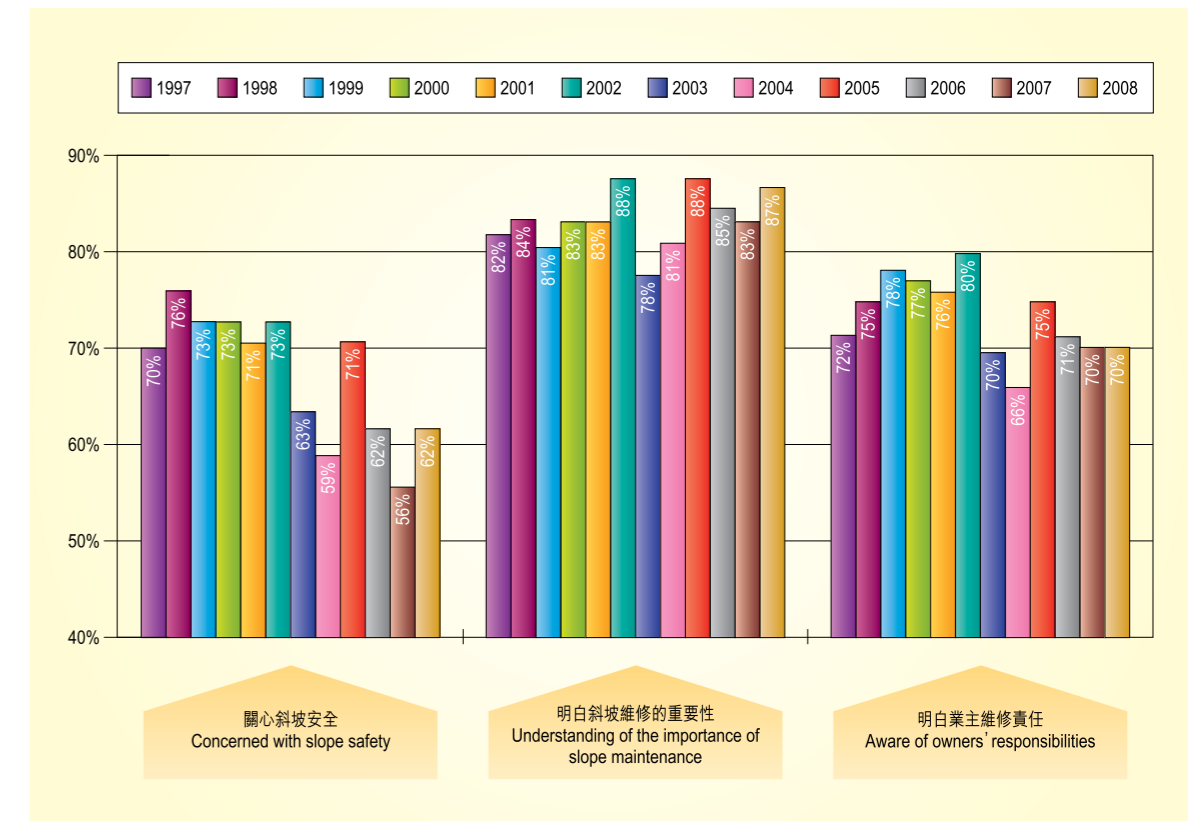


圖31. 公眾對香港山泥傾瀉風險的認知。
Figure 31. Public awareness of landslide risk in HK.

除了宣傳活動，土力工程處亦主動為業主提供各種協助及諮詢服務，以幫助他們履行其斜坡維修責任。土力工程處已建立一個電腦化的《斜坡資訊系統》，儲存在《斜坡紀錄冊》內，包括本港57,000幅人造斜坡的資料，以幫助斜坡業主維修其負責的斜坡(圖32)。這個系統已上載至香港斜坡安全網頁(<http://hkss.cedd.gov.hk>)，方便市民免費查閱資料。

除了涉及斜坡的實質資料之外，有關個別斜坡的維修責任資料，對於迅速執行所需的維修及修復工程亦十分重要。斜坡維修責任的資料已上載於地政總署的「斜坡維修責任信息系統」網頁(<http://www.slope.landsd.gov.hk/smr/s/>)。

土力工程處亦已設立社區諮詢服務組，就如何進行所需的斜坡鞏固和維修工程，

主動外訪為私人斜坡業主提供服務。社區諮詢服務組的主要職責包括舉行斜坡安全講座和座談會、會見市民，以及就有關斜坡維修和《危險斜坡修葺令》的個案提供諮詢服務(圖33)。儘管山泥傾瀉風險永遠無法完全消除，政府相信透過公眾教育及諮詢服務，可令市民保持對斜坡安全的意識，亦可促使社會共同努力把這風險減至可達到的最低水平。

近年，除了改善斜坡安全，土力工程處亦提倡綠化斜坡以迎合公眾對此不斷上升的期望，即有著既安全又綠化的斜坡，以達至較佳的生活環境(圖34)。

公眾教育所需的費用遠低於工程開支，但能對減低山泥傾瀉風險有很大的幫助。

In addition to the publicity activities, the GEO also proactively provides various kinds of assistance and advisory services to help owners maintain their slopes. A computerized Slope Information System (SIS) has been set up to contain the Catalogue of Slopes, which includes useful information on all 57,000 sizeable man-made slopes in Hong Kong to facilitate owners to maintain their slopes (Figure 32). The internet version of SIS is available in the Hong Kong Slope Safety Website (<http://hkss.cedd.gov.hk>) to provide easy and free public access.

Apart from the physical information on slopes, information on the maintenance responsibility of individual slopes is also essential for prompt action for necessary maintenance/repair works. The information on maintenance responsibility can be obtained in Lands Department's Website on Slope Maintenance Responsibility Information System (<http://www.slope.landsd.gov.hk/smr/s/>) through the internet.

The GEO has also set up a Community Advisory Unit (CAU) to provide proactive outreach services to

advise private slope owners on how to proceed with the necessary slope upgrading and maintenance works. The principal functions of the CAU include slope safety talks and seminars, meet-the-public sessions and advisory services on slope maintenance and Dangerous Hillside Order cases (Figure 33). Although the landslide risk in Hong Kong can never be reduced to zero, the government is confident that through public education and advisory services, she can continue to upkeep public awareness of slope safety and the concerted efforts of the whole community to help reduce the risk to as low as practically achievable.

In addition to enhancement of slope safety, the GEO has also been promoting slope greening in recent years to meet the ever-rising public expectation for a better living environment with "safe and green" slopes (Figure 34).

Public education, which is far less expensive than engineering works, has greatly helped to combat the landslide threat in Hong Kong.



圖32. 香港斜坡安全網頁。
Figure 32. Hong Kong Slope Safety Website.



圖33. 土力工程處社區諮詢服務組的一些工作實例。
Figure 33. Some examples showing the duties of the GEO's Community Advisory Unit.



圖34. 綠化斜坡的宣傳教育。
Figure 34. Promotion on slope greening.

長遠防治山泥傾瀉計劃

政府各有關方面在過去三十年群策群力，大幅改善了斜坡安全，近年因山泥傾瀉而死亡的人數亦顯著減少(圖8)。現階段的「防止山泥傾瀉計劃」將於二零一零年完成，屆時將有合共約7,000幅人造斜坡在該計劃下完成鞏固工程，而人造斜坡的整體山泥傾瀉風險將會大幅減至低於一九七七年的25%，達到合理的低水平，並符合國際認可的最佳風險管理水平(圖35)。

不過，「防止山泥傾瀉計劃」在二零一零年完成後，餘下的山泥傾瀉風險仍對社會構成潛在危險。這些餘下的山泥傾瀉風險，主要

來自約15,000幅影響已發展區的中等風險人造斜坡，以及約2,700幅已知有潛在危險，而且接近現有建築物和重要交通走廊的天然山坡。由於斜坡的狀態會日漸衰敗，加上越來越多都市發展或重建均靠近陡峭的山坡，如果我們不繼續在斜坡安全方面投放資源，山泥傾瀉的風險便會逐漸增加。這情況除了對人命構成威脅外，亦可能因堵塞道路或引致居民須撤離樓宇而帶來重大的經濟損失和干擾社會秩序，因而危害公眾安全，損及可持續發展的能力，以及影響香港作為一個現代化都會和旅遊樞紐的聲譽(圖36)。

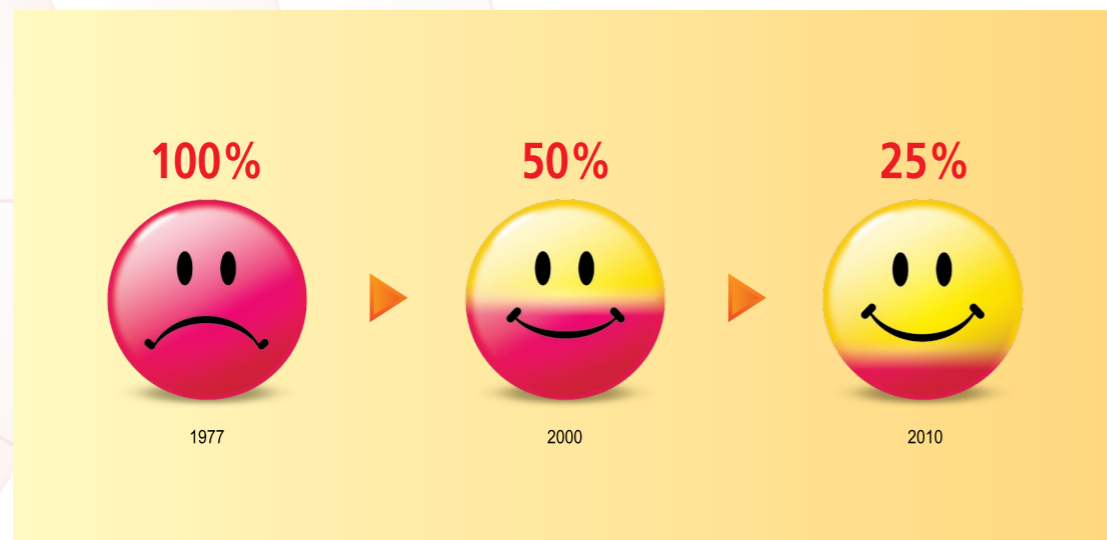


圖35. 政府在減低舊人造斜坡的山泥傾瀉風險之目標。
Figure 35. The government's target on the reduction of landslide risk for old man-made slopes.

The Landslip Prevention and Mitigation Programme (LPMitP)

Government's concerted effort in the past 30 years has brought about substantial improvement in slope safety and a significant reduction in the number of landslide fatalities in recent years (Figure 8). When the current phase of the LPM Programme is completed in 2010, a total of about 7,000 man-made slopes will have been upgraded and the overall landslide risk from man-made slopes will be substantially reduced to less than 25% of that existed in 1977, reaching a reasonably low level that is commensurate with the international best practice in risk management (Figure 35).

However, after 2010, there are still remaining landslide risks that pose a hazard to the community. The majority of the remaining landslide risk comes from about 15,000 moderate-risk man-made slopes affecting development and about 2,700 natural hillside catchments with known hazards and close to existing buildings and important transport corridors. If investment in slope safety were not maintained, landslide risk would progressively increase with time due to slope degradation and encroachment of more urban development or redevelopment on steep hillsides. This will cause, in addition to risk to life, significant economic losses and social disruption as a result of road blockages and building evacuation due to landslides, thereby compromising public safety, sustainable development and Hong Kong's reputation as a modern metropolitan city and tourist hub (Figure 36).



圖36. 斜坡安全所面對的長遠挑戰。
Figure 36. Long-term slope safety challenges.

二零一零年後的「長遠防治山泥傾瀉計劃」目標是把香港山泥傾瀉的風險長遠控制在「合理可行的低限度」水平(圖37)。

天然山坡與人造斜坡不同，在天然山坡進行大規模的斜坡鞏固工程，往往不切實際而且費用高昂，並有礙環保。取而代之，我們可以採取風險緩減措施(例如外國常用的泥石欄和防護屏障)(圖38)，以較具成本效益的方法，緩減天然山坡的山泥傾瀉風險。我們會使用一套風險評級系統，選出最值得處理並已知有潛在危險的天然山坡，以便採取行動。

「防治計劃」的每年開支預計最少為6億元，包括處理不合標準人造斜坡約3億元，以及處理已知有潛在危險的天然山坡約3億元。

結語

政府各有關方面，聯同業界及私人斜坡業主在過去三十年群策群力，把人造斜坡的整體山泥傾瀉風險大幅降低。香港亦擁有一個有效的斜坡安全系統以處理山泥傾瀉問題，使香港的山泥傾瀉規模和嚴重性得以大大減低。而隨著更多新發展項目在陡峭的天然山坡或其附近範圍內開展，政府將會投放更多資源以應付天然斜坡山泥傾瀉風險的上升。此外，政府亦率先於人造斜坡進行景觀處理及生物工程的研究和應用，並已開始把應用伸延至修復天然山坡的山泥傾瀉痕跡。政府、專業人員及大眾須繼續通力合作以減低山泥傾瀉的風險，進一步改善生活環境，使香港成為既安全又綠化的理想居住地方。

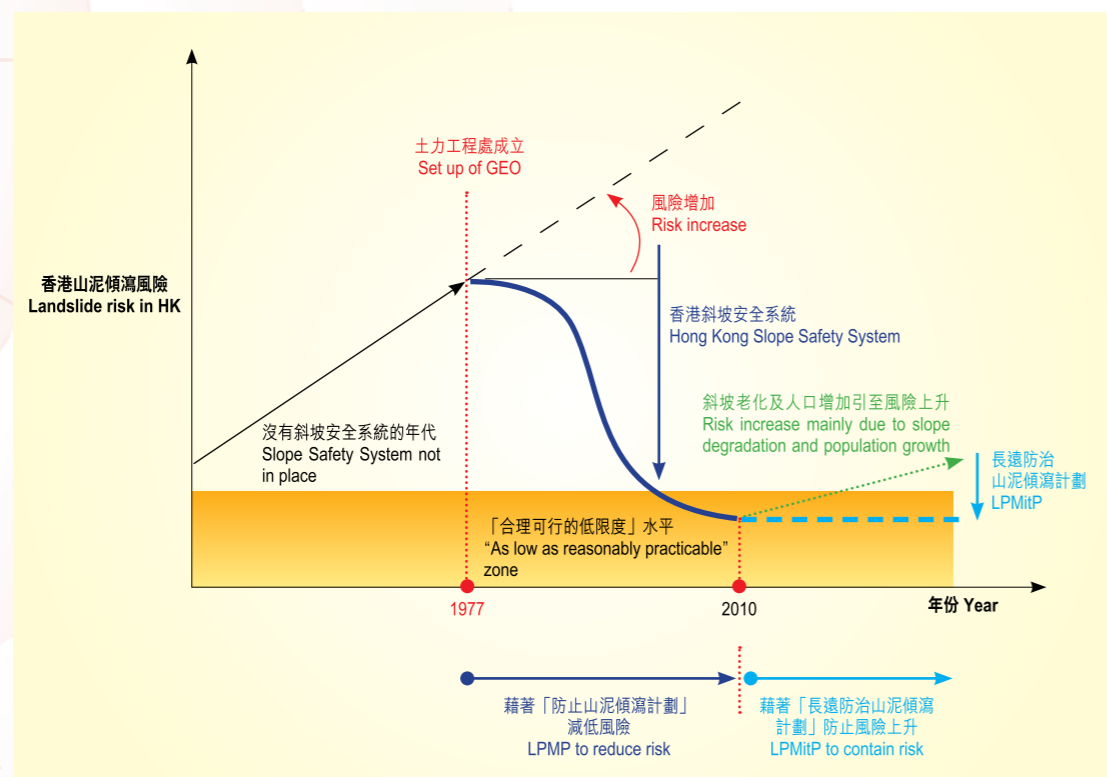


圖37. 風險趨勢。
Figure 37. Trend of risk.



圖38. 一些防治天然山坡山泥傾瀉的風險緩減措施例子。
Figure 38. Some examples of natural terrain landslide mitigation measures.

The objective of the LPMitP is to contain the landslide risks in Hong Kong within a reasonably low level in the long term (Figure 37).

Unlike man-made slopes, it is often impractical, costly and environmentally undesirable to carry out extensive slope stabilization works on natural hillsides. Instead, natural terrain landslide risk can be mitigated in a more cost effective manner through mitigation measures such as the debris traps and barriers, which are commonly adopted in other countries (Figure 38). A risk-based priority ranking system will be used to select the most deserving natural hillside catchments with known hazards for action.

The anticipated annual expenditure required for the LPMitP is at least \$600 million, comprising some \$300 million for dealing with substandard man-made slopes and some \$300 million for dealing with vulnerable natural hillside catchments.

Conclusions

The overall landslide risk from old substandard man-made slopes has been reduced significantly in the past three decades through the concerted effort of the Government, the geotechnical profession and the private slope owners. A comprehensive Slope Safety System is in place to deal with the landslide problems. The scale and severity of the landslide problems in Hong Kong have been much reduced. Rising landslide risk from natural hillsides deserves increasing attention as more developments encroach closer to steep hillsides. The Government has also taken the lead in pioneering research and application of landscape treatment and bio-engineering in man-made slopes, and has started to extend its application to repair natural terrain landslide scars. Continuing joint efforts by the Government, the profession and the public need to be maintained so as to reduce the landslide risk, and to further enhance our surrounding environment – to make Hong Kong a safe and green place to live.

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香港九龍公主道一零一號
土木工程拓展署大樓
土木工程拓展署 土力工程處

網址：<http://www.cedd.gov.hk>
香港斜坡安全網頁：<http://hkss.cedd.gov.hk>

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Geotechnical Engineering Office, Civil Engineering and Development Department,
Civil Engineering and Development Building, 101 Princess Margaret Road,
Homantin, Kowloon, Hong Kong

Internet homepage : <http://www.cedd.gov.hk>
Hong Kong Slope Safety Website : <http://hkss.cedd.gov.hk>

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