



**2023**

# **Post Disaster Needs Assessment**

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**Glacial Lake Outburst Flood Sikkim - 2023**

## Message

In the early hours of 4<sup>th</sup> October, 2023, the state of Sikkim faced an unprecedented calamity, marking one of the worst ever incidents in the past decade. The night of 3<sup>rd</sup> October, 2023, witnessed a massive landmass slipping into the South Lhonak lake, triggering a chain of events that led to a devastating flash flood downstream along the Teesta River basin. This catastrophe resulted in severe damages to the low-lying areas of 4 districts namely, Mangan, Gangtok, Namchi and Pakyong.

Tragically, 55 lives were lost and an estimated 80,000 people across 100 villages were affected. In response, relief assistance was swiftly provided to displaced families as per the prevailing norms in the State, over and above the norms of assistance laid by the Government of India. The coordinated efforts of rescue teams from the National Disaster Response Force, State Disaster Response Force, Army, Sikkim Police and ITBP were pivotal in saving numerous lives. The commendable actions of the community / locals in evacuation and rescue of stranded people merit special acknowledgement.

As the affected population gradually resumed normalcy, the State transitioned from relief to the recovery phase. The State Government of Sikkim, in collaboration with the National Disaster Management Authority (NDMA), initiated the post disaster needs assessment (PDNA) from 7<sup>th</sup> to 11<sup>th</sup> December, 2023. This collaborative effort involved various Line departments from the State, as well as experts from international and national agencies. The participatory appraisal encompassing several rounds of consultations with all the stakeholders and communities in the affected areas, resulted in a comprehensive report that covers eight sectors, cross cutting issues and a recovery strategy.

This PDNA is not just a document; it is a dedication to those who suffered during this calamity. We extend our heartfelt gratitude to everyone who contributed to its creation. The report outlines a vision of recovery that goes beyond rebuilding Sikkim, aiming to create a more resilient and sustainable future. This vision centers around integrated communication for risk informed practices, mainstreaming disaster risk reduction in development planning, community centered reconstruction and technology Integration for early warning.

As we move forward, we look forward to working with all the stakeholders in the implementation of the recovery programmes proposed in this PDNA report. Together we strive towards a resilient and sustainable Sikkim.

Sd/-  
Chief Secretary  
Government of Sikkim.

## Acknowledgement

The state of Sikkim is prone to frequent disasters owing to the various hazards like Earthquake, Landslides, GLOF & Flashfloods, Lightning, Forest Fire, etc. Every monsoon, the state experiences mass destruction due to heavy and sporadic rainfall. The flashflood of Oct 3<sup>rd</sup> & 4<sup>th</sup> 2023 owing to the Landslide in the South Lhonak lake resulted to spill over of water in the Teesa River induced massive destruction of properties, loss of human and animal lives. The total road network of Mangan District was badly affected by the flashflood. Other Districts which were affected are Gangtok, Namchi and Pakyong.

In view of recovery and reconstruction, the Govt. of Sikkim requested NDMA for assistance to carry out Post Disaster Needs Assessment (PDNA) in the State. NDMA provided required technical support for conducting the exercise and completing it early. The Govt. of Sikkim, SSDMA expresses its gratitude for technical support extended by NDMA, especially the personal intervention and guidance from Shri. Kamal Kishore, Member Secretary, NDMA and Shri Kunal Satyarthi, IFS, Joint Secretary (PP) NDMA, in collaboration with National & International Agencies like UNDP, CDRI, NIDM, UNICEF, IIT and Central as well as State Expert Group members for their coordination and support. Special mention goes to the four Districts Disaster Management Authorities and Line Departments for assisting the expert teams in proper assessment of damages.

Sd/-

Shri Anil Raj Rai (IAS)  
State Relief Com-cum-Secretary  
Land Rev. & Disaster Mgt. Deptt.  
Govt. of Sikkim

# Contents

**Message**

**Acknowledgement**

**List of Tables**

## **1. Preliminaries**

- 1.1. Background
- 1.2. Rationale for Post Disaster Needs Assessment
- 1.3. Overview of the assessment process and methodology
- 1.4. Limitations of the assessments

## **2. Overview**

- 2.1. Profile of the State
- 2.2. Disaster Profile
- 2.3. Disaster Event
- 2.4. District Wise Impact of the Disaster
- 2.5. Response of the State Government and District Administration
- 2.6. Recovery Vision
- 2.7. Specific Recovery Objectives
- 2.8. Recovery Principles

## **3. Social Sector**

- 3.1. Housing
- 3.2. Education
- 3.3. Health, Anganwadi and Community Buildings

## **4. Productive Sector**

- 4.1. Agriculture and Horticulture
- 4.2. Animal Husbandry and Livestock
- 4.3. Tourism

## **5. Infrastructure Sector**

- 5.1. Roads and Transport
- 5.2. Drinking Water and Sanitation

## **6. Cross Cutting Issues**

- 6.1. Forest and Environment
- 6.2. Disaster Risk Reduction

## **7. Resource Mobilization, Implementation, Monitoring and Evaluation of the plan**

- 7.1. Resource Mobilization
- 7.2. Program Implementation
- 7.3. Program Monitoring and Evaluation



## List of Tables

[Table 1. Profile of the State](#)

[Table 2. Timeline of the Events](#)

[Table 3. District wise impact of disaster](#)

[Table 4. Summary of Damage, Losses and R&R needs.](#)

[Table 5. Housing: Damage to Housing Sector](#)

[Table 6. Housing: Existing floor areas of pucca, semi-pucca and kutcha buildings](#)

[Table 7. Housing: Basic unit costs, areas and number of floods or pucca. Semi-Pucca and kuccha buildings](#)

[Table 8. Housing: Partially damage building cost: Built-up area by housing type, Covered Area – "like for like"](#)

[Table 9. Housing: Damage Cost Estimates](#)

[Table 10. Quantities and cost of debris management](#)

[Table 11. Reconstruction: Unit Cost, Area per unit and Built-Up area](#)

[Table 12. Repair and retrofitting: Unit-cost, area, number of HH's per floods and number of stories](#)

[Table 13. Housing and settlement recovery cost, cost of damage and loss](#)

[Table 14. Education Sector Profile](#)

[Table 15. Education Sector Policies](#)

[Table 16. Impact of Disaster](#)

[Table 17. Damage in Education Sector](#)

[Table 18. Education Sector: Damage Estimate](#)

[Table 19. Education Sector: Component wise assumption of damage estimate](#)

[Table 20. Recovery and Reconstruction Needs for education Sector](#)

[Table 21. Education Sector: Component wise recovery of ATTC](#)

[Table 22. Education Sector: Implementation Framework](#)

[Table 23. Health Sector: Key Health Indicators highlighting performance of Sikkim Health Sector](#)

[Table 24. Health Sector: Key Health Indicators for Sikkim on Non-Communicable Disease](#)

[Table 25. Health Sector: Summary of Capacity of Health Infrastructure in Sikkim](#)

[Table 26. Health Sector: Summary of Anganwadi and Community Buildings that reported Damages](#)

[Table 27. Health Sector: Summary of ownership of Anganwadi from reported buildings](#)

[Table 28. Health Sector: Patient Load on Singtam District during disaster \(IPD capacity 150 beds\)](#)

[Table 29. Health Sector: District wise impact on access of health services.](#)

[Table 30. Health Sector: Impact of Disaster on Anganwadi 7](#)

[Table 31. Health Sector: Damage Assessment of Anganwadi's](#)

[Table 32. Health Sector: Assumption for Damage estimate for Health Sector](#)

[Table 33. Health Sector: Damage Estimate for health Sector](#)

[Table 34. Health Sector: Item wise assumption for damage estimate in Anganwadi's](#)

[Table 35. Health Sector: Component and District wise damage estimate for Anganwadi's](#)

[Table 36. Health Sector: Total Damage Estimate for Anganwadi](#)

[Table 37. Health Sector: Total Economic Losses \(in Crore\) based on inputs from Health Department](#)

[Table 38. Health Sector: overall reconstruction cost estimates for Health Sector](#)

[Table 39. Health Sector: Overall recovery need estimate for health sector](#)

[Table 40. Recovery and Reconstruction Needs for Anganwadi and Community Buildings](#)

[Table 41. Agriculture Sector: Details of Damage to Land](#)

[Table 42. Agriculture Sector: Overall Damage Numbers in Hectare](#)

[Table 43. Agriculture Sector: Overall Damage Cost Estimate in Crore](#)

[Table 44. Agriculture Sector: Overall Economic Loss Estimate in Crore](#)

[Table 45. Agriculture Sector: Number of Farmers affected](#)

[Table 46. Agriculture Sector: Components of Damages and Losses \(In Crore\)](#)

[Table 47. Agriculture Sector: Reconstruction Cost estimate \(In Crore\)](#)

[Table 48. Agriculture Sector: Recovery Cost Estimate \(In Crore\)](#)

[Table 49. Agriculture Sector: Implementation mechanism](#)

[Table 50. Animal Husbandry and Livestock: Profile](#)

[Table 51. Animal Husbandry and Livestock: Damages in Animal Husbandry and Fisheries Sector](#)

[Table 52. Animal Husbandry and Livestock: District Wise Damage and Replacement Cost \(In crore\)](#)

[Table 53. Animal Husbandry and Livestock: Replacement Cost Fisheries \(In crore\)](#)

[Table 54. Animal Husbandry and Livestock: Overall Infrastructure Damage \(In crore\)](#)

[Table 55. Animal Husbandry and Livestock: Economic Losses in AH& L \(In crore\)](#)

[Table 56. Animal Husbandry and Livestock: Unit Cost assumption for replacement cost](#)

[Table 57. Animal Husbandry and Livestock: Methodology for assumption for Economic Loss](#)

[Table 58. Tourism: Tentative revenue Loss in hotel Sector \(In Rupees\)](#)

[Table 59. Tourism: Tentative revenue Loss in Homestay Sector \(In Rupees\)](#)

[Table 60. Tourism: Tentative revenue Loss in Tours and Travels Sector \(In Rupees\)](#)

[Table 61. Roads and Transport: Damaged Road Infrastructure](#)

[Table 62. Roads and Transport: Total Damage, Recovery estimate for Road Sector](#)

[Table 63. Roads and Transport: Primary Road Network in Sikkim 8](#)

[Table 64. Roads and Transport: Road Sector Damage w.r.t Asset Type](#)

[Table 65. Roads and Transport: Damage Estimate \(In lakh\)](#)

[Table 66. Roads and Transport: Unit Cost for Road and Bridge Works](#)

[Table 67. Roads and Transport: Asset-wise Reconstruction and Recovery Cost Estimate for Sikkim \(Short to Medium term\)](#)

[Table 68. Roads and Transport: Recovery Framework](#)

[Table 69. Drinking Water and Sanitation: Recovery Framework](#)

[Table 70. Drinking Water and Sanitation: Summary of Covered Population](#)

[Table 71. Drinking Water and Sanitation: Details of Sewage Treatment Plants in Sikkim](#)

[Table 72. Drinking Water and Sanitation: Sectoral Policies and Departments](#)

[Table 73. Drinking Water and Sanitation: Overall Damage numbers](#)

[Table 74. Drinking Water and Sanitation: Damage Cost Estimate](#)

[Table 75. Drinking Water and Sanitation: District Wise Damage Estimate](#)

[Table 76. Drinking Water and Sanitation: Component Wise Damage Estimate](#)

[Table 77. Drinking Water and Sanitation: District Wise Loss Estimate](#)

[Table 78. Drinking Water and Sanitation: Recovery and Reconstruction Needs Assessment](#)

[Table 79. Drinking Water and Sanitation: Reconstruction Cost Estimate - Water \(In Crore\)](#)

[Table 80. Drinking Water and Sanitation: Reconstruction Cost Estimate – Sanitation \(In Crore\)](#)

[Table 81. Drinking Water and Sanitation: Reconstruction Cost Estimate - Summary of R&R needs](#)

[Table 82. Drinking Water and Sanitation: Recovery Framework](#)

[Table 83. Forest and Environment: Affected Protected Forest Area land under Forest and Environment Department along Teesta River](#)

[Table 84. Forest and Environment: Damage Estimate as per NPV](#)

[Table 85. Forest and Environment: Damage to Nurseries of the Forest and Environment Department.](#)

[Table 86. Forest and Environment: Damage to Forest Department Built up Infrastructure](#)

[Table 87. Forest and Environment: Damage to Malli Sheds](#)

[Table 88. Forest and Environment: Damage to Eco-Tourism Infrastructure](#)

[Table 89. Forest and Environment: Loss to collection sites for sand, stone and loose boulders- loss of revenue for department](#)

[Table 90. Forest and Environment: Loss to collection sites for sand, stone and loose boulders- loss of individuals with tenders.](#)

[Table 91. Forest and Environment: Summary of total Loss to collection sites.](#)

[Table 92. Forest and Environment: Summary of damage and Loss to collection sites.](#)

[Table 93. Forest and Environment: Summary of forest restoration.](#)

[Table 94. Forest and Environment: Reestablishment of the Nurseries 9](#)

[Table 95. Forest and Environment: Reconstruction of Infrastructure damages](#)

[Table 96. Forest and Environment: Reconstruction of Malli Sheds](#)

[Table 97. Forest and Environment: Estimation for restoration and upgradation for communication systems](#)

[Table 98. Forest and Environment: Reconstruction of Eco-Tourism](#)

[Table 99. Forest and Environment: Summary of Reconstruction cost](#)

[Table 100. Forest and Environment: Cost estimate for Recovery interventions](#)

[Table 101. Forest and Environment: Reconstruction and recovery Framework](#)

[Table 102. Disaster Risk Reduction: Cost Estimate - Monitoring and Early Warning System](#)

[Table 103. Disaster Risk Reduction: Cost Estimate - Flood Forecasting Systems](#)

[Table 104. Disaster Risk Reduction: Cost Estimate - Structural Mitigation measures](#)

[Table 105. Disaster Risk Reduction: Cost Estimate - Non-Structural Mitigation measures](#)

[Table 106. Disaster Risk Reduction: Cost Estimate - CBDRR Measures](#)

[Table 107. Disaster Risk Reduction: Cost Estimate - Emergency Response Planning](#)

[Table 108. Disaster Risk Reduction: Summary of cost Estimate for DRR measures](#)

[Table 109. Program Implementation: Members of State Executive Committee](#)

[Table 110. Program Implementation: Technical Appraisal Committee](#)

[Table 111. Program Implementation: Monitoring and Evaluation framework](#)

# 1. Preliminaries

## 1.1. Background

Sikkim, the 22<sup>nd</sup> state of the Indian Union is located in the foothills of the Eastern Himalayas and it has a mountainous terrain with elevations ranging from 280 meters to 8585 meters. About one third of the state is covered by forests. It has 28 peaks and more than 400 glaciers with similar number of high altitude glacial lakes. Due to its unique terrain and location, it is susceptible to multi hazards like earthquake, landslides, GLOF, lightning, thunder, hailstorms and so on. On the night of 3<sup>rd</sup> October, 2023, a huge landmass slipped into the South Lhonak, located in the north western part of the state, which caused the lake to overflow. The water from the lake flowed into the Teesta River which caused the water level to rise beyond 15 feet. This led to surge in the flow of the river causing widespread damages to lives and properties at the downstream locations.

Sikkim State Disaster Management Authority / SSDMA in consultation with State departments of Government of Sikkim and stakeholders conducted initial damage assessment and has submitted interim memorandums seeking for additional financial assistance from NDRF for sector wise damage for recent Sikkim Flash Floods 2023 to the Central Government under;

- a. Immediate Restoration amounting to Rs 776 Cr
- b. Long term Restoration amounting to Rs 25000 Cr

The 15<sup>th</sup> Finance Commission has recommended that a disaster event must be assessed using a PDNA tool to comprehensively assess damages, losses and recovery needs. The data assessed through PDNA is the basis for allocation of funds from the recovery and reconstruction window of NDRF.

## 1.2. Rationale for Post Disaster Needs Assessment

Post disaster needs assessment (PDNA) is crucial for evaluating losses and damages encompassing infrastructure, services and outcomes. These assessments, as outlined in NDMA draft guidelines on Recovery & Reconstruction serve as a pivotal link between disasters and long-term recovery. A qualitative analysis underscores the significance of understanding the multi-faceted impact, aiding in strategic planning and resource allocation. The exercise will guide prioritization of interventions, facilitation of restoration of essential services and infrastructure, thereby steering post – disaster initiatives towards effective, targeted and informed development.

## 1.3. Overview of the assessment process and methodology

This PDNA exercise was led by the State Government of Sikkim jointly supported by NDMA, NIDM, relevant departments, national and international agencies and other stakeholders. The following process was followed for PDNA:

- **Setting up the Team, Preparation and Coordination:** SSDMA constituted a multi stakeholder state level coordination team consisting of sector experts, representatives from the government, international organizations and other stakeholders.
- **Training Program:** Experts from NDMA conducted a training program for constituted teams focusing on the process, data collection, analysis, recovery needs and report writing for PDNA.



- **Sectoral Assessments:** Detailed sectoral assessments were done by sectoral teams constituted by the State. The district team supported the Sector experts in the provision of baseline information, damage data, GPS locations etc.
- **Drafting of PDNA report:** Following the collection of data, the team prepared the report presenting sector wise damage. The cost estimates of all the damage including the cost of damage, unit cost is included in the report.
- **Sectoral Expert Group (SEG):** The SEG consisted of members from NDMA, NIDM, national and international organizations. The SEG was responsible for data analysis and assessment, identification of recovery needs, development of recovery framework and formulation of sectoral reports.

#### **1.4. Limitations of the assessments**

The PDNA has faced limitation in relevance due to delays in assessment and submission of reports owing to Government holidays. Methodological challenges include standardization issues and balancing qualitative and quantitative data. There have been resource constraints in terms of skilled workforce which has limited comprehensive assessments of certain sectors. At some areas, the team was unable to reach the area of impact due to damage in road infrastructure. The team faced technical challenges in using the templates for data collection leading to insufficient data input in certain sectors.

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## 2. Overview

### 2.1. Profile of the State

Sikkim is a land-lock hilly state and its strategic location confines with Darjeeling district of West Bengal which is delineated by major rivers that flows from within the state. It shares its state border with three sovereign nations, Nepal in the West, Bhutan in the East and vast stretches of Tibetan plateau of China in the North. The state is situated between 27°04' 46" and 28°07'48" north latitudes and 88°00'58" and 88°55'25" east longitudes. The state extends approximately 114 km from north to south and 64 km from east to west and has a total geographical area of 7,096 sq km. Rivers and mountains define the boundaries of Sikkim.

Table 1. Profile of the State <sup>1</sup>	
Feature	Description
Area	7096 sq.km
Location	Situated between the latitude of 27°04' North to 28°07' East and the longitude of 88°01' East to 88°55' East on the Tibetan Plateau.
Borders/ Neighboring Countries	North: China South: West Bengal East: China and Bhutan West: Nepal
Major Rivers	Teesta River and Rangit River
Forest Covers	584 (Area in hectares) (82.31 percent of the total geographical area of the State)
Population	610,577 (Census 2011)
Districts	6 Districts (Gangtok, Mangan, Namchi, Pakyong, Gyalshing, Soreng)
Sub-divisions	16
Sex Ratio	890 females per 1,000 males (Census 2011)
Population Density	86 persons per sq.km (Census 2011)
Population share	0.05% (Census 2011)
Climate	i. Cold Weather Season (December-February) ii. Spring Season (March-May) iii. South West Monsoon (June-September) iv. Period of Retreating Monsoon (October-November)

1 Sikkim General Profile:

Reference: [www.census2011.co.in/census/state/sikkim.html](http://www.census2011.co.in/census/state/sikkim.html), [www.sikkimtourism.gov.in/Webforms/General/SikkimAtAGlance/Climate.aspx](http://www.sikkimtourism.gov.in/Webforms/General/SikkimAtAGlance/Climate.aspx)

## **2.2. Disaster Profile**

State of Sikkim due to its physiographic and climatic condition is one of the most disaster-prone areas of the country. With the natural factors, various human induced activities like increasing demographic pressure, deteriorating environmental conditions, deforestation, unscientific development, faulty agricultural practices and grazing, unplanned urbanization, construction of large dams on river channels etc. are also responsible for accelerated impact and increase in frequency of disasters in the country.

### **Earthquake**

The State falls within the seismic Zone IV of Seismic Vulnerability Atlas of India and is prone to frequent earthquakes. The major earthquakes felt by the State are the ones of 1986 of 5.3 magnitude, 14<sup>th</sup> Feb 2006 of 5.3 magnitude and the most recent one of 18<sup>th</sup> September 2011 of 6.8 magnitude. Widespread human and materials losses, destruction and damages of infrastructures and services are the major consequence of the earthquakes.

### **Landslides (mud slide and snow avalanche)**

The state of Sikkim is susceptible to landslides owing to geological characteristics, tectonic activity, slope instability, weak composition of the soil or rocks. Some of the factors causing slope instability are rain, flooding, seismic events, removal of vegetation, construction activities, etc. Scientific observations in North Sikkim clearly recall that there is an average of 2 landslides one sq.km. This means the rate of land loss is to the tune of 120m/km/year and annual soil loss is about 2500 tons/sq.km. The unprecedented rain triggers frequent landslides which causes severe damage to the vital road networks, essential public properties and other agricultural crops.

Snow avalanches are common in three districts of the state; Mangan, Gangtok, Gyalshing Districts. The avalanches are reported of killing army personnel and damaging roads and causing serious damages of roads and settlements falling in its way. The recent most devastating one is the snow slide of 4<sup>th</sup> April 2023 at 17th mile on Jawaharlal Nehru Road connecting Gangtok to Nathu-La pass which took nine lives including those of five foreign nationals.

### **Fire**

The South-Western part of the State is prone to forest fire triggered by dry winter spells. Domestic fire occurrences are also on the rise due to human induced errors. Fire can also be the secondary effect of a disaster like an earthquake. Secondary fires after a disaster like earthquakes constitute a substantial and heavy risk. Damage to natural gas systems during an earthquake can lead to major fires and explosions. Damages to electrical systems during a disaster can ignite major fires. Varying risk scenarios need different approaches and intervention.

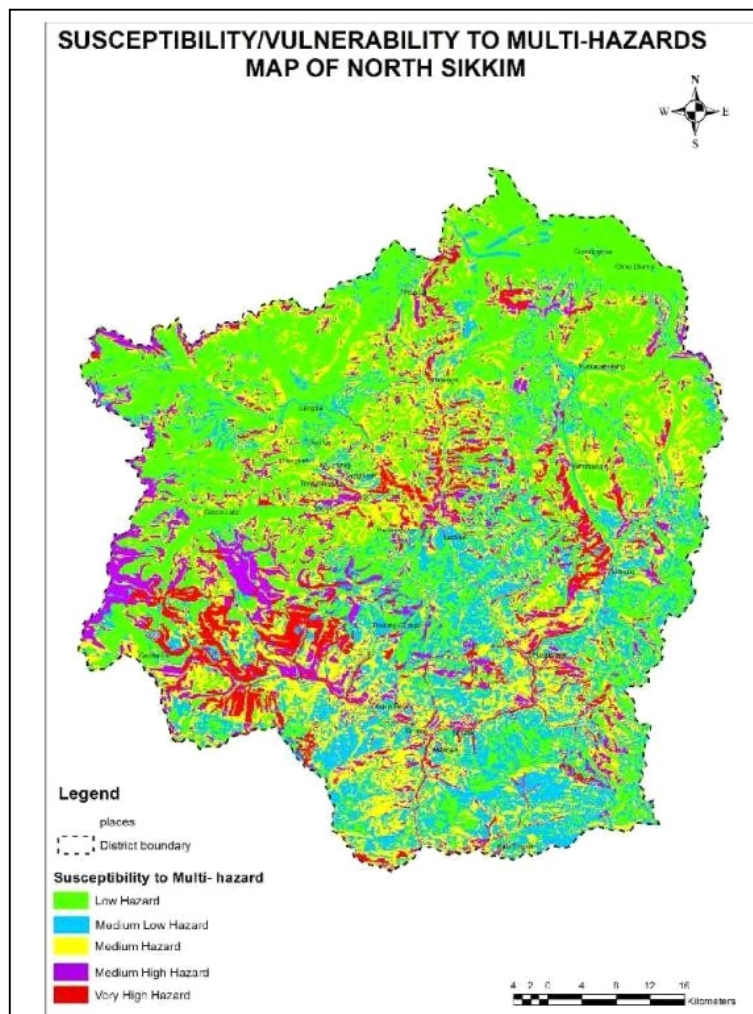
The forest fire incidence is on rise in areas under Gyalshing, Gangtok, and Namchi districts of the State. The steady increase of forest fire is largely attributed to the impending effect of environmental degradation and climate change, resulting in a long hall of dry spell in the months starting from October till March.

### **Wind and Storm**

The State of Sikkim generally witnesses cyclone induced windstorms originating from North Bay of Bengal with their impact comparatively high and devastating. The wind storm occurs in the months of April and May. Whereas cold windstorms are prevalent in higher ridges of Mangan and Gangtok Districts originating due to formation of pressure belts in Tibetan Plateau region. Wind storms have been destroying the Rabi crops.

### Thunderstorm and Lightning

Thunderstorms and lightning occur round the year in different parts of the State. However, their frequency and intensity are maximum in the spring (March to June) season.



### Hailstorm

Sikkim is among the states in the country with the highest frequency of hail. The hailstorms are mainly observed in the winter and pre-monsoon seasons with virtually no events after the onset of the southwest monsoon. At times, it causes considerable crop damage though the spell lasts a few minutes. Hail is often associated with thunderstorm activity and changing weather fronts. As a thunderstorm moves along, it deposits its hail in a long narrow band (often several kilometers wide and about 10 kilometers long) known as a hail-streak or hail-swath. If the storm remains almost stationary for some time, substantial accumulation of hail is possible. Its size and shape depend on how fast the storm is moving and how strong the updrafts are inside the storm.

### Cloudburst and Flash Flood

The higher reaches of the state have a catchment area which is susceptible to high precipitation resulting in cloud burst which in turn causes flash flood along the river basin causing damages to life, livestock and properties. During the monsoon season cloudburst resulting in flash floods are frequent occurrences in all districts of the State. The state receives rainfall starting from May till late October. Cloudbursts are prevalent through the state that triggers widespread flash floods causing loss of human lives and severe damage to public utilities and other cultivable crops.



### **Glacial Lake Outburst Flood (GLOF)**

The Sikkim Himalayan Region (HR) is facing important challenges in view of coping with the adverse effects of climate change. Physically, the shrinking of mountain glaciers and expansion of Glacial Lakes are amongst the most recognizable and dynamic impacts of climate warming in this environment. In combination with this altered stability of surrounding rock and ice walls, the potential threat from Glacial Lake Outburst Flood (GLOF) is evolving over time. For the month of October, 2023, a total of 902 Glacial Lakes and Water Bodies have been monitored. It includes 477 Glacial Lakes & Water Bodies, with water spread area greater than 50 ha, which are being monitored since 2011. All Glacial Lakes with size of 10 ha and above as per NRSC inventory, 2009 have been monitored.

### **Human Induced Hazards:**

With the establishment of industries in the State, hydel power projects, pharmaceutical companies and other related industries along the river basins the state is vulnerable to human-induced hazards also such as:

- Chemical and Industrial Disasters,
- Nuclear and Radiological Emergencies (NRE),
- Biological and Public Health Emergencies (BPHE)

## **2.3. Disaster Event**

### **Description:**

The Sikkim State Council of Science and Technology an autonomous organization of Science and Technology Department, Government of Sikkim in collaboration with Space Applications Centre (SAC), ISRO has published a 'Glacier Atlas of Sikkim' way back in the year 1998. In the later years, the State Council also prepared the 'Land use Landcover Map of Sikkim', 'Wetland Map of Sikkim' with the support of SAC. It is through such engagements; the growth of glacial lakes came in notice of the state government. The growth of glacial lakes and associated risks was found to have accelerated from 1990s. So, it was established that the major reason behind such growth was due to the fast melting of the glaciers on account of ongoing climate change.

South Lhonak Lake located in extreme North Western part of Sikkim was one of the fastest growing glacial lakes in Sikkim Himalayas as the parent glacier is melting rapidly. In addition, the melt water from Lhonak Lake and North Lhonak glacier is also draining the South Lhonak Lake. The first field visit to the South Lhonak Lake by the State Council was carried out in April 2012 to ascertain the status of the outlet of the lake under a collaborative project with CDAC, Pune. In 2013, a request was made by DST, Sikkim to Department of Science and Technology, Government of India to help and support for the study and mitigation of glacial threat in South Lhonak Lake. In response to the request, a Working Group was constituted by DST, Government of India under the chairmanship of the then Director SASE to suggest the mitigation measures in South Lhonak Lake. The other members of the Working Group consisted of glaciologists working in different organization of India.

The Working Group suggested for both short term and long-term mitigation measures in the meeting held in Gangtok. Based on the suggestions of the Working Group, the State Council with the support of DST, GoI, carried out the bathymetry survey in order to estimate the volume of the lake and electrical resistivity survey of the moraine dam to understand the subsurface features of moraine damming the lake in the year 2014. With the outcome of the survey report, the Working Group further suggested to carry out the siphoning of the lake and installation of early warning sensor. In 2016, 3 number of pipelines installed in the lake to siphon the water of the lake with the technical support of SECMOL, Ladakh and the logistic support of Land Revenue and Disaster Management Department, Government of Sikkim. The siphoning helped to release about 150 liters of water per seconds, in

addition to the natural discharge from the outlet. An experimental real time water level sensor developed by CDAC, Pune was also installed in the lake. However, the system was damaged after 6 months of installation probably by the floating ice masses generated through calving by the glacier's snout.

Controlled widening of the outlet was one of the mitigation measures suggested by the working group. In 2018, a multi departmental team headed by Special Secretary, Land Revenue and Disaster Management Department from state government visited the lake.

### **Possible triggers**

The failure of the side wall of the lake towards the North Western side of the lake produced massive calving of ice blocks from the snout of the South Lhonak Glacier measuring about 600 m x 50 m. Both processes generated extensive waves in the lake that eventually produced massive floods downstream on 4<sup>th</sup> October 2023. This massive wave in the lake with huge volume of water eroded the outlet making it much wider and deeper. This event results in draining of huge volume of water from the lake to the downstream areas. The side wall which plunged down to the lake is the part of the end or dead moraine of the two glaciers, the North Lhonak and the Lhonak glacier located in the area. The end moraines were once supported by the South Lhonak Glacier, however with the melting of the glacial ice, the moraines base was exposed to the lake water and most probably it disturbed the stability of the moraine and it plunged down to the lake. (Source: Department of Science & Technology, Govt of Sikkim) The State Government is in the process of forming an Expert Committee:

- To look into the cause of the disaster that struck the state on 4<sup>th</sup> October, 2023
- To suggest suitable mitigation measures for future events

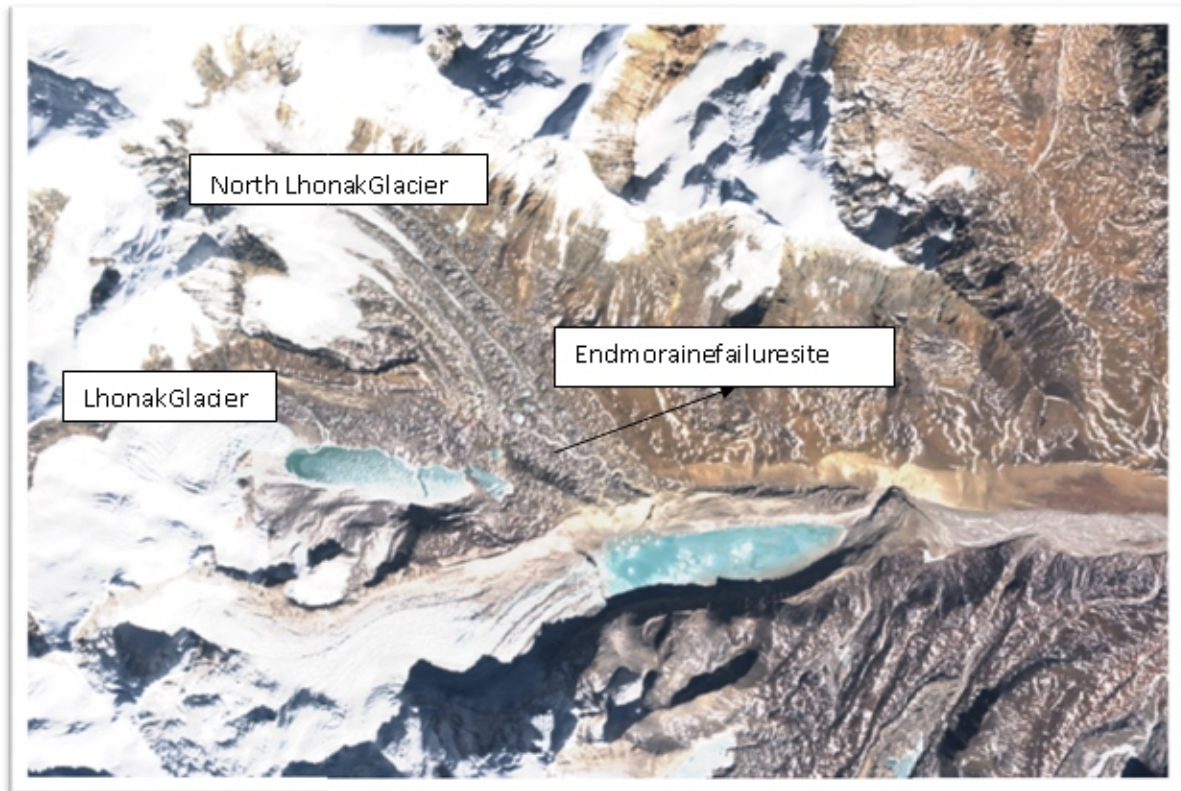


Figure 1. Sentinel image 25 December 2023

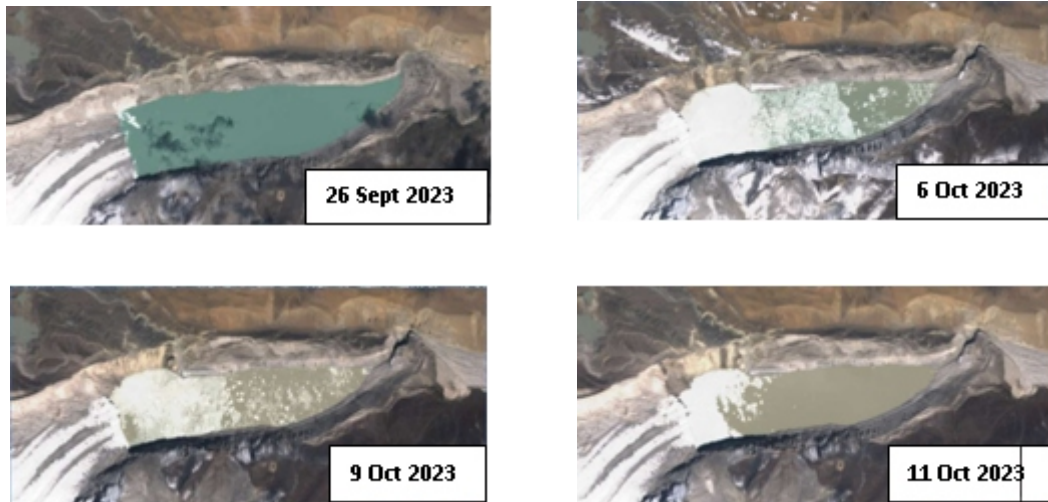


Figure 2. The pre- and post-flood satellite images interpretation of the South Lhonak Lake

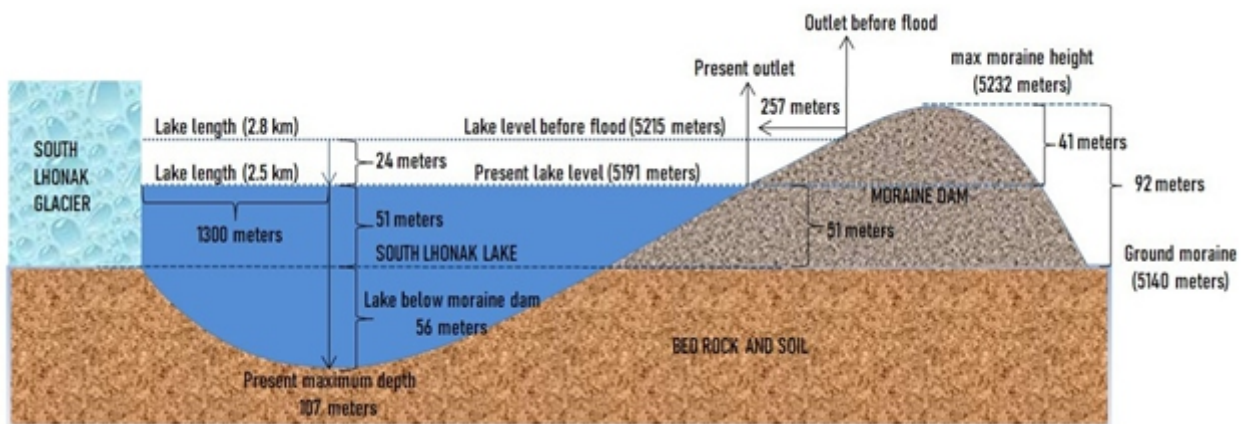


Figure 3. Schematic representation of Pre and post flood conditions of South Lhonak Lake. Figures are based on field survey (pre flood) as well as Remote Sensing image interpretation (Image source: Remote Sensing Division, DST- Sikkim)

**Table 2. Timeline of the Events**

Date	Events
03.10.2023	<ul style="list-style-type: none"> <li>• District authorities were informed &amp; siren along with public announcements were made to alert residents at downstream areas along the Teesta Basin</li> <li>• First Incident Report was sent from State EOC thereafter hourly reports were sent to MHA, NDMA etc.</li> <li>• Immediate evacuation of residents from vulnerable areas to higher ground was ordered</li> <li>• State Police, SDRF, NDRF, Forest Guards &amp; QRTs with community volunteers activated for search &amp; rescue operations</li> <li>• Dam authorities were directed to give timely updates of water discharge</li> </ul>
04.10.2023	<ul style="list-style-type: none"> <li>• Reports of loss of lives and public property along with major bridges and vital installations along the Teesta Basin being washed away was received</li> <li>• HCM, Council of Ministers, CS, DGP &amp; other senior officers along with elected representatives visited the affected areas under Pakyong, Namchi &amp; Gangtok Districts in the morning hours.</li> <li>• State Executive Committee, SSDMA under the chairmanship of CS declared the event as a Disaster.</li> <li>• Time to time situational report of Disaster event was sent to MHA</li> <li>• Relief Camps were set-up at 30 locations accommodating about 7000 evacuees</li> <li>• District Hospital Emergency units were activated</li> <li>• State Incident Response System (IRS) was activated, Incident Command Post (ICP) was established at Teesta lounge, Tashiling Secretariat and Emergency Operations Centre of Sikkim State Disaster Management Authority (SSDMA)</li> <li>• District IRS was simultaneously activated, following ICPs was established: a) Pakyong ICP – Rangpo tourist Lodge, b) Gangtok ICP – Singtam Police Station, c) Mangan ICP – Chungthang Police Station</li> <li>• Relief Camps were set up at 30 locations in the affected areas of the state</li> </ul>
5.10.2023	<ul style="list-style-type: none"> <li>• Tourists were evacuated from affected districts</li> <li>• Relief materials were dispatched to affected districts</li> <li>• Electricity and communications were restored</li> </ul>
6.10.2023	<ul style="list-style-type: none"> <li>• National Crisis Management Committee chaired by Cabinet Secretary met on 5.10.2023 &amp; 9.10.2023</li> </ul>
7.10.2023	<ul style="list-style-type: none"> <li>• Director General, BRO visited the affected areas on</li> <li>• Union Minister of State for Home Affairs visited the affected areas on 7.10.2023</li> </ul>
8.10.2023 & 9.10.2023	<ul style="list-style-type: none"> <li>• Inter-Ministerial Central Team visited the affected areas on 8.10.2023 &amp; 9.10.2023</li> <li>• Chief of Army Staff visited the affected areas on 9.10.2023</li> </ul>
18.10.2023	<ul style="list-style-type: none"> <li>• NDMA team led by Member Secretary visited the affected areas on 18.10.2023</li> <li>• Union Power Minister chaired a meeting on 18.10.2023</li> </ul>



## 2.4. District Wise Impact of the Disaster

Table 3. District wise impact of disaster <sup>2</sup>							
District	Villages Affected	Family displaced	People Died	People displaced	No of damaged houses	No of relief camps opened	No of people missing
Mangan	50	588	4	2350	568	7	23
Pakyong	7	419	10+7	1677	635	10	27
Gangtok	19	477	16+15 (Indian Army)	1910	319	5	20
Namchi	24	272	3	1088	482	8	4
<b>Sikkim</b>	<b>100</b>	<b>1756</b>	<b>55</b>	<b>7025</b>	<b>2004</b>	<b>30</b>	<b>74</b>

## 2.5. Response of the State Government and District Administration

### Search & Rescue - Mangan District

- ITBP posted at Pegong along with Sikkim Fire & Emergency services commenced evacuation & rescue on 4.10.2023.
- Team of Sikkim Police led by DIG/Range/North & East was the first to reach Chungthang by foot on 5.10.2023.
- SDRF reached Chungthang by foot on 6.10.2023.
- One team of NDRF reached Chungthang by foot on 7.10.2023 and started operations. Another team of NDRF reached Mangan on 8.10.2023 and proceeded to Chungthang on 9.10.2023 while the third team of NDRF was airlifted on 9.10.2023 and started operation.
- Heptars were deployed for Air Evacuation of stranded tourists, workers & locals from 9.10.2023
- Teams led by District Authorities including Sikkim Police, Sikkim Fire & Emergency Services, NDRF, SDRF, ITBP, Army, Forest Guards, QRTs and local volunteers-initiated search & rescue operations from the morning hours of 4.10.2023.
- District control room numbers were widely disseminated on 4.10.23.
- District Hospital emergency units were activated on the morning hours of 4.10.2023
- Electricity and communications were restored on 5.10.2023.

### Relief Measures

- Setting of 30 Relief Camps for 7025 affected people: Gangtok District: 10 Relief Camps for 1910 inmates, Pakyong District: 5 Relief Camps for 1677 inmates, Namchi District: 8 Relief Camps for 1088 inmates, Mangan District: 7 Relief Camps for 2350 inmates.
- Ex-Gratia to next of kin of deceased and injured disbursed.
- Relief with Essential Commodities disbursed to affected people. Distribution of clean water to affected areas.

<sup>2</sup>[www.census2011.co.in/census/state/sikkim.html](http://www.census2011.co.in/census/state/sikkim.html), [www.sikkimtourism.gov.in/Webforms/General/SikkimAtAGlance/Climate.aspx](http://www.sikkimtourism.gov.in/Webforms/General/SikkimAtAGlance/Climate.aspx)

- Transportation to daily wage earners and tourists arranged.
- Psychosocial care and counselling provided to trauma victims
- Construction of gender segregated washrooms set up at affected areas
- De-fogging, sanitization & cleaning drives of affected areas frequently done

#### **Immediate recovery & restoration measures towards rehabilitation**

- Re-issuance of lost documents and school uniform with textbooks initiated.
- Debris clearance at affected areas initiated.
- Construction of traditional log bridges completed. Construction of Bailey Bridge over Sangkhalang, Chungthang & Zema completed by BRO.
- Controlled detonation of ammunition by Army initiated.
- Communications re-established at key locations with TSPs and VSATs.
- Electricity, Water Supply restored at affected locations.
- Vital road linkages re-established.

#### **Emergency Cabinet announcement by Government of Sikkim**

- Sikkim Punarwas Awas Yojana in which 2100 new houses are to be constructed.
- Sikkim Janta Housing Colony in which 2000 houses are to be constructed for tenants. Relief camp inmates will be granted at Rs. 5000/month for three months.
- Affected students to be provided a one-time grant of Rs. 10000 for purchase of books & uniforms.
- To constitute a Technical Committee consisting of experts to look into the cause of the recent disaster and mitigation measures thereof.
- Loan moratorium for affected business owners.

**Government of Sikkim's initiatives on GLOF Management:** Sikkim State Disaster Management Authority with the District Disaster Management Authorities and other stakeholders has conducted:

- Awareness and sensitisation programmes at all vulnerable downstream locations: Chungthang, Phidang, Mangan, Dikchu, Singtam, Rangpo & Melli
- Basic Search, Rescue and First Aid Training was imparted to volunteers
- Participatory Rural Appraisal to map the hazards and associated risks was completed
- Evacuation maps were prepared and shared with all key stakeholders
- State Level Mock exercise on earthquake triggered GLOF was conducted on May, 2023
- Chungthang Sub-Division Office with SUL conducted Mock Drill on GLOF on 18.09.2023

## **2.6. Recovery Vision**

The recovery vision for Sikkim Flash Floods 2023 envisions a holistic and resilient transformation focusing on:

- a. Integrated communication for risk informed practices: Foster collaboration and communication between government agencies, NGOs, private sector and local communities, pooling resources and expertise for a coordinated and sustainable recovery effort
- b. Mainstreaming Disaster Risk Reduction in Development Planning: Review and update existing policies related to disaster management, land use and environmental protection, adapt to changing conditions and enhance resilience against future disasters.
- c. Community Centered Reconstruction
- d. Technology Integration for Early Warning: Enhance and expand early warning systems through the integration of cutting- edge technologies, providing timely alerts and ensuring effective preparedness for future disasters

This recovery vision aims not only to rebuild Sikkim but to create a more resilient and sustainable future, fostering a sense of community empowerment and environmental stewardship.

## 2.7. Specific Recovery Objectives

- **Infrastructure Rehabilitation:** Prioritize the reconstruction of damaged roads, bridges, and buildings to restore connectivity and essential services for affected communities
- **Community Resettlement and Housing:** Develop a plan for the safe and sustainable resettlement of displaced families, ensuring access to adequate housing and basic amenities
- **Livelihood Restoration:** Implement programs to revive local economies, supporting farmers, businesses etc. affected by the flash floods
- **Healthcare Strengthening:** Enhance healthcare facilities and services in the region, addressing immediate health needs and building resilience against potential disease outbreaks.
- **Education Recovery:** Rebuild damaged schools and educational institutions, providing resources for students and teachers to resume learning activities
- **Environmental Rehabilitation:** Undertake initiatives for watershed management, soil conservation and afforestation to reduce the risk of future flash floods and enhance environmental sustainability
- **Community Empowerment and Training:** Conduct training programs to educate communities on disaster preparedness, early warning systems, and response strategies, empowering them to handle future emergencies effectively
- **Technology Integration:** Integrate advanced technologies for early warning systems, monitoring and data analysis to improve disaster preparedness and response capabilities
- **Government Policy Review:** Evaluate existing policies related to land use, construction and environmental protection to enhance resilience and mitigate future disaster risks in Sikkim.

## 2.8. Recovery Principles

- **Community - Centric Approach:** Prioritize the active involvement and empowerment of local communities in decision making processes to ensure that recovery efforts align with their needs and priorities
- **Sustainability and Resilience:** Embed principles of sustainability in recovery projects, focusing on eco - friendly infrastructure, resilient urban planning, and long-term environmental conservation
- **Inclusive Recovery:** Ensure that vulnerable groups, such as women, children and elderly, are specifically addressed in recovery plans, with targeted support to meet their unique needs
- **Partnership and Collaboration:** Foster collaboration between government agencies, NGOs, private sector and international organizations to pool resources, expertise and ensure a coordinated and effective recovery effort
- **Transparency and Accountability:** Maintain transparency in resource allocation, project implementation, and decision-making processes, and establish mechanisms for accountability to build trust among stakeholders
- **Innovative Technology Integration:** Embrace innovative technologies for efficient data collection, early warning systems, and information dissemination to enhance preparedness and response capabilities
- **Cultural Sensitivity:** Respect and integrate local cultural practices, belief and traditions into recovery efforts recognizing their importance in fostering community cohesion and resilience
- **Adaptive Planning:** Develop flexible and adaptive recovery plans that can evolve based on changing circumstances and emerging challenges

- **Capacity Building:** Invest in training and skill development programs for local communities, local officials and responders to enhance their capacity to cope with and respond to future disasters
- **Risk Reduction and Preparedness:** Integrate risk reduction measures into recovery plans, emphasizing early warning systems, land use planning and infrastructure design that mitigate the impact of future flash floods.

## 2.9. Sectoral Specific Findings on Damages, Losses and Recovery Need

<i>Sector</i>	<i>Sub-Sector</i>	Damages	Losses	Damage + Losses	Recovery and Reconstruction	Recovery & Reconstruction Needs (%)
Social	Housing	560.73	30.52	591.25	670.3	30.57%
	Health	1.15	3.783	4.933	9.11	0.42%
	Education	27.94	1.843	29.783	30.68	1.40%
	Community Buildings	4.92	0	4.92	9.13	0.42%
<b>Social Total</b>		<b>594.74</b>	<b>36.146</b>	<b>630.886</b>	<b>719.22</b>	<b>32.81%</b>
Productive	Tourism	0	241.53	241.53	241.53	11.02%
	Animal Husbandry, Livestock and Fisheries	23.38	11.38	34.76	39.51	1.80%
	Agriculture and Horticulture	26.47	53.97	80.44	31.22	1.42%
<b>Productive Total</b>		<b>49.85</b>	<b>306.88</b>	<b>356.73</b>	<b>312.26</b>	<b>14.24%</b>
Infrastructure	Roads and Transport	163.52	41.87	205.4	395.38	18.03%
	Drinking Water and Sanitation	37.9	3.49	41.39	45.21	2.06%
<b>Infrastructure Total</b>		<b>201.42</b>	<b>45.36</b>	<b>246.79</b>	<b>440.59</b>	<b>20.09%</b>
Crosscutting	Forest and Environment	202.69	42.97	245.66	245.77	11.21%
	Disaster Risk Reduction	0	0	0	474.5	21.65%
<b>Crosscutting Total</b>		<b>202.69</b>	<b>42.97</b>	<b>245.66</b>	<b>720.52</b>	<b>32.86%</b>
<b>Grand Total</b>		<b>1048.7</b>	<b>431.37</b>	<b>1480.066</b>	<b>2192.59</b>	<b>100.00%</b>

## 3. Social Sector

### 3.1. Housing

#### Basic Profile of the Sector

Sikkim's population was 6.1 lakh (Census, 2011) with a total 1,51,772 houses. About 66% of the houses were of CGI/metal/Asbestos sheet followed by 26% RCC roofs. About 42% of the houses were with brick/concrete block walls, 58% of the walls were either kutcha or of vernacular materials and 24% of the houses had mud flooring. The present projected population of the state is about 6.9 lakh (2023) and Sikkim has a significant number of migrant workers from the neighbouring states who come to Sikkim for livelihood. A significant percentage of both the Sikkimese and people from other states live in rented premises which are 5-6 storied RCC framed structure buildings owned by the local people.

Sikkim has its rich vernacular architecture which was evolved over time in a holistic manner and acts as the cultural continuity and identity of the people. Unfortunately, lack of awareness and knowledge on the technical aspects of this architecture has pushed it on the verge of extinction. The engineering and architecture colleges do not teach this type of architecture. While these houses have the required seismic resilience, such technologies should be revitalized based on the latest building safety codes and reintroduced in the government buildings to encourage people to adopt these. Recovery would be a good opportunity for adopting these technologies.

#### Sectoral Policies

In 2010, "Chief Minister's Rural Housing Mission" (CMRHM) was launched under the State Plan with the target of converting the existing 6,000 kutcha dwellings to single storey, earthquake resistant pucca houses and become the first kutcha house free state in the country. Sikkim had attained its target of rural housing under the Pradhan Mantri Awas Yojana Grameen and Urban programmes in 2017. The state has an ongoing programme; Sikkim Garib Awas Yojana that provides pucca houses to the families who cannot afford one. The divisional engineer of RDD, Sikkim reported that the target of the scheme is to construct 10,000 houses. Sikkim Housing and Development Board is currently constructing 38 houses for the people. Apart from these schemes, there are contractors, promoters and local engineers who have been constructing houses for the economically well-off people primarily in the urban areas. A significant number of HHs live in rented houses. Recently the GoS has launched Janta Housing Colony scheme for constructing a Housing Colony for those who do not have their own homes. For the affected persons to live in the Janta Housing Colony, they will not have to pay any rent to the government for the next three years.

#### Damages in the Sector

It may be noted that 79% of the damaged housing stock due to the flash flood was well built RCC structures. While the major cause of damage was the exceptional water load on them due to their close proximity to the river (*clear violation of safety norm*), it must also be noted that the flash flood in October was unprecedented; never experienced before in Sikkim; not even exist in the Sikkimese folklore. During the field visits it was observed that majority of the buildings by the roadside were of RCC framed structures. Many of them were 5 or more storied with CGI sheet or metal track deck as the top floor roof. There were load bearing brick masonry and hybrid buildings as well. Most of the RC framed buildings in some places were found to be in good condition even after facing the huge water load during the flash flood. Only the ground and first floor were affected by the flash flood.



One of the prime causes of the devastation was; buildings located close to the river bed or at less than 6m above the river water level. Most of the RCC framed structures were 4-5 storied. This was followed by load bearing stone/brick wall structure (10%) and timber framed structure (12%). The water level was exceptionally higher than one would expect, and no one had even seen before such height and current of water in the river. Many buildings on the slope facing the river simply got washed away or badly damaged. Scouring of soil and buildings on steep slope were also the causes of building damage. Some of the kutcha houses, which were built on the riverbed (IBM) got washed away. Non-compliance with safety norm caused a massive destruction. Building Bye laws are not mandatory in most of the places visited, which is a major cause of the disaster. Building permit is required only in the TCP area. People reported that obtaining a building permit is complex and time consuming.

A huge quantity of debris is the major issue that made the process of getting back to the normal life slow and expensive. The septic tanks have been damaged. However, the major issue is that they are now buried under debris brought by the flash flood and removal is both time consuming and expensive. The following Tables show the damage pattern across the four districts of Sikkim.

<b>Table 5. Housing: Damage to Housing Sector</b>					
<i>Sub-Sector</i>	<i>Items</i>	<b>1_Totally Damaged</b>	<b>2_Severly Damaged</b>	<b>3_Partially Damaged</b>	<b>Grand Total</b>
Housing	A. Pucca Houses	128	303	858	1289
	B. Semi-Pucca	77	26	48	151
	c. Hut/ Kuccha	138	35	23	196
	C. Cattle Sheds	168	0	103	271
		<b>511</b>	<b>364</b>	<b>1032</b>	<b>1907</b>
		<b>511</b>	<b>364</b>	<b>1032</b>	<b>1907</b>

<b>Table 6. Housing: Existing floor areas of pucca, semi-pucca and kutcha buildings</b>					
	<b>Total Built-up Area (sqm)</b>	<b>Av. Built-up area/house (sqm)</b>	<b>Average number of stories</b>	<b>Av area/floor (sqm)</b>	<b>Total Number of Buildings</b>
Pucca	570215	442.370	3.365	131.48	1289
Semipucca	32317	214.020	1.397	153.16	151
Hut/Kutcha	20326	103.704	1.194	86.86	196
<b>Total</b>	<b>622858</b>				<b>1636</b>

## Damage cost

The cost of housing damage is calculated based on the current replacement cost of a building by its structure-type, e.g., pucca, semi-pucca and kutcha, since their unit construction costs are different. The classification of damage categories is done based on the required repair/retrofitting cost of a building of a particular structure type to get back to its pre-disaster condition. This is expressed as a percentage of the current replacement cost of a building. For example, 30% damage means that the building requires a repair that would cost 30% of its current replacement cost. The damage categories adopted in Sikkim are: a) damage <30%, b) damage >30%<50%, c) damage >50%<70% and d) damage >70% or destroyed. The damage category "b" and "c" have been clubbed together as >30%-<70% making three categories of damages which would make classification, implementation, and fund allocation easy in recovery.

During field visits, the unit cost of construction was obtained from different sources. For example, the local masons at IBM, Bardang and Singtam informed that a load bearing wall structure with RCC roof would cost Rs 29,052/sqm and that of a RCC framed structure around Rs. 32,280 per sqm. The same in Mangan would be Rs 39,500/ sqm. In consultation with the engineers of Sikkim Housing and Development Board, Department of Education and Rural Development Department, the cost of a finished new building with resilient features, internal electrical wiring and toilet was decided to be Rs 37,660 per square meter. This was accepted by the chief engineer, Sikkim, Housing and Development Board. This cost is in line with the GoS's building specifications and market rate. Since many of the existing buildings did have resilient features which was about 20% of the reconstruction cost, the unit cost of damage was considered as  $37660 \times 0.8 =$  Rs 30,128/sqm, agreed upon by the government engineers. *The unit cost of reconstruction is excluding taxes, land development and land-cost.* Based on the field experience and considering the difficult hilly terrain of Sikkim, 15 percent of the building damage cost (excluding water and sanitation) was added for plot land damage.

Covered area considered for damage cost is "like for like" for the pucca, semi-pucca and kutcha buildings which have been totally destroyed or >70% damage (area pucca-442.37 sqm, semi-pucca- 214.02 sqm, kutcha-103.7 sqm). In the partially damaged 4-5 storied RCC buildings, only the ground and first floor have been affected without structural damages in the upper floors. Hence, the cost of two floors have been considered for the pucca 4-5 storeyed buildings ( $131.477 \times 2 = 262.95$  sqm), while like for like area has been considered for the partially damaged semi-pucca and kutcha buildings since they are on an average 1.397 and 1.194 storied (area pucca-262.95sqm, semi- pucca- 214.02 sqm, kutcha-103.7 sqm).

The assistant engineer of RDD, GoS informed that a septic tank for a single housing unit with 2 bedrooms, kitchen and toilet would cost Rs 59,400 and drinking water system (1000 lit OH tank + pipelines) would cost Rs 15,000 per housing unit (all market rates). For the reconstruction of cattle-shed, Rs 1 lakh per unit was accepted in consultation with the district level engineers during the field visits. The unit construction costs of Kutcha and Semi-Pucca houses were assumed to be 50% and 75% of current replacement cost of pucca buildings, which was agreed by the government engineers.

For the septic tank and drinking water facilities within the plot of a HH, the basis of damage assessment is as follows; a) reconstruction cost of a totally damaged septic tank Rs. 0.594 lakh/HH, b) repair/retrofitting cost partially damaged septic tank is 50% of the current replacement cost Rs. 0.297 lakh/HH, c) reconstruction cost of a totally damaged overhead water tank with pipelines Rs. 0.15 lakh/HH, d) for partially damaged water tank with pipelines Rs. 0.075 lakh/HH. The Table 3-2 and Table 3-3 show the cost related data in the domain of damage cost estimation. Table 3.4 shows the overall and district-wise damage cost in the housing and settlements sector caused by the GLOF in October 2023 in Sikkim.

<b>Table 7. Housing: Basic unit costs, areas and number of floods or pucca. Semi-Pucca and kuccha buildings</b>			
Area	Pucca	Semi Pucca	Kutchha
Factor with Respect to The Total Unit Cost	1	0.75	0.5
Damage Cost Rs/Sqm	30128.00	22596	15064
Average number of floor- existing	<b>3.365 floors</b>	<b>1.397 floors</b>	<b>1.194 floors</b>
Average number of floor -part damage & retrofitting	<b>2.000 floors</b>	<b>1.397 floors</b>	<b>1.194 floors</b>
Average floor area/floor	131.477 sqm	153.161 sqm	86.863 sqm
Total actual built up area	442.370 sqm	214.020 sqm	103.704 sqm

<b>Table 8. Housing: Partially damage building cost: Built-up area by housing type, Covered Area – "like for like"</b>								
Pucca House, Area - Like for Like			Semi pucca, Area Like for Like			Hut/Kutchha		
Unit cost Rs/sqm	Tot BUA (sqm)/ house	Tot Cost Lakh	Unit cost Rs/sqm	Total BUA (sqm)	Cost/house	Unit cost Rs/sqm	Total BUA (sqm)	Cost/ house
30128.00	262.95**	Rs. 7922268	22596	214.02	Rs. 4835993	15064	103.70	Rs. 1562198

**Note:** \*\*Area of a totally destroyed/>70% for pucca buildings is 442.37sqm (Rs133.68 lakh). For partially damaged pucca building, considering two floors only is 131.477x 2 stories= 262.95sqm (Rs 79.222 lakh)

**Table 9. Housing: Damage Cost Estimates**

	<b>DAMAGE: AREA LIKE FOR LIKE</b>	<b>Nos</b>	<b>Unit Cost- INR</b>	<b>Amount (Crore INR)</b>	<b>Sub Total</b>
1	<b>&gt;70% + &gt;30%&lt;70% damaged Hut/Kutcha houses</b> -103.7sqm	173 Nos	1,562,198	27.03 Cr INR	
2	Semi-pucca <b>houses as Pucca</b> - > 70% damage or totally destroyed 214.02 sqm	77 Nos	Rs. 4835993	37.24 Cr INR	
3	<b>Pucca houses</b> > 70% damage or totally destroyed 442.37	128 Nos	13,327,725	170.59 Cr INR	
4	Reconstruction of <b>Cattle sheds</b>	168 Nos	100,000	1.68 Cr INR	
					<b>236.54 Cr. INR</b>
5	<b>Medium to minor repair and retrofitting-Kutcha</b> <30% damage 103.7sqm	23 Nos	234330	0.54 Cr INR	
6	<b>Major repair and retrofitting-semi-Pucca house</b> >30%<70% damage- Covered Area 214.02 sqm	26 Nos	2,417,996	6.29 Cr INR	
7	<b>Medium to minor repair and retrofitting-semi-Pucca house</b> <30% damage- Covered Area 214.02 sqm	48 Nos	725,399	3.48 Cr INR	
8	<b>Major repair and retrofitting-pucca</b> >30%<70% damage 262.95	303 Nos	3,961,134	120.02 Cr INR	
9	<b>Medium to minor repair and retrofitting-Pucca</b> <30% damage- 262.95 sqm	858 Nos	1,188,340	101.96 Cr INR	
10	<b>Major repair and retrofitting-Cattle shed</b> <50%	103 Nos	50,000	0.52 Cr INR	
11	15% of cost is for plot-land damage			70.40 Cr INR	<b>303.21 Cr. INR</b>
12	Retaining wall at plot level to protect the house	293 Nos	Costing included in other sector		

13	Land lost due to flood/land slide	343 Nos	State to include the land cost		
14	Destroyed/severely damaged Septic Tank	1387 Nos	59,400	8.24 Cr INR	
15	Damaged Septic Tank	2840 Nos	29,700	8.43 Cr INR	
16	Damaged drinking water system	2282 Nos	7,500	1.71 Cr INR	
17	Destroyed/severely damaged drinking water tank+pipes	1736 Nos	15,000	2.60 Cr INR	<b>20.99 Cr. INR</b>
	<b>Total Damage cost</b>			<b>560.73 Cr INR</b>	<b>560.73 Cr. INR</b>



## **Disaster Risk Reduction (DRR)**

Sustainable housing must be risk informed. The main objective of DRR in housing is to ensure that the reconstruction and retrofitting under recovery are resilient against multi-hazards. Based on the field visit, it may be said that the reasons for building failure in Sikkim due to the recent flash flood were:

- absence of risk-informed land-use planning with respect to the intensity of hazard-risk,
- lack of risk-based planning of settlement/housing colonies,
- in some places did not adopt disaster-safety features in design and construction,
- inadequate skill of construction workers.
- gaps in existing building bye laws and TCP act. Lack of development control along river
- inadequate enforcement of regulations and inadequate institutional mechanism for holding the HHs accountable in case of non-compliance with safety norms.

Based on the findings of the causes of building failure, it may be said that there is a need for policy revision for mainstreaming DRR through Build Back Better. Interactions with the different departments related to housing and settlement revealed that there is a need for enhanced capacity (technical and human resources) to support resilient housing construction. During the field visit, interaction with the homeowners revealed that people were interested to get their houses approved by the authority, provided that the building permit system is simple and easy to get.

Build Back Better is an integral part of DRR. The objective of BBB in a post-disaster situation is to view the housing recovery as a scope for increasing resilience of the communities. It could be done by integrating DRR measures into the rehabilitation, reconstruction, retrofitting of the damaged houses. The recovery strongly suggests adoption of appropriate design, material, skill and technologies that revitalizes livelihoods, economies and the environment. Community wisdom is a good resource for DRR. One important dimension of DRR is to carry out community-assisted vulnerability assessment and identify the possible risks and what could be the remedial measures based on people's past experience and scientific knowledge.

Under DRR, there is a need for short, medium and long-term recovery interventions to ensure BBB. Local-specific DRR interventions would be necessary, e.g., a) earthen embankment between Teesta and settlement at IBM, b) riverbank protection wall at the confluence of Teesta and Ranikhola rivers at Golitar, c) building permit and house insurance, d) risk-informed land use map, e) riverbank protection measures at vulnerable locations. There is a strong need to help people to access insurance system to protect personal property and belongings. Premiums should be affordable to people, especially for the poor and vulnerable HHs.

### **Economic Losses in the Sector**

Loss refers to the change in economic flow at HH, district and state level due to a disaster causing many people to live below the pre-disaster standard of living. The present disaster has temporarily disrupted the pre-disaster supply chain of goods and services in the domain of housing and the HHs. The change in economic flow due to a disaster is difficult to assess due to a lack of validated data at HH level, which varies widely. The district level officials and the affected HHs provided data on loss due to higher rent they were paying and impaired income due to damaged shops. The following change in flow has been observed during the field visit in the Housing Sector caused by the GLOF- related flash flood.

- **Rental Loss:** A large number of HHs now live in new rental premises and pay an average of Rs 5,500-6,000 per month (Rs 2,500 extra) since their original rented houses are filled with debris/damaged/destroyed. There are 1116 HHs (tenants) who have been badly affected by the flash flood and suffered financial loss on many accounts, e.g., shifting to a new place, higher rent, high cost of living in the post disaster situation, and other losses that could not be monetized. These HHs would require about 12 months to get back to their normal lives. Under such circumstances, it may be proposed that all the 1116 HHs be given financial assistance as follows; a) 12 months' extra rent of Rs 2500/month, b) onetime transportation cost of Rs 5000/HH, c) deduct Rs 20,000/HH which the state government has already paid to the affected HHs. Therefore, the estimated compensation would be at the rate of Rs 15,000/HH, i.e., a total amount of **Rs.1.674 Cr.**
- **Loss of income and employment:** Some of the HHs had grocery shops at ground level. On an average the HHs used to earn Rs. 1000 per day from the shops. Their shops have been damaged due to the flood water resulting in a loss of about Rs. 30,000 per month. It would take them about six months to resume their business. According to SSDMA, 922 shops have been affected by the present disaster and hence, the total loss on this account would be  $922 \text{ nos.} \times \text{Rs.} 30,000 \times 6 \text{ months} = \text{Rs.} 16.596 \text{ crore}$ . Most of the damaged houses have suffered a loss of about a week's work with a loss of Rs 750 per day, which amounted to Rs 5250 x 2 HH members = Rs 10,500/HH. However, considering the government's support in terms of food and other facilities after the disaster, this need not be considered in loss calculation.
- **Temporary Shelters:** In the four flash-flood-affected districts, 343 plots with houses have been washed away or in vulnerable conditions which were very close to the riverbed. Therefore, there is a dire need for temporary shelters for such affected HHs. It is very import to set up temporary shelters with services at the earliest considering the extreme winter and women's privacy. Based on interactions with the local masons and carpenters, an average of Rs 2.6 lakh (2 lakh+0.6 lakh) has been assumed as the cost per unit of shelter with services (30%). Since 4493 HHs were living in 1636 buildings, there would be a need for  $4493/1636 \times 343$  plots, i.e., 942 accommodations as temporary shelter. Consultation with the affected people and the district level officials revealed that the actual need for temporary shelter would be about 50% of 942 HHs, i.e., 471 units. Therefore, the cost of temporary shelter would be  $471 \text{ HHs} \times \text{Rs.} 2.6 \text{ lakh} = \text{Rs.} 12.25 \text{ crore}$ . While this is a loss, for convenience of funding, this amount has been included in recovery.
- **Debris:** A massive quantity of debris has been brought by the river during the October 2023 flash flood. It is very important to calculate the quantum of debris and make arrangements for the management of the sand which could be an opportunity for livelihood generation and other meaningful use in the recovery process. Local unskilled people including the house owners can contribute to the debris management. While selecting, adapting and developing technologies for reconstruction, it would be prudent to maximize the use of sand, which would reduce debris disposal cost and the other negative environmental impacts. The overall management cost and cost of hiring experts and equipment should also be accounted for in costing of debris clearance. Additional debris would be created if the river dredging is adopted.
- While GoS is clearing debris in the common areas of settlements, the clearance of sand and mud within the house is the owners' responsibility. The cost of debris clearance was acquired from the affected settlements, e.g., IBM. The average cost of debris from a 111.524sqm covered area and 2.4m sand-mud height the cost was Rs 60,000. The cost of the same for a 185.874sqm was Rs 1,50,000. The average cost of debris removal from inside of a house to just outside was Rs  $(224.166+336.248)/2 = \text{Rs.} 280.21/\text{cum}$ .

The local contractors informed that the same cost (Rs 280.21/cum) would be applicable for acquiring the debris from the collapsed buildings to a place next to the plot. There was no data on the unit cost of disposal of debris from the housing colonies to a safe place in Sikkim. Consultation with the local contractors and the government engineers revealed that the debris removal from the source to a safe place (15-20 kms distance) could also be considered as Rs.280.21/cum. Assuming that 30% of the debris from the buildings could be recycled in reconstruction, the approximate cost of debris removal from the housing sector would be Rs 21.91 crore. Table 3-5 shows the cost breakdown.

Table 10. Quantities and cost of debris management								
	Debris from inside Partially damaged building.				Debris created by totally collapsed (>70%) buildings			
	Built-up area sqm	Debris height (meter)	Number of bldgs.	Volume in cum	Built-up area sqm	Debris height (meter)	Number of bldgs.	Volume in cum
Pucca	131.47	2.40	1161	366328.01	442.37	1.75	128	99090.9
Semi-pucca	153.16	2.40	74	27201.22	214.01	1.75	77	28837.8
Kutcha	86.86	2.40	58	12090.91	103.70	1.75	138	25043.6
				405620.13				
		Internal debris volume		cum		Collapsed buildings' debris volume		152972.27 cum
Total volume of debris after deducting 30% for recycling								391014.68 cum
Assuming collapsed buildings' debris removal cost same as that of the partially damaged buildings' debris clearance and assuming the total debris removal and transportation cost to a safe place is 2x Rs. 280.208/cum = Rs 560.42/cum						Rs. 560.42 /cum	Total cost of debris removal	Rs.21.91 Crore

The total loss due to the present disaster is Rs.16.596 Cr (income)+ Rs.1.674 Rs. +12.25 Cr (temporary shelters) = Rs.30.52Cr. However, the income loss of Rs. 16.596 Cr. due to the damaged shops and rental loss of the tenant HHs Rs. 1.674r = Rs. 18.27Cr.has been accounted for as loss and Rs. 12.25 Cr. (temporary shelter) considered under recovery for the convenience of implementation.

#### Socio-Economic Impact on People.

**Micro and Macroeconomic Impacts:** After the present disaster, additional expenditure on temporary shelter, cost of demolition and removal of debris, etc. would be over and above the government's regular budget for housing. This data would be used for the analysis of macroeconomic impact on fiscal budget. There is a need for calculating the higher cost of transportation spent by HHs or its members during their temporary occupation of shelter camps or alternative housing arrangements (micro-level). This has been accounted for in this report. Loss of home-based entrepreneurship for livelihood has been accounted for in this report.

**Human Development Impacts:** The three basic aspects of human development are; health (life expectancy), knowledge (years of schooling) and standard of living (per capita income). All three are closely linked with housing. In many of the affected places, the home was a source of livelihood. It has been noticed and reported by the temporarily displaced HHs that they are constrained to live in sub-standard living conditions compared to the pre-disaster situation.

About 1116 HHs, i.e. 5019 people are living in sub-standard living conditions. During field visits it was noticed that the worst affected were the women, children and the elderly people. The local doctor at IBM reported that the trauma of the present disaster is still fresh in the affected people and a good number of them have been reported to be in shock and suffering from sleeplessness and hypertension. Children's education was disrupted for a few days. While schooling has been restored, the environment at home is not conducive for study. The PDNA proposes a financial support of Rs 1.674 Cr to the 1116 HHs (affected tenants) and a policy review in this regard for future events. It is to be noted that the rental accommodations are predominantly private owned, which is a support to the government and the society. While the private owners of the damaged and destroyed houses would receive money for reconstruction/repair/retrofitting, the tenants will suffer the most since the former are economically well off while the latter is not. Hence, a special immediate focused action is suggested for the 1116 HHs. The 922 affected shops would require a financial support of Rs. 16.596 crore for loss of livelihood for six months. However, it is the GoS who would decide how much compensation could be given to the affected Hhs.

### **Reconstruction and Recovery Needs Assessment**

**Recovery Needs:** A total of 1636 houses with services and 271 cattle sheds were affected by the present disaster. Out of that, 343 destroyed/damaged structures, and 168 cattle sheds need reconstruction. A total of 1293 houses need repair/ retrofitting. It is important to note that the partially damaged houses must be retrofitted in line with BBB principles in order to enhance their resilience against not just flash flood, but also other hazards such as earthquake (zone IV), high wind, landslide etc. In the four districts, 343 plots have been lost.

### **Reconstruction Cost Estimates**

As mentioned before, in consultation with the engineers of the Sikkim Housing and Development Board, RDD and the department of education, the reconstruction cost of a finished pucca buildings with internal wiring and toilet was decided to be Rs 37,660/sqm inclusive of BBB features, which is the market rate and as per the specifications of the GoS. The unit cost of reconstruction is based on the assumption that the reconstructed buildings would either be RCC framed structure or confined masonry, the latter being more sustainable. Any other resilient structural system with low carbon footprint should be encouraged in reconstruction. However, such systems must have structural validation.

The destroyed semi-pucca buildings would be reconstructed as pucca based on the MHUPA, 2012 suggested area and unit cost of Rs.37,660/sqm. While the same amount of money will be allocated to them if they choose to reconstruct the destroyed house as traditional Sikkimese architecture, the GoS may provide some sort of incentives to encourage such HHs. All kutcha and semi-pucca houses would be reconstructed as pucca. For cattle shed, Rs 1 lakh per unit is adopted based on the discussion with the district level engineers. Reconstruction costs per unit of septic tank and drinking water supply (1000 litre water tank with pipelines) have been considered as Rs 59,400 and Rs 15,000 respectively. The septic tank, toilet and drinking water system within the plot of a house have been included in housing and the rest of such services beyond the plot boundary are under WASH.

As with the damage cost, "like for like" (same as the existing area) has been adopted in repair and retrofitting of the damaged houses under recovery. However, the unit cost of repair and retrofitting (Rs.37,660/sqm) is higher than the damage cost (Rs.30128/sqm) since the former includes BBB features. In consultation with the SSDMA, it was decided that the MHUPA, 2012 guidelines will be followed in reconstruction; a) average covered area of a pucca house has been calculated as 58.08 sqm and b) semi-pucca is 46 sqm which are comparable with the state norms of Sikkim for housing. The existing rental housing also has similar covered area per HH. Since private rental housing is a profit-making business to many people, increased covered would attract more rent, i.e., more than Rs.3000-4000/month, making

them economically non-viable for the tenants whose income is generally less than Rs.20,000/month. The destroyed >70% and damage category >30%-<70% kutch houses would be reconstructed as pucca as per the PMAY-G standard of 25 sqm per HH. The unit cost of reconstruction, repair and retrofitting has been adopted in recovery as follows:

<b>Table 11. Reconstruction: Unit Cost, Area per unit and Built-Up area</b>								
<b>Pucca House, Area as/MHUPA, 2012</b>			<b>Semi-pucca reconstructed as Pucca, Area as/MHUPA, 2012</b>			<b>Hut/Kutch reconstruct as pucca</b>		
Unit cost Rs/sqm	Area (sqm)	Cost/ house	Unit cost Rs/sqm	Area (sqm)	Cost/house			Cost/hut
37660.0	390.801	Rs. 14717567	37660.00	64.28	Rs. 2420715	37660.00	29.85	Rs. 1124036

**Note:** Pucca 58.08sqmx 3.365 floors x 2flats/floor, Semi-pucca 46 sqmx1.397 floors, Kutcha 25sqmx1.194 floors (existing pattern),

<b>Table 12. Repair and retrofitting: Unit-cost, area, number of HH's per floods and number of stories</b>								
<b>Pucca House area Like for like</b>			<b>Semi-pucca house area like for like</b>			<b>Hut/Kutch</b>		
Unit cost Rs/sqm	Area (sqm)	Cost/ house	Unit cost Rs/sqm	Area (sqm)	Cost/ house	Unit cost Rs/sqm	Unit Area	Cost/ hut
37660.00	262.95	Rs. 9902835	28245.00	214.02	Rs. 604499 1	18830	103.7 0	Rs. 195274 8
	Pucca sqm			Semi-pucca sqm			Kutcha sqm	
Average no of floors	2 floors damaged due to flood			1.397			1.194	
Average floor area/floor	131.477			153.16			86.86	
Total built up area	262.954			214.02			103.70	

**Note:** Built-up area – like for like



For individual houses, it has been assumed that the people would expand their homes incrementally in course of time. The following are the basis of calculating the reconstruction, repair and retrofitting costs under the housing recovery programme in Sikkim.

### **Assumption/Basis of cost of reconstruction and repair/ retrofitting**

The principles adopted for undertaking reconstruction, repair and retrofitting have been outlined below.

- Reconstruct the destroyed and >30%-<70% damage category kutcha houses as pucca. The total built-up area considered as per PMAY-G standard of 25 sqm per HH x 1.194 stories- 29.85 sqm and unit cost of construction 29.85x Rs. 37,660/sqm= 11.24 lakh/building.
- Reconstruct the semi-pucca buildings as pucca which were destroyed or fall under the damage category > 70%. Total built-up area as per MHUPA, 2012 standard- 46 sqm/ HH x 1.397 stories x Rs 37,666/sqm = Rs. 24.21 lakh/ building.
- Reconstruct the pucca buildings as pucca which were destroyed or fall under the damage category > 70%. Total built-up area as per MHUPA, 2012 standard- 58.08 sqm x 3.365 stories x 2 flats/ floor Rs 37,666/sqm = Rs. 147.228 lakh/ building.
- Reconstruct the destroyed cattle sheds @ Rs 1 lakh/unit.
- Repair and retrofit the <30 damage kutcha houses in line with BBB principles -in-situ. The costs considered are 15% (30%/2) of their respective current replacement cost. Cost= 86.86 sqm x 1.194 stories x Rs 18830/ sqm. = Rs19.53 lakh/ building x 0.15=Rs.2.93 lakh.
- Repair and retrofit the severely damaged (>30% and <70% damage category), semi-pucca buildings in line with BBB principles -in-situ. Cost= 153.161sqm x 1.397 stories x Rs 28245/ sqm. = Rs60.45 lakh/ building x 0.5= Rs. 30.225 lakh.
- Repair and retrofit the <30% damaged semi-pucca buildings in line with BBB principles -in- situ. Cost= 153.161sqm x 1.397 stories x Rs 28245/ sqm. = Rs60.45 lakh/ building x 0.15= Rs. 9.07 lakh.
- Repair and retrofit the severely damaged (>30% and <70% damage category), pucca buildings in line with BBB principles -in-situ. The costs considered are 50% ((30%+70%)/2) of their respective current replacement cost. Considering the ground and first floor damaged due to flood, area=131.477x2 floor x Rs 37660/ sqm. = Rs99.03 lakh/ buildingx0.5= Rs. 49.52 lakh.
- Repair and retrofit the <30% damaged, pucca buildings in line with BBB principles -in-situ. The ground and first floor damaged due to flood, area=131.477x2 floor x Rs 37660/ sqm. = Rs99.03 lakh/ buildingx0.15= Rs. 14.85 lakh.
- All the above costs are inclusive of internal water supply, sanitation and electrical wiring and excluding septic tank and overhead water tank.
- For the septic tank and drinking water facilities within the plot of a HH, the basis of reconstruction is as follows; a) reconstruction cost of a totally damaged septic tank Rs. 0.594 lakh/HH, b) repair/retrofitting cost partially damaged septic tank is 50% of the current replacement cost Rs 0.297 lakh/HH, c) reconstruction cost of a totally damaged overhead water tank with pipelines Rs. 0.15 lakh/HH, d) for partially damaged water tank with pipelines Rs. 0.075 lakh/HH.
- 15% of the cost of reconstruction, repair and retrofitting has been added to the recovery as plot-land development considering the hilly terrain of Sikkim and based on field visit experience.

**Special note:** A detailed structural investigation needs to be carried out to adopt appropriate retrofit strategies by a competent agency for each house to be repaired/retrofitted.

### Recovery Cost Estimates

Apart from reconstruction, repair and retrofitting interventions, the housing recovery needs the following for high quality, sustainability and resilience of the housing and settlement sector.

**Relocation cost:** Site and infrastructure: There are 343 plots which have been completely destroyed and washed away by the flash flood water and they need relocation. While interacting with such HHs during the field visits, people informed that they were willing to relocate to a nearby safe place not far away from their place of livelihood. The district and state level officials informed that they were already expediting feasible safe sites for relocation. Mangan has identified relocation sites for 151 HHs at Chungthang ward, Bhoghari (Rhelpatam) reserve forest and Surum/ Bhotaychok in reserve forest under Toong block. Relocation cost should be calculated based on the; a) value of the relocation land, b) infrastructure cost, internal access road, water, sanitation, power, telecommunications and related basic services, c) cost of settlement planning, d) cost of transporting HH goods to new location: furniture and equipment etc.; e) cost of new dwellings. In absence of information on specific site, it is not possible to calculate the cost of relocation in the present context. However, based on the recent PDNA report of a Joshimath, which is similar to the hilly terrain of Sikkim, it may be said that about Rs 2 crore will be required to develop a small place for 25 HHs in Sikkim including services and infrastructure within the boundary but excluding land and building cost. The estimated cost includes internal roads, boundary wall, all services, retaining walls, etc. Therefore, the *cost of relocation for 343 plots will be approximately Rs 27.44 Crore.*

**Temporary Shelter:** Due to the flash flood, 343 plots have been washed away and the occupants are presently living in poor conditions. About 942 HHs lived in the 343 plots out of which 50% would need temporary shelters (471HHs). Winter has already arrived in Sikkim and hence, there is a strong need for temporary shelters which should be thermally comfortable and close to the place of the affected peoples' livelihood. Prefabricated porta cabin type of temporary shelters would be a feasible option. However, mobilizing prefabricated porta cabin type temporary houses would require some time and its acceptance to the affected people appeared to be an issue. Hence, an owner- driven approach could be adopted to build the temporary shelters based on local vernacular architecture of Ikra and bamboo truss construction. The district level officials and the affected people found this to be a viable option. However, it would require a well-coordinated construction management system by organizing materials and techno-managerial support to the affected people to build the temporary shelters. Based on interactions with the local masons, it appears that a small house (25 sqm) with one large room and a veranda, also used as a kitchen could be constructed within two lakhs with locally available material. An additional 30% would be required for the services and hence, Rs 2.6 lakh/HH could be a viable option for temporary shelter. Therefore, as a general strategy, Rs 2.6 lakh per family could be given to 471 HHs to setup their temporary shelters and hence, total amount for this intervention **would be Rs. 12.25 Crore.**

**Cost for Capacity Building of Human Resources:** There is a strong need for awareness and capacity building of the affected people, masons, carpenters, the engineers, and architects. Based on field visit, the causes behind building damage could be attributed to; a) lack of awareness of people on flash flood, earthquake, and landslide safety and, b) local masons' lack of knowledge on how to build safely on slope. Hence, an immediate intervention is required to enhance capacity of the local masons. Table 3-9 shows the expenditure of costing of capacity building for resilient housing including *training on traditional construction.*

**Entrepreneurship:** The construction industry of Sikkim is primarily dependent on Siliguri, West Bengal. There would be a sudden rise in demand for building materials due to the reconstruction. To deal with the situation, one of the feasible options would be the development of local level entrepreneurship for producing building materials using local resources, cost-effective, labour intensive and environment-friendly methods. Small units run by SHGs would be a feasible option for Sikkim. It would require small machineries and skill training. Pre-cast seismic bands, pre-cast door/ window frames, etc. would be sustainable options in the context of Sikkim. This will lead to income generation of the local people. Such centres should be like a one-stop shop where items such as door/window hinge, handles, water saving taps, etc. would be available. Table 3-9 shows the expenditure in this regard.

**HFC:** The disaster-affected people in the four districts of Sikkim would need technical support at their doorsteps to ensure that the houses are resilient, which could be done through Housing Facilitation Centres (HFC). The HFCs would be with minimum staff strength of three engineers/architects supported by three technical assistants to help house owners, masons, and carpenters. The facilitators' main job would be to prepare drawings, estimates for all the reconstruction activities, be it new construction or repair and retrofitting. HFC will work under the district level officials with the help of the local engineering college teachers and private practicing architects and engineers who have worked in the field of BBB. This would result in a significant number of green and resilient buildings in Sikkim. Local NGOs could be appointed on a timebound contract to setup and run the HFCs. Table 3-9 shows the expenditure detail of establishing and running of HFC for 18 months. It also shows the cost of recovery requirements for the four districts of Sikkim.

<b>Table13. Housing and settlement recovery cost, cost of damage and loss</b>					
	<b>RECOVERY COST</b>	<b>Nos</b>	<b>Cost/ Unit- INR</b>	<b>Amount (Crore INR)</b>	<b>Sub Total</b>
<b>RECONSTRUCTION</b>	<b>Reconstruction of damaged (&gt;70%+&gt;30%&lt;70%) Hut/Kutcha houses as pucca - area 25sqm x1.194 str= 29.85 sqm</b>	173 Nos	Rs. 1124036	19.45 Cr. INR	
	<b>Reconstruction of Semi-pucca houses as Pucca- &gt; 70% damage or totally destroyed-Covered Area @ 46 sqm x1HH/floor 1.397 stories= 64.28</b>	77 Nos	Rs. 2420715	18.64 Cr. INR	
	<b>Reconstruction of Pucca houses &gt; 70% damage or totally destroyed-Covered Area @58.08 sqm x2 HHs/floor x 3.365 stories= 390.9sqm</b>	128 Nos	Rs. 1471756 7	188.38 Cr. INR	
	<b>Reconstruction of destroyed/severely damaged cattle-sheds</b>	168 Nos	Rs. 100000	1.68 Cr. INR	
					<b>228.15 Cr. INR</b>

<b>REPAIR+RETROFITTING</b>	<b>Medium to minor repair and retrofitting-Kutchha</b> <30% damage- 103.7sqm stories/building	23 Nos	Rs. 292912	0.67 Cr. INR	
	<b>Major repair and retrofitting semi-Pucca house</b> >30%<70% damage 214.02 sqm/ building	26 Nos	Rs. 3022496	7.86 Cr. INR	
	<b>Medium to minor repair and retrofitting semi-Pucca house</b> <30% damage 214.02sqm/ building	48 Nos	Rs. 906749	4.35 Cr. INR	
	<b>Major repair and retrofitting-pucca</b> >30%<70% damage 262.95sqm/ building	303 Nos	Rs. 4951417	150.03 Cr. INR	
	<b>Medium to minor repair and retrofitting-Pucca</b> <30% damage 262.95sqm/ building	858 Nos	Rs. 1485425	127.45 Cr. INR	
	<b>Major repair and retrofitting-Cattle-shed</b> <50%	103 Nos	Rs. 50000	0.52 Cr. INR	
	15% of retrofitting cost is for plot-land preparation			77.85 Cr. INR	
					<b>368.73 Cr. INR</b>
<b>SPECIAL ITEMS</b>	Temporary Shelters + 30% for infrastructure (without land cost). For People in camps/ with friends/relatives	471 Nos	Rs. 260000	12.25 Cr INR	
	Relocation of HHs of 343 washed away plots @ Rs 2 Crore/ 25 plot (without land cost)- cost of campus + infrastructure	343 Nos		27.44 Cr INR	
	Retaining wall at plot level to protect the house	293 Nos	Costing included in other sector		
	Cost of land	343 Nos	State to include the land cost		
					<b>39.69 Cr. INR</b>
<b>WASH</b>	<b>Reconstruction Septic Tank-</b> destroyed + 30%-70% damage HH basis	1387 Nos	Rs. 59400	8.24 Cr INR	
	Retrofitting of Septic Tank HH basis	2840 Nos	Rs. 29700	8.43 Cr INR	
	Repair of damaged drinking water - pipelines HH basis	2282 Nos	Rs. 7500	1.71 Cr INR	
	<b>Medium to minor repair and retrofitting semi-Pucca house</b> <30% damage 214.02sqm/ building	1736 Nos	Rs. 15000	2.60 Cr INR	
					<b>20.99 Cr. INR</b>

	Ensuring BBB elements in reconstruction, repair and retrofitting, a) Masons and carpenters' top-up training 5 days + b) multi-skill workers for retrofitting + c) Engineers training - Food + lodging - training x 40+40+40 candidates x INR 35,000/ candidate +35% management cost, toolkit gadgets etc including IEC	4 Nos	Rs. 5670000	2.27 Cr INR	
	Small entrepreneurship units of precast RC posts and DW frames, CSEB, etc.@ INR 50 lakh/ unit including leased land	4 Nos	Rs. 5000000	2.00 Cr INR	
	Industry partnership: Production yards 4 @ INR 75 lakhs/unit, industry will pay for this as they will have business profit	4 Nos	Rs. 7500000	3.00 Cr INR	
	<b>Expenditure of the Housing Facilitation Centre</b>				<b>7.27 Cr. INR</b>
<b>DEVELOPMENTAL COST</b>	Run by 3 architects/ engineers @ (Rs. 50,000 salary + Rs 7000 for transport, communications)/head x 18 months x 8 locations - 2 per district x4	8Nos	Rs. 3078000	2.46Cr INR	
	3 Technical assistants @ (Rs. 30,000 salaries + Rs 7000 for transport, communications)/head x 18 months x 8 locations	8 Nos	Rs. 1998000	1.60 Cr INR	
	Rs. 4 Lakh capital cost/ HFC	8 Nos	Rs. 400000	0.32 Cr INR	
	Communication: Awareness campaign, Workshops, peer review, evaluation, etc and overhead 25% of HFC			1.10Cr INR	<b>5.48 Cr. INR</b>
	<b>TOTAL COST OF RECOVERY</b>			<b>670.30 Cr INR</b>	<b>670.30Cr. INR</b>



## Impact of Recovery

Reconstruction, repair and retrofitting of 1636 houses, 271 cattle sheds and other interventions will have an impact on the people, environment, and other aspects of human living in the four districts in the next 36 months. While the recovery could be an opportunity for creating high quality and resilient housing and settlements in Sikkim, it could also be a threat to the environment if not planned prudently. The following is a brief discussion on the impacts of the recovery interventions on building materials, livelihood, environment, gender and DRR. The main objective is to make use of recovery to maximize environmental and social benefits towards resilient future Sikkim. Recovery has been viewed to have positive impact on the women, marginalised and other disadvantaged groups.

- Impact of recovery on building materials and skills: The damage caused by the flash flood has resulted in a huge demand for materials required to reconstruct, repair and retrofit the houses in limited time. Unless the reconstruction and repair/ retrofitting are well planned, the management of supplying construction materials in the post disaster scenario would turn out to be a major challenge. Reconstruction of 343 destroyed buildings and repair and retrofitting of 1293 damaged buildings would require about 2 crore bricks and proportionate quantities of cement, steel, sand and aggregates. Since the reconstruction period is 18-24 months, there is a need for preparing procurement plans for each sub-division at the earliest to enable reconstruction work to start. Since most of the construction materials are brought from Siliguri, it is important to look for alternatives such as stones from debris and use of sand for block making, otherwise the recovery would lead to price hike and compromise with material quality.
- Impact of recovery on Livelihood and Employment: While flash flood has been a disaster in Sikkim, its recovery opens a window for creating a variety of livelihood opportunities for the local people. The recovery will generate a good number of working days for skilled masons and unskilled workers as well. Acquiring sand from the debris will create significant employment and this will reduce the use of energy intensive materials such as bricks and cement, etc. If labour intensive technologies are adopted in reconstruction based on local materials, there will be a significant increase in employment opportunities and skill building on exit of recovery. About Rs.168 crore would be the labour component of the recovery; creating an employment opportunity for 8.4 lakh working days for the construction workers. *There are ample opportunities for the women to get skilled and earn money from the recovery.*
- Impact of recovery on the Environment: While the housing recovery is a good opportunity for creating resilient housing alongside creating local level employment, the use of brick, cement and steel would have negative impact on the environment in terms of huge emission of CO<sub>2</sub>, depletion of natural resources for production and transportation of the materials. It is very important that the recovery focuses on the use of green design and appropriate technologies which are climate change resilient and mitigate the negative impact on the environment. Use of local materials, upgraded vernacular construction techniques and confined masonry would have less negative impact on environment. Sikkim can promote sustainable green development through the recovery, e.g., bamboo-based technologies in single storied houses since the state has abundance of structural bamboos which could be treated for durability.
- Gender and PWD: According to the damage assessment data, out of the 357 women headed HHs, 99 are widows. During the field visits, a number of women-headed families were found to be in poor condition. The impact of the disaster on such HHs have been disproportionately high and hence they should be prioritized in the recovery framework. In Sikkim, 2.98% of the population have different types of disabilities<sup>3</sup>. All these groups will need enhanced technical and financial assistance from the government for rebuilding their houses. Formation of women's SHG to support the reconstruction by quality control supervision will be a tool to empower women and give them an opportunity to have alternative skills for livelihood.

## Sector recovery policy and strategy

The housing recovery must be people-centric and environmentally compatible, and should be through a consultative process involving local people and other stakeholders including geologists, ecologist, developmental experts, engineers, and technologist etc. Such plans may be subjected to review for their impact on people's livelihood, natural resources, environment, and social aspirations of development, besides opening window of economic development. Risk mitigation strategies must be integrated into the whole recovery process with "Build Back Better" strategy and resilience to risk of disasters. The housing recovery in Sikkim will require a team of dedicated workers working on a mission mode since the line department staffs are already overloaded with the existing housing and other projects and programmes.

**Role of line Departments:** All the government construction departments need to co-ordinate with each other for the procurement of materials and masons for the reconstruction work. However, they need to strengthen their capacity in DRR by undergoing training. For monitoring and control, adequate number of staffs should be deputed with clear job description. Considering this situation, eight Housing Facilitation Centres (HFC) may be established in the four affected districts. The HFCs would assist local house owners in developing designs, sourcing materials, and in ensuring quality control. The RDD, Housing and Development Board, state PWD, MSME, ULB/municipality, town and country planning department, district collectors need to form a planning and implementation team with clear job-descriptions.

**Design Assistance:** Recovery should be people centric. People's aspiration for their dream home should be the focus of the reconstruction. This would be done by conducting participatory design exercise involving the affected people. House design and detailing would have the flexibility for expansion to suit individual needs and grow incrementally.

**Materials, technologies, and costs:** Use of treated bamboo may be encouraged in reconstruction of small houses. There are 30 species of bamboo under 8 genera in Sikkim. Alternative to clay bricks such as cement stabilized compressed earth block may be introduced since there is abundance of sand as debris. This would reduce construction cost with less carbon footprint.

## Key recommendations

The housing recovery programme of Sikkim would require a robust institutional mechanism to drive the recovery process effectively and bring equity and transparency in interventions. It is important for the SSDMA to plan for the recovery based on good practices in India and across the world. To support the recovery of the GLOF-related disaster in Sikkim and to bring its people back to normalcy by promoting multi-hazard resilience, the following key recommendations have been put forward.

### Policy:

- The government of Sikkim needs to pass a law for regulating the development on both sides of the Teesta and other glacier-fed rivers in Sikkim.
- The state Housing Policy may be reviewed in the light of the present disaster where a large number of tenants with children, PWD and elderly people were displaced to temporary accommodations compromising safety, health and comfort of living. Device a sustainable and humanitarian system of post-disaster support to the migratory population of Sikkim.

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<sup>3</sup> [https://ceobihar.nic.in/PDF/Disabled\\_persons\\_in\\_India\\_2016.pdf](https://ceobihar.nic.in/PDF/Disabled_persons_in_India_2016.pdf)

- Review the existing policy of sand mining and come up with a sustainable solution for utilizing the huge quantum of debris.
- Policy on river management- how to deal with the reduced river depth and course change and riverbank protection at appropriate locations. Consider dredging of the debris deposit in Teesta in consultation with the geologist and other river-related specialists.
- Recognize community as a resource in the context of disaster-resilience and involve local people through participatory vulnerability mapping at community level, which could be done in a decentralized manner in short time with less expenditure forming a major input to the specialists' map making.
- In IBM, 148 houses have been washed away and the people are currently living in relief camps or in rented houses consisting of one room with a toilet and without cooking space. Many of them are from other states. These HHs did not have landownership. Since they have been living in their current place for decades, the GoS may consider rental housing for them in a safe place not too far from their place of livelihood.

### **Strategy:**

- There are 15 glacial lakes in Sikkim which are vulnerable. Carryout risk assessment of the full lengths of the glacial lake-fed rivers along their courses in the state and prepare flood risk map showing water width and height during rainy season and the probabilistic flash flood 51 situations. Show the safe distance for building construction from the river edge and height from HFL.
- Prepare a risk-informed land-use map for the state of Sikkim based on flash flood and land slide. The whole state is in zone IV of seismicity. Prepare micro-zonation map of earthquake, flash flood for a few vulnerable locations.
- Amend the existing TCP act and building bye laws, e.g., Sikkim building construction regulations 1991, based on the risk-informed land-use map. There is a need for declaring no- construction zone based on geological and hydrological considerations in Sikkim.
- Review the existing building bye laws and update it from multi-hazard point of view.
- Strengthen enforcement mechanisms for ensuring compliance with building byelaws with adequate staff and capacity-building of regulatory staff members of the municipalities/ULBs. Enforcement of building bye laws should be supplemented with periodic awareness- campaign on multi-hazard safety for the people.
- Develop a mechanism for structural health audit of the existing stock of buildings.
- Adopt 'Build back Better' in reconstruction, repair/ retrofitting and Integrate Disaster-Risk Reduction and Environment Safety Considerations in development plan. Prepare a resilient house construction guidebook for the masons, carpenter, and the people.
- 78% of the damaged/destroyed houses were 5 to 6 storied RCC framed structures and located close to the riverbed. There is a strong need for strict developmental control.
- While relocation should be the last option in post disaster housing recovery, some settlements would need relocation and hence, there is a need for temporary shelters with services. Relocation must be community driven. Select safe sites for relocation, certified by geologists. *Review the existing land use acts to find out land for relocation.*
- There are many 4 to 5 storied buildings with about 1 to 3 tenants per floor. While the ground floor and sometimes the first floors are filled with debris, the buildings have not suffered any major structural damage. They may be just cleaned and painted with minor repair to make them fit for living. However, the threat of similar future situation still exists. This requires place by place solution with appropriate site specific DRR measures and some of them could be as follows.

- The IBM housing area is close to the confluence of Rangpo and Teesta having its ground level at least 6m or more from the top of river water. The river next to the site has changed its course after the 4<sup>th</sup> of October by drifting about 300m towards the habitation. The pucca buildings did not suffer structural damage in IBM. So far, the debris clearance is almost done. Many have started repairing their houses. If a natural bund or retaining wall is built which would be about 1.5 km along the riverbank, the colony may remain in place. However, such solution has to be reviewed by a team of experts.
- In Golitar, the situation is similar to that of IBM. It is at the confluence of Teesta and Ranikhola river. There also the buildings did not suffer significant structural damage. The ground and sometimes the first floor have been filled with debris and most of the house owners, with the help of the GoS have cleared the debris. Here the ground floor may be used as a store or for other meaningful purposes and human living should be from first floor and above. No sanitation or drinking water supply system would be permitted at GF. There is a need for innovation in the water supply and sanitation system and instead of individual septic tanks STP could be considered.
- The debris consist of sand mixed with silt and clay. The shake test at Bardang revealed that the silt+clay content of the sand is about 14% and the rest is medium coarse sand, which creates an opportunity making cement stabilized sand-mud block and other building components.
- It is suggested that there is no need for constructing RCC framed structure for two to three storied buildings, since confined masonry will be a cost effective, green and resilient option. Note that Sikkimese architecture has inherent resilience against earthquake. Revive the traditional architecture since it is rich, aesthetically pleasing the carries the memories of cultural past and must be reintroduced in recovery. SSDMA may make use of the PMAY-G designs based on local architecture.
- In the recovery, techno managerial support at doorsteps to be provided to the affected people, especially the widows, women headed HHs, PWD and other vulnerable groups.
- Recovery should be people-centric through a participatory process and the state may consider making the implementation owner-driven.
- Sikkim is in seismic zone IV with landslide vulnerability. Training of masons, contractors, engineers, and awareness campaign on resilient construction is needed immediately. This intervention would make Sikkim resilient.
- Majority of the building are without insurance due to a lack of awareness and access to the facilities. Building permit not being mandatory in non-TCP areas, the people cannot access building insurance- needs an appropriate system to facilitate building-insurance.
- There is a need for relief of the interest amount on house building loan for six months since some houses have pending loan-repayment and right now it is difficult for them pay EMI for some time.
- There will be a sudden rise in demand for materials, masons and carpenters due to the housing recovery. Hence, procurement plan and the environmental impact assessment of the recovery needs would require an in-depth study before the implementation.
- Institutional strengthening is a priority. There is a need for engaging expert human resources to strengthen the implementation process. This should be on a time-bound contact basis and for the implementation time period only.
- There is a need for mission mode of working towards making "Resilient Sikkim" with all the required resilient features (BBB) to combat all future hazards in Sikkim.
- Retrofitted houses under recovery should act as good examples of resilient houses and inspire, educate, and motivate others in the community and bring in a culture of resilience as part of life and practice which would make Sikkim resilient to the future hazards.

## Implementation mechanism

The line Departments would be headed by SSDMA, who will coordinate with Sikkim Housing and Development Board, Rural Development Department, Public Works Department, Urban Development Department, etc. There is a need for partnering with the NGOs, CSOs. The following is the suggested government assistance for the affected HHs.

- NDRF/SDRF 1.3 lakh per HH for the houses totally destroyed (kutcha or pucca)-
- NDRF/SDRF Rs 12,500/HH for repair of the damaged pucca houses
- NDRF/SDRF Rs 10,000/HH for repair of the damaged kutcha houses
- provide Rs 2.6 lakh/ HH for temporary shelter with services -proposed.
- provide additional Rs 2 Lakh/HH for reconstruction, repair, and retrofitting- proposed.
- explore any other source of grant in cash or in materials- proposed.
- organize soft loan (simple interest @2%) from B/FI for the rest of the construction of a basic structure,
- setup revolving fund system- proposed.
- EMI to be paid directly to the B/FI by the state government for the first two years; thereafter, the affected HHs will pay back EMI including the portion paid by the government- proposed.

## Recovery Framework Table

Considering the quantum of damage and the geographical terrain of Sikkim, the recovery period would take about 36 months. This requires a "zero-time-wastage" approach in the recovery process. The present recovery process has been divided into three phases: a) short-term (first 12 months), b) medium-term (24 months) and long term (36 months). These phases are not independent; instead, they complement one another and have considerable overlap. Reconstruction planning should begin with risk sensitive land use and landscape management based on hazard risk assessment concerned with the ecological, social, and economic sustainability at local levels. The following implementation plan is being suggested to achieve a resilient and green recovery in the sector of Housing and settlement in Sikkim.

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### 3.2. Education

#### Basic Profile of the Sector

Sikkim has a robust infrastructure for learning with provisions of education from the pre-primary to the higher secondary school. There are in total 1259 schools in the state with 1.3 lakhs students and 13613 teachers. 99% of these schools have functional boys' toilet and 92.13% have functional girls toilet. 98.41% of all the schools have functional electricity and nearly 7% use alternative energy source in the form of solar panels. Out of the total schools 685 are primary schools, 307 are upper primary, 150 are secondary and 117 are senior secondary schools.

Within the administration and management of the education department in the four districts selected for the current Post Disaster's Needs Assessment, there are 537 schools out of which 262 are primary schools, 126 are middle school, 88 are higher secondary school and 61 are senior secondary schools. Among these districts, the highest number of Primary schools is in Namchi followed by Pakyong and Gangtok. In total there are 115 schools in Pakyong out of which 21 are middle school, 26 are HS school and 12 are senior secondary school. Primary Schools are reported to have two buildings in general except in Mangan where one primary school were witnessed to have five buildings within the campus. There are 21 building which were found to have multiple building typologies, i.e. they have both concrete structures as well as timber-based structures in their premises.

School Category	Mangan	Pakyong	Gangtok	Namchi	Total
Sr.Secondary School	7	12	20	22	61
Higher Secondary School	12	26	16	34	88
Middle School	15	21	32	58	126
Primary School	43	56	50	113	262
TechnicalInstitute	0	1	0	1	2
<b>Total</b>	<b>77</b>	<b>116</b>	<b>118</b>	<b>228</b>	<b>539</b>

#### Sectoral Policies

Within the ambit of Samgra Siksha, efforts have been made by the Sikkim government to ensure universal access including Infrastructure Development and Retention, Gender and Equity, Inclusive Education, Digitalization of learning and ensuring of RTE Entitlements including uniforms, textbooks etc to students from all socio-economic background<sup>4</sup>. Details of the different sectoral policies are listed below:

Name of the Scheme	Details
Samgra Siksha	<ul style="list-style-type: none"><li>In Sikkim, within the ambit of Samagra Shiksha, the Education department has provided the financial assistance to procure textbooks of Rs. 250/- per student at Primary Level and Rs. 400/- per student at Upper Primary Level.</li></ul>

<sup>4</sup><https://sikkimhrdd.org/GeneralSection/UploadedFiles/AnnualReport/13.pdf>



	<ul style="list-style-type: none"> <li>• In 2020-21, Samagra Shiksha was sanctioned Rs. 188.315 lakh for providing free textbook to the 57694 students studying at the Elementary Level which also included 21 Braille Books for children with special needs.</li> <li>• In 2015-16, the Sikkim government had committed to ensure the implementation of admission of 25% children from disadvantage groups and weaker section in class I in private unaided schools as mandated by section 12(1) (c) of RTE 20095.</li> </ul>
Hon'ble Chief Minister's Merit Scholarship Scheme (HMMSS).	<ul style="list-style-type: none"> <li>• Merit Scholarship: Within this scheme, the state government provides free education to meritorious students from under-privileged families including those who have migrated from other states<sup>6</sup>. In 2020-21, 55 meritorious students (33 girls and 22 boys) from economically marginalised families were admitted 9 different schools in the state through this scheme<sup>7</sup>.</li> </ul>
Post Matric Scholarship.	<ul style="list-style-type: none"> <li>• Scholarship varying from Rs.800/- to Rs. 2,000/- per month is provided to students securing 80% and above in Class XII Board Examination or equivalent.</li> <li>• An annual reimbursement of maximum Rs.10,000/- is also provided for some courses viz. MBBS/BDS, B. Tech/ B. Arch and some notified honours at graduation level.</li> </ul>
General Scholarship	<ul style="list-style-type: none"> <li>• Sikkim's local students securing less than 80% but more than 60% in selected courses as notified by the Department. Students need to submit a valid income certificate of Rs.10, 000/- per month or less for both parents.</li> <li>• Further, annual reimbursement of maximum Rs.10, 000/- is also awarded for some courses viz. MBBS/BDS, B. Tech/ B. Arch and some notified honours at graduation level.</li> </ul>
National Means cum Merit Scholarship Scheme (NMMSS).	<ul style="list-style-type: none"> <li>• The Northeast Education Council has provided the education department financial support for students to higher education in professional courses under "Stipend and Book Grant" mostly in the form of stipend and book grant to the students for Diploma, Degree, Post Graduation, M. Phil and Ph. D. courses<sup>8</sup>.</li> <li>• This assistance is now integrated with the National Scholarship Portal (NSP).</li> </ul>
National Talent Search Examination (NTSE)	<ul style="list-style-type: none"> <li>• Two staged processes for identifying and selecting meritorious students for receiving scholarship from Class XI to PhD.</li> </ul>
National Means cum Merit Scholarship Scheme (NMMSS)	<ul style="list-style-type: none"> <li>• Scholarship of Rs. 12000/per annum (Rs. 1000/- per month) per student every year for students studying in classes IX to XII in schools supported by State Government and other local body schools.</li> <li>• Eligible students refer to those whose parental income from all sources is not more than Rs. 1,50,000/- per annum.</li> <li>• In 2022-21, 58 students out of which 11 ST and 06 SCs have received the benefit.</li> </ul>

<sup>5</sup><https://dse.education.gov.in/sites/default/files/2020-08/Sikkim.pdf>

<sup>6</sup><https://sikkim.gov.in/departments/education-department/scholarships-section#:~:text=The%20State%20Government%20of%20Sikkim,within%20and%20outside%20the%20State.>

<sup>7</sup>Annual Report, Education Department, Sikkim, 2020-21, pp: 17, Accessible at <https://sikkimhrdd.org/GeneralSection/UploadedFiles/AnnualReport/13.pdf>

<sup>8</sup>Annual Report, Education Department, 2020-21

## Damages in the sector

As per the information received from the education department, a total of 12.89% of students have been affected in 33 schools concentrated in the four districts of Gangtok, Mangan, Pakyong and Namchi. Out of these 33 Schools 13 are secondary, 3 are higher secondary school, 5 are in middle school and 11 are in primary school. 27 schools have reported to minor and partial form of damages to their classroom along with other infrastructural damages. 17 schools out of 33 have reported damages to drinking water facilities. Toilets were damaged in 5 schools and septic tanks were reported to be damaged in 6 schools. Retaining walls were damaged in 7 schools & Kitchen sheds were damaged in 6 schools. Damages are reported for various components including infrastructure, WASH, nutrition, and important school assets. One of the most debilitated condition is that of Kendriya Vidyalay in Namchi, major parts of which has been damaged beyond the scope any future repair.

<b>Table 16. Impact of Disaster</b>		
<b>District</b>	<b>Number of Student</b>	<b>Number of Student affected</b>
Mangan	2282	42
Pakyong	2586	823
Gangtok	5402	541
Namchi	1500	111
<b>Total</b>	<b>11770</b>	<b>1517</b>

<b>Table 17. Damage in Education Sector</b>				
<b>Items</b>	<b>1_Totally Damaged</b>	<b>2_Severly Damaged</b>	<b>3_Partially Damaged</b>	<b>Grand Total</b>
A. Primary School	0	0	11	11
B. Middle School	0	0	5	5
C. Secondary School	0	5	8	13
D. Higher Secondary School	0	1	2	3
E. Technical Polytechnic College	0	1	0	1
<b>Total</b>	<b>0</b>	<b>7</b>	<b>26</b>	<b>33</b>

**Table 18. Education Sector: Damage Estimate**

	Totally Damaged	Severly Damaged	Partially Damaged	Total
Primary School	0	0	0	0.3
Middle School	0	0	0.2	0.2
Secondary School	0	1.1	0.4	1.5
Higher Secondary School	0	0	0.2	0.2
TechnicalPolytechnic college	0	25.74	0	25.74
<b>Total</b>	<b>0</b>	<b>26.84</b>	<b>0.8</b>	<b>27.94</b>

The total damage estimated for the education sector is Rs. 27.94 Crores out of which 2.2 Crores is for the school education component within the sector. A total damage of Rs. 1.5 Crores is being estimated for the secondary school premises out of which Rs. 1.1 Crores are severely damaged and Rs. 0.4 Crores are partially damaged. Within the higher secondary school premises, the total damage is estimated to be Rs. 0.2 crores which are mostly severe in nature. The total damage in the middle school level is estimated to be Rs. 0.2 Crores which are mostly partial in nature. The total damage in the Primary school level is estimated to be Rs. 0.3 Crores. It is also estimated that within the secondary school premises, Rs. 1.1 Crore are severely damaged and Rs. 0.4 Crores are partially damaged. Most of the damages are being reported from Mangan and Pakyong districts.

**Technical Education:** A total of Rs.25.74 Crores has been reported to be damaged within the technical education component within the education sector. All of these damages are concentrated in the Advanced Technical Training Centre in Pakyong district. The damages are reported for the major infrastructure, machineries, and equipment.



Advanced Technical Training Centre (ATTC) is one of the premier institutions set up to cater to the technical education needs of students of East and North Sikkim. Established in 1999, ATTC today has over ten thousand alumni pursuing careers across India and abroad. Not only students from Sikkim

have benefited from ATTC's unique teaching experience but also students from West Bengal, Punjab, Jamshedpur, Andhra Pradesh, Kerala and so on<sup>9</sup>.

This Centre is Sikkim's lifeline as far as producing quality technical human resources is concerned. Candidates from the far-reaching mountainous region as well in the lower highlands have been benefited tremendously since its inception because of its affordability and quality educational services. Companies like Maruti Suzuki India Limited, Gurugram, CIPLA Pharmaceuticals and so many more recruit students from these centres augmenting and contributing to the state's economy through remittances. The recent GLOF damaged the excellent machineries, laboratories and equipment including those within various MODROB schemes of AICTE. The current damage will have a cascading effect on the learning opportunities of 250 students who find a hope in the centre. Without the machineries, equipment and facilities for accommodation students will have limited scope to learn in the future. Their contribution could be also understood qualitatively especially in the overall development of the state. Without the availability of newer and improved learning facilities and resilient infrastructure, the principle of resilient recovery would not be achieved in its truest sense. The Technical centre has already accumulated newer risks which are coupling with the various structural vulnerabilities paving way for its future demise in a worse way imagined.

**Academic Block:** The entire basement and workshop floor have been submerged under sand and debris. All machinery in the workshop, including a high-end CNC machine, milling, radial drilling, milling, tools and workbenches are now under the debris. These machines cannot be restored again and must be disposed as of scrap material. Since the river has also changed its course and in the light of future risks, the ground floor of the administrative building as well as the first floor seems to be highly vulnerable.

**Boys Hostel:** The entire ground floor of the Boys Hostel is submerged in sand and debris. Facilities located on the ground floor, such as the mess, kitchen, kitchen store, gym, and first-year Physics and Chemistry labs, have been affected. The entire ground floor of the Boys Hostel, including the mess, kitchen, kitchen store, gym, and first-year Physics and Chemistry labs, is submerged in sand and debris. This has affected facilities crucial for student living. A significant number of students in the hostel are now in search of alternative accommodation.

**Powerhouse:** The Powerhouse, housing the transformer, power control room, and panels, is completely submerged in sand and debris. The generator shed and generator are severely damaged.

V. Principal and HoD Quarters Six quarters in the HoD Quarters building have been affected, with two on the ground floor submerged up to 5 feet.

**Pump House and Water Tank:** The pump house and water tank are submerged, affecting water supply to the campus. This has largely affected the WASH related components in the campus which can be largely attributed to the after risks generated by the GLOF.

**ST/SC Hostel Building:** Many ST/SC students in Sikkim are first generation learners. This institute is the only learning option for these students. Some of them migrate from far distant mountainous regions with no provisions of any alternate accommodation. Since the major portion of the SC/ST hostel is exposed to different forms of newer risks triggered by the unprecedented hazard, it is likely that in the next monsoon, structural vulnerabilities threatening the integrity of the building might get amplified resulting in severe damages.

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<sup>9</sup>The infrastructure and facilities offered by ATTC in terms of machinery and labs are outstanding, with the help of World Bank setting up the Institute along with MHRDD back in 1999.

## Economic Losses in the Sector

- It is estimated that a total of Rs. 1.843 crores have been lost due to the current disaster in Sikkim. The GLOF resulted in the loss of textbooks and other learning materials which were estimated based on the expenses the government made in order to provide relief to students.
- Except the NHPC maintained Kendriya Vidyalaya and the Advanced Training Technical Centre, there was not much direct damage being observed affecting the educational sector.
- However, students were affected indirectly in various ways especially those whose houses were damaged in different ways or whose parents lost their livelihood.
- As per the report being provided by the education department a total of 1517 students were affected in different ways in the state out of which 54.25% are alone in Pakyong which also harbours the state's technical institute.
- Nearly 37% of the students were reported to be affected in Gangtok. Out of the total assistance being provided to the students, 0.126 Crores were exclusively for the lost textbooks and copies that were either washed away or damaged during and due to the unprecedented GLOF. Additionally, many schools especially in Pakyong have reported an unprecedented expenditure of Rs. 0.20 Crores exclusively for debris cleaning.

## Methods and Assumptions

In Sikkim, the nature of school building and their built-up areas vary significantly. It is found that most of the public schools are located in a relatively safer location as compared to private schools. Damages for classrooms were estimated using a standard area for each classroom, a severity factor, number of classroom damaged and construction cost (per square metre). The construction of any standard room is taken to be Rs. 30128 per square (as provided by the divisional engineer). This is taken entirely for the purpose of assessing the structural damage within a classroom. It is argued that it is entirely because of the absence of a resilient component that the classroom was damaged. Hence the increase in the cost has a justification that more sustainable and risk informed design, the classrooms will be able to withstand any kind of disaster.

For the ease of analysis and calculations, we have taken the total built up area of each classroom to be 25 square metres. This has been assumed universal for any standard class-room environment in the state. Additionally, it has also been assumed that each classroom before the damage was on a stable land environment. It has also been assumed that each damaged classroom had maintained minimum standards of child friendly environment. For other structures within the school premises, estimations were made based on the reporting by the department. The severity index was used during the estimations. All Classrooms in any school building throughout the state are expected to be of same size. (An average size is considered).

Severity Index	Index
Fully damaged	1
Severely damage	0.5
Partially damage	0.3

*Damaged Area = Unit Area of one classroom \* No of class room damaged \* Severity Proportion*  
*Total estimated Damage = Damaged Area \* Construction cost (Per Sq metre)*

While for the assessment of damages to classroom an indirect method was used, for all other assessment were based on actual reporting by the education department. The engineering cell of the concerned department provided the details of damages for the Retaining wall, Kitchen Shed, Cooking utensils, Toilet for both (Boys and Girls), Septic Tank or Soak Pit, Drinking Water Supply Connection, drinking water tank and filtration, Lab equipment damaged, Bench and Tables, Sports Equipment, Computers Damaged, Electrical Equipment, Furniture, Classroom, Black Board and Cupboard. The Advanced Technical Training centre in Pakyong also provided their estimates which were then validated and finally used for further analysis.

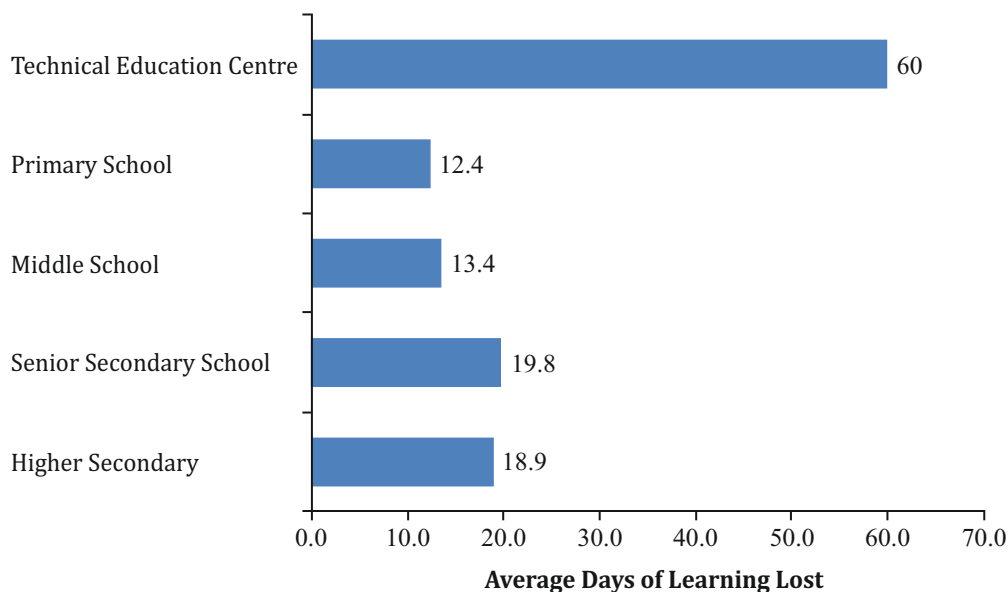
<b>Table 19. Education Sector: Component wise assumption of damage estimate</b>				
Sl.No.	Type of Works	No. of Schools which have reported	School Education (in Crores Rs.)	Unit Cost for School Education (in Crores Rs.)
1	Retaining wall	7	0.2817	0.0469
2	Kitchen Shed	6	0.0354	0.0071
3	Toilet for both (Boys and Girls)	5	0.0300	0.0075
4	Septic Tank or Soak Pit	6	0.1252	0.0250
5	Drinking Water Supply Connection	17	0.1042	0.0065
6	Drinking water tank and filtration	6	0.0401	0.0080
7	Benches, Desks, Tables, and other classroom furniture	5	0.0501	0.0125
8	Sports Equipment	2	0.0050	0.0050
9	Computers Damaged	4	0.0250	0.0083
10	Electrical Equipment	3	0.0275	0.0138
11	Furniture in Office	7	0.0326	0.0109
12	Classroom	6	1.34	Area of one classroom*No of classroom* Construction cost*Severity proportion
13	Black Boards	5	0.10	0.09600
14	Cupboard	6	0.00	0.003



### Socio-Economic Impact on People:

- **Learning Loss:** The average learning opportunities disturbed due to the GLOF is estimated to be 25 days. Even though there were immediate arrangements for continuity of schools through virtual medium, variable effect on the quality of learning is being observed especially a skewed effect on children living in informal settlements. Consequently, students whose homes have been impacted had to struggle in accessing internet during the initial few days of the disasters.
- **Drop Out:** With the closing down of classes within ATTC, students coming from different areas in the state are devoid of learning which may induce a risk of probable drop out tendencies if materials and equipment are not being recovered on a timely manner. Continuity and assurance of technical education also has an indirect yet significant effect on the overall socio-economic parameters of the state.
- **Burden of Self Reliance:** Private Schools face severe challenges as many of the schools that were either washed away or damaged severely needs to recover itself on its own strength or with community support. In such a scenario, there are economic pressures expected to be on students for timely submission of fees. This might prove burdening for those students whose houses have been equally impacted. The timely submission of the fees is directly co- related to the timely release of salaries to the teachers in these schools.
- **Loss of learning spaces:** Migrant Children living in the most affected areas especially in the settlements near the river have been affected indirectly. One is the effect on their learning time which has been compromised severely due to the lack of a proper learning space. Families without a proper housing do not have adequate learning spaces for their children. This has largely affected exam preparations which many teachers fear would impact their learning in the future.
- **Distance Factor:** Since many families have been displaced due to the GLOF, schools which were earlier nearer to their homes are now perceived to be far away from the current place of residence. This has created problem for those parents who are stroked by an unprecedented state of poverty and are economically not so well off to find an affordable solution to the problem.
- **Anticipation of future risks:** One of the most crucial impacts as reported by the school is the risk-phobia that has been triggered in the minds of the school management because of the newer forms of vulnerabilities that are being identified within the school premises or in its peripheries. These risks are all GLOF induced and are expected to have significant impact on the overall structural parameters of the school ecosystem. The condition witnessed in the NHPC maintained KV premises leave a thought-provoking question. As what would have been the scenario if the disaster would have occurred during the day?

**Fig 3: Average Learning days missed as per the nature and level of education institution**



### Response by the Government

- The government of Sikkim has provided support to children by providing financial assistance as immediate relief. As per the information received from the government, a total of 1517 students are provided financial assistance.
- A total of Rs. 1.517 Crore Rs. Was provided to students @Rs. 10,000 per students<sup>10</sup>. This amount could prove very beneficial for affected students for buying different learning materials as per need.
- Along with this, the government has also provided special assistance for providing textbooks and copies to all affected school going children. This also includes students studying in the affected KV school at Namchi under the administrative jurisdiction of NHPC.

### Reconstruction and Recovery Needs Assessment

- Since most of the school buildings are damaged either severely or partially and not fully, structural recovery would focus mostly on repairing the damaged classrooms, WASH facilities and procurement of equipment and materials necessary for the continuity of education.
- The disaster has also triggered landslide vulnerability in few locations which has generated future risks in few schools where the land has become highly unstable. This includes 8 schools in Gangtok and two in Mangan wherein structural recovery should also consider the assessment of land stability to understand the pattern of risk accumulation.
- Retaining walls in five schools in Pakyong and two in Mangan have experienced partial to severe damages. These walls play an important role in reduce the risk of landslide in the area but since land stability has been compromised, it is highly likely the soil which is being retained by these walls may slip triggering future structural risks. One of the most immediate factors why these retaining wall is damaged could be land instability triggered by the GLOF. During the implementation of the recovery plan, education department in collaboration with other relevant stakeholders may conduct a assessment of the structural vulnerabilities identifying the antecedent factors which may have acted as proximate determinants for land stability.

<sup>10</sup><https://www.indiatodayne.in/amp/sikkim/story/sikkim-flash-floods-state-cabinet-approves-construction-of-4100-houses-worth-over-rs-800-crore-696716-2023-10-18>

- Since roads play a major role in ensuring a healthy logistic component within the school education system. It has been observed that different roads in the vicinity of the damaged educational institution require special focus since these damaged roads if disrupted further in the next monsoon, then approach road leading to these schools might be completely washed. In this context, special considerations may be made for all those schools (including private) which are on the bank of the Teesta or any of its tributaries. The PWD (Roads) will have a very significant and bigger role to play in understanding the spatial pattern of student and teacher's mobilities in these regions.
- The current recovery strategy should take into consideration the need for introducing and integrating new technology within the school education curriculum and systems for future recovery programmes. As a midterm recovery strategy, few vulnerable buildings which are already exposed to newer forms of risks may be relocated with special technological solutions. With these, these strategies should integrate minimum standards of WASH, land conservation and risk reduction approaches.

### Recovery and Reconstruction Cost Estimates

The total Reconstruction Needs for the education sector stands at **Rs. 30.68 Crore** out of which **Rs. 2.42 Crore** is being estimated for the school education component and **Rs. 27.60** is being estimated for the technical education sector. The details of the reconstruction needs are segregated separately for the schools and the Advanced Training Technical Centre (ATTC) in table below:

Recovery Estimates are being provided mostly for the school education component wherein the loss of educational materials, textbooks and other essential materials has been considered to be included for the recovery estimation. The analysis also considers the plight of the children belonging to migrant families who due to unavailability or loss of documents may be excluded from any kind of assistance. An additional Rs. 2 Lakhs per school have also been considered for different unknown parameters which might have influenced the damages. This may be various determinants and factors which are systemic to the damages, and it may act as multiplier to supplement the overall recovery measures for achieving long term resilience in the education sector.

### Early recovery Interventions

- Schools in Mangan especially Primary school would require special attention because there is very limited scope for educational continuity in the absence of proper learning facilities and materials.
- Early Recovery interventions especially for the students of KV, Namchi who would require immediate support for continuity of their education.
- Students who have lost all their belongings (especially those living near the near or whose settlements are washed away, e.g.: IBM, Pakyong) would require immediate support. This recovery would also support students who might drop out from technical education because of non-availability of technical resources (e.g.: laptop or other engineering tools)

<b>Table 20. Recovery and Reconstruction Needs for education Sector</b>	
Reconstruction Needs	Total Reconstruction Estimate (Crore)
Reconstruction of physical infrastructure and equipment in Schools	2.42
Reconstruction and replacement of equipment in ATTC	25.09
Training and capacity building of education staff for Disaster Risk Reduction in Education Sector	2.51
Provision of textbooks, loss of uniforms and other aspect at rate of 2 Lakh per schools	0.66
<b>Total Recovery and Reconstruction needs</b>	<b>30.68</b>

<b>Table 21. Education Sector: Component wise recovery of ATTC</b>	
Type of Works	ATTC (in Crores Rs.)
Retaining wall	5.70
Kitchen Shed	0
Cooking utensils	0.25
Toilet for both (Boys and Girls)	0.5
Septic Tank or Soak Pit	0.2
Drinking Water Supply Connection	0.553
Drinking water tank and filtration	0.01
Benches, Desks, Tables, and other classroom furniture	0.6
Sports Equipment	0.35
Computers Damaged	0.3
Electrical Equipment	1.18
Furniture in Office	0
Classroom	0.75
Black Boards	0
Cupboard	0
Lab equipment damaged	14.69
Training, Capacity Building, and other resilient components	2.51
<b>Total</b>	<b>27.60</b>

## **Impact of Recovery**

Many government schools in Sikkim were perceived to be built in safer location which could be understood mainly in relation to the pre GLOF meandering of the river and other geo-morphological characteristics. One of the most important contributions of the current recovery will be the identification of probable locations within a school or campus which has been made vulnerable due to the GLOF. Secondly the SMC including the teachers and students who were earlier familiar with the terrain will be better able to identify the vulnerable hotspots within their school premises and take an organised and institutionalised mitigation step for risk reduction.

The impact of the current recovery initiative could be seen especially in the areas of technical education in the state. With timely intervention of the proposed recovery strategy, ATTC will have resilient infrastructure, systems, machineries, and equipment to actually ensure that students aspiring for vocational education will not deviate to any other forms of engagement. This is very important for those students whose houses are damaged as well those who are in some form of temporary housing system. Since the workshop is the heart of the institute, timely recovery of engineering materials would mean that institute would be able to ensure continuity of educational services which has been heavily compromised since October 2023.

The current recovery will reduce the risk of dropouts and unemployment if implemented in its true spirit. Since the hostel facilities in the Advanced Technical Training Centre require facility restoration, students are arranging their own accommodation elsewhere on their own. Ironically with the reduction in the tangible number of houses, many students are struggling to find affordable housing for rent. This has augmented the overall expenditure on rent because of increasing demands for accommodation in towns. The implementation of the current recovery programme will reduce the burden of out-of-pocket expenditure on renting especially among students coming from remote areas or from low socio-economic background.

The suggested recovery framework takes into account the different WASH needs of boys and girls. Those schools or educational institutions which lost its WASH facilities will now have renewed and resilient water and sanitation provisions. This will also largely affect the development parameter related to drinking water and sanitation.

Since education is not merely about textbooks but also about a healthy socio-cultural environment, the psychosocial stress that children have faced due to the past disaster can only be healed when educational institutions run in its previous way. With the current recovery plan implemented, schools will again begin in its offline mode paving way for a livelier teacher-student and student- student interaction.

## **Implementation mechanism**

The main implementing agency responsible for the recovery programme would be the education department. The concerned department in proper co-ordination with other relevant line departments may constitute expert and advisory committees for designing the future course of action for implementing the recovery projects concerning the resilience of the education sector. In this, the education department should consider the role of the School Management committee in determining the nature of the recovery plans. This would also be an opportunity to involve students in decision making and planning for increased ownership and ensuring sustainability. The Sikkim State Disaster Management Authority as a technical partner will have to provide necessary guidance to the concerned line department for ensuring a better combination of both Structural and Non- Structural measures during the implementation of the recovery plan. The involvement of wide range of experts and stakeholders would provide a spectrum of opportunities for the sector to recover in a phased manner.

<b>Table 22. Education Sector: Implementation Framework</b>	
Line Departments	Education Department as lead agency, PWD(R) for technical support on constructing approach roads, PHED for WASH components,
Partner	Sikkim State Disaster Management Authority, Sikkim University, Sikkim Manipal University, UNICEF,
Funding Sources	NDRF and SDRF Recovery Windows, Samagra Siksha, Northeastern Council, All India Council of Technical Education, CSR
Modalities of Assistance	Recovery Assistance & Departmental Annual Plan, Financial Grants.

### 3.3. Health, Anganwadi and Community Buildings

The Department of Health and Family Welfare, the nodal health agency in the state of Sikkim, envisions to foster a healthy society through provision of quality health care services for all its citizens from womb to tomb, and to reach quality health care services up to remotest village of the State' Empowered with this vision, the Health Department has achieved commendable successes. In pre-COVID era, NITI Aayog in its 'Performance on Health Outcomes: State Health Index', has ranked Sikkim 4<sup>th</sup> (2017-18) and 5<sup>th</sup> (2018-19) for absolute performance in smaller state's category.<sup>11</sup> Table 01 shows that infant mortality rate (IMR) of Sikkim is 5 which is significantly lower than IMR 30 for India. During the COVID, the health sector in Sikkim demonstrated strong performance with stringent containment measures and proactive health services.<sup>12</sup> Further, unlike many states of India, the health sector in Sikkim is largely dependent on government health facilities<sup>13</sup> with per capita expenditure about Rs 8457 (compared to Rs 4297 for India). Sikkim also has an appreciable ratio of 14 public health providers (medical officer, specialists, staff nurse, and ANM) per 100,000 population<sup>1</sup>. Annual state budget for Health department in 2023-24 is Rs 730.74 crore.

As per HMIS Survey Report (2019-20), full immunization and institutional delivery has reached 95.5% and 99.3%, respectively<sup>14</sup>. Impacts of such effects are also Non-Communicable Diseases (NCDs) contribute to 68.22% of Disability-adjusted-life-year (DALYs), whereas injuries contribute to 10.39% of DALYs. Blood pressure and diabetes has been recognised as the most prevalent health challenges (Table 02). Anaemia in women of reproductive age group is more than twice when compared with men of similar age group. Key health indicators of the state are summarized in the table below.<sup>15</sup>

<sup>11</sup>Health Dossier 2021, Reflections of Key Health Indicators, Sikkim NHSRC India, [https://nhsrcindia.org/sites/default/files/practice\\_image/HealthDossier2021/Sikkim.pdf](https://nhsrcindia.org/sites/default/files/practice_image/HealthDossier2021/Sikkim.pdf)

<sup>12</sup>Response to COVID-19, Sikkim, No mountain high enough, NDMA-CDRI <https://ndma.gov.in/sites/default/files/PDF/covid/sikkim-eng.pdf>

<sup>13</sup>State Health Accounts Estimates for Sikkim 2017-18, NHSRC India, [https://nhsrcindia.org/sites/default/files/2023-06/SHA\\_Sikkim.pdf](https://nhsrcindia.org/sites/default/files/2023-06/SHA_Sikkim.pdf)

<sup>14</sup>Dept. of Health and Family Welfare, Govt. of Sikkim website

<sup>15</sup> Sample Registration Survey (SRS) Bulletin 2018 and 2019.



Table: Key health indicators highlight good performance of Sikkim health sector

<b>Table 23. Health Sector: Key Health Indicators highlighting performance of Sikkim Health Sector</b>			
<b>Sl.</b>	<b>Indicator (per 1000 population)</b>	<b>Sikkim</b>	<b>India</b>
1.	Infant Mortality Rate (IMR)	5	30
2.	Crude Death Rate (CDR)	4.2	6
3.	Crude Birth Rate (CBR)	16.5	19.7
4.	Maternal Mortality Ratio (MMR)	85	113

Table: Non-Communicable Disease – blood pressure and diabetes

<b>Table 24. Health Sector: Key Health Indicators for Sikkim on Non-Communicable Disease</b>			
<b>Sl.</b>	<b>Indicator</b>	<b>Sikkim</b>	<b>India</b>
1.	Women - Mildly elevated Blood Pressure (Systolic 140-159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%)	18.5	12.4
2.	Men - Mildly elevated Blood Pressure (Systolic 140- 159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%)	25	15.7
3.	Women - Blood sugar level - high (141-160 mg/dl) (%)	6.2	6.1
4.	Men - Blood sugar level - high (141-160 mg/dl) (%)	7.5	7.3

In total Sikkim has 178 functional government health facilities including 1 state referral hospital and 4 district hospital. In recent years, Sikkim has restructured its administrative units from previous four districts (North, South, East, West) to six districts (Mangan, Gangtok, Pakyong, Namchi, Gyalshing, and Soring). Creation of new districts also coincides with increasing capacity of state's health infrastructure substantially. For example, the state-of-art New STNM Hospital at Gangtok with 1100 bed capacity commissioned in 2018 now serves as the state referral hospital. Previously, Central Referral Hospital of Sikkim Manipal Institute of Medical Sciences (CRH-SMIMS) was the state referral hospitals. Many other hospitals are being upgraded with completely new building or new additional blocks.

Among smaller health facilities, Sikkim has 2 Community Health Centres (CHCs), 24 (PHC, including 2 urban PHCs), and 147 Primary Health Sub-centres (PHSC)<sup>16</sup>. Many of these facilities have also been upgraded under as Health & Wellness centres under National Health Mission and Ayushman Bharat schemes. A highlight of Sikkim health sector is that most upgraded healthcare facilities in Sikkim are much larger than national standards for PHCs and Sub-centres. For example, health care centres at

<sup>16</sup>National Health Mission Sikkim; <https://nhmsikkim.org/health-centers/health-centers-south-sikkim/>

Lachen HWSC (four storied, 508 sqm), Lachung (two storied, 396 sqm) Chungthang (recently renovated, 450 sqm), have larger areas and additional facilities. Average capacity of PHCs including their sub-centres are 50-60 beds. Among 178 health facilities, 17 are located close to the flash flood route in Teesta.

Table: Summary of capacity of health infrastructure in the state is as follows:

<b>Table 25. Health Sector: Summary of Capacity of Health Infrastructure in Sikkim</b>		
District	Name of hospital – bed capacity	Capacity under construction <sup>17</sup>
Gangtok	New STNM Hospital - 1100	-
Gangtok	Singtam- old district hospital - 150	New Singtam hospital – 300
Mangan	District hospital – 80	Additional block – 50
Namchi	District hospital - 300	New District hospital – 300
Pakyong	-	New District hospital – 100
Gyalshing	District hospital - 150	Critical care block – 50
Soreng	-	District hospital – 100
Total Sikkim	1780	900

### **Anganwadi**

Anganwadi centers and community buildings play crucial roles in the social fabric of Sikkim, India. Anganwadis serve as vital hubs for early childhood care and education, maternal healthcare, and nutrition support for women and children. These centers, scattered across Sikkim's diverse landscape, provide essential services to rural and remote communities, promoting child development and maternal well-being.

Additionally, community buildings serve as focal points for various social, cultural, and educational activities within villages and towns. They often host community meetings, religious gatherings, educational programs, and cultural events, fostering social cohesion and community engagement. In Sikkim, where communities are closely knit and traditions run deep, these buildings serve as platforms for preserving local heritage and promoting unity among diverse ethnic groups.

- Sikkim hosts a total of 1308 Anganwadi centers, each supported by 1308 Anganwadi workers and 1248 Anganwadi helpers.
- The infrastructure of Anganwadi centers in rural areas is government-owned, while those in urban and peri-urban areas are housed in rented buildings.
- The Government of India has introduced the "Poshan Tracker" Application to enhance transparency and strengthen the nutrition delivery support system at Anganwadi centers.
- This application facilitates the tracking of various aspects including daily attendance, Early Childhood Care and Education (ECCE), provision of Hot Cooked Meal, Take-Home Rations (THR), among others.

**Table 26. Health Sector: Summary of Anganwadi and Community Buildings that reported Damages**

District	Anganwadi	Community Assets / Gram panchayat Buildings etc	Grand Total
Gangtok	1	9	10
Mangan	36	23	59
Namchi	1	11	12
Pakyong	4	7	11
<b>Grand Total</b>	<b>42</b>	<b>50</b>	<b>92</b>

**Table 27. Health Sector: Summary of ownership of Anganwadi from reported buildings**

Anganwadi Ownership	Anganwadi Ownership		
District	Owned Building	Rented Building	Grand Total
Gangtok		1	1
Mangan	28	8	36
Namchi		1	1
Pakyong	3	1	4
<b>Grand Total</b>	<b>31</b>	<b>11</b>	<b>42</b>

<sup>17</sup>Dept. of Health and State general budget, Sikkim Chronicle, <https://www.thesikkimchronicle.com/sikkim-all-set-for-healthcare-upgrade-ps-tamang-assures-of-numerous-new-healthcare-centres/>

## Sectoral Policies for Health and Nutrition Sector

Over a decade, Sikkim has successfully implemented several health including key initiatives from the central government, and multilateral organizations.

- CATCH (Chief Minister's Comprehensive Annual & Total Health Checkup, Care For Healthy Sikkim, 2010): Launched in 2010, the programme aimed to make Sikkim healthy by providing a comprehensive routine check-up Total (Head to Toe) from villages to towns for all the citizens of Sikkim<sup>7</sup>.
- SAATHI (Sikkim Against Drug Addiction Towards Healthy India, 2013): Launched in 2013, this programme aimed to reduce substance abuse among students by reversing the peer pressure through positive peer pressure education model<sup>7</sup>.
- Mukhya Mantri Sishu Suraksha Yojana Avam Sutkeri Sahayog Yojana (MMSSYASSY, 2010). Launched in 2010, the programmed targets every pregnant woman of a BPL family with cash assistance for availing better treatment for delivery and support their child till the age of six years.<sup>7</sup>
- School Health Programme in the North District: This programme focuses on sensitization awareness and health Checkups by Medical Officers visiting Anganwadi Centres for all adolescent girl every three months.<sup>7</sup>
- ASHA Programme: Launched under National Health Mission (NHM) in 2006, includes women from villages passionate about rendering voluntary services to bridge the gap between the community and Health System<sup>7</sup>.
- Su-Swastha Yojna: The Employees' Health Services Scheme by the Department of Health & Family Welfare, Government of Sikkim, aims to provide healthcare services to state government employees and their dependents for a cashless benefit covering hospitalizations across top-tier hospitals in India.
- Resilient Health Infrastructure for Sikkim (2023)<sup>18</sup>: SSDMA and the Health Department, with technical assistance from WHO and the Coalition for Disaster Resilient Infrastructure (CDRI), are implementing this programme to develop a long term Policy roadmap for resilience of health infrastructure through Capacity building, Risk and resilience assessment, and Technical support. Between April-August 2023, six workshops have been organized across Gangtok, Singtam (2), Mangan, Namchi, and Mangan. These workshops sensitized over 500 medical and non-medical hospital staff on disaster risk management and resilience, reviewed their Disaster Management Plans, conducted rapid visual vulnerability assessments, and simulated Incident Response System (IRS).
- For Anganwadi, Government of India has launched a scheme, where there is a provision of upgradation of 2 Lakh Anganwadi Centres (AWC's) as Saksham Anganwadi with improved infrastructure in Aspirational districts. Few measures from the scheme can be integrated for recovery of Anganwadi's impacted by the disaster.

## Impact of Disaster on Health Sector

Impacts of the recent disaster on the health sector can be summarised in two parts: (i) Immediate and long-term impacts on health of people which will create additional burden for health service to recover to its pre-disaster status, and (ii) Impact on the health infrastructure leading to damages and need for repair/reconstruction/replacement.

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<sup>18</sup>Resilient Health Infrastructure Programme launched, Sikkim Herald, Govt. of Sikkim, [https://sikkim.gov.in/uploads/SikkimHerald/May\\_20\\_BUDGET\\_0\\_20230522.pdf](https://sikkim.gov.in/uploads/SikkimHerald/May_20_BUDGET_0_20230522.pdf)

The flash flood triggered at South Lhonak Lake on 3-4 October 2023 has impacted a population of 88,400 across 100 villages located along the Lachen-chu and Teesta valley across 4 districts of Mangan, Gangtok, Pakyong, and Namchi. Total 48 lives are lost, 75 reported missing, along with 26 grievously injured were hospitalised and later discharged<sup>19</sup>. Hundreds of people have been given first aid and psychosocial counselling during the response phase and continue to receive related health care support. During the field visit for PDNA on 9-10 December 2023, Lachen was not accessible and only limited information is available to support this report. Salient points are summarised in two broad categories – immediate impacts, and future health risks<sup>20</sup>.

- Densely populated areas with maximum impact Rangpo, Singtam, and Mazitar, are in the vicinity of Singtam district hospitals and serviced by it (Gangtok district). For first five days, Singtam with bed capacity of 150 had patients loads at peak 413 (275%), and average of 167%. Limited data is available on hospitalized patients. This had created huge stress on the hospital resources, requiring mobilization of resources from other districts. At Singtam DH, total 1676 patients were treated between 5-15 October 2023. (Table XX)
- The Health Department has reported seven health facilities located across Mangan (Naga, Dikchu, Lachen, Lachung, Chungthang), Gangtok (Makha), and Namchi (Melli) being impacted by the disaster. Overall, these health facilities have registered 112 pregnant/lactating women and 116 infants, and they service 177 patients on an average (Table XXX).
- The disaster has also impacted key highways on Singtam-Dikchu-Mangan-Chungthang- Lachen route and rural roads causing disruption of routine post-natal and ante-natal visits, particularly in regions served by Naga HWSC, Lachen HWSC, Lachung WHSC, and Chungthang PHWC. Vaccination services for polio, DPT Booster, Pentavalent, ROTA, PCV, IPV, and MR, especially around Chungthang was impacted.
- All these facilities, located in Mangan district have registered 52 pregnant/lactating women, 36 infants and 13 children who are likely to be impacted. Further, these health facilities have reported cough-cold, fever, and digestive problems as prominent illnesses. Trends of new/increase diseases are likely to emerge in future.
- Reduced affordability for health services: The disaster has damaged houses (2004 number), assets and sources of livelihoods such as shops (922 numbers), rental incomes, and other forms of income from tourism sectors. People have also lost their medical records, documents, and medicine. These impacts have reduced the affordability of people for accessing health services, which over-time may impact health in future.
- Future health risks: Damages to water and sanitation (WASH) systems in many villages and towns creates additional risks of water and vector borne diseases or unhygienic conditions.
- There was no disruption of vaccination cold chains. Further, there was also no major outbreak of diarrheal or water borne diseases.
- In Anganwadi, with loss of few Anganwadi's there is an unanticipated pressure on women to take children to their workplace or loss of daily wage.

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<sup>19</sup> Report on the extent of damage due to Cloudburst induced flooding in the Teesta basin ... SSDMA report, 4th October 2023. 83

<sup>20</sup> Health department activities during Flash flood disaster, October 04 2023, Singtam district hospital.

Date	No of casualties	No. of patients (IPD+OPD)	Patient load %
04-Oct-23	5	NA	NA
05-Oct-23	4	335	223%
06-Oct-23	3	413	275%
07-Oct-23	-	231	154%
08-Oct-23	-	138	92%
09-Oct-23	-	133	89%
10-Oct-23	-	98	65%
11-Oct-23	1	123	82%
12-Oct-23	-	86	57%
13-Oct-23	-	62	41%
14-Oct-23	-	42	28%
15-Oct-23	-	15	10%
<b>Total</b>	<b>13</b>	<b>1676</b>	<b>Peakload 275%</b>

Table: District wise impact on health and access to health services<sup>21</sup>

District wise impacted health facilities	Population impacted	Name of health facilities	Daily average patients (male, female, children)	Registered pregnant/lactating women	Infants
Mangan	30300	(Dikchu, Naga, Lachen, Chungthang, Lachung)	120	55	46
Gangtok	20000	Makha	23	30	28
Namchi	30000	Melli	34	27	41
Pakyong	8100	-	NA	NA	NA
<b>Total</b>	<b>88400</b>	<b>-</b>	<b>177</b>	<b>112</b>	<b>115</b>

- In the disaster 42 Anganwadi's were impacted which is attended by 126 Boys and 13 Girls. These Anganwadi's were non-operational for 2 weeks, they became functional depending on the scale of the impact of the disaster.
- Out of 42 Anganwadi's & 7 Anganwadi's have reported total damage and needs to be reconstructed and 3 Anganwadi's have reported no damage. 32 Anganwadi's have reported damage to physical infrastructure of various intensity.

<sup>21</sup>Based on the Data provided during PDNA exercise.



Table 30. Health Sector: Impact of Disaster on Anganwadi		
District	Boys	Girls
Gangtok	10	12
Mangan	78	70
Namchi	2	6
Pakyong	36	44
<b>Grand Total</b>	<b>126</b>	<b>132</b>

Table 31. Health Sector: Damage Assessment of Anganwadi's						
District	(No Damage)	Minor structural damage	Major structural damage	Small portion of the house has collapsed	Totally collapsed	Grand Total
Gangtok					1	1
Mangan	3	18	12	1	2	36
Namchi					1	1
Pakyong			1		3	4
<b>Grand Total</b>	<b>3</b>	<b>18</b>	<b>13</b>	<b>1</b>	<b>7</b>	<b>42</b>

## **Socio-Economic Impact on population**

Socio-impact analysis of the disaster from the perspective of health second can be assessed in three categories as noted below:

First, direct impact of disaster on health of population (disabilities, immediate illness, etc.) with short- and long-term impacts. As per reports, all seriously injured people have been treated and discharged.

Second, disaster impacts health infrastructure and systems causing disruptions in health services (such as missing vaccines, pre-natal care, etc.) which will have long term impact on health of populations. Field visits under PDNA highlighted that disruption of transportation networks has created accessibility challenges for vulnerable population such as pregnant, lactating women, children, elderly, and people with disabilities, affecting their ability to seek health services. Such disruptions have also created adverse travelling and working conditions for health workers and grassroot workers like ASHA.

Third, disaster impacts people's income and livelihood, houses, and assets drastically reducing their affordability for seeking health care, access to clean water and sanitation, and hazardous living conditions. Such challenges will lead to long term risks on health of population. In the Sikkim disaster, 2004 houses are damaged, along with 5019 persons living in rented houses. There are also significant proportion of population who have lost livelihood (922 shops damaged, loss of rented income from houses, and loss of income due to impact on tourism. These cascading impacts of third category is very prominent in case of Sikkim.

The socio-economic impacts are difficult to quantify with limited data and information. However, the state will require a community driven support mechanism to encourage performance of health sector. And such measures must consider challenges faced by health service providers.

## **Damages to Infrastructure**

Out of state's total 178 health facilities, 17 health facilities are situated close the Teesta basin affected by flash floods. The Health Department has reported seven health facilities located across Mangan (Naga, Dikchu, Lachen, Lachung, Chungthang), Gangtok (Makha), and Namchi (Melli) being impacted by the disaster. Based on data received, two facilities are excluded from damage assessment - Melli (Namchi) PHC does not have any significant reported damage, and Lachung HWSC is not located in the flood route. A summary of damages to five facilities is given below. It is also notable that regions along Mangan-Chungthang route is frequently impacted by monsoon floods leading to disruption of roads.

- Apart from the six health facilities reported here, rest of them are located well above the river basin and continued to provide services during the disaster. Though, provide them with additional resources was a challenge due to disruption of transportation network.
- Naga HWSC (Mangan)– Naga village is under sever subsidence and relocation of entire village is being considered by the authorities. Naga HWSC has suffered significant damages including settled floors, wall cracks, damaged roof, and sinking land area. Require replacement and relocation.
- Dikchu PHWC (Mangan) – Minor damages to infrastructure, but the stability of surrounding areas requires to be assessed.
- Chungthang PHWC (Mangan) – Water supply line and sewage systems are damaged. The facility may be relocated in case Chungthang town is replanned.

- Lachen HWSC (Mangan) – Damage to external water supply, but limited information is available.
- Makha HWSC (Gangtok) – Established in 1993 the building is old and damaged due to falling tree. Will require significant repair, while replacement may be considered.



Figure 1 Damages to Naga Health and Wellness Sub Centre



Figure 2 Damages at Makha Health and Wellness Sub Centre, District Gangtok

**Assumptions for damage estimate calculations:**

- Damage area of building is calculated as 'Level of damage in percentage' x total built up area of the building x Damage.
- Unit rate assumption for estimation of damage to buildings are as follows. Damage costs = Damaged area x Unit damage rate.

Table 32. Health Sector: Assumption for Damage estimate for Health Sector			
Description	Pucca	Semi Pucca	Kutcha
Factors with respect to type of buildings	1	0.75	0.5
Damage cost (Rs/sqm)	30128	22596	15064

- There are cases of damages are reported for water supply system and sanitation (toilet etc.), but not to buildings. For such cases, partial damages of water (5%) and sanitation (5%) are calculated from total Plinth Area Rate (i.e., damage for water = Total built up area x Unit Cost of damage x 5%).



**Table 33. Health Sector: Damage Estimate for health Sector**

	District	Totally Damaged	Severely Damaged	Partially damaged	Total Damage
HWSC		0.248556	0.135576	0.0956564	0.4797884
PHWC		0	0	0.67788	0.67788
Total		0.248556	0.135576	0.7735364	1.1576684

### Damage to Anganwadi's and other community Buildings

- The total of 24 cases of damage to Water, Sanitation, and Hygiene (WASH) facilities in Anganwadis, with 15 instances of damaged toilets, 1 case of a damaged septic tank or soak pit, and 8 incidents where both the toilet and septic tank or soak pit were damaged.
- Damages to movable equipment in Anganwadi's was different across different districts, with Gangtok having one each of damaged furniture, toys, children's books, kitchen utensils, water filters, and weighing machines, Mangan experiencing the highest damage count in furniture, toys, and kitchen utensils, Namchi and Pakyong with similar damage distribution across categories, and a grand total of 12 damaged furniture, 10 toys, 9 children's books, 11 kitchen utensils, 14 water filters, and 8 weighing machines across all districts.

### Assumptions for damage estimate to Anganwadis

Based on the various discussion with AWW and AWH, following assumptions are inferred for estimating damages in AWC.

- Average Size of Building: The average size of an Anganwadi building is assumed to be 225 square feet.
- Average Size of Plot: The average size of the plot on which an Anganwadi building is constructed is assumed to be 1200 square feet.
- Average Cost of Construction: The average cost of constructing an Anganwadi building is assumed to be 3800 Rupees per square foot. The total cost of constructing an Anganwadi building is calculated to be 855000 Rupees based on the average size and cost of construction.
- Cost of Furniture, Toys, Children Books, Kitchen Utensils, Water Filter, and Weighing Machine: These are assumed costs associated with equipping an Anganwadi center with necessary furniture and materials.

These assumptions provide a basis for estimating the costs and requirements for setting up and maintaining Anganwadi centers. However, actual costs and requirements may vary based on factors such as location, materials used, labor costs, and specific needs of each center. Therefore, it's essential to consider these assumptions as estimates and adjust them as needed based on real- world conditions and circumstances.

Based on this assumption total damage estimate for Anganwadi buildings is estimated to be **1.92 Crores**.

**Table 34. Health Sector: Item wise assumption for damage estimate in Anganwadi's**

<b>Item</b>	<b>Assumption</b>
Average Size of Building	225 Sq. ft
Average Size of Building	1200 Sq. ft
Average Cost of Construction	3800 Rupees
Cost of Construction	855000 Rupees
Furniture	30000 Rupees
Toys	20000 Rupees
Children Books	5000 Rupees
Kitchen Utensils	20000 Rupees
Water Filter	10000 Rupees
Weighing Machine	2000 Rupees



## Total Damage Estimate - Anganwadi's

Table 35. Health Sector: Component and District wise damage estimate for Anganwadi's								
District	Building	Toilet	Furniture	Toys	Children Books	Kitchen Utensils	Water Filter	Weighing Machine
Gangtok	675000	200000	30000	20000	5000	20000	10000	2000
Mangan	9517500	3600000	240000	120000	15000	180000	100000	4000
Namchi	675000	200000	30000	20000	5000	20000	10000	2000
Pakyong	2362500	800000	120000	80000	20000	80000	40000	8000
<b>Grand Total</b>	<b>13230000</b>	<b>4800000</b>	<b>420000</b>	<b>240000</b>	<b>45000</b>	<b>300000</b>	<b>160000</b>	<b>16000</b>

Table 36. Health Sector: Total Damage Estimate for Anganwadi		
District	Total Damage Estimate	Total Damage Estimate in Crore
Gangtok	962000	0.0962
Mangan	13776500	1.37765
Namchi	962000	0.0962
Pakyong	3510500	0.35105
<b>Grand Total</b>	<b>19211000</b>	<b>1.9211</b>

## Response by Government and Economic Losses in Health Sector

The health policy of Sikkim aims to provide majority of services for public good. The private health sector has limited presence, largely in cities like Gangtok, hence the disaster has caused negligible loss of revenue. However, the health sector has incurred extra expenses during the disaster response phase, and it is likely to incur additional costs during the recovery phase till next three years.

Disaster response for the health sector consisted of, among others, following steps<sup>22, 23</sup>.

- The health department mobilized its resources along the flood route (Chungthang, Mangan, Singtam, Rangpo, Melli) and the health facilities away from the flood route such as New STNM in Gangtok and Sikkim Manipal Hospital assisted these hospitals.
- Casualty management including transportation of dead bodies, post-mortem, storage, and last rites. Singtam DH hospital catered to 13 casualties with all formalities. During the field visit for the PDNA it was learnt that respectful management of dead bodies was challenging due limited and poor conditions of mortuary complicated with disruption of transport network and shortage of hearse vehicle, postmortem equipment, and delapidated conditions of mortuary at Mangan district hospital with current capacity for eight casualties. It is also noteworthy that this flash flood became the worst disaster for Sikkim surpassing the earthquake of 18 September 2011 when about 60 lives were lost<sup>24</sup>. Hence, there is an infrastructure capacity gap for casualty management for large scale disasters.
- Management of injured persons including transportation, hospitalization, and treatment of grievously injured persons, along with provision of medicine, water, food, etc. As per state report, 26 persons were grievously injured requiring hospitalization and later all were discharged (as on 4 December 2023). Singtam DH alone treated 1676 patients between 5-15 October 2023.
- Set up 40 health posts for 24x7 service at relief centres, first aids, psychosocial counselling, psychopharmacological medication, preventive actions for control of vector and water borne diseases, yoga sessions, etc. Representative figures are included below).
- Total 8 relief centres were set up mostly nearby Singtam. Except the two major relief camps having about 1500 persons, smaller camps had an average occupancy of 300-500 persons.
- Each health post had an Ayush doctor, a gynaecologist, and dentist along with all medicines, and accessories like spectacles, sanitary kits, etc.
- Two Mobile village clinics were set up for 24x7 services with lab facilities, pharmacy, nursing staff, paediatrician, and a gynaecologist.
- Mental counselling and psychological support are being provided 24x7 through the Tele Manas services (Toll free number 14416) launched on 07 December 2023 and Crisis Helpline 18003453225/03592-202111. Trained counsellors and psychologists have been recruited to augment capacity. Counsellors were also given online training by Tata Institute of Social Sciences (TISS) Mumbai.
- Awareness campaigns have been organized for potential health hazards, vector control, hygienic drinking water, hand washing, posting IEC materials (Information, education, communication) and outreach efforts to affected community.

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<sup>22</sup>Health department activities during Flash flood disaster, October 04, 2023, Singtam district hospital.

<sup>23</sup>Activities of Health Dept. submitted to Member Secretary, SSDMA 96

<sup>24</sup>National Information Centre of Earthquake Engineering; <https://www.nicee.org/Sikkim2011.php>

- Proactive steps to ensure best health facilities for pregnant women/infants by transporting them closer to larger hospitals in Gangtok/Mangan. So far, five pregnant women have been shifted closer to bigger health facilities in Gangtok.

To implement above responses the Dept. of Health has incurred extra expenses which Economic Loss section.



*Figure 1: Health Relief and Counselling Camp*



*Figure 2: Initiatives for vector control*



*Figure 3: Dedicated awareness campaign for children*



*Figure 4: Health screening campaign for elderly and woman*

<b>Table 37. Health Sector: Total Economic Losses (in Crore) based on inputs from Health Department</b>		
<b>District</b>	<b>Medical supplies and consumables</b>	<b>Operational costs health posts at relief camps, health camps, mobility support, etc.</b>
Mangan	0.28	
Pakyong	0.9	
Gangtok (Singtam)	1.343	
Namchi	0.36	0.9
Sub-total	2.883	0.9
<b>Total loss for state (Health Dept.)</b>	<b>3.783</b>	

### **Reconstruction and Recovery Needs Assessment**

Like other infrastructure systems, the health infrastructure in Sikkim is vulnerable to multi-hazards like earthquake, flash floods, cloud bursts, landslides, GLOF, avalanche, and impacts of climate changes. Over years, the health sector in Sikkim has demonstrated commendable performances. But setbacks caused by the recent disaster have raised new challenges which requires to be addressed, along with consideration of build back better. Provisions of PM Ayushman Bharat Health Infrastructure Mission (PM ABHIM) under National Health Mission can be explored.

Reconstruction needs: Specific requirements of the impacted health facilities include -

- Immediate replacement is requirement for Naga HWSC. However, as Naga village is expected to be relocated due to land subsidence caused by toe erosion by Teesta, mobile health clinics may be considered as an interim measure. In addition to building new Naga HWSC building, addition costs like land acquisition, approach road, area development, soil investigation, protective works, consultancy charges, etc. will be incurred.
- Immediate repair and reconstructions are required at Makha HWSC, Lachen HWSC, Dikchu PHWC, and Chungthang PHWC. Makha HWSC is about 30 years old and may be considered for replacement in near future.
- Assessment of land stability for health facilities at Dickchu, Melli, and Lachen is required to ensure their safety.

## Reconstruction Cost Estimates

- Reconstruction/repair are also required for water supply system and sanitation (toilet etc.), but not to buildings. For such cases, partial reconstruction/repair of water (5%) and sanitation (5%) are calculated from total Plinth Area Rate. For example, partial reconstruction/repair of water system = (Total built up area x Unit Cost of reconstruction x 5%).
- Replacement cost for one health facility (Naga Sub-center) is calculated as (Built up area 110 sqm x Unit rate for Semi Pucca) as base cost of the hospital building. Additional costs will be required for approach road, area development, soil investigation, protective works, consultancy and design charges, WASH system, electrification, fire system, furniture and cladding works, cost escalations, GST, etc. will be incurred. Note: As per new government guidelines, the area of new Naga Sub Centre may be increased.

<b>Table 38. Health Sector: overall reconstruction cost estimates for Health Sector</b>					
	<b>District</b>	<b>Totally Damaged</b>	<b>Severely Damaged</b>	<b>Partially damaged</b>	<b>Total Reconstruction Estimate</b>
HWSC	Mangan	1.25310		0.09566	1.34876
	Pakyong				
	Gangtok		0.15535		0.15535
	Namchi				
PHWC	Mangan			0.84735	0.84735
	Pakyong				
	Gangtok				
	Namchi				
<b>Total</b>		<b>1.25310</b>	<b>0.15535</b>	<b>0.94301</b>	<b>2.35146</b>

- For Damages of Anganwadi- reconstruction of physical infrastructure and equipment is estimated to be 1.92 Crore.
- Along with Anganwadi's there are 2 Gram Panchayat Buildings that needs recovery interventions the overall cost estimate for rehabilitation of Gram Panchayat buildings is estimated to 20 lakhs rupees at rate of 10 Lakhs lumpsum amount to be provided for rehabilitation of physical infrastructure.
- Amount various community buildings. There are 7 Crematoriums that are totally damaged. As per the discussion with the Assistant Engineers from the Rural Development Department on Crematorium was recently constructed with a cost estimate of 40 Lakh rupees. The reconstruction of Crematorium is estimated at 2.80 crore.

## Recovery strategy and their impacts

The reconstruction needs summarised in the previous section address the damages caused by the flash floods of 4 October 2023. Compared to other sectors like transport and housing, the damages to health infrastructure are limited as most health facilities are located at safe distance and elevation from the Teesta basin. 101

However, the disaster underlined few gaps in health infrastructure and capacity, which needs consideration to ensure that Health sector continues to respond effectively to future disasters. Further, there is urgent need to provide effective and affordable health care services to people who have lost livelihoods, houses, and assets. A graded recovery strategy is proposed for health sector by considering Build Back Better approach and proforma estimates prepared in consultation with the Dept. of Health. This recovery strategy also considers risks that may arise during next two monsoon season.

### Short term strategy (up to 12 months)

- **Augment infrastructure at district hospitals for mass casualty management:** Disasters like the October 2023 floods also necessitates timely and respectful large number of dead bodies to ensure social harmony and infection controls. As per new protocol for post-mortem procedure notified by the Government of India in November 2021, adequate facilities are required for conduct post-mortems after the sunset<sup>25</sup>. During the PDNA field visit, needs for augmenting the mortuary facilities at all district hospitals, especially at Mangan DH due to its remoteness, with adequate equipment, power back, storage etc. are required.
- **Augment infrastructure in cluster of health care facilities:** The peak patient load with respect to IPD bed capacity at Singtam was 275%, with first five-day average patient load of 167%. It was well supported by STNM, Sikkim Manipal Hospital, and other nearby hospitals. Due to multi-hazard vulnerability of Sikkim, and geographical locations, augmenting capacity of health systems in clusters by adding facilities and surge capacity will promote collaborative support. For example, during monsoon season, Mongan-Chungthang-Lachen- Lachung routes often gets disrupted, and isolated. Increasing capacity of PHCs and Sub- centres in Chungthang, Lachung, and Lachen circuit (and similarly other clusters) with tents, temporary beds, folding stretchers, power back up (generators, inverters, solar power), pre- positioning of medicines, will make these vulnerable regions more self-reliant.
- **Restore temporary health infrastructure:** More permanent reconstruction of damaged infrastructure may take few years. Meanwhile it is necessary to establish one temporary facilities for Naga PHSC. Additionally, two mobile clinics set up by the Health Department during the response phase may be continued to serve remote areas that are cut off due to damages to highways and rural roads. Temporary health camps are required primarily in Mangan district's Dzongu region, Chungthang, Lachen, etc. Existing CATCH and Health scheme for schoolgirls in North Sikkim may focus on affected areas
- **Continued awareness campaigns and mock drills:** The most important success lessons from Sikkim disaster was the mock drills and awareness campaigns by the SSDMA conducted on 12 May and 18 September 2023, which led to timely evacuation and saving thousands of lives. Current crisis also gives an opportunity to continue this good practice by setting up Audio-Visual systems and IEC materials at New STNM, 4 district hospitals, 2 CHCs, and 26 PHCs, Total 33 facilities). The message may focus on risks from other disasters, disease surveillance, and governments recovery policies. Hospitals should conduct multi-hazards mock drills as per SSDMA guidelines and recently updated Hospital Disaster Management Plans.

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<sup>25</sup>New Protocol for post-mortem procedure.  
<https://pib.gov.in/PressReleaselframePage.aspx?PRID=1772057>



- **Digital technology for medical record keeping:** Damages to houses also led to loss of valuable medical records. Use of digital technologies such as online storage of medical records should be promoted. For example, Digi locker for individuals and for Ayushman Bharat Digital Mission for hospitals can be considered.
- **Risk mitigation measures for health infrastructure:** The flash floods have caused massive damages to slope and lands around health facilities. Appropriate site assessment followed by protective works may be required to prevent future damages to health infrastructure. Assessment should also consider risks from monsoon and landslides.
- **- Targeted financial support to affected people for affording health service:** To ensure that impacts like loss of houses, assets and livelihood do not discourage access to health services, the Health Department has been taking proactive steps to support vulnerable populations such as pregnant women, infants, children, and elderly. This approach may be expanded to include all impacted persons.
- **Support the ongoing programme 'Resilient Health Infrastructure for Sikkim<sup>26</sup>' by the Sikkim Govt.:** On 11 May 2023, SSDMA and the Health Dept. have jointly launched a programme 'Resilient Health Infrastructure for Sikkim'. First phase of this programme has sensitized more than 500 hospitals staff on disaster risk management, vulnerability assessment and resilience. In next phase, the government intends address the vulnerabilities New STNM and four district hospitals to increase their reliability during disasters. Additional financial support to the Sikkim Govt. for implementing this programme will ensure higher resilience of health infrastructure.
- **Multi-hazard resilience measures for upcoming health infrastructure:** Sikkim is constructing major hospital projects at Singtam, Namchi, Mangan, Gyalshing, and Pakyong with combined capacity of about 900 additional beds. Proactive risk assessment and mitigation measures can be taken to ensure that upcoming facilities are resilient from potential hazards including earthquake.
- **Advance logistics systems:** Due to adverse geographical terrain and frequent disruption of roads in Sikkim, transportation of patients and medical supplies leads to loss of critical time and assistance. Modern transport solutions like Air ambulances using helicopters and heavy-duty drones for supplies are becoming technically and commercially more feasible. These options are likely to become necessities during 2024 monsoon seasons as many areas may not be get connected through all-weather roads. Unit cost of a heavy-duty drone of 10 kg payload and 1 hour flying time and its accessories is about Rs 50,00,000<sup>27</sup>.

#### Long term strategy (up to 12-36 months)

- **Safe hospitals in safe zones:** Physiological changes in the Teesta basin and rise of riverbed may lead to new risks in future. As government develops new policy for risk mitigation, it should ensure that critical infrastructure like health care facilities is in low risks zones.
- **Reliable early warning and telecom services:** The early warning received from the ITBP personnel leading to successful evacuations highlights the importance of early warning and telecom services for disaster response. Providing early warning systems and telecom services with higher redundancy to health system will help in more prompt and effective response.
- **Retrofitting of health infrastructure in line with latest standards and guidelines:** Indian Public Health System (IPHS) guidelines mandates that existing and new health infrastructure to be upgraded with latest building codes, especially for fire and seismic hazards.
- **Integration of fire safety personnel at hospitals:** Fire is most common and impactful hazard for hospitals. Currently in Sikkim, fire safety at hospitals is managed by electrical departments with inputs from district fire department. It is important to have dedicated fire personnel at all major hospitals to ensure adequate planning and monitoring.



- **Promote health insurance:** To minimize the impact of disaster on health expenditure by people and the state, health insurance programmes from the Central government and private sector should be promoted. Existing scheme of Su-Swasth yojna may be expanded to cover all health workers.
- **Promote Travel health insurance for tourists:** A significant number of people impacted by disasters are often tourists. The state should vigorously promote Travel and Health insurance to reduce burden of responses for tourists. The proposal can be discussed with Dept. of Tourism.
- **Integration of disaster management in medical courses:** The success of disaster preparedness and mock drills in Sikkim makes a case for inclusion of related courses in relevant professional degree programmes, including medical and engineering courses.
- **Sustainable and green energy solutions:** Damage to hydel power project and power supply lines has highlighted the energy vulnerability of Sikkim. To building redundancy in power supply, along with generators, small scale solar and other green energy solutions can be explored.

### Recovery cost estimate

Implementing recovery strategy suggested in the previous section has two aspects –

- **Recovery of health services and their impact on health indicators:** As per reports, there is no major health service disruptions and health indicators. So far, the Health Department has restored service continuity (such as vaccinations, health access, etc.) affordability, and outreach through existing departmental resources.
- **Recovery and augmentation of health infrastructure and facilities:** Considering the impact on health infrastructure, future risks in coming monsoon seasons and other hazards, there is need to augment health facilities with higher resilience. In addition to Reconstruction/repair and Replacement estimates reported in previous sections, additional resources and funds will be required to help the state build back better its health infrastructure. A proforma estimate is provided along with specific recovery needs prepared in discussion with the Department of Health.

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<sup>26</sup>Resilient Health Infrastructure Programme launched, Sikkim Herald, Govt. of Sikkim, [https://sikkim.gov.in/uploads/SikkimHerald/May\\_20\\_BUDGET\\_0\\_20230522.pdf](https://sikkim.gov.in/uploads/SikkimHerald/May_20_BUDGET_0_20230522.pdf)

<sup>27</sup><https://shotkit.com/drone-cost/>; and inputs from Throttle Aeroagency.

**Annexure Table:** Recovery needs along with required funding support.

<b>Table 39. Health Sector: Overall recovery need estimate for health sector</b>			
<b>Sl</b>	<b>Items</b>	<b>Estimate (Rs)</b>	<b>Remarks</b>
	<b>Augment infrastructure at district hospitals for Casualty Management</b>	<b>1,78,60,000</b>	<b>Required at</b>
	Cost of constructing a new mortuary replacing old mortuary (approx. 110 sqm, @ Rs 37660 per sqm)	40,00,000	Mangan DH
	Dead body preservation fridge (capacity 8-12)	23,10,000	Mangan DH
	Post-mortem equipment with electric saw	14,00,000	Mangan DH
	Embalming machine	7,00,000	Mangan DH
	Hearse vehicle, (6 Nos., one for each district, Unit rate Rs 15,00,000)	90,00,000	State level
	Repair of mortuary with Civil Works at Gyalshing District Hospital	3,00,000	Gyalshing DH
	Repair of mortuary with Civil Works at Namchi District Hospital	1,50,000	Namchi DH
<b>B</b>	<b>Augment infrastructure and facilities at hospitals higher response capacity</b>	<b>2,82,20,000</b>	
	Drone (heavy duty with carrying capacity of 15 kg)	50,00,000	State level
	ALS ambulance 1 Nos. (unit cost all-inclusive Rs 60,00,000)	60,00,000	State level
	BLS Ambulance (2 Nos); (Unit cost all equipment inclusive Rs 45,00,000)	90,00,000	State level
	Diesel generator 10 kVA for district hospitals (3 Nos., Unit rate Rs 3,70,000)	11,00,000	State level
	Diesel generator 1.5 kVA for CHCs (Unit rate Rs 40000)	12,00,000	State level
	Diesel generator 5 kVA for PHCs (14 nos. Unit rate Rs 1,80,000)	25,00,000	State level
	Inverter 2.5 kVA with batteries for sub centres, (20 Nos. Unit rate Rs 50000)	10,00,000	State level
	Collapsible stretcher (two in each PHC, and ten per district hospital), Unit costs Rs 50000.	1,60,000	State level
	Foldable tents with accommodation for at least four foldable beds (one in each PHC); Unit cost for bed 20000;	15,00,000	State level
	B type oxygen cylinder, 40 Nos. (Unit cost Rs 13700)	5,50,000	State level
	Walkie – talkie (standard range, 1 set)	2,10,000	State level
<b>C</b>	<b>Capacity building of Hospital staff, and community on Disaster Preparedness and awareness</b>	<b>34,90,000</b>	

	Training of first aid team at every PHSC and Gram Panchayat Unit (6 Nos. 2-day training workshop over 2 years 1 for each district, Cost of 1 training workshop Rs 40000)	2,40,000	State level
	Training of rapid response team at every PHC, CHC, and Urban Health and Wellness Centres (1 Nos. 2-day training workshop for five major hospitals annually 2 years; Cost of 1 training workshop Rs 75,000)	7,50,000	State level
	AV equipment and IEC materials for continuous display of Disaster preparedness messaging and awareness (for each PHC, CHC and major govt. hospitals); For STNM Rs 9,00,000; for 4 district hospitals Rs 4,00,000 each)	25,00,000	State level
<b>D</b>	<b>Risk Mitigation and resilience measures: To support Sikkim Govt. on-going Programme. - 'Resilient Health Infrastructure for Sikkim'</b>	<b>1,80,00,000</b>	
	Funding support for Govt's ongoing programme 'Resilient Health Infrastructure for Sikkim' by SSDMA and Dept. of Health. Next phase focuses on undertaking interventions for structural, non- structural, and functional vulnerabilities of major hospitals. New STNM Rs. 40,00,000; 4 district hospitals Rs 15,00,000 each)	1,00,00,000	State level
	Undertake comprehensive multi-hazards (including earthquake, flash floods) vulnerability assessment of major existing and upcoming hospitals. New STNM Rs. 20,00,000; 4 district hospitals 7,50,000 each)	50,00,000	State level
	Equip the Public Health Engineering Departments (PHED) with tools/kits for structural health monitoring and effective maintenance of hospital buildings. Equipment include Thermal scanner for seepage and leaks, Concrete penetration radar, etc.)	30,00,000	State level
	<b>Total (Recovery needs)</b>	<b>6,75,70,000</b>	
	<b>Recovery needs in Crore</b>	<b>6.76 Crore</b>	

The PDNA estimate for the health sector is about 2% of the State's Annual Budget for the health sector. Hence, majority of the measures can be implemented directly by the Health Department in coordination with SSDMA.

<b>Table 40. Recovery and Reconstruction Needs for Anganwadi and Community Buildings</b>		
<b>Sl</b>	<b>Interventions</b>	<b>Estimate (Rs in Crore)</b>
1		1.92 Crore
2	Repair of Gram Panchayat buildings	0.20 Crore

3	Reconstruction of Crematorium	2.8 Crore
4	Provide support for converting Rented Anganwadi to Government owned Anganwadi by construction child friendly Anganwadis @ 11 Lakh per Anganwadi	1.21 Crore
5	Conduct an assessment of the affected community to identify the level of trauma for each community member where possible.	1 Crore
6	Support Anganwadi Workers/ Helpers and non-family caregivers with Psychosocial support to play an effective role in forging normalcy in the community.	2 Crore
	<b>Total R&amp;R needs</b>	<b>9.13</b>

Total recovery and reconstruction need for Anganwadi, and community buildings is estimated to **9.13 Cr** which includes, reconstruction and repair of physically damaged Anganwadi, provision of equipment and other resources, reconstruction of gram panchayat buildings and reconstruction of Crematorium. The recovery needs also include supporting assessment and Psychosocial support for long term recovery and resilience building.

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## 4. Productive Sector

### 4.1 Agriculture and Horticulture

Agriculture is the main driver of the rural economy of the State with an estimated 60% of the total population's livelihood depending majorly on income from agricultural activities. Out of 1,29,006 households in Sikkim, 93,288 are rural households dependent mostly on farm income. Small and marginal farmers account for 79% of the total cultivators but own only 39% of the cultivated area. The average land holding of small/marginal farmer in the state is 0.62 Ha.

While a fragile ecology, low production and productivity remains a reality of the state, it is capitalizing more on its inherent strength of organic farming. The net sown area in the state is 70280 ha and gross cropped area is 83975 ha with a cropping intensity of 120%. The cultivable wastelands comprising of current / other fallows is 8794 ha. This offers scope for crop diversification and for bringing new area under cultivation.

The shrinking land asset, rising per unit cost of cultivation, decreasing net income, fragmented land holdings coupled with low productivity are the constraints being faced by the farmers of the State.

In order to harness the collective bargaining power of small and marginal farmers, provide easy access to technology, credit and market promotion, farmers' aggregates, collectivization of agricultural produce and formation of FPOs (Farmers' Producers Organisations) would be the most effective solution to achieve sustainable economies of scale and enhance farm incomes.

#### Sectoral Policies

The State has an Organic Farming policy, and it is being implemented on a mission mode since 2010. The State has been declared as India's "First Organic State" on 18th January 2016 by the Honorable Prime Minister of India. Government of Sikkim has initiated various measures like Promotion of FPOs, Organic Certification and marketing interventions like "Buyer-Seller" meets, marketing outlets, processing/value addition for organic produce.

In Sikkim, total 76 clusters areas have been identified for FPO promotion and out of which in 28 clusters FPOs have been promoted and additional 28 are being planned under the Mission Organic Value Chain development (MOVCD) covering about 8500 farmers.

NABARD has supported promotion of 17 FPOs in the state of which 05 FPOs are under the Central Sector Scheme. Identified FPOs have been successfully linked with marketing interventions involving retail outlet, exhibitions and buyer seller meets.

The subsidy programmes of National Horticulture Board are also available in the State for cultivation of horticultural crops.

#### Damages in the Sector

The flash floods affected four districts of Mangan, Gangtok, Pakyong and Namchi along both bank of river Teesta. However, no agricultural crop or land damage has been reported from Pakyong district. The flash floods moved at a rapid pace in a linear manner destroying all standing structures including annual and perennial crops in its way. 618 farmers are affected with 497 ha of agricultural land fully damaged and 9.76 ha partially damaged. In the absence of exact quantification, and the low degree of materiality of the partially damaged area which is only 2% of the total area damaged, the losses has been estimated at 50% from partially damaged area i.e.4.88 ha. The total crop area loss is 502ha.

<b>Table 41. Agriculture sector : Details of Damage to Land</b>					
<b>District</b>	<b>Cropped Area Ha</b>	<b>Area Fully damaged Ha</b>	<b>Area Partially damaged</b>	<b>Area Partially damaged taken at 50% Ha</b>	<b>Net area damaged Ha.</b>
Mangan	443.52	420.05	0	0	420.05
Gangtok	38.94	34.68	3.47	1.74	36.42
Namchi	52.99	42.28	6.29	3.15	45.43
<b>SikkimTotal</b>	<b>535.45</b>	<b>497.01</b>	<b>9.76</b>	<b>4.88</b>	<b>501.89</b>

The damage to the land includes land erosion, deposit of heavy boulders and silt on the land. The filed visits revealed that the sedimentation of silt and debris is several feet high. The soil profile of the sedimentation is similar to plain cement rendering most of the areas difficult to reclaim. The removal of heavy debris and caked silk will require the use of heavy earth mover machinery and substantial labour to manage the operations. It is assumed that the work can be completed before the next crop sowing season in June/July if recovery efforts are mounted early. However, the cleared land will need to be subjected to soil reclamation efforts including the use of microbial infusions and is estimated to take at least one year. This means that one additional year of income is expected to be unavailable to the farmers from the affected areas.

The main crops affected are large cardamom and paddy at 322 ha and 109 ha respectively followed by 69 ha of mandarin. The damage to mandarin and cardamom gardens has significant impact on crop restoration as these are long terms crops which takes almost 6 to 8 years to reach full yield stage. This cost is in addition to the land restoration cost. The total replanting of perennial crops is estimated to cost Rs. 990.70 Lakh and the soil restoration cost is estimated at 1505.68 Lakh. The replanting of perennial crops as well as cultivation of annual crops is expected only in June/July of 2025. The State has informed that power supply system to an agri-produce processing centre has been lost at a cost of Rs.150.00 Lakh.

<b>Table 42. Agriculture Sector: Overall Damage Numbers in Hectare</b>					
	<b>District</b>	<b>Totally Damaged</b>	<b>Severely Damaged</b>	<b>Partially damaged taken at 50% of reported area)</b>	<b>Total</b>
Annual Cropped Area damaged Ha	Mangan	84.73		0.00	84.73
	Pakyong	0.00		0.00	0.00
	Gangtok	29.76		0.54	30.30
	Namchi	17.32		2.65	19.97
Sub-Total		131.81		3.18	134.99
Perennial Cropped	Mangan	335.32		0.00	335.32

Area damaged Ha	Pakyong	0.00		0.00	0.00
	Gangtok	4.92		1.20	6.12
	Namchi	24.96		0.50	25.46
Sub-Total		365.20		1.70	366.90
Damage to power supply system at agro processing centre	Mangan				
	Pakyong				
	Gangtok	1			1
	Namchi				
Sub-Total		1			1

**Table 43. Agriculture Sector : Overall Damage Cost Estimate in Crore**

Particulars	District	Totally Damaged	Severely Damaged	Partially damaged	Total Damage Estimate
Total damages to perennial crops (Replanting cost @ NABARD Unit Cost for 2023-24) (Rs. Lakh)	Mangan	948.14		0.00	948.14
	Pakyong	0.00		0.00	0.00
	Gangtok	6.56		1.62	8.18
	Namchi	33.70		0.68	34.38
<b>Sub-total</b>		<b>988.40</b>		<b>2.30</b>	990.70
Soil desilting/debris clearance cost for damaged areas	Mangan	1050.13		0.00	1050.13
	Pakyong	0.00	0.00	0.00	
	Gangtok	86.70	4.34	91.04	
	Namchi	105.70	7.86	113.56	
<b>Sub-total</b>		<b>1242.53</b>		12.20	<b>1254.73</b>
Soil reclamation cost for damaged areas	Mangan	210.03		0.00	210.03
	Pakyong	<b>0.00</b>	0.00	0.00	



Gangtok	17.34		0.87	18.21	
Namchi	21.14		1.57	22.71	
<b>Sub-Total</b>		<b>248.51</b>		<b>2.44</b>	<b>250.95</b>
Damage to power supply system at agro processing centre	Mangan				
	Pakyong				
	Gangtok	150.00			150.00
	Namchi				
<b>Sub-Total</b>		<b>150.00</b>			<b>150.00</b>

### Economic Losses in the Sector

As stated earlier, 613 farmers were affected by the floods. The total estimated losses from the standing annual crops washed away almost at harvest-ready stage is estimated at Rs.1633.68 Lakh and the loss from the perennial crops is computed at Rs. 375.97 Lakh. As explained, the next crop can be taken only after 18 months taken for silt/debris removal and reclamation. Hence, the farmers shall lose their income for one additional season as far as the annual crops are concerned. The replanting of the perennial crops can also be done only after 18 months. Both large cardamom and mandarin have an average gestation time of 3 years resulting in the farmers suffering income losses for three additional years till the new crop start yielding. The detailed computation of the economic losses in the crop sector is given below in Table 44

<b>Table 44. Agriculture Sector: Overall Economic Loss Estimate in Crore</b>				
<b>District</b>	<b>Totally Damaged</b>	<b>Severely Damaged</b>	<b>Partially damaged</b>	<b>Total Damage Estimate</b>
Mangan	2226.80		0.00	2226.80
Pakyong	2655.29		21.16	2676.45
Gangtok	0.00		0.00	0.00
Namchi	440.66		53.37	494.03
<b>SUB TOTAL</b>	<b>5322.76</b>		<b>74.52</b>	<b>5397.28</b>

The loss from annual crops lost is estimated at Rs. 1687.86 lakh and that from perennial crops is Rs.404.31 Lakh for the crop season 2023-24, totalling Rs. 2092.17 Lakh Crore. However, due to the heavy damage, no agricultural activities other than clearing and restoration is envisaged till crop season 2024-25 leading to an additional stoppage of cropping activity-based income for one additional season. Given this effect the total losses from entire crop sector is estimated to be two times the annual loss computed as Rs.4184.35 Lakh. In the case of the perennials, the major crops damaged are Large Cardamom and Mandarin, both of which will take at least 3 years to yield after fresh planting. Hence an additional amount of Rs.1212.93 Lakh will not be available to farmers during this period. Therefore, the gross effect of the floods by way of economic losses of income from standing crops is estimated at Rs. 5397.28 Lakh.

It is important to mention here that no expenditure towards annual crop cultivation is expected for the annual crops and hence any compensation, if envisaged for future losses, need to be paid only at maintenance levels as a percentage to income from annual crops. For the purpose of recovery costs, this is assumed to be 10% of per season income at Rs.209.21 Lakh.

### Socio-Economic Impact on People.

The flash floods resulted in extensive damage to agricultural lands on the banks of river Teesta but remained confined to a small linear width on both sides. The total area damaged was 066% of the net sown area in the State affecting about 0.72% of the rural population. Thus, the overall impact of the disaster from an economic point of view remained limited. The Social impact has two major dimensions. A significant area of the agriculture lands on the riverbank were cultivated by oral- tenant farmers and only the rest is by the owners. Unfortunately, the statistics of this division is not available. Based on interactions with the community, it is possible to peg the owner cultivation between 30 to 50 % and rest by the oral tenants.

<b>Table 45. Agriculture Sector: Number of Farmers affected</b>			
<b>District</b>	<b>Agriculture &amp; Horticulture Annual Crops</b>	<b>Agriculture &amp; Horticulture Perennial Crops</b>	<b>Total</b>
Mangan	314	49	363
Gangtok	102	20	122
Namchi	111	22	133
<b>Sikkim</b>	<b>527</b>	<b>91</b>	<b>618</b>

Another socio-economic dimension is that there is a widespread practice of sharing the proceeds of the cash crops on a 50% sharing basis between the landowner and the tenant while the annual cereals and other crops are not shared. On this basis it can be seen that the economic impact of the disaster is largely suffered by the tenants.

The State may take a compassionate approach to compensate the tenants and provide options to rehabilitate them in alternate livelihoods. The cost on re-skilling, compensation etc., is not computed in the crop sector.

In terms of economic losses due to loss of income and the damages to crops, land and property, the sector reports a total effect of Rs.8043.66 Lakh. Out of this, the total losses amount to Rs.5397.28 Lakh and damages account for Rs.2646.38 lakh.

<b>Table 46. Agriculture Sector : Components of Damages and Losses ( In Crore)</b>					
<b>Sub-sector</b>	<b>Damage</b>	<b>Losses</b>	<b>Total effects (Lakh)</b>	<b>Ownership</b>	
				<b>Private</b>	<b>Public</b>
Crops					
Components of damage	26.46		26.46	24.96	1.50
Components of losses		53.97	53.97	53.97	
<b>Total crop sector</b>			<b>80.43</b>	<b>78.93</b>	<b>1.50</b>

## Reconstruction and Recovery Needs Assessment

The expenses for reconstruction constitute of cost of replacing the power supply system damaged at Rs.195 Lakh. The recovery costs are based on strategies to restore organic agriculture in the damaged lands on Build Back Better basis. This includes replanting of perennial crops under good agricultural practices basis at Rs.990.70 lakh, soil restoration at Rs. 878.32 Lakh and provision of training and inputs. A compensation of Rs.309.00 Lakh is envisaged for crop losses. Apart from this the State has to take steps to introduce better quality of seeds/planting materials as well as adopt modern crop production techniques in the area bearing mind the fact that the entire area will become new-to-crop after restoration. It is proposed that a modern nursery may be centrally established in each of the affected districts for which an outlay of Rs. 37.50 lakh is proposed. A sum of Rs.24.72 lakh is proposed for training of farmers and supply of inputs.

The total recovery and reconstruction cost is estimated at Rs. 3122.16 Lakh.

### Reconstruction Cost Estimates

In the Agriculture sector (agriculture and horticulture), the only reported damage to property/infrastructure that was intimated to the PDNA team is the damages to the power supply system at an Agro-Processing Centre. The cost of damage is estimated at Rs.150 Lakh and the reconstruction cost on a build back better basis is considered at 30% higher expenditure at Rs.195.00 Lakh.

Another damage which can be considered under reconstruction is the damage to the perennial crops which require replanting at a total cost of Rs.990.70 Lakh. However, this is part of the livelihood restoration process and do not come strictly under reconstruction definition. Hence considered under the recovery chapter.

Table 47. Agriculture Sector : Reconstruction Cost estimate ( In Crore)	
Particulars	In crore
Reconstruction of damaged power supply system at processing centre on build back better basis Rs. Lakh	1.95.00
Total reconstruction cost Rs. Lakh	1.95.00

### Recovery Cost Estimates

The total recovery cost is estimated at Rs. **3122.16** Lakh. It is proposed that compensation to the farmers may be provided at the rate of 10% of the annual losses for two seasons at an outlay of Rs.

418.42 Lakh. The major costs are related to desilting/ debris clearance at Rs. **627.37** Lakh and replanting of perennial crops Rs.990.70 Lakh. Soil reclamation measures will need to be taken for restoring the soil properties favourable to agriculture and an amount of Rs.250.95 Lakh is provided. The recovery strategy envisages comprehensive re-establishing of the organic farming practices. Therefore, trainings for farmers in organic agriculture, soil reclamation, organic inputs production etc., are suggested. The establishment modern nurseries for supply of good quality planting material are planned at a total cost of Rs.37.50 Lakh. As vermiculture is an integral part of organic agriculture, outlay of Rs. **463.50** Lakh is proposed for establishing production facilities at each farm as proposed under the Government of India's RAFTAAR scheme with people's participation. The affected farmer with annual crops is expected to suffer crop-based income losses for two seasons and that of perennial crops for almost 5 seasons. Even the annual crops are expected to regain the pre disaster yield levels only after a few years of restoration of farming. Therefore, financial and training support for alternative livelihood options are included in the recovery strategies at Rs. **309.00** Lakh. Other interventions are training to farmers and supply of organic inputs at a combined cost of Rs.24.72 Lakh.

**Table 48. Agriculture Sector: Recovery Cost Estimate ( In Crore)**

Particulars	Amount Rs. Crore
Compensation for crop losses @ 10% of one season loss for two seasons	4.18
Assistance for alternate livelihood options like dairying, poultry or micro-enterprise units at average unit cost of Rs. 0.50 lakh	3.09
Vermicompost pits @ Rs.0.75 Lakh per unit	4.64
Supply of Organic inputs for 618 affected farmers @ Rs.2000/- per farmer	0.12
Total cost of crops damaged computed at replacement cost: Rs. Lakh	9.91
Cost for Soil desilting/debris clearance in damaged areas @ Rs.1.25 L per Ha.	6.27
Soil reclamation cost for damaged areas at 0.50 lakh per ha.	2.51
Cost of training of farmers in better farming practices (618* Rs.2000/-) Rs. Lakh	0.12
Establishment of seedlings nursery for supply of adequate, high quality planting materials @ 1 nursery per affected district	0.38
<b>Total Recovery cost</b>	<b>31.22</b>

### Impact of Recovery

The recovery efforts suggested are expected to redeem all the damaged land to agricultural use. The suggested skill training programs will result in improving farming practices and increase in yield, production and quality of produce leading to better than pre-disaster incomes to the farmers.

### Implementation mechanism

**Table 49. Agriculture Sector: Implementation mechanism**

Line Departments	Department of Agriculture and Department of Horticulture
Partner	Public Works department and Department of Power
Funding Sources	Partly funded by State Government and partly from Disaster Relief Funds in addition to the funds that have to brought by landowners.
Modalities of Assistance	State Finance and Disaster Relief Funds

## 4.2 Animal Husbandry and Livestock

### Basic Profile of the Sector

The Animal Husbandry sector in Sikkim is the primary employer and income source for small and marginal farmers, complementing agriculture. Over 80 percent of rural households in the state own livestock, with small-scale producers dominating, holding nearly 85 percent of all livestock and poultry species. Over the past four decades, the Animal Husbandry and Veterinary Services in Sikkim have experienced remarkable growth, evident in enhanced animal health management and advanced veterinary practices<sup>28</sup>. Livestock farming has become a crucial source of income and employment in rural Sikkim, contributing not only to household earnings but also supporting crop production and offering full-time occupations that optimize human resources.

The significance of livestock farming extends to providing balanced nutrition through milk and playing a pivotal role in employment generation, particularly in self-employment, with a notable participation of women, especially in the challenging hilly terrain. The primary responsibility of the Animal Husbandry Department lies in supporting local farmers by providing essential infrastructure, including demonstration farms, germplasm stock, feed godowns for highlander livestock, seed banks, veterinary healthcare centers, and livestock processing centers. These infrastructural provisions aim to enhance livestock productivity, protect against diseases through preventive and curative healthcare facilities, develop farmers' skills through modern and scientific animal husbandry training programs, and maintain demonstration farms and marketing initiatives. Despite operating on less than 55 percent of farmland, these farmers practice a mixed crop-livestock system, generating substantial incomes and enriching family diets with nutrient-rich animal products.

The gross state domestic product was 11,16,510 lakh during 2011-12 with livestock sector growth of 14.68 % which increased to 36,82,497 lakh in 2021-22 with a growth of 17.58 %. The size of the livestock sector was 0.68% which became 1.26% in 2021-22.

The Animal Husbandry sector being a primary employer and income source for small and marginal farmers, state is rich with a decent amount of available species and animals. According to the 20th Livestock Census– 2019, poultry has a high existence of a total of 5,80,864 in the state, thereafter, cattle, goats and pigs respectively. However, district-wise wise count of the species/animals is almost similar except in the north district. The below tables provide a glimpse of the same.

District	Cattle	Buffalo	Yak	Sheep	Goat	Pig	Total Livestock
East	46,864	87	1,509	103	29,238	7,351	83,643
North	11,918	49	3,616	337	3,595	2,053	17,952
South	46,558	151	0	591	27,079	9,021	83,400
West	42,670	857	94	985	30,594	8,895	84,001
Sikkim	1,48,010	1,144	5,219	2,016	90,506	27,320	2,68,99

<sup>28</sup> Report On Rebuilding and Resilient Building of AH & Livestock Sector, Government of Sikkim  
<sup>29</sup> Tabulated 20<sup>th</sup> Livestock Census State data on Livestock and Poultry

## Livestock Asset Value<sup>30</sup>

In the fiscal year 2020-2021, the livestock sector made a substantial contribution to the Gross State Domestic Product (GSDP), accounting for 13.2% at current prices. Within the agriculture domain, milk emerged as the predominant produce, surpassing even maize in production volume. The organized sector alone facilitated the direct transfer of Rs. 45.5 Crore to dairy farmers annually through milk sales. Furthermore, dairy farmers benefit from an additional incentive of over 12 crore directly transferred to them. The state also boasts a thriving poultry industry, with approximately 100 Crore in business related to poultry. Specifically, 2000 households are actively engaged in broiler production, contributing significantly to the state's economy. Dairy farming, a crucial component of the agricultural landscape, involves around 15,000 farmers in the state. Impressively, the state secures the 12th rank in milk per capita availability, reflecting the significance of the livestock sector in both economic and nutritional aspects.

## Animal Husbandry & Veterinary Service Department (AH&VS Department)

The AH&VS Department's core function is to boost the production of essential commodities like milk, meat, eggs, and wool. By doing so, it aims to meet the increasing demand for animal protein in the human population. Additionally, the department is tasked with enhancing aspects related to livestock production, animal health, preservation, and safeguarding livestock and poultry development <sup>31</sup>.

## Importance Of Animal Husbandry Sector

- Small and marginal farmers, landless labourers and women are more dependent on livestock farming for supplementing incomes and generating gainful employment in rural areas.
- Livestock farming is an important source of income and employment in rural areas. They contribute to household income besides assisting crop production.
- This sector provides full-time occupation in some cases at the location itself with better utilization of human resources.
- It provides balanced nutrition in the form of milk, egg and meat besides farm power.
- Livestock farming plays a major role in providing employment, especially self-employment with high participation of women.
- Farm animals are a source of cash income and are considered as "Moving Bank".

Rural prosperity is now more dependent on per capita livestock ownership than on farms. This implies that the growth of the livestock sector would have more effect on poverty reduction than the growth of the crop sector

## Sectoral Policies

Department of Animal Husbandry and Veterinary Services of Sikkim have various schemes and programmes. The following table provides a glimpse into the important schemes and programmes of the department. These schemes/programmes will be useful for resilience building and long-term recovery in the Area of Animal Husbandry & Livelihoods.

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<sup>29</sup> Source: 20th Livestock Census– 2019, All India Report; Government of India, Ministry of Fisheries, Animal Husbandry & Dairying, Department of Animal Husbandry and Dairying, Animal Husbandry Statistics Division

<sup>30</sup> Animal Husbandry & Veterinary Services Department Government Of Sikkim

<sup>31</sup> <https://ahvssikkim.in/aboutus/about-us>

S.No	Scheme/ Programme	Description
1	<b>Veterinary Services</b>	The Veterinary Services & Animal Health deals with the entire Animal Disease control programme of the state.
2	<b>Sikkim Livestock Development Board (SLDB)/Cattle And Buffalo Development And Breeding</b>	<p>Sikkim Livestock Development Board (SLDB) is an Autonomous Body under the Animal Husbandry &amp; Veterinary Service Department and is extensively involved in the breeding activities of cattle and buffaloes and in lesser extent to yaks of the state there are two major schemes under which SLDB functions and these are:</p> <p><b>a) Rashtriya Gokul Mission (RGM).</b></p> <p>Under RGM Sikkim Livestock Development Board Carries Out Various programs such As Artificial Insemination, Natural Service, Conservation of Siri Cattle, Training Of Maitris, Awareness Camps, Fertility Camps Etc.</p> <p><b>b) National Livestock Mission (NLM).</b></p> <p>Under the National Livestock Development Board, SLDB has been looking after the Activity Of Cattle Insurance, thereby Benefitting Local Cattle Rearers Directly In Case of Cattle Death.</p>
3	<b>National Livestock Mission</b>	<p><b>a) National Livestock Mission, Sub-Mission on Skill Development &amp; Technology Transfer</b></p> <p>The sub-mission on skill development &amp; technology transfer under National Livestock Mission (NLM) intends to develop the entrepreneurs, livestock &amp; poultry farmers to adopt animal husbandry rearing and marketing skill development, technology transfer through classroom training, field training, hands on training, live demonstrations, field visits for learning practices, awareness camps and orientation camps. under this program, livestock farmers, interested entrepreneurs, educated unemployed youths, officers of different capacities, para veterinarians, AI workers, and pashu sakhis are imparted various need-based training/skill development, technology transfer, etc.</p> <p><b>b) National Livestock Mission, Submission On Livestock Insurance Scheme</b></p> <p>Under this scheme, insurance of dairy cattle is done where subsidy to BPL and APL beneficiaries @ 90% and 70% respectively are given. the scheme also covers permanent total disability (PTD) if fails to produce milk due to any reason except old age, the beneficiary is entitled to 70% of the total claim. through this scheme, the management of risk and uncertainties is guaranteed by providing protection mechanism to the farmers against any eventual loss of their animals due to death or being unproductive. it also provides financial security to the farmers in case of loss of the animal.</p>



		<p><b>c) NIM, Sub-Mission on Feed and Fodder Development Programme</b></p> <p>In order to maintain dairy cows properly an availability of roughages in the form of green fodder, silage, hay straw etc. in the right amount and at the right time is very important. but usually under Sikkim condition, there is severe scarcity of quality and quantity of green fodder. therefore, the department is implementing this program through NLM for distribution of hand-driven chaff cutters, small silo units and transfer of technology for the progressive dairy farmers of Sikkim.</p>
4	<b>Poultry Development Programme:</b>	<p>The Poultry Development Programme Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Assistance for Poultry Development (CSS)</li> <li>• Promotion of Poultry Entrepreneurs</li> <li>• Poultry Estate for Poultry Development</li> <li>• Rural Backyard Poultry Development (NLM)</li> <li>• Sub-Mission on Livestock Development</li> <li>• Sikkim Hatcheries Ltd., Bermiok, South Sikkim</li> </ul>
5	<b>Sheep, Wool and Goat Development</b>	<ul style="list-style-type: none"> <li>• Extension of Sheep Breeding Centers</li> <li>• Conservation of Sheep and Goat Population</li> </ul>
6	<b>Piggery Development</b>	<p>Piggery Development Under National Livestock Management Programme Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Sub-Mission on Piggery Development in the North Eastern Region (90:10% CSS)</li> <li>• Intensive Piggery Development</li> <li>• Indigenous Pig Conservation Programme</li> <li>• Pig Production Incentive Scheme</li> </ul>
7	<b>Other Livestock Development:</b>	<p>Other Livestock Development Under National Livestock Management Programme Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Strengthening &amp; Conservation of Indigenous Goat</li> <li>• Conservation &amp; Strengthening of Banpala Sheep.</li> <li>• Establishment of Nucleus Farm of Barbari / Jamunapari / Beetal / Jhakran</li> <li>• Conservation of Highly Threatened Yak/Banpala Sheep Species</li> <li>• Facilitating of Various Bankable Credit Subsidy Scheme</li> </ul>
8	<b>Fodder and Feed Development</b>	<p>Fodder and Feed Development Under National Livestock Management Programme Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Fodder Sapling Distribution and Demonstration</li> <li>• Feed &amp; Fodder Seed Procurement and Distribution (90:10% CSS)</li> <li>• Sub-Mission on Feed and Fodder Development</li> <li>• Livestock Feed, Pasture Development &amp; Area Expansion</li> <li>• Mineral Mapping &amp; Farm Mechanisation</li> </ul>

9	<b>Extension and Training</b>	<p>Extension and Training Under National Livestock Management Programme Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Farmers Training and Extension Programme</li> <li>• Establishment of Regional Veterinary Training Centre</li> <li>• Strengthening of Extension and Training</li> </ul>
10	<b>Investigation &amp; Statistics, Dairying, Monitoring &amp; Quality Control</b>	<p>Administrative Investigation &amp; Statistics Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Integrated Sample Survey For Estimation of Production of Major Livestock Products (90:10% CSS) &amp; Survey and Investigation</li> </ul>
11	<b>Dairy Development</b>	<p>Dairy Development Under Performs the Following Functions:</p> <ul style="list-style-type: none"> <li>• Milk Incentive Scheme</li> <li>• Sikkim Milk Union</li> <li>• North Dairy</li> <li>• Dentam Cheese Plant</li> </ul>
12	<b>Monitoring and Quality Control</b>	<p>Monitoring and Quality Control Performs the Following Function to Provide Hygienic, Safety Arid Meat And Meat Products</p> <ul style="list-style-type: none"> <li>• Construction of Modern Abattoir, Mazitar,</li> <li>• Construction of Poultry Processing Unit, Melli Dara, South Sikkim</li> </ul> <p>Experts Must Reach out to Relevant Line Departments to Understand Vicarious State and Central Government Policies and Must Establish Linkages to these Relevant Schemes In Later Sections.</p>

## Damages in the Sector

### Farmers and Pet Animals

The recent devastating GLOF-induced Flash Flood has caused unprecedented destruction and loss of human and animal lives, and it equally has the post-disaster potential for tremendous effects on animal welfare and marginalized farmers who are solely dependent on livestock. During such natural disaster animal component plays a significant role in mitigating post-disaster impact. In Sikkim, most farmers have only one or two cows and perhaps a few goats and each animal is critically important to the household economy. During such disasters, the main problems with livestock, companions and stray animals are injury, displacement, starvation and post-disaster traumatic syndrome. According to the department officials, the majority of the animals were in trauma, homeless and some were orphaned. Generally, animals are left to fend for themselves during such disasters.

The after-math situation in Rongpo and Singtam area was chaotic and many people and animals have lost their lives. About 100% of the households from the IBM area had moved to the relief camps. Most of the people kept pet animals, however, a lot of stray dogs were left behind. Some of the animals were injured, some displaced, and some were starving as there was no access to proper food, water and veterinary aid. Most animals were found to be traumatized which was an important issue to address. The AH&VS Department being an advocate on matters pertaining to the relief of suffering and distress of animals, the Veterinary relief team immediately responded to the disaster. In a proactive move to alleviate the suffering of animals and the welfare of farmers, the Government of Sikkim, through the Animal Husbandry & Veterinary Services Department has instituted processes to ensure the care of the household and stray animals.

### Departmental Infrastructures and Animals

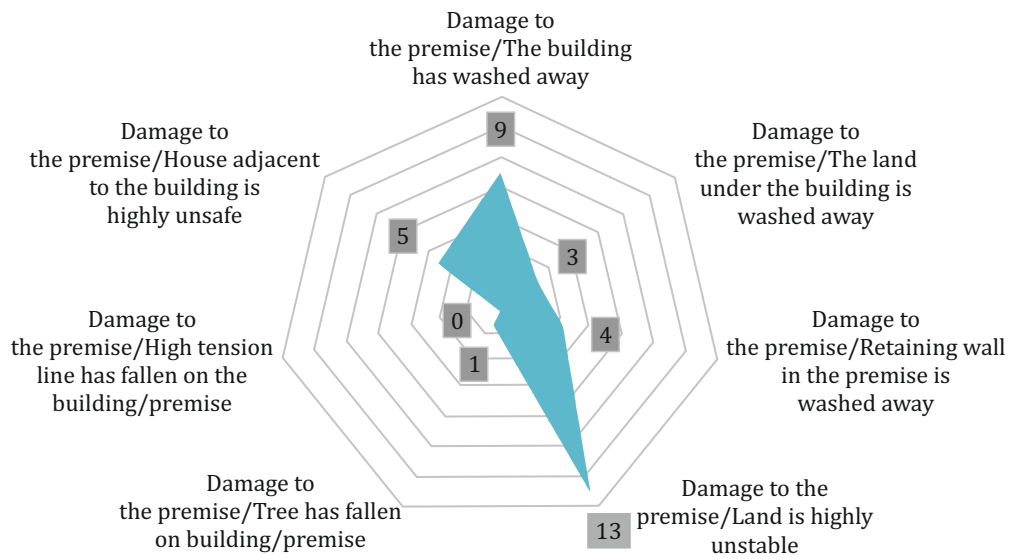
Animal Husbandry & Veterinary Services Department has set up substantial numbers of infrastructures and assets all across the state and prominently in northern and eastern parts of Sikkim. The majority of these infrastructures have sustained massive damage, and some have been swept away by the recent catastrophic GLOF-induced Flash Flood. Moreover, the AH&VS Department is also engaged in supporting Yak herders and Rabbitry farmers in higher areas of North Sikkim through infrastructure development, health care, genetic upgradation, feed and fodder, etc. and some of the infrastructure has also been severely damaged or swept away by the flash flood. The infrastructures and assets including farm animal sheds and fisheries suffered heavy damage. The majority of damaged infrastructures and other allied activities were mostly of Yak, Dairying, Rabbitry, Sheep, Piggery, Slaughter Houses, and Fisheries. The following tables provide the details of animal livestock and fisheries damages followed by the table on the infrastructure damages and employment loss.

<b>Table 51. Animal Husbandry and Livestock : Damages in Animal Husbandry and Fisheries Sector</b>							
<b>Animal Husbandry Damages</b>							
	Cattle	Sheep	Goat	Pig	Poultry	Calf	Rabbit
Total	148010	2,016	90,506	27,320	580,864	-	-
Damages	547	<b>62</b>	664	586	7252	51	200
<b>Fisheries Damages</b>							
	Rainbow Trout	Brown Trout	Yearling fish	Advance Fingerling	Trout	Carps	
Damages	50 (75 kg)	20 (30 kg)	127 (63 kg)	10200 (510 kg)	5105 (678 kg)	2702 (108 kg)	

### Structural Damages – Animal Husbandry & Fisheries

The extent of structural damages remained relatively low, as the disaster unfolded in a linear pattern, with its impacts predominantly concentrated along the course of the Teesta River. The following graph highlights the structural damages in the animal husbandry and fisheries sector.

## Structural Damages - Animal Husbandry & Fisheries



Structural Damages – AH & L and Fisheries



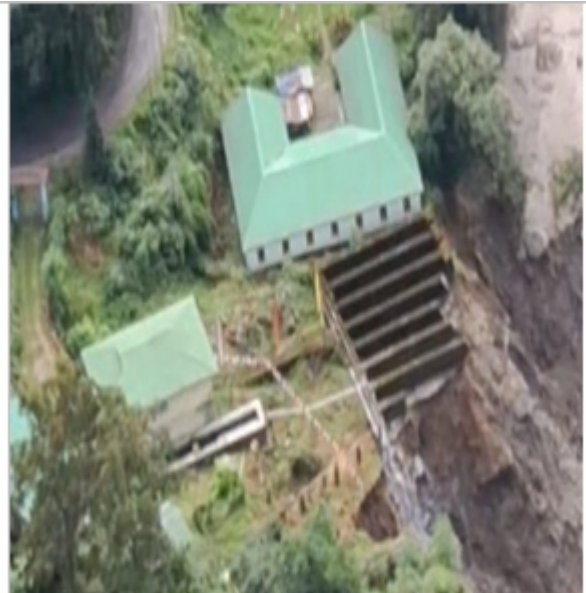




*Damaged Pig Cages (private) and temporary shelter for the Rabbits (Government)*

### **Trout Farm cum Hatchery Unit, Rabum, Lachen**

The part of 14 Nos. of Raceways has been washed away along with the land on which it rested. The water supply has also been damaged. The following pictures provide a glimpse of the damage to the sector.





Before



After

Table 52. Animal Husbandry and Livestock: District Wise Damage and Replacement Cost ( 1 crore)								
Damages and Replacement Cost (AH & L + Fisheries + Structural Damages) = (5.6+17.78) = 23.38 Crore								
Damages - Details								
	Goat	Sheep	Pig	Cow	Calf	Poultry Hen	Rabbit	Total
Gangtok	78		38	10	1	395	0	522
Mangan	154	62	309	479	40	1450	200	2674
Namchi	202	0	37	43	8	1736	0	2026
Pakyong	230		202	15	2	3671	0	4120
GrandTotal (No.)	664	62	586	547	51	7252	200	9362
Replacement Cost – AH (Rs.5.55 Crore)								
	Goat	Sheep	Pig	Cow	Calf	Poultry Hen	Rabbit	
Damage Cost	15000	30000 (Tibetan sheep)	5000	72000	10000	75	2000	
Gangtok	1170000	0	190000	720000	10000	29625	0	
Mangan	2310000	1860000	1545000	34488000	400000	108750	400000	
Namchi	3030000	0	185000	3096000	80000	130200	0	
Pakyong	3450000	0	1010000	1080000	20000	275325	0	
Grand Total (Rs.)	9960000	1860000	2930000	39384000	510000	543900	400000	

<b>Table 53. Animal Husbandry and Livestock: Replacement Cost Fisheries (In crore)</b>						
<b>Replacement Cost – Fisheries (Rs. 0.11 Crore)</b>						
	Rainbow Trout	Brown Trout	Yearling fish	Advance Fingerling	Trout	Carp
Damages	50	20	127	10200	5105	2702
Weight	75	30	63	510	678	108
Total Replacement (Rs.)	60000	24000	50400	408000	542400	43,200
<b>Replacement Cost (AH &amp; L +Fisheries)</b>						<b>Rs. 5.6 Crore</b>

<b>Table 54. Animal Husbandry and Livestock: Overall Infrastructure Damage (In crore)</b>									
Sector	District	Totally Damaged			Severely Damaged			Total	
		No.	Area (Sq.M)	Total (crore)	No.	Area (Sq.M)	Total (crore)	No.	Area (Sq.M)
<b>Animal Husbandry &amp; Livelihoods</b>	Mangan	7 - structure	3125	10.221875	2 - structure	96	0.157008	9	3221
	Pakyong	-	0	-	-	-	-	-	-
	Gangtok	-	0	-	-	-	-	-	-
	Namchi	-	-	-	-	-	-	-	-
	Mangan	30-tanks; 1-structure	280	2.7091588	-	-	-	30-tanks; 1-structure	280
<b>Fisheries</b>	Pakyong	2-structures	584	1.910264	17-tanks; 2-structure	777	0.1531.2707835	17-tanks; 4-structure	1478 1361
	Gangtok	1-structure	100	0.3271	14 tanks	-	0.126	14-tanks; 1-structure	100
	Namchi	-	-	-	-	-	-	-	-
	<b>Total</b>		<b>4089</b>	<b>16.075119</b>		<b>873</b>	<b>1.7067915</b>		<b>9440</b>
<b>Total Amount</b>								<b>17.7819105</b>	



Economic Losses = **Rs. 11.38**

Detail out the overall economic losses suffered in the sector, mention how it was estimated and tabulate overall economic losses in the sector. Some of the sectors might not have any economic losses.

Economic Losses 11.38							
Table 55. Animal Husbandry and Livestock : Economic Losses in AH& L ( In crore)							
	Goat	Sheep	Pigs	Cow	Calf	Poultry-Hen	Yak
Loss Cost	14000	7200	10000	108000	10000	750	1800
Gangtok	1092000	0	380000	1080000	10000	296250	0
Mangan	2156000	446400	3090000	51732000	400000	1087500	33250000
Namchi	2828000	0	370000	4644000	80000	1302000	0
Pakyong	3220000	0	2020000	1620000	20000	2753250	0
Grand Total	9296000	446400	5860000	59076000	510000	5439000	33250000

**Methodology for Calculation: Damage & Losses Rates – Animal Husbandry and Livelihoods**  
**Replacement Cost**

Table 56. Animal Husbandry and Livestock: Unit Cost assumption for replacement cost		
Animal/Poultry	Average adult animal/poultry Weight/ Age/Milk	Replacement Cost (Rs.)
Goat	Female - 12000 and male Rs. 15000/-	15000
Sheep	Tibetan Sheep (mostly Tibetan)	30000
Pig	50 KG Pig- Female - 4500/- Male- 5000/-	5000
Cow	Cow- 6000/- litre i.e for a cow in 2nd lactation and calf on foot with 10-12 litres a day (Rs. 60000-72000)	72000
Calf	1 year	10000
Heifer Calf	15-18 months	25000
Poultry-Hen	chick	75
Lamb	baby	10000
Angora Rabbit		2000

# Replacement on a little higher end as there are intangible losses too i.e. trauma etc.

## Economic Losses

Table 57. Animal Husbandry and Livestock: Methodology for assumption for Economic Loss		
Animal/Poultry	Annual Income	Explanation
Goat	14000	A goat will give birth twice in 1 year. On selling the kids male kids are sold at approximately @Rs.7000 and female kids at Rs.6000 approximately. So, 1 adult female goat will come to around Rs 28000 approx (Including 14000 meat cost) 700 PKG X 20 kg=14000
Sheep	800  10000+800  Rs.10000 (average on higher end)	Sheep 25 KG x 800 Rs. PKG = 20000 - Wool is sold @ Rs. 400/kg. Approx. 2 kg produced per annum = 400 x 2 = 800  Female is 12000/-  - gives birth to 1 lamb once a year (lamb cost Rs. 10000)  - Wool is sold @ Rs. 400/kg. Approx. 2 kg produced per annum = 400 x 2 = 800
Pig	15000 10000	Pork 50 KG x 300 Rs PKG (5000 is replacement cost)
Cow	1,08,000	1 milch cow will on average give 10 litres per day which will be sold @Rs 60 per liter. In a year 300 days of lactation period, the income will come to Rs.1,08,000 + manure + 1 calf each year (not calculated)
Yak	250000	Herd =15 Yak = butter, cheese, other products = 250000 Total 2000 yak affected *15 = 133 133*250000= 3,32,50,000
Infrastructure Damages		The approach used by Animal Husbandry & Livelihood and Fisheries for assessing building damages mirrors the housing sector's methodology. It involves determining the pre-disaster construction cost by multiplying INR 40,888 per sq m by a factor of 0.8, resulting in INR 32,710 per sq m. To calculate damage, the pre-disaster construction cost per sq m is multiplied by a factor of 1 for completely damaged buildings, 0.5 for severely damaged ones, and 0.15 for partially damaged structures.  Tank cost -9 Lakh per tank for totally damages. 4.5 for severely damaged.

## **Socio-Economic Impact on People.**

The consequences of Glacial Lake Outburst Floods on individuals relying on animal husbandry and fisheries-based livelihoods are significant and diverse. Numerous families experienced intense losses, including 9362 animals and poultry, along with 15610 fisheries.

The majority of the rural population depends on animal husbandry and fisheries for their sustenance. Approximately 80 percent of rural households in the state are engaged in livestock ownership, predominantly consisting of small-scale producers who own nearly 85 percent of all livestock and poultry species. The GLOF disaster severely disrupted their livelihoods, thus, recovery is expected to be a little time-consuming process as it includes risk mitigation measures alongside reconstruction efforts.

The structural damages incurred highlight the necessity of understanding the underlying causes. Land use planning emerges as a critical factor, given that a substantial portion of the infrastructure was situated near the riverbed. Interactions with locals revealed an awareness of unsafe construction practices along the river, indicating a positive behavioural shift within the communities.

A considerable portion of the population used to reside in rental houses along with their livestock. Currently, they face challenges as they don't have suitable accommodations where they can keep their animals and livestock. Many have been relocated to safer places in other rental houses, however, space constraints for animals and livestock pose a significant challenge.

The October 2023 disaster extends its impact beyond tangible losses to affect the mental health of the affected populations. The intensity of the disaster, coupled with unprecedented losses of family, friends, and animals, has left a lasting psychological impact. Moreover, a substantial number of individuals employed in the animal husbandry, livestock, and fisheries sectors have become unemployed, exacerbating the hardship faced by the affected communities.

## **Response by the Government**

### **Response Measures:**

- The Animal Husbandry and Veterinary Services department constituted a veterinary team to ensure the proper veterinary aid and the rehabilitation of the victims. This includes setting up temporary shelters, providing food and water, and offering veterinary care as needed. The team has provided extensive support to marginal and poor farmers. Along with livelihoods and sustenance, animals are also a source of food and nutrition. Considering the importance and immediate needs, the department has taken care of the health aspects of the animals.
- The veterinary team established animal relief and rescue camps and treated numerous injured animals. Thereafter, rehabilitation activities have been initiated. The affected communities have also faced psychological challenges which have been also addressed by the department. The Department has also undertaken measures to manage the potential spread of diseases associated with animals. The veterinary team dedicatedly worked towards the distribution of food, and fodder to affected areas and guaranteed that livestock received the nourishment they needed to survive and thrive. The action saved the stability of local daily industry and safeguarded the livelihoods of the affected farmers.
- The high-altitude regions of Sikkim are home to diverse wildlife, including Angora Rabbits and Yaks. Through collaborative initiatives, a number of Angora rabbits were effectively rescued, and impromptu shelters were set up in higher elevations. A comprehensive aid strategy has been implemented, involving the supply of mineral mixtures for relocated livestock, visits by

a team of doctors and support staff to evaluate livestock losses and provide assistance, distribution of pet food, and the provision of kutti/chaffed straw. These endeavours exemplify a well-rounded approach to fulfilling different requirements and safeguarding the overall welfare of the impacted animals.

- Dedicated rescue and emergency shelter initiative was undertaken for animals in distress. Feed and water were supplied to the displaced livestock in various locations. Stray animals were mass-fed in Singtam, Rongpo, Dikchu, and Bardang. Multiple rescue teams were deployed to locate and aid stranded animals. Makeshift shelters were established for pigs at J.P Company, Serwani, pigs were rescued from there and sheltered at SARAH, Gangtok. The team promptly disposed of animal carcasses and disinfected areas, including IBM, Rongpo.

### **Lost and Found Pet Services**

- The Department implemented a centralized system for reporting lost and found pets, aiming to facilitate the reunification of owners with their animals. This system ensures a streamlined process for reporting, making it easier to locate lost pets and promptly provide care for animals found in distress.

### **Animal Welfare Hotline:**

- The Department introduced an animal welfare hotline, staffed by trained professionals 24/7, to report distressed animals. Collaborating with local authorities and organizations, the Department focuses on ensuring the safety of animals affected by flash floods. Advisories have been issued to guide the safeguarding of animals. Various institutions, in coordination with NGOs and community support, provide uninterrupted health services for animals in flood-affected areas, including feeding stray animals. The Department also works to guarantee a steady supply of feed for livestock, offering support to farmers. To address potential disruptions caused by flash floods, the Sikkim Milk Union has contingency plans in place, ensuring an uninterrupted supply of milk and related products to consumers.

### **Reconstruction and Recovery Needs Assessment**

The disaster resulted in loss of income through animal products and damage to infrastructure and livestock assets, including the deaths of more than 547 cows, over 7000 chickens, 586 pigs, 664 goats and 62 sheep. The worst affected districts were Mangan, Namchi, Gangtok and Pakyong. Likewise, the fisheries sector also had severe damage to fisheries and infrastructure. A total of 18204 damages happened to the fisheries with an estimated total loss of Rs.23.38 crore including structural damages.

Reconstruction and recovery efforts within the animal husbandry and fisheries sector will adopt a comprehensive approach. This strategy emphasizes restoring damaged assets, reconstructing infrastructure, investing in mitigation measures, aiding livelihood recovery, and developing eco-tourism assets. It aims to create a roadmap for inclusive resilience-building efforts, focusing on scientific precision and ecosystem-centered approaches to improve people's livelihoods. The implementation plan will prioritize diversifying livelihoods to foster sustainable development in Sikkim including exploring alternative livelihood options. Collaborative partnerships between departments will be established to coordinate efforts effectively. This strategy's potency will be strengthened by leveraging existing schemes and resources of the Government of Sikkim.

## Reconstruction Cost Estimates

The norms for reconstruction cost have been estimated as per the cost decided by the housing sector which has been fixed in consultation with the engineers of the Sikkim Housing and Development Board, RDD and the Department of Education, the reconstruction cost of a finished pucca buildings with internal wiring and toilet was decided to be Rs 37,660/sqm inclusive of BBB features, which is the market rate and as per the specifications of the GoS. The unit cost of reconstruction is based on the assumption that the reconstructed buildings would either be RCC- framed structures or confined masonry, the latter being more sustainable. Any other resilient structural system with a low carbon footprint should be encouraged in reconstruction. However, such systems must have structural validation. The total reconstruction cost of the damages came to **36.14 crore**. A total of 15 structures + 61 tanks related to the AH &L and Fisheries Department are affected.

## Recovery Cost Estimate = 39.51 Crore

Animal Husbandry and Livestock: Overall recovery Cost Estimate (In Crore)					
Recovery Measures	District	Numbers	Average Cost	Recovery Cost Estimate (In Crore INR)	Early recovery / Medium to Long Terms Recovery
Replacement to damages (Animals/poultry loss)	All affected districts	-	-	5.67	Short Term Recovery
Psychological support	All affected districts	All affected districts	This will be taken care of by the Medical Dept	-	Short Term Recovery
Financial support to losses because of income loss through animals	All affected districts	-	-	11.38	Medium Term Recovery
Implementing flood control measures	All districts		This can be taken care of by the PWD/Irrigation Dept/SSDMA	-	Medium Term Recovery
Need to encourage the farmers and Department to keep a diverse livestock population	All districts	-	This will be done by the department through existing programmes – Extension & Training Programme.	-	Medium Term Recovery

Adaptive Breeding Programs	All districts	-	This will be done by the department through existing programmes – Extension & Training Programme.	-	Medium Term Recovery
Establishment of kennels and sheds	All districts	31 constituency	12 lakh for one shed (At the moment no sheds for DM purposes)	3.72	Medium Term Recovery
Emergency Medicine Stock for Readiness	All affected districts	409	019 (each district)	.077	Medium Term Recovery
Revised Risk Assessment	State level	-	This can be taken care of by the DRR section	-	Long Term Recovery
Setting up of various farms/infra in less disaster impact vulnerable locations	All districts	All vulnerable settlement	Need counselling through awareness generation programme-extension & training cell / SSDMA Capacity building and awareness programmes	-	Long Term Recovery
Resilient Infrastructure	All districts	35	Need to translocate, or rebuilt	17.78	Long Term Recovery
Connectivity with the Early Warning Systems	All AH & L offices	All AH & L offices	This can be done by SSDMA + solar power satellite phone, Hotline	-	Long Term Recovery

Education and Training	All districts	AH &L officials & Communities	In coordination with SSDMA capacity-building programmes	-	Long Term Recovery
Emergency Response Plans	All districts	4	EMP/DMP for all districts	0.03	Long Term Recovery
Insurance and Risk Management	All districts	All vulnerable settlements	In coordination with AH &L Dept	-	Long Term Recovery
Research and Innovation (DRM Cell)	All districts	All districts	Establishment of a Unit – 3600000 [3 years (2 experts 50000x 2 = 1 lakh PM)]	0.36	Long Term Recovery
Resources for an immediate response- Instruments etc ##	All districts	All districts	In coordination with AH &L Dept	0.5	Long Term Recovery

- Pre-emptive natural disaster mitigation measures involve a range of logistical, equipment, and medical assistance requirements to ensure effective preparedness and response.

#### **Logistics:**

- Transportation: Adequate transportation is crucial for the rapid deployment of resources and personnel to affected areas. This includes vehicles for moving personnel, equipment, and supplies.

#### **Equipment:**

- Secure transportation resources, including trucks and trailers, to facilitate the evacuation of livestock.
- Stockpile necessary supplies, such as feed, water, and bedding, at evacuation sites.
- Equipment such as generators, portable fencing, and lighting to support emergency operations.

#### **Medicines and veterinary emergency response team**

- Stockpiling medical supplies, including first aid kits, medications, and surgical equipment, is crucial for treating injuries and preventing the spread of disease
- Veterinary emergency response team capable of providing medical assistance to injured or stressed animals.



## Possible Impact of Recovery

Resilience within the animal husbandry sector holds paramount importance in mitigating the repercussions of natural disasters. The proposed recovery intervention, when executed in tandem with the suggested reconstruction measures, plays a pivotal role in rejuvenating the livelihoods of communities heavily dependent on animal husbandry and fisheries. The envisioned livelihoods strategy aims to enhance the resilience of the affected population, taking a proactive step beyond mere recovery and reconstruction. These strategies are formulated based on insights gleaned from the lessons learned during the GLOF incident of October 2023. The following table provides an idea about the proposed interventions for resilience building in the state of Sikkim.

By embracing this approach, a smooth transition to resilience is anticipated. Concurrently, it will facilitate a secure settlement strategy for both humans and the diverse domains of animals, poultry, and fisheries. Following are the recovery interventions designed to reinforce the resilience of the Animal Husbandry and Livelihoods (AH&L) and Fisheries Sectors.

Recovery Intervention	Initiative	Descriptions
RI-1	Animal Husbandry & Livestock and Fisheries focused Risk Assessment	<p>To conduct an Animal Husbandry &amp; Livestock and Fisheries focused Risk Assessment to understand various risks related to AH &amp; L and Fisheries. Detailed risk assessment to be integrated within State and District Disaster Management Plans.</p> <p>This Assessment will also be important to identify the safer locations for settlement planning and to precisely understand and analyze the possible impacts of disasters like GLOF and other state-specific disasters.</p>
RI-2	Setting up of high-risk farms/infrastructure in safe locations	<p>Encouraging this shift to higher ground is a strategic measure to reduce vulnerability to potential disasters. Higher ridges offer a natural elevation that can safeguard AH and livestock facilities from the adverse effects of river-related events, helping to protect both infrastructure and animals. This relocation strategy aligns with resilience-building efforts, emphasizing the importance of adapting to the geographical and environmental dynamics of the region.</p>
RI-3	Diverse livestock population	<p>Diversity in the livestock population offers several advantages. Different species and breeds may exhibit varying levels of resilience to diseases, climatic changes, or other environmental challenges. This diversity acts as a form of insurance, ensuring that if one segment of the population faces a threat or succumbs to a particular issue, others may remain unaffected or less impacted.</p>

RI-4	Adaptive Breeding Programs	Encouraging farmers to embrace diversity in their livestock holdings not only contributes to the overall robustness of the agricultural system but also aligns with sustainable farming practices. By preserving and promoting various breeds adapted to different conditions, contributes to the conservation of genetic diversity within the livestock sector.
RI-5	Improved Infrastructure	Robust infrastructure is a fundamental component of disaster preparedness. Constructing buildings, storage facilities, and other essential structures with materials and designs that withstand adverse weather conditions and disasters enhances the overall resilience of the agricultural sector. Locating these infrastructures away from vulnerable areas, such as flood-prone zones, further mitigates potential risks.
RI-6	Early Warning Systems	The development and implementation of early warning systems for disasters are critical for large infrastructures and veterinary centers, ensuring timely evacuation or protective measures for both livestock and farmers. It is imperative that these systems are robust and effective, considering the vulnerability of animals and the limited time available for evacuation in some situations. Additionally, incorporating renewable energy sources, such as solar power, is essential for enhancing the reliability of these warning systems.
RI-7	Education and Training	Providing regular training on disaster preparedness and response strategies is crucial for farmers and field functionaries. These training sessions serve as a proactive approach to equip individuals with the necessary skills and knowledge to effectively handle emergencies. Additionally, educating livestock owners on recognizing signs of stress or illness in animals is essential for enabling early intervention, especially during and after disasters.
RI-8	Emergency Response Plans	Establishing a Veterinary Relief and Rescue Team within the department is a proactive measure that enhances the department's capacity to respond swiftly during disasters. This specialized team should be trained and equipped to address veterinary emergencies, providing immediate assistance to animals in distress. Their prompt deployment can significantly contribute to the well-being of livestock and help in minimizing the long-term impact on the agricultural sector. The emergency response plans should include detailed procedures for evacuation, shelter management, communication strategies, and allocation of resources. By clearly delineating roles and responsibilities, these plans enable a quick and effective response to unfolding situations, minimizing the risk to both livestock and farmers.
RI-9	Tools and Logistics	Ensuring a well-prepared response to natural disasters in the agriculture and livestock sector involves the availability of various tools and logistics. These essential resources include a mobile clinic staffed with veterinary professionals and equipped with necessary medical supplies for on-site health assessments and treatments for distressed animals. Additionally, a mechanized chain pulley is indispensable for safe and efficient animal rescue operations, minimizing the risk of injury to both animals and rescue teams.

RI-10	Kennels and Sheds	Establishing kennels and sheds in each Sub-Divisional and District Veterinary Hospital is a crucial step for enhancing rescue and rehabilitation capabilities, particularly during and after natural disasters. This infrastructure will serve as dedicated spaces to house and care for animals in need of rescue or rehabilitation.
RI-11	Insurance and Risk Management	Promoting the uptake of insurance programs among farmers to cover losses arising from natural disasters is a key strategy for enhancing financial resilience. Encouraging farmers to invest in insurance provides a safety net, helping them recover economically in the aftermath of disasters. Additionally, exploring risk management strategies is crucial to further bolster financial recovery for farmers affected by such events. Note: The scheme is there for dairy animals but not for all kinds of livestock. Pig, goats have very short lifespans, so insurance is tough as insurance companies don't take interest.
RI-12	Sustainable Land Management	Implementing sustainable land management practices is essential for preventing soil erosion, improving pasture quality, and maintaining overall ecosystem health. These practices play a vital role in enhancing the resilience of the animal husbandry sector and promoting sustainable agriculture.
RI-13	Research and Innovation	Nodal agencies, including the Indian Council of Agricultural Research (ICAR), Krishi Vigyan Kendras (KVKs), and collaborative efforts with the Department, should actively engage in research initiatives aimed at developing innovative technologies to enhance the resilience of livestock to natural disasters. Embracing advancements in monitoring systems and data analytics is crucial for early threat detection and effective disaster management. Engaging in more scientific studies is crucial for gaining a deeper understanding of the complex correlations between various factors. This approach involves systematic research and analysis to uncover relationships, causations, and patterns.
R 14	Capacity Building	Conducting emergency management exercises at both the block and gram panchayat (GP) levels is crucial for enhancing preparedness and resilience, particularly in addressing emergencies like Glacial Lake Outburst Floods (GLOFs) and flash floods. Capacity building initiatives across all Gram Panchayat Units (GPUs) in Sikkim are essential for fostering resilience, and the engagement of civil societies further strengthens community participation.
R 15	Community-Based Disaster Management (CBDM)	The livelihood and lives of the locals are severely impacted due to disasters. The examples and understanding of cascading hazards in HKH region (of which Sikkim is a part) clearly indicate that plans and policies are required with people's participation in a bottom-up approach. The regions falling under HKH require regional cooperation and local community involvement. Increasing understanding and awareness of flash floods across communities, professionals, and policymakers at various levels will improve readiness.

R 16	Fodder Management for Emergencies	Planning for the feeding requirements per animal is a crucial aspect of effective disaster management, especially in relief camps. This approach ensures that the nutritional needs of animals are adequately addressed, promoting their health and well-being in the aftermath of a disaster.
R 17	Animal Health Camps	Planning for animal health camps is indeed crucial for effective post-disaster management, especially in situations where animals may be vulnerable and in need of medical attention.
R 18	Management of Carcass	Carcass management planning is indeed crucial for systematically disposing of dead animals in the aftermath of disasters, as it helps minimize the risk of both animal and human health hazards. Proper disposal is essential to prevent the spread of diseases, contamination of water sources.
R 19	Vaccination of Animals	The practice of pre and post-flood vaccination of animals is indeed a crucial aspect that should be integrated into the planning efforts of relevant departments. This approach contributes significantly to the overall health and well-being of livestock populations in flood-prone area.
R 20	Flood Mitigation Measures	Constructing flood-retaining walls and similar mitigation structures at strategic locations is indeed crucial for protecting communities and animal sheds from the devastating impact of floods. These structures play a vital role in minimizing future losses and enhancing overall resilience.
R 21	Flash Flood Modeling	Utilizing flash flood modeling and hazard mapping is a proactive and effective approach to identify areas susceptible to Glacial Lake Outburst Floods (GLOFs) and other disasters. This information can inform the establishment of land use guidelines and construction regulations, particularly in regions where animal husbandry and livelihoods are at risk. Implementing these measures in collaboration with local stakeholders enhances their effectiveness.
R 22	Alternate Livelihood Options	Exploring alternative livelihood options in Sikkim is a practical approach, especially considering the scarcity of land and the challenges faced by individuals who have experienced land loss. This initiative serves a dual purpose by providing alternative means of sustaining livelihoods and facilitating the relocation of those individuals who have lost their animals and need to move away from vulnerable locations.

## 4.3 Tourism

### Basic Profile of the Sector

Sikkim, situated among the Himalayan states of India, stands as a prominent advocate for mountain tourism in the northeastern region. As indicated by the report from the Forest and Environmental Department of the Sikkim government, the state boasts the largest forested area, covering a remarkable 82.31% of its geographical expanse. Categorized into Reserve Forest, Khasmal, and Gorucharan, Sikkim's diverse forests contribute significantly to its scenic allure. Revered as a place of sheer enchantment, Sikkim isn't merely the most stunning destination globally; it also stands out for its cleanliness and safety. The state's allure, once confined to mist-shrouded landscapes, majestic mountains, and vibrant butterflies, has now expanded to encompass tangible development and progress. Sikkim, with its distinctive culture and unspoiled natural panorama, epitomizes perfection and pristine beauty.

Nestled in the Himalayas, and blessed with abundant natural resources, Sikkim emerges as a biodiversity and development hotspot. Despite its modest size, Sikkim has gained global recognition as a crucial repository of germ plasmas of unparalleled dimensions. The scenic grandeur of Sikkim unfolds at every twist and turn of its roads, presenting a spectacle unrivaled in any other part of the world. Despite being landlocked, Sikkim holds strategic importance and stands as one of the most beautiful states in the Indian Union. Bordered by Nepal, Bhutan, and Tibet on three sides, and sharing boundaries with the sister state of West Bengal, Sikkim's natural beauty becomes a magnet for tourism<sup>32</sup>.

Tourism plays a pivotal role in the economy of Sikkim, providing livelihoods for a significant portion of the local population. The warm hospitality of the Sikkimese people contributes to the state's reputation as a welcoming and tourist-friendly destination. The livelihoods of the local population are intricately intertwined with tourism and agriculture, with a substantial 70% relying on tourism for their economic sustenance. It's evident that tourism plays a crucial role in the economy of Sikkim, not only in providing livelihoods for a significant portion of the local population but also in contributing to the state's.

Gross State Domestic Product (GSDP). The substantial contribution of tourism to the GSDP, accounting for 7.9% in the year 2021-2022, further emphasizes its significance in the economic landscape of Sikkim. A robust tourism sector not only provides direct employment in areas such as hospitality, transportation, and entertainment but also stimulates related industries and services, leading to a multiplier effect on the overall economy.

Sikkim is a pioneer in sustainable tourism practices, with a focus on eco-friendly measures and responsible tourism. The state's commitment to preserving its natural and cultural heritage ensures a harmonious coexistence between tourism and the environment. Sikkim's tourism profile is a tapestry of natural beauty, cultural diversity, and adventure, making it a must-visit destination for those seeking a harmonious blend of serenity and excitement<sup>33</sup>.

### Sectoral Policies

Sikkim, the 22nd State of the Indian Union, synonymous as World's 1st 100% Organic State, is a resolute in setting its benchmark as the most coveted Tourism Destination in the country. Tourism in Sikkim has seen a rapid growth over the years, there has been an extraordinary increase in tourist arrival in the State.

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<sup>32</sup> Tourism Department Report, Sikkim

<sup>33</sup> <http://www.sikkimtourism.gov.in/Public/index>

The augmentation of world class tourism infrastructure, assurance of quality standards in services of tourism service providers and promotion of responsible sustainable tourism has garnered aplenty laurels and accolades for Sikkim Tourism, from across the world in the last 25 years.

The foresight of the State Government to make significant advancements in the Tourism Sector has not only seen significant growth in GSDP of the state, but has also ensured sustained fiscal receipts, employment, environmental sustainability and partnerships for development right from the grassroots to the urban sphere. The State is also harnessing the vast untapped Rural Tourism potential by giving higher impetus on rural tourism so that its multiplier benefits reaches out directly to the rural masses. The rural tourism concept is fast growing in Sikkim as a responsible and sustainable tourism product with critical social objectives through people's participation

Eco-Tourism being aggressively propagated by planning of tourism related activities with optimum environmental care and keeping in view the principles of conservation and sustainability. While planning of tourism infrastructure, due care is also taken to ensure that the tourism products being created are self-sustained and they are in harmony with nature, culture and heritage of Sikkim. The major steps adopted by the State Government in promoting eco-tourism includes:-

- Ban on use of plastic bags,
- Declaration of Sikkim as 'Organic State'
- Scientific method for disposal of Solid Waste,
- 'Green Mission' and 'Ten minutes to Greenery' as mega plantation programme,
- Gangtok is 'Spit and Litter Free Zone' and all public places as 'No smoking Zone',
- Use of garbage bags in the vehicles,
- "Ban on Grazing" for conservation of green belts,
- Tourist Police for safety of the tourists and maintain DO's and DONT's,
- Capacity building for tourism facility providers and drivers,
- Extensive propagation of 'Green Sikkim-Clean Sikkim',
- Complete ban on disposal of waste in the water crossings/streams
- Ban on single use plastic water bottles of 2litres or less
- Ban on use of fire crackers

All of above policy interventions has helped Sikkim gain the status of Clean n Green hill station which in turn has impacted the flow of tourist to the state.

### **Damages in the Sector**

The Teesta floods on 4th October 2023 pose a significant threat to the tourism sector in the affected region. However, there are no direct infrastructure damages but the damages to the interconnected sectors have greatly influenced the losses in the tourism sector. Following are the kinds of impacts encountered by the sector:

- Infrastructure Damage: The floods have resulted in the destruction of critical infrastructure, including bridges, roads, and the Teesta III Dam. This has led to the isolation of towns and cities, making it difficult for tourists to access popular destinations and hindering transportation within the region.
- Stranded Tourists: With thousands of tourists stranded across Sikkim, there is a negative impact on the overall tourism experience. Travel disruptions and the lack of mobility can create a sense of insecurity among tourists, potentially discouraging future visits.

- **Attraction Inaccessibility:** Many transportation networks, including Chungthang, Dikchu, Singtam, Rangpo, Melli, and Teesta Bazaar, have suffered extensive damage. The inaccessibility of these areas not only limits the tourism in the state but also diminishes the appeal of the region.
- **Natural Landscape Alterations:** The flood has likely caused changes to the natural landscape, affecting the scenic beauty that attracts tourists to Sikkim. Landscapes altered by the flood may not offer the same aesthetic and recreational value, impacting the overall tourism experience.
- **Negative Public Perception:** Natural disasters can lead to negative media coverage and public perception. Reports of the floods and their aftermath may dissuade potential tourists from choosing Sikkim as their destination, as concerns about safety and infrastructure reliability may arise.
- **Economic Impact:** The tourism sector is a significant contributor to the local economy. The disruption caused by the Teesta floods not only affects tourism-related businesses directly but also has a ripple effect on other sectors that depend on tourist spending, such as hospitality, transportation, and local markets.
- **Rebuilding and Recovery Period:** The time required for rebuilding and recovery efforts can be lengthy. During this period, the tourism sector may experience a downturn, as attractions remain closed or are undergoing reconstruction. The uncertainty surrounding the timeline for recovery can further deter potential visitors.

### Economic Losses in the Sector

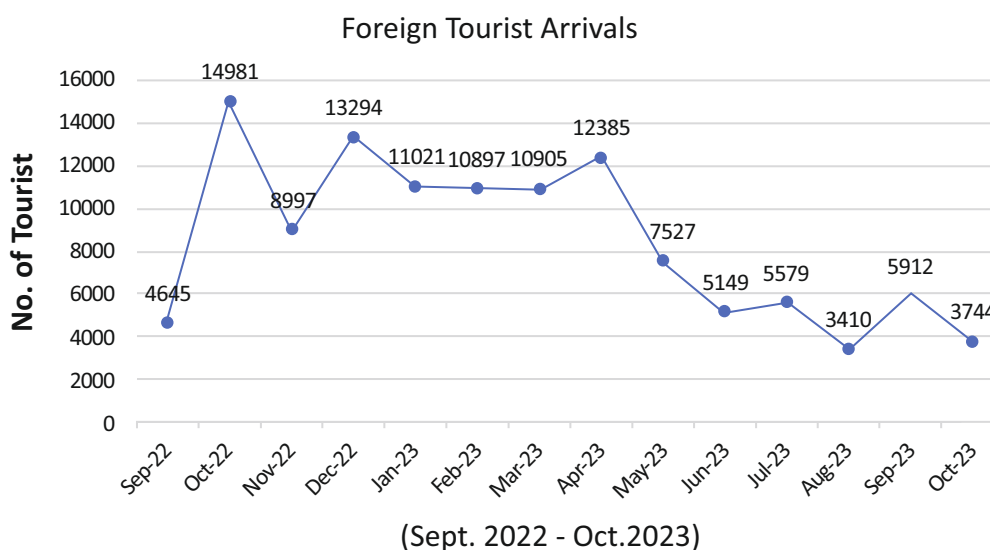
Sikkim heavily relies on tourism, with 70% of its population engaged in the industry as a primary source of income. The peak tourist seasons, attracting both domestic and foreign visitors, are from September to December and March to May. Notably, the northern parts of Sikkim, including Lachen, Lachung, and Yumthang, draw substantial tourist numbers during these peak periods. However, a somber shift in the tourism landscape became evident when comparing the tourist data of both domestic and international between September 2022 and October 2023 (refer Table 4.1 & 4.2 respectively). During this timeframe, the state experienced a dramatic decline in tourist arrivals, and a stark contrast emerged when compared to previous years. The primary catalyst for this downturn was the unfortunate occurrence of the Teesta Floods, which had a profound impact on the region.

**Table 4.1:** Domestic Tourist Arrival Data (Between Sept. 2022-Oct. 2023).





**Table 4.2:** International Tourist Arrivals (Between Sept. 2022 - Oct.2023).



The disaster significantly deterred both domestic and foreign travelers from venturing into the state. The aftermath of the floods created an atmosphere of caution, causing a notable drop in tourist numbers. This unfortunate natural disaster not only disrupted the usual ebb and flow of tourism but also emphasized the vulnerability of the region to such environmental challenges. This year, Sikkim faced a devastating flash flood, leading to severe consequences. The flash flood caused extensive landslides in the northern part of the state, completely isolating the region and causing widespread damage. This catastrophic event not only impacted tourism businesses in North Sikkim but also affected the entire tourism sector of the state. Pre-booked package tours for both North and other parts of Sikkim had to be canceled by tourists. Hoteliers and homestay operators faced the challenge of refunding advance payments to clients as they had to cancel room reservations. Tourist taxi drivers were also severely affected, struggling to repay loans obtained from various banks. During the flash flood, tourists on North Sikkim tours found themselves stranded for several days, with approximately 2000 tourist vehicles stuck in various areas of the North district due to damaged main access roads. The government, with the assistance of the Army and local residents, later coordinated efforts to evacuate these stranded vehicles and individuals, mitigating the immediate crisis. The tourism sector in Sikkim incurred losses of more than twenty-four crores on accommodation and transportation sector including tours and travels due to the Teesta Floods, accommodation sector as indicated in below tables.

- Total Loss for Hotel Sector = Rs. 1,46,45,11,600/- (Rupees One Hundred Forty Six Crore Forty Five Lakh Eleven Thousand Six Hundred) only
- Total Loss for Homestay Sector = RS. 45,20,52,000/- (Rupees Forty-Five Crore Twenty Lakh Fifty-Two Thousand) only

**Table 58. Tourism: Tentative revenue Loss in hotel Sector (In Rupees)**

District	No. of Hotels	No. of Rooms	No. of Beds		Total capacity	MONTHLY LOSS VIS-A-VIS NO. OF AFFECTED DAYS (IN RS.)		
			Single	Double		OCTOBER (28 DAYS)	NOVEMBER (30 DAYS)	TOTAL TENTATIVE LOSS (COL. 7 + COL. 8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GANGTOK	599	8910	8275	703	17253	8910* Rs.2000/- *28 days = Rs. 49,89,60,000	8910* Rs.2000/- *30 days = Rs. 53,46,00,000	Rs. 1,03,35,60,000
PAKYONG	78	568	521	52	1094	568*Rs.2000 /- *28 days =Rs. 3,18,08,000	568* Rs.2000/- *30 days = Rs.3,40,80,000	Rs. 6,58,88,000
GYALSHING	205	2221	2093	135	4321	2221*Rs.200 0/- *28 days =Rs.2,43,76, 000	2221*Rs.2000/ - *30 days =Rs.13,32,60,0 00	Rs. 2,57,63,600
SORENG	30	206	180	25	385	206*Rs.2000 /- *28 days =Rs.11,536,0 00	206*Rs.2000/- *30 days = Rs. 1,23,60,000	Rs.2,38,96,000
NAMCHI	104	1080	939	124	2002	1080*Rs.200 0/- *28 days =Rs.6,04,80, 000	1080*Rs.2000/ - *30 days=Rs. 6,48,00,000	Rs.12,52,80,000
MANGAN	142	1639	1520	125	3165	1639*Rs.200 0/-*28 days =Rs.9,17,84, 000	1639*Rs.2000/ - *30 days =Rs.9,83,40,00 0	Rs.19,01,24,000
<b>TOTAL</b>	<b>1158</b>	<b>14624</b>	<b>13528</b>	<b>1164</b>	<b>28220</b>	<b>Rs.70,70,05, 600</b>	<b>Rs.75,75,06,00 0</b>	<b>Rs.1,46,45,11,600</b>

**Table 59. Tourism: Tentative revenue Loss in Homestay Sector ( In Rupees)**

District	No. of Hotels	No. of Rooms	No. of Beds		Total capacity	MONTHLY LOSS VIS-A-VIS NO. OF AFFECTED DAYS (IN RS.)		
			Single	Double		OCTOBER (28 DAYS)	NOVEMBER (30 DAYS)	TOTAL TENTATIVE LOSS (COL. 7 + COL. 8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GANGTOK	290	1275	1235	40	2510	1275*Rs.1500/-*28 days = Rs.5,35,50,000	1275*Rs.1500/-*30 days = Rs.5,73,75,000	Rs.11,09,25,000
PAKYONG	328	1437	1405	32	2842	1437*Rs.1500/-*28 days =Rs.6,03,54,000	1437*Rs.1500/-*30 days =Rs.6,46,65,000	Rs.12,50,19,000
GYALSHING	126	591	533	58	1124	591*Rs.1500/-*28 days = Rs.2,48,22,000	591*Rs.1500/-*30 days = Rs.2,65,95,000	RS. 5,14,17,000
SORENG	131	551	506	45	1057	551*Rs.1500/-*28 days = Rs.2,31,42,000	551*Rs.1500/-*30 days = Rs.2,47,95,000	Rs. 4,79,37,000
NAMCHI	238	1040	1015	25	2055	1040*Rs.1500/-*28 days = Rs.4,36,80,000	1040*Rs.1500/-*30 days = Rs.4,68,00,000	Rs. 9,04,80,000
MANGAN	69	302	298	4	600	302*Rs1500/-*28 days =Rs.1,26,84,000	302*Rs.1500/-*30 days = Rs.1,35,90,000	Rs.2,62,74,000
<b>TOTAL</b>	<b>1182</b>	<b>5196</b>	<b>4992</b>	<b>204</b>	<b>10188</b>	<b>Rs. 21,82,32,000</b>	<b>Rs 23,38,20,000</b>	<b>Rs. 45,20,52,000</b>
<b>Total</b>								<b>45.20 Crore</b>

During the flash flood, transportation sector (especially Tours and Travels) was severely affected. The revenue losses from both luxury and ordinary vehicle estimated approximately Rs. 3,80,16,000/ (refer table 4.5).

<b>Table 60. Tourism: Tentative revenue Loss in Tours and Travels Sector ( In Rupees)</b>				
Sl. No.	TOTAL NO. OF TOURS & TRAVELS IN SIKKIM	MONTHLY LOSS VIS-A-VIS NO. OF AFFECTED DAYS (IN RS.)		
		OCTOBER (28 DAYS)	NOVEMBER (30 DAYS)	TOTAL TENTATIVE LOSS (COL. 4 + COL. 5)
(1)	(2)	(3)	(4)	(5)
1	1720	1720*Rs.5000*28 = Rs.24,08,00,000	1720*Rs.5000*30 = Rs.25,80,00,000	Rs.49,88,00,000
	<b>Total</b>			<b>0.49 Crore</b>

### Response by the Government

The Government of Sikkim responded swiftly and decisively to the Teesta floods in October 2023, particularly focusing on safeguarding the tourism sector. With a prioritization of tourist safety, they collaborated closely with local authorities and rescue teams for timely evacuations and set up emergency shelters for stranded visitors. Communication was transparent and robust, utilizing social media, official channels, and a dedicated helpline to keep tourists informed and assist them promptly. Collaborating with stakeholders, they assessed damages, supported recovery efforts, and launched a reassuring marketing campaign emphasizing the region's resilience and untouched natural beauty. Financial aid was extended to affected businesses, and plans were laid for long-term risk mitigation, including reviewing disaster plans and working on climate-related risks. Through these proactive steps, Sikkim aimed to rebuild trust, showcase its resilience, and foster the gradual revival of its tourism sector.

### Socio-Economic Impact on People

The socio-economic impact on people resulting from the Teesta floods profound and multifaceted. The aftermath of the recent floods has led to a series of difficulties, greatly affecting various aspects of life for the affected individuals. Jobs have been lost, especially in the tourism industry, leading to widespread unemployment. Financial troubles are a big concern, potentially increasing poverty levels and making it hard for families to meet their basic needs. These challenges are straining relationships within communities and causing changes in how people interact. People affected by the floods are increasingly relying on outside help, feeling more exposed and dependent.

Additionally, the floods have caused some people to move to different areas, changing the population in those places.

The long-term socio-economic impact on people due to the Teesta floods underscores the importance of comprehensive recovery and rebuilding efforts that address immediate needs while promoting resilience, sustainable development, and community well-being. Collaboration among government agencies, NGOs, and the international community is crucial to ensuring a coordinated and effective response.

## **Reconstruction and Recovery Needs**

Firstly, the rebuilding of damaged roads, bridges, and transportation networks aims to restore connectivity to the areas affected by the recent floods which is important for the tourism sector. This restoration is crucial for facilitating movement and access within these regions. Additionally, repairing or reconstructing dams, notably the Teesta III Dam, and hydroelectric power facilities is imperative to ensure the resumption of essential services. These facilities play a key role in providing power and supporting various services, making their restoration essential for the affected communities' functioning.

Focusing on Tourist Facilities and Attractions involves restoring and improving accommodations and attractions to draw visitors back, along with implementing safety measures for future resilience. Environmental Restoration initiatives aim to preserve the region's natural beauty and biodiversity while adopting sustainable practices to reduce the impact of future disasters. Similarly, Community and Social Support prioritize aiding displaced populations with temporary housing, healthcare, and employment opportunities. Additionally, mental health programs are crucial for the well-being of affected communities. Economic Recovery strategies include financial aid and incentives for tourism-related businesses and exploring alternative livelihood options.

Healthcare Infrastructure rebuilding and upgrades are necessary to meet increased medical demands post-floods, accompanied by public health campaigns addressing waterborne diseases. Preserving Cultural Heritage involves restoring affected sites and safeguarding them against future disasters which is linked to the tourism sector.

To prevent future calamities, Risk Reduction and Preparedness entail developing early warning systems, improving infrastructure, and investing in technology to boost resilience. Financial Support is essential, seeking resources from government budgets, international aid, and private partnerships for both immediate relief and long-term reconstruction.

Public Awareness and Education are vital, focusing on disaster preparedness, climate change, and sustainable tourism. Engaging communities in disaster reduction and conservation initiatives is crucial. Enhancing Government Capacity involves strengthening agencies to effectively lead and manage recovery, fostering ongoing collaboration with local groups, NGOs, and international partners.

Lastly, a robust Monitoring and Evaluation system is necessary to track progress, using feedback mechanisms to adapt strategies to emerging challenges.

Sectoral Activities Details		
Tourist Facilities and Attractions	<ul style="list-style-type: none"> <li>Restore and upgrade tourist accommodations, recreational facilities, and key attractions to attract visitors and rejuvenate the tourism sector.</li> <li>Implement safety measures and resilient designs to minimize future vulnerability.</li> </ul>	Tourism
Environmental Restoration	<ul style="list-style-type: none"> <li>Undertake initiatives for ecological restoration to preserve the natural beauty and biodiversity of the region.</li> <li>Implement sustainable practices to mitigate the impact of future natural disasters on the environment.</li> </ul>	Forest Department
Economic Recovery	<ul style="list-style-type: none"> <li>Financial aid and incentives to businesses in the tourism sector and related industries to expedite their recovery.</li> <li>Promote alternative livelihood opportunities for those whose traditional livelihoods have been disrupted.</li> </ul>	Financial Services
Cultural Heritage Restoration	<ul style="list-style-type: none"> <li>Restore and preserve cultural heritage sites (such as Namprikdhang) and landmarks affected by the floods.</li> <li>Implement measures to protect and safeguard cultural assets against future natural disasters.</li> </ul>	Department of Culture
Public Awareness and Education	<ul style="list-style-type: none"> <li>Implement educational programs to raise public awareness about disaster preparedness, climate change, and sustainable tourism practices.</li> <li>Promote community engagement in disaster risk reduction and environmental conservation initiatives.</li> </ul>	SSDMA

### Recovery Framework Table

Reconstruction and Recovery Framework = 241.53 Cr						
Reconstruction, Recovery measures	Overall Budget Requirements	Line Department	Supporting Department	Funding Sources ( Primary/ Secondary )	Modalities of Assistance	Timeline
Revenue Loss in the Hotel Sector	Rs.1,46,45,11,600	Tourism	SSDMA	NDRF		Medium Term
Revenue Loss in AHomestay Sector	Rs.45,20,52,000	Tourism	SSDMA			Medium Term
Revenue Loss in Tours and Travels	Rs.49,88,00,000	Tourism	SSDMA			Medium Term
Understanding Risks	-	Tourism	SSDMA		This can be done through SSDMA	
Planning and Prioritization		Tourism	SSDMA		This can be done through SSDMA	

Mitigation and Preparedness		All concerned Depts. PWD, BRO, Forest etc.	SSDMA		This can be done through SSDMA	
Response and Recovery	-	Tourism	SSDMA		This can be done through SSDMA	
Long-Term Resilience Actions		All concerned Departments	SSDMA		This can be done through SSDMA	
<b>Total</b>	<b>2,41,53,63,600</b>					
<b>Two Hundred Forty One Crore Fifty Three Lakh Sixty Three Thousand Six Hundred</b>						

### Disaster Risk Reduction

The strategies proposed for enhancing mountain tourism focus on diversification beyond seasonal attractions, promoting sustainable practices, improving infrastructure for better access, and establishing a robust digital presence to attract visitors year-round. Involving local communities in tourism planning, implementing risk management plans, offering off-peak incentives, fostering collaborations among stakeholders, investing in training, and adapting to climate change collectively aim to ensure resilience and sustainability in mountain tourism. These measures aim to preserve the natural beauty of mountains, offer authentic experiences, and ensure the resilience of the tourism sector.



## 5. Infrastructure Sector

### 5.1 Roads and Transport

#### Summary

In the early hours of October 4, 2023, Sikkim was hit by a large glacial lake outburst flood (GLOF) in South Lhonak, located at an altitude of 5200 metres. This event resulted in flooding of the Teesta (average height raised by 15-20 feet). The first point of impact was Lachen, a small hamlet in North Sikkim, where severe damage was reported, followed by Chungthang Valley, where widespread flooding and inundation along the banks occurred. The main bridge connecting Chungthang with the district headquarters Mangan and the state capital Gangtok was washed away. The 1200 MW dam downstream of Chungthang (Teesta 3, Sikkim Urja Limited) collapsed and water from the reservoir and GLOF flowed downstream causing extensive damage to the state road network, road bridges (33 nos-13 major and 20 minor) at Toong, Sankhlang, Phidang, Tanak, Baluatar, Sirwani, Adarsh gaon, Bardang, Rangpo and Melli and several footbridges across the Teesta River basin.

The PDNA is an attempt to assess the reported damages and losses to the road and bridge infrastructure of the R&B Department, RDD and ULBs in Mangan, Gangtok, Namchi and Pakyong districts. There are several roads and bridges under the management of the BRO (especially in Mangan district) that have been affected and are currently being rehabilitated. A temporary Bailey bridge has been constructed in Chungthang by BRO, but it will take another 6 months to establish a direct link to Lachen. Some of the PMGSY roads located in the Teesta River basin have also been affected.

The total damage and loss to the road and bridge network (managed by R&B, RDD and ULB) in the 4 districts is estimated at INR 205.4 Crore, with damage estimated at INR 163.5 Crore and loss at INR 41.9 Crore. In addition, the short to medium term recovery and reconstruction is estimated at INR 395.4 Crore. Most of the damage is to road and pedestrian bridges across Teesta as the flash floods washed out bridges and road sections. Post flash floods, landslides due to destabilisation of hillsides caused by toe erosion/scour by river have also occurred in several areas. The losses in road sector were mainly on the removal of sand/debris accumulated along river basins to clear the roads, bridges and habitations along the river banks.



The damage to the infrastructure was found to be linearly distributed along the Teesta River basin area. It was found that the roads had either been washed away or subsided due to landslides/landslips. Resilient reconstruction shall require new alignments, retaining and breast walls (single or double layer), lateral drains, box culverts and extensive bank protection and toe walls to address the risk of future flash flooding and scours. Bio- engineering solution is proposed as critical measure in slope stabilisation in the recovery process.

The bulk of the restoration and reconstruction estimates in the 4 districts include the re-construction of 2 bridges that have been washed away along following resilient standards and associated river training works to prevent scours. The preference shall be innovative integral/RCC steel composite (weathering steel)/balanced cantilever structures with long single span avoiding piers in between to mitigate the risk of future scour induced bridge failures. A system to monitor the health condition of bridges and identifying retro-fitment measures for weak bridges needs to be taken up on priority along with associated river flow control mechanisms. This needs to be done in due technical consultation with Central Water Commission (CWC) and Water Resources Department to determine river flow characteristics and associated river bank stabilisation needs like use of revetments, gabions and other flow controls structures like dykes and check dams. There is a dire need to develop a community pedestrian bridge program for service resilience in the state promoting nature based local cost architecture "Jhulanga bridges" suspension bridges with treated bamboo superstructures (explore if double decks can be provided for enhanced safety -locally grown and can sustain 15 years), steel suspension and small truss type along the Teesta River basin area. Some of hill slopes in Mangam district along the Teesta valley were found to be badly eroded by the GLOF led flash floods resulting in landslips and subsidence of the road formation. At these locations, the hill toes need to be protected with a combination of retaining walls, gabions, revetments as part of the recovery. The use of bio-engineering needs to be promoted to stabilise the hill slopes-based on innovative engineering solutions. Sikkim being a state having international borders with Bhutan, Tibet and China needs to plan a long-term recovery program with Government of India (GOI) support to develop few strategic new bridges across Teesta (which can be sanctioned under Setu Bandhan program of Ministry of Road Transport and Highways, GOI), alternate road network connecting North Sikkim, alternate highway to the existing NH 10 connecting Melli in the Namchi District to Singtam in the Gangtok District (South Sikkim) are critical transport projects. While the planning and design for these can be taken up in the next 24 months, the execution can be in the long term (24-60 months). The total recovery & reconstruction needs of the state is estimated at INR 395.4 Crs. Table 1 presents the distribution of damage, loss, and recovery.

<b>Table 61. Roads and Transport : Damaged Road Infrastructure</b>			
<b>Asset Category</b>	<b>Totally Damaged (m)</b>	<b>Severely Damaged (m)</b>	<b>Partially Damaged (m)</b>
MDR	510		-
ODR	3345		-
Village Road	1160		-
Internal Road	1805	325	-
Major Bridge (RCC, Steel)	320	453.5	-
Minor Bridge	36		-

Pedestrian Bridge (Cable Suspension Bridge)	1218	150	-
Pedestrian Bridge (Small Span Truss/RCC)	20		-
Bailey Bridges		70	-

**Table 62. Roads and Transport: Total Damage, Recovery estimate for Road Sector**

**Table: Total damage, recovery, and loss estimates of the six districts (in Lakh INR)**

Districts	Damages (INR Lakhs)	Losses (INR Lakhs)	Damage + Losses (INR Lakhs)	Recovery & Reconstruction Needs (INR Lakhs)
Mangan (for R&B roads)	705.18	1069.79	1774.98	1998.33
Gangtok (for R&B roads)	452.94	1436.58	1889.52	535.33
Pakyong (for R&B roads)	480.88	1681.10	2161.98	559.86
Namchi (for R&B roads)	2048.41		2048.41	4373.37
Combined for 4 Districts (R&B Roads)	3687.41	4187.47	7874.88	7466.88
Combined for 4 Districts (Internal Roads)	847.70		847.70	1620.89
Combined for 4 Districts (Road & Pedestrian Bridges and Culverts)	11817.24		11817.24	25850.30
Other Resilient Recovery Measures (Technical Studies, and Capacity Building of Agencies)				4600.00
Total	16352.34	4187.47	20539.82	39538.07

## Road Transport Profile

Sikkim is located in the eastern part of the country and is connected to the rest of the country only through the state of West Bengal by the NH10. The other district capitals are connected by a limited number of state highways. The only greenfield airport, Pakyong, is unpredictable with frequent weather changes in Sikkim and currently offers few flight connections. A new 44 km Sivok–Rangpo railroad line is under construction, which when completed in 2025 will connect three districts of Sikkim, Pakyong, Gangtok and Mangan districts. Thus, roads and bridges remain the main means of transportation in Sikkim (similar to other mountainous states in India) and provide the lion’s share of transport connectivity (to the local population, the international borders and tourist destinations). Sikkim has a

3218 km primary road network (NH, SH, MDR, ODR) managed by 3 major agencies: the Road & Bridges Department of the Government of Sikkim (GoS), the Border Roads Organisation (BRO) and the National Highways and Infrastructure Development Corporation (NHIDCL) under Government of India (GoI). In addition, the Rural Development Department (RDD) and ULBs under GoS manage the PMGSY program, rural and urban internal road network and footbridges.

Roads are the key transportation assets for Sikkim as it provides the lion's share of transport connectivity with over 3218 km of primary road network comprising national highways (NHs), state highways (SHs), major district roads (MDRs) and other district roads (ODRs). Sikkim being a state having international borders with Tibet, Bhutan and China some of the NHs are developed and maintained by BRO and NHIDCL. Balance NH, SH, MDR and ODR are managed by the R & B Department. The distribution of the key road network in Sikkim<sup>34</sup> is presented in Table 2.

<b>Table 63. Roads and Transport: Primary Road Network in Sikkim</b>		
<b>Road Class</b>	<b>Length (Km)</b>	<b>Remarks</b>
National Highways (NHs)	521.95	R&B Dept (165), BRO (101 km), NHIDCL (256 km)
State Highways (SHs)	743.81	R&B Dept.
Major District Roads (MDRs)	1119.31	R&B Dept.
Other District Roads (ODRs)	833.54	R&B Dept.
<b>Total</b>	<b>3218.61</b>	

Source: R&B Dept, Government of Sikkim

R&B Department also manage 200 bridge and 11,863 culverts assets located on the state network. The village roads (VRs) and internal roads are also important community connectors in the hills and are managed by R&B Dept., RDD and ULBs under Government Sikkim. The PMGSY program for all weather village road connectivity in the state (90% funded by GoI and 10% by GoS) - is also implemented by RDD<sup>35</sup>. So far, under PMGSY-I which started in 2000, 4794 km was sanctioned for Sikkim and 4512 km has been completed at a cost of Rs. 2135 Cr, with 282 km remaining (as reported in FY21-22)<sup>36</sup>. Under PMGSY-II, around 121 km of road was sanctioned in 2018-19 of which

111.51 km has been completed. As on date, 225 km of the PMGSY-I & II remains to be completed with a target date of completion of 31st March 2024, beyond which the central support will cease. However, in light of the GLOF led disaster in the state which has a directly impacted construction activities these works may need some more time to be completed and extension of support by GoI beyond currently envisaged timelines may be required. RDD are responsible for development and management of pedestrian bridges (suspension and steel truss) which are critical connectivity infrastructure used by the community to reach agriculture and horticulture farms, production centres, markets, schools and health centres. A resilient pedestrian infrastructure is thus key to resilient Sikkim.

<sup>34</sup>Data from R&B Department, Govt. of Sikkim

<sup>35</sup>Discussion with RDD, Govt. of Sikkim

<sup>36</sup>Online Management, Monitoring and Accounting System of PMGSY

The geographical features of Sikkim, with mountains and valleys, and rivers constrain the road infrastructure to be built around the hills, with limited available detours. This makes the majority of existing road networks and their sustainable maintenance of critical importance to ensure connectivity to production centres and accessibility of the people to essential needs and to be made resilient in light of the new emerging climate risks like GLOFs, cloud burst, flash floods and high intensity rainfalls. Preparing for future climate and disaster resilience should be the cornerstone of resilient recovery of Sikkim.

### **Sectoral Policies**

The Government of India has accelerated development initiatives in North East (NE) states over the last decade with several Central Sector Schemes (CSS) being launched. The Ministry of Road Transport support provides annual budgetary support for development of the new and existing road connectivity in the state using the Central Road Fund (100% CSS) that follows the CRIF Act. Several road projects under North East Road Sector Development Scheme (NERSDS) are sanctioned by the North Eastern Council. Some road and bridge works are also taken up under the North Eastern Special Infrastructure Development Scheme (NESIDS). The Ministry of Development of North Eastern Region (MDoNER), Government of India, also provides funds for construction, up-gradation, widening and construction of roads and bridges under a non-lapsable central pool of resources (90:10). Multiple projects have also been successfully completed in the state through external aid financed by the Asian Development Bank (ADB). NABARD has sanctioned projects under Rural Infrastructure Development Fund (RIDF) -with 90% loan component and 10% state share.

Roads & Bridges Department, Government of Sikkim have also laid out favourable road sector policies and executed plans to expand its road network throughout the State targeting connectivity in every village, institutions of education and health, market areas and tourists and religious destinations. The State Government's top priority is to provide uninterrupted road connectivity in the State for improvement of socio-economic condition of the people by up-grading the existing major district roads to intermediate lane with priority on the enhanced load carrying capacity. The State Highways which connect the District Head Quarters have also been declared as National Highways. The fund created from the collection of Cess on Petrol and High-Speed Diesel (HSD) is provided for development and maintenance of State Roads and Rural Roads under State Transport Infrastructure Development Fund (STIDF). The Fair-Weather Road includes cutting of the formation width, installation of protective works and drainage system with a sanctioned length of 1505 km and cost of INR 749.8 Cr. R&B Department has also proposed several bridge projects to be taken up under GOI's Setu Bandhan program. In 2021-23, R&B Dept had a capital expenditure of INR 225.6 Crores.

### **Damages in Road and Bridges Sector**

The online training for state officials of Sikkim to conduct PDNA was carried out by NDMA in November 2023. Representative engineers from R&B, RDD and ULBs of 4 impacted districts worked together and collected data using the KoBo tool, as the 1<sup>st</sup> step towards PDNA exercise. During 7<sup>th</sup> to 11<sup>th</sup> December 2023, central PDNA team did field visits and the data collected by the state team were analysed and sanitised for errors and duplications to estimated damage, loss reconstruction and recovery needs. Owing to the nature of the GLOF led disaster, damages were primarily found to be linearly distributed along the Teesta River basin area. The intensity of the disaster was found to be of higher magnitude in areas upstream and downstream of the reservoirs of the several hydro- power dams located along Teesta. The data on internal roads and some bridges (many bridges were under BRO) did not have any information related to the districts and thus could only be analysed at the state level. Here is the summary of damage classifications:



- **Totally Destroyed/Washed away:** Here the roads, bridges, and culverts either got washed away, or damaged to the level owing to subsidence and slip circle failure of the hill slopes. These sections will need near complete reconstruction along with river protection works, bio-engineering treatments of hill slopes and river embankments for greener recovery. Some detours and traversing up the mountain and away from the river may also be required in a few sections to avoid risk of failures from excess scouring.
- **Severely Damaged:** Roads with major segments damaged, or significant damage to retaining and breast walls, roads sinking due to destabilisation of the slope due to toe erosion, crust damaged, potholes, damage to drainage [where the repair cost can be estimated to be between 70% of the total replacement cost and additional river training and toe protection works needs to be undertaken.

While Sikkim was hit by GLOF in October which is an emerging natural hazard in the changing climate, the state is also annually impacted by landslides owing to prevalence of phyllite and schist rocks, steep terrain and intense precipitation led flash floods. There are a large number of hydropower dams, the outflows of which in events of high rainfalls are managed prudently and in an integrated manner also pose significant risks of flooding downstream. Sikkim also falls in Seismic Zone 4 and faces earthquake related risks. A GLOF incident can be triggered by seismic activity and with several high-risk glacial lakes, the transport infrastructure has to be planned accordingly.

The nature and extent of damage was reviewed for correct assessment of recovery and reconstruction estimates through field visits by PDNA experts across all 4 districts. For reconstruction & repair costs factored for damage and reconstruction estimates were based on unit rates derived PWD schedule of rates 2020 inflation indexed to December 2023 (excluding 18% GST component).

Total damage to the state managed road network has been estimated to be INR 163 Cr. This is caused due to critical damage/wash out to a reported 7.15 kms of roads, wash out of 2 major bridges under R&B Department (Indrani and LD Kazi), severe damages to 3 major bridges (Melli Bridge, Tanak Mamrin) and 1 minor road bridge and 12 pedestrian bridges were reported to be washed out and while severe damages to another 7 bridges and several culverts.

The (centrally funded) BRO Road network connecting Mangan to Lachen got severely impacted under GLOF with several bridges and road network being washed out. It is leading to significant traffic detours to reach North Sikkim. It is understood that 9 bailey bridges have been proposed to be constructed by BRO across Teesta. A bailey bridge has been constructed at Chungthang, Mangan to connect the community living in the Chungthang, Lachung/Lachen valleys.



Bailey bridge at Sankalang has also been constructed. Several more bailey bridges have been sanctioned (at Indrani Bridge location, Ranguthang, Tanak, lower Samdung, Phidang, Toong) however at some of these locations Bailey bridges cannot be constructed as width of the river has widened. Establishing direct connectivity to Lachen will take another 6 more months as the extent of damage to BRO maintained road is quite enormous. RDD also reported that some of the PMGSY roads (90% centrally funded) were also damaged and needed to be reconstructed. South Sikkim has reported 3.5 km of road damaged which requires major restoration with 700 m the road requiring realignment (new cutting). In Mangan District (North Sikkim), total 5 km of road has been totally washed away will require additional 2 km of realignment and 3 km has been damaged critically and one 60 m steel girder bridge being washed away in Choten village downstream of Teesta 3 (Sikkim Urja Limited Hydropower Station) which busted owing to GLOF incident.

The Tables 64 and 65 provide the overall damage of the road and bridge assets in Nos and financial terms.

**Table: Road Sector Damage across State (Numbers)\***

<b>Table 64. Roads and Transport : Road Sector Damage w.r.t Asset Type</b>			
<b>Asset Type</b>	<b>Totally Damaged/Washed Away</b>	<b>Severely Damaged</b>	<b>Total</b>
Roads	km	km	km
Black Top	5.38	0.325	5.71
Earthen and Others	1.44		1.44
Bridges and Structures	Nos	Nos	Total (In Nos)
Major Bridge	2	3	5
Minor Bridge	1	1	2
Pedestrian Bridge (Cable Suspension Bridge)	9	2	11
Pedestrian Bridge (Small Span Truss/RCC)	3		3
Bailey Bridges		3	3
RCC Box Culverts	3	7	10

**Note:** \* List includes road assets under R&B Department, RDD Departments and ULBs. PMGSY is excluded owing to 90% funded by GOI, as 162 well as roads under BRO/NHIDCL management.



**Table: Road Sector Damage across State (In INR Lakhs)\***

<b>Table 65. Roads and Transport: Damage Estimate (In lakh)</b>			
<b>Asset Type</b>	<b>Totally Damaged/Washed Away</b>	<b>Severely Damaged</b>	<b>Total</b>
Roads	INR Lakhs	INR Lakhs	INR Lakhs
Black Top	3410.79	127.504	3538.29
Earthen and Others	996.81		996.81
Sub Total (Roads)	28% of the Total Damage		4535.11
Bridges and Structures	INR Lakhs	INR Lakhs	Total (INR Lakhs)
Major Bridge	8000	819.325	8819.325
Minor Bridge (including Baileys)	121.27		121.27
Pedestrian Bridge (Cable Suspension Bridge)	2671.61		2671.61
Pedestrian Bridge (Small Span Truss)	106.78		106.78
RCC Box Culverts	98.25		98.25
Sub Total (Bridges)-	72% of the Total Damage		11817.24
<b>Total Damage (Roads + Bridges)</b>			<b>16352.34</b>

*Note: \* List includes road assets under R&B Department, RDD Departments and ULBs. PMGSY is excluded owing to 90% funded by GOI, as well as roads under BRO/NHIDCL management.*

The damages were calculated based on the total length of road (in km) damaged at different levels. These lengths were then multiplied with the unit cost of replacement, major repair. For bridges washed away in GOLF, the damage cost was estimated based on the replacement cost by similar bridge while for major damages 20% of the replacement cost has been assumed as damage estimates. The bridges are generally designed for 100 years life. As per Ministry of Road Transport and IRC guidelines, design discharge for computing the waterway and length of the bridge, are based on maximum flood discharge at least for a return period of 100 years. However, the combined discharge of GLOF and the Teesta 3 reservoir may have been much more compared to maximum design discharge of many of bridges leading to wash outs and severe distress to the existing bridges which may need retro- fitments in the structure and flow control measures in the river channel in near future. Table 5 presents the net average unit costs of damage per asset type at the state level.



**Table 66. Roads and Transport : Unit Cost for Road and Bridge Works**

Type of Roads	Average Replacement Cost		Average Major Repair Cost	
	MDR**	ODR/VR/IR* *	MDR**	ODR/VR/IR**
	(INR Lakh/km) *		(INR Lakh/km) *	
Black Top	251	141	150.6	84.6
Earthen and Others		100		60
Road Bridges/Structures	Lakh/sqm) *		Lakh/sqm) *	
Major Bridge	3.00	3.00	Varies	
Minor Bridge	1.00	1.00	Varies	
RCC Box Culverts	0.55	0.55	0.1	
Pedestrian Bridges	(Lakh/m) *		(Lakh/sqm)	
Pedestrian Bridge (Cable Suspension Bridge)	2.12	2.12		
Pedestrian Bridge (Small Span Truss)	1.27	1.27		
Protection Works	Average Cost (Rs/m) *			
	Height (6m)	Height (3m)		
Breast Wall	1,27,000	50,379		
RCC Retaining Wall	3,34,000	118,000		
Gabion Wall	48,600	28,600		
V shaped Drain (150mm vertical side thickness x 450mm depth)	1608			
Box Drain (650 mm ht. 450 mm width)	2172			
Box Drain (300 mm ht. 450 mm width)	3102			
Earthen Drain (V shaped)	420			

\*Rates are based on Sikkim PWD Schedule of Rates 2020 and indexed to December 2023 excludes GST 165

\*\*MDR (Major District Road), ODR (Other District Road), VR (Village Road), IR (Internal Road)

## Loss Estimate

The total losses in the road sector are estimated at Rs. 41.87 Crores. Based on data provided by R&B Dep, this amount has been estimated for the cost of removing accumulations of muck, debris and sand from an approximate area of 140 hectares having an average height of about 2 metres. The rate use is Rs. 205 per cubic metre as per schedule of rates with 5 km lead considered. The largest accumulations were 50 hectares in the IBM area, Rango Post, 45 hectares in Singtam Bazar and Golitar (90% of which has already been removed). Around 30 hectares of accumulation in Chungthang, where the removal process will begin shortly. For loss calculations, it has been assumed that 70% of the accumulations cannot be used as construction material and hence the cost of removal will eventually have to be paid to the resourceful contractors who have been mobilised by R&B Dept, GoS for this work. However, it is to be noted that there is no government order (GO) to this effect of compensating the contractors mobilised for this purpose. Thus, it is more of notional loss to the state exchequer but has been factored in road sector loss assessment and it is important to note that it should not be calculated additionally in other sectors.

While the above mentioned losses incurred to the road sector are direct in nature, however, the losses incurred by other sectors such as tourism, horticulture due to bridge and road washouts resulting in traffic detours and loss of connectivity are equally important for overall quantification of such losses to state's exchequer and presented in other sectors like tourism, agriculture and forestry.

## Socio-Economic Impact on People

The road network and bridges particularly in Mangan District (North Sikkim) has been badly impacted by the GLOF. The transport network connectivity to the habitations (rural/urban), district centres, tourist destinations, fruit orchards, spice plantations and their access to wholesale markets and factories, are thus impacted for more than 2 months. The connectivity to Lachen a popular tourist destination will take another 6 months to be re-established. Not only the roads and bridges have been washed away the impact of scours have led to large section of the hill roads sinking which few days post the flash flood and thus have impacted community connectivity in several hamlets who are depending currently on foot treks/jeepable formation tracks.

Sikkim being located in the Indian Himalayan Mountain Region pose significant geo-hazard (landslide), fluvial flood risks from high intensity rainfalls. The new climate hazards like the GLOF with several active glacial lakes in the state are now emerging threats for which the state has to be prepared. It may be appreciated that it is very difficult to design fully resilient road and bridge infrastructure to engineering standards that is GLOF ready and thus efficient and integrated approach to dam reservoir management and early warning systems are critical to save life, infrastructure and minimise damage and losses. The strategic assets have to be prepared for GLOF and thus needs to be planned at locations with lower hazards exposures and risks.

As the livelihood of a large section of the population in tourist destinations of North Sikkim (Chungthang, Lachen and Lachung) are dependent on tourist flows, they have suffered major business loss.

Post October disaster, the national and state administration was involved with immediate traffic restoration and providing connectivity to road sections lost due to floods and landslides. The onslaught of GLOF has negatively impacting tourist inflows for next few months, leading to state exchequer loss as well as loss of livelihood for the population dependent on tourism.

In 2016, Sikkim was the first state in the world to implement 100% organic policy. Majority of Sikkim's population (around 62%) is employed Agriculture and horticulture-based sectors and 80% of rural population is employed in this sector. Black Cardamon, Tea and mandarin (orange) are major produce of the state with significant exports. With the road network being damaged and envisaged time to fully restore connectivity, the farmers are also looking at losses owing to breaks in transport connectivity and higher cost of transport. While these aspects are mentioned in this chapter the quantification of these losses are presented chapters related to livelihood, tourism, agriculture and forestry etc.



Several of the private houses and commercial properties abutting the roadside also got damaged by flash floods and landslips. These incidents have resulted not only in damage and loss of property, land, and livelihood but also an enormous non-quantifiable and non-monetary loss. This includes, for instance, the emotional shocks, psychosocial damages, distress, and trauma as well as the high insecurities experienced by people who have lost their valuable possessions, home along with jewellery, official documents and relatives and friends. There is still fear in the minds of community living along Teesta and as part of health sector recovery community counselling and awareness generation on the risks of living close to river basin should be communicated.

### Recovery and Reconstruction Needs Assessment

Road transport being the mainstay of economic activities in Sikkim., the current GLOF led flash floods has severely impacted the state's economy and need to be recovered soon to its original state. For the short to medium term (0-24 months), the sector reconstruction and resilient recovery needs analysis have been carried out for 4 districts for road and bridge assets under R&B, RDD and ULBs.<sup>37</sup> The overall reconstruction and recovery need (infrastructure costs) in the short to medium term has been estimated at Rs. 395.4 Crores and presented in Table 6 below.

<b>Table 67. Roads and Transport : Asset-wise Reconstruction and Recovery Cost Estimate for Sikkim (Short to Medium term)</b>				
<b>Asset Type</b>	<b>Short Term (0-6 Months)</b>	<b>Medium Term (6-24 Months)</b>	<b>(24-36 Months)</b>	<b>Total Cost (INR Lakhs)</b>
R&B & RDD Roads Rehabilitation Program	7466.88			7466.88
Internal Roads Rehabilitation Program	1620.89			1620.89
Resilient Road Bridge Reconstruction and Rehabilitation Program	2643.43	13860.58	4930.29	21434.30
Community Connectivity Program with Jhulanga Bridges across Teesta +small truss bridges in 4 affected districts (Old + New Locations)	1766.40	2649.60		4416.00
Other Recovery Measures	1840.00	2760.00		4600.00
<b>Total</b>	<b>15337.60</b>	<b>19270.18</b>		<b>39538.07</b>

<sup>37</sup>Needs for recovering BRO, NHIDCL managed roads, PMGSY roads are separate and accounts for substantial loss to national exchequer to rebuilt some of these strategic border connecting assets in a resilient manner.

In the estimation process, the principles of “Build Back Better” have been embedded for short to medium term reconstruction and recovery along with inclusion of several policy, institutional and technical studies for determining long term resilient recovery pathways for the state.

### Short to Medium Term (0- 24 Months)

In the immediate to short term road transport agencies, Government of Sikkim (GoS), had already deployed its own resources, for the clearance of debris, construction of few temporary diversions/fair weather formation cutting, repair and reconstruction of failed hill slopes, pavement restorations in order to keep the roads trafficable. However, given the nature of the damages the repairs and reconstruction need to incorporate site-specific design requirements that allow incorporation of



good engineering principles. Several

damaged roads require new and alternate alignments to restore connectivity to community, associate river training works along various vulnerable sections of Teesta River channels. Along with the need for capital-intensive combination of retaining and breast walls with use of gabions, RCC retaining walls and CRSM breast walls with lined drains and culverts outfalls. Landslide protections using nature-based solutions along the hill side is strongly recommended as part of recovery which needs to be mainstreamed, as currently its use is still not at the desired level.



For repair, reconstruction and recovery estimates in the short to medium term, PWD Schedule of rates 2020 indexed to December 2023 have been used. These rates were found to be quite high compared to road works in plain areas primarily owing to operating conditions like higher lead of construction materials, terrain and availability of labour and local syndicates.<sup>38</sup> Some of the recovery if undertaken by GOI agencies the cost to the national and state exchequer may be lesser owing to more competition and centralised procurement.

For sequencing budgetary reconstruction and recovery estimates into short term (0-6 months) and medium-term requirements (06-24 months)- it is assumed all road related recovery work will be completed in next 6 months before the monsoons of 2024. This being a critical need to cover risks of landslides, landslips that can be triggered by rains and cause further damages to vulnerable road assets. Pedestrian bridges in Sikkim play a vital role in providing community connectivity. Many of the existing of pedestrian bridges were washed during GLOF, thus a special "Community Connectivity Program" with a mix of "Jholanga (Suspension)" made out of treated bamboo plate superstructure, steel suspensions with MS chequered plates and small truss bridges in the Teesta River Basin area is proposed covering the existing damaged/washed away locations and additionally 50 new ones. It is assumed that this scheme will be sanctioned by the state with GOI adaptation funding support and 40% of these works will be completed in short-term and rest in next one year. The resilient road bridge reconstruction and rehabilitation program for damaged/washed away bridges, will need careful planning in terms of location with lower hazard risks and feasibility of integrating with the location developments, design discharge factoring hydraulics and hydrology of Teesta River and sudden upsurge on account of flash floods from GLOF, cloud burst; local geological factors, land availability.

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<sup>38</sup> As per Labour Department, GoS the labour rates vary accordingly to altitude of the location. There are 3 graded rates.



Thus, construction of new bridges at the locations close to Indrani and LD Kazi bridge which got washed away has been considered along with significant river training works upstream and downstream of the bridge locations. Meanwhile, construction of Bailey bridges by BRO at these Indrani Bridge location is under consideration, however, it may not be technically feasible. The construction of new permanent bridges may need 36 months and thus will cross beyond medium term. It is assumed that 10% of the construction works can be taken up on short term while 60% to be completed in medium term and balance 30% in between 24-36 months.

Additionally, cross-sectoral interventions like river training works/channelization, dykes and check dams particularly at some critical bridge locations has emerged as a critical need to reduce scours of hill toes and abutments edges. A thorough health monitoring of the bridges has been proposed to determine retrofit measures (strengthening of piers, abutments, scour protections, replacement of bearings, expansion joints, raising deck if feasible) along with some river training works as describe above and expected to be completed in next 2 years.

The reconstruction and recovery of road works has to lay focus to enhance disaster and climate resilience with a package of engineering and non-engineering climate resilient measures e.g., pavement crust repairs, shoulder dressing with granular material, slope protection works along the hillside at critical landslide hotspots with combination of breast wall and bio-engineering/soil nailing, retaining walls at valley side, lined drains (V and U type), replacement of all damaged pipe culverts with box/slab culverts for accommodating larger waterways, additional pipe/slab culverts, protection works for CD structures; toe wall protections against river erosion particularly with gabions and retaining walls.

In order to safeguard road transport infrastructure a detailed vulnerability assessment of road network along Teesta River, identifying hotspots of toe erosion for River Training works has been proposed. This can be done in consultation with the Forest and Water Resources Department. A preliminary report from Water Resources department has proposed counterfort retaining walls at several vulnerable locations along Teesta River, this needs more detailed assessment and combination of non-structural bio-engineering measures. The cost of implementation of all long- term measures however have not been factored and expected to be covered under cross-sectoral flood mitigation estimates jointly implemented by Forest and Water Resources Department. The use of standard designs is discouraged in short-medium recovery. It is recommended that Road Agencies in Sikkim (R&B, RDD and ULBs) use specific design calculations for breast walls, retaining walls and other slope stabilisation measures, river erosion protection measures as per actual field parameters and site conditions. Thus, R&B, GoS may need to induct of necessary skilled staff for this purpose during the short to medium period recovery period spanning the next 2 years. Under ADB support, R&B Dept is developing a Road Asset Management System (RAMS). In light of the preparedness for future disasters and climate shocks in the state, it is advised that the RAMS should be climate informed and include for bridge inventory and condition assessment which needs to be mainstreamed in the state.

For ensuring community resilience that suffered connectivity loss at critical locations in Mangan district, it is proposed to introduce a special pilot state program for all weather roads along Teesta<sup>39</sup> covering around 50 km of roads where formation width has already been laid out by R&B Department under state's Fair-weather scheme.

### **Technical Studies for "Long Term" Resilient Recovery**

It is recommended that a strategic options study (SOS) is taken up in short to medium term to plan new road and bridge infrastructure for resilient connectivity to North Sikkim/ International borders

identifying alternate road networks that can remain functional irrespective of disasters of the magnitude of GLOF. Some the capital works that R&B Dept. has expressed a need to consider in medium to long-term for service socio-economic resilience include.

- Construction of 150-180 m span bridge over Teesta River from Nawtar Lower Rangtu to Rangutar Lower Mangli connecting Gangtok District with the Namchi District including upgradation of 3km of road on Gangtok side and construction of 1.5 km approach road on the Namchi side. This bridge can also provide an alternate route in the event of blockade of the Pabong–Simchuthang Yangang road at Guyey Kholsa, which is an annual phenomenon.
- Construction of 190 m span over Teesta River from Lower Samdong Bazaar to Lower Payong connecting Gangtok District with the Namchi District including upgradation of 2.5km of road on the Lingee Payong road and construction of 2 km length approach road on the Lower Samdong side. This bridge will connect Lower Samdong in the Gangtok district to the Lingmoo village in the Namchi District.
- These bridges will by-pass vulnerable stretches of roads which will require re-settlement and massive slope protection work along the Teesta River Basin. This can be taken up under Setu Bandhan Project of GOI.
- Alternate road to existing NH 10 connecting Melli in the Namchi District to Singtam in the Gangtok District
- Alternate resilient road connecting Chungthang to Lachen
- Technical studies and DPRs for the above projects are proposed to be taken up by the State with support of DFIs wherever feasible.

## **Impact of Recovery**

The proposed recovery and reconstruction interventions when undertaken will directly contribute to the resilient recovery of the state's road and bridge infrastructure and also enable the process of mainstreaming the resilient approaches for future planning, design and execution of works. The state needs a "whole of system" approach for resilient transport networks. Scientific monitoring of the river and associated ecosystem contributing to Disaster Risk Reduction of the infrastructure sector.

## **Implementation mechanism**

The proposed reconstruction and recovery interventions will be undertaken by the R&B Department and Rural Development Department and few ULBs. All initiatives shall be undertaken in consultation and coordination with the Sikkim State Disaster Management Authority. Based on the access to funding from the National Disaster Relief Fund, State Disaster Relief Fund, State and Central Sector Schemes as well as DFIs (Development Finance Institutes). A project Implementation unit (PIU) under the leaderships of the Principal Chief Engineer- Secretary of R&B Department and Secretary-RDD will be established to ensure effective implementation and monitoring of the reconstruction and recovery initiatives. Multi-stakeholder partnerships will comprise of stakeholders from research organisations, scientific institutions, community to ensure the effective on-ground planning and timely implementation of the proposed reconstruction and recovery interventions.

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<sup>39</sup> The state already has a sanctioned plan for 1506 km Fair weather roads with state planned budget of Rs 750 Crs (R&B Dept. Annual Report 2022-23)



All recovery actions should be in line with the principles of 'Build Back Better' (BBB) to increase the resilience of the state and its communities. The disaster risk reduction measures should factor the needs of ecologically sensitive Indian Himalayan Region. The basic principles of recovery efforts have to start from short-term and evolve into a more sustainable mainstreamed practice in the medium to long term which are informed by various technical studies. Some of the focus areas for recovery actions include:

### **Policy and Systems**

- Mainstream resilience in the Himalayan Mountain roads, protecting the natural and social environment. The R&B Department should focus on developing a policy framework, strategies and technical manuals for mainstreaming resilience by developing and adopting (i) an integrated landslide risk mitigation strategy, (ii) planning and design of roads along river courses with soft banks (iii) an emergency warning and response system, (iv) nature-based solutions and resource protection, and (v) an environmental and social management framework.
- Develop a local guideline for resilient road infrastructure based on own assessment, local engineering, use of local and marginal materials, nature-based solutions and lessons learned from other states that will inform reconstruction and recovery. Wherever possible, apply bio-engineering solutions with low-cost structural measures like gabions for slope stabilisation to support a greener recovery.
- Develop RAMS for scientific planning, budgeting and execution of work and explore the possibility of implementing a GIS-based climate module with multi-hazard mapping, climate and population data for conducting vulnerability assessments and climate and hazard risk assessments of road and bridge assets. Develop a bridge module in RAMS to capture a detailed as-built and condition survey to be overlaid with climate and hazard data on the GIS platform.
- The practise of bridge inspections and repairs should be carried out more frequently to ensure that increasing damage does not worsen and is repaired before it causes major damage to the bridge during flash floods resulting from events like GLOF, cloud burst or high intensity rainfall. Conducting routine health assessment of bridges should be thus mainstreamed as part of Bridge Module Manual of RAMS.

### **Institutional**

- Expand the capacity of the Planning Division of the Department of Research and Development to design and construct climate-resilient roads and bridges. The department may contract the services of 1 geologist cum geotechnical expert, 1 hydrology expert, 1 bridge and 1 road design expert for the next 2 years. These experts shall report to the Additional CE planning team and support in pragmatic planning and design as part of the short to medium term recovery and reconstruction. This team should also be responsible to support RDD and ULBs on planning and design matters. The RDD should also explore collaboration with IIT Guwahati, IIT Kharagpur and local engineering colleges for training and capacity building and technical guidance to the resilient design team.
- The hydropower companies like NHPC /CWC/Water Resources are the key stakeholders to designing resilient roads and bridges across the Teesta. The new bridge locations, flow conditions and river training requirements are determined in consultation with them and all meetings recorded.

## Engineering

- R&B Department should initiate a site-specific flood and landslide vulnerability assessment on roads along the Teesta River watershed in the next 2-3 months. This will enable road agencies to undertake comprehensive flood risk mapping, identification and characterization of unstable hillsides, and soil and rock characterization. This assessment should enable road sector to determine viable options for slope protection, preferably focusing on a combination of retaining structures (breast wall and retaining wall) and bioengineering solutions. This exercise is crucial in a post-disaster scenario as it will enable R&B to identify and mark critical locations for flood breaches and scouring of slopes by rivers with geo- tagging. Some of the resilience building measures may require cross-sector collaboration, e.g. with Water Resources Dept. /hydropower companies for toe protection, selected dredging, river training/channelization, bank protections using retaining walls, check dams and dykes at the approach to major bridges. Similarly for critical landslide/big slip circle failed locations along road alignments, multi-sectoral assessment by Water Resources /Forest/SDMA and construction of detailed ground model may be the best way forward to determine mitigative approach.
- Conduct detailed monitoring of the condition of all major and minor bridges in the state and develop a programmatic approach for replacement of old and severely deteriorated bridges, repair/rehabilitation of weak bridges - including measures such as replacement or restoration of expansion joints, bearings, raising the bridge deck above the HFL, wherever possible, protection measures against unforeseen changes in river flow such as dykes and check dams, and stabilisation of riverbanks.
- Climate-resistant bridge structures should be designed based on thorough hydrological and geological conditions. Given the terrain, bridges with long spans, i.e. integrated bridges, cantilever bridges and composite steel bridges, are the best choice. Events such as GLOF and future flash floods in Teesta and other river basins the bridge foundations should be deepened. If piers cannot be avoided, a well foundation is preferable to a raft foundation. Bridge scour is a major cause of bridge failure and collapse; protecting bridges from scour is very important when evaluating adaptation options. Stabilized riverbanks can prevent erosion and protect the bridge from scour. Protection against bridge scour and stabilization of riverbanks can be achieved by installing revetments, gabions, riprap or other measures such as increasing vegetation/forest cover (a large part of this forest cover was impacted by the recent GLOF).
- As R&B and RDD Dept, restore and rebuild some of the damaged roads, it is recommended that wherever slope failures have occurred, slope stabilisation should be carried out first to prevent further landslides. A combination of a breast wall on hill side and a retaining wall on the valley side with site-specific designs of rubble masonry, gabion or RCC (one or two layers). At critical sections, nature-based solutions such as bio-engineering with geo- cells/geogrids or bolted nets should also be used to prevent surface erosion. Retrofit CD structures (Bridges/Culverts) with erosion protection (e.g., bed aprons, river/streams embankment protection with boulder pitching, bio-engineering solutions like use of vetiver grass, hydro-seeding, bamboo and shrub plantation).
- New CD structures (Bridges/Culverts) should be designed to the latest flood and hydrological flows accounting climate projections. The hill side drains damaged should be constructed along with catch water /chute drains to discharge water from the hills to the lead away drains to the nearest CD outfall.
- For rural roads where the HFL cannot be maintained at the river/stream crossings and there is a possibility that the river/stream banks will be severely undermined, it is thus advisable to build low-cost bailey rather than expensive permanent bridges. The mechanical engineering department of R&B and RDD needs to be strengthened to maintain such network of bridges in the state.

### **Technical Assistance Support Required (In Short to Medium Term)**

- Geotechnical and geomorphologic studies for critical slopes by SSDMA with the help of reputed national/international academic institutes (to be completed in the next 24 months, Rs 5 crores)
- DPRs for "fair weather to all weather road program along Teesta River basin" 50 km for 4 districts
- Detailed program design and DPRs for the community footbridge program
- Detailed study for the program to connect new bridges across the Teesta and designs for 2 new bridges at the site of the Indrani and LD Kazi bridges that were washed away during the GLOF
- Strategic connectivity option study for North Sikkim and Teesta River basin
- Capacity building of R&B department engineers and local contractors on resilient road design and construction, bio-engineering solutions, topsoil conservation during construction, value engineering using local and marginal materials, sensitization on long-term performance-based management contracts and their role in sustainable road maintenance for core facilities. This can be achieved through capacity building trainings, targeted contractor outreach programs and some advanced seminars on relevant topics in the state.

The overall recovery matrix for short to medium term is provided in Table 7 below which has infrastructure cost as well as soft costs related for technical studies, training and capacity augmentation.

Table 68. Roads and Transport: Recovery Framework					
Recovery and Reconstruction Needs	Amount (INR Lakhs)	Responsible Department	Supporting Department	Funding Source	Timeline
Reconstruction of majorly damaged/washed away road sections with river training works, breast walls, retaining walls and drains	9088		SSDMA/Forest/State Finance Dept./NHPC/ Water Resources Dept.	GoS/NDRF/SDRF	0-24 months
Resilient Road Bridge Reconstruction and Rehabilitation Program for damaged /washed away bridges/culverts	16434	R&B	State Finance Dept., BRO, NHIDCL	GoS/GOI-Setu Bandhan/SDRF	0-36 months
Detailed Study and DPRs for New Bridges Connectivity Program along Teesta (Under Setu Bandhan)	1000	R&B	State Finance Dept., BRO, NHIDCL, GOI	GoS/SDRF	0-24 months
Health Monitoring of all major Bridges followed by Retrofitting and River Training works/Hydraulic control works like check dams/dykes at vulnerable bridge locations and downstream of Dams	5000	R&B	State Finance Dept., CWC, Water Resources Dept., NHPC, NDMA, BRO, SSDMA	GoS/SDRF/NDRF	0-24 months
Road Asset Management System with Bridge and Climate Module	1000	R&B	SSDMA/DFIs	GoS/DFIs/SDRF	0-24 months
Community Connectivity Program with "Jholanga (Suspension)" Bridges along Teesta in 4 affected districts (Old + New Locations) with quick DPRs	4416	RDD	State Finance Dept. and GOI	GoS/NDRF	0-24 months

Recovery and Reconstruction Needs	Amount (INR Lakhs)	Responsible Department	Supporting Department	Funding Source	Timeline
Technical studies to deal with sinking sections, bridge design options across mountainous rivers with considering high flow discharge as result of events like GLOF and local geo-morphology	500	R&B	SSDMA/DFIs	GoS/DFIs/SDRF	0-12 months
Vulnerability assessment of road network along Teesta River, identifying hotspots of Toe erosion by High floods for River Training works including dykes	500	R&B	SSDMA/Forest/DFIs	GoS/DFIs/NDRF	0-6 months
Strategic Connectivity Option Study for North Sikkim and Teesta River Basin Area	500	R&B	BRO	GoS/DFIs/NDRF	0-12 months
Capacity Building (Refer section 2.1.1.3)		PWD	Finance/DFIs		
Induction of resilient design engineers in R&B Design Wing for 2 Years	600	PWD	Finance/DFIs	GoS/DFIs/SDRF	0-3 Months
Training and Capacity Building of R&B, RDD Engineers and Contractor on resilient road design, bridge health design and management	500	PWD	Finance/DFIs	GoS/DFIs/SDRF	0-12 months
Policy Linkages	Refer sub-sections under 2.1.1.6 above				
Disaster Risk Reduction Measures					
<b>Total (In INR Lakhs)</b>	<b>39538</b>				

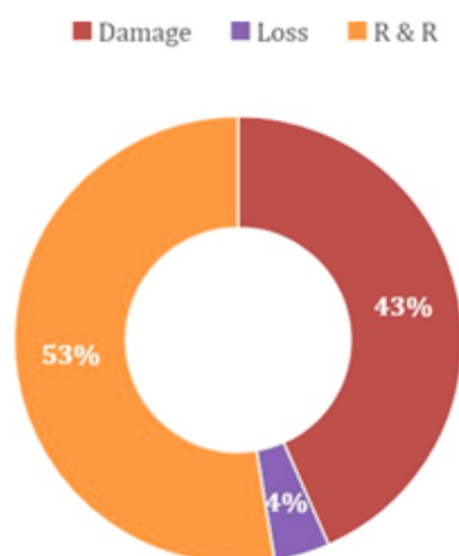
## 5.2 Drinking Water and Sanitation

### Summary

The catastrophic event at Lhonak Lake in October 2023 significantly impacted the water and sewage infrastructure in Sikkim's districts of Gangtok, Mangan, Namchi, and Pakyong. The breach in the lake's embankments, caused by a cloud burst, led to extensive flooding in these areas, severely disrupting both urban and rural communities. Water Supply: One WTP is completely down and two partially compromised out of seven, Sewer Treatment Plant: Three STPs across the regions are totally damaged, leading to a loss of 2.56 MLD in treatment capacity. Three toilets in Pakyong are damaged, and there's significant compromise in the drainage infrastructure with a total of 8,400 meters damaged. Each district demonstrates a unique pattern of damage, reflecting the varying impact of the disaster on different aspects of infrastructure. Damaged water and sewage treatment facilities have increased dependence on unsafe water sources and the potential spread of waterborne diseases. This situation poses a direct threat to public health and has adverse economic implications, particularly for the crucial tourism sector, affecting community livelihoods and the local economy.

Table 69. Drinking Water and Sanitation: Recovery Framework			
District	Damage	Loss	Recovery and Reconstruction
Gangtok	13.03	1.325	16.26
Mangan	3.59	1.63	5.19
Namchi	5.16	1.16	6.49
Pakyong	16.11	0.54	18.00
<b>Total</b>	<b>37.90</b>	<b>3.495</b>	<b>45.93</b>

The reported damage to water and sanitation infrastructure are: in Gangtok, 6.5 km of pipeline, an STP, 3,500 meters of trunk lines, 200 RCC chambers, 1,700 meters of drainage, and 44 civil structures were damaged. Mangan saw one WTP and 7.5 km of pipeline nonfunctional, 9 MLD reservoir impact, and six damaged RCC chambers. Namchi had 1.636 km of pipeline, an STP, 2,000 meters of trunk lines, and 15 RCC chambers affected. Pakyong faced partial damages to two WTPs, 6.4 km of pipeline, all pumps, 60.0016 MLD reservoir capacity, 35 civil structures, 2,500 meters of trunk lines, 135 RCC chambers, three toilets, and 5,200 meters of drainage systems compromised. This lead to the estimated cost of damage estimated as: Rs. 9.92 crores for pipeline infrastructure, Rs. 3.69 crores for civil infrastructure, Rs. 0.83 crores for pump systems (localized in Pakyong), Rs. 0.11 crores for water reservoir capacities, and Rs. 0.28 crores for RCC chambers at Water Treatment Plants.



In sanitation, STPs across three districts suffered damages totaling Rs. 10.24 crores, with trunk line damages at Rs. 6.00 crores. RCC Chambers at STPs faced Rs. 1.73 crores in damages, toilets in Pakyong cost Rs. 0.41 crores, and drainage systems saw Rs. 4.70 crores in damage, highlighting the need for urgent repairs and resilience upgrades.

Following the disaster in Sikkim, significant economic losses were incurred across various districts, with urgent response and rehabilitation measures implemented to address the immediate needs. Makeshift pipelines and bottled water were provided to relief camps, and water tankers were dispatched for continuous supply. Five community hydrants were set up in the IBM area to temporarily replace household connections. The total loss estimates for the districts were Rs. 1.32 crores for Gangtok, Rs. 1.63 crores for Mangan, Rs. 0.16 crores for Namchi, and Rs. 0.54 crores for Pakyong.

The recovery plan for Sikkim includes repairing and upgrading the pipeline network, with a focus on landslide protection and long-term resilience. For water treatment plants, immediate cleaning of sand filters and repair of reservoir tanks are prioritized. Civil infrastructure requires detailed assessment and repair, especially for water intake facilities prone to landslides. Transitional sewage treatment involves constructing temporary holding tanks, while damaged drainage systems need urgent repair to prevent public health risks. Capacity building in resilient construction techniques is crucial. Additionally, reconstructing RCC chambers and community toilets with improved designs and septic tanks is emphasized, considering the need for increased resilience and public health safety.

The recovery plan in Sikkim addresses extensive damage to the water supply and sanitation infrastructure. Key actions include upgrading the pipeline network with durable materials and protective measures against landslides, costing Rs. 11.90 crores. Water Treatment Plants require immediate repairs, especially for sand filters and reservoir tanks, with a total estimated cost of Rs. 0.13 crores. The civil infrastructure, severely affected by landslides, needs extensive repair work, totaling Rs. 4.41 crores. Transitional sewage treatment facilities will cost Rs. 2.52 crores. Additionally, Rs. 7.20 crores are allocated for repairing trunk lines, Rs. 0.60 crores for capacity building, and Rs. 2.25 crores for drainage system reconstruction. Reconstruction costs include Rs. 0.44 crores for RCC Chambers at WTPs, Rs. 12.29 crores for sewage treatment plants, Rs. 2.69 crores for RCC Chambers at STPs, and Rs. 0.78 crores for rebuilding community toilets, totaling Rs. 16.20 crores.

In Sikkim's recovery plan, a collaborative approach involves key departments—PHED for water and sewage, Rural Development for high-altitude water structures, and Urban Development for STP reconstruction and compliance. State and district-level task forces, including SDMA and DDMA experts, will enforce, review, and adapt strategies. Academic professionals provide specialized support, while SDMA/DDMA aid in technical and capacity building. Funding from NDRF/SDRF will cover recovery costs, and schemes like Swachh Bharat Mission-Urban 2.0 and AMRUT 2.0 will support additional infrastructure enhancements.

### **Basic Profile of the Sector**

In addressing the fundamental needs of communities for safe water and sanitation, the Department of Water Security & Public Health Engineering assumes a crucial role amid rapid growth and development. With a focus on environmental protection, the department minimizes hazards by establishing functional sewerage treatment plants for the safe disposal of effluent and water treatment plants to ensure a clean water supply. Catering to citizens across urban, semi-urban, and rural areas, dedicated officers and staff work tirelessly to provide essential services. In rural regions, the collaboration with the Rural Development Department (RDD<sup>40</sup>) involves the Dhara Vikas Yojna, a spring shed development scheme aimed at rejuvenating drying water sources for source sustainability and safe drinking water.





The details of STP<sup>43</sup> in the state and its capacity explained the table below:

Sl.No.	Location	Capacity (MLD)	Capacity Being Utilized (%)
1.	Gangtok Zone I, Adampool	8.0	100
2.	Gangtok Zone I, Adampool	4.69	85
3.	Gangtok Zone I, Ranipool	1.27	85
4.	Gangtok Zone IV, Lower Sichey	3.90	85
5.	Singtam	0.66	80
6.	Melli	0.50	0
7.	Gangtok Zone III, Tathangchen	3.25	7.0
8.	Gangtok Zone II, Lower Syari	1.60	95.0
9.	Rangpo	1.40	95.0

Upon the field visit, it became apparent that every household possesses a toilet and a septic tank within its premises. Specific details regarding individual household toilets will be elaborated upon in the housing chapter. However, it is noteworthy that not all household toilets are linked to a Sewer Treatment Plant (STP) chamber or pipeline. A study<sup>44</sup> conducted by the Gangtok PHED in the Singtam Lal Bazar area revealed that over 35% of household septic tanks are not connected to an STP chamber or pipeline.

Significant challenges persist in Sikkim concerning the treatment of gray water and the drainage system. A considerable percentage of households, as previously highlighted, have septic tanks not connected to sewer chambers. Instead, some households in urban areas opt to connect their sewer lines directly to available drainage. Unfortunately, untreated gray water is being discharged into river lines. Additionally, the existing drainage systems face issues with improper covering, enabling easy disposal of solid waste, including plastics, into the drains. This lack of proper drainage management poses a major concern, especially considering Sikkim's historical instances of waterborne communicable diseases like dengue. Addressing these challenges is essential for maintaining public health and mitigating the risk of such diseases.

### **Sectoral Policies and Schemes**

The brief outlines various policies, acts, and organizational structures in Sikkim, India, focusing on water management, sewage disposal, and environmental preservation:

- Jal Jeevan Mission - JJM is a flagship program by Government of India to provide functional tap to each household in the country.
- Sikkim Water Policy, 2009: A comprehensive policy focusing on the sustainable management and utilization of water resources in Sikkim.
- Sikkim Sewerage and Sewage Disposal Act, 1987: Legislation governing the management, treatment, and disposal of sewage in the state.

<sup>43</sup> National Mission for Clean Ganga Progress Report in the NGT Matter, [https://nmcg.nic.in/writereaddata/fileupload/ngtmpr/51\\_Sikkim%20-%20MPR%20-%20November%202020.pdf](https://nmcg.nic.in/writereaddata/fileupload/ngtmpr/51_Sikkim%20-%20MPR%20-%20November%202020.pdf)

<sup>44</sup> Study was conducted by PHED East Circle office

- Sikkim Sewerage and Sewage Disposal Rules, 1990: Detailed rules implementing the 1987 Act, providing specifics on how sewage should be managed and disposed of.
- Sikkim Water Supply and Water Tax Act, 1986: Establishes regulations for water supply and introduces taxation related to water usage.
- Sikkim Water Supply (Amendment) Rules, 2014: Amendments to the existing water supply rules, possibly to update or improve upon the existing framework.
- Sikkim Water Supply Rules, 1990: Detailed rules for the provision and management of water supply in the state.
- Sikkim Irrigation Water Tax Act, 2002: Legislation that imposes taxes on the use of water for irrigation purposes.
- Sikkim Forests, Water Courses And Road Reserve (Preservation And Protection) Act, 1988: A comprehensive act aimed at preserving and protecting forests, water courses, and road reserves.
- Sikkim Water Supply Act, 1991: A specific act focused on the provision and management of water supply.
- Sewerage and Sewerage Disposal Act, 1991: A further legislative measure to manage sewerage and its disposal in Sikkim.

<b>Table 72. Drinking Water and Sanitation: Sectoral Policies and Departments</b>			
Sl. No	Organisation/Institution	Key Functions	Relevant Act/Law/Policy
1	Public Health Engineering Department (PHED)	Providing safe and sufficient water, developing water and sewerage strategies, environmental conservation Construction and maintenance of water, sewerage, and sanitation facilities; formulating and implementing tariffs; watershed and water source conservation	Sikkim Water Supply and Water Tax Act, 1986; Sikkim Water Supply Act, 1991; National Water Policy Sikkim Sewerage and Sewage Disposal Act, 1987; Sikkim Sewerage and Sewage Disposal Rules, 1990; National Urban Sanitation Policy
2	Urban Development And Housing Department	Management of Solid Waste and Liquid Wastes Disposal; Storm Water Drainage	National Urban Sanitation Policy; Solid Waste Management Rules, 2016
3	Sikkim State Pollution Control Board (SPCB)	Water Quality Monitoring to assess pollution levels	Water (Prevention and Control of Pollution) Act, 1974; Environment (Protection) Act, 1986
4	Forest Environment and Wildlife Management Department	Preservation of natural environment quality (water, air, soil); Implementation of environmental protection acts	Sikkim Forests, Water Courses And Road Reserve (Preservation And Protection) Act, 1988; Forest (Conservation) Act, 1980; Wildlife Protection Act, 1972
5	Rural Management & Development Department (RMDD)	Providing clean drinking water in rural areas, improving sanitation, ensuring water security, Water supply assessment, water source surveying, water quality monitoring, and promoting alternative water technologies	National Rural Drinking Water Programme; Swachh Bharat Mission (Rural)

## Damages in the Sector

In the remote North-Western reaches of Sikkim, Lhonak Lake, ensconced amidst glacial moraines, bore witness to a catastrophic event on October 4th, 2023. A breach of its embankments, triggered by an intense cloud burst, unleashed a devastating deluge upon the Teesta River basin, inflicting extensive harm upon lives and property. The repercussions of this breach extended far beyond the lake's shores, impacting the entire expanse of the Teesta River, stretching from its source to Melli in Sikkim and even spilling over into the neighbouring state of West Bengal. The districts of Gangtok, Mangan, Namchi, and Pakyong in Sikkim have been impacted by recent flooding, affecting both urban and rural areas. The blocks within these districts that have faced disruptions include Singtam, Mangan, Chungthang, Rangpo, Duga, Temi Tarku, Namthang, Sumbuk, and several areas within.



Fig: IBM Rangpo

## Temi

In the urban settings, the Nagar Panchayats have been actively managing the situation. Singtam's urban area in Gangtok district is under the jurisdiction of the Singtam Nagar Panchayat. The Mangan Nagar Panchayat is responsible for the urban section of Mangan. Furthermore, the urban regions of Rangpo and Duga in the Pakyong district are administered by the Rangpo Nagar Panchayat, coordinating the response to the flood's challenges.

Concurrently, the rural areas have been under the stewardship of the Gram Panchayats, which are spearheading the management and relief operations. Mangan's rural territories, including Ramthang-Tanek GPU, Chungthang-Pegong GPU, Toong Naga, Singhik sentam, and Mangshilla tibuk, are supported by their respective Gram Panchayats. The Pakyong district's West Pendam and the Namchi district's Temi Tarku, Namthang, Sumbuk, 11-TARKU TANAK, and 09-ben namprick also rely on their Gram Panchayats for recovery efforts and to ensure the well-being of the affected rural communities.

Unfortunately, these communities bore the brunt of the catastrophe, enduring severe damage and crippling disruptions to essential services, specifically the water supply and sewerage systems. The flash flood, with its overwhelming force, swept away essential equipment, service vehicles, and the very infrastructure essential for water supply and sewerage systems, rendering them nonfunctional and compounding the challenges faced by the affected population.





*Fig: damaged drain singtam- toilet -Ramgpo*



*Fig: Pipes being excavated from silt IBM(left) WTP Singtam ( right) (8/12/2023)*



*Fig: Before and after STP - Singtam*

Table 1 Overall Damage Numbers (Absolute/ Sq.m areas/ both)

Table 73. Drinking Water and Sanitation: Overall Damage numbers					
Categories	District	Totally Damaged	Severely Damaged	Partially Damaged	Total
Category 1 Water Treatment Plant (WTP)	Gangtok	0	0	0	1
	Mangan	1	0	0	4
	Namchi	0	0	0	0
	Pakyong	0	0	2	2
Sub-Total		1	0	2	7
Category 2 Pipe line		Damaged in KML		Total in KML	
		6.5		32	
		7.5		29.824	
		1.636		5.6	
		6.4		60.4	
Sub-Total		22.036		127.824	
Category 3 Pump		Totally Damaged	Severely Damaged	Partially Damaged	Total
		0	0	0	0
		0	0	0	0
		0	0	0	0
		4	0	0	10
Sub-Total		4	0	0	10
Sub-totCategory 4 Water Reservoir Capacity (MLD)	District	Totally Damaged	Severely Damaged	Partially Damaged	Total
	Gangtok	0	0	0	1.35
	Mangan	9	0	2	11.057
	Namchi	4.005	0	0	4.005
	Pakyong	60	0	0	60.0016
Sub-Total		73.005	0	2	76.4136
Category 5 Civil infrastructure	District	Sum of Civil Infrastructure (in number)		Sum of Approx. area Damaged	
	Gangtok	44		880	
	Mangan	3		60	
	Namchi	0		0	
	Pakyong	35		280	
Sub-Total		82		1160	
Category 6	District	Totally Damaged		Total	
	Gangtok	40		Not mentioned	

RCC Chambers WTP IN number	Mangan	6	Notmentioned	
	Namchi	0	Notmentioned	
	Pakyong	35	Notmentioned	
Sub-Total		81		
	District	Totally Damaged	Capacity in MLD	Total
Category 7 Sewage Treatment Plant	Gangtok	1	0.66	1
	Mangan	0	0	0
	Namchi	1	0.5	1
	Pakyong	1	1.4	1
Sub-Total		3	2.56	3
	District	Totally Damaged	Total	
Category 8 Trunk Lines (meter)	Gangtok	3500	Notmentioned	
	Mangan	0	Notmentioned	
	Namchi	2000	Notmentioned	
	Pakyong	2500	Notmentioned	
Sub-total		8000		
	District	Totally Damaged	Total	
Category 9 RCC Chambers STP	Gangtok	200	Notmentioned	
	Mangan	0	Notmentioned	
	Namchi	15	Notmentioned	
	Pakyong	100	Notmentioned	
IN number				
Sub-Total		315		
	District	Totally Damaged	Total	
Category 10 Toilet (In number )	Gangtok	0	Notmentioned	
	Mangan	0	Notmentioned	
	Namchi	0	Notmentioned	
	Pakyong	3	Notmentioned	
Sub-Total		3		
	District	Totally Damaged	Total	
Category 11 Drainage ( meter)	Gangtok	1700	Notmentioned	
	Mangan	0	Notmentioned	
	Namchi	1500	Notmentioned	
	Pakyong	5200	Notmentioned	
Sub-Total		8400		



The provided data offers a comprehensive overview of the infrastructure damages sustained in the Teesta River basin following a significant natural disaster. This analysis encompasses various critical categories such as Water Treatment Plants (WTPs), pipelines, pumps, water reservoir capacities, civil infrastructure, sewage treatment plants, trunk lines, and reinforced concrete chambers (RCC Chambers). The assessment is detailed on a district-by-district basis, highlighting the extent of damage in Gangtok, Mangan, Namchi, and Pakyong. These insights are crucial for understanding the scale and scope of the damages, facilitating the prioritization of repair and restoration efforts in each district. The following summary encapsulates the key findings from each category, providing a clear snapshot of the impact across the affected areas:

In the aftermath of the recent natural disaster affecting the Teesta River basin, the district of Gangtok has seen 6.5 km of its 32 km pipeline network damaged, one sewage treatment plant (STP) completely compromised, 3,500 meters of trunk lines, and 200 RCC chambers at STPs totally damaged, alongside 1,700 meters of drainage systems and 44 pieces of civil infrastructure. Mangan district reports one out of four water treatment plants (WTPs) and 7.5 km of its pipeline network completely nonfunctional, with 9 MLD of its water reservoir capacity also impacted, and six RCC chambers at WTPs damaged. Namchi district's infrastructure sustained damage to 1.636 km of pipelines, one STP with a 0.5 MLD capacity, and 2,000 meters of trunk lines, as well as 15 RCC chambers at STPs. Pakyong district faced partial damages to both of its WTPs, 6.4 km of its expansive 60.4 km pipeline network, all four pumps, and its entire 60.0016 MLD water reservoir capacity, with significant damages to 35 structures of civil infrastructure, 2,500 meters of trunk lines, 135 RCC chambers across WTPs and STPs, three toilet facilities, and a substantial 5,200 meters of drainage systems.

**Water supply:** The recent infrastructure assessment reveals substantial damage to the water supply scheme. The water treatment infrastructure reports one plant completely down and two partially compromised, out of a total of seven. The pipeline network has incurred 22.036 kilometers of damage, reflecting a significant impact on water distribution. Additionally, four pumps are entirely out of commission, which affects the water flow to the end-users. The water reservoirs have a combined loss of 73.005 MLD capacity, critically reducing the storage and supply of water. Civil infrastructure has not been spared, with 82 structures reported as damaged, along with 81 RCC chambers linked to water treatment plants being totally damaged. These damages to the water supply infrastructure underscore the need for immediate restoration actions to ensure the continuity of water services.

It's important to note that among the water treatment plants (WTPs) that sustained partial damage, one has experienced a breach in its inlet pipeline. Although this facility remains operational, its sand filtration system is currently impaired due to the influx of silt brought in by floodwaters. Furthermore, another WTP, which is connected to a lift system located near the Rangpo Sewage Treatment Plant (STP), has sustained severe damage. The associated lift system, including its newly installed pumps – two 10 HP and two 100 HP – has been washed away by the floods. Such destruction significantly hampers the functionality of the water treatment processes, posing a risk to the steady supply of clean water. Additionally, there's a WTP which is marked as fully damaged, in which the filtration system and storage tank have been completely destroyed. This particular damage affects a specific section of the storage tank and its associated civil infrastructure.

**Sewer Treatment Plant:** The sewerage treatment infrastructure has been significantly impacted, with three sewage treatment plants (STPs) reported as totally damaged across the regions, leading to a total loss of 2.56 MLD in treatment capacity. The trunk line system, critical for waste conveyance, has suffered 8,000 meters of total damage, which could potentially disrupt the sewage management and processing flow. In addition, the sewage network's structural integrity is compromised with 315 reinforced

concrete chambers (RCC Chambers) associated with STPs reported as totally damaged, predominantly in Gangtok and Pakyong. These damages to the sewer treatment facilities are critical and demand prompt repair and recovery efforts to prevent further environmental and public health issues.

**Public sanitation and Drainage:** The assessment reveals that toilets have sustained damage exclusively in Pakyong with three units affected, which will require attention to ensure sanitary conditions are restored. Drainage infrastructure has been significantly compromised with a total of 8,400 meters damaged, which may lead to water management issues such as flooding or inadequate sewage disposal. Immediate remedial actions are critical to restore these facilities to operational status to prevent potential public health risks and environmental impacts.

Table 2 Damage cost estimate

<b>Table 74. Drinking Water and Sanitation: Damage Cost Estimate</b>	
<b>Category</b>	<b>Cost in crore</b>
Category 1-Pipeline	9.92
Category 2-Pump	0.83
Category 3-Water Reservoir Capacity (MLD)	0.11
Category 4-Civil infrastructure	3.68
Category 5-RCC Chambers WTPI Nnumber	0.28
Category 6-Sewage Treatment Plant	10.24
Category 7-Trunk Lines (meter)	6
Category 8-RCC Chambers STPI Nnumber	1.73
Category 9-Toilet (unit)	0.41
Category 10-Drainage (meter)	4.7
<b>Total damage estimate</b>	<b>37.9</b>

Sikkim's water supply and sanitation infrastructure damage reveals a total cost of ₹37.90 crores, with Pakyong district incurring the highest damage at ₹16.11 crores, largely due to significant costs in sewage treatment plants (STP) and pipelines. Across the districts, the most impacted component is STP, accounting for ₹10.24 crores of the total damages. Gangtok follows Pakyong in terms of district-wide damage with ₹13.03 crores, primarily due to pipeline and STP-related costs. Mangan and Namchi report lower total damages at ₹3.59 crores and ₹5.16 crores, respectively. Overall, the data indicates that STP and pipeline infrastructure are the most affected components across the districts, contributing substantially to the region's total damage costs.

Table 3 District wise damage cost estimate Table

Table 75. Drinking Water and Sanitation: District Wise Damage Estimate	
District	Total
Gangtok	13.03
Mangan	3.59
Namchi	5.16
Pakyong	16.11
Total	37.90

**Gangtok:** The damages in Gangtok total Rs. 13.03 crores, with pipelines suffering the most at Rs. 2.93 crores. Civil infrastructure and RCC chambers for water treatment plants (WTP) follow closely at Rs. 2.65 crores and Rs. 0.14 crores, respectively. Sewage treatment plants (STP) and their trunk lines also face significant damages, costing Rs. 2.64 crores and Rs. 2.63 crores. Additionally, Rs. 1.10 crores in damages are reported for RCC chambers STP, and drainage systems show a cost of Rs. 0.95 crores.

**Mangan:** Mangan's total damages amount to Rs. 3.59 crores, primarily in pipelines (Rs.3.38 crores). Minimal damages are observed in water reservoirs and civil infrastructure, costing Rs. 0.01 crores and Rs. 0.18 crores, respectively, along with a minor Rs. 0.02 crores in RCC chambers WTP.

**Namchi:** Namchi reports damages totaling Rs. 5.16 crores, with significant costs in STP (Rs. 2.00 crores) and its trunk lines (Rs. 1.50 crores). Pipeline damages are relatively lower at Rs. 0.74 crores. Additional costs include Rs. 0.01 crores for water reservoirs, Rs. 0.08 crores for RCC chambers STP, and Rs. 0.84 crores for drainage systems.

**Pakyong:** Pakyong faces the highest total damages at Rs. 16.11 crores. The most significant impact is on STP, costing Rs. 5.60 crores, followed by pipelines (Rs. 2.88 crores) and trunk lines (Rs. 1.88 crores). Pumps and water reservoirs also show considerable damages at Rs. 0.83 crores and Rs. 0.09 crores, respectively. Other costs include Rs. 0.84 crores for civil infrastructure, Rs. 0.12 crores for RCC chambers WTP, Rs. 0.55 crores for RCC chambers STP, Rs. 0.41 crores for toilets, and Rs. 2.91 crores for drainage systems.

Table 76. Drinking Water and Sanitation: Component Wise Damage Estimate											
Water supply						Sanitation					
District	Pipe line	Pu mp	Water Reser voir	Civil infrastruc ture	RCC Cham bers WTP	STP	Trunk Lines	RCC Chamb ers STP	Toilet	Draina ge	Total
Gangtok	2.93	-	-	2.65	0.14	2.64	2.63	1.10	-	0.95	13.03
Mangan	3.38	-	0.01	0.18	0.02	-	-	-	-	-	3.59
Namchi	0.74	-	0.01	-	-	2.00	1.50	0.08	-	0.84	5.16
Pakyong	2.88	0.83	0.09	0.84	0.12	5.60	1.88	0.55	0.41	2.91	16.11
Total	9.92	0.83	0.11	3.68	0.28	10.24	6.00	1.73	0.41	4.70	37.90

## Water supply:

The water supply system damages in Sikkim across four districts due to a recent disaster are significant, with the highest impact on pipeline infrastructure at Rs. 9.92 crores, indicating it as the most vulnerable component. Civil infrastructure follows, with a total damage cost of Rs. 3.69 crores, requiring substantial repair and rebuilding. Pump system damages were localized to Pakyong, accounting for Rs. 0.83 crores. Water reservoir capacities and RCC chambers at Water Treatment Plants suffered relatively minor damages, with Rs. 0.11 crores and Rs. 0.28 crores respectively.

## Sanitation:

In Sikkim, the sanitation system faced considerable damages due to a recent disaster, with the Sewage Treatment Plants (STPs) experiencing the highest impact. The STPs across three districts suffered damages amounting to Rs. 10.24 crores, with Pakyong incurring the most at Rs. 5.60 crores, followed by Gangtok and Namchi with Rs. 2.64 crores and Rs. 2.00 crores, respectively. Mangan reported no STP damages. Trunk line damages were also significant at Rs. 6.00 crores collectively, indicating a disrupted sewage disposal network. RCC Chambers at the STPs faced lesser damages totaling Rs. 1.73 crores, with Pakyong, Gangtok, and Namchi bearing costs of Rs. 0.55 crores, Rs. 1.10 crores, and Rs. 0.08 crores, respectively. Toilet facilities were affected only in Pakyong, at a cost of Rs. 0.41 crores. Drainage systems saw damages worth Rs. 4.70 crores, with Pakyong again facing the highest damage costs. The data underscores the extensive damage to critical sanitation infrastructure, necessitating urgent repairs and potential system upgrades for increased resilience.

## Economic Losses in the Sector

The financial burden incurred from urgent response and rehabilitation measures undertaken in the aftermath of the disaster. The exigency of the situation compelled the operation of many pipelines on a provisional basis, as verified by the latest field visit. Relief camps were swiftly provided with water via makeshift pipelines (mostly used Alkathene pipe) linked to existing distribution networks. The response also entailed the provision of bottled drinking water, in 20-liter and 5-liter quantities, tailored to the needs and capacities of the various relief and food camps established in the affected areas.

To further aid affected communities, water tankers with a capacity of 8,000 liters were dispatched to supply water over a span of 20 days. Additionally, five community hydrants capable of delivering water for six hours daily were set up in the IBM area, using 25 mm and 20 mm alkathene pipes, to temporarily replace household water connections. Temporary sanitation installations were another aspect of the emergency response.

District	Total loss Estimate <sup>45</sup>
Gangtok	1.32
Mangan	1.63
Namchi	1.16
Pakyong	0.54
<b>Total</b>	<b>3.49</b>

Significant restoration initiatives were quickly mobilized in Singtam Town, where hosepipes, fastened with 12mm suspension cables, were used to restore water supply in areas destabilized by landslides. The Chagay, Dikiling, and Kamarey raw water pipelines received prompt repairs with hosepipes and HDPE pipes to resume operations.

Labor played a pivotal role in the cleanup and restoration process, excavating infrastructure and equipment, including pipelines. Excavators were specifically used to remove silt from sewage treatment plant (STP) sites and to extract pipelines that had been buried. Additionally, workers were employed to remove debris from residential areas and to clean fecal sludge from chambers (manholes). The deployment of labor and resources for these intensive efforts was crucial to mitigate the extensive damage sustained by the water supply infrastructure.

### Socio-Economic Impact on People

The recent flood in Sikkim has brought about significant challenges in water supply and sanitation, profoundly impacting the lives and health of local communities. This crisis has underscored the vulnerability of essential infrastructure to natural disasters and highlighted the urgent need for effective response and recovery strategies.

- **Disrupted Water Supply-** The damage to the Water Treatment Plants in Mangan and the partial damages in Pakyong have significantly impacted the quality and availability of drinking water. Communities may now be forced to depend on alternative water sources, which might not meet safety standards, potentially exposing them to health risks.



- **Compromised Sanitation Facilities:** The destruction and impairment of Sewage Treatment Plants in Gangtok, Namchi, and Pakyong have led to a critical breakdown in sanitation facilities. This situation could result in the discharge of untreated sewage into open drains and subsequently into rivers, escalating the risk of waterborne diseases. Furthermore, the issue of household septic tanks not being connected to STP chambers, coupled with direct discharge of untreated gray water into rivers, poses severe environmental and public health threats.

- **Economic Implications:** The economic repercussions of the flood are twofold. Firstly, there is an immediate financial strain due to the costs associated with alternative water supply and temporary restoration efforts.

Secondly, the disruption in WASH (Water, Sanitation, and Hygiene) facilities could adversely affect the tourism sector, a crucial component of Sikkim's economy. This disruption could lead to a direct negative impact on community livelihoods and the local economy.





- **Increased Health Risks:** The damage to water and sanitation infrastructure has heightened the risk of waterborne diseases, exacerbated by inadequate waste management and potential contamination of water bodies. This breakdown not only poses immediate health risks but also threatens the long-term well-being of the communities.
- The aftermath of the flood presents significant challenges in terms of water supply, sanitation, health, and economic stability. Addressing these issues requires a focused and efficient approach to not only restore but also strengthen the water and sanitation infrastructure, ensuring the resilience and health of the affected communities.

### Response by the Government

Following the catastrophic flash flood of the Teesta River, the Public Health Engineering Department (PHED) promptly mobilized its teams in Rangpo and Singtam to support the communities of Singtam, Rangpo, Majhitar, Mining, and Bageykhola. A thorough evaluation of the damage was carried out by engineers and field supervisors on October 4th, and the findings were reported to the District Disaster Management Authorities in Pakyong and Gangtok by October 5th, 2023.



In Rangpo, the PHED's response included:



Picture: 8 sewer chamber cleaning Lalbazar, water supply Rangpo

<sup>45</sup> This figure is given by the department mostly by PHED and rural development but it is important to note that this doesn't cover the loss by department of urban development



- Ensuring a steady water supply to relief camps through temporary pipelines at locations such as Sikkim Distilleries Hall and Government Secondary School.
- Setting up five community hydrants in the IBM area, providing water for six hours daily via 25 and 20 mm alkathene pipes.
- Repairing water mains damaged by landslides and boulders using hose and HDPE pipes, thus restoring water supply to Rangpo and Mining.
- Addressing the severe damage to the 1.4 MLD Sewage Treatment Plant and sewer trunk lines, with debris accumulation of up to 20 feet.
- Excavating and restoring the water supply lines in the IBM area, buried under debris across 6500 meters.
- Establishing dedicated water supplies at relief camps with HDPE pipes.

**In Singtam, measures taken were:**

- Continuously supplying water to relief camps such as Bihari Dharamsala and Singtam Sr. Sec. School, along with distributing 20-liter and 5-liter packaged drinking water.
- Restoring disrupted water supply mains along Sangkhola-Zingla Road using hosepipes and 12mm suspension cables.
- Dealing with the total loss of the 0.66 MLD Sewerage Treatment Plant and clearing flood debris from the sewer network.
- Repairing water supply lines in lower Singtam Bazaar that were severely damaged by the debris.
- Clearing chambers for sewage flow, constructing temporary septic tanks, and restoring raw water mains with hose pipes.

**Apart from PHED urban development has done**

- Clearance of floodwater, specifically addressing the affected areas and the drainage system.
- Clearance of debris from urban areas affected by the disaster,

**Reconstruction and Recovery Needs Assessment**

In the wake of any disasters or crises, regions like Sikkim face significant challenges in restoring and improving their critical infrastructure, particularly in the water supply and sanitation sectors. The following plan outlines a strategic approach, dividing the response into two key phases: early recovery and long-term reconstruction. This approach ensures not only the swift restoration of essential services but also their enhancement to withstand future adversities.

**Table 78. Drinking Water and Sanitation: Recovery and Reconstruction Needs Assessment**

Sector	Needs	Early Recovery Interventions	Reconstruction Intervention
Water supply	Water Treatment Plants	Clean the RSFS immediately	Construct additional small scale WTP for diversification of water supply system
		Repair the damaged water reservoir	
	Pipeline Network	Repair damaged sections	Complete pipeline network overhaul
		Replace the temporality arranged pipelines	Protection works for pipe lines.
Sanitation	Sewage Treatment Plants	Debris removal	Full-scale rehabilitation and capacity enhancement of the by 150%
		Build soak pits temporarily	Integrate flood protection in all STPs
	Pipeline Network	Repair damaged sections	Complete pipeline network overhaul with resilience measures
	Household Sewer Connection	Ensure connection to the drainage system	Build appropriate number of chambers which will make it easy for the house hold to connect with the chambers
	RCC Chambers Repair	Cleaning and sanitization	Upgrade for enhanced resilience (enhanced the size with height)
	Toilet Facilities		Construct new, resilient facilities
	Drainage System	cleaning and sanitisation	Comprehensive overhaul with underground systems in urban areas
		Repair partially damaged drainage	
Capacity building and leadership	Human Resources	Training on resilience construction	Regular training of office personal and mason training on resilience construction
	Information Management System	Regular water testing and HH visit	Implementing robust data management and monitoring systems
	Leadership and Coordination	Establishing a disaster response task force	Strengthening institutional frameworks for disaster management

**Water Supply Sector:** In Sikkim, the immediate recovery of the water supply sector focuses on restoring basic functionality to Water Treatment Plants (WTPs) by cleaning Rapid Sand Filtration Systems and repairing damaged water reservoirs. The reconstruction phase aims for a more resilient system, marked by the construction of additional small-scale WTPs to diversify the water supply. Similarly, the pipeline network requires urgent repair of damaged sections and replacement of temporary arrangements in the early recovery stage. The long-term reconstruction plan includes a complete overhaul of the pipeline network, incorporating protective works, crucial for a region susceptible to natural disasters.

**Sanitation Sector:** The sanitation sector's recovery begins with debris removal from Sewage Treatment Plants (STPs) and the repair of damaged sewage pipelines, essential for restoring basic sanitation services in Sikkim. The reconstruction phase focuses on full-scale rehabilitation of STPs with capacity enhancement and integration of flood protection, considering the region's flood risks. Additionally, ensuring household sewer connections and building chambers for easier connectivity is prioritized. The reconstruction also includes upgrading RCC chambers for better resilience and constructing new, resilient toilet facilities. The overhaul of the drainage system, especially in urban areas, involves implementing underground systems for long-term efficiency and safety.

**Capacity building and leadership:** Addressing the human resource needs, the plan involves training personnel in resilience construction techniques. In the realm of information management, regular water testing and household visits are crucial during early recovery, with a shift towards robust data management and monitoring systems in the recovery and reconstruction phase. Leadership and coordination are strengthened by establishing a disaster response task force, crucial for efficient immediate response, and enhancing institutional frameworks for sustained disaster management, ensuring Sikkim's preparedness and resilience in the face of future challenges.

**Recovery cost estimate:**

Table 79. Drinking Water and Sanitation: Reconstruction Cost Estimate-Water (In Crore)								
District	Pipeline	Water Reservoir	Civil Infrastructure	Holding Tank	Trunk Lines	Capacity Building	Drainage	Total
Gangtok	3.51	-	3.18	0.72	3.15	0.15	0.46	11.17
Mangan	4.05	0.02	0.22	0	-	0.15	0	5.15
Namchi	0.88	0.01	-	0.72	1.80	0.15	0.4	3.96
Pakyong	3.46	0.11	1.01	1.08	2.25	0.15	1.39	9.44
Total	11.90	0.13	4.41	2.52	7.20	0.60	2.25	29.73

The total estimated recovery cost across the districts for water supply and sanitation sectors is approximately Rs. 29.73 crores. The cost distribution indicates prioritization of pipeline networks and civil infrastructure, with significant funds also allocated for sewage treatment and drainage systems.

- For the Pipeline Network, it is crucial to not only conduct repairs on the damaged sections but also to replace any temporary pipelines with appropriate, durable alternatives. This strategic upgrade will significantly enhance the reliability and longevity of the water supply network, thereby minimizing the risk of future disruptions. Additionally, it is important to implement protective measures for pipelines, especially those connecting upstream water intake

structures with the Water Treatment Plants (WTP). These pipelines are particularly vulnerable to regular landslides, a risk that intensifies during the rainy season. Implementing robust protection work in these areas is essential to safeguard the infrastructure against environmental challenges and ensure uninterrupted water supply. The recovery cost is estimated for the damaged 22.1 KML of pipeline network.

- For Water Treatment Plants, it is imperative to prioritize the immediate cleaning and repair of Slow Sand Filters (SSF) and Rapid Sand Filters (RSF). Additionally, the construction and repair of damaged water reservoir tanks should be undertaken promptly. These actions are essential for ensuring the efficient functioning of the water treatment process and maintaining a consistent supply of clean water.
- For the Civil Infrastructure component, a detailed assessment is required to specify the repair work needed for each element of the infrastructure. This includes the water intake facilities, which are in urgent need of intensive repair. It has been observed that these facilities frequently sustain varying degrees of damage annually, necessitating consistent maintenance. Moreover, some of these facilities have also suffered from landslides. The above cost for the recovery work consists of 82 such structure totalling 1160 sqm.

Given this context, it is strongly advised that the recovery and repair work for the damaged infrastructure should incorporate comprehensive protection measures against floods and landslides. This proactive approach will not only address the current damages but also enhance the resilience of the infrastructure against future natural disasters. Implementing such protective measures is crucial for ensuring the long-term sustainability and reliability of the civil infrastructure, particularly in areas prone to environmental challenges.

- For the Transitional Sewage Treatment Facility, the construction of temporary holding tanks is proposed as an effective interim solution. Recognizing the considerable time required to build a fully functional Sewage Treatment Plant (STP) and the urgent need for sewage management, these temporary holding tanks will serve as a crucial stopgap. They will effectively manage sewage in the short term, mitigating environmental and health risks. This approach ensures continuity in sewage treatment and maintains public health standards while permanent STP facilities are being constructed. These interim solutions are vital for bridging the gap in sewage management until the new STPs become operational, thereby ensuring no lapse in essential sewage treatment services. The proposed holding tanks for the transitional sewage treatment facilities are tailored to the specific needs of each location: 300 square meters for both Gangtok and Namchi, and a larger capacity of 450 square meters for Pakyong, reflecting its greater requirements. It's important to note that these sizes are provisional and subject to adjustment. The final dimensions of the holding tanks may vary depending on the availability of suitable locations and the evolving needs of each area. This flexible approach ensures that the temporary sewage management solutions are both effective and adaptable to changing circumstances, providing a practical and responsive strategy in the interim period before permanent facilities are established.
- As highlighted in the damage assessment, the drainage system has incurred substantial damage, necessitating immediate repair and reconstruction. These drainage channels are crucial for managing gray water originating from households, shops, and public amenities, as well as for facilitating rainwater clearance.
- The urgency of repairing these drainage systems cannot be overstated. In their current damaged state, there is a significant risk of waterlogging, which can transform these areas into breeding grounds for waterborne diseases. This situation not only poses a direct threat to public health but also carries the potential risk of escalating into a pandemic if not addressed promptly. Therefore, swift and effective restoration of the drainage infrastructure is imperative to prevent health hazards and ensure the safety and well-being of the community.

During the field visit, it was noted that in areas lacking proper sewer pipelines, communities have resorted to connecting their household sewage lines directly to the drainage system. While the urgent construction of the drainage system is essential, it is equally important to implement strict regulations prohibiting the connection of sewage lines to drainage channels.

To effectively enforce these regulations, the establishment of a coordinated enforcement mechanism is crucial. This body should comprise representatives from the Public Health Engineering Department (PHED), Urban Development Department, and include a Sanitation Inspector. The collaborative efforts of these departments will be key in monitoring compliance, ensuring that no household sewage is improperly channeled into the drainage system. This measure will not only maintain the integrity of the drainage infrastructure but also safeguard public health and environmental standards.

**Capacity building:** In light of the recent disaster, the necessity for capacity building has become strikingly clear, both at the institutional and individual levels. While enhancing institutional capacity is a long-term endeavor, there is an immediate need to focus on the capacity building of personnel, especially in the areas of Water, Sanitation, and Hygiene (WASH) recovery and reconstruction. This training should commence prior to the full-scale initiation of reconstruction efforts.

A key component of this capacity building should be training in resilient construction techniques. This training is crucial not only in the early recovery phase but also throughout the reconstruction process. It will ensure that personnel are equipped with the skills and knowledge necessary to build structures that are more resistant to future disasters. By investing in such skill development, we can significantly improve the quality and durability of the reconstruction work, thereby enhancing the overall resilience of the community against future calamities.

### Reconstruction Cost Estimates

Table 80. Drinking Water and Sanitation: Reconstruction Cost Estimate - Sanitation(In Crore)					
District	RCC Chambers WTP	Sewage Treatment Plant	RCC Chambers STP	Toilet	Total
Gangtok	0.22	3.17	1.705	0	5.09
Mangan	0.03	-	0	0	0.03
Namchi	0.00	2.40	0.127875	0	2.53
Pakyong	0.19	6.72	0.8525	0.784263	8.55
Total					16.20

The estimated costs for reconstruction interventions in the sanitation sector are approximately ₹16.20 crores, focusing on enhancing the resilience of WTP and STP chambers, with additional investments in toilet facilities and sewage treatment capacity enhancement.

- **RCC Chambers (WTP):** The Reinforced Cement Concrete (RCC) chambers for Water Treatment Plants (WTP) play a pivotal role in connecting the pipelines from the WTP to household connections. Prompt construction of these chambers is a critical step in restoring household water connections.

Ensuring their immediate and efficient construction will not only facilitate the smooth transmission of treated water but also significantly contribute to the rapid restoration of essential water services to households. The reconstruction cost estimated for 81 damaged such Water Supply chambers.

- Sewage Treatment Plant: Significant investments in Gangtok, Namchi, and Pakyong for sewage treatment plants focus on full-scale rehabilitation.

It's crucial to note that the damaged sewage treatment plants (STP) were originally designed nearly a decade ago. Given the swift pace of urbanization and population growth since then, there is an urgent need to upgrade these STPs. This upgrade should not only focus on modernizing the facilities but also aim to expand their capacity by at least 150% to adequately meet the increased demand and ensure sustainable management of wastewater in the face of ongoing urban development.

During the field visit, it became evident that the two sewage treatment plants (STPs) were constructed on riverbeds. While it's understood that designing STPs at lower altitudes is beneficial for gravity-based operation, this very advantage also renders them vulnerable to disasters. It's advisable to avoid constructing STPs, or any infrastructure for that matter, on riverbeds due to their high susceptibility to natural calamities. Instead, alternative locations should be identified that offer a balance between operational efficiency and reduced risk of disaster impact. This approach is crucial for ensuring the long-term sustainability and safety of such essential infrastructure.

- RCC Chambers STP: Chambers are fundamental in the maintenance and inspection of the underground sewage network, acting as crucial intersections where main sewer lines meet household sewage pipelines. These strategically positioned chambers are key in managing the flow of sewage, allowing for the redirection or adjustment of the flow to ensure a smooth and effective sewage management system. These chambers are also vital for operational maintenance. They offer essential access points for workers, enabling them to undertake critical tasks such as conducting repairs, clearing blockages, and performing routine checks. This access is crucial for maintaining the system's efficiency and preventing disruptions.
- The reconstruction of these chambers is essential for the effective transportation of sewage to treatment plants. Without these chambers, there is a heightened risk to public health and environmental safety. They play a significant role in preventing sewage overflows and leaks, which could lead to the contamination of water sources and the spread of diseases.
- To enhance their functionality, it is recommended that these chambers be constructed with an improved height to prevent rainwater from entering. This design consideration is crucial in areas prone to heavy rainfall, as it helps to maintain the integrity of the sewage system and protects against potential flooding and overflow issues. By implementing these improvements, the sewage network can be made more resilient and effective in safeguarding public health and the environment.
- Community Toilets: The public toilet facilities in Pakyong were notably reported as severely damaged, underscoring the need for their urgent reconstruction. These facilities, situated in market areas, are essential for the local community, providing a vital public service. Given the extent of the damage, a complete reconstruction is necessary, rather than mere repairs.
- While the existing locations of the damaged toilets can be utilized for this reconstruction, an additional consideration is the cost associated with constructing septic tanks alongside each toilet unit. The implementation of septic tanks is particularly crucial in this scenario, as the local Sewage Treatment Plants (STPs) were also damaged. These septic tanks will serve as a necessary interim solution for sewage management, ensuring that the rebuilt public toilets are functional and sanitary, even in the absence of fully operational STPs.
- This reconstruction and the addition of septic tanks are not just about restoring facilities; they are about reinstating a crucial aspect of public health infrastructure in Pakyong, especially in areas of high communal activity like marketplaces. The new construction should ideally incorporate resilient design principles to withstand future damages and serve the community effectively.



## Summary of Recovery and Reconstruction:

Table 81. Drinking Water and Sanitation : Reconstruction Cost Estimate - Summary of R&R needs		
Sl No	Category	Cost
1	Pipeline	11.90
2	Water Reservoir	0.13
3	Civil Infrastructure	4.41
4	Soap pit with holding tank	2.52
5	Trunk Lines	7.20
6	Capacity building	0.60
7	Drainage	2.25
8	RCC Chambers WTP	0.44
9	Sewage Treatment Plant	12.29
10	RCC Chambers STP	2.69
11	Toilet	0.78
Total		45.21

## Impact of Recovery

- **Enhanced Water Supply Reliability:** Repairing and upgrading the pipeline network ensures a more reliable and consistent water supply, reducing the likelihood of future disruptions.
- **Improved Water Quality:** Immediate cleaning and repair of water treatment facilities, including SSF and RSF, ensure the provision of clean and safe drinking water.
- **Increased Resilience to Natural Disasters:** Incorporating protective measures against floods and landslides in the civil infrastructure and STPs enhances the resilience of these systems against environmental challenges.
- **Effective Sewage Management:** The construction of temporary holding tanks for sewage treatment provides an immediate solution to sewage management, mitigating health and environmental risks.
- **Public Health Protection:** Repairing and reconstructing the drainage system prevents waterlogging and the spread of waterborne diseases, safeguarding public health.
- **Regulatory Compliance and Environmental Protection:** Implementing strict regulations against improper sewage disposal into drainage channels, enforced by a coordinated body, helps maintain environmental standards.
- **Capacity Building:** Training personnel in resilient construction techniques improves the quality and durability of reconstruction work, enhancing the community's resilience to future calamities.
- **Restoration of Essential Services:** Prompt construction of RCC chambers for WTPs and STPs ensures the restoration of essential water and sewage services to households.

- **Modernization and Expansion of STPs:** Upgrading sewage treatment plants to meet the demands of urbanization and population growth ensures sustainable wastewater management.
- **Public Convenience and Hygiene:** Reconstructing community toilets, especially in market areas, provides essential public services, maintaining hygiene and convenience for the community.
- **Long-Term Sustainability:** The overall approach, focusing on resilience, modernization, and compliance, contributes to the long-term sustainability and reliability of the region's water and sewage infrastructure.

### Implementation mechanism

- **Public Health Engineering Department (PHED):** The primary role of PHED will be ensuring access to safe water at the household level and providing sewage facilities. This will involve close coordination with other departments for comprehensive water management and infrastructure rebuilding.
- **Rural Development Department:** This department will support PHED in reconstructing intake structures, typically located at high altitudes. The rural development department's expertise in managing water sources and high-altitude construction will be crucial.
- **Urban Development Department:** For STP reconstruction, PHED will require support from the Urban Development Department, especially for site allocation and obtaining necessary clearances from the Pollution Control Board. This collaboration ensures adherence to environmental standards and efficient site selection.
- **Sanitation Facilities:** The Urban Development Department will oversee the reconstruction of drainage facilities and community toilets. PHED will provide the water supply for these community toilets, ensuring a coordinated approach to sanitation infrastructure development.

#### **Formation of an Enforcement Body:**

State Level: A high-level task force, including key representatives from the Public Health Engineering, Urban Development, and Rural Development departments.

**District Level:** Parallel district-level task forces mirroring the state body's composition.

Both levels will incorporate expertise from the State Disaster Management Authority (SDMA) and District Disaster Management Authority (DDMA) as specialist agencies.

**Regular Review and Adaptation:** Implement a mechanism for continual assessment and modification of strategies to address evolving recovery needs and challenges.

**Inclusion of Academic Experts:** Integrate academic professionals for specialized technical support, ensuring innovative and effective solutions.

**Technical Support and Capacity Building:** Facilitate access to SDMA/DDMA's technical assistance for both state and district task forces, emphasising knowledge enhancement and system development.

This integrated approach leverages the strengths of each department, ensuring efficient and effective recovery and reconstruction of water supply and sanitation infrastructure in the region.

For the funding NDRF/ SDRF fund should cover this recovery and reconstruction cost and the other improvement need like enhance the capacity of STP, increase the number of RCC chambers should be aim at developmental schemes like Swachh Bharat Mission-Urban 2.0, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0.

Recovery Framework Table

Table 82. Drinking Water and Sanitation: Recovery Framework							
		Interventions		Budget requirement	Line Department	Supporting Department	Timeline (in months)
1	R E C O V E R Y	Repairing and upgrading the pipeline network ensures a more reliable and consistent water supply, reducing the likelihood of future disruptions	22.036 KML	11.90	PHED	RD, UD	6-12
2		Immediate cleaning and repair of water treatment facilities, including SSF and RSF, ensure the provision of clean and safe drinking water.	73 MLD	0.13	PHED	RD	12-18
3		Immediate repair of damaged civil infrastructure which will mostly the intake structures	35 SQM	4.41	PHED	RD, UD	12-18
4		The construction of temporary holding tanks for sewage treatment provides an immediate solution to sewage management, mitigating health and environmental risks.	3 unit	2.52	PHED		12-18
5		Enhancing and refurbishing the network significantly improves the reliability and consistency of sewage flow from households to the Sewage Treatment Plant (STP), thereby minimizing the risk of future disruptions.	2500 meter	7.20	PHED	UD	6-12
6		Training personnel in resilient construction techniques improves the quality and durability of reconstruction work, enhancing the community's resilience to future calamities	Specific number can be defined after assessment here assumed for 120 personnel	0.60	PHED	SDMA	3-6
7		Repairing and reconstructing the drainage system to prevent waterlogging and the spread of waterborne diseases, safeguarding public health	5200 sqm	2.25	UD	PHED	6-12
8		Prompt construction of RCC chambers for WTPs ensures the restoration of essential water services to households.	81 unit	0.44	PHED	UD	12-36

9	R E C O N S T R U C T I O N	Training personnel in resilient construction techniques improves the quality and durability of reconstruction work, enhancing the community's resilience to future calamities	Specific number can be defined after assessment here assumed for 120 personnel	0.60	PHED	SDMA	3-6
10		Repairing and reconstructing the drainage system to prevent waterlogging and the spread of waterborne diseases, safeguarding public health	5200 sqm	2.25	UD	PHED	6-12
11		Prompt construction of RCC chambers for WTPs ensures the restoration of essential water services to households.	81 unit	0.44	PHED	UD	12-36

## 6. Cross Cutting Issues

### 6.1 Forest and Environment

#### Basic Profile of the Forest and Environment Sector

Forests are one of the richest and important natural resources of Sikkim. Forests account for the major land use and land cover in the State. The State Forest and Environment Department is the nodal agency and has administrative control of 82.31% of the total geographical area of the State. The total forest and tree cover accounts to 47.63% of the total geographical area of the state. The composition of the forest's ranges from tropical dry deciduous forests with sal and its associates in the valleys of Teesta and Rangit to the alpine scrub and grasslands in the high-altitude areas.<sup>46,47,48</sup>

Sikkim is also endowed with rich floral and faunal diversity. Species wise, the State harbors over 4500 flowering plants, 550 orchids, 36 rhododendrons, 16 conifers, 28 bamboos, 362 ferns and its allies, 9 tree ferns, 30 primulas, 11 oaks, over 424 medicinal plants, over 144 mammals, 550 birds, 48 fishes and over 600 butterflies. Most of the high-altitude medicinal plants are rare and endangered species. Sikkim also has 28 mountains/peaks, more than 80 glaciers, 227 high altitude lakes/wetlands and over 104 rivers and streams. Nature has been particularly generous in her gift of sylvan treasures to the state of Sikkim. The luxuriant forest, abound in all part of state and the variety of medicinal plants, herbs, shrubs, bamboos, and trees growing in state is truly rich. The forests have several plants whose medicinal values have been well recognized by the local people as well as by different pharmaceutical, insecticidal and perfumery stakeholders.

With a view to conserve the rich biodiversity, wide areas of Sikkim have been included in the Protected Area Network (PAN). There are 8 protected areas in Sikkim which are Khangchendzonga National Park, Fambong-Lho Wildlife Sanctuary, Kyongnosla Alpine Sanctuary, Barsey Rhododendron Sanctuary, Maenam Wildlife Sanctuary, Shingba Rhododendron Sanctuary, Kitam Bird Sanctuary and Pangolakha Wildlife sanctuaries.

The Glacial Lake Outburst Flood (GLOF) that occurred along the Teesta River originating from Lhonak Lake in the North up to Melli in the South and has resulted in damage and losses to forests, forest land, the riverbed, also affecting Forest and Environment Departments infrastructure. Projects of the forest department facing damages include nurseries, plantations- including sea buckthorn plantations, areas containing medical plants, eco- tourism trails, camping sites, etc. The discharge of copious amounts of water from the lake and dam failure has resulted in the flooding along the river Teesta. The inflow of water and sediments coupled with the velocity has resulted in extensive erosion of the riverbed, riverbank and has resulted in large scale damage to vegetation. The deposition of sediments along the river has changed the course of the river in many places. The riverbed prior to the disaster was used for the collection of sand, stone and loose boulders contributing as a livelihood source for the local population accessed through a license via an annual tender process. The access to the riverbed is sanctioned by way of demarcated plots outlaid by the Forest and Environment Department. As a result of the disaster, the Forest and Environment Department has also lost a vital source of revenue as the riverbed along the Teesta River in Sikkim comes under administrative control/ jurisdiction of the Forest and Environment Department. Apart from this eco- tourism activities such as river rafting, trekking trails, bird watching, sightseeing, and camping have also been paused as the roads and trails at several locations are now inaccessible and untenable.

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<sup>46</sup> <https://sikkim.gov.in/departments/forest-environment-and-wildlife-department/forest-and-forestry2021-ISFR-Sikkim.pdf> (sikenvis.nic.in)

<sup>47</sup> [Forests, Environment & Wildlife Management Department | Government of Sikkim \(sikkimforest.gov.in\)](https://www.sikkimforest.gov.in/)

<sup>48</sup> [Sikkim Biodiversity Board \(sbsikkim.nic.in\)](https://www.sbsikkim.nic.in/)

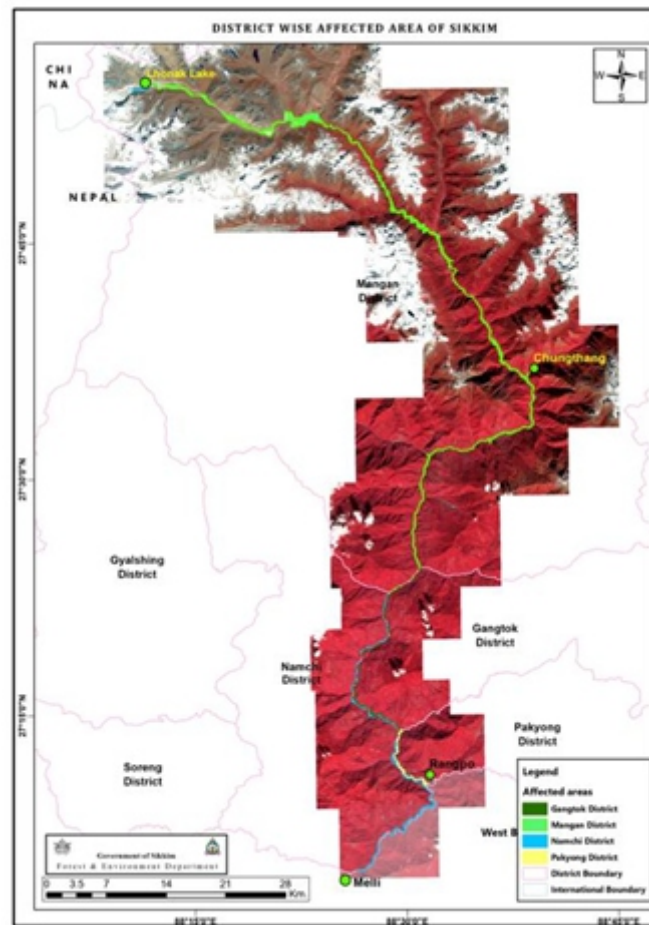


Figure 1: Depiction of the district wise affected areas along the Teesta River, Sikkim spanning 160.69 kms.

### Sectoral Policies for Forest and Environment

The area under the Forest and Environment Department of the Government of Sikkim is governed by the Sikkim Forest, Water Courses, and Road Reserve (Preservation and Protection) Act of 1988. This act serves as a comprehensive legal framework to protect the state's vital natural resources. Its implementation contributes significantly to the conservation and sustainable management of forests, water bodies, and road reserves in Sikkim. Various rules and guidelines are formulated under the provisions of the act by the department from time to time for the proper management of different categories of forests as defined by the Act. As per section 2 (b) of the act, "forest" means an extensive tract of land covered with trees and undergrowth, sometimes intermingled with pastures, alpine scrubs and (c) "forest land" means the land shown as forest land in the records of right including areas under perpetual snow, alpine scrubs or alpine pasture or the land as declared as forest land by the Government, by notification. Section 29 of the Act defines river reserves as "riverbanks in relation to rivers enumerated in the schedule means and includes an area of sixty meters on either side of such river or area within high flood level mark, whichever is less". Forest management and protection as conscripted within the Act are the dual functions of the territorial sector within the Forest and Environment Department.

Sikkim has long been renowned for its natural beauty and is recognised as an ecotourism hub. However, the landscapes along the river Teesta have suffered significant damages and losses impacting the Sikkim



has long been renowned for its natural beauty and is recognised as an ecotourism hub. However, the landscapes along the river Teesta have suffered significant damages and losses impacting the Lachen, Lachung and Dzongu ecotourism zones. The Sikkim ecotourism policy, 2011 governs eco-tourism activities in the state, it is notified and implemented by the Forest and Environment Department, Government of Sikkim.

Collection of sand, stones and loose boulders from the Teesta riverbed and bank is a livelihood source for the local population and migrant workers. The collection sites along the riverbed and banks are under the administrative control of the Forest and Environment Department. These collection sites are made available to individuals via an annual tender process.

This collection of sand, stones and boulders is governed as defined under section 2 (f) (iv) "forest produce" includes peat, dolomite, graphite, rock, surface soil, sand stones, slates, and other minerals including laterite, mineral oils and all other products of mines and quarries of the Sikkim Forest, Water Courses, and Road Reserve (Preservation and Protection) Act of 1988.

The State Forest and Environment Department conducts an open tender of designated and demarcated sites for collection of sand, stones, and loose boulders. These sites are identified as per an approved District Survey Report prepared for each district in compliance of the Ministry of Environment, Forest, and Climate Change (MoEFCC), Government of India Notification S.O. 141 (E) dated 15-1-2016, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India vide Notification S.O. 3611 (E) dated 25-7-2018 and the sustainable sand mining guidelines issued in 2022 by the Government of India, which are in pursuance to the orders of the National Green Tribunal. A tender committee is constituted as part of the process and consists of officials from the District Administration, Finance Department and Forest and Environment Department which examine the compliance of bids and then annual tenders are issued to the highest bidder for a period of one year.

The above form the major sectoral policies for administration and governance of forests under the jurisdiction of the Forest and Environment Department, Government of Sikkim.

### **Damages in the Forestry and Environment Sector**

The river Teesta originates from the glaciers located at the far Northern part of Sikkim and travels downward from an elevation of 8500 meters above Mean Sea Level. Besides the numerous streams and rivers with their sources in the Himalayas and glaciers, the Teesta River meets with Talung chu at Singhik which originates from Talung glacier and is a part of Kanchenzonga range. From Singhik, the river further flows South to Singtam and Rangpo with a drop in elevation of about 200 meters.

The hazard event coupled with a cloudburst over the Lhonak Lake in North Sikkim triggered the Glacial Lake Outburst Flood (GLOF) along the Teesta River basin along with five times higher than normal levels of precipitation observed coinciding with the event. The South Lhonak lake burst its shores, causing flash floods. Satellite images from the Indian Space Research Organisation's RISAT-1A show that the lake's surface area shrunk by more than 100 hectares (247 acres) in a matter of few hours.

Water levels downstream in the River Teesta subsequently rose by 15 to 20 feet (4.6 to 6.1 m), flooding many areas in Mangan, Gangtok, Pakyong, and Namchi districts in Sikkim. Fifteen bridges across the state were washed away, and the north of the state, including the capital Gangtok, was cut off from the rest of India as parts of National Highway- 10 faced severe damages. Towns and cities like Chungthang, Dikchu, Singtam, Rangpo, Melli, and Teesta Bazaar observed severe damage and loss caused due to the floods.

The Forest and Environment Department immediately established an Emergency Operation Centre and deployed their officials and staff to support with the rescue and relief operations. The National Disaster Response Force and the Indian Army were involved in the ongoing relief operations and were assisted with the departmental staff. Local populations and groups also supported with the ongoing efforts to provide timely rescue and relief services.

The Glacial Lake Outburst Flood (GLOF) led to severe damages of forest lands and infrastructure under the administrative jurisdiction of the Forest and Environment Department along the Teesta River basin. The surge in Teesta River's water level resulted in heavy inflow of water carrying with it rocks, debris and sediment causing extensive destruction to infrastructure, facilities and properties belonging to the Forest and Environment Department, Government of Sikkim.

The once-pristine landscapes along the Teesta River adorned with diverse flora and fauna are now marred by the destructive force of the Glacial Lake Outburst Flood (GLOF). The fragile ecosystem faced severe degradation, severely impacting vegetation, and wildlife. The disruption of the natural habitats also poses a long-term threat to the biodiversity of the region.

The department incurred significant losses, including the damage to range offices, block offices, forest check posts, staff quarters, forest nurseries, field nurseries, staff quarters, nursery multipurpose stores, wireless communication systems. Similarly, field nurseries in Lingmoo, Naga, Dzongu, Toong, and Singtam were completely washed away by the flood waters. Ecological assets including forest cover (flora and fauna), plantations, soil, and moisture conservation works along the Teesta River are severely impacted.

With respect to the collection sites for sand, stone, and loose boulders which accounts for a major livelihood source extensive damages and losses have been observed in terms of deposition of large quantities of sediments along the riverbank. This has directly resulted in damages to the collections plots, inaccessibility to collection sites which has directly led to revenue and livelihood losses of the department, the labour employed and individuals holding approved tenders for the sanctioned collection of sand, stones, and loose boulders along the Teesta riverbed.

The state has observed a reduction in tourist footfall visiting eco- tourism destinations like Shingba, Yumthang, and Gurudongmar. This has directly impacted the revenue collection at the state level and affected local livelihoods due to the restrictions in road access caused due to damaged road networks, impacting accessibility. Forests and endemic flora are affected in Muguthang, Dolmasampa, and Goma, affecting wildlife habitats of the Black-necked crane, Blue sheep, Snow leopards, and indigenous fish species. The Green Lake trekking trail among many others along with internal access routes within the forests have also been swept away, affecting not only trekkers and tourists but also impacting the Forest and Environment Departments routine monitoring and patrolling exercises.

Furthermore, the infrastructure supporting ecotourism, including trekking routes, lodges, and facilities for visitors have observed direct and indirect damage and losses. Roads and trails vital for tourism and local transportation are damaged, severely impacting accessibility to the area, the state government is consistently making efforts to restore the road networks and critical infrastructure required to support transportation, tourism, and national security.

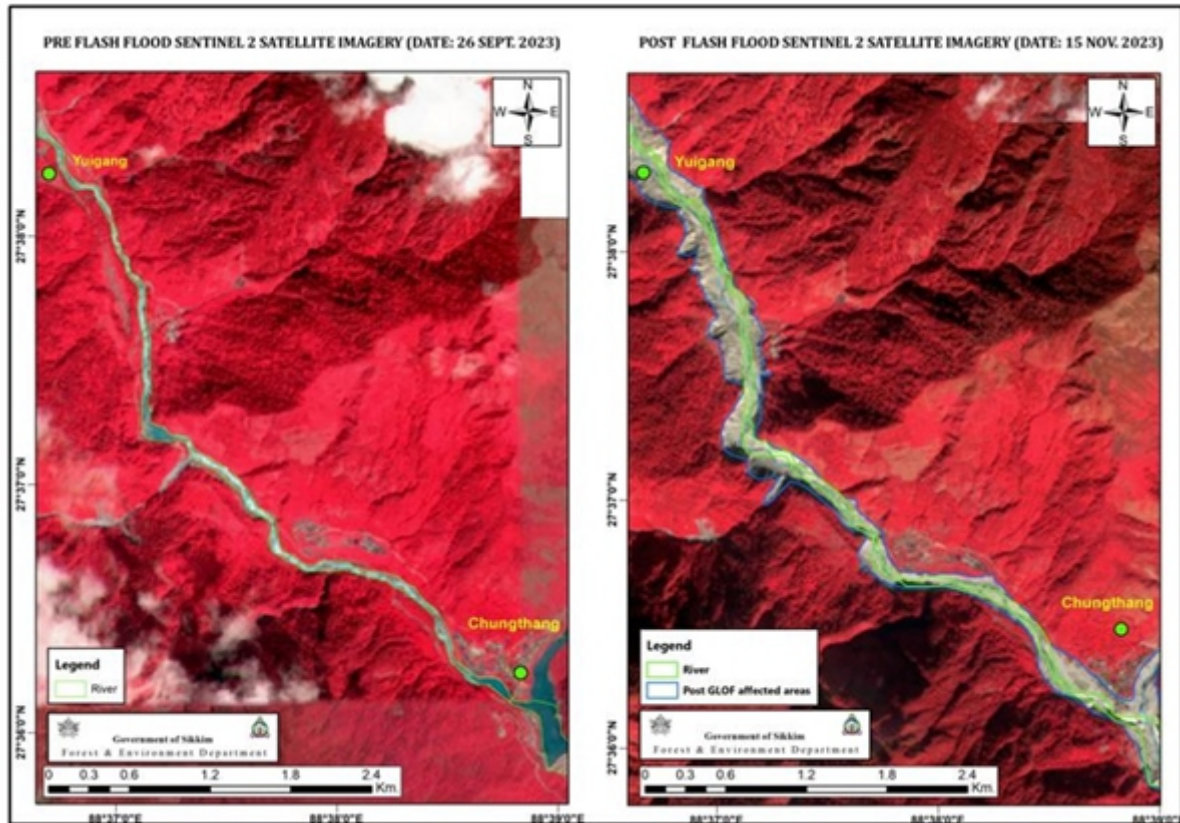


Figure 2: Satellite imagery depicting the riverbank between Yuigang and Chungthang mapping the pre and post disaster scenario. The imagery depicts the extent of flooding and damage caused along the course of the river Teesta. (Representative section and not the whole river- similar maps have been created by the Forest and Environment Department for the entire River based on pre and post disaster satellite imagery)

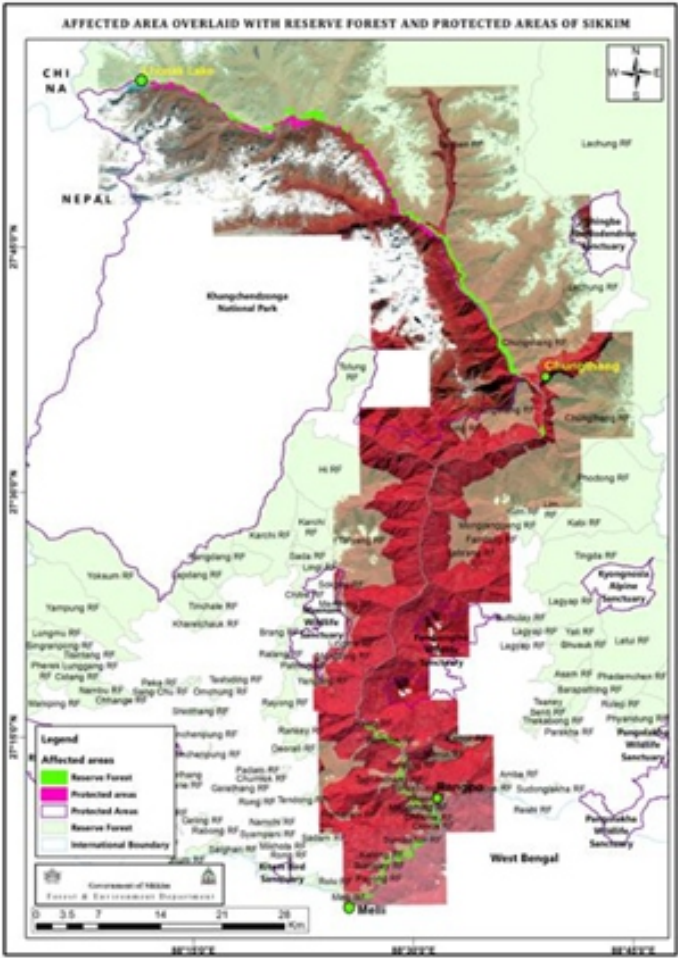
### Methodology for calculation

The False Colour Composite satellite imagery of Sentinel 2 with resolution of 10 meter has been accessed from <https://soar.earth/>. The time series data comprising of the months May, August and September 2023 has been considered for the pre disaster period and October and November 2023 for the post disaster period. The projected coordinate system of the satellite images is UTM ZONE 45N and datum is WGS 84. ARCGIS 10.5.1v software is used to mosaic the satellite data/ imagery along the affected areas of the Teesta River line to obtain a single pre-flood and post flood layer. Delineation of vegetation cover along the riverbank line and determination of the pre-flood and post flood data was done using ARCGIS. The post flood vector area obtained was clipped by the pre flood vector area to obtain the pre-flood area under vegetation that has faced damage and losses due to the disaster. The density map of the Forest Survey of India for the year 2017 was overlaid on the affected vegetation loss area and further affected areas in different density classes has been obtained. Therefore, the estimation of the affected protected forest areas has been undertaken by overlaying pre and post disaster satellite imagery.

**Table 83. Forest and Environment: Affected Protected Forest Area land under Forest and Environment Department along Teesta River**

Type	Area in ha
Reserved Forests	706.94
Wildlife Protected Areas	419.85
Total	1126.79

Additionally, physical records corroborated with ground truth verification exercises have been utilised to ascertain the damaged area under forests, river reserves, khasmal and gaucharan lands under the administrative control of the Forest and Environment Department that were excluded in the above analysis to estimate the total area facing damage and loss. It is important to note that a detailed damage assessment will contribute to ascertaining the actual damages and losses in the sector.



*Figure 3: Overlay of the disaster affected areas with reserve forests and wildlife protected areas in Sikkim.*

## Damage and losses to Forests and Environment Sector

### Damage and loss to Forests

The damage and loss incurred to the forests and vegetation as part of the affected area along the Teesta River has been calculated by determining the area of impact by using the pre and post disaster maps/satellite imagery, along with inputs from physical records and ground truth verification exercises. This has enabled the Forest and Environment Department to ascertain the damage to forests and vegetation under the various classification types. The Net Present Value i.e., method used for calculating the forest land value inclusive of all bio- resources, for each classification type has been utilised for calculating the damage and losses. This method of valuation is used while processing the diversion of forest land for non- forestry purposes as per the Forest Conservation Act 1980. The details for calculating the Net Present Value of the forest land have been notified as per the Ministry of Environment, Forests and Climate Change File No. 5- 3/ 2011- FC (Volume 1) Dated 6-1-2022 and is in congruence with the Forest Conservation Act and Guidelines. The damage and Loss to biodiversity caused by the disaster has not been estimated as part of this exercise.

<b>Table 84. Forest and Environment: Damage Estimate as per NPV</b>						
Affected areas where damage to forests and vegetation loss has been observed and calculated as per the Net Present Value (NPV)						
Forest Type	Type ffected area High Altitude (above 2400 m elevation) in Ha	Affected area in Low Altitude (below 2400 m elevation) in Ha	NPV Rates (HA) per Ha in INR	NPV Rates (LA) per Ha in INR	Loss calculated as per NPV (HA)	Loss calculated as per NPV (LA)
VERY DENSE-FOREST			1 5,16,230	1 4,36,670	12,9 8,49,937	15,13, 10,084
DENSE-FOREST	126.99	318.26	1 3,72,410	1 2,92,850	17,4 2,82,346	41,14, 62,441
OPEN-FOREST	65.43	126.29	1 0,69,470	1 0,05,210	6,99, 75,422	12,69, 47,971
SCRUB	33.47	1.12			-	-
NON-FOREST	121.80	256.91			-	-
Above treeline scrub	577.68	0	1 0,69,470		61,7 8,11,430	-
Total	1011.02	807.9			99,1 9,19,135	68,97, 20,496
Grand Total of forest damaged in Ha	1818.92		Grand Total of Forestry losses in INR		1,68,16,39,631 (168.16 Crore)	
NOTE: Area under the forest types (Very Dense Forest, Moderate Dense Forest and Open Forest has been enhanced by 20% to accommodate the slope factor						



Therefore, it is estimated that 1818.92 ha of forests and vegetation under the administrative control of the Forest and Environment Department has been damaged amounting to INR 168.16 Crore. The use of Net Present value rates for the damage and loss calculation has been undertaken to arrive at an estimate and value of the damages caused to forest and vegetation by the GLOF and is not intended to either seek full recovery compensation neither to propose the damaged area for diversion for non- forest uses.

### Damage to Nurseries

The forest department estimates damages to 17 nurseries spanning over 25 ha approximately (1 Ha is equal to 10,000 sq m, therefore 2,50,000 sq m). The unit size of nurseries that have been affected ranges from 0.5 to 2.5 ha. As per the official schedule of rates of the Forest and Environment Department the cost for nursery establishment in Low Altitude areas is INR 110 per sq m and the cost of nursery establishment in High Altitude areas is INR 153 per sq m. Therefore, the estimation of damages incurred to 11 nurseries at High Altitude spans approximately 18 Ha i.e., 1,80,000 sq m is (1,80,000x 153= INR 2,75,40,000/-) and estimation of damages incurred to 6 nurseries at Low Altitude spans 7 ha i.e., 70,000 sq m is (70000x 110= INR 77,00,000/-). Hence, the total damage to nurseries is estimated at INR 3,52,40,000/- (3.52 Cr).

<b>Table 85. Forest and Environment: Damage to Nurseries of the Forest and Environment Department.</b>				
<b>District</b>	<b>Totally Damaged (Units)</b>	<b>High Altitude (Units)</b>	<b>Low Altitude (Units)</b>	<b>Total</b>
Mangan	11	11		11
Pakyong	2		2	2
Gangtok	2		2	2
Namchi	2		2	2
<b>Grand Total</b>	<b>17</b>	<b>11</b>	<b>6</b>	<b>17</b>

### Infrastructure damages

The disaster has severely impacted the buildings and structures of the Forest and Environment Department. After assessment exercises carried out by the Forest and Environment Department in the post disaster situation at the district level the following damage to infrastructure is observed.

Mangan District has observed total damages to 2 rest houses, 1 range office, 1 staff quarters, 1 wireless transmission station and infrastructure under 1- biodiversity park. Severe damages are observed in 1 check post and 1 staff quarter. Partial damages are observed in 2 structures, with a total of 10 structures. Pakyong District has observed total damages to 2 check posts, and partial damage to 1 range office with a total of 3 structures. Gangtok district has observed severe damages to 1 staff quarter and 1 check post with a total of 2 structure. Namchi district has observed total damages to 1 staff quarter, 1 Check Post and 2 Range Offices



Table 86. Forest and Environment: Damage to Forest Department Built up Infrastructure								
District	Totally Damaged		Severely Damaged		Partially damaged		Total	
	No.	Area (sq m)	No.	Area (sq m)	No.	Area (sq m)	No.	Area (sq m)
Mangan	7	5803.88	2	1054	2	364.18	11	7221.88
Pakyong	2				1	182.09	3	874.21
Gangtok			2	364.18			2	364.18
Namchi	2	539.02	2	1253.62			4	1792.64
Total	11	6342.9	4	2671.8	3	546.27	20	10252.91

The methodology for calculating the damages to buildings of the Forest and Environment Department follows the methodology utilised under the housing sector where in the reconstruction cost of INR 37,660 per sq m is multiplied by a factor of 0.8 to ascertain the cost of construction in the pre- disaster scenario/ period i.e., INR 30,128 per sq m. For calculating the damage, the rate for pre disaster construction cost per sq m is multiplied with a factor of 1 for totally damaged buildings, a factor of 0.5 for severely damaged buildings and a factor of 0.15 for partially damaged buildings.

Therefore, damage calculation for buildings of the Forest and Environment Department is

- Totally Damaged-  $6342.9 \times 30128 = 19,10,98,89$
- Severely Damaged-  $2671.8 \times 30128 \times 0.5 = 4,02,47,995.2$
- Partially Damaged-  $546.27 \times 30128 \times 0.15 = 24,68,703.39$

Therefore, the total damages to infrastructure of the Forest and Environment Department is estimated at INR 23,38,15,590/- i.e., **23.38 Crore.**

#### Damage to Malli Sheds and multi- propose stores of the Forest and Environment Department

The Malli sheds and multi- purpose stores are built and used by the Forest and Environment at nurseries and field plantation sites. A total of 9 Malli sheds/ multi-purpose stores with an average size of 300 sq ft or 27.87 sq m per unit have been totally damaged by the disaster, totalling to 250.83 sq m. Considering the pre disaster cost of construction of kutcha construction is considered as INR 15,064/- per square meter. This value is arrived at by considering the INR 37,660 per sq m as cost of new construction, multiplied by a factor of 0.8 to arrive at the pre disaster construction cost of INR 30,128, and then multiplying this amount per sq m with a factor of 0.5 to determine the pre disaster cost of construction per sq m for kutcha constructions i.e., therefore the damage calculation is estimated at  $250.83 \times 15064 = \text{INR } 37,78,503.12$ . i.e **0.38 Crore.**

Table 87. Forest and Environment: Damage to Malli Sheds		
Damage to Malli Sheds and multi-propose stores		
District	Totally Damaged	Area (sq m)
Mangan	Pakyong	195.09
Pakyong		
Gangtok	1	27.87
Namchi	1	27.87
<b>Total</b>	<b>9</b>	<b>250.83</b>

**Damages to the wireless communication infrastructure of the Forest and Environment Department**

Damages to the wireless communication infrastructure and 2 repeater stations located at Mangan have been damaged indirectly by the disaster. This communication infrastructure in Managan provides line of sight/ long range connectivity forming an important pillar for state-wide connectivity of the Forest and Environment Department. Therefore, this communication infrastructure not only enables and supports communication within the department but functions as a lifeline communication channel in the context of early warnings, disaster relief and response and communication for security and surveillance within Sikkim. Therefore, it is important to strengthen this communication infrastructure with a vision for long sustainability of 10 years. Based on ground level assessments and interactions with the Forest Department Officials the damages are estimated at **INR 45,00,000.**



*Figure 4: Representative picture for understanding of the nature of wireless infrastructure and associated building condition from where wireless communication operates.*

## Damage to eco-tourism- trails, and allied infrastructure

The Lachen Valley, nestled in the stunning state of Sikkim, has long been renowned for its natural beauty and is a renowned ecotourism hub. However, the disaster has impacted the Lachen ecotourism zone severely. The Glacial Lake Outburst Flood unleashed a torrent of water, rocks, and debris down the valley. This disaster wreaked havoc on the fragile ecosystem. The disaster caused extensive damage to the surrounding flora, fauna, and the infrastructure catering to tourists and local populations. The once-pristine landscapes adorned with diverse flora and fauna is now marred by the destructive force of the disaster. The fragile ecosystem faced severe degradation, with vegetation and wildlife suffering immensely. The impact on the natural habitats poses a long-term threat to the biodiversity of the region. Furthermore, the infrastructure supporting ecotourism, including trekking routes, lodges, and facilities for visitors, bore the brunt of this natural disaster. Roads and trails vital for tourism and local transportation were damaged, severely impacting accessibility to the area.

Efforts to restore the Lachen ecotourism zone have been underway since the disaster. The focus lies not only on rebuilding infrastructure but also on rejuvenating the natural environment, rehabilitating the affected flora and fauna, and implementing measures to prevent such disasters in the future. Collaborative initiatives between local authorities, environmental organizations, and community participation are pivotal for the revival and sustainable development of the region.

Table 88. Forest and Environment: Damage to Eco-Tourism Infrastructure			
Infrastructure Type	Totally Damaged	Unit Rate	Damage in INR
Trekking Trails (In Km)	39	400000	15600000
Resting Shed (In Nos)	14	314541	4403574
Camp Sites (In Nos)	6	1000000	6000000
<b>Total loss in INR</b>			<b>2,60,03,574</b>

In the post disaster context, it is crucial to raise awareness about the implications of climate change and the urgent need for measures to mitigate its effects. Preserving and safeguarding ecotourism zones like the Lachen valley is imperative for the sustainable coexistence of nature and human activity contributing to the livelihoods and economy of Sikkim. The assessment was only able to capture the direct damages to ecotourism infrastructure under the jurisdiction of the Forest and Environment Department at Mangan district. Indirect losses to livelihoods dependent on eco- tourism and private eco- tourism infrastructure have not been captured. For the purpose of damage calculation, the schedule of rates of the Forest and Environment Department have been considered based on the type of infrastructure. Therefore, the total damages to the eco-tourism infrastructure is estimated at INR 26003574 i.e. 2.6 Crore. Note: The total trails utilised for eco-tourism in Sikkim is 260 kms, of which 61 kms observed damages. For the purpose of damage calculation only totally damages trails amounting to 39 kms have been considered.

It has also been observed that the biodiversity park /nature park at Labarbote, Dikchu, North Sikkim has been totally damaged the damages are estimated at **4.2 crore**. This estimate is arrived at based on the cost of commissioning of the project.



*Figure 5: Representative picture depicting the damaged Biodiversity Park at Labarbotey, Dikchu- Mangan*

### **Damage and loss to collection sites of sand, stones and loose boulders along the Teesta River**

Collection sites for sand, stone, stone-chips and loose boulders has been a source of income for many communities residing in townships along the Teesta River in Sikkim for many decades. The disruption of collection activities due to the disaster has resulted in loss of livelihood to the license/ tender holders for these sites and associated labourers engaged in collecting and loading river-bed materials and truck-drivers transporting them, impacting their financial stability and economic well-being. The closure of these collection operations has had broader economic repercussions, affecting businesses relying on this industry for supplies (E.g., All major and minor construction), equipment (hot-mix plants, stone crusher plants etc.), or transportation services (trucks, 407s, pick-up etc). The local economy has been impacted due to reduced economic activity and loss of income from collection of sand, stone, and stone-chips-related businesses.

The Glacial Lake Outburst and Floods have caused significant damage to 107 collection sites of sand, stone, and stone-chips in the 4 affected districts of Sikkim. The immediate result of the disaster was an abrupt and complete termination of collection of sand, stone, stone-chips, and boulders from the collection sites provided by an annual tender process. Due to largescale sediment and debris collection along the riverbank and riverbed these sites have been totally damaged and rendered inaccessible to the people whose livelihood is dependent on the activity. The disaster has impacted approximately 5,673 individual labourers, 107 license/ tender holders involved in the activity. The allied infrastructure and machinery utilised at the collection sites has also been lost and damaged.

### **Economic and livelihood losses from damage to the collection sites of sand, stones and loose boulders along the Teesta river**

Loss of livelihood for 5,673 workers at the collection sites is calculated for a wage loss of 3 months post the disaster at the rate of INR 15,000 per individual per month amounting to INR 25,52,85,000 i.e., INR 25.53 Crore. The gender ratio of the workforce consists of 40% female workers i.e., 2,270 individuals. Based on a field interaction with workers associated with the collection sites it was observed that the losses in livelihoods have led to economic hardships and they don't have an alternate source of livelihood nor do they possess agriculture land, and are also not integrated into the agricultural value chain. Many of the workers are migrants from neighbouring areas/ districts and states who were employed at the collection sites. The losses incurred by the 107 tender/ license holders have not been considered as part of this assessment, whereas the overall revenue and economic losses have been estimated. Machinery losses have not been accounted for as part of the assessment.

**Assumptions:**

The estimation of revenue and economic losses due to the abrupt pause in collection operations of sand, stone and loose boulders in the 4 districts post the disaster has been based on the following:

1. Revenue loss: Revenue generated by the Forest and Environment Department from transit of Forest Produce has been based on the output figures from collection sites for the financial year 2022-23.
2. Material loss: Three types of Forest Produce, namely Sand (Rs.1.05/cft), Stone (Rs.0.90/cft) and Stone-chips (Rs.1.80/cft) is collected from these sites. An average transit rate of Rs.1.25/cft has been taken for the purpose of calculation of volume of the materials over last financial year revenue/ output figures.

<b>Table 89. Forest and Environment: Loss to collection sites for sand, stone and loose boulders- loss of revenue for department</b>					
PARTICULARS	PAKYONG	MANGAN	GANGTOK	NAMCHI	Total
Number of Affected Sites	33	11	35	28	107
Total Affected Area (in sqm)	80287	13076	50000	71599	214962
Number of Persons Affected	3000	143	430	2100	5673
LOSS OF MATERIALS (in cft)	2800000	806400	3146332	440000	7192732
Loss of Material in Cubic Meter	79287	22835	89094	12459	203675
Revenue Loss to the Forest and Environment Department in INR	35,00,000	10,08,000	39,32,916	5,50,000	89,90,916
Revenue loss to the Forest Department= Transport Rate collected by the Forest and Environment Department at check posts as revenue collection by the Forest and Environment Department					
Rate for transit of sand per cft	Rs. 1.05	Note: Loss of revenue is calculated by arriving at an average rate per cubic foot collected by the Forest and Environment Department as collected from the transporter while exiting collection sites at designated check posts of the Forest and Environment Department.			
Rate for transit of stone per cft	Rs. 0.90				
Rate for transit of stone chips per cft	Rs. 1.80				
Average rate used for Loss Calculation	Rs. 1.25				

**Table 90. Forest and Environment: Loss to collection sites for sand, stone and loose boulders- loss of individuals with tenders.**

PARTICULARS	PAKYONG	MANGAN	MANGAN	NAMCHI	Total
Number of Affected Sites	33	11	35	28	107
Total Affected Area (in sqm)	80287	13076	50000	71599	214962
Number of Persons Affected	3000	143	430	2100	5673
LOSS OF MATERIALS (in cft)	2800000	806400	3146332	440000	7192732
Loss of Material in Cubic Meter	79287	22835	89094	12459	203675
Revenue Loss to the tender holders and business stakeholders as per Govt Rate in INR	14,000,00	40,32,000	1,57,31,664	22,00,000	3,59,63,664
Revenue Loss to the tender holders and business stakeholders as per average market Rate in INR	64,400,000	18,547,200	72,365,654	10,120,000	1,65,432,854

Above are the total revenue turnover estimates with the deduction of operational costs.

Base government Rate for Purchase of Material per sq ft	Rs. 5.00	Note: Loss of revenue is calculated by arriving at an average rate per cubic foot by taking an average of the Government Base purchase rate per sq ft and the upper market rate for the purchase of material per sq ft.
Lower range of Market Rate for purchase of material per sq ft	Rs. 10.00	
Upper range of market rate for Purchase of material	Rs. 36.00	
Average Market Rate	Rs. 23.00	



Loss to collection sites of sand, stones and loose boulders along the Teesta river

**Table 91. Forest and Environment: Summary of total Loss to collection sites.**

Details	Amount in INR
Revenue Loss to the Forest and Environment Department	89,90,916
Damage to collection sites for sand, stone and loose boulders and loss of individuals with tenders	16,54,32,854
Livelihood and wage loss of 3 months post the disaster	25,52,85,000
Total Damage and Loss in INR i.e., 42. 97 Crore	42,97,08,761

Therefore, the total loss to the activity of collection sites of sand, stones and loose boulders along the Teesta River in Sikkim incurred by all stakeholders is estimated at INR 42.97 Crore.

### Summary of Damage under the Forestry and Environment Sector

**Table 92. Forest and Environment: Summary of damage and Loss to collection sites.**

Details	Amount in Crore (INR)
Damage to forests and vegetation calculated as per the Net Present Value (NPV)	168.16
Damage to Nurseries of the Forest and Environment Department	3.52
Damage to Forest Department Built up infrastructure/ buildings	23.38
Damage to Malli Sheds and Multi- propose stores	0.38
Damage to the wireless communication infrastructure	0.45
Damage to Eco-tourism infrastructure	2.6
Biodiversity Park /nature park at Labarbote, Dikchu, North Sikkim	4.2
Loss to collection sites of sand, stones and loose boulders along the Teesta River including livelihoods	42.97
Total INR in Crore	245.66

The total damage and loss under the Forestry and Environment Sector is estimated at INR 245.66 Crore. The above estimates are not all inclusive considering the scale of the disaster.

### Relief and Response undertaken by the Forest and Environment Department

The Forest and Environment Department has undertaken a crucial role to support the relief and response efforts across the disaster affected districts in Sikkim. As part of immediate relief and restoration works an amount of INR 1.58 Crore was utilised. Apart from this, various efforts were undertaken in coordination with the Sikkim State Disaster Management Authority to support with rescue, relief, and early recovery of the affected population. Some of the interventions undertaken were:

1. Operationalising of a control room at the Forest and Environment Department Headquarters to establish helplines and coordinate rescue and relief efforts in the affected districts,
2. Deployment of department officials and staff for rescue and relief activities
3. Damage assessment of departmental assets and forests, 4. Clearance of trees, debris and temporary restoration of roads to provide access to rescue and relief teams, 5. Setting up of relief camps and community kitchens to support the needs of the affected population, 6. Supporting with last mile connectivity and communication through the departments communication infrastructure.



*Figure 6: Representative pictures of rescue, relief and response activities undertaken by the Forest and Environment Department.*

### **Socio-Economic Impact on People and their Livelihoods**

The socio-economic impact of the Glacial Lake Outburst Floods on people dependent on the collection of sand, stone, loose boulders along the Teesta riverbed is substantial and wide-ranging as many people are dependent on these activities for their livelihood. The disaster has directly impacted 5,637 labourers and 107 individuals holding tenders and licenses. Indirect impacts are observed on people whose livelihoods are dependent on eco-tourism.

- **Disruption of Collection Activities:** The disaster has caused large scale deposition of sediments along the riverbed and riverbanks. This has damaged and rendered inaccessible the collection sites utilised for collection of sand, stone, and loose boulders. There is an observed pause in collection activities. Damages have also been observed to the infrastructure and, machinery utilised at the collection sites, which has not been accounted for as part of this assessment, causing immediate economic losses to the stakeholders.

- **Loss of Livelihood:** Riverbed collection of sand, stone and loose boulders is a source of income for individuals and households residing along many rivers in Sikkim. The disruption of collection activities due to disaster has resulted in loss of livelihood for license holders for these sites and associated workers, impacting their financial stability and economic well-being.
- **Economic Repercussions:** It has been observed that closure of the collection sites and operations have broader economic repercussions, and have affected businesses which rely on the sand, stone, and loose boulder as supplies and, provision equipment, or transportation services to the activity. The local economy has suffered due to reduced economic activity and loss of income from collection sites, especially as the materials are used as an input to construction businesses. This has also led to a fluctuation in the market prices of sand, stone, and loose boulders due to pause in supply and increasing demand.
- **Environmental Impact:** Changes to the course of the river has been observed, resulting in deposit of sediments/debris, erosion of the riverbanks and riverbed. Collection of sand, stone and loose boulders after the disaster have been paused by a government order issued by the Forest and Environment Department. Increased sedimentation, changes in river morphology, and environmental factors have limited collection activities.
- **Community Resilience and Recovery:** Displaced workers and affected communities are struggling to restore their livelihoods. Loss of river-bed materials, infrastructure, and livelihoods have impacted the ability of affected communities to recover and rebuild their lives, which will require sustained support from the government. It is important to invest in livelihood diversification strategies to ensure timely recovery of the affected population.
- **Tourism and Eco- Tourism:** Considering tourism and eco-tourism forms a major livelihood source in Sikkim the disaster has resulted in lower tourist footfall, losses to restaurants, reduction in bookings in accommodation facilitates, impact on transport service providers. The disruption in road access and connectivity has further impacted the livelihoods and economy.

Considering the above socio-economic impacts, it is important to design a robust recovery strategy considering life and livelihoods in Sikkim are closely dependent on the forestry and environment sector.

### **Reconstruction and Recovery Needs Assessment**

The approaches to reconstruction and recovery interventions within the forestry and environment sector will follow a multi- pronged approach with emphasis on restoration of forestry damages, rebuilding of damaged infrastructure, investing in mitigation interventions, supporting livelihoods recovery and development of eco- tourism assets. This approach will design and build a road map for inclusive resilience building efforts with emphasis on scientific rigour and ecosystem based inclusive approaches that enhance people's livelihoods. The implementation framework will determine approaches with focus a livelihoods diversification contributing to sustainable development of Sikkim. This approach will strike a balance between forest and environment protection and restoration in the context of disasters and climate change and will strengthen the livelihoods of the people dependent on forests and allied productive sectors such as eco- tourism, agriculture, horticulture, animal husbandry, handlooms, and handicrafts. The alternative livelihoods strategy will leverage ecological monitoring, nature-based solutions and micro-enterprises contributing to the quantification of eco-system services provided by the State of Sikkim.

Further field assessments will be conducted for planning permanent restoration efforts as part of the medium to long term recovery strategy. Partnerships will be developed for coordinated inter departmental efforts to ensure effectiveness of the strategy that will be strengthened by ongoing schemes and resources of the Government of Sikkim.

### **Recovery of Forest land and vegetation**

The proposed strategy for afforestation and plantations to restore and regenerate the damaged forest land and vegetation comprises of

1. Raising / creation of artificial regeneration (AR)/ Block Plantation with 1000 number of saplings of medicinally/ economically important and selected mixed species/ Ha estimated at a cost of INR 99,571 per ha for high altitude areas and INR 68,374 per Ha for low altitude areas. This approach will be implemented for restoration of forestry damages in very dense forest areas.
1. Raising/ creation of Natural Assisted Regeneration (NAR) with 400 seedlings and other integrated activities/ Ha estimated at a cost of INR 67,053 per Ha for high altitude areas and INR 46,162 per ha for low altitude areas. This approach will be implemented for restoration of forestry damages in moderately dense forest areas.
2. Plantation activity above the tree line will consider indigenous herb and shrub species based on locale specific assessments to determine the plantation plan in areas the tree line based on the need.

Recovery is calculated based on the above proposed schedule of rates per hectare for plantations as determined by the Forest and Environment Department, Government of Sikkim.

For the restoration of affected forest lands in high altitude and low altitude areas, the Forest and Environment Department will determine appropriate species for plantations after conducting field level assessments and planning considering appropriate ecological, economic, and medicinal value parameters.

Seabuckthorn plantations though proposed at Zema, Lachen, Mangan districts for land stabilization and soil binding of vulnerable areas in the High-Altitude areas, other appropriate species along with restoration techniques and solutions may also be explored and selected based on the ecological value and restoration patterns. This intervention is aimed to contribute to the rehabilitation and stabilization of fragile slopes through soil binding. Seabuckthorn plantation will also contribute as an income generation initiative when managed by the Forest and Environment Department in partnership with the Village Forest Management Committee/s as the plant has economic, medicinal, and aromatic properties and value. Similarly other indigenous species contributing to the increase in biodiversity, having appropriate ecological function and economic value may also be considered.

Proposed plantation areas for the seabuckthorn restoration interventions have been identified and mapped based on an assessment of the disaster affected forest area. The sites for seabuckthorn restoration and plantation have been selected in North Sikkim. Similar mapping with ground truth verification exercises will need to be undertaken to identify plantation zones in high and low altitude areas along the river Teesta impacted by the Glacial Lake Outburst Flood.

Planning and selection of appropriate interventions for plantations and restoration of damage to forests and vegetation may refer to the Compensatory Afforestation Fund Act, 2016 and Compensatory Afforestation Fund Rules, 2018 of the Government of India, contextualised based on the needs.

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<sup>49</sup> <https://parivesh.nic.in/acts.aspx?id=CAMPA>

**Table 93. Forest and Environment: Summary of forest restoration.**

Affected areas and restoration requirements where damage to forests and vegetation loss has been observed and calculated as per the Schedule of Rates for Plantations

Forest Type	Affected area High Altitude (above 2400 m elevation) in Ha	Affected area in Low Altitude (below 2400 m elevation) in Ha	Cost of Plantation in High Altitude per Ha	Cost of Plantation in Low Altitude per Ha	Recovery Cost (High Altitude)	Recovery Cost (Low Altitude)
Very Dense-Forest	85.64	105.32	99,571	68,374	85,27,260	72,01,150
Moderate Dense-Forest	126.99	318.26	67,053	46,162	85,15,060	1,46,91,518
Open-Forest	65.43	126.29				
Scrub	33.47	1.12				
Non-Forest	121.80	256.91				
Above Treeline Scrub	577.68	0	1,60,124	1,05,550	2,500,432 <sup>9</sup>	
Total	1011.02	807.9		Total	10,95,42,753	2,18,92,668
<b>Grand Total of Forest Damaged in Ha</b>	<b>1818.92</b>		<b>Grand Total of Recover Cost for plantations/ restoration of forests in INR</b>			<b>13,14,35,421</b>

Therefore, based on the above approach the total cost for plantations and restoration initiatives using indigenous forest species is INR 13.14 Crore.

## Reestablishment of Nurseries

The Forest and Environment Department proposes to re-establish 17 nurseries spanning over 25 ha approximately (1 Ha is equal to 10,000 sq m, therefore 2,50,000 sq m) that were damaged by the disaster. Nurseries from a core component of mandated interventions of the department. The unit size of the nurseries that have been affected ranges from 0.5 ha to 2.5 ha. The nurseries will be re-established based on the schedule of rates of the Forest and Environment Department in compliance with the cost of nursery establishment in Low Altitude areas i.e., INR 110 per sq m and the cost of nursery establishment in High Altitude areas is INR 153 per sq m. Therefore, the recovery cost estimate for 11 nurseries at high altitude spanning approximately 18 Ha i.e., 1,80,000 sq m is (1,80,000x 153= INR 2,75,40,000/-) and 6 nurseries at low altitude spanning 7 ha i.e., 70,000 sq m is (70000x 110= INR 77,00,000/-). Therefore, the total cost to re-establish all 17 nurseries is estimated at INR 3,52,40,000/- (3.52 Cr)

Table 94. Forest and Environment : Reestablishment of the Nurseries				
District	Totally Damaged (Units)	High Altitude (Units)	Low Altitude (Units)	Total
Mangan	11	11		11
Pakyong	2		11	2
Gangtok	2		2	2
Namchi	2		2	2
<b>Grand Total</b>	<b>17</b>	<b>11</b>	<b>6</b>	<b>17</b>

## Reconstruction of Infrastructure damages

The methodology for calculating the reconstruction cost to re-construct the damaged buildings of the Forest and Environment Department follows the methodology utilised under the housing sector where the reconstruction cost of INR 37,660 per sq m is used for totally damaged buildings. For calculating the reconstruction cost of severely damaged buildings the sq m rate is multiplied by a factor of 0.5 and a factor of 0.15 for partially damaged buildings.

Table 95. Forest and Environment: Reconstruction of Infrastructure damages								
Reconstruction of Forest Department Built up infrastructure/ buildings (Number of units and built-up area in Sq. m)								
District	Totally Damaged		Severely Damaged		Partially damaged		Total	
	No.	Area (sq m)	No.	Area (sq m)	No.	Area (sq m)	No.	Area (sq m)
Mangan	7	5803.88	2	1054	2	364.18	11	7221.88
Pakyong	2				1	182.09	3	874.21
Gangtok			2	364.18			2	364.18
Namchi	2	539.02	2	1253.62			4	1792.64
<b>Total</b>	<b>11</b>	<b>6342.9</b>	<b>4</b>	<b>2671.8</b>	<b>3</b>	<b>546.27</b>	<b>20</b>	<b>10252.91</b>



Therefore, reconstruction cost calculation for buildings of the Forest and Environment Department is estimated as follows:

- Totally Damaged-  $6,342.9 \times 37,660 = 23,88,73,61$
- Severely Damaged-  $2,671.8 \times 37,660 \times 0.5 = 5,03,09,994$
- Partially Damaged-  $546.27 \times 37,660 \times 0.15 = 30,85,87$

Total reconstruction cost for the rebuilding, retrofitting of the infrastructure of the Forest and Environment Department is INR 29,22,69,487/- i.e., 29.23 Crore.

### Debris removal

Debris removal and safe disposal forms an important component of the reconstruction process, the calculations for removal and safe disposal follows the same method as applied under the housing sector. An amount of INR 560.42 per cum has been assumed. Therefore, the cost calculation is estimated at  $10252.91 \text{ sq m} \times 1.75 = 17942.60$  cum of debris is calculated for safe removal and disposal requirements as part of the Infrastructure damages under the forest and environment sector. Therefore, the estimated cost for removal and disposal of debris is  $17942.60 \times 560.42 = 1,00,55,391.9$  i.e., INR 1.06 Crore.

### Reconstruction of Malli Sheds and Multi- propose stores of the Forest and Environment Department

The Malli sheds and multi- purpose stores are required to be re-built and used by the Forest and Environment at nurseries and field plantation sites. A total of 9 Malli sheds/ multi-purpose stores with an average size of 300 sq ft or 27.87 sq m per unit have been totally damages damaged, amounting to 250.83 sq m. The cost of re- construction of a kutcha construction is considered as INR 18,830/- per square meter. This value is arrived at by considering INR 37,660 per sq m as the cost of new construction followed under the housing sector, multiplied by a factor of 0.5 to arrive at construction cost of INR 18,830 for kutcha constructions, therefore the reconstruction cost calculation is estimates at  $250.83 \times 18,830 = \text{INR } 47,23,128.9$  i.e., 0.47 Crore.

Table 96. Forest and Environment: Reconstruction of Malli Sheds		
District	Totally Damaged	Area (sq m)
Mangan	7	195.09
Pakyong		
Gangtok	1	27.87
Namchi	1	27.87
<b>Total</b>	<b>9</b>	<b>250.83</b>

## Upgradation of the wireless communication infrastructure of the Forest and Environment Department

As the wireless communication infrastructure provides state-wide connectivity to the Forest and Environment Department. It is proposed that the infrastructure be upgraded as a component under Build Back Better principles to support strengthened communication systems within the department and function as a lifeline communication channel in the context of early warnings, disaster relief and response, and communication for security and surveillance in the pre and post disaster context within Sikkim. Therefore, it is important to strengthen and upgrade the communication infrastructure with a vision for long term sustainability of 10 years. Based on ground level visual assessments and interactions with the Forest Department Officials the upgradation cost is estimated at **INR 0.62 Crore**.

Tentative estimate for restoration and upgradation of the communication system of the Forest and Environment Department, Government of Sikkim			
<b>Table 97. Forest and Environment: Estimation for restoration and upgradation for communication systems</b>			
Item Description	QTY	Price in INR	Amount
Repeater sets for (Namthang, Rabdentse, Lachung, Barapthing, Megidara)	5	500,000	25,00,000
S.S Tower for Repeater stations	5	2,00,000	1,00,00,000
Repeater House	10	25,00,000	2,50,00,000
Solar panels with all accessories for 27 Ranges + 40 Blocks + 25 Check post	92	3,00,000	2,76,00,000
Sets: Static	50	60,000	30,00,000
Handheld Devices	150	50,000	75,00,000
Communication Vehicles	4	15,00,000	60,00,000
Approach road up to repeater station			10,00,000
Antenna, P.S unit, Low loss Cable, Connector etc			1,00,00,000
Operations and maintenance cost for 5 repeater sets for 5 years, including Human Resources	5	3,60,000	18,00,000
Batteries for different model handheld sets	200	5,000	10,00,000
Battery for static/repeater station	60	1,80,000	1,08,00,000
<b>Total</b>			<b>10,62,00,000</b>

## Reconstruction of eco-tourism- trails, and allied infrastructure

In the post disaster context, an emphasis is being laid to restore and enhance eco-tourism infrastructure and activities. The re- construction of damaged infrastructure will provide the necessary impetus for restoring tourism requirements and promote livelihood diversification, considering the loss of livelihoods of people and households impacted by the disaster. The reconstruction of eco-tourism infrastructure under the jurisdiction of the Forest and Environment Department is estimated at INR 2,60,03,574 i.e., **2.6 Crore**. Note: It is proposed to restore and reconstruct the totally damages trails of length 39 kms. Additionally, the estimated reconstruction of the biodiversity park /nature park at Labarbote, Dikchu, North Sikkim is estimated at **4.2 crore**.

<b>Table 98. Forest and Environment: Reconstruction of Eco-Tourism</b>			
<b>Infrastructure Type</b>	<b>Totally Damaged</b>	<b>Unit Rate</b>	<b>Cost in INR</b>
Trekking Trails (In Km)	39	4,00,000	1,56,00,000
Resting Shed (In Nos)	14	3,14,541	44,03,574
Camp Sites (In Nos)	6	10,00,000	60,00,000
Total in INR			2,60,03,574
Reconstruction of the biodiversity park /nature park at Labarbote, Dikchu, North Sikkim			4,20,00,000
<b>Grand Total in INR</b>			<b>6,80,00,000</b>

Reconstruction rates have been calculated based on the item wise schedule of rates and estimates prepared by the department. Therefore, the total reconstruction cost of the eco- tourism infrastructure is estimated at INR 6.8 Crore.

## Mitigation interventions along the Teesta River

The purpose of implementing the mitigation interventions is aimed at reducing future risk of landslips caused due to riverine erosion and positioning of river training structures along the major river turns to reduce hazard risk to settlements and critical infrastructure. One of the proposed interventions is the bio- civil restoration model used to protect and strengthen the areas along the major turns of the Teesta River. The specific locations will be identified based on criteria such as proximity to settlements and critical infrastructure such as roads where the impact of water is observed. The proposed intervention may also be coupled with groynes and spurs to enhance the function of the model as a mitigation measure to address riverine erosion. The proposed intervention is designed to account for all major turns spanning 46.3 Km of the total 160.69 km river length from South Lonark to Melli in Sikkim. It is proposed that 92 units of 500-meter length each will be built at strategic and vulnerable flooding sites. The design of the structure will include a sausage wall, soil moisture conservation species and block plantations. Spurs, groynes, or any other relevant solution may be integrated into the design based on the location specific needs. The estimated cost for the proposed length of 46.3 Km is INR **86.44 Crore**. All rates considered for the estimation of costs are in compliance with the approved schedule of rates of the Forest and Environment Department and the Sikkim Public Works Department, Government of Sikkim, separate rates have been considered for the high and low altitude areas as per a detailed project document available with the Food and Environment Department. The above interventions are suggested to mitigate land slips, further erosion, and function as a flood protection solution.



## Summary of Reconstruction costs estimates under the Forestry and Environment Sector

<b>Table 99. Forest and Environment: Summary of Reconstruction cost</b>	
<b>Details</b>	<b>Amount in Crore (INR)</b>
Restoration forests and vegetation through plantations as per the Schedule of Rates	13.14
Reestablishment of Nurseries of the Forest and Environment Department	3.52
Reconstruction of Infrastructure of Forest Department	29.23
Reconstruction of Malli Sheds and Multi- propose stores	0.47
Upgradation of the wireless communication infrastructure	10.62
Reconstruction of the Eco-tourism infrastructure	2.6
Reconstruction of the Biodiversity Park /nature park at Labarbote, dikchu, North Sikkim	4.2
Protection interventions along the river using a bio- civil restoration model	86.44
Debris removal- Infrastructure damage	1.05
<b>Total INR in Crore</b>	<b>151.27</b>

The above reconstruction costs are calculated based on the damage estimates recorded in the earlier sections of the sector report. Therefore, the total of reconstruction cost estimated under the Forestry and Environment sector is **INR 151.27 Crore**.

### Recovery Cost Estimates

#### Recovery interventions essential for protection and risk reduction under the Forest and Environment Sector contributing to economic and livelihood resilience

It is proposed that a livelihoods approach to recovery will be adopted under the forestry and environment sector wherein the labour dependent on the collection sites of sand, stones and loose boulders along the Teesta River and the affected communities will be provided with employment opportunities under the reconstruction and recovery interventions proposed under the sector. Apart from this various capacity building interventions will be undertaken to promote alternative livelihoods that will contribute to eco-tourism and village tourism in the affected districts. Additionally, recovery interventions require research and studies to ascertain 1. Impact of flash flood on riverine ecosystem along the Teesta Basin, 2. Study of Impact of flash floods on the trans Himalayan ecosystem, 3. Study on impact on Biodiversity loss and mitigation mainly focusing on high altitude medicinal plants after the flash flood, 4. Study on impact on livelihoods dependence on forest post the flash flood, 5. Livelihood and social impact assessments of people dependent on protected forests for livelihoods. Additionally various interrelated interventions are proposed for the monitoring, management of the Teesta River and the establishment of Early Warning systems. Various capacity building initiatives will also be integrated into the recovery planning and implementation process.

## **Economic and livelihood recovery of individuals and stakeholders engaged in the collection sites of sand, stones and loose boulders along the Teesta river**

The livelihood diversification strategy is envisioned as a program and scheme specifically for the individuals who have lost their livelihoods at the sand, stone, and loose boulder collection sites. Field interactions with the labourers indicate that they are relying on informal loans from local markets to support their subsistence currently and a structured recovery programme will support the transition of the labour into alternative livelihood avenues as the collection sites have large sediment deposits and may remain unviable in for a couple of seasons. The labourers may also be provided employment under the scheme as part of the various reconstruction and recovery initiatives proposed under the larger reconstruction and recovery framework for Sikkim. The scheme should ensure that females are given priority as 40% of the affected individuals are women. The individuals holding tenders for the collection sites may be directed to avail interest free loans up to INR 10 Lakhs as being offered by the relief package announced by the Office of the Chief Minister of Sikkim. Apart from this the Forest and Environment Department may encourage the tender holder to enroll and partake in alternative livelihood activities in alignment with eco-tourism and forest restoration, seed funding/ grant through a sand box/ proposal-based approach may be explored. The Forest and Environment Department after due technical investigation may consider auctioning the sediment deposits on the riverbed in a regulated manner if ascertained to be a viable construction material. This will contribute to the recovery of revenue losses incurred by the Forest and Environment Department through a proposed revenue model integrated with a recovery cess to recover revenue losses of the Forest and Environment Department caused by the disaster. It is important to ensure the enrolment of migrants settled in the state for employment under this category as beneficiaries of the proposed recovery initiatives. This approach has been proposed as no livelihood relief assistance has been made available to the individuals engaged in the collection sites who have lost their livelihoods, with a majority of them being daily wage labourers.

It is proposed that a robust programmatic approach be adopted to ensure early recovery of the 5,673 workers employed at the collection sites by provisioning assistance to ensure access to diversified livelihoods and employment. It is proposed that a livelihood recovery corpus fund of INR 60 Crore be established for the persons who have been affected by the disruption in collection of sand, stones, and boulders from the Teesta River. The proposed funding arrangement will be administered by the Forest and Environment Department and will focus on a livelihood diversification strategy that supports the affected population by creating productive assets that directly contribute to their livelihood, employment, and income. Institutional and administrative arrangements/ mechanisms within the government's administrative framework such as Village Organizations that govern a group of SHG's and Village Forest Management Committees will be given the responsibility to enroll and target beneficiaries at the area level, such that the loss in livelihoods is addressed. Further subsidized credit may also be provided at the Village Organisation or Self-Help Group Levels to support livelihood diversification activities through the proposed livelihood recovery corpus fund. The terms of repayment of the loans/ credit availed may be restricted to a period of one year and will be administered through the Village Organization level, this is proposed to ensure the sustainability of the corpus fund. The focus of livelihood diversification will be centred around creating livelihood assets/ productive assets under eco-tourism, animal husbandry, pisciculture, handlooms and handicrafts, transport services, tourism services, hospitality including restaurants and home stays, and other locally viable and important livelihoods. The Forest and Environment Department will partner with relevant line departments to ensure effective implementation of the scheme.



<b>Table 100. Forest and Environment: Cost estimate for Recovery interventions</b>					
<b>Recovery Measures</b>	<b>Districts</b>	<b>Numbers</b>	<b>Average Cost</b>	<b>Recovery Cost Estimate</b>	<b>Early recovery / Medium to Long Terms Recovery</b>
Riverine Monitoring system with communication systems integrated to a control room	Mangan, Namchi, Gangtok, Pakyong	12	0.5	6	Immediate (0-12 months)
Research and Studies	Mangan, Namchi, Gangtok, Pakyong	5	1	5	Immediate (0-12 months)
Interpretation Centre for Tourist on GLOF early warning and Preparedness	Gangtok, Mangan	2	1	2	Medium (12-24 months)
Satellite based early warning system (sensors with cameras) at observation posts for GLOF	Mangan, Namchi, Gangtok, Pakyong	12	0.5	6	Medium (12-24 months)
Access creation road access to the river beds for restoration, patrolling and monitoring	Mangan, Namchi, Gangtok, Pakyong	10km	0.15	1.5	Immediate (0-12 months)
Capacity building for emergency response and preparedness/ rescue of Forest Department Staff and community volunteers	Mangan, Namchi, Gangtok, Pakyong			2	Medium (12-24 months)
Collection of debris form access routes and road of the forest	Mangan, Namchi, Gangtok, Pakyong	10	0.2	2	Immediate (0-12 months)
Physical survey/ detailed assessment of the damaged area under the department	Mangan, Namchi, Gangtok, Pakyong	10	0.2	2	Immediate (0-12 months)

Flood zonation mapping and DEM for Teesta	Mangan, Namchi, Gangtok, Pakyong	1	2	2	Medium (12-24 months)
High Tide Line marking with pillars 32 Control Points for demarcation of no construction zone, with surveillance system	Mangan, Namchi, Gangtok, Pakyong	32	0.1	3.2	Medium (12-24 months)
Procurement of Satellite Imagery for Hazard Zonation and Vulnerability assessment	Mangan, Namchi, Gangtok, Pakyong			2	Medium (12-24 months)
Programmes and training for promoting eco- tourism based alternative livelihoods	Mangan, Namchi, Gangtok, Pakyong			2	Medium (12-24 months), Long (24 to 36 months)
Programmes and training for promoting establishing herbal/ medicinal gardens	Mangan, Namchi, Gangtok, Pakyong			2	Medium (12-24 months), Long (24 to 36 months)
Recovery of individuals and stakeholders engaged in the collection sites of sand, stones, and loose boulders	Mangan, Namchi, Gangtok, Pakyong			60	Immediate (0-12 months), Medium (12-24 months), Long (24 to 36 months)
<b>Total in Crore INR</b>				<b>94.5</b>	

The above recovery costs are calculated based on the damage and loss estimates recorded in the earlier sections of the sector report. Therefore, the total of recovery cost estimated under the Forestry and Environment Sector, including livelihoods recovery is INR 94.5 Crore.

## Impact of Recovery

The proposed recovery intervention when undertaken in alignment with the proposed reconstruction interventions directly contributes to the livelihood recovery of the affected populations dependent on the sand, stone and loose boulder collection sites across the riverbed and eco-tourism activities. The proposed alternative livelihoods strategy will enable the transition of the affected population to adopt sustainable livelihoods contributing to ecosystem services. This approach will ensure the restoration, regeneration and protection of forest areas, river reserves and will reduce encroachments and unsustainable extraction of forest produce along the river Teesta. Scientific monitoring of the river and associated ecosystem will directly contribute to Disaster Risk Reduction. This approach will maintain ecological integrity through strategic interventions contributing to preparedness, mitigation and resilience building through ecosystem-based livelihoods.

## Implementation mechanism

The proposed reconstruction and recovery interventions will be undertaken by the Department of Forest and Environment as the Nodal Department and all initiatives will be undertaken in consultation and coordination with the Sikkim State Disaster Management Authority and other relevant line departments as may be required. The interventions will be designed based on access to funding from the National Disaster Relief Fund and the State Disaster Relief Fund. A project Implementation unit under the leadership of the Principal Secretary, Department of Forest and Environment will be established to ensure effective implementation and monitoring of the reconstruction and recovery initiatives. Multi- stakeholder partnerships will comprise of stakeholders from research organisations, scientific institutions, non- government organisations, businesses to ensure the effective and timely implementation of the proposed reconstruction and recovery interventions.

<b>Table 101. Forest and Environment : Reconstruction and recovery Framework</b>					
<b>Reconstruction, Recovery measures</b>	<b>Overall Budget Requirements in Crore INR</b>	<b>Line Department</b>	<b>Supporting Department</b>	<b>Funding Sources (Primary/ Secondary )</b>	<b>Timeline</b>
<b>Reconstruction Measures</b>					
Restoration forests and vegetation through plantations as per the Net Present Value (NPV)	13.14	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)
Reestablishment of Nurseries of the Forest and Environment Department	3.52	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)
Reconstruction of Infrastructure of Forest Department	29.23	Forest and Environment Department	Sikkim State Disaster Management Authority/ Sikkim Public Works Department	NDRF	Medium (12-24 months)

Reconstruction of Malli Sheds and Multi- propose stores	0.47	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)
Upgradation of the wireless communication infrastructure	10.62	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Immediate (0-12 months)
Reconstruction of the Eco-tourism infrastructure	2.6	Forest and Environment Department	Department of Tourism	NDRF	Long (24 to 36 months)
Reconstruction of the Biodiversity Park /nature park at Labarbote, dikchu, North Sikkim	4.2	Forest and Environment Department	Sikkim State Disaster Management Authority/ Sikkim Public Works Department	NDRF	Long (24 to 36 months)
Protection interventions along the river using a bio-civil restoration model	86.44	Forest and Environment Department	Sikkim State Disaster Management Authority/ Sikkim Public Works Department	NDRF	Medium (12-24 months)
Debris Removal	1.05	Forest and Environment Department	Sikkim State Disaster Management Authority/ Sikkim Public Works Department	NDRF	Immediate (0-12 months)
<b>Total INR in Crore Reconstruction</b>	<b>151.27</b>				
<b>Recovery Measures</b>					
Riverine Monitoring system with communication systems integrated to a control room	6	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Immediate (0-12 months)
Research and Studies	5	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Immediate (0-12 months)
Interpretation Centre for Tourist on GLOF early warning and Preparedness	2	Forest and Environment Department	Tourism Department	NDRF	Medium (12-24 months)
Satellite based early warning system (sensors with cameras) at observation posts for GLOF	6	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)

Access creation road access to the river beds for restoration, patrolling and monitoring	1.5	Forest and Environment Department	Sikkim Public Works Department	NDRF	Immediate (0-12 months)
Capacity building for emergency response and preparedness/ rescue of Forest Department Staff and community volunteers	2	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)
Collection of debris form access routes and road of the forest	2	Forest and Environment Department	Sikkim Public Works Department	NDRF	Immediate (0-12 months)
Physical survey/ detailed assessment of the damaged area under the department	2	Forest and Environment Department	Sikkim Public Works Deptt./ Sikkim State Disaster Management Authority	NDRF	Immediate (0-12 months)
Flood zonation mapping and DEM for Teesta	2	Forest and Environment Department	Water Resources Department	NDRF	Medium (12-24 months)
High Tide Line marking with pillars 32 Control Points for demarcation of no construction zone, with surveillance system	3.2	Forest and Environment Department	Sikkim State Disaster Management Authority/ Water Resources Department	NDRF	Medium (12-24 months)
Procurement of Satellite Imagery for Hazard Zonation and Vulnerability assessment	2	Forest and Environment Department	Sikkim State Disaster Management Authority	NDRF	Medium (12-24 months)
Programmes and training for promoting eco-tourism based alternative livelihoods	2	Forest and Environment Department	Tourism Deptt./ Rural Development Department	NDRF	Medium (12- 24 months), Long (24 to 36 months)
Programmes and training for promoting establishing herbal/ medicinal gardens	2	Forest and Environment Department	Department of Commerce and Industries/ Rural Development Department	NDRF	Medium (12- 24 months), Long (24 to 36 months)
Recovery of individuals and stakeholders engaged in the collection sites of sand, stones, and loose boulders		Forest and Environment Department	Department of Commerce and Industries/ Rural Development Department	NDRF	Immediate (0-12 months), Medium (12- 24 months), Long (24 to 36 months)
<b>Total in Crore INR</b>	<b>94.5</b>				
<b>Grand Total of Reconstruction and Recovery requirement in Crore INR</b>	<b>245.77</b>				

The above reconstruction and recovery requirements are calculated based on the damage and loss estimates recorded in the earlier sections of the sector report. Therefore, the total of reconstruction and recovery cost under the Forestry and Environment Sector, including livelihoods recovery is estimated at INR 245.77 Crore.

## **Recommendations**

Under the forestry and environment sector the following recommendations are proposed

- Demarcation of post flood High Water level along the Teesta River is necessary to notify a no-construction zone via a legislation.
  - Restoration and promotion of the forestry and environment sector and routine departmental activities will require the implementation of the proposed reconstruction and recovery intervention through an eco-systems-based livelihoods approach those priorities disaster risk reduction initiatives contributing to ecological integrity.
  - Collaborative initiatives between local authorities, environmental organizations, sectoral experts, institutions, Non-government Organisations and community participation will play a pivotal role as part of the proposed reconstruction and recovery strategy.
  - In the post disaster context, it is crucial to raise awareness among resident populations, tourists, businesses, and stakeholders to determine a climate friendly pathways and disaster resilient tourism initiatives for Sikkim, with focus on eco- tourism. Preserving and safeguarding ecotourism zones is imperative for the sustainable coexistence of nature and human activity as is essential to support the livelihoods of the population and stakeholders. Tourism being a major source of the state's revenue it is important to make adequate recovery investments under forestry and environment sector and explore the possibility of a disaster resilience cess.
  - Livelihood recovery initiatives should be prioritised for the individual's facing loss in livelihoods and employment due to the disruption of collection of sand, stones and loose boulders from the Teesta Riverbed and should be planned for 3 years.
  - Invest in early warning technologies, communication systems that can support the emergency communication infrastructure in the state and undertake mitigation intervention by utilising nature-based solutions.
  - All interventions under the Forest and Environment Sector should be envisaged with cross sectoral linkages and should be integrated into the overall all recovery framework with focus on resilience building investments based on Build Back Better Principles.
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## 6.2 Disaster Risk Reduction

### Summary

On October 4, 2023, a devastating flood wreaked havoc in the downstream of Teesta valley, causing significant damage to homes, bridges, and infrastructure. 46 lives were lost in the disaster and 88,400 people were affected as per SSDMA report of 23.11.2023. The South Lhonak glacier lake, located at N-W parts of Sikkim 27°54'56.7"N and 88°12'25"E in the Teesta Basin, Sikkim, Himalaya at an elevation of 5245 meters. The glacier covers an area of 12.5 km<sup>2</sup>. Over the years, as the glacier retreated, the lake expanded significantly from 0.42 km<sup>2</sup> in 1990 to 1.35 km<sup>2</sup> in 2019.

On October 4, 2023, South Lhonak Lake in North Sikkim overflowed, causing a Glacial Lake Outburst Flood (GLOF). Downstream, about 60 kilometers away in Chungthang town, part of the Mangan district, the Teesta III dam, Sikkim's largest hydropower project at 1,200 MW, was severely damaged. The GLOF resulted in widespread devastation in nearby areas and communities.

This event has implications for the river's behaviour in the upcoming rainy season. The flash flood from the GLOF in South Lhonak significantly impacted Gangtok, Mangan, Namchi, and Pakyong mostly. The state's swift response to the flash flood was commendable and played a crucial role in saving many lives.

### Purpose and Scope of Disaster Risk Reduction

The aim of Disaster Risk Reduction (DRR) following the GLOF in Sikkim is to minimize the impact of similar events and support sustainable recovery. DRR and environmental considerations are integral to Sikkim's Recovery and Reconstruction plan after the GLOF.

### Hazard Profile of Sikkim

Sikkim's hazard profile is marked by its location in Seismic Zone V and diverse topography, making it susceptible to various natural disasters annually. The key hazards include:

- **Landslides:** The presence of steeper slopes, particularly in the North district at 600m per km, poses a heightened risk of landslides. Areas with slopes ranging between 300-600m per km, such as the Teesta valley and Rabongla, are also vulnerable. The southern parts of the West and South districts, with slopes ranging from 150m-300m per km, are prone to landslides as well.
- **Floods:** Sikkim faces the risk of floods, often triggered by factors such as heavy rainfall, glacial melt, or riverbank erosion.
- **Riverbank Erosion:** The diverse physiographic zones contribute to the susceptibility of riverbank erosion in certain areas.
- **Glacial Hazards:** The presence of 84 glaciers and 42 glacial lakes, with 15 classified as high-risk, poses potential hazards. GLOFs have the potential to occur at any time, affecting areas downstream.
- **Seismic Activity:** As a part of Seismic Zone V, Sikkim is at risk of earthquakes.

## Historical Overview of Disasters

Sikkim experienced a significant earthquake on September 18, 2011, measuring 6.8 on the Richter scale. The epicenter, located 64 kilometers northwest of Gangtok, caused landslides, roadblocks, and other destructive events, resulting in 63 fatalities and numerous injuries. This seismic activity underscores the region's vulnerability to moderate to great earthquakes.

In October 1968, continuous rainfall led to landslides and extensive damage in Sikkim and Darjeeling. Interestingly, a recent Glacial Lake Outburst Flood (GLOF) in 2023 during the same timeframe caused harm to lives, infrastructure, and various sectors, posing a potential threat, particularly during the upcoming monsoon season. Despite the challenges, these disasters offer valuable learning experiences, emphasizing the importance of risk assessment, preparedness, and effective disaster risk reduction strategies.

## The existing disaster risk in Sikkim

Sikkim, surrounded by the Greater Himalaya, has rugged terrain. The state has four districts namely (a) East District, (b) West District, (c) North District and (d) South District. The Teesta River, originating from the Pahunri glacier, divides the state as it flows from north to south, serving as a crucial surface water resource for hydro-electricity. The predominant rock, Darjeeling gneiss, results in shallow brown clay soil. The Teesta, with swift and rocky upper reaches, becomes unnavigable in the monsoon. Beyond Chungthang, the northern part of the state features the highest region characterized by deep escarpments. Chungthang marks the starting point of the devastation caused by the GLOF on October 4. The existing multi-hazards map prepared by SSDMA (Figure 1), for North Sikkim present significant findings across different domains. In terms of landslides, 1.27% of the area poses a very high risk, impacting 1.32% of settlements, while earthquake risk is notable with 7.04% in a very high-risk zone. Snow and avalanche hazards predominantly fall into very high-risk zones (17.74%), although flash floods demonstrate a contrasting pattern, with only 1.97% in a very high-risk zone. The multi-hazard risk maps created by SSDMA pre-defined the Chungthang region as an area falling within the medium high to very high-hazard zone.

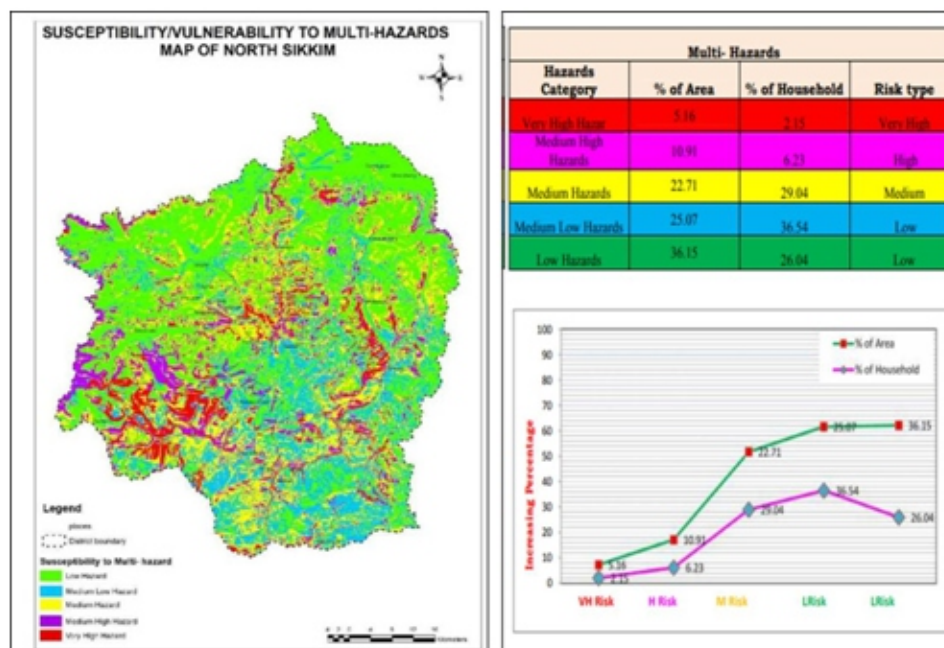


Figure 1 – Multi-hazard risk vulnerability assessment North Sikkim

The recent Sikkim flash floods exposed vulnerabilities, leading to loss of life and building failures. Critical issues include a lack of risk-informed land-use planning, insufficient risk-based planning for settlements, and absence of disaster-safety features in some constructions. Inadequate skills among construction workers, gaps in building bye-laws and the TCP Act, and lack of development control along riverbanks were also identified. Enforcement of safety regulations and accountability mechanisms was deemed inadequate. The severe impact on road infrastructure, with roads being washed away or subsiding due to landslides, underscores the urgency of addressing these issues to enhance resilience in Sikkim.

### Sikkim Susceptibility

The Geological Survey of India (GSI) conducted a National Landslide Susceptibility Mapping (NLSM) Programme at a macro-scale (1:50,000) in Sikkim, integrating thematic maps such as earthquake, landslide points, polygons, roads, and rivers. Figure 2 illustrates the pre-GLOF (prior to October 2023) profile of the affected and surrounding region. The region's history of landslides and seismic activities, coupled with the presence of faults and thrusts, indicates susceptibility to geological hazards.

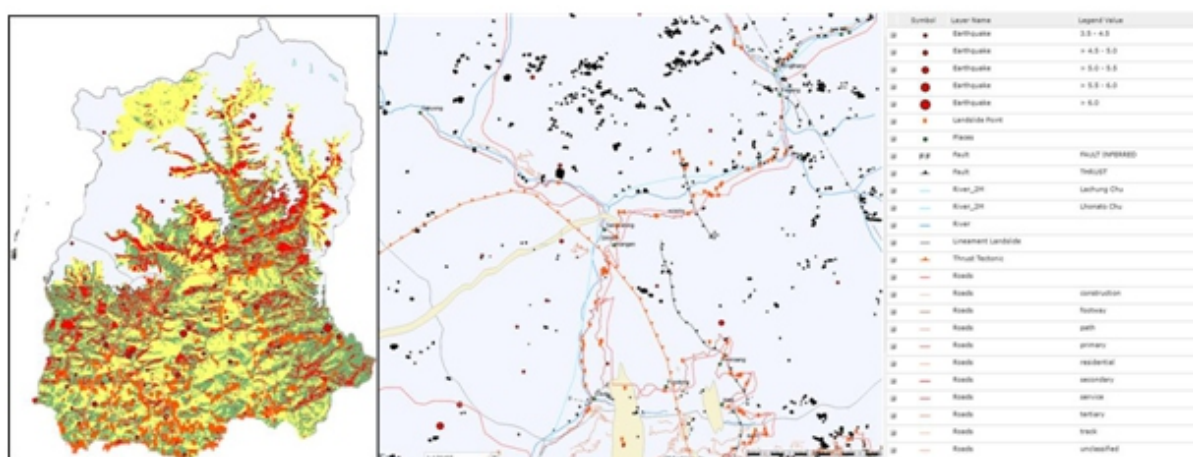


Figure 2 NLSM of Sikkim by GSI

### Disaster Risk Governance in Sikkim

The Sikkim State Emergency Control Room, situated at the Secretariat, functions around the clock, staffed by Control Room Operators and the Quick Response Team (QRT) for immediate emergency response. It maintains connectivity with National Disaster Management Hubs, such as the MHA Control Room, NRSC Hyderabad, and NESAC Shillong. Additionally, District Emergency Operational Centres (DEOC) operate 24/7 in all four districts, playing a crucial role in local emergency coordination.

However, the absence of a State Emergency Operations Centre (SEOC), as outlined in the State Disaster Plan 2010-11, presents challenges. The SEOC acts as the central hub for coordinated responses, and its non-existence poses risks of delayed and fragmented communication, impeding timely disaster assessment and management. Establishing a well-equipped SEOC is essential to enhance disaster management capabilities.

The Sikkim State Action Plan on Climate Change highlights the potential threat of moraine dam breaks leading to catastrophic floods downstream. It outlines mitigation strategies for GLOFs, emphasizing the importance of reducing lake water volume to minimize peak surge discharge. Protective measures for downstream infrastructure and continuous monitoring during and after construction are crucial. Global warming and precipitation changes increase GLOF risks, impacting river flows and hydropower generation.

## Gaps/ Challenges observed in 2023 Disaster-

- NDMA-led multi-agency expeditions to the high-risk glacial lakes, South Lhonak and Shako Cho in Sikkim (~15-16,000 feet; September 6-18, 2023), successfully deployed two solar- powered, twin-camera Automated Weather Stations (AWS) on September 16, 2023. Daily reports, including one set of camera views and over 250 weather observations, were received without issue. Unfortunately, the equipment at South Lhonak ceased transmission after September 19. An ITBP contingent physically inspected the equipment on September 28 and confirmed its stability, but despite efforts, it could not be revived. The equipment failure resulted in the inability to monitor the glacial lake, leading to a lack of information on its potential bursting. Immediate action is crucial if the equipment fails to function in the future to address the situation promptly.
- The dams involved in the incident lacked transparent communication on dam operation and management, a requirement under the Dam Safety Act 2021. The absence of monitoring systems, including hydro-meteorological networks and flood warning systems, further highlights non-compliance. The incident's timeline, as reported by the Deputy General Manager (DGM), underscores challenges in confirming the exact time of the dam breach due to communication blackout and power failure, emphasizing critical deficiencies in operational procedures.
- The SSDMA has hazard profiles maps for various disasters, but these maps are a decade old, limiting their effectiveness in the decision-making process. The outdated information hinders its application in informed planning and decision-making at local levels.
- The absence of SEOC resulted in a lack of last-mile dissemination. The entire EWS relied solely on a phone call from ITBP. If the call hadn't been made or there were network issues, the situation could have worsened. Public access to flood, cyclone, and landslide warnings via national media (radio and TV) is hampered by weather conditions, power failures, or late- night broadcasts. Additionally, poor public awareness and distrust in warning messages contribute to these limitations, as many people do not engage with radio or television broadcasts
- During interactions with residents in Sikkim, it became apparent that there were significant gaps in knowledge, technology, and systems related to excreta management and drinking water, especially at the domestic level.
- Post-disaster interactions revealed a gap in providing psychosocial support to individuals who have lost homes, businesses, or family members.
- The lack of a micro-scale study in Sikkim results in a gap in understanding localized hazards, impeding the creation of tailored mitigation strategies, accurate early warning systems, and informed community preparedness. This gap restricts the efficient allocation of resources, infrastructure planning, and policy formulation for robust disaster management. Closing this knowledge gap is crucial for strengthening Sikkim's resilience to potential hazards
- Most of the electrical units and distribution lines sustained damage due to their proximity to the river belt. There was a lack of proper compliance with guidelines regarding the placement of these lines.
- The absence of field hospitals after a disaster underscores the critical need for their presence in post-disaster scenarios. Field hospitals play a vital role in providing immediate medical care and addressing the health needs of affected communities. By investing in training initiatives, communities and response teams can better prepare for the establishment and operation of field hospitals, ultimately improving the overall resilience and effectiveness of disaster response efforts.

## **Interventions and Measures for Addressing Gaps/Challenges Observed in the 2023 Disaster:**

### High-Risk Glacial Lakes Monitoring:

- Implement regular maintenance and monitoring protocols for Automated Weather Stations (AWS) to prevent equipment failures.
- Establish contingency plans and backup communication systems for continuous data transmission.
- Invest in advanced technologies and real-time monitoring solutions to enhance the resilience of monitoring equipment.

### Dam Safety and Communication Compliance:

- Enforce strict adherence to the Dam Safety Act 2021, ensuring the establishment of mandated dam safety units and transparent communication on dam operations.
- Upgrade monitoring systems, including hydro-meteorological networks and flood warning systems, to comply with regulations and enhance preparedness.
- Conduct regular drills and exercises to ensure effective communication during emergencies, overcoming blackout and power failure challenges.

### Outdated Hazard Profiles and Insufficient Data:

- Conduct a comprehensive review and update of hazard profiles maps to reflect current risks and vulnerabilities.
- Invest in advanced technology and data collection methods to ensure real-time and accurate risk and vulnerability-related information.
- Enhance training and capacity-building programs for local authorities to effectively utilize updated hazard profiles in decision-making.

### Emergency Operations Center (SEOC) and Last-Mile Dissemination:

- Establish a robust SEOC to ensure timely and efficient last-mile dissemination of critical information.
- Implement alternative communication methods, such as satellite-based systems, to overcome network issues and power failures.
- Conduct awareness campaigns to build public trust and engagement with warning messages, encouraging the use of multiple communication channels.

### Knowledge Gaps in Excreta Management and Drinking Water:

- Launch community education programs to raise awareness about proper excreta management and safe drinking water practices.
- Introduce accessible technologies and systems for domestic-level excreta management and water purification.
- Collaborate with technology providers and research institutions to bridge knowledge and technology gaps.

### Resilience of Vulnerable Populations:

- Develop targeted programs to enhance the resilience of vulnerable populations through education, training, and community engagement.
- Strengthen social support networks and psychosocial services to address the specific needs of those impacted by various shocks.
- Integrate resilience-building initiatives into existing community development programs.

#### Micro-Scale Study for Localized Hazards:

- Conduct a comprehensive micro-scale study to understand and map localized hazards in Sikkim.
- Use the study findings to tailor mitigation strategies, enhance early warning systems, and inform community preparedness efforts.
- Allocate resources for infrastructure planning based on the micro-scale study results.

#### Compliance with Guidelines for Electrical Units:

- Enforce strict compliance with guidelines regarding the placement of electrical units and distribution lines, especially in vulnerable areas.
- Conduct regular audits and inspections to ensure that electrical infrastructure adheres to safety guidelines.
- Invest in relocating electrical infrastructure away from high-risk zones to minimize damage during disasters.

#### Field Hospitals in Post-Disaster Scenarios:

- Develop and implement guidelines for the strategic placement of field hospitals in disaster-prone regions.
- Conduct regular training exercises for response teams and communities to establish and operate field hospitals efficiently.
- Collaborate with health organizations to ensure the availability of necessary medical resources and personnel in field hospitals during emergencies.

#### Multi-Hazard Mapping, Flood Hazard Zonation, Bathymetric Surveys, Satellite-Based Early Warning System, Flood and GLOF Monitoring, Effective Communication, Utilization of Accumulated Sand:

- Create comprehensive maps for various hazards at micro or meso scales, integrating advanced technology for detailed planning.
- Utilize drone surveys for accurate flood hazard maps within a 2 km river buffer zone.
- Conduct bathymetric surveys to understand underwater topography in riverbeds and glacial lakes.
- Install satellite-based early warning systems in safe locations, combining human observations with automated technology.
- Utilize remote sensing data and hydrological models for monitoring water levels and predicting floods and GLOFs.
- Develop strong communication channels for prompt and efficient warning dissemination to at-risk communities.
- Implement governance for authorized sand mining from riverbeds for building purposes, generating additional revenue for the state.

#### **Structural Measures:**

- Flood Control Measures: Build embankments, diversion channels, and detention ponds for flood control.
- GLOF Mitigation: Construct dams, diversion tunnels, and early warning systems around glacial lakes to manage potential outbursts
- Elevated River Discharge Monitoring Station: Place monitoring stations in higher locations to protect them from impending floods.
- Small Check Dams: Construct as flood protection measures with regular monitoring in the upper reaches of glacier valley.



## **Non-Structural Measures**

### **6.4.2 Non-Structural Measures:**

- Mapping Changes in River Course: Account for changes caused by GLOF events, mapping alterations in river courses.
- Regular Monitoring of Glacial Lakes and Dams: Establish mechanisms for continuous monitoring.
- GIS/Remote sensing Utilization and capacity building: Use GIS/Remote Sensing for hazard mapping, vulnerability assessment, and emergency response planning using remote sensing satellite data, drone survey data, hydrological and hydro-meteorological analysis
- Bathymetry Studies: Use studies to predict GLOF paths and enhance early warnings.

### **CBDRR Measures:**

Indigenous Knowledge Integration: Combine indigenous knowledge with advanced technology for effective DRR.

Implementing a women-led recovery system, developing proper evacuation plans for vulnerable groups, considering the needs of the tenant population in developmental plans, and conducting community-based disaster preparedness programs are crucial aspects of disaster risk reduction (DRR). Empowering communities through risk assessment, monitoring, and mitigation, along with capacity building through training for officials, responders, and local communities, ensures effective disaster response and management. Organizing frequent mock drills and promoting mass awareness about GLOF risk management contribute to a comprehensive DRR strategy. Involving local people in a participatory approach for effective regulation implementation and making informed decisions on building in high-risk zones are essential for monitoring and governance of recovery visions. Overall, a comprehensive DRR strategy is vital to minimize the impact of GLOF-triggered flash floods.

### **Budget**

The Sikkim PDNA DRR involves six disaster risk reduction measures with a total budget of 474.75 Crore rupees, notably allocating 94.6% to structural measures, emphasizing the focus on building infrastructure for Sikkim's natural disaster protection.

The details of the budget have been classified into six heads, and the details are given below.

### **Monitoring and Early Warning Systems**

Sikkim's DRR plan prioritizes flood prevention with a 11.50 Crore rupees budget, emphasizing a technology-driven early warning system and real-time data monitoring, particularly focusing on automated weather stations (6 Crore rupees) and water level monitoring (1 Crore rupees). The approach aims to minimize flood risks through timely warnings and informed decision-making.

Table 102. Disaster Risk Reduction: Cost Estimate - Monitoring and Early Warning System			
SL	Mitigation Intervention	Unit	Cost (Cr.)
A	Establishing effective systems for disseminating early warnings to at-risk communities. Regular monitoring of water level, glacial melt rate, and stability of dams. Especially on the vulnerable Glacier lakes. Utilizing various communication radio broadcasts, and mobile phone apps.	50 Units EWS - 5 Lac.	2.50
B		30-unit AWS 20 Lac.	6.00
C		100 Water Level recorder in downstream 2 Lac	1.00
D		Glacier Inventory GPR Survey	1.00
E	Utilizing high resolution remote sensing data for monitoring glacial lake dynamics	Satellite data procurement, Image processing, Analysis and Database generation (GIS) and analysis	1.00
	Total		11.50

### Flood Forecasting Station

Sikkim's DRR plan emphasizes accurate flood prediction through a dedicated Flood Forecasting Station, investing a total of 5.25 Crore rupees in model development (0.25 Crore rupees) and station establishment (5.00 Crore rupees). The focus is on proactive flood management and mitigation through predictive models and monitoring stations to minimize the impact of GLOFs.

Table 103. Disaster Risk Reduction: Cost Estimate - Flood Forecasting Systems			
SL	Mitigation Intervention	Unit	Cost (Cr.)
a	Developing flood forecasting models to predict the timing and magnitude of potential GLOFs. Utilizing meteorological data, hydrological models, and real-time monitoring information.	The establishment involves setting up Flood Monitoring and Forecasting Stations, incorporating both level forecast and inflow forecast stations. These stations are designed to monitor water levels and predict inflows, enabling proactive flood management and mitigation.	0.25
b	Establishment of Flood Monitoring and Forecasting Stations including level forecast and inflow forecast stations		5.00
	Total		5.25

### Structural Measures

Sikkim's DRR plan prioritizes structural measures, investing a total of 450 Crore rupees in dam construction and maintenance (200 Crore), diversion channels (200 Crore), and debris flow barriers (50 Crore). These large-scale interventions aim to directly manage and mitigate GLOF risks by addressing water levels, controlling water flow, and protecting villages from debris impact.

3 Structural Measures			
Table 104. Disaster Risk Reduction: Cost Estimate - Structural Mitigation measures			
SL	Mitigation Intervention	Unit	Cost (Cr.)
A	Dam Construction and Maintenance	According to reports from NRSC, CWC, GSI, C-DAC, and other sources, there are 42 lakes identified in Sikkim. Among these, 15 lakes are highly vulnerable to Glacial Lake Outburst Floods (GLOFs). Urgent structural interventions are required to reduce the risk of these potential hazards.	200.00
	Construction of check dams or reinforcing natural dams of the glacial lakes and regulate water levels. (Building embankments to contain the lake and prevent overflowing.)		
B	Diversion Channels		200.00
	Construction of diversion channels/ Headrace tunnel to control the release of water from glacial lakes and reduce the risk of sudden outbursts. (Constructing tunnels or siphons to gradually release water from the lake, lowering its level and reducing pressure.)		
C	Debris Flow Barriers	27 villages across the four districts of Mangan, Gangtok, Pakyong and Namchi.	50.00
	Constructing debris flow barriers along river channels to mitigate the impact of debris and sediment carried by the floodwat		
	Retaining wall		50.00
	Already included in the forest sector		
	Total		450.00

### Non-Structural Measures

Sikkim's DRR plan prioritizes non-structural measures of 4 Crore, allocating 1 Crore for preventing development in flood zones and 3 Crores for multi-hazard mapping, emphasizing long-term community resilience.

Table .105 Disaster Risk Reduction: Cost Estimate - Non-Structural Mitigation measures			
SL	Mitigation Intervention	Unit	Cost (Cr.)
a	Update and implementing large scale land-use plans that restrict development in flood-prone areas.	Updating and enforcing extensive land-use plans to limit development in flood-prone zones.	1.00
b	Multi Hazards micro zonation mapping including Earthquake, Landslide & Avalanche in Geospatial Environment	In Sikkim, multi-hazard micro- zonation maps, integrating earthquake, landslide, and avalanche risks in a geospatial platform, empower informed decisions for safer settlements and infrastructure.	3.00
	Total		4.00

### Community-Based Disaster Risk Reduction

Sikkim's DRR plan prioritizes community empowerment through awareness campaigns (2 Crore), mock drills, collaborative risk reduction strategies, community-based monitoring and early warning systems, and regulation enforcement, fostering local ownership and action for long-term sustainability and resilience in managing GLOF risks.

Table 106. Disaster Risk Reduction: Cost Estimate - CBDRR Measures		
SL	Mitigation Intervention	Cost (Cr.)
A	Conducting awareness campaigns to educate communities about GLOF risks and preparedness measures.	2.00
B	Organizing mock drills and simulations to familiarize communities with evacuation procedures and emergency response protocols.	
C	Collaborating with local communities to develop and implement localized risk reduction strategies.	
D	Empowering communities to monitor glacial lakes, identify early warning signs, and establish evacuation plans.	
E	Identifying and enforcing regulations on settlements, agricultural land, and critical infrastructure.	
	Total	2.00

### Emergency Response Planning

Sikkim's DRR plan prioritizes strengthening emergency response capabilities for GLOF events by allocating 2 Crores for comprehensive plans and emphasizing efficient evacuation, search and rescue operations, and post-disaster recovery efforts to minimize impact and facilitate swift recovery.

Table 107. Disaster Risk Reduction: Cost Estimate - Emergency Response Planning			
SL	Mitigation Intervention	Unit	Cost (Cr.)
A	Developing comprehensive emergency response plans that outline roles and responsibilities for different stakeholders during a GLOF event.	Existing plan is there, need to be implemented or the existing plan should be updated depending on the recent experiences	2 .00
B	Ensuring efficient evacuation procedures, search and rescue operations, and post-disaster recovery efforts.		
		Total	2 .00

## Summary and Conclusion

The proposed GLOF risk reduction plan for Sikkim encompasses a range of interventions with a total estimated cost 474.75 Crore. The allocation of 11.5 Crore for Monitoring and Early Warning Systems signifies a commitment to timely detection and communication of potential GLOF events through various channels and advanced technologies. The Flood Forecasting Station, with an investment of 5.25 Crore aims to proactively manage and mitigate GLOF risks by predicting the timing and magnitude of potential floods. Structural measures, including dam construction, diversion channels, and debris flow barriers, constitute the major portion of the budget (450.00 Crore), acknowledging the urgent need for physical interventions to reduce the risk of GLOFs in the identified vulnerable lakes. Non-structural measures, community-based disaster risk reduction, and emergency response planning, with a combined cost of 6.00 Crore reflect a holistic approach that involves community engagement, land-use planning, and effective emergency response coordination. While the financial commitment is substantial, the success of these measures will depend on effective implementation, ongoing monitoring, and community participation in mitigating the complex natural hazard of GLOFs in Sikkim.

**Table 108. Disaster Risk Reduction: Summary of cost Estimate for DRR measures**

Sl. No.	Mitigation Measure	Amount in (Cr)
1	Monitoring and Early Warning Systems	11.50
2	Flood Forecasting Station	5.25
3	Structural Measures	450.00
4	Non-Structural Measures	4.00
5	Community-Based Disaster Risk Reduction	2.00
6	Emergency Response Planning	2.00
	Total	474.75

## 7. Resource Mobilisation, Implementation, Monitoring and Evaluation of the plan

### 7.1 Resource Mobilisation

The State Government takes responsibility for rebuilding and repairing the government assets. The loss and damages incurred to a private asset is typically governed by items and norms of assistance issued by Ministry of Home affairs. However, rebuilding all the assets is beyond the fiscal capacity of the government. Therefore, additional assistance would be required to meet the total estimated cost of loss and damages.

The recovery and reconstruction need of INR 1480.066 crore for Sikkim over a time frame of five years could be raised through the following channels:

- a. **NDRF – Recovery and Reconstruction funding window:** A part of the cost may be funded through the NDRF for supporting the reconstruction component. Additional funding may be provided in his regard.
- b. **Special Assistance to State from Government of India:** Sikkim may get additional funds from the Central government under Centrally Sponsored Schemes (CSS) like the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) for livelihoods, Pradhan Mantri Awas Yojana, (PMAY) for housing, and other central schemes.
- c. **Deficit if any will be met up by Gap Funding, CSR Funds and other funding channels that the state will activate for long term recovery.**

### 7.2 Program Implementation

The State Government of Sikkim will constitute the Sikkim Flash Floods 2023 Recovery & Reconstruction Unit (SFFRRU) within the Sikkim State Disaster Management Authority (SSDMA). The Sikkim Recovery and Reconstruction Cell / Unit is headed by Director / SSDMA. The roles and responsibilities of the SFFRU are as follows:

- Overall monitoring and coordination of the project at the state and district levels, and host decision support system for all the investments in the project
- Setting up the Project Appraisal Committee and Develop a Roster of Consultants for technical support
- Inviting project proposals, conduct preliminary scrutiny and coordinate with the Project Appraisal Committee for technical review of the project.
- Coordination with Project Approval Committee for appraisal of selected projects
- Monitoring of implementation of the project
- Set-up and manage a Sikkim Flash Floods 2023 Recovery & Reconstruction Portal for submission, approval, funding and monitoring of the project proposals at all stages.
- Monitor fund utilization and facilitate Disaster Management Authorities to manage the Funds, raise additional resources, and suggest improvement in Recovery & Reconstruction Strategy.

The Sikkim Recovery and Reconstruction Cell / Unit is supported by an appropriate governance structure. Various elements of the governance structure are necessary to ensure the impact of the investment in the project and accountability in the utilization of funds. The Sikkim Flash Floods 2023 Recovery & Reconstruction Unit will be governed by the State Executive Committee which is chaired by the Chief Secretary of the State. The members of the SEC are as follows:



<b>Table 109. Program Implementation: Members of State Executive Committee</b>		
1	Chief Secretary, Home Department	Chairman ex- Officio
2	Secretary/ State Relief Commissioner, Land Revenue and Disaster Management Department	Member
3	Secretary, Finance Department	Member
4	Secretary, Health and Family Welfare Department	Member
5	Secretary, Urban Development Department	Member

#### **Technical Appraisal Committee:**

The State Government will constitute a Technical Appraisal Committee (TAC). The TAC will consist of officers from different sectoral Line Departments which are headed by Director, SSDMA. The Technical Committee Members may comprise of the following:

<b>Table 110. Program Implementation: Technical Appraisal Committee</b>		
1	Director, SSDMA	Chairman
2	Chief Engineer, Building & Housing Department	Member
3	Chief Conservator of Forests, Forest & Environment	Member
4	Director, Education Department	Member
5	Director, Health & Family Welfare Department	Member
6	Director, Tourism & Civil Aviation Department	Member
7	Director, Agriculture & Horticulture Departments	Member
8	Chief Engineer, Water Resources Department	Member
9	Director, Animal Husbandry & Veterinary Sciences Department	Member
10	Chief Engineer, Power Department	Member
11	Chief Engineer, Roads & Bridges Department	Member

Some Disaster Management Experts may be invited for all the meetings for cross cutting perspective, while relevant hazard/theme experts may be invited for specific project appraisal meetings. The Technical Appraisal Committee will be responsible for administrative and financial appraisal of the project.

## **Preparation of Detailed Project Report (DPR)**

The DPR is a technical and financial document. The DPR lays down the project goals, its activities, cost estimates and intended impacts in adequate detail. The formulation of DPR would require several steps:

- A risk assessment of the identified hazard, risk exposure and accompanying vulnerabilities
- An analysis of the context—socio-economic, governance / regulatory, and environmental.
- An analysis of the stakeholders' capacities—technical, organizational, and financial.
- Activities planned under the project and the outputs
- Cost-benefit analysis
- Budget for the project activities
- Implementation plan and the timeline for the completion of the project
- Reporting and monitoring arrangements

The submitted DPRs will be appraised and reviewed by the Technical Appraisal Committee (TAC) for all the technical, financial and social aspects of the project. The TAC will review the proposal following a checklist, which will consist of the scope and scale of the project, eligibility of the Line Department, appropriateness of implementation measures, cost-effectiveness, expected results, implementation arrangements, community participation and social inclusion, and monitoring arrangements. The TAC may ask for clarifications concerning the project, refer it back to the respective Department for necessary revision. Based on technical evaluation, the TAC may recommend it to the SSDMA. Once the DPR is recommended by the TAC, the SSDMA may follow internal mechanisms to process the approval of the project. If the TAC does not recommend the proposal, the SSDMA may refer it back to the concerned Line Department for necessary modifications. The technical review and recommendation of TAC is a requisite condition for the approval of the DPR. The process of review and approval through the TAC and the SSDMA will be completed within two months of the submission of the DPR.

## **Project Implementation**

- The Implementing Line Department signs a project agreement with the Sikkim State Disaster Management Authority (SSDMA) and undertakes to implement the project as per the approved Implementation Plan in the DPR. A detailed project agreement is drawn up specifically for the Sikkim Flash Floods 2023 Recovery & Reconstruction project.
- The Project is implemented by a Project team, which will be constituted within one month of the project approval. The Implementing Line Department informs the SSDMA of the Project Team as well as the Lead.
- In those cases where more than one Line Department has partnered to implement the project, the Consortium informs the SSDMA of the project management arrangements and produces a formal consent from all the participating Line Departments to this effect. The Consortium designates a lead Department which coordinates with the SSDMA on all the issues related to the project.
- The Implementing Line Department hires the staff and deploys them for the project implementation. The Implementing Line Department assumes the full responsibility for the service conditions and safety of the project staff. The SSDMA has no liability for the project staff.
- The Implementing Line Department submits an implementation plan, which lays down the time-frame for the completion of all the project activities. The project implementation must adhere to the time-frame mentioned in the plan. If the project needs to be extended, the implementing Line Department will request the Sikkim Disaster Management Authority for such an extension, who can take a decision on the matter

- The projects have an approved budget for all the activities included in the implementation plan. In addition to the budget, the fund flow for the project activities is decided in advance. The disbursement of the funds is linked to the activities and outputs and released in tranches as agreed with the implementing Line Department. All the financial decisions concerning unspent allocations or extension of projects will lie with the Sikkim Disaster Management Authority
- In respect to procurement under the Sikkim Flash Floods Recovery & Reconstruction project, the Line Departments need to follow the rules and procedures laid down by the State Government of Sikkim
- Sikkim Disaster Management Authorities have the necessary authority to take suitable decisions if the project is delayed or being implemented incorrectly. Sikkim Disaster Management Authority reserves the right to terminate the Project at any stage if it is convinced that the grant has not been properly utilised or satisfactory progress is not being made
- The implementing Line Department ensures that there is no harm to the community in the process of implementing the project. It adheres to all the laws and regulations of the country and the state
- The implementing Line Department is responsible for the protection of forests, wildlife parks, rivers and wetlands, and any other natural or environmental asset. The project aims to reduce not just the risks posed by hazards, but also addresses climate change impacts and reduces pollution and waste of natural resources
- The implementing Line Department must observe and uphold the values underlying the labour laws. In its work, the implementing Line Department must promote the ideals of gender equality and women's empowerment. Participation of the tribal communities and traditional forest dwellers need to be attempted, to utilise their local knowledge and traditional practices.
- - The implementing Line Department maintains all the rules and agreements related to intellectual property rights. All the publications and knowledge products emanating from the project cannot be disseminated without the permission of Sikkim Disaster Management Authority.

#### **7.4 Program Monitoring and Evaluation**

The nature of objectives and indicators of Sikkim Flash Floods 2023 Recovery & Reconstruction Project requires both quantitative and qualitative methods to be employed for monitoring, evaluation, accountability and learning purposes. The quantitative approach will inform the progress or the lack thereof while the qualitative approach will support in understanding the processes that are effective and should be replicated. Analysis of both will support an informed decision-making process.

In summary, the following MEAL interventions will be used:

1. KPIs – quarterly
2. Midterm and annual learning review
3. Project Audit

Two project reviews will be carried out in a duration of one year. One review will be organized after six months of project commencement date (mid-term review) and another at the end of project period (annual review). All the Line Departments involved in the project will participate in the review.

Discussion about what was planned, what has been achieved and what is remaining will be done in mid-term review. This will help the team in reviewing the achievements of the project so far and to make necessary changes on time. The following format will be used:

Table 111. Program Implementation: Monitoring and Evaluation framework				
Plans	Achievements	Challenges	Solutions to challenges	Required changes
Output 1				
Output 2				
Output 3				

The Annual review will be an opportunity for the team to analyze plan vs achievement. The challenges, best practices and learning of the project will be discussed in presence of all the members.

- Project Monitoring is conducted throughout the project implementation to measure the progress of the project towards achieving expected/planned objectives.
- All the projects submit a progress report and statements of expenditure in the prescribed format as prescribed by authority. The projects also submit necessary certificates of completion of the project and utilization of the project budget
- All the projects conduct a periodic review of the project, providing baseline information, mid-term review and the end-results evaluation upon the completion of the project. The mid-term review and the project-end evaluation are conducted through external experts to get an objective picture of the project performance. The results of the mid-term review are used for improving the project results.
- All the projects are evaluated for the results and their overall impact at their conclusion. The Implementing Line Department reports the project results, which are evaluated externally for their adherence to project design and the outcome. All the review and evaluation reports are submitted to Sikkim Flash Floods 2023 Recovery & Reconstruction Unit.
- All projects have components of self-evaluation, where the Implementing Line Departments critically review the quality, relevance and effectiveness of the project activities they have implemented against the expected results.
- SSDMA may conduct an evaluation, including third party evaluation, of any project approved under the Sikkim Flash Floods Recovery and Reconstruction Fund

#### Project Audits:

Based on the scale and nature of the projects, all the projects are taken up for financial and social audits as decided by the Sikkim Disaster Management Authority.

- Financial Audits** – A financial audit of the funds received and expenditure made is carried out by the Comptroller and Auditor-General (CAG) or external auditors as decided by the Sikkim Disaster Management Authority.
- Technical Audits** – Sikkim Disaster Management Authority will identify technical experts to conduct technical audits of all the projects. Number of required audits will be decided by the authority as per size and complexity of the project. The mid-term reviews and project-end evaluations should be undertaken by experts included in the roster for this purpose.
- Social Audit** – Since most of the recovery & reconstruction measures require community participation during its process, social audit will be conducted during the project cycle to review how the project has sought to involve the people at risk and deliver the results to communities, as prescribed by the authority.

## Team

**Team Lead-** Kunal Satyarthi (IFS), NDMA

### **State Team**

Education – Nirmaya Pradhan, Advanced Technical Training Centre (ATTC); Health – Dr. Binu Upreti, Sikkim Manipal Institute of Medical Science (SMIMS); Forest and Environment – Mr. Tshering Pintso Bhutia, Additional Director, Forest & Environment Department, Govt. of Sikkim; Housing – Mr. Guru Prasad Sharma, Assistant Professor, Sikkim Manipal Institute of Technology (SMIT); Agriculture, Fisheries and Horticulture – Prof. J. Panda, College of Agricultural Engineering and Post Harvest Technology (CAEPHT); Animal Husbandry – Dr. Thinlay Nedup Bhutia, Additional Director, Animal Husbandry and Veterinary Sciences Department, Govt. of Sikkim; Road & Transport – Col. A.K. Dixit, Commander 758 BRTF of Project Swastik, Border Roads Organisation (BRO); Power – Mr. B.K. Rai, Additional Chief Engineer, Power Department, Govt. of Sikkim.

### **Central Support Team**

**Coordination** - S K Jena, NDMA; Amit Tandon, NDMA; **Housing** - P K Das, UNDP, Mikey Dalbhera, CBRI; **Education** - Mukunda Upadhyay, UNICEF; **Health, Nutrition and Community Buildings** - Ratnesh Kumar, CDRI, Amit Tandon, NDMA; **Agriculture and Horticulture** - C P Mohan , UNDP; **Animal Husbandry and Livestock** - Abhinav Walia, NDMA, **Tourism** - Vivek Coleho , WFP, Abhinav Walia, NDMA; **Road and Transportation** - Indranil Bose, CDRI; **Drinking Water and Sanitation** - Rahul Dey, CDRI ; **Forest and Environment** - Vivek Coleho, WFP; Disaster Risk Reduction; Sweta Baidya (NDMA), Deepali Jindal (NDMA), Piyush Gaurav( NDMA)





**Title- Post Disaster Needs Assessment - Template for Report Writing  
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