A
First Information Report

On

Current Scenario of Sikkim Glacial Lake Outburst Flood (GLOF)

Submitted by

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Sikkim flash flood | 14 dead, 102 missing as natural
calamity leaves trail of devastation

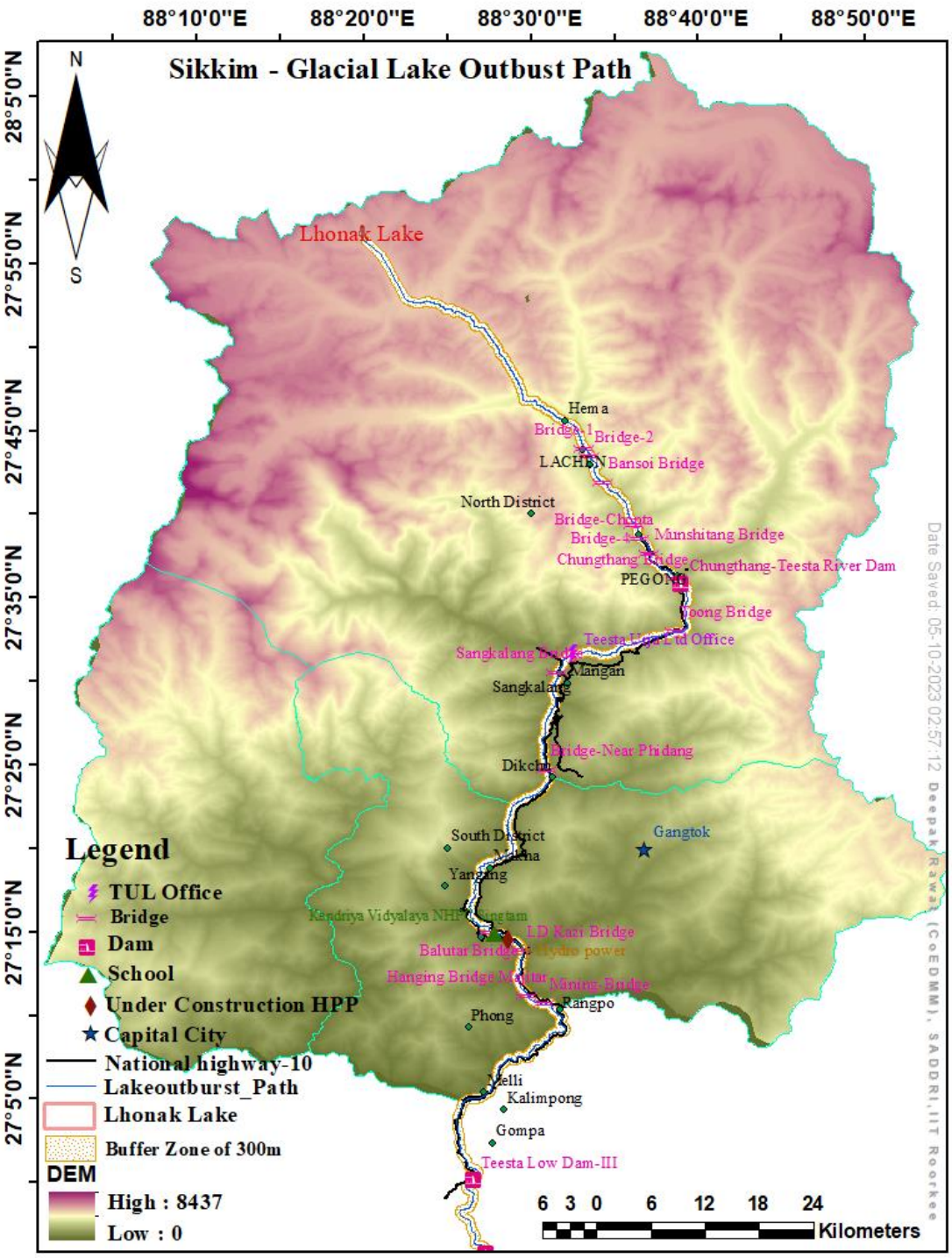

Figure.1 *South Lhonak Lake serves as the point of origin for the catastrophic flood event, and the subsequent course of the flood extends along the Teesta River and National Highway 10. This trajectory reveals the specific areas heavily impacted by the flash flood, resulting in property damage and significant consequences. The figure provides a clear depiction of the vulnerability of this valley, highlighting the presence of critical infrastructure, including schools, in the affected region.*

The date of October 4, 2023, marks an important event in located in the state of Sikkim. A devastating flash flood, initiated by a sudden and intense rainfall event over South Lhonak Lake in North Sikkim, has caused widespread devastation in the northeastern state, resulting in significant damage and loss. According to the most recent updates, a minimum of eight individuals have tragically perished, while 23 members of the Army have been reported as missing. The catastrophe has moreover resulted in substantial harm to infrastructure, including the structural failure of bridges and the submergence of vital transportation networks. Presented below is a comprehensive outline of the ongoing crisis:

The Unleashing of Nature's Fury:

The flash flood, which is said to have initiated at 1:30 am on October 4th, was intensified due to the discharge of water from the Chungthang dam. The occurrence of an abrupt cloud burst above Lhonak Lake led to a subsequent surge of water that descended into the Teesta River, hence giving rise to flash floods across many towns situated within the Teesta River basin, namely Dikchu, Singtam, and Rangpo **(Figure.1)**. The exacerbation of the crisis was caused by the excessive flow of the Teesta river, resulting in the erosion and destruction of sections of NH-10, a crucial transportation route linking Sikkim with the remainder of the nation.

The catastrophic event has resulted in a minimum of 19 fatalities, and efforts to locate others who are unaccounted for are ongoing. Regrettably, a total of 23 Army men are still unaccounted for, and ongoing endeavors are being made to identify and retrieve them. Rescue activities are currently being executed with a high degree of urgency, with a primary focus on locating and recovering the missing individuals, which are more than 100 in total till now.

The catastrophic event has resulted in significant destruction to critical infrastructure, notably the complete collapse of six bridges spanning the distance between Chungthang and Rangpo **(Figure.3)** and eight other bridge got damaged some other place on Teesta river. The National Highway 10, which is regarded as a critical transportation route in Sikkim, has experienced substantial damage, resulting in the inaccessibility of numerous regions. The occurrence of this exceptional incident has highlighted the susceptibility of infrastructure in locations prone to disasters. The dam of the Teesta 3 HEP, which is Sikkim's largest hydroelectric plant with a capacity of 1200 MW, was completely destroyed, resulting in its 60-meter height being washed away **(Figure.2)**.

The flash flood resulted in significant damage to Sikkim Urja Limited, the largest hydro power facility in Sikkim. The destruction of the dam at Chungthang and the subsequent loss of the bridge linking the powerhouse have presented considerable obstacles to power generation, hence requiring substantial restoration endeavours.

The flash floods had a widespread impact on the districts of Sikkim, with Mangan in North Sikkim seeing the most severe consequences. Other districts that have been impacted are Pakyong and Gangtok, located in East Sikkim. Due to the extensive magnitude of devastation, the educational institutions in the districts of Mangan, Gangtok, Pakyong, and Namchi have been compelled to suspend their operations till October 8th, in order to priorities the well-being and security of both students and local inhabitants.

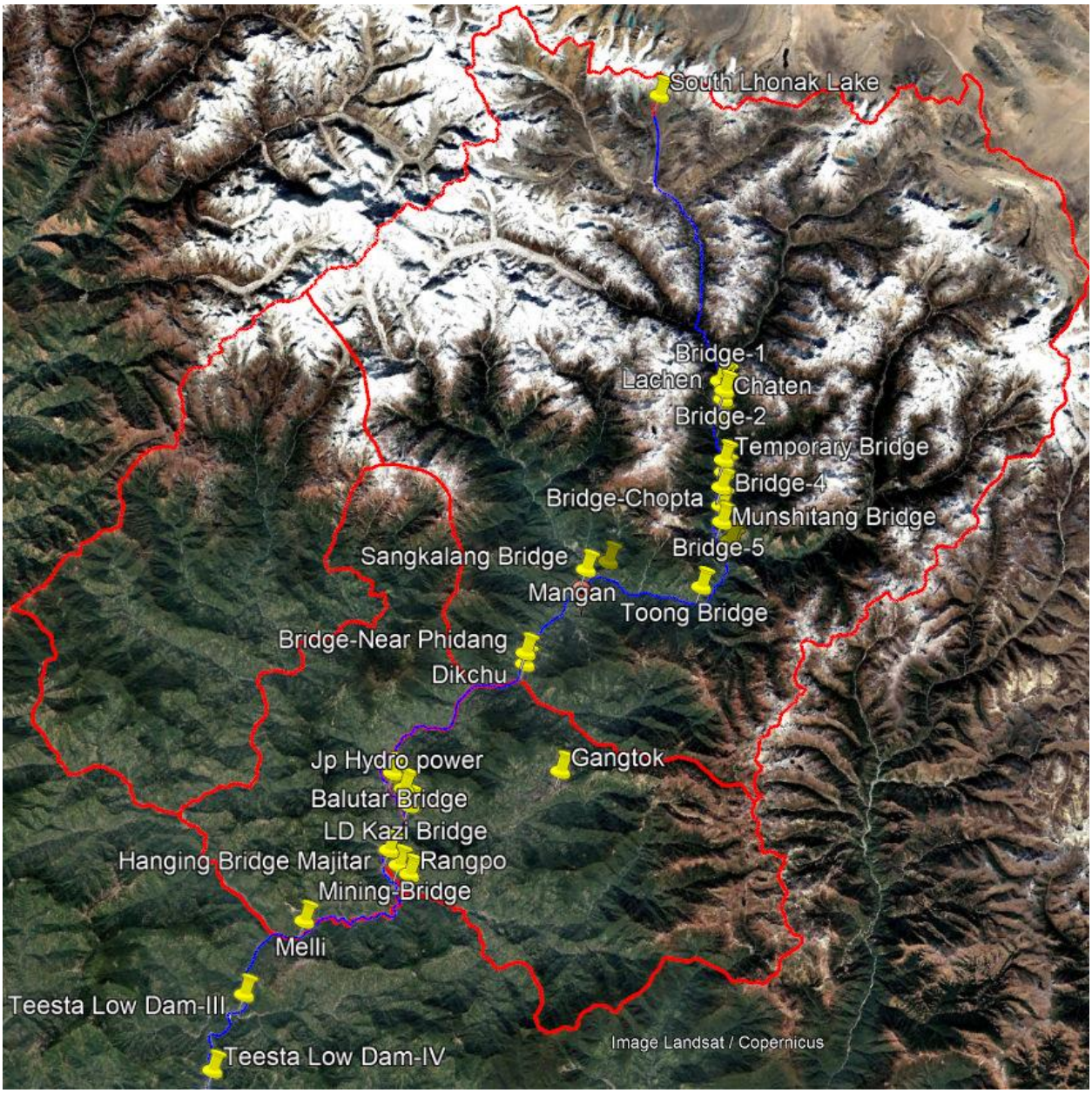

Figure. 2. *Red border showing the Sikkim state and district boundaries. Blue line sowing the path followed by the GLOF and along this path devastation have seen by flash flood and major critical place have been marked.*

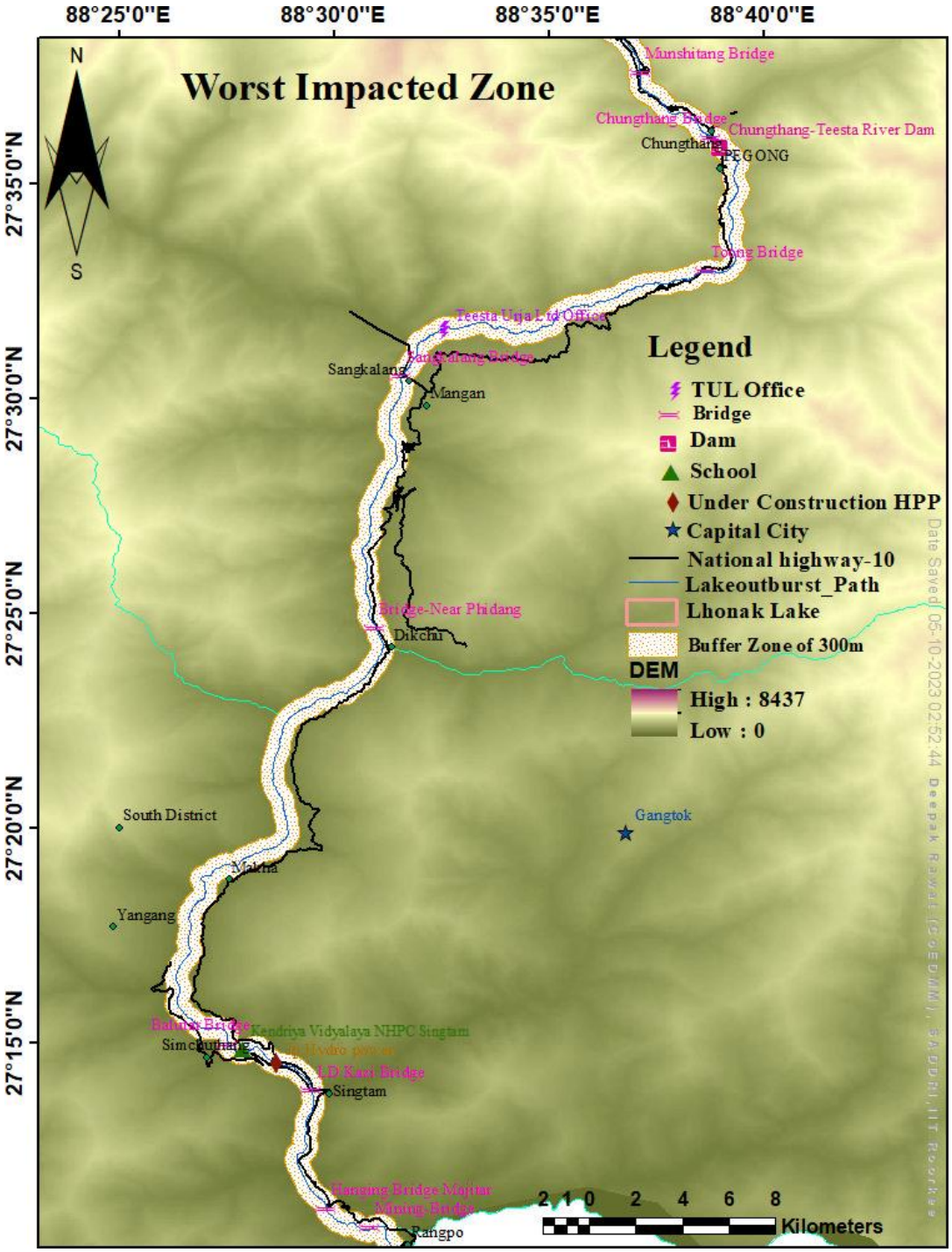

Figure.3 *The worst impacted site in the Teesta Valley was between Rangpo and Chungthang, where six bridges had been washed away, and many of them significantly connected the people across the valley.*

Prompt and Timely Response and Assistance: Ongoing rescue and relief activities are being conducted, wherein the National Disaster Response Force (NDRF) has deployed three teams to provide aid and support in the impacted regions. The Indian Army, local authorities, and disaster management teams are diligently engaged in efforts to locate persons who are missing and offer aid to those who have been impacted. Prime Minister Narendra Modi has expressed his commitment to providing comprehensive assistance to Chief Minister Prem Singh Tamang of Sikkim amidst the current difficult circumstances.

South Lhohak Lake: Located in the remote northwestern part of Sikkim, South Lhonak Lake is a notable glacial-moraine-dammed lake renowned for its remarkable rate of expansion, rendering it one of the most rapidly expanding lakes in the Sikkim Himalaya region. This particular lake is one of the fourteen lakes in the region that are regarded as having the potential to provide hazards due to their vulnerability to Glacial Lake Outburst Floods (GLOFs). South Lhonak Lake, situated at an elevation of 5,200 metres (17,100 feet) above sea level, is formed as a result of the glacial meltwater from the Lhonak glacier [1], [2].

The lake is undergoing a notable and rapid expansion, mostly attributed to the melting of the South Lhonak glacier itself, together with the supplementary influx of meltwater originating from the surrounding North Lhonak and main Lhonak glaciers. The lake's geographical coordinates are estimated to be roughly 27°56'50.93"N latitude and 88°19'53.54"E longitude. The dimensions of the object in question consist of a maximum length measuring 1.98 kilometres, a maximum width measuring 0.45 kilometres, a surface area measuring 1.26 square kilometres, and a maximum depth reaching 79.24 metres (https://sandrp.in/).

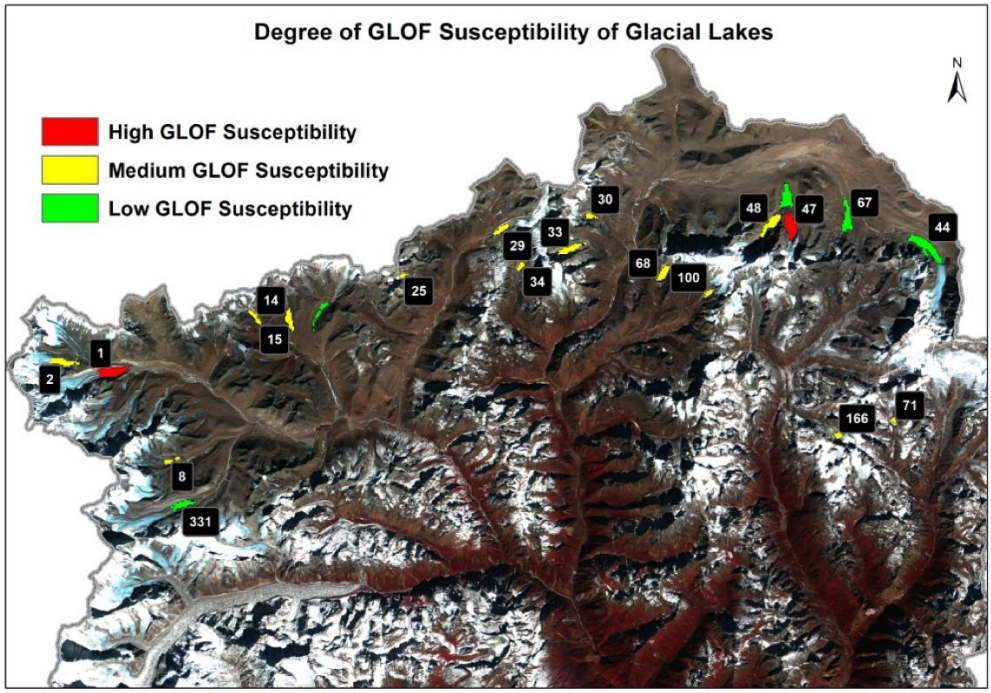

Figure. 4 *Location of the glacial lakes in Sikkim (After [1]).*

Table. 1. *Description of glacial lake (After [1])*

GLOF susceptibility	Lake ID (name)	Description
High	Lake0001 (South Lhonak) Lake0047 (Gurudongmar 2)	Moraine-dammed lakes and steep slope areas with unstable behaviour of shape and size of the lakes.
Medium	Lake0002 (North Lhonak)	Moraine-dammed lakes with less dynamic behaviour of size and shape in last decades. These lakes need further monitoring as their future GLOF susceptibility is difficult to predict.
	Lake0008	
	Lake0014	
	Lake0015	
	Lake0025	
	Lake0029	
	Lake0030	
	Lake0033	
	Lake0034	
	Lake0048 (Mashya-Tso)	
	Lake0068 (Gyapji Chho)	
	Lake0071	
	Lake0100	
	Lake0166	
Low	Lake0018	This category consists the 5 moraine-dammed lakes including 4 largest lakes in the study area. Lake0018 is located in trough valley. Lake0044, 0067 and 0331 are proglacial lakes.
	Lake0044 (Khangchung Chho)	
	Lake0051 (Gurudongmar Lake)	
	Lake0067 (Chholamo)	
	Lake0331 (Pandon Chho)	

As observed by [1], [2] identified and calculated the GLOF susceptibility, as shown in **Table-1, Figure-4**. Still, no preventive measures haven't taken. As we have also seen, the rapid development due to people encroaching on the river path and human habitation have been increasing on the banks of the Teesta River. It can also be mentioned and seen in the **Figure. 5.**

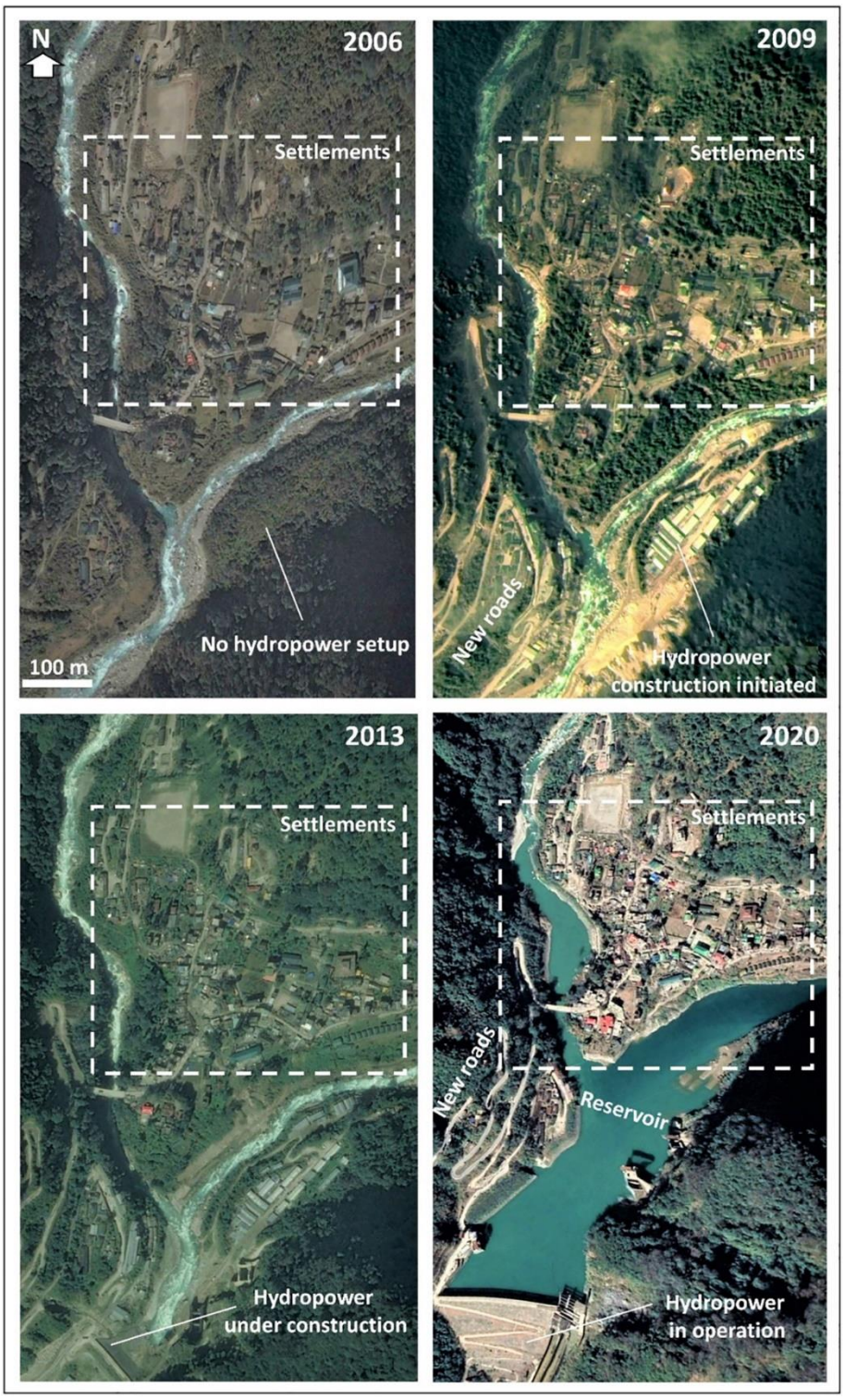

Figure. 5. *Settlement increase have been observed over the period of time, near Chungthang Reservoir (After* [2]*)*

Present Challenges

Current situation following the flash flood, it is evident that affected individuals are grappling with a multitude of challenges. Beyond the immediate loss of homes and possessions, several other pressing issues have arisen as a result of this devastating event.

Water Supply Disruption: The flash flood has caused extensive damage to the water supply infrastructure, leaving many communities without access to clean water. This is not only a basic necessity but also critical for hygiene and sanitation.

Food Shortages: The destruction of roads and bridges has disrupted the transportation of food supplies to the affected areas. Consequently, there is a growing concern about food shortages, which could lead to a potential crisis if not addressed promptly.

Communication Breakdown: The flash flood has wiped out communication towers and disrupted the region's communication network. This has not only hindered emergency response efforts but also left residents isolated from external assistance and information.

Power Outages: With electricity distribution infrastructure severely damaged, communities are experiencing prolonged power outages. This has a cascading effect on essential services, including healthcare and communication.

Loss of Livelihoods: In addition to homes, people have lost their marketplaces, land, and livestock. This not only impacts their immediate survival but also threatens their long-term livelihoods.

Identity and Documentation Loss: Many individuals have lost their identification documents, making it challenging to access government assistance and services. This loss of identity exacerbates the vulnerability of the affected population.

Healthcare Challenges: Access to medical facilities is hampered by the damaged transportation routes, particularly in the narrow Teesta Valley where helicopter landings are difficult. This poses a significant challenge for those in need of medical attention, including pregnant women and newborns.

Psychological Trauma: The trauma experienced by survivors cannot be understated. Many have lost not only their homes but also their savings and sense of security. The psychological impact of such a disaster is likely to be long-lasting and widespread.

Shelter Crisis: With houses destroyed, people are left without proper shelter, which is especially concerning for vulnerable populations, including pregnant women, new mothers, and infants.

Observation: Upon a comprehensive examination of the current Sikkim disaster situation, several noteworthy points emerge. Firstly, it raises questions about the proactive measures taken by the disaster risk reduction community. The fact that the potential for a glacial lake outburst from Lhonak Lake had been identified underscores the need for a well-structured action plan. Preparedness could have been significantly enhanced to safeguard lives and property in the event of such an occurrence. Secondly, the observation highlights the critical importance of developing

a monitoring system, particularly for regions like the Teesta valley, where a substantial population resides. Given that the Teesta River plays a dominant role in receiving approximately 95% of the water from various streams across the entire state **(Figure.6),** implementing flood forecasting and other flood management techniques becomes imperative. Lastly, the devastating aftermath of disasters in the valley region points to the pressing need for strategic disaster recovery planning. One of the primary challenges lies in the disruption of crucial transportation routes. To address this issue, it is essential to establish alternative routes that can be swiftly activated in times of crisis, ensuring efficient response and recovery efforts. These observations underscore the significance of proactive planning, technological advancements in monitoring and forecasting, and the development of resilient infrastructure to mitigate the impact of future disasters in vulnerable regions like Sikkim.

An Urgent Call to Action for Enhancing Disaster Risk Reduction Efforts:

The occurrence of this tragic event serves as a poignant reminder of the significance of implementing disaster risk reduction measures in areas that are susceptible to natural disasters. The expeditious initiation of flash floods underscores the necessity for expanded early warning systems, heightened infrastructure resilience, and augmented catastrophe preparedness. Although the occurrence of this flash flood cannot be attributed to a cloud burst, it serves as a reminder of the inherent unpredictability of such phenomena and the imperative need for the implementation of comprehensive systems for managing and mitigating disaster risks.

Sikkim, situated in the eastern Himalayas, is renowned for its awe-inspiring topography and rich wildlife. Nevertheless, the region is also prone to many natural calamities, hence emphasising the utmost importance of disaster risk mitigation. As the impacted communities embark on the challenging journey of recovery, it is imperative for the scientific community and practitioners in disaster risk reduction to acknowledge and reflect upon the insights gained from this unfortunate incident. The effective management of future disasters in this region relies on bolstered preparedness, resilient infrastructure, and prompt reaction procedures.

The tenacity and commitment exhibited by Sikkim will undeniably have a significant impact on its trajectory towards recovery. The disaster risk reduction community should pay attention to this incident in order to enhance preparedness and resilience in Sikkim and other comparable places, enabling them to effectively confront and surmount similar obstacles in subsequent occurrences.

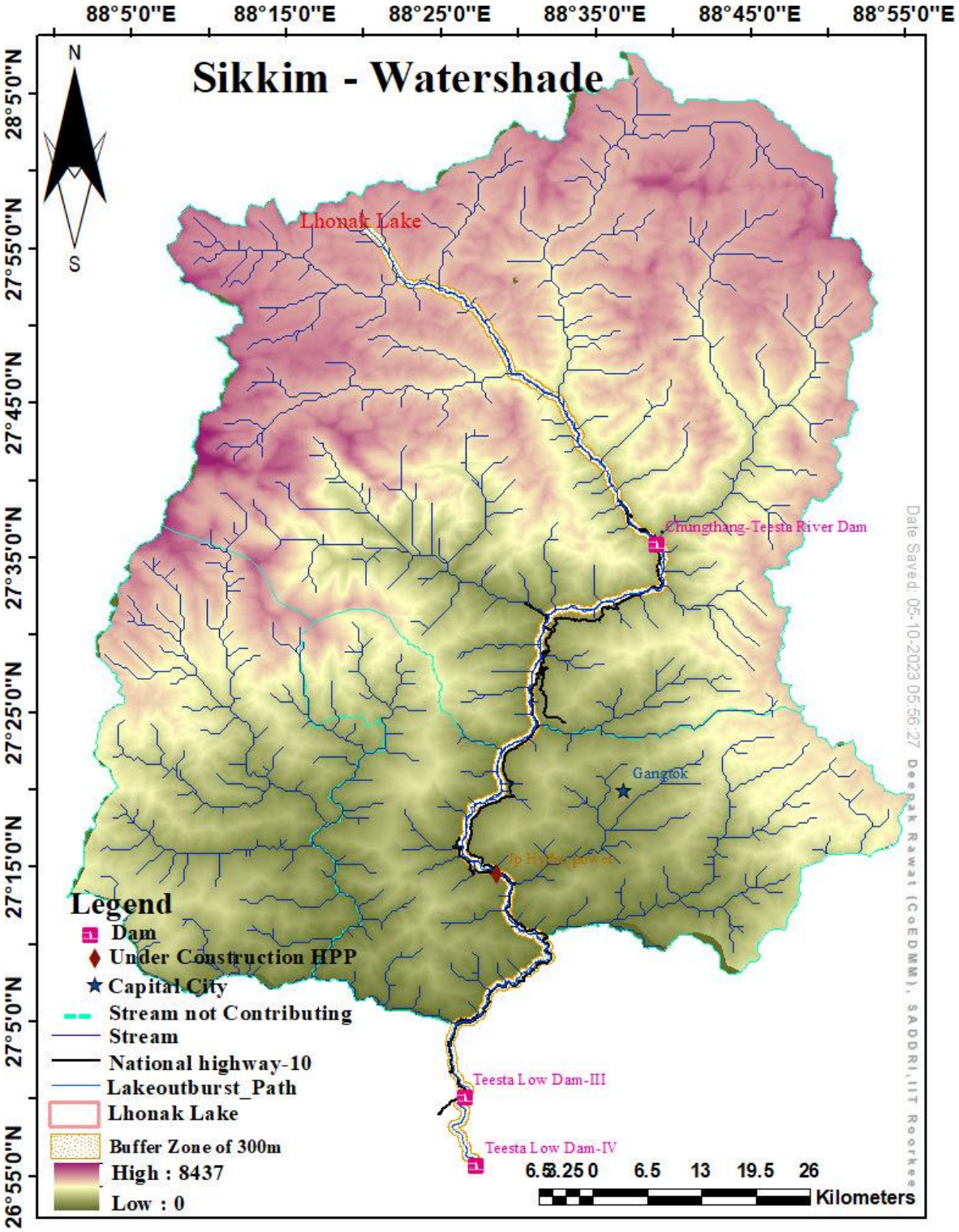

Figure.6. *Teesta River is the largest and longest river in the Sikkim state, and with this figure, we can understand why this happens. Through the stream network distribution, we can see the approx. 95% of streams are contributing to the Teesta River.*

Need of the hour:

The occurrence of the catastrophic flash flood in North Sikkim presents a pressing demand for the scientific community to take immediate action. This event also highlights the necessity for collaborative endeavours aimed at strengthening the ability of regions susceptible to natural disasters to withstand and recover from such occurrences. In order to adequately respond to such occurrences, it is crucial to prioritise multidisciplinary research and collaboration among professionals in the fields of meteorology, geology, hydrology, and disaster management. Enhancing preparedness can be greatly facilitated through the allocation of resources towards investments in early warning systems, real-time monitoring of weather patterns, and the advancement of predictive models. Furthermore, it is imperative to enhance the resilience of infrastructure by employing sophisticated engineering methodologies and adopting sustainable land-use strategies. Community participation and education activities have the potential to enhance the capacity of citizens to effectively respond in emergency situations. This tragic incident underscores the significance of a cohesive approach in mitigating disaster risks, wherein the scientific community assumes a leading role, collaborating closely with governments, local communities, and humanitarian organisations to promote a more secure and resilient future.\

References:

[1] S. Aggarwal, S. C. Rai, P. K. Thakur, and A. Emmer, "Inventory and recently increasing GLOF susceptibility of glacial lakes in Sikkim, Eastern Himalaya," *Geomorphology*, vol. 295, pp. 39–54, Oct. 2017, doi: 10.1016/J.GEOMORPH.2017.06.014.

[2] A. Sattar *et al.*, "Future Glacial Lake Outburst Flood (GLOF) hazard of the South Lhonak Lake, Sikkim Himalaya," *Geomorphology*, vol. 388, p. 107783, Sep. 2021, doi: 10.1016/J.GEOMORPH.2021.107783.