Government of Jammu & Kashmir
Forest, Ecology & Environment Department
Civil Secretariat, Srinagar/Jammu
(Legal Section)

Consultant (Judicial),
Hon'ble National Green Tribunal,
Principal Bench, New Delhi.

No: - FST-Lit/33/2023-02-Forest Department Dated: - 24.05.2023

Subject: - O.A. No. 93/2023-News item published in Newspaper "The Hindu" dated 04.02.2023 titled "19 families shifted after houses in J&K village develop cracks."

Sir,

With reference to the subject captioned above, I am to inform that the Hon'ble Tribunal was pleased to pass an order dated 17.02.2023 in the afore-cited matter, operative part whereof reads as under: -

"...we direct constitution of a joint Committee to be headed by Chief Secretary, J&K. Other members will be Wadia Institute of Himalayan Geology Dehradun, Govind Ballabh Pant National Institute of Himalaya and Environment, National Institute of Hydrology (NIH), Roorkee, Prof. J.S Rawat, Kumaon University, Almora, Space Application Centre, Ahmedabad, National Institute of Rock Mechanics, Bangalore, CPCB and ACS Environment, J&K. ACS Environment J&K will act as nodal agency for coordination and compliance. ACS, Environment will provide for travel and logistics for members to the extent necessary. Meetings may be held online or offline as may be necessary except for visit to the site.

The Committee may suggest remedial measures to prevent environmental damage in the light of carrying capacity, hydro-

geology studies, geo-morphological studies and also covering other allied and incidental issues. The Committee will be at liberty to take assistance from any other expert/institution. The Committee may meet within two weeks and complete its studies within two months. The Committee may furnish its report by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF on or before May 15, 2023.

The Committee will be free to interact with the stakeholders including the inhabitants/members of civil societies. The Committee may also consider the concerns in the media report. It will be open to the Chief Secretary, J&K to take preventive and remedial measures found necessary in the light of the media report otherwise..."

2. That in compliance with the aforesaid order dated 17.02.2023, Government in the General Administration Department vide G.O. No. 387-JK(GAD) of 2023 dated 24.03.2023, copy whereof is enclosed herewith as **Annexure-I**, constituted a committee with the similar composition and mandate as directed by the Hon'ble Tribunal.

3. That the constituted committee subsequently prepared a draft report on the subject, copy whereof is enclosed herewith as **Annexure-II**, with the following recommendations and suggestion: -

RECOMMENDATIONS BY THE EXPERT COMMITTEE:

(i) No further civil construction within the affected area of Nai Basti may be allowed. In view of the coming monsoon season, the affected area needs to be under observation of district administration. In case of any new sign of major cracks in houses

outside the affected area, residents to be evacuated immediately. Moreover, as a precautionary measure, people living in houses outside the affected area and adjoining houses/structures not yet affected may also be asked to relocate to a safer place.

(ii) A retention wall of around 400 m with weep holes may be constructed near the base of the land slide area (at the toe of the slope) at the road level to stop any further slope failure.

(iii) All cracks to be filled up with the cement slurry well before the onset of monsoon to control the percolation of rain water/surface water and to monitor any further displacements.

(iv) The natural diversion and drainage channels within the area may be restored or renovated immediately so that the surface run-off could be diverted. Proper drainage and sewer plan for the entire are to be developed and implemented.

(v) Any further construction outside of the affected area only to be allowed after geotechnical assessments such as soil bearing tests etc. Since the affected area is situated just above Chenab river channel, to stop the river erosion, Gabion Wall with a suitable dimension may be constructed on the riverside.

(vi) The area lacks high resolution geotagged data of natural and man-made resources. Hence, a "geo-portal" containing the data/information of all the concerned departments/research institutions/agencies in one common platform may be developed (at 1:10,000 scale) by the district GIS cell in collaboration with Department of RS & GIS, Jammu University or such other agencies for better planning, management and regular monitoring.

(vii) Geomorphic map which could depict the spatial distribution landforms such as colluvial cones, colluvial fans, alluvial terraces, colluvial fans underlained by alluvial terraces etc. composed of

Quaternary deposits i.e., colluvium and alluvium is to be developed for the area under reference at 1:10000 scale for sustainable planning and development of all civil engineering works, their regular monitoring and management.

(viii) Detailed Landslide Hazard Zonation++- of the entire new Thathri town is to be carried out, preferably by Geological Survey of India, in view of similar type of geological and geomorphologic setup in the Thathri area.

(ix) No subsurface engineering activity may be allowed within an area circumscribing 500 m of the affected location.

(x) The present residents of the affected 24 houses of Nai Basti Thathri may be rehabilitated to a suitable safer location within the framework of applicable laws.

SUGGESTION BY THE EXPERT COMMITTEE:

It is suggested that for the sustenance of the environment, the Thathri type foot slope zones of hill spurs in the entire District Doda should be mapped using geospatial technologies at 1:10,000 scale by which such ill-suited sites may be avoided for civil engineering works in future.

4. That in order to discuss the above referred to draft report, a meeting under the chairmanship of Chief Secretary, J&K was held on 22.05.2023, record note whereof is enclosed herewith as **Annexure-III**, and after deliberating on the issues and recommendations, following decisions were taken: -

a. No further constructions within the affected area of Nai Basti may be allowed.

b. The recommendations of the committee may be conveyed to the local population for a stake-holder consultation by the District Administration within 15 days, so that further action on the recommendations of the committee could be taken.

c. Draft report was agreed in principle to be submitted to the Hon'ble Tribunal.

5. That subsequently, the report as finalized in the meeting held under the chairmanship of Chief Secretary, J&K on 22.05.2023 was forwarded to the undersigned by the Chief Conservator of Forests, Jammu vide his communication No. CCF-J/LO/F.16/23/389-90 dated 23.05.2023, copy whereof is enclosed herewith as **Annexure-IV**.

6. In the above backdrop, it is requested that the afore-stated position may kindly be placed before the Hon'ble Tribunal, for its kind consideration.

Yours faithfully,

(Dheeraj Gupta) IAS
Principal Secretary to Government

Encls: As above.

Copy (with enclosures) to the: -

Shri G. M. Kawoosa, Additional Standing Counsel for Government of J&K in Hon'ble National Green Tribunal-Principal Bench, New Delhi, for information and necessary action.

"ANNEXURE-I"

GOVERNMENT OF JAMMU AND KASHMIR,
GENERAL ADMINISTRATION DEPARTMENT,
Civil Secretariat, J&K.

Subject:- Hon'ble NGT Order dated 17.02.2023,regarding sinking of land in District Doda, constitution of Committee thereof.

Ref No:- U.O No. FST-Lit/33/2023-02- received from Forest Department.

Government Order No.387-JK(GAD) of 2023
Dated: 24.03-2023

Sanction is hereby accorded to constitution of a Committee, comprising the following, to suggest remedial measures for preventing environmental damage in light of carrying capacity, hydro-geology/geo-morphological studies along-with covering other allied and incidentalissues of land subsidence at District Doda, J&K:-

1	Chief Secretary, J&K	Chairman
2	Principal Secretary to Government, Forest, Ecology & Environment Department, Govt. of J&K (Nodal agency for coordination & compliance)	Member-Convenor
3	Prof. J. S. Rawat, Kumaon University, Almora	Member
4	Representative of Wadia Institute of Himalayan Geology, Dehradun	Member
5	Representative of Govind Ballabh Pant National Institute of Himalaya and Environment	Member
6	Representative of National Institute of Hydrology, Roorkee	Member
7	Representative of Space Application Centre, Ahmadabad	Member
8	Representative of National Institute of Rock Mechanics, Bangalore	Member
9	Representative of Central Pollution Control Board	Member

Terms of Reference of the Committee shall be as under:

i) **The Committee shall suggest remedial measures to prevent environmental damage in the light of carrying capacity, hydro-geology studies, geo-morphological studies and also covering other allied and incidental issues.**

ii) **The Committee shall be at liberty to take assistance from any other expert/institution. The Committee shall be free to interact with the stakeholders including the inhabitants/members of civil societies and may also consider the concerns in the media report.**

iii) **The Committee shall complete its studies within two months and furnish its report to Hon'ble NGT by e-mail on or before May 15, 2023.**

The Committee shall meet within two weeks and complete its studies within two months and shall be serviced by the Department of Forest, Ecology & Environment.

By Order of Government of Jammu and Kashmir.

Sd/-
(Sanjeev Verma) IAS
Commissioner/Secretary to the Government

No. GAD-ADM0IV/31/2023-09-GAD Dated: 24.03.2022

Copy to the:-

1. Principal Secretary to Government, Forest, Ecology & Environment Department.
2. Joint Secretary (J&K), Ministry of Home Affairs, Government of India.
3. Prof. J. S. Rawat, Kumaon University, Almora.
4. Representative of Wadia Institute of Himalayan Geology, Dehradun.
5. Representative of Govind Ballabh Pant National Institute of Himalaya andEnvironment.
6. Representative of National Institute of Hydrology, Roorkee.
7. Representative of Space Application Centre, Ahmadabad
8. Representative of National Institute of Rock Mechanics, Bangalore.
9. Representative of Central Pollution Control Board.
10. Director, Archives, Archaeology and Museums, J&K.
11. Principal Private Secretary to Hon'ble Lieutenant Governor, J&K.
12. Private Secretary to the Chief Secretary, J&K.
13. Private Secretary to Advisor (B) to the Lieutenant Governor.
14. Private Secretary to Commissioner/Secretary to the Government, GAD.
15. Government Order/Stock file/Website, GAD. Hindi and Urdu version shall follow.

24.3.22
(Mohit Raina) JKAS
Under Secretary to the Government

"ANNEXURE - III"

Government of Jammu and Kashmir
Forest, Ecology & Environment Department
Civil Secretariat, Jammu/Srinagar

Record note of the meeting of the Committee constituted by the General Administration Department, J&K vide Government order No.387-JK(GAD) of 2023 dated 24.03.2023, in compliance to the directions issued by Hon'ble NGT in the matter of Original Application No. 93/2023, held on 22.05.2023 under the Chairmanship of Chief Secretary, J&K.

A meeting chaired by the Chief Secretary, J&K was held on 22.5.2023 at 1.00 P.M in the Committee Room, 3rd Floor, Civil Secretariat, Srinagar and through VC in Meeting Hall, 2nd Floor, Civil Secretariat Jammu to discuss the draft report on remedial measures for preventing environmental damage in light of carrying capacity, hydro-geology/geo-morphological studies, along with covering other allied and incidental issues of land subsidence at Nayi Basti in Thathri area of District Doda, J&K.

The Draft Report was prepared by expert members of the Committee headed by Chief Secretary, J&K constituted by the J&K Government in pursuance to directions issued in Order dated 17.02.2023 by Hon'ble NGT. Following Officers/expert members participated in the meeting:-

1. Principal Secretary to the Government, Forest, Ecology & Environment Department (Member-Convenor).
2. APCCF/CCF, Jammu.
3. Special Secretary (Tech.), Forest, Ecology & Environment Department.
4. Prof. J.S. Rawat, Kumaon University Almora.
5. Dr. Khayingshing Luirei, Wadia Institute of Himalayan Geology, Dehradun.
6. Dr. Sandipan Mukherjee, G.B Pant National Institute of Himalayan Environment.
7. Dr. PG Jose, National Institute of Hydrology, Roorkee.
8. Dr. Ritesh Agarwal, Space Applications Centre, Ahmedabad.
9. Dr. Devendra Singh Rawat, National Institute of Rock Mechanics, Bangalore.
10. Dr. Narendra Sharma, CPCB, RO Chandigarh.

Prof. J.S. Rawat briefed the participants about the salient points of the Draft Report, as well as about the recommendations, on behalf of the expert members.

After deliberating on the issues & recommendations, it was decided as follows:-

1. No further construction within the affected area of Nayi Basti may be allowed as recommended by the Committee till adequate measures are in place.
2. The recommendations of the Committee may by conveyed to the local population for a stake-holder consultation by the District Administration, within 15 days, so that further action on the recommendations of the committee could be taken.

With this, the draft report was agreed in principle to be submitted to the Hon'ble NGT.

(Dr. Harpreet Kaur)
Special Secretary (Technical)

No.FST-Lit/33/2023(7197330) Dated.24-05-2023

Copy to the:

1. All concerned Members.
2. Deputy Commissioner, Doda.
3. Conservator of Forests, Chenab Circle, Jammu.
4. DFO, Doda/Bhaderwah.
5. Sub-Divisional Magistrate, Thathri.
6. PS to Chief Secretary, J&K.
7. PS to Principal Secretary to the Government, Forest, Ecology & Environment Department.
8. Stock file.

ANNEXURE-IV

GOVERNMENT OF JAMMU AND KASHMIR
OFFICE OF THE CHIEF CONSERVATOR OF FORESTS, JAMMU
(Forest Complex Exchange Road, Dogra Hall) Ph. 0191 – 2547748, 2545400 email ccfjammu1@gmail.com

The Principal Secretary to the Government,
Forest, Ecology & Env. Department,
Civil Secretariat, J&K.

No. CCF-J/LO/F.16/23/389-90 Dated 23/05/2023

Sub: Hon'ble NGT Order dated 17.02.2023 in O.A No.93/2023 in re: News item published in Newspaper 'The Hindu' dated 04.02.2023 titled "19 families shifted after houses in J&K develop cracks".

Sir,

Kindly find enclosed the report received from the expert members of the Committee constituted by Hon'ble NGT in O.A No.93/2023 as finalized in the meeting held by the Chief Secretary on 22.05.2023 for necessary action.

Yours faithfully,

Encls:A/A.

23/05/23
(B.M Sharma)
Chief Conservator of Forests,
Jammu.

Copy to Special Secretary (Technical) Forests, Ecology & Env. Department Civil Secretariat, J&K. for information and necessary action.

REPORT

of the Committee Constituted under the Chairmanship of the Chief Secretary, J&K in compliance to directions issued by

Hon'ble National Green Tribunal in

Original Application Number: 93/2023

In re: News item published in Newspaper "The Hindu" dated 04.02.2023 titled "19 families shifted after houses in J&K village develop cracks"

Member-Convenor:

Principal Secretary to Govt., Forest, Ecology & Environment Department, J&K Govt.

Expert Members:

Prof. J. S. Rawat (Retd.), Kumaon University

Dr. PG Jose (National Institute of Hydrology, Roorkee)

Dr. Narender Sharma (Central Pollution Control Board, RO Chandigarh)

Sh. Ritesh Agrawal (Space Application Centre, ISRO, Ahmedabad)

Dr. K Luirei (Wadia Institute of Himalayan Geology, Dehradun)

Dr. Devendra Singh Rawat (National Institute of Rock Mechanics, Bengaluru)

Dr. Sandipan Mukherjee (GB Pant National Institute of Himalayan Environment, Almora)

1. Background:

In compliance to the directions issued by Hon'ble NGT vide Order dated 17.02.2023 in the matter of Original Application Number 93/2023 In re: News item published in Newspaper "The Hindu" dated 04.02.2023 titled "19 families shifted after houses in J&K village develop cracks" (**Annexure-I**) , the J&K Government constituted a Committee vide G.O. No. 387-JK(GAD) of 2023 dated 24.03.2023 (**Annexure-II**) headed by the Chief Secretary, J&K and Principal Secretary, Forest, Ecology & Environment Department as Member-Convenor, to suggest remedial measures for preventing environmental damage in light of carrying capacity, hydro-geology/geo-morphological studies along with covering other allied and incidental issues of land subsidence at District Doda in J&K. The following expert members were nominated by the Institutions mentioned in the Hon'ble NGT Order after nominations were invited by the J&K Govt.:

1. Prof. J.S. Rawat (Retd.), (Kumaon University)
2. Dr. Khayingshing Luirei (Wadia Institute of Himalayan Geology, Dehradun);
3. Dr. P. G. Jose (National Institute of Hydrology, Roorkee);
4. Sh. Ritesh Agarwal (Space Application Centre, ISRO, Ahmedabad);
5. Dr. Sandipan Mukherjee (GB Pant National Institute of Himalayan Environment, Almora);
6. Dr. Devendra Singh Rawat (National Institute of Rock Mechanics, Bengaluru);
7. Dr. Narendra Sharma (Central Pollution Control Board, Regional Office, Chandigarh);

The matter was discussed preliminarily by the expert members and it was decided to conduct the study visit to get a first-hand knowledge of the issue. The expert members reached Jammu on 7th May, 2023, and a meeting was organised at 07:00PM, at the Circuit House Jammu. The meeting was organized in hybrid

mode, wherein Prof. JS Rawat (Kumaon University) and the Conservator of Forests, Chenab Circle participated online. The logistics for the visit were provided by Chief Conservator of Forests, Jammu.

The agenda for the meeting was to brief the committee regarding the scope of the task and the procedure to be followed in preparing and submitting its report within the timelines as well as to prepare a plan for field survey at the affected area of Thathri in Doda District of UT of Jammu and Kashmir. The record note of the meeting is attached as **Annexure III**.

As decided in the meeting, the Study Reports "*Note on the preliminary geological assessment of slope instability at Nai Basti area, Thathri, District Doda, Jammu-Kashmir*", prepared by the Geological Survey of India during February, 2023, was provided to the committee members along with the "*Preliminary report on landslide investigation at Nai Basti, Thathri, Doda District, Jammu and Kashmir*" prepared by the Department of Geology and Mining, Government of Jammu and Kashmir. The expert members took note of these reports and conducted a detailed field survey at the affected area of Nai Basti, Thathri, Doda District, J&K during 08-09 May, 2023.

Observations of the committee along with the recommendations are elaborated below.

1.1 Doda District and the Affected Area of Thathri

Doda district located in the eastern part of the Jammu region in the Union territory of Jammu & Kashmir, is comprised of 16 Tehsils. The district is bounded by Kishtwar to the northeast, Kathua to the south, Ramban to the northwest, Udhampur to the southwest, and Anantnag to the north. The total geographical area of the district is 2306 sq. km, and the administrative center of the district is situated in Doda, which is approximately 160 km away from Jammu. Due to its distinctive geoclimatic conditions, Doda has historically been

susceptible to natural disasters such as floods, droughts, landslides, and earthquakes, as indicated by the disaster matrix presented in **Table 1**. Throughout history, Doda District has experienced a number of disasters, one of the most recent being the 2017 cloudburst in Tehsil Thathri.

Table 1: Recorded incidents of disasters within District Doda.

Type of Disaster	Month / Year	Affected Area	Details of damages caused		
			Deaths	Injury	Structures Damaged
Earthquake	May, 2013	Entire district	-	-	70074
Cloudburst	Apr, 2014	Thathri & Kahara	06	01	09
Flood/Rain	Sep, 2014	Entire district	01	05	1304
Flood/Rain	Feb, March, April, 2015	Entire district	07	09	1706
Cloudburst	April, 2015	Bhagwah	06	-	01
Cloudburst	Jul, 2017	Thathri	06	02	09

(Source: District Disaster Management Plant (DDMP), Doda, Rather A. H., 2018)

According to *Ansari et al (2022,* https://doi.org/10.1007/s40098-022-00694-0*.),* Doda, Udhampur, Ramban and Reasi within Jammu Region are more vulnerable to earthquakes because of the centrally positioned Main Central Thrust and Udhampur Fault in the Region. Other high-risk locations include the northern outskirts of Doda and Kishtwar and the north-western part of Jammu, where mild earthquakes of magnitude Mw $\geq$ 5.0 have been detected regularly in Kishtwar Window and Main Frontal Thrust. The affected area of Thathri falls in Survey of India Toposheet number 43O/16, and the geographical coordinates are 33° 08' 45.21" N, 75° 47' 3.12" E with elevation of approx. 997 m. The Nai Basti, Thathri area, is situated on the left bank of the Chenab River just above the NH244 and below a village road (**Figure 1**), and has a general slope of 65-70°.

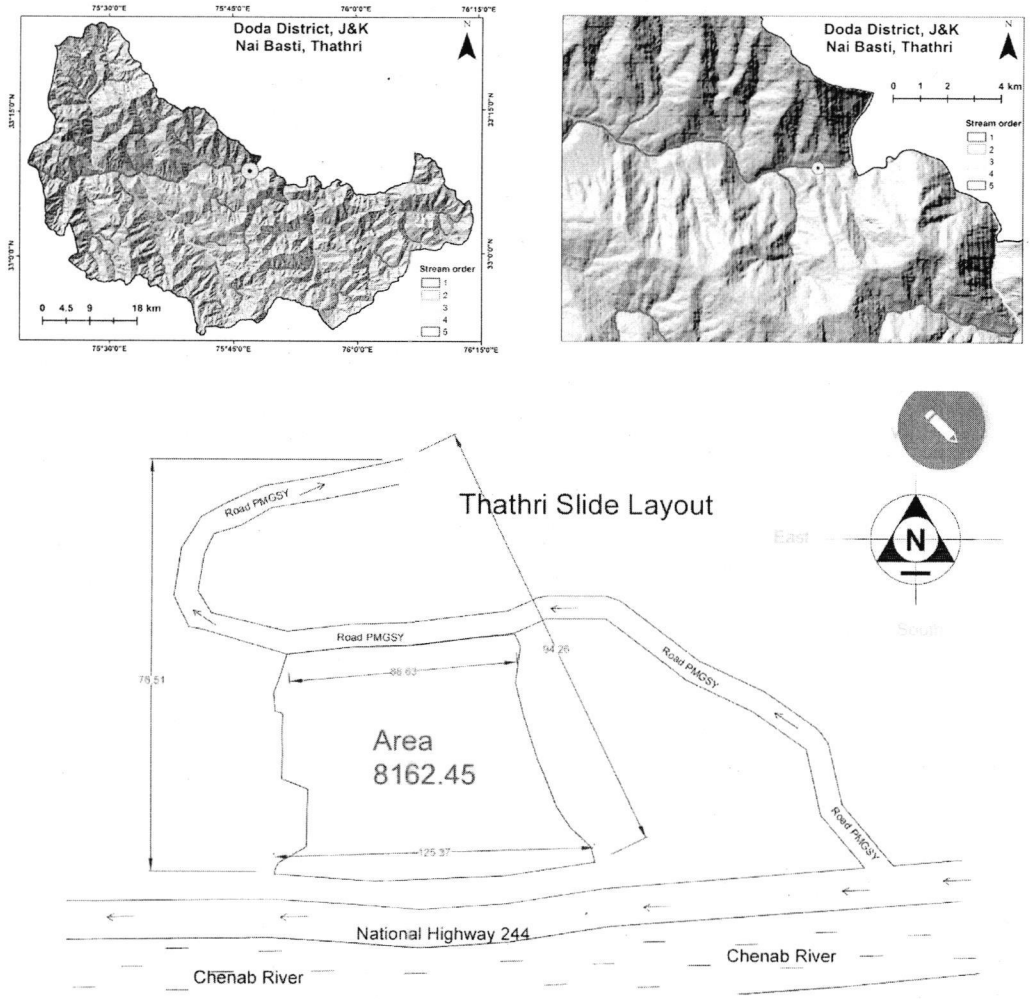

Figure 1: Location of Thathri within District Doda is shown in left panel. The right panel shows zoomed location of Thathri with a first order stream almost 01 km west of the affected area. A generic layout of the Nai Basti affected area of Thathri is presented in the lower panel (not to scale).

1.2 InSAR analysis of Thatri Area, Doda District, J & K

An InSAR (Interferometric Synthetic Aperture Radar) based survey was conducted to understand the evolution of land deformation at Thathri and surrounding regions. The objectives of the analysis were to examine evolution of land displacement since January 2023. Time-series data sets from Sentinel-1 (January 2023-April 2023) satellites were processed using Small Baseline Subset Interferometry (SBAS) technique to map the surface deformation.

Interferograms were corrected for topographic and phase unwrapping errors for obtaining reliable deformation time-series. Finally, areas having coherence < 0.4 were masked to further reduce noise due to land surface changes. Map showing surface deformation along the line of sight of the satellite during 2023-01-06 and 2023-04-26 is shown in **Figure 2**. InSAR analysis did not show any surface deformation associated with the ground cracks / rock slides in the study region.

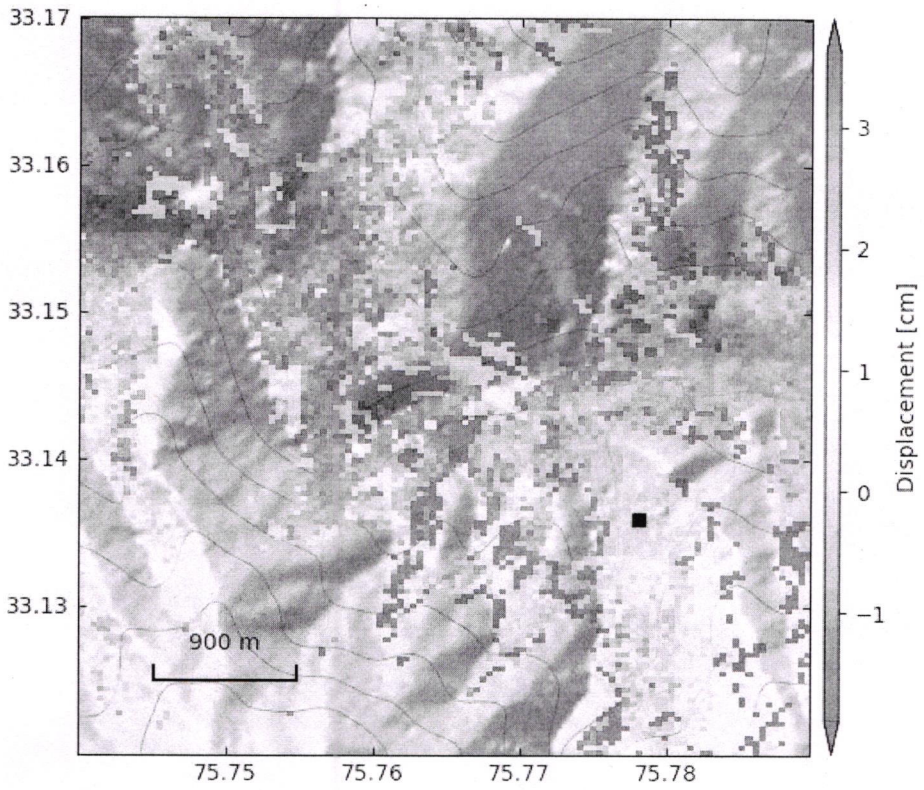

Figure 2: Maps showing cumulative LOS deformation at Thatri and surrounding regions from 2023-01-06 to 2023-04-26 Drapped over DEM.

2. General observations of the affected area by the Expert Committee

The committee conducted a detailed field survey of the affected area of Nai Basti, Thathri, Doda District, Jammu and Kashmir during 08-09 May, 2023 accompanied by the Sub-divisional Magistrate (SDM) Thathri and the Conservator of Forests, Chenab Circle with their respective teams. The specific observations of the committee are as follows:

- The affected settlement at Nai Basti, Thathri (24 affected houses/structures) was established majorly on Shamlat land (i. e. village pasture land) prior to 2014 when Thathri became a municipality, as informed by SDM Thathri. As such, there were no extant construction by-laws applicable and no retaining wall with weep holes, or planned drainage or sewage disposal structures were observed in the affected area, except unplanned PVC pipes for the purpose of sewerage disposal to the road side drainage downslope. As per local officials, soil bearing capacity assessment, other feasibility studies, etc. also would not have been carried out prior to the construction of these structures.
- The physical inspection of cracks by the committee at various locations within the affected area revealed horizontal, lateral and vertical displacements with maximum value of cracks more than 50 cm (**Figure 3**). The total affected area is noted to be approximately 8000 m^2.

Figure 3: Cracks observed in the various structures of the affected areas. The lower right panel shows the committee members with the Conservator of Forests, Chenab Circle, Jammu and Kashmir.

- The SDM Thathri and local residents informed the committee that the incident initiated on 1st February, 2023 and continued till 5th February, 2023. No new cracks are reported from 6th February, 2023 onward. The total number of structures affected is 24 including 3 completely damaged structures, 11 having major cracks and 10 having minor cracks.
- The slope of the affected area is towards north and approximately 65-70°. The affected area is predominantly on schist bedrock overlain by thin

layer of soil. The layer of the river born material exposed towards the crown of the landslide is not much affected by the landslide as only small cracks and subsidence are observed on the road (**Figure 4**). The Chenab River valley between Lalhote and New Thatri is made up mainly of slate, phyllite, schist, marble and orthogneiss. The landslide affected slope at New Thatri is made up mainly of weathered schist intervened by un-weathered schist in between. The foliation dips moderately towards the south. The bedrock is traversed by two important joint sets forming wedges towards the daylight slope (**Figure 4**). The bedrock data from the immediate adjoining slope is also made up of highly weathered schist that dips moderately to gently towards the south with wide open fractures. The slope dips steeply towards the north. The Quaternary deposits and morphology of the Chenab River valley suggest that the valley is susceptible to landslides. Observation of landslide and lacustrine deposits in the slopes a height of about 200 m from the present river bed suggest that the Chenab River was blocked by landslides from time to time. The south facing slope that is the right bank slope of the Chenab River is more susceptible to landslides as number of old and active landslides are observed. Steep slopes are observed on both sides of the river valley the south facing slope being steeper than the north facing. Geological traverses were carried out along the road sections of the Nai Basti Thathri area. The main rock types are schists and gneisses (**Figure 5 c&b**) of Salkhala Formation belonging to Proterozoic age. The exposed rocks are slightly to moderately weathered in nature as per ISRM 1978. The details of the discontinuities are given in **Table 2 and 3**.

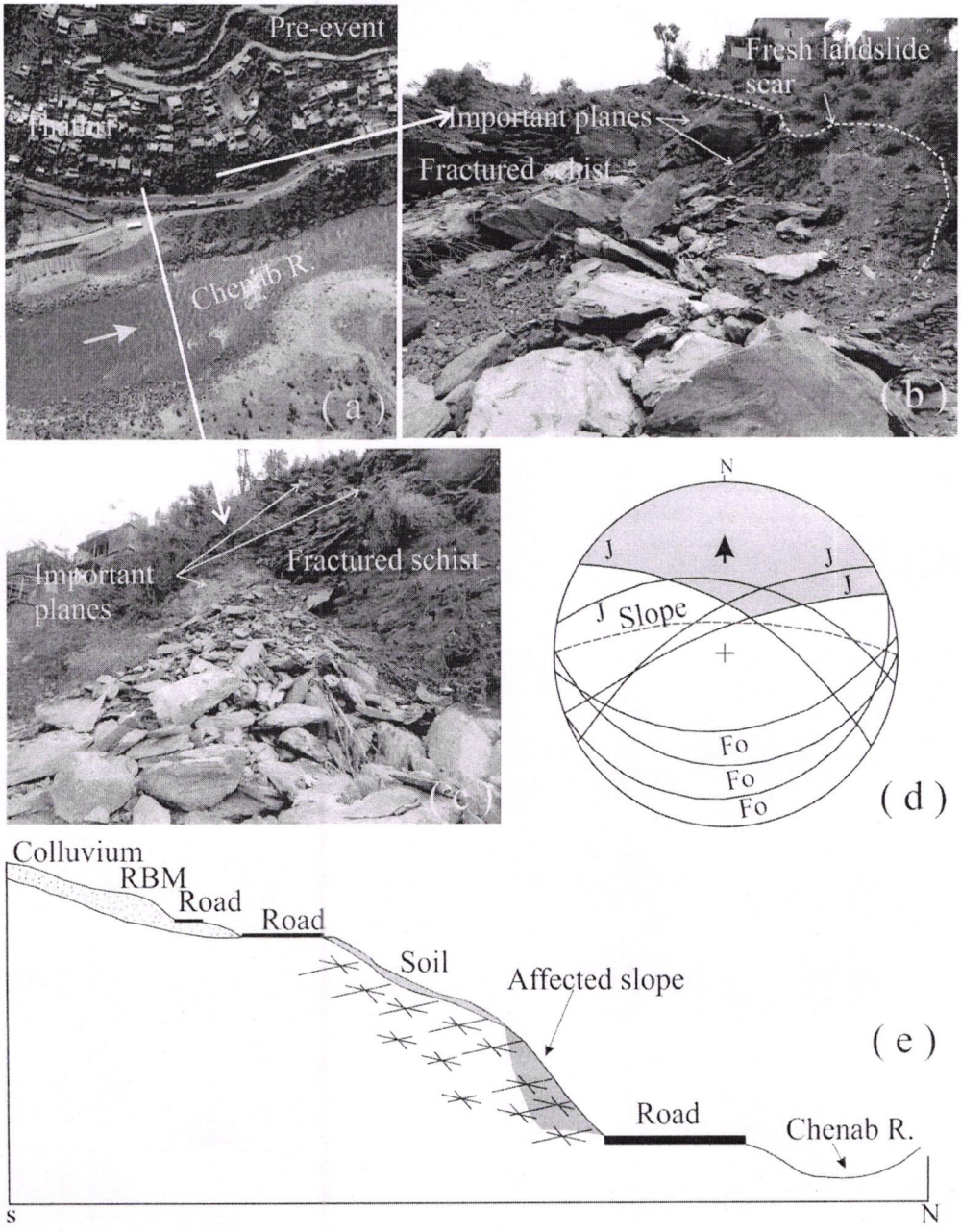

Figure 4: Subplot (a) shows Google Earth image showing pre-landslide slope of the New Thatri. (b & c) Field photographs showing landslide affected slope with important joint planes, weathered, and fractured nature of the bedrock forming the slope. (d) Kinematics analysis of the joints indicating the intersecting joints forming wedges towards daylight slope (J – Joint; Fo – Foliation); (e) Schematic diagram representing the affected slope, bedrock, joints and Quaternary deposits (RMB – River Born Material).

Figure 5: Subplot (a) Coarsely laminated fluvial deposit towards the crown of the landslide; (b, c, d) highly weathered schist and un-weathered gneiss with wide open fractures towards the crown of the landslide; (e & f) cracks developed in the concrete structures; (g) landslide scar developed within the slide mass; (h) tilted retaining and longitudinal landslide scar.

Table 2: Discontinuities observed in the exposed schistose rock at the NH-244

Joint Set	Dip direction / Dip Amount	Spacing (cm)	Persistence (m)	Roughness*	Aperture (mm)	Infilling	WG*	Ground Water	Remark
Foliation	N140° /50°	40-100	5-15	S/U	Tight-2	None	WI-III	Dry	Foliation joint
J1	N050°/40°	10-30	5-10	S/U	Tight-2	None	WI-III	Dry	Critical joint
J2	230°/60-65°	10-20	>10	S/U	1-3	None	WI-III	Dry	Prominent joint
J3	N340°/40°	-	2-5	S/U	1-3	None	WI-III	Dry	Random joint
S/U* Smooth undulating, WG* Weathering grades									

Table 3: Discontinuities observed in the exposed gneisses rock at the link road

Joint Set	Dip direction / Dip Amount	Spacing (cm)	Persistence (m)	Roughness*	Aperture (mm)	Infilling	WG	Ground Water	Remark
Foliation	N160° /50°	8-20	5-15	R/U	Tight	None	WI-III	Dry	Foliation joint
J1	N150°/90°	10-30	5-15	R/U	Tight	None	W-I	Dry	Prominent joint
R/U* Rough undulating, WG* Weathering grades									

- The committee further noted that the affected area did not have any ground water springs/streams, and no ground water bore-well.
- The committee further examined the report produced by GSI, GoI, wherein the total rainfall was reported to be 201.2 mm during 20th January to 31st January, 2023. This heavy rainfall spell might have resulted saturation of the soil/rocks which might have triggered slides.
- Minor cracks were observed by the committee on the road above the affected area, and in the adjoining structures.

3. Recommendations by the Expert Committee

- No further civil construction within the affected area of Nai Basti may be allowed. In view of the coming monsoon season, the affected area needs to be under observation of district administration. In case of any new sign of major cracks in houses outside the affected area, residents to be evacuated immediately. Moreover, as a precautionary measure, people living in houses outside the affected area and adjoining houses/structures not yet affected may also be asked to relocate to a safer place.
- A retention wall of around 400 m with weep holes may be constructed near the base of the land slide area (at the toe of the slope) at the road level to stop any further slope failure.
- All cracks to be filled up with the cement slurry well before the onset of monsoon to control the percolation of rain water/surface water and to monitor any further displacements.
- The natural diversion and drainage channels within the area may be restored or renovated immediately so that the surface run-off could be diverted. Proper drainage and sewer plan for the entire area to be developed and implemented.
- Any further construction outside of the affected area only to be allowed after geotechnical assessments such as soil bearing tests, etc. Since the affected area is situated just above the Chenab river channel, to stop the river erosion, Gabion Wall with a suitable dimension may be constructed on the riverside.
- The area lacks high resolution geotagged data of natural and man-made resources. Hence, a "geo-portal" containing the data/information of all the concerned departments/research institutions/agencies in one common platform may be developed (at 1:10,000 scale) by the district GIS cell in

collaboration with Department of RS & GIS, Jammu University or such other agencies for better planning, management and regular monitoring.

- Geomorphic map which could depict the spatial distribution landforms such as colluvial cones, colluvial fans, alluvial terraces, colluvial fans underlained by alluvial terraces, etc. composed of Quaternary deposits i.e., colluvium and alluvium is to be developed for the area under reference at 1:10000 scale for sustainable planning and development of all civil engineering works, their regular monitoring and management.
- Detailed Landslide Hazard Zonation of the entire new Thathri town is to be carried out, preferably by Geological Survey of India, in view of similar type of geological and geomorphologic setup in the Thathri area.
- No subsurface engineering activity may be allowed within an area circumscribing 500 m of the affected location.
- The present residents of the affected 24 houses of Nai Basti Thathri may be rehabilitated to a suitable safer location within the framework of applicable laws.

4. Suggestion by the Expert Committee

In steep mountainous terrain, geomorphologically a hill spur has three components: crest, mid crest and foot slope. All these three components have distinct hydro-geomorphic processes and landforms. The area under reference lies on foot slope of Thathri hills spur. Figure 6 depicts the hydro-geomorphic cross-section of the foot slope zone of the Thathri hill spur which depicts: i) rain water recharge zone made-up of Quaternary landforms, i.e., colluvial fan underlained by the Chenab river terraces having very high infiltration capacity; and ii) sub-surface flow paths of infiltrated water causing earth creeping due to steadily increasing pore water pressure during rain resulting in development of multiple cracks, sinking of land, landslides and rock falls causing damages to

buildings and roads constructed on this highly ill-suited site (may be due to ignorance of the local people and government also). It is suggested that for the sustenance of the environment, the Thathri type foot slope zones (**Figure 6**) of hill spurs in the entire District Doda should be mapped using geospatial technologies at 1:10,000 scale by which such ill-suited sites may avoided for civil engineering works in future.

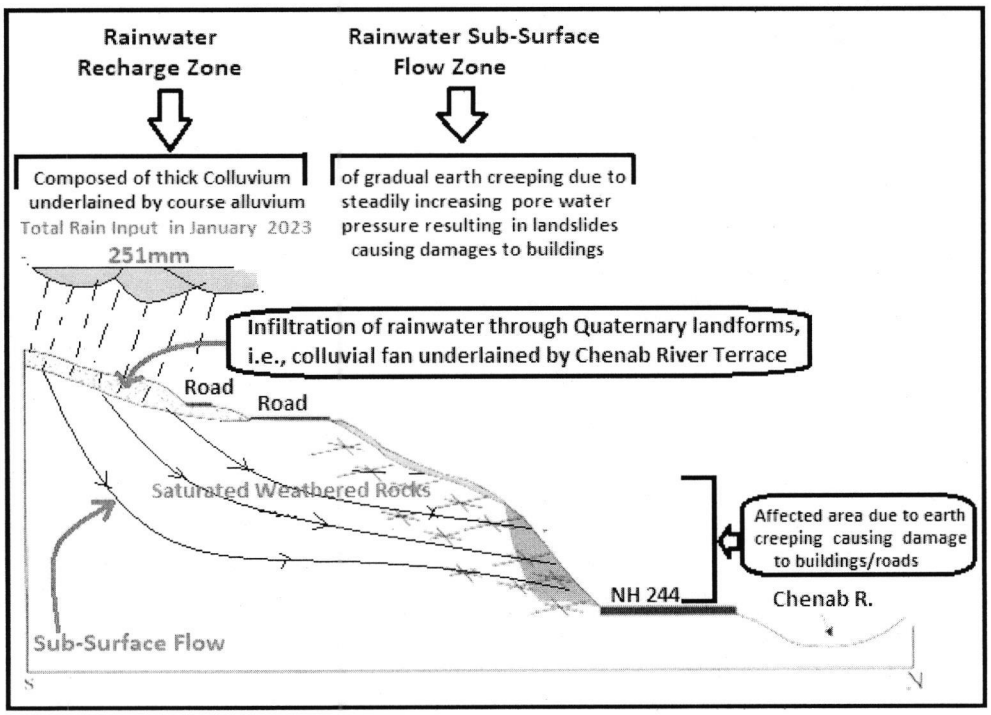

Figure 6: Hydro-geomorphic cross-section of foot slope zone of the Thathri hill spur depicting geomorphic landforms and hydrologic processes.

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