NOTE ON POST DIASTER LANDSLIDE STUDIES IN MALAPPUAM AND PALAKKAD DISTRICTS, KERALA DURING JUNE 2018

(Field Season: 2018 - 19, Item No.: M4SI/NC/SR/SU-KRL/2018/21108)

By

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INTRODUCTION

Following the media reports of landslides in the eastern parts of Malappuram and Palakkad districts on the onset of south-western monsoon, Geological Survey of India, State Unit Kerala responded by sending a team of two geologists and carried out preliminary assessment of 13 nos. of landslide events (9 nos. of 'debris flows' and 4 nos. of 'debris slides'). Out of these, 9 are from Malappuram district and the remaining is from Palakkad (Fig: 1).

The studies were carried out from 03rd July 2018 to 07th of July 2018 in parts of SoI toposheet nos.58A/03, 58A/04, 58B/09 and 58B/11. The objective of the study was to carry out a preliminary assessment of the landslide besides the suggestion of long term permanent control and corrective measures and suggestion of immediate temporary measures, if any needed. The details of each landslide were collected and compiled in a predefined datasheet having 42 point geo-parametric attributes (Annexure-I).

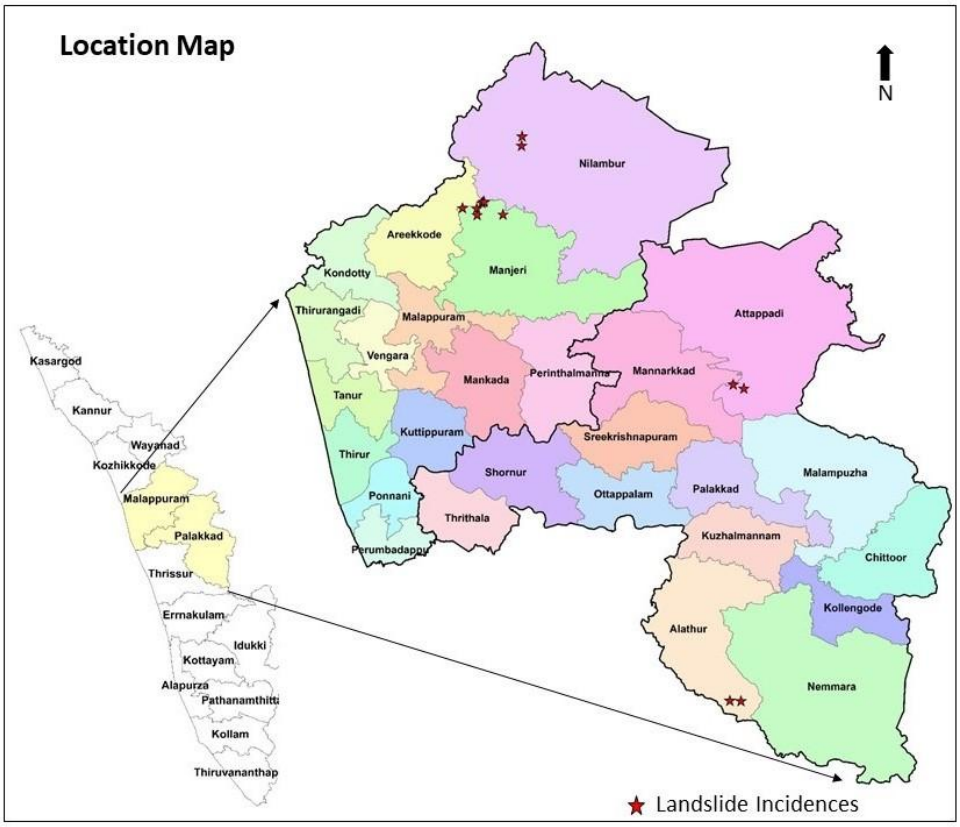


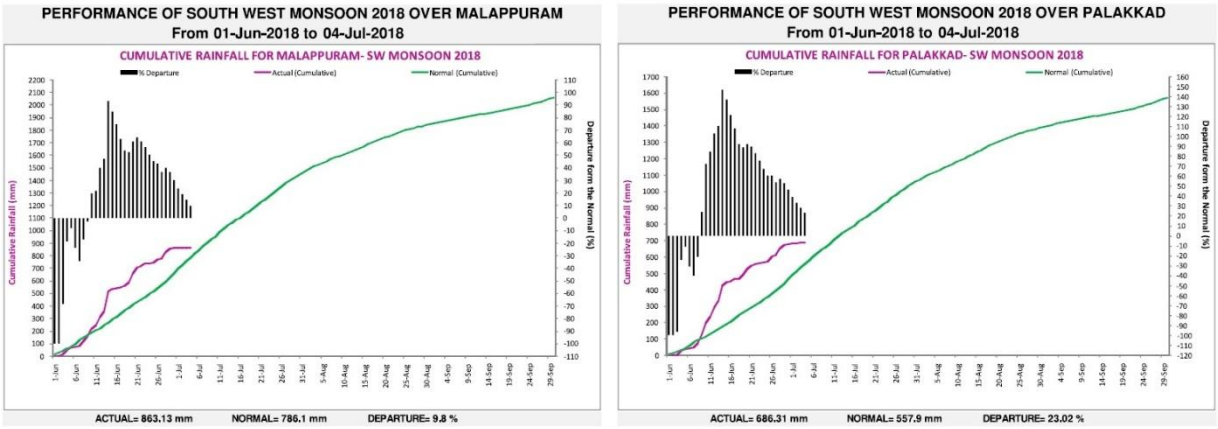
Fig: 1 Location map with landslide incidences

The investigated sites form part of moderately dissected slopes with relatively thin cover of overburden material (<5m) comprising mainly soil and debris. The area is occupied predominantly by rocks of Archaean Wayanad and Southern Granulite, Peninsular Gneissic Complex of Proterozoic Age and Neoproterozoic intrusives of acidic compositions.

The causative factors for the investigated slides are either due to one or due to combination of following factors.

1. Near vertical slope excavation and removal of lateral support.
2. Toe erosion by rivers and streams.
3. Unscientific modification of original slopes.
4. Defective maintenance of natural drainage systems, especially of small orders.
5. Weathered rock mass forming potential wedges and blocks.
6. Physical characteristic and thickness of loose slope forming mass.

Incessant torrential rain which started from 08th of June, 2018 in Malappuram and Palakkad districts is assessed to be the triggering factor. The cumulative rainfall graph of Malappuram and Palakkad district during the SW monsoon is given below (Fig. 2).



(Source: Indian Meteorological Department, Thiruvananthapuram)

Fig. 2 Cumulative rainfall graph of Malappuram and Palakkad district, June 2018

Slide-1:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/01*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Perakamanna*
6	NH/SH/Locality	:	*West Chathalloor- Odanpara, Ernad Taluk*
7	Latitude	:	*11.26246° N*
8	Longitude	:	*76.11503° E*
9	Length	:	*650 m*
10	Width	:	*~20 m*

11	Height	:	*230 m*
12	Area	:	
13	Depth	:	*3 m*
14	Volume	:	
15	Run out distance	:	*300 m*
16	Type of Material	:	*rock-cum- debris*
17	Type of movement	:	*Flows*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as shallow planar failure*
23	History	:	*14th June, 2018 at 03:00 hrs.*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*J1(Foliation & parallel Joint): N80°E- S80°W / sub-vertical to vertical dip, J2:N30ºW- S30°E/80º NE, J3:N15ºE- S15ºW/65ºSE, J3:N20ºE – S20ºW/60ºNW*
27	Landuse/ Landcover	:	*Rubber plantation. Area upslope of the scar at the source area is forested*
28	Hydrological condition	:	*Flowing at toe area and damp at source area*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Residents of 3 houses on the runout path were evacuated just before the slide. Debris accumulated in the compounds of these houses.*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road blocked*
34	Infrastructure	:	*2 dug wells filled up by the debris. Electric pole and lines were damaged.*
35	Agriculture/forest/Barren	:	*Agriculture (High Height Plantation)*
36	Geo-scientific Causes	:	*Natural slope had been benched for rubber cultivation thereby blocking natural drainage. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on saturation. Landslide was initiated as planar failure along rock-overburden contact and then transformed into debris flow in sequence.*
37	Remedial measures	:	*The overburden material has been stripped off exposing bed rock along the runout path. Dislodged boulders along the runout path/nala may be removed. Natural drainage paths may not be encroached.*
38	Remarks, if any		

39	Photos. Sketch of Plan & section of the slide	:	
			
40	Summary/Abstract	:	*A debris flow occurred on 14th June, 2018 at 03:00 hrs at Perakamanna, West Chathaloor in Malappuram District. Natural slope at the area had been benched for rubber cultivation thereby blocking natural drainage. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on saturation. Landslide was initiated as planar failure along rock-overburden contact and then transformed into debris flow in sequence. The overburden material has been stripped off exposing bed rock along the runout path. Dislodged boulders along the runout path/nala may be removed. Natural drainage paths may not be encroached.*
41	Date of Reporting	:	*03/07/2018*
42	Landslide Category	:	*III*

Slide-2:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/02*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Cholara*
6	NH/SH/Locality	:	*Cholara-Karinchola, Ernad Taluk*
7	Latitude	:	*11.26152° N*
8	Longitude	:	*76.13833° E*
9	Length	:	*15 m*
10	Width	:	*~20 m*
11	Height	:	*15 m*
12	Area	:	
13	Depth	:	*2-3 m*
14	Volume	:	
15	Run out distance	:	
16	Type of Material	:	*Debris*
17	Type of movement	:	*Slide*
18	Rate of movement	:	*Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Retrogressive and widening*
21	Style	:	*Single*
22	Failure mechanism	:	*Shallow Rotational failure*
23	History	:	*14th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*Foliation:N55°E-S55°W/70°S*
27	Landuse/ Landcover	:	*Forest*
28	Hydrological condition	:	*Damp*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road (unmetalled) blocked*
34	Infrastructure	:	*Electric line damaged*
35	Agriculture/forest/Barren	:	*Forest*
36	Geo-scientific Causes	:	*Toe was removed during widening of the road about 5 years back leaving a vertical cut with no lateral support. Heavy rainfall resulted in reduction of strength due to saturation and subsequent failure.*
37	Remedial measures	:	*Easing of the slope may be carried out and removal of precariously resting boulders upslope of the crown is recommended. Heavy rains will erode the base resulting in toppling of these boulders which will endanger houses located downslope of the road.*
38	Remarks, if any		

39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*A debris slide due to cut slope failure occurred on 14th June, 2018 at Cholara-Karinchola road in Ernad taluk, Malappuram district. Toe was removed during widening of the unmetalled road about 5 years back leaving a vertical cut with no lateral support. Heavy rainfall resulted in reduction of strength due to saturation and subsequent failure. Easing of the slope may be carried out and removal of precariously resting boulders upslope of the crown is recommended.*
41	Date of Reporting	:	*03/07/2018*
42	Landslide Category	:	*III*

Slide-3:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/03*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Kappakallu*
6	NH/SH/Locality	:	*East Chathaloor, Ernad Taluk*
7	Latitude	:	*11.25106° N*
8	Longitude	:	*76.13881° E*
9	Length	:	*50 m*
10	Width	:	*~12 m*
11	Height	:	*25 m*
12	Area	:	
13	Depth	:	*2-3 m*
14	Volume	:	
15	Run out distance	:	*50 m*
16	Type of Material	:	*Rock cum Debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Shallow planar failure. (Initiated as rock slide)*

23	History	:	*September, 2017*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*J1(Foliation & parallel Joint): N80°E- S80°W / sub-vertical to vertical dip, J2:N30ºW- S30°E/80º NE*
27	Landuse/ Landcover	:	Forest
28	Hydrological condition	:	*Damp*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road (unmetalled) blocked*
34	Infrastructure	:	*Debris accumulated in the compound of one house.*
35	Agriculture/forest/Barren	:	*Forest*
36	Geo-scientific Causes	:	*Initiated as rock slide due to root wedging and built up of cleft water pressure. It transformed into debris flow resulting in runout of debris material up to a nala down slope.*
37	Remedial measures	:	*The overburden material has been stripped off exposing bed rock along the run out path. Dislodged boulders along the runout path/nala may be removed.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*In September 2017, a debris flow occurred at Kappakallu in East Chathalloor, Ernad Taluk, Malappuram district. The slide was initiated as rock slide due to root wedging and built up of cleft water pressure. It transformed into debris flow resulting in runout of debris material up to a nala downslope. The overburden material has been stripped off exposing bed rock along the runout path. Dislodged boulders along the runout path/nala may be removed.*
41	Date of Reporting	:	*03/07/2018*
42	Landslide Category	:	*III*

Slide-4:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/04*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/04*

5	Name of the slide	:	*Bheemangal*
6	NH/SH/Locality	:	*Odayikkal-Edavanna, Pullipadam Vilage, Ernad Taluk*
7	Latitude	:	*11.25171° N*
8	Longitude	:	*76.18100° E*
9	Length	:	*~10 m*
10	Width	:	*100 m*
11	Height	:	*8-9 m*
12	Area	:	
13	Depth	:	*10 m*
14	Volume	:	
15	Run out distance	:	*50 m*
16	Type of Material	:	*Soil*
17	Type of movement	:	*Slide*
18	Rate of movement	:	*Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Retrogressive and widening*
21	Style	:	*Single*
22	Failure mechanism	:	*Deep rotational failure*
23	History	:	*14th June, 2018*
24	Geomorphology	:	*Rolling plain*
25	Geology/Lithology	:	*Hornblende biotite gneiss*
26	Structure	:	*N5°E-S5°W/75°E*
27	Landuse/ Landcover	:	*Cultivated and settlement area*
28	Hydrological condition	:	*Damp*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*A 100 m section of road caved into the river.*
34	Infrastructure	:	*Bank protection works along with road damaged*
35	Agriculture/forest/Barren	:	*Agriculture*
36	Geo-scientific Causes	:	*River bank erosion*
37	Remedial measures	:	*RCC flood protection walls to be constructed on both banks with foundation on bed rock which is available at the river bed.*
38	Remarks, if any		*The Odayikkal regulator cum bridge across Chaliyar River was constructed in 2015. The approach road to the bridge on the left bank was laid by filling earth over loose alluvium and terrace deposits. The distressed area forms part of the inner bank and similar failures are also noticed in the outer right bank. Though the RCC flood protection walls were provided along the left bank for a distance of about 225 m in the downstream of the bridge, the further downstream was protected only by RR pitching using grids of reinforced beams. The latter structure was installed at about 5m towards the bank with a bathing ghat in between without any smooth transition. The length of flood protection walls provided for the outer right bank is even shorter and the bank witnesses more frequent failures during floods.*

39	Photos. Sketch of Plan & section of the slide	:	
			
40	Summary/Abstract	:	*A soil slide due to bank erosion occurred on 14th June 2018 at Bheemangal, near Odayikkal regulator cum bridge in Pullipadam Village, Ernad Taluk, Malappuram district. The bank erosion resulted in caving in of a 100m section of newly laid road and bank protection work. Unscientific construction of flood protection walls seems to be the cause for failure. It is recommended to construct RCC flood protection walls on both banks with foundation on bed rock which is available at the river bed.*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*II*

Slide-5:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/05*
2	State	:	*Kerala*
3	District		*Malappuram*

4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Madam Colony 1*
6	NH/SH/Locality	:	*Pullipadam Village, Nilambur Taluk*
7	Latitude	:	*11.27061° N*
8	Longitude	:	*76.14651° E*
9	Length	:	*50 m*
10	Width	:	*3-4 m*
11	Height	:	*15 m*
12	Area	:	
13	Depth	:	*2-3 m*
14	Volume	:	
15	Run out distance	:	*850 m*
16	Type of Material	:	*Rock cum Debris*
17	Type of movement	:	*Flows*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as shallow planar slide*
23	History	:	*14th June, 2018 at 05:00 hrs*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*Foliation N60ºE – S60ºW/85º NW*
27	Landuse/ Landcover	:	*Forest in the source area and the runout area is inhabited.*
28	Hydrological condition	:	*Flowing*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Residents of 3 houses in the immediate downstream below the road bench has been evacuated just before the slide. Debris accumulated in the compounds of 15 houses about 850m downstream causing partial damage of two houses.*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road (unmetalled) and culvert blocked. Road scoured for a distance of 450 m.*
34	Infrastructure	:	*Debris accumulated in the compounds of three houses and partially damaged two houses.*
35	Agriculture/forest/Barren	:	*Forest*
36	Geo-scientific Causes	:	*Heavy antecedent rainfall for 3 days preceding the event resulted in raising of water levels in natural streamlets causing erosion of flanks. Landslide was initiated as planar failure along rock-overburden contact due to toe erosion and then transformed into debris flow along heavily flowing stream path.*
37	Remedial measures	:	*The overburden material has been stripped off exposing bed rock along the depleted zone. Large sized dislodged boulders hampering the smooth flow of water along the stream path may be removed. Larger culvert to be provided at road for smoother passage of debris.*
38	Remarks, if any		*The debris flow followed the natural streamlet up to the road level. The bigger boulders got stuck at the culvert and hampered the flow resulting in its bifurcation. The diverted debris laden stream scoured the road for a distance of about 450m before joining another stream.*

			The other followed the original course and debris material got accumulated in the compounds of 15 houses further downstream and caused partial damage of two houses.
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*A debris flow occurred on 14th June 2018 at Madam Colony in Pullipadam Village, Nilambur Taluk, Malappuram district. Landslide was initiated as planar failure along rock-overburden contact due to toe erosion and then transformed into debris flow along existing stream path. Due to culvert of insufficient span, debris got accumulated and resulted in bifurcation of flow. The diverted arm flown through the road bench heavily scouring it for a distance of about 450m. Along the original course, debris laden stream breached and entered into compounds of about 15 houses and damaging two houses partially. Large sized dislodged boulders hampering the smooth flow of water along the stream path may be removed. Larger culvert to be provided for smoother passage of debris. The houses in the brim of the stream may be relocated to higher, safer grounds.*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*III*

Slide-6:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/06*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Madam Colony 2*
6	NH/SH/Locality	:	*Pullipadam Village, Nilambur Taluk*
7	Latitude	:	*11.27260° N*

8	Longitude	:	*76.14928° E*
9	Length	:	*5 m*
10	Width	:	*20 m*
11	Height	:	*4-5 m*
12	Area	:	
13	Depth	:	*1-2 m*
14	Volume	:	
15	Run out distance	:	
16	Type of Material	:	*Debris*
17	Type of movement	:	*Slide*
18	Rate of movement	:	*Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Retrogressive and widening*
21	Style	:	*Single*
22	Failure mechanism	:	*Shallow planar failure*
23	History	:	*14th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Lateritic soil and moderately weathered charnockite .*
26	Structure	:	*Foliation N60ºE – S60ºW/85º NW; Joint N60ºW- S60ºE/60º NE (Plane of movement)*
27	Landuse/ Landcover	:	*Cultivated*
28	Hydrological condition	:	Damp
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	
31	People affected	:	*Residents from a house have been evacuated prior to the event.*
32	Livestock Loss	:	
33	Communication	:	*Road blockade*
34	Infrastructure	:	*Debris and water entered into compounds of about 15 houses.*
35	Agriculture/forest/Barren	:	*Agricultural (High height plantation)*
36	Geo-scientific Causes	:	*Failure of overburden (lateritic soil) material along the joint N60ºW-S60ºE/60º NE. Day-lighting of the joint plane in the near vertical cut causes the failure.*
37	Remedial measures	:	*Easing of the slope with installation of proper toe support.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	

40	Summary/Abstract	:	*A debris slide occurred on 14th June 2018 at Madam Colony in Pullipadam Village, Nilambur Taluk, Malappuram district. Slide is of translational type resulting in failure of loose overburden material sliding along a day-lighting joint in a near vertical road cut. Towards the flanks, especially in the right, the depth of loose overburden is greater and in view of the arcuate tension cracks in the crown area, the slope may be eased in conjunction with toe support.*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*II*

Slide-7:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/07*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Madam Colony 3*
6	NH/SH/Locality	:	*Pullipadam Village, Ernad Taluk*
7	Latitude	:	*11.27212° N*
8	Longitude	:	*76.15036° E*
9	Length	:	*3 m*
10	Width	:	*10 m*
11	Height	:	*3 m*
12	Area	:	
13	Depth	:	*1-2 m*
14	Volume	:	
15	Run out distance	:	
16	Type of Material	:	*Debris*
17	Type of movement	:	*Slide*
18	Rate of movement	:	*Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Retrogressive and widening*
21	Style	:	*Single*
22	Failure mechanism	:	*Shallow rotational failure*
23	History	:	*14th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*In-situ soil and weathered charnockite*
26	Structure	:	*Foliation N60ºE – S60ºW/85º NW*
27	Landuse/ Landcover	:	*Cultivated and inhabited*
28	Hydrological condition	:	*Dry*
29	Triggering Factor	:	*Rainfall in mm*
30	Death of persons	:	*Nil*
31	People affected	:	*Residents from a house upslope of the crown were evacuated prior to the event*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road blockade*
34	Infrastructure	:	
35	Agriculture/forest/Barren	:	*Agricultural (High height plantation)*
36	Geo-scientific Causes	:	*The toe has been removed for widening of the road leaving a vertical*

			cut in the loose overburden without any support intervention. To aggravate the situation, the toe has been eroded by heavily flowing water diverted from a stream due to blockade of a culvert. The lined road side drain arrangement channelized the water and caused heavy flow. In the distressed site, the side ditch was left unlined causing scouring of the toe area.
37	Remedial measures	:	*Roadside drain should be lined throughout. RCC retaining wall with proper drainage arrangement should be constructed at the location.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*On 14th June 2018, a debris slide occurred at Madam Colony in Pullipadam Village, Nilambur Taluk, Malappuram district. The material from the diverted Madam colony 1 debris flow got channelized along the lined roadside drain and eroded away the toe of the vertical cut at the point where the lined drain ends which resulted in the failure. Residents from a house upslope of the crown were evacuated prior to the event. It is recommended that the roadside drain should be lined throughout. RCC retaining wall with proper drainage arrangement should be constructed at the location.*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*III*

Slide-8:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/08*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Chettiyampara colony*
6	NH/SH/Locality	:	*Chettiyampara colony Erumamunda, ,Kurumbilangod Village, Nilambur Taluk*
7	Latitude	:	*11.36217778º N*
8	Longitude	:	*76.21179444º E*
9	Length	:	*~100 m*

10	Width	:	*5-7 m*
11	Height	:	*~ 35-40m*
12	Area	:	
13	Depth	:	*1-2 m*
14	Volume	:	
15	Run out distance	:	*~250*
16	Type of Material	:	*Rock cum debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as shallow planar failure*
23	History	:	*15th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*Foliation and parallel joints N10ºE- S10ºW/75º NNW, Joint N55ºW-S55ºE/72º NE*
27	Landuse/ Landcover	:	*Cultivated*
28	Hydrological condition	:	*Damp*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road blockade*
34	Infrastructure	:	*Damaged mixed plantation (High height)*
35	Agriculture/forest/Barren	:	*Agricultural (High height plantation)*
36	Geo-scientific Causes	:	*Natural slope had been modified for planting crops by blocking natural gullies and streamlets. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on saturation. Landslide was initiated as shallow planar failure along rock-overburden contact and then transformed into debris flow in sequence.*
37	Remedial measures	:	*The overburden material (1-2 m thick) has been stripped off exposing fresh bed rock along the runout path. Dislodged boulders along the runout path/nala should be removed. Natural drainage should be maintained.*
38	Remarks, if any		

39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*A debris flow occurred on 14th June, 2018 at Chettiyampara colony in Kurumbilangod Village in Malappuram District. The slope has been modified for plantation purpose by blocking natural drainage. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on saturation. Landslide was initiated as a shallow planar failure along rock-overburden contact and then transformed into debris flow in sequence. Though the most of the overburden material has been stripped off exposing bed rock, the run out path should be cleared from dislodged rock fragments and debris. The natural gullies and streamlets may be maintained*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*III*

Slide-9:

No	Field		Description
1	Slide No.	:	*KRL/MPM/58A3/2018/09*
2	State	:	*Kerala*
3	District		*Malappuram*
4	Toposheet No.	:	*58A/03*
5	Name of the slide	:	*Vilakkennanpara*
6	NH/SH/Locality	:	*Vilakkennanpara, Kurumbilangod Village, Nilambur Taluk*
7	Latitude	:	*11.37724 ºN*
8	Longitude	:	*76.21258 ºE*
9	Length	:	*30m*
10	Width	:	*3-5m*
11	Height	:	*15m*
12	Area	:	
13	Depth	:	*2m*

14	Volume	:	
15	Run out distance	:	*30 m*
16	Type of Material	:	*Rock cum debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Reactivated*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Shallow planar failure*
23	History	:	*14th June, 2018; Rock/debris slide had occurred at the same spot about 5-6 years back also. Also about 40 years back, a huge rock block of about 6m x 4m x3m had displaced further upslope of this location, rolled down till road bench and killed three people.*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*Foliation:N10ºE- S10ºW/75º NNW*
27	Landuse/ Landcover	:	*High Height Plantation*
28	Hydrological condition	:	*Dry*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Unpaved road blocked*
34	Infrastructure	:	
35	Agriculture/forest/Barren	:	*Agriculture*
36	Geo-scientific Causes	:	*Initiated as rock slide. Failure happened along weathered seam developed within a valley dipping plane. It further graded into a debris flow collecting more debris and soil, following a natural stream path.*
37	Remedial measures	:	*Precariously positioned boulders along the runout path should be removed.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	

40	Summary/Abstract	:	*A debris flow occurred on 14th June, 2018 at Vilakkennanpara, Kurumbilangod Village, Nilambur Taluk, Malappuram district. The debris flow initiated as shallow planar failure along a weathered seam developed within a valley dipping plane and further graded into a debris flow collecting more debris and soil, following a natural stream path. Precariously positioned boulders along the runout path should be removed and natural drainage paths not to be blocked.*
41	Date of Reporting	:	*05/07/2018*
42	Landslide Category	:	*III*

Slide-10:

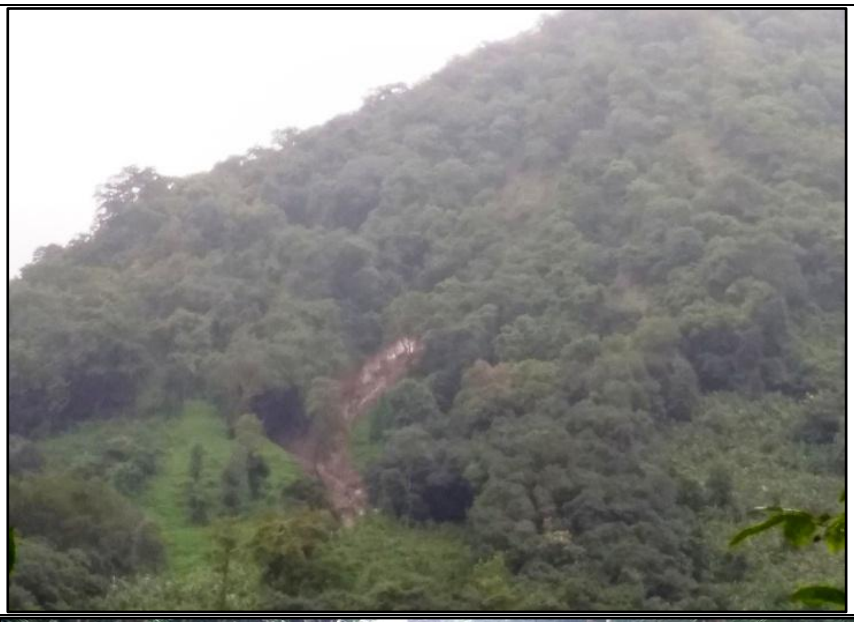
No	Field		Description
1	Slide No.	:	*KRL/PKD/58B9/2018/01*
2	State	:	*Kerala*
3	District		*Palakkad*
4	Toposheet No.	:	*58B/09*
5	Name of the slide	:	*Paypullu*
6	NH/SH/Locality	:	*Palakayam Village, Mannarkad Taluk*
7	Latitude	:	*10.97659ºN*
8	Longitude	:	*76.55491ºE*
9	Length	:	*450 m*
10	Width	:	*20 m*
11	Height	:	*180 m*
12	Area	:	
13	Depth	:	*2m at source. The overburden thickness goes up to 4-5m at the foot area.*
14	Volume	:	
15	Run out distance	:	*250 m*
16	Type of Material	:	*Rock cum debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as shallow planar failure*
23	History	:	*12th June, 2018; about 22:30 hrs*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Granite gneiss*
26	Structure	:	*N85ºE-S85ºW/Vertical*
27	Landuse/ Landcover	:	*High Height Plantation*
28	Hydrological condition	:	*Dry at source region and flowing at toe area*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Residents of 2 houses could escape just before the event. One single-storied house completely washed away. Another single storied house partially damaged*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road and road side drain blocked*
34	Infrastructure	:	*Telephone and electric lines damaged*

35	Agriculture/forest/Barren	:	*Agriculture*
36	Geo-scientific Causes	:	*Natural slope had been benched for cash crops thereby blocking natural drainage. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on saturation. Landslide was initiated as planar failure along rock-overburden contact and then transformed into debris flow in sequence.*
37	Remedial measures	:	*The overburden material (1-2 m thick) has been stripped off exposing fresh bed rock along the runout path. Dislodged boulders along the runout path/nala should be removed. Natural drainage should be maintained. A culvert of suitable dimensions to be constructed at the road bench to facilitate smooth water/debris flow.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	
			
40	Summary/Abstract	:	*On 12th June 2018, a debris flow occurred at Paypullu, Palakayam Village, Mannarkad Taluk in Palakkad district. One house was*

			completely destroyed while another was partially damaged by the runout. The natural slope at the source area had been benched for cash crops thereby blocking natural drainage. Heavy antecedent rainfall for 3 days preceding the event resulted in building up of excess pore water pressure and reduction of strength on super-saturation. Landslide was initiated as planar failure along rock-overburden contact and then transformed into debris flow in sequence. The overburden material (1-2 m thick) has been stripped off exposing fresh bed rock along the runout path. Dislodged boulders along the runout path/nala should be removed. Natural drainage should be maintained. A culvert of suitable dimensions to be constructed at the road bench to facilitate smooth water/debris flow
41	Date of Reporting	:	*06/07/2018*
42	Landslide Category	:	*II*

Slide-11:

No	Field		Description
1	Slide No.	:	*KRL/PKD/58B9/2018/02*
2	State	:	*Kerala*
3	District		*Palakkad*
4	Toposheet No.	:	*58B/09*
5	Name of the slide	:	*Kundampotti-Vattapara*
6	NH/SH/Locality	:	*Palakyam Village, Mannarkad Taluk*
7	Latitude	:	*10.97039ºN*
8	Longitude	:	*76.57454ºE*
9	Length	:	*~150 m*
10	Width	:	*~20m*
11	Height	:	*60m*
12	Area	:	
13	Depth	:	*3-4m*
14	Volume	:	
15	Run out distance	:	*350m*
16	Type of Material	:	*Rock cum debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as Shallow planar failure*
23	History	:	*12th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Hornblende biotite gneiss*
26	Structure	:	*N20ºW-S20ºE/60ºN*
27	Landuse/ Landcover	:	*High Height Plantation in runout area; Forest at source.*
28	Hydrological condition	:	*Flowing*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Road blocked*

34	Infrastructure	:	
35	Agriculture/forest/Barren	:	*Rubber plantation*
36	Geo-scientific Causes	:	*Initiated as rock slide dislodging huge boulders that size up to 3m X 3m X 2m. It further graded into a debris flow collecting more debris and soil, following a natural stream path.*
37	Remedial measures	:	*Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered.*
38	Remarks, if any		
39	Photos. Sketch of Plan & section of the slide	:	
			
40	Summary/Abstract	:	*A debris flow occurred on 12th June, 2018 at Kundampotti-Vattapara, Palakayam Village, Palakkad district. The debris flow initiated as rock slide within forest area and further graded into a debris flow collecting more debris and soil, following a natural stream path through a plantation area. Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered.*
41	Date of Reporting	:	*06/07/2018*
42	Landslide Category	:	*III*

Slide-12:

No	Field		Description
1	Slide No.	:	*KRL/PKD/58B11/2018/03*
2	State	:	*Kerala*
3	District		*Palakkad*
4	Toposheet No.	:	*58B/11*
5	Name of the slide	:	*Mannannakayam*
6	NH/SH/Locality	:	*Kizhekkencherry Village, Alathur Taluk*
7	Latitude	:	*10.97039ºN*
8	Longitude	:	*76.57454ºE*
9	Length	:	*~170 m*
10	Width	:	*~15m*
11	Height	:	*70m*
12	Area	:	
13	Depth	:	*3-4m*
14	Volume	:	
15	Run out distance	:	*>750m and flowed through a higher order stream*
16	Type of Material	:	*Rock cum debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Initiated as Shallow planar failure*
23	History	:	*12th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*J1(Foliation & parallel Joint): N40°W- S40°E/15°NE*
27	Landuse/ Landcover	:	*High Height Plantation*
28	Hydrological condition	:	*Flowing*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Jeep road blocked*
34	Infrastructure	:	
35	Agriculture/forest/Barren	:	*Mainly Rubber plantation*
36	Geo-scientific Causes	:	*Incessant rainfall for 3 days resulted in built up of cleft water pressure initiating rock slide. It further graded into a debris flow collecting more debris and soil, following a natural stream path and joined a higher order stream.*
37	Remedial measures	:	*Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered.*
38	Remarks, if any		*The stream is debris flow prone as evidenced by the presence of old slide debris along the flanks.*

39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*A debris flow occurred on 13th June, 2018, 0130 hrs at Mannannakayam, Kizhekkencherry Village, Palakkad district. The debris flow initiated as rock slide and further graded into a debris flow along a natural stream path through a plantation area. Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered.*
41	Date of Reporting	:	*07/07/2018*
42	Landslide Category	:	*III*

Slide-13:

No	Field		Description
1	Slide No.	:	*KRL/PKD/58B11/2018/04*
2	State	:	*Kerala*
3	District		*Palakkad*
4	Toposheet No.	:	*58B/11*
5	Name of the slide	:	*Kadappara*
6	NH/SH/Locality	:	*Kizhekkencherry Village, Alathur Taluk*
7	Latitude	:	*10.46591ºN*
8	Longitude	:	*76.5648ºE*
9	Length	:	*~220 m*
10	Width	:	*~15-20m*
11	Height	:	*90m*
12	Area	:	
13	Depth	:	*3-4m*
14	Volume	:	
15	Run out distance	:	*140m*
16	Type of Material	:	*Debris*
17	Type of movement	:	*Flow*
18	Rate of movement	:	*Very Rapid*
19	Activity	:	*Suspended*
20	Distribution	:	*Confined*
21	Style	:	*Complex*
22	Failure mechanism	:	*Shallow rotational failure*

23	History	:	*13th June, 2018*
24	Geomorphology	:	*Moderately dissected slope*
25	Geology/Lithology	:	*Charnockite*
26	Structure	:	*J1(Foliation & parallel Joint): N40°W- S40°E/35°NE*
27	Landuse/ Landcover	:	*High Height Plantation*
28	Hydrological condition	:	*Flowing*
29	Triggering Factor	:	*Rainfall*
30	Death of persons	:	*Nil*
31	People affected	:	*Nil*
32	Livestock Loss	:	*Nil*
33	Communication	:	*Jeep road blocked*
34	Infrastructure	:	*Electrical line damaged*
35	Agriculture/forest/Barren	:	*Mainly Rubber plantation*
36	Geo-scientific Causes	:	*Initiated as shallow rotational failure due to super saturation of slope debris following incessant rain for 3 days. It further graded into a debris flow collecting more debris and soil, following a natural stream path and joined a higher order stream.*
37	Remedial measures	:	*Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered. One house located on the right flank of this stream and another located on the adjoining parallel stream should be relocated.*
38	Remarks, if any		*The streams in the area are debris flow prone as evidenced by the presence of old slide debris along the flanks.*
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	*A debris flow occurred on 13th June, 2018 at Kadapparam, Kizhekkencherry Village, Palakkad district. The debris flow initiated as shallow rotational failure due to super saturation of slope debris following incessant rain for 3 days. It further graded into a debris flow collecting more debris and soil, following a natural stream path and joined a higher order stream. Precariously positioned boulders in the flow path should be removed. Natural drainage should be left unaltered. One house located on the right flank of this stream and another located on the adjoining parallel stream should be relocated.*
41	Date of Reporting	:	*07/07/2018*
42	Landslide Category	:	*II*