

International Geotechnics Symposium cum International
Meeting of CSRME 14th Biennial National Congress
16 Dec 2016

Urban Landslide Risk Management amid the Challenge of Climate Change



HK is among the best in the world



Urban Landslide Risk Management amid the Challenge of Climate Change



**HK is still vulnerable, and we are
enhancing our preparedness & resilience**



**Densely
developed**



Heavy rain

Urban Landslide Risk Management



Steep terrain



Deep weathering

Serious Landslides in HK



1972 Po Shan (67 fatalities)



1976 Sau Mau Ping (18 fatalities)

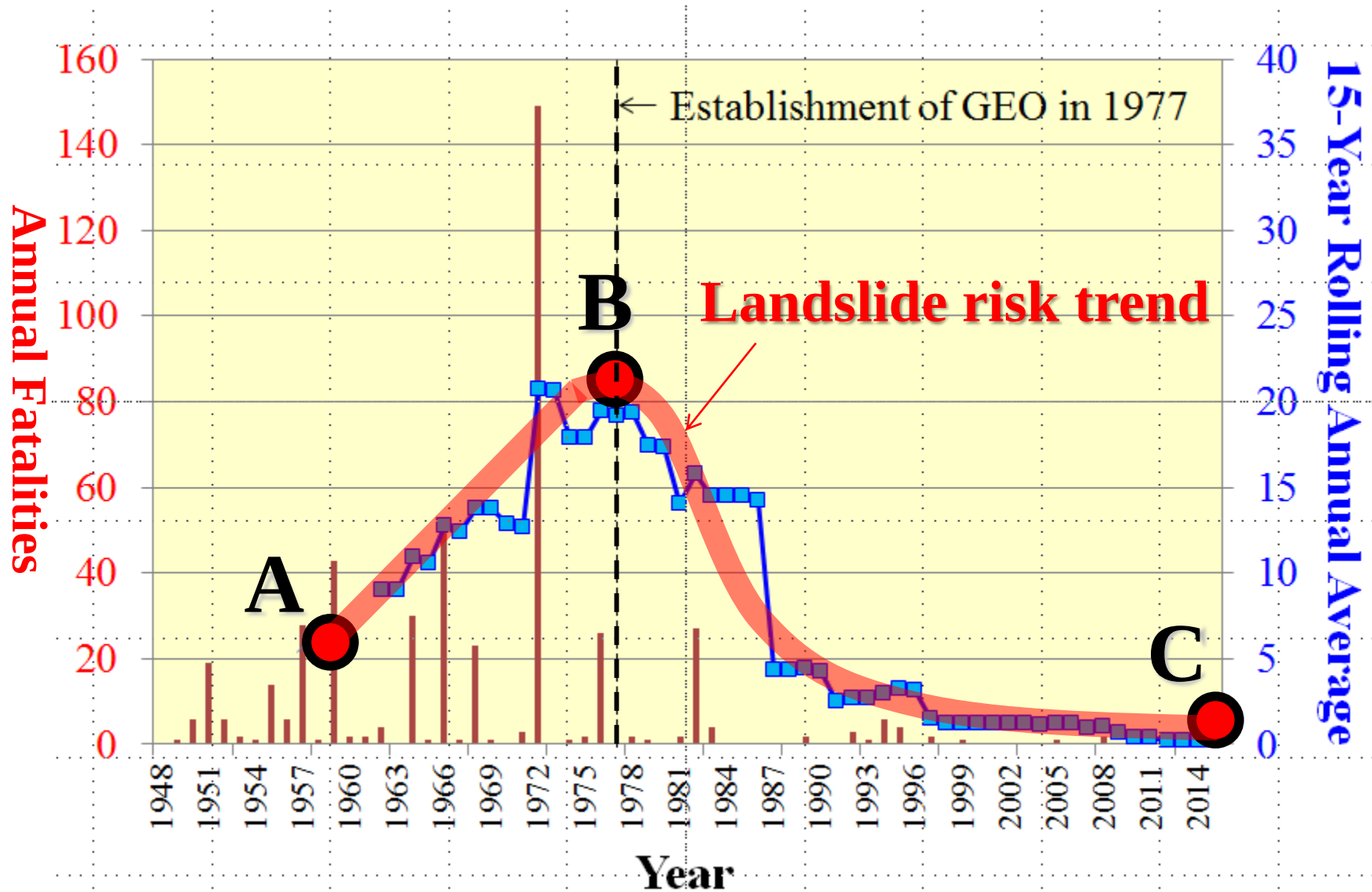


1972 Sau Mau Ping (72 fatalities)

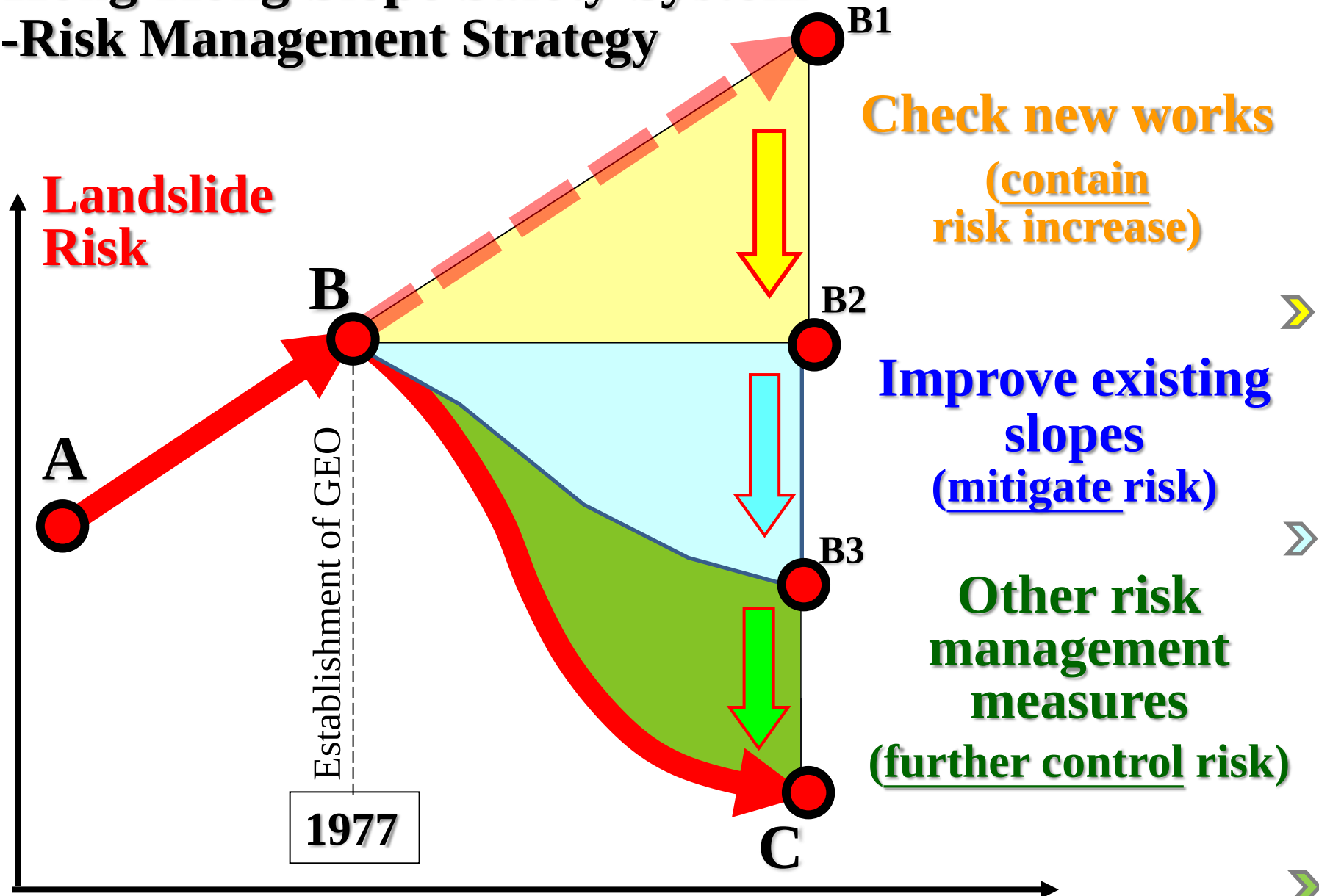


1994 Kwun Lung Lau (5 fatalities)

Landslide Risk Trend

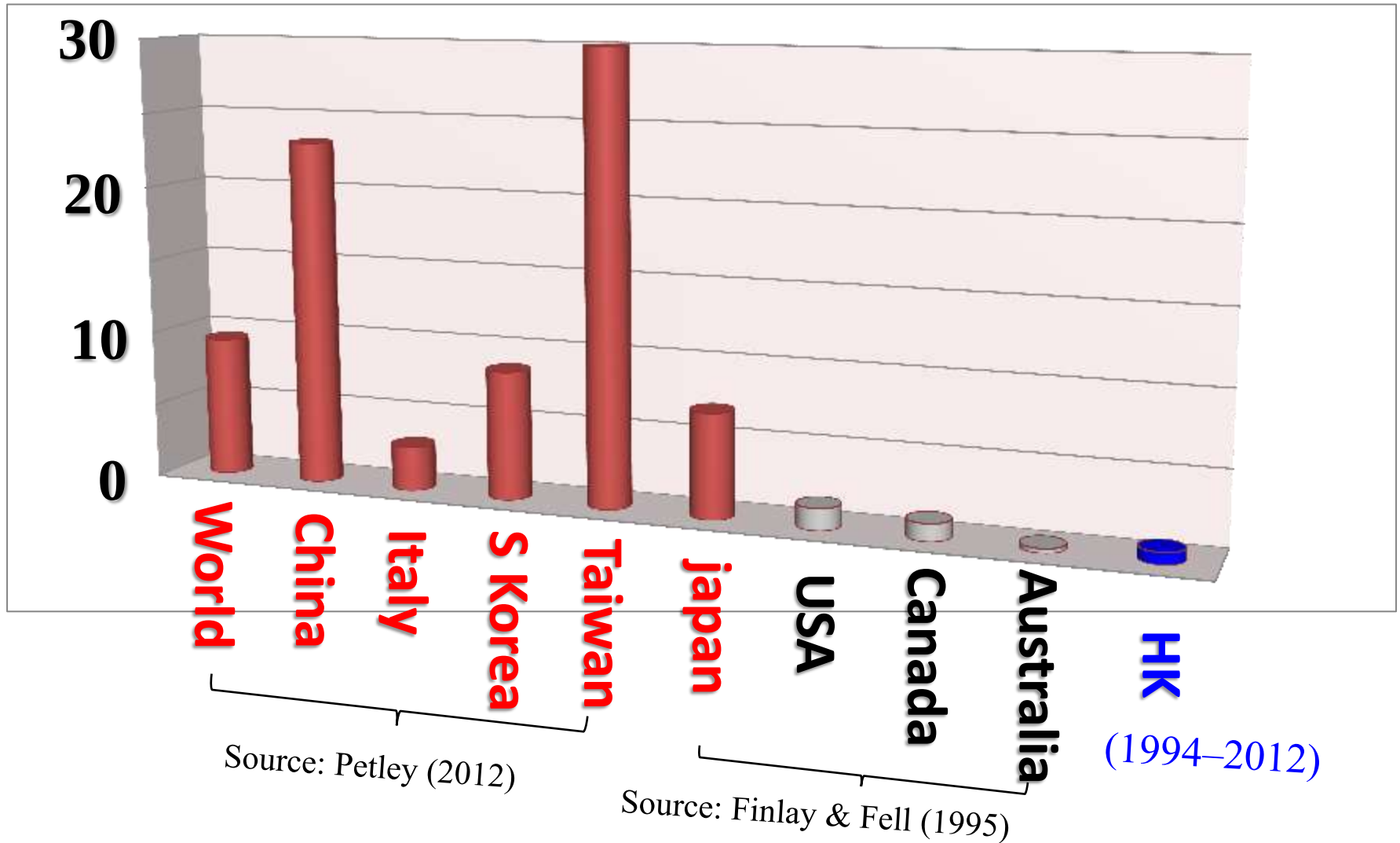


Hong Kong Slope Safety System -Risk Management Strategy



Landslide Risk

(Actual fatalities per 7 million population)



International Benchmarking

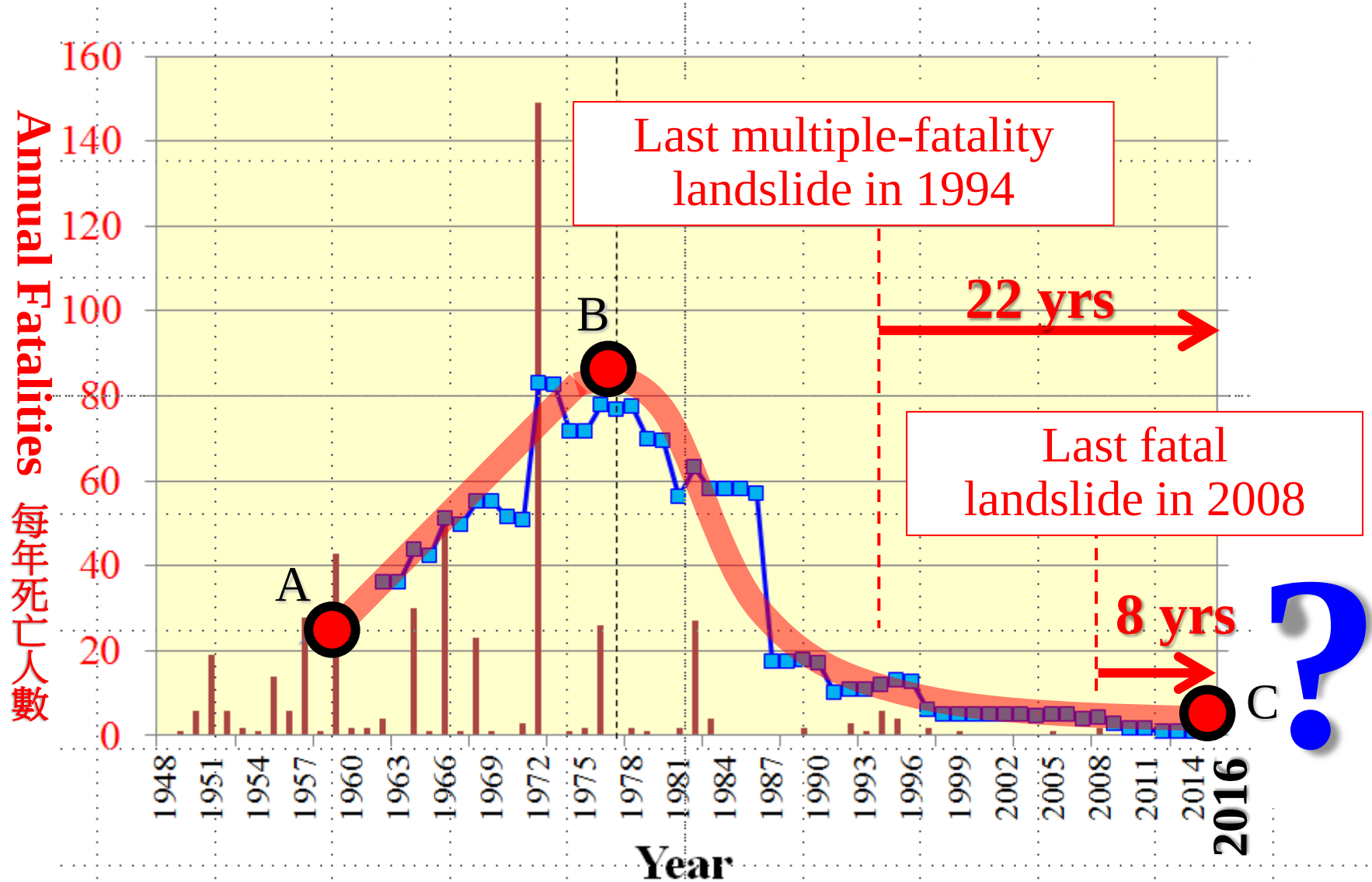
Slope Safety Technical Review Board (SSTRB) 2016 Report (Nov 2016)

“SSTRB finds that GEO continues to lead international practice on slope safety and is a model that other countries aspire to follow.”

Annual review of
HK's slope safety
by SSTRB



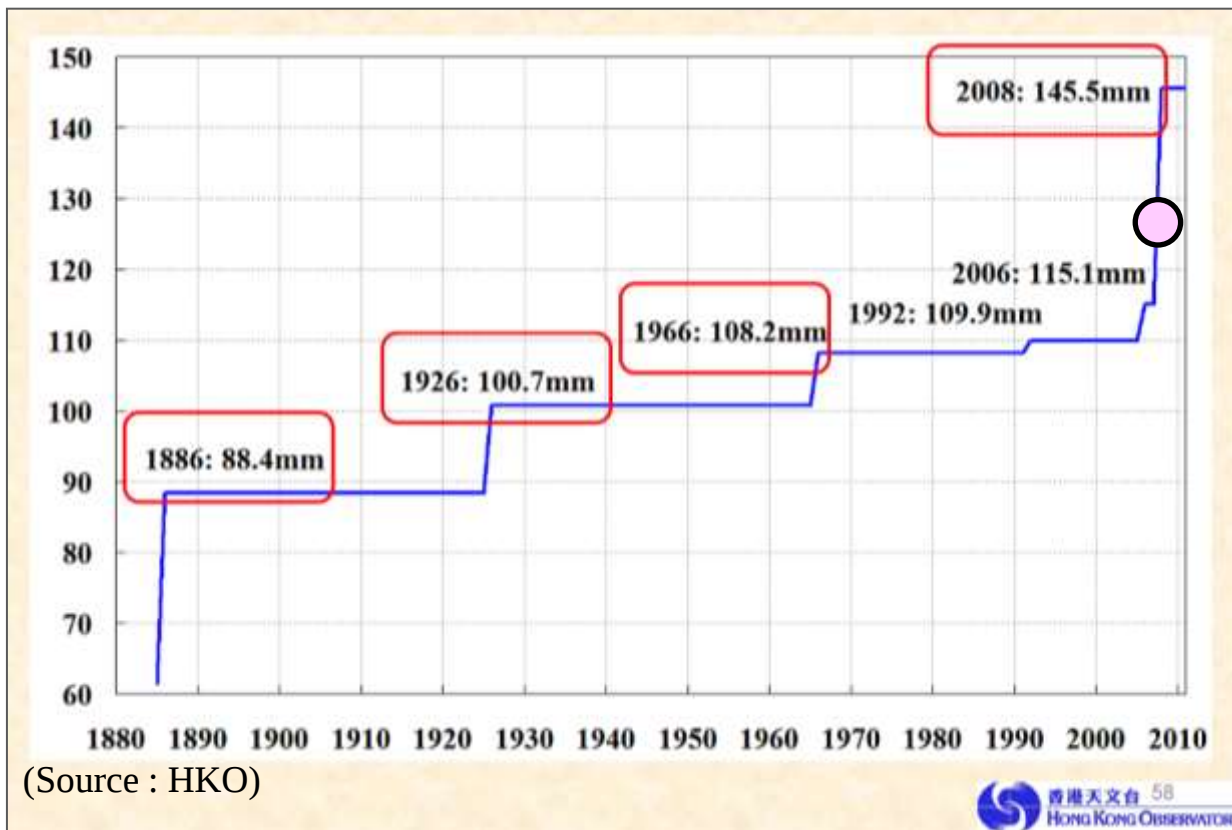
So far so good, but what next?



Extreme Weather Threats

Record-breaking 1-hr rainfall at HKO

7.10.2015 in Sai Kung
1-hr rainfall = 126 mm
(300-yr return period)



More Rain + More Extreme Rainfall



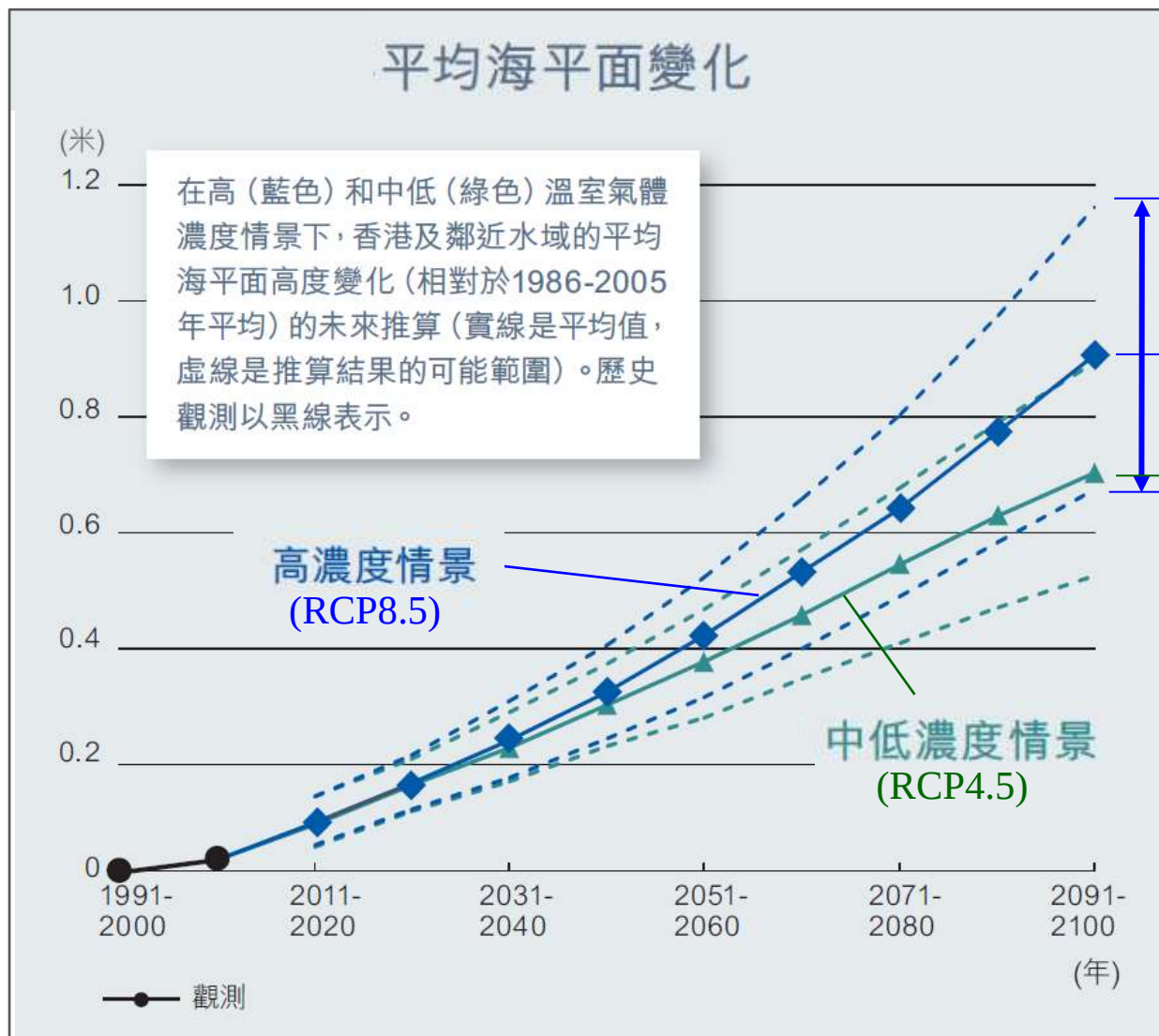
根據IPCC發佈的最新情況，在高溫室氣體濃度情景下，預計香港極端多雨的年份將由1885-2005年間的3年，上升至2006-2100年的12年。此外，在21世紀末的每年降雨量，預計將較1986-2005的平均降雨量上升約180毫米。極端降雨事件亦會在本世紀增加。



**極端降雨
將更頻繁**



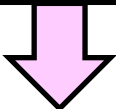
Mean Sea-level Change (0.7 m – 0.9 m rise by 2100)



(Source : ENB's "Hong Kong Climate Change Report 2015")



Climate change will increase both the frequency and intensity of extreme weather events



We face extreme weather events occasionally

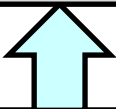
Rain

Typhoon

Drought

Heat

...

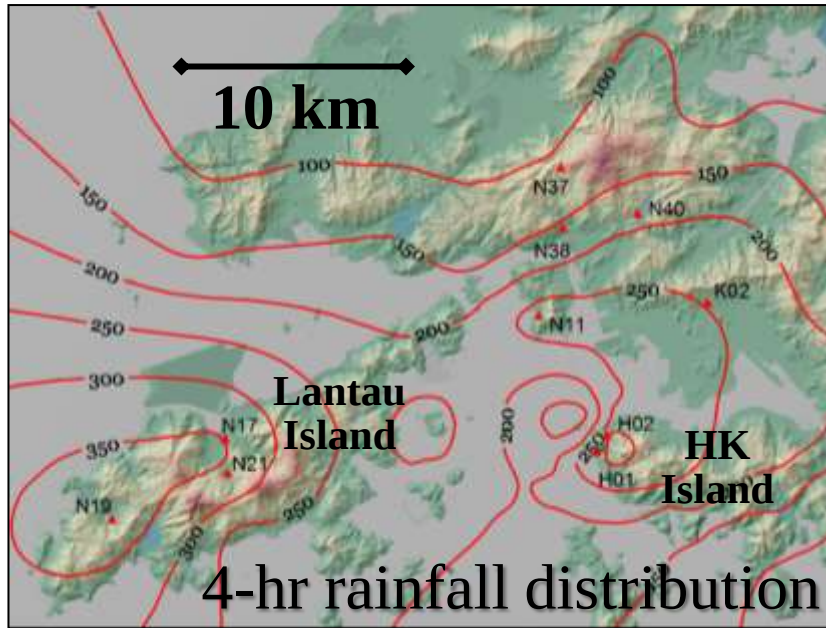


“Extreme weather includes unusual, severe or unseasonal weather; weather at the extremes of the historical distribution
– the range that has been seen in the past”
(Intergovernmental Panel on Climate Change, IPCC)

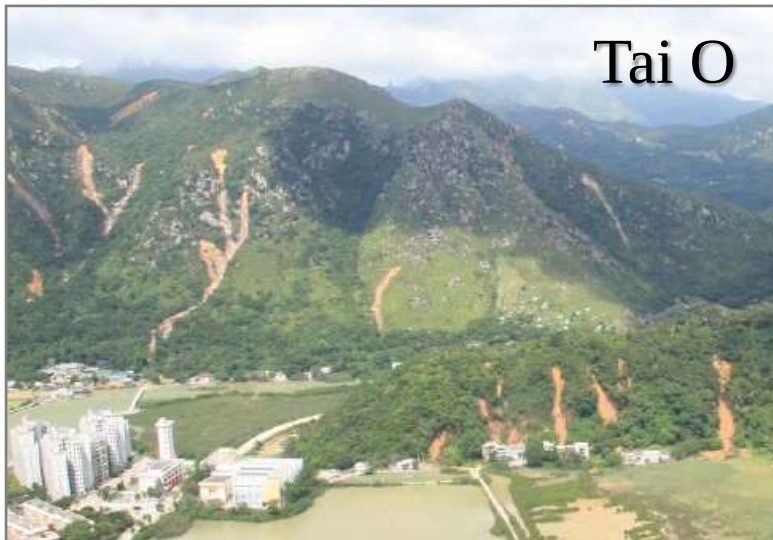
Recent Examples (landslides) in the Region



June 2008 Rainstorm on Western Lantau



- Unprecedented rainfall
- Widespread natural terrain landslides & debris flows (2400 nos.)
- Major disruptions



Recent Examples (other hazards)

極端天氣引發的其他災害



2005 Hurricane Katrina
(~1800 fatalities in USA)



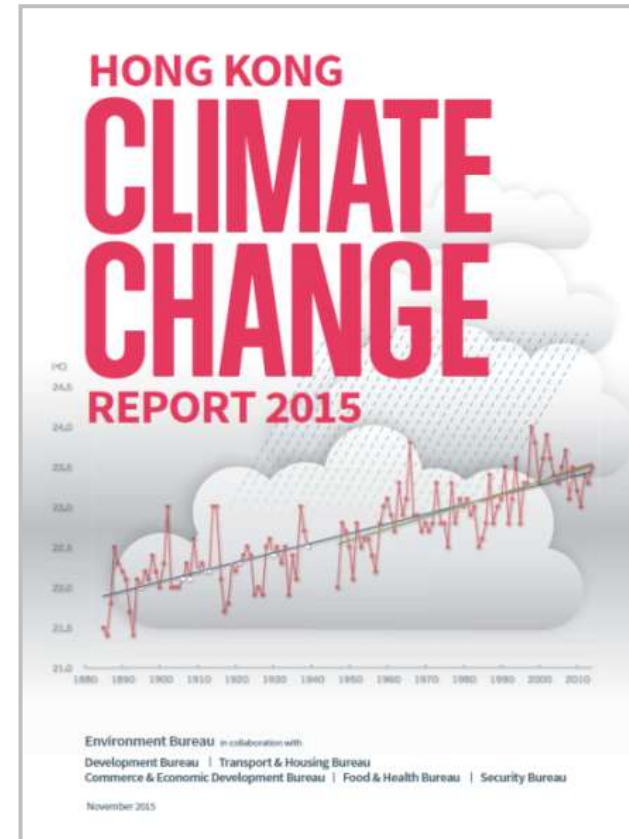
Storm surge in Typhoon Ellen (HK, 1983)



2013 Typhoon Haiyan
(>6000 fatalities in Philippines)

Meet the challenge :

- **Mitigation** – to reduce or prevent emission of GHG
- **Adaptation** – to anticipate adverse effects and take actions to minimise damage
- **Resilience** – to strengthen community's capability to cope with climate change related stresses and maintain the functional operation of public services, and economic and social activities



(Source : “Hong Kong Climate Change Report 2015” by Environment Bureau, HKSAR Government)

Vulnerability Assessment ('Adaptation')



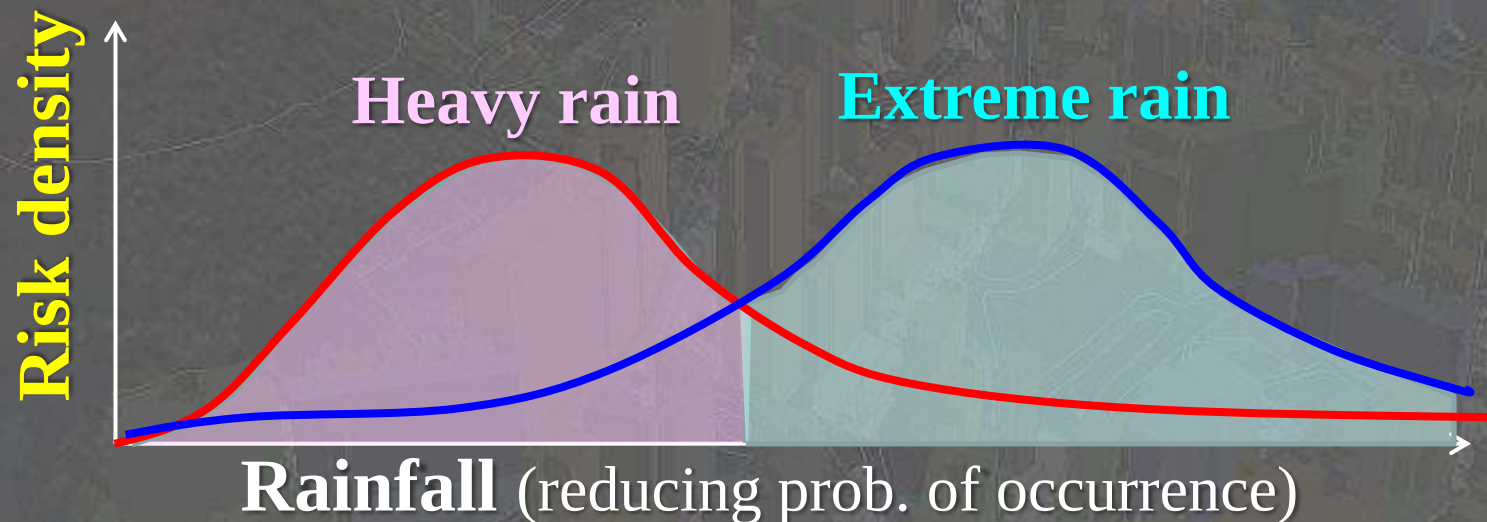
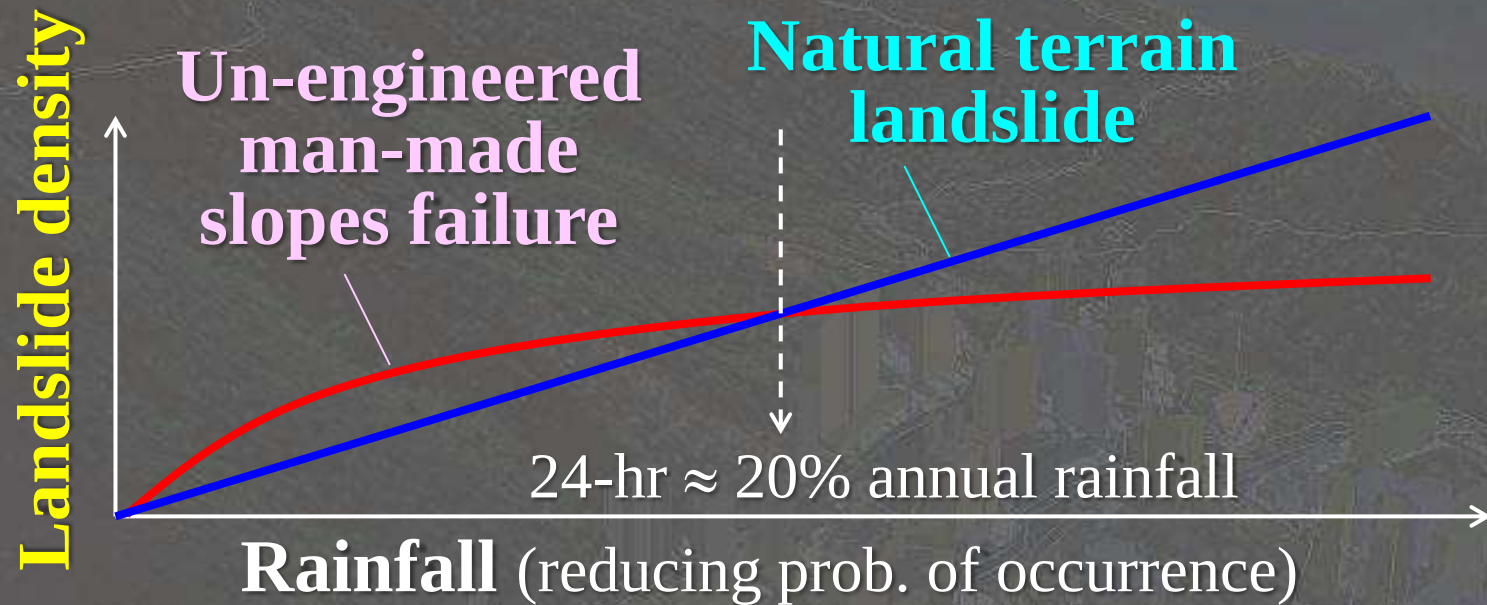
- ~ 200 to 300 landslides (mainly **natural terrain**) may impact on buildings and roads
- Existing landslide emergency system stretched to limit



- ~ 4,000 to 9,000 landslides (mostly **natural terrain**) may impact on buildings and roads
- Existing landslide emergency system over-whelmed



Landslides under extreme rainfall





1966 (HK Island)

- 64 fatalities
- 29 injuries
- 2672 homeless
- 8561 evacuated

Victoria Road



1982 (Central NT)

Shan Tseng San Tsuen

Once every 15 years

(wide-spread natural terrain
landslides in a region in HK)



1993 (S. Lantau)

South Lantau



2008 (W. Lantau)

Western Lantau

Enhanced Slope Engineering ('Adaptation')

- Robust slope design
(e.g. soil nailing since early 2000s)
- Natural terrain landslide mitigation works
(since 2010)



- Increased slope surface drainage capacity
(since mid-2000s)

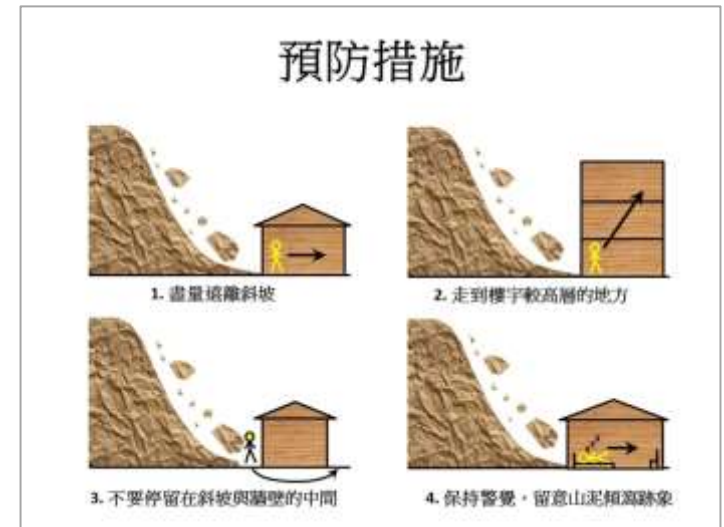


- Slope maintenance
(since late 1990s)



Emergency Preparedness (‘Resilience’)

- Strengthen landslide emergency system
- Public education and information – stay vigilant and ‘self-help’
- Collaborative emergency management for multiple hazards (e.g. landslides, flooding, storm surges, road closure, etc.)



**Natural Terrain
LANDSLIDE**
Hazards in
Hong Kong



Geotechnical Engineering Office
Civil Engineering and
Development Department

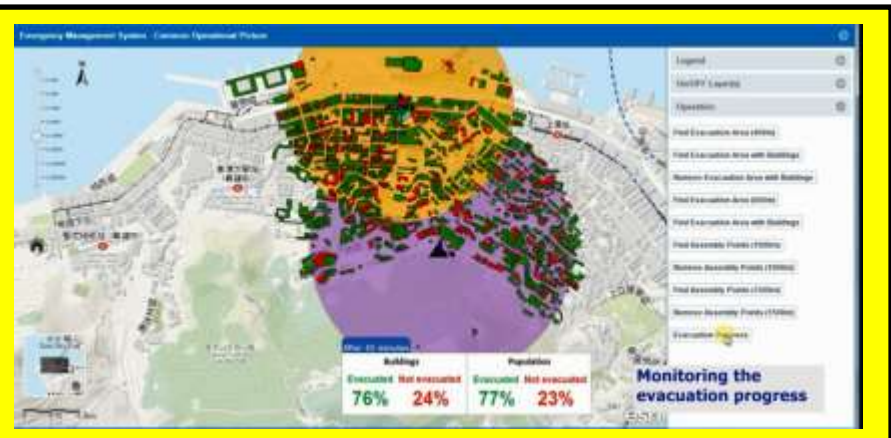
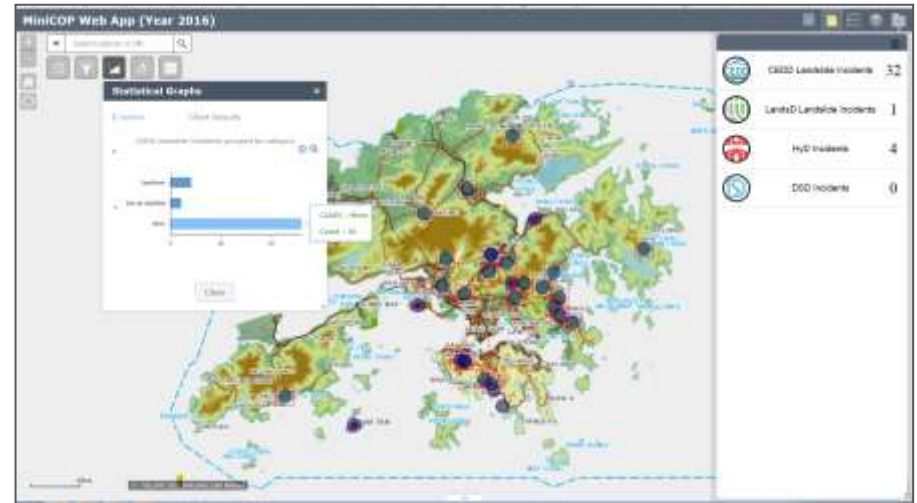
**香港的天然山坡
山泥傾瀉
災害**



土木工程拓展署
土力工程處

Common Operational Picture (COP)

- Unified GIS platform for collaborative emergency management
- Prototype COP set up and evaluated in 2016



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**HK is still vulnerable, and we are
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Thank You

and be prepared

Check New Works (contain risk increase)



Development planning

Setting standards



Design and construction audits



Improve existing slopes 防治工程 (mitigate risk)

Landslip Prevention and Mitigation Programme (LPMitP)

~\$1B/yr



Annual output :

- Upgrade 150 Government man-made slopes
- Safety-screen 100 private man-made slopes
- Mitigation risk at 30 hillside catchments

Slope Maintenance

~\$0.9B/yr



- Routine and preventive maintenance
- Engineer Inspections



Other Risk Management Measures (further control risk)

Squatter clearance



Public education



Information
and
community
advisory
service



Landslide
warning and
emergency
service



GEO Landslide Emergency Service (1994 – 2012)

Landslip Warning issued	Landslides inspected and dealt with	Evacuation		Road sections and facilities closed
		Multi- storey buildings	Houses	
62 (3.3)	4915 (259)	21 (1.1)	122 (6.6)	2308 (~122)

Total No.

Annual Average No.

