



Sri Lanka is located between northern latitude of 5° 51' and 9° 51' and eastern longitude of 79° 40' and 81° 55'. It occupies an area of nearly 65,000 sq. km, stretching 435km from north to south and 224 km from west to east.

Climate varies from semi – arid to mild temperature

(This variation is due to central highland region, which is surround by an extensive low land area, as also because of the fact that the country is influenced by monsoonal and inter monsoonal periods).


Annual rainfall

2500mm to 5000mm in the south – west
 500mm – 2000mm in the north – east

Mean annual temperature – 27°C (low lands) :15°C (central highland).

Forests occupy 23.75% sq. km. of 39% of total land area.

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Landslides in Sri Lanka

Nearly 20% of the land area from 65,000Sq. km of total area in Sri Lanka was identified as landslide prone. These landslide prone areas are spread over in Badulla, Nuwara Eliya, Kandy, Matale, Ratnapura, Kegalle, Kalutara, Galle, Matara and Habantota districts.

Due to bad land use practices, Cutting failure incidents are increasing at Gampha and Colombo districts

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Present Situation of Landslides in Sri Lanka

Incidences and frequency of Landslides are growing. The present landslide density is estimated to be on the order of 1-2 landslides per sq.km

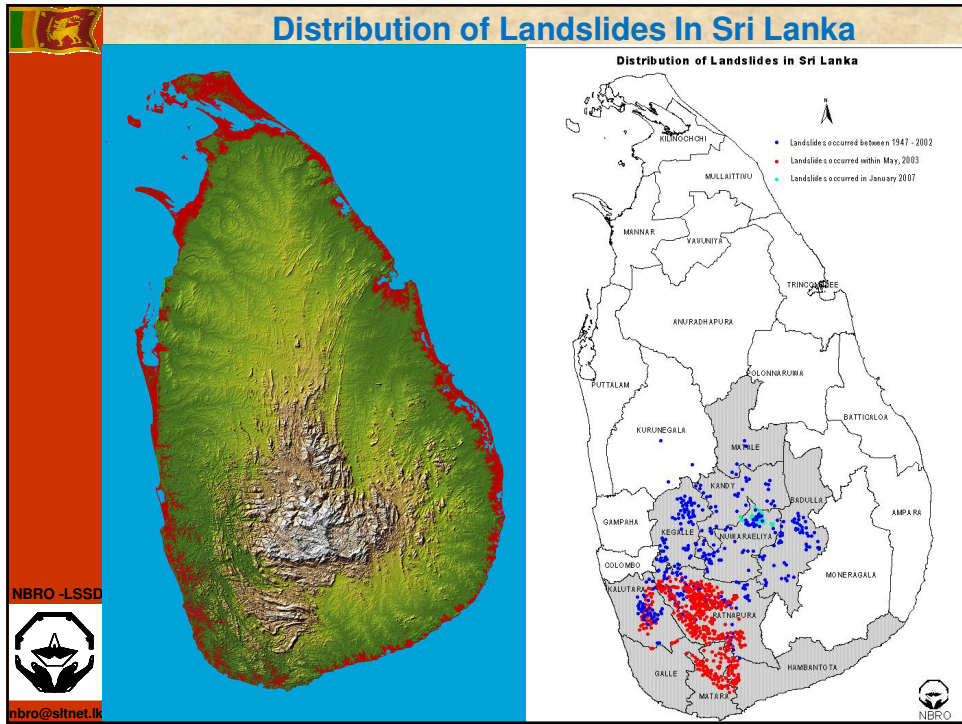
Each and Every rain it is common to have a one or two landslides or cutting failures .

Landslides in Sri Lanka occurs due to natural causes as well as due to man made causes

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Ladupita, Kiriwanella- Nuwara Eliya District 2007




Reactivation of Beragala Landslide (Badulla District) 2009


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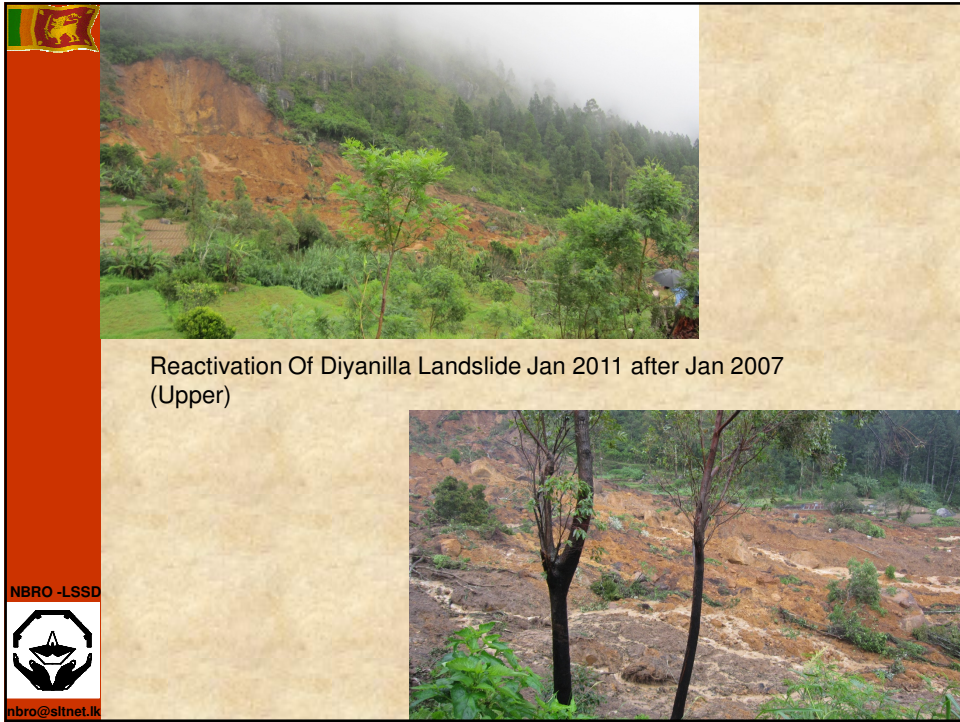
Reactivation of Mahawewa Landslide January 2011 after January 2007



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Landslides and Cutting failures in 2003

Districts	Landslides	Rock Fall	Old Landslides	Cutting Failures	Unstable Slopes
Ratnapura	117	21	23	68	138
Galle	05	01	01	12	03
Hambantota	11	-	-	-	-
Kalutara	07	04	06	18	07
Matara	71	07	06	25	39
Total	211	33	36	123	187

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Landslides in 2006

Districts	Landslides	Rock Falls	Old Landslides	Cutting Failures
Kandy	07	-	-	54
Kegalle	46	-	-	49
Badulla	09	01	02	22
Matale	03	01		10
Kalutara	-	-	-	05
Matale	03	01		10
Ratnapura	03	01	03	02
Gampha	-	-	-	06
Colombo	-	-	-	03
Total	71	04	05	161

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Landslides and Cutting failures in some districts - 2007

District	Landslides	Rock Fall	Retaining wall failures	Cutting Failures	Others
Galle	05	03	01	46	03
Kalutara	-	01	-	23	03
Total	05	04	01	69	06

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Summary of Landslide Victims in 2003				
District	High risk	Medium risk	Low risk	Total
Ratnapura	947	646	259	1852
Matara	467	249	131	844
Hambantota	133	29	2	164
Kegalle	31	49	5	85
Galle	37	23	25	85
Kalutara	41	38	17	96
N Eliya	1617	692	-	2309

Summary of Landslide Victims in 2007					
AGA Div.	Reported Sites	Investigated sites	High risk Families	Medium risk Families	Total
Walapane	198	148	897	380	1277
Hanguranketha	52	32	720	312	1032



Summary of landslide incidence Nov 2010 to Feb 2011						
District	Type of Landslide					Total
	Landslide	cutting Failure	Rock fall	Slope failure	Other	
Nuwra Eliya	23	7	2	3	2	37
Matale	11	3	9	1	6	30
Badulla	16	4	0	0	1	21
Kandy	17	22	2	9	0	50
Kegalle	8	7	0	0	1	16
Total	75	43	13	13	10	154




**Landslide events recorded during 26th and 27th May 2011
at Kegalle district**

Four people died due to landslide incidents

Divisional Secretariat	No of Landslide events	No of families in high hazard area	No of families in Medium hazard area
Galigamuwa	33	36	54
Bulatkohupitiya	07	24	00
Kegalle	06	00	01
Warakapola	17	08	08
Deraniyagala	03	04	05
Dehiowita	03	01	00
Yatiantota	06	05	06
Total	75	78	74





Landslide Management In Sri Lanka

Identification

Awareness

Early warning

Monitoring


Mitigation

Land use planning and Building
Guidelines

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Landslide Hazard Identification

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Landslide Hazard Identification

Landslide Hazard zonation mapping programme is in progress to identify the landslide vulnerable zones, considering the following factors

Scale 1:10000 & 1: 50000

Bed Rock Geology & Geological Structures

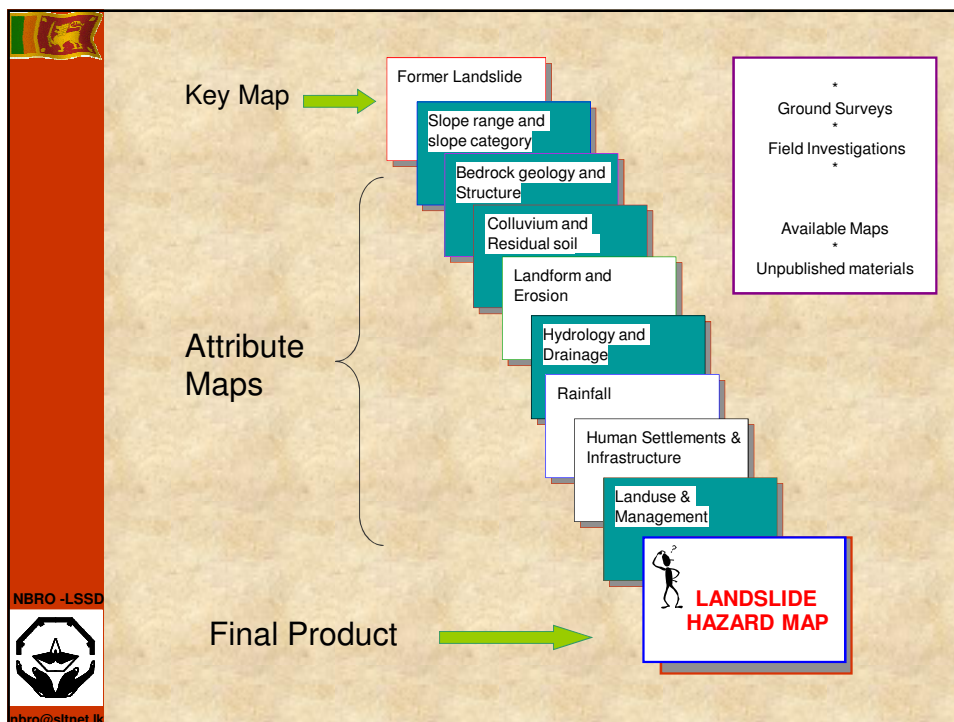
Surface Deposits (Soil Type – Colluvium & Residual Soil)

Slope Range & Category

Hydrology & Drainage

Land use & Management

Landform





LANDSLIDE SUSCEPTIBILITY EVALUATION					
Major factors, Maximum weighting & Qualitative rating	Sub factor, Maximum weighting & Qualitative rating	Sub factor elements	Linguistic rating(x), Qualitative rating(y) & Score(z)		
			x	y z	
Bedrock Geology & Geological structures*	20 B Lithology	8 A Marble	very low	E 0	
			low	B 1	
	Amount and Direction of dip (degrees)	4 C	Dip and scarp 20-90	very low	E 0
				low	D 1
	Dip-slip, scarp 45-55, and interm. slopes	6 B	Dip 0-10, scarp 20-45	medium	C 2
				high	B 3
	Dip 10-30, scarp 45-55, and interm. slopes	6 B	Dip 10-30, scarp 45-55, and interm. slopes	very high	A 4
				very low	E 0
	Dip 30-55, scarp 0-20	6 B	Dip 30-55, scarp 0-20	low	D 2
				high	B 4
Dip 55-90	6 B	Dip 55-90	very high	A 6	
			very low	E 0	
Discontinuities, lineaments, faults & master joints	2 E	To be decided on case to case basis	very low	E 0	
			very high	A 2	
Surface Deposits (colluvium & residual soils)	10 D Soil Cover (m)	10 A Bare bedrock	very low	E 0	
			low	D 2	
			medium	C 8	
			high	B 8	
Slope Range & Slope category	25 A Slope Range & category (degrees)	25 A	very high	A 10	
			very low	E 5	
			low	D 10	
			medium	C 15	
			high	B 20	
			very high	A 25	
Hydrology & Drainage	20 B Relief Amplitude (m)	5 A	very low	E 1	
			medium	C 2	
	Hydrological map unit Area (sq.km)	4 B	area 0.02 or > 0.5	very low	E 1
				medium	C 2
	Hydrological map unit Shape (Form factor)	4 B	0.5-1.0	very high	A 4
				very low	E 1
	Drainage density (km/km ²) with or without soil cover	5 A	with > 5 or without > 10	very high	A 5
				medium	C 2
	Proximity to water bodies	2 D	To be decided on case to case basis	very low	E 0
				medium	C 1
Land use and Management	15 C	Land use and Management	very low	E 3	
			medium	C 8	
Landform	10 D	Landform	very high	A 15	
			very low	E 1	

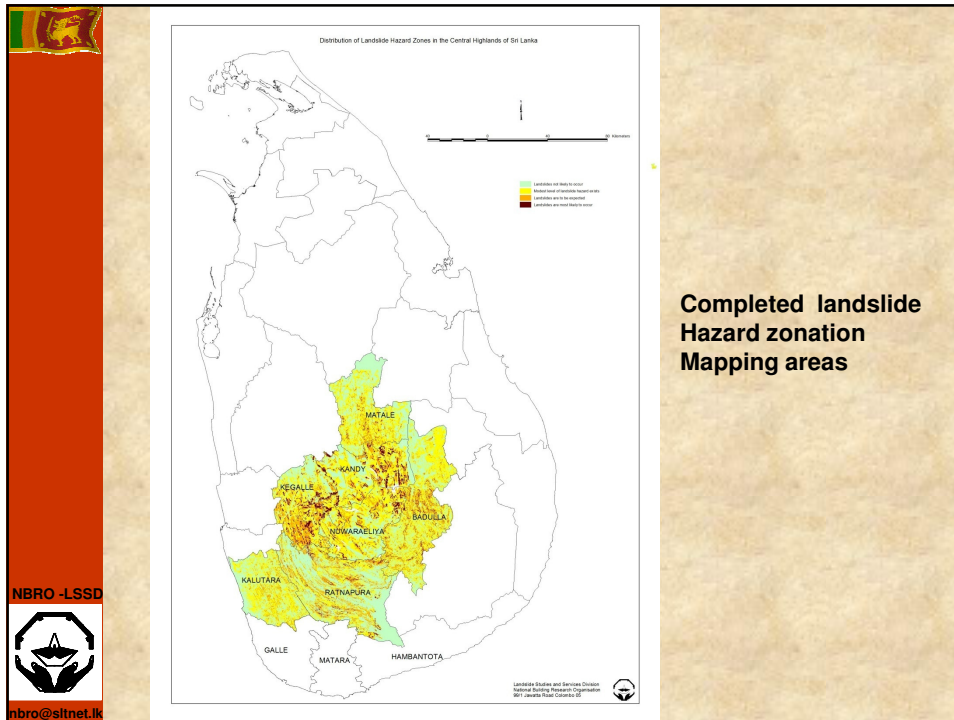
Allocated weights for attributes and factor maps - according to the statistical analysis and experts knowledge

- ❖ BEDROCK GEOLOGY - 20
- ❖ HYDROLOGY & DRAINAGE - 20
- ❖ SOIL COVER - 10
- ❖ SLOPE RANGE & CATEGORY - 25
- ❖ LAND USE & MANAGEMENT - 15
- ❖ LAND FORM - 10



Cumulative Attribute Values

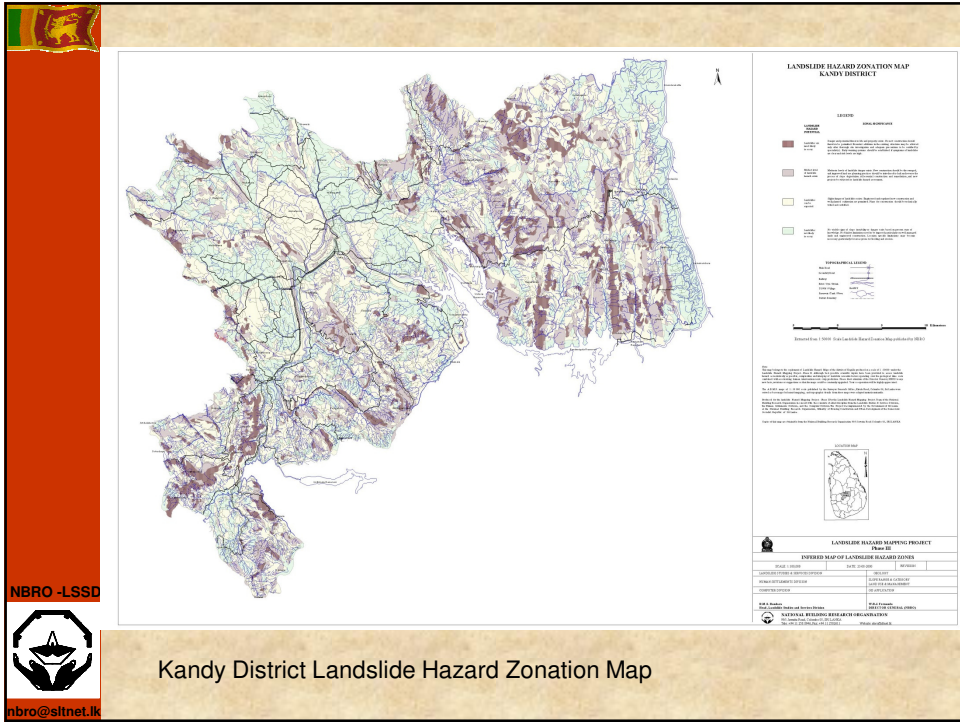
Description	Ranges
Safe area	$R \leq 40$ (Green)
Moderately Hazards	$40 < R \leq 55$ (Yellow)
Hazards	$55 < R \leq 70$ (Light Brown)
Most Hazards	$70 < R < 100$ (Dark Brown)



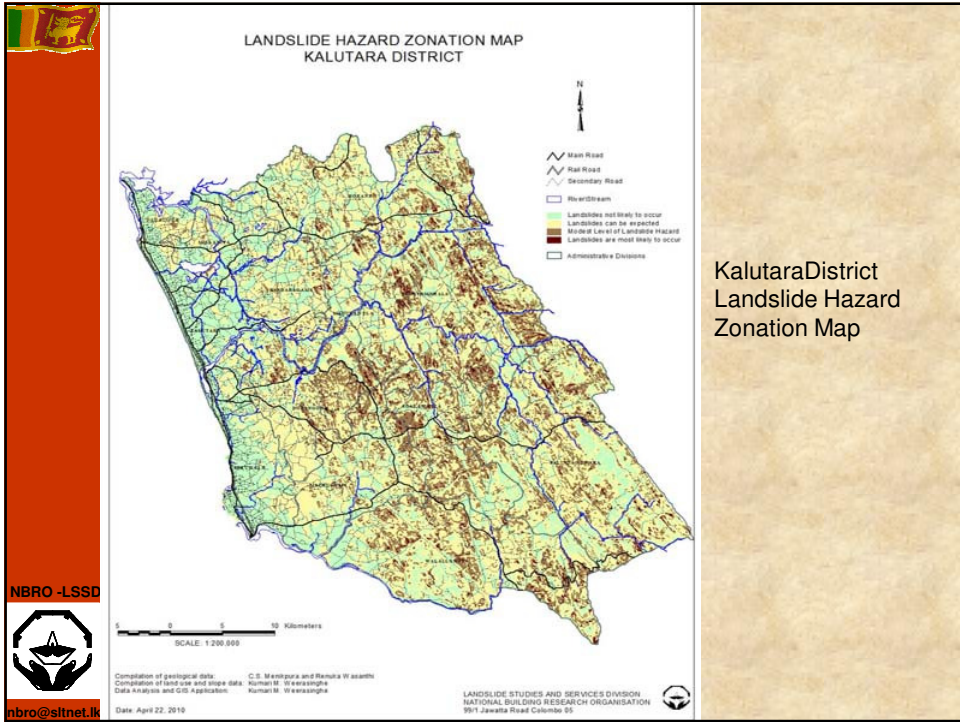
ZONAL SIGNIFICANCE

	Landslides have been occurred in the Past	Known danger of landslides and therefore, perennial threat to life and property exists in the area. All new construction should be prohibited and the land use & management practices should be studied & improved to halt and reverse the process of slope degradation. Landslide remediation should be undertaken and early warning systems should be established at all problematic sites.
	Subsidence & Rockfall	
	Landslides are to be Expected	Danger and potential threat to life and property exists. No new construction should therefore be permitted. Essential additions in the existing structures may be allowed only after thorough site investigation and adequate precautions to be certified by specialist(s). Early warning systems should be established if symptoms of landslides are clear and risk levels are high.
	Modest level of landslide hazard exists	Moderate levels of landslide danger exists. New construction should be discouraged, and improved land use planning practices should be introduced to halt and reverse the process of slope degradation. All essential construction and remediation, and new projects be subjected to landslide hazard assessment.
	Landslides not likely to occur	Slight danger of landslides exists. Engineered and regulated new construction and well planned cultivation are permitted. Plans for construction should be technically vetted and certified.
	Safe Slopes	No visible signs of slope instability or danger exist based on present state of knowledge. No blanket limitations need to be imposed particularly on well managed lands and engineered construction. Location specific limitations may become necessary, particularly for areas prone to flooding and erosion.
	Inaccessible Slopes	Inaccessible areas about which no direct information is yet available.

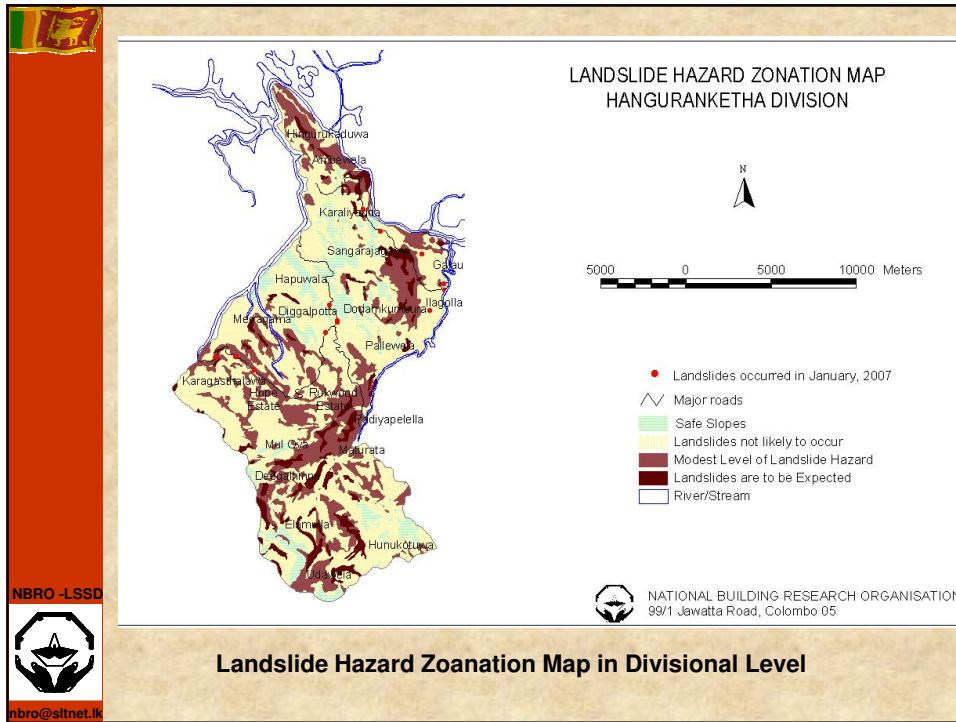
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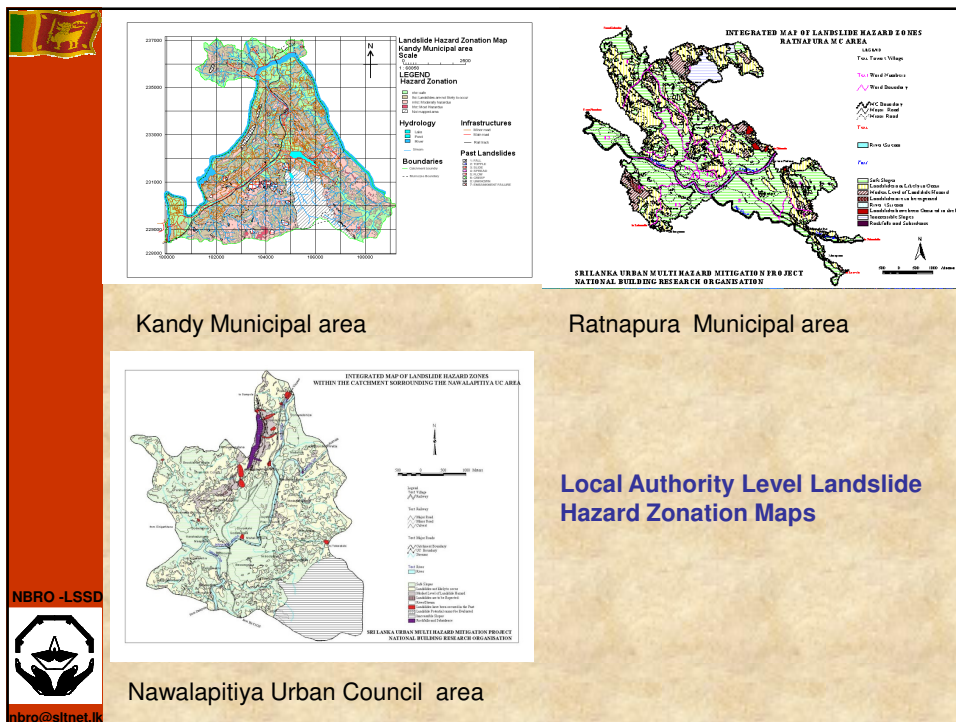
Kandy District Landslide Hazard Zonation Map



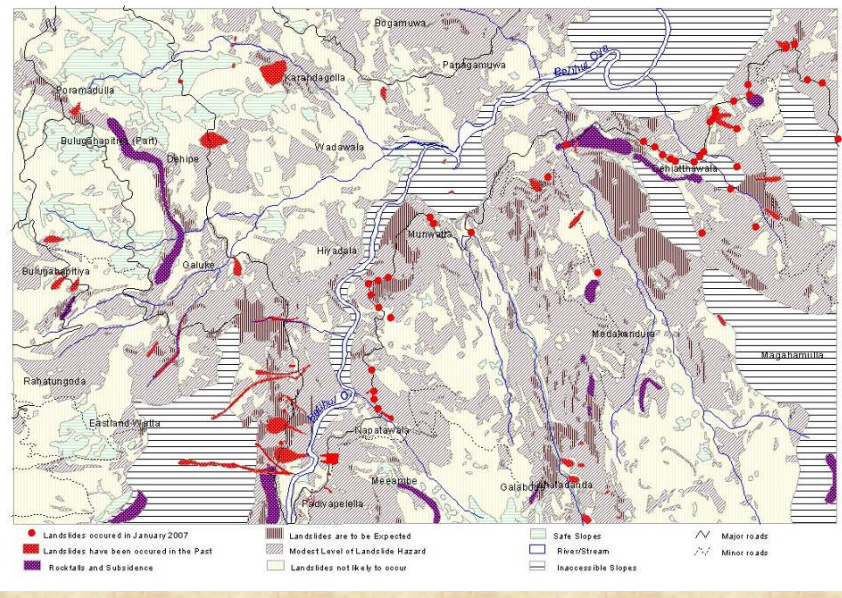
Kalutara District Landslide Hazard Zonation Map



Landslide Hazard Zonation Map in Divisional Level



Landslide Hazard Zonation Map of Padiyapelella Munwatta Area – Sheet 62/11



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LANDSLIDE HAZARD ZONATION MAP WITH POSSIBLE PATHS, FINLAY FACTORY HAPUTHALE



- Most possible paths of landslides, which can be initiated at the upper slope
 - path
 - Possible Landslide initiation areas
 - Effective area 1
 - effective area 2
 - Factory area
 - Finlay Quarters
 - Beragala - Wellawaya road
 - Colombo-Badulla main road
 - Minor road
 - Road to Finlay Factory
 - Road to Kovil
 - Road to village below the factory
- Scale: 1:5000

LANDSLIDE STUDIES AND SERVICES
 NATIONAL BUILDING RESEARCH ORGANIZATION
 99/1, Jawatta Road,
 Colombo 5
 Sept. 2002

Map : 2

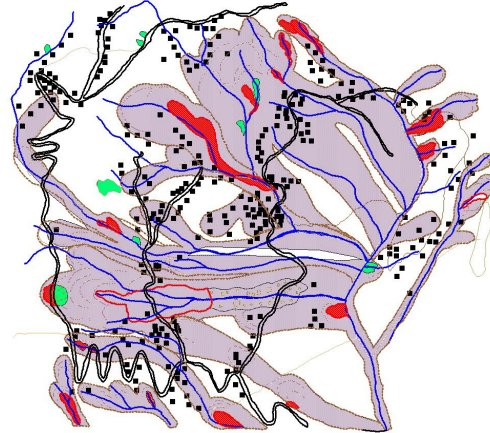
Possible Paths of Landslides

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Information Produced from Special Investigations

Landslide Map of Ketayapathana, Gonakele
& Alakolawewa area of
Hanguranketha and Walapane AGA Divisions



Legend

- Recent Landslide
- Potential Areas
- Old Landslides
- Houses

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UTILIZATION OF MAPS

Landslide hazard zonation maps and associated construction guidelines are incorporated in development plans prepared by,

- ❖ National Physical Planning Department (NPPD)
- ❖ Urban Development Authority (UDA)
- ❖ Road Development Authority (RDA)
- ❖ Local Authorities in landslide prone districts
- ❖ Central Environmental Authority (CEA)



Banks and Insurance companies also can utilize these maps in considering for loans and insurance plans

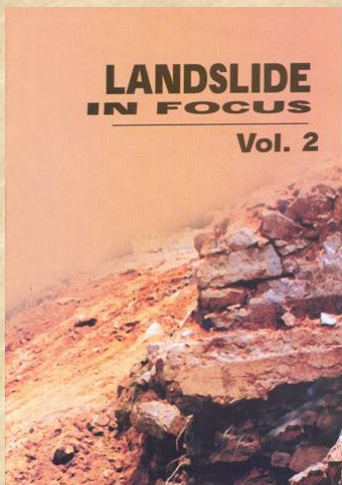
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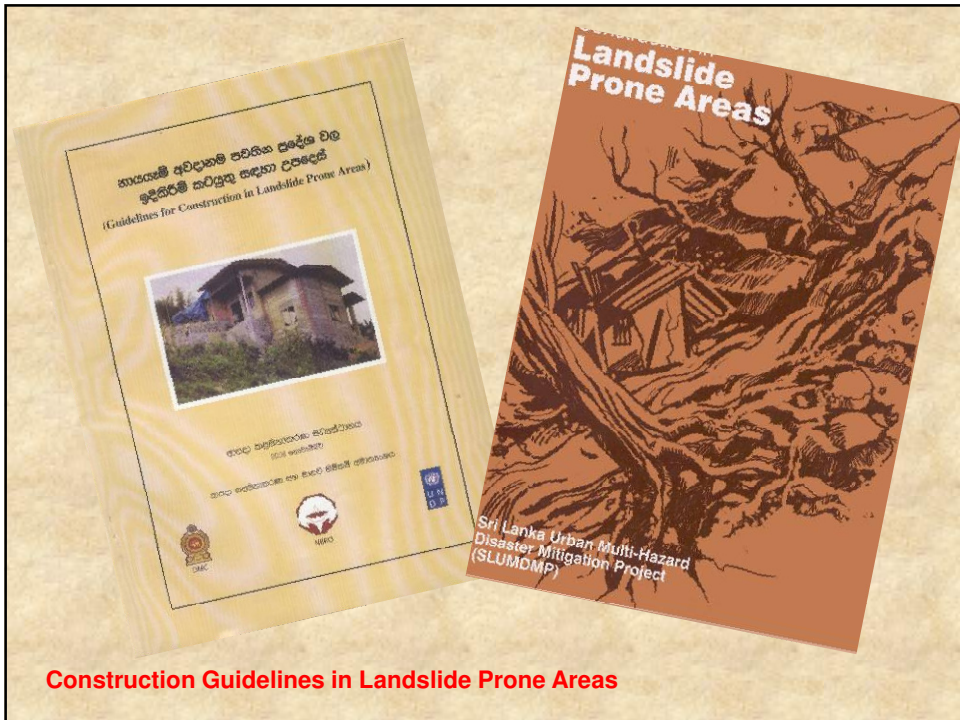
oekqj;a lsrSu - **Awareness**

Creating awareness through

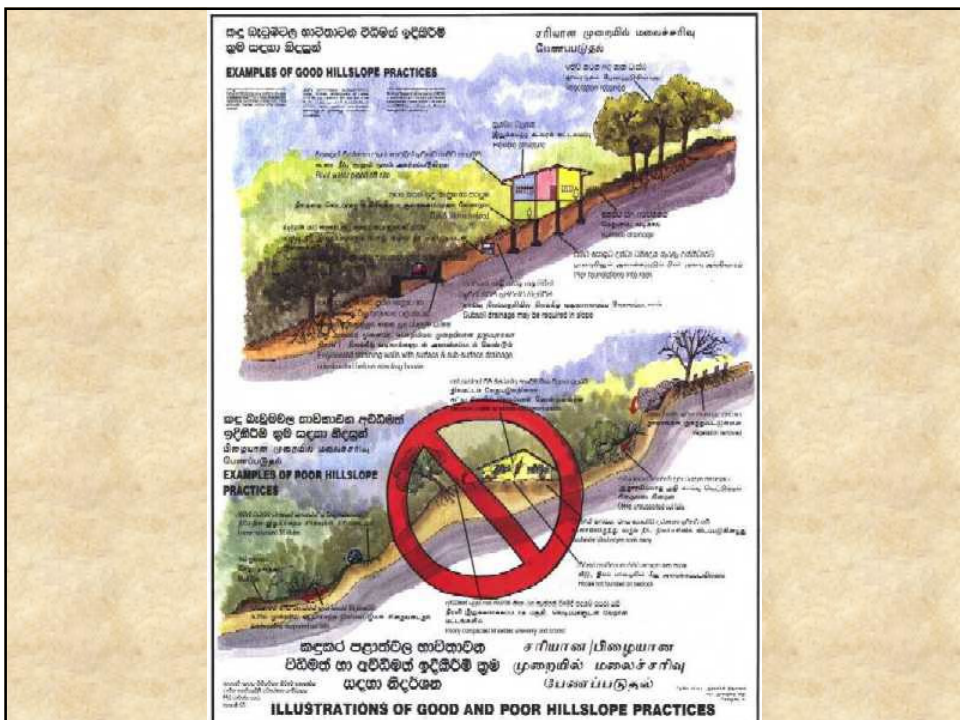


Handbooks
and





Construction Guidelines in Landslide Prone Areas



ILLUSTRATIONS OF GOOD AND POOR HILLSLOPE PRACTICES





 <p>Introducing of signboards in Landslide Vulnerable Areas</p>  <p>nbro@sltnet.lk</p>	
	<p>අනතුරුදායකයි Danger அபாயம்</p> <p>නාශ හා හැකි ප්‍රදේශයකි. Landslide Prone Area. மண்சரிவினால் பாதிப்படையக் கூடிய பிரதேசம்</p>
	<p>National Building Research Organisation ජාතික ගොඩනැගිලි පර්යේෂණ සංවිධානය தேசிய கட்டிட ஆராய்ச்சி நிறுவனம்</p>  
	<p>ආපදා කළමනාකරණ මධ්‍යස්ථානය එක්සත් ජාතීන්ගේ සංවර්ධන වැඩසටහන</p> 



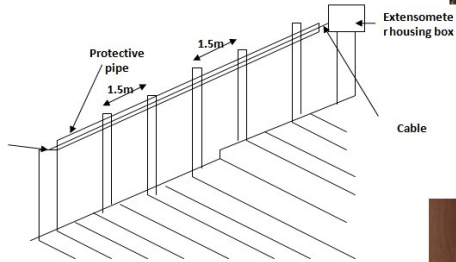
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Extensometer

Extensometer is used to measure the surface movement of the land

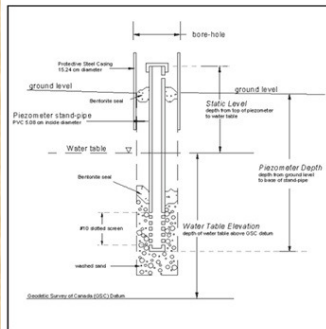


Mahawawa/NuwaraEliya District-2010



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Piezometer

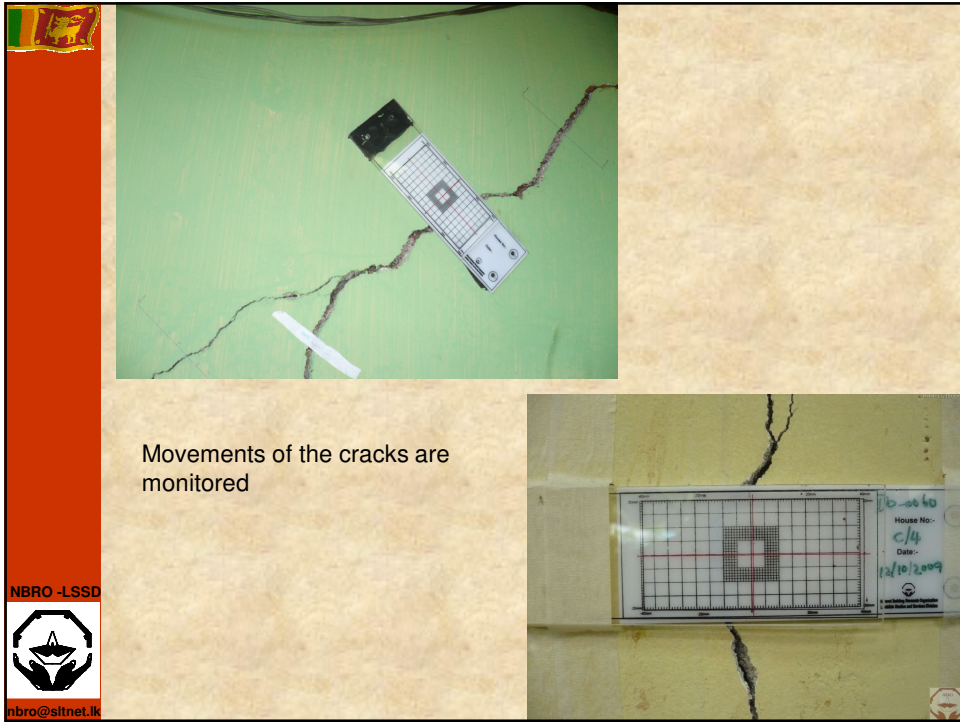


The ground water level is being monitored using this device.



Mahawawa/NuwaraEliya Dist.-2010

LSSD-NBRO



Movements of the cracks are monitored

ia:djr lsrsu - **Stabilization**

Retaining Structures (Traditional methods and Scientific methods)







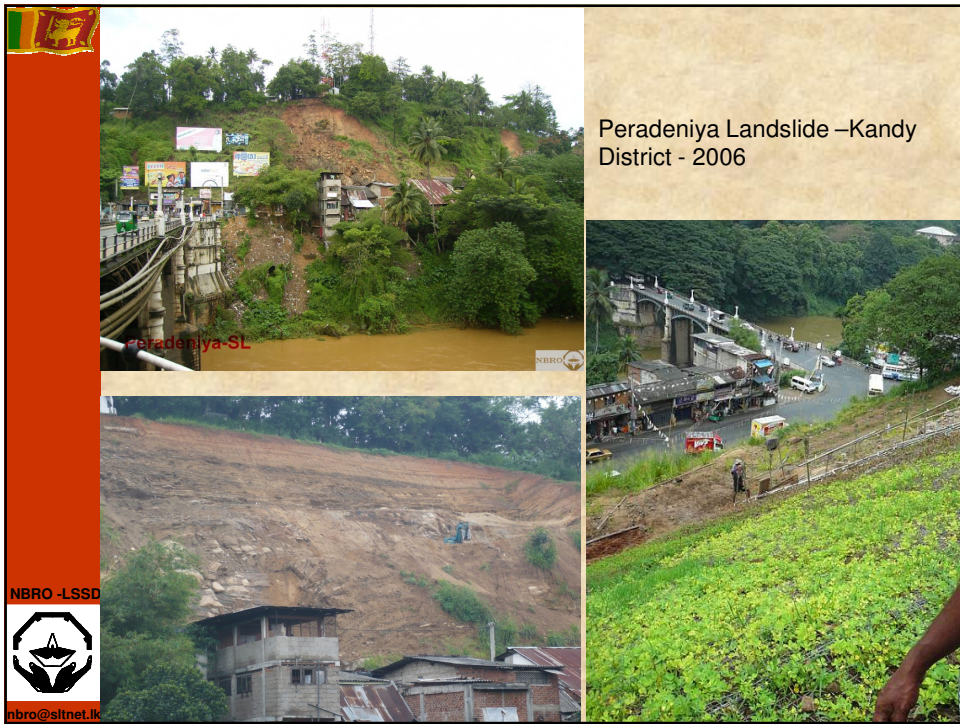
Peradeniya Landslide Mitigation work

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Peradeniya Landslide

NBRO




Peradeniya Landslide –Kandy District - 2006

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Peradeniya-SL

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Surface & Subsurface Drainage Development



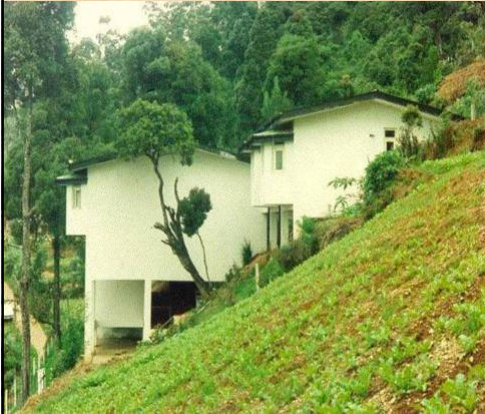


Pussellawa




Good Landuse Practices

nEjquz mjsk wdk;shg trs.k wkaoug tys ia:djrajng wju ydksbla we;afle fi ksfia yd wfkl=sa boslsruz isoq lsrSu




Construction of houses suit to the slope angle and minimum damage to the slope





**Early Warning in Sri Lankan
Landslides**

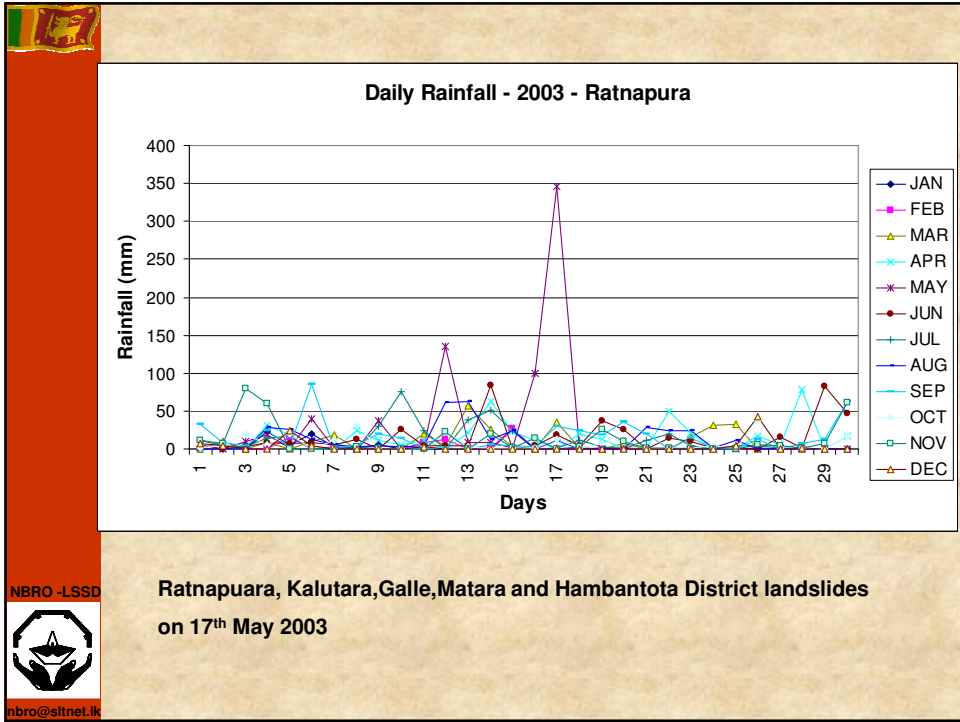
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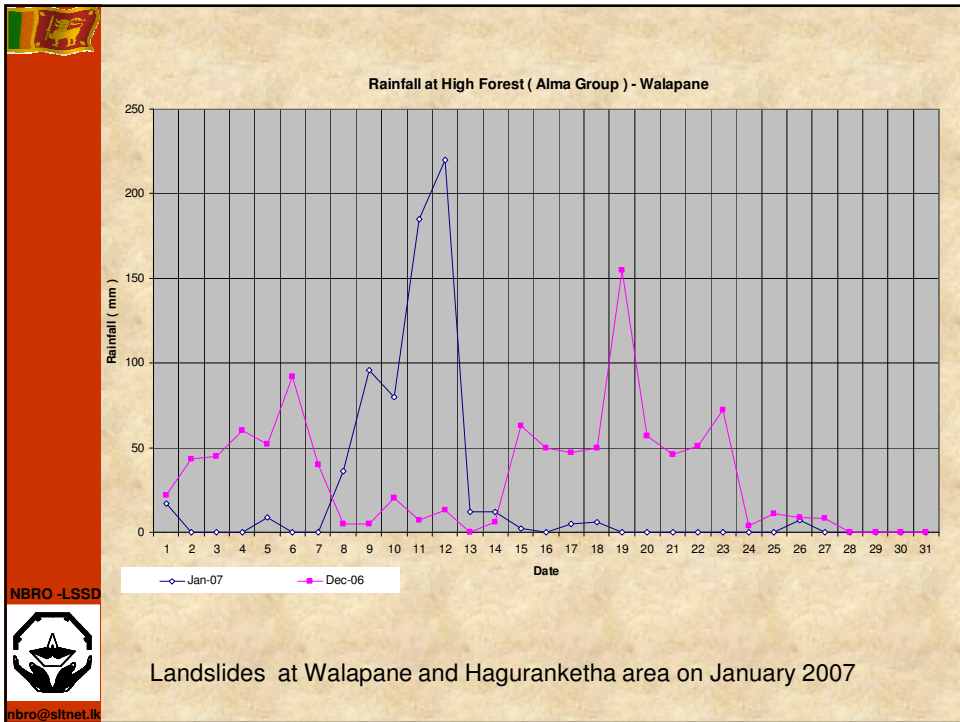
**Main triggering factor for
Sri Lankan Landslides
– Rainfall**

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Ratnapuara, Kalutara, Galle, Matara and Hambantota District landslides on 17th May 2003



Landslides at Walapane and Haguranketha area on January 2007

Real time forecasting/ Warning from the Landslide Hazard Zonation Maps

Introduction of an additional layer on real time precipitation rates

From this development we hope to achieve

a. A much accurate improved real time location specific forecasting

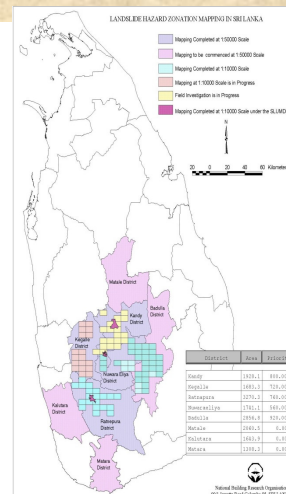
b. Identify safe locations and evacuation routes for victims

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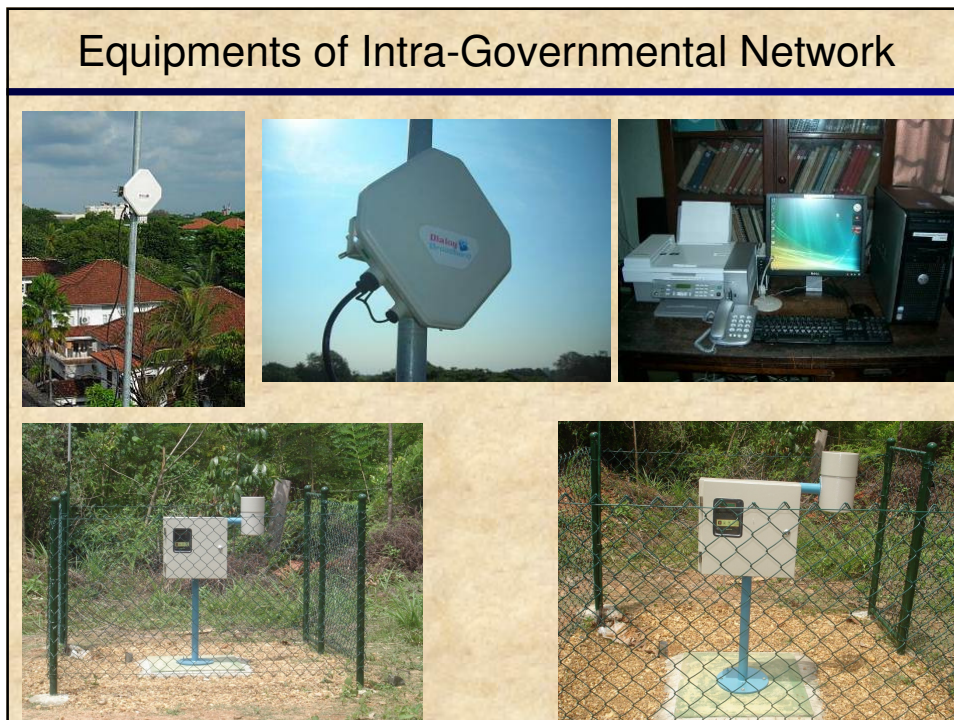
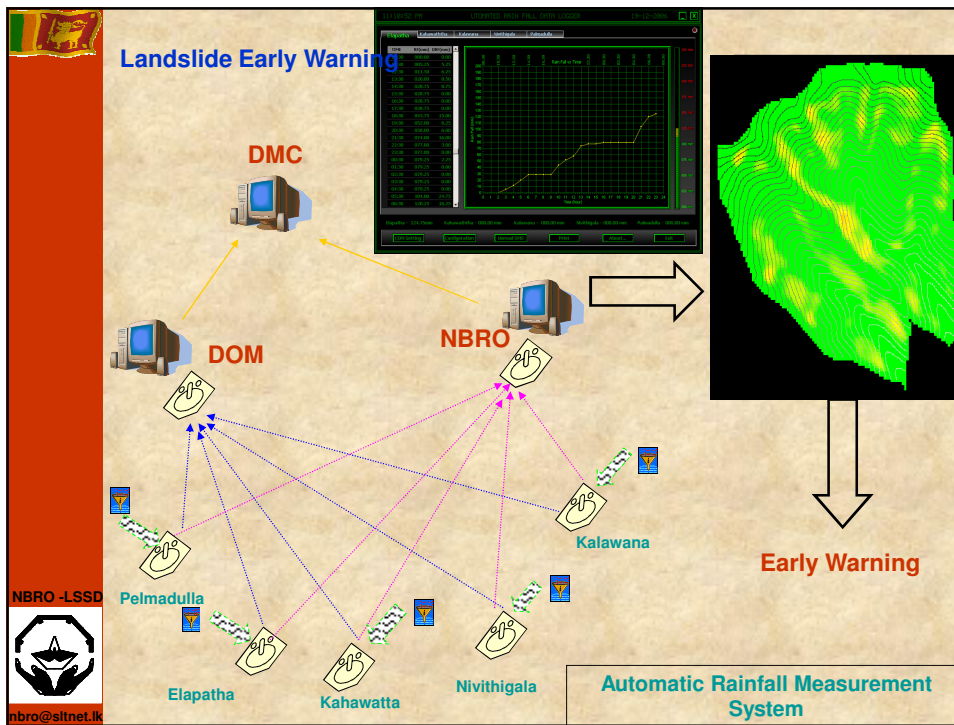
Landslide Vulnerable Regions in Sri Lanka

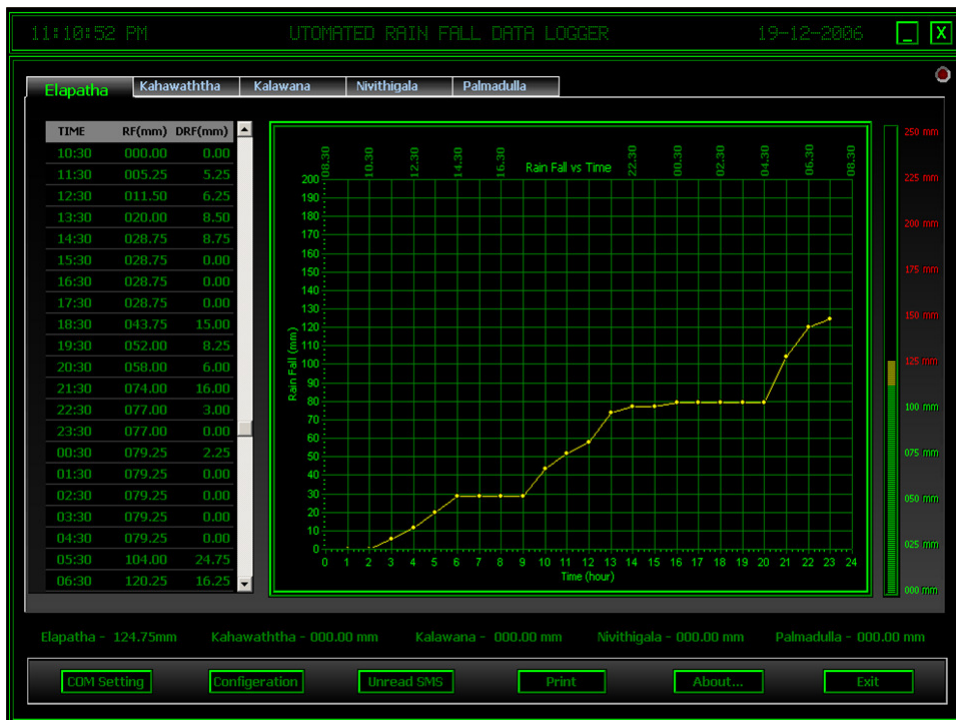



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Warning and Evacuation

Standard threshold limits of the Rainfall for landslides

Alert	75 mm/day
Warning	100mm/day
Evacuation, Off limit	75 mm/hour or 150mm/day

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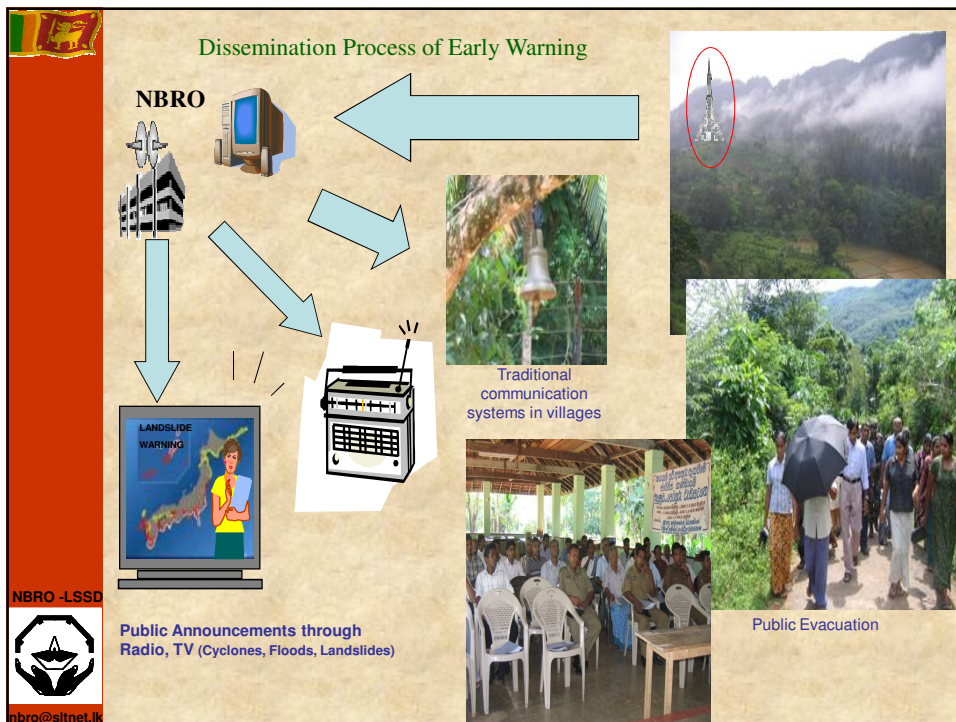
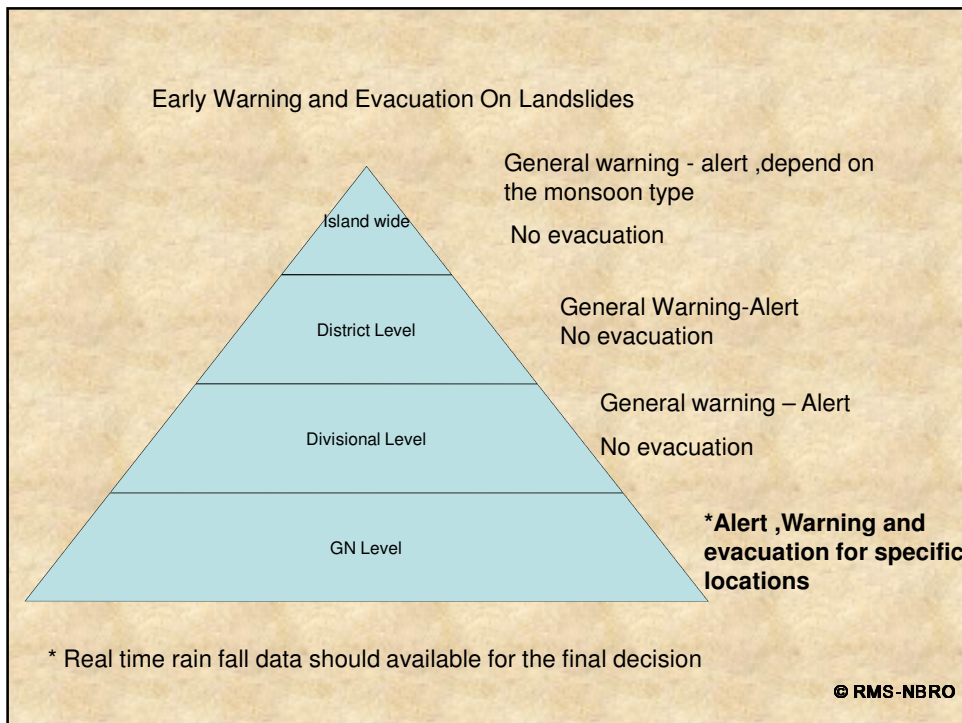
Threshold limits for landslide warnings in Sri Lankan Landslide

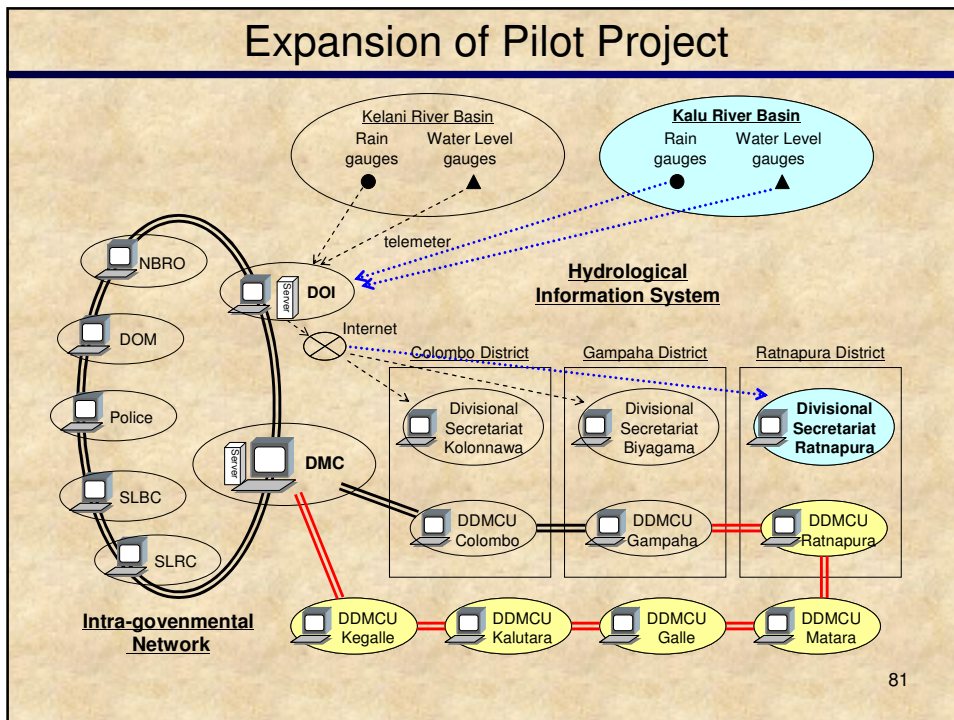
Warning Part 1
75 mm rainfall for 24 hours - alert for Landslides

Warning Part 2
100 mm rainfall for 24 hours – Get ready to evacuation
under short notice

Warning Part 3
150 mm rainfall for 24 hours - Evacuation
Or
70mm rainfall per hour - Warning for evacuation

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Early Warning (Technical Agency) Part 1

ld.,-K jsoHd fomdrA;fuska;+fjs o;a;hkag wkqj miq.sh meh 24 ;=< j.mfka m%dfaoYSh f,aluz fldgzGdYh wdY%>; m%foaYhg us'uS' 70 g jvd jevs jrAIdm;khla ,enS ;sfnz' cd;sl f.dvke.s,s mrAfhaIK ixjsOdkfha wOHhkhkag wkqj j.mfka m%dfaoYSh f,aluz fldgzGdYh ;=< .,nv, yS.iaw,a, leglqr, Wvudoqr, je/,a,m;k .%du ks<OdrS fldgzGdY wdY%>; m%foaYj, kdhEfuz jevs m%jk;djhla mjS' tnejska bosrs meh lSmh ;=< jrAIdm;kh os.gu mj;skafka kuz tu m%foaYj, m%dfaoYSh f,aluzjreka, m%dfaoYSh iNd iNdm;sjreka yd .%du ks<OdrSka jsiska cd;sl f.dvke.s,s mrAfhaIK ixjsOdkfha oS we;s Wmfoia wkq.ukh lrk f,i tu ixjsOdkh oekquz fohs'

Early Warning (Technical Agency) Part 1

According to the Met dept., **Walapane** Divisional secretariat area of **NuwaraEliya** District has received more than 70mm of rainfall during the past 24 hours. According to the studies carried out by the National Building Research Organisation, there is a threat of landslide occurrences in **Galaboda, Hegasulla, Katandura, Udamadura, and Walapane** Grananiladari divisions. If the rain continues during the next few hours, Divisional secretaries, Municipal Councils Chairman, Grama Niladaries should follow the instructions given by NBRO

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 ආරක්ෂක සහ මහජන සේවා අමාත්‍යාංශය
 Ministry of Disaster Management and Human Rights

ජාතික ගොඩනැගිලි පර්යේෂණ සංවිධානය
ජාතික ගොඩනැගිලි පර්යේෂණ සංවිධානය
NATIONAL BUILDING RESEARCH ORGANISATION


99/1 | විද්‍යා මාර්ග, කොළඹ 5
 Research Road, Colombo 5, Sri Lanka
 99/1 | Director General - 2505149
 Office - 2588946, 2591834, 2590354 Fax - 2502611
 E-mail - Director.General@nbro.gov.lk - Gen. - nbro@sltnet.lk
 Website - www.nbro.gov.lk

Our Ref : NBRO/LSSD/LIMP/19/2008 Your Ref : Date : 2008/03/15

LANDSLIDE WARNING MESSAGE (Level 3)

For information and necessary action of Provincial council chairmen, District Secretaries, Divisional Secretaries, and Pradeshiya Sabha Chairmen

Type of Warning: Evacuation (Level 3)

Reason for issuing warning: Rainfall exceeding 150 mm in the landslide prone areas identified by NBRO

Area on threat

Districts: Ratnapura
 Divisions: Ratnapura
 GN Divisions/Villages: Malwala, Ratnapura

Special attention for users of Ratnapura-Alupola roads

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පළාත් සභා සභාපතිවරුන්, දිස්ත්‍රික් ලේකම් වරුන්, ප්‍රාදේශීය ලේකම් වරුන්, ප්‍රාදේශීය සභා සභාපති වරුන් සහ දැන ගැනීම සහ අනෙකුත් අදාළ පාර්ශ්වයන් සඳහා

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නිවේදනය නිකුත් කිරීමට හේතු: කාන්තෘදු අනතුරු වැඩි වීම හේතුවෙන් ප්‍රදේශයේ ප්‍රදේශ වල වර්ෂාවකට මි.මී.150 සහ වැඩි වීම

අවධානය ලැබිය යුතු ප්‍රදේශ

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 ග්‍රාමිකයන් / ගම් : අනෙකුත් සභාවල ප්‍රදේශය, පාන කන්ද, පැරණි පාන කන්ද
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Date issued: February 26, 2008 R. M. S. Bandara
 Time: 10.00 am Head, Landslide Studies and Services Division

Copy to: Director General, NBRO – for information

NBRO -LSSD

 nbro@sltnet.lk

SOP 1: NBRO - Meteorological Department

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SOP 1: NBRO - Meteorological Department

During the rainy season, The Met dept should issue the hourly rainfall data recorded in all the rain gauges in every Divisional Secretariat of the following Districts to NBRO at each hour.

Landslide vulnerable District of Sri Lanka

Matale, Kandy, Nuwara Eliya, Badulla, Ratnapura, Kegalle, Kalutara, Galle, Matara, and Hambantota

NBRO -LSSD

 nbro@sltnet.lk



SOP 2 (A) NBRO - Meteorological Department, Divisional Secretaries, Chairpersons of Pradeshiya Sabha, Grama Niladhari, DMC Coordinators

NBRO should create awareness among above stake holders on how to read and use landslide hazard zonation maps to locate areas with higher landslide potential

NBRO should educate the communities of safe areas and suitable evacuation routes to be used during an evacuation.

NBRO should make communities aware of identification of pre warning signals of landslides

Met Department should make communities aware on installing a simple rain gauge and measuring rainfall using such rain gauges

NBRO -LSSD



nbro@sltnet.lk



SOP 2 (B) NBRO - Meteorological Department, Divisional Secretaries, Chairpersons of Pradeshiya Sabha, Grama Niladhari, DMC Coordinators

As soon as NBRO issues Part 1 of Early Warning, above officers should pay special attention to the areas as identified as high or medium potential to landslides for any development of pre warning signals

Continue to measure rainfall using a simple rain gauge

If rainfall reaches 100 mm, inform the communities to get ready for evacuation under a short notice

If rainfall reaches 150 mm, evacuate the people to safer locations

NBRO -LSSD



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Regulations and Legalization procedures on landslide prone areas in Sri Lanka

Disaster Management act was passed on 13th May 2005

Ministry of Disaster Management
Disaster Management Council
Disaster Management Center

Disaster Management Policy prepared by DMC

Identified NBRO as the authorized agency for Landslide related work in Sri Lanka

Disaster Management Council

Has already taken a decision not to allow any Constructions or Developments in Landslide prone areas without the permission of NBRO

15th February 2011, Circular was issued for any type of construction on landslide prone areas. According to the circular any type of construction on landslide prone areas should have the NBRO certificate / recommendation on landslide vulnerability.

NBRO -LSSD



nbro@sltnet.lk



Still The Problem Remain to Solve



NBRO -LSSD



nbro@sltnet.lk

Disaster comes when the last one is forgotten

Plan ahead! Be prepared!

Thank You

Brahmana Falls
Lankagama

