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GEOLOGICAL SURVEY OF INDIA

Note on the preliminary Assessment of Landslides at Dakshin Kannada Districts, Karnataka, 2023.

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सेंथिलकुमार के
वरिष्ठ भूवैज्ञानिक

Senthilkumar K
Senior Geologist

Under the guidance of

Dr. R Sajeev
Director (G)
Engg. Geology & Landslide Division
State Unit: Karnataka & Goa
Southern Region

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Note on the preliminary assessment of landslides at Chikmangalur, Dakshin Kannada, and Kodagu Districts, Karnataka

सेंथिलकुमार के , वरिष्ठ भूवैज्ञानिक **Senthilkumar.K, Senior Geologist**

1. Introduction

Geological Survey of India, SU: KG collaborated with officials from the Dakshin Kannada District Disaster Management Authority to conduct a comprehensive study on post-disaster landslides in the district, on 4th August 2023. The primary objective of this study is to gather on-site data for an initial geoscientific assessment, which will help identify the factors contributing to and impacting the documented landslides. This assessment takes into account the current geological, hydrological, and slope conditions in the region.

2. Location of the landslides

The landslide area is situated within toposheet number 48P/1, specifically in the Bantwal taluk of Dakshin Kannad district. Within this region, one of the locations is Sajipamunnur village, while the other locations are Gudinapali and Bantwala Mooda village, situated on the right bank of the Netravati River (refer to Figure 1). The details of inventoried landslides are given in ***Annexure – I.***

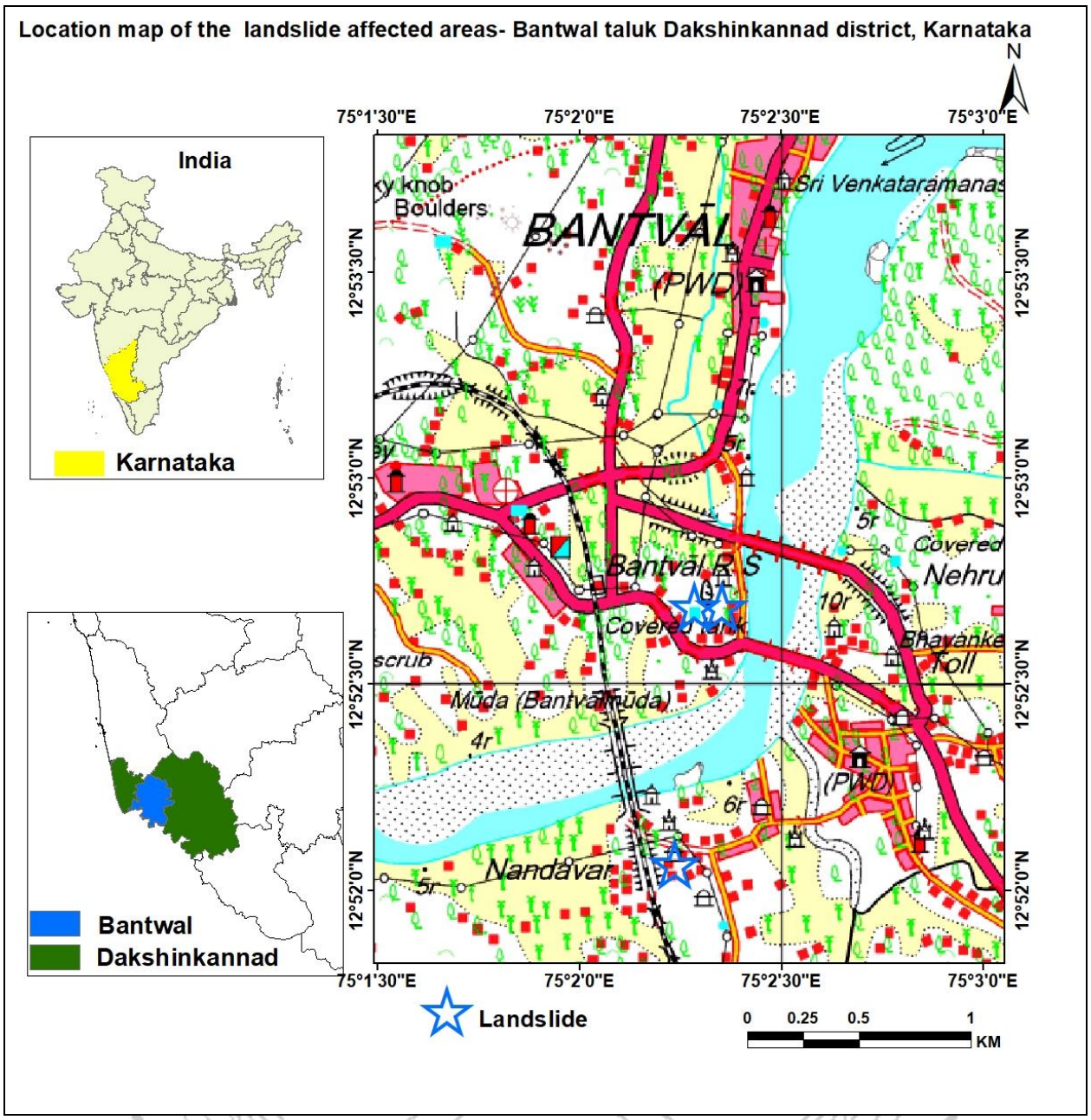

Fig.1 Location of the landslide-affected areas in Dakshin Kannad district of Karnataka

3. Regional Geology of the area

The general geology of the Dakshin Kannada is represented by the litho units of the Sargur Group, Peninsular Gneissic Complex with acid and basic intrusives. The Dakshin Kannada districts are predominantly covered by the Peninsular Gneissic Complex (PGC-I) represented by granite gneiss, and Laterite of the Cenozoic age. (Fig. 2). The basement rock of the PGC-I is the Sargur Group of rocks represented by the amphibolite, garnet biotite gneiss, fuchsite quartzite, garnet-sillimanite schist, etc. Both the Sargur group of rocks and the PGC are traversed by younger basic and acid intrusives of the Paleoproterozoic age. Large parts of Dakshin Kannada are represented by the laterites. Laterite is seen extensively capping the Peninsular Gneiss and the thickness of the laterites varies from 3-20m. The location of the landslide incident area is largely

occupied by the laterite. The documented landslides are falling in the lateritic terrain (Sajipamunnur landslide) and Granite gneissic terrain (Gudinapali landslide).

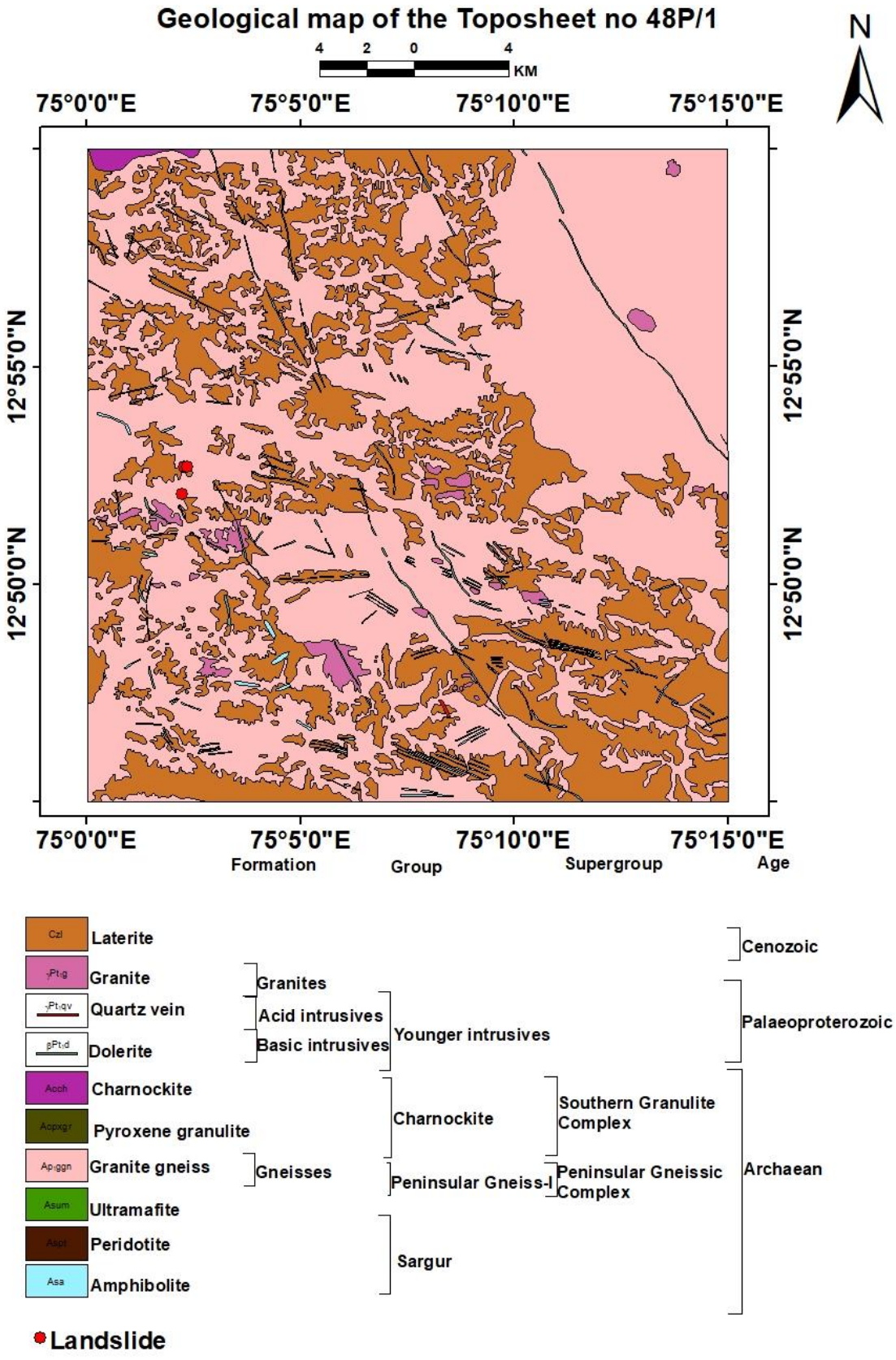

Fig. 2 Geological map of Toposheet no 48P/1
(Source: GSI, 1:50k Geological map)

4. Susceptibility condition of the area

Under the National Landslide Susceptibility Mapping Program (NLSM) on a 1:50000 scale, the areas of Dakshin Kannada have been covered (Fig.3). The eastern part of the district is dominated by the Western Ghats, a mountain range that runs parallel to the western coast of India. The Ghats in these regions is characterized by steep slopes, rugged terrain, and dense forests. The eastern side of the hill slopes are moderate to highly dissected with high relative relief and the middle part of the district is occupied by lowly undulating terrain. The slope-forming material of the study area is thick lateritic and in situ soil.

4.1 Dakshin Kannada

Approximately 19% of the region covered by the National Landslide Susceptibility Mapping (NLSM) in Dakshin Kannada, equivalent to 818 square kilometers, exhibits a combined moderate and high susceptibility to landslides. These vulnerable areas are primarily concentrated within the Kadaba, Sulya, and Beltangadi taluks. In Bantwal taluk, specifically in the Sajipamunnur village, the topography is characterized by gently undulating landforms situated at an elevation of approximately 45 meters above sea level. The landslide incident took place in an area characterized by cut slopes.

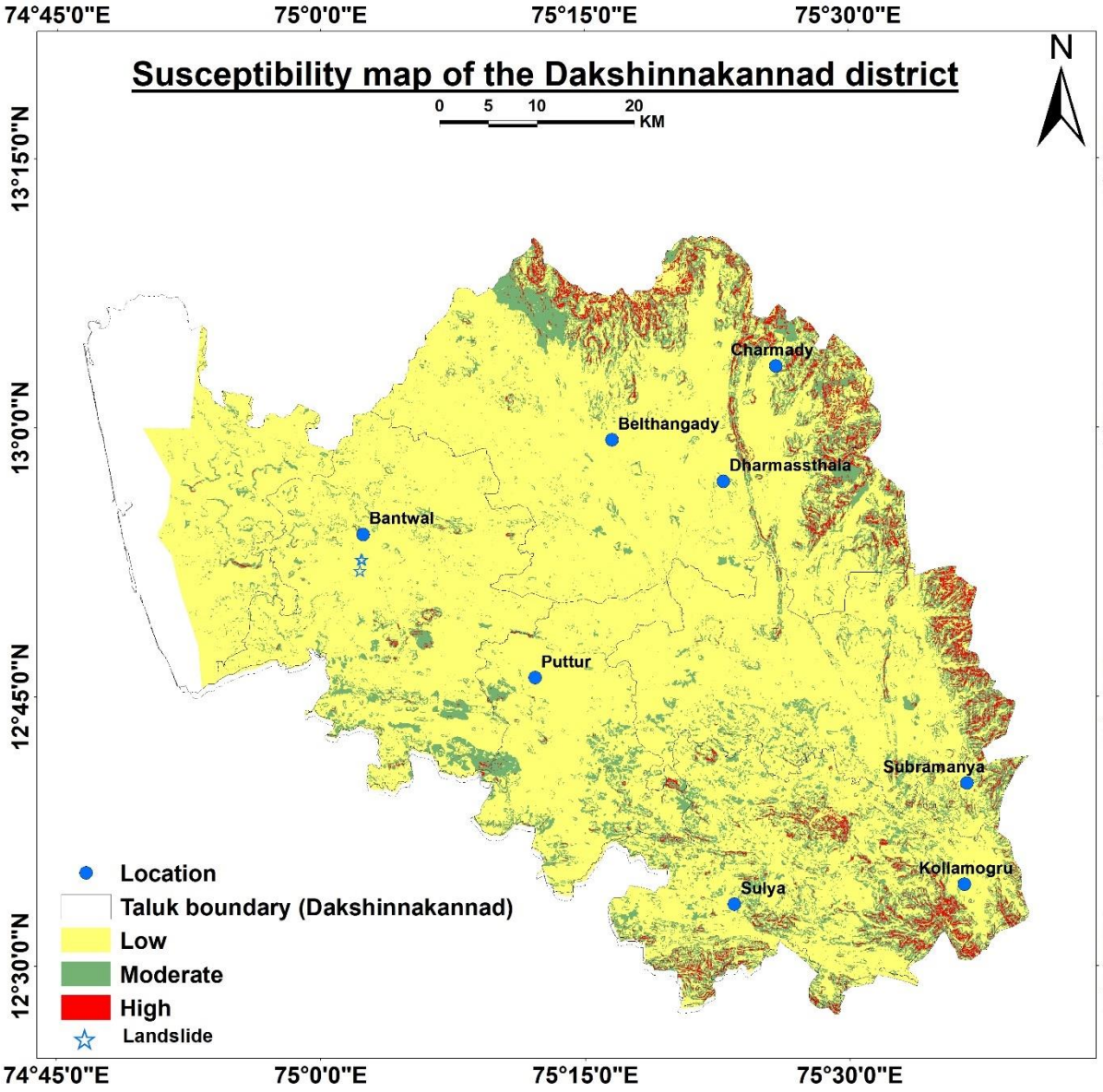

Fig.3 Landslide locations on the national landslide susceptibility map (NLSM) of the Dakshin Kannada districts (GSI, 1:50k NLSM map)

5. Observations and causative factors of the landslides

A preliminary field investigation has been conducted to assess the reported landslides, with one event occurring on 7th July 2023, and another in 2022, both taking place along cut slopes. These landslides are classified as shallow translational earth slides.

In Sajipamunnur village, Dakshin Kannada, the landslide that resulted in casualties initiated on a steep cut slope, approximately 7-8 meters high, which had been modified for settlement purposes but lacked essential features like a toe buttress system or benching to stabilize the slope. This slope had been excavated about 20 years ago, and the material comprising it was lateritic clay-rich soil with a thickness of 8-10 meters. The failure of this slope was triggered by

heavy rainfall. The primary contributing factor to the landslide was the presence of a thick layer of clay-rich soil on the cut slope section. This event led to the complete destruction of one settlement, one fatality, and severe injury to another individual. The adjacent areas with similar slope structure are susceptible to failure during intense rainfall, although no surface cracks are currently visible in the crown part of the slope.

In Gudinapali village, a landslide occurred in 2022 (Particular date unknown) during the rainy season. The slope had been cut for settlement construction without implementing any remedial measures. The material forming the slope is thick in situ soil. The slide took place just below the road bench and impacted the settlement on the cut slope. The terrain upslope from the settlement exhibits a moderate dip with slope angles ranging from 15 to 20 degrees.

In Bantwala Mooda village, no landslides were reported, but the area was shown by the DDMA to know about the susceptible conditions. As per the landslide susceptibility map, the area comes under the moderate susceptibility and by the field observations of the present conditions like slope angle, geomorphology and anthropogenic activity the areas comes under the moderated to high susceptible.

6. Rainfall condition/any other trigger:

The primary catalyst for the landslide in Sajipamunnur village was heavy rainfall, which occurred on 7th July 2023. The analysis of rainfall data reveals a significant spike in precipitation (as depicted in Figure 4) from the 5th to the 7th of July 2023, and it was this particular rainfall event that triggered the Sajipamunnur landslide. Furthermore, an examination of cumulative rainfall data from 2018 to 2023 illustrates that Sajipamunnur Hobli consistently experiences its highest levels of rainfall during July (as shown in Figure 5).

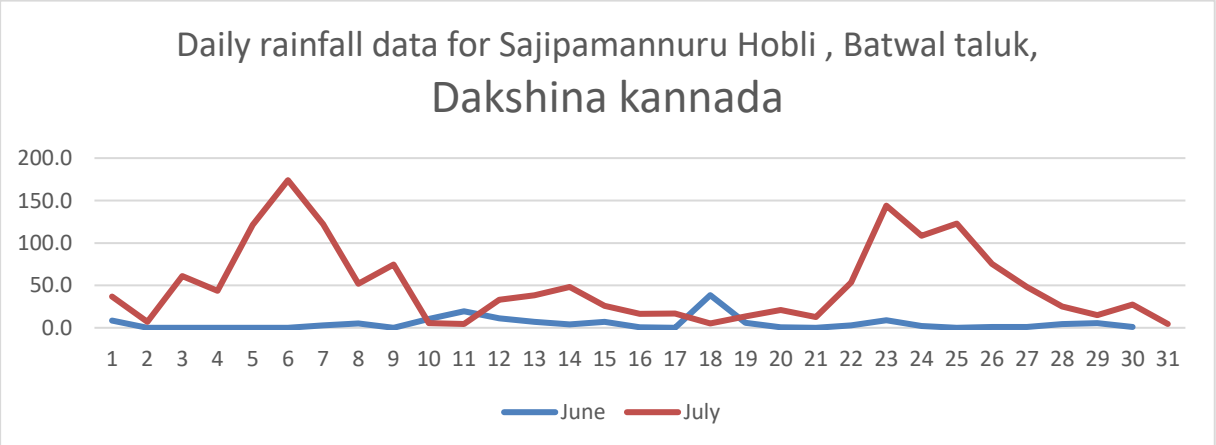

Fig. 4. Daily rainfall data for June to July from Sajipamunnur Hobli, Batwal taluks (KSNDMC)

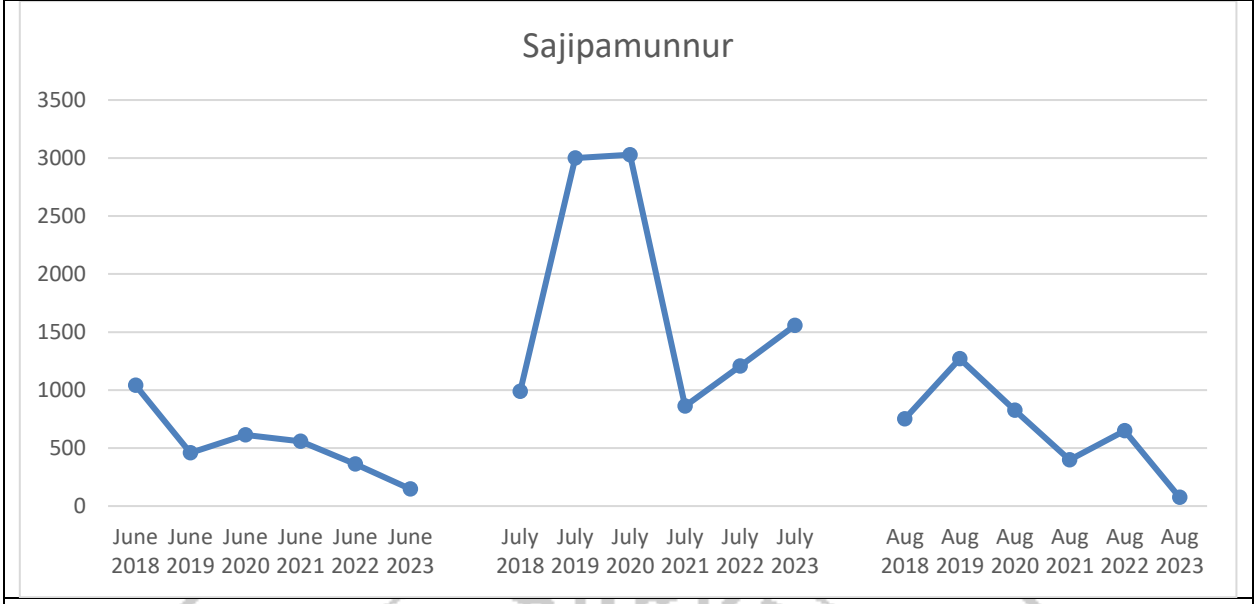

Fig.5. Cumulative rainfall Graphical representation of rainfall data from June 2018 to August 2023 for Sajipamunnur Hobli Bantwal Taluk

7. Conclusions and Recommendations:

In the aftermath of the landslide events, two landslides were documented through the evaluation of 42-point geo-parametric attributes. These landslides were primarily triggered by heavy rainfall, occurring prominently in July of both 2023 and 2022. Notably, both landslides initiated in areas characterized by steep slopes and a substantial thickness of regolith, lacking adequate buttress support or effective drainage systems. The initial field assessment categorizes one of these landslides as falling under Category II (Sajipamunnur landslide) while the other is categorized as Category I (Gudinapali village), according to the landslide alert classification (outlined in SOP for Disaster Alert, 2017, OM, December 15, 2017, MHA). For detailed information on these landslides, including specific remedial measures, please refer to Annexure I (42-point proforma). However, in a broader context, the field observations and slope stability assessments made during the site visits suggest the following recommendations:

1. Implementation of Buttress Systems: A crucial measure for slope stabilization involves the installation of buttress systems for both cut slopes and fill slopes. This can be achieved by constructing breast walls using dry stone masonry and gabion walls in sections where the slope has substantial soil and debris layers. Particularly in areas like the Sajipamunnur landslide, which resulted in the loss of life, it is essential to establish benching and buttress systems for cut slopes adjacent to settlement areas. Benching, in particular, reduces slope angles and enhances overall stability.

2. Enhanced Drainage Systems: Landslides represent a significant hazard, especially during the monsoon season. Their occurrence can be mitigated or prevented through the implementation

of effective drainage systems. Field investigations have revealed that inadequate drainage was a primary factor contributing to the landslides. Therefore, it is imperative to establish proper drainage systems to manage excess rainfall and reduce the risk of landslides.

8. Acknowledgements

Initially the authors acknowledge The Additional Director General and HOD, GSI (SR), and Dy. Director General, GSI, SU: K&G for giving an opportunity to attend the Post disaster study. Next the author acknowledges with deep appreciation the invaluable guidance and contributions of Dr R Sajeev, Director of the LS Division, in enhancing the quality of this Post-Disaster Study report. The author expresses profound gratitude to the Dakshin Kannada district administration for providing accommodation and support for the post-disaster landslide investigations. Sincere thanks are extended to the officials of the District Disaster Management Authority and the taluk who joined during the field visits to the impacted regions. Additionally, the officer extends his appreciation to the Karnataka State Natural Disaster Monitoring Centre for facilitating access to daily rainfall data for the affected areas.

Annexure I – 42-point geo-parametric sheet

No	Field	
1	Slide No (LS .No.)	KA/DK/48P/1/2023/01
2	State	Karnataka
3	District	Dakshin kannad
4	Toposheet	48P/1
5	Name of the slide	Sajipamunnur slide
6	NH/SH/Locality	Sajipamunnur village
7	Latitude	12° 52' 3.8"N
8	Longitude	75°2' 14"E
9	Length	8
10	Width	7
11	Height	7
12	Area	$56m^2$
13	Depth	0.5m
14	Volume	$28m^3$
15	Run out distance	NIL
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	07/07/2023 5:50 to 6:00 AM
24	Geomorphology	Lowly undulating hill
25	Geology	Laterite
26	Structure	Nil
27	Land use/ Land cover	Built-up area (Settlement)
28	Hydrological condition	Wet
29	Triggering Factor	Rainfall
30	Death of persons	One Female
31	People affected	One person severely injured
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	One house was totally damaged.
35	Agriculture/forest/Barren	Settlement
36	Geo-scientific Causes	Slope-forming material was lateritic clay-rich material and the The cut slope was not protected by any retaining structure. During rainfall time the clay-rich materials are over-saturated.

37	Remedial measures	RCC retaining wall has to be constructed and backfilled with appropriate material or vertical cut slope angle to be reduced by benching.
38	Remarks, if any	The same geological conditions and anthropogenic factors (slope cutting) that contributed to the slide were present in the vicinity. Therefore, the remedial measures mentioned above are necessary to prevent further damage.
39	Photos. Sketch of Plan & section of the slide	 
40	Summary/Abstract	On 07th July 2023, a landslide occurred due to a lack of proper slope stabilization. The slope had been cut vertically by 8m without any retaining structure at the base. The heavy rainfall caused the lateritic clay-rich soil to become saturated and collapse. To prevent further damage, a retaining wall with a solid foundation should be constructed or the slope angle should be reduced by creating benches.
41	Pdf	Attached
42	Landslide category	II

No	Field	
1	Slide No (LS .No.)	KA/DK/48P/2/2023/02
2	State	Karnataka
3	District	Dakshin kannad
4	Toposheet	48P/1
5	Name of the slide	Gudinapali slide
6	NH/SH/Locality	Gudinapali village
7	Latitude	12°52'41.28"N
8	Longitude	75° 2'17.00"E
9	Length	~20 m
10	Width	~10
11	Height	~15m
12	Area	~200m^2
13	Depth	~5 m
14	Volume	~1000m
15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	Initiated on 2022
24	Geomorphology	Low dissected hill
25	Geology	PGC
26	Structure	NA
27	Land use/ Land cover	Build up area
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Settlement
36	Geo-scientific Causes	1. The landslide initiated on the downslope of the village link road due to steep cutting for settlement without a toe buttress system.

		2. The slope-forming material is thick soil and the surface runoff from the road due to lack of proper drainage saturated the slope material.
37	Remedial measures	1. A retaining wall to be constructed to protect the road as well as the cut slope settlement 2. Hill-side lined drainage to be provided to avoid surface runoff.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	 
40	Summary/Abstract	The construction of a settlement involved a steep toe cut on the slope, which was left unprotected. The thick in situ soil on the vertical cut slope became unstable and started to slide from the downslope of the road bench. The sliding material accumulated behind the settlement and exerted pressure on the structure. There were also fresh landslide scars near the settlement. To prevent further damage, a retaining wall should be built at the downslope of the road bench and behind the settlement. Additionally, proper drainage should be installed to divert the surface runoff.
41	Pdf	Attached
42	Landslide category	I