REPORT ON
POST DISASTER NEEDS ASSESSMENT
HIMACHAL PRADESH
MONSOON - 2023
FLOODS, CLOUDBURSTS & LANDSLIDES

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POST DISASTER NEEDS ASSESSMENT
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Floods, Cloudbursts and Landslides

Onkar Chand Sharma, IAS

Principal Secretary (Rev)
Govt. of Himachal Pradesh

ACKNOWLEDGMENT

Occurrence of floods, cloud bursts, landslides, forest fires and snow avalanches is a common phenomena in Himachal Pradesh as well as the adjoining Himalayan States of Uttrakhand, Jammu & Kashmir and Ladakh . The widespread damage and destruction occurred during 2023 monsoons due to flash floods, landslides arising out of the consistent rainfall during July and August has rendered many of our people homeless and destroyed their property affecting their social life. Within a span of two months only, the State suffered huge financial loss of more than 10,000 Crores, besides loss of more than 500 precious human lives. The roads were badly affected in almost each district affecting the communication network for a considerable time during that period as a result of which major sectors like tourism and transport suffered huge loss.

In order to work further on the recovery and reconstruction, the Government of Himachal Pradesh requested National Disaster Management Authority (NDMA), Ministry of Home Affairs, Govt. of India to help and assist the State Government in carrying out the Post Disaster Needs Assessment (PDNA) in the State. NDMA provided all technical support for conducting the PDNA exercise which was completed in two different phases covering all the 12 districts of the State. The technical support was provided by NDMA in terms of the sectoral experts and further training to the State Government stakeholders in different sectors. The Government of Himachal Pradesh , HP State Disaster Management Authority, Revenue Department expresses its gratitude for the technical support extended by NDMA especially the personal efforts made by the Sh.Kamal Kishore, Member Secretary , NDMA, Sh. Krishna S. Vatsa, Hon'ble Member, NDMA and Sh. Kunal Satyarthi, IFS, Joint Secretary (PP) NDMA in carrying the PDNA exercise for the State of Himachal Pradesh in collaboration with National and International agencies like UNDP, CDRI, UNICEF, IIT, J P. University and GB Pant Institute. The HPSDMA also extends its gratitude to the Central & State Expert Group Members for their coordination with the stakeholders in carrying the PDNA exercise and logistic support extended by all Deputy Commissioners, Himachal Pradesh, all stakeholder departments and the field staff of the different department for their efforts in the collection of the field data and its synthesis at different levels.

(Onkar Chand Sharma, IAS)

कुणाल सत्यार्थी, आई.एफ.एस.
संयुक्त सचिव
Kunal Satyarthi, IFS
Joint Secretary

सत्यमेव जयते

राष्ट्रीय आपदा प्रबंधन प्राधिकरण
गृह मंत्रालय, भारत सरकार
National Disaster Management Authority
Ministry of Home Affairs
Government of India

No.48/20/2023-RR

Dated: 21st November, 2023

Sh. D.C. Ranaji

Please refer to your letter dated 25.7.2023 and 18.08.2023 and subsequently NDMAs office order No. 48/20/2023-RR dated 05.08.2023 with regard to providing necessary technical support for conducting Post Disaster Needs Assessment (PDNA) exercise in the State of Himachal Pradesh.

The Draft Post Disaster Needs Assessment (PDNA) as prepared by State of HP and as reviewed by the Joint Expert Group constituted by NDMA for the State of Himachal Pradesh as per the ToR is forwarded herewith for further necessary action.

With regards,

Encl: as above

Yours Sincerely,

21/11/23

(Kunal Satyarthi)

Shri. D.C. Rana, IAS
Director-cum-Spl Secy. (Rev-DM)
Department of Revenue (DM Cell)
Government of Himachal Pradesh
Shimla

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1. Introduction

Disaster Profile of Himachal Pradesh

1.1.1 BACKGROUND:

Himachal Pradesh, a small hilly state, forms a part of the Northwestern Himalaya of the Indian Himalayan Region (IHR). The environmentally fragile and ecologically vulnerable Himalayan part has rendered the state highly vulnerable and sensitive from the natural disaster point of view. Physiographically the state has been divided into three broad units viz. Lower or Outer Himalaya, Middle Himalaya and the Higher or Great Himalaya and each unit is susceptible to different types of hazards depending upon the lithological, soils and local climatic variations. Himachal Pradesh was formed as a Union Territory in 1948, after amalgamation of 31 erstwhile princely states and attained full statehood on 25th January 1971. Administratively the State comprises 12 Districts, 75 Tehsils and 34 Sub-Tehsil with a total geographical area of 55,673 km^2. The State also shows considerable variations in the distribution of rainfall and temperature due to the varying aspects and altitudes. Precipitation declines from west to east and south to north. The average annual rainfall is about 1111mm, varying from about 450 mm in Lahaul & Spiti to over 3400 mm in Dharamshala, the district headquarter of Kangra. About 70% of precipitation is received from July to September. Winter precipitation in the form of snow is received at elevation above 1800 m.

1.1.2 OVERVIEW OF DISASTERS:

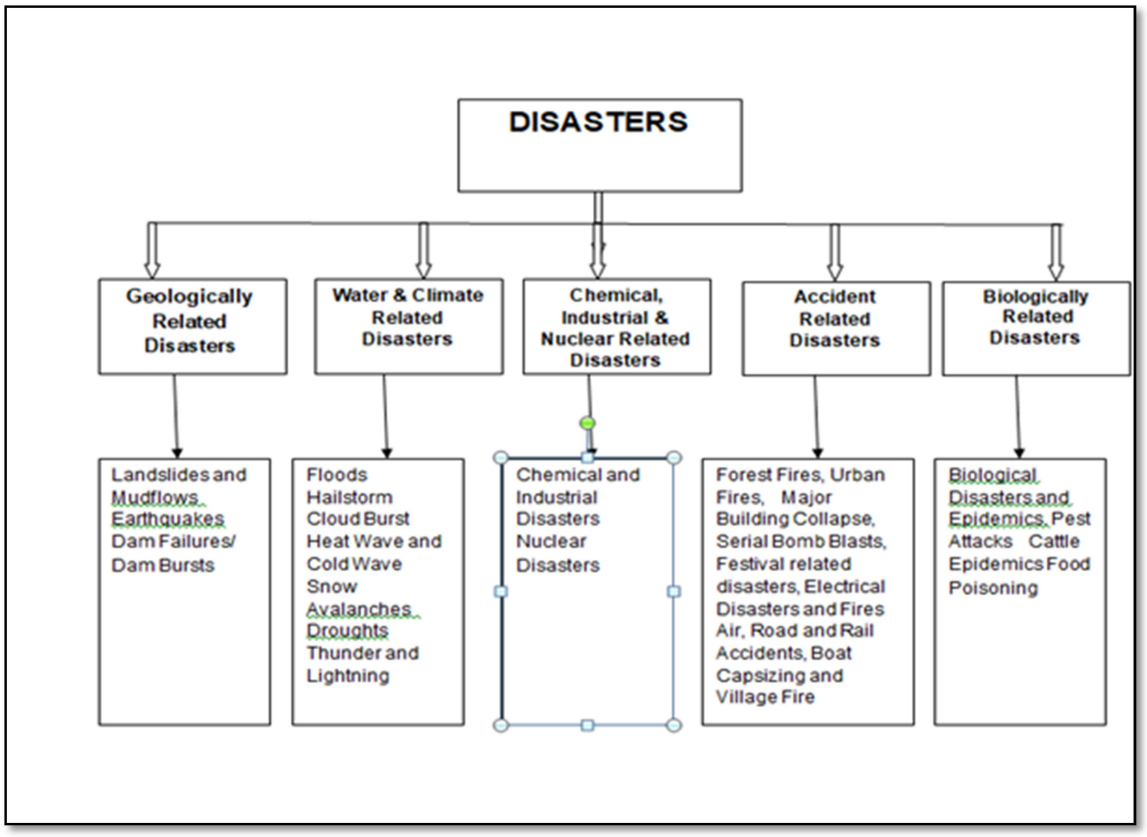
Before Independence, droughts and famines were the biggest killers in India. The situation stands somewhat altered today, wherein a combination of factors like increased irrigation development, improved water management and food security measures have reduced the deaths caused by droughts and famines considerably. Floods, cyclones, and earthquakes dominate (98%) the reported injuries, with ever increasing in the last ten years. The period from 1973 to 1997 has been associated with a large number of earthquakes in Asia that have a relatively high injury-to-death ratio. Floods, droughts, cyclones, earthquakes, landslides and avalanches are some of the major natural disasters that repeatedly and increasingly affect India. The fast pace of growth and expansion without comprehensive understanding or preparedness has brought forth a range of issues that seek urgent attention at all levels. In the absence of such measures, the growing numbers in our population are at risk of prospective hazards such as air accidents, rail accidents, road accidents, boat capsizing, building collapse, electric fires, festival related disasters, oil spills, serial bomb blasts, and fires. The safeguards within the existing system are limited and the risk involved is high.

1.1.3 HAZARD PROFILE OF HIMACHAL PRADESH

Mountain areas are highly vulnerable to natural disasters where development over the years has compounded the problem by upsetting the natural balance of various physical processes. The increased pressure on the mountain environment has contributed in some measure to environmental problems such as landslides, land subsidence, removal of vegetation and soil erosion. According to one estimate, about 58.36% of the land is subjected to intense soil erosion, the majority of which is located in the Himalaya.

The State of Himachal Pradesh, which forms part of the Western Himalaya, is environmentally fragile and ecologically vulnerable. Geologically the Himalaya is considered to be the youngest mountain chain in the world and is still in the building phase. Natural hazards are a matter of immediate concern to the State of Himachal Pradesh, as every year the State experiences the fury of nature in various forms like landslides, cloud bursts, flash floods, snow avalanches and droughts etc. The fragile ecology of the mountain state coupled with large variations in physio-climatic conditions has rendered it vulnerable to the vagaries of nature. The incidence of cloudbursts in the last few years has been unprecedented. Notwithstanding, the continuous efforts made by the Government to cope with natural hazards through relief and rehabilitation measures, landslides and snow avalanches continue to inflict widespread harm and damage to human life as well as property. The roads that are the State's lifeline are repeatedly damaged, blocked or washed away by one or other acts of nature. In these circumstances, the Government has to divert the already scarce resources of the state for relief and rehabilitation measures.

Himachal Pradesh is vulnerable to 25 out of 33 types of hazards identified by the High Powered Committee (HPC) of Government of India and categorised into 5 subgroups. Apart from identified hazards by HPC, the state is also confronting the emerging threats of climate change and man and animal conflict. Some of the identified hazards or prognostic hazards in Himachal Pradesh are as under:



1.1.4 District Wise Hazard Vulnerability of the State:

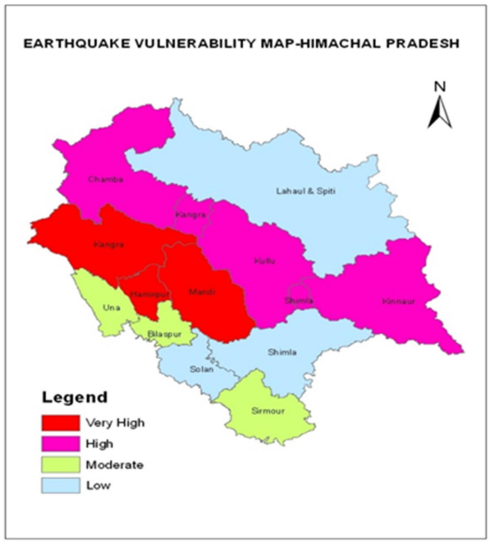
An attempt was made to develop a vulnerability matrix for the state as a whole. Qualitative weight age was given in the scale of 0-5 for different hazards such as earthquakes, landslides, avalanches, industrial hazards, construction type and density of population. District wise matrix was prepared by evaluating the risk severity. The evaluation also gives weight age to the density of population likely to be affected. The matrix also includes the evaluation of hazards likely to be induced on account of development of projects such as hydel projects, roads industries etc. In case of earthquake vulnerability, the districts Kangra, Hamirpur and Mandi fall in a very high vulnerable category on the basis of the matrix devised. The districts which falls in high earthquake vulnerability are Chamba, Kullu, Kinnaur and part of Kangra and Shimla districts, whereas the moderate and low vulnerable districts are Una, Bilaspur ,Sirmour and Solan, Shimla and Lahaul & Spiti districts respectively. The landslide vulnerability in case of Chamba, Kullu, Kinnaur and part of Kangra and Shimla districts is high followed by Kangra, Mandi, Bilaspur, Shimla, Sirmour and Lahaul & Spiti districts falling in moderate vulnerable category. The areas falling in the low vulnerable category are in the districts of Una, Hamirpur and Solan. The avalanche hazard vulnerability map suggests that the districts of Lahaul & Spiti and Kinnaur are very highly vulnerable followed by Chamba, Kullu and part of Kangra and Shimla as moderate vulnerable areas whereas the remaining districts fall in the category where avalanche hazards are nil. The flood hazard vulnerability map indicates that the areas falling in the districts of Chamba, Kullu ,Una and Kinnaur falls in high vulnerable districts where as the Lahaul & Spiti, Mandi, Shimla , Kangra,Hamirpur, Bilaspur, Solan and Sirmaur falls in moderate and low vulnerability areas. The overall vulnerability of the state on the basis of the matrix clearly suggests that the district Chamba, Kinnaur Kullu and part of Kangra and Shimla falls in very high vulnerable risk. Similarly district Kangra, Mandi, Una ,Shimla and Lahaul and Spiti falls in high vulnerable risk status. The districts Hamirpur, Bilaspur, Solan and Sirmaur fall in moderate vulnerable risk status. The disaster management strategies and infrastructure required to be evolved by taking the above factors into consideration.

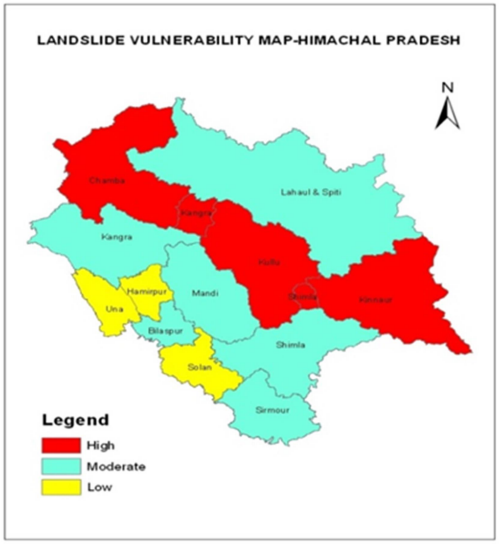
Table: District Wise Vulnerability Matrix

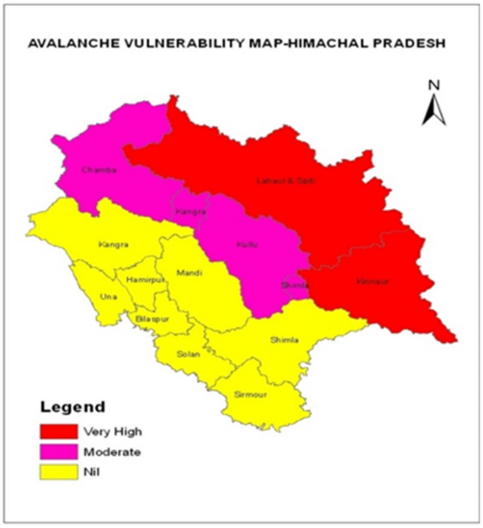
DISTRICT	EARTHQUAKE	LANDSLIDE	FLOODS	AVALANCHES	INDUSTRIAL	OVERALL VULNEABILITY
Kangra	VH	M	L	-----	M	H
Chamba	H	H	H	M	M	VH
Hamirpur	VH	L	L	-----	-----	M
Mandi	VH	M	M	-----	-----	H
Kullu	H	H	H	M	H	VH
Bilaspur	M	M	L	------	M	M
Una	M	L	H	------	H	H
Sirmour	M	M	L	-------	H	M
Solan	L	L	L	-------	H	M
Kinnaur	H	H	H	VH	H	VH
L&Spiti	L	M	M	VH	-------	H
Shimla	L	M	M	--------	H	H

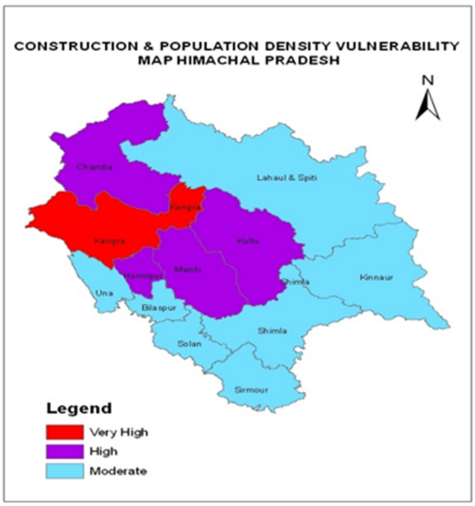
VH: Very High, H: High, M: Moderate, L: Low

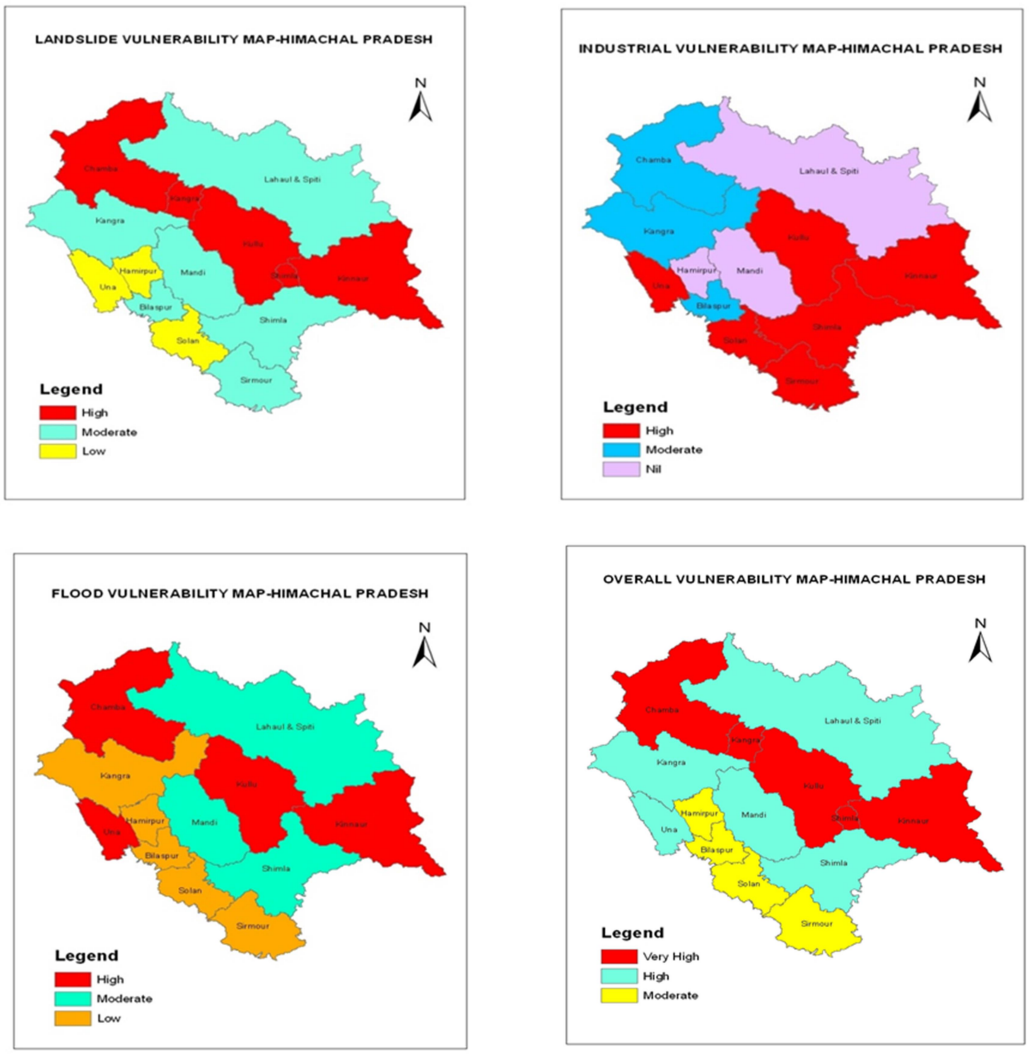
Source : State Council for Science Technology & Environment Analysis


EARTHQUAKE VULNERABILITY MAP-HIMACHAL PRADESH
N
Chamba
Lahaul & Spiti
Kangra
Kangra
Kullu
Hamirpur
Mandi
Shimla
Kinnaur
Una
Bilaspur
Shimla
Solan
Sirmour
Legend
Very High
High
Moderate
Low


LANDSLIDE VULNERABILITY MAP-HIMACHAL PRADESH
N
Chamba
Lahaul & Spiti
Kangra
Kangra
Kullu
Hamirpur
Mandi
Shimla
Kinnaur
Una
Bilaspur
Shimla
Solan
Sirmour
Legend
High
Moderate
Low


AVALANCHE VULNERABILITY MAP-HIMACHAL PRADESH
N
Chamba
Lahaul & Spiti
Kangra
Kangra
Kullu
Hamirpur
Mandi
Shimla
Kinnaur
Una
Bilaspur
Shimla
Solan
Sirmour
Legend
Very High
Moderate
Nil


CONSTRUCTION & POPULATION DENSITY VULNERABILITY MAP HIMACHAL PRADESH
N
Chamba
Lahaul & Spiti
Kangra
Kangra
Kullu
Hamirpur
Mandi
Shimla
Kinnaur
Una
Bilaspur
Shimla
Solan
Sirmour
Legend
Very High
High
Moderate



District Wise Hazard Vulnerability of the State (Source : HIMCOSTE)

1.1.5 BACKGROUND OF THE EVENTS

In 2023, Northern India was hit hard by a torrent of monsoon rains in combination with western disturbances, leading to extensive flooding and landslides. Among the affected regions, Himachal Pradesh was particularly impacted, marking this as one of its most challenging monsoon seasons in recent memory. Himachal Pradesh, with its hilly terrain and river valleys, is no stranger to the annual monsoons. However, the convergence of an intensified monsoon coupled with a western disturbance during this year brought about rainfall levels not seen in decades. This exceptional downpour caused several rivers within the state to swell beyond their usual bounds, wreaking havoc in both urban and rural areas.

In various parts of Himachal Pradesh, roads and bridges, many of which served as crucial links between remote villages and larger towns, were washed away. Numerous vehicles were caught in the surging waters, leading to immense damage and loss. The state's infrastructure, especially power and electricity services, faced severe disruptions, leaving many residents in the dark and disconnected from essential services.

July stood out as a particularly grim month for Himachal Pradesh. Over a mere two-week period, torrential rains and subsequent floods claimed the lives of a significant number of people. Relief and rescue operations became imperative, and thousands found themselves being evacuated from their homes, only to seek temporary shelter in hastily set up relief camps. Given the widespread devastation, the state authorities decided to shut down schools and educational institutions to prioritise safety.

In July 2023, the IMCT team assessed significant damage in Himachal Pradesh due to floods. This led the state government to request support from NDMA for a comprehensive Post Disaster Needs Assessment (PDNA). Discussion was initiated on July 25th, 2023, outlining guidelines (Terms of Reference).

1.1.6 FLOODS AND LANDSLIDE -2023

Due to the diverse topography of the area, the flood problem in the state is largely isolated in nature. The monsoon, apart from acting as the lifeline in the young, lofty, and fragile mountain belt of the Himalaya, becomes a potential cause for disturbing slope stability, inflicting heavy loss of life, and damaging Government, private, and public property. High monsoon rains in the areas of the Shiwalik and Lower and Mid Himalayan ranges cause extensive floods during the rainy season. In the upper reaches of the Beas and Satluj valleys, the main problems are flash floods and bank erosion because of the steep slopes of rivers and High River flows due to heavy rains. Often, flash floods caused by cloudbursts and temporary blockages of the river channels have also been observed. Extremely high-intensity rainfall events over a short period of time, or 'cloudbursts', as they may be called, are a natural phenomenon in the Himalaya and have been found to be a dominant factor in causing extensive damage in different parts of the State during the monsoon period every year.

During the current monsoon period of 2023, the State witnessed three different spells of very high precipitation during 7-11 July 2023 (Ist spell), 11-14 August 2023 (IInd spell) and 21-23 August 2023 (IIIrd spell) causing widespread damage across the State. From July 7th to 11th, 2023, Himachal Pradesh experienced intense monsoon activity, resulting in widespread, heavy to extremely heavy rainfall across most of the state[1]. Historically, during the monsoon season (June-September) from 1971-2020, the state averaged a rainfall of 734.4 mm. remarkably, in just four days, from July 7th to 11th, 2023, the state recorded 223 mm of rainfall, a staggering 436% above the typical amount of 41.6 mm for such a period. This surge in rainfall was unprecedented according to historical data. Every district in the state recorded excessive rainfall, with Kinnaur, Kullu, and Solan receiving the

[1]https://mausam.imd.gov.in/Forecast/mcmarq/mcmarq_data/Press%20release%20for%20Unprecedented%20Rainfall(07th%20to%2011th%20July.pdf

most. In particular, Kinnaur and Lahaul Spiti received 43% and 33%, respectively, of their average seasonal rainfall in these four days—a record high. A detailed district-by-district rainfall breakdown for this period is provided in a table below. The heavy rainfall caused significant damage, including overflowing rivers, road obstructions, landslides, flash floods, bridge damage, and total disruptions to electricity and communication. Furthermore, there were tragic losses of life. The state has also witnessed the second wave of rainfall from 14th to 20th August 2023, which has impacted the other districts, Hamirpur, Kangra, Una, Lahaul- Spiti, Sirmaur and Bilaspur.

The district wise precipitation received during the different spells is as under:-

Cumulative district wise rainfall ((7th to 11th July 2023)

DISTRICT	ACTUAL(in mm)	NORMAL(in mm)	DEPARTURE (in %)
BILASPUR	335.9	44.5	655
CHAMBA	207.9	49.6	319
HAMIRPUR	258.7	49.2	426
KANGRA	225.3	93.7	140
KINNAUR	107.6	11.2	861
KULLU	280.1	30.7	812
LAHAUL & SPITI	124.8	21	494
MANDI	245.5	68.2	260
SHIMLA	268.9	35.4	660
SIRMAUR	514	67.9	657
SOLAN	472.6	52	809
UNA	265.3	49	441
HIMACHAL PRADESH	223	41.6	436

Cumulative district wise rainfall during 11th to 14th August 2023

DISTRICTS	ACTUAL (in mm)	NORMAL (in mm)	DEPARTURE(in%)
BILASPUR	235.1	56.5	316
CHAMBA	37.6	41.4	-9
HAMIRPUR	328.4	86.1	281
KANGRA	309.9	98.3	215
KINNAUR	5.8	12	-52
KULLU	60.7	31.9	90
LAHAUL & SPITI	3	15.5	-80
MANDI	365.2	70.8	416
SHIMLA	123.8	31.9	288
SIRMAUR	93.6	66.3	41
SOLAN	194	54.1	259
UNA	112.8	80.3	40
HIMACHAL PRADESH	107.2	41.7	157

Cumulative district wise rainfall (21-23 August 2023)

NAME	ACTUAL	NORMAL	DEP
HIMACHAL PRADESH	36.2	21.1	72
BILASPUR	155.2	21	639
CHAMBA	11.7	21.1	-45
HAMIRPUR	138.9	31.3	344
KANGRA	85.6	55.3	55
KINNAUR	0	6.4	-100
KULLU	7	14.4	-51
LAHAUL & SPITI	0	9.3	-100
MANDI	111	33.8	228
SHIMLA	38.6	18.6	107
SIRMAUR	29.7	32.3	-8
SOLAN	124.3	22.5	452
UNA	73.3	31.9	130
SUBDIVISION RAINFALL	36.2	21.1	72

1.1.7 Rainfall Trend Analysis in Himachal Pradesh

In order to supplement the view of heavy precipitation during 2023, the rainfall analysis for the state of Himachal Pradesh was also carried out using the available IMD data from 2014-2023 during the period April to August each year. The rainfall data at five locations Mandi, Shimla, Bhuntar, Kangra and Kalpa in district Kinnaur

has been used to validate and to quantify the rainfall data at these locations in H.P. Based on the analysis carried out, the following inferences were made:

- A large variation was recorded in the summer precipitation during the period 2014-2023 i.e in April 2023, the rainfall recorded was on a higher side in 2023 than the preceding years. In April 2014 (33.00mm) whereas in 2023 it increased to 185.20 mm at Mandi.

- Likewise in May 2014, the rainfall recorded at Mandi was 76.50 mm (2014) whereas in 2023 (253.80 mm) with a few variations i.e. 2021(104.80 mm) and 2022(150.80 mm) respectively.

- In June, the rainfall recorded at Mandi varies from 155.50 mm (2014) to 286.80 mm (2023) with high rainfall during 2017 (220.50) ,2020 (190.70) ,2021 (112.30) respectively and the variation is mainly due to arrival of monsoon which generally arrives Himachal in the month of June.

- July is the peak monsoon month and the rainfall varies from 414.60 mm (2014) to 528.70 mm (2023) with a comparatively more rainfall in 2022 (571.80 mm) than 2023.

- Likewise, similar trend of rainfall was recorded at Shimla i.e from April to August, the rainfall varies from 62.90 mm (April 2014) to 47.60 mm (August 2014) where as in 2023 it varies from 221.40 mm (April 2023) to 552.10 mm (August 2023) respectively.

- Likewise, at Bhuntar during 2023, the rainfall varies from 396.70 mm (April) to 138.50 mm (May) to 86.50 mm (June) to 257.10 mm (July) to 134.10 mm (August) which is comparatively more in summer months April and May 2023 than the preceding years.

- In Kangra, a similar increasing trend was observed in 2023 which varies from 122.30 mm (April) to 213.20 mm (May) to 336.00mm (June) to 595.20 mm (July) to 628.30 mm (August) in comparison to the preceding years.

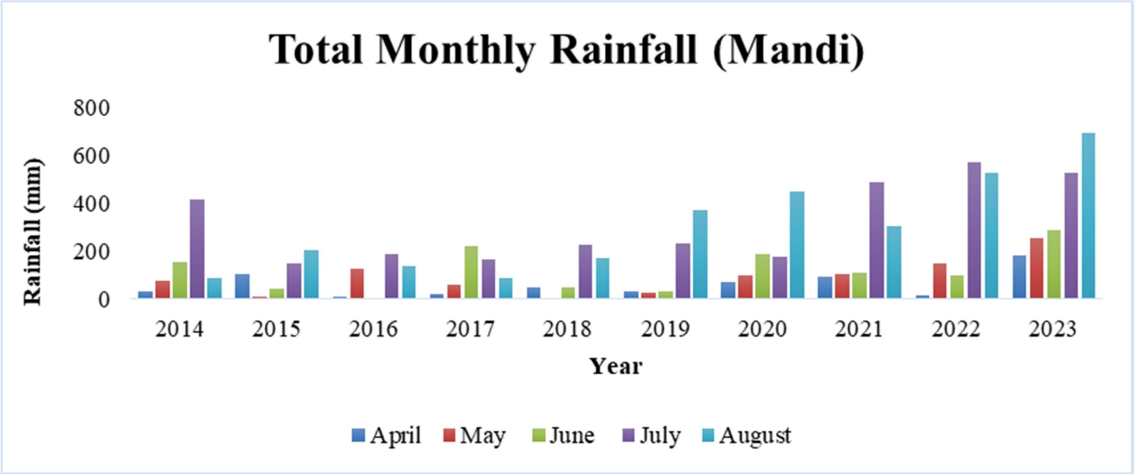
- At Kalpa which is on eastern side of the state and also falls on the rain shadow zone, the recorded rainfall in 2023 has varied from 120.80 mm (April) to 82.60 mm (May) to 31.20mm (June) to 196.60 mm9 July) to 14.6 mm (August) respectively and is on the higher side than the preceding years except a few exceptions.

- In other words, we can say that during 2023, the rainfall was on a higher side even in the summer months in April & May in the state and at these stations with very high rainfall during peak monsoon months i.e., July and August.

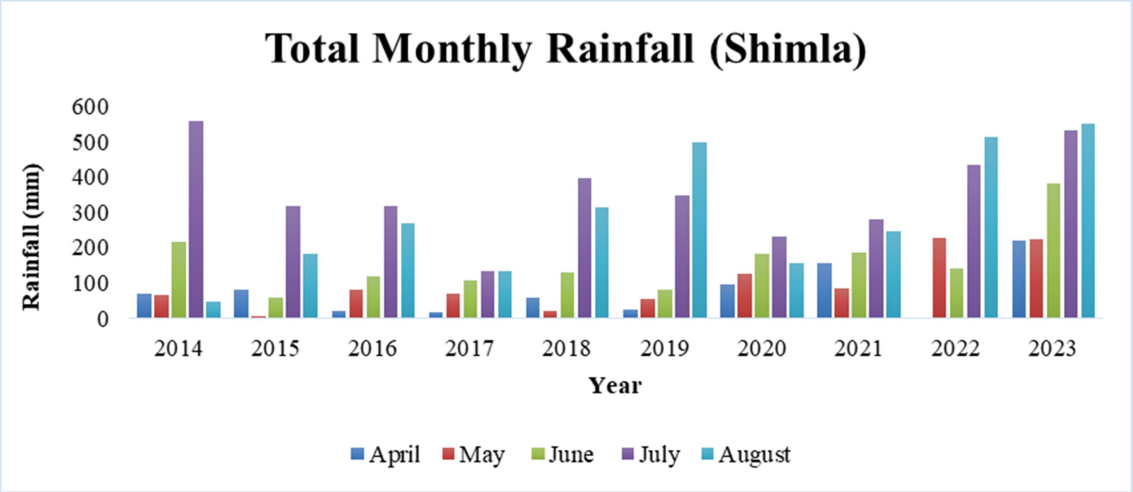
- On the other hand, it is also seen that by and large the number of rainy days have been reduced in 2023 and the rainfall has increased indicating heavy spells during 2023.

Rainfall Trend Analysis

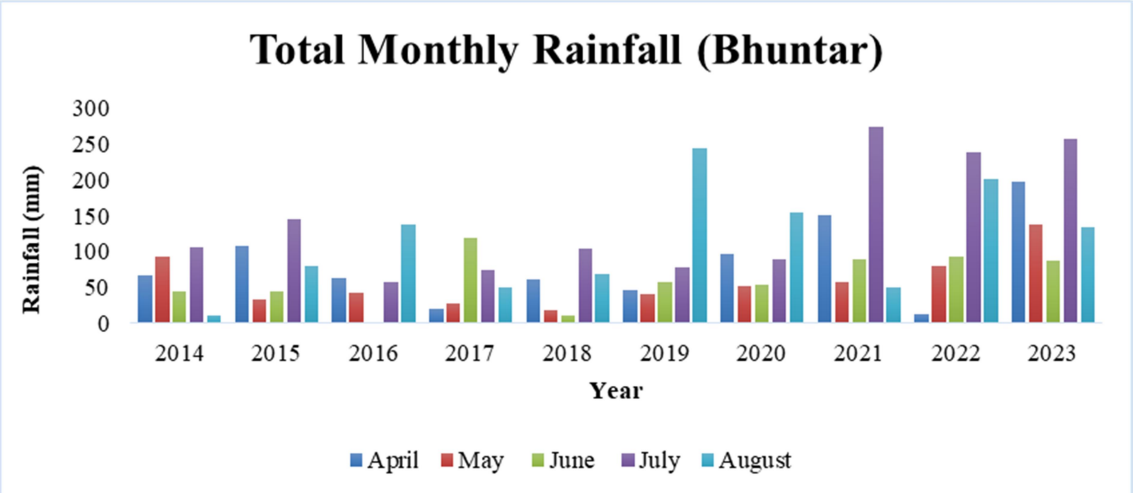
Rainfall Mandi (Monthly Rainfall)										
Year	No. of Rainy Days (April)	Total Monthly Rainfall (April)	No. of Rainy Days (May)	Total Monthly Rainfall (May)	No. of Rainy Days (June)	Total Monthly Rainfall (June)	No. of Rainy Days (July)	Total Monthly Rainfall (July)	No. of Rainy Days (August)	Total Monthly Rainfall (August)
2014	4	33.00	8	76.50	10	155.40	21	414.60	10	89.60
2015	8	105.10	1	9.40	9	41.60	12	150	15	204.40
2016	2	11.90	7	127.00	0	0	12	185.70	10	138.90
2017	2	20.20	4	60.40	9	220.50	12	164.80	9	87.30
2018	3	47.10	1	6.20	3	51.6	14	229.60	11	173.4
2019	4	32.60	3	28.50	5	33.60	18	232.30	20	372.60
2020	8	73.90	9	97.50	16	190.70	13	176.50	19	451.00
2021	5	93.60	12	104.80	13	112.30	23	485.80	22	305.40
2022	5	13.20	18	150.80	9	96.40	24	571.80	20	525.40
2023	14	185.20	18	253.80	15.00	286.80	27	528.70	17	693.7



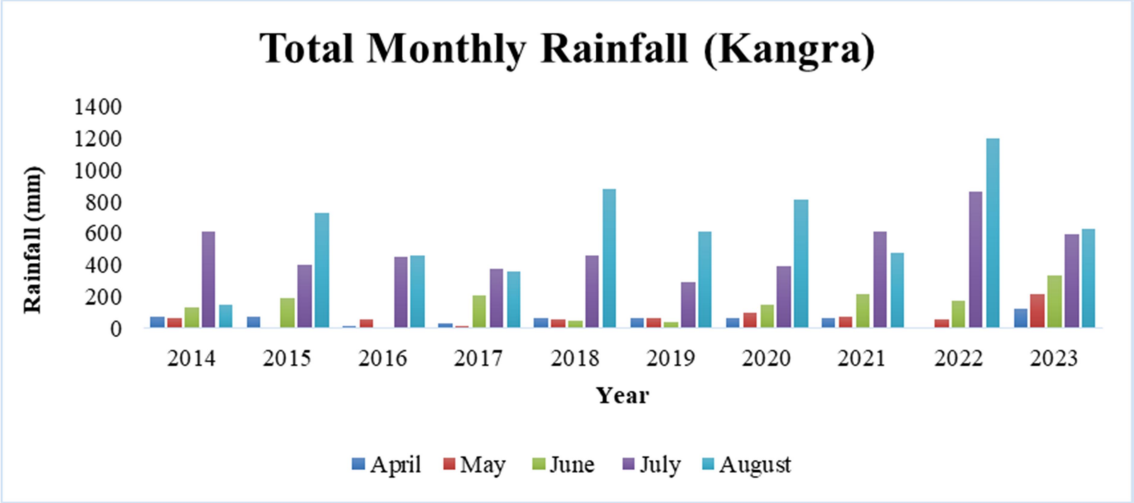
Rainfall Shimla (Monthly Rainfall)										
Year	No. of Rainy Days (April)	Total Monthly Rainfall (April)	No. of Rainy Days (May)	Total Monthly Rainfall (May)	No. of Rainy Days (June)	Total Monthly Rainfall (June)	No. of Rainy Days (July)	Total Monthly Rainfall (July)	No. of Rainy Days (August)	Total Monthly Rainfall (August)
2014	7	68.90	11	65.00	13	218.00	22	560.10	8	47.40
2015	12	81.70	2	1.50	13	58.10	18	317.80	17	182.70
2016	4	21.10	6	81.50	9	118.80	18	316.50	17	267.20
2017	3	16.20	8	68.40	11	105.20	14	133.70	10	134.80
2018	8	56.20	7	20.60	5	128.50	19	398.50	14	313.70
2019	4	24.50	9	54.90	10	79.50	24	346.20	25	499.00
2020	10	94.20	13	124.00	11	183.20	22	232.90	22	156.90
2021	5	156.50	13	86.20	16	186.00	21	281.40	22	246.40
2022	0	0.00	14	227.40	14	139.50	28	433.90	27	514.30
2023	14	221.40	18	225.40	21	383.60	30	530.70	20	552.1



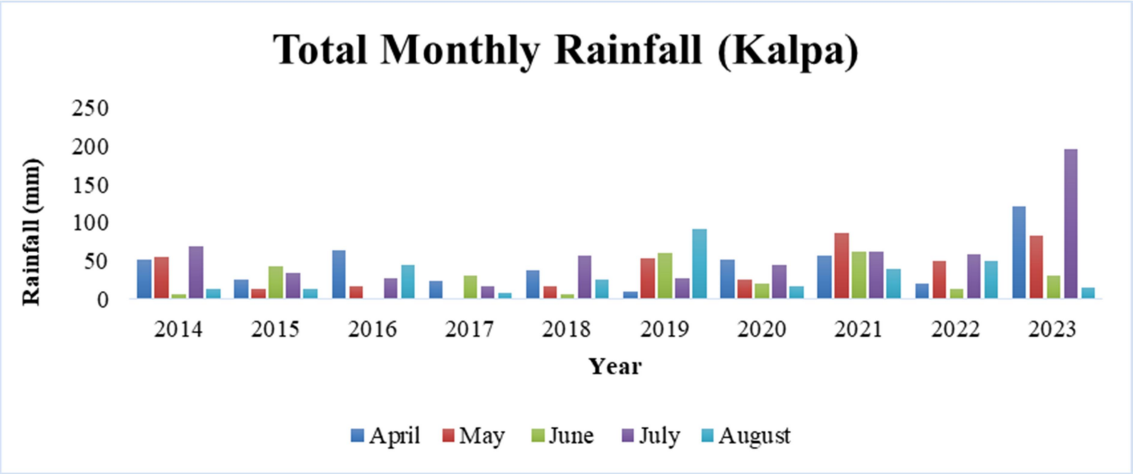
Rainfall Bhuntar (Monthly Rainfall)										
Year	No. of Rainy Days (April)	Total Monthly Rainfall (April)	No. of Rainy Days (May)	Total Monthly Rainfall (May)	No. of Rainy Days (June)	Total Monthly Rainfall (June)	No. of Rainy Days (July)	Total Monthly Rainfall (July)	No. of Rainy Days (August)	Total Monthly Rainfall (August)
2014	8	66.10	12	92.8	10	44.50	13	106.80	4	10.5
2015	11	108.40	3	33.10	13	43.80	10	146	14	80.60
2016	4	62.60	6	42.10	0	0	15	57.10	15	137.00
2017	2	20.4	7	27.90	10	118.70	11	74.50	10	50.50
2018	9	61.40	6	17.50	4	11.1	14	104.10	9	69
2019	6	45.40	8	40.00	11	56.60	13	77.30	20	243.30
2020	16	96.90	13	52.60	12	52.8	16	88.70	17	153.90
2021	7	150.40	14	57.60	11	89.40	19	274.70	12	50.30
2022	9	13.40	17	80.00	15	92.30	26	239.30	18	201.90
2023	14	196.70	17	138.50	15	86.50	19	257.1	7	134.1



Rainfall Kangra (Monthly Rainfall)										
Year	No. of Rainy Days (April)	Total Monthly Rainfall (April)	No. of Rainy Days (May)	Total Monthly Rainfall (May)	No. of Rainy Days (June)	Total Monthly Rainfall (June)	No. of Rainy Days (July)	Total Monthly Rainfall (July)	No. of Rainy Days (August)	Total Monthly Rainfall (August)
2014	6	71.10	6	59.10	9	132.30	22	606.90	10	145.00
2015	7	69.20	0	0.00	9	186.70	17	399.20	20	731.00
2016	2	10.00	6	55.30	0	0	19	450.30	12	456.00
2017	2	31.20	3	12.10	10	209.40	15	377.90	11	359.10
2018	8	60.00	5	50.80	4	44.4	20	461.90	15	881
2019	3	63.50	7	59.90	9	40.10	22	288.80	22	608.80
2020	10	62.70	10	98.00	14	147.40	21	387.80	24	814.60
2021	6	64.30	14	74.00	13	216.80	23	609.30	26	477.30
2022	3	2.80	12	56.90	12	175.00	30	863.80	23	1196.00
2023	12	122.30	16	213.20	19	336.00	28	595.50	22	628.3



Rainfall Kalpa (Monthly Rainfall)										
Year	No. of Rainy Days (April)	Total Monthly Rainfall (April)	No. of Rainy Days (May)	Total Monthly Rainfall (May)	No. of Rainy Days (June)	Total Monthly Rainfall (June)	No. of Rainy Days (July)	Total Monthly Rainfall (July)	No. of Rainy Days (August)	Total Monthly Rainfall (August)
2014	9	51.60	9	55.30	5	7.00	11	69.30	6	12.90
2015	8	25.00	7	13.50	11	42.90	11	34.20	11	13.90
2016	5	64.40	8	17.00	0	0.00	9	28.20	16	44.60
2017	3	23.80	3	1.80	7	30.60	14	16.60	6	7.60
2018	9	38.20	5	16.40	3	7.2	15	57.80	6	25.2
2019	5	10.70	10	53.50	11	59.80	15	26.80	20	91.20
2020	15	51.00	13	25.40	12	21.00	13	44.90	13	17.80
2021	8	56.20	12	87.20	18	62.00	18	62.00	11	39.60
2022	14	20.20	13	50.60	9	14.20	19	58.40	17	50.90
2023	17	120.80	19	82.60	12	31.70	22	196.60	5	14.6



Himachal Pradesh's unique and diverse topographical layout ensured that the recent deluge impacted its regions - high, middle, and lower - in distinct manners. The HPSDMA's report offers a comprehensive glimpse into the scale of these climatic challenges. Over 5,400 landslides were recorded, indicating significant soil erosion and potential long-term ecological implications. Himachal Pradesh, also suffered with 45 Cloudburst and 83 flash floods like situation causing massive devastation across the state.

District wise report on Flash Floods		
Sr No	**District Name**	**Total (Nos.)**
1.	**Bilaspur**	**01**
2.	**Chamba**	**04**
3.	**Hamirpur**	**01**
4.	**Lahaul Spiti**	**25**
5.	**Kangra**	**01**
6.	**Kullu**	**20**
7.	**Kinnaur**	**12**
8.	**Mandi**	**10**
9.	**Una**	**01**
10.	**Shimla**	**05**
11.	**Sirmour**	**03**
Total		**83**

It was observed that the higher altitudes of Himachal Pradesh were especially vulnerable to cloudbursts and sporadic landslides across various hills. Cloudburst causes sudden and intense rainfalls that can cause swift devastation. These cloudbursts were the trigger behind the numerous landslides of varying sizes. Landslides, often caused by the saturation of the ground and destabilisation of slopes, posed immediate threats to transportation, infrastructure, and lives. Their aftermath can linger, making areas prone to further disasters and hampering relief and recovery operations. The middle and lower terrains faced the wrath of flash floods. Flash floods, rapid and

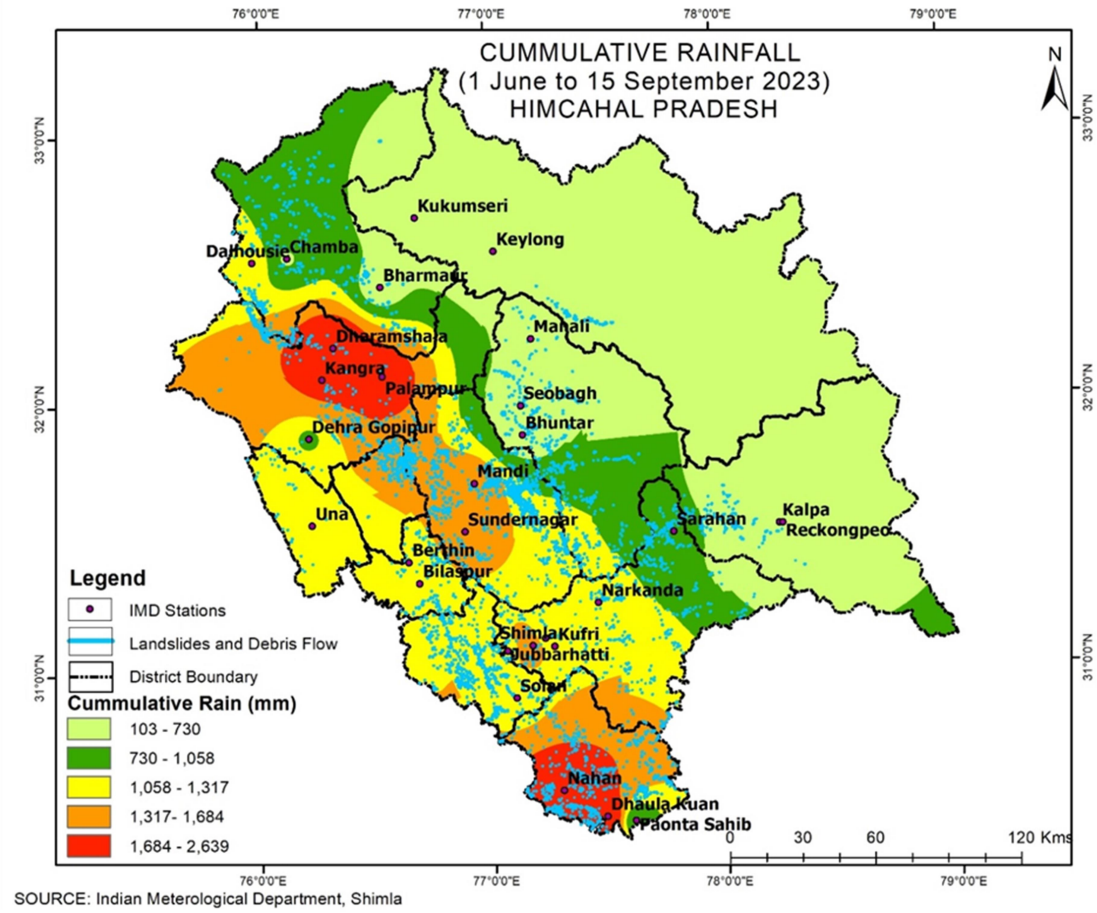
intense inundations, can be particularly challenging in hilly areas. Swift-flowing water, carrying debris and silt, threatens not just human settlements but also agriculture and local ecosystems.

Unregulated development in Himachal Pradesh, in the fragile mountainous ecosystems, has added to the vulnerability of the himalayan region creating a cascade of environmental and infrastructural challenges, amplifying the disaster risks in the region. The drive for urbanisation and tourism has led to rapid construction activities. Often, these constructions ignore essential guidelines, leading to establishments on unstable slopes or floodplains. Such development comprises the natural drainage systems and makes areas susceptible to landslides, particularly during the monsoon seasons.

Additionally, the state's increasing road networks, while essential for connectivity, sometimes cut across ecologically sensitive zones. The removal of vast green covers and digging into heels without proper safeguards often destabilise the terrain, intensifying the threat of landslides. Moreover, the unchecked growth of settlements around river banks and valleys, driven by tourism and a growing population, puts many at direct risk during flash floods. Water channels, which should act as natural outlets, are often encroached upon, leading to a higher vulnerability during heavy rainfalls.

The Government of Himachal Pradesh undertook a rigorous assessment to gauge the extent of damages in the aftermath of the recent climatic adversities. Utilising pre- and post-disaster satellite imagery, the evaluation brought forth some striking revelations regarding the vulnerability of civil infrastructures, prominently roads, buildings, and other constructions.

Using satellite data for the month of September /October 2022 and April /May 2023 before the monsoon period and satellite data for the month of July/August 2023 as the post event has been used for investigation purposes. All the landslides/ slips and debris flow that have been mapped from the satellite data used during investigation are mainly the rainfall triggered during the month of July/August 2023. Total number of landslides mapped in each district along with the total rainfall and rainfall deviation (%) from normal for each district during 1st June to 15th September, 2023 has been shown in the Table 1 (Source: IMD). The brief details of all landslides along with their total affected area in each district is as under:

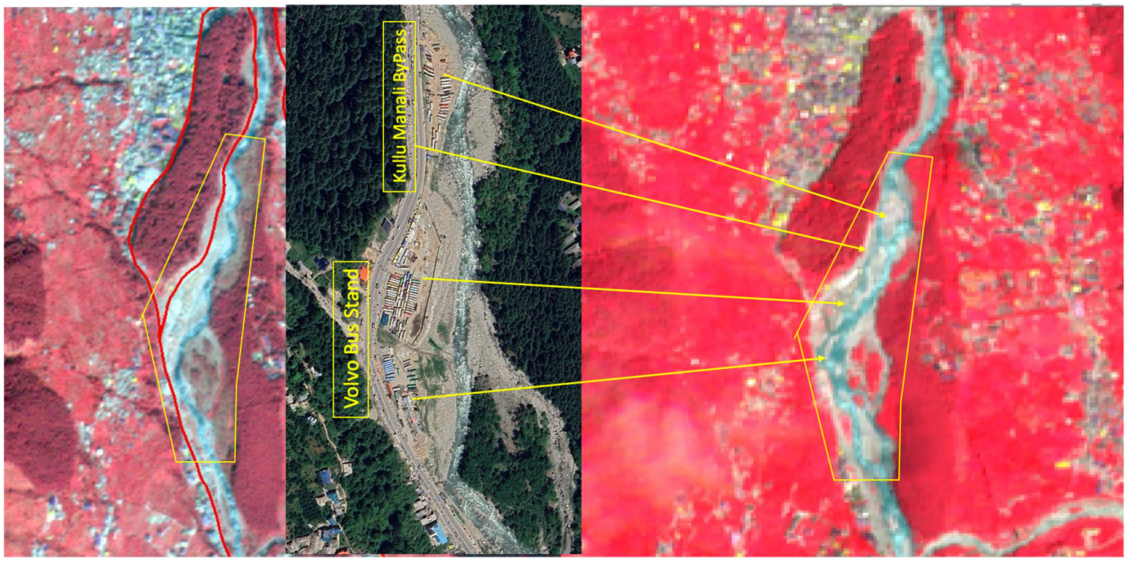


SOURCE: Indian Meterological Department, Shimla

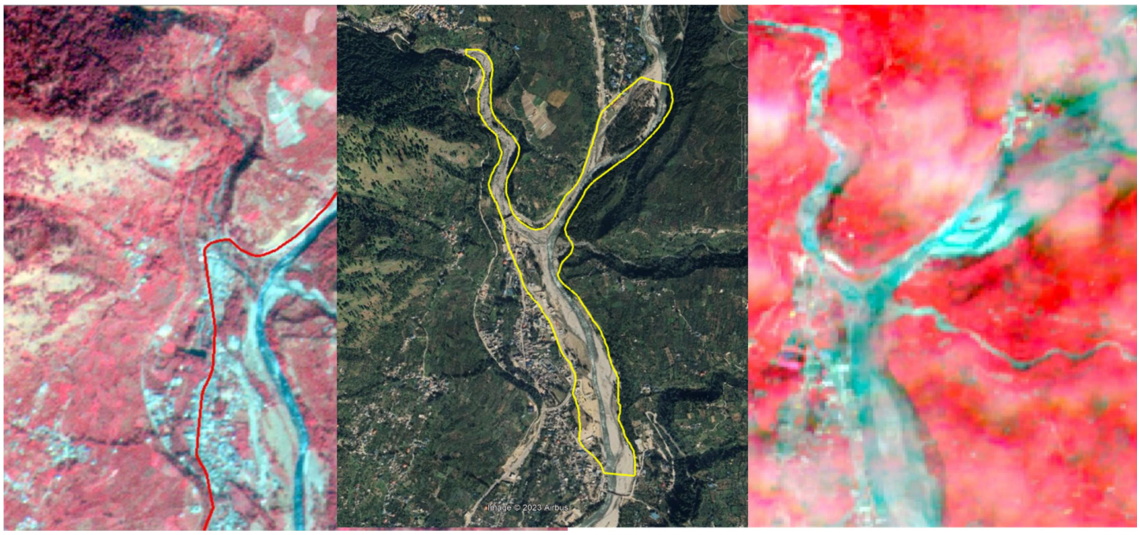
District	Total No. of Landslide	Total area of landslides (SqKm^2)	Rainfall (mm) (Ist June to 15 September 2023)	Deviation from normal rainfall (%)
Bilaspur	172	1.14	1258.4	62
Chamba	437	7.36	852.9	6
Hamirpur	287	1.39	1298.9	40
Kangra	366	2.3	1671.5	8
Kinnaur	144	2.48	267.1	21
Kullu	634	4.73	755.7	49
Lahaul & Spiti	56	1.33	209.5	-39
Mandi	1257	10.4	1525.5	45
Shimla	644	3.79	1001.3	71
Sirmour	924	6.35	1642.5	46
Solan	787	3.92	1455	77
Una	40	0.25	865.4	-5
Total	5748	45.44	840.6	22

The satellite images were also used to assess damage along the river channels in different basins based on pre and post disaster satellite data analysis. The drainage analysis reveals that most of the destruction that occurred along the Beas river in Kullu district was mainly due to overflow of the

water along the palaeo channels following the old river course along which the developmental activities have taken place. The observed damage from the different satellite images is as per the following figures:-



IRS, R2 -LISS IV 95/48, 31st October 2017 Sentinel 2A, 13th July 2023



1.2 Post Disaster Needs Assessment : Scope and Methodology

The state of Himachal Pradesh faced unprecedented rains during 26th June -11th July 2023 and from August 14th to August 20th leading to floods and landslides across 12 districts in the State. During this disaster, more than 500 people lost their lives and the state suffered severe damages to housing, civic infrastructure, and other economic losses. In order to make broad assessments of the damages, the IMCT team made a visit to the state from 19-21 July and thereafter from 27—29 September 2023 to the affected areas. As per the initial finds from the IMCT team, it is understood that the state has reported damages primarily by Irrigation and Public Health Department, Power Department and Public Works Department. Other damages include housing, agriculture and other infrastructure from Rural Development and Urban Development Departments.

In order to undertake Recovery and Reconstruction in the disaster-affected areas of the State, the State of Himachal Pradesh requested technical assistance from NDMA to conduct Post Disaster Needs Assessment (PDNA), through letter No.l RV (DMC) (F)-2-2/2023 dated 25th July 2023. In reference to the letter, the Terms of Reference are prepared to establish the process, sector, and timelines for conducting PDNA.

1.2.1 Objectives

The objective of the PDNA is to assess the damages due to the flood in Himachal Pradesh and define a strategy for recovery including its financial costs.The specific objectives of the PDNA could be as follows are:

- Estimate the overall impact of the event on the socio-economic development of the country at the national level and on affected states and communities;
- Assess the effects and impacts of the disaster to develop a Recovery Strategy the early, medium and long term recovery and reconstruction needs with costs and a timeline in one consolidated report.
- Ensure that strategies for recovery integrate concepts of disaster risk reduction and "build back better" and address gender and environmental concerns;
- Developing a recovery strategy is representative of the needs and priorities of the affected communities.
- Recommend and define a strategy for Disaster Risk Management.
- Recommend institutional mechanisms and policy options to be undertaken in support of the recovery and reconstruction process and that promote long term disaster resilience.

1.2.2 METHODOLOGY

The methodology for the PDNA in Himachal Pradesh involved several phases and activities to comprehensively understand the damage, need and the risks in the region. Here's a detailed elaboration of each phase:

- Orientation Workshop (August 8th, 2023): The PDNA commenced with an orientation workshop, jointly organised by the Himachal Pradesh State Disaster Management Authority (HPSDMA) and the National Disaster Management Authority (NDMA). During this workshop, templates and assessment guidelines were disseminated to the relevant line departments responsible for data collection and assessments in their respective sectors. Additionally, these templates were shared with administrative heads of the districts to ensure a coordinated effort.
- Data Collection and Field Visit (Phase 1): Following the orientation workshop, teams were deployed to six selected districts in the first phase of data collection and field visits. These teams were tasked with gathering on-ground information related to damage and recovery needs.
- Submission of Interim Report (Phase 1): After completing the first phase of data collection and field visits, an interim report and an executive summary were prepared and submitted. This initial report likely provided a preliminary overview of the PDNA
- Challenges with Subsequent Flood Waves: Following the first phase of the assessment, Himachal Pradesh faced a second and third wave of floods and landslides. These subsequent disasters had a significantly worse impact on the state's infrastructure, services, and housing conditions. The increased devastation underscored the importance of an extensive and detailed assessment.
- Redevelopment of Templates (Phase 2): In response to the evolving disaster situation and based on the lessons learned from the first phase, it was decided to expand the scope of the assessment to cover all 12 districts of the state. To facilitate this broader assessment, the templates for data collection were re-engineered into a digital format using Kobo tools. This digital transformation enhanced data granularity and facilitated more in-depth analysis
- Data Collection, Analysis, and Report Writing (Phase 2): In the second phase, grassroots functionaries were trained to use the Kobo tools for data collection. This phase aimed to

gather detailed, granular data that could be used for comprehensive analysis. Sectoral experts reviewed and analysed the collected data, contributing to a deeper understanding of disaster impacts across all districts

- Presentation by NDMA and Discussion on DRR Measures: Following the data analysis and report writing phase, the NDMA made a presentation summarising their findings. Along with the presentation team from NDMA participated in the discussions organised by HPSDMA and HIPA involving various stakeholders from different sectors and levels of government. The goal was to identify and prioritise disaster risk reduction (DRR) measures that needed to be adopted based on the assessment's findings.
- Compilation of the Final Report: The findings, analysis, and recommendations from both phases of the disaster risk assessment were compiled into a comprehensive final report. This report provided a detailed overview of the damage assessment incorporating data from all 12 districts

1.2.3 LIMITATIONS

Limitations of the exercises were observed throughout both phases of the disaster risk assessment process. These limitations encompassed various aspects:

- Adequacy of Data: During the first phase of the assessment, one of the primary limitations was the adequacy of data. The ongoing nature of the disaster, coupled with dynamic and rapidly changing conditions, made it challenging for field functionaries to provide complete and up-to-date information. This limitation hindered the accuracy and comprehensiveness of the initial data collection.
- Complex Data Analysis: In the second phase, the process of updating data and the addition of multiple templates introduced complexities into the data analysis and computation. Handling a larger volume of data, especially when it was collected using various templates and tools, required additional time and resources. This complexity potentially delayed the analysis and reporting stages
- Mobilisation of Sector Experts: Another limitation arose from the division of the assessment into two phases. Mobilising sector experts for the second phase proved to be challenging, as some experts had prior commitments or were unavailable. Consequently, the number of experts engaged in the second phase was reduced, potentially impacting the depth and breadth of sector-specific assessments
- Extended Report Writing: The division of the assessment into two phases also extended the report writing process. With data collection and analysis spanning both phases, compiling and synthesising findings, recommendations, and insights into a final report became a more time-consuming task. This delay in report writing could have implications for the timely dissemination of critical information.

These limitations lead to learning in case of other PDNA exercises with careful planning and coordination to ensure the availability of adequate, up-to-date data, as well as effective mobilisation of sector experts. Additionally, addressing these limitations can help streamline the data collection, analysis, and reporting processes, ultimately enhancing the quality and usefulness of the exercise.

2 Overall Summary of Damage and Loss Assessment

The Post Disaster Needs Assessment (PDNA) was conducted to comprehensively evaluate the impact of the disaster across three primary sectors: Social, Infrastructure, and Productive sectors, with each sector further divided into sub-sectors. The assessment aimed to provide a detailed understanding of the damage, losses, and recovery needs in each area. The overall recovery needs for sectoral damage is estimated to 8667.66 Crore and DRR needs are estimated to 375 crore.

2.1 Social Sector

- Housing: The disaster caused significant damage to housing infrastructure, with an estimated damage of 2,284.34 crore and a loss of 24.57 crore. The combined damage and loss in this sector amounted to 2,308.91 crore. The recovery estimate for housing was 2,353.65 crore.
- Education: Damage in the education sector was estimated at 369.14 crore, with a negligible loss of 0.25 crore, resulting in a combined damage and loss of 369.39 crore. The recovery estimate for education was 369.14 crore.
- Health: The health sector incurred damage worth 182.55 crore, along with a loss of 1.09 crore, leading to a combined damage and loss of 183.64 crore. The recovery estimate for health was 182.55 crore.
- Community Buildings and Amenities: Damage in this sub-sector amounted to 37.04 crore, with no recorded losses. The recovery estimate for community buildings and amenities was also 38.95 crore.
- The total recovery estimate for the Social Sector was 2,944.29 crore.

2.2 Infrastructure Sector

- Roads: The disaster had a significant impact on roads, resulting in damage estimated at 1,506.40 crore and a loss of 126.40 crore. The combined damage and loss for roads amounted to 1,632.80 crore. The recovery estimate for roads was 2,458.30 crore.
- Drinking Water and Sanitation: Damage in this sub-sector was estimated at 1,849.59 crore, with a substantial loss of 818.72 crore, leading to a combined damage and loss of 2,668.31 crore. The recovery estimate for drinking water and sanitation was 2,228.48 crore.
- Power: The power sector incurred damage worth 213.94 crore, along with a loss of 65.62 crore, resulting in a combined damage and loss of 279.56 crore. The recovery estimate for power was 213.94 crore. The total recovery estimate for the Infrastructure Sector was 4,900.72 crore.

2.3 Productive Sector:

- Agriculture: Damage in the agriculture sector was estimated at 7.81 crore, with a substantial loss of 192.20 crore, leading to a combined damage and loss of 200.01 crore. The recovery estimate for agriculture was 200.01 crore.
- Horticulture: Damage in horticulture was estimated at 28.39 crore, with a significant loss of 260.81 crore, resulting in a combined damage and loss of 289.20 crore. The recovery estimate for horticulture was 289.20 crore.

- Animal Husbandry: Damage in this sub-sector amounted to 17.82 crore, with a loss of 35.58 crore, leading to a combined damage and loss of 53.40 crore. The recovery estimate for animal husbandry was 53.40 crore.
- Fisheries: Damage in fisheries was 11.22 crore, with a loss of 4.41 crore, resulting in a combined damage and loss of 15.63 crore. The recovery estimate for fisheries was 15.63 crore.
- Tourism: The tourism sector incurred damage worth 43.83 crore, along with a loss of 220.58 crore, leading to a combined damage and loss of 264.41 crore. The recovery estimate for tourism was 264.41 crore. The total recovery estimate for the Productive Sector was 822.65 crore.

Sector_1	*Sector*	Damage Estimate	Loss Estimate	Damage + Loss	Recovery Estimate
1_Social	1_Housing	2,284.34	24.57	2,308.91	2,353.65
	2_Education	369.14	0.25	369.39	369.14
	3_Health	182.55	1.09	183.64	182.55
	4_Community Buildings and Amenities	38.95	0.00	38.95	38.95
1_Social Total		2,874.98	25.91	2,900.89	2,944.29
2_Infrastructure	1_Roads	1,506.40	126.40	1,632.80	2,458.30
	2_Drinking Water and Sanitation	1,849.59	818.72	2,668.31	2,228.48
	3_Power	213.94	65.62	279.56	213.94
2_Infrastructure Total		3,569.93	1,010.74	4,580.67	4,900.72
3_Productive	1_Agriculture	7.81	192.20	200.01	200.01
	2_Horticulture	28.39	260.81	289.20	289.20
	3_Animal Husbandry	17.82	35.58	53.40	53.40
	4_Fisheries	11.22	4.41	15.63	15.63
	5_Tourism	43.83	220.58	264.41	264.41
3_Productive Total		109.07	713.58	822.65	822.65
4_Disaster Risk Reduction	1_DRR and Environment	0.00	0.00	0.00	375.00
4_Disaster Risk Reduction Total		0.00	0.00	0.00	375.00
Grand Total		**6,553.98**	**1,750.23**	**8,304.21**	**9,042.66**

3 Housing

3.1 SUMMARY

The state of Himachal Pradesh in North-West India is inherently susceptible to a range of natural disasters, including floods, flash floods, landslides, and earthquakes. The recent torrential rains starting from July 7, 2023, to July 11, 2023, wreaked havoc in all districts of the State in varying intensity. The second spell of rains struck the state in the month of August. There were flash floods. Rivers swelled, leading to floods that submerged numerous areas, particularly those situated along riverbanks. Landslides were triggered by the saturated soil caused by the unprecedented rainfall, exacerbating the devastation. The extent of the disaster was vast and had caused a substantial quantum of housing damage, loss and some life loss. The disaster has significantly disrupted the livelihoods of the people. Many HHs are living in relief camps, with friends/relatives or in other alternative accommodations. Therefore, there is a strong need for proactive disaster mitigation measures at the earliest.

The current disaster has left a significant impact on the housing infrastructure, affecting a total of *24885 houses comprising pucca, semi-pucca, kutcha houses, huts, and cattle sheds*. A total of *22,879 HHs* have been directly affected by the disaster. There is a need for reconstruction of 3185 cattle sheds and 4948 houses and repair and retrofitting of 10986 houses and 5766 cattle sheds in line with BBB principles. There are 846 cases of land loss across the twelve affected districts. Landslide damages were sporadic and localised while flood damages were over large areas with buildings often situated in unsafe locations lacking compliance with safety norms. Shimla had more sporadic landslides, Kullu had more floods and Mandi/ Solan had both landslides and floods. Similar pattern has been observed in the second phase of the disaster in Bilaspur, Hamirpur, Kangra, etc.

The present disaster has left the affected households in significant physical and psychological distress, especially the vulnerable groups such as senior citizens, women, children, and people with disabilities. Many are displaced, living temporarily in precarious conditions, and struggling with the loss of livelihoods and possessions. The disruption to services, including damaged toilets and sewerage systems, further compounds the challenges.

Immediate intervention is proposed to mitigate the adverse social and economic effects and to help the affected individuals and families to rebuild their lives in a safe and secure environment. In terms of priority, the immediate interventions to have an overall effective disaster resilient housing environment in Himachal Pradesh are

- Providing financial and techno-managerial support to the HHs living in relief camps to build in-situ temporary shelters, provided that the lands are safe.
- To identify geologically safe sites for relocation of those who lost their lands. Acquire land and start infrastructure development in the next three months. Provide financial and techno-managerial support to the affected HHs to build temporary shelters,
- For the category “a” and “b” build permanent houses on an incremental basis.,
- Set up housing facilitation centres at twelve districts by hiring local NGOs for eighteen months.
- Implement comprehensive training for construction workers and district-level engineers.

- Awareness campaign for owner-driven-housing-reconstruction explaining roles and responsibilities of the government and the beneficiaries.

The partially damaged houses must be retrofitted in accordance with the Build Back Better (BBB) principles, not only for landslide safety but also to withstand other hazards such as earthquakes. The same applies to the reconstruction work. Special items like temporary shelters and retaining walls should be integrated into the recovery. The unit costs for recovery have been based on the HIMUDA rate, 2023 for the phase I districts and the Hamirpur rate of 2023 for the phase II districts. Total cost of damage and loss has been calculated as Rs. 2308.91 Crores and the cost of recovery with BBB is Rs. 2353.65 Crores.

In view of the limited financial capacities of the disaster affected HHs, and considering the high cost of reconstruction, repair and retrofitting, it may be suggested that the government of Himachal and the central government provide financial assistance for temporary and permanent shelters as per the existing norms. However, such financial assistance will not be adequate to complete a basic house in Himachal. Therefore, it may be suggested that the government; a) may explore any other source of grant in cash or in materials; b) organise a soft loan (simple interest @2%) from B/FI for completing the construction of a basic structure; c) setup a revolving fund system; d) pay the EMI directly to the B/FI by the state government for the first two years; thereafter, the affected HHs will pay back the EMI, including the portion paid by the government.

The recovery strategy has included capacity-building focusing on training local masons, engineers, contractors, and entrepreneurs. The recovery strategy emphasises the engagement of women and marginalised groups, environmentally conscious designs, strengthened information system-based government departments, and disaster risk reduction measures. The strategy aims to combine people-centric design, technical support, and monitoring to create a resilient and culturally rich recovery pathway for Himachal Pradesh.

Recovery has been viewed as an opportunity for generating significant livelihood opportunities, particularly by establishing small-scale building materials production facilities aligned with Himachal's aspiration for sustainable and resilient housing. The recovery suggests the adoption of confined masonry for low rise houses in reconstruction and encourages the use of improved Kath Kuni structures based on alternatives to timber and stone plate, which demonstrate inherent resilience against multi-hazards.

The recommendations encompass various aspects such as hazard mapping, resilient construction practices, regulatory reforms, and community involvement. The recovery emphasises immediate actions like relocating HHs to safe zones and promotes a sustainable approach to recovery, including traditional architectural revival and owner-driven housing recovery. The recovery plan is divided into short-term and medium-term phases, with a zero-time-waste approach aimed at completing recovery within 18 months, fostering resilient, inclusive, and environmentally conscious housing for the region. Risk-sensitive land use planning and landscape management based on hazard assessments are integral to the overall recovery process. Emphasis should be placed on ecological, social, and economic sustainability. The recommendations and implementation plan collectively aim to establish a resilient recovery framework that addresses the diverse challenges posed by the disaster in Himachal Pradesh. By integrating these measures, the recovery process can efficiently lead the region toward a resilient and sustainable future.

3.2 OVERVIEW OF HOUSING, LAND, AND SETTLEMENTS

Housing and land settlement patterns in Himachal Pradesh reflect its unique geographical and cultural diversity. From remote tribal villages to bustling towns, housing typologies vary. Traditional homes often use local materials like wood, stone, and mud, utilising techniques that are resilient to environmental challenges. Urban areas, on the other hand, feature a mix of traditional and modern architectural styles. Kath-Kuni construction is one of the oldest forms of traditional construction widely seen in Shimla, Kullu, Kinnaur, and Mandi districts of Himachal Pradesh. Traditional housing typologies make prudential use of locally available natural materials such as timber, stone, rammed earth, mud, etc., for building construction to achieve dual objectives of climate and disaster resilience.

Settlements are characterised by adaptations to the challenging terrain. People are dependent on land for agriculture and horticulture. Patwaris prepare the entire revenue records, measure land on the ground, and maintain all the prescribed records, which are checked, verified, and made final by the higher officials. The Government of Himachal Pradesh developed Town and Country Planning rules in 2014 which was later amended in 2022.

3.3 HOUSING STOCK, TYPOLOGIES

There were 25.76 lakh houses spread over twelve districts of Himachal (Census 2011). There has been a population increase of 12.9% between 2011 and 2023 and hence, one would expect a proportionate increase in the number of houses. According to Census (2011), brick-walls are more in the lower hills, whereas stone walls are common in the middle and high levels. Stone roofing is high in number in Mandi, Kullu and Shimla. In districts such as Kangra and Hamirpur, a large number of houses with mud walls and slate roofing have been observed.

- Masonry Buildings: Most of the vernacular buildings in Himachal are two-storied built with 600mm thick undressed dry-stone masonry walls with horizontal wooden members (Kath Kuni) in alternative courses, well bonded at corners. This induces resilience in the rigid masonry wall. The roof is made with a stone plate supported on wooden rafters and purlins. Such typology fulfils most of the seismic safety requirements, viz. anchorage, bracings, and proper connections between different elements. Dhajji Wall was another type of building observed during the field visit.
- The present-day practice is brick masonry walls in cement mortar with RCC lintel band. These are built by migratory masons who come to Himachal in favourable construction seasons from the other states. The present-day construction market is dominated by migrant construction workers who know only the brick masonry in cement mortar and RCC. During field visits it was noticed that many such houses did not have the required seismic bands and there were unsafe gable walls. The local traditional masons are almost extinct since there is hardly any scope for traditional construction evolved over generations.
- Reinforced Concrete Frame Buildings: Most of the RCC framed buildings were found to have seismic bands to some extent, however, their location on unsafe slopes was the major cause of building collapse and destruction. The RCC framed structures were made of burnt clay or concrete block infill walls. They were up to 5-6 stories and found on isolated footing of size

ranging between 1.2-1.5m square in plan. A majority of the buildings had floors matching the sloping ground, thus contributing to significant vertical irregularity of the buildings.

3.4 HOUSING POLICY AND ENFORCEMENT

Himachal Pradesh has formulated housing policies to address the needs of its diverse population. The government of Himachal Pradesh had developed Himachal Pradesh Housing and Urban Development Authority Act, 2004 to re-enact the law to provide for the creation of a Development Authority to plan and develop land and create infrastructure to meet the housing needs of different income groups. It provides different development schemes for mobilising public and private resources for the promotion of housing colonies and related infrastructure in Himachal Pradesh.

However, enforcement challenges arise due to rapid urbanisation and changing socio-economic dynamics. Instances of unauthorised construction have led to issues of building quality, land misuse, and safety concerns. Ensuring strict adherence to regulations and conducting regular audits is crucial.

At present, there are building bye laws which are not mandatory in the areas outside the TCP zones. As a result, most of the houses in rural areas are without safety checks. People obtain permits only in case they need a loan or any other government facility. One of the prime reasons for Himachal's current vulnerable situation is the absence of a building permit system. The existing building bye laws need a thorough examination to ensure that all the multi-hazard issues, especially landslide and earthquake, are addressed. Compliance of buildings with multi-hazard safety norms requires awareness campaign and a strong people-government partnership

3.5 GOVERNMENT SOCIAL HOUSING PROGRAMMES

The Himachal Pradesh government has launched various social housing schemes to provide affordable housing to the marginalised sections of the society. The "Pradhan Mantri Awas Yojana-Urban and Rural" and "Rajiv Awas Yojana" aim to provide affordable pucca housing to both the rural and urban poor in Himachal Pradesh. Additionally, the State Government is implementing various schemes for the welfare of the weaker sections of the society. The Swarn Jayanti Aashray Yojana is being implemented to help realise the dream of a home for poor families belonging to Scheduled Castes, Scheduled Tribes and Other Backward Classes. The "Himachal Grihini Suvidha Yojana" supports women-headed households in building houses. These initiatives help to reduce housing disparities and uplift the vulnerable communities of Himachal Pradesh.

3.6 BUILDING MATERIALS AND TECHNOLOGIES

Himachal Pradesh's unique geographical challenges dictate its housing materials and techniques. Traditional homes use locally available materials like stone and wood. Kath Kuni is a traditional construction technique widely seen in Shimla, Kullu, Kinnaur, and Mandi districts. Nowadays, stone and brick masonry construction are prevalent in the areas where people have been forced to leave their traditional construction practices due to the scarcity of wood. Due to the region's heavy precipitation both in terms of rainfall (June to July) as well as snowfall (October to March), stones are preferred over the alternative locally available construction material, i.e. mud. Dry Stone construction is commonly found in rural and suburban areas of the districts Mandi, Chamba, Shimla, Kullu and Kinnaur. In contrast, modern buildings adopt reinforced concrete and brick masonry

structures. The slate-quarries in Kangra have been closed. However, slate is still available since many HHs pull down their old slate roofed buildings and construct new houses with RCC slab or CGI roof and sell the roofing slates which are of excellent quality.

3.7 CAPACITIES: ENGINEERS, MASONS, LABOUR

At block level, a few government engineers exist who are already burdened with the ongoing construction programmes and implementation of various schemes. They hardly have time to provide technical guidance to the house building process by the owners. While the government engineers have knowledge on RCC construction works, they need to upgrade their capacity on disaster-resilient construction practices. There is a strong need for refresher courses on resilient construction, especially by upgrading the vernacular technologies to comply with the present building codes.

During the field visits a few masons were interviewed. Their level of skill appeared inadequate for safe construction. A majority of the masons are from Bihar, UP, etc. and have the basic knowledge of RCC construction. The local knowledge on vernacular construction is almost extinct due to the lack of employment opportunities and encouragement. The traditional skills still exist and could be revived/revitalised if the reconstruction encourages the use of upgraded Kath Kuni construction based on alternatives to timber and stone plate roofs.

The capacity of engineers and masons are of paramount significance in this vulnerable landscape. There is a strong need for training and upskilling of the masons, carpenters, plumbers, electricians and the engineers on multi-hazard safe construction. Training programs should focus on disaster resilience, and environment-friendly practices. The trained people will play a crucial role in developing structures that would withstand natural hazards in a sustainable manner, which is the best disaster mitigation effort.

3.8 ASSESSMENT OF POST-DISASTER EFFECTS: DAMAGE AND LOSS

3.8.1 ASSESSMENT PROCESS.

A team comprising housing experts, state level engineers, and the district level officers got together for a capacity building exercise for two days in Shimla. On day 1, the basic concept and process of conducting PDNA was introduced. On day 2, the participants and the experts went for a field visit to carry out a hands-on exercise on damage assessment. From day 3 onwards, the housing team visited districts, blocks, Tehsils, GPs and the villages to interact with the people to understand their distresses as well as to get ideas on what would be the most appropriate recovery strategy to suit to the affected peoples' aspirations and emerge with a resilient future Himachal Pradesh. The people, especially women and the poor/marginalised, were the focus of PDNA exercise. While the PDNA report writing on the phase I districts was going on, the second spell of rains arrived in Himachal in August. This time the remaining six districts (Bilaspur, Hamirpur, Kangra, Lahaul and Spiti and Una) were severely affected alongside the six districts of Phase I. The sector teams, on request of the government of Himachal Pradesh, included the new six districts under PDNA and visited Kangra and Hamirpur in September 2023.

The government of Himachal Pradesh had collected damage data through the Tehsil level officials. It has been informed and cross verified during the field visit that the data was collected by the Patwaris. The JEs were not involved. The housing damage assessment by the Patwaris was categorised into two, a) totally damaged and b) partially damaged. However, the partially damaged category needed to be subdivided into two as per the NIDM format. Apart from that, there were some gaps in the housing related data. While the Partwaris have grassroot level information in their finger-tips, they are not trained to assess damage. Therefore, the ADCs/SDMs who took part in the two-day capacity building workshop in Shimla (7^{th}-8^{th} August) were especially trained on how to classify a damaged building into sub-categories (G1 to G5). They went to the respective districts and explained the matter to the Patwaris and the JEs. Following that, the Patwaris filled out the housing data forms. The housing related data format was contextualised in consultation with the ADCs/SDMs from the six disaster affected districts. Subsequently, the districts sent the housing data, which was cleaned through online interactions between the district-teams and the PDNA housing experts. In the second Phase of the PDNA a new format similar to that of the NIDM format was prepared and data on damage and loss were captured by the patwaris at district level. ***It is important to note that the damage-data received from twelve districts included the damaged PMAY-G and PMAY-U houses. Within the time frame, segregation of the damaged housing data under PMAY-G and PMAY-U could not be done by the district teams. Therefore, housing damage and recovery costing in this PDNA report include these two and should be excluded by the state government once the appropriate data on these two housing schemes is acquired by the district teams.***

3.8.2 Field Visits.

The housing team visited three districts; Solan, Shimla and Mandi. They visited fourteen villages, eight blocks and carried out eight consultations with the disaster-affected women, communities, Tehsil and GP level officials and a few construction workers in August 2023. In the second phase, Kangra and Hamirpur districts were visited by the housing team. Consultation with the district teams provided a deep insight into how the top and middle-level management viewed the damage and the possible recovery strategies for housing. The district-level officials provided detailed accounts of when and how the disasters struck the districts and affected a large number of HHs, some of whom are still living in the relief camps.

Most of the places suffered flash flood, flood, land-subsidence and landslide. Many houses have been washed away by the flash flood and flood. Some buildings were filled up with rubbles and mud and are difficult and costly to recover. In some of the districts (e.g. Mandi) river flood had washed away some houses which were close to the river bed and did not leave behind any livable land. Such HHs are now landless. In many places, there was no land other than the forest where the affected people could be relocated.

In the urban areas, most of the houses were of RCC framed structures with top roof in CGI sheet. In the rural areas, pucca walls with CGI roofs were common. Vernacular/traditional buildings, although not much visible in the urban areas, were found to be in pockets where they existed in good numbers as memories of the traditional wisdom. Building Bye laws are not applicable in most parts of the places visited, which is one of the causes of the disaster. One JE looking after a large number of houses makes housing in Himachal an inherently under-prepared system to combat hazards.

Presently, building permits are necessary only in the TCP areas. The process of obtaining a building permit is as follows; a) Submit map according to TCP Act, Bye laws or ELU with revenue document, b) Forward to SADA, ULB, TCP, c) Checking by JE, ATP and, d) Approval by authority. It takes 15 days for approval.

Most of the HHs were found to be financially in good condition. According to the Block level officials (e.g. Jubbal) 70% people have the capacity to invest on house construction. However, some families are virtually without any capacity at this moment to invest in new construction in the post disaster situation. Similar trend was observed in Kangra and Hamirpur.

Many traditional buildings were found during the field visit and while travelling from one Taluka to another. These were found to be vibrant, architecturally rich and reflected the local culture and heritage. There is ample scope to revive and mainstream such construction types by upgrading them to the safety norms of the current building codes and by using alternatives to timber and heavy roof stone slabs. The skill exists even today, however, there is a strong need for creating job opportunities for the traditional builders. At each block, a government building could be built based on the traditional system to encourage the continuity of the ancient wisdom and icon of cultural identity of the Himachal region.

The Tehsil office JE, Jubbal, informed that about 80% HHs have septic tanks costing about rupees 0.7 to 1.0 Lakh. About 20% of HHs use pit latrines and all HHs are connected to the power grid. People hardly use solar or wind power. Most of the HHs have piped water while about 25% depend on natural sources.

3.8.3 HOUSING TYPOLOGY

The housing typologies are categorised as; a) Pucca, b) Kutchha and, c) Hut in the phase I districts. Hut is not a living quarter, it is used as a space for looking after the orchards and agriculture fields and mostly built with locally available materials. In the phase II districts, houses are classified as; a) Pucca, b) Semi-Pucca and c) Kutchha. In addition, the damaged cattle sheds are also considered under the PDNA since in Himachal rural area, cattle is part of human living. During the field visits to Hamirpur, Kangra, etc., it was observed that almost all the houses had at least one buffalo/cow providing milk for the family and in case of more than one such livestock, the surplus was sold to the government's milk collection centres. People love and care for their livestock as family members. In many places, the cattle sheds had brick walls for protecting the livestock from rain and cold.

In the urban areas, the predominant structural system was RCC framed structure, whereas, the majority of the buildings in the rural areas had load bearing brick walls with CGI roofing. As mentioned earlier, a good number of vernacular buildings called "Kath Kuni" existed in most parts of the six affected districts (phase I), with geometric shapes to create stunning architecture. "Kath" means wood and Kuni means corner. It is a dry-stone masonry with alternate layers of wooden beams, which gives the Kath Kuni structures their resilience against seismic force.

3.8.4 DAMAGE ANALYSIS

Flood, Flash Flood, land-subsidence and Landslide**:** A meeting with the six ADCs of Chamba, Kinnaur, Kullu, Mandi, Shimla and Solan revealed that the building damages were caused by flash flood, land-

subsidence and landslide in the hills. Some of the settlements next to the rivers suffered house and land loss and a part of the village got washed away by the flood and there is no scope for reclaiming such lands. In some cases, the flash flood and landslide took place together. In Solan at Shamti, six families lost both houses and lands due to flash floods coupled with landslides. Till 8th August, in the same place, 55 HHs had lost their buildings. The field inspection revealed that limestone boulders of considerable sizes had rolled down the slope and destroyed the buildings at lower level. A good number of buildings were standing precariously which were in highly vulnerable conditions posing a danger of collapse that would damage the buildings existing down the slope. Some of the buildings had listed badly and were beyond repair and retrofitting. They need demolition. In a congested place and being a highly landslide prone place, demolition would be a challenge and would require expert human resources and equipment.

In Mandi, the area surrounding the Beas River had experienced significant flooding, resulting in minor damages to several houses, which were close to the riverbank. In a few locations, a significant portion of a road had slid down due to the failure of a retaining wall caused by heavy rain. This incident posed not only an immediate threat to the road's integrity but also a potential danger to some of the houses situated on private land at a distance of 1-2 metres from the affected area. While the houses had currently suffered no damage, future damage is anticipated due to the highly unstable slope that experiences recurring landslides during the rainy season every year. The houses, while unharmed presently, are at risk due to the instability of the land. Discussions with the homeowners revealed their concerns, and they were in fear and expressed their willingness to vacate their houses if the government provided a safe relocation site.

In Mandi, a Brick Masonry Building had suffered partial damage due to flooding. The ground storey was laden with silt, resulting in dampness and the removal of plaster. Occupants on the ground floor were relocated to the first floor, and they were compensated with Rs. 50,000 each for their loss of belongings. Moreover, approximately 10-12 pucca houses on the other side in close proximity to the river Beas had also sustained partial damage (minor cracks) due to silting on their ground floors.

The major causes of housing damage in the phase II districts were; a) flood, b) land subsidence, c) landslide and d) flash floods. In Niyangal GP, block Nagrata, a massive landslide took place on the 19th August at 2PM completely destroying 13 Houses who are now staying in the government middle school at Bohunka. It was observed that 57 people were living in 4 classrooms. All the male members were staying in separate classrooms. The family members were provided food from the kitchen of the school. A meeting with the men and women revealed that they wanted to relocate at the earliest since their children's education was affected, there was no privacy and it was difficult to manage their cattle while they lived in the school. Apart from the inconvenience of the affected people staying in a relief camp, the normal functioning of the school is hampered and hence, there is an immediate need for relocating such HHs to the new plots. The district administration informed that the relocation land has been identified and very soon, the affected households living in the relief camps will move to their newly allocated land. Based on the community consultation, it may be suggested that a lump sum amount of money could be given to the affected HHs so that they could build their make-shift houses by themselves. Owner-driven approach towards building temporary or permanent houses appeared feasible since the community consultation revealed that the affected HHs would contribute from their own sources for house building.

3.9 SUMMARY OF DAMAGE ASSESSMENT.

Landslide and land subsidence have been observed to be sporadic and local in nature in most of the sites where the buildings have been damaged or destroyed. In the future it may happen in any place should there be excessive rainfall. In some cases, the buildings were intact since they were built with some degree of resilience. However, they may collapse any time due to further landslides. Unsafe location of buildings and stopping of the natural flow of water are among some of the reasons for landslide-related damage. Some people had insured the building while many did not.

Many areas visited during field visits were landslide prone of varying degrees depending upon the geological characteristics of the soil/rock, slope and the moisture content of the ground. It was observed that people have built their houses, especially in the urban areas, on unsafe land and hardly cared for the slope of the soil. Non-compliance with safety norms is one of the major causes of building damage. While the buildings were built with some degrees of resilience, subsidence/sliding of the lands have led to partial to total destruction. There are many partially damaged buildings which are retrofittable. However, they cannot be retrofitted unless a geologist certifies that the soil sliding/subsidence has stopped. The root cause of the disaster, as informed by the local people and the government officials including the engineers were, a) steep unprotected slope, b) excessive rains- usually a week's rains makes the soil landslide prone, c) blockage of the natural water drainage, etc. In a few places, the retaining walls were removed prior to the rains for road widening, which had rendered the buildings at the upper level unsafe for human living.

Flooding along the banks of Beas river has damaged/destroyed many buildings due to the unprecedented rainfall in a short time period. Cloud burst was reported in a few places. In the village Milwan, Kangra, Block Indora, a community meeting was held. The villagers reported that every year there is a flood, which does not cause much damage. This year the damage was significant since the 150m long river bank of Beas collapsed. The river is 1 km away from the village. This year, the flood was unprecedented. The villagers informed that they have resources to repair the damaged houses, however, that is not sustainable if the flooding happens every year. They suggested that the government should repair and raise the river bank by 4mx150m(long), which will save the village from seasonal floods.

Cattle sheds are part of living in Himachal. A good number of cattle sheds have been destroyed or damaged. Totally damaged houses have lost their septic tanks and the drinking water systems along with the electrical appliances and wiring. A general observation is, many buildings did not have resilient features from the point of the earthquake. Considering the ground situation, the following may be suggested

- Continuous public awareness on building safety, especially where not to build.
- A geologist at district level who should review the site before building permit is issued.
- Extensive training of the construction workers and most importantly, the district level Junior engineers.
- Involving the community for macro level zoning since people were found to be aware of the specific spots which may trigger landslides.
- not to block or divert the natural flow of the small streams.

- Many buildings could be made safe by minor retrofitting if the damaged/removed/destroyed retaining walls are built. However, this is subject to the condition that the soil has stabilised and declared safe by a geologist.

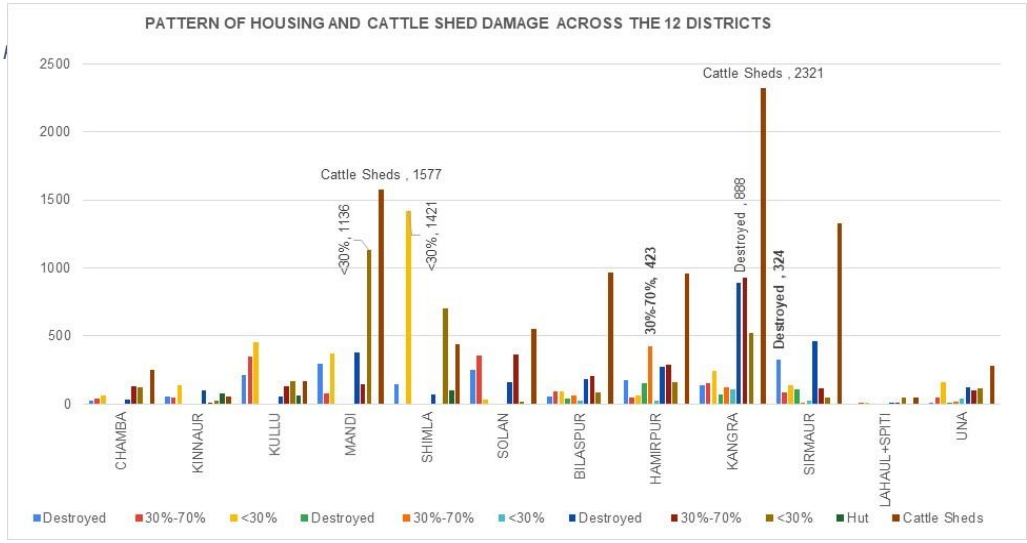
3.9.1 QUANTUM AND COSTING OF DAMAGE

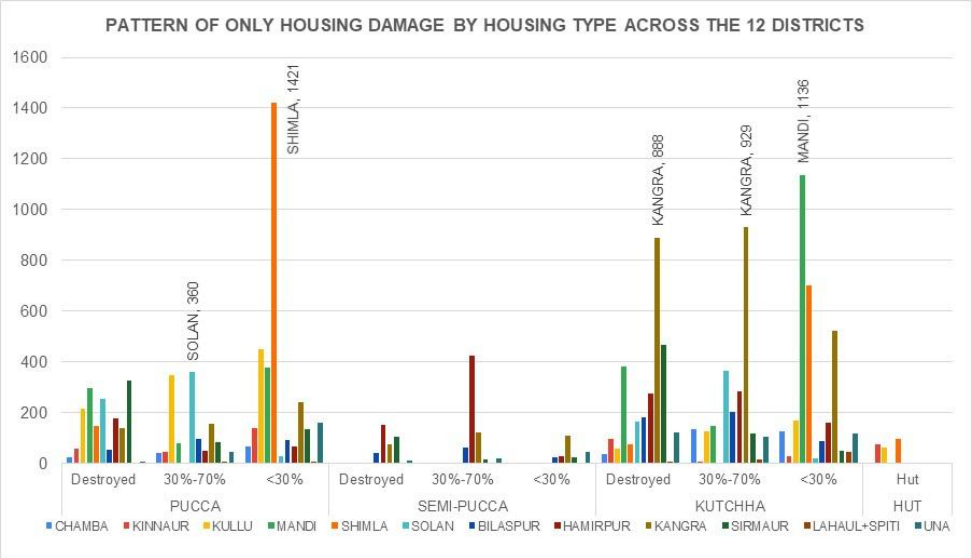
Below mentioned tables show the pattern of damages across the 12 districts of Himachal. The most dominant component of the damage is the cattle sheds followed by a large number of partially damaged houses. The maximum damage to the cattle sheds is in Kangra followed by Mandi, Sirmaur and others. The major contributors towards the cost of recovery are the damage categories; a) >30%-<70% and b) <30%, which are more in the Phase I districts than that of the phase II. Totally destroyed houses are the maximum in Kangra. Since the repair and retrofitting is based on like for like area and the reconstruction is based on 60.60 sqm, 54.9 sqm and 49.2 sqm of covered areas, the cost of recovery is more governed by the former.

Pattern of housing damages in Phase I and Phase II - twelve districts

		PUCCA				KACHHA				HUT				Cattle Sheds			
Dist Total no of houses	DISTRICT NAME	District total-PUCCA	Totally Destroyed (damage> 70%)	Severely Damaged (damage > 30% <	Partially Damaged (damage< 30%)	District total KACHHA	Totally Destroyed (damage> 70%)	Severely Damaged (damage >30% < 70%)	Partially Damaged (damage< 30%)	District total	Totally Destroyed (damage> 70%)	Severely Damaged (damage >30% < 70%)	Partially Damaged (damage< 30%)	District total	Totally Destroyed (damage> 70%)	Severely Damaged (damage >30% < 70%)	Partially Damaged (damage< 30%)
678	CHAMBA	129	24	41	64	296	36	134	126	0	0	0	0	253	87	90	76
487	KINNAUR	237	55	44	138	124	97	1	26	74	68	2	4	52	46	0	6
1591	KULLU	1010	213	346	451	352	56	127	169	60	45	7	8	169	94	37	38
3987	MANDI	747	294	78	375	1663	380	147	1136	0	0	0	0	1577	605	72	900
2879	SHIMLA	1566	145	0	1421	773	72	0	701	97	40	0	57	443	176	1	266
1737	SOLAN	641	252	360	29	543	163	363	17	0	0	0	0	553	172	367	14
11359	SIX DISTRICT TOTAL	4330 Nos	983 Nos	######	2478 Nos	3751 Nos	804 Nos	772 Nos	2175 Nos	231 Nos	153 Nos	9 Nos	69 Nos	3047 Nos	1180 Nos	567 Nos	1300 Nos

		PUCCA					SEMI-PUCCA					HUT/KUTCHHA					Cattleshed		
Dist Total no of houses	DISTRICT NAME	District total-Pucca	Totally Destroyed (damage> 70%)	Severely Damaged	Partially Damaged (damage> 30%<50%)	Partially Damaged (damage< 30%)	District total Semi-Pucca	Totally Destroyed (damage> 70%)	Severely Damaged (damage > 50% <	Partially Damaged (damage> 30%<50%)	Partially Damaged (damage< 30%)	District total Hut/Kuchha	Totally Destroyed (damage>	Severely Damaged (damage > 50% <	Partially Damaged (damage> 30%<50%)	Partially Damaged (damage< 30%)	District total Cattleshed	Totally Destroyed (damage> 70%)	Severely Damaged (damage >50% <
1800	BILASPUR	239	53	52	43	91	127	41	40	23	23	470	182	108	95	85	964	300	664
2567	HAMIRPUR	288	175	19	29	65	601	150	18	405	28	721	275	113	172	161	957	414	543
5492	KANGRA	532	138	63	91	240	299	72	24	96	107	2340	888	394	535	523	2321	1085	1236
2645	SIRMAUR	543	324	23	61	135	141	105	7	6	23	630	465	43	72	50	1331	128	1203
120	LAHAUL+SPIT	5	0	0	2	3	0	0	0	0	0	64	5	3	10	46	51	3	48
902	UNA	209	4	19	25	161	73	10	9	11	43	340	121	43	61	115	280	75	205
13526	SIX DISTRICT TOTAL	1816 Nos	694 Nos	#####	251 Nos	695 Nos	1241 Nos	378 Nos	98 Nos	541 Nos	224 Nos	4565 Nos	1936 Nos	704 Nos	945 Nos	980 Nos	5904 Nos	2005 Nos	3899 Nos





3.9.2 COST OF HOUSING DAMAGE

The three most important parameters in damage and recovery cost calculations are, a) covered area of a house, b) unit cost of the damaged house and c) unit cost of reconstruction, repair and retrofitting. The following Table provides the average areas of different categories of buildings calculated based on the damage assessment data provided by the government of Himachal Pradesh.

Table 2-2: Plinth and total cover area in sqm of pucca and kutcha houses in twelve districts. Shows total number of affected HHs

	PUCCA	KUTCHA	HUT	Cattle Sheds	AFFECTED HHS NOS	
	TOT AV COV AREA	TOT AV COV AREA	AV COV AREA	AV COV AREA	PUCCA	KUTCHA
CHAMBA	139.77	106.4	0	33.25	162	352
KINNAUR	193.17	117.2	50	46.4	277	155
KULLU	182.24	139.54	60.7	52.46	1558	370
MANDI	144.61	120.68	0	74.93	938	1995
SHIMLA					1834	948
SOLAN	124.6	114	0	60.67	1410	848
SIX DISTRICTS	156.88	119.55	55.37	53.54	6179	4668

Note: Data on covered area of Shimla was not be acquired

	PUCCA	SEMI-PUCCA	KUTCHHA	AFFECTED HHS NOS		
	TOT AV COV AREA	TOT AV COV AREA	AV COV AREA	PUCCA	SEMI-PUCCA	HUT/KUTCHHA
BILASPUR	128.85	83.9	72.7	369	390	1008
HAMIRPUR	159.75	119.9	99.6	517	344	4218
KANGRA	152.5	129.2	119	654	333	2449
SIRMAUR	123.93	109.57	82.85	679	53	220
LAHAUL+SPITI	125	0	82	7	0	51
UNA	133.1	149	140	283	145	312
SIX DISTRICTS	137.19	118.42	99.36	2509	1265	8258

The existing average total covered area of a pucca house is 156.88 sqm, kutcha house is 119.55 sqm, hut is 55.37 sqm and Cattle shed is 53.54 sqm in the phase I districts. In the phase II districts, the total covered areas are; a) 137.19 sqm in pucca, b) 118.42sqm in semi-pucca and c) 99.36 sqm in the kutcha houses. The damage and retrofitting costs have been calculated separately based on the average existing total covered areas by housing types of the phase I and phase II districts - like for like.

The average total covered areas of the existing houses are too high by the average Indian standard and hence, for reconstruction, the recommended covered areas for LIG and MIG housing by MHUPA, 2012 have been adopted (refer to the section recovery cost) with an idea that the people would expand their houses incrementally in course of time. For damage and reconstruction of huts, the NDMA norm of Rs 70,000 per HH has been adopted. For the reconstruction of cattle sheds Rs 1 lakh per unit has been considered based on discussions with the district level engineers and officials of Himachal Pradesh during the field visits.

For the phase I districts, there were three sources of construction cost, a) HIMUDA, based on state PWD, b) CPWD plinth area rate (2023) and c) the cost provided by the district level engineers. In consultation with the HP government officials, the HIMUDA rate for 2023 has been accepted. For the phase II districts, rates provided by Hamirpur have been accepted as the basis of costing. **The unit damage costs of Kutcha and Semi-Pucca houses were assumed to be 50% and 75% of reconstruction cost,** based on the standards obtained from Mandi district. Since a majority of the existing buildings did not have adequate resilient elements, the damage cost has been assumed to be 18% less than the basic reconstruction cost. Huts are traditionally made of vernacular materials which are used for looking after orchids or agriculture fields.

Basis of costing (HIMUDA, 2023) Damage: Phase I districts

HOUSING CONSTRUCTION BY OWNER	RS/SQM
Basic Cost of Construction	25000.00
Water Supply and Sanitary Installation 12.5%	3125.00
Internal Electrical Installation 12.5%	3125.00
Site Development 5%	1250.00
Add 1% Labour Cess	325.00
Add 1% Quality Control	325.00
Add 3% Contingency	975.00
Total Unit Cost Of Reconstruction Rs/Sqm	**34125.00**
Damage Cost 18% Less on Basic Cost Of Construction For Lack Of Resilient Features	**29625**

Phase I Districts	**Pucca House, Area - Like for Like**			**Kutcha, Area Like for Like**			**Hut**	
	Unit cost Rs/sqm	**Area (sqm)**	**Cost/house**	**Unit cost Rs/sqm**	**Area (sqm)**	**Cost/house**		**Cost/hut**
Damage cost	29625.00	156.88	Rs. 4647646	14812.5	119.55	Rs. 1770866	AS PER NDMA GUIDELINES	Rs. 70000

Cost of Damage to Housing: Phase I Districts. Basis HIMUDA 2023 (no depreciation)

Sr No	DAMAGE COST	Nos	Cost/ Housing Unit- INR	Amount (Crore INR)
1	**Kutcha houses** > 70% damage or totally destroyed-Covered Area @ 119.55sqm	804	1,770,866	142.38 Cr INR
2	**Pucca houses** > 70% damage or totally destroyed-Covered Area @156.88 sqm	983	4,647,646	456.86 Cr INR
3	**Huts** covered as/NDMA guidelines Rs 70,000/HH	153	70,000	1.07 Cr INR
4	**Cattle Sheds >70% or totally destroyed**	1,180	100,000	11.80 Cr INR
5	**Kutcha** house >30%<70% damage- Covered Area 119.55 sqm	772	885,433	68.36 Cr INR
6	**Kutcha** house <30% damage- Covered Area 119.55 sqm	2,175	354,173	77.03 Cr INR
7	**Pucca house** >30%<70% damage- Covered Area 156.88 sqm	869	2,323,823	201.94 Cr INR
8	**Pucca house** <30% damage- Covered Area 156.88 sqm	2,478	929,529	230.34 Cr INR
9	**Huts** >30%<70% damage	9	35,000	0.03 Cr INR
10	**Huts** <30% damage	69	14,000	0.10 Cr INR
11	**Cattle Shed** >30%<70% damage	567	50,000	2.84 Cr INR
12	**Cattle Shed** <30% damage	1,300	20,000	2.60 Cr INR
13	Retaining wall at plot level to protect the house	4,205	Costing included in other sector	
14	Land lost due to flood/landslide	340	State to include the land cost	
15	Septic Tank- destroyed >70%	1,787	75,000	13.40 Cr INR
16	Septic Tank- destroyed 30%-70% damage	1,641	37,500	6.15 Cr INR
17	Septic Tank <30% damage	4,653	15,000	6.98 Cr INR
	TOTAL COST OF DAMAGE			**1221.88 Cr INR**

Basis of costing (Hamirpur, 2023: Damage: Phase II districts

Description of Item	Qty.	Rate	Unit	Amount
Building Construction Rate for RCC Frame structure	1.00	22650.00	Per sqm	22650.00
Add 9% for water supply and sanitary installation.	22650.00	9.00%	%	2039.00
Add 12.5% for internal electrical installation.	22650.00	12.50%	%	2831.00
Add Site development	22650.00	10.00%	%	2265.00
Add 10.50% escalation charges for two years	29785.00	10.50%	%	3127.00
Add 3% contingency charges.	32912.00	3.00%	%	987.00
Reconstruction Cost Rs/Sqm				**33899.00**
Damage cost 18% less on Rs 22,650/sqm				**27799.00**

Phase II Districts	Pucca House, Area - Like for Like			Semi-Pucca, Area Like for Like			Kutcha Like for Like		
	Unit cost Rs/sqm	Area (sqm)	Cost/house (Rs)	Unit cost Rs/sqm	Area (sqm)	Cost/house (Rs.)	Unit cost Rs/sqm	Unit Area (m2)	Cost/Kutchha (Rs.)
Damage cost	27799.00	137.19	3813790	20849.25	118.42	2468885	13899.5	99.36	1381016

Cost of Damage to Housing: Phase II. Basis Hamirpur 2023 (no depreciation)

Sr No	DAMAGE COST	Nos	Cost/ Housing Unit- INR	Amount (Crore INR)
1	**Kutcha houses** > 70% damage or totally destroyed-Covered Area @ 99.36 sqm	1,936	1381016.38	267.36 Cr INR
2	**Pucca houses** > 70% damage or totally destroyed-Covered Area @137.19 sqm	694	3813790.10	264.68 Cr INR
3	**Semi-pucca** > 70% damage or totally destroyed covered area @118.42 sqm	378	2468885.05	93.32 Cr INR
4	Cattle shed > 70% damage or totally destroyed	2,005	100000	20.05 Cr INR
5	**Kutcha** house >30%<70% damage- Covered Area 99.36 sqm	1,649	690508.19	113.86 Cr INR
6	**Kutcha** house <30% damage- Covered Area 99.36 sqm	980	276203.28	27.07 Cr INR
7	**Pucca** house >50%<70% damage- Covered Area 137.19 sqm	427	1906895.05	81.42 Cr INR
8	**Pucca** house <30% damage- Covered Area 137.19 sqm	**695**	762758.02	53.01 Cr INR
9	**Semi-pucca** house >50%<70% damage- Covered Area 118.42 sqm	**639**	1234442.52	78.88 Cr INR
10	**semi-pucca** house <30% damage- Covered Area 118.42 sqm	**224**	493777.01	11.06 Cr INR
11	**Cattle shed** >30%<70% damage	**3,899**	50,000	19.50 Cr INR
12	Destroyed Septic Tank	3,008	67,950	20.44 Cr INR
13	Damaged Septic Tank- >30%<70% damage	2,715	33,975	9.22 Cr INR
14	Damaged Septic Tank- destroyed <30%	1,899	13,590	2.58 Cr INR
15	Damaged slope/retaining wall. Damage cost under other sector	449		
16	Land lost due to flood/landslide. State to include land cost	506		
	TOTAL DAMAGE COST			1062.47 Cr. INR
	TOTAL DAMAGE COST PHASE I+II			2284.35 Cr. INR

Special note: Damage cost for the >30% and <70% category has been assumed to be 50% of the costs shown Table 2-3 and Table 2-5. Damage category <30%, the damage cost has been assumed to be 20% (2/3rd of 30%) of Table 2-3 and Table 2-5. This pattern has been applied to the damage costs of different housing typologies.

The PMAY-G and PMAY-U houses are included in the damage cost. The government of Himachal Pradesh has to acquire damage data of these two housing programmes and deduct the costs from the above calculation.

3.9.3 HOUSING LOSS

The present disaster has temporarily disrupted the pre-disaster supply chain of goods and services in the domain of housing. The assessment of change in flow of the economy due to a disaster is difficult to assess due to a lack of validated data. The district level officials provided data on loss of HH belongings and rental loss. The following change in economic flows has been observed during field visits in the Housing Sector.

Rental Loss.

While many families who lost their houses are living temporarily with relatives or space provided by the neighbours, they are already looking for rented premises. The rent varies from place to place (Rs. 2000/ month to Rs 5000/month). If the recovery takes 18 months, then a family will have an additional burden of Rs. 63,000 (@ Rs 3,500/month). Some of the HHs had grocery shops at ground level. The HH used to earn on an average of Rs. 1000- 3000 per day which had been reduced to less than Rs 500 per day resulting in a loss of Rs 1500 per day. The flooding along the banks of the Beas River has gravely affected the lives and livelihoods of the people, particularly the vulnerable segment of population. Situated close to the river, their homes have been inundated with silt and their belongings, including essential items like beds, utensils, gas stoves, and cylinders, have been swept away by the flood. The government has provided Rs. 15,000 to each family as compensation for their loss of belongings. Their houses have become uninhabitable, rendering them reliant on a single rented room costing Rs. 1500 per month for their shelter. In Mandi, a Four-Storied RCC Building was significantly affected by siltation at the ground floor. Six tenants residing on the ground and first floor lost their belongings and had to vacate their houses. Each tenant received Rs. 50,000 compensation. The affected tenants were engaged in various occupations such as labour, painting, and selling vegetables. The total rental loss recorded by the twelve district teams is Rs. 0.57 crore

Loss of employment.

Most of the damaged houses have suffered a loss of about a week's time of work with a loss of Rs 500 per day, which amounts to be Rs 3,500 x 2 HH members = Rs 7000/HH

Temporary Shelter.

It was reported by the government of Himachal Pradesh that the HHs rendered houseless by the recent disaster have temporarily been accommodated in the schools and other community buildings including food. Many houseless HHs have made their own arrangements, e.g. a family in Shamti is presently staying in a local temple. The reason why the number of houseless HHs staying in the relief camps is much lower than the actual number of houseless families is that many have alternative accommodations, have social support from friends, relatives and sometimes the neighbours came forward to provide shelter to the affected people. However, such benevolence should not be banked upon for a long time and hence, such HHs need temporary shelters immediately.

In the twelve affected districts, 846 plots have been completely lost. The total number of HHs in relief camps, with friends and relatives and in other temporary shelters is 4700 in twelve districts.

This number includes those who lost their lands (with houses), destroyed houses and houses that need urgent repair to live in. Since winter is very close, there is an urgent need for temporary shelters for the 4700 HHs. Community interactions during the field visits revealed that, most of the temporarily houseless HHs would prefer to build a temporary shelter on the new site or repair the existing damaged houses and leave the relief camp and other places where they are staying now. For the people who lost their lands, temporary shelters should be built on or next to the relocation sites, which are close to the livelihood activities of the affected people since they need a lot of supervision for their orchards. Such shelters should be provided with access roads, water, sanitation, electricity and appropriate solid and waste disposal systems. The temporary shelters must not block the natural drainage of water. The destroyed houses, where the land is geologically safe, temporary shelters could be built in-situ, preferably upgradeable to pucca structure over time. The damaged houses that could be retrofitted within reasonable time and cost, a part of an existing house with two rooms, a toilet, and veranda—should be strengthened first so that the HHs can move there. However, it is very important to note that such an option must be assessed by a trained engineer certifying the portion that could be retrofitted.

The affected HHs staying in the relief camps opined during interactions with the PDNA housing team that they would prefer to build their own houses with the help of local masons and by procuring construction materials. Considering this situation and the community's views, it may be suggested that the state government arrange funds to provide assistance to the HHs living in the relief camps to build temporary shelters. Consultations with the local masons and the engineers revealed that a semi pucca building of 25 sqm of covered area could be constructed within Rs. 2 lakh without interior and exterior finish. Another 30% of the cost, i.e., Rs 60,000 would be required for the services (WASH) to each affected family. The construction of temporary shelters should be owner-driven to make the implementation fast, ensuring the best use of money with high possibility of owners' contribution in recovery.

Debris.

Majority of the debris could be attributed to the landslide and by the flood and flash flood. It is difficult to quantify the debris. The DRR team would calculate the volume of the debris. During the field visits, it was observed that people have already started stacking the stone blocks brought by landslides that could directly be used in the housing reconstruction programme. Debris from the partially/totally collapsed buildings could also be partially recycled in the reconstruction programme. Care should be taken in handling structurally dangerous buildings, hazardous materials such as asbestos, dust particles, etc. The number of totally destroyed houses is 4948. Based on the type of structure found during the field visits, it may be assumed that a volume of approximately 2.1 cum per sqm of plan area per floor would be the debris from the collapsed buildings. Therefore, 4948 totally destroyed buildings (@ 114.46 sqm) would result in 11.89 lakh cum of debris.

In Himachal, the post-disaster waste mostly comprises timber, doors and windows, roof truss, vegetation, rocks, mud, soil etc. About 30% of construction and demolition waste from buildings can be recycled. Local unskilled people including the house owners can contribute to debris management. While selecting, adapting and developing technologies for reconstruction, try to maximise the use of recycled construction materials that will help to reduce debris disposal and other negative environmental impacts. The unit cost of debris per building should be calculated by

including the cost of equipment and human resources for demolition, transport and safe disposal or recycling of the debris. The overall management cost and cost of hiring demolition experts should also be accounted for in the cost of debris clearance.

The calculation of loss (Table 2-7) under housing has been based on the data supplied by the district officials.

Loss due to the disaster Phase I + Phase II Districts

	Approximate cost of Belongings	Misc, e.g. rental loss of the owner
SIX DISTRICT TOTAL = 24.57 INR	24.00 Cr INR	0.57 Cr INR

3.10 DISASTER IMPACT

3.10.1 IMPACT ON HOUSING SECTOR GOALS

The present disaster has caused destruction and severe damage to several buildings across the 12 districts under the PDNA. There will be a sudden rise in the demand for a considerable quantity of construction materials and human resources to reconstruct, repair and retrofit the 24,885 houses, cattle sheds and huts. This will adversely affect the government housing schemes such as PMAY-G and PMAY-U apart from the general house building by the people in general. As a result of the housing damage and destruction, many households having senior citizens, women and children are constrained to live in temporary locations affecting various aspects of life. In summary, it may be said that the housing recovery will face a challenge since it will put an additional burden on the available materials and human resources at district level.

3.10.2 IMPACT ON PEOPLE (WOMEN, CHILDREN, ELDERLY, PEOPLE WITH DISABILITY, SC ST, ETC.)

The social implications of the present disaster in Himachal are significant. The affected homeowners are in a state of distress due to the looming threat to their properties. Adequate support from the government can alleviate their concerns and provide them with a sense of security. There is an urgent need for timely intervention by the government to support the affected people by providing techno-managerial support at door-steps. The affected families, already residing in vulnerable areas, face not only the loss of property but also disruptions to their daily lives and livelihoods. This particularly affects tenants who are engaged in various occupations. The affected families, primarily the widows and their children, face an uphill battle in rebuilding their lives. The loss of their already limited possessions further weakens their financial stability, eroding ability to meet even their basic needs. Furthermore, the emotional and psychological trauma of losing their homes and possessions is significant. These families find themselves trapped in a cycle of poverty and displacement.

Interactions with the affected people revealed that they needed, (a) safe shelter away from flood-prone zones, b) facilitation of livelihood; (c) necessary aid for rebuilding their homes and restoring

their lives. Hence, urgent provision of safe and suitable temporary shelters is imperative. Collaborating with local NGOs or agencies that specialise in disaster relief can ensure that immediate housing needs are met. Moreover, avenues for livelihood support, skill development, and employment should be explored to help them regain their self-sufficiency. Due to the disaster, the children's education was disrupted for a few days; however, it has been restored. Damage of cattle sheds has affected daily life since people are dependent on milk and milk products. Many houses with home-based income generating activities have suffered.

It was reported by the people at village level that they take a loan of about 1 lakh from the bank (Kisan Credit Card) for the maintenance and plucking of the fruits from their orchards, which has to be returned within a year. Because of the present disaster, they are not in a position to return the money since many of them lost their houses or the houses got damaged.

3.10.3 SERVICES:

Many toilets were damaged due to the disaster. In numerous buildings the sewerage system has been severely affected. This is a serious issue as it has a direct bearing on the health of the affected people. There is an urgent need for restoration and revitalization of the sewerage system. This aspect of recovery should be converged with the WASH sector and hence, it has been excluded from the housing recovery.

3.10.4 DRR : INCREASES RISK

Some HHs have already repaired buildings with minor cracks and got back to the old houses. Many such houses might be on unstable soil, thus making human life extremely unsafe. While a building has been completely destroyed, the adjacent one, though on unsafe soil, is being used by the people. Some families are still living in the houses which have been declared unsafe by the authorities. This is increasing the vulnerability of the repaired houses since the local masons do not have sound knowledge on the BBB components of resilience. There is also a lack of awareness of the people on disaster-safety.

The repaired buildings on unsafe slopes are not going to be safe in future. Another issue in this context is that the Himachal is in zone IV and V of seismicity and many buildings were found to have inadequate earthquake-resilient features. All these are going to increase the vulnerability of the lives of the affected people in Himachal. Some of the places, e.g., the Bazar area of Solan, has exceeded its carrying capacity far beyond its limit, and hence, there should be strict rules to regulate new construction. The existing buildings must be examined to assess their safety against future hazards. Under such circumstances, it is suggested that there is a strong need for community awareness and masons' and carpenters' training on flood, soil subsidence, landslide and seismic safe construction. The engineers/architects and contractors' capacity on multi-hazard construction is the need of the day.

3.11 HOUSING RECOVER NEEDS AND STRATEGY

3.11.1 RECOVERY NEEDS

A total of 24,885 houses, huts and cattle sheds have been affected by the present disaster. Out of that, 4948 destroyed/damaged structures, 153 huts and 3185 cattle sheds need reconstruction. A total of 10,986 houses need repair/ retrofitting. It is important to note that the retrofitting of the partially damaged houses and the reconstruction must be in line with BBB principles to enhance their resilience against not just against the present hazards, but also other hazards such as earthquakes. There are 846 cases of land loss in the twelve affected districts. The following Tables show the recovery needs in Himachal Pradesh due to the present disaster (July-August, 2023).

Table 4-1: Recovery needs of the physical structures: Phase I

	RECOVERY COST	Nos
RECONSTRUCTION	Reconstruction of Kutcha houses as Pucca- > 70% damage or totally destroyed-Covered Area @ 49.2 sqm	804
	Reconstruction of Pucca houses > 70% damage or totally destroyed-Covered Area @60.6 sqm	983
	Reconstruction- Huts as/NDMA guidelines Rs 70,000/HH	153
	Reconstruction of Cattle sheds	1,180
REPAIR & RETROFITTING	Major repair and retrofitting-Kutcha house >30%<70% damage- Covered Area 119.55 sqm	772
	Medium to minor repair and retrofitting-Kutcha house <30% damage- Covered Area 119.55 sqm	2,175
	Major repair and retrofitting-Pucca house >30%<70% damage- Covered Area 156.88 sqm	869
	Medium to minor repair and retrofitting-Pucca house <30% damage- Covered Area 156.88 sqm	2,478
	Major repair and retrofitting-Huts >30%<70% damage	9
	Medium to minor repair and retrofitting-Huts <30% damage	69
	Major repair and retrofitting-Cattle shed >30%<70% damage	567
	Medium to minor repair and retrofitting-Cattle shed <30% damage	1,300
SPECIAL ITEMS	Temporary Shelters + 30% for infrastructure (without land cost). People in relief camp + temporary accommodation +staying with friends/relatives	2,465
	Relocation @ Rs 2 Crore/ 25 plot (without land cost)- Campus + infrastructure	340

	Retaining wall at plot level to protect the house	4,205
	Land lost due to flood/landslide	340
WASH	Reconstruction Septic Tank- destroyed + 30%-70% damage	3,428
	Retrofitting of Septic Tank other than total destruction	4,653

Table 4-2: Recovery needs of the physical structures: Phase II

	RECOVERY COST	Nos
RECONSTRUCTION	Reconstruction of Kutcha houses as Pucca- > 70% damage or totally destroyed-Covered Area @ 49.2 sqm	1,936
	Reconstruction of Pucca houses > 70% damage or totally destroyed-Covered Area @60.6 sqm	694
	Reconstruction of semi-pucca > 70% damage or totally destroyed as pucca covered area @54.9 sqm	378
	Reconstruction of Cattle sheds	2,005
REPAIR & RETROFITTING	Repair and retrofitting-Kutcha house >30%<70% damage- Covered Area 99.36 sqm	1,649
	Repair and retrofitting-Kutcha house <30% damage- Covered Area 99.36 sqm	980
	Repair and retrofitting-Pucca house >30%<70% damage- Covered Area 137.19 sqm	427
	Repair and retrofitting-Pucca house <30% damage- Covered Area 137.19 sqm	695
	Repair and retrofitting-Semi-pucca house >30%<70% damage- Covered Area 118.42 sqm	639
	Repair and retrofitting-semi-pucca house <30% damage- Covered Area 118.42 sqm	224
	Major repair and retrofitting-Cattle shed >30%<70% damage	3,899
SPECIAL ITEMS	Temporary Shelters + 30% for infrastructure (without land cost). People in relief camp + temporary accommodation +staying with friends/relatives	2,235
	Relocation @ Rs 2 Crore/ 25 plot (without land cost)- Campus + infrastructure	506
	Retaining wall at plot level to protect the house	449
	Land lost due to flood/landslide	506
WASH	Reconstruction Septic Tank- destroyed + 50%-70% damage	3,986
	Retrofitting of Septic Tank upto 50%	3,636

CROSS CUTTING:

The water and sanitation costs including septic tanks, etc, all within the plot of a HH, have been included in housing recovery. The rest of the water and sanitation services beyond the HH plot boundary are under the WASH sector. During the field visits, it was noticed that a good number of houses on the road-sides could be saved if appropriate retaining walls are constructed. Data analysis shows that a large number of houses (4654 plots) need retaining walls to protect them against landslides. The relevant sector will address this issue. Housing recovery will generate a considerable amount of livelihood opportunities. Setting up small scale local resources-based building material production yards will also help Himachal Pradesh to achieve its goal of green and resilient housing.

3.11.2 COST OF RECOVERY

It is important to note that the current disaster has been caused by landslide, land subsidence, flood and flash flood. However, every house repaired/retrofitted or reconstructed under the recovery programme must be seismic safe as well, since the entire area falls under seismic Zone IV and V of India. As already mentioned earlier, out of the three sources of unit cost, the HIMUDA rate (RCC framed structure) for the financial year 2023 has been adopted in damage and recovery cost calculation (phase I districts) after having a consultation with the HP government officials. Cost of reconstruction for the phase II districts has been based on the data provided by the Hamirpur districts. The HIMUDA and Hamirpur rates include the BBB elements for multi-hazard situations. However, it is strongly suggested that the reconstruction of the low-rise buildings should be of confined masonry. Under recovery, the improved Kath Kuni structures which are inherently resilient against multi hazards (except landslide) should be encouraged. In place of timber in wall and slate/stone plate as roof alternative materials such as thin RCC bands and CGI sheet may be suggested. Since the huts are for looking after the orchards or the agriculture fields, vernacular structure has been proposed, which will be safe and suitable to the visual landscape of the hills. For cattle shed, the Rs 1 lakh per unit was adopted based on the discussion with the district level engineers. Reconstruction costs of septic tanks for phase I and phase II districts have been considered as Rs 75,000 and Rs 67,950 respectively based on data provided by the district teams.

As mentioned earlier, the costs of damage have been calculated based on the average total covered area of a pucca, semi-pucca and kutcha houses (like for like). The same principle of “like for like” areas have been adopted in repair and retrofitting of the damaged houses under recovery. However, the unit cost of the repair and retrofitting is higher than that of the damage cost since the latter includes BBB features. *It is important to note that the existing average total covered areas of the houses in Himachal are far too high by the average Indian housing standards*. However, there is no option other than like for like in retrofitting since the houses are existing and they would be renewed to a new structure with resilience.

Adopting such a high covered area in reconstruction will pose a number of problems, which will not be sustainable. Apart from the very high cost of construction, adopting such covered areas under reconstruction will delay the whole process of recovery much beyond the target of 18 months for many reasons; a) high demand for materials will severely disturb the existing supply-chain of the construction material market and lead to price increase. Experience elsewhere shows that there is a possibility of low-quality materials sold at cheaper rate attracting people to use them in

reconstruction, b) Himachal construction industry is primarily run by the migratory masons from other states and hence, limited in supply. High demand for construction workers will make room for low skill construction workers getting involved in reconstruction, creating low quality and unsafe buildings and c) large buildings will require more time to build a house. Under such circumstance it may be prudential to adopt the specifications (2012) of the Ministry of Housing and Urban Poverty Alleviation for housing which is as follows;

Table 4-3: Definition of affordable housing, MHUPA (2012): Cost/housing unit in Phase I and II districts

PHASE I DISTRICTS	Carpet Area	Covered area	Unit cost	Cost/Unit of house
LIG	41.00 sqm	***49.20 sqm***	Rs 34,125/Sqm	***Rs. 16.79 Lakh***
MIG	50.50 sqm	***60.60 sqm***	Rs 34,125/Sqm	***Rs. 20.68 Lakh***

PHASE II DISTRICTS	**Carpet Area**	**covered area**	Unit cost	**Cost/Unit of house**
LIG	41.00 sqm	***49.20 sqm***	Rs 33,899/Sqm	***Rs. 16.68 Lakh***
SEMI PUCCA	45.75 sqm	***54.90 sqm***	Rs 33,899/Sqm	***Rs. 18.61 Lakh***
MIG	50.50 sqm	***60.60 sqm***	Rs 33,899/Sqm	***Rs. 20.54 Lakh***

Based on the above Table, this report has adopted 49.2 sqm for the reconstruction of Kutcha building as Pucca and 60.60sqm has been adopted for the reconstruction of the pucca buildings. The area of a semi-pucca house is an average of the LIG and MIG specifications, which is 54.9 sqm. The unit cost of construction is different in the phase I and II districts as shown in the above tables. It has been assumed that the people would expand their houses incrementally. The following are the basis of calculating the reconstruction, repair and retrofitting costs under the housing recovery in Himachal Pradesh.

3.11.3 ASSUMPTION/BASIS OF COST OF RECONSTRUCTION AND REPAIR/ RETROFITTING

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

- Reconstruct the kutchha, pucca and semi-pucca buildings which were destroyed or fall under the damage category > 70%. Rs 16.79 Lakh/unit (Ph I) and Rs.16.68 Lakh/unit (Ph II) have been adopted for kutcha buildings replaced as pucca (49.2sqm). Rs. 20.68/unit (Ph I) and Rs 20.54 lakh/unit (Ph II) for pucca building reconstruction (60.6 sqm). Rs. 18.61 lakh /unit (Ph II) for reconstruction of semi-pucca as pucca building (54.9 sqm). Unit cost of reconstruction adopted are Rs 34,125/sqm (Ph I) and Rs 33,889/sqm (Ph II).
- Repair and retrofit the severely damaged (>30% and <70% damage category) kutchha, pucca, and semi-pucca buildings and huts in line with BBB principles -in-situ. The unit costs of repair and retrofitting considered are 50% ((30%+70%)/2) of the reconstruction costs of

pucca, semi-pucca and kutchha buildings for the phase I and II districts as shown in Table 4-6. Areas are like-for-like as existing.

- Repair and retrofit the moderately to minor damaged (<30% damage category) kutchha, pucca, semi-pucca buildings and huts in line with BBB principles -in-situ. The unit costs considered are 20% (2/3rd of 30%) of the reconstruction costs of pucca, semi-pucca and kutchha buildings and huts for the phase I and II districts as shown in Table 4-6. Areas are like-for-like as existing.
- Rs. 1 lakh has been adopted as the reconstruction cost of a cattle shed. For repair and retrofitting of the cattle sheds with >30% and <70% damage, 50% of 1 lakh has been adopted. For repair and retrofitting of the cattle sheds with <30% damage, 20% of 1 lakh has been adopted.
- Rs 70,000 has been adopted as the reconstruction cost of huts as per the NDMA guidelines.
- All the above costs are inclusive of internal water supply, sanitation and electrical system and excluding septic tank
- It has been assumed that the buildings destroyed and severely damaged (>30% and <70%) will require reconstruction of septic tanks. The current rate of Rs 75,000 (Ph I) and Rs 67,950 (Ph II) per septic tank have been considered in recovery.
- It has been assumed that the houses that belong to the category of <30% damage, the septic tank repair will cost 50% of the new construction, i.e., 50% of Rs 37,500 (Ph I) and 50% of Rs. 33,975 (Ph II) / septic tank.

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

3.11.4 RELOCATION COST: SITE AND INFRASTRUCTURE

There are 846 plots which have been completely destroyed and they need relocation. While interacting with such HHs during the field visits, people informed that they are willing to relocate to a nearby place not far away from their orchards and agriculture fields. In Himachal, so far, the decision on relocation has not been ascertained. While people at district and state level informed that the only possible place of relocation is the forest, the existing rules do not allow that. Each district has to expedite the feasible and safe sites for relocation, which should not be a colony type with many households for the protection of the environment. There is a need for small pockets on relocation sites since people would like to relocate to a place close to their sources of livelihood. Considering the fact that the need for relocation is dispersed, i.e., small numbers of houses located far apart, it does not seem to have a significant negative environmental impact.

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. The total relocation cost should be calculated under the individual heads or alternatively in terms of overall cost of relocation per housing unit and then multiplied by the number of households to be relocated. In the absence of information on a specific site, it is not possible to calculate the cost of relocation. However, based on the recent PDNA report of a neighbouring state of Himachal Pradesh with similar hilly terrain and landslide proneness, it may be said that about Rs 2 crore will be required to develop a small place for 25 HHs in Himachal

including services and infrastructure within the boundary. The estimated cost includes internal roads, boundary wall, all services, retaining walls, etc. Based on the data sent by the Patwaris, 846 plots have been lost. Therefore, the ***cost of relocation for 846 plots will be approximately Rs 67.68 Crore***.

3.11.5 TEMPORARY SHELTER

Since winter is a month and a half away, there is a strong need for temporary shelters which are thermally comfortable and close to the place of the peoples' livelihood. Such shelters could be porta cabin type with adequate insulation and having a life of at least 25 years. After 18 months of use, when the affected people would go back to their safe houses, some of such shelters could be used as government offices and some could be taken down by parts and kept safely for near future since the occurrences of landslide related house damage, though small in number, would happen frequently.

However, interactions with the people living in the relief camps revealed that they wanted to build their temporary and permanent houses by themselves. The affected people urged that they should be given land immediately and some financial assistance so that they could build their own temporary shelter at the earliest. Thereafter, they will construct their permanent houses either a new one on the same plot or upgrade the temporary shelter into a permanent structure. This could also be a viable option for temporary shelters. The temporary shelters should be thermally comfortable for the occupants. A well-coordinated construction management system is required to provide 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 with two rooms and a veranda (also used as a kitchen) could be constructed within two lakhs with locally available material and reclaimed materials from the debris. An additional 30% would be required for the services and hence, Rs 2.6 lakh/HH could be a viable option for temporary shelter. It may be noted that, out of 4700 HHs living in relief camps right now, a significant number of HHs have lost their buildings, while their plots of lands are safe. Therefore, as a general strategy, Rs 2.6 lakh could be given to 4700 HHs to set up their temporary shelters and hence, the total amount for this purpose ***would be Rs. 122.2 Crore***.

3.11.6 COST FOR CAPACITY BUILDING OF HUMAN RESOURCES

While Kath Kuni buildings are resilient against seismic safety, it does not make a building safe, if situated on an unsafe slope. This applies to the RCC structures as well. It should also be noted that many buildings did not have the required resilient features against multi-hazards. A collapsed RCC structure in Rohru showed that the column reinforcement (links) at base level did not have adequate hooks which resulted in the building collapse. Based on the experience of seeing the pattern of building collapse, the causes behind those could be attributed to; a) lack of awareness of the people on landslide safety, a) local masons do not have very clear idea on how to make a multi-hazard-safe building, c) there are hardly any affordable architects or engineers to provide technical and managerial support to the local people. Because of this trend for a long time and building construction under the influence of commercial gain, the disaster risk has increased in the urban areas. Considering the ground situation, it is strongly suggested that an immediate intervention is required to enhance the capacity of the local masons so that they do not repeat the past mistakes.

ENGINEERS/CONTRACTORS

The locals and engineers also need capacity building on landslide and seismic safe construction considering the high degree of vulnerability of Himachal Pradesh in terms of landslide and seismicity (Zone IV and V). The need for capacity building of the local contractors is of paramount importance since, in absence of adequately qualified architects/engineers, the contractors act as the technical advisers to the people.

ENTREPRENEURSHIP.

Very soon, due to the reconstruction programme, there would be a sudden rise of the demand for building materials. To deal with the situation, one of the feasible options would be 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 Himachal. It would require small machineries and skill training. Precast seismic bands, precast door/ window frames, etc. would be sustainable options in the context of Himachal. 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 hinges, handles, water saving taps, etc. would be available.

HOUSING FACILITATION CENTRES

The disaster affected people in all the twelve districts will need technical support at their door steps to ensure that the houses are actually resilient, which could be done through Housing Facilitation Centres (HFC). The HFCs have been assumed to 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. There is a need for monthly peer review of the HFC activities by a committee led by the Tehsil level officials with the help of the local engineering college teachers and private practising architects and engineers who have worked in the field of BBB. This would result in hundreds of green and resilient buildings in Himachal Pradesh. Based on the above discussion, the following Tables show the recovery requirements of the twelve districts of Himachal Pradesh. Local NGOs could be appointed on a time bound contract to set up and run the HFCs.

Total cost of housing recovery Phase I Districts: Basis - MHUPA 2012

	RECOVERY COST	Nos	Cost/ Housing Unit- INR	Amount (Crore INR)	Sub Total	% of Total
RECONSTRUCTION	**Reconstruction** of **Kutcha houses** as **Pucca-** > 70% damage or totally destroyed-Covered Area @ 49.2 sqm	804	1,678,950	134.99 Cr INR		
	Reconstruction of **Pucca houses** > 70% damage or totally destroyed-Covered Area @60.6 sqm	983	2,067,975	203.28 Cr INR		
	Reconstruction- **Huts** as/NDMA guidelines Rs 70,000/HH	153	70,000	1.07 Cr INR		
	Reconstruction of **Cattlesheds**	1,180	100,000	11.80 Cr INR		
					351.14 Cr. INR	29.87%
REPAIR & RETROFITTING	**Major repair and retrofitting-Kutcha** house >30%<70% damage- Covered Area 119.55 sqm	772	1,019,929	78.74 Cr INR		
	Medium to minor repair and retrofitting-Kutcha house <30% damage- Covered Area 119.55 sqm	2,175	407,972	88.73 Cr INR		
	Major repair and retrofitting-Pucca house >30%<70% damage- Covered Area 156.88 sqm	869	2,676,809	232.61 Cr INR		
	Medium to minor repair and retrofitting-Pucca house <30% damage- Covered Area 156.88 sqm	2,478	1,070,724	265.33 Cr INR		
	Major repair and retrofitting-Huts >30%<70% damage	9	35,000	0.03 Cr INR		
	Medium to minor repair and retrofitting-Huts <30% damage	69	14,000	0.10 Cr INR		
	Major repair and retrofitting-Cattleshed >30%<70% damage	567	50,000	2.84 Cr INR		
	Medium to minor repair and retrofitting-Cattleshed <30% damage	1,300	20,000	2.60 Cr INR		
					670.98 Cr. INR	57.07%
SPECIAL ITEMS	Temporary Shelters + 30% for infrastructure (without land cost). People in relief camp + temporary accommodation +staying with friends/relatives	2,465	260,000	64.09 Cr INR		
	Relocation @ Rs 2 Crore/ 25 plot (without land cost)- Campus + infrastructure	340		27.20 Cr INR		
	Retaining wall at plot level to protect the house	4,205	Costing included in other sector			
	Land lost due to flood/land slide	340	State to include the land cost			
					91.29 Cr. INR	7.76%
WASH	Reconstruction Septic Tank- destroyed + 30%-70% damage	3,428	75,000	25.71 Cr INR		
	Retrofitting of Septic Tank other than total destruction	4,653	37,500	17.45 Cr INR		
					43.16 Cr. INR	3.67%
DEVELOPMENTAL COST	Ensuring BBB elements in reconstruction, repair and retrofitting, a) Masons and carpenters' topup training 5 days + b) multi-skill workers for retrofitting + c) Engineers training 6 Locations- Fooding + loding - 6 training x 40+40+40 candiadtes x INR 35,000/ candidate +35% management cost, toolkit gadgets etc including IEC	6	5670000	3.40 Cr INR		
	Small entrepreneurship 6 units of precast RC posts and DW frames, CSEB, flyash block, etc, etc. @ INR 50 lakh/ unit including leased land	6	5000000.000	3.00 Cr INR		
	Industry partnership: Production yards 6 @ INR 75 lakhs/unit, industry will pay for this since they will have business profit	6	7500000.000	4.50 Cr INR		
	Expenditure of the Housing Facilitation Centre				**10.90 Cr. INR**	0.93%
	Run by 3 architects/ engineers @ (Rs. 50,000 salary + Rs 7000 for transport, commmunications) x 18 months x 12 locations - 2 per district x6	12	3078000.000	3.69 Cr INR		
	3 Technical assistants @ (Rs. 30,000 salary + Rs 7000 for transport, communications) x 18 months x 12 locations	12	1998000.000	2.40 Cr INR		
	Rs. 4 Lakh capital cost/ HFC	12	400000.000	0.48 Cr INR		
	Communication: Awareness campaign, Workshops, peer review, evaluation, etc and overhead 25% of HFC			1.64 Cr INR	**8.21 Cr. INR**	0.70%
	TOTAL COST OF RECOVERY			1175.68 Cr INR		100.00%

Total cost of housing recovery Phase II Districts: Basis - MHUPA, 2012

	RECOVERY COST	Nos	Cost/ Housing Unit- INR	Amount (Crore INR)	Sub-Total	% of Total
RECONSTRUCTION	**Reconstruction** of **Kutcha houses** as Pucca- > 70% damage or totally destroyed-Covered Area @ 49.2 sqm	1,936	1,667,831	322.89 Cr INR		
	Reconstruction of **Pucca houses** > 70% damage or totally destroyed-Covered Area @60.6 sqm	694	2,054,279	142.57 Cr INR		
	Reconstruction of semi-pucca > 70% damage or totally destroyed as pucca covered area @54.9 sqm	378	1,861,055	70.35 Cr INR		
	Reconstruction of **Cattlesheds**	2,005	100,000	20.05 Cr INR		
					555.86 Cr. INR	47.19%
REPAIR & RETROFITTING	**Repair and retrofitting-Kutcha** house >30%<70% damage- Covered Area 99.36 sqm	1,649	842,028	138.85 Cr INR		
	Repair and retrofitting-Kutcha house <30% damage- Covered Area 99.36 sqm	980	336,811	33.01 Cr INR		
	Repair and retrofitting-Pucca house >30%<70% damage- Covered Area 137.19 sqm	427	2,325,330	99.29 Cr INR		
	Repair and retrofitting-Pucca house <30% damage- Covered Area 137.19 sqm	695	930,132	64.64 Cr INR		
	Repair and retrofitting-Semi-pucca house >30%<70% damage- Covered Area 118.42 sqm	639	1,505,319	96.19 Cr INR		
	Repair and retrofitting-semi-pucca house <30% damage- Covered Area 118.42 sqm	224	602,128	13.49 Cr INR		
	Major repair and retrofitting-Cattleshed >30%<70% damage	3,899	50,000	19.50 Cr INR		
					464.97 Cr. INR	39.47%
SPECIAL ITEMS	Temporary Shelters + 30% for infrastructure (without land cost). People in relief camp + temporary accommodation +staying with friends/relatives	2,235	260,000	58.11 Cr INR		
	Relocation @ Rs 2 Crore/ 25 plot (without land cost)- Campus + infrastructure	506		40.48 Cr INR		
	Retaining wall at plot level to protect the house	449	Costing included in other sector			
	Land lost due to flood/land slide	506	State to include the land cost			
					98.59 Cr. INR	8.37%
WASH	Reconstruction Septic Tank- destroyed + 50%-70% damage	3,986	67,950	27.08 Cr INR		
	Retrofitting of Septic Tank upto 50%	3,636	33,975	12.35 Cr INR		
					39.44 Cr. INR	3.35%
DEVELOPMENTAL COST	Ensuring BBB elements in reconstruction, repair and retrofitting, a) Masons and carpenters' topup training 5 days + b) multi-skill workers for retrofitting + c) Engineers training 6 Locations- Fooding + loding - 6 training x 40+40+40 candiadtes x INR 35,000/ candidate +35% management cost, toolkit gadgets etc including IEC	6	5670000	3.40 Cr INR		
	Small entrepreneurship 6 units of precast RC posts and DW frames, CSEB, flyash block, etc, etc.@ INR 50 lakh/ unit including leased land	6	5000000.000	3.00 Cr INR		
	Industry partnership: Production yards 6 @ INR 75 lakhs/unit, industry will pay for this since they will have business profit	6	7500000.000	4.50 Cr INR		
	Expenditure of the Housing Facilitation Centre				**10.90 Cr. INR**	0.93%
	Run by 3 architects/ engineers @ (Rs. 50,000 salary + Rs 7000 for transport, commmunications) x 18 months x 12 locations - 2 per district x 6	12	3078000.000	3.69 Cr INR		
	3 Technical assistants @ (Rs. 30,000 salary + Rs 7000 for transport, communications) x 18 months x 12 locations	12	1998000.000	2.40 Cr INR		
	Rs. 4 Lakh capital cost/ HFC	12	400000.000	0.48 Cr INR		
	Communication: Awareness campaign, Workshops, peer review, evaluation, etc and overhead 25%			1.64 Cr INR	**8.21 Cr. INR**	0.70%
	TOTAL COST OF RECOVERY			1177.97 Cr INR		100.00%

Special note: The PMAY-G and PMAY-U houses are included in the recovery cost. The government of Himachal Pradesh has to acquire damage data of these two housing programmes and deduct the costs from the above calculation.

Basis of recovery cost Phase I and Phase II Districts

Phase I Districts	**Pucca House, Area as/MHUPA, 2012**			**Kutcha to be reconstructed as Pucca, Area as/MHUPA, 2012**			**Hut**	
	Unit cost Rs/sqm	**Area (sqm)**	**Cost/house**	**Unit cost Rs/sqm**	**Area (sqm)**	**Cost/house**		**Cost/ hut**
Reconstruction cost	34125.00	60.60	Rs. 2067975	34125.00	49.20	Rs. 1678950	AS PER NDMA GUIDELINES	Rs. 70000
	Pucca House area Like for like			**Kutcha house area like for like**			**Hut**	
	Unit cost Rs/sqm	**Area (sqm)**	**Cost/house**	**Unit cost Rs/sqm**	**Area (sqm)**	**Cost/house**		**Cost/ hut**
Repair and retrofitting cost	34125.00	156.88	Rs. 5353618	17062.50	119.55	Rs. 2039858	AS PER NDMA GUIDELINES	Rs. 70000

Phase II Districts	**Pucca House, Area as/MHUPA, 2012**			**Semi-Pucca rebuilt as pucca, Area as/MHUPA, 2012**			**Kutchha reconstructed as pucca, Area 49.2 sqm as/MHUPA, 2012**		
	Unit cost Rs/sqm	**Area (sqm)**	**Cost/ house**	**Unit cost Rs/sqm**	**Area (sqm)**	**Cost/ house**	**Unit cost Rs/sqm**	**Unit Area (m2)**	**Cost/ House**
Reconstruction cost	33899.00	60.60	Rs. 2054279	33899.00	54.90	Rs. 1861055	33899.00	***49.20***	Rs. 1667831
Phase II Districts	**Pucca House area Like for like**			**Semi-Pucca house area like for like**			**Kutchha Like for Like**		
	Unit cost Rs/sqm	**Area (sqm)**	**Cost/ house**	**Unit cost Rs/sqm**	**Area (sqm)**	**Cost/ house**	**Unit cost Rs/sqm**	**Unit Area**	**Cost/ House**
Repair and retrofitting cost	33899.00	137.19	Rs. 4650659	25424.25	118.42	Rs. 3010638	16949.50	99.36	Rs. 1684056

Value of Damage, Loss, and Recovery: Summary (INR crore)

Damage Phase I Districts	**Loss**	**D+L**	**Total recovery**
1221.88 Cr. INR	24.407 Cr. INR	1246.28 Cr. INR	1175.68 Cr. INR
Damage Phase II Districts	Loss	D+L	Total recovery
1062.47 Cr. INR	0.163 Cr. INR	1062.63 Cr. INR	1177.97 Cr. INR
Phase I + Phase II	24.570 Cr. INR	2308.91 Cr. INR	2353.65 Cr. INR

Special Note: Loss calculated above excludes cost of demolition and removal of debris of the 24,885 buildings and cattle sheds to a safe place (to be under DRR).

3.12 IMPACT OF RECOVERY

Reconstruction, repair and retrofitting of 24,885 houses, huts and cattle sheds will have an impact on several aspects of the people, environment and other aspects of the human living in the twelve districts in the coming 18-24 months. 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 the recovery to maximise the environmental and social benefits towards a resilient future Himachal.

3.12.1 IMPACT OF RECOVERY ON BUILDING MATERIALS AND SKILLS:

The damage caused by the landslide has resulted in a huge demand for material 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 4948 destroyed buildings will require about 4 crore bricks and proportionate quantities of cement, steel, sand and aggregates. If one considers the repair, retrofitting and reconstruction of the huts and the cattle sheds the quantities of materials will be much more. Since the recovery period is 18 months, there is a need for preparing procurement plans for each Tehsil at the earliest to enable reconstruction work to start. It is very important to look for alternatives such as stones from the debris.

3.12.2 IMPACT OF RECOVERY ON LIVELIHOOD AND EMPLOYMENT

While the landslide has been a disaster, its recovery opens up 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. Alongside, there will be opportunities for skill upgrading through BBB training programmes. Sorting of the stone blocks 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 the recovery

3.12.3 IMPACT OF RECOVERY ON THE ENVIRONMENT:

While the reconstruction, repair and retrofitting are good opportunities for creating resilient housing alongside creating local level employment, the use of brick, cement and steel would have a negative impact on the environment. *Brick (4 crore) alone will lead to a significant quantity of emission of CO2 excluding the emission caused by transportation*. It is very important that the reconstruction programme 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 the environment. Therefore, Himachal can reinforce this approach and promote sustainable green development with BBB features.

3.12.4 GENDER, SOCIAL INCLUSION AND DISASTER RISK REDUCTION

: During the field visits, a number of women-headed families were found to be in poor conditions. These HHs should be prioritised in the recovery framework. People with disabilities are also one of the most affected ones due to the disaster. All these groups will need enhanced technical and financial assistance from the government for rebuilding their houses. Safe settlement planning, introducing building bye laws and building permit systems, awareness and capacity building of the people and the construction workers will enhance resilience. *Formation of women's SHG to support the reconstruction by quality control supervision will be a tool to empower women and give an opportunity to have alternative skills for livelihood.*

3.13 SECTOR RECOVERY STRATEGY

In Himachal, 846 plots will require relocation while some out of the 4948 totally destroyed houses will need relocation if the landslide and settlement continues beyond safety limits. There is a need for in-situ repair and retrofitting of 10,986 houses provided that the landslide has stopped and the plots are at safe distance from the river banks. Some of the towns (such as Solan) have exceeded their carrying capacities far beyond and any new construction would have non-linearly detrimental impact endangering the people's lives. Since winter will begin in another month and a half, there is an urgent need for relocation under the present recovery intervention.

Historically, many attempts for relocation have failed due to a number of reasons, out of which, the most frequently occurring cause has been a lack of public participation in the process, starting from site selection down to design and construction of houses. Relocation should consider the fact that Himachal's economy largely depends upon orchards and tourism.

The housing recovery must be people-centric but environmentally compatible, and be built through a consultative process involving local people and other stakeholders including geologists, ecologists, developmental experts, engineers and technologists etc. Such plans may be subjected to a review for their impact on people's livelihood, natural resources, environment and social aspirations of development, besides opening a 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 Himachal will require a team of dedicated workers working on a mission mode since the line department staff are already overloaded with the existing housing and other projects and programmes.

The reconstruction, repair and retrofitting works should be Owner-Driven and wherever feasible Community-Driven. There is a strong need for techno-managerial support to ensure that the owner-driven approach results in high quality resilient housing in Himachal based on appropriate green, cost effective technologies with BBB principles. In the implementation of the recovery programme, women headed HHs, people with disability, the elderly and the widows should be given high priority by taking them up in the first phase of the recovery and by offering additional facilitation.

There is a need for strengthening the MIS by capacity building of the key staff members. Despite being in a vulnerable zone, there is a lack of database, land-use map, and regulation policies on housing in Himachal. Therefore, the recovery interventions should enable the local government to digitise information and acquire high quality data by using modern methods (e.g. drone). By

adopting such measures, the recovery interventions will ensure the effective and efficient use of resources and ensure that the recovery is within 18 months and are sustainable in the long run.

3.14 ROLE OF LINE DEPARTMENT

All the government construction departments need to coordinate 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, an adequate number of staff should be deputed with a clear job description. Considering this situation, twelve HFCs could be established in twelve districts. The HFCs would assist local house owners to develop designs, sourcing materials, and ensuring quality control. Local NGOs on a time bound contract could be appointed to run the HFCs.

The young and well educated Patwaris are the key role players for building damage assessment, however, they are not trained in damage assessment. If they are trained, the quality of damage assessment will improve significantly. However, the JEs must be a part of the assessment team. There is a craze for RCC framed structure in the state even if one constructs a two storied building. The government needs to encourage the use of confined masonry and upgraded Kath Koni architecture, which are cost effective, resilient and green

3.15 RESILIENT HIMACHAL (BUILDING BACK BETTER)

In Himachal, reconstruction, repair and retrofitting must be multi-hazard safe (including zone IV and V of seismicity) and not just focused only on landslide and flood. Recovery should be integrated with DRR measures built into it (priority 4 of Sendai Framework). Under the recovery programme, the retrofitted houses would act as good examples of resilient houses and inspire, educate and motivate others in the community. The objective is to bring in a culture of resilience as a part of life and practice which would make Himachal resilient for the future hazards. The following actions will ensure this objective.

- Prioritise the stabilisation of the slope through advanced engineering techniques. Geo-technical studies should be conducted to determine the most suitable stabilisation methods, which might include retaining walls, soil reinforcement, drainage systems, and vegetation control.
- Implement flood-resilient construction practices for new houses and renovations, considering elevation, foundation, and flood-resistant materials.
- Needs a waste management system to prevent direct disposal of kitchen waste into the land.
- Needs awareness campaigns on flood risks, early warning systems, and emergency preparedness.
- Enforce regulations to restrict construction in flood-prone areas (along riverbanks).
- Invest in comprehensive flood management infrastructure, including river embankments, floodwalls, and drainage systems.

3.16 PROPOSED ECONOMIC AND TECHNICAL ARRANGEMENTS FOR RECONSTRUCTION

- The DM's office would be the nodal agency for all the reconstruction works under recovery
- The affected people will get the same degree of technical support at door steps for reconstruction, repair and retrofitting.
- Provide techno-managerial support at door steps of the affected people, through the HFCs coordinated by the DC-office. HFCs will provide information on the ongoing governmental programmes to the HHs, e.g., financial assistance, toilet, drinking water, solar lighting programmes and also inform people what they are entitled for. This will make the people informed citizens.

3.17 FUNDING MECHANISM

In the post-disaster situation of Himachal, smooth disbursement of adequate financial assistance is key to the successful implementation of the housing reconstruction. This includes the government's financial grant, loan, or any other form of financial support; e.g., through revolving funds. The challenges of the housing recovery in Himachal would be, i) the government grant is not sufficient to construct a basic house, ii) households may not have savings or whatever they had might have been spent for food, accommodation, medicines, and other basic needs after a disaster, iii) unpaid loans such as Kisan Credit Card. The situation could be difficult for the poor and vulnerable households.

One crucial issue in funding is; the Banks require guarantee or collateral including a repayment plan and regular income source before lending a credit. This may not be available to many disaster-affected people. A comprehensive plan should be prepared based on the BFIs' requirements and the socio-economic conditions of the disaster affected households. There could be a need for a policy amendment in this regard.

Another important issue in the financial assistance programme is the potential misuse and diversion of funds by the beneficiaries. At the planning stage, socially suitable mitigating measures should be formulated. The beneficiaries should be duly made aware of the consequences of misuse and diversion of funds. All the factors discussed above should be considered while developing the financial disbursement system.

Generally, the poor and the vulnerable households do not have savings (cash in hand) to pay for the material procurement and daily labour charges, if the tranche release is delayed (may happen due to a number of reasons). This issue could be resolved by setting up a revolving fund scheme where members could access short term loans for the continuation of reconstruction. The beneficiaries should be duly made aware of the consequences of misuse and diversion of funds. All the factors discussed above should be considered while developing the financial disbursement system.

For Himachal, it may be suggested that the government provides assistances per affected HH as follows;

- NDRF/SDRF ₹1.3 lakh per HH for the houses totally destroyed (kutchha or pucca)- already approved
- NDRF/SDRF ₹Rs 12,500/HH for repair of the damaged pucca houses- already approved
- NDRF/SDRF ₹Rs 10,000/HH for repair of the damaged kutchha houses- already approved

- 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
- organise 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 the EMI including the portion paid by the government- proposed

3.18 DESIGN ASSISTANCE

Recovery should be people-centric. People's aspiration for their dream home should be in the centre of the reconstruction. This would be done by conducting participatory design exercise involving the affected people. In this process a basket of designs would be made available to the people. However, every HH would take the final decision on house design. People would have the flexibility of customising the design to suit their pattern of living and culture. Design and detailing would have the flexibility of expansion to suit individual needs and grow incrementally.

Under recovery, a house should be viewed as a complete unit with toilet, drinking water facilities, solid and liquid waste disposal system, energy and livestock. The facilitators of the HFC would act as a technical support to the people and prepare the working drawings, estimation of materials and cost of house construction. House design and access to the common facilities should be barrier free for the people with disability (both temporary and permanent), the elderly, pregnant women, and children. This aspect of house design is very important especially during emergencies.

3.19 MATERIALS, TECHNOLOGIES AND COSTS

Stone-based walling and foundation would be the most cost-effective system of reconstruction since the basic materials could be reclaimed from the debris. Having said that, it must also be remembered that the weight of the walling system should be reduced by reducing wall thickness, using hollow concrete blocks, cellular light weight blocks to make the structures seismic safe. In the reconstruction works, the house owners will select the materials. The home owners may order the construction materials directly or may take help of the facilitators from the HFCs. In consultation with the government engineers, the facilitators of HFC will prepare the estimates, working drawings, models etc.

3.20 BUILDING CAPACITY FOR BBB

The key role players in BBB are the masons, contractors, engineers, district, block/Tehsil level support staff. Resilient development is only possible when the whole team at the state, district and other related offices understand the philosophy of BBB. Therefore, training of all of them should be the top priority and part of immediate response. The first one to be trained is the existing masons to develop skills in cost effective, labour intensive and green technologies with multi-hazard safety to ensure that all houses are indeed built back better.

The HFCs, on exit of the entire housing recovery, would continue to work in the different parts of the state and continue to support the government and private housing programmes. The facilitators would remain as human resources for future decades to come, this would help change the Himachal landscape to a resilient and eco-friendly environment. It is important to create a database of the existing masons, both migratory and local, for the ease of procurement of their services wherever needed.

3.21 IMPLEMENTATION METHOD

Owner-driven reconstruction and repair, with technical support of the HFC would be a feasible option in the present context. However, reconstruction of houses for the people with physical or mental disabilities, the elderly, women-headed households, etc., would need government support as well as additional support of HFC. All hands-on mason training programmes conducted by the HFC will be at building sites so that additional technical guidance and manpower can be provided to the house-owner.

3.22 MONITORING AND QUALITY CONTROL

People do need active monitoring and control to avoid the kind of disasters Himachal is facing over time. There is a need for high-tech systems for monitoring and control of the reconstruction work since high quality construction would reduce frequency of maintenance and enhance durability of the buildings. The technical staff at ground level would use Mobile phone-based data collection and documentation methods. The HFC would coordinate between the beneficiaries and the material suppliers.

3.23 CULTURE AND HERITAGE

The traditional architecture of Himachal, Kath Kuni and Dhajji are almost extinct. It was a rich form based on local materials and evolved by the people holistically over a long time. The traditional architecture of the place has most of the seismic safety features which should be revived and brought into the mainstream of contemporary architecture. The traditional builders, some still exist, should be identified and a training programme should be conducted to revitalise the traditional building form, which is a pride of the place. Alternatives to timber and stone roof would be thin RC bands and CGI that would help revive the modern vernacular of Himachal.

3.24 KEY RECOMMENDATIONS

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

- **Prepare a Micro-zonation map of land subsistence and landslide of Himachal**. Refer to good examples such as Aizawl Municipal Corporation.
- Decisions on buildability of safe structure would require **multi-hazard maps in 1:5000 scale**. Site selection and type of building structure should be according to the multi-hazard maps.

- **Designate the no-building zones in the land-use maps** (e.g. flood-prone areas along riverbanks, unsafe slope). Anyone building in the no-building zones will not be entitled to receive any government facilities (grants or reliefs) should there be a disaster
- **Implement flood-resilient construction** practices for new houses and renovations, considering elevation, foundation, and flood-resistant materials.

Town Planning, Building Rules and Enforcement

- Review the existing town and country planning act and update it from a multi-hazard point of view. It must be in place at the earliest. *There is an immediate need for introducing a rule that buildings should not be more than three- storied (without soft storey) in areas outside the TCP notified areas. However, if one wants to have a three-storeyed building and a car parking floor as per the TCP Act Appendix 8, one has to get the design approved by the TCP.*

- Review the existing building by laws and update it from a multi-hazard point of view.

- Establish an appropriate techno-legal regime that stems from the development of the hazard-zonation maps at adequate scales, making building rules applied at house level, and capacity development of regulatory authorities.

- Strengthen enforcement mechanisms in all zones, with adequate staffing of competent regulatory agencies and capacity-building of regulatory staff members However, awareness campaigns appear more useful since compliance with rules is better than imposition.

- Introduce penalty for violation and incentives (non monetized) for compliance

- Develop a mechanism for structural health audit of the existing stock of buildings

Adopt 'Build back Better' in reconstruction, repair and retrofitting and Integrate Disaster-Risk Reduction and Environment Safety Considerations

- Revitalise the traditional construction Kath Kuni system which has the resilient features against earthquakes. Use RCC bands in stone masonry as an alternative to timber, which will reduce the existing wall thickness from 600mm to 300mm. As a stop gap, CGI sheet could be used instead of stone plate, however, there is a strong need for an alternative to CGI. Encourage this system in reconstruction- device a non-monetized incentive for HHs who would adopt this system.

- Introduce slope modification regulations to maintain stability of hill slopes, e.g. slope cutting, filling, increasing the amount of groundwater penetrating into slopes, and disposing of sewage onto slopes, etc.

- Constitute an expert committee at the state level to develop guidelines for hillside construction. Refer to the good examples in this regard, especially some of the north eastern states.

- Lack of insurance of the buildings is due to a lack of awareness and lack of access to the facilities. In absence of building bye laws and building permits not being mandatory, the people cannot access building insurance. Provide access to the people of Himachal to insurance. The insurance agencies should train their inspectors to carry out multi-hazard risk assessment of buildings and calculate premiums. Special efforts of the government would

be necessary to ensure that the insurance premium for the widowed, elderly, PWD, etc. could be subsidised or be paid under convergence

Relocation and Resettlement Planning

- Select safe sites for relocation only after thorough examination of the land by geologists. Small settlements spread over a large area will reduce negative environmental impact
- *Review the existing land use acts to find out land for relocation*
- In relocation, a group of dwelling units should have an integrated assigned space to allow the residents to carry out some of their small livelihood activities. Similarly, the complex may also include a multi-functional open space for livelihood related activities.
- Convergence with the various governmental programmes for WASH, access roads, solar lighting etc. should be ensured.
- Create a comprehensive plan for early recovery needs to ensure that the affected HHs receive the necessary support and assistance during the relocation/rehabilitation process, while also ensuring that the local economy and tourism industry are not severely impacted

Temporary Shelter

- Identify geologist-certified safe sites for temporary shelter.
- Provide techno-managerial support to the affected HHs to build temporary shelter – organise construction materials.
- Identify the HHs who are temporarily displaced and currently living with relatives, neighbours and in rented premises. Provide transportation facilities to the affected HHs to move to the temporary shelters.
- Ensure that the temporary shelters are close to the peoples' place of livelihood and have adequate mechanisms for education, health, water, and sanitation facilities.

Monitoring and Control

- The most crucial component of the recovery is monitoring and control and to ensure that, there is a strong need for additional supervision staff to be appointed for the recovery period working with the existing government staff. Mobile based applications should be developed for on-site data monitoring and acquiring data on progress and quality of the construction. HFC would be a good support to the recovery implementation process.

Design and Technologies

- Involve state level institutes to carry out resource mapping exercises to prepare zone specific designs and technologies based on participatory process (the affected people at the centre).

Mode of Implementing recovery

- Adopt an owner-driven housing recovery model. Adequate awareness campaigns are necessary to make ODHR successful.

- Additional help in recovery is necessary for the women-headed HHs, PWD, elderly, pregnant women and socially disadvantaged HHs. Converge with “Himachal Grihini Suvidha Yojana”

- ODHR will need techno-managerial support at door steps. In ODHR, there is a need for mid-term correction of construction mistakes- needs periodic supervision.

Funding

- The state government to finalise the sources of funding.

- The housing need (covered area) of the people in Himachal being much higher than the national average, needs alternative sources of funding- explore the possibility of revolving funding by the communities.

- Arrange for funding to establish and run HFCs for 18-24 months.

Immediate Actions

- Identify the sites by the road side where the buildings are structurally safe but as a whole unsafe because of potential future landslides. Many such buildings could be saved if the retaining walls are constructed at the earliest.

- The local government should release information on severe, high, and medium risk at the earliest and inform about phase-wise relocation and evacuation needs. Communication of necessary information will ensure building trust in the communities and ensure community engagement in permanent rehabilitation

- Relocate people from 'unusable and demolished' buildings. Citizens must be given choices. The relocation must be prioritised based on the following parameters: 'Elderly/ Landless women and Single women-headed households, Landless Citizen, Households with land in risky areas. The prioritisation should be communicated and consulted with various citizen groups.

- Appoint the team of experts consisting of the local technical institutes to carry out a detailed damage assessment of the buildings in all twelve districts. They need training on how to carry out detailed damage assessment and retrofitting of buildings.

3.25 Implementation Plan

The housing recovery process, in consultation with the state government, has been assumed to be of 18 months. This requires a “zero-time-wastage” approach in the recovery process. The present recovery process has been divided into two phases; a) short-term and, b) medium-term. 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 in Himachal.

Implementation Timeline: Short and Medium--term Interventions for Recovery

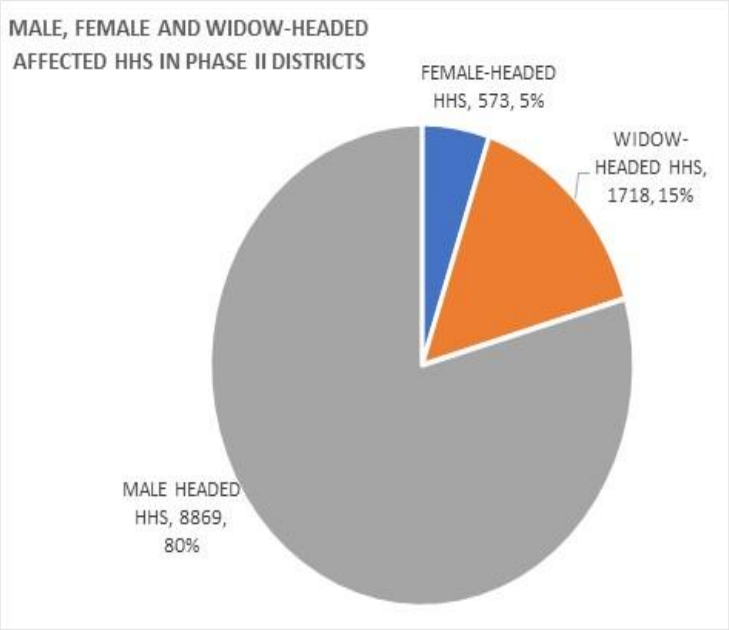
Sr. No.	Period and Task	Lead department	Duration-Parallel activities
	SHORT TERM 0–12 MONTHS (Rs 1569.10 Cr, i.e. @ Rs 392.27 Cr. /quarter)		
S1	Form a project implementation team by coordinating with the line departments	HPSDMA	3 MONTHS
S2	Establish Housing Facilitation Centres (HFC) to promote speedy, safe and sustainable construction using locally available materials	HPSDMA DC	3 MONTHS
S3	Identification of sites of Rehabilitation for families Affected by Land Loss		
S4	Construction of temporary shelters for families Affected by Land Loss and Damaged Houses	HIMUDA+ DC	3 MONTHS
S5	Carryout detailed engineering (Holistic planning, design, construction of Confined Masonry Buildings) analysis of rehabilitation sites for families affected by Land Loss and Damaged Houses.	HIMUDA+ TCPO+ HPSDMA	3 MONTHS
S6	Training of Masons, Unskilled Labourers, Engineers for Best Construction Practices, retrofitting, Structural health audit of existing and newly constructed buildings / with hands-on exercise with examination and certification mechanism	HIMUDA+ HPSDMA	6 MONTHS
S7	Mass awareness on building rules, building codes and their compliance	HIMUDA	12 MONTHS
S8	IEC Material (preferably in pictorial form) on Best Construction Practice, Retrofitting, Maintenance for awareness of Community, Training, Drills, Skill Development activities in construction sector	HPSDMA	12 MONTHS
S9	Identification of sites of Temporary Shelter for families Affected by Land Loss and Damaged Houses	HPSDMA	3 MONTHS
S10	Reconstruction of Damaged houses, Huts and Cattle shed	HIMUDA	12 MONTHS
S11	Identification of sites for dumping of Construction Demolition Waste at different locations	HPSDMA	3 MONTHS
S12	Systematic disposal of Construction Demolition Waste with a view to Recycle / Reuse for value added product	PWD	12 MONTHS
S13	Promotion of Traditional Construction with focus on hazard resiliency in construction	HPSDMA	12 MONTHS
S14	Implementation of planned sewerage and drainage system for the community	MCD	6 MONTHS
S15	Reconstruction and retrofitting of Septic Tank	MCD	6 MONTHS
S16	Model Retrofit of Building Program	HPSDMA	12 MONTHS
S17	Procurement of special equipment for monitoring and control	HPSDMA	12 MONTHS
S18	Strengthen resources in Himachal Pradesh: Technical institutions/ knowledge tapping, Building materials	HPSDMA	12 MONTHS
	MEDIUM TERM 0–18 MONTHS (Rs 784.5 Cr @ Rs 130.76 Cr/quarter)		
M1	Develop Micro zonation (Multi-hazard) Map in 1:5000 scale for Himachal	HPSDMA	12 MONTHS
M2	Based on Micro zonation map of Landslide, treat the un-stabilized slope	HPSDMA	12 MONTHS
M3	Develop typed design of housing (complete detail including architecture, structural (confined masonry), services, etc.	HPSDMA + HIMUDA	6 MONTHS
M4	Establish Techno-Legal Regime Mechanism in Himachal Pradesh	HPSDMA	18 MONTHS
M5	Reuse, Recycle of Construction Demolition Waste into building components	HPSDMA	18 MONTHS
M6	Channelize planning processes, stakeholder consultations and IEC campaigns for better outreach and introducing people to the urban dynamics.	HPSDMA	18 MONTHS
M7	Master Plan for Himachal Pradesh with emphasis on controlled land-use, Slums & unauthorised constructions, Constructions in No-Development Zones, Infrastructure development (roads, water supply etc.)	HPSDMA + TCPO	18 MONTHS
M8	Creation of local think tanks with local expertise should be contemplated and made a reality	HPSDMA	18 MONTHS

3.25.1 Priorities

- Relocation/retro-fitting of women-headed houses, persons with disabilities and vulnerable group

- Establish HFCs at the earliest and make them operational at twelve locations
- Conduct an audit on how many skilled masons and labourers exist in Himachal and where they are located (migratory and local). Also, carry out skill-gap analysis and implement training (BBB)
- Prepare a procurement plan of the construction materials which are available in the district and assess how much is to be acquired from local sources and neighbouring states. Conduct resource-mapping exercise through the HFC
- Prepare a detailed construction management plan of the reconstruction work, along with human resources requirements and a mechanism for monitoring and quality control.
- Immediately establish a control room at district offices, networked with HFCs and HPSDMA for tight supervision and technical support to the affected people. The control room should be led by a professional Project Manager with computerised planning, scheduling, monitoring and control skills
- Documented the entire process from day 1 of the housing recovery process.

Figure 7-1 Prioritise the widow and women-headed HHs in recovery



4 Education

4.1 SUMMARY

The PDNA for the education sector was conducted through the leadership of the HP State Disaster Management Authority (Revenue- DM Department), Government of Himachal Pradesh. The exercise was conducted through a joint effort of the State Government and District Administration in 12 districts in two phases due to two disaster events that occurred in July 2023 and in August 2023. In the first phase of assessment 6 districts namely Chamba, Kinnaur, Solan, Mandi, Kullu and Shimla were covered, which was impacted in the July event. The second phase of assessment and data collection for assessment was undertaken in Hamirpur, Kangra, Una, Lahaul- Spiti, Sirmaur and Bilaspur including few districts which were impacted in the first phase.

The Education Assessment was led by the Deputy Directors of Higher Education in coordination with the Elementary Education department. Knowledge partnership was through the National Disaster Management Authority.

4.2 OBJECTIVES

The objectives of this assessment were 3-fold:

- Validate the Damages and Losses reported by the Education Sector to arrive at appropriate costs (estimates) of the recovery and reconstruction needs using the principle of Build Back Better.
- To Train and Orient the District level education officers in the process of preparing the Damages and Losses report
- Chalk out Recovery and Reconstruction plan over a 3-year period (Short/Immediate, Medium, and long term)

The PDNA was conducted in 12 districts of the State in two phases, the first was in August and second was in September. The data provided by the State and Field visits enabled the team to arrive at an approximate figure of Damages and Losses and the cost for Recovery and Reconstruction.

- As per data a total of 1209 schools were affected from minor to fully damaged status. For PDNA analysis only 766 schools, which are partially, severely, and fully damaged are considered and of which 569 are elementary and middle schools and 197 are Senior Secondary Schools (includes ITIs and Government Colleges). Among the 766 schools, 52 of the elementary schools and 16 of the higher secondary schools are fully damaged.
- The net value of the infrastructural damages to school buildings, WASH and Mid-Day meal kitchens managed by the education sector at INR 183.74 Cr, including cost of INR 2.2 Cr for replacing teaching and learning materials
- The total recovery and reconstruction needed for the education sector for the next three years, using the principle of Build Back Better is estimated for 12 districts is INR 304.97 Crs and Teaching and Learning materials is 2.16 crore. Approximate cost for recovery for each of the 12 districts is INR 25 Cr.

The assessment covers general school education (grades 1–12), higher education, vocational education, and non- formal adult education. The cost shows a drastic high in relation to reconstruction activities. The higher side of the cost is based on fragile land conditions, attribution to the weather conditions, from safety parameters of buildings and increase in the cost of Teaching and Learning Materials that are important for Quality Education and to regain the lost time for learning among the affected children.

The education sector suffered damages and losses due to floods and severe landslides, affecting existing buildings and stoppage of new constructions works in the school campus The chapter also provides estimates and strategies for recovery and reconstruction, using the principle of 'Build Back Better' for infrastructures, incorporating Comprehensive School Safety (Covers DRR and Child Protection) and Climate Change measures.

The major recovery strategies and innovations suggested are based on an approach of "Zero Deaths and Zero Dropouts". The above approach emphasises comprehensive school safety measures and protection of Child abuses and exploitation. If the above approach is considered, it not only supports children, but also the community at large. The following initiatives are suggested as part of Recovery and Reconstruction mechanisms for building resilience of the School Department and Children.

- Ensure the infrastructure investments are based on building codes and are environmentally sustainable.
- Develop infrastructural designs for schools and educational centres taking into context topography, climate, local conditions, which could include principles of sustainable building in all educational centres.
- Strengthen the ongoing school safety program with a comprehensive school safety program which addresses 3 broad areas – Safe Learning Measures, School Disaster Management and Risk and Resilience Building.
- Strengthen the mental health programme for students and teachers (psycho- social support; school counsellors; integrate it in the curriculum).
- Improve access path to schools either through traditional ways or adopting local mechanisms
- Create awareness on child protection issues and strengthening mechanisms to reduce abuse, exploitation, and violence against children (sharp rise of POCSO cases in the State from 2021)[2]

4.3 EDUCATION PROFILE- THE PRE-DISASTER CONTEXT

Literacy rate in Himachal Pradesh has seen upward trend and 82.80% of the population are literate as per latest population census. The male literacy stands at 89.53 percent while female literacy is at 75.93 percent. (Data source: Department of Statistics -2011 Census). About 89.53% literacy rate for males and 75.93 percent for females.

[2] https://www.tribuneindia.com/news/himachal/in-himachal-pocso-cases-up-44-in-6-years-403627

The Average dropout level at Primary level is Zero and at Elementary level is 1%. Whereas, in relation to GER for Higher Education (18+ students) is 40.8% and of the SC students GER is 29.2% in 2022.according to All India Survey on Higher Education (AISHE)

Key Education Indicators

Indicators	**Himachal Pradesh**		Source
	M	F	
Total Literacy rate	89.53	75.63	
Literacy rate of SC and ST			
Annual average dropout rates at Primary level	0	0	https://educationforallinindia.com/dropout-rates-in-schools-in-india. 2021-22
Annual Average dropout rates at Elementary level	0.6	0.5	
Annual Average dropout rates at secondary level	2	0.9	

Education and Technical Sector at a Glance

Sub-Sector	**Number of Students (Lakhs)**		**Number of Institutions**	**Personnel**	
	Boys	**Girls**		**Male**	**Female**
Primary	**148906**	**153907**	**10657**	**13980**	**9929**
Middle/Elementary	**106586**	**108259**	**1996**	**4792**	**1822**
Higher/Secondary	**170673**	**166648**	**2749**	**22746**	**13542**
Technical/Vocational			**159**		
Degree Colleges			**178**		

(Source **:** https://himachalservices.nic.in/economics/pdf/StatisticalAbstract_2017_18.pdf**)**

4.3.1 SAFE SCHOOL INITIATIVE OF HIMACHAL PRADESH

Under School safety initiative, efforts have been undertaken to mainstream disaster risk reduction (DRR) and safety in school education. The school safety program of HPSDMA in collaboration with the education department has provided basic orientation to Hazards, Risk and Vulnerabilities. Majority of teaching faculties and students are oriented towards earthquakes. School level disaster management plans are prepared and according to school authorities 3 mock drills are conducted every year.

In addition to the school safety program, HPSDMA through DDMAs have taken up capacity building programs in collaboration with UNDP.

Further, most of the schools in the state have developed and implemented School Disaster Risk Management Plan and as a result not a single school child or teacher have lost their lives during the

floods/landslides. This is primarily because of the awareness through IEC materials, mock drills and Planning exercise conducted across the schools in the state.

4.4 DAMAGE AND LOSS ESTIMATE

The unprecedented more excess rainfall during the months of July and August 2023, led to floods, flash floods and landslides, causing minor level to fully damaged status. As per data collected in both the phases, 66 education facilities were totally damaged, 204 facilities severely damaged, 486 partially damaged and 409 schools suffered minor damages.

As part of the relief measures the State Government ensured that all the schools could fully function, by clearing debris and slush, and functioning within the school campus to operate. The PWD department has assessed some severely and fully damaged schools to be abandoned as part of safety measures.

Phase 1 - School Damage Data						
School Facility	1_No Damage	2_Minor Damaged	3_Partially Damaged	4_Severly Damaged	5_Totally Damaged	Grand Total
Degree College	3					3
Primary School	349	249	263	35	26	922
Secondary School	108	87	89	8	11	303
Vocational Training Institute		1				1
Grand Total	**460**	**337**	**352**	**43**	**37**	**1229**

Phase 2 : School Damage Data						
Select Educational Institute Category	1_No Damage	2_Minor Damage	3_Partially Damaged	4_Severly Damaged	5_Totally Damaged	Grand Total
Higher Secondary School	55	8	10	23	3	99
Middle School	9	4	5		1	19
Primary School	289	48	94	117	25	573
Secondary School	81	12	24	21		138
Training Institute	1		1			2
Grand Total	**435**	**72**	**134**	**161**	**29**	**831**

The damages as occurred to other facilities in the schools, that are essential for the operation of the schools effectively, such as Mid-Day Meal Kitchens, Access roads to schools, sinking of breast/reclining walls that protects school buildings are damaged completely The damages have impacted nutrition service delivery (Mid-Day Meal), the teaching and learning process, is affected.

According to the information provided by the State and observations at the field level, the impact is severe and needs long-term strategy for Recovery, Reconstruction and Resilience Building, through a collaborative and coordinated effort of multiple stakeholders. The school education department needs to find various financial instruments and Risk transfer mechanisms, in the emanating new scenario in Himachal Pradesh.

As per information from 1165 education facilities , are showing either minor, partially, severely, or fully damaged. In 219 schools the school boundary walls are damaged. In 88 schools WASH units need to be rebuilt and majorly in about 187 schools the cost of retaining walls to be supported, as they are either cracked and fallen on school buildings or have lost the ground or tilted.

The Mid-day meal kitchens are damaged in 71 schools. For about 23 schools the access roads to attend schools are damaged or washed away or have become narrow making it difficult to walk to schools. In about 82 schools support is required for repairing benches for using them again and computer labs in 11 schools must be replaced, as the CPUs are completely damaged due to flooding and inundation of classrooms.

Damage to facilities in Schools

	Rooms	Boundary walls	WASH units	Retaining walls	MDM units	Access to Schools
Chamba	47	7	2	10	2	2
Kinnaur	0	2	0	5	0	0
Kullu	110	50	17	63	5	7
Mandi	24	10	1	6	0	3
Shimla	498	120	19	52	8	10
Solan	97	1	2	31	1	1
Bilaspur	194	20	20	5	16	0
Hamirpur	55	3	10	5	10	
Kangra	185	6	10	3	12	0
L&S	4	0	0	0	1	0
Sirmaur	89	11	3	6	14	0
Una	24	5	4	1	2	0
Total	1327	214	88	187	71	23

Note: WASH covers damages to Water and Sanitation facilities

4.4.1 ASSUMPTION FOR DAMAGE ESTIMATE CALCULATIONS

- In Himachal Pradesh, the typology of school buildings and their respective built-up areas vary significantly. To calculate damage costs for educational buildings, we made the following assumptions: primary schools have a total built-up area of 250 sq.m, secondary schools, middle schools, and training institutes have 500 sq.m, high schools and higher secondary schools have 650 sq.m, and government colleges have 1,000 sq.m of built-up area.

Area estimated for Education buildings		
Education Facility	Avg. Built up Area	Average replacement Cost (Approx)
Primary School	250	76.5 Lakh
Secondary School	500	1.53 Crore
Middle School	500	1.53 Crore
High School	650	1.98Crore
Higher Secondary School	650	1.98Crore
Government College	1000	3.05 Crore
Training Institute	500	1.53 Crore

- The average replacement cost for the civil infrastructure is derived from HIMUDA standards of Rs 30,597 Sq.m.
- The replacement cost for non-structural amenities such as furniture, equipment, laboratory facilities, sports equipment etc. is considered as Rs 2 Lakh for Primary School and Rs 5 Lakh for all other education facilities.
- Any education facility which has reported damage to retaining walls additional amount of Rs 2 lakh per school was added to the loss estimate.
- To calculate the overall damage cost, a damage factor was taken into account, which varies based on the extent of damage. For minor damage, the average replacement cost was set at 10%, for partially damaged structures, it was established at 30%, for severely damaged buildings, it amounted to 70%, and in the case of total damage, the full 100% replacement value was considered.

Damage Category	Damage Factor
No Damage	0
Minor Damage	0.1
partially Damaged	0.3
Severely Damaged	0.7
Totally Damaged	1

- Loss estimate : When estimating the loss, any expenses related to renting, debris removal, or any other additional costs incurred by the educational facility are included as part of the overall loss estimate.

- The overall damage estimated as per the current replacement cost is 369.14 Crore. And Damage loss estimate is 369.39 Crore. The maximum number of damage is reported from Bilaspur District, Shimla District and Kangra District.

Damage and Loss Estimate		
District	**Damage Estimate**	**Damage + Loss Estimate**
Bilaspur	90.18	90.23
Chamba	13.79	13.79
Hamirpur	22.64	22.72
Kangra	56.08	56.13
Kinnaur	0.05	0.05
Kullu	23.91	23.91
Lahaul & Spiti	1.03	1.03
Mandi	17.49	17.49
Shimla	82.11	82.12
Sirmour	29.45	29.46
Solan	25.35	25.36
Una	7.05	7.07
Grand Total	**369.14**	**369.39**

EFFECTS ON INFRASTRUCTURE AND PHYSICAL ASSETS

Based on the quantitative data and validation of assessment team in the field, indicates that the Rains in July and continued heavy downpour in August/Sept has led to numerous landslides and floods causing sinking of ground and erosion of land, that has either damaged the schools' infrastructures or nor habitable due to cracks in the buildings and sinking of playgrounds.

4.5 IMPACT ON SCHOOL EDUCATION

As per the data available, including minor damages, a total of 1165 education were impacted in 12 districts, wherein schools had to be shut ranging from 4 days to 30 days. This affected functioning of schools, learning environment and mid-day meal programs.

The teaching and learning were affected across the State. Most of the education institutions were closed for a period between 4 days to 30 days depending on the impact of damages. The closure of schools had less impact on teaching and learning at primary level, whereas schools at secondary level had major impact as their science lab and computer labs were damaged/destroyed.

The unsafe environment is prevailing as of present. According to data, on an average 12 days of learning instruction was lost by the schools due to floods, landslides and cleaning of muck, pathways not being functional and damage to facilities.

The closure of schools for monsoon was a province, no deaths and no casualties reported in the school campus. In the post disaster, the school's management had the major task of assessing the damages to schools and clearing the debris and muck in the schools. Where the school buildings are affected severely or fully, the school management has made alternative arrangements of conducting classes within its premises in most cases. But that has affected the quality of teaching and learning.

As per data, about 19 schools' management have incurred additional costs ranging from Rs.300/- to Rs.41,950/-. In Shimla district 13 schools' management are incurring additional cost, 3 schools in Solan, 2 schools in Kullu and 1 school in Chamba. Though the loss of class hours can't be quantified, it can be observed/assumed that it would impact on the short term, wherein the school teaching faculty must put extra hours, especially for 10th and 12th standard students to prepare them for Board Exams.

As per the information from the school management the attendance to schools is normalised in post disaster scenario.Though the period of lost instructional days can't be quantified, the conditions of the schools and the environment of fear will impact the learning process. Playgrounds have either sunk/dipped a bit from its natural positions is an area of concern. One important aspect to be noted is the damage to roads, and access paths to schools. The present situation will impact the overall performance of the children.

4.5.1 Impact on Service Delivery and Governance Mechanisms

The Districts Education Office or the State Education offices had no damages during the floods and landslides. As a result, the governance mechanisms were able to function and provide necessary support at the ground level. The primary and secondary education units function independently and that provides focused support to the respective units.

The mid-day meal program is affected to certain extent, as transportation of grains to the designated schools are damaged and getting supplies on time is affected.

4.5.2 Increased Risk and Vulnerabilities

The State's major focus was on earthquakes and a number of simulation exercises were conducted for the same. Most of the teachers and students are aware of their roles and responsibilities during earthquake hazard events. But the scenario for hazard events and risks is fast changing in the hills due to various factors – Infrastructures development, no adherence to building bye-laws, deforestation, exposure of ground to heavy rains in short spells or incessant rains for longer periods are causing flooding and landslides. Landslides had occurred earlier, but were not menacing, but whereas, in the present context the number of landslide events has increased across the State is a worrisome scenario for the State Administration, District and Local Self Governments.

Risks have increased to Schools, as many schools are in flood prone zones (closer to the banks of rivers or streams). Landslides can cause high mortality and casualties from rapidly flowing water and debris. Risks have increased to buildings, roads, and pathways, thus, vulnerability has increased for

school children and teachers, as cloud burst has increased during rainy seasons and scientific communities have indicated of more cloudburst and landslides due to climate change, for which the administration and systems are to gear up and need to bring in new way of working at all levels to safeguard children.

The increased events of landslides and protection of schools require a multi-stakeholder approach to reduce risks and vulnerabilities from hazards. The stakeholders such as PWD, Education, Forest, HP-SDMA and Grama Panchayats need to work jointly. It is said that the Major Roads are under the jurisdiction of PWD and whereas village roads are in the purview of Grama Panchayats. Even Grama Panchayats construct roads, and its debris are dumped indiscriminately on the hills. During rains, the debris is washed on the roads causing slush and muck on roads, hindering traffic movement. The roads made by Grama Panchayats do not involve science or technology and that could also be one of the reasons for the increase of landslides.

Children can be safe only when external environments to the schools are secure. The identification of school locations to be priority and ensuring the locations are well protected by adopting best technology to protect the buildings and its environment. To reduce risks and vulnerability of children and teaching faculty, even pathways to school to be broad and safe. The journey to school is a tedious journey.

The present hazards -Landslides and Floods have created new threats or conditions of vulnerability that will worsen soon if major U turn is not considered at the earliest. The recovery works to focus on new technologies for construction of schools and undertake mitigation measures that can reduce the impact of landslides. The school data shows, the majority of the population are oriented to provide education to the children at elementary and secondary level, it is only at college level the enrollment ratio is low. This could also be because the number of institutions in the State for Higher Education is limited. For example, the State has only 33 PolyTechnic Institute. Scope for child labour is limited.

The damage to 1327 rooms and some schools are inhabitable for learning, either the buildings have developed cracks, floors are damp and damaged. WASH units in 88 schools are non-functional due to damage either for water availability or sanitation facilities, thus creating problems for adolescent girls. Some of the schools that were visited during the assessment have been declared unfit for use by PWD. Children studying in these schools are operating in rented places or arrangements are made within the existing buildings.

4.6 Recovery and Reconstruction Needs

The recovery strategy for the Education sector in infrastructure is based on the principle of Build Back Better (Look forward in the context of Climate Change Impact to Hills).

4.6.1 Rebuilding and Repair of Physical Infrastructure

The total estimated recovery and reconstruction cost for education facilities is estimated to be 369.14 Crore. This cost includes recovery of various damaged physical infrastructure, rebuilding of WASH facilities, building of retaining wall wherever required and replacement of furniture and equipment in the school. This cost does not include the cost of land which is required for the schools

that need to be relocated in a different location. Since, The HIMUDA standards are provided for an engineered building, it is assumed that those standards have integrated build back better requirements.

Apart from the school building, even the additional structures such as Mid-Day Meal Kitchen, WASH facilities (Sanitation and Water) and retaining walls for protection of school buildings are to be constructed to minimise damages. The present situation calls for long term plans for ensuring good construction to address improved accessibility (Pathways to Schools), better safety & hygiene.

In relation to SFDRR 4th priority, which will address the first 3 targets – reduce deaths, casualties and economic loss, the State and Education Departments needs to address with the intent to ensure the structures of schools are built, based on building codes to reduce the risks emerging from Earthquake, Flooding and Landslides.

District	Damage Estimate	Damage + Loss Estimate	Recovery Estimate
Bilaspur	90.18	90.23	90.18
Chamba	13.79	13.79	13.79
Hamirpur	22.64	22.72	22.64
Kangra	56.08	56.13	56.08
Kinnaur	0.05	0.05	0.05
Kullu	23.91	23.91	23.91
Lahaul & Spiti	1.03	1.03	1.03
Mandi	17.49	17.49	17.49
Shimla	82.11	82.12	82.11
Sirmour	29.45	29.46	29.45
Solan	25.35	25.36	25.35
Una	7.05	7.07	7.05
Grand Total	**369.14**	**369.39**	**369.14**

Assumptions for estimating recovery needs.

- Primary school indicator covers both primary school and middle school
- Area considered for primary school is 250 SqM and for Secondary school is 500 SqM. The cost of rebuilding per SqM is Rs. 30597/-
- Cost provided for fully damaged is 100% (Rs.30597), Severely damaged is 50% (Rs.15298.5) and partially damaged is 30% (Rs.9179.1)
- Secondary school indicator covers Secondary, Higher Secondary schools, Training Institutes and Colleges.
- The cost for primary school of 250 SqM works out Rs. 7,649,250/- and for Secondary school of 500 SqM is Rs. 15,298,500

- **Equipment and other Learning Accessories damages – Replacement**
- School is the unit
- Rs.200000/- per school for benches and cupboards and learning materials
- Rs. 500000/- per school for Computer and Science lab

4.7 RECOVERY AND RECONSTRUCTION STRATEGY

The State Government envisions the idea of "Zero Death, Zero Dropouts", wherein all children in the school have access to qualitative learning through various mediums in a protected and safe environment. The focus of the recovery and reconstruction strategy in the Education sector is to ensure that children are safe from the time they leave home and return to home, which means apart from school safety, the focus will be on road safety and creating safe school zones and for that purpose investments are to be made.

The present situation is an opportunity for the Education Department to ensure their role is critical in building stronger and more resilient communities and individuals. They can bring in Environment Sustainable approach learning in school and college syllabus. As part of recovery strategy changes, the education sector could consider addressing the knowledge, skills and attitudes of school students, faculty, parents, and communities, for sustaining the environment they live-in. Based on the global vision (SFDRR), the following is thought about by the Education Department as Recovery and Reconstruction measures:

- The school buildings which have more than 70% damage (damages to more than 4 rooms) need to be re-built keeping in mind the concept of safe schools and building codes in the Himachal Pradesh context (Earthquake, Landslides and Flooding). Whereas the schools in the category of severely damaged must consider retrofitting works for safety. Safe land will be a difficult option, but it is a critical factor in ensuring infrastructure safety, by adapting new technologies and construction materials.
- As most of the schools are in the hills, the terrain for children to access schools is tough even in normal times, it becomes very critical that the school authorities, grama panchayats and PWD need to plan and work for safe pathways to schools. The playgrounds of the schools in the flood prone areas must ensure for proper drainage system for water passage
- The re-building of schools to ensure proper protected drinking water and toilet facilities that are child-friendly and cater to children/people with special needs while allowing for effective waste and water management
- An opportunity is to be created to integrate principles of safe learning schools (in-campus and outside the campus) for example the child-friendly learning spaces, appropriate display and sign boards for road safety and safe school zones, dissemination mechanism for early warning, and evacuation arrangements. A pilot initiative can be taken up in one district with support of UN agencies or CSR support and same to be led for possible replication.

- For recovery and reconstruction, the Education department needs to draw out a detailed plan for the next 3 years and work out the financial implications and resources. As part of reconstruction measures, the school structures are to be insured and for which premium needs to be earmarked. One of the important measures that the Education department needs to do is to insure school buildings.
- The below matrix of an envisioned plan of the Education Department, is to strategize the activities broadly as short-, medium- and long-term (designed for the periods as disaster year, 2nd year and 3rd year respectively.

The short-term activities will include the following (disaster year):

Infrastructures -Reconstruction	Teaching, learning and Capacity building - Preparedness
• Repair works will be undertaken to fix minor and partial damages that have occurred to classrooms, flooring, Mid-day Meal kitchens, WASH structures and Boundary walls. These activities could be executed by School Management Committee (SMC) of the concerned schools with technical support from PWD	• Undertake PSS activities in the schools, along with awareness on hazard events, either through programs at schools or virtual mode or tele-counselling works to reduce trauma among children and faculty members • Exposure visits to Education Department Staff to Kerala as the terrain is similar and how the education and CSOs are working to address Climate related issues and taking up DRR works.
• Ensure pathways for schools are improved, emphasis is on Road safety and create safe school zones in the State.	• Strengthen coordination and inter-department convergence amongst various institutional structures at the district and state levels, that would promote participation of children in Risk Governance mechanisms.
• Promote construction of schools with materials that reduce risk from natural hazards. Construction or re-location of schools to be done in the context of resilient technology that will give quality services for all children/learners including children with special needs. The main pillars of these schools are to be risk reduction, good WASH unit, waste management, water, and hill conservation	• Continue with more addition of DRR-CCA measures in the ongoing program on school safety, covering areas of road safety, safe school paths. • Build DRR cadres in the departments, who will undertake HRVA of schools, conduct audits of safety of schools. • Initiate school safety programs in one district for piloting.

Medium Term -2nd year

Infrastructures	Teaching and learning – Capacity building
• The medium-term interventions will focus on severely damaged schools and would ensure construction of new classrooms as per the standards specified by the building codes.	• Through schools, promote afforestation with school zones and implement small mitigation measures to reduce rock falling and erosion of hills
• The construction work to be monitored by 3rd Party consultants appointed by the Department as per the standard practice. The third party will engage in the monitoring of quality assurance of civil works.	• Integration of DRR in school curriculum from 1st to 12th Standard in State Board Education System
• Technology to be introduced for early warning at school's level. The local schools could be receiver of early warning under dissemination plan	• Ensure all the schools are virtually connected for learning, even during emergencies.
• Undertake Risk Transfer Mechanisms to school infrastructures	• After 2018 floods in Kerala, the State Government has initiated Uschool App to capture school details, prepared School level DM plans, conduct building audit etc., similar intervention could be possible • Insure all children for life and health

Long term measures -3rd year

Infrastructures	Teaching and learning – Capacity building
• With the support of IIT or other Academic Institutes evolve school models that can sustain natural hazards, for the fully damaged schools.	• Integration of DRR/CCA syllabus in Higher Education (Technical Institutions, Degree Colleges, and Universities.
• Alternative power back-up to be available for all schools to continue learning and teaching	• Increase the GER at higher education level and promote technical education
•	• Build cadre for DRR in the Education department from the first year

4.8 IMPLEMENTATION ARRANGEMENTS

The Recovery and Reconstruction measures of the education sector to be evolved by the department through a series of dialogue with stakeholders – School Management Committee, Parents, Children and Government Officials. The example of Kerala Government "Rebuild Kerala Initiative" could be considered. It is suggested that the Himachal Pradesh Team could visit Kerala and Odisha to understand the process, which could be useful for rebuilding resilience in the Education Sector and in other sectors. The Education Department needs to map the resources in Himachal Pradesh and outside the State to undertake Recovery measures in relation to Teaching/Learning support.

5 Health

5.1 SUMMARY

In the wake of the unprecedented rainfall in the month of July-August due to the confluence of the western disturbance and the monsoon, the State of Himachal Pradesh was badly affected with floods, land and mudslides at various sites. This adversely affected the health sector both with damages and losses to the public health infrastructure and short and long term impact on the health of the people in these areas.

The PDNA exercise undertaken in the state, reviewed the damages and losses in the allopathic system of medicine under the Department of Health and Family Welfare. A total of 473 Allopathic health centres were impacted of which 16 have been totally damaged (10 HSCs; 02 PHCs, 03 CHCs, 1 Medical Hospital), 91 PHI sites severely damaged (53 HSCs, 27 PHCs, 10 CHCs, 01 Medical Hospital) and 64 partially damaged (33 HSCs, 21 PHCs, 8 CHCs, 02 Medical Hospital) in the health sector.

Total damages account for INR 107,15,59,159 Cr for health infrastructures and INR 42,83,358 for replacement cost. Total losses in the six districts amounted to INR 19,58,550 with recovery needs being INR INR 126,87,23,165 cr. Most of the damages are to the Health Sub centres (HSCs), PHCs , CHCs followed by Medical Hospitals in that order however the proportionate damage to CHCs is the maximum(0.42), followed by PHCs(0.125), HSC (0.07), Medical Hospital (0.07). Mandi and Kullu districts account for the maximum damages and losses of the six districts affected by the disaster events

The 'Build Back Better Himachal' vision is supported and zoning of the health sector to safe zones based on GSI landslide assessment is highly encouraged so as to ensure seamless health services in disaster situations with least impact on the health infrastructure and overall health conditions of the communities. Ensuring a robust road infrastructure goes a long way in ensuring safe and continuous access to the health sector in any disaster situation and public health emergency.

In preview of the disaster vulnerability of the state, it is important to ensure disaster resilient infrastructure and multiple accesses of PHIs wherever possible, with ensuring continuous power backup and communication network. Breached cold chain system at various PHIs sites, due to power outage and loss of road connectivity, leading to failure of the contingency plan calls for up gradation of the already existing drone technology, the first state in the country to be utilising drones in the health sector can now be upgraded to use in shifting vaccines during disaster situations and reduce vaccine wastage and discard.

Major impetus of WASH sector strengthening will also go a long way in building resilience of the health sector, being a hilly terrain and breach in various STPs lead to an increase in the gastro enteric infections post disaster and also a diarrhoea outbreak of Shigella and E.coli.

Various health centres have reported an increase in patient visits for psychosomatic issues post disaster, with also the health staff reporting symptoms of psychosomatic conditions. Addressing the mental health issues of the communities, and also the health staff needs to be strengthened to ensure appropriate long term recovery post disasters.

5.2 HEALTH SECTOR PROFILE

The health services in the 12 districts affected by the heavy rains, floods, and landslides are provided by the department of Health and Family Welfare through 99 Hospitals, 91 CHCs, 576 PHCs, and 2114 Sub centres. To support these services various provisions have been made for secondary level health care facilities through specialised hospitals and those attached to state medical colleges.In Himachal Pradesh the hospital population ratio is 0.79 hospitals per lakh persons which is much less than other hilly states of India where there are 2.20 hospitals per lac person (National Health Profile, 2011). In Shimla and Solan however the number of hospitals per one lakh persons was higher than the state average of 0.79 hospitals per 1 lakh persons. In districts of Mandi, Kullu and Chamba the number of hospitals per one lakh person was much less than the state. The districts of Kinnaur and Shimla have had more than 1 hospital per lakh persons in the states. The state of Himachal Pradesh had 0.91 CHCs per 80,000 persons as compared to other hilly states of India which had 0.45 CHCs per 80,000 persons (NHP,2011). The districts of Kullu, Chamba, Mandi, Kinnaur possessed a higher number of CHCs per 80,000 persons. The remaining districts had less number of CHCs per 80,000 persons than the state average.

Number of Health Facilities in Himachal Pradesh										
District	Hospitals	Dispensaries	CHC/RH	Primary Health Centres	Total	Allopathic Beds	Ayurvedic Hospitals	Ayurvedic Dispensaries/ Health Centre	Ayurvedic Beds available	Total bed Available
Bilaspur	5	1	6	38	50	655	2	69	20	675
Chamba	8	0	4	46	58	1190	2	113	60	1250
Hamirpur	6	0	2	32	40	720	5	72	100	820
Kangra	20	1	19	88	128	3093	7	249	285	3378
Kinnaur	2	0	4	23	29	271	1	30	20	291
Kullu	6	0	4	24	34	820	2	70	30	850
Lahaul-spiti	1	0	3	16	20	204	1	24	10	214
Mandi	17	0	11	85	113	2312	2	178	40	2352
Shimla	15	2	17	115	149	2951	3	162	80	3031
Sirmaur	6	3	6	46	61	836	2	87	30	866
Solan	7	7	6	39	59	907	2	80	30	937
Una	6	2	9	24	41	594	5	70	70	664
Himachal Pradesh	**99**	**16**	**91**	**576**	**782**	**14553**	**34**	**1204**	**775**	**15328**

There are 1.39 PHCs per 20,000 persons in HP in 2011.This ratio is lower than other hilly states in the country.

In Himachal Pradesh the HSCs population ratio was 0.90 per 3000 persons, which is higher than other hill states of India where this ratio is 0.48 per 3000 SCs in 2011(NHP, 2011). In Shimla, Solan, Mandi, Chamba and Kinnaur, the HSCs per 3000 persons was higher than state average, in Kullu the HSCs were however less than the state average of HSCs per 3000 persons. [1]

The state of HP is multi- hazard prone being at risk for Earthquakes, Flash Floods, Cloud Bursts, Landslides, Lightning and Forest Fires. The rapid developmental changes with environmental degradation in the state is making the hills fragile, construction of tunnels and multiple lane highways in the hills, along with an unplanned urbanisation, population increase and climate change is making the situation worse. In the wake of this disaster risk profile, it is important to have a strengthened health sector in terms of both Human resource and Infrastructure. There is an urgent need for planned development of health services as there exists regional imbalances in the availability of different components of health care infrastructure, services and human resource. Human and physical resources are the key components of a health system. These resources may include human health resources such as doctors, nurses, technical staff etc and physical health

resources such as beds, machines, equipment etc. There are wide variations in the number of doctors and nurses across the districts which should be addressed.

5.3 DAMAGE AND LOSS.

The damage was accounted for in two phases; following the two waves of floods. In the first phase districts that were accounted for were Shimla, Solan, Kullu, Mandi, Kinnaur and Chamba. In the second phase districts that were accounted for were Bilaspur, Hamirpur, Kangra, Sirmaur, Una and Lahaul- Spiti.

In the first phase, the data highlights the status of various health facilities, encompassing Community Health Centres (CHCs), Medical Hospitals, Primary Health Care Centres (PHCs), and Sub-Centres. Notably, among the 39 CHCs analysed, 14 remained undamaged, 14 experienced minor damage (10%), and 9 were partially damaged (more than 30%). Similarly, among the 115 PHC, 47 remained undamaged, 46 reported minor damage, 17 was partially damaged and 5 were Severely Damaged. Similarly, for the sub-centre 319 were analysed, 4 were totally damaged, 22 were severely damaged and 30 were partially damaged.

In the second phase, additional insights into the extent of damage to health facilities emerged in other six districts. The data collected indicates that CHCs with maternity wards, Community Health Centres, and Primary Health Centres (PHCs) continue to be affected, with varying degrees of damage, ranging from no damage to severe damage. In total, 8 health facilities were classified as totally damaged. This comprehensive data is invaluable for health sector specialists and disaster management authorities as it guides them in allocating resources strategically and efficiently to address the varying degrees of damage and prioritise the restoration of healthcare services for the affected population. It underscores the need for a phased approach to disaster response and recovery, ensuring that no facility remains overlooked and that healthcare services are promptly reinstated in areas with the most significant damage.

The data from the second phase of damage assessment provides a clear picture of the extent of damage to various health facilities. It reveals that Community Health Centres (CHCs) and Primary Health Centres (PHCs) have borne the brunt of the damage, with several of them being partially or severely affected. 8 health facilities were reported as totally damaged. Which requires rebuilding of the health facility. 20 Health facilities were severely damaged which require structural repair and 243 health facilities faced minor damaged and require repair

Damage Data : 1st Phase

Health Facility	No Damage	Minor Damage (10%)	Partially Damaged (More than 30%)	Severely Damaged (More than 50%).	Totally damaged or washed away (More than 70% damaged)	Total
Community Health Centre	14	14	9		2	39
Medical Hospital	4	6	1		1	12

Primary Health Care Centre	47	46	17	5		115
Sub -Centre	185	78	30	22	4	319
Grand Total	**250**	**144**	**57**	**27**	**7**	**485**

Damage Data : 2nd Phase						
	No Damage	Minor Damage	Partially Damaged	Severely Damaged	Totally Damaged	Total
CHC - With Maternity Ward	1	0	2	1	0	4
Community Health Centre	12	1	17	3	1	34
District Hospital	2	0	0	0	0	2
Other - Health facility			4			4
Primary Health Centre	46	4	71	1	4	126
Sub Centre	108	10	138	15	3	274
Sub District Hospital	5	2	11	0	0	18
Total	**174**	**17**	**243**	**20**	**8**	**462**

5.3.1 ASSUMPTION FOR DAMAGE ESTIMATE

- In Himachal Pradesh, the typology of health facilities and their respective built-up areas are standardised as per the recommended guidelines. To calculate the damages cost for the health facilities following assumptions were made - Sub -Centre - 155 sq.ml; PHC - 350 sq m; CHC- 1500 Sqm ; CHC- with maternity ward - 1650 sqm ; District /Sub-district Hospital - 2500 Sqm.

Area Estimate for Health Facility			
Reporting Asset_Health	Average of Area (In Sqm)	Average Replacement Cost (Approx - For Load Bearing Construction and Timber framed structure	Average Replacement Cost (Approx - RCC structure)

Sub Centre	155	38.75 Lakh	46.50 lakh
Primary Health Centre	350	87.50 Lakh	1.005 Crore
Community Health Centre	1500	3.75 Crore	4.5 Crore
CHC - With Maternity Ward	1650	4.13 Crore	4.95 Crore
District Hospital	2500	6.25 Crore	7.5 Crore
Sub District Hospital	2500	6.25 Crore	7.5 Crore

- The average replacement cost for the civil infrastructure is assumed with following standards
- Rs 25,000 per sq m for Load bearing structures
- Rs 30,000 per sq m for RCC structures
- Rs 25,000 per sq m for Timber framed structures
- The replacement cost for non-structural amenities such as any health equipment if reported damaged following replacement cost is considered per health facility
- Lakh for SDH/DH
- 1.5 Lakh for CHC + Maternity Ward
- 1 lakh for PHC
- 30,000 for Sub Centre
- In the second phase, additional information was considered for WASH and Healths and damage cost for those facility was also accounted for in damage estimation
- To calculate the overall damage cost, a damage factor was taken into account, which varies based on the extent of damage. For minor damage, the average replacement cost was set at 10%, for partially damaged structures, it was established at 30%, for severely damaged buildings, it amounted to 70%, and in the case of total damage, the full 100% replacement value was considered.

Damage Category	Damage Factor
No Damage	0
Minor Damage	0.1
partially Damaged	0.3
Severely Damaged	0.7
Totally Damaged	1

- Loss estimate : When estimating the loss, any expenses related to renting, debris removal, or any other additional costs incurred by the educational facility are included as part of the overall loss estimate.

5.3.2 DAMAGE AND LOSS ESTIMATE.

The overall damage estimated for the health sector is estimated to 184.09 Crore and total damage +loss is estimated to 185.18 Crore. It must be considered that the damage cost is calculated based on the adequate area of the health facility, a standardised unit replacement cost of the health facility and the damage factor based on the extent of damage.

District	Damage	Damage + Loss
Bilaspur	12.39	12.54
Chamba	9.72	9.72
Hamirpur	16.84	16.90
Kangra	36.80	37.01
Kinnaur	2.08	2.08
Kullu	19.11	19.11
Mandi	25.95	25.95
Shimla	11.73	11.73
Sirmour	32.92	33.07
Solan	1.89	1.89
Una	14.66	15.17
Grand Total	**184.09**	**185.18**

5.4 IMPACT ON HEALTH

Along with the structural damage, analysis was conducted to see impact on health of the people based on primary data analysis as reported by the health facilities. As per the Data

- 10.6% PHIs reported an increase in disease burden after the disaster. An increase in cases of Acute Respiratory Infection, followed by fever and gastroenteritis, followed by Eye Flu were reported by physicians from the various health institutes.

- An increase in Psycho-Somatic problems has been reported from 4% PHIs. This calls for an addressal of the mental health well-being of the communities and vulnerable involved.

- 15.5% Health facilities reported a disruption of services in Village health and nutrition days post disaster that severely impacted the health status of the rural areas being catered to. Loss of various sanitation drives and health and nutritional support provided to the communities was lost leading to long term impacts on the health and well-being of the affiliated population.

- 12.7% of Health sites reported disruption in routine ANC services & 10.4% disruption in Postnatal visits impacting maternal and infant well-being. This failure of service Increases the risk of maternal Mortality, low birth weight infants, poor lactational support to lactating mothers, failure to screen and address post natal depression, and Infant Mortality.

- 54 RI centres reported a delay in the continuation of the very essential routine immunisation services provided to new-borns, children and pregnant women, posing an impending threat to future outbreaks of the well-controlled Vaccine preventable diseases.

- 07% sites reported a breach in cold chain facility, with 10 sites having had to discard vaccines

- BCG, Polio, RVV, Pentavalent, IPV, PCV, MR, TD, DPT - 216 vials of these vaccines were destroyed in district Kullu; 01 vial of Rabies vaccine and anti-Rabies Serum each was also destroyed, vaccine safety being a critical health service modality with serious consequences on breach in the cold chain maintenance calls for robust cold chain management strategies in preview of the disaster profile of the state.

It is understood that the health sector double burden of disasters expecting to perform optimally despite being affected by the disaster itself, in the wake of which the health staff also suffers the impact of the disaster leading to experiencing various psychosomatic issues and poor mental health symptoms, which come in the way of delivering the best of health services to the communities affected. At 06 PHIs, one or more health staff reported symptoms of Psycho – somatic illness, which needs to be addressed through specialised care in the future disasters.

5.5 RECOVERY AND RECONSTRUCTION ESTIMATE.

The estimated cost for the recovery and reconstruction of health facilities, incorporating a "build back better" approach, amounts to 184.09 Crore. This calculation considers the replacement cost of physical infrastructure, WASH facilities, and retaining walls. Additionally, it includes an average amount allocated for the replacement of equipment required for Sub-centres, Primary Health Centres (PHCs), and Community Health Centres (CHCs). It's important to note that this recovery cost does not encompass expenses related to capacity-building initiatives, psychosocial support, and other such programs. These aspects, however, have been included in the mid-term and long-term recovery needs planning.

District	Damage	Damage + Loss	Recovery Estimate
Bilaspur	12.39	12.54	12.39
Chamba	9.72	9.72	9.72

Hamirpur	16.84	16.90	16.84
Kangra	36.80	37.01	36.80
Kinnaur	2.08	2.08	2.08
Kullu	19.11	19.11	19.11
Mandi	25.95	25.95	25.95
Shimla	11.73	11.73	11.73
Sirmour	32.92	33.07	32.92
Solan	1.89	1.89	1.89
Una	14.66	15.17	14.66
Grand Total	**184.09**	**185.18**	**184.09**

5.6 RECOVERY AND RECONSTRUCTION STRATEGIES

The health sector needs recovery on a priority basis so as to restore the functioning of the services at the earliest and lessen the impact on the various dimensions of health of the people. When restoring the sector the opportunity to build back better should be exercised to the fullest so as to have a disaster resilient sector and prepared enough to face any future disaster events wherein the access to the health sector is not compromised, vulnerability reduced, and continuation of health services maintained.

5.6.1 SHORT- TERM STRATEGIES (12 MONTHS)

- The reconstruction and repair of health institutions in HP in the BBB plan must include the 'Safe hospital in safe zone' initiative, which will ensure the health infrastructure is disaster resilient and in an all year long accessible location, providing yearlong health services to its optimal capacity without any breach during disaster and post disaster times.
- Building sites, design, and material used for construction are resilient to withstand any future disasters. Provisions for continuous power and water supply also be ensured as hospitals and health centres are critical infrastructure.
- Health sector development model to very carefully factor in the vulnerability of the terrain, Infrastructure planning and safety be made in preview of multi hazard profiling of the state.
- The building codes and disaster mitigation measures be strictly adhered to and strict legal actions be taken on failure to adhere to the same be entrusted upon.
- Solid waste and Bio medical waste be kept safe from a disaster preview.
- Critical hospital contents and infrastructure like medical records, equipment's, Operation theatres, labour room, administrative blocks be kept protected and safe with the disaster likelihood in view.
- Hospital contingency plans are prepared and brought to action when needed, with staff training for disaster-like situations being practised during pre-disaster times.
- Health infrastructures are built as per population norms of hilly areas in accordance with the Indian Public Health Standards, to address the spatial variations in health services across districts.

- Green sources of power generation like wind and solar energy are utilised for individual PHI power generation.
- The list of essential equipments be made and acquired with adequate buffer for disaster times
- Cold chain contingency plan be strengthened, and upgrading the drone technology so as to carry vaccine carriers in case of power outage and road cut off
- Due to the break in continuation of the Routine immunisation services, catch- up campaigns will be held for missed dose vaccinations to protect the beneficiaries against vaccine preventable diseases as fast as possible.
- Underserved high risk pregnancies and neonates are catered to through special outreach camps in the communities.
- A policy for solid waste management of items spoilt by floods and need to be discarding/destroying be developed.
- The state and district command system at all levels will be enhanced to ensure effective and efficient healthcare response. The emergency operations centres at the state and district levels must be enhanced with state-of-the-art health control rooms to coordinate and manage emergencies, including natural disasters.
- Strengthened surveillance for communicable diseases be ensured along with a strong liasoning with the private setups so as to prevent and identify an outbreak at the earliest
- Measures should be undertaken to prevent any disruption in the management of non-communicable and palliative care services, like dialysis etc
- Prioritising mental health during and post disaster be ensured, with special focus on the vulnerable and also the health staff rendering their services in the challenging times. Communities be encouraged to engage in providing psychosocial first aid so as to prevent any overt mental health conditions burdening in the long term. Continuous psycho-social counselling and treatment be extended to those needing it in the communities
- Emergency transport system of patients to be established, including air ambulances in case of extreme emergency especially for the hard to reach areas in the state
- Practice of Early warning System reporting through IDSP be utilised to the fullest at the time of disasters.
- Identifying and rewarding the health workers who put in their best to provide health services in the challenging disaster times be undertaken for its ripple effect on the health staff.

5.6.2 MEDIUM-TERM STRATEGIES (12-36 MONTHS)

- Continue reconstruction of health infrastructure with the BBB concept, in safe zones preventing any damage and accessibility breach.
- Planning and preparedness to handle disasters that the state is vulnerable to should be initiated. Disaster management plans will be made for each health institute, both private and public.
- Induction of health staff by the concerned to increase the doctor/ nurses/ Health worker is to population ratios.
- Up scaling of health infrastructure to increase hospital is to population ratios
- Rapid response teams are constituted, mock drills, command and control tasks are practised periodically so as to handle any kind of mass casualty incidents.

- Capacity building workshops and training are held at district and state level for the health staff.
- Safety of health institutes be assessed for the multi hazards vulnerabilities.
- Legislative framework be ensured so as to have disaster resilient infrastructure health institutes being a critical infrastructure.
- Strong liasoning with the private sector can be ensured through IDSP in outbreak reporting and also to work together during disaster situations.
- Establishing state of the art laboratories to diagnose various public health diseases that pose a threat post disasters.
- Redressal mechanisms are placed for health staff to report and seek assistance for Psychosomatic symptoms faced by them.
- Ensuring tree plantation drives in and around health centres to ensure soil hold and prevent caving in of ground and accessibility loss of health centres.
- Ensuring potable water supply in hospital premises.
- Installing rainwater harvesting structures in PHIs wherever possible.

5.6.3 LONG-TERM STRATEGIES (12-36 MONTHS)

- Road infrastructure be strengthened to ensure round the year all weather accessibility of health infrastructures, with multiple access routes wherever possible.
- Health structure safety audit in the sliding and landslide prone areas be made mandatory.
- WASH sector also be strengthened to avoid sewage treatment plant failures due to disaster, leading to water borne disease outbreaks.

5.6.4 DISASTER RISK REDUCTION.

- Identifying disaster prone facilities, risk assessing and up gradation be done on priority.
- Policy decision to delegate one PHI holding adequate buffer supply at the district level to act as a referral institute at the time of disaster be made, so as to handle the patient load during disaster situation.
- Cold chain breach and contingency plan failure can be prevented by utilising non-electrical cold chain options and upgrading drone technology to carry vaccine carriers to avoid vaccine wastage and discard.
- Having adequate health human resource at frequently disaster hit areas, so as to ensure continuation of services during disaster timesUtilising the list and needs of high risk pregnancies, disabled, geriatric and other vulnerable be known so as to converge services to them during and after disasters.
- Impetus be given to continue lactational support to lactating mothers in the pre, during and post disaster times.
- Mock drills and capacity building of health staff be ensured.
- Contingency plan for power back up be made and exercised.
- Prepare SOPs for evacuation and follow up of vulnerable health workers to reduce impact of disaster on them. Ensuring knowing the needs of each vulnerable by the health worker of the vulnerable in his/ her area so as to converge those health services to the vulnerable.

- Weather warnings and alerts are issued to health staff for preparedness and planning at the decentralised institute.

- Decentralised disaster management body will be established to work to coordinate and manage the health sector work during disasters.
- Directorate of Health and Family welfare to ensure health human resource adequacy especially at disaster prone areas
- Mental health support and counselling services to be ensured at a decentralised level so as to prevent early diagnosis and manage overt mental health conditions.

6 Public Buildings and Civic Amenities

6.1 INTRODUCTION

Public buildings and civic amenities are vital components of a community's infrastructure and services. They play a crucial role in providing essential services, government assistance to the community, administrative functions, and community spaces for residents. These buildings contain a variety of amenities, including public service buildings, hospitals, schools, emergency response facilities, recreation grounds, and more. Their importance goes beyond simple utility because they improve a community's social cohesiveness, general well-being, and quality of life. Such buildings and amenities are in both rural and urban areas. Majority of government departments do have such facilities at different administrative levels.

Disasters severely interrupt public structures and municipal amenities, interfering with crucial services and social functions. Access to healthcare, emergency services, administration, and education is hampered by infrastructure damage. Social cohesiveness is hampered by the loss of shared facilities / areas. The delivery of services, the distribution of resources, and administrative tasks all experience recovery delays. Communities, thus, encounter difficulties in re-establishing order, which has an impact on government, collective relationships, and general well-being. Damage, destruction or disruption of such buildings in a disaster situation can have a severe impact on the ability of communities to respond, provision of relief, rehabilitation of affected communities, rebuilding of the affected areas.

The PDNA exercise of public buildings and civic amenities tries to look into the damages to all such facilities and evaluate its impact on the affected community. In addition, through PDNA an attempt is made to calculate repair, replacement and reconstruction of such facilities. The PDNA advocates for building all such facilities in a better manner to survive the impact of similar events in future.

The present PDNA exercise covered the various public buildings and facilities related to different departments including Aganvadi, Urban Development Department, Fisheries Department, Nagar Nigam, Panchayati Raj, Women and Child Development Department, Rural Development Department, Revenue Department and some other departments having minor damages and losses.

The assessment of damages and losses is typically conducted in collaboration with state government and local authorities, community leaders, and other stakeholders, ensuring that the recovery efforts align with the needs and priorities of the affected communities.

The PDNA for the public buildings and civic amenities is a joint exercise of the state government of HP, NDMA, NIDM, UNICEF, UNDP, CDRI, JP University and other agencies.

6.2 ASSESSMENT METHODOLOGY

The main purpose of the PDNA exercise is to assess the extent of damage and estimate the cost of recovery/reconstruction for public buildings and civic amenities. The exercise includes facilities which have been impacted due to heavy rain induced flood, landslide and other associated processes in disaster affected areas.

In the first phase, the PDNA was conducted for the six worst affected districts of Chamba, Kinnaur, Kullu, Mandi, Shimla and Solan (during the month of August). The second phase of PDNA was able to cover all remaining districts of the state, with data update due to impact of rains/ floods in the second and third phase of damages (during the month of September). The PDNA team followed the methodology developed by NIDM under overall leadership of NDMA. The general approach of PDNA is heavily dependent on data collected by the state government official through standard formats provided by the PDNA sectoral experts. In addition, the sectoral teams collected sample data from all affected districts during the familiarisation visits to the affected districts.

In general, the following methodology was adopted for conducting the PDNA exercise for Himachal Pradesh:

- Orientation workshop at HIPA, Shimla with all stakeholders including PDNA Team Members, state government functionaries etc.
- During the workshop, a one day trip was conducted to various locations to familiarise the team members about the impact and on how to make calculations.
- The PDNA Team was divided into sectoral sub-teams and district teams. A mix of sectoral teams visited the district to familiarise themselves with the damage pattern and collection of sample data. Team members were encouraged to discuss with stakeholders, to collect evidence and to draw well informed inferences.
- Data was collected by the state government officials as per the format provided by the sectoral teams. Data analysis for determining the sectoral needs and report writing by the respective sectoral teams was completed.
- Throughout the process detailed discussions were held among the team members.
- In the process, PDNA Team worked very closely with the state government officials (including SDMA at Shimla, DDMAs of respective districts, District Administration, local sub division and Tehsil level officials/other functionaries) and interacted with locals and officials of various public buildings/facilities visited by the Team.

The report provides estimates of the recovery and reconstruction needs for building back better of various buildings of different departments including Revenue, RD and Panchayati Raj, Women and Child Development, Health, Agriculture Department, Fisheries and Urban Development Department, etc.

During the process, there were numerous limitations faced by the teams including.

- Quantity and quality of data – due to continuous heavy rain data collection by the state government officials was a big challenge.
- Coverage of numerous departments posed a challenge to the state government officials to compile the data.

6.3 Brief introduction - affected departments / facilities

6.3.1 Rural Development and Panchayati Raj Department

There are 12 Zila Parishads, 81 Panchayat Samtitis and 3615 Gram Panchayats in the State. The following table[3] showing the present setup including total no. of ERs and average population in each level of PRIs:

S. No.	Name of the Panchayati Raj Institutions	Total Number	Average Population
1.	Zila Parishads	12	500000
2.	Panchayat Samities	81	80000
3.	Gram Panchayats	3615	1900

6.3.2 Women and Child Development

There are 43 Child Care Institutions including open shelters in Himachal Pradesh[4,5]. There are five Anganwadi Training Centres(AWTCs) located at Theog and Sunni, District Shimla, Rasmai, District Mandi, Gaggal, District Kangra and AWTC, CSK HP Agriculture University Palampur

6.4 Impact on Community

The destruction of public/government buildings after disasters has significant impacts on communities. These structures are essential for services, administration, and communal activities. Disrupted services include healthcare, administration, education, and emergency response, leaving communities vulnerable. Loss of administrative offices delays governance and resource allocation. Destruction of records and communal spaces worsens challenges. In summary, building demolition post-disaster leads to reduced services, hindered governance, economic decline, education setbacks, and weakened community bonds.

Disruption on Public Services:

- Crucial public services disrupted: healthcare, administration, education, emergency response.
- Curtailment hampers access to vital resources, leaving the community vulnerable.
- Vulnerability to medical emergencies, hindrance in disaster response, and difficulties in seeking government aid.

[3] Source- https://hppanchayat.nic.in/Department.html

[4] Source - https://himachal.nic.in/showfile.php?lang=1&dpt_id=176&level=0&linkid=5544&lid=22841

[5] Source- https://himachal.nic.in/WriteReadData/l892s/176_l892s/List%20of%20Training%20Institutions%20of%20Anganwadi%20Traning%20Centers-37520145.pdf

Loss of Administrative Offices:

- Loss of administrative offices disrupts effective governance.
- Leads to delays in decision-making, resource allocation, and public service delivery.
- Coordination of recovery efforts and resource allocation becomes challenging, worsening the crisis.

Impact on Records and Information:

- Government facilities carry important records, information, and paperwork.
- Loss of documents makes it harder to confirm legal rights, property ownership, and historical data access.
- May lead to legal conflicts, administrative obstacles, and delayed recovery efforts.

Disruption of Community Spaces:

- Disruption of communal spaces and facilities affects social cohesion and networks.
- Exacerbates challenges for affected individuals dealing with the aftermath of the disaster.

6.5 NEEDS ASSESSMENT

The PDNA exercise was conducted for the all affected districts of the State in two phases. The sectoral teams had compiled data on the impact of the disaster on the buildings of different departments including Aganvadi, Urban Development Department, Fisheries, Women and Child Development, Rural Development and Panchayati Raj Department, Revenue Department etc. The report provides estimates of the recovery and reconstruction needs for building back better of various buildings of different departments.

The functionality of the buildings of these sectors needs to be ensured during any emergency not only to serve the affected community better but also to ensure the functionality of the administrative system along with security of data and records.

Immediate needs for repair, recovery and reconstruction of public buildings and civic amenities have been calculated (Table 1).

Table 1: District Wise Need Assessment

Phase 1: District Wise Need Assessment (Lakh)		
	Anganwadi	Rural Development Department
Chamba	0.00	14.00
Kinnaur	19.03	0.00
Kullu	144.50	31.14
Mandi	53.80	1023.55
Shimla	60.00	44.80
Solan	0.00	948.02
Total	277.33	2061.50

Phase 2: District Wise Need Assessment (Lakh)		
	Anganwadi	Rural Development Department
Sirmaur	199.90	70.95
Hamirpur	58.60	304.50
Kangra	36.30	635.08
Bilaspur	53.80	0.00
Una	12.10	194.83
Lahaul Spiti	0.00	0.00
Total	360.70	1205.36

Table 1A: Total Sectoral Damage (Rs. in Lakh)		
	Anganwadi	Rural Development Department
Phase 1	277.33	2061.5
Phase 2	360.70	1205.36
Total	638.03	3266.855

The calculations have been derived from the calculations made for individual districts, which have been compiled. In total 135 public buildings of various departments got damaged due to rains/floods in which 76 are Pucca, 52 are Semi Pucca and 7 are Kutcha.

- Out of 135 buildings, 28 are totally damaged, 58 are severely damaged and 50 are partially damaged.
- In total 102 Aganwadi got damaged due to floods in which 96 are Pucca, and 6 are Kutcha.
- Out of 102 damaged Aganwadi, 22 are totally damaged, 39 are severely damaged and 41 are partially damaged.

- Assumption for calculating Loss and Damage –

- Unit Price of Pucca house was considered 30,000 sq.m, unit price of Semi Pucca and Kutcha is considered 25,000 sq.m.
- An estimation of factor of 1 for totally damages, 0.7 for severely damaged and 0.3 for partial damaged are used for estimating damage
- Rs. 10,000/- was added in all Anganwadi as a loss
- . Land Loss is not considered in the calculation.

6.6 REBUILDING PUBLIC FACILITIES

Based on the available information (as provided by the respective districts / departments), experience from the field visits of the sectoral and district teams, it may be concluded that:

- There are buildings that have been severely and fully damaged from different departments/ sectors. Such buildings either have to be rebuilt or repaired.

- The mid-term arrangements to the fully damaged buildings have been calculated. Offices with such buildings need to be shifted to make shift arrangements.
- Long term rehabilitation needs of the community, including the need for upgrades to existing infrastructure and the construction of new infrastructure is required.
- All public buildings falling in high risk zones should be rebuilt at alternate safe locations.
- Provisions for safety against earthquakes have to be incorporated /multi hazard approach to be adopted in all newly built/ retrofitted and repaired buildings.

Short Term Arrangements:

- Construction related debris management is an important aspect of sustainable construction practices, especially in all districts where the landscape is fragile and prone to subsidence. The construction debris needs to be managed well. The DRR Team will manage the debris management related issues.
- There are several buildings falling under the purview of various departments, which have to be rehabilitated/renovated/ retrofitted and reconstructed; such buildings must be developed as the demonstrative units for showing the techniques used to raise awareness among the community about the retrofitting techniques and other features of building safety for hilly regions including seismic safety features.
- It is proposed to consider promoting light weight (pre-fabricated) material for the buildings which are going to be reconstructed.
- Long Term Arrangements:
- For construction of any public building, proper engineering methods based on NBC-2016 must be ensured like selection of appropriate site with detailed soil investigation, proper architectural and engineering designs and proper execution of construction plan under supervision of an experienced engineer.
- It is also proposed that appropriate actions must be ensured after Detailed Vulnerability Assessment (DVA) of all facilities falling under life line infrastructure.

6.7 Recovery and Reconstruction Strategies

Government buildings and civic amenities like administrative and revenue buildings play a vital role in overall management of situations like this. The survival of such buildings needs to be ensured to provide confidence for management of the situation after any big calamity like the present one. Importance of such buildings can be highlighted in the following ways:

- Provision of Critical Services: Government buildings are often responsible for providing critical services to the affected population, such as law enforcement, disaster response coordination, and administrative services. In the aftermath of a disaster, these services are even more critical, and the government buildings that house them must be assessed for damage and repaired quickly to restore these critical services.
- Public Safety: Government buildings such as patwarkhana, panchayat ghar, community centres, yuva mandals, etc. play a crucial role in ensuring public confidence during and after a disaster. These buildings often serve as command centres for disaster response efforts and must be operational to provide emergency response services to the affected population.

- Emergency Shelters: Government buildings such as schools and community centres along with other public buildings can also serve as emergency cum distribution shelters / centres during and after a disaster. These buildings must be assessed for damage and must be repaired quickly to ensure that they are safe and habitable for the affected population.
- Recovery and Rehabilitation: Government buildings play a critical role in the long-term recovery and rehabilitation efforts after a disaster. These buildings often house government agencies responsible for recovery and rehabilitation efforts, and their assessment and repair are essential to ensure that these efforts can be carried out effectively.
- Symbolic Value: Government buildings also have significance as symbols of power and government authority and resilience in the face of diversity. Repairing and restoring these buildings sends a strong message of government commitment to recovery and rebuilding efforts and can help to instil a sense of confidence and hope in the affected population. The most critical public buildings must be prioritised to be demolished and in-situ constructed.

The recovery and reconstruction strategy needs to be a three-year programme with a detailed schedule. The policies and guidelines regarding the safety and DRR preparedness in all departmental buildings need to be revisited. It is recommended to review existing safety guidelines and provide recommendations to conform and adhere to NDMA and BIS/ NBC2016 guidelines, required standards.

While reconstructing new buildings, safety of the site needs to be ensured with the assistance of the state/ district **Town and Country Planning Department**.

6.7.1 SHORT TERM MEASURES (UP TO 1 YEAR)

A detailed vulnerability assessment (DVA) has to be conducted across all public /departmental and civic amenities buildings to evaluate the need of strengthening including the site planning and location point of view. The location and site evaluation has to be undertaken with the assistance of the state Town and Country Planning office. In case of location changes or for reconstruction of buildings, efforts need to be made to use light weight structures to accommodate all such buildings. For buildings like Patwarkhana, which were constructed about 35-40 years back, it is proposed that these buildings need to be reconstructed using a multi-hazard approach for safety against all possible hazards like earthquake, floods and landslides etc. Similar approach has to be adapted to other sectoral/ departmental buildings as well.

In addition, following measures need to be taken care off to improve the efficiency of public buildings in delivery of services. For this purpose, it is proposed to provide redundancy in provision of facilities and delivery of services and management of all amenities in the sectors like

- Power/electricity – by providing solar panels in all buildings including Patwarkhanas, Panchayat Ghars and Aanganwadis etc.
- Data Management – in addition to existing manual data management, storage, retrieval and disbursal etc., there is a need to supplement this process by using digital methods. Provisions for providing computing services need to be made specially in Patwarkhana and Panchayat Ghars etc.
- Training and capacity building of engineers and masons to be undertaken with the help of

technical institutes. At least10 engineers and 100 masons per district need to be trained to carry out the reconstruction work. In addition, capacity of staff at district and state level needs to be built to carry out and supervise the reconstruction and rehabilitation work at state level.

- The places where new buildings are being constructed, it is proposed to use traditional construction practices. These units will act as demonstration units in place of modern RCC structures.

6.7.2 MEDIUM TO LONG TERM MEASURES

Medium to long term measures will be focused on the reconstruction of fully damaged buildings. Based on the DVA, other buildings requiring reconstructing like Patwarkhanas need to be reconstructed in this phase. Other buildings and facilities requiring strengthening, retrofitting etc. need to be reviewed according to the existing legal and oversight mechanisms for strengthening and ensuring safety in all such types of public buildings and civic amenities as per NDMA and BIS/ NBC 2016 guidelines.

The new public buildings structures would be constructed, either in traditional methods and/ or using prefabricated techniques. There is a need to develop expertise for pre-fabricated based designs for all such types of buildings.

Long-term measures involve rebuilding and restoring public buildings and civic amenities to higher standards in comparison to what existed before the disaster. This includes incorporating disaster risk reduction measures into the design and construction of buildings to ensure their resilience to future disasters.

To manage public buildings and amenities effectively and efficiently, capacity building of institutions and all other stakeholders on disaster risk reduction and disaster preparedness is an essential requirement. The well trained and aware state machinery will be helpful to respond to future crises in an efficient manner.

Capacity building measures like training for staff, improving planning and establishing monitoring and evaluation mechanisms to assess the effectiveness of the recovery efforts need to be taken up on priority basis.

Involving the community in the recovery process is essential to ensure that public buildings and civic amenities meet their needs and are designed and managed in a way that promotes community resilience. This includes engaging the community in the design and planning of public buildings and civic amenities at local levels, providing education and awareness-raising activities on disaster risk reduction, and involving them in monitoring and evaluating the effectiveness of the recovery efforts.Sustainable financing is crucial to ensure that public buildings and civic amenities are adequately funded in the long term. This includes developing innovative financing mechanisms, such as public-private partnerships or insurance schemes, and establishing a contingency fund to provide quick access to funds in the event of a disaster.

7 Road and Transport

7.1 SUMMARY

Roads are the key transportation asset for Himachal Pradesh as they provide lion's share of transport connectivity with over 73,230 km[6] of the road network. The state has a smaller share of railway network of 317 km[7], of which 20 km is broad gauge and the remaining is single/ narrow gauge built in the early 1990s. Within the transport sector, the roads were the main infrastructure impacted by the disaster in the six districts for which the PDNA exercise has been undertaken. Total damage and losses to the road system are estimated at INR 1633 Cr, with damage estimates of INR 1506 Crs, and loss estimates of INR 127 Crs. Furthermore, necessary recovery needs beyond reconstruction in short to medium term is estimated at INR 932 Crs. The majority of damages are to the village roads, with floods washing out bridges and road segments, and landslides causing significant road washouts and destabilisation. Kullu, Shimla, and Kangra were the most impacted districts. The losses incurred by the road sector were mainly on the removal of landslide debris to clear the roads, and temporary diversions, and bridges set up for immediate assistance. Kullu and Mandi had the highest losses among the 12 districts, collectively accounting for almost 40% of the total losses. In many areas, roads sank due to landslides, requiring new retaining and breast walls to be constructed with the road reconstruction. This is a major piece of the recovery estimates across the 12 districts. Kullu and BIlaspur have noted the highest additional recovery needs, accounting for over 45% of the overall recovery estimate in total. Total recovery & reconstruction needs are estimated at INR 2438 Crs. Figure x and table x presents the distribution of damage, loss, and recovery across the 12 districts.

Table 1: Total damage, loss, and recovery needs (Crs INR)

Region	Total Damage (Cr)	Total Loss (Cr)	Total Recovery (Cr)	Reconstruction + Recovery Needs (Cr)
Kinnaur	15.2	4.0	40.0	55.1
Solan	37.3	13.1	58.6	95.9
Kullu	399.0	30.0	214.1	613.0
Mandi	187.0	20.3	22.6	209.6
Chamba	107.1	14.2	88.4	195.6
Shimla	378.8	0.4	80.0	458.8

[6]Data source: https://morth.nic.in/sites/default/files/Basic%20Road%20Statistics%20in%20India-2018-19.pdf

[7] Data Source: https://www.ceicdata.com/en/india/length-of-railways-running-track-kilometres/length-of-railways-running-track-kilometres-himachal-pradesh

Bilaspur	30.5	5.1	208.7	239.2
Hamirpur	78.6	6.9	37.2	115.8
Kangra	140.9	10.3	87.5	228.4
Lahaul & Spiti	19.6	8.1	4.1	23.7
Sirmaur	75.5	11.6	40.6	116.1
Una	36.8	2.4	34.1	70.9
Overall BBB actions			36	36
State	**1506.4**	**126.6**	**915.8**	**2458.3**

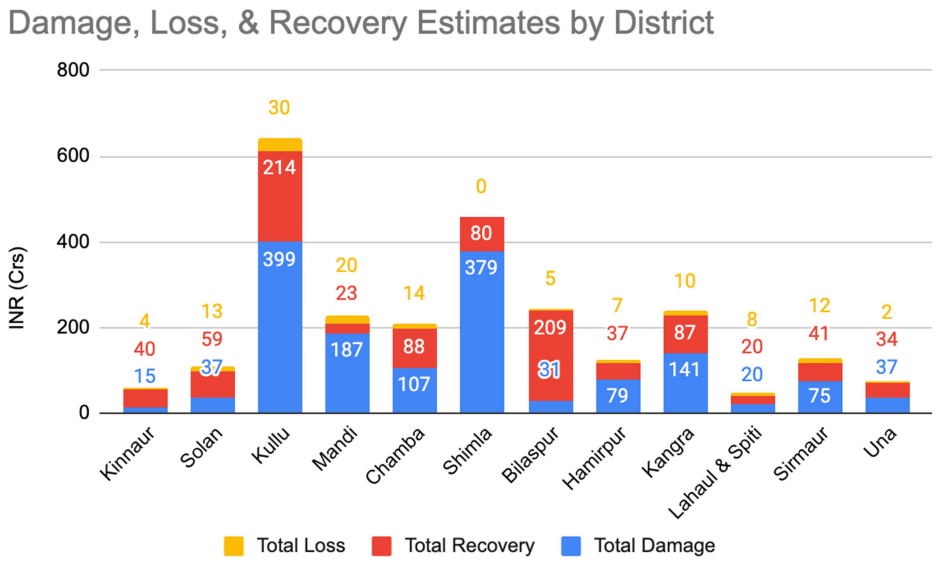


Figure 1: Total damage, recovery, and loss estimates of the 12 districts (in Crs INR)

7.2 Roads and Transportation Profile

Transportation systems are critical for any state's economic and social well-being. For Himachal Pradesh, all the key economic and livelihood activities such as tourism, agriculture, horticulture, mining, and forestry depend on a sound and connected transportation structure. Social well-being aspects such as access to education and health are also dependent on mobility. Roads are the key transportation asset for Himachal Pradesh as it provides the lion's share of transport connectivity with over 73,230 km of road network. The main road network, comprising National Highways, Major District Roads, and Village Roads contribute to almost 60,000 km of road stretch, while other road segments include project roads such as those managed by forest, irrigation, and other departments. The state has a smaller share of a railway network of 200 km, of which 20 km is broad gauge and the

remaining is single/ narrow gauge built in the early 1990s. Chandigarh is the closest rail terminal for transloading/transshipment. Some of the national highways have been recently developed by the National Highway Authority of India (NHAI) as 4 lane-divided carriageways roads (NH5- Kalka to Shimla, NH21- Kiratpur-Manali) while the majority of the two/intermediate lane NHs are maintained by PWD-NH Wing and some by Border Road Organization (BRO). The distribution of the key road network in HP as of the latest data released by Ministry of Road Transport & Highways, Government of India in 2019[8] is presented in Table x.

Transport Asset Type	Length (Km)
Highways	3,434
Major District Roads	4,277
Village Roads (Rural Roads)	53,033

The state MDR and village road (majorly single lane to intermediate lane), jeepable roads, and ropeways/pedestrian bridges are developed and maintained by State PWD, and are the main transport medium for goods, services, and people. This assessment focuses on these MDRs & VRs, owned and managed by the state.

The geographical features of Himachal Pradesh, with mountains and valleys, constrain the road infrastructure to be built around the hills, with limited available detours. This makes the majority of such roads, both Major District Roads (MDR) and Village Roads (VR), of critical importance to ensure connectivity to production centres and accessibility of the people to essential needs.

The Major District Roads (MDR) and Village Roads (VR) are constructed and maintained by the state Public Works Department (PWD), with administration divided within four zones, and further into individual circles and districts. The state has a total of 40,303 km of road network as of March 2023. Chandigarh is the closest rail terminal for transloading/transshipment. In the 12 districts that are part of this PDNA, a total length of 36,303 km of road is being assessed for damages and losses. Almost 93 % (35,542 km) of the total road length is village roads, and the remaining 7 % (2761 km) is MDR. The key road infrastructure features that were impacted by the disaster include culverts, drainage systems, and slope stabilisation systems like retaining and breast walls.

7.3 DAMAGE ESTIMATE

7.3.1 ASSESSMENT APPROACH

The data collection and assessment was conducted in two phases, with the first phase being conducted after the July floods & landslides. During the first phase of assessment, within the PDNA training in Shimla, representative engineers from the PWD department of the six districts were

[8] Data source: https://morth.nic.in/sites/default/files/Basic%20Road%20Statistics%20in%20India-2018-19.pdf

present (Kinnaur, Solan, Kullu, Mandi, Chamba, and Shimla). They worked together with the road sector experts to build capacity in the state teams to accurately estimate the damage and loss. In the two-day training, the PWD engineers were introduced to the concepts of damage and loss as identified within the PDNA exercise on the first day. On the second day of training, the road sector experts and the PWD engineers went on field trip for a hands-on exercise in accurately categorising damage, loss & recovery costs. Post the training, each district's PWD team worked on synthesising data in the PDNA formats.

The district teams already had the granular data on the road damage. But it was collected prior to the PDNA exercise, thus the raw data format was not categorised in the format needed for PDNA. Especially ,the damage categories of total, severe, and partially damaged roads, and cost estimates segregation into loss, damage, and recovery needed to be reworked on the original raw data. Another key challenge was that a lot of districts had done the data collection on-paper, and it needed to be digitised for the PDNA. The road sector experts and the district PWD engineers worked together to identify how the districts can categorise the existing data into the PDNA format. Clear guidelines were given to the district engineers on which damage type will be included in each damage category. Here is a summary of damage category clarification:

- Totally Destroyed: Roads, bridges, and culverts that got totally washed away, or damaged to the level that they will need near complete reconstruction [Where the cost of rebuilding can be estimated to be > 70% of total replacement cost]

- Severely Damaged: Roads with major segments damaged, or significant damage to retaining and breast walls, Roads sinking due to destabilisation of the slope below [Where the repair cost can be estimated to be between 30-70% of the total replacement cost]

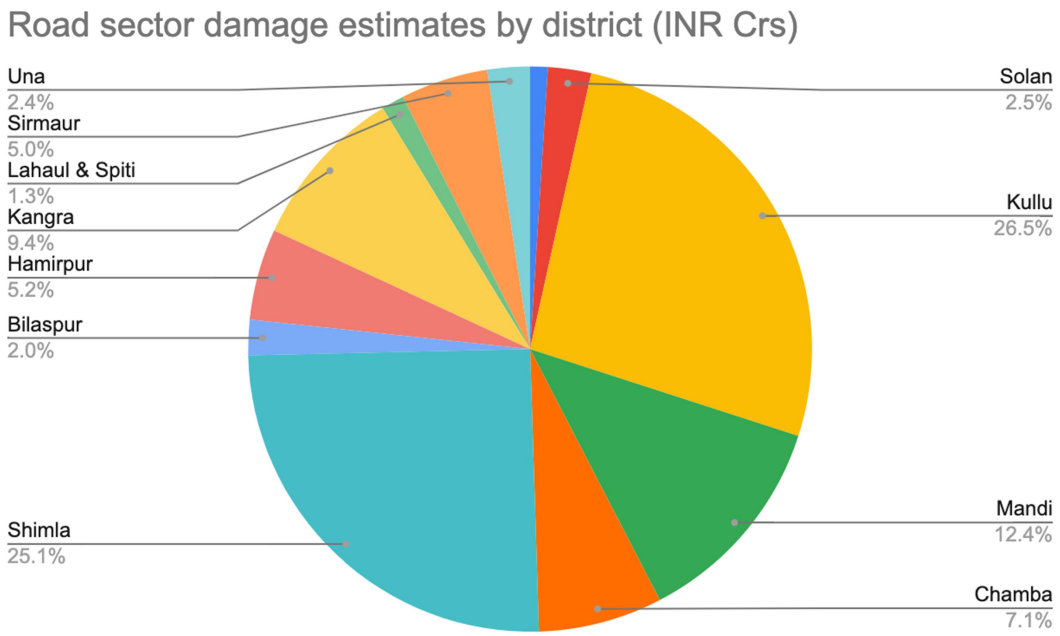
- Partially Damaged: Crust damaged, potholes, damage to drainage etc [Where the cost of repair can be estimated to be < 30% of total replacement cost]

- Loss estimate: The cost of debris removal and of additional machinery & temporary setups made for detours, i.e. the additional costs beyond those included in reconstruction/repair of the damaged assets

After the second wave of the disaster in August, a virtual conference was organised to transfer the knowledge to the other six districts that were heavily impacted by the August disaster. These districts were then provided with a survey tool developed by the central team and the road sector experts to mitigate the data challenges identified from phase 1. This allowed the new six districts to do the raw and granular data collection in a format consistent with the PDNA format requirements, thus reducing the need for data cleaning & reorganisation post the granular data collection. The data provided by the districts was then reviewed by the road sector experts by comparing it with the current market rate of equivalent reconstruction & repair costs in the regions. The extent of damage and correct categorization was reviewed through field visits of the road experts in Kullu and Mandi, and cross validated by other sector expert team member's input who visited the remaining districts.

7.3.2 ASSESSMENT RESULTS

Total damage to the road sector, estimated to be at INR 1506 Crs is caused due to impact to an estimated 21% of the total road length of the 12 districts. Figure 2 provides a district-wise summary



of the damage.

Figure 2: Damage distribution across the 12 districts (Crs INR)

A total of over 8040 km of road, accounting for 21% of the total road length in the 12 districts, were damaged by the disaster in some capacity. The damage is categorised into three categories - totally damaged, severely damaged, and partially damaged. Road assets that got completely washed away or are beyond repair and need a complete replacement are accounted for in the 'totally destroyed' category. This includes any road infrastructure with a damage estimate of 70% or higher than the replacement cost of the asset at today's market value. A total of 395 km of roads were categorised as 'totally destroyed', accounting for 1% of the total road length of the 12 districts, and about 5% of the total road length damaged. Roads with estimated damage of 30%-70% of the replacement cost were accounted for under the 'severely damaged' category. This included roads that had damage types such as portions washed away, damage beyond the crust level, damage to the retaining and breast walls, and partially sunk roads due to slope destabilisation below the roads and toe failures by river scours. 1218 km of road was severely damaged, accounting for 3% of the total road length of the 12 districts, and ~15% of the total damaged roads. The roads in this category will require rehabilitation, and potentially additional recovery measures to ensure their resilience to future disasters. Lastly, the road infrastructure that had minor damages that would estimate to be less than 30% of the replacement cost was listed under the 'partially damaged' category. This included

road crust erosion/damages, major potholes, guardrail damage to bridges etc. Most of the damage to the roads was under this category, with a length of 6427 km incurring partial damage, accounting for ~17 % of the total road length, and ~80% of the total damaged roads.

Below mentioned table presents the overall MDR & VR damage for all 12 districts and the cumulative damage for the state. This includes damage to the road pavement, bridges, culverts, and other structures on the road network, categorised whether it was on MDR or VR. To understand these numbers, tables 1 & 2 present the detailed damage estimates per damage level. Table x presents the distribution of damages across the six districts where the data collection happened in both phases. Table y presents the same data for the districts where the data collection was conducted during phase 2.

Table 2: Damage estimate by type of road (Crs INR)

District	MDR Damage	VR Damage	Total Damage
Kinnaur	3.5	11.7	15.2
Solan	14.9	22.4	37.3
Kullu	32.4	366.5	399.0
Mandi	40.3	146.7	187.0
Chamba	24.7	82.4	107.1
Shimla	68.1	310.8	378.8
Bilaspur	7.6	22.9	30.5
Hamirpur	18.0	60.6	78.6
Kangra	8.1	132.8	140.9
Lahaul & Spiti	0.0	19.6	19.6
Sirmaur	11.6	63.9	75.5
Una	3.6	33.3	36.9
State	**232.7**	**1273.7**	**1506.4**

Table 3 Damage Estimate Details (Crs INR)

(Kinnaur, Solan, Kullu, Mandi, Chamba, & Shimla)

Damage Category	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
MDR Totally Destroyed - Replacement	2.34	9.19	19.35	10.72	1.56	7.69
MDR: Severely Damaged - Major Repair	0.84	5.32	7.58	25.98	13.88	45.25
MDR: Partially Damaged - Minor Repair	0.32	0.39	4.80	3.36	4.07	2.70
MDR Total Damage	3.50	14.89	31.72	40.06	19.50	55.64
VR Totally Destroyed- Replacement Cost	8.91	13.21	269.92	36.68	2.17	59.34
VR: Major Repair	2.19	6.41	82.88	92.81	32.76	230.37

VR: Minor Repair	0.59	2.81	5.54	17.25	31.42	21.08
VR Total Damage	11.69	22.44	358.34	146.74	66.35	310.79
Total Damage (MDR + VR)	**15.19**	**37.33**	**390.06**	**186.80**	**85.86**	**366.43**

Table 4 Damage Estimate Details (Crs INR)

(Bilaspur, Hamirpur, Kangra, Lahaul & Spiti, Sirmaur, & Una)

Damage Category	Bilaspur	Hamirpur	Kangra	Lahaul & Spiti	Sirmaur	Una
MDR Totally Destroyed - Replacement	4.5	15.0	4.7	0.0	10.3	2.8
MDR: Severely Damaged - Major Repair	2.6	2.6	2.5	0.0	0.8	0.7
MDR: Partially Damaged - Minor Repair	0.5	0.4	0.9	0.0	0.5	0.0
MDR Total Damage	**7.6**	**18.0**	**8.1**	**0.0**	**11.6**	**3.6**
VR Totally Destroyed- Replacement Cost	21.6	53.9	103.7	18.5	52.6	30.0
VR: Major Repair	0.7	4.4	25.6	0.7	8.5	2.2
VR: Minor Repair	0.7	2.3	3.5	0.4	2.8	1.0
VR Total Damage	22.9	60.6	132.8	19.6	63.9	33.3
Total Damage (MDR + VR)	**30.5**	**78.6**	**140.9**	**19.6**	**75.5**	**36.9**

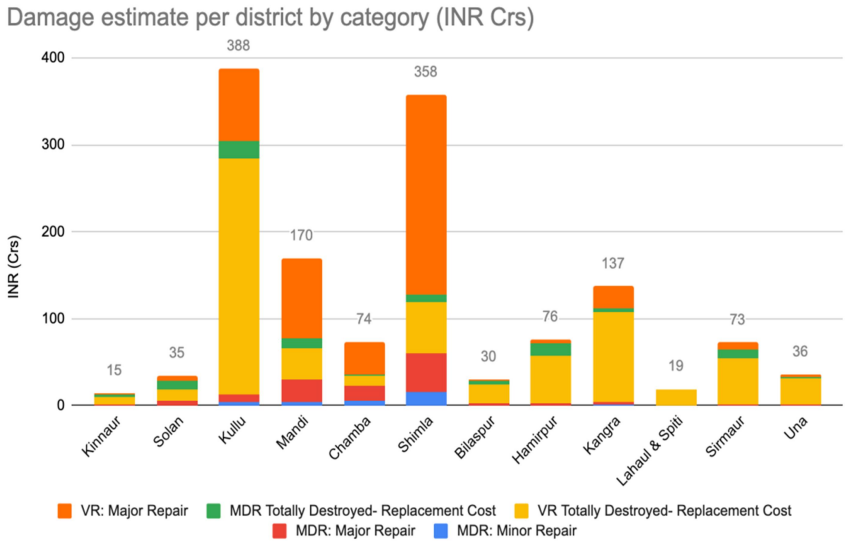


Figure 3: Damage estimates categorised by road type and damage category (CRs INR)

Above figure illustrates the damage distribution infographically. We can observe that the damage to the village roads is contributing most to the total damage estimate. Data also shows that Kullu, Shimla, & Mandi have the most damage, with Kullu's damage mainly stemming from total destruction of village roads, while Shimla and Mandi have significantly severely damaged village roads contributing mainly to the damage costs. These trends can be attributed to the existing very high vulnerability of Kullu, and high vulnerability of Shimla and Mandi, combined with this disaster's high intensity of localised cloudbursts in Kullu, Shimla & Mandi. The general disaster vulnerability map of districts of HP, as identified by HPSDMA is presented in FIgure 4.

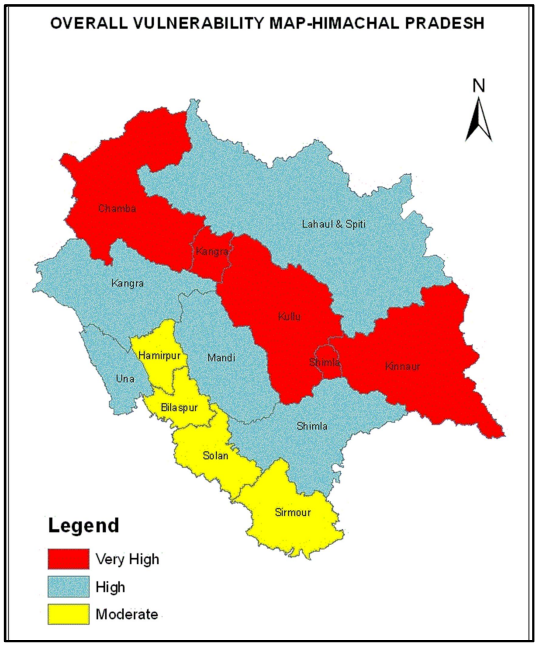


Figure 4: Overall Vulnerability Map of Himachal Pradesh by Districts

The damages were calculated based on the total length of road & bridges (in km & m respectively) damaged at different levels, as provided by the district engineers. These lengths were then multiplied with the unit cost of replacement, major repair, and minor repair costs. For the six districts that were part of the first phase assessment, the unit costs were estimated by the district engineers and calibrated and validated by the road experts. Slight variation in the unit rates across districts exist due to different needs, and road configurations. For instance, roads in hilly areas will need a higher speed of retaining walls, while roads in the valleys next to the rivers might need flood protection measures such as crib walls but not extensive retaining walls. Similarly, the distribution of single, intermediate, and double lane roads among the districts is different, thereby causing differences in the unit rates of reconstruction and repair. With such nuances in consideration, Annex x presents the unit rates for replacement, major repair, and minor repair for each of the six districts. The unit cost per district and the length of damage in each category was then used to do a weighted average to calculate the net average unit cost of damage at the state level. The average unit costs indicate the average cost of damage at different levels per unit of road assets damaged in this given disaster. This is contextual to this disaster and the geographical & demographic context of the affected region, and should be calibrated with the nuances in consideration for any future similar disasters. Table x presents the net average unit costs of damage per asset type for these six districts at the state level.

Table 5: Baseline data for the six districts where data collection was conducted in both phases of assessment

Kinnaur, Solan, Kullu, Mandi, Chamba, & Shimla						
	Average Replacement Cost (Lakh/km)		Average Major Repair Cost (Lakh/km)		Average Minor Repair Cost (Lakh/km)	
Type of Roads	**MDR**	**VR**	**MDR**	**VR**	**MDR**	**VR**
Water-Bound Macadam	60	57	54	23	1	1
Black Top	111	85	64	49	2	2
cement concrete		25				
	Average Replacement Cost (Lakh/m)		Average Major Repair Cost (Lakh/m)		Average Minor Repair Cost (Lakh/m)	
Type of Bridges	**MDR**	**VR**	**MDR**	**VR**	**MDR**	**VR**
Steel	30	11	3	3	1	1
Concrete		13	5	3	1	1
RCC Concrete Culvert	-	15	-	-	-	-
Others (specify) Cable & suspension bridge, bailey bridge	-	4	2	1	-	-
Ropeways and Jhulas	-	5	-	-	-	1

For assets that did not have any damage , such as RCC culverts on MDR roads, the unit costs were not calculated to ensure efficiency in the time-sensitive data collection process.

For the other six districts where the data collection was conducted during phase 2, and used the granular survey tool to collect the data, the yardstick rates of construction & repair provided by HP PWD were used as the main consistent source of cost estimation. This dataset also had additional categories of damage being reported (pipe & box culverts, and additional structures on the road), which are provided in the baseline table. Table 5 presents the baseline estimates used for these districts (Bilaspur, Hamirpur, Kangra, Lahaul & Spiti, Sirmaur, and Una).

Bilaspur, Hamirpur, Kangra, Lahaul & Spiti, Sirmaur, and Una						
	Average Replacement Cost (Lakh/km)		Average Major Repair Cost(Lakh/km)		Average Minor Repair Cost (Lakh/km)	
Type of Roads	**MDR**	**VR**	**MDR**	**VR**	**MDR**	**VR**
Water-Bound Macadam	56.5	28	23	18	2	1
Black Top	64	32	23	18	2	1
Cement Concrete	60	30	23.17	17.6	1.75	1.3
R Wall	400	400	280	280	120	120
B Wall	320	320	224	224	96	96
Earthen Road						0.78
Type of Bridges	**Replacement Cost (lakh/m)**		**Average major Repair Cost(lakh/m)**		**Average Minor Repair Cost(lakh/m)**	

	MDR	VR	MDR	VR	MDR	VR
Steel	6.6	4.2	4.6	3.0	1.97	1.27
RCC Bridge	4.2	2.8	3.0	2.0	1.3	0.8
Vented Causeway/Slab Culvert	2.5917	2.1147	1.8	1.5	0.8	0.6
Suspension Bridge	2.8	2.8	2.0	2.0	0.8	0.8
Ropeway & Others	2.4	1.5	1.7	1.06	0.7	0.45
Culverts	**Average Replacement Cost (Lakh/m)**		**Average Major Repair Cost (Lakh/m)**		**Average Minor Repair Cost (Lakh/m)**	
	MDR	**VR**	**MDR**	**VR**	**MDR**	**VR**
Pipe Culvert	0.96	0.96	0.67	0.672	0.28	0.28
Box Culvert	1.66	1.33	1.16	0.931	0.49	0.39
Additional Structures	**Average Replacement Cost (Lakh/m)**		**Average Major Repair Cost (Lakh/m)**		**Average Minor Repair Cost (Lakh/m)**	
	MDR	**VR**	**MDR**	**VR**	**MDR**	**VR**
Cross Drainage	16	12	11.2	8.4	4.8	3.6
Crash barrier/railing	9.71	9.71	6.97	6.77	2.13	2.9
Roadside Drainage	4.08	4.08	2.56	2.86	1.24	1.2
Traffic and Safety Devices	0.32	0.32	0.24	0.24	0.01	0.01

7.4 LOSS ESTIMATE

Total losses sustained by the road sector are estimated at 127 Crs INR, with the majority of losses incurred in the Kullu and Mandi districts. In the August phase, Kangra also faced significant losses. Losses relate mainly to the debris removal from roads after landslides, additional machinery use, and temporary alternate routes and bridge places to function until the replacements & repairs are completed. These loss estimates were obtained by the district PWD engineers as the overall expense per asset type, broken down by MDR & DR. The unit cost of landslide slip removal is obtained from the latest yardstick rates published by PWDs that accounts for the latest labour and material costs[9]. Detailed consultation with the road sectors and the district PWD engineers to ensure the losses were correctly accounted for. The process is outlined in the assessment approach segment under 4.1.1.3.

[9] Example yardstick rate reference https://hppwd.hp.gov.in/sites/default/files/circular-documents/Scan_20230724_161216.pdf

https://hppwd.hp.gov.in/sites/default/files/circular-documents/bridge%20rates.pdf

https://hppwd.hp.gov.in/sites/default/files/circular-documents/Yardstick%20Rate.pdf

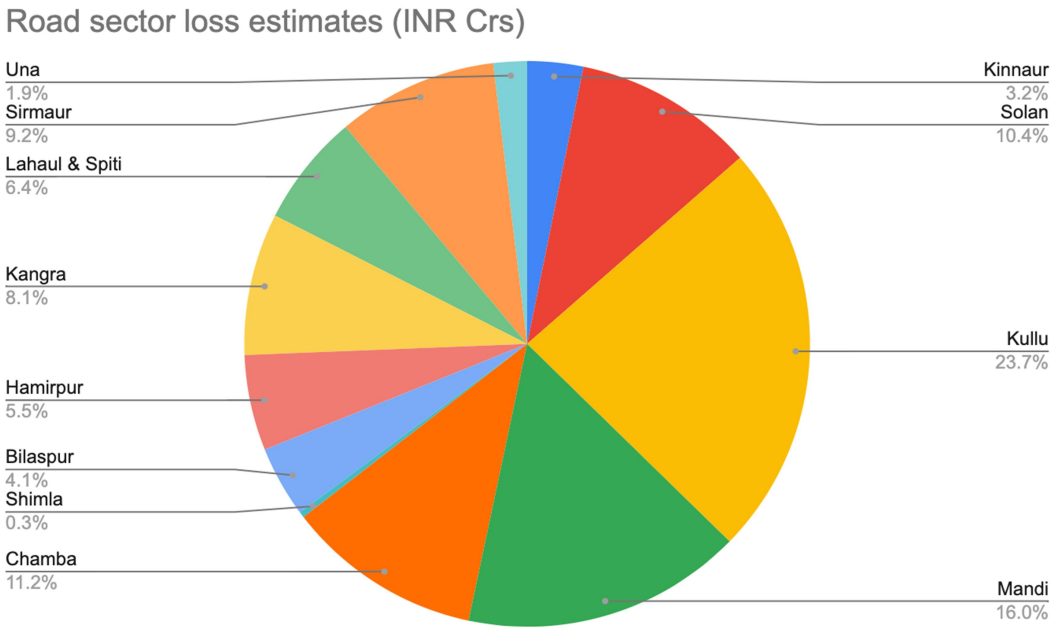


FIgure 5: Loss estimates distributed across the six districts (Crs INR)

While these losses are incurred by the road sector, the losses incurred by other sectors due to road disruptions including national highways are also equally if not more relevant to be addressed. Each sector section discusses such losses mainly due to delays in transportation due to road closures and overall represented as a loss to state GDP. The subsequent section on social and economic impact also highlights the road sector's impact on other sectors, and hence the impact of road damages on the social and economic growth of the state.

7.5 Social and Economic Impact on People

The state MDR and village road (majorly single lane to intermediate lane), jeepable roads, and ropeways/pedestrian bridges provide connectivity to the habitations (rural/urban), district centres, tourist destinations, religious places, fruit belts- orchards/agriculture fields, wholesale markets, factories, and hydropower stations.

The state being located in the Indian Himalayan Mountain Region pose significant geo-hazard (landslide) and fluvial flood risks to all kinds of road infrastructure and associated transport and logistics services for the districts assessed. The entire set of road assets and also recently constructed major 4 lane NH corridors, NH-5 and NH-21 were put to the extreme stress test as the state experienced a high pre-monsoon rainfall followed by intense rainfalls during monsoon. Between 7th to 11th July 2023, Kullu, Shimla, Solan, and Kinnaur received 600-800% more rainfall. This triggered landslides, cloud bursts events with flash floods, rock & mud slips, the extreme river flows in the valleys from excess rainfall as well as dam water release, leading to fluvial flooding and road breaches, toe erosion of road embankments, sinking of road sections, pavement, retaining structure, bridge and culvert damages. The districts lost transport connectivity for days and weeks

and intermittently even after the resumption with fresh slides. The disruption to traffic flows to and from the state has resulted in a significant detour for road traffic leading to the state's economic loss owing to increased transport costs. It is roughly estimated that almost 9000 vehicles per day to/from Manali are diverted to use MDR 29 (Naggar- Manali road), as a section of NH-21 near the Manali bus stand is washed away and also there are disruptions on Mandi section of NH leading major detour Similarly, Parwanoo- Solan section of the Kalka- Shimla Highway (NH-5) was completely damaged owing to landslides with several of the in-bound and out-bound traffic including trucks carrying Apples from Kinnaur either having to detour 80 km via Manali- Shimla Road or using MDR- 6. Besides, as several sections of MDRs and village roads were also damaged or blocked by landslides, there was a complete or partial lack of access to districts, towns, health facilities, and schools throughout the months of July and August.

As the livelihood of a large section of the population in tourist destinations of Himachal Pradesh is dependent on tourist flows, they have suffered major business loss (covered in detail in section 2.2 of the report). Post the July disaster, the national and state administration was involved with immediate traffic restoration and providing connectivity to road sections lost due to floods and landslides. But fresh bouts of high-intensity rainfalls in Shimla, Solan, Mandi, Kangra, Una, Hamirpur, Bilaspur from 12th to 14th August 2023 have also added to the damages to the districts already covered and remaining six districts. The onslaught of monsoon is also expected to negatively impact tourist inflows in the peak season starting September onwards, leading to state exchequer loss as well as loss of livelihood for the population dependent on tourism

Agriculture/horticulture is one of the mainstays of HP's economy providing employment to about 62 percent of the total workers in the state, mainly small-holding farmers with apples being a key product of the state. With the road network being damaged and envisaged time to fully restore connectivity in the prime apple harvest season of August to September, the farmers are looking at huge losses owing to breaks in transport connectivity and higher cost of transport.

Several of the private houses and commercial properties abutting the roadside also got damaged by floods and landslides. 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.

7.6 RECOVERY AND RECONSTRUCTION NEEDS

Road transport being the mainstay of economic activities in H.P., the current flood and landslide disaster in H.P. has severely impacted the state's economy and needs 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 all 12 districts segregated by Major District Roads (MDR) & Village Roads (VR). The overall reconstruction and recovery needs (infrastructure costs) in the short to medium term has been estimated at INR 2438 Crores (INR 479 Cr. for MDR and INR 1943 Cr. for VR) and are summarised in Tables x, x.

Table 6: District-wise Reconstruction & Recovery Estimates for MDRs (Short to Medium Term)

Districts	Short Term (0-6 Months)	Medium Term (6-24 Months)	Total Cost (INR Cr.)
Kinnaur	0.74	11.7	12.42
Solan	3.05	42.3	45.35
Kullu	8.59	74.2	82.76
Mandi	16.50	42.3	58.85
Chamba	14.08	61.7	75.79
Shimla	37.74	60.3	98.05
Bilaspur	1.79	20.6	22.37
Hamirpur	1.69	29.6	31.29
Kangra	2.21	19.7	21.90
Lahaul & Spiti	0.00	0.0	0.00
Sirmaur	0.92	21.7	22.58
Una	0.37	7.1	7.44
Total	**87.69**	**391.1**	**478.80**

Districts	Short Term (0-6 Months)	Medium Term (6-24 Months)	Total Cost (INR Cr.)
Kinnaur	1.68	41.0	42.73
Solan	6.02	44.6	50.57
Kullu	52.73	477.6	530.28
Mandi	63.65	87.1	150.80
Chamba	52.27	67.5	119.77
Shimla	136.27	224.5	360.79
Bilaspur	1.00	215.8	216.83
Hamirpur	4.50	80.0	84.52
Kangra	16.29	190.2	206.53
Lahaul & Spiti	0.79	22.9	23.66
Sirmaur	7.04	86.5	93.50
Una	2.16	61.3	63.48
Total	**344.38**	**1599.1**	**1943.46**

7.6.1 SHORT TO MEDIUM TERM (0-24 MONTHS)

In the immediate to short term, PWD, Government of Himachal (GoH), had already deployed its own resources, for the clearance of debris, construction of temporary diversions, repair as well as reconstruction of failed hill slopes, pavement and bridge restorations in order to keep the roads trafficable. For repair, reconstruction and recovery estimates in the short to medium term, market rates have been used. The market rates for different road work items were collected from PWD Engineers and cross-validated. The rates were found to vary within a reasonable range across districts, primarily owing to difference in the cost of inputs and other nuances akin to the terrain and geographic location of the district.[10]

Overall, 395 km of roads were listed as totally damaged and thus have been considered for reconstruction along with recovery using "BBB" principles. In addition, 7645 km of roads which suffered major and minor damages are considered for repairs and reconstruction incorporating site-specific design requirements that allow good engineering considerations. For sequencing budgetary estimates into short term (0-6 months) and medium-term requirements (06-24 months)- repairs of 100% "partially damaged" and 50% "severely damaged" roads and bridge sections have been considered (as short-term) while the rest of the interventions that needs recovery and reconstruction based on resilient principles are listed under long term.

For the medium term (06-24 month), the reconstruction and recovery has laid focus largely on reconstruction of totally and severely damaged sections with an aim 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 with grouted gabions.

The typical cost for such additional recovery measures (applied to part/full of the totally damaged road sections as determined by district authorities) is estimated as Rs 2.56 Crores/km for MDR and Rs 2.05 for VR. Additionally, there is a case of cross-sectoral interventions like river training works/channelization at some critical locations, this cost however has not been factored and expected to be covered under cross-sectoral flood mitigation estimates. The use of standard designs is discouraged in short-medium recovery (where major activities shall happen). It is recommended that PWD's design wing 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, PWD, GoH may need to induct necessary skilled staff for this purpose during

[10] Typical unit rates across districts for major road work items that were considered for recovery and reconstruction estimates included different pavement layers i.e., BC- Rs 15,500/ cum, BM- Rs. 10,500/cum, granular base/sub-base-Rs 3000-3300/cum; hill slope protection- breast walls (2-3m height) Rs 32000/m, retaining wall (4-5m height) Rs 40000/m bioengineering/geo-grid with soil nailing-Rs3000/sqm; V drain- Rs 575/m, U Drain- Rs 1300/m, slab culvert (of 3 m span) @Rs 15 lakhs per unit, pipe culverts @ Rs 4 lakhs/unit;

the short to medium recovery period spanning the next 2 years. The overall recovery matrix for short to medium term is provided in Table X below which has infrastructure cost as well as soft costs related for technical studies, training and capacity augmentation.

Table 7 Recovery and Reconstruction Needs in short to medium term

Recovery and Reconstruction Needs	Amount (INR Cr.)	Responsible Department	Supporting Department	Priority	Timeline
Major & Minor Repair Works for severely and partially damaged sections	735.0	PWD	Finance	High	0-6 months
Reconstruction of Totally Damaged Section	771.4	PWD	Finance	High	0-12 months
Additional Resilient Recovery for high risk/ totally damaged sections	915.8	PWD	SDMA/Jal Shakti/Forest /Finance Dept./Hydropower Entities	High	0-24 months
Technical studies to plan, design, evolve standards, systems and processes for long term recovery program (Refer section 4.1.1.7)	25			High	0-24 months
Capacity Building (Refer section 4.1.1.7)		PWD	Finance/MDBs		
Induction of resilient design engineers in PWD Design Wing for 2 Years	6	PWD	Finance/MDBs		0-3 Months
Training and Capacity Building of PWD Engineers and Contractor on resilient road design and management	5	PWD	Finance/MDBs		0-24 months
Policy Linkages	Refer section 4.1.1.7				
Disaster Risk Reduction Measures					
Total (In INR Crores)	**2458**	**Rupees twenty four hundred fifty eight crores**			

7.6.2 Long Term Needs (24-60 Months)

To recover from the floods and landslides in a resilient and sustainable manner, it is felt that a traditional approach to recovery and reconstruction in Himachal Pradesh would be insufficient. Thus, a detailed deep dive is required to diagnose the fundamental drivers of key hazards like floods and landslides and future climate that will impact all major infrastructure including roads. And based on this analysis determine a clear policy, regulatory, institutional, investment actions which can then be converted into programmatic implementation mode with a multi-sectoral approach. In this

endeavour of long-term recovery planning, it would also be important to assess the current road construction and maintenance practices used in the state, factor in incremental risks and vulnerability that road assets face post the current disaster and develop understanding of future macro and micro climatic risks of the state. Once these are assessed, it can be systematically integrated into a set of optimal road infrastructure resilient design provisions and implementation modalities to be better prepared for future disaster events. The road sector's long-term disaster risk reduction and recovery strategy (24 to 60 months) thus would need to focus on a cross-sectoral approach targeting resilience in institutions, systems, evolved resilient design standards to address climate change induced natural hazards, promote green construction & maintenance standards, improve contractor capacity building to deliver on these requirements and ease in access to adaptation financing. In the long-term (24-60 months) an investment to the tune of Rs 6000-8,000 Cr. (0.75 -1 Bn USD) and a programmatic approach for state's climate adaptation works thus envisaged to be required *(the TA studies as envisaged in section 4.1.1.7 would enable to throw some light on the actual requirements).* This will only enable the state to improve transport value chains, address logistic bottlenecks and reduce overall climate risks and vulnerabilities. The district wise recovery needs will also differ across geography, geo-hazard type, rainfall/snowfall pattern, location of assets with respect to river, community living along the assets, overall land use pattern and forest cover etc. This needs to be determined as part of the long-term state-wide recovery program. Box 1 below provides a broad overview on how a long-term road sector resilience program in districts like in Kullu may look like. In the next 2 years, GoH should attempt to develop a cross-sectoral resilient recovery program to be implemented in the long term (24-60 months) and beyond.

7.7 DISASTER RISK REDUCTION MEASURES

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 by integrating disaster risk reduction measures into the recovery. The basic principles of recovery efforts have to start from short-term and should evolve into a more sustainable mainstream practice in the medium to long term which are informed by various technical studies. Some of the focus areas for PWD, GoH in recovery actions include.

7.7.1 POLICY AND SYSTEMS

- Mainstream resilience in the Himalayan Mountain roads, protecting the natural and social environment. PWD's focus should be to develop a policy framework, strategies and technical manuals for mainstreaming resilience by preparing and adopting: (i) an integrated landslide risk mitigation strategy (ii) emergency warning and response system; (iii) nature-based solutions and resource conservation; and (iv) environmental and social management framework *(Timeline: over next 24 months)*
- States may evolve a local resilient road infrastructure guideline in the next 1 year based on their own assessment, local engineering, use of local and marginal materials, nature-based solutions and learnings from other states which gets embedded during reconstruction and recovery. Bioengineering solutions for slope protection where-ever feasible shall support greener recovery rather than a non-sustainable concrete solution *(Timeline: over next 18 months)*
- Output and Performance-based management contracts (OPBRC)- Operationalise 5 Year (recovery +maintenance contracts) built on resilient standards and provisions to deal with

emergency works. Long term performance-based contracts, already launched in HP in 2017/2018 can be used for maintenance of key MDR corridors. Once the assets are recovered and reconstructed (in the medium term), PWD may consider awarding some of the critical MDR connecting tourist and horticulture belts under OPBRC. *(Timeline: 24 to 60 Months)*

- Mainstream use of RMMS for scientific planning, budgeting, and works implementation for MDRs and explore possibility to introduce climate module on a GIS base with mapping of multi-hazards, climate and population data for conducting vulnerability assessment and climate and hazard risk rating of road assets *(Timeline: 24 Months)*

7.7.2 INSTITUTIONAL

- There is a need to augment capacity building of the Design Wing Engineers about climate resilient designs. PWD Design Wing should recruit - 1 geologist, 1 geo-technical expert, 1 hydrology and drainage expert, one resilient bridge and 1 resilient road/pavement expert under central CE- Design and one resilient road expert in each of the 12 districts for next 2 years to have pragmatic designs as part of short to medium term recovery and reconstruction in next 2 years. PWD may explore collaboration with CBRI, Roorkee/IIT Mandi for training and capacity building and expert guidance of the resilient design team of PWD. A minimum of Rs 6 Crores is required for next 2 years.
- The first World Bank funded HP State Road Project (HPSRP I) supported the establishment of the Himachal Pradesh Road and other Infrastructure Development Corporation (HPRIDC) and process reengineering, but the reforms were not transformational. HPRIDC was supposed to manage 4000 km of Strategic MDR network. However, HPRIDC is functioning like a Project Implementation Unit (PIU). The existing legal structure of HPRIDC as a 'Private' Limited Company and appropriate to meet the objectives of a public road asset management entity. HPRIDC's board is not operational. The Company does not have permanent employees on its roll, which means there is no institutional knowledge base/ capacity and makes its sustainability questionable. This institution should be used effectively in the resilient road recovery program outside legacy PWD systems. However, for this to happen both institutional strengthening and empowering of HPRIDC with necessary administrative and financial autonomy has to happen.
- Hydropower companies/Jal Shakti are required to be made key stakeholders in resilient road infrastructure planning and development in their critical zone of influence.

7.7.3 ENGINEERING

- PWD should initiate site-specific flood and landslide hazard vulnerability assessment in the next 2-3 months for all disaster-impacted roads. This will enable PWD to have a comprehensive flood risk mapping, identification, and characterization of unstable land slopes along with soil characterization. This assessment shall enable PWD to determine feasible slope protection options with a focus preferably on a combination of retaining structures (breast wall and retaining wall) along + bio-engineering solutions. This exercise is critical, in a post disaster scenario as it shall enable PWD to identify and geo-tag (using DGPS) critical locations flood breaches, and embankment to scour locations by rivers.

Several of the resilient building efforts may require cross-sectoral collaboration, for e.g., with Irrigation/Hydropower companies for toe wall protection and select dredging, river training/channelization. Similarly for critical landslide/big slip circle failed locations along road alignments, multi-sectoral assessment by Irrigation/Forest/ SDMA and construction of detailed ground model may be the best way forward.

- As PWD has already started restoring and reconstructing some of the damaged roads, it is advised that wherever slope failures have occurred slope stabilisation is done at first to prevent further slides. It shall then be followed by slope protection with a combination of breast wall on the hill side and retaining wall in the valley side with site specific designs. The nature-based solutions like bio-engineering with geo-cells/geo grids or bolted netting should also be applied at critical locations to prevent surface erosion. Wherever it is feasible, the breast walls should be constructed, post-monsoon as in order to install them there is a need to excavate, which may worsen the problem by further destabilising the slope.
- During the ongoing monsoons, efforts should continue to clear all natural drains and streams blocked with dumped spoil, so that the expected runoff from the watershed can safely be disposed of to the nearest river, drain or nala. The U and V type drains along the road side which are damaged should be reinstated for ensuring proper road drainage. The rainwater cuts on the shoulders should be dressed properly so that it doesn't destabilise the embankment.
- 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).
- New CD structures (Bridges/Culverts) should be designed to the latest flood and hydrological data and 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.
- Adopt "Life cycle cost" approach and "Environmentally Optimised Design" measures to rehabilitation and reconstruction of road pavement i.e., use of warm mix asphalt, CRMB bituminous pavement for water resistance, RAP, subsurface drainage, value engineering techniques for use of local and marginal materials.

7.8 TECHNICAL ASSISTANCE SUPPORT REQUIRED (ALL IN SHORT TO MEDIUM TERM)

- Prioritisation study for identification of 800-1000 km of economically important and climate vulnerable PWD road network that can be developed with green and climate resilient standards *(To be completed in next 3 months, Rs 2 Crores).*
- Enhance existing GIS mapping of the highway network with detailed multi-hazard location for vulnerability assessment. The GIS to map also river systems, geo-hazard zones, cloudburst locations, flood breaches, and micro-climates under the existing system and also population details *(To be completed in next 12 months, Rs 2 Crores).*
- Geotechnical and Geomorphological studies for critical slopes by SDMA with help of academic national/international institutes of repute *(To be completed in next 24 months, Rs 5 Crores)*

- DPRs for 800-1000 km of green and climate resilient road work avoiding land acquisition, and widening preferably on the valley at key bottlenecks, only scientific hill cutting with steps and stabilisation efforts wherever it cannot be avoided. The consultants should have good exposure in Hill roads and must be given sufficient time and resources to carry out the necessary work *(To be completed in next 12-18 months Rs 10 Crores).*
- Develop 1. bio-engineering manual and 2. local climate resilient standard and guidelines for H.P. Explore the possibility of involving local academic institutes of repute like IIT Mandi and CBRI, Roorkee for this initiative *(To be completed in next 24 months- Rs 2 Crores).*
- Institutional Strengthening and Capacity Building of HPRIDC to evolve as an important partner institution for resilient and green recovery of Himachal Roads *(To be completed in next 24 months- Rs 2 Crores).*
- Augmenting capacity of PWD engineers and local contractors for design and construction of resilient roads, bio-engineering solutions, top soil preservation during construction, value engineering using local and marginal materials, awareness generation about long term performance-based management contracts and its role in sustainable road maintenance for core assets. This can be achieved through capacity building training, targeted outreach programs to contractors and few advanced seminars on relevant topics in the state *(To be completed in Next 24 months- Rs 5 Crores).*
- Pilot Research led the technical solutions for sinking sections of MDR 30 Bhuntar- Manikaran road (35 km) in Sainj valley or similar other locations in H.P. can be taken up by IIT Mandi/IIT Roorkee/ CBRI Roorkee *(To be completed within next 3-6 months, Rs 2 Crores)*

8 Drinking Water and Sanitation

8.1 SUMMARY

Water supply and sewer systems in Himachal Pradesh constitute critical pillars of infrastructure that sustain the health, well-being, and economic prosperity of its communities. These systems are meticulously designed to provide clean, safe, and accessible water for daily consumption, while also managing the proper disposal of wastewater to maintain environmental hygiene. The diverse terrain of Himachal Pradesh presents unique challenges in infrastructure development, particularly in hilly regions prone to landslides and floods. As the state strives to meet the needs of its growing population and navigate the changing climate landscape, a strategic and holistic approach to water supply and sewer system management remains paramount, ensuring the sustenance and thriving of both people and the environment.

Sl No	Name of the District	Total Damage	Loss
1	Shimla	246.89	169.92
2	Kullu	238.22	214.34
3	Mandi	343.89	148.92
4	Kinnaur	11.97	10.39
5	Chamba	106.70	102.60
6	Solan	38.90	12.04
7	Bilaspur	178.08	45.62
8	Hamirpur	120.00	19.65
9	Kangra	245.42	74.25
10	Lahaul and Spiti	46.62	0.64
11	Sirmaur	214.79	0.02
12	Una	58.11	20.33
	Total	**1849.57**	**818.7**

The recent floods and landslides in Himachal Pradesh have had a significant and far-reaching impact on the state's water supply and sewer systems. Critical infrastructure, including water treatment plants, pipelines, pump houses, and sewage networks, have been severely damaged, disrupting the regular flow of clean water and proper wastewater management. The disruption has not only affected the daily lives of residents but has also posed serious health and environmental risks due to sewer system damage. The challenges posed by the disasters underscore the need for comprehensive disaster risk reduction strategies, resilient infrastructure design, and immediate restoration efforts to ensure the restoration of safe and functional water supply and sewer systems for the well-being of the communities and the sustainable development of the region.

8.2 PRE DISASTER CONTEXT

The state of Himachal Pradesh is richly endowed with a hilly terrain having an enormous volume of water from the catchment areas of Satluj, Beas, Ravi, Yamuna and Chenab rivers. Drinking water is also supplemented from other sources (Ground water: springs, tube wells, etc.; Surface Water: (rivers, khad1 , Nallah, lakes, etc. There are approximately 1.96 lakh water sources in the State as of March 2021. (cag. audit_report/2023). With urbanisation, the plains have transitioned into bustling

cities where government water supply schemes play a pivotal role in meeting water needs. Across the region, including the districts in focus, a total of 5329 operational water supply schemes contribute to this effort. Additionally, communities rely on wells, hand pumps, and boreholes for household water needs. Although their number is limited, these alternative water sources are vital for the covered communities.

Drinking water is supplied to the population through gravity water supply schemes and lift water supply schemes. Under gravity water systems the water is transported through gravity from the source to users through a piped network without use of any external energy. In the Lift water system, water is transported by using external energy through fuel based or electric power using pumps. Main components of water supply schemes in the State include source of water, rising/ gravity main, water treatment plant, pump house, storage tank and distribution line.

The sewer system in Himachal Pradesh primarily encompasses the urban areas, including municipalities and their surrounding regions. The fundamental purpose of the sewer system in Himachal is to effectively manage and treat the wastewater originating from toilets, ensuring its proper treatment before its discharge into rivers or other water bodies.

As of the latest available data, Himachal Pradesh operates a network of sewage treatment plants that collectively treat a substantial amount of sewage generated in urban areas. According to 2020 Existing no. of STPs: 65 and Total Treatment Capacity of STPs (in MLD): 120.496(National Mission for Clean Ganga Format for submission of Monthly Progress Report in the NGT Matter OA No. 673 of 2018 (in compliance to NGT order dated 24.09.2020).

The sewage treatment process implemented in Himachal Pradesh, the raw sewage undergoes several stages to ensure effective treatment and safe discharge. The initial step involves preliminary treatment, wherein the sewage is screened to remove large debris, and grit is removed to safeguard downstream equipment. Following this, the sewage enters primary settling tanks, where heavy solids settle as sludge at the bottom, and the partially treated wastewater moves on to the next stage.

Aeration and secondary treatment play a crucial role, where oxygen is supplied to aeration tanks to encourage the growth of aerobic microorganisms. These microorganisms digest the remaining organic matter in the sewage, enhancing its purification. Subsequently, the mixed liquor is directed to secondary settling tanks, where activated sludge settles, forming sludge, and the clarified effluent overflows for further treatment.

8.2.1 DRINKING WATER SUPPLY PROGRAMMES

Water is a state subject, and the State Government is responsible for ensuring access to a minimum quantity of potable water. Government of India (GoI) supplements the efforts of the State governments with technical and financial assistance for provision of safe drinking water to the habitations in the State. In Himachal Pradesh, Jal Shakti Vibhag (JSV) (erstwhile Irrigation and Public Health (IPH) department), is responsible for providing drinking water services. It is the nodal department in the State for development, execution, operation and maintenance of water supply schemes. The schemes are approved under GOI programmes {National Rural Drinking Water Programme (NRDWP)/ Jal Jeevan Mission (JJM)} and State programmes for Rural/ Urban Water

Supply Schemes. A majority of water supply schemes in the State are executed, implemented and monitored through departmental regulations and under guidelines of NRDWP/ JJM.

8.2.2 AN OVERVIEW OF WATER SUPPLY BASED ON TERRAINS WITHIN HIMACHAL PRADESH:

- Mountainous Regions (Hilly Terrain): In districts like Kullu and Kinnaur, characterised by steep slopes and varying elevations, gravity-based water supply schemes are commonly utilised. Intake structures are strategically placed at higher altitudes to capture water from natural springs and streams. The water is then conveyed through gravity-fed pipelines to distribution points in lower-lying areas. These schemes require less energy for water transportation and are effective in hilly terrains.In hill areas, where terrain and natural water sources are more accessible, the dependency on government water supply schemes might be relatively lower.
- Hill Rural Areas: In districts like Kinnaur and Chamba, where hilly terrain allows for greater access to natural water sources, the dependency on government schemes is comparatively lower. Around 50% of the hill rural population relies on government water supply schemes, while the rest might have their private sources like springs, wells, and hand pumps.
- Hill Urban Areas: In some hilly urban areas, the percentage of people relying on government water supply schemes can be lower due to relatively better access to natural water sources. For example, in Kinnaur, the population dependent on government schemes is around 60%.
- Valleys and Plateaus: In districts such as Mandi and Kangra, which have valleys and plateaus, a mix of gravity-based and lift-based schemes are employed. Gravity schemes take advantage of local water sources and allow water to flow through pipelines to communities. However, for areas where the source is at a lower elevation, such as in valleys, lift-based schemes are adopted. Water is pumped from rivers or wells to storage tanks, and then distributed using gravity pipelines.
- Districts along rivers like Shimla and Solan have the advantage of easily accessible water sources. Intake structures are set up along the riverbanks to collect water. After treatment, water is transported through pipeline networks to communities. Water treatment plants (WTPs) play a critical role in ensuring water quality before distribution.
- Urban Areas: In urban areas like Shimla and Solan, where population density is relatively high (around 80% and 60% urban population respectively), the dependency on government water supply schemes is significant. Approximately 90% of the urban population relies on these schemes for their water needs. For instance, in Shimla, out of the total population of approximately 1.72 million, about 1.55 million people depend on government water supply schemes.
- Plain Rural Areas: In plain rural areas of districts like Mandi and Kullu, the government water supply schemes are also crucial. The population in these districts often relies on these schemes due to limited access to private sources. Around 70% of the plain rural population depends on government schemes for their water supply.

8.2.3 AN OVERVIEW OF SEWER SYSTEM (STP) WITHIN VARIOUS DISTRICT OF WITHIN HIMACHAL PRADESH:

In Shimla, as the capital and a densely populated urban centre, the sewer system is highly advanced and covers a significant portion of the population. Approximately 90% of the urban population is connected to the government sewer system. This system includes modern sewage treatment plants (STPs) strategically placed to treat wastewater before discharge. In Kullu, with a mix of urban and rural areas, the sewer system is designed to cater to both settings. Urban areas, comprising around 40% of the district's population, are equipped with sewer networks, ensuring proper wastewater management. However, in rural regions, the dependence on private septic tanks is higher due to the dispersed settlement pattern. Mandi District exhibits a varied landscape, with valleys and plains. In urban centres like Mandi town, nearly 70% of the population benefits from a government-operated sewer system. In rural areas, septic tanks are prevalent, catering to the remaining population.

In the high-altitude region of Kinnaur, the sewer system is modest due to the challenging terrain. Urban areas rely on decentralised wastewater treatment units, servicing around 60% of the population. Chamba, with its valleys and hills, has a diverse sewer scenario. Urban centres like Chamba town are serviced by a sewer network that covers around 50% of the population. In hill rural areas, septic tanks are common, serving the remaining residents.Solan, known for its urban centres and industrial zones, has a well-developed sewer system covering approximately 80% of the population. Urban areas have sophisticated sewage treatment plants, ensuring proper treatment of wastewater.

8.3 POST DISASTER SCENARIO

The aftermath of this disaster has resulted in widespread damage, with the water supply and sewer network bearing evident scars. The flood's impact has been particularly severe, causing harm to over half of the water supply schemes. The lift water system has been notably affected, with damaged pipelines, pump houses, and storage tanks standing as stark reminders of the disaster's impact. Pump houses, especially in the Kullu and Mandi district, have sustained significant damage, some even obliterated by the sheer force of the flood.

The inundation caused by the floodwaters has led to the deterioration of sewer infrastructure, including pipelines, manholes, and sewage treatment plants. The force of the floodwaters has resulted in structural damage, erosion, and blockages within the sewer network, impairing its functionality. As a consequence, sewage overflow and contamination have become pronounced issues, posing health and environmental risks to the affected regions. The extent of the damage varies across locations, with some areas experiencing more severe impacts than others.

Following the flood, a significant portion of the pipeline infrastructure has been restored. However, while progress has been made in restoring the treatment facilities, they are not yet operating at full functionality. Efforts to rehabilitate the treatment plants are ongoing, involving tasks such as clearing out accumulated silt and debris, as well as cleaning and restoring the equipment used in the treatment process.

Some key details about the damage to the sewer system due to the flood include:

Pipeline Damage: The floodwaters have eroded the ground and weakened the foundations of sewer pipelines. As a result, many pipelines have suffered structural damage, leading to leaks, cracks, and even complete breaks in some cases.

8.4 Department Response to Disaster

In response to the recent flood and landslide, the Jal Shakti Department in Himachal Pradesh has undertaken a multifaceted mission to expedite the restoration of both water supply and sewer systems. Their resolute endeavours are channelled towards rejuvenating vital water supply schemes, with an unwavering aim to reinstate their operational functionality. While the remedies deployed by the department may assume a provisional character, their impact has been profound, effectively revitalising water supply in numerous areas that were adversely affected. It is important to acknowledge that these interim solutions are inherently short-term in nature, necessitating periodic maintenance and repairs. Nonetheless, the strategic implementation of these measures has triumphantly reinstated access to water supply within a significant number of the affected regions

8.5 Limitations

The purpose of the post-disaster needs assessment conducted for Himachal Pradesh in the aftermath of the recent flood was to thoroughly analyse the impact of the disaster on different facets of the water supply and sewer system infrastructure. Given the complexity of these systems, which encompass a range of interconnected components, gauging the overall extent of the damage posed a significant challenge. Consequently, the assessment was designed to dissect and comprehend the impairment incurred by each distinct segment within the water supply and sewer system. For instance, this entailed evaluating the impairment along the entire trajectory of water supply—from its origin point to the distribution nodes—and similarly, for the sewer system, it encompassed evaluating the harm sustained at an individual household level, extending all the way to the ultimate outlet point.

- The documentation of damages to the water supply system has been extensive, facilitating a relatively well-founded derivation of the incurred losses. However, it's important to note that the damages to individual or privately owned water supply infrastructure have not been systematically recorded by any governmental body, resulting in an absence of direct data. Consequently, this assessment does not encompass the evaluation of damages at the individual level for such infrastructure.
- Regarding the sewer system, the documentation of damages has predominantly occurred. Nonetheless, it is noteworthy that damages to the individual components of the sewer system, particularly at the level of private facilities like septic tanks, remain unrecorded and unavailable in terms of documented data.

8.6 Damage Assessment

8.6.1 Water Supply

The assessment's focus was to evaluate the disaster's repercussions on various components of water supply infrastructure. This meticulous scrutiny encompassed every facet of piped water

supply schemes, delving into details from the water source all the way to the distribution points. The evaluation encapsulated a comprehensive examination, commencing at the water source and extending throughout the entirety of the distribution network. Water-supply system damages have been largely documented, and therefore, could be reasonably derived. The damages to individual or private water supply infrastructure had not been documented by any government authority, and direct data is unavailable therefore this assessment doesn't cover the damage at individual level.

GROUND WATER SOURCE

The recent devastating flood in Himachal Pradesh has inflicted varying degrees of damage upon different types of water supply sources, including open wells, closed wells with hand pumps, closed wells with storage and electric water pumps, and boreholes. The floodwaters have led to the unfortunate contamination of well water due to the influx of pollutants and debris. Sediments and contaminants carried by the flood have accumulated within the wells, thereby compromising the quality of water and rendering it hazardous for consumption. Furthermore, the force of the floodwaters has potentially compromised the structural integrity of open wells in some instances, resulting in irreparable damage.

	Open well (in number)		Closed Well with Hand Pump (in number)		Closed well with storage & Electric water pump & Tap stand (in number)	
Name of the district	Total	Damage	Total	Damage	Total	Damage
Shimla	1	1	250	41	1	0
Kullu	4	0	1250	183	188	22
Mandi	0	0	1570	0	62	0
Kinnaur	0	0	0	0	0	0
Chamba	0	0	0	0	0	0
Solan	0	0	0	0	126	61
Bilaspur	66	28	72	28	52	28
Hamirpur	19	28	47	28	101	28
Kangra	93	99	82	99	345	99
Lahaul and Spiti	7	5	0	5	104	5
Sirmaur	15	24	37	24	457	24
Una	1	5	22	5	68	5
Total	206	190	3330	413	1504	272

The electrical components of water pumps associated with closed wells have been severely damaged by the flood, rendering them nonfunctional. Additionally, floodwaters have infiltrated storage tanks, thereby compromising the quality of stored water. The tap stands, which are crucial for the distribution of water to the community, have also fallen victim to the flood, suffering damage or being washed away. Moreover, the flood's impact has disrupted the pumping mechanism of boreholes, rendering them unusable until extensive repairs can be undertaken.

The cumulative effect of this calamity has taken a toll on the groundwater supply system, leading to significant impairment. Unfortunately, repair work on these water sources has not yet commenced, underscoring the urgent need for rehabilitation efforts to reinstate these vital sources of clean water for the affected communities. The table account of the impact on each of these water supply sources:

WATER SUPPLY SCHEME

The recent flood in Himachal Pradesh has caused extensive damage to the water supply schemes across the region. The flood's impact has been felt throughout the entire water supply system, affecting various components of the infrastructure. The damage includes disruption of pipelines, pump houses, treatment facilities, storage tanks, and distribution networks.

Pipelines, which form the backbone of the water supply system, have suffered from the force of the floodwaters. Many pipelines have been damaged or washed away, leading to interruptions in water flow and distribution. Pump houses, essential for maintaining water pressure and flow, have also been severely impacted. The structural integrity of pump houses has been compromised, with some being completely destroyed by the flood's force.

Treatment facilities, vital for ensuring the quality of water, have been affected as well. The flood has led to the accumulation of silt and debris in treatment plants, rendering them inoperative. Storage tanks, responsible for storing treated water, have also suffered damage. Floodwaters have infiltrated storage tanks, affecting the stored water's quality and safety.

Furthermore, the distribution network, including tap stands and distribution points, has not been spared. The flood has damaged or washed away tap stands, hampering the distribution of water to communities. The overall impact of the flood on the water supply scheme has been extensive, leading to disruptions in water availability and quality for the affected areas.

Bellow section explain the damage to each component in detailed

INTAKE FACILITY

The "intake water facility" in Himachal Pradesh refers to the infrastructure and arrangements put in place to extract water from natural sources such as rivers, streams. This facility serves as the starting point for water supply systems, where water is collected, treated (if necessary), and then distributed to communities for various uses, including drinking. It can have a length of around 5 to 10 metres and a height of 1 to 2 metres. Water-Holding Capacity: The collection chamber behind the dam or weir can store approximately 5,000 to 10,000 cubic metres of water. These numbers are provided as general estimates and can vary based on specific site conditions, flow rates, and design considerations

The intake structures play a crucial role in both gravity and lift water schemes, with the exception of schemes relying solely on bore holes. Whether the water source is a natural stream, river, or any other, these schemes incorporate intake structures prior to conveying water to treatment facilities or water storage tanks. Across both types of schemes, this initial structure is integral to the process

Sl no	Name of the district	Intake structure	
		Total Number	Damaged in Nos.
1	Shimla	2997	1,613
2	Kullu	483	208
3	Mandi	1795	1,152
4	Kinnaur	0	84
5	Chamba	176	508
6	Solan	605	238
		6056	3803

According to the assessment, nearly 62% of the existing water intake facilities have suffered damage. It's important to clarify that this percentage doesn't encompass intake structures developed at the individual level. Moreover, in the wake of this calamity, communities have turned to individual-level intake facilities. In such cases, temporary pipelines are typically connected to facilitate water transportation and distribution at the individual level.

WATER TANK

Water tanks form a vital part of Himachal Pradesh's water supply infrastructure, crucial for maintaining a consistent and dependable water supply to communities. These reservoirs, also referred to as storage tanks, are strategically integrated into the water distribution network, serving to store and control water flow. Varying in size, design, and material, water tanks play a pivotal role in storing water collected from natural sources or treatment facilities. This stored water can then be released to meet population demands, ensuring a steady supply even in times of water scarcity.

In the context of the water supply strategy in Himachal Pradesh, a diverse array of water tanks is integrated, encompassing elevated storage tanks and ground-level reservoirs. These tanks strategically address the challenges posed by both hilly and plain terrains, ensuring optimal water pressure for distribution in elevated tanks, while also accommodating ground-level reservoirs where elevation constraints exist. These reservoirs hold variable capacities, thoughtfully aligned with the demands of the specific regions they cater to. These reservoirs, with their multifaceted designs, play a pivotal role in upholding a reliable and uniform water distribution system. Their capacities span a spectrum, from 50,000 to 100,000 litres, catering to smaller settlements, and further expanding to 200,000 to 500,000 litres, addressing the needs of larger urban centres. Such design considerations are augmented by a holistic approach, facilitating the service of diverse communities. Notably, a reservoir holding 150,000 litres can accommodate the consumption requirements of approximately 3,000 individuals, reflecting the interplay of design and practicality. These reservoirs also foster community integration, extending their reach to encompass the water needs of 3 to 5 neighbouring villages, encapsulating the ethos of shared resources and collective well-being.

Additionally, tanks linked to treatment plants contribute to water treatment and mixing processes, allowing chemicals to take effect before distribution.

	Water Tank	
Name of the district	Total Tanks in Nos.	Damaged tanks in Nos.
Shimla	4276	316
Kullu	1738	103

Mandi	3187	90
Kinnaur	Not mentioned	10
Chamba	157	20
Solan	1590	106
Bilaspur	4,132	259
Hamirpur	1738	96
Kangra	3187	45
Lahaul and Spiti	231	10
Sirmaur	746	20
Una	1590	102
Total	22572	1,177

Though the assessment found that only 5 % of the water tanks were damaged, it is important to note that these waters rank plays a vital role in the water distribution system.

PUMP SETS

In Himachal Pradesh's lift water schemes, pumps play a critical role in facilitating the transportation of water from lower to higher elevations. These schemes are designed to overcome the geographical challenges posed by the region's mountainous terrain. The pump stations are strategically positioned at lower points near water sources, such as rivers or streams, and are responsible for lifting the water to elevated storage tanks or reservoirs located in areas that require water supply. a range of pump sets are employed to ensure effective water distribution. These pump sets encompass various types, each with distinct size capacities tailored to specific needs. Moreover, the choice of pump type is influenced by the varied terrains found across the region.

		Pump	
Sl no	Name of the district	Total Number	Damage in Number
1.	Shimla	659	147
2.	Kullu	246	53
3.	Mandi	572	112
4.	Kinnaur	0	0
5.	Chamba	0	3
6.	Solan	1174	155
7.	Bilaspur	637	60
8.	Hamirpur	630	72
9.	Kangra	1172	171
10.	Lahaul and Spiti	2	0
11.	Sirmaur	662	63
12.	Una	218	37
		5972	873

The recent catastrophe has inflicted significant damage on the water pumps, including the associated motors housed within the pump houses. The disaster's intensity led to the destruction of a considerable number of water pumps, leading to a complete halt in the operation of water supply schemes. These pumps vary in terms of types and capacities, catering to diverse needs across

different areas. As per the assessment, a total of 873 pumps have either been washed away or suffered complete damage as a consequence of the disaster.

PUMP HOUSE

The robustness of the pump house structures has been notably compromised, exhibiting a range of damages that differ from one location to another. The extent and type of damage vary, indicative of the multifaceted consequences of the disaster. It is imperative to conduct individualised assessments for each pump house to comprehensively depict the actual extent of damage and accurately portray the prevailing situation

Sl no	Name of the district	Pump house:	
		Total in Nos.	Total damage in Nos.
1.	Shimla	448	400
2.	Kullu	25	4
3.	Mandi	318	57
4.	Kinnaur	0	0
5.	Chamba	2	1
6.	Solan	550	114
7.	Bilaspur	416	108
8.	Hamirpur	290	58
9.	Kangra	402	74
10.	Lahaul and Spiti	3	0
11.	Sirmaur	513	52
12.	Una	37	14
Total		3004	882

The provided table outlines the damage to pump houses in various districts of Himachal Pradesh, along with the respective total plinth areas damaged in square metres. In Shimla, out of 448 pump houses, 400 are damaged, with a plinth area of 7,305 sqm. Kullu has 25 pump houses, 4 damaged, and a plinth area of 1,482 sqm. Mandi, with 318 pump houses, has 57 damaged and a plinth area of 3,540 sqm. Kinnaur has no damaged pump houses (0 sqm). Chamba has 2 pump houses, 1 damaged, with a plinth area of 58 sqm. Solan has 550 pump houses, 114 damaged, and a plinth area of 2,321 sqm. Bilaspur has 416 pump houses, 108 damaged, and a plinth area of 441 sqm. Hamirpur has 290 pump houses, 58 damaged, and a plinth area of 630 sqm. Kangra has 402 pump houses, 74 damaged, with a plinth area of 2,206 sqm. Lahaul and Spiti has 3 pump houses, none damaged (0 sqm). Sirmaur has 513 pump houses, 52 damaged, and a plinth area of 1,226 sqm. Una has 37 pump houses, 14 damaged, with a plinth area of 585 sqm. Overall, the region has 3,004 pump houses, with 882 damaged, and a total plinth area of 15,705 sqm.

WATER TREATMENT PLANT

In Himachal Pradesh, government-operated water treatment plants stand as integral elements of the water supply infrastructure, ensuring the provision of safe and potable drinking water for the population. Employing a blend of physical, chemical, and biological processes, these plants purify raw water sourced from rivers or streams. This purification involves coagulation, flocculation, sedimentation, filtration, and disinfection, collectively eradicating particles, pathogens, and contaminants.

The process includes-

Coagulation and Flocculation: The process begins with the addition of coagulants such as alum to the raw water. These coagulants promote the clumping of fine particles and suspended matter. Mixing and gentle stirring during flocculation encourage the formation of larger particles called flocs, which facilitate easier removal in subsequent stages.

Sedimentation: The water is then allowed to rest in sedimentation basins. During this phase, the flocs settle to the bottom due to gravity, forming a sludge layer. Clear water accumulates at the top of the basin.

Filtration: The clarified water is subjected to filtration to further remove smaller suspended particles that may have escaped sedimentation. Filters made of layers of sand, gravel, and sometimes activated carbon effectively trap these particles.

Disinfection: To eliminate harmful microorganisms and bacteria, the treated water undergoes disinfection. Chlorine or chloramines are commonly used for this purpose. These disinfectants break down pathogens and prevent their growth during distribution.

pH Adjustment: pH adjustment may be necessary to optimise the water's pH level for safe consumption. Lime or other chemicals are added to maintain a balanced pH.

Fluoridation (if required): In certain areas, fluoride may be added to the treated water to prevent dental issues and improve oral health. This step is carefully regulated to maintain appropriate fluoride levels.

Clearwell Storage: The treated water is stored in clearwells, allowing any remaining particles to settle, and ensuring a consistent supply for distribution.
Distribution: The treated water is then distributed through a network of pipelines to homes, businesses, and communities across Himachal Pradesh.
Stringent adherence to quality standards, regular monitoring, and testing ascertain that the treated water meets safety benchmarks. Equipped with diverse technologies and equipment, these plants tailor their approach based on local conditions.

		WTP Water Treatment Plant	
Sl no	Name of the district	Total	Total damaged
1.	Shimla	466	126
2.	Kullu	31	6
3.	Mandi	1313	144
4.	Kinnaur	0	2
5.	Chamba	3	39
6.	Solan	159	23
7.	Bilaspur	55	19
8.	Hamirpur	72	41
9.	Kangra	58	17
10.	Lahaul and Spiti	1	0
11.	Sirmaur	88	57
12.	Una	17	16
		2263	490

A total of 490 water treatment plants have been damaged. This also includes equipment inside the treatment plants.

The district with the highest damage to Water Treatment Plants (WTPs) is Mandi, where 144 out of 1,313 WTPs have been affected, resulting in an approximately 8.14% damage rate. Mandi necessitates focused attention for recovery and disaster risk reduction efforts. Additionally, Hamirpur exhibits a substantial 56.94% damage rate, with 41 out of 72 WTPs damaged, while Sirmaur reports a 64.77% damage rate, with 57 out of 88 WTPs affected. In contrast, Kinnaur, Chamba, and Lahaul and Spiti have maintained their WTPs without any reported damage, signifying 0% damage rates. In summary, out of a total of 2,263 WTPs across all districts, 490 have been reported as damaged, accounting for approximately 12.61% damage.

PIPE LINE

This table provides details on the damage to water supply system pipelines in various districts, along with an analysis of how different terrains in each district played a role in the damage

Sl No	Name of the District	Total in KML	Damaged in KML
1.	Shimla	7874.94	1217.75
2.	Kullu	9362.71	1537.55
3.	Mandi	95113.35	1065.85
4.	Kinnaur	0.00	67.12
5.	Chamba	7165.65	731.96
6.	Solan	2069.63	79.00
7.	Bilaspur	100187.65	252.75
8.	Hamirpur	73432.898	216.70
9.	Kangra	487230.755	437.40
10.	Lahaul and Spiti	432.65	91.32
11.	Sirmaur	92919.594	400.47
12.	Una	2831.168	89.05
Total		878621.00	6186.89

Shimla, Kullu, and Mandi are districts with extensive lengths of water supply pipelines. Shimla has 1,217.75 kilometres of its 7,874.94 kilometres of pipelines reported as damaged. Kullu, with a total of 9,362.71 kilometres of pipelines, experiences 768.78 kilometres in damage. Mandi, boasting the longest pipeline network at 95,113.35 kilometres, has 1,065.85 kilometres damaged.

On the contrary, Kinnaur, Chamba, Lahaul and Spiti, and Una report no damage to their pipelines, likely due to the absence of infrastructure or minimal damage. Meanwhile, Bilaspur, Hamirpur, Kangra, Solan, and Sirmaur face varying degrees of damage in their water supply pipelines.

In total, the "Total in KML" for all districts adds up to 878,621 kilometres, while the "Damaged in KML" amounts to 6,186.89 kilometres. This data underscores the critical need to assess and address pipeline damage to ensure a reliable and efficient water supply system in Himachal Pradesh, particularly in districts where damage is relatively high

8.6.2 OTHERS (WATER SUPPLY)

The flood's impact has extended beyond the core components of the water supply scheme, causing damage to auxiliary structures and equipment as well. Crossing truss bridges, vital for maintaining

connectivity and accessibility, have been adversely affected. Additionally, winch and trolley systems, essential for transporting equipment and materials, have suffered damage, hampering the logistical operations associated with water supply restoration. The flood's destructive force has also impacted lab equipment crucial for water quality testing and assessment, further complicating efforts to ensure safe water provision. Moreover, furniture linked to the water supply scheme, utilised for administrative and operational purposes, has not been spared from the flood's impact. This comprehensive damage underscores the multi-faceted challenges that authorities face in their endeavour to fully reinstate and operationalize the water supply system in the aftermath of this calamity. The estimated cost of damage of these items are documented in the damage section.

8.6.3 SEWER SYSTEM

The recent flood in Himachal Pradesh has inflicted significant damage to the sewer system across various areas. The inundation caused by the floodwaters has led to the deterioration of sewer infrastructure, including pipelines, manholes, and sewage treatment plants. The force of the floodwaters has resulted in structural damage, erosion, and blockages within the sewer network, impairing its functionality. As a consequence, sewage overflow and contamination have become pronounced issues, posing health and environmental risks to the affected regions. The extent of the damage varies across locations, with some areas experiencing more severe impacts than others.

Following the flood, a significant portion of the pipeline infrastructure has been restored. However, while progress has been made in restoring the treatment facilities, they are not yet operating at full functionality. Efforts to rehabilitate the treatment plants are ongoing, involving tasks such as clearing out accumulated silt and debris, as well as cleaning and restoring the equipment used in the treatment process.

Some key details about the damage to the sewer system due to the flood include:

PIPELINE DAMAGE:

The floodwaters have eroded the ground and weakened the foundations of sewer pipelines. As a result, many pipelines have suffered structural damage, leading to leaks, cracks, and even complete breaks in some cases.

Name of the district	Total in KML	Damage KML
Shimla	76.25	68.778
Kullu	101.65	8.65
Mandi	236.357	42.55
Kinnaur	0	3.65
Chamba	0	4.217
Solan	196.377	4.119
Bilaspur	0	1.22
Hamirpur	0	0.277
Kangra	0	6.105
Lahaul and Spiti	0	0
Sirmaur	0	0.2
Una	0	0
Total	610.634	139.766

In a comprehensive sewer system, pipelines are indispensable components strategically placed across various locations to facilitate the efficient management of wastewater. These pipelines serve multiple critical purposes in urban sanitation. In residential and commercial areas, sewage pipelines, ranging from Ductile Iron (DI) pipes with diameters of 150mm to 350mm, and High-Density Polyethylene (HDPE) pipes with diameters of 100mm to 300mm, are buried beneath streets to gather sewage from buildings and homes. They form a cohesive collection network that efficiently transports wastewater to larger main sewer lines. Main sewer lines, often made of DI or HDPE pipes, carry substantial volumes of sewage to treatment plants or disposal points. Interceptors, trunk sewers, and force mains—constructed from these pipe materials—manage sewage flow over long distances and challenging terrains. Pumping stations equipped with DI or HDPE pipes aid in transporting sewage through force mains or elevating it when needed. At wastewater treatment plants, pipelines direct sewage to various treatment processes. Additionally, outfall pipelines made of DI or HDPE pipes safely convey treated effluent to bodies of water for responsible disposal. Emergency overflow pipelines equipped with these pipe materials prevent flooding during heavy rainfall. Overall, the strategic placement and selection of DI and HDPE pipelines ensure the effective collection, transport, treatment, and environmentally conscious disposal of sewage, safeguarding public health and the environment.

The table provides information on the damage to sewer system pipelines in various districts of the region. Shimla has a total of 76.25 kilometres of sewer pipelines, with 68.778 kilometres reported as damaged. Kullu reports 101.65 kilometres of sewer pipelines, with 8.65 kilometres damaged. Mandi has 236.357 kilometres of pipelines, of which 42.55 kilometres are damaged. In contrast, Kinnaur, Chamba, Solan, Bilaspur, Hamirpur, Kangra, Lahaul and Spiti, Sirmaur, and Una report either minimal damage or none at all to their sewer pipelines. The total for all districts combined is 610.634 kilometres of sewer pipelines, with 139.766 kilometres reported as damaged

Manhole

The force of the floodwaters has affected manholes and access points, leading to dislodged covers, collapsed manholes, and blocked entryways. This has hindered maintenance and inspection activities.

Manhole		
Name of the District	Total	Damaged
Shimla	1810	394
Kullu	5712	452
Mandi	9244	1066
Kinnaur	0	170
Chamba	0	176
Solan	5517	102
Total	22283	2360

Manholes are integral components of a sewer system, serving as access points for maintenance, inspection, and repair activities. They play a crucial role in facilitating the flow of wastewater and gases, while also preventing sewer blockages and ensuring the overall functionality of the system. Manholes are designed to provide a safe and convenient means for workers to enter and work within the sewer network, eliminating the need to access the sewer line directly.

Among these districts, Shimla has the highest percentage of damaged manholes, indicating a significant concern in the district regarding the condition of its manholes. Kullu and Mandi also report a considerable percentage of damaged manholes, emphasising the need for focused attention on infrastructure repair and disaster risk reduction efforts in these areas. Shimla: 21.77% of its manholes are damaged. Kullu: 7.92% of its manholes are damaged. Mandi: 11.54% of its manholes are damaged.Meanwhile, Kinnaur and Chamba have minimal to no reported damage to their manholes, which can serve as a benchmark for resilience in infrastructure management. Solan falls within the mid-range, with 1.85% of its manholes damaged, suggesting a relatively better infrastructure condition compared to Shimla, Kullu, and Mandi.

Sewage Treatment Plant:

Floodwaters have infiltrated sewage treatment plants, causing damage to equipment, electrical systems, and infrastructure. The excess water entering the treatment plants has overwhelmed their capacity, leading to inefficiencies in treating sewage.

Name of the District	STP		Pump		Pump house:	
	Total	Damaged	TOTAL	Damaged	Total	Damaged in
Shimla	4	0	6	3	4	0
Kullu	8	0	75	3	5	0
Mandi	6	0	10	10	8	
Kinnaur	0	0	0	0	0	0
Chamba	0	0	0	0	0	0
Solan	5	0	0	0	3	0
Bilaspur	2	0	0	0	0	0
Hamirpur	51	18	0	0	0	0
Kangra	34	0	0	0	0	0
Lahaul and Spiti	0	0	0	0	0	0
Sirmaur	1	0	0	0	0	0
Una	0	0	0	0	0	0
Total	111	18	91	16	20	0

Sewage treatment plants (STPs) play a pivotal role in safeguarding public health and the environment by treating and purifying wastewater before it is released into natural water bodies. They effectively remove contaminants and pollutants, ensuring that the discharged water meets safety standards. The table provided delineates the damage suffered by various sections—STPs, Pumps, and Pump houses—in different districts of Himachal Pradesh, as a consequence of recent floods and landslides.

8.7 DAMAGE COST ESTIMATE:

The damages to water-supply systems have been extensively documented, making them reasonably quantifiable. However, damages to individual or private water supply infrastructure have not been documented by any government authority, resulting in the unavailability of direct data. Consequently, this assessment does not encompass damages at the individual level.

- The determination of damage costs is intricately linked to the data supplied by the department, encompassing a comprehensive inventory of items meticulously outlined during the damage assessment process. The cost computation process is a result of the department's provision of data, and it entails the meticulous breakdown of calculations for individual components constituting the sector.
- The current market rates have been sourced from the department and cross-validated with market data to ensure accuracy. The calculated average cost is a balanced representation of both market rates and rates provided by various district departments.

Accordingly, the infrastructure statistics used for costing and analysed damages associated with the disaster are summarised in Table below.

District Wise Damage Estimate of Water Supply System

	Name of the district	Ground water source	Intake Structure	Pump	Pump House	Tank	WTP	Pipeline	Total
1	Shimla	1.44	12.10	13.67	18.26	16.29	7.61	168.90	238.27
2	Kullu	7.95	1.56	7.11	3.71	2.54	0.66	213.26	236.77
3	Mandi	0.00	8.64	8.98	8.85	6.03	80.75	147.83	261.08
4	Kinnaur	0.00	0.63	0.00	0.00	0.31	0.22	9.31	10.46
5	Chamba	0.00	3.81	0.08	0.14	0.41	0.00	101.52	105.96
6	Solan	4.27	1.79	8.59	5.80	6.76	0.56	10.96	38.72
7	Bilaspur	2.98	28.52	4.01	1.10	13.81	1.28	126.37	178.08
8	Hamirpur	2.98	0.00	1.81	1.58	2.50	2.77	108.35	119.99
9	Kangra	10.54	0.00	6.49	5.52	3.01	1.15	218.70	245.41
10	Lahaul and Spiti	0.53	0.00	0.12	0.00	0.31	0.00	45.66	46.62
11	Sirmaur	2.56	0.00	4.68	3.07	0.41	3.85	200.23	214.79
12	Una	0.53	0.00	3.85	1.46	6.66	1.08	44.52	58.11
	Total	**33.78**	**57.05**	**59.38**	**49.48**	**59.05**	**99.91**	**1395.62**	**1754.27**

The table presents a district-wise breakdown of the cost of damage to water infrastructure components in Himachal Pradesh, measured in crores.

The table provides a comprehensive cost breakdown of damage to various components of water infrastructure in Himachal Pradesh, measured in crores. Groundwater sources collectively incur a cost of 33.78 crores, while intake structures record 57.05 crores in damage. Pumps represent 59.38 crores in damage costs, with pump houses at 49.48 crores, and water storage tanks at 59.05 crores. Water treatment plants account for 99.91 crores in damage. The most substantial cost, 1395.62 crores, is attributed to damage in water supply pipelines, making it the most financially impactful component

Shimla district reports a total damage cost of 238.27 crores, with notable damage to intake structures and pumps. Kullu has a total damage cost of 236.77 crores, primarily due to pipeline and groundwater source damage. Mandi reports the highest damage cost at 261.08 crores, with significant costs attributed to water treatment plants and pipelines. Kinnaur has the lowest damage cost at 10.46 crores, mainly due to minimal damage across components. Chamba's damage cost is 105.96 crores, primarily due to intake structures. Solan has a total damage cost of 38.72 crores, with notable damage to pumps. Bilaspur reports a damage cost of 178.08 crores, primarily due to intake structures and pipelines. Hamirpur's total damage cost is 119.99 crores, with a significant cost attributed to pumps. Kangra reports the highest damage cost at 245.41 crores, primarily due to tank and pipeline damage. Lahaul and Spiti's damage cost is 46.62 crores, mainly due to groundwater source damage. Sirmaur's total damage cost is 214.79 crores, with considerable damage in water treatment plants and pipelines. Una has a total damage cost of 58.11 crores, primarily due to tanks and pipelines. These district-wise cost breakdowns are essential for assessing the financial implications of damage and guiding resource allocation for effective recovery efforts in the region.

District Wise Damage estimate for Sewer system							
	Name of the district	Pump	Pump House	STP	Manhole	Pipeline	Total
1	Shimla	0.128	3.288	4.732	0.445	0.026	8.619
2	Kullu	0.158	0.080	1.208	0.000	0.000	1.446
3	Mandi	0.150	1.125	78.855	2.665	0.011	82.806
4	Kinnaur	0.000	0.000	1.505	0.000	0.000	1.505
5	Chamba	0.000	0.000	0.735	0.000	0.000	0.735
6	Solan	0.167	0.000	0.000	0.015	0.000	0.182
7	Bilaspur	0.000	0.000	0.002	0.000	0.001	0.003
8	Hamirpur	0.000	0.000	0.007	0.000	0.000	0.007
9	Kangra	0.000	0.000	0.000	0.000	0.003	0.003
10	Lahaul and Spiti	0.000	0.000	0.000	0.000	0.000	0.000
11	Sirmaur	0.000	0.000	0.000	0.000	0.000	0.000
12	Una	0.000	0.000	0.000	0.000	0.000	0.000
	Total	**0.602**	**4.493**	**87.044**	**3.125**	**0.042**	**95.305**

The table presents the cost of damage to sewer system components in Himachal Pradesh, measured in crores. Across the districts, the total cost of damage is 95.305 crores. Mandi district has the highest total damage cost, amounting to 82.806 crores, primarily due to significant damage to Sewage Treatment Plants (STPs). Shimla has a total cost of 8.619 crores, with notable damage to pump houses and STPs. Kullu reports a total damage cost of 1.446 crores, mainly due to damage in pumps and STPs. The other districts, including Kinnaur, Chamba, Solan, Bilaspur, Hamirpur, Kangra, Lahaul and Spiti, Sirmaur, and Una, report relatively minimal damage to sewer system components, with costs ranging from fractions to zero

The total damage cost is 95.305 crores. The highest cost is attributed to Sewage Treatment Plants (STPs), with 87.044 crores. Pump houses have incurred a cost of 4.493 crores, while manholes account for 3.125 crores in damage. Pumps contribute 0.602 crores to the total cost, and sewage pipelines show minimal damage, with a cost of 0.042 crores.

8.8 LOSS ESTIMATE:

In water supply the losses encompass expenditures associated with the implementation of temporary or alternative water supply measures. These expenses encompass the costs incurred for the execution of alternative water supply initiatives undertaken by the Jal Shakti Vibhag (JSV), encompassing both labour and predominantly pipeline-related costs.

For the sewer system the loss sustained due to the cost of cleaning sewage treatment plants (STPs) and restoring pile piles and manholes. The computation of these losses is based on the subsequent assumptions: silt removal from the STP, repair work on pipelines, cleaning blockages from households, and the loss of equipment

The calculation of these losses adheres to the following assumptions:

- Labour costs are attributed to activities executed within the past 30 days.
- Expenses related to materials and equipment are considered in the establishment of these services.
- Recognizing the intricacies of calculating precise individual costs, an approach that involves determining average costs has been adopted.
- The costs within each category were sourced from JSV engineers, and comprehensive calculations were meticulously conducted.

Sl No	Name of the District	Loss
1	Shimla	169.92
2	Kullu	214.34
3	Mandi	148.92
4	Kinnaur	10.39
5	Chamba	102.60
6	Solan	12.04
7	Bilaspur	45.62
8	Hamirpur	19.65
9	Kangra	74.25
10	Lahaul and Spiti	0.64

11	Sirmaur	0.02
12	Una	20.33
	Total	**818.7**

The table provided offers an insightful overview of the incurred losses in both water supply and sewer systems across different districts. These losses primarily arise from the implementation of temporary or alternative water supply measures, as well as the need to restore the sewer system, encompassing activities such as cleaning sewage treatment plants (STPs) and revitalising pile piles and manholes.

In the context of water supply, the incurred losses reflect the expenses related to alternative water supply initiatives carried out by the Jal Shakti Vibhag (JSV). These initiatives entail both labour costs, associated with activities conducted over the past 30 days, and predominantly pipeline-related expenditures. The calculation of these losses employs an approach that factors in expenses for materials and equipment in setting up these temporary water supply measures. Due to the intricacies of deriving precise individual costs, an average cost methodology has been adopted. The figures in this category were obtained from JSV engineers, and calculated assessments were carried out.

Shifting to the sewer system, the losses stem from the costs incurred in cleaning STPs and restoring pile piles and manholes. This computation is based on specific assumptions, including the removal of silt from STPs, repair work on pipelines, clearing blockages from households, and accounting for the loss of equipment.

8.9 IMPACT ON COMMUNITIES:

In the aftermath of the recent floods, the absence of pre-disaster water sources has compelled local communities to resort to alternative sources, often situated at higher elevations. This transition has introduced a cascade of challenges, encompassing:

- Prolonged Water Collection Time: The collection of water by the community now demands notably more time. Accessing these alternative sources necessitates additional effort and duration from individuals, thereby disrupting their daily routines and overall productivity.
- Vulnerable Water Sources: Many of these makeshift water sources carry inherent risks, as their water quality remains largely uncertain. Rainfall events introduce an added layer of uncertainty, potentially contaminating these sources and posing risks to public health.
- Seasonal Limitations: The adoption of alternative water collection methods is primarily viable during the current rainy season. However, as winter approaches, these makeshift sources are susceptible to depletion, intensifying the challenges faced by the community. The imminent scarcity of water supply could have severe consequences if the water supply system is not promptly restored.
- Health Hazards: The degradation of the sewer infrastructure has led to sewage overflow and contamination in the surroundings. This, in turn, has created an environment conducive to disease transmission, posing a direct menace to public health. Contaminated water and

exposure to unsanitary conditions escalate the risk of waterborne diseases, potentially causing health complications among community members.

- Economic Ramifications: The deterioration of the environment due to sewage overflow could adversely affect businesses, especially those reliant on tourism. The broader economic activities within the community might suffer, potentially leading to income loss for households and economic strain.
- This amalgamation of challenges highlights the urgent need for swift and effective recovery measures to reinstate both the water supply and sewer systems. Addressing these challenges will not only restore the basic needs of the affected communities but also safeguard their health, livelihoods, and overall well-being.

8.10 RECONSTRUCTION AND RECOVERY

Both the water supply and sewer systems fall under the purview of the JSV department, and as such, the reconstruction recommendations will apply to both these essential components of infrastructure

- Instead of employing a universal approach, a customised strategy is essential. The department should discern between assets that can be repaired and those that have surpassed repairable limits.
- The path to long-term recovery necessitates in-depth, district-specific studies. Given the uniqueness of each case, a comprehensive recovery strategy is essential.
- This strategy should encompass a range of hazard mitigation measures, addressing potential threats such as floods, landslides, and earthquakes. Special attention must be placed on lift schemes situated in close proximity to rivers, making flood mitigation measures crucial. Additionally, exploring the feasibility of relocation to less vulnerable areas should be a pivotal consideration within this strategy
- All restoration endeavours must encompass mitigation measures. Schemes situated in vulnerable regions, a proactive adoption of multi-hazard mitigation measures is recommended. Incorporating these measures should be a mandatory consideration from the initial design phase through to the implementation stage.
- Essential for the department is to carry out an assessment aimed at evaluating the effectiveness of flood mitigation measures. This evaluation should encompass an analysis of both successful and unsuccessful approaches, offering valuable insights for future planning endeavours. The study serves a dual purpose – not only identifying best practices but also contributing to well-informed decision-making for upcoming initiatives.

SL no	Name of the district	Recovery Cost
1	Shimla	297.01
2	Kullu	286.61
3	Mandi	413.41
4	Kinnaur	15.11
5	Chamba	128.79
6	Solan	47.43
7	Bilaspur	214.45
8	Hamirpur	144.75

9	Kangra	295.25
10	Lahaul and Spiti	56.69
11	Sirmaur	258.50
12	Una	70.48
	Total	2228.49

The recovery cost is an essential element of disaster risk reduction and mitigation efforts. It reflects the financial resources allocated to rebuild and reinforce water supply and sewer systems to withstand future hazards. These measures typically include:

Structure Enhancement: This component focuses on improving the resilience and structural integrity of existing water supply and sewer infrastructure. It may involve strengthening key components, such as water treatment plants, pipelines, and storage tanks, to better withstand natural disasters and mitigate damage.

Preventive Measures for the Structure: These measures encompass a range of strategies aimed at minimising the impact of future hazards. This can include flood control measures, earthquake-resistant construction, and improved maintenance practices to ensure the long-term reliability of the infrastructure.

Detail assessment or study: The cost in question involves the allocation of resources to engage a specialised team or agency with the expertise required to conduct a thorough and comprehensive study. This study serves a dual role in terms of its objectives.

Firstly, it aims to provide detailed insights and recommendations for the future design aspects of infrastructure projects. This involves a meticulous examination of various factors such as the latest engineering and safety standards, technological advancements, and sustainable practices. The expert team or agency will assess and propose design changes that align with these considerations, ensuring that any new infrastructure projects meet the highest standards in terms of safety, efficiency, and environmental impact.

Secondly, the study seeks to offer a clear and in-depth assessment of existing infrastructure located in areas prone to hazards. This includes the evaluation of structures such as buildings, roads, bridges, and other critical assets situated in regions susceptible to natural disasters like floods, earthquakes, or hurricanes. The aim here is to identify any vulnerabilities, potential risks, and the need for relocation or retrofitting to enhance resilience and minimise damage in the face of future hazards.

The combination of these two objectives makes the cost investment in hiring an expert team or agency a prudent decision. It not only ensures that future infrastructure projects are designed with the latest and most advanced principles but also prioritises safety and resilience by addressing the needs of existing infrastructure in high-risk zones.

The recovery cost table demonstrates the financial commitment required to enhance and protect water supply and sewer systems in Himachal Pradesh from the impact of natural disasters. By allocating resources to structure enhancement, pipeline relocation, and preventive measures, these

districts are actively working to reduce the risk and improve the resilience of their infrastructure for future hazard events.

8.11 Implementation strategy for recovery including Build Back Better

8.11.1 Short Term

- Immediate Restoration: Quickly restore water supply and sewer systems by repairing damaged components, such as pipelines, pump houses, and treatment plants, to ensure basic services are functional again.
- Temporary Solutions: Implement temporary solutions for water supply, like using alternative sources to meet immediate needs while extensive repairs are underway.
- Health and Sanitation: Address health risks due to sewage overflow by conducting thorough cleaning and disinfection of affected areas to prevent disease outbreaks.
- Data Collection: Gather accurate data on damage and losses to facilitate comprehensive assessment and prioritisation of recovery efforts.

8.11.2 Mid Term

- Infrastructure Repair: Repair and rehabilitate damaged water supply and sewer infrastructure, including pipelines, treatment plants, pump houses, and storage tanks, to restore full operational capacity.
- Capacity Building: Train staff in emergency response and recovery maintenance and disaster response to ensure resilience in the face of future calamities.
- Mitigation Measures: Implement flood-resistant design and construction standards for infrastructure to enhance resilience against similar events.
- Community Engagement: Involve local communities in planning and decision-making for recovery, ensuring their needs and concerns are addressed effectively.

8.11.3 Long Term

- Comprehensive Planning: Develop comprehensive disaster recovery and management plans that integrate water supply and sewer system components to minimise future vulnerabilities.
- Diversified Sources: Invest in diversified water sources and treatment systems to reduce reliance on a single source and mitigate risks of contamination.
- Ecosystem Restoration: Undertake watershed management and ecosystem restoration initiatives to safeguard water sources and reduce the impact of floods.

- Resilient Infrastructure: Construct new infrastructure with resilient features, such as elevated treatment plants and reinforced pipelines, to withstand future flood events.
- Public Awareness: Promote public awareness campaigns on water conservation, proper waste disposal, and disaster preparedness to ensure sustainable and resilient water and sewer systems.
- Incorporating these short-term, medium-term, and long-term recovery needs will be crucial to effectively rehabilitate the water supply and sewer systems damaged and affected by the recent floods in Himachal Pradesh.

8.12 WAY FORWARD : STRENGTHENING DISASTER RISK REDUCTION THROUGH POLICY INTEGRATION: A PATH FORWARD FOR HIMACHAL PRADESH'S JAL SHAKTI DEPARTMENT

The recent flood and landslides in Himachal Pradesh have underscored the urgent need for robust Disaster Risk Reduction (DRR) strategies in the water supply and sanitation sector. As the Jal Shakti Department grapples with the aftermath, a comprehensive DRR approach emerges as crucial for resilience against future disasters. This shift in approach involves integrating disaster risk factors into every phase of infrastructure development, from design to construction and operation. Collaboration with experts and institutions in disaster management and technology will be pivotal in harnessing innovative tools for risk assessment. By embedding DRR principles into policies, planning, design, and community engagement, the foundation for a resilient future can be firmly established

DM PLANNING

Recent events have highlighted the imperative of embedding disaster risk reduction within water supply and sanitation planning. Traditionally, efforts have concentrated on delivering essential services, often overlooking the importance of fortifying systems against natural calamities. Adopting a DRR-focused approach entails a preemptive analysis of vulnerabilities, the establishment of robust mitigation tactics, and the enhancement of capabilities across all departmental tiers. It's vital to mandate disaster management plans from state to district levels, and ensure consistent monitoring of plan implementation.

PLANNING LEVEL AND DESIGN LEVEL RESILIENCE:

At the planning level, the department must prioritise site selection, taking into account hazard-prone areas and adopting measures to minimise exposure. Design-level resilience involves incorporating features such as elevated structures, reinforced pipelines, and robust treatment facilities that can withstand the impact of floods, landslides, and other disasters. Such measures not only ensure service continuity but also safeguard public health during and after disasters.

9 Power Sector

9.1 SUMMARY

The objective of the Post Disaster Needs Assessment (PDNA) in the Power Supply Sector is to identify the damage and losses caused to the power sector by the disaster, and thereby assess the larger impact on the economy of the state and gain a better understanding of the recovery needs of the power sector to ensure a resilient rebuilding process. PDNA has been conducted in two phases. In the first phase, PDNA of six districts Shimla, Solan, Kullu, Mandi, Chamba, and Kinnaur was done. In second phase PDNA, New six districts Bilaspur, Hamirpur, Kangra, Sirmour, Una, and Lahaul Spiti have been included along with six districts of the first phase Shimla, Solan, Kullu, Mandi, Chamba, and Kinnaur. Damage was caused to the electricity distribution network of Himachal Pradesh.

Floods are commonly associated with power outages. Erosion due to the floodwaters and landslides triggered by floods undermine the foundations of transmission towers. Serious, and often explosive, damage may occur when electrified equipment comes in contact with water, while moisture and dirt intrusion require time-consuming repairs of inundated equipment. In contrast to earthquakes, early warning is possible, and enables electric utilities to shut off power to facilities in flood zones, therefore minimising damage. The most effective mitigation strategies included elevation, levees and locating critical facilities outside the flood zone. Recovery time was driven by the number of needed repairs, and site access as repairs cannot start until floodwaters have receded.

The damage and loss data were provided by the Himachal Pradesh State Electricity Board out of which 6 districts were identified as affected in this sector. The highest number of damages we rerecorded in the Mandi, Kullu and Shimla Districts. This sector assessment has identified the measures that need to be taken in reducing the future disaster risk and the measures to be taken to restore the power supply with immediate effect.

The state of Himachal was the hardest hit from 9th of July 2023 to August 2023 with heavy rainfall and flood following landslides in different districts. This led to the interruption in the Power sector as the structures were deformed, lines were damaged and the Distribution transformers were washed out. This resulted in power cuts and black out in different areas. The state Electricity board worked day and night to restore the power supply with minimum man power which took more than 10 days to temporarily restore the power.

Other factors affecting the power grid recovery time in the aftermath of natural disasters include the resilience of electric power utilities, and the disruption of other critical infrastructure (mainly transportation and telecommunications), either as a direct result of the natural event, or because of the loss of power supply.

This report outlines the damages and losses faced by HPSEB (Himachal Pradesh State Electricity Board Ltd) during the Flood that occurred from 9th July 2023 to August 2023. The damage and loss assumptions are taken from the cost data book provided to HPSEB. The cost of Damages, Losses, and recovery in 12 districts of Himachal Pradesh have been summarised in following table

Summary of estimated cost of damages infrastructure, losses, and recovery in Cr*			
District	Total Damages	Total Losses	Recovery cost
Simla	56.37	0.76	57.13
Kullu	23.69	23.7	47.39
Solan	24	25.14	49.14
Mandi	30.23	9	39.23
Kinnaur	3.52	2.92	6.44
Chamba	26	4.1	30.1
Bilaspur	4.11	0	4.11
Hamirpur	10.71	0	10.71
Kangra	21.58	0	21.58
Sirmour	7.75	0	7.75
Una	5.98	0	5.98
Lahaul Spiti	0.74	0.17	0.91
Total	214.68	65.79	280.47
*Damages Losses associated with larji hydropower plant are not considered in this analysis			

The total damage and losses of the power sector have been estimated for 12 districts are Rs 214.68 cr, and Rs 65.79 cr respectively.

9.2 OVERVIEW OF POWER SECTOR

Himachal Pradesh is almost wholly mountainous state having altitudes ranging from 350 metres to 6,975 metres with climate conditions varying from semi-tropical to semi-arctic. The total population of Himachal Pradesh as per 2011 census was 68,56,509 with population density being 123 persons per sq. Km. Electric supply at the time of formation of the state in 1948 was available only in the Capitals of the erstwhile princely states and the connected load at the time was less than 500 kW.Thus the organisation of the power utility in the state began relatively recently and first electrical division was formed in August, 1953 under the Public Works Department.

Subsequently a department of M.P.P & Power was formed in April, 1964. The Himachal Pradesh State Electricity Board was constituted on 1st September, 1971 in accordance with the provisions of Electricity Supply Act (1948) and has been reorganised as Himachal Pradesh State Electricity Board Ltd. W.E.F. 14.06.2010 under the company act 1956.

The first electrical division of the state was established under the Public Works Department in August 1953. Later on, a department of M.P.P and Power was formed in April 1964. The registered office of HPSEBL is situated at Vidyut Bhawan, Shimla- 171004, Himachal Pradesh and is responsible for the supply of Uninterrupted & Quality power to all categories of consumers in Himachal Pradesh at the most economical rates

The Himachal Pradesh State Electricity Board has been re-organized as Himachal Pradesh State Electricity Board Ltd. W.E.F. 14.06.2010 under the Company Act. 1956. HPSEBL is responsible for the supply of Uninterrupted & Quality power to all consumers in Himachal Pradesh. Power is being

supplied through a network of Transmission; Sub-Transmission & Distribution lines laid in the state. Since its inception, the Board has made long strides in executing the targets entrusted to it.Himachal Pradesh achieved 100% Electrification for all its census villages in the year 1988 and ensured 24 x 7 uninterrupted Power Supply. Himachal Pradesh has the honour of providing electricity at lowest tariff in the country. Himachal Pradesh achieved the unique distinction of 100% metering, billing and collection. The board achieved the highest household/consumer coverage ratio in the country i.e. about 98% as per REC's survey & they have been adjudged one of the best Board's in the country. They also installed and commissioned a power house at the highest altitude in the world (Rongtong Power House at an altitude of approx. 12,000 ft.), Installed and commissioned a totally underground Power House which is unique in Asia (Bhabha PowerHouse 120 MW).

For administrative convenience, the distribution area of HPSEB Ltd is divided into different regions. Presently, there are three zones viz. South, Central & North. Resource rich Himachal Pradesh has a great potential for hydroelectric projects. So far, Himachal Pradesh has only harnessed 10351 MW capacity of a total approximate of 27436 MW. There are more than 30 Hydel projects having capacity more than 25 MW commenced in the state of Himachal Pradesh.

9.3 ELECTRICITY POLICY AND LAWS

9.3.1 HYDRO POWER POLICY -2006

Hydro-power Policy, 2006 ford development of Himachal Pradesh as a "HydroPower State" of the country, to provide an affordable, reliable, and quality power to the consumers round the clock, throughout the year, create avenues for employment to the residents of Himachal Pradesh in the Power Projects and at the same time mitigate the Social, Economic and Environmental impact. The Policy also takes care of the various stipulates of the Electricity Act, 2003 which seeks to promote competition, protect the interest of the consumers, tariff rationalisation, removal of subsidies, strengthening the regulatory institutions and providing indiscriminate open access to different users.

9.3.2 ELECTRICITY POLICIES UTILITIES IN INDIA FOR UTILITIES.

- Central Electricity Authority (CEA) is a competent technical authority of Govt. of India; formulate regulations from time to time in accordance with the Electricity Act, 2010 and carry out the provisions of the Act. Following relevant regulations are notified and published in the official gazette of GOI and available on the web-site of CEA.
- Central Electricity Authority (Grid Standards for Operation & Maintenance of Transmission lines) Regulations, 2010- notified on 26.06.2010.
- Central Electricity Authority (Measures relating to safety & Electric Supply) Regulations, 2010- notified on 24-09-2010.
- Central Electricity Authority (Technical Standards for Construction of Electric Plants and Electric Lines) regulations, 2010-notified on 20-08-2010.
- Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plant and Electrical Lines) Regulations, 2011-notified on 14-02.2011. CII.2: Codes, Standards, Design & Regulations Page 29
- Central Electricity Authority (Technical Standards for connectivity to the Grid) (Amendment) Regulations, 2010.

- CEA Report on cyclone resilient robust transmission and distribution Infrastructure march 2021.
- Disaster Management plan for power sector by GOI, January 2021, Prepared by CEA.

9.3.3 Codes and Indian Standards

Generally, Electricity utilities adopt following **IS** for construction of electrical lines and substations

- IS 5613 (Part 1/Sec 1):Code of Practice for Design, Installation and Maintenance of overhead power lines up to and including 11 kV) – Section 1 Design
- IS 5613 (Part 1/Sec 2): Code of Practice for Design, Installation and Maintenance of overhead power lines up to and including 11 kV) – Section 2 Installation and maintenance
- IS 802: Use of Structural Steel in Overhead Transmission Line Towers-Code of Practice – Design strength
- IS 4091 : Design and construction of foundation for transmission line tower and pole
- REC specifications for construction of lines and substations.

9.3.4 Capacity Building : Engineers and Officers

According to Central Electricity Authority Regulation 2010 (measures relating to safety and electric supply), there is a need for training and development of skills (including disaster management as a part of the program) for the personnel involved in the operation and maintenance of generation,

9.4 Standards and Technology

9.4.1 Power Lines

Mostly present 11kV,22kV and 33kV lines are constructed in steel tubular poles with concrete foundations with span length ranging from 30 to 60-metre lengths. These poles are having less longitudinal strength and may damage in broken wire condition. Mainly the design construction practices follow REC guide lines. At few places guysets are missing at the line bending locations to the poles.LT lines are taken in AB cables and at some places bare conductors. In some cases HT and LT lines are running together.

9.4.2 DISTRIBUTION SUBSTATIONS

Most of the DT substations are DP mounted and some with plinth mounted. DP mounted substations are more susceptible to landslide and damage easily. Transformers above 250kVA are mostly plinth mounted. Plinths are constructed with stone masonry.

9.5 DAMAGE ASSESSMENT PROCESS

A team comprising the power sector experts and the state level engineers and the district level officers got together for a capacity building exercise for two days. On day 1, the basic concept and process of conducting PDNA was introduced. On day 2, the participants and the experts went for a field visit to carry out hands-on exercise on damage assessment.

DATA COLLECTION:

Following data collection template was provided to collect the data from field levels.

Damage to Structures and Assets		Totally destroyed		Partially damaged		Total Damages (Rs.)	Average Time to Replace or Repair (Days)
	Unit	Number of Totally Destroyed	Average Replacement Cost (Rs.)	Number of Partially Damaged	Average Repair Cost (Rs.)		

A team comprising the Electrical Xens, SDOs and SE got together for a capacity building exercise for two days. On the 1st day a thorough training was given to all sector experts and officials. On day 2 a team consisting of sector experts and related government officials were formed and sent to visit the fields and make some observations. From day 3 different sector officials with their experts were allotted their districts and sent for field verifications.

The Himachal Government had collected data from different sectors. The officials had prepared a sheet regarding the damages and losses. The power sector was led by SE sir and under his guidance, Xens and SDOs had to collect the damage and losses data from various section offices and compile it Division wise. After visiting the sites, SE sir conducted a brief meeting with their officials about the data collection process and a training regarding filling out the formats, which were circulated among them, was given.

FIELD VISITS

The power sector team visited 4 districts namely Kullu, Mandi, Shimla and Solan. District Kullu and Mandi were affected severely. A brief meeting was held with The DC of Kullu before visiting the sites and getting to know about the actual condition of some places. It was observed that on 9th of July 2023, the flash flood and landslide affected major portions of the above districts. The placement of the poles and structures are done on the bank of the river which led them to get washed out. At Shamti, 1 transformer with its foundation and poles was washed out due to landslide, which was a terrifying incident. Many consumers including commercial and domestic, got affected due to the flood as the distribution company had to take shut down measures.

The State Electricity Board had to supply temporary connections to the consumers as the restoration work was very challenging. They had to hire experts for Re-Stringing of the conductors, which was a tough job for them at that particular period of time. They had to send the conductors from one end of the river to the other, for which they had to use the latest technologies like guns and Drones.

The State Electricity Board had to hire more masons and that too by paying them more than the market rate as it was too risky to work under those circumstances. It took 4 to 15 days to provide the power supply back to the consumers. The state govt officials of the Power sector are working day and night to restore the supply as soon as possible. After visiting the sites for 2 days a briefing was done at the DC's office with all sector experts, Govt officials and The DC himself, explaining the actual conditions, damages and some measures to be taken to avoid future damages and losses.

AFFECTED ELECTRICAL INFRASTRUCTURE

HPSEB Ltd sustained losses on all fronts viz. Generation, Transmission, Distribution and by way of loss of revenue due to loss of load. Consumer affected are shown in

Case-1 : Damage at Balan (Solan) due to flood and landslide:

One Distribution Transformer with DP structures at Balana (Solan) has been washed out due to debris of the landslide from opposite hill on 10th July 2023.Below Fig-2 shows post disaster and Fig-3 shows after recovery.

Figure 2 Location after disaster

Figure3 Location after restoration

Case-2: Damage at Samti due to flood and LandSlide

One Distribution Transformer with DP structures at Samti has been washed out and fully damaged due to debris of the landslide from opposite hill (Fisheries building side) that occurred on 10th July 23. Fig-4 and 5 post disaster images collected during field visit.

Figure 4 Location before disaster

Figure 5 Fully washed out and found nearby place

Case-3: Damages at RundanGhoroun (Kasauli) due to landslide

Structures of LT line, HT lines, LT poles (4) and HT poles (6) are fully damaged along with trans former due to debris of the landslide from hill on 9th July 2023 at RundanGhoroun structure (Kasauli)

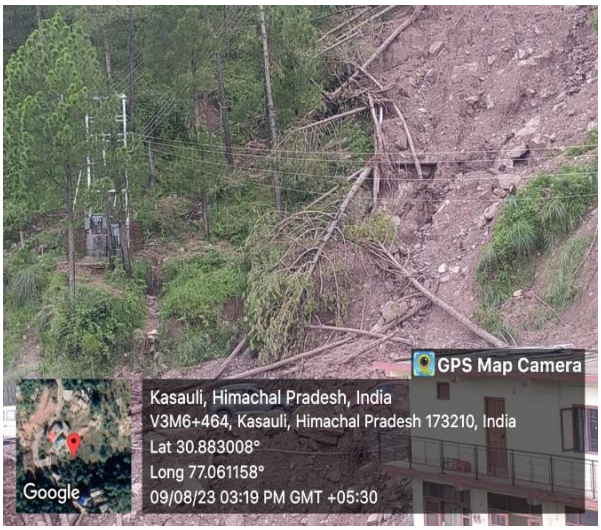


Figure 6 Location before disaster and after restoration

Figure 7. Fully washed out and found nearby place

Case-4: Damages at Badauni (Kasauli) due to LandSlide

Figure 8 shows damages to LT poles (4) and HT poles (3) of transformer along with two KM conductor due to debris of the landslide from hill on 9th July 2023 at Badauni (Kasauli)

Figure 4 Damages at Badauni (Kasauli)

Case-5: Figure 9 shows restored lines with new conductors at Thalaut SubStation and Figure 9, to Figure 15 shows deformed structures due to flood.

Figure 9. Restored lines with new conductor's flood

at Thalaut SubStation

Figure 10. Poles Deformity of Structures Due to

Figure 11. Debris Collected After Flood

Figure 12 Deformed Poles Due to Flood

Figure 13 Restoration Work In Progress

Figure 14 Foundation of The Structure Uprooted

Figure 15. Dismantled poles After the Flood Impact

9.6 Damage and Loss Estimate

The total amount for damages is calculated to be 213.94 Cr Rupees which includes damages to the structures, transformers, conductors and civil structures of transmission and distribution companies. This will continue to happen as the land allotted for erection of poles and construction of structures and plinth for transformers' installation is not suitable for flood resilience.

The distribution transformers and structures are being washed out because of the poor placement. Changes in designs of the foundations and structures are highly recommended to withstand the flood impacts. It took the workers more than 10 days to reconstruct the structures and give back the connections temporarily. Major Distribution transformers are washed out which shall be replaced completely to fulfil the total demand of the consumers.

The total amount for losses is calculated as 65.62 cr Rupees, which includes temporary connections, Vehicle movement for cleaning up the debris, manpower for reconstruction, foregone income and other unexpected expenses.

9.7 CASCADING IMPACT OF DISRUPTION OF POWER SECTOR

9.7.1 IMPACT ON POWER SECTOR

Generation, Transmission and Distribution sectors are most affected in the present calamities. Hydro Generating stations especially Larji is the one which was completely submerged by flood water and sludges. Almost 80% of the generating station required overhauling. In order to bring the power station back to normalcy, it requires not less than a year. Similarly, Transmission and Distribution Sectors are also affected out of which distribution sectors are highly affected.There will be a sudden rise in the demand for a considerable quantity of construction materials and human resources to reconstruct, repair and retrofit the power infrastructures like Distribution Substations,lines etc.

9.7.2 IMPACT ON ESSENTIAL SERVICES

Because of power failure, most of the establishments are closed. Essential services like Hospitals, water supply, shelter homes, food processing industries, administrative offices etc are facing a lot of difficulties. Tourism, which is a major source of income in the region, is adversely affected and may take months to revive.

9.7.3 IMPACT ON INDUSTRIAL SECTOR

All industries have stopped their production due to power failure during the disaster and they incurred huge losses. Food processing industries are mostly affected due to preservation of raw materials and wasted due to long power supply failure. Those industries can only be operational after reaping lines and substations.

9.8 POWER SECTOR RECOVERY NEEDS AND STRATEGY

9.8.1 RECOVERY AND RECONSTRUCTION NEEDS

The overall recovery needs and their cost has been summarised in the following

Summary of recovery needs and cost			
Recovery Needs	**Unit**	**Cost per unit**	**Recovery Cost (Rs)**
Substation / Transformers, that have been completely damaged / washed out during flood, works-out to be To acquire different Ratings of these Transformers, average cost of Rs. 350000/- per unit to be incurred	2287	0.035	80.045
Substation / Transformers, that have been partially damaged during the flood, works-out to be 17 Nos. To repair such damaged Substations / Transformers, cost of Rs. 170000/- per unit to be incurred.	1002	0.017	17.034

No. of Tubular Poles & Structures, used for transmission of HT & LT power have been totally damaged across . The cost per Unit to furnish these Poles & Structures works out to be Rs. 15500/-.	1301	0.00155	2.01655
A total Nos. of Tubular Poles & Structures, used for transmission of HT & LT power have been partially damaged. The cost per Unit to furnish these Poles & Structures works out to be Rs. 10850/-.	966	0.001085	1.04811
In the case of the 33 kV Line, overall 3 CKM have been totally damaged . The cost to be incurred per CKM for totally damaged 33 kV Lines works out to be Rs. 18 Lakhs	48.04	0.18	8.6472
In the case of the 33 kV Line, 6.3 CKM has been partially damaged. The cost to be incurred per CKM for totally damaged cost to be incurred per CKM for partially damaged 33 kV Lines works out to be Rs. 12.60 Lakhs.	35	0.126	4.41
In case of 22 kV Line, overall unit CKM has been totally damaged, The cost to be incurred per CKM for totally damaged 22 kV Lines works out to be Rs. 8.50 Lakhs	144.51	0.085	12.2834
In case of 22 kV Line, unit CKM has been partially damaged and cost to be incurred per CKM for partially damaged 22 kV Lines works out to be Rs. 4.35 Lakhs.	269	0.0435	11.7015
In case of 11 kV Line, overall 17.89 CKM have been totally damaged, The cost to be incurred per CKM for totally damaged 11 kV Lines works out to be Rs. 8.50 Lakhs.	339.75	0.085	28.8788
In the case of the 11 kV Line, 99.16 CKM have been partially damaged. The cost to be incurred per CKM for partially damaged 11 kV Lines works out to be Rs. 5.95 Lakhs.	585	0.0435	25.4475
In the case of the LT Line, overall 23 CKM have been totally damaged. The cost to be incurred per CKM for totally damaged LT Lines works out to be Rs. 5.50 Lakhs	552	0.055	30.36
In the case of the LT Line, overall 1356.42 CKM have been partially damaged. The cost to be incurred per CKM for partially damaged LT Lines works out to be Rs. 3.85 Lakhs.	999	0.0385	38.4615
Water Conductor System Completely damaged of Holi Powerhouse under Khauli PowerHouse Division(calculated in cubic metre)	516	0.001163	0.6
04 Nos Water channel system of MHEPs under ED Killer	4	1.455	5.82
Transmission Structures fully damaged	1	0.3	0.3
Transmission Structures partially damaged	14	0.049071	0.687
Distribution structures fully damaged	1891	0.00155	2.93105
Distribution structures partially damaged	1878	0.001085	2.03763

civil work of power distribution section (in cubic metre)	911	0.001163	1.0593
civil work of power generation n (in cubic metre)	786	0.001163	0.91395
civil work of power transmission	1745	0.001163	2.02907
Power generation structures fully damaged	5	0.348	1.74
Power generation structures partially damaged	8	0.166	1.328
1 no.tower structure completely damaged	2	0.066	0.132
Tower revetment and equipment foundation damaged	2	0.07	0.14
Revetment of 2 No. Tower Damaged	2	0.21	0.42
Power cables in km	29	0.000639	0.01854
Damages/wash out of the RCC retaining walls, wire crates, Spur wall provided for the protection of HPSEBL Colony at Thalout and damage to the HPSEB laboratory at Thalout	1	0.15	0.15
Total Recovery			280.64

9.8.2 CAPACITY BUILDING REQUIREMENTS

As per DMP 2018, DOE has developed a framework to build capacity by categorising training programs with the targeted audience and it needs to be implemented.

Sl. No.	Training Programs on	Key Component	Target Audience
1	Awareness and sensitization on Best Disaster Management with the existing resource	• Planning for deployment of the technical and non-technical groups during the emergency. • Checking the available tools and allotment to each group	Superintending Engineer, Executive Engineer, SDO and Junior Manager of the concerned area
2	Training and development Skill	• CEA guidelines relating to safety and electric supply • Use of safety tools during a disaster	Executive Engineer, SDO and Junior Manager of the concerned area
3	Preplanning of material Procurement and Services	• Ear Marking of Budget • Delegation of financial power for Disaster Management	Superintending Engineer, Executive Engineer of the concerned area

4	Approach for restoration of power supply on priority	• Restoration of power supply on priority according to the nature of Public Service of the Institution	Executive Engineer, SDO and Junior Manager of the concerned area
5	Training Program on Safety	• Mock Drill	All Electricity Staff officers and Contractors.

9.8.3 APPROACH FOR TRAINING

To optimise the ensuing learning in a variety of situations spanning hazards,and levels, diverse training methods and methodologies must be used. Training methods comprises theoretical training which is a cognitive method and practical training aimed at developing behavioural skills. Similarly on job training and off job training are two broad categories for management development.

Table 3 Capacity development for key aspects of DRR

Key Aspects	Brief Description	Training Approach	Intended Audience
Prevention or mitigation for disaster risk reduction	• Knowledge session on climate change and its impact on power utility. • Risk assessment and Vulnerability study in each area of responsibility. • Mainstreaming of disaster risk assessment, mapping and management into development plans and programs • Building Resilience in Electricity Infrastructure.	• Interactive lecture sessions. • Discussions • Online training • Observation and study tour • Workshops, seminars, and conferences	• Government Officials
	• Public Awareness Programs. • Promote culture of disaster risk prevention, mitigation, and better risk management • Awareness about precautions to be taken and emergency communication details of nodal officers	• Awareness Campaign • Pamphlet and Booklet • Permanent Notice board at all suitable place	• Executives & Non - Executives • NGOs
Effective preparedness and response	• Response and recovery • Responsibilities of Teams • Black Start Facilities • Emergency Restoration Systems (ERS) • Rescue equipment at all levels	• Mock Drill Exercises • Promote planning and execution of emergency drills and restoration • Demonstrations • Field Assignments	• Executives Non–ExecutivesNGOs
	• Adoption and adaptation of emerging global good practices • Early warnings, maps/ satellite data/ effective dissemination of information • Systems to provide basic services in emergencies • Media relations	• Peer to peer twining • Case Studies • Media communications	• Government officials and Executives

Recovery and Build Back Better	• Post-event investigation & analysis and strategy for the future • Damage assessment mechanisms. • Planning capabilities to ensure coherence of BBB with overall development efforts and goals • Studies on past disasters and recovery to draw useful lessons	• Training Sessions • Field Assignments • Workshop • Observation and study tour • Brainstorming Exercise	• Government officials and Executives

Training based on disaster management could be facilitated through workshops, seminars and online training. The addition of interactive activities with this traditional segment would be a dynamic step in integrating disaster risk assessment and vulnerability study in power sector development plans and programs.

Peer-to-peer twining on an adaptation of emerging global best practices in building resilience in the electricity sector aids learning about new applications, new processes, or new technologies.

Observations and study tours demonstrate a fruitful approach to studying past disasters and conducting a post-disaster damage assessment. The inclusion of physical training such as mock drills, field assignments, case studies, role play and simulation exercises along with the above exercises is an effective approach for the recovery and restoration phase.

9.9 IMPACT OF RECOVERY

The Government of Himachal Pradesh, using its own resources, has started providing immediate short-term repair of energy access, clearance of debris, temporary connection etc. Most of the restoration works were done with the immediate intent of restoring the supply to the consumers without insisting on standard procedures and practices, as a temporary measure, sometimes by extending supply with the help of weatherproof wire, sometimes without connecting metres and in many cases by bringing in prewired essential supply points. Back-feeding from distant areas has been resorted to,in many cases. A major portion of the flooded transformers with considerably decreased residual life (due to weakened insulation) have been put back into service after reconditioning as a temporary measure. These transformers will have to be replaced at the earliest.Energy metres have been bypassed in many cases and connection restored with the existing faulty metres in others. A large number of transformers and metres will therefore be required. There are a lot of houses where the wiring circuits were damaged and found unsafe, and where essential supply points were given from prewired kits.List of Works to be carried out during Emergency for Restoration of Power Supply:

- Rectification of fallen poles.
- Re-conducting/re-stringing of snapped conductors.
- Replacement of faulty distribution transformers.
- Rectification of fallen LT / HT lines.
- Clearing of fallen trees / branches

9.10 Sector Recovery Strategy

9.10.1 Role of Line Departments

All the government construction departments need to coordinate with each other for the procurement of materials for the reconstruction work. However, they need to strengthen their capacity in DRR by undergoing training. For monitoring and control, an adequate number of staff should be deputed with a clear job description.

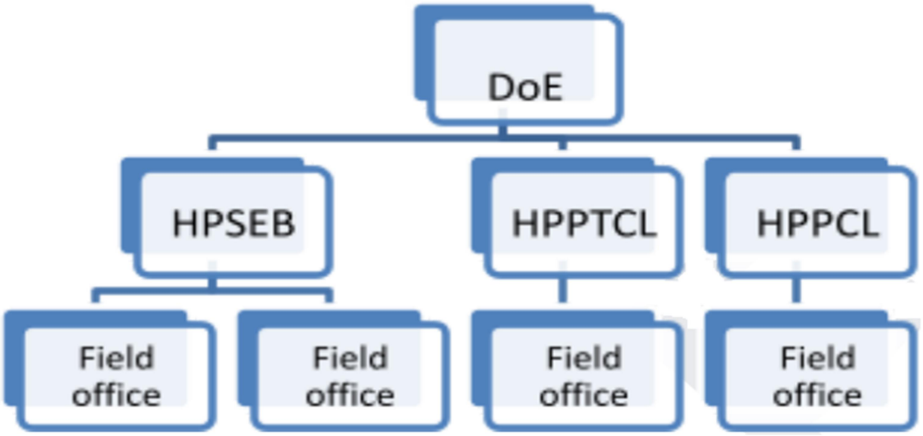


Figure 12. Controlling structure of power sector

9.10.2 Need Analysis

The needs are based on the lessons learnt from historical experiences of 'building back better' that inform the design of a comprehensive recovery framework in Himachal Pradesh. The framework would set the groundwork as a way forward to improve the resilience of state infrastructure and its communities from future natural disasters.Based on the needs assessment, overall distribution sector would need to be significantly reconstructed along with major generation and transmission corridors.Additionally, to enhance disaster resilience, technological interventions are suggested.

Medium to short term recovery strategy should focus on embracing the latest technology principles and work towards improving the planning,design, construction and operation and maintenance practices, particularly in the areas with distribution and flooding risks. The state must start evolving towards newer transmission technology areas and look at adopting them on an urgent basis

9.10.3 BUILD BACK BETTER REQUIREMENTS

HPSEB Ltd has decided that the re-building activity will not be a business as usual but will follow the principle of building back better. It is recommended to implement latest technological and more resilient solutions e.g.

- The distribution poles to be used should be higher than the maximum flood limits on a solid foundation that too firmly grouted.
- Application of SCADA based Flood prediction system,
- Climate proofing of Distribution transformers,
- Use of multi circuit towers
- Dam improvement technologies.
- If the Transformers are to be placed on slopes, then retaining is highly needed.
- The distribution of power in the cities should be underground, however its initial cost is high but it needs less maintenance.
- Resilient structure for the transformers is proposed in the next subsections

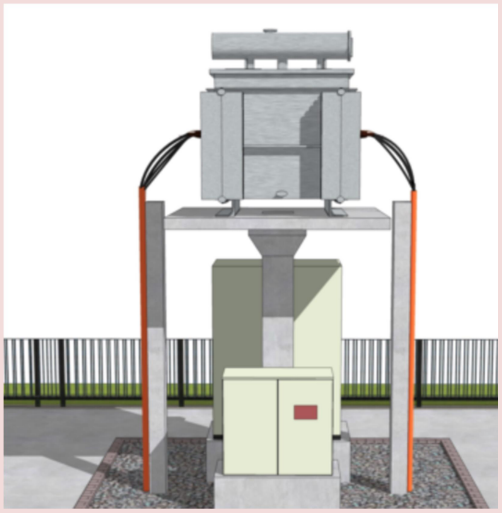
Plinth Mounted Prefabricated Foundation:

Figure 13 Plinth mounted prefabricated

Standard Plinth mounted distribution substations are more vulnerable to flooding because of its existing foundation design. Existing DTs are either pole mounted or Plinth mounted. Some of the substations need to be renovated or converted to prefabricated foundations with other accessories. DPs, replacement of AB switches, installation of LA, HG fuse, LT panel, LT Cable, Earthings etc. are to be renovated.

Poles should be steel H-Type of poles.

Outdoor Plinth mounted DT and Compact Secondary Substation



This is one of the best options for flood and cyclone prone areas to be installed with UG cabling networks. It requires less space and is economical as compared to CSS. This DT will have one LBS and can be operated through common controlled switches. Many DTs can be group controlled remotely for maintenance or during exigencies.The design is easy for retrofitting of existing DP mounted substations.

Figure 14 Single LBS with DT

H-Type Galvanised Structure:

One of the most cost-effective structures which are reliable to use as compared to concrete poles. It can be constructed in any congested area as it requires very less space to erect in comparison to towers or DP structures.

Two Galvanised GI channels are rigidly embedded with each other to form a single structure.33kV and 11kV lines (span length 50m) with H poles can be designed with Panther or Dog Conductors.

Figure 15 H-Type Pole

Critical customers need to be identified before disaster strikes, so that repairs can be expedited. Critical clients may include oil and gas refineries, water-treatment plants, telecommunication networks, service stations, hospitals, pharmacies, and other facilities.

9.11 Recovery Road Map

9.11.1 Short to Medium Term

- Restoration of supply to consumers on war footing.
- Develop a priority schedule (location and time-frame) for recovery of normal services to affected areas.
- Back feeding from distant areas.
- Sourcing of equipment for continuity of connections.

9.11.2 Medium to Long Term

- Long Term Transmission Plan.
- Conduct a detailed damage and loss assessment
- Restoration of infrastructure
- Reconstruction / repair of infrastructure / damaged assets
- Disaster Resilient construction to ensure supply redundancy.
- Strengthening of Power evacuation system with focus of enhancing reliability of power supply blended with loss reductions.

9.11.3 Long Term

- Extending Smart metre service to remote areas.
- Technology based Dam Management inter alia silting aspects.
- Application of SCADA/Climate based flood prediction system

9.12 Key Recommendation

Electricity is the one critical infrastructure sector upon which all others depend. A reliable supply of electric power is a major underpinning of the economy of our country. This study has outlined the impact to the power grid from floods and landslides, and how the recovery time may differ based on the type of damage sustained by each hazard. Power Infrastructures to be rebuilt with reference to latest standards.

- Substation foundations to be constructed considering local DFL and pole foundations. Electrical Infrastructures need to be relocated to a safe zone other than landslide zone.
- Erosion and landslides triggered by floods undermine the foundations of transmission towers. Serious, and often explosive, damage may occur when electrified equipment comes in contact with water, while moisture and dirt intrusion require time-consuming repairs of inundated equipment. In contrast to earthquakes, early warning is possible, and enables electric utilities to shut off power to facilities in flood zones, therefore minimising damage. The most effective mitigation strategies included elevation, levees and locating critical facilities outside the flood zone. Recovery time was driven by the same parameters as in the case of landslides, namely the sheer number of needed repairs, and access as repairs cannot start until floodwaters have receded. In this case, power was back online from 24 hours up to 3 weeks after the flood.

- Traditional hazard mitigation strategies have focused on strengthening components of the power grid, such as equipment and buildings, based on the expected level of risk. For example, if a risk assessment indicates that a substation is exposed to a flood hazard, utilities may elevate sensitive equipment and/or buildings, or build a levee to protect the substation. However, given the epistemic uncertainties of risk assessments, hardening measures may be decided based on poor information. For example, a risk assessment may use, e.g. a 100-year flood scenario as the basis for a hazard mitigation strategy. However, current climate change projections indicate an increased frequency of severe hydro-meteorological events.
- The availability of spares and replacement parts and equipment for critical assets and facilities was a critical need throughout this study and often made the difference between a speedy and prolonged recovery. Repairs were faster whenever spare parts were readily available. For instance, switchyard equipment was always faster to repair, because spare parts are less expensive and easier to acquire and store in sufficient quantities. On the other hand, repairing or replacing Large Power Transformers was often cited as a major challenge. Electric utility companies maintain a stock of spare items to handle daily repairs and minor emergencies. Extending these stocks to cover natural disasters and other major emergencies is a form of self-insurance and can expedite repairs and ultimately reduce the duration of outages.

Building more resilient infrastructure assets in exposed areas involves high amounts of costs, and hence requires high levels of judicious and meticulous planning. The additional up-front cost of more resilient infrastructure assets ranges from negative to a doubling of the construction cost, depending on the asset and the identified/ envisaged hazard levels. Interventions to make assets more resilient include using alternative materials, digging deeper foundations, elevating assets, building flood protection around the asset, or adding redundant components. However, making infrastructure more resilient by strengthening assets would be more realistic and bear the desired results, only if the appropriate data on the spatial distribution of natural hazards are available.

9.13 Case Study of Larji Hydro-Electric Plant

HPSEBL had constructed 3×42 MW Larji HEP to generate 586.82 GWH of power in a 90% dependable year. All the three units of Larji HEP were commissioned and put on commercial operation on the following dates: -

- Unit-III – 25th Sept., 2006.
- Unit-II – 12th Oct., 2006.
- Unit-I – 19th Feb., 2007.

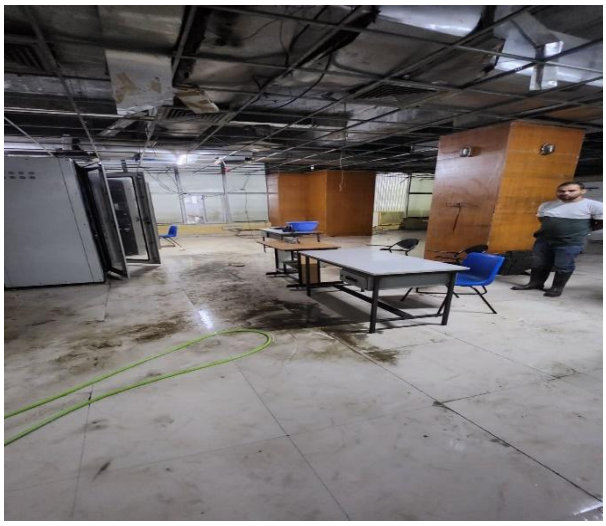
Larji HEP utilises river Beas water through a gross head of 74.78 mtr, for generation of 126 MW of power by three vertical Francis Turbines in an underground power station. The project consists of concrete diversion Barrage 26.50 mtr. high above the river bed level on river Beas about 600 mtr. downstream of the confluence of river Sainj and Tirthan, a spillway section 72.5 mtr. long having five bays controlled by five radial gates 11m × 12 m size to pass a standard project flood of 8100 cumecs with an intake arrangement on the right bank for drawing a discharge of 312.50 cumecs, an underground de-sanding arrangement on the right bank with four chambers of 127 m × 16 m each

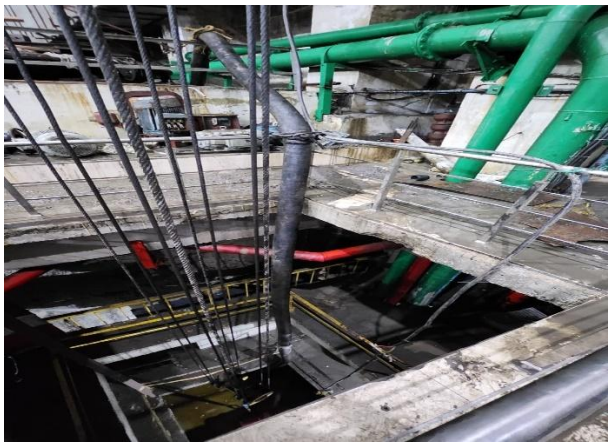
into depth varying from 15.5 m to 16.24 m to exclude all silt particles of size 0.4 mm and above, a 4119.861 m long 8.5 m dia. circular head race tunnel opening into a 37 m dia. restricted orifice type surge shaft with top at 1010.0 m, three pressure shafts of 4.5 m dia. each taking off from surge shaft with length 83.33 m each (Average) and further feeding three Francis vertical axis turbines/generating units of 42 MW each through net head of 56.84 m in an underground Power House on the right bank of river Beas and tail race chamber and tail race for conveying the water back to river Beas. All three vertical Francis Turbines and Synchronous Generators of 42 MW each generate power at 11 KV which is stepped up to 132 KV through three nos. of Generator Transformer for transmission to various load centres at Kangoo, Bajaura Bijni through four (4) 132 KV Feeders. The Generator Transformers are connected on the LV side to the generating units through 11 KV segregated phase bus duct, routed through bus duct tunnel and on HV side to the SF6 132 KV GIS through 132 KV GIS Bus Duct. The Power is further evacuated to the overhead transmission lines through 132 KV XLPE Cables.

On 09.07.2023, a heavy rainfall took place in the upstream of the Larji Power House which resulted in a heavy flash flood entering inside the PowerHouse at around 14:20 Hrs through the Main access tunnel (MAT) and Construction Adit Tunnel after crossing the NH 21 which is just adjacent to the Power House. The designated highest flood level of the river Beas at the Power House location i.e., at the portal of Main Access tunnel & Construction Adit tunnel is at EL 909 mtr. whereas the flood level experienced on 09.07.2023 and 10.07.2023 was upto EL 914 mtr. which eventually led to the filling up of Power House with debris, silt and muddy water covering MAT (EL 907.00 m), Transformer Hall (EL 907.00 m), Service Bay (EL 907.00 m), SCADA Floor (EL 910.00 m) Machine Floor and LT panel room (EL 905.50 m), Generator floor (EL 901.50 m), MIV floor (EL 890.00 m) and Turbine floor (EL 897.50 m) i. e. complete submergence of Larji Power House. Further, this heavy flash flood also damaged/washed out RCC retaining walls, wire crates, and the Spur wall provided for the protection of HPSEBL Colony at Thalout and damaged HPSEB laboratory at Thalout. In addition to above, the heavy Flash Flood in river Beas also damaged/washed out LT line, hooter line/Alert Inform & Direct (AID) system provided in the downstream of Larji Barrage along the Beas River Larji Power House. The tentative cost of damages/Losses of Larji Power House due to Heavy Flash Flood in River Beas is as under please

Losses of Larji Power House		
Sr.No.	Description	Tentative AmountOf Losses/Damages(in Crores)
1	Complete Electrical & hydro mechanical components Larji Power House due to flooding in the Power House (30% of electrical & H/M equipment's of total cost of Larji I.E. 0.30 X 1421.61= Rs. 426.49 Crores)	Rs. 426.49 Crores
4	Fresh water supply line of the HPSEB Colony Thalout	Rs. 0.75 Crores
5	Generation loss due to shut down of Power House i.e. 404 MU's for the year 2023-24 @ Rs. 5 per unit (Average prevailing rate)	Rs. 202.0 Crores
6	Mitigation measure for mud, silt deposited in the Power House	Rs. 12.00 Crores
	Total	Rs. 641.24 Crores

Some of the photographs showing submergence of Power house and other damages are shown as follows:





10 AGRICULTURE AND ALLIED SECTOR.

Agriculture and its allied sectors are a major contributor to Himachal Pradesh's economy. It accounts for around 13.47 per cent of the total Gross State Value Added (GSVA) and directly employs about 57.03 per cent of the State's workforce. Crops is a major sub-sector, accounting for 8.43 per cent of the state's GSVA in FY 2022-23 (and 62.6 percent of GSVA within the agriculture and allied sectors). In FY 2022-23, the contribution of livestock, fishery, and forestry were 1.61 per cent, 3.28 per cent, and 0.14 per cent respectively of the state's GSV.

10.1 AGRICULTURE : PRE DISASTER CONTEXT

The crops sub-sector includes foodgrains (paddy, maize, ragi, millet, pulses), commercial crops (potato, vegetables) and oilseeds. In FY 2018-19, about 391.4 hectares were under cultivation yielding 896.3 MT. The highest yielding crop was Maize followed by Paddy and Pulses. The districts with highest crop area include Kangra (96.8 hectare, 212.15 MT) followed by Mandi (68.97 hectare,155.68 MT). The districts of Chamba and Solan also have considerable area under food grain cultivation.

Areas under food grain cultivation are gradually shifting to commercial crops; potatoes, vegetables and ginger being the major commercial crops. In FY 2020-21, food grains contributed around 43.0 per cent and commercial crops contributed 57.0 per cent of the total crop production of the state Production data from FY 2018-19 (last available crop-wise baseline) shows: (a) the commercial cropping area was 61.68 hectare yielding 1,208.30 MT. Shimla and Solan districts led commercial crop production yielding 213.24 MT and 203 MT respectively. (b) the area under vegetables cultivation was 46.6 hectare yielding 1,015 MT. Solan, Shimla and Mandi were the districts with highest vegetable production in the state. (c) the area under oilseeds was 7.6 hectares yielding 4.25 MT. Kangra and Chamba were major oilseeds producing districts.

10.1.1 DAMAGE AND LOSS ASSESSMENT

The major crop losses were in cereal crops, vegetables, pulses, oilseeds, and black cumin. Vegetable farms have seen the highest loss both in terms of loss in production value and wages. Overall 1,27, 028 farm families and households were impacted and 1,35,013 hectares of cropped land was either fully or partially destroyed.

10.1.2 RECOVERY NEEDS

The total recovery needs for the agriculture sector in the state amounts to Rs. 200.01 crores. This includes Rs. 7.81 crores as restoration cost / reconstruction assistance needs and Rs. 192. 20 crores as reactivation assistance needs for the farmers. Further details are provided separately

10.2 HORTICULTURE : PRE DISASTER CONTEXT

Horticulture in the state is growing faster than agriculture; the area under horticulture increased from 792 Hectares in 1950-51 to 2,30,802 hectares in 2018-19 further increasing to 2,35,785 hectares in 2021-22. Horticulture was 26 per cent of the total area under agriculture, and contributed to 22 per cent in terms of value of the produce (agriculture crops value ₹16,076 crore including vegetables, horticulture crops value ₹3,583 crore). In FY 2018-19, the state's fruit production was around 513 thousand MT which, in FY 2021-22, increased to 753.96 thousand MT (47 per cent increase). Apple, Mango, Orange, Pear, Plum, Peach, Galgal and Apricot are the major horticulture crops in the state. Apple is the main fruit produced, accounting for nearly 85 percent of the state's fruit production having 48.8 percent of cultivation area. Shimla produces the highest quantity of apples (229 thousand MT in 2018-19). Besides apples, stone fruits like plum, peace, apricot, mango, and some tropical and subtropical fruits are also widely grown.

10.2.1 DAMAGE AND LOSS ASSESSMENT

Apple is the main fruit of the state, and the losses in this crop was about 82 percent of the horticulture sector losses. Shimla, Kullu and Mandi are the highest apple producing districts and have borne major losses. A significant number of farm families and wage workers are engaged in apple production. In all 57,210 apple orchardist households and farm families engaged in apple growing were impacted. Besides apples, orchard losses in stone fruits (such as peaches, plums, apricots), citrus, mangoes and other crops were also seen in the districts. Overall 35,159 hectares of horticulture cropping area was affected, impacting 75,414 farm families and orchardist households engaged in the horticulture sector.

10.2.2 RECOVERY NEEDS

The total recovery needs for the horticulture sector in the state amounts to Rs. 289.20 crores. This includes Rs. 28.39 crores as restoration cost / reconstruction assistance needs and Rs. 260. 81 crores as reactivation assistance needs for the farmers. Within this, the amount of reactivation assistance needed for apple orchards alone stand at Rs. 213.10 crores (break up: Rs. 63.80 for high density plantations and Rs. 149.30 for normally spaced plantations). Further details by each horticulture crop are provided separately.

10.3 ANIMAL HUSBANDRY : PRE DISASTER CONTEXT

The state has 0.82 per cent share of India's total livestock and 0.16 per cent of the total poultry (Livestock Census 2019). The total livestock population in the state stood at 44.13 lakh, and the poultry population was 13.42 lakh. Cattle (41.42 per cent) is the largest share within the livestock population, followed by Goats (25.11 per cent), sheep (17.92 per cent) and buffaloes (14.66 per cent). The growth of livestock sub-sector decelerated to 4.3 per cent in FY 2022-23 vis-à-vis a higher growth rate of 16.3 per cent in 2018-19, and 9.9 per cent in FY 2019-20. By FY 2022-23, the livestock sub-sector accounted for 1.61 per cent of state's GSVA and 12.0 per cent of agriculture and allied sector GSVA.

10.3.1 DAMAGE AND LOSS ASSESSMENT

The livestock farm losses have been estimated under three categories: cattle (cows, buffalo), small ruminants (goat, sheep) and draught animals (equine and bovine). The milk losses were both for farmers and the Milk Federation), followed by small ruminants and draught animals. The loss incurred in the poultry sector is seen in Broiler Farms and Layer Farms.

10.3.2 RECOVERY NEEDS

The total recovery needs for the animal husbandry sector in state amounts (both animals and poultry) to Rs. 53.40 crores. This includes Rs. 17.82 crores as restoration cost / reconstruction assistance needs and Rs. 35.58 crores as reactivation assistance needs for the livestock farmers. Further details by each animal category, poultry and milk federation are provided separately.

10.4 FISHERIES : PRE- DISASTER CONTEXT

In FY 2018-19, the state's inland fish production was 12,765.36 MT, valued at Rs. 158.22 crore. Among the districts, Kangra had the highest inland fish production at 3,916.15 MT, valued at Rs. 57.50 crore. The fishing sector has shown a growth over the past five years; it was projected to expand by 7.8 per cent in FY 2021-22 and again 7.0 per cent in FY 2022-23 aiming to account for 0.14 percent of the state's FY 2022-23 GSVA at current prices and 1.0 per cent of the agricultural and allied sector GSVA. Inter-state sales from cold water fisheries in the state (especially trout) have a great potential. In FY 2017-18 (last baseline available) fisheries Inter-state sales were 1,391.9 MT valued at Rs. 16.32 crore. Una and Mandi were the largest fish exporting districts of the state.

10.4.1 DAMAGE AND LOSS ASSESSMENT

The losses to farms producing Trouts and Carps were computed separately. About 38 farm households and 57 establishments were impacted. Besides the loss of catch, there were damages to fish processing units, RAS buildings and raceways.

10.4.2 RECOVERY NEEDS

The total recovery needs for the fisheries sector (trout and carps) in the state amounts to Rs. 15.63 crores. This includes Rs. 11.22 crores as restoration cost / reconstruction assistance needs and Rs.

4.41 crores as reactivation assistance needs for the fish farmers (such as providing fingerlings, feed, and other items). Further details are provided separately.

10.5 SUMMARY OF SECTORAL RECOVERY NEEDS.

The summary of recovery needs in the agriculture and allied sectors, as reported by the respective Departments is Rs. 558.24 crores (in words Rupees Five Hundred Fifty-Eight Crores Twenty-Four Lakh only). The break-up by Departments is provided in the following table. This excludes any damages to structures reported by these Departments to the Revenue Department.

Sector	Reconstruction assistance for damages (in Crore)	Reactivation Assistant for Production losses (In Crore)	Sector Recovery Needs (In crore)
Agriculture	7.81	192.20	200.01
Horticulture	28.39	260.81	289.20
Animal Husbandry	17.82	35.58	53.40
Fisheries	11.22	4.41	15.63
Total Agriculture and Allied Sector	**65.24**	**493.00**	**558.24**

11 Tourism Sector

11.1 PRE DISASTER CONTEXT

Tourism is one of the primary drivers of income generation, job opportunities and livelihoods for people of Himachal Pradesh. The State's geographical advantages position it favourably within the Indian tourism sector. The Himachal Pradesh Tourism Development Corporation (HPTDC) is a pioneer in developing tourist infrastructure in the state and offers a comprehensive tourism package, including accommodations, transportation, conferences, and sporting activities, with 55 hotels and restaurants in the state. As of 2022, the state had a total of 4,297 hotels, 907 restaurants and 3,733 Home Stay facilities. Kullu, Kangra, Shimla and Solan are the leading districts in terms of these tourist infrastructure facilities.

While the COVID-19 outbreak had caused a significant decline in tourist arrivals (years 2020 and 2021), the year 2022 and recent months of 2023 were good for the sector as tourist arrivals picked up. Specifically, the number of domestic tourist arrivals surged from a low of 32.13 lakh in 2020 and 56.37 lakh in 2021, to 150.99 lakh in 2022. The data indicates that tourist arrivals were approaching levels observed prior to the onset of the pandemic till the present calamitous Floods and Landslides hit the state.

Year	**Indian arrivals (in Lakhs)**	**Foreign arrivals (in Lakhs)**	**Total arrivals (in lakhs)**
2018	160.94	3.56	164.5
2019	168.23	3.83	172.12
2020	31.7	0.43	32.13
2021	56.32	0.05	56.37
2022 (up to Dec 2022)	**150.7**	**0.29**	**150.99**

11.2 Damage and Loss Assessment

Overall losses in the tourism sector includes estimated wages lost by workers in hotels, restaurants, guides, homestays and B&B units, travel agencies and others. In all, 35,682 establishments (hotels, restaurants, cafes, and other establishments) and 2,407 home stays were impacted. Establishments also lost due to salary payments towards idle staff and becoming liable to pay a fixed component of electricity demand charges that were levied according to norms (3,327 such establishments) even though there were very little tourist arrivals. The floods also caused significant damage to tourism infrastructure in the affected districts, such as government or public sector owned tourist facilities, private hotels, homestays and facilities, and community owned assets.

11.3 Recovery Needs

The total recovery needs for the tourism sector in the state amounts to Rs. 264.41 crores. This includes Rs. 43.83 crores as restoration cost / reconstruction assistance needs and Rs. 220. 58 crores as reactivation assistance needs for establishments and labour markets.

- The restoration cost / reconstruction assistance estimates of Rs. 43.83 crores at current market prices by districts is provided in Table 2. Further details for restoration cost / reconstruction assistance needed by each government and community asset is provided separately. This excludes any damages to structures that may have been reported by the Tourism Department to the Revenue Department.

Ownership	**District**	**Estimated Restoration Cost (Rupees lakhs)**
Government and Public Owned	Hamirpur	0.24
	Una	21.32
	Chamba	66.02
	Sirmour	51.33
	Mandi	101
	Bilaspur	25
	Kullu	2132.12
Private sector owned facility/ assets that is used as public purpose	Mandi	104
	Kinnaur	12.5
	Kullu	1719.5
Community Owned facilities	Mandi	150
Total		4383
Total (IN crore)		**43.83**

- In addition to reconstruction assistance, Rs. 220.58 crores are needed to be provided as reactivation assistance to hospitality establishments and the sectoral labour markets.

Category of Reactivation Assistance	Affected Establishments	Impact Duration (In Months)	Recovery Need Estimation (In Crore)	Remarks
Electricity Fixed Charges Levied on the Hotel Sector	3237	2	1.38	Data obtained from HPSEB as per actual demands charges raised by HPSEB during the affected period
Estimated Wages lost by Occupations in Tourism Sector	35,682	2	194.46	Given that the number of workers affected in the reported number of establishments have been multiplied by the number of working days lost and the product is further multiplied by the average wage rates thus arriving at the total income loss for the workers in tourism sector
Loss for Homestay units due to idle staff salary payment	2407	2	22.74	Given that one person is employed for one room in a homestay and total no. of permissible rooms is four per establishment. Further the period of loss is two months and the notified wage of labour and employment is Rs 350 per day. Thus estimated loss due to idle staff salary payment is a product of the three quantities mentioned.
Total			**220.58 Crore**	

12 Disaster Risk Reduction

12.1 Introduction

Situated in the North-western Himalayas, the state of Himachal Pradesh contends annually with the impact of climatological variations, resulting in a range of natural hazards. These hazards encompass cloudbursts, flash floods, landslides, earthquakes, snow avalanches, and droughts. The recurrence of these calamities has raised immediate concerns for the region. The mountainous topography of Himachal Pradesh, which is categorised into three distinct physiographic units—the Lower or Outer Himalaya, the Middle Himalaya, and the Higher or Great Himalaya—significantly heightens its vulnerability to a diverse array of hazards. Furthermore, the geological composition, soil types, and localised climate fluctuations within each unit add complexity to the state's exposure to disaster risks.

Recognizing the urgent necessity for a comprehensive understanding of the disaster events experienced in 2023 and the additional vulnerabilities faced by the state, it becomes imperative to provide a comprehensive overview of Disaster Risk Reduction (DRR) measures from a multi-hazard perspective. These DRR measures should not only be integrated within the recovery interventions but should also be considered as sector-agnostic measures that encompass various development initiatives aimed at building a resilient Himachal Pradesh. This chapter outlines various DRR interventions that can be integrated into the broader, long-term development discourse

12.2 Risk Profile of Himachal Pradesh

Himachal Pradesh, faces a multitude of natural hazards, each posing unique challenges to the state's safety and resilience. Among the prominent hazards are floods, landslides, and earthquakes, each characterised by distinct characteristics and impacts.

12.2.1 Earthquakes

Himachal Pradesh, nestled in himalayan ranges, experiences significant seismic activity. The state is geologically diverse, with various lithological variations ranging from Pre-Cambrian to the Holocene-Recent. This geological diversity contributes to its sensitivity to earthquakes. The tectonic features such as the Himalayan Frontal Thrust (HFT), Main Boundary Thrust (MBT), Main Central Thrust (MCT), and others play a pivotal role in shaping the region's seismic landscape.

- The seismicity in Himachal Pradesh results from the northward movement of the Indian plate, making it fall into Seismic Zones IV and V, the latter being the Very High Damage Risk Zone.
- Notably, districts like Kangra, Mandi, Kullu, Chamba, and parts of Kangra and Shimla are highly vulnerable to severe seismic activity, causing not only loss of life but extensive damage to the economic and social infrastructure.

12.2.2 Landslide

Landslides in Himachal Pradesh occur due to a combination of factors, including the tectonically unstable terrain, monsoons, and high-intensity earthquakes. The Himalayan region's steep slopes and geological instability further exacerbate the vulnerability to landslides.

- Unsustainable human activities like deforestation, road construction, terracing, and changes in agriculture practices have increased the susceptibility of the region to landslides.
- Himachal Pradesh's hilly areas face ongoing threats from landslides, resulting in loss of life, property damage, soil erosion, and disruptions to infrastructure

12.2.3 FLOODS

The state's topography plays a significant role in its flood vulnerability. High monsoon rainfall in the Shiwalik, Lower, and Mid-Himalayan ranges often leads to extensive flooding during the rainy season.

- Flash floods in the upper reaches of rivers like Beas and Satluj are common, with causes including cloudbursts, glacial lake outbursts, and temporary river channel blockages.
- While widespread floods inundating large areas are not a common occurrence due to the state's topography, ongoing attention is essential to mitigate flood hazards, particularly in vulnerable regions.

12.2.4 HAILSTORM/ DROUGHT

The state experiences inclement weather conditions such as excess rains, droughts, and hail storms due to its diverse topography, which has led to crop failure in the middle and upper himalayan region. There are also reported incidents impacting horticulture in the region.

12.3 DISTRICT WISE VULNERABILITY MATRIX

A vulnerability matrix was developed by the State Council for Science, Technology and Environmental Analysis for Himachal Pradesh to assess the state's susceptibility to various hazards. Qualitative weightage, rated from 0 to 5, was assigned to different risks, including earthquakes, landslides, avalanches, industrial hazards, construction types, and population density. District-specific matrices were developed to evaluate the severity of risks, considering population density and potential hazards induced by development projects like hydel projects and roads.

District-specific evaluations categorised Kangra, Hamirpur, and Mandi as 'very highly vulnerable' to earthquakes, with Chamba, Kullu, Kinnaur, and parts of Kangra and Shimla as 'highly vulnerable.' Una, Bilaspur, Sirmour, Solan, Shimla, and Lahaul & Spiti fell into 'moderate' to 'low' vulnerability. For landslides, Chamba, Kullu, Kinnaur, and parts of Kangra and Shimla were 'highly vulnerable,' while Kangra, Mandi, Bilaspur, Shimla, Sirmour, and Lahaul & Spiti were 'moderate.' Avalanches posed 'very high' risk in Lahaul & Spiti and Kinnaur, 'moderate' in Chamba, Kullu, and parts of Kangra and Shimla, and 'nil' in the remaining districts. Flood vulnerability was 'high' in Chamba, Kullu, Una,

and Kinnaur, while Lahaul & Spiti, Mandi, Shimla, Kangra, Hamirpur, Bilaspur, Solan, and Sirmour faced 'moderate' to 'low' vulnerability.

DISTRICT	EARTHQUAKE	LANDSLIDE	FLOODS	AVALANCHES	INDUSTRIAL	OVERALL VULNEABILITY
Kangra	VH	M	L	-----	M	H
Chamba	H	H	H	M	M	VH
Hamirpur	VH	L	L	-----	-----	M
Mandi	VH	M	M	-----	-----	H
Kullu	H	H	H	M	H	VH
Bilaspur	M	M	L	------	M	M
Una	M	L	H	------	H	H
Sirmour	M	M	L	-------	H	M
Solan	L	L	L	-------	H	M
Kinnaur	H	H	H	VH	H	VH
L&Spiti	L	M	M	VH	-------	H
Shimla	L	M	M	--------	H	H

VH: Very High, H: High, M: Moderate, L: Low

Source : State Council for Science Technology & Environment Analysis

12.4 Gaps/ Challenges observed in 2023 Disaster.

Lack of recognition of Himalayan Ecology in development activities.

The Himalayan region has witnessed a surge in development activities in recent years. While progress and development are crucial for the well-being of the region and its inhabitants, it is essential to acknowledge that the intricate Himalayan geology is sometimes overlooked in the process. The rapid expansion of infrastructure, including the construction of roads, dams, urbanisation, and the growth of tourism activities, often occurs without due consideration of the fragile geological foundations upon which these projects are built.

Large-scale road development, although vital for connectivity and economic growth, has disrupted the delicate Himalayan terrain. The steep slopes and susceptibility to landslides and erosion require meticulous planning and engineering solutions that respect the geological intricacies. Similarly, the construction of dams and hydropower projects can have geological consequences, potentially altering river courses and exacerbating the risk of seismic activity. Himachal Pradesh being a tourist destination has been hub of urbanisation and tourism. While these sectors promote economic opportunities, they can strain the region's resources and contribute to environmental degradation.

It is imperative that we strike a harmonious balance between development and environmental preservation in the Himalayan region. Engaging in comprehensive geological studies, involving local communities, and adhering to stringent environmental regulations can help mitigate the adverse impacts of development activities. Additionally, promoting responsible tourism and sustainable infrastructure planning can be catalysts for long-term growth while safeguarding the geological integrity of this magnificent region. By recognizing and respecting the unique geological challenges of the Himalayas, we can foster a sustainable and prosperous future for both the people and the environment in this remarkable part of the world.

To address this situation there is need for optimisation of road design for himalayan region in collaboration with National HIghway Authority of India, Border Road Organisation and State Public Works Department. At community level we need to strengthen community based disaster risk reduction measures, which identifies localised risk.

SPORADIC AND STATE-WIDE INCIDENTS OF LANDSLIDE.

The state of Himachal Pradesh experienced sporadic and widespread landslides during the months of September and October 2022 and again in April and May 2023, prior to the onset of the monsoon season. To investigate these events, satellite data from July and August 2023, following the monsoon period, was utilised. The comprehensive investigation involved mapping all landslides, slips, and debris flows using the satellite data. Notably, the majority of these geological events were triggered by heavy rainfall occurring during the months of July and August 2023.

In the table below there is a summary of the total number of landslides mapped in each district, along with relevant meteorological data. This data includes the total rainfall and the percentage deviation from the normal rainfall patterns for each district, recorded during the period from June 1st to September 15th, 2023. As per this information there were a total 5748 landslides spread across the State impacting 45.44 Sq km of area.

District	**Total No. of Landslide**	**Total area of landslides ($SqKm^2$)**	**Rainfall (mm) (Ist June to 15 September 2023)**	**Deviation from normal rainfall (%)**
Bilaspur	172	1.14	1258.4	62
Chamba	437	7.36	852.9	6
Hamirpur	287	1.39	1298.9	40
Kangra	366	2.30	1671.5	8
Kinnaur	144	2.48	267.1	21
Kullu	634	4.73	755.7	49
Lahaul & Spiti	56	1.33	209.5	-39
Mandi	1257	10.40	1525.5	45
Shimla	644	3.79	1001.3	71
Sirmour	924	6.35	1642.5	46
Solan	787	3.92	1455	77

Una	40	0.25	865.4	-5
Total	**5748**	**45.44**	**840.6**	**22**

These findings indicate the need for a comprehensive Statewide landslide risk mitigation program, which includes both structural and non-structural measures in place.

LACK OF COMPREHENSIVE EARLY WARNING SYSTEMS IN PLACE.

The state of Himachal Pradesh exhibits a diverse range of geo-climatic conditions, with variations often occurring within small geographical areas. To enhance our understanding and prediction of climate patterns, it is imperative to collect localised weather data encompassing parameters such as temperature, humidity, precipitation, and wind speed.

The existing weather monitoring network managed by the IMD (Indian Meteorological Department) is notably limited in its coverage. Presently, only 31 operational weather stations are in place. These stations are listed below, comprising key locations across the state. This sparse network falls short in capturing crucial data required for effective climate modelling and forecasting, resulting in a dearth of localised and actionable warnings for extreme weather events.

List of Weather Station in Himachal Pradesh		
Shimla	**Manali**	**Kukumseri**
Sunder Nagar	**Kangra**	**Narkanda**
Bhuntar	**Mandi**	**Bharmour**
Kalpa	**Bilaspur**	**Reckong Peo**
Dharamshala	**Hamirpur**	**Seobagh**
Una	**Chamba**	**Dhaula Kuan**
Nahan	**Dalhousie**	**Berthin**
Keylong	**Jubbarhatti**	**Samdo**
Palampur	**Kufri**	**Mashobra**
Solan	**Dehra Gopipur**	**PaontaSahib**
Sarahan		

Furthermore, the region has witnessed an increasing number of cloudburst incidents in recent years, particularly during the monsoon season. In the most recent monsoon season, a total of 27 cloudbursts were recorded, as outlined in Table 2, with varying occurrences across different districts. Likewise, flash floods have been a concern, with a total of 83 incidents documented during the same monsoon season, as detailed in Table 3. These flash floods affected multiple districts, demonstrating the vulnerability of the state to such events.

The inadequacy of the existing weather network has become evident, especially in issuing timely and actionable early warnings, as witnessed during extreme events like the Beas River flooding in Kullu, Manali, Mandi, and Kangra districts.

To address these challenges, there is an urgent need to expand and strengthen the weather monitoring network, following the Karnataka model, reaching down to the Panchayat level. Furthermore, establishing a centralised data centre at the state level for integrating and processing this data, coupled with AI-based early warning systems.

LACK OF RIVER BOUNDARIES AND FLOODPLAINS.

The lack of well-defined river boundaries in floodplains is a prominent issue in Himachal Pradesh, posing significant challenges to both the environment and local communities. In 2023 floods, One of the areas severely affected was Beas River basin. Kullu, Mandi and Kangra were the worst affected. One of the reasons for large- scale devastation due to river floods was that the Beas river has not been channelized. Small protection walls put in Kullu district at some locations such as near Manali Volvo Bus Stand, Akhara Bazaar have saved huge areas from devastation. In the context where rivers meander through the Himalayan terrain, the absence of clearly delineated river boundaries exacerbates the vulnerability of flood-prone areas.

Another concern arising from this lack of river boundaries is the increased risk of riverbank erosion. Without clearly demarcated boundaries, rivers are free to shift their courses during periods of heavy rainfall or snowmelt, leading to the erosion of riverbanks and adjacent lands. This erosion not only results in the loss of valuable agricultural land but also endangers human settlements and infrastructure situated in close proximity to the rivers. Furthermore, the absence of defined river boundaries hampers effective land-use planning , development regulations. It becomes challenging to establish setback distances and zoning regulations that account for floodplains and their dynamics. This leads to unchecked construction and development in areas susceptible to flooding, increasing the potential for property damage and loss of life during flood events.

Inadequate river boundaries also impede disaster preparedness and response efforts. It becomes difficult to determine the extent of flood-affected areas and plan evacuation routes and relief efforts effectively. Without clear boundaries, flood forecasting and early warning systems may also be less accurate, leaving communities unprepared for impending disasters.

To address this issue, there is a pressing need for comprehensive river boundary mapping and the establishment of floodplain management guidelines in Himachal Pradesh. Clear river boundaries, demarcated based on scientific assessments of historical flood patterns and erosion risks, would not only enhance disaster resilience but also safeguard the environment and livelihoods of those living in flood-prone areas. Previously, Himachal Pradesh has submitted a proposal developed by jal Shakti Vibhag seeking funds to channelsea river on large scale. The DPR was prepared in 2021 for Rs. 1600 cr. Approx. However, in view of the recent floods where HFL has been redefined and keeping in view the cost escalation, the estimated cost may reach around Rs. 2000/- crore.

While reviewing the DPR, it is understood that the river channelisation efforts predominantly require concretisation, which is not advisable in HImalayan Ecology. It is recommended that Jal Shakti Vibhag may review the proposal with Nature Based Solution Approach with an appropriate balance of structural and nonstructural measures for mitigation.

LACK OF INSURANCE AS A RISK TRANSFER MECHANISM FOR HOUSING, CROP AND COMMUNITY INFRASTRUCTURE.

The lack of insurance or any other risk transfer mechanism for housing, crop and infrastructure development in Himachal Pradesh has emerged as an critical challenge, with field experiences highlighting these findings. It has become evident that most of the homeowners do not leverage house insurance, resulting in a substantial protection gap for property and infrastructure.

Currently, it is primarily individuals who are obtaining housing loans that are compelled to acquire insurance. This limited approach leaves a vast segment of the population exposed to various risks, such as natural disasters, without adequate financial protection. Insurance, as a crucial aspect of risk transfer, holds the potential to provide financial security and resilience to households and communities in the face of unforeseen events.

To address this issue, there is an urgent need for concentrated efforts by the State Government to promote insurance adoption, encompassing various sectors such as housing, agriculture, and infrastructure. Collaboration with insurance companies and the Insurance Regulatory and Development Authority (IRDA) can be instrumental in developing tailored insurance models, outreach mechanisms, and affordable insurance products that cater to the unique needs and vulnerabilities of the region.

Moreover, to encourage insurance uptake, it is imperative that the State Government establishes robust support systems for individuals and communities who have already insured their buildings, crops, or assets. This includes streamlining claims processes and ensuring timely and efficient claim settlements. Building a positive reputation and trust among the population regarding insurance is pivotal in encouraging more people to invest in risk mitigation.

In addition to individual insurance, the Government may consider providing incentives or subsidies, such as premium support, to Gram Panchayats to extend coverage to community buildings and assets. This holistic approach to insurance penetration not only safeguards individuals but also strengthens the resilience of communities and the state as a whole against the impacts of disasters and unforeseen events.

IMPLEMENTATION AND EFFICACY OF TOWN AND COUNTRY PLANNING ACT IN HIMACHAL PRADESH

The Town and Country Planning Act of Himachal Pradesh is a legislative framework designed to regulate and manage land use, development, and urban planning within the state. However, it faces substantial criticism for its limitations and shortcomings in effectively addressing the challenges posed by rapid urbanisation and development in the region. Currently, there are approximately 102 notified areas under the purview of the department. The Town and Country Planning Act of 1977 (Urban and Rural) covers a total area of 204,056.20 hectares in Himachal Pradesh and is applicable in 54 urban local bodies across the state. It is understood that 21.70 percent of the state's total population and less than 10% of the total areas falls under the ambit of the Himachal Pradesh Town and Country Planning Act of 1977.

One of the primary concerns surrounding the act is its limited effectiveness in curbing unauthorised and haphazard urban development. Despite having regulatory provisions in place, unauthorised

construction often goes unchecked, leading to violations of land use norms, encroachment on environmentally sensitive areas, and inadequacies in infrastructure planning. Additionally, the act lacks clarity in its definitions and concepts, making it difficult for both authorities and the public to interpret and apply its provisions consistently. This ambiguity can result in legal disputes and hinder efficient decision-making processes.

The act does not provide sufficient safeguards for Himachal Pradesh's fragile ecology. This has raised concerns about the adverse impact of development activities on natural resources, including forests, rivers, and wildlife. The act also falls short in emphasising the need for infrastructure development in tandem with urban expansion, leading to inadequate provision of essential amenities like water supply, sanitation, and transportation in urban areas.

While. The act primarily applies to urban and municipal areas where town planning and development regulations are enforced. Rural areas, on the other hand, often have different rules and regulations, and construction activities may not always require formal permission for construction. To enhance regulations in rural areas and promote more organised and sustainable development, several measures need to be adopted to enhance extension of regulation to rural areas: awareness, building hill area development plan, community engagement and capacity building measures.

12.5 PROPOSED DISASTER RISK REDUCTION INTERVENTIONS.

STATE-WIDE LANDSLIDE RISK MITIGATION PROGRAM:

Between July and August 2023, Himachal Pradesh experienced approximately 5,748 landslides, resulting in a total land damage of 45.55 square kilometres. This damage spanned residential areas, open lands, and forests. It is observed that the damage due to landslides are highly dynamic in nature. During the first visit, (12th July), in peri-urban areas of Solan district, there were 6 families that suffered the loss of both homes and land due to a combination of flash floods, landslides, and land subsidence, however, by August 8th, the numbers escalated to 55 households in the same area had lost their buildings. These events highlight the widespread issue of landslides, land subsidence and dynamic nature of the risks associated with landslides, underlining the need for a long-term study and strategy focused on landslide risk reduction.

District	**Total No. of Landslide**	**Total area of landslides (SqKm^2)**
Bilaspur	172	1.14
Chamba	437	7.36
Hamirpur	287	1.39
Kangra	366	2.30
Kinnaur	144	2.48
Kullu	634	4.73
Lahaul & Spiti	56	1.33
Mandi	1257	10.40
Shimla	644	3.79
Sirmour	924	6.35
Solan	787	3.92
Una	40	0.25
Total	**5748**	**45.44**

The aims of the study will be to mitigate the recurrent and destructive risks of landslides in Himachal Pradesh. It may also include comprehensive geological surveys and suggest both non-structural and structural mitigation strategies.These measures can be developed as part of a long-term program, potentially funded through dedicated channels for landslide risk mitigation. An amount of 10 Crore is budgeted to conduct the study and build a risk informed program for the State.

STRENGTHENING COMMUNITY-BASED DISASTER RISK REDUCTION MEASURES:

The impact of floods and landslide in 2023, is both localised and widespread

This initiative empowers local communities in Himachal Pradesh to prepare for and respond to disasters effectively. It includes capacity building, awareness campaigns, and the establishment of localised disaster risk reduction mechanisms, strengthening communities' resilience, particularly in remote areas.

JOINT INITIATIVES FOR OPTIMISING ROAD DESIGN:

The Himachal Pradesh State Disaster Management Authority and the Himachal Pradesh Institute of Public Administration organised a session in the Colloquium Series on Infrastructure and Disaster Risk Reduction (DRR), with a focused conversation to understand the interconnectedness of road infrastructure with current disasters. The presentation by HPPWD estimated damages of Rs 280.07 Crore, and discussions by the Geological Survey of India centred on understanding geological aspects as part of road design. A key takeaway from the colloquium is the need for collaborative efforts between agencies like NHAI, BRO, GSI, HPPWD, and other technical agencies to optimise road design for the Himalayan region. As part of the DRR strategy, it is proposed to fund research on specialised road design, aiming to propose a design for highways, Major District Roads (MDR), and village roads that align with Himalayan ecology. A budget of 10 Crore is allocated for this study

STRENGTHENING THE EARLY WARNING SYSTEM:

This initiative enhances the state's preparedness for extreme weather events. It involves the establishment of a centralised data centre and local weather monitoring systems in Gram Panchayats to enable better weather modelling, early warnings, and improved disaster response.

With only 31 weather stations currently operational, the state's weather prediction and early warning capabilities are limited. It is observed that the cloudburst in Himachal Pradesh were highly sporadic and the weather changes across all the hills, leading to highly diverse weather conditions and in order to manage extreme weather events granularity of weather data and penetration of early warning systems is extremely essential. During the disaster, inadequacy of information and lack of early warning systems was observed by communities as well as state functionaries.[11] The chief minister of Himachal Pradesh has also shown keen interests in equipping the state with automatic weather stations and having. In order to augment early warning systems in place, it is recommended to install automatic weather stations across each gram panchayat and strengthen

[11] https://indianexpress.com/article/cities/chandigarh/himachal-cm-sukhu-demands-automatic-weather-stations-8896540/

early warning systems with an allocated budget of 50 Crore. By making weather data more granular and accessible, this investment holds the potential to strengthen weather prediction, disaster preparedness, and response in the state.

ESTABLISHMENT OF FLOODPLAIN MANAGEMENT GUIDELINES:

During the flood, large amount of damages and losses happened because of construction in the floods plains. Looking at this scenario it is essential to demarcate historic flood plains, and have appropriate policy instruments and implementation mechanisms to restrict any construction in the areas. Clear guidelines need to be developed to define setback distances and land-use regulations in flood-prone areas. These guidelines promote organised development and safeguard lives and property.Budget of Rs 10 crore is allocated to conduct studies to establish floodplain management guidelines and define setback distances based on scientific assessments.

Risk transfer program and support systems for insurance claims and outreach.

The penetration of house insurance is minimal in the region, during the second phase of data collection out of 7476 houses only 50 houses were insured out of which only 40 houses applied for claims. With only 0.66 percent of insured houses, it is evident that it is essential to enhance penetration of house insurance in the region. Currently only homeowners, who are availing home loans are required to take insurance, however the people who have taken insurance face challenges to avail the claim. In order to enhance penetration of insurance. Himachal Government may conduct studies along with IRDA and other insurance companies to develop tailored insurance models and affordable products for housing, agriculture and infrastructure. Along with that, the Himachal Government may establish systems in place to ensure that people who have insured their assets can access timely and efficient claim settlements, building trust in insurance mechanisms. A budget of 30 Crore is proposed to establish a focussed program on disaster risk insurance in the state.

STRENGTHENING THE TOWN AND COUNTRY PLANNING ACT AND BUILDING BY LAWS FOR URBAN DISASTER RISK REDUCTION.

The Town and Country Planning Act of 1977 (Urban and Rural) covers a total area of 204,056.20 hectares in Himachal Pradesh and is applicable in 54 urban local bodies across the state. It is understood that 21.70 percent of the state's total population and less than 10% of the total areas falls under the ambit of the Himachal Pradesh Town and Country Planning Act of 1977. Following up on the recommendation of NDMA report submitted to NGT in 2017, It is important to take a closer look at the current building bye-laws and the TCP Act,, analyse their impact on vulnerability of the building stock (e.g. height permissibility irrespective of slope and sub-soil conditions), assess their suitability for the hill environment,, and revise if necessary. It is important to review these changes in conjunction with BIS codes for multi-hazard safety in order to arrest any kind of increasing urban risk. A budget of Rs 10 Crore is allocated for Strengthening and enhancing Town and Country Planning Act with appropriate policy instruments to address multi-hazard risk in Urban areas. The initiative must strive for

- Improved coordination between institutions responsible for land use planning and building bye-laws.
- Strengthen the building approval process
- Create a mandatory process to ensure multi-hazard safety of buildings along in the context of the plots area and location of the building.

Establishment of local Hill Area Development Authorities:

In recent years, the Himalayan region has witnessed several disasters, including those in Joshimath in 2022 and Himachal Pradesh in 2023. The absence of adequate planning in hilly areas exacerbates existing vulnerabilities. It is crucial to establish a techno-legal framework to monitor and regulate development in these mountainous regions. The proposal involves launching pilot initiatives aimed at regulating rural construction and fostering sustainable development. This approach would be underpinned by a dedicated authority equipped with legal authority, technical expertise, and human resources, all directed towards enhancing rural development in a structured and sustainable way. Total budgeted amount for this pilot program is 10 Cr.

Forecast based Dam management Systems -

Currently, there are 135 dams in the State however, which requires augmentation of a forecast based management and safety systems in place. With the advent of technology; it is important for Dams to function on prediction based modelling and must account for 3-5 days of weather data from the catchments for flood warning. To establish a control systems a budget of 20 crore is allocated for the project

Establishment of a Himalayan Centre for Disaster Risk Reduction:

It is proposed to establish a centre to conduct scientific assessments, studies, and guide disaster risk reduction measures across all hill states in India. Collaboration and knowledge sharing in the region enhance preparedness and resilience in the face of disasters

The overall budget requested for implementation of these proposed intervention for Disaster Risk Reduction is

S.no	Proposed Interventions	Proposed Amount (In Crore)
1	State wide landslide risk mitigation program to include studies, non-structural and structural mitigation measures	10
2	Strengthen Community based Disaster Risk Reduction Measures in each gram Panchayat with approximate budget of 5 lakh per Gram Panchayat	200
3	Joint initiatives of State PWD, with NHAI, BRO along with research institutions to optimise road design (MDR, ODR and VR) as per himalayan geology. The initiative may include studies to understand impact of roads and propose new design of roads in Hilly regions	10
4	Strengthening early warning system by providing local weather monitoring systems in each gram panchayat, Set up a centralised data centre at the state level and integrating with State Emergency Operation Centre for weather modelling and predictions, forecasting and dissemination of early warning	50
6	Conduct studies and Establish floodplain management guidelines and define setback distances based on scientific assessments.	10
7	State wide risk transfer program to develop insurance models, establish support systems to access insurance claims and outreach for penetration of insurance schemes in collaboration with insurance companies and IRDA	30
10	Strengthening and enhancing Town and Country Planning Act with appropriate policy instruments	10
11	Establish local hill area development authority, to regulate construction in the rural areas by appropriate legal support, technical capacities and human resources on Pilot basis.	10
12	Forecast based dam management system	20
12	Establish Himalayan Centre for Disaster Risk Reduction to conduct scientific assessments, studies and guide disaster risk reduction measures across all hill states in India	25
	Total	375 Crore

12.6 LONG TERM DISASTER RISK REDUCTION MEASURES

Beyond the immediate Disaster Risk Reduction (DRR) requirements integrated within recovery efforts, there is a need for long-term measures to prevent and mitigate risks from landslides, earthquakes, floods, and other hazards. These efforts constitute comprehensive long-term strategies to address both rural and urban disaster risks. They encompass large-scale programs incorporating both structural and non-structural measures. Given that the funding for such measures falls outside the scope of typical recovery and reconstruction funds, their costs are not included in the recovery needs assessment. Nevertheless, these programs are developed with a long-term vision in mind. Consequently, Himachal Pradesh will strive to prioritise sourcing funds to implement these crucial programs.

- **Demarcation of floodplains, river boundaries, and channelization:**

The lack of well-defined river boundaries hinders effective disaster preparedness and response, especially in managing floods. Uncertainty about the extent of flood-impacted zones makes it challenging to organise evacuation plans and relief operations. Moreover, the absence of precise boundaries can lead to inaccuracies in flood forecasting and early warning systems, leaving communities vulnerable to sudden disasters.

In Himachal Pradesh, there is an urgent need for thorough river boundary mapping and the development of floodplain management protocols. Establishing clear river boundaries through scientific methods, which take into account historical flood data and erosion hazards, is crucial for enhancing disaster resilience, protecting the environment, and securing the livelihoods of those in flood-susceptible regions. Himachal Pradesh had previously put forward a proposal by the Jal Shakti Vibhag to undertake large-scale river channelization. The Detailed Project Report (DPR) created in 2021 estimated the cost at approximately INR 1,600 crores. However, considering the recent floods, which have necessitated a redefinition of the High Flood Level (HFL), and accounting for cost increases, the budget is expected to rise to about INR 2,000 crores. While there is high relevance for this project, funds may be sought from other funding channels to implement this project.

- **State-wide landslide risk mitigation program**:

Himachal Pradesh witnessed intermittent and extensive landslides in September and October of 2022, and then again in April and May of 2023, before the monsoon season began. To analyse these incidents, satellite imagery from July and August 2023, post-monsoon, was employed. This detailed analysis involved charting all landslides, slippages, and debris flows identified in the satellite data. It was observed that most of these geologic occurrences were caused by intense rainfall during July and August of 2023.

In response, the Himachal Pradesh State Disaster Management Authority (HPSDMA) is contemplating the implementation of a comprehensive landslide risk reduction program with a budget of INR 500 crore that may be funded through Mitigation Funds. This program is designed to address the frequent and damaging landslides in the region. It encompasses exhaustive geological assessments, the creation of zoning maps for landslide and rockfall susceptibility using geological and geotechnical studies, the adoption of non-structural strategies like early warning systems, and structural interventions such as slope stabilisation and construction of retaining walls. The objective

is to protect vulnerable communities, critical infrastructure, and the lives of those living in areas at risk of landslides.

- **Vision for Urban Disaster Risk Reduction through risk governance approach.**

In Himachal Pradesh, urban areas constitute a mere 10% of the region. Notwithstanding, there is an emerging trend of infrastructural development in rural zones. The urban planning in Shimla, specifically, appears to be contributing to an increased regional carrying capacity. This trend is evidenced not only by the recent landslides in Shimla in August 2023 but also by the severe water scarcity the city experienced in 2018 and 2022[12]. The expansion of urban clusters and the establishment of new urban centres beyond the Town and Country Planning (TCP) jurisdiction intensify multi-hazard risks in the state. Addressing these risks urgently necessitates comprehensive strategic interventions. These interventions should aim to improve economic opportunities in rural areas, regulate the development of the built environment, and reduce congestion in urban locales. These efforts should be part of a long-term vision aligned with the Global Sustainable Development Goals (SDGs). Learning from these disasters, the Government of Himachal Pradesh is committed to developing a long-term vision and strategy to manage urban disaster risks through a multi-sectoral risk governance framework.

[12]https://indianexpress.com/article/cities/chandigarh/shimla-water-shortage-worst-since-2018-crisis-7990581/#:~:text=Water%20 availability%20had%20 dropped%20to,37%2D38%20 MLD%20 back%20 then.&text=Four%20 years%20 since%20its%20 worst,for%20for%20a%20 fortnight%20now.

13 Way forward : Climate Adaptation for a Resilient Recovery

13.1 INTRODUCTION

In light of the recent floods and landslides in Himachal Pradesh, the residents have experienced damages totaling 8,665 crore. These damages span assets, individual and public services, and livelihoods. A post-disaster needs assessment provides a comprehensive review of the damages and losses endured by the people of Himachal Pradesh. Recognizing the areas where prior development plans fell short is crucial in outlining a path for effective long-term recovery

The team, after engaging with the local community, various departments, and experts during the assessment, identified that the substantial damages and losses resulted from accumulation of vulnerabilities. These vulnerabilities arose due to unplanned and non-scientific developments in the fragile Himalayan ecosystem. These vulnerabilities were exacerbated by floods resulting from the convergence of monsoon winds and western disturbances in July-August 2023, leading to significant devastation. It is acknowledged that the frequency of such extreme events may increase due to climate change. Given the uncertainties of our changing climate, it's pivotal that recovery efforts be informed by an understanding of these risks.

The purpose of this chapter is to delve into the vulnerabilities and risks Himachal Pradesh faces and to propose a strategic vision for recovery planning.

13.2 RECOVERY VISION AND STRATEGIES.

In the context of climate change and disaster risk reduction, India is a signatory to the Sendai Framework. This framework places a strong emphasis on adopting measures that address three dimensions of disaster risk: exposure to hazards, vulnerabilities, and hazard characteristics. Its primary goal is to prevent the creation of new risks, reduce existing risks, and enhance resilience. Within the context of climate change, the level of risk exposure in Himachal Pradesh has become increasingly unpredictable. According to the 2022 IPCC report, two key regions in the Indian subcontinent are particularly vulnerable to climate-induced disasters: the Indian Himalayas and coastal India. The ongoing disaster in Himachal Pradesh serves as an indicator of such events, which are expected to rise in the near future.

It's important to note that the Sendai Framework for Disaster Risk Reduction (DRR) complements the Paris Agreement on climate change, as both frameworks are interconnected in their efforts to achieve the Sustainable Development Goals (SDGs). In the current discourse, there is a growing emphasis on localising the SDGs. This means that the SDGs for 2030 must be adapted to fit local contexts and challenges. Strengthening the implementation of these goals at the local level is vital to contribute effectively to the global achievement of the SDGs.

While the recovery vision often aligns with the normative framework of "building back better," the path to recovery for Himachal Pradesh must also include measures for localising SDG interventions. This approach promotes adaptability to climate change and the reduction of risks at the local level, ultimately enhancing the region's resilience.

13.3 APPROACH

Understanding a Citizen-Centric Approach to Reduce Vulnerabilities

The damages that occurred in Himachal Pradesh are concentrated as well as sporadic across the regions. The floods in the river brought damages along the riverbed, landslides along the roads, and small, decentralised landslides and land subsidence in various parts of the upper Himalayan region. While the impact of the disaster is localised and citizen-centric, we need to acknowledge citizen-centric and community-based interventions for Disaster Risk Reduction. The recovery approach aims to strengthen citizen science initiatives, localised and decentralised risk reduction interventions by providing gram panchayats power, resources, and information to have risk-informed local development plans.

Risk Reduction through risk diversification

Horticulture and tourism are the primary sources of livelihood in the state, contributing to over 30% of its GDP. The floods disrupted the road network, severely impacting both sectors due to their high dependence on external markets. The inability to connect with urban market centres resulted in financial losses for apple farmers, and news of the disaster diverted tourists to other states. This high reliance on external markets intensifies risks. To mitigate these risks, it's essential to adopt a diversified approach. This includes reducing dependence on major roads by emphasising the reconstruction of superior village roads and networks. Additionally, broadening economic activities to encompass globally relevant skills, local IT initiatives, and fostering a scientific mindset through local knowledge can further safeguard the state's economic resilience

Optimising built infrastructure in HImalayan Ecology

Over recent decades, Himachal Pradesh has witnessed significant developments, including the construction of road infrastructure, dams, urban centre expansion, and residential developments. Given the unique Himalayan context, it's essential that construction practices undergo rigorous evaluation. Road construction and design should be reconfigured to reduce ecological impact. The environmental effects of various hydro projects, whether large, medium, small, or run-of-the-river, need to be assessed cumulatively. Construction methodologies for major projects should be contextualised to the Himalayan ecosystem, and building regulations require updating and reinforcement to ensure that ecology of the HImalayan region is not affected. To guide development in this sensitive region, the state government must introduce robust initiatives, institutions, legal structures, and policy tools.

Strengthening Risk Informed Development Planning approach.

In pursuit for a resilient Himachal Pradesh and sustainable future, the state must approach ``Risk Informed Development Planning ''. This strategy entails empowering local Gram Panchayats with technological support and adequate resource allocation, thereby enhancing their capacity to make informed decisions with adequate information of the risks and vulnerabilities faced by them.

In the pursuit of a more resilient and sustainable future, we advocate for a "Strengthening Risk-Informed Development Planning" approach. This strategy entails empowering local Gram Panchayats with technological support and resource allocation, thereby enhancing their capacity to

make informed decisions in the face of disaster risks. Additionally, we emphasise the importance of citizen science initiatives, which engage communities in data collection and analysis, promoting a collaborative effort to understand and mitigate risks. This holistic approach aligns stakeholders, strengthens governance, and fosters a culture of preparedness and resilience at the grassroots level.

Localisation by reinforcing the traditional knowledge system.

The recent disaster has shed light on the wisdom embedded within traditional knowledge systems, particularly in areas related to housing, food security, and livelihoods. Historically, these traditional knowledge systems have emphasised self-reliance and sustainability, promoting practices that allowed communities to thrive in harmony with their environments. In the wake of the disaster, it has become evident that there is a pressing need to not only recognize but also strengthen these traditional knowledge systems as part of a broader approach to localization.

Traditional knowledge systems offer a wealth of insights and practices that are deeply rooted in the local context. For instance, traditional housing styles are often designed to withstand local weather conditions and seismic risks, showcasing understanding of the environment. Similarly, traditional food practices are often based on locally available resources, promoting food security and resilience. While, the modernization and globalisation of societies have sometimes led to the erosion of these traditional knowledge systems, as communities increasingly adopt external practices and technologies. This shift has often made communities more vulnerable to disasters and external shocks. To address this vulnerability and promote localization, it is essential to contextualise and revitalise traditional knowledge systems. This involves acknowledging the rich tapestry of practices and insights that have been passed down through generations and integrating them into contemporary disaster management and development strategies. Local communities must play a central role in this process, as their intimate knowledge of their environments and cultures is a valuable resource.

13.4 Recovery Planning

After submission of the report, HPSDMA needs to develop a detailed recovery and adopt the above mentioned approach. The recovery plan may align with the recovery strategies recommended in the report.

- The first step in developing the recovery plan is a thorough assessment of the recovery needs. This entails a comprehensive review of the report's findings and recommendations, focusing on areas such as infrastructure, livelihoods, housing, healthcare, education, and environmental rehabilitation. The plan will prioritise these needs based on their impact and urgency, ensuring that resources are allocated where they are needed most.
- A recovery plan will operate within a clearly defined timeline to ensure efficient and timely implementation. HPSDMA will collaborate with relevant stakeholders to establish a detailed schedule, outlining when specific recovery activities and projects are to be initiated and completed. This timeline will enable better coordination and accountability in the recovery process.
- To oversee the recovery efforts, HPSDMA will establish a dedicated Recovery Management Unit (RMU) within its organisational framework. This unit will be responsible for coordinating recovery activities, liaising with other government departments, and ensuring

that the recovery plan's objectives are met. Additionally, the RMU will work in close collaboration with district-level authorities and local Gram Panchayats to ensure grassroots involvement and community participation in the recovery process. The functions of the RMU are suggested in further sections.

In conclusion, the development of a detailed recovery plan, aligned with the PDNA report's recommendations, is a critical endeavour for Himachal Pradesh. HPSDMA's commitment to identifying recovery needs, establishing a timeline, creating institutional systems, securing funding sources, and implementing a monitoring system will be instrumental in the state's journey towards a resilient and prosperous future.

13.5 Strengthen Institutional Mechanism.

To implement recovery interventions in Himachal Pradesh effectively, the state government can establish a Recovery Management Unit dedicated to disaster recovery and rehabilitation, this institution may be embedded within the State Disaster management Authority and District Disaster Management Authorities across all districts of Himachal Pradesh.

- The structure of the entity may adopt the role of a Program Management Unit and must report to HPSDMA which comprise representatives from the relevant government departments. The entity needs to be techno-managerial in nature which provides technical support for recovery planning , ensure integration of DRR measures and manage recovery intervention.
- The entity would be responsible for coordinating and overseeing recovery efforts in the state following a disaster. Its key responsibilities would include assessing damage through a detailed damage assessment, developing recovery plans, managing financial resources, and monitoring the implementation of recovery projects.
- The entity would have a dedicated budget for recovery efforts, which could be sourced from the state government, central government grants, and external funding agencies. This funding would be used for various recovery interventions, such as infrastructure rebuilding, livelihood restoration, and community resilience building.
- The entity would collaborate closely with relevant government departments, local authorities, NGOs, and international agencies to ensure a coordinated and efficient recovery process. It would also engage with affected communities to gather input and ensure their needs are addressed.
- The entity could provide training and capacity-building programs for local government officials, community leaders, and volunteers in disaster recovery and rehabilitation techniques.
- The entity would maintain a database of initiatives for disaster recovery, including damage assessments, recovery plans, and lessons learned from previous disasters. This data would help inform future recovery strategies.
- The entity would develop strategies to promote and adopt innovative strategies for building resilience and reducing risk in case of future disasters.
- The entity would conduct regular assessments and evaluations would be conducted to measure the effectiveness of recovery interventions and make necessary adjustments to improve outcomes.

13.6 TIMELINES AND PHASES.

The disaster in Himachal Pradesh, with an estimated cost of approximately 8700 Crore, demands a comprehensive and multi-faceted approach to disaster recovery. Recovery is a crucial phase that bridges the gap between the immediate disaster response and long-term development, acknowledging that the impact of disasters is often long after the initial event. The timeline for Himachal Pradesh's recovery interventions is expected to span between 2 to 3 years, aiming to achieve a comprehensive and sustainable recovery process.

It's important to note that climate change poses an ongoing threat, increasing the likelihood of recurrent disasters during the recovery period. These subsequent events can potentially damage already recovered infrastructure and enhance the vulnerabilities of critical assets. Therefore, the Himachal Pradesh State Disaster Management Authority (HPSDMA) must proactively anticipate and factor in these climate-related risks when planning and implementing recovery initiatives.

HPSDMA also recognizes that recovery interventions are not without their challenges and uncertainties. During implementation, there may be unforeseen risks, logistical hurdles, and evolving needs that need to be addressed promptly. Thus, a dynamic and adaptive approach to recovery planning is essential. Furthermore, the disasters in Himachal Pradesh serve as a source of valuable lessons. Learning from these events should inform recovery actions and contribute to broader development discourse. The insights gained can guide future policies, practices, and investments aimed at enhancing resilience and reducing vulnerability.

Regarding the phases of recovery interventions, it is imperative to align them with the region's climatic conditions. The monsoon and winter seasons are particularly critical as they bring extreme weather conditions, including heavy rainfall, landslides, and harsh winters, which can pose additional risks to the affected population. Therefore, recovery phases should be anchored around these seasonal variations, ensuring that preparedness measures are in place to address weather-related challenges.

14 Annexure

STATE TEAM

Sh Duni Chand Rana, Director cum Special Secretary (HPSDMA)
Sh. Balwan Chand, Joint Secretary
Sh S.S. Randhawa, Principal Scientific Officer (HIMCOSTE)
Sh Praveen Bhardwaj DM Specialist (HPSDMA)
Sh Vijay Kumar, IT Specialist (HPSDMA)
Sh Rohit Chauhan, RS & GIS Specialist (HPSDMA)
Sh Nitin Sharma, T&CB Coordinator (HPSDMA)

DISTRICT TEAMS

CEO DDMAs of all 12 Districts
Nodal Officers of Departments invoved in TNA

CENTRAL SUPPORT TEAM

NDMA - Kunal Satyarthi, SK Jena, Amit Tandon, Ranu Chauhan, Priyank Jindal
NIDM - Santosh Kumar, Amir Ali Khan, Manjeet Dhillon
UNDP - PK Das, Prerna Singh, Partha Bannerji
Unicef - Mahendra Rajaram , Rejeev Kumar
CDRI - Rahul Dey , Indranil Bose, Saubhra Ranjan Swain
IIT- Mandi - Uday Kala
JUIT, Solan - Tanmay Gupta, Chandra Pal Gautam, Sunil Datt Sarma
GB Pant University - Kesar Chand

Annex X

Reference for the consolidated sheet with the assessment method & data:

Phase 1 & 2 data assessment for original six districts (**Kinnaur, Solan, Kullu, Mandi, Chamba, & Shimla**): Road Sector PDNA Consolidated Sheet - 6 Districts Aug 23.xlsx

Phase 2 data assessment for the six new districts (**Bilaspur, Hamirpur, Kangra, Lahaul & Spiti, Sirmaur, and Una**): Road Sector PDNA Phase 2 - 6 new Districts.xlsx

Consolidated data across 12 districts: Phase 1 & 2 Consolidated Road Data

Folder with the raw data from each district: https://drive.google.com/drive/folders/16MKYLFSbkGExjEqO6xSYq8qKh_atwT4W?usp=sharing

Unit rates for road sector damage per district for the six districts that were part of phase 1 & 2 assessment:

Replacement Cost							
	Type of Roads	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
	Water-Bound Macadam	101	78	60	60	78	78
	Black Top	120	110	103	115	112	112
	cement concrete	-	30	-	-	30	30
	R/Wall	-	400	400	400	400	400
	B/Wall	-	320	320	320	320	320
MDR	**Type of Bridges**						
	Steel	15	19	12	10	10	10
	Concrete	18	18	20	9	9	9
	RCC Concrete Culvert	-	15	15	-		
	Others, Cable & suspension bridge	6	15	15		..	..
	Ropeways and Jhulas		4		-		
VR	**Type of Roads**	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla

	Water-Bound Macadam	80	62	48	48	60	70
	Black Top	96	88	80	90	100	100
	cement concrete	-	25	25	-	25	25
	R/Wall	-	400	400	400	400	400
	B/Wall	-	320	320	320	320	320
	Type of Bridges						
	Steel	12	12	12	10	10	10
	Concrete	15	15	15	9	9	9
	RCC Concrete Culvert	-	15	15	-	-	-
	Others, Cable & suspension bridge	6	2	2	4	8	8
	Ropeways and Jhulas		4	7	-	6	4
	Major Repair Cost						
MDR	**Type of Roads**	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
	Water-Bound Macadam	61	56	48	54	54	50
	Black Top	72	66	56	57	80	65
	cement concrete	-	18		-	18	18
	Type of Bridges						
	Steel	3	3	3	3	3	3
	Concrete	3	3	3	3	3	3
	RCC Concrete Culvert	-	3	-	-	-	-
	Others, Cable & suspension bridge	5	3	3	-	-	-
	Ropeways and Jhulas	-	2	-	-	-	-
VR	**Type of Roads**	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
	Water-Bound Macadam	37	22	24	24	22	22

	Black Top	43	50	45	45	65	50
	cement concrete		15	15		15	15
	Type of Bridges						
	Steel	3	3	3	3	3	3
	Concrete	3	3	3	3	3	3
	RCC Concrete Culvert		3		-	-	-
	Others, Cable & suspension bridge	1	1	1	-	2	2
	Ropeways and Jhulas		2	3	-	1	1
	Minor Repair Cost						
MDR	**Type of Roads**	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
	Water-Bound Macadam	4	2	4	1	2	2
	Black Top	4	2	4	1	2	2
	cement concrete	-	2	-	-	1	1
	Type of Bridges						
	Steel	1	1	1	1	1	1
	Concrete	1	1	1	1	1	1
	RCC Concrete Culvert		1		-	-	-
	Others, Cable & suspension bridge	-	1	-	-	-	-
	Ropeways and Jhulas		1	-	-	-	-
VR	**Type of Roads**	Kinnaur	Solan	Kullu	Mandi	Chamba	Shimla
	Water-Bound Macadam	2	2	2	1	2	2
	Black Top	2	2	2	1	2	2
	cement concrete	-	2	2	-	-	-
	Type of Bridges						

	Steel	1	1	1	1	1	1
	Concrete	1	1	1	1	1	1
	RCC Concrete Culvert	-	1		-	-	-
	Others, Cable & suspension bridge	-	1	1		1	1
	Ropeways and Jhulas		1	2	-	1	1

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