Session 7
Global Approach to Slope Safety in Hong Kong (Part 2)

[3:30 – 5:00 pm, 19 February 2009]

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Geotechnical Engineering Office

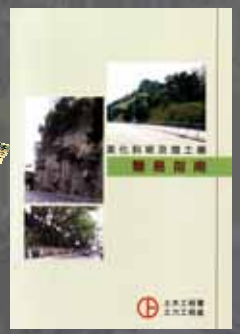
Enhancing Appearance of Private Slopes

Layman's Guide to Landscape Treatment of Man-made Slopes and Retaining Walls

- **Published in July 2002**
- **For use of the general public**
- **Distributed to District Offices and Building Management Resources Centres**
- **Slope Landscaping Kit containing the booklet, a poster and other related materials to be distributed to Owners' Corporations, Mutual Aid Committees and Property Management Companies**
- **Press briefing**
- **Roving exhibitions**

Poster

Bookmarks



Layman's Guide

Information Sheets

Assistance to Private Slope Owners

- **Community Advisory Unit, GEO provide general advice and reference information on slope appearance enhancement to :**
  - private slope owners who received DHOs on slope upgrading works
  - Owners' Corporations and Mutual Aid Committees on slope maintenance works

Best Landscaped Slope Awards – 2003-04

Best Landscaped Slope Awards – 2003-04

- Encourage private owners by commending the good performers in landscaping slopes.
- 55 entries involving 90 private and government slopes - response overwhelming

Best Landscaped Slope Awards – 2003-04

Award Presentation ceremony was officiated by the Secretary for the Environment, Transport and Works

Best Landscaped Slope Awards

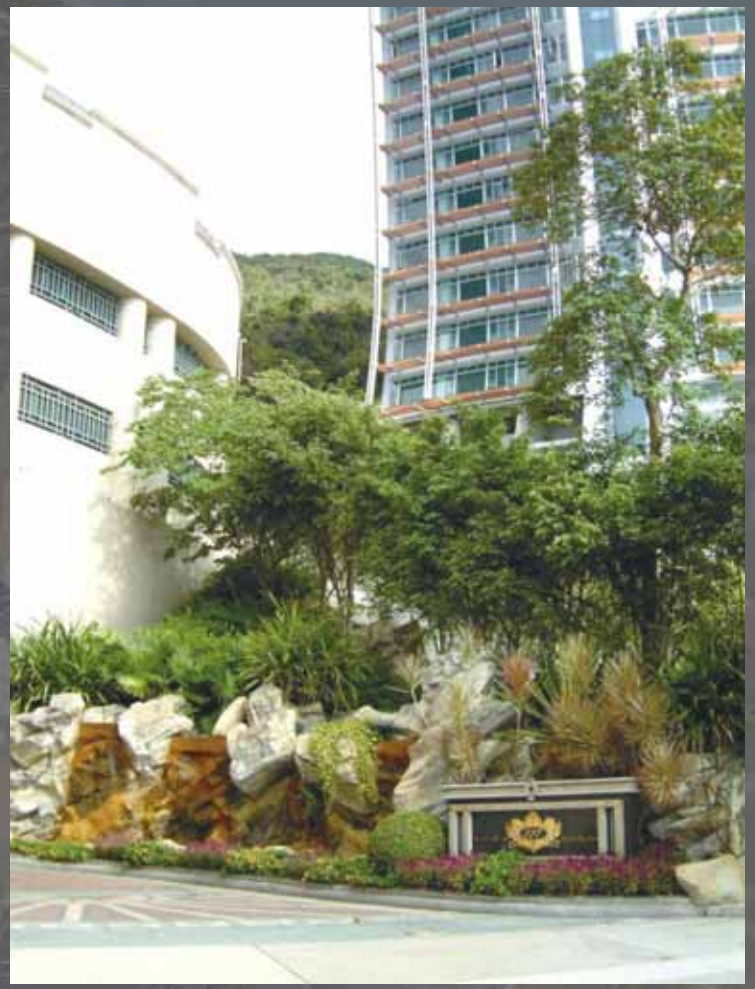
Best Landscaped Slope Awards – 2003-04

Champion Slope at Lung Tak Court, Stanley

1st Runner-up Slope at Sau Mau Ping

Best Landscaped Slope Awards – 2003-04

2nd Runner-up Slope at Hong Kong International School



2nd Runner-up Slope at Repulse Bay Road

Soft Landscape Works

Long-term targets of slope greening

- **To establish robust, cost-effective and eco-friendly vegetation covers on man-made slopes with minimal long-term maintenance requirements.**
- **To meet erosion control, aesthetic, economic and ecological requirements.**

Points to Note

- A comprehensive Slope Safety System is in place to deal with the landslide problems.
- The overall landslide risk from old substandard man-made slopes to the community has been reduced significantly in the last 28 years.
- The scale and severity of the landslide problems in Hong Kong have been much decreased.

Points to Note

- Rapid advancement in geotechnical and information technology will continue and that open up more opportunity for its application in geotechnical engineering.
- Rising landslide risk from natural hillsides deserves increasing attention.
- The aesthetics of slopes are being enhanced.

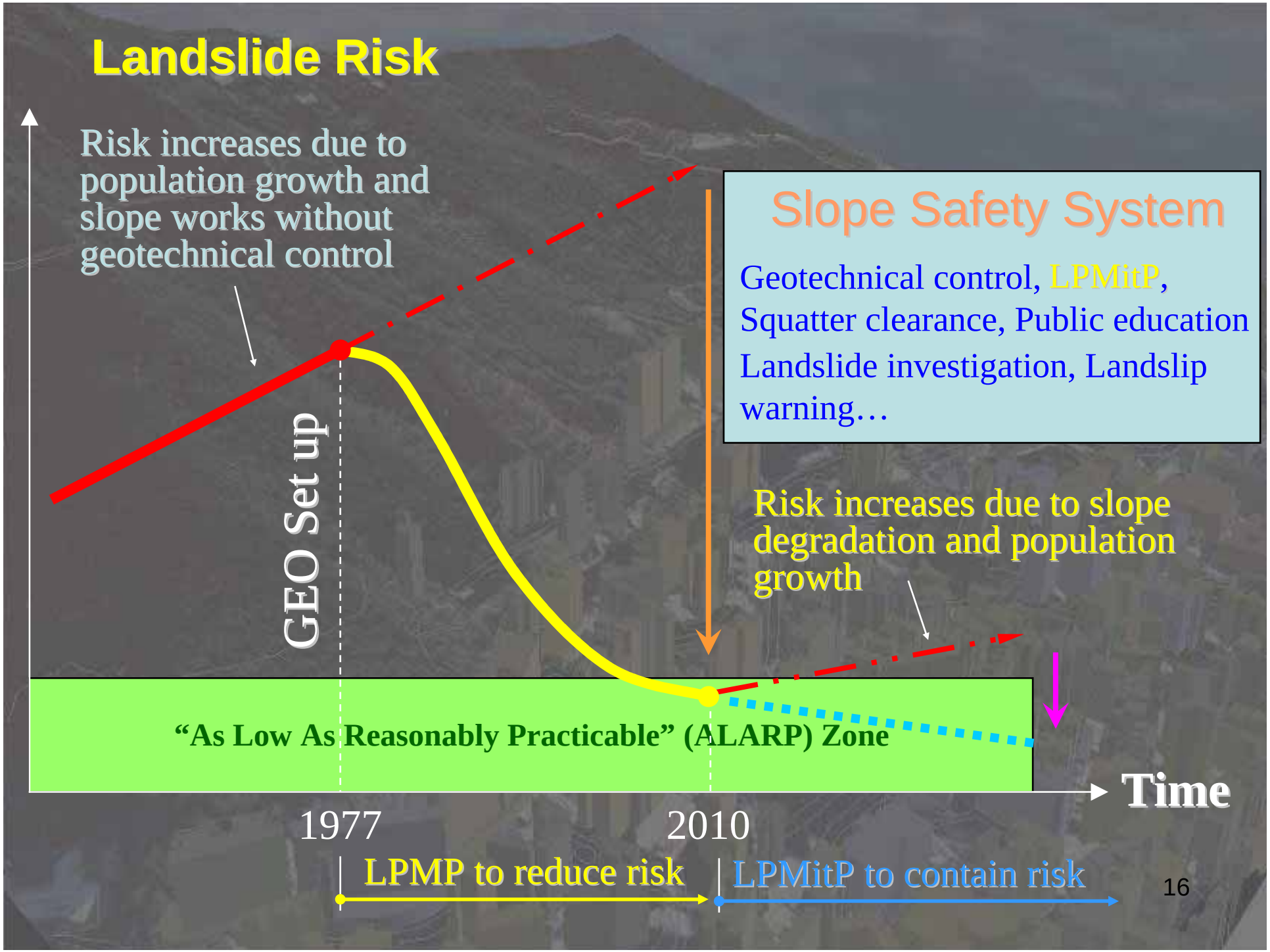
Points to Note

- Integration of slope upgrading works and provision of landscape treatment and bio-engineering at the design and construction stage.
- The Government has taken the lead in pioneering research and application of landscape treatment and bio-engineering on man-made slopes.
- Extension of implementing bio-engineering measures on natural terrain landslide scars

Points to Note

- There is still more room for improvement.
- We had several relatively dry years and there were no significant landslides before 2008.
- It is hard to maintain public awareness of landslide risk at time of relatively calm period.
- Do not be complacent on landslide risk.
- The Government, profession and the public need to be alert and continue to be vigilant.


Questions?

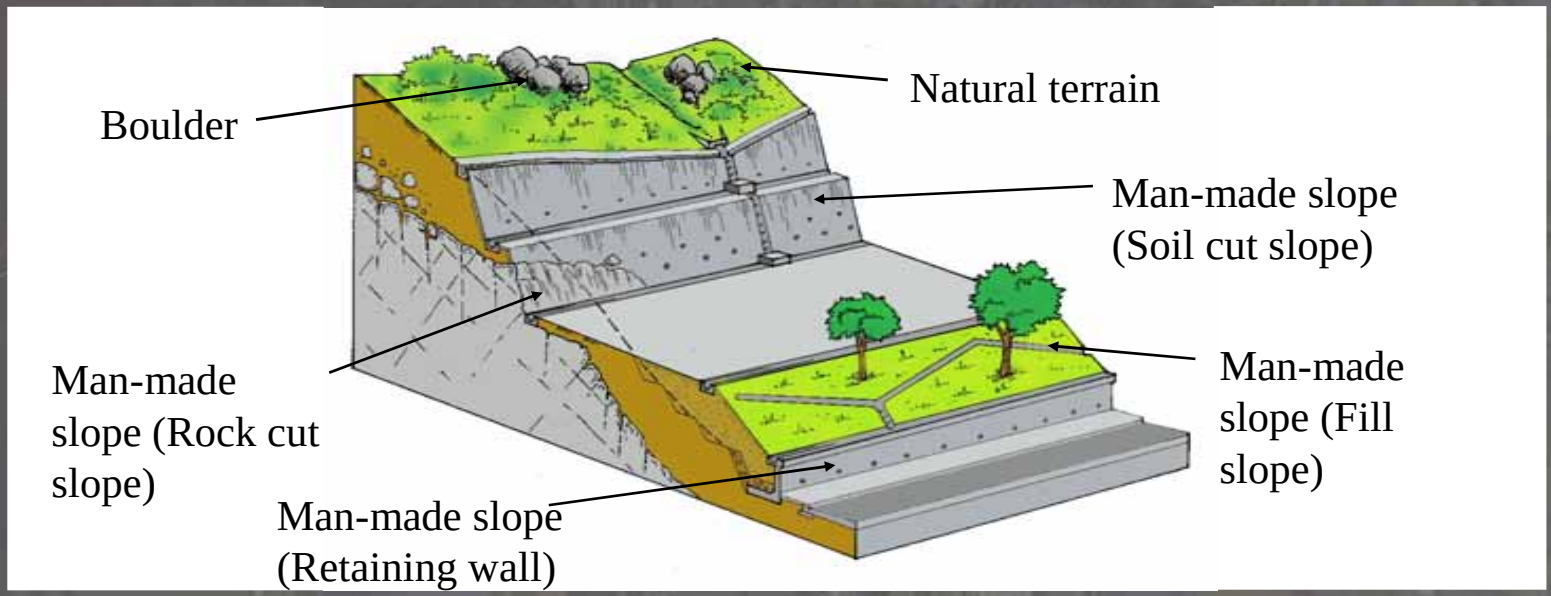

Landslide Risk
Risk increases due to population growth and slope works without geotechnical control
GEO Set up
Slope Safety System
Geotechnical control, LPMitP, Squatter clearance, Public education
Landslide investigation, Landslip warning…
Risk increases due to slope degradation and population growth
"As Low As Reasonably Practicable" (ALARP) Zone
Time
1977
2010
LPMP to reduce risk
LPMitP to contain risk

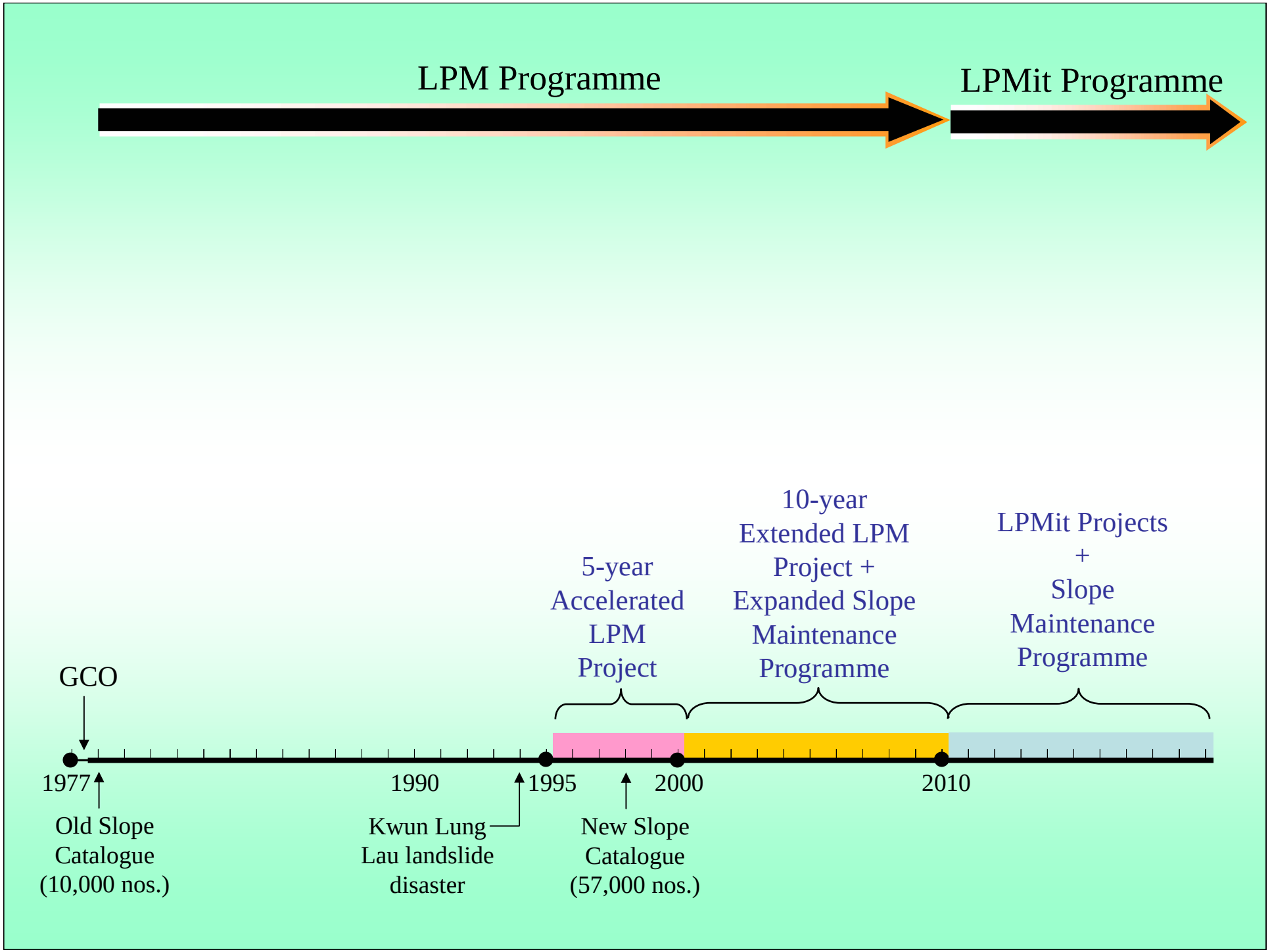
Post-2010 Landslip Prevention and Mitigation Programme (LPMitP)

Long-term strategy

…to contain risk through:

- **rolling enhancement of man-made slope**
- **systematic mitigation of natural terrain landslide risk**




LPM Programme
LPMit Programme
5-year Accelerated LPM Project
10-year Extended LPM Project + Expanded Slope Maintenance Programme
LPMit Projects + Slope Maintenance Programme
GCO
1977
1990
1995
2000
2010
Old Slope Catalogue (10,000 nos.)
Kwun Lung Lau landslide disaster
New Slope Catalogue (57,000 nos.)

Current Committed Programme

In 1998, pledged to ExCo/LegCo to deal with all old (pre-1977), high-priority man-made slopes (i.e. high risk slopes affecting major roads and developments) between 2000 and 2010 via :

(a) *10-year Extended LPM Project* under LPM Programme

(b) integrated action under development projects

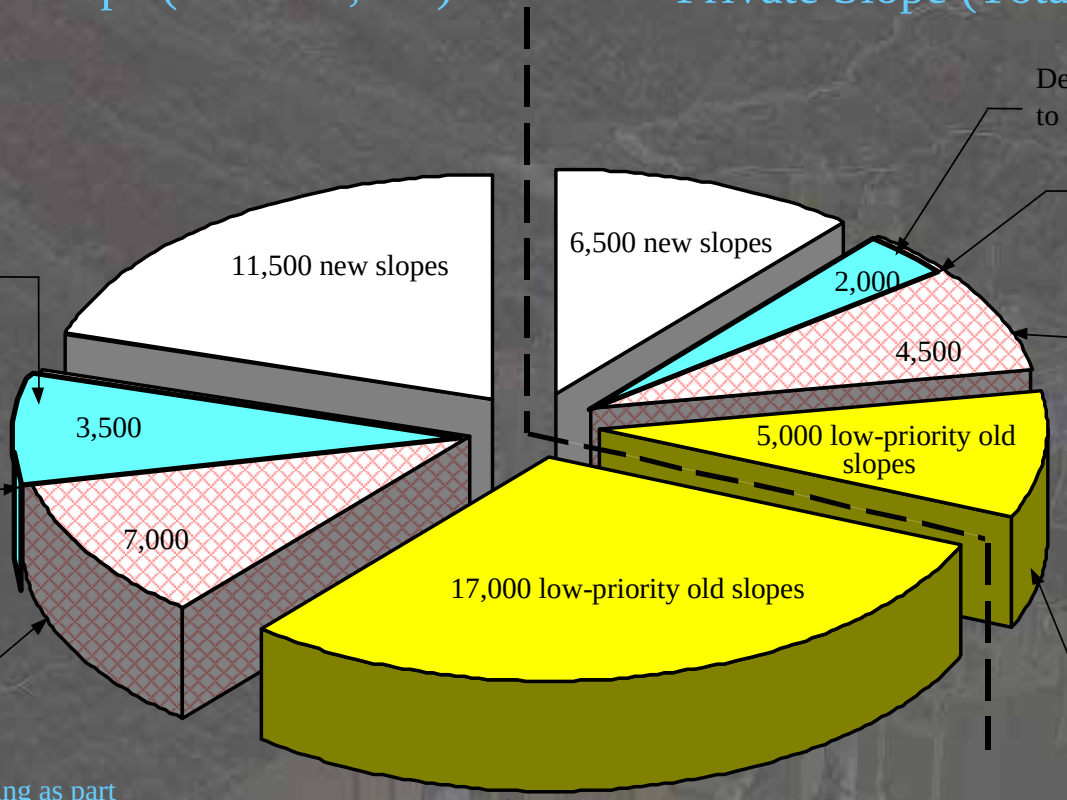
(c) enhanced maintenance programme (EMP)

(d) non-development clearance (NDC) of vulnerable squatters

CLASSIFICATION OF REGISTERED SLOPES

Government Slope (Total 39,000)

Private Slope (Total 18,000)



From year 2000 to 2010 :

- Safety screening (if necessary by service of Dangerous Hillside Order)
- Upgrading as part of redevelopment

From year 2000 to 2010 :

- Upgrading under the LPM Programme
- Squatter clearance, upgrading as part of redevelopment and enhanced maintenance

Maintenance and upgrading as part of redevelopment

Enhanced maintenance and upgrading as part of redevelopment

Notes : (1) All slopes require maintenance
(2) New Slope : slope formed after establishment of GEO in 1977
(3) Old Slope : slope formed before establishment of GEO in 1977

Scope of 10-year Extended LPM Project 2000 – 2010

Government Man-made Slopes
- detailed study and upgrading works where found necessary

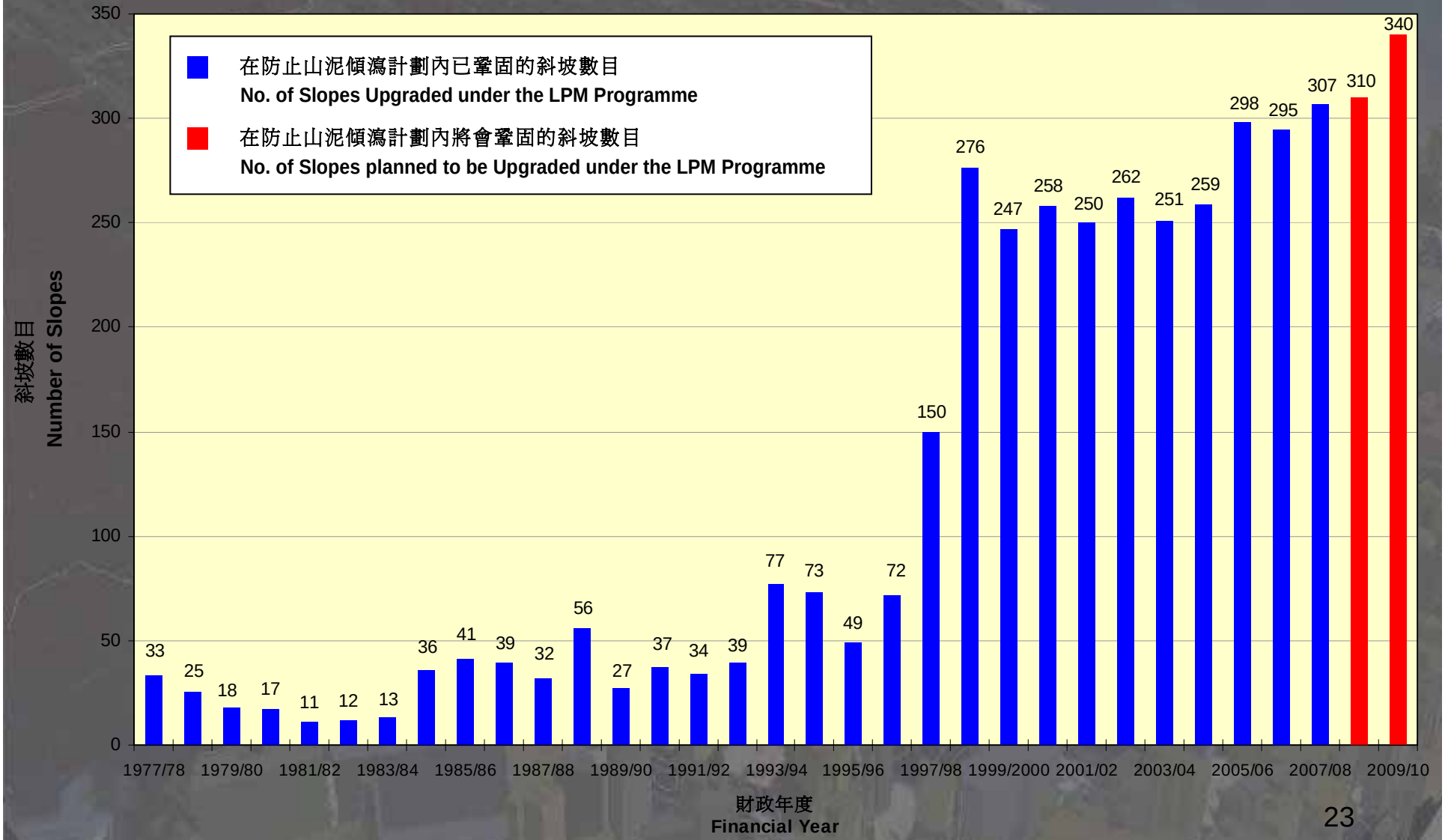
Private Man-made Slopes
- detailed study (safety-screening); and enforcement of Dangerous Hillside Orders under the Buildings Ordinance where found necessary

Landslip Investigation

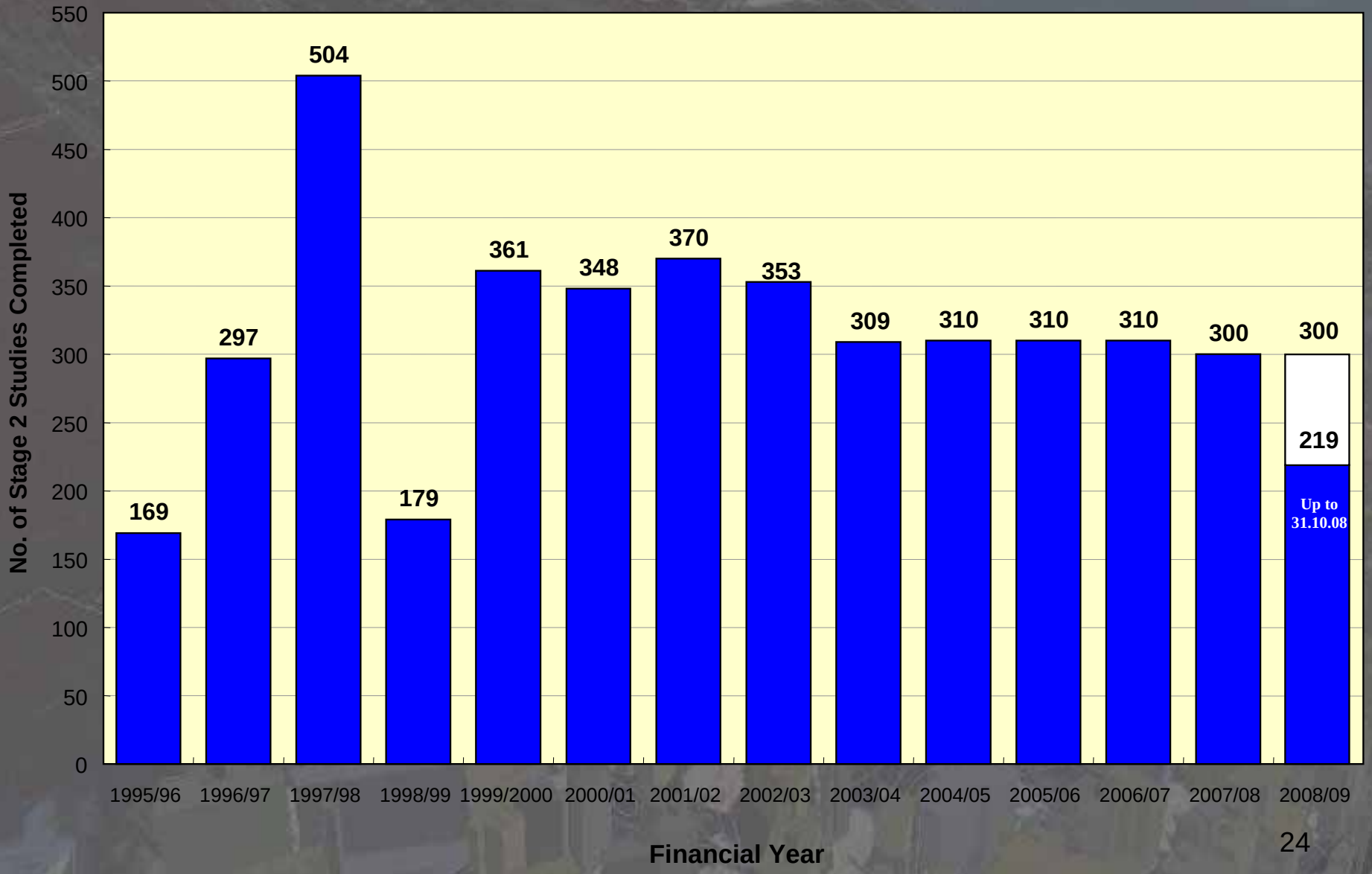
On-going LPM Targets
2000 - 2010

- To upgrade 250 Government man-made slopes per year
- To complete safety-screening studies of 300 private man-made slopes per year
- To landscape every slope upgraded under the LPM Programme
- To reduce the overall landslip risk arising from old substandard man-made slopes by 2010, to less than 25% of the level in 1977

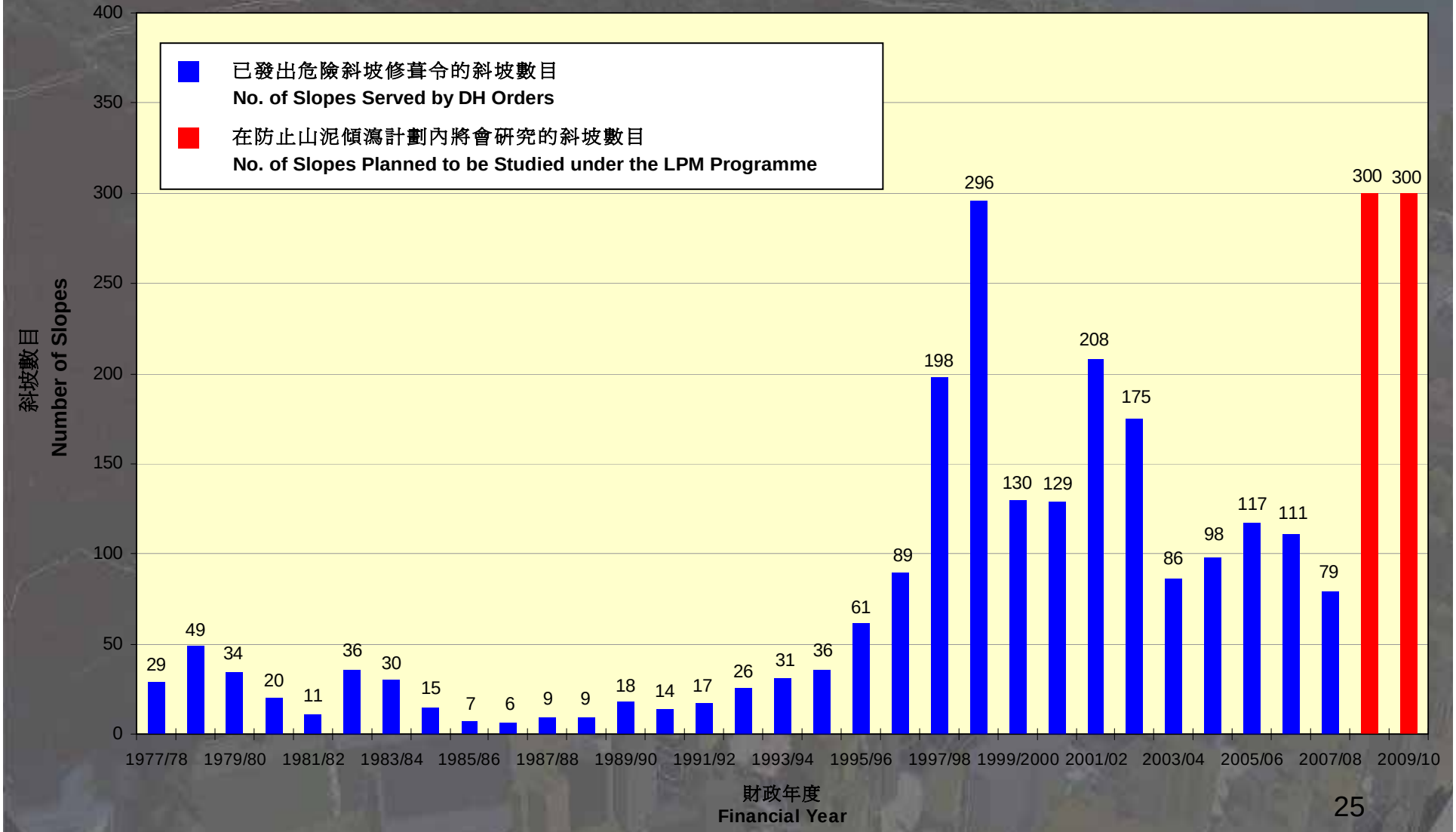
在防止山泥傾瀉計劃下已鞏固 / 將會鞏固的政府斜坡
No. of Government Slopes Upgraded / Planned to be Upgraded under the LPM Programme



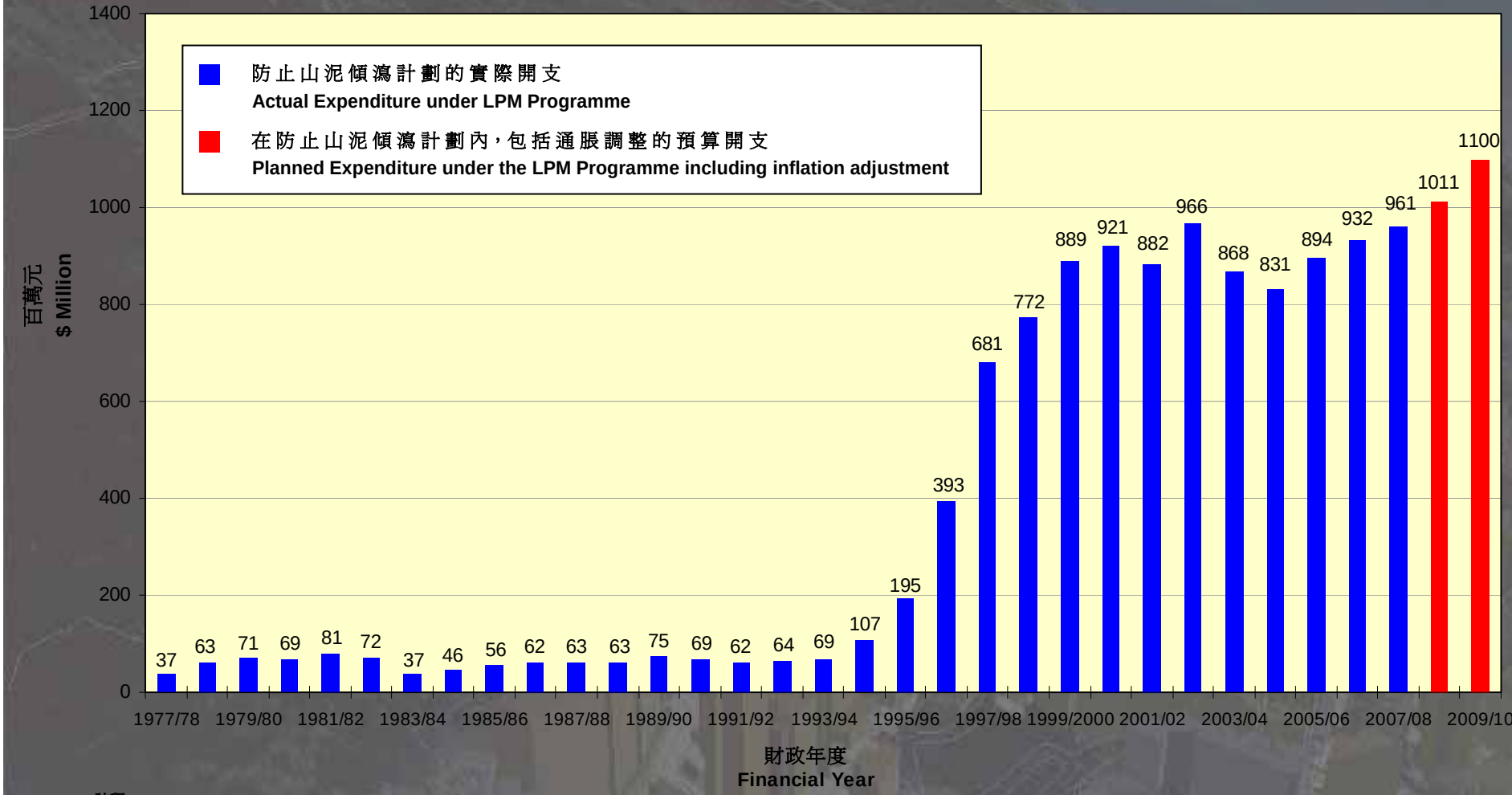
Number of Stage 2 Studies Completed from 1995/1996 to 2008/2009



屋宇署已發出的危險斜坡修葺令和在防止山泥傾瀉計劃下將會詳細研究的私人斜坡
DH-Orders Served by BD and Planned Detailed Studies on Private Slopes under the LPM Programme



防止山泥傾瀉計劃的開支
Annual LPM Expenditure
1977/1978 to 2009/2010

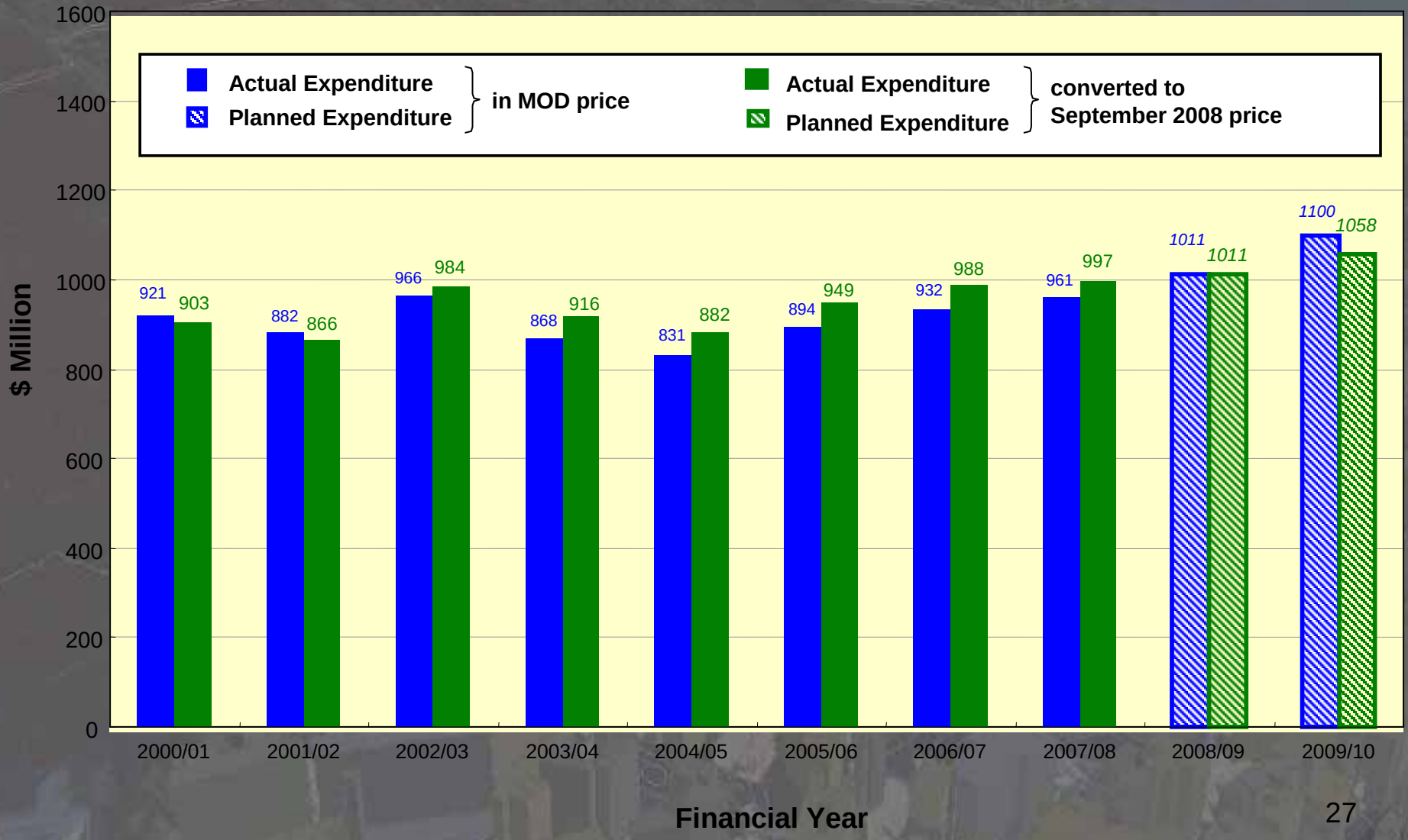


註釋
Notes:

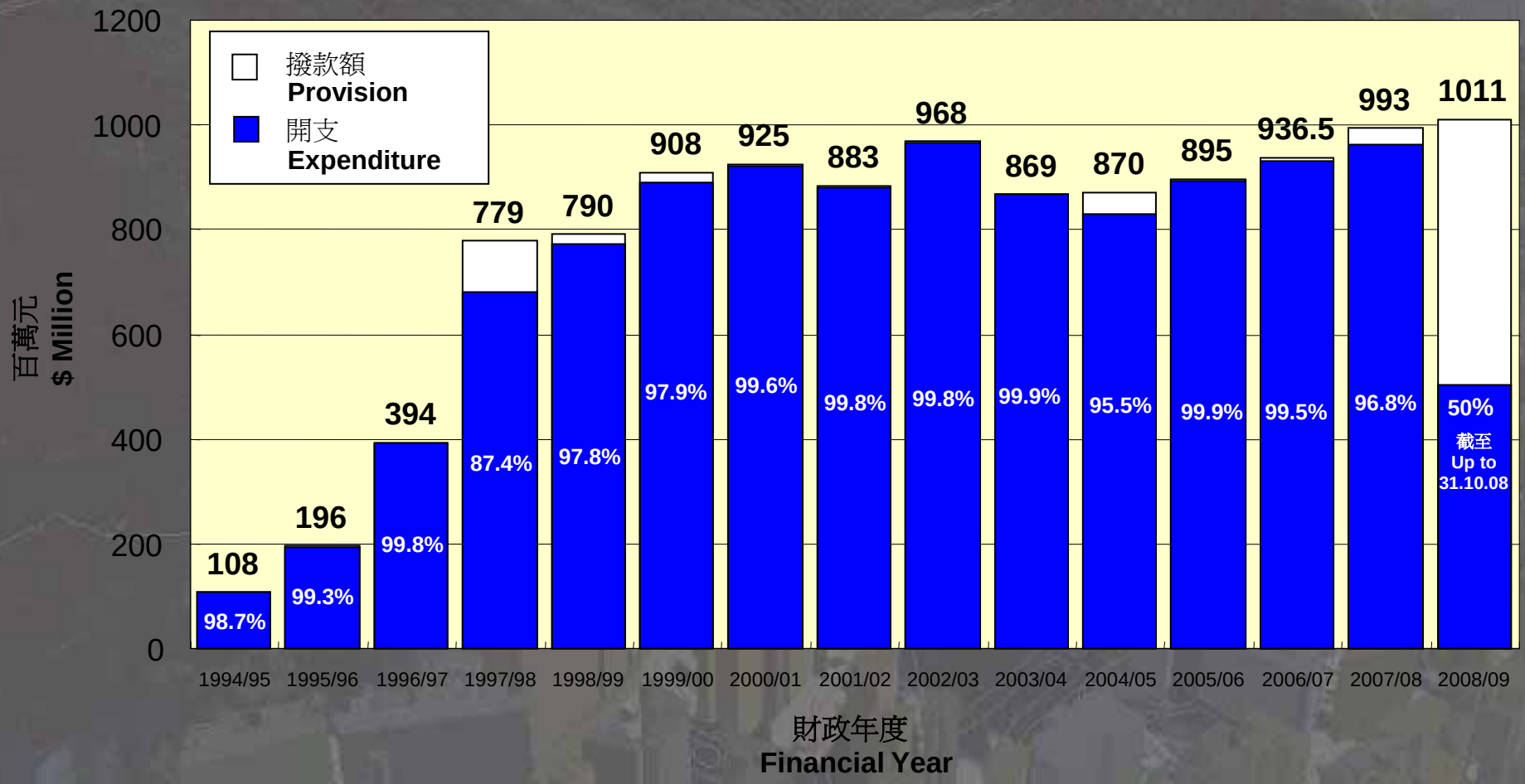
(1) 以上數字也包括在政府土地上提供緊急維修工程及其他特別研究和勘測的開支
The figures given above also include provision for urgent repair works to Government land and expenditure for special studies and investigations.

(2) 所有開支及預算都按付款當日價格計算
All expenditure and estimate are given at MOD prices.

Annual LPM Expenditure from FY 2000/01 to FY 2009/10
(Converted to September 2008 Price)



防止山泥傾瀉計劃的撥款和開支
Expenditure on LPM Block Vote - Head 705 Subhead 5001BX
1994/1995 to 2007/2008



Expenditure Control in FY2008/09

- Approved provision: $953M
- Expenditure up to end of September: $424M (44%)
- Forecast of expenditure: $1,011M
- Estimated shortfall: $58M
- Supplementary provision of $58M endorsed by LegCo Development Panel on 28 October 2008, endorsed by PWSC on 7 November 2008, and approved by Finance Committee on 21 November 2008

Delivery of the 10-year (2000-2010) Extended LPM Project

- Upgrading of Government slopes
  (80% outsourced; 20% by in-house staff)
- Safety-screening of private slopes
  (100% outsourced)
- Separate consultancies for upgrading works to government slopes and study of private slopes
- Consultants run GI, SOR and BOQ works contracts as required for slope upgrading works

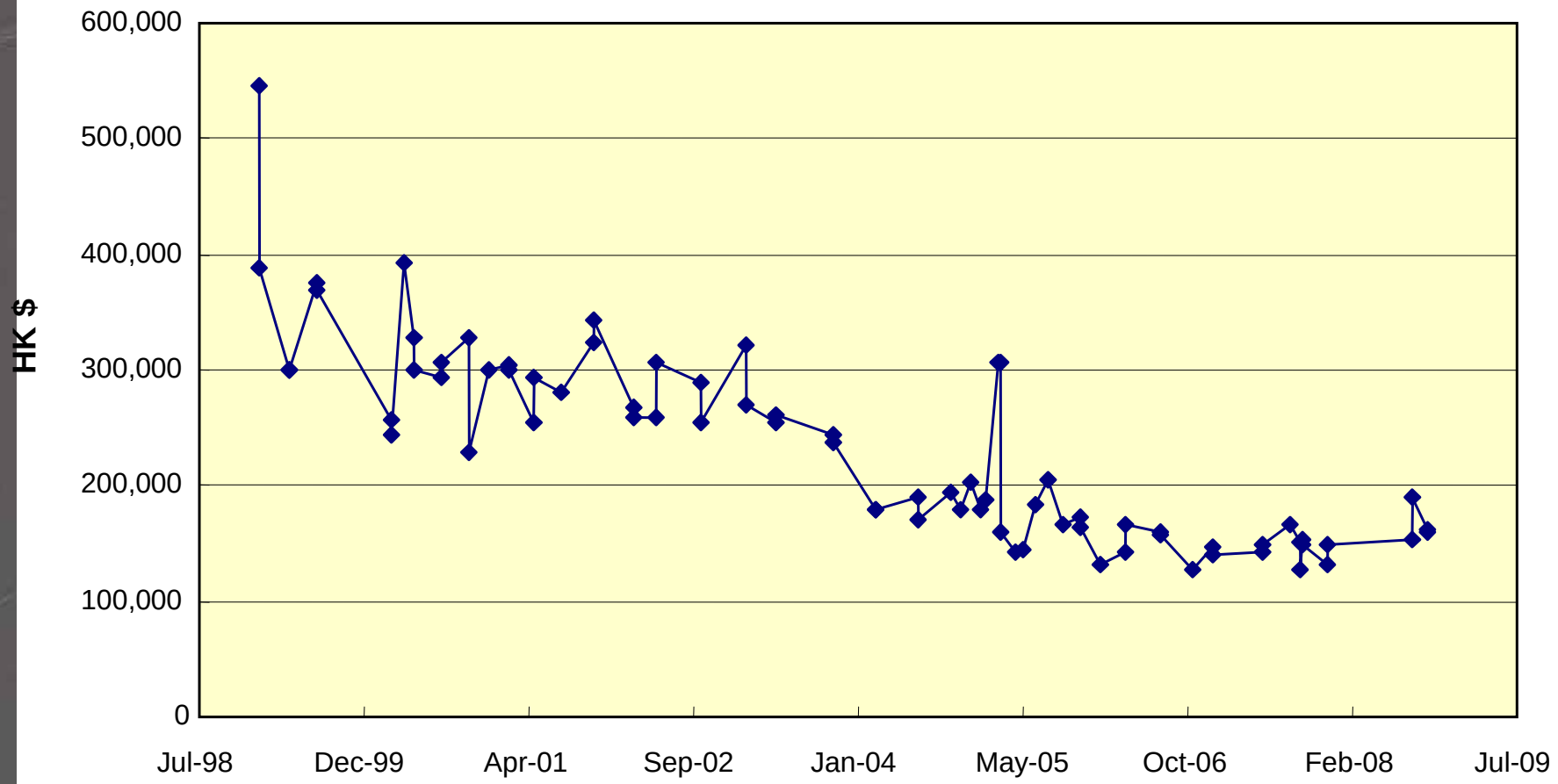
Technical Experience Sharing for LPM Projects

- Liaison Meetings with LPM Consultants and Contractors
- GEO Seminars
- 28th Annual Seminar of the Geotechnical Division of HKIE held on 2 May 2008

Delivery of the 10-year (2000-2010) Extended LPM Project

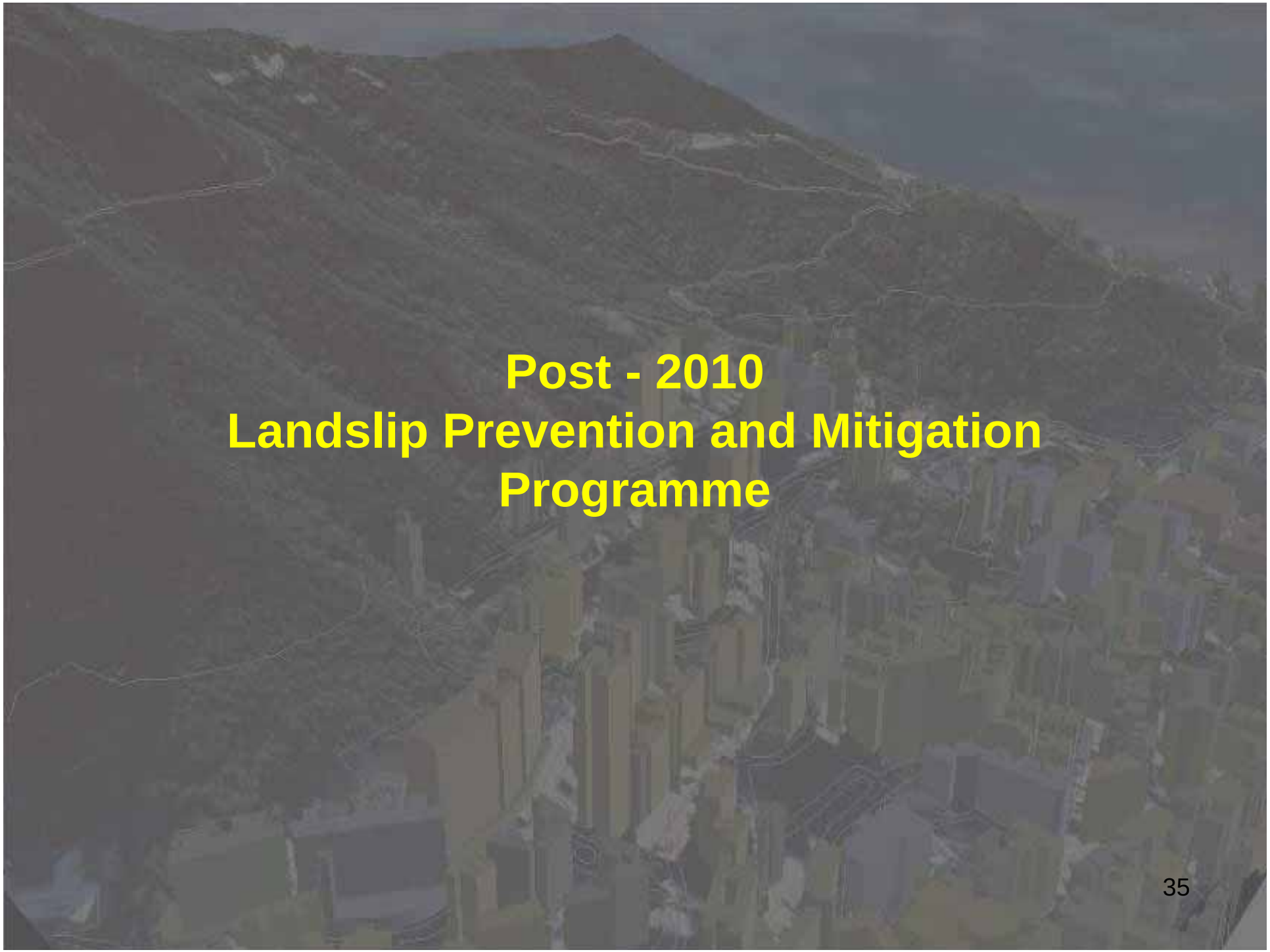
- After the last Slope Safety Technical Review Board (SSTRB) meeting in 2007, the last two consultancies for slope upgrading have been awarded
- Total numbers for the 10-year LPM Project:
- 71 consultancies have been awarded for detailed study and upgrading of Government man-made slopes (80%)
- 17 LPM works packages by in-house teams (20%)
- 20 consultancies have been awarded for safety-screening of private man-made slopes (100%)

Lump Sum Fee per Slope Upgraded/to be Upgraded under LPM/LPMit Consultancies Let Since 1998 (Converted to September 2008 Price)



Delivery of the 10-year (2000-2010) Extended LPM Project

- For FY 2008/09, 15 LPM works contracts for upgrading of Government man-made slopes are planned to be let
- 11 have been awarded to date
- 4 have been tendered/are to be awarded



Post - 2010
Landslip Prevention and Mitigation Programme

Slope Profile in 2010

Man-made slopes

- 3,000 slopes affecting squatters
- 10,000 moderate-risk old slopes
- 5,000 moderate-risk ‘old technology’ slopes
- 38,000 low-risk slopes
  - including 14,000 old slopes and 4,000 old technology slopes of Consequence-to-life Cat. 3, and 20,000 robust technology slopes

Slope Profile in 2010

Natural hillsides

- 2,700 natural hillside catchments with historical landslides close to buildings and important transport corridors
- Number of other potentially vulnerable catchments without historical landslides not known (thousands)

Natural Hillside Catchments with Known Historical Landslides Close to Existing Development

Natural Hillside Catchments with Known Historical Landslides Close to Existing Development

Multi-storey Buildings (~ 250 catchments)

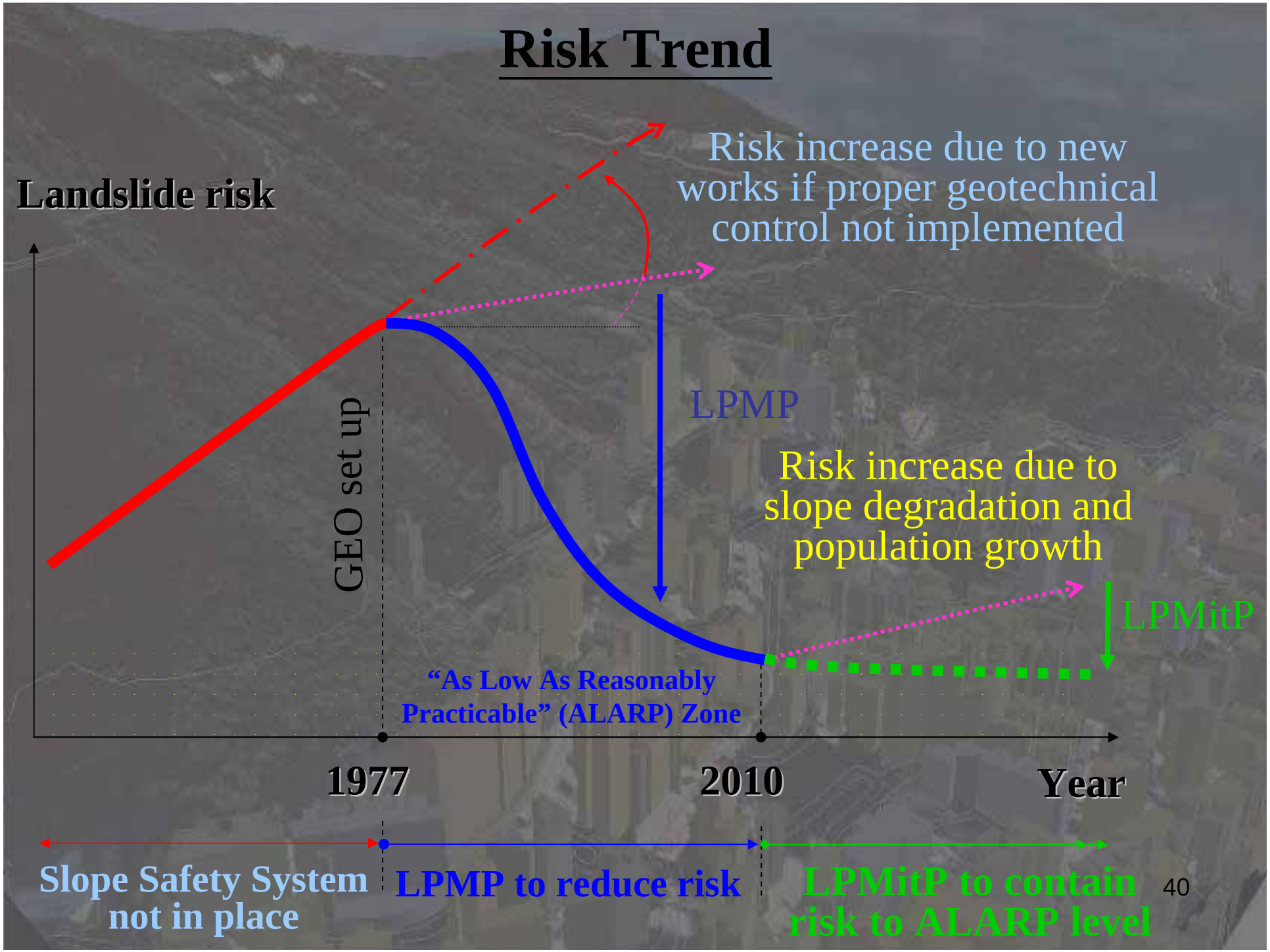
Low-rise Buildings (~ 2,050 catchments *)

Important Transport Corridors (~ 400 catchments)

Note: up to about 50% of the above are debris flow catchments

* 300 nos. of these also affect important transport corridors

Risk Trend


Landslide risk
Risk increase due to new works if proper geotechnical control not implemented
LPMP
GEO set up
Risk increase due to slope degradation and population growth
LPMitP
"As Low As Reasonably Practicable" (ALARP) Zone
1977
2010
Year
Slope Safety System not in place
LPMP to reduce risk
LPMitP to contain risk to ALARP level

Long-term Slope Safety Challenges

→ Slope degradation and requiring improvement/repair

→ Study and mitigation of natural terrain landslide risk

- Population increase
- Possibility of more extreme weather conditions

Action to contain Landslide Risk

Man-made Slopes *

- Upgrading moderate-risk government slopes under LPMitP
- Regular maintenance of all government slopes
- Safety-screening of moderate-risk private slopes
- Sustain public education to maintain public awareness of landslide risk and issue Landslip Warnings

* slopes affecting squatters to be considered separately

Action to contain Landslide Risk

Natural Hillsides

- Risk mitigation measures under LPMitP
- Sustain public education to maintain public awareness of landslide risk and issue Landslip Warnings

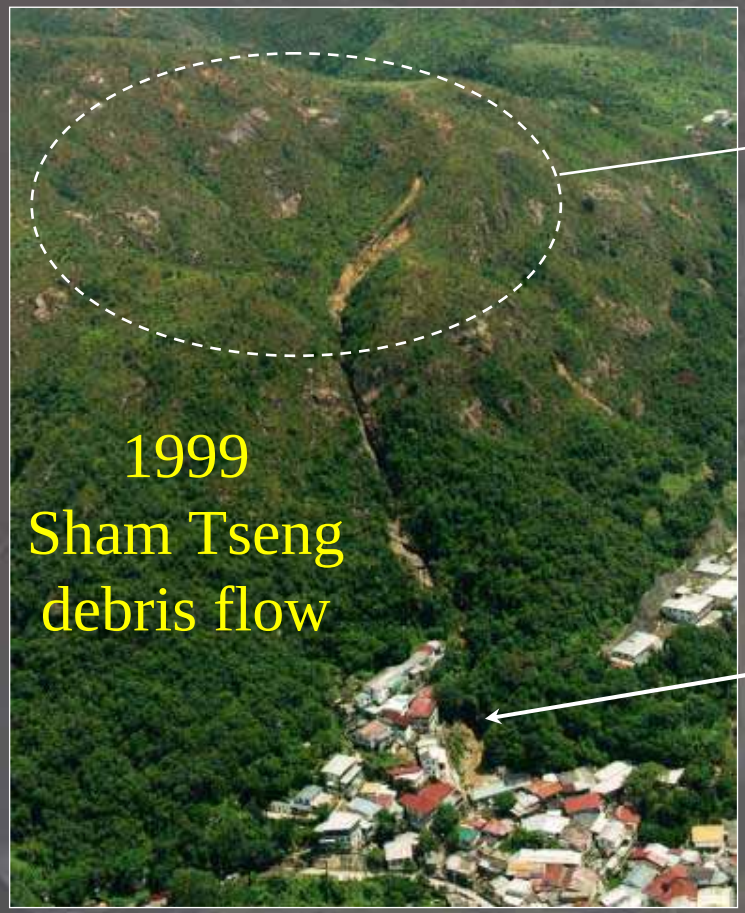
Landslide Investigation and LPMitP

- Systematic landslide investigations will continue to form an integral part of the future landslide prevention and mitigation programme on a rolling basis

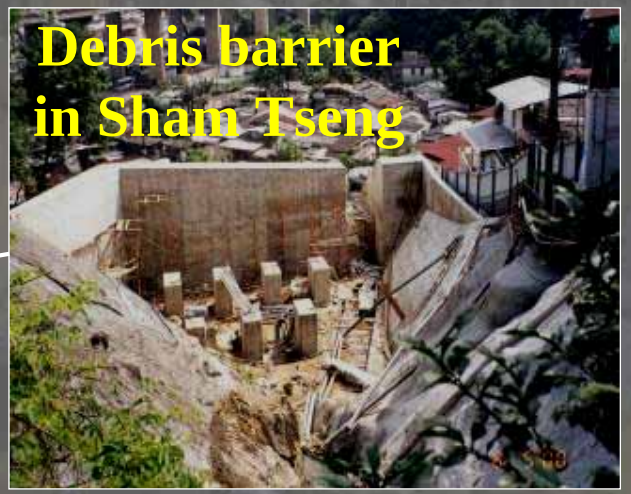
Landslip Prevention

Landslip Prevention and Mitigation

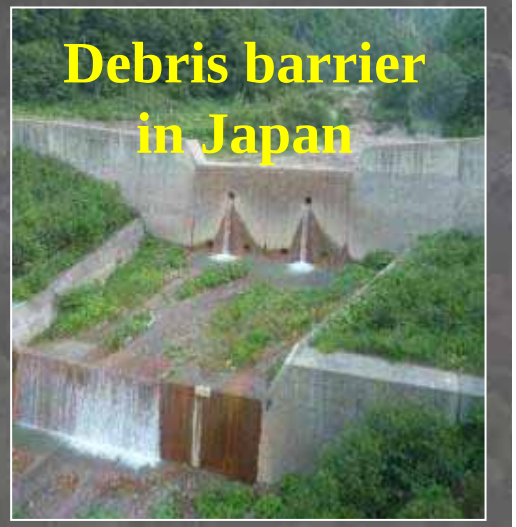
Natural terrain landslide risk is typically dealt with by mitigation measures, instead of extensive slope stabilization



1999
Sham Tseng
debris flow



Debris barrier in Sham Tseng



Debris barrier in Japan

Flexible barrier in Switzerland

Long-term Strategy of LPMitP

Contain risk through

- Rolling enhancement of man-made slopes
- Systematic mitigation of natural terrain landslide risk

Annual Targets for LPMitP on rolling basis from 2010 onwards

- Upgrade 150 government man-made slopes
- Conduct safety-screening studies for 100 private man-made slopes
- Implement risk mitigation works for 30 natural hillside catchments

LPMitP Consultancies planned to be let in FY 2008/2009

- 2 consultancies for data updating for man-made slopes
- 6 consultancies for upgrading of government man-made slopes
- 4 consultancies for natural terrain hazard studies & mitigation works
- 1 consultancy for safety-screening of private man-made slopes

LPMitP Consultancies awarded since December 2007

Agreement No.	Scope of Work	Date of Award
CE 20/2008 (GE)	Data updating for man-made slopes	14.8.2008
CE 16/2008 (GE)	Natural Terrain Hazard Mitigation Works	21.8.2008
CE 17/2008 (GE)	Natural Terrain Hazard Mitigation Works	21.8.2008
CE 18/2008 (GE)	IDC for 35 government man-made slopes	21.8.2008
CE 19/2008 (GE)	IDC for 35 government man-made slopes	21.8.2008
CE 27/2008 (GE)	IDC for 35 government man-made slopes	6.10.2008
CE 28/2008 (GE)	IDC for 35 government man-made slopes	6.10.2008
CE 21/2008 (GE)	Data updating for man-made slopes	10.10.2008

More LPMitP Consultancies to be awarded in 2009

LPMitP Consultancies to be injected in early 2009 as a result of the June 2008 rainstorm

- 2 consultancies for natural terrain hazard studies & mitigation works

  - one for regional approach for study of hazards in the western part of Lantau Island

  - one for five landslide cases in other areas

  based on the 'react-to-known-hazard' principle

LPMitP Consultancies planned to be let in FY 2009/2010

- 5 consultancies for upgrading of government man-made slopes
- 4 consultancies for natural terrain hazard studies & mitigation works
- 1 consultancy for safety-screening of private man-made slopes

Challenges for Natural Terrain Hazard Studies & Mitigation Works

- Expertise and experience available ? – Hazard Assessment based on Design Event & QRA, Debris Mobility Modeling, Mitigation Works Design etc
- Environmental Impact & Ecological Assessment
- Difficult Access & Mobilization
- Capitalize the knowledge gained from the landslide incidents in June 2008
- Innovative/Prescriptive Measures Design
- Landscaping Measures and Greening Techniques – shotcrete, barriers and check dams

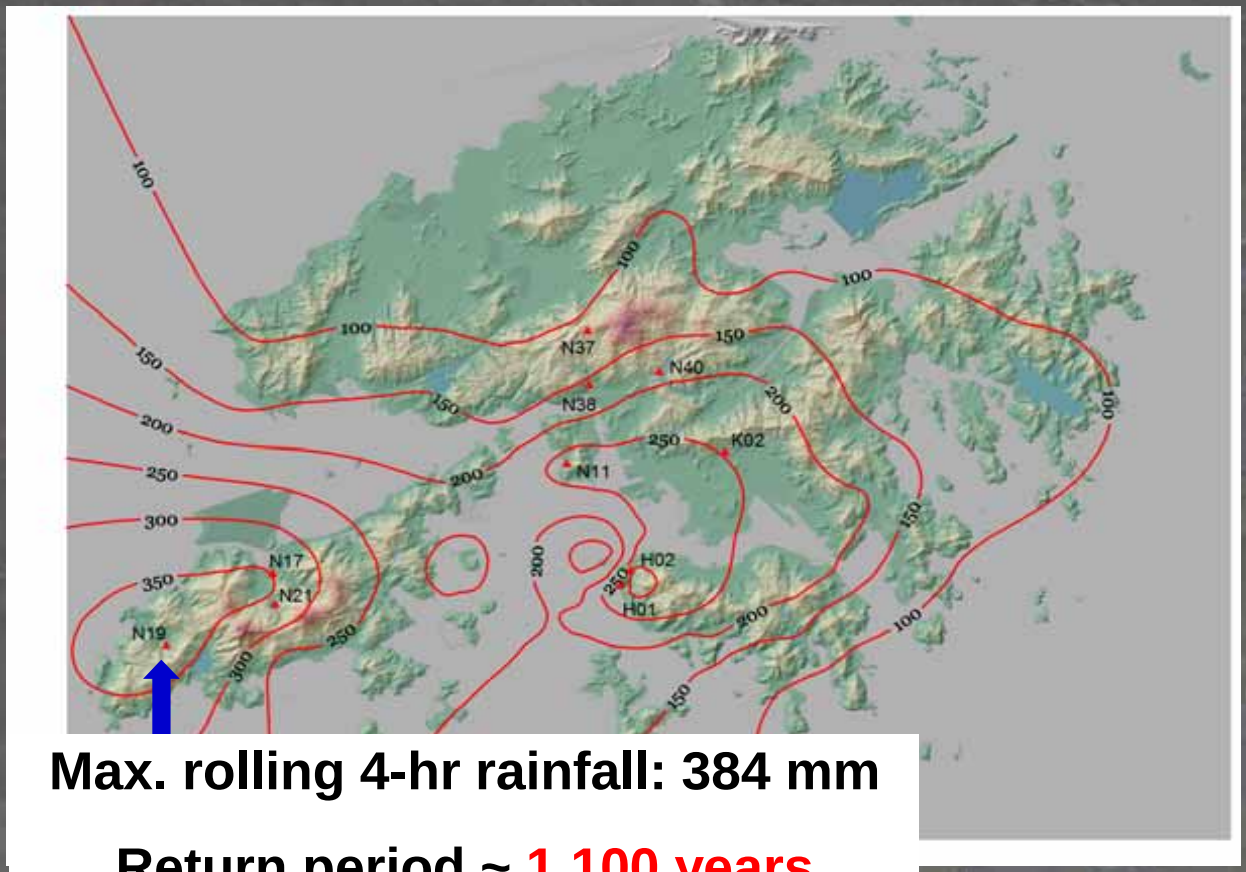
Review Mechanisms

- SSTRB to undertake an overview of the LPMitP on an annual basis and continue to benchmark the slope safety work of the HKSAR Government with that of other developed countries
- GEO will conduct a comprehensive review of the progress and effectiveness of the LPMitP in 2015


Large nos. of natural terrain landslides occurred in the June 2008 rainstorms

Severe Rainstorm on 7 June 2008

- Maximum hourly rainfall: 145.5 mm
- 24-hour cumulative rainfall: 622.5 mm

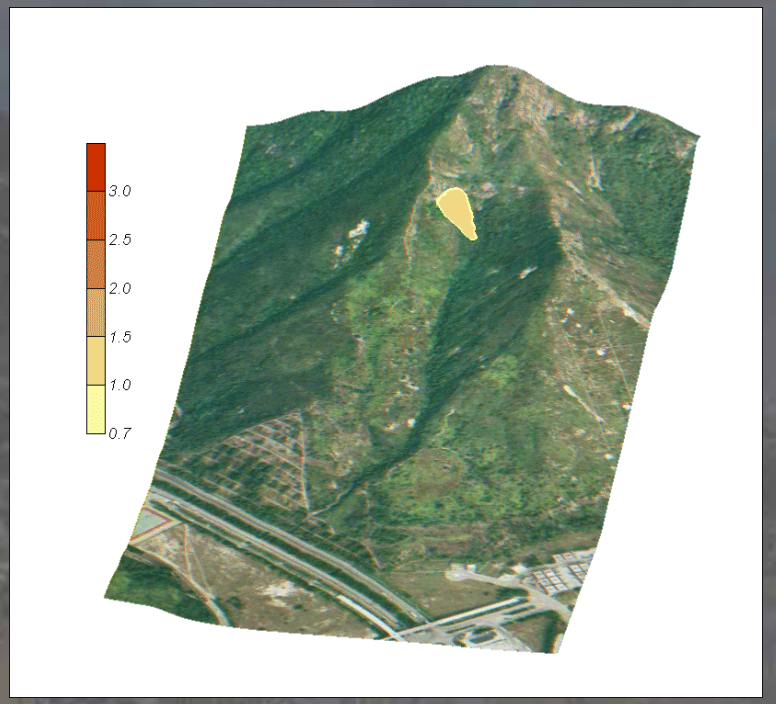


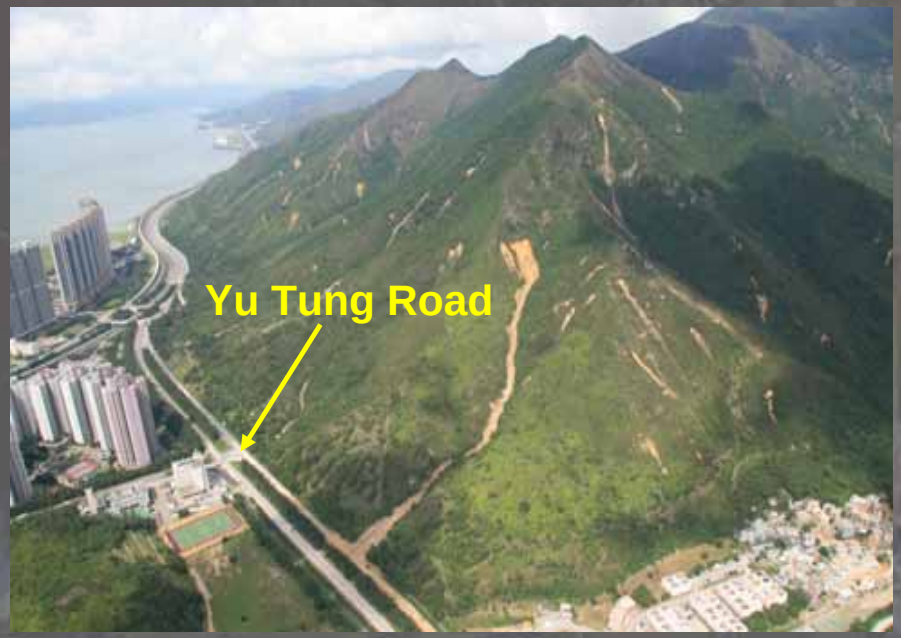
Max. rolling 4-hr rainfall: 384 mm

Return period ~ 1,100 years

7 June 2008 Rainstorm

- The severe rainstorm has brought about over 800 landslides
- Most of the landslides occurred on natural hillside. Many are sizeable failures that developed into debris flows and affected developed areas





Source vol. ~ 1,500 m^3

~ 2,500 m^3 debris reaching the road

Run-out ~ 600 m

Vertical drop ~ 230 m

Max. velocity ~ 15 m/s


The post-2010 Landslip Prevention and Mitigation Programme is introduced timely


Questions?


Video on
Safe and Green Slopes
in Hong Kong


Thank You