

NOTE ON POST DISASTER STUDIES FOR LANDSLIDES OCCURRED IN JUNE 2018 AT IDUKKI DISTRICT, KERALA

Field Season 2018-2019
FSP No: M4SI/NC/SR/SU-KRL/2018/21108

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Under GSI's 'Post disaster studies in Kerala' a team of two geoscientists carried out post event studies at 10 recently occurred landslides locations in Idukki district, Kerala during the months of June and July. Slope failures were reported from 9th June, 2018 in different parts of Idukki district, Kerala falling in Survey of India toposheet nos. 58B/16, 58C/03, 58 F/04 and 58G/01. This report pertains to the initial assessment of the landslide affected areas, suggestions rendered as immediate corrective measures and the 42 point detailed geo-parametric attributes of the landslide inventory.

In general, the geomorphic terrain of the area is divided into four viz. rugged hills, ridges and valleys, fringe slope and plateau. Majority of the landslides studied fall in the fringe slopes of rugged hill bordering the Munnar plateau of the Western Ghats. Moderately dissected slope and lowly dissected slope are the major geomorphic unit encountered in the slided area. A few perennial springs spout at different places, indicating the shallow depth of ground water level.

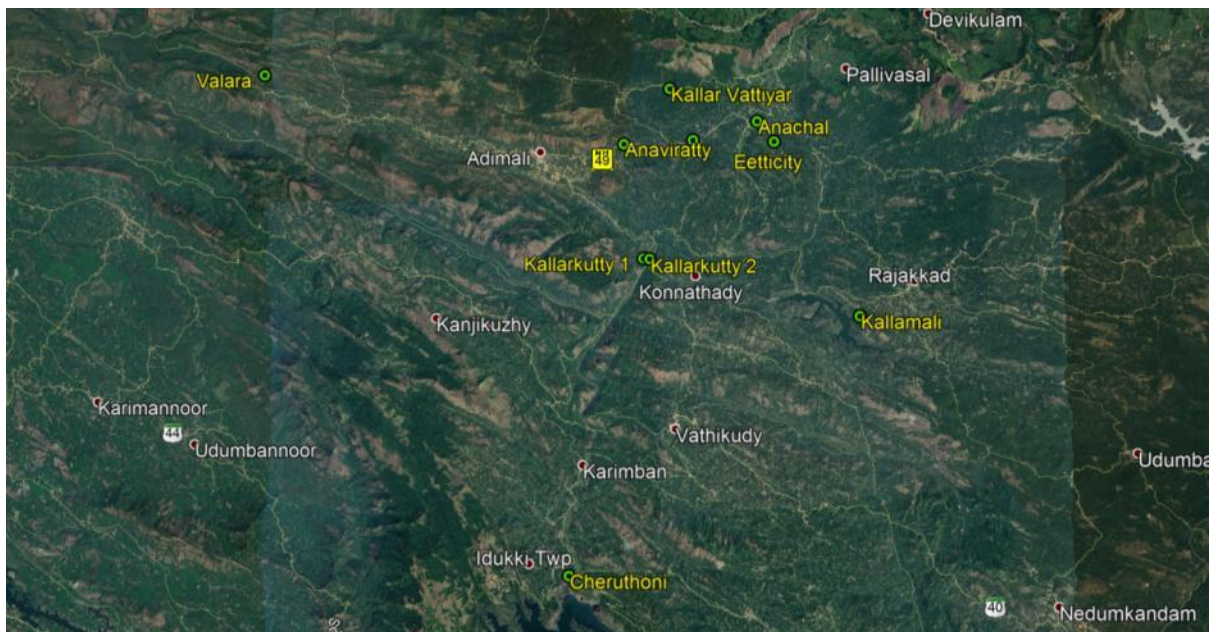


Fig: Aerial view of all landslide locations from Google imagery.

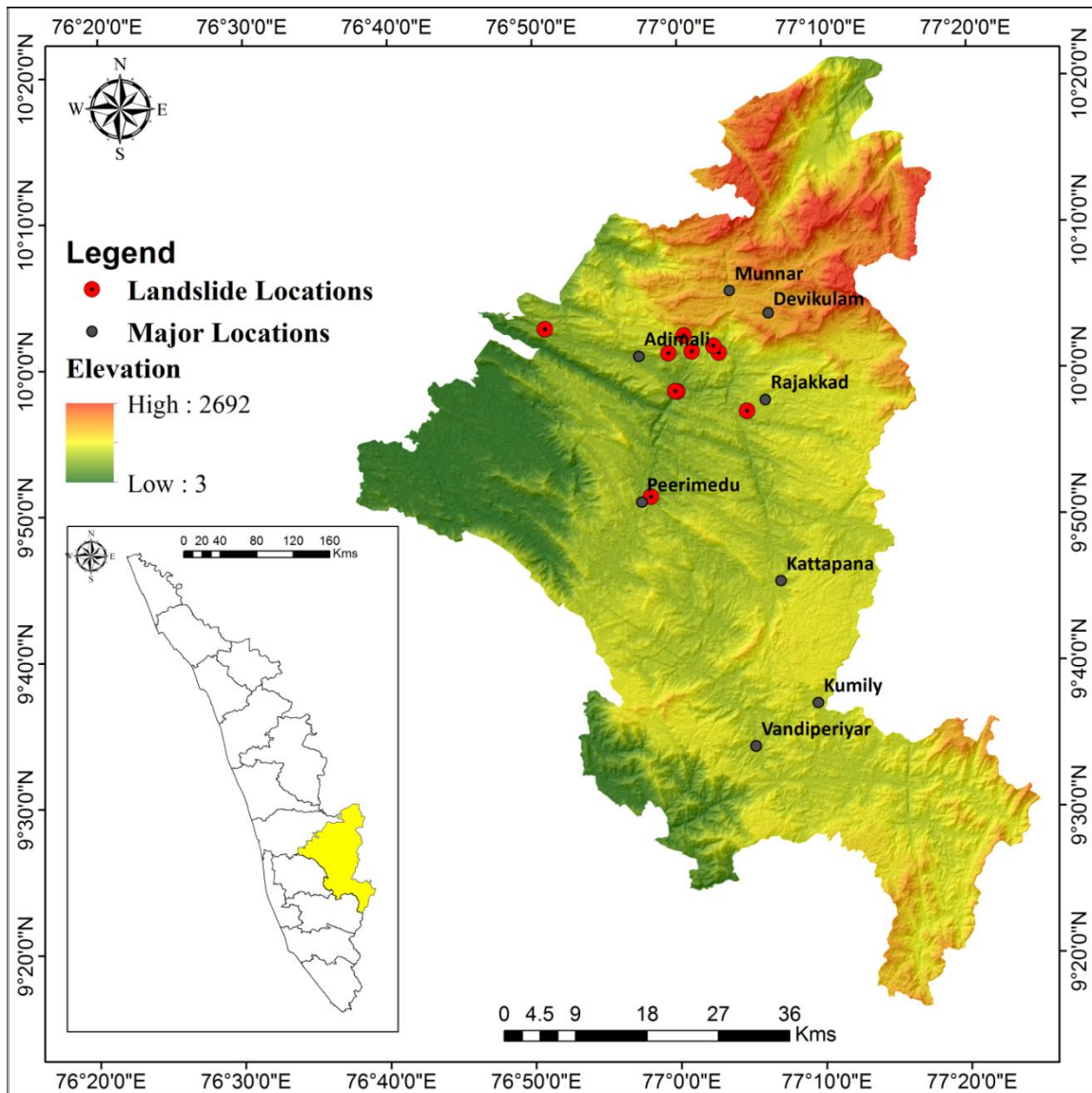
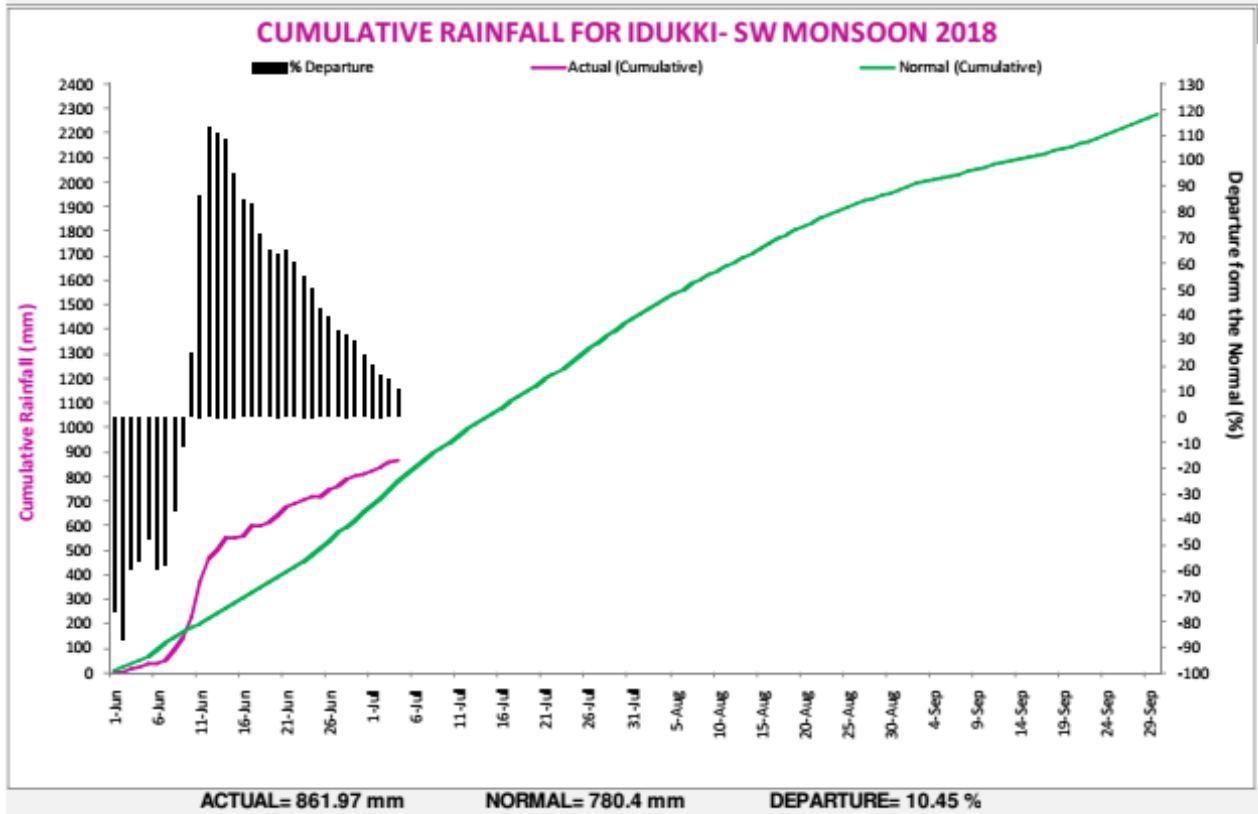


Fig: Location map of landslide incidences at Idukki District

Geologically the area forms a part of the Precambrian metamorphic shield of South India comprising rocks of the Wayanad, Khondalite, Charnockite and Migmatite Groups. Major rock units of the area are the garnet biotite gneiss, hornblende biotite gneiss, pink granitogneiss and small patch of charnockite body.

The preparatory factors observed in the study are weathering, loading of the slope or its crest, excavation of the slope of its toe, defective maintenance of drainage systems, land use and land cover including road and other physical features, physical state of slope such as slope gradient, slope aspect and slope curvature and physical characteristics of slope forming mass. Slope failures are more common along the road corridors and the corridors are highly susceptible to failures as the thick column of vertically cut old debris/soil mass remained untreated after the construction of road. Incessant torrential rain started from 08th of June, 2018 in Idukki district is assessed to be the triggering factor. The cumulative rainfall graph of Idukki district during the SW monsoon is given below.

PERFORMANCE OF SOUTH WEST MONSOON 2018 OVER IDUKKI
From 01-Jun-2018 to 04-Jul-2018



(Source: Indian Meteorological Department, Thiruvananthapuram)

The 42 point detailed geo-parametric attributes of landslide inventory are given below:

Location 1:

No	Field	Description
1	Slide No.	: <i>KER/IDK/58F04/2018/01</i>
2	State	: <i>Kerala</i>
3	District	: <i>Idukki</i>
4	Toposheet No.	: <i>58F/04</i>
5	Name of the slide	: <i>KallarVattiyar</i>
6	NH/SH/Locality	: <i>NH – 49 (Kochi – Dhanushkodi Road)</i>
7	Latitude	: <i>10.0372 N</i>
8	Longitude	: <i>77.0068 E</i>
9	Length	: <i>60m</i>
10	Width	: <i>30m</i>
11	Height	: <i>60m</i>
12	Area	: <i>1800m²</i>
13	Depth	: <i>4m (approx.)</i>
14	Volume	: <i>7200m³</i>

15	Run out distance	:	<i>70m</i>
16	Type of Material	:	<i>Rock-cum- debris</i>
17	Type of movement	:	<i>Flow</i>
18	Rate of movement	:	<i>Very Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Advancing</i>
21	Style	:	<i>Single</i>
22	Failure mechanism	:	<i>Shallow planar ($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation: 09th June, 2018</i>
24	Geomorphology	:	<i>Moderately Dissected Slope, Slide direction is towards S7°W</i>
25	Geology/Lithology	:	<i>Pink Granite Gneiss</i>
26	Structure	:	<i>-</i>
27	Landuse/ Landcover	:	<i>Low Height Plantation (Cardamom)</i>
28	Hydrological condition	:	<i>Flowing</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>2 persons got injured</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>NH – 49 (Kochi – Dhanushkodi Road) damaged and blocked for hours.</i>
34	Infrastructure	:	<i>One house partially damaged, one culvert completely damaged.</i>
35	Agriculture/forest/Barren	:	<i>Agriculture: Cardamom, mixed cultivation.</i>
36	Geo-scientific Causes	:	<i>Loosening the overburden for cardamom plantation, adverse cultivation pattern, defective maintenance of drainage systems along with reduction of strength on super saturation due to continuous shower. The natural course of the drainage was blocked for cardamom plantation.</i>
37	Remedial measures	:	<i>As an immediate measure the loose unsorted debris should be removed retaining the natural course of the nala and construction of a proper culvert for the free flowing of water across the road. The next step is the restriction of unscientific hill slope modification. The hill slope modification if required may be carried out after considering the slope stability and engineering aspects. Proper land use practice must be followed along the vulnerable slopes. Terracing and contour bounding should not be allowed along the slope. People must be educated about the importance of proper land use practices to minimise the risks. Afforestation of the slope with suitable plant species has to be done.</i>
38	Remarks, if any	:	<i>If immediate remedial measures not taken, the chances are very high for reactivation.</i>

39 Photos. Sketch of Plan & section of the slide :



Fig: The upper part of the failed surface.



Fig: The run out path.

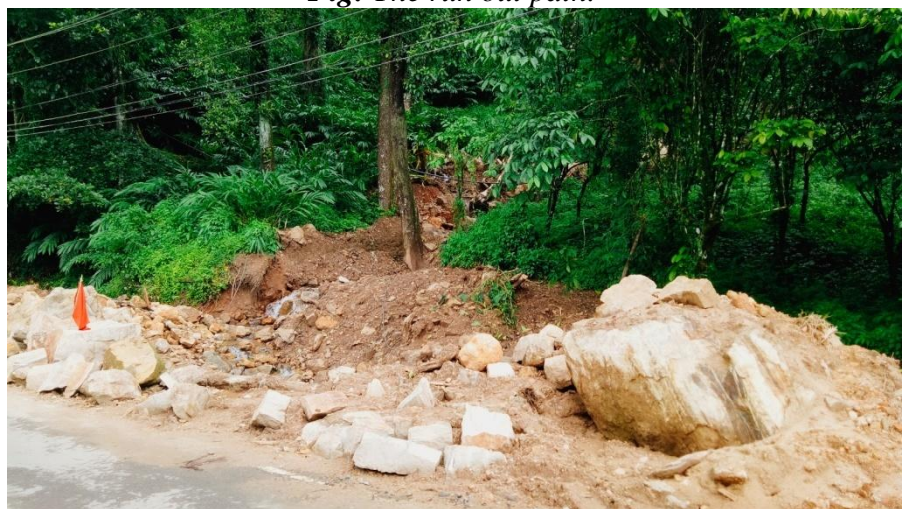


Fig: Accumulation of failed mass on the slope break.

40	Summary/Abstract	:	<i>A debris flow occurred in Kallar-Vattiyar area, Pallivasal Village, Devikulam Taluk, Idukki district at about 1900hrs on 9th June, 2018. Two persons got injured; the material with huge boulders caused partial damage to one house and the National Highway 49. The length, width and depth of the slide are about 60m, 30m and 4m respectively. The material comprising a complex mixture of fine clay and sand and coarse gravel, cobbles and boulders with a variable water quantity has been dislodged and moved down to about 70m and disrupted traffic in the Kochi-Dhanushkodi road. Part of the debris has accumulated on the road and part moved down up to the bottom of the slope damaging one house in its path. The adverse cultivation pattern by modification of slope, defective maintenance of drainage systems and nature of slope forming material are the preparatory factors. Increase of pore pressure due to infiltration and accumulation of rain water along the loose debris is the triggering factor for the slide.</i>
41	Date of Reporting	:	<i>29th June, 2018</i>
42	Landslide Category	:	<i>Category III</i>

Location 2:

No	Field	:	Description
1	Slide No.	:	<i>KER/IDK/58F04/2018/02</i>
2	State	:	<i>Kerala</i>
3	District	:	<i>Idukki</i>
4	Toposheet No.	:	<i>58F/04</i>
5	Name of the slide	:	<i>Anachal</i>
6	NH/SH/Locality	:	<i>2nd Mile Bus stop road (via Anachal), a bifurcation road in NH-49.</i>
7	Latitude	:	<i>10.0254 N</i>
8	Longitude	:	<i>77.0407 E</i>
9	Length	:	<i>20m</i>
10	Width	:	<i>30m</i>
11	Height	:	<i>25m</i>
12	Area	:	<i>600m²</i>
13	Depth	:	<i>3m</i>
14	Volume	:	<i>1800m³</i>
15	Run out distance	:	<i>15m</i>
16	Type of Material	:	<i>Debris</i>
17	Type of movement	:	<i>Slide</i>
18	Rate of movement	:	<i>Extremely Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Retrogressive</i>

21	Style	:	<i>Single</i>
22	Failure mechanism	:	<i>Shallow planar ($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation: 11th June, 2018 (1400hrs)</i>
24	Geomorphology	:	<i>Lowly Dissected Slope, Slide direction is towards N40°E</i>
25	Geology/Lithology	:	<i>Pink Granite Gneiss</i>
26	Structure	:	-
27	Landuse/ Landcover	:	<i>Settlement</i>
28	Hydrological condition	:	<i>Wet</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Nil</i>
34	Infrastructure	:	<i>Newly constructed four storied building completely collapsed.</i>
35	Agriculture/forest/Barren	:	<i>Nil</i>
36	Geo-scientific Causes	:	<i>Construction of building (four storied) in loose overburden material without proper strengthening of foundation which in turn resulted in loading at the head of the slope break. Improper maintenance of drainage system: As the culverts in the road were blocked, the excess water has accumulated besides the building in the road corridor as that part of the road is having a slight depression. This excess water seepage through the loose overburden material increased the pore water pressure which in turn initiated the slide.</i>
37	Remedial measures	:	<i>As an immediate remedial measure remove the accumulated remains of collapsed building and the slided materials from the slope, open all the culverts and divert the water through culverts without allowing it to settle in the vulnerable slopes. In future, before initiating any construction, carry out the site feasibility study in order to understand the characteristics of subsoil. Remove and replace the undesirable in situ soil or soil stabilization may be done to improve soil strength and increase the resistance to its softening by water through bonding the soil particles together.</i>
38	Remarks, if any	:	<i>Another five storied building, situated adjacent to the collapsed building, is in the brim of danger.</i>

39 Photos. Sketch of Plan & section of the slide :



Fig: The crown of the slide



Fig: Accumulated remains of building and debris.



Fig: A view from the crown of the slide depicts the collapsed building.

40	Summary/Abstract	:	<i>A debris slide occurred in Anachal, Pallivasal Village, Devikulam Taluk, Idukki district at about 1400hrs on 11th June, 2018. Newly constructed four storied building got completely devastated during the slide. The length, width and depth of the slide are about 20m, 30m and 3m respectively. The material there was very loose coarse-grained in-situ soil. The slide occurred on a very steep slope of about 60°-70°. The building with its base built on this loose soil added a head loading to the break in slope. All the culverts beside the road were blocked which cause the accumulation of water besides the building in the road corridor. This resulted in increase of pore pressure due to infiltration along the loose overburden material which in turn initiated the slide.</i>
41	Date of Reporting	:	<i>29th June, 2018</i>
42	Landslide Category	:	<i>Category II</i>


Location 3:

No	Field	:	Description
1	Slide No.	:	<i>KER/IDK/58F04/2018/03</i>
2	State	:	<i>Kerala</i>
3	District	:	<i>Idukki</i>
4	Toposheet No.	:	<i>58F/04</i>
5	Name of the slide	:	<i>Eetticity</i>
6	NH/SH/Locality	:	<i>Anachal-Pothupara road</i>
7	Latitude	:	<i>10.0176 N</i>
8	Longitude	:	<i>77.0472 E</i>
9	Length	:	<i>60m</i>
10	Width	:	<i>50m</i>
11	Height	:	<i>45m</i>
12	Area	:	<i>3000 m²</i>
13	Depth	:	<i>4m</i>
14	Volume	:	<i>12000m³</i>
15	Run out distance	:	<i>60m</i>
16	Type of Material	:	<i>Debris</i>
17	Type of movement	:	<i>Slide</i>
18	Rate of movement	:	<i>Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Advancing</i>
21	Style	:	<i>Single</i>
22	Failure mechanism	:	<i>Shallow planar ($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation:09th June, 2018</i>

24	Geomorphology	:	<i>Lowly Dissected Slope</i>
25	Geology/Lithology	:	<i>Pink Granite Gneiss</i>
26	Structure	:	-
27	Landuse/ Landcover	:	<i>Settlement, Moderate Vegetation, Slide direction is towards N20°E</i>
28	Hydrological condition	:	<i>Wet</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Nil</i>
34	Infrastructure	:	<i>Nil</i>
35	Agriculture/forest/Barren	:	<i>Mixed plantations</i>
36	Geo-scientific Causes	:	<i>During the construction of a resort in Eetticity, the material removed where collected in more than 100 sacks and the sacks where then loaded in the head of the slope beneath the building. During heavy rain, water seepage through these sacks created increase in pore water pressure together with the weight of the sacks initiate the sliding. The sack surface acted as a non-cohesive surface which in turn increased the possibility of slide.</i>
37	Remedial measures	:	<i>As an immediate measure the district authority cover the slided area with polythene sheets which prevented further infiltration or exposure to rain water. Reducing the slope height, reducing the slope angle, removing unstable wash away loose unsorted materials and incorporating benches in the slope.</i>
38	Remarks, if any	:	-
39	Photos. Sketch of Plan & section of the slide	:	-
40	Summary/Abstract	:	<i>A debris slide occurred in Eetticity, Vellathooval Panchayat, Idukki district on 9th June, 2018. The material below a newly constructed resort got slided due to the head loading of slope by the dumped excavated material during the construction of the resort. The length, width and depth of the slide are about 60m, 50m and 4m respectively. The direction of the slide is N20°E with slope angle 50°-60°. The material removed during the construction of the resort was dumped in the head portion of the slope in sacks and with the increase in pore water pressure the slide was triggered. As an immediate measure the district authority evacuate the area, closed the resort and covered the slided area with polythene sheets which prevented further infiltration or exposure to rain water.</i>
41	Date of Reporting	:	<i>28th June, 2018</i>
42	Landslide Category	:	<i>Category III</i>

Location 4:

No	Field	Description
1	Slide No.	: <i>KER/IDK/58G01/2018/04</i>
2	State	: <i>Kerala</i>
3	District	: <i>Idukki</i>
4	Toposheet No.	: <i>58G/01</i>
5	Name of the slide	: <i>Kallimali</i>
6	NH/SH/Locality	: <i>Unmetalled road to Ponmudi Reservoir connecting the Adimali-Rajakad road.</i>
7	Latitude	: <i>09.9509 N</i>
8	Longitude	: <i>77.0795 E</i>
9	Length	: <i>45m</i>
10	Width	: <i>8m</i>
11	Height	: <i>40m</i>
12	Area	: <i>360m²</i>
13	Depth	: <i>7m (approx.)</i>
14	Volume	: <i>2570m³</i>
15	Run out distance	: <i>100m</i>
16	Type of Material	: <i>Debris</i>
17	Type of movement	: <i>Flow</i>
18	Rate of movement	: <i>Very Rapid</i>
19	Activity	: <i>Active</i>
20	Distribution	: <i>Advancing</i>
21	Style	: <i>Single</i>
22	Failure mechanism	: <i>Deep planar ($\geq 5m$) failure</i>
23	History	: <i>Date of initiation: 09th June, 2018</i>
24	Geomorphology	: <i>Moderately Dissected Slope, Slide direction is towards S25°W</i>
25	Geology/Lithology	: <i>Charnockite</i>
26	Structure	: -
27	Landuse/ Landcover	: <i>Moderate Vegetation</i>
28	Hydrological condition	: <i>Flowing</i>
29	Triggering Factor	: <i>Rainfall</i>
30	Death of persons	: <i>Nil</i>
31	People affected	: <i>Nil</i>
32	Livestock Loss	: <i>Nil</i>
33	Communication	: <i>Unmetalled road partly damaged.</i>
34	Infrastructure	: <i>Nil</i>
35	Agriculture/forest/Barren	: <i>Destroyed 1.5 acre agriculture land (Pepper)</i>
36	Geo-scientific Causes	: <i>Pore water pressure, presence of unsorted overburden materials, unplanned cultivation obstructing the natural course of drainage, slope modification for the construction of road.</i>
37	Remedial measures	: <i>As the area is devoid of any settlements and anthropogenic presence, removing the unsorted loose overburden and reducing the slope angle along with proper maintenance of drainage system will serve the purpose.</i>
38	Remarks, if any	: -

39	Photos. Sketch of Plan & section of the slide	<p data-bbox="571 129 1501 683">  </p> <p data-bbox="810 689 1273 719">Fig: A view from the toe of the slide</p> <p data-bbox="571 725 1501 1249">  </p> <p data-bbox="788 1252 1295 1281">Fig: A view from the crown of the slide</p>
40	Summary/Abstract	<p data-bbox="571 1281 1530 1655"> <i>The slide occurred in the western slope of Ponnudi reservoir. The slope and the natural course of the river were modified for cultivation and for the construction of an unmetalled road. The excavated material after the formation of road was dumped in the crest of the slope and the incessant shower prevailed from 08th June, 2018 initiate the sliding. The length, width and depth of the slide are about 45m, 8m and 7m (approx.) respectively. The direction of the slide is S25°W with a slope angle varying from 25°-35°. Smoothing the topography by removing the unsorted loose overburden material with proper maintenance of drainage system is the suggested immediate remedial measures.</i> </p>
41	Date of Reporting	<p data-bbox="571 1655 1530 1693"> <i>28th June, 2018.</i> </p>
42	Landslide Category	<p data-bbox="571 1693 1530 1729"> <i>Category III</i> </p>

Location5:


No	Field	Description
1	Slide No.	: <i>KER/IDK/58G01/2018/05</i>
2	State	: <i>Kerala</i>
3	District	: <i>Idukki (Devikulam Taluk)</i>
4	Toposheet No.	: <i>58G/01</i>
5	Name of the slide	: <i>Kallarkutty</i>
6	NH/SH/Locality	: <i>Kallarkutty Dam Road</i>
7	Latitude	: <i>09.974 N</i>
8	Longitude	: <i>76.9968 E</i>
9	Length	: <i>8m</i>
10	Width	: <i>9m</i>
11	Height	: <i>20m</i>
12	Area	: <i>72m²</i>
13	Depth	: <i>5m</i>
14	Volume	: <i>360m³</i>
15	Run out distance	: <i>5m</i>
16	Type of Material	: <i>Debris</i>
17	Type of movement	: <i>Slide</i>
18	Rate of movement	: <i>Moderate</i>
19	Activity	: <i>Active</i>
20	Distribution	: <i>Advancing</i>
21	Style	: <i>Single</i>
22	Failure mechanism	: <i>Shallow rotational($\leq 5m$) failure</i>
23	History	: <i>Date of initiation:09th June, 2018</i>
24	Geomorphology	: <i>Lowly Dissected Slope, Slide direction is towards S58°W</i>
25	Geology/Lithology	: <i>Hornblende biotite Gneiss</i>
26	Structure	: <i>-</i>
27	Landuse/ Landcover	: <i>Moderate Vegetation</i>
28	Hydrological condition	: <i>Flowing</i>
29	Triggering Factor	: <i>Rainfall</i>
30	Death of persons	: <i>Nil</i>
31	People affected	: <i>Nil</i>
32	Livestock Loss	: <i>Nil</i>
33	Communication	: <i>Kallarkutty dam road blocked for hours.</i>
34	Infrastructure	: <i>One house partly damaged.</i>

35	Agriculture/forest/Barren	:	Nil
36	Geo-scientific Causes	:	Pore water pressure, reduction of strength on super saturation, unplanned construction, loading at head region and excavation of the slope.
37	Remedial measures	:	Removal of slided material, smoothing the slope face and installation of proper drainage conduits/pipes to ooze out the free flowing water from the surface.
38	Remarks, if any	:	-
39	Photos. Sketch of Plan & section of the slide	:	 <p style="text-align: center;">Fig: Kallarkutty debris slide</p>
40	Summary/Abstract	:	The debris slide occurred beside the Kallarkutty dam road has resulted in partial damage to one house and the road was blocked for hours. The length, width and depth of the slide are about 8m, 9m and 5m respectively. The direction of the slide is S58°W with a slope angle >45°. During the study it was found that the modification of slope for making path to access the house is the major preparatory factor and the excess pore-water pressure developed during incessant rainfall is the triggering factor. The continuous oozing out of water from different parts of slide points to the presence of an impermeable layer below, which resulted in increased pore-water pressure and decreased shear strength, thus facilitating slope failure.
41	Date of Reporting	:	01 st July, 2018.
42	Landslide Category	:	Category III

Location 6:

No	Field	:	Description
1	Slide No.	:	KER/IDK/58C03/2018/06
2	State	:	Kerala
3	District	:	Idukki
4	Toposheet No.	:	58C/03
5	Name of the slide	:	Kallarkutty II
6	NH/SH/Locality	:	Kallarkutty approach road


7	Latitude	:	<i>09.9737 N</i>
8	Longitude	:	<i>76.9992 E</i>
9	Length	:	-
10	Width	:	<i>30m</i>
11	Height	:	-
12	Area	:	-
13	Depth	:	<i>3m</i>
14	Volume	:	-
15	Run out distance	:	-
16	Type of Material	:	<i>Soil</i>
17	Type of movement	:	<i>Subsidence</i>
18	Rate of movement	:	<i>Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Moving</i>
21	Style	:	<i>Single</i>
22	Failure mechanism	:	<i>Shallow planar ($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation:09th June, 2018, 02.00hrs</i>
24	Geomorphology	:	<i>Valley</i>
25	Geology/Lithology	:	<i>Hornblende biotite Gneiss</i>
26	Structure	:	-
27	Landuse/ Landcover	:	<i>Moderate Vegetation</i>
28	Hydrological condition	:	<i>Flowing</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Nil</i>
34	Infrastructure	:	<i>Road side concrete retaining wall</i>
35	Agriculture/forest/Barren	:	<i>Agriculture (pepper)</i>
36	Geo-scientific Causes	:	<i>As there was a column of soil between the road and the newly constructed retaining wall the water perched through the column resulted in soaking of the material mass & caused increase in weight along with the pore water pressure created an additional stress towards the retaining wall. This along with the removal of lateral support due to erosion by nala initiated the subsidence.</i>
37	Remedial measures	:	<i>Remove the collapsed retaining wall and loose overburden material. Construction of concrete reinforced gravity wall with proper drainage conduits. Proper maintenance of road drainage system through construction of impermeable side ditches and culverts.</i>

38	Remarks, if any	-
39	Photos. Sketch of Plan & section of the slide	 <p style="text-align: center;">Fig: Subsidence in Kallarkutty approach road.</p>
40	Summary/Abstract	<p><i>The subsidence occurred beside the Kallarkutty approach road at 1400hrs on 09.07.2018. The subsidence occurred as a result of the toe erosion by one of the tributaries of Mutira Puzha along with the weight of the retaining wall constructed beneath the approach road. Some parallel cracks were also observed in the approach road which will fall eventually if any retaining wall was not constructed.</i></p>
41	Date of Reporting	: 01 st June, 2018
42	Landslide Category	: Category III

Location 7:

No	Field	Description
1	Slide No.	: KER/IDK/58B16/2018/07
2	State	: Kerala
3	District	Idukki
4	Toposheet No.	: 58B/16
5	Name of the slide	: Cheruthoni



6	NH/SH/Locality	:	<i>Thodupuzha-Puliyannmala road</i>
7	Latitude	:	<i>09.8538 N</i>
8	Longitude	:	<i>76.9681 E</i>
9	Length	:	<i>6m</i>
10	Width	:	<i>15m</i>
11	Height	:	<i>9m</i>
12	Area	:	<i>90m²</i>
13	Depth	:	<i>0.5m</i>
14	Volume	:	<i>45m³</i>
15	Run out distance	:	<i>2.5m</i>
16	Type of Material	:	<i>Soil</i>
17	Type of movement	:	<i>Slide</i>
18	Rate of movement	:	<i>Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Advancing</i>
21	Style	:	<i>Single</i>
22	Failure mechanism	:	<i>Shallow planar($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation:09th June, 2018</i>
24	Geomorphology	:	<i>Lowly Dissected Slope</i>
25	Geology/Lithology	:	<i>Biotite Gneiss</i>
26	Structure	:	<i>-</i>
27	Landuse/ Landcover	:	<i>Settlement</i>
28	Hydrological condition	:	<i>Dripping</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Nil</i>
34	Infrastructure	:	<i>One house partly affected.</i>
35	Agriculture/forest/Barren	:	<i>Nil</i>
36	Geo-scientific Causes	:	<i>The slope was modified for the construction of one house and left behind the cut slope without construction of any retaining wall. The weight of the trees at the edge of the excavated slope along with the infiltration of rain water initiated the movement.</i>
37	Remedial measures	:	<i>Removal of trees from the edge of the cut slope, removing material from the area driving the landslide and reducing general slope angle.</i>
38	Remarks, if any	:	<i>As water is still dripping out of the failed surface, the chance of</i>

			<i>recurrence is there.</i>
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	<i>The slope was modified for the construction of one house and left behind the cut slope without construction of any retaining wall. The weight of the trees at the edge of the excavated slope along with the infiltration of rain water resulted in sliding. As water is still dripping out of the failed surface, the chance of recurrence is there. Removal of trees from the edge of the cut slope, removing material from the area driving the landslide and reducing general slope angle can slow or stop further sliding.</i>
41	Date of Reporting	:	<i>01st July, 2018</i>
42	Landslide Category	:	<i>Category III</i>

Location 8:

No	Field		Description
1	Slide No.	:	<i>KER/IDK/58B16/2018/08</i>
2	State	:	<i>Kerala</i>
3	District		<i>Idukki</i>
4	Toposheet No.	:	<i>58B/16</i>
5	Name of the slide	:	<i>Valara</i>


6	NH/SH/Locality	:	<i>Valara-Vadakkechal road (By road to NH 49)</i>
7	Latitude	:	<i>10.0455 N</i>
8	Longitude	:	<i>76.8472 E</i>
9	Length	:	-
10	Width	:	-
11	Height	:	-
12	Area	:	-
13	Depth	:	-
14	Volume	:	-
15	Run out distance	:	-
16	Type of Material	:	<i>Rock</i>
17	Type of movement	:	<i>Fall</i>
18	Rate of movement	:	<i>Extremely Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	-
21	Style	:	<i>Successive</i>
22	Failure mechanism	:	
23	History	:	<i>Date of initiation:03rd May, 2018, Date of reactivation:09th June, 2018</i>
24	Geomorphology	:	<i>Moderately Dissected Slope</i>
25	Geology/Lithology	:	<i>Biotite Gneiss</i>
26	Structure	:	-
27	Landuse/ Landcover	:	<i>High Height Plantation</i>
28	Hydrological condition	:	<i>Wet</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Nil</i>
34	Infrastructure	:	<i>Nil</i>
35	Agriculture/forest/Barren	:	<i>Agriculture (Rubber)</i>
36	Geo-scientific Causes	:	<i>After site inspection it was concluded that weathering and erosion have resulted in the development of fractures parallel to the surface (sheet joints). Over long periods, daily temperature variations and extreme heat along with water flowing through fractures decomposes the bedrock, loosened bonds that hold rocks in place which created large slabs of rock by the process of exfoliation. Vegetation growth along with the triggering factor of</i>

			<i>rainfall finally forced the unstable rock to fall.</i>
37	Remedial measures	:	<i>Removal of protrusions and overhangs (exfoliated rock slabs) retained in the top by scaling (manual or mechanical) if possible.</i>
38	Remarks, if any		-
39	Photos. Sketch of Plan & section of the slide	:	 
40	Summary/Abstract	:	<i>Two successive rockfalls occurred in Valara on 03rd May, 2018 and 09th June, 2018. A fragment of rock detached by falling along the sub-vertical ridge faces and proceeded down slope by bouncing along the thick high height plantations (Rubber) below. After site inspection it was concluded that weathering and erosion have resulted in the development of fractures parallel to the surface (sheet joints). Over long periods, daily temperature variations and extreme heat along with water flowing through fractures decomposes the bedrock, loosened bonds that hold rocks in place which created large slabs of rock by the process of</i>

			<i>exfoliation. Vegetation growth along with the triggering factor of rainfall finally forced the unstable rock to fall. Removing the protrusions and overhangs (exfoliated rock slabs) retained in the top by scaling (manual or mechanical) if possible is the suggested mitigation measure.</i>
41	Date of Reporting	:	<i>02nd July, 2018</i>
42	Landslide Category	:	<i>Category III</i>


Location 9:

No	Field		Description
1	Slide No.	:	<i>KER/IDK/58F04/2018/09</i>
2	State	:	<i>Kerala</i>
3	District		<i>Idukki</i>
4	Toposheet No.	:	<i>58F/04</i>
5	Name of the slide	:	<i>Anaviratty</i>
6	NH/SH/Locality	:	<i>NH – 49 (Kochi – Dhanushkodi Road)</i>
7	Latitude	:	<i>10.0172 N</i>
8	Longitude	:	<i>76.9891 E</i>
9	Length	:	<i>7m</i>
10	Width	:	<i>10m</i>
11	Height	:	<i>10m</i>
12	Area	:	<i>70m²</i>
13	Depth	:	<i>1m</i>
14	Volume	:	<i>70m³</i>
15	Run out distance	:	<i>3m</i>
16	Type of Material	:	<i>Soil</i>
17	Type of movement	:	<i>Slide</i>
18	Rate of movement	:	<i>Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Retrogressive</i>
21	Style	:	<i>Successive</i>
22	Failure mechanism	:	<i>Shallow planar($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation:09th June, 2018</i>
24	Geomorphology	:	<i>Moderately Dissected Slope, Slide direction is towards S 70°W</i>
25	Geology/Lithology	:	<i>Hornblende biotite Gneiss</i>
26	Structure	:	<i>-</i>
27	Landuse/ Landcover	:	<i>Thick vegetation, Extensive slope cut for construction of road.</i>
28	Hydrological condition	:	<i>Wet</i>

29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Road blocked- NH – 49 (Kochi – Dhanushkodi Road)</i>
34	Infrastructure	:	<i>Nil</i>
35	Agriculture/forest/Barren	:	<i>Forest</i>
36	Geo-scientific Causes	:	<i>Unplanned cutting of slope for the construction of NH – 49 (Kochi – Dhanushkodi Road). Saturation of loose overburden due to incessant rainfall.</i>
37	Remedial measures	:	<i>Construction of gabion retaining wall.</i>
38	Remarks, if any		<i>Slope failures are common along the road corridors as the roads are constructed by vertically cutting thick column of old debris/soil mass and leaving the cut slope untreated making them highly susceptible to failure.</i>
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	<i>A cut slope failure occurred in Anaviratty, Devikulam Taluk, Idukki district on 9th June, 2018. As a result of the failure the NH – 49 (Kochi – Dhanushkodi Road) was blocked for hours. The length, width and depth of the slide are about 7m, 10m and 1m respectively. Part of the dislodged material was accumulated on the road disrupting the traffic in Kochi – Dhanushkodi Road. The unplanned cutting of hill slope for the construction of NH - 49 along with the oversaturation of loose overburden due to incessant rainfall triggered the slide.</i>
41	Date of Reporting	:	<i>29th June, 2018</i>
42	Landslide Category	:	<i>Category III</i>

Location 10:

No	Field		Description
1	Slide No.	:	<i>KER/IDK/58F04/2018/10</i>
2	State	:	<i>Kerala</i>
3	District		<i>Idukki</i>
4	Toposheet No.	:	<i>58F/04</i>
5	Name of the slide	:	<i>Ambazhachal</i>
6	NH/SH/Locality	:	<i>Thottapura-Selliampara Road</i>
7	Latitude	:	<i>10.0191 N</i>
8	Longitude	:	<i>77.0162 E</i>
9	Length	:	<i>3.5m</i>
10	Width	:	<i>5m</i>
11	Height	:	<i>5m</i>
12	Area	:	<i>17.5m²</i>
13	Depth	:	<i>1m</i>
14	Volume	:	<i>17.5m³</i>
15	Run out distance	:	<i>-</i>
16	Type of Material	:	<i>Soil</i>
17	Type of movement	:	<i>Slide</i>
18	Rate of movement	:	<i>Rapid</i>
19	Activity	:	<i>Active</i>
20	Distribution	:	<i>Retrogressive</i>
21	Style	:	<i>Successive</i>
22	Failure mechanism	:	<i>Shallow planar ($\leq 5m$) failure</i>
23	History	:	<i>Date of initiation:09th June, 2018</i>
24	Geomorphology	:	<i>Lowly Dissected Slope, Slide flow is towards N 40°W</i>
25	Geology/Lithology	:	<i>Pink Granite Gneiss</i>
26	Structure	:	<i>-</i>
27	Landuse/ Landcover	:	<i>Moderate vegetation, Extensive slope cut for construction of road.</i>
28	Hydrological condition	:	<i>Wet</i>
29	Triggering Factor	:	<i>Rainfall</i>
30	Death of persons	:	<i>Nil</i>
31	People affected	:	<i>Nil</i>
32	Livestock Loss	:	<i>Nil</i>
33	Communication	:	<i>Thottapura – Selliampara Road blocked for hours.</i>

34	Infrastructure	:	<i>Nil</i>
35	Agriculture/forest/Barren	:	<i>Moderate vegetation with settlement.</i>
36	Geo-scientific Causes	:	<i>Unplanned cutting of Ambazhachal hill slope for the construction of Thottapura – Selliampara road. Saturation of loose overburden due to incessant rainfall.</i>
37	Remedial measures	:	<i>Construction of gabion retaining wall.</i>
38	Remarks, if any	:	<i>Slope failures are common along the road corridors as the roads are constructed by vertically cutting thick column of old debris/soil mass and leaving the cut slope untreated making them highly susceptible to failure.</i>
39	Photos. Sketch of Plan & section of the slide	:	
40	Summary/Abstract	:	<i>A cut slope failure occurred in Ambazhachal, Pallivasal Village, Devikulam Taluk, Idukki district on 9th June, 2018. As a result of the failure the Thottapura-Selliampara road was blocked for hours. The length, width and depth of the slide are about 3.5m, 5m and 1m respectively. Part of the dislodged material was accumulated on the road disrupting the traffic in the Thottapura-Selliampara road. The unplanned cutting of Ambazhachal hill slope for the construction of Thottapura - Selliampara road along with the saturation of loose overburden due to incessant rainfall triggered the slide.</i>
41	Date of Reporting	:	<i>29th June, 2018</i>
42	Landslide Category	:	<i>Category III</i>