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(Climate Change & Disaster Management)
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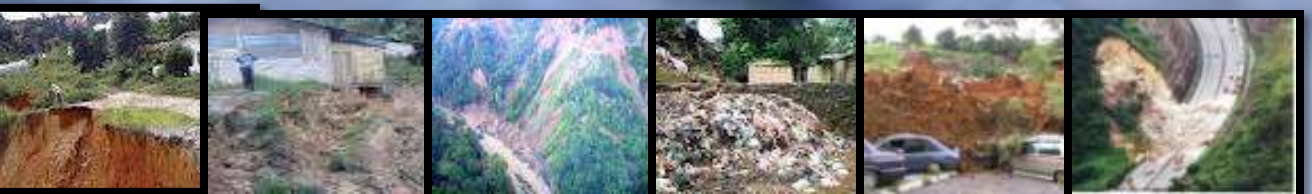
PWTC, Kuala Lumpur

Presentation Topic:
Forecasting Erosion Induced Landslide

SPEAKER:

Prof. Dr Roslan Zainal Abidin,
Infrastructure University Kuala Lumpur



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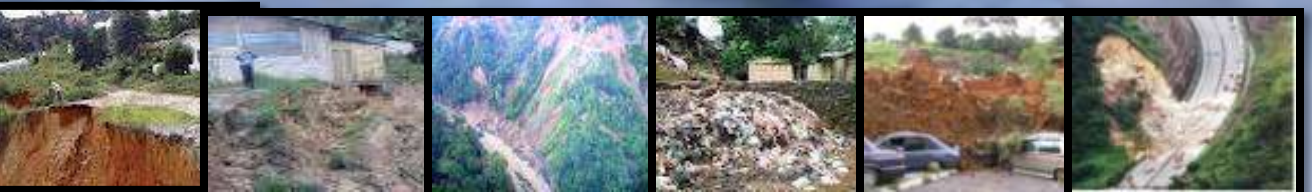
Forecasting Erosion Induced Landslide



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Natural disasters strike MALAYSIA every year !

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thestar online

Sunday, Nov 20, 2011

According to the National Slope Master Plan (NSMP) 2009-2023, Selangor and Federal Territory have experienced the most landslides since the 1970s followed by Pahang, Penang and Sabah.

- 600 deaths recorded since 1961.
- The highest fatality for a single landslide was recorded on Dec 26, 1996 where 302 people in Keningau, Sabah.
- Economic losses from landslides totalled almost RM3 billion (S$1.2 billion) from 1961 until 2007.

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Landslide Tragedies in Malaysia (1994-2013)

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KG. RAJA, CAMERON HIGHLAND
(7th December 1994)

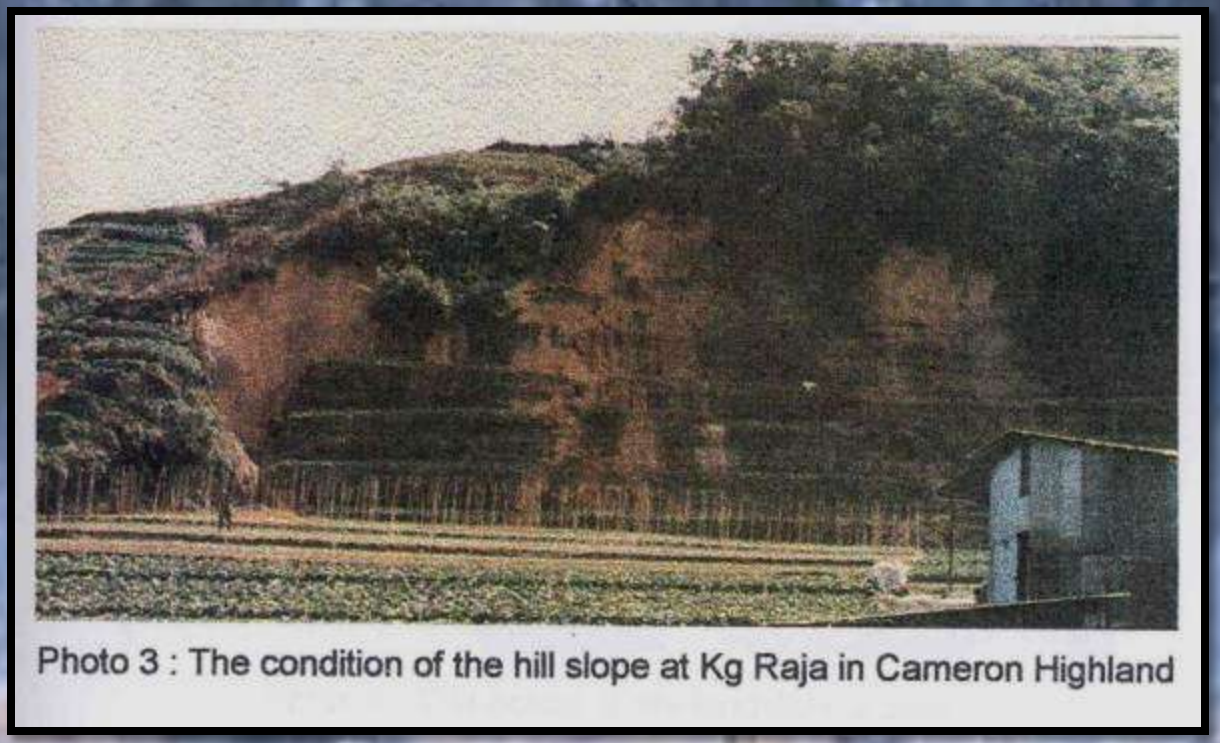

Photo 3 : The condition of the hill slope at Kg Raja in Cameron Highland

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KM39, KL – KARAK HIGHWAY (30th June 1995)

Photo 4 : The scene at the landslide location

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GUA TEMPURUNG, NORTH-SOUTH EXPRESSWAY (6th January 1996)

Photo 5 : The landslide interrupted the expressway traffic flow

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JALAN TUN SARDON, BALIK PULAU, PENANG (16TH November 1998)

Photo 9 : Boulders from the hill slope

Photo 10 : The emergency clearing work at the site

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BUKIT AWANA, PAYA TERUBONG PENANG (28TH November 1998)

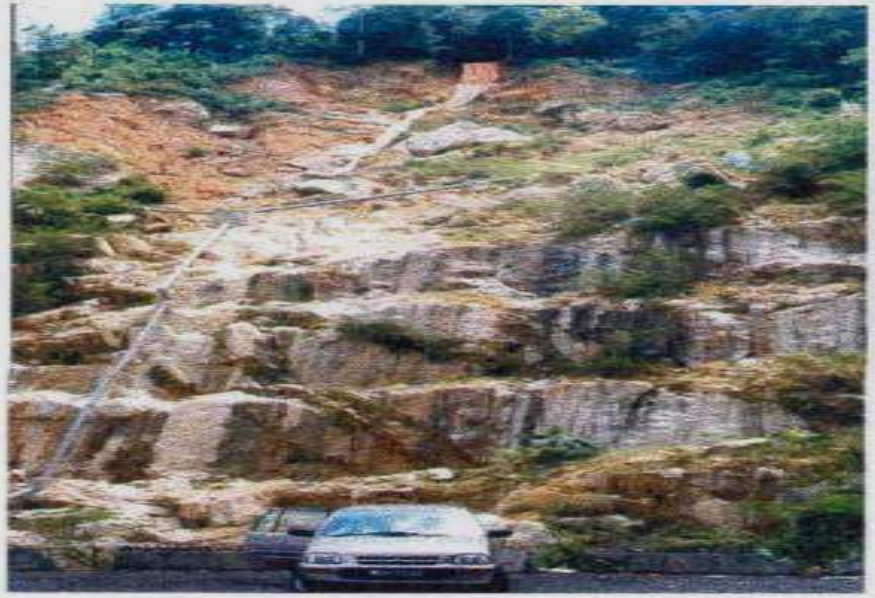

Photo 11 : The current condition of the hill slope

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BUKIT ANTARABANGSA, ULU KELANG (15th May 1999)

Photo 12 : The Bukit Antarabangsa hill slope's scar

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JALAN TUN SARDON, BALIK PULAU, PENANG
(5TH September 1999)

Photo 13 : Huge boulders blocking the access road

Photo 14 : The boulders clearing work

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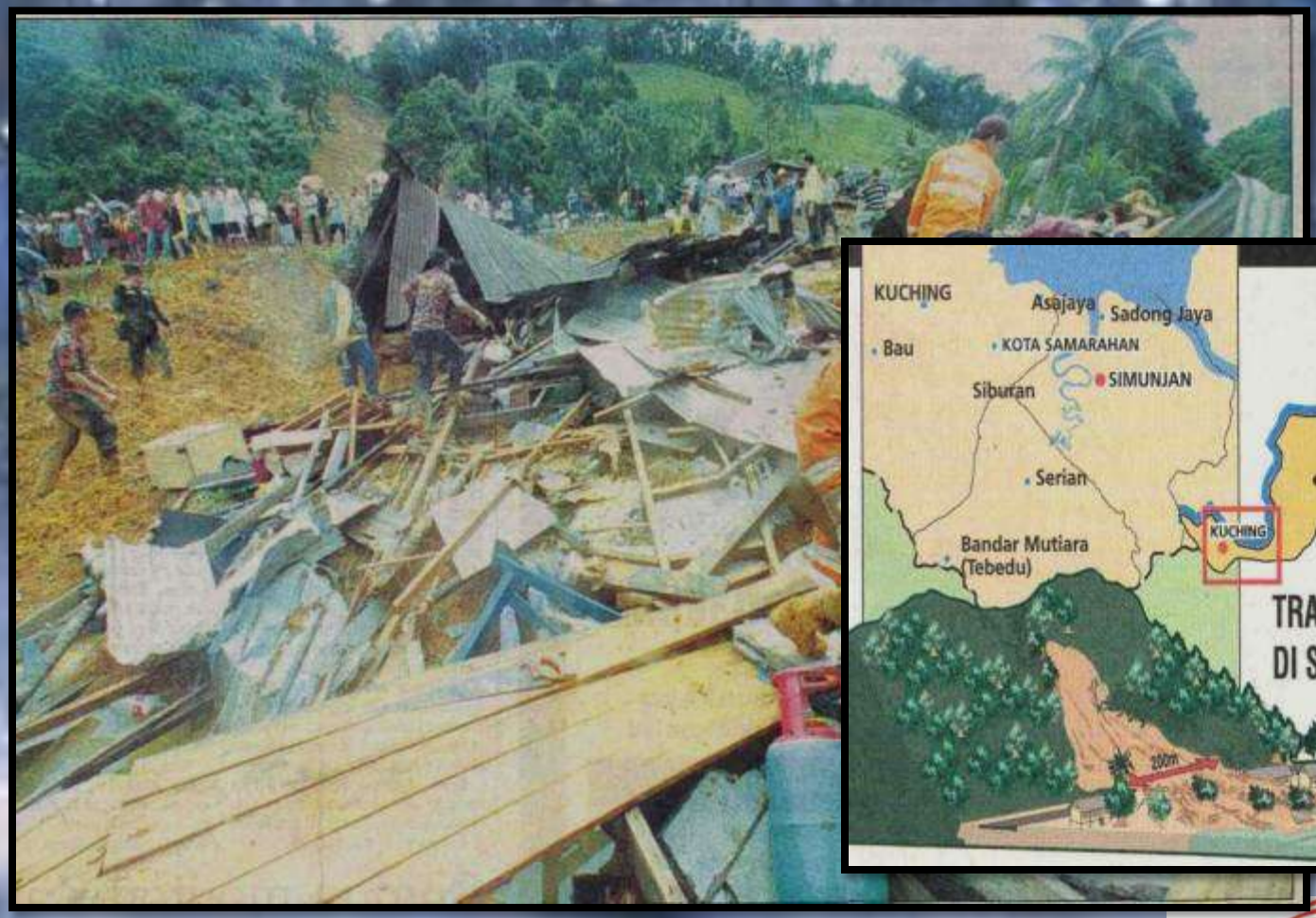
LANDSLIDE TRAGEDY AT SIMUNJAN, SARAWAK
(28th January 2002)



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LANDSLIDE TRAGEDY AT TAMAN HILLVIEW
(20th November 2002)

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LANDSLIDE TRAGEDY AT KM52 JALAN TAPAH-CAMERON HIGHLAND (24th February 2004)

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MUDSLIDE AT KM303 NORTH-SOUTH EXPRESSWAY (October 2004)

Kawasan libatkan tiga negeri sepanjang Lebuh Raya Utara-Selatan

105 lokasi mudah runtuh

KUALA LUMPUR 12 Okt. — Sebanyak 105 lokasi di sepanjang Lebuh Raya Utara-Selatan berpotensi untuk mengalami kejadian tanah runtuh pada bila-bila masa seperti yang berlaku di kawasan Gua Tempurung, Ipoh, semalam terutamanya dalam bulan ini.

Pengarah Pusat Penyelidikan Hakisan Tanah Negara (NASET), Universiti Teknologi Mara (UiTM), Prof. Dr. Roslan Zainal Abidin yang membuat kajian mengenai perkara itu sejak tahun 2000 berkata, kawasan berkenaan ialah 43 lokasi di Perak, 39 (Selangor) dan 23 (Negeri Sembilan).

Menurut beliau, punca menyebabkan kawasan itu mudah mengalami runtuhan tanah ialah muka buminya yang berlekuk.

"Berdasarkan kajian yang kami buat sejak tahun 2000, keadaan muka bumi yang bergeluk atau berlekuk merupakan satu tahap kritikal di mana runtuhan tanah boleh berlaku pada bila-bila masa, lebih-lebih lagi apabila hujan lebat.

"Berdasarkan data-data hujan yang diperoleh, kami dapati bulan Oktober merupakan bulan bahaya di sepanjang lebuh raya tersebut berikutan kadar hujan yang besar biasa, ia diikuti bulan April, September dan November," katanya.

Antara kawasan yang dikenal pasti berisiko tinggi mengalami tanah runtuh dikesan di Perak ialah di Songkai, Slim River, Tapah, Bidor, Simpang Kampung Pulai dan Jelapang.

Dr. Roslan memberitahu hasil kajian berhubung hakisan tanah sepanjang lebuh raya itu kepada *Utusan Malaysia* hari ini kerana diminta mengulas kejadian tanah runtuh di Kilometer 303 Lebuh Raya Utara-Selatan berhampiran Gua Tempurung semalam.

Kejadian tanah runtuh kali kedua di kawasan yang hampir sama di Gua Tempurung itu menyebabkan seorang penunggang motosikal cedera parah.

Dalam kejadian itu juga, empat kenderaan termasuk sebuah lori turut terperangkap berhampiran tanah runtuh pada kejadi...

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LANDSLIDE TRAGEDY AT KM52 JALAN TAPAH-CAMERON HIGHLAND (24th February 2004)

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LANDSLIDE AT RANAU, TAMPARULI (26th June 2004)

Runtuhan hampir jejaskan hubungan Ranau, Tamparuli

KUNDASANG: Satu runtuhan besar berlaku di jalan Kiau-Nabalu berhampiran Gunung Kinabalu kelmarin, menyebabkan perhubungan antara daerah Ranau dengan Tamparuli hampir terputus.

Runtuhan itu berlaku di tembok penghadang berhampiran Hutan Simpan Tinompok kira-kira jam 11 pagi kelmarin, yang menyebabkan beratus-ratus kenderaan terkandas di kawasan itu.

Lahan yang terjejas itu letaknya kira-kira 27 kilometer dari Pekan Ranau atau kira-kira 95 kilometer dari ibu negeri serta kira-kira tiga kilometer dari Taman Negara Kinabalu.

Berikutan itu, pemandu kenderaan yang melalui jalan daerah ini ke Pantai Timur termasuk Sandakan, dinasihatkan supaya memandu dengan berhati-hati bagi memastikan runtuhan tidak menimpa mereka.

Tinjauan mendapati satu lahan sementara sepanjang 50 meter yang hanya mampu dilalui sekurang-kurangnya sebuah lori, mula dibuka pada pada jam 2 pagi semalam.

Operasi pembaikan dan pembersihan sementara itu dilakukan oleh kira-kira 30 kakitangan Jabatan Kerja Raya (JKR) dengan menggunakan bantuan jentera berat.

Jurucakap jabatan itu ketika ditemui berkata, mereka akan mendirikan khemah sementara untuk memantau runtuhan itu bagi tempoh dua minggu.

"Kami perlu membersihkan lorong itu dan masih menunggu arahan daripada jurutera kami untuk tindakan lanjut dan bagi menyelesaikannya untuk jangka masa panjang.

"Ketika ini, kami mengawasi tiga bahagian di pinggir bukit berikutan terdapat lekuk besar yang kelihatan akan runtuh pada bila-bila masa saja," katanya.

SEORANG anggota polis memantau runtuhan batu di Jalan Kiau-Nabalu berhampiran Gunung Kinabalu, kelmarin. – Gambar oleh Edmund Samunting

Seorang pengusaha restoran, Justin Dinsin, yang menjalankan perniagaan kira-kira 150 meter dari tempat kejadian mendakwa lahan itu mula akibat dihempap sebiji batu besar.

Beliau berkata, bunyi runtuhan itu seperti dentuman guruh ketika hujan lebat dan ia hanya berdentum sekali.

Sambil menoleh ke arah jalan itu, beliau yang berasal dari Kampung Kiau-Toburi, Kota Belud, berkata, ketika itu tiada ujan dan mendakwa runtuhan biasanya berlaku ketika musim kering.

"Keadaan ini sudah lama berlanjutan dan jika diperhatikan tidak ada orang yang membina rumah di kawasan bukit ini kerana tahu runtuhan seperti ini sering berlaku," kata.

Seorang anggota polis yang bertugas di tempat kejadian berkata, mereka kini berjaga-jaga kerana khuatir batu berguguran apabila angin bertiup kencang atau ketika kenderaan berat melaluinya.

"Masih ada beberapa runtuhan dikesan pagi semalam, apabila batu sebesar televisyen bergolek dan jatuh ke atas jalan raya sehingga hampir menghempap sebuah kenderaan," katanya.

Kawasan runtuhan itu adalah perhubungan utama laluan darat antara Pantai Timur dan Pantai Barat, biarpun terdapat laluan lain tetapi ia mengambil masa kira-kira tiga jam untuk sampai ke ibu negeri.

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TAMAN PUSING INDAH, BATU GAJAH, PERAK
(7TH January 2006)

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BUKIT BELIMBING
(11TH May 2006)

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TAMAN CHERAS AWANA
(17TH June 2006)

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SECTION 10, WANGSA MAJU
(9TH October 2006)

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GURUN, KEDAH
(5TH November 2006)

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PERSINT 9, PUTRAJAYA
(22 March 2007)

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JALAN DUTA, KUALA LUMPUR
(3 June 2007)

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TAMAN MELAWATI
26 September 2007

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TRAGEDI BANGUNAN RUNTUH DI TASIK BANDING, GERIK PERAK (13 NOVEMBER 2007)

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KM 64 TAIPING – KUALA KANGSAR
22 November 2007

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MEDAN - DAMANSARA
11 November 2008

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ULU YAM PERDANA - SELANGOR
30 November 2008

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TAMAN MEWAH, BUKIT ANTARABANGSA
6 December 2008

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RUMAH ANAK YATIM DAN ANAK HIDAYAH MADRASAH AT-TAQWA KAMPUNG SUNGAI GAHAL, HULU LANGAT

21 May 2011

Infrastructure University Kuala Lumpur

PERKAMPUNGAN ORANG ASLI SUNGAI RUIL, CAMERON HIGHLANDS
7 August 2011

Headline	Kerajaan perlu lakukan kajian kecerunan hadapi tanah runtuh		
Date	10 Aug 2011	Language	Malay
MediaTitle	Utusan Malaysia	Page No	11
Section	Dim Negeri	Article Size	120 cm²
Journalist	N/A	Color	Black/white
Frequency	Daily	ADValue	1,564
Circ / Read	197,952 / 833,287	PRValue	4,692

Kerajaan perlu lakukan kajian kecerunan hadapi tanah runtuh

KUALA LUMPUR 9 Ogos - Kerajaan diminta melakukan kajian kecerunan ke atas kawasan yang berisiko tinggi berlakunya kejadian tanah runtuh dan menghimpunkan data berkenaan ke dalam satu direktori dalam usaha mengekang kejadian tersebut daripada berulang.

Pakar tanah runtuh dan kecerunan, Kolej Universiti Infrastruktur Kuala Lumpur (KLIUC), Prof. Dr. Roslan Zainal Abidin berkata, terdapat banyak faktor yang menyebabkan berlaku tanah runtuh, antaranya keadaan fizikal tanah dan hujan yang berterusan.

"Justeru, menerusi direktori seperti itu, ia secara tidak langsung dapat membantu mengenal pasti kawasan-kawasan sensitif dan berisiko tinggi berlakunya tanah runtuh.

"Setiap kerajaan negeri sepatutnya mengambil tindakan mengumpul data-data seperti taburan hujan dan inventori kecerunan kawasan tanah tinggi di negeri masing-masing," katanya ketika dihubungi *Utusan Malaysia* di sini hari ini.

Beliau mengulas kejadian tanah runtuh yang mengorbankan tujuh mangsa di Perkampungan Orang Asli Sungai Ruil, Cameron Highlands, Pahang, kelmarin.

Katanya, inventori terbabit mampu membantu pihak yang terlibat melakukan pemantauan dan bersedia dalam menghadapi bencana yang merbahaya itu.

Sementara itu, Ketua Pusat Penyelidikan Alam Sekitar Universiti Teknologi Mara (UiTM), Prof. Dr. Ku Halim Ku Hamid tidak menolak kemungkinan penarahan tanah yang tidak konsisten merupakan penyumbang kejadian tanah runtuh di Cameron Highlands tersebut.

"Perubahan struktur tanah mengambil masa dan berlaku secara perlahan-lahan. Justeru, pembangunan yang dibuat akan hanya menunjukkan kesannya dalam jangka masa panjang.

"Tanah runtuh terjadi apabila sifat fizikal tanah berubah dan adanya pergerakan tanah yang kuat lalu terjadi tanah runtuh sehingga boleh menyebabkan penempatan yang berada di lereng tersebut musnah," katanya.

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PUNCAK BUKIT MUTIARA, TANJUNG BUNGAH, PENANG
1 June 2012

Infrastructure University Kuala Lumpur

Landslide in Putra Heights buries six vehicles
4 January 2013

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NEXT LANDSLIDE TRAGEDY

WHEN???

WHERE???

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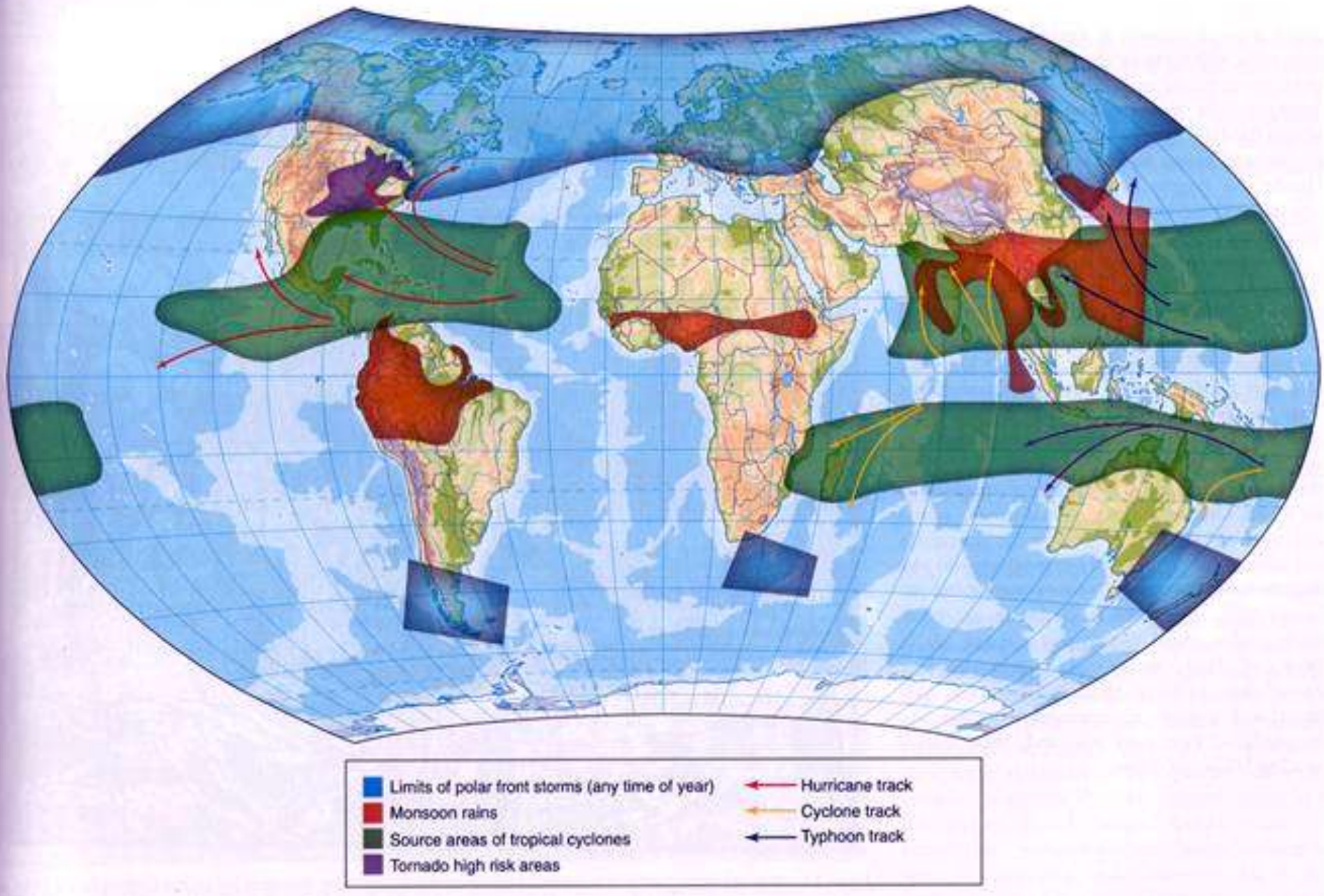
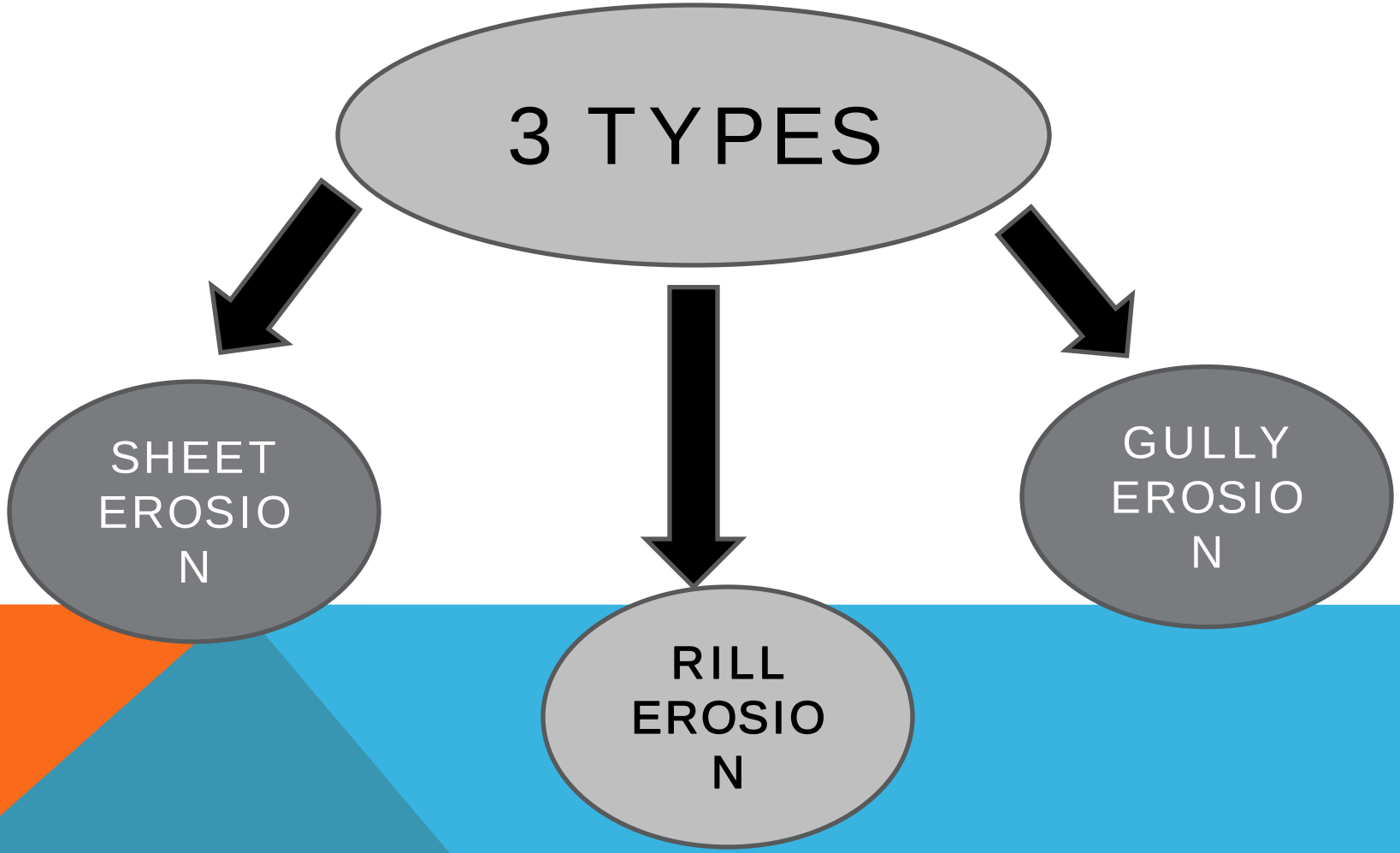


Figure 1.7 Floods and windstorms can occur anywhere on the planet. Monsoon and storm track disposition, however, provides a guide to those regions that are worst and repeatedly affected by meteorological hazards. Modified from Maslin (2002).

INTRODUCTION

- Erosion induced landslide poses enormous threats and fear
- Claiming lives, caused severe damages to and properties arrests development in urban and rural areas
- Identification of potential erosion induced landslide locations is significantly crucial in leading to the determination of landslide risk areas
- Appropriate mitigating measures against erosion induced landslide is essential in planning new development project

EROSION FEATURES



SHEET EROSION

RILL EROSION

GULLY EROSION

Classification of Slope Movement (After Varnes, 1978)

TYPE OF MOVEMENT			TYPE OF MATERIAL		
			Bedrock	Engineering Soils	
				Predominantly Coarse	Predominantly Fine
Falls			Rock fall	Debris fall	Earth fall
Topples			Rock topples	Debris topples	Earth topples
Slides	Rotational	Few units	Rock slump	Debris slump	Earth slump
	Translational	Few units	Rock block slide	Debris block slide	Earth block
		Many units	Rock slide	Debris slide	Earth slide
Lateral spread			Rock spread	Debris spread	Earth slide
Flows			Rock flow	Debris flow	Earth flow
Complex			Combination of two or more principal types of movement		

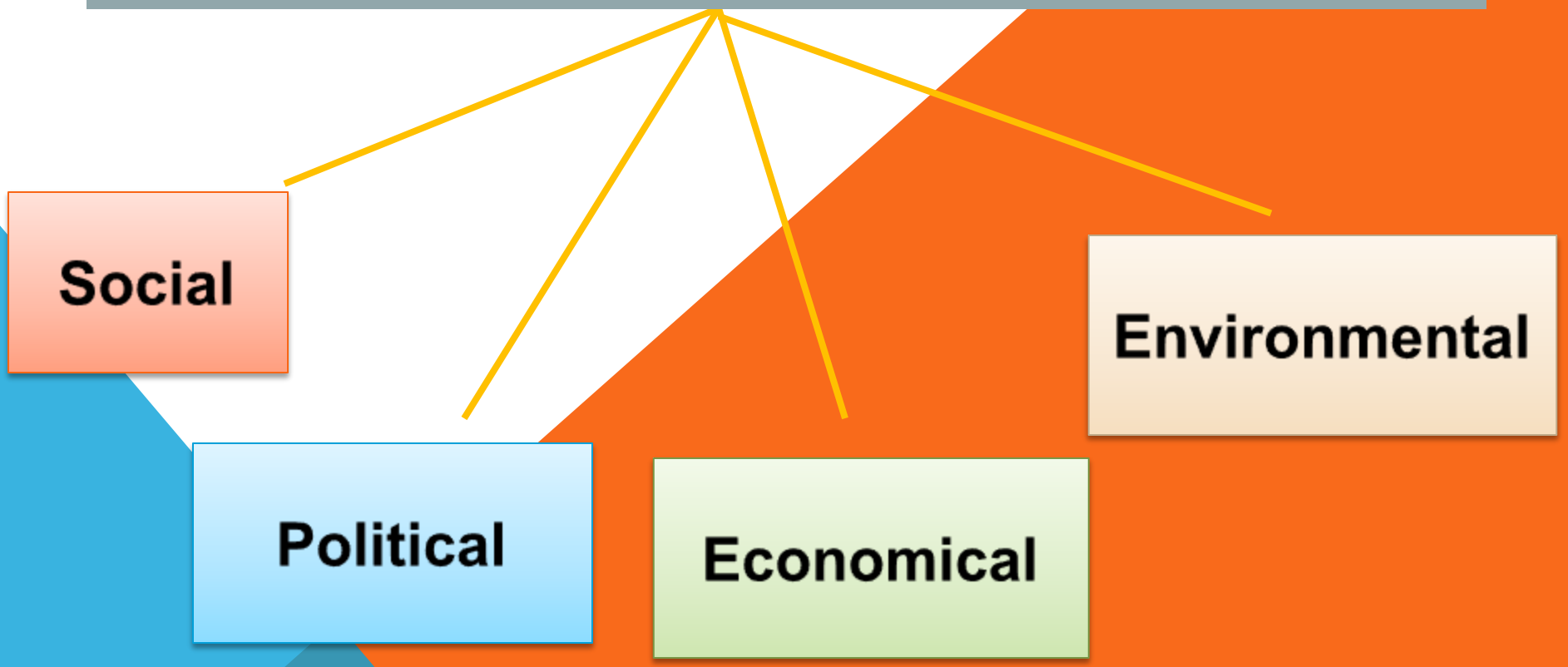
- Landslide Prone Areas
  - Hilly Terrain
  - Deep weathered rock profiles.
  - High seasonal Rainfall.
  - Development close to hill slide.
  - Inadequate slope maintenance.

- Past Landslide had killed more than 500 people in Malaysia since 1961. Most Landslide occurred on Man made slopes which were triggered by heavy rainfall.

- Resulting economic loss was estimated to be about more than RM2.5 billion.

- Heavy rainfall in tropical/ equatorial areas is largely responsible for the many slope failure that accured in steep terrain, rapid infiltration of water is due to high permeability of residual soil material.

Impact of Landslide



- Not practical to freeze all hill slope developments which are demanded by the free market as well as the increase in Land use by the growing population in urban area.

- Criteria for allowing new hill slope development have become more stringent as there are more than 13 government agencies to carry out the evaluation.

SOME MAJOR LANDSLIDE IN MALAYSIA

Place	Date	Consequence	Estimated loss (RM Millions)
Ringlet, Cameron Highlands	1961	16 deaths	35
Highland Tower, Selangor	1993	48 deaths	185
Genting Sempah jalan ke Genting Highlands, Selangor.	1995	20 deaths	48
Lebuh Raya Utara Selatan di Gua Tempurung, Perak.	1996	1 deaths, expressway closed for 15 days	17
Aliran puing keningau, Sabah.	1996	302 deaths	456
Simunjan, Sarawak	2002	16 deaths	32
Km 44 Jalan Spg. Pulai Cameron Highlands	2000	Road opened in 2004 (4 years delay)	355
Bukit Lanjan, Lebuhraya NKVE	2003	Expressway closed for 6 months	860
Kg. Pasir, Ulu Kelang	2006	4 deaths	21
Bukit Antarabangsa, Selangor	2008	5 deaths	200

Number of major landslide according to states since January 2000 – February 2013

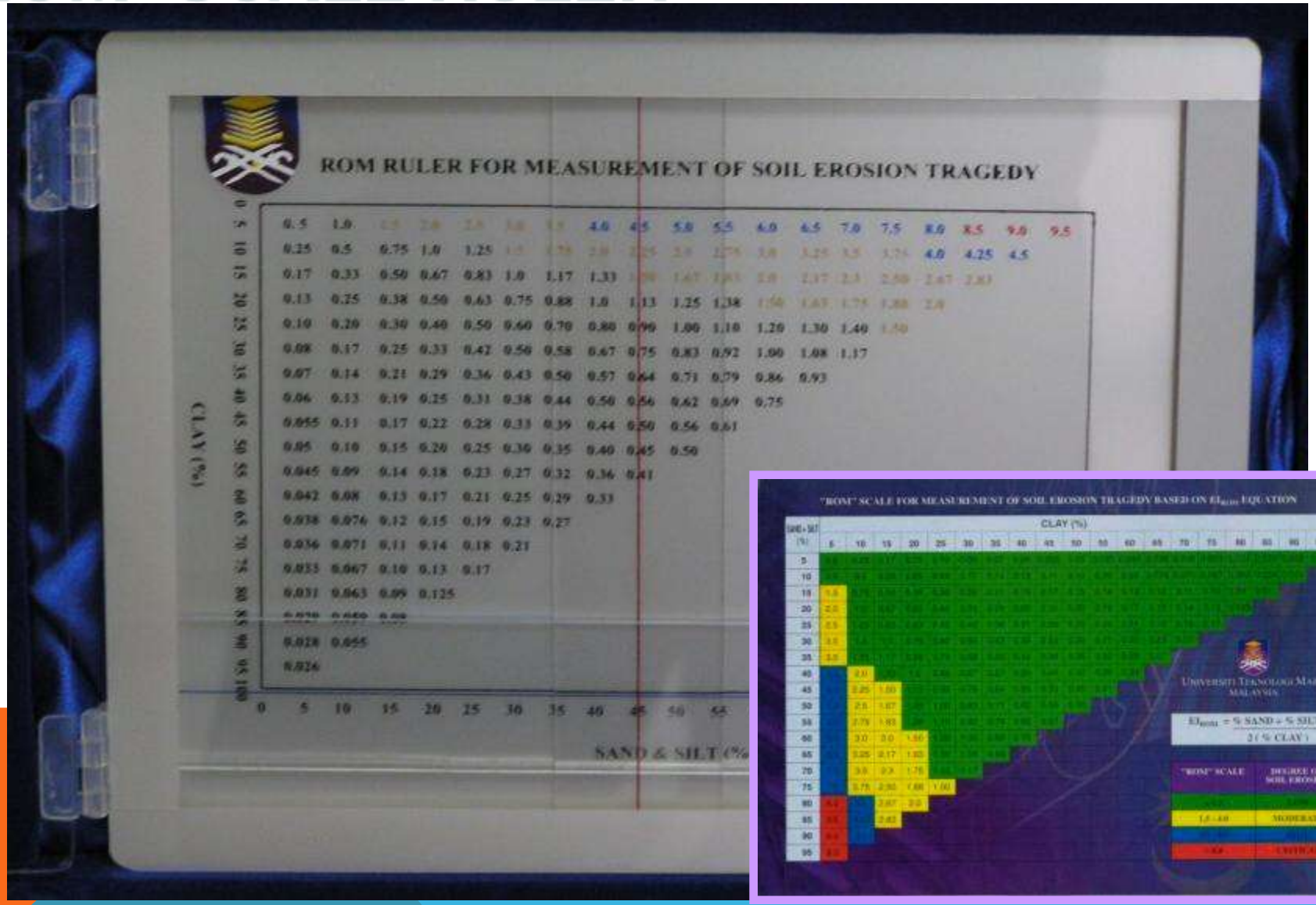
No.	States	Number of Landslide
1	Sarawak	12
2	Federal Territory	11
3	Sabah	9
4	Pahang	10
5	Selangor	7
6	Perak	5
7	Johor	4
8	Pulau Pinang	4
9	Negeri Sembilan	3
10	Kedah	3
11	Kelantan	2
12	Terengganu	0
13	Perlis	0
14	Melaka	0

EROSION INDUCED LANDSLIDE : SOIL ERODIBILITY

‘ROM’ SCALE SOFTWARE

'ROM' Scale	*Soil Erodibility Category*
< 1.5	Low
1.5 ~ 4.0	Moderate
4.0 ~ 8.0	High
8.0 ~ 12.0	Very High
> 12.0	Critical

‘ROM’ SCALE RULER



DEGREE OF SOIL ERODIBILITY AT LANDSLIDE TRAGEDY SITE

No.	*Date*	*Landslide Tragedy Location*	*Erodibility Values*	*'ROM' Scale Category*
1	11 Dec 93	Highland Tower	15	Critical
2	26 Dec 93	Km 72 Gerik – Jeli	14	Critical
3	8 Dec 94	Km 29 Tapah – Tanah Rata	13	Critical
4	30 Jun 98	Genting Highland	4	High
5	01 Jul 98	Kuala Lumpur - Karak	5	High
6	28 Nov 98	Bukit Awana, Paya Terubong Penang	5	High
7	15 May 99	Bukit Antarabangsa,Ulu Kelang	7	High
8	07 Dec 99	Paya Terubung, Pulau Pinang	5	High
9	28 Jan 02	Kampung Ruan Changkul	24	Critical
10	20 Nov 02	Taman Hillview	4	High
11	24 Feb 04	Cameron Highland	38	Critical
12	11 Oct 04	KM 303 Gua Tempurung	20	Critical
13	17 Dec 05	KM 42 Cameron Highland (Tapah- Ringlet)	28	Critical
14	08 Jan 06	Taman Pusing, Ipoh	2	Moderate
15	15 Jan 06	Taman Desa, Jalan Kelang Lama	2	Moderate
16	16 Apr 06	Kg. Sg. Bukit Putih, Ampang	4	High
17	17 May 06	Taman Bukit Belimbing, Balakong	10	Very High

No.	*Date*	*Landslide Tragedy Location*	*Erodibility Values*	*'ROM' Scale Category*
18	01 June 06	Kg. Pasir, Ulu Kelang	3	Moderate
19	25 June 06	Karambunai, Sabah	10	Very High
20	03 Oct 06	Wangsa Maju, Kuala Lumpur	21	Critical
21	07 Nov 06	Gunung Jerai, Kedah	40	Critical
22	11 Nov 06	Kg. Sg. Bukit Putih, Ampang	13	Critical
23	18 Nov 06	Puchong Jaya	2	Moderate
24	23 Nov 06	Taman Bukit Serdang	4	High
25	28 Nov 06	KM 262.6	21	Critical
26	29 Dec 06	Kapit, Sarawak	9	Very High
27	12 Jan 07	Jalan Lela, Sandakan	17	Critical
28	27 Feb 07	Taman Pelangi, Rawang	15	Critical
29	21 Mar 07	Wilayah Persekutuan Putrajaya	11	Very High
30	02 June 07	Jalan Duta, Kuala Lumpur	2	Moderate
31	02 Aug 07	Lorong Ayer Panas Baharu, Kuala Lumpur	12	Critical
32	30 Nov 08	Ulu Yam Perdana	11	Very High
33	6 Dec 08	Taman Bukit Mewah, Bukit Antarabangsa	23	Critical

EROSION INDUCED LANDSLIDE : RAINFALL EROSIVITY

‘ROSE’ INDEX SOFTWARE

DEGREE OF 'ROSE' INDEX IN CATEGORISING RAINFALL EROSIVITY (ROSLAN & SHAFEE, 2005)

'ROSE' INDEX (ton m^2 / ha.hr)	CATEGORY
< 500	LOW
500 – 1000	MODERATE
1000 – 1500	HIGH
1500 – 2000	VERY HIGH
> 2000	CRITICAL

‘ROSE’ INDEX CATEGORY WITH RESPECT TO LANDSLIDE INCIDENTS

Rank	Landslide sites	Rainfall erosivity (ton m^2 / ha.hr)	‘ROSE’ Index Category
1	Kg. Sg. Bukit Putih, Ampang	3886	Critical
2	Lorong Ayer Panas Baharu, Kuala Lumpur	3560	Critical
3	Taman Harmonis, Gombak	2870	Critical
4	Gunung Jerai, Sg. Petani Kedah	2600	Critical
5	Taman Hillview	2574	Critical
6	Wangsa Maju, Kuala Lumpur	2354	Critical
7	Bukit Awana, Paya Terubong Penang	1875	Very High
8	Bandar Country Homes	1469	High
9	Kg. Pasir, Ulu Kelang	1469	High
10	Jalan Duta, Kuala Lumpur	1434	High

11	**Taman Pusing, Ipoh**	**1326**	**High**
12	**Tanah Rata Cameron Highland**	**1169**	**High**
13	**Bukit Antarabangsa, Ulu Kelang**	**1157**	**High**
14	**Kg. Sg. Bukit Putih, Ampang**	**1095**	**High**
15	**Taman Pelangi, Rawang**	**977**	**Moderate**
16	**Taman Beringin, Kepong**	**870**	**Moderate**
17	**Highland Tower**	**868**	**Moderate**
18	**Taman Desa, Jalan Kelang Lama**	**733**	**Moderate**
19	**Karambunai, Sabah**	**556**	**Moderate**
20	**Wilayah Persekutuan Putrajaya**	**136**	**Low**
21	Jalan Duta, Kuala Lumpur	**1434**	**High**
22	Setapak, Kuala Lumpur	**3560**	**Critical**
23	Ulu Yam Perdana	**3044**	**Critical**
24	Taman Bukit Mewah, Bukit Antarabangsa	**1356**	**High**

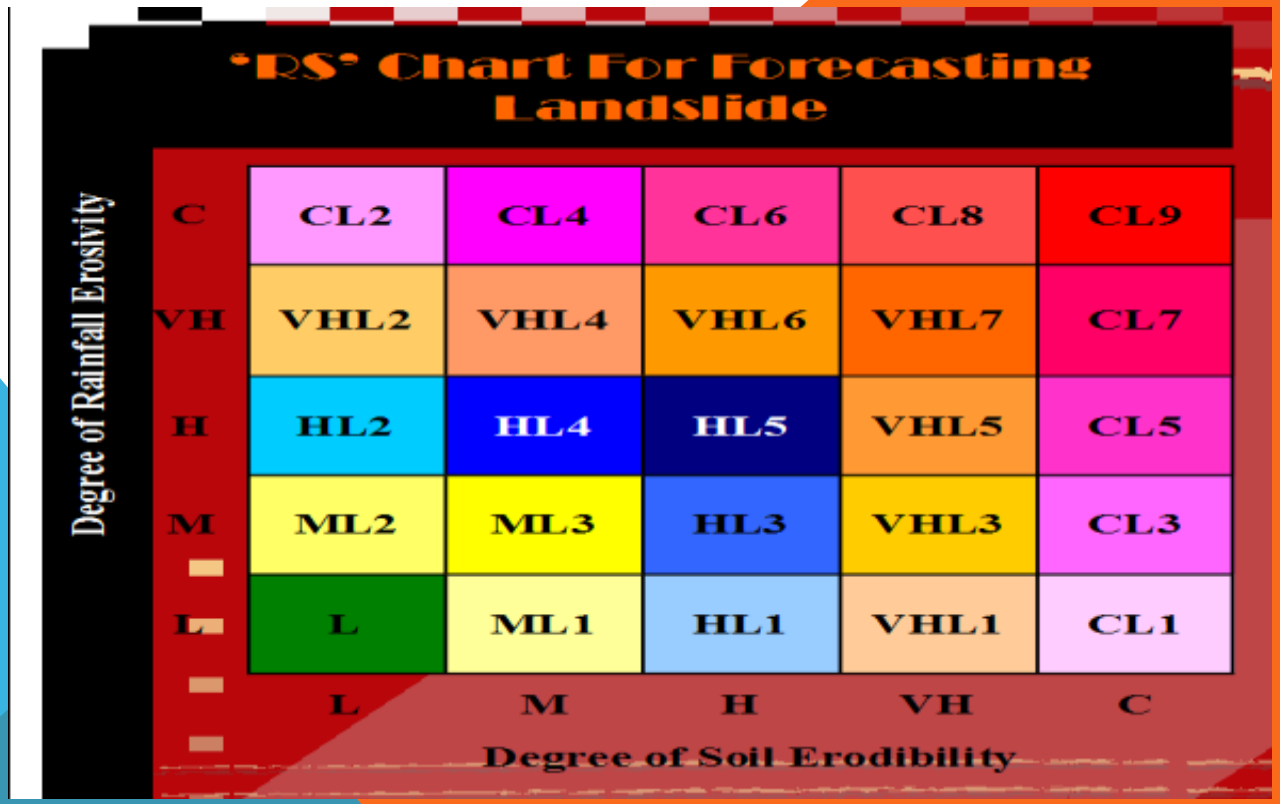
Landslide risk month ranking with regards to rainfall erosivity at various highland areas

Highland Areas	Dangerous Month Ranking											
	1	2	3	4	5	6	7	8	9	10	11	12
Gunung Pulai	Jan	Mar	Sept	July	Oct	Apr	Nov	June	Feb	Dec	Aug	May
Genting Highland	Nov	July	May	Oct	Apr	Mar	Feb	June	Sept	Dec	Aug	Jan
Bukit Tinggi	Nov	July	May	Oct	Apr	Mar	Feb	June	Sept	Dec	Aug	Jan
Fraser Hill	Nov	Dec	Apr	Feb	June	Oct	Jan	Sept	Mar	May	July	Aug
Cameron Highland	Apr	Oct	Dec	Mar	Jan	Feb	May	July	Aug	Nov	Sept	June
Maxwell Hill	Nov	Mar	Mar	Feb	Apr	May	Oct	June	Dec	Jan	July	Aug
Penang Hill	Oct	Sept	Aug	Apr	Nov	July	June	May	Dec	Mar	Feb	Jan
Gunung Jerai	Oct	Nov	Sept	Apr	Aug	Mar	June	May	July	Dec	Jan	Feb
Gunung kerengga	May	Mar	Apr	Oct	June	July	Aug	Dec	Jan	Nov	Sept	Feb
Gunung Raya	Nov	Aug	Oct	June	Sept	May	Apr	Mar	July	Jan	Dec	Feb

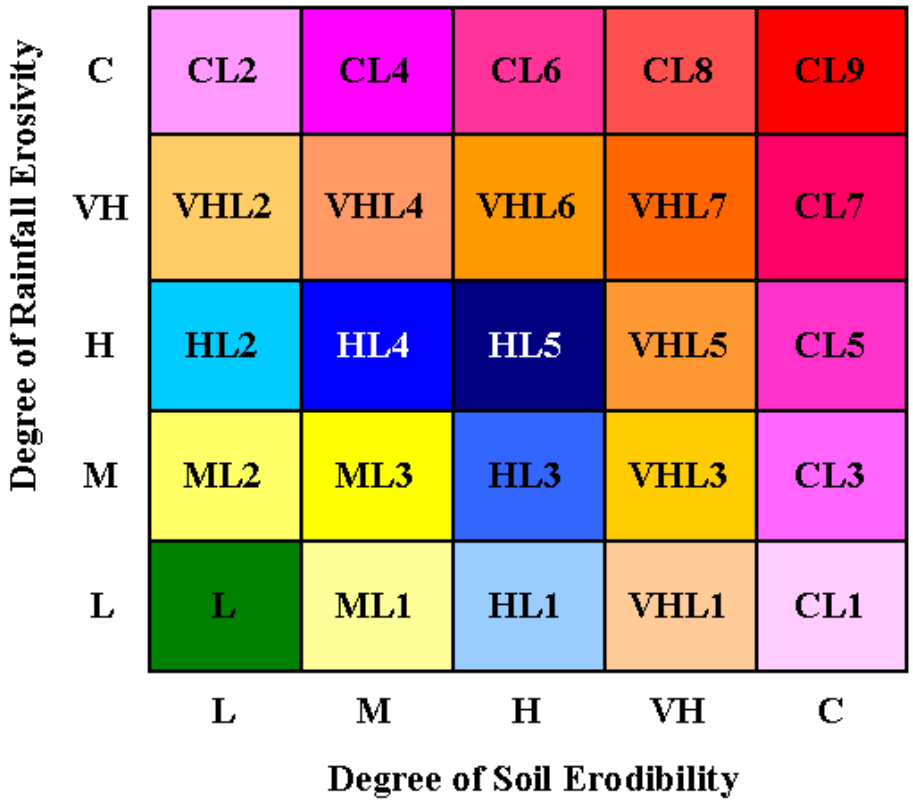
COMBINATION OF SOIL ERODIBILITY & RAINFALL EROSIVITY ('RS' CHART)

‘RS’ CHART SOFTWARE

COMBINATION OF SOIL ERODIBILITY & RAINFALL EROSIVITY ('RS' CHART)



RAINFALL-SOIL CHART FOR FORECASTING EROSION INDUCED LANDSLIDE



COLOUR INDICATOR	DEGREE OF LANDSLIDE RISK
L	Low
ML1	Moderate Level 1
ML2	Moderate Level 2
ML3	Moderate Level 3
HL1	High Level 1
HL2	High Level 2
HL3	High Level 3
HL4	High Level 4
HL5	High Level 5
VHL1	Very High Level 1
VHL2	Very High Level 2
VHL3	Very High Level 3
VHL4	Very High Level 4

COLOUR INDICATOR	DEGREE OF LANDSLIDE RISK
VHL5	Very High Level 5
VHL6	Very High Level 6
VHL7	Very High Level 7
CL1	Critical Level 1
CL2	Critical Level 2
CL3	Critical Level 3
CL4	Critical Level 4
CL5	Critical Level 5
CL6	Critical Level 6
CL7	Critical Level 7
CL8	Critical Level 8
CL9	Critical Level 9

LANDSLIDE TRAGEDY WITH REGARDS TO LANDSLIDE RISK LEVEL USING RAINFALL SOIL CHART

NO	DATE	LOCATION	'ROM' SCALE	'ROSE' INDEX	RISK LEVEL
1	11 Dec 93	Highland Tower	15	868	CL3
2	07 Dec 94	Kg.Raja, Tanah Rata Cameron Highland	55	1169	CL7
3	28 Nov 98	Bukit Awana, Paya Terubong Penang	5	1875	VHL6
4	15 May 99	Bukit Antarabangsa, Ulu Kelang	7	1157	HL5
5	20 Nov 02	Taman Hillview	4	2574	CL6
6	08 Jan 06	Taman Pusing, Ipoh	2	1326	HL3
7	15 Jan 06	Taman Desa, Jalan Kelang Lama	2	733	ML3
8	16 Apr 06	Kg. Sg. Bukit Putih, Ampang	4	3886	CL6
9	01 June 06	Kg. Pasir, Ulu Kelang	3	1469	HL4
10	25 June 06	Karambunai, Sabah	10	556	CL3
11	03 Oct 06	Wangsa Maju, Kuala Lumpur	21	2354	CL9
12	07 Nov 06	Gunung Jerai, Sg. Petani Kedah	40	2600	CL9
13	10 Nov 06	Kg. Sg. Bukit Putih, Ampang	13	1095	CL5
14	27 Feb 07	Taman Pelangi, Rawang	15	977	CL3
15	02 June 07	Jalan Duta, Kuala Lumpur	2	1434	HL4
16	08 June 07	Setapak, Kuala Lumpur	12	3560	CL9
17	23 Nov 07	Jalan Kuala Kangsar, Taiping Perak	52	968	CL3
18	21 March 07	Putrajaya, Federal Teritory	11	136	VHL1
19	06 Dec 08	Tmn. Bkt. Mewah, Bkt. Antarabangsa	33	1356	CL5

HIGHLAND TOWER
(11 DECEMBER 1993)

RAINFALL EROSIVITY 868

SOIL ERODIBILITY 15

'RS' Chart

Degree of Rainfall Erosivity

C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1
	L	M	H	VH	C

Degree of Soil Erodibility

BUKIT AWANA, PENANG
(28 NOVEMBER 1998)

RAINFALL EROSIVITY 1875

SOIL ERODIBILITY 5

'RS' Chart

Degree of Rainfall Erosivity	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

Degree of Soil Erodibility

TAMAN PUSING, IPOH
(08 JANUARY 2006)

RAINFALL EROSIVITY 1326

SOIL ERODIBILITY 2

'RS' Chart

Degree of Rainfall Erosivity					
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1
	L	M	H	VH	C

Degree of Soil Erodibility

TAMAN DESA
(15 JANUARY 2006)

RAINFALL EROSIVITY
733

SOIL ERODIBILITY
2

'RS' Chart

Degree of Rainfall Erosivity	Degree of Soil Erodibility				
	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

KG. PASIR
(31 MAY 2006)

RAINFALL EROSIVITY 1469

SOIL ERODIBILITY 3

'RS' Chart

Degree of Rainfall Erosivity

C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1
	L	M	H	VH	C

Degree of Soil Erodibility

KARAMBUNAI
(25 JUNE 2006)

RAINFALL EROSIVITY 556

SOIL ERODIBILITY 10

'RS' Chart

Degree of Rainfall Erosivity	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

Degree of Soil Erodibility

WANGSAMAJU
(03 OCTOBER 2006)

RAINFALL EROSIVITY 2354

SOIL ERODIBILITY 21

'RS' Chart

Degree of Rainfall Erosivity	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

Degree of Soil Erodibility

GUNUNG JERAI
(07 NOVEMBER 2006)

RAINFALL EROSIVITY 2600

SOIL ERODIBILITY 40

'RS' Chart

Degree of Rainfall Erosivity	Degree of Soil Erodibility: L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

KG. SG. BUKIT PUTIH
(10 NOVEMBER 2006)

RAINFALL EROSIVITY 1095

SOIL ERODIBILITY 13

'RS' Chart

Degree of Rainfall Erosivity	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

Degree of Soil Erodibility

TAMAN PELANGI, RAWANG
(27 FEBRUARY 2007)

RAINFALL EROSIVITY 977

SOIL ERODIBILITY 15

"RS" Chart

Degree of Rainfall Erosivity	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

Degree of Soil Erodibility

TAMAN MELAWATI
(26 SEPTEMBER 2007)

RAINFALL EROSIVITY 2045

SOIL ERODIBILITY 20

'RS' Chart

Degree of Rainfall Erosivity	Degree of Soil Erodibility				
	L	M	H	VH	C
C	CL2	CL4	CL6	CL8	CL9
VH	VHL2	VHL4	VHL6	VHL7	CL7
H	HL2	HL4	HL5	VHL5	CL5
M	ML2	ML3	HL3	VHL3	CL3
L	L	ML1	HL1	VHL1	CL1

DANGEROUS MONTH OF EROSION INDUCED LANDSLIDE IN PENINSULAR & EAST MALAYSIA

STATE	DANGEROUS MONTH
Federal Territory	March, May & Nov
Johor	Dec, Sept & Nov
Melaka	March & June
Negeri Sembilan	March & June
Selangor	Nov, Dec & Apr
Perak	Jan, Nov & Dec
Penang	Sept & Nov
Kedah	Oct & Nov
Perlis	Oct & Nov
Kelantan	Jan & Dec
Terengganu	Jan & Dec
Pahang	Jan, Apr & Oct
Sarawak	Jan, Dec & Apr
Sabah	Jan, Feb & Dec

‘ROSE’ INDEX CATEGORY WITH RESPECT TO LANDSLIDE INCIDENTS

Rank	Landslide sites	Rainfall erosivity (ton m^2 / ha.hr)	‘ROSE’ Index Category
1	Kg. Sg. Bukit Putih, Ampang	3886	Critical
2	Lorong Ayer Panas Baharu, Kuala Lumpur	3560	Critical
3	Taman Harmonis, Gombak	2870	Critical
4	Gunung Jerai, Sg. Petani Kedah	2600	Critical
5	Taman Hillview	2574	Critical
6	Wangsa Maju, Kuala Lumpur	2354	Critical
7	Bukit Awana, Paya Terubong Penang	1875	Very High
8	Bandar Country Homes	1469	High
9	Kg. Pasir, Ulu Kelang	1469	High
10	Jalan Duta, Kuala Lumpur	1434	High

LANDSLIDE TRAGEDY WITH REGARDS TO LANDSLIDE RISK LEVEL USING RAINFALL SOIL CHART

NO	DATE	LOCATION	'ROM' SCALE	'ROSE' INDEX	RISK LEVEL
1	11 Dec 93	Highland Tower	15	868	CL3
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4	15 May 99	Bukit Antarabangsa, Ulu Kelang	7	1157	HL5
5	20 Nov 02	Taman Hillview	4	2574	CL6
6	08 Jan 06	Taman Pusing, Ipoh	2	1326	HL3
7	15 Jan 06	Taman Desa, Jalan Kelang Lama	2	733	ML3
8	16 Apr 06	Kg. Sg. Bukit Putih, Ampang	4	3886	CL6
9	01 June 06	Kg. Pasir, Ulu Kelang	3	1469	HL4
10	25 June 06	Karambunai, Sabah	10	556	CL3
11	03 Oct 06	Wangsa Maju, Kuala Lumpur	21	2354	CL9
12	07 Nov 06	Gunung Jerai, Sg. Petani Kedah	40	2600	CL9
13	10 Nov 06	Kg. Sg. Bukit Putih, Ampang	13	1095	CL5
14	27 Feb 07	Taman Pelangi, Rawang	15	977	CL3
15	02 June 07	Jalan Duta, Kuala Lumpur	2	1434	HL4
16	08 June 07	Setapak, Kuala Lumpur	12	3560	CL9
17	23 Nov 07	Jalan Kuala Kangsar, Taiping Perak	52	968	CL3
18	21 March 07	Putrajaya, Federal Teritory	11	136	VHL1
19	06 Dec 08	Tmn. Bkt. Mewah, Bkt. Antarabangsa	33	1356	CL5

STRATEGIES

- Government Agencies such as JKR, CIDB, JPS, Town Planners, developers, Architects, Engineers, contractors and House owner should work hand in hand in dealing with the safety of hill slope developments.

- Developers should be more careful with hill site developments by realising the associated risks.

- Providing sufficient budget to hire geotechnical engineers and contractors who have the relevant experience and knowledge.

- Not to compromise on any safety issues which will put public safety at risk.

- To put more emphasis slope safety during construction activities.

- Existing rules and laws related to hill slope developments should be strictly enforced particularly for maintenance works required by the local authorities.

- Routine inspections on the drainage system at landslide prone areas.

- A “Professional Engineer’s Due Diligence Report” is required for hill slope development to ensure Public Safety.

- A comprehensive infrastructure master plan should be in place before a hill slope development is approved. (Access roads, drainage, retaining structure, water & power supply & telecommunication etc.)

- Slope Catalogue/ Inventory must be made available.

- Conducting regular Audits to improve slope maintenance works.

- Systematic public education program to encourage private owners to maintain their slopes.

- Landslide warnings, emergency service and information to the public.

- Making man made slopes look as natural as possible and blending with the surrounding.

- Setting Geotechnical Standards and prepare professional Guidance documents for practitioners.

- Reduce Landslide Risk:
  - arising from new developments.
  - by improving the stability of existing slopes.
  - By minimising the possible consequences of Landslides.

- Full time supervision by independent Professional Engineers for hill slope development is crucial for successful rehabilitation work of failed slope or new developments.

- Regular maintenance after the design and construction stage as many failures are long term failures and do not happen immedeately.

- Training of local authority outfits should be more qualified in terms of monitoring in areas related to slope failures and maintenance.

- Must include comprehensive study on site assessment.

- With the existence of so many agencies, should avoids monopoly by any agency. Instead, centralised to one agency.

- Relevant authorities to carry out a survey and classification on existing hill slopes nationwide on the (i) development worthiness (ii) identification on critical areas prone to landslide and to inform the public of the findings.

- To devise a concrete policy and regulation on how hill slope development should be regulated and implemented.

- To set up a specialised agency to oversee the formulation of policy rules and regulations in safe development and maintenance on hill slope development as well as the implementation and enforcement of these rules and regulations.

- Developers to ensure that any future hill slope development is safe for the habitation of house buyers.

- Responsibility and liability are currently insufficient. To ensure these culpable are accountable. Impose on them a stiffer penalty and imprisonment since dealing with human lives.

- Administration of all slopes in Malaysia and the implementation of the National slope master plan (NSMP) spanning from 2009~ 2023 by the slope Engineering Division Public works Department.

- NSMP is to provide a comprehensive and effective national policy, strategy and Action plan for reducing landslide risks and losses.

- Successful implementation of the NSMP depend on the coorperation and interactive between various relevent agencies, the public, formation of a dedicated agency to administer and coordinate all slope work and guidelines.

- The National Physical plan supported environmentally sensitive areas to be conserved and integrated in the planning and management of land use and natural resources. (Town & Country planning Act. Section 52A)

SLOPE STABILISATION

- Resloping by flatteing the slope or creating berms or terraces.
- Drainage and surface protection are generally the most cost-effective solutions. Thus, slopes generally will not be safe without a high quality surface and efficient well maintained internal drainage system.
- Soil reinforcement method comprise of geosynthetics materials and other types of reinformcement for walls.

- Identifying landslide risk through hazard mapping by knowing the level of soil erodibility and rainfall erosivity.

- Frequent periodic inspection of facilities which are vulnerable to landslide.

- Observing any early of distress

- Maintaining and improving drainage system in areas vulnerable to landslide.

- Providing forecasted rainfall erosivity directory and soil erodibility inventory.

Key contributory factors to failure of engineered soil cuts in Hong Kong

Contributing factor	All failures	Minor failures	Major failures
Adverse groundwater conditions	30%	38%	75%
Weak geological material	46%	40%	67%
Inadequate slope maintenance	45%	55%	19%
Inadequate surface drainage provisions	5%	7.50%	Nil
Uncontrolled, concentrated surface water flow	2%	2.50%	Nil

Key contributory factors to failure of engineered soil cuts in Malaysia

- Inadequate slope maintenance
- Weak geological material
- Adverse groundwater conditions
- Inadequate surface drainage provision
- Uncontrolled, concentrated surface water flow

Lessons Learned From Recent Water – Related Disasters

Awareness of
- disaster risks,
- vulnerability by social change,
- possible climate change impacts

Insufficient preparedness due to
- lack of proper information,
- overconfidence or ignorance,
- limited budget

Needs for
- capacity building, education
- integrated disaster management,
- funding

Disaster Management Cycle

INTEGRATED RESEARCH ON DISASTER RISK (IRDR)

Legacy

An enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts.

Societies to shift focus from response-recovery towards prevention-mitigation, building resilience and reducing risks, learning from experience and avoiding past mistakes.

A natural disaster strikes when people lose their memory of the previous one.

災は忘れた頃にやってくる

By Dr. Torahiko Terada

(1878-1935)

TERIMA KASIH