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GOVERNMENT OF INDIA

MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

GROUND WATER YEAR BOOK HIMACHAL PRADESH (2020-2021)

NORTHERN HIMALAYAN REGION
DHARAMSHALA
(H.P)
October, 2021

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GROUND WATER YEAR BOOK
HIMACHAL PRADESH
(2020-2021)

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NORTHERN HIMALAYAN REGION
DHARAMSHALA
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FOREWARD

For an efficient management and development of ground water resources, it is imperative to have a reliable database on water level and water quality. Central Ground Water Board, in addition to various other activities on scientific studies related to groundwater, collects data from a network of National Hydrograph Network Stations also called Ground Water Monitoring Wells and prepares a scientific base for the proper planning and judicious use of available groundwater resources.

Most of the area in Himachal Pradesh is hilly, mountainous with few intermontane valleys in between them. The traditional ground water structures, which are under observation at present, are open wells mostly located in the valley area. Therefore, the ground water regime monitoring programme is concentrated mostly in valley area of the state and at some places in hard rock area. Efforts are however going on to increase the number of observation wells and include the piezometers of state government under the groundwater regime monitoring.

The measurement of these National Hydrograph Network Stations is carried out four times in a year during the month of January, May, August and November and water samples are collected during pre-monsoon period viz., May for chemical analysis. The analysis of the data indicates the changes in ground water scenario and thereby helps in adopting measures if required in the area under monitoring for the sustainable development and management of the ground water resource. The human induced problems like depletion in water level, water logging, can be identified from the maps prepared during the analysis of water level data.

This report presents the water level data for the National Hydrograph Network Stations collected during the year 2020-2021 and its analysis and interpretations in the form of tables, maps and their descriptions to bring out the overall ground water scenario and the changes in ground water regime during the ground water year. The chemical results are awaited and will be issued separately.

The field data has been collected, processed and compiled by the scientific officers of NHR, Dharamsala. This report has been compiled by Smt. Rachna Bhatti, Scientist 'C' & Sh. Vidya Bhooshan, Senoir Technical Assistant (Hg). The samples were collected by Sh. Jugal Kishore, Surveyor and entered in GEMS by Smt. Anju Devi draftsman. The efforts of Report & Processing Section in scrutiny, processing and issuance of report is also highly significant.

This ground water year book contains useful data for water year 2020-2021 for all the planners and user agencies dealing with the development of ground water resources and it is hoped that it would be utilized fully for the real time management of ground water resources in the State.

Dated: 08.10.2021

Dharamshala

8/10/21

(J N BHAGAT)

Head of Office

GROUND WATER YEAR BOOK
HIMACHAL PRADESH
2020-2021
EXECUTIVE SUMMARY

- Central Ground Water Board, NHR has set up a network of 128 National Hydrograph Stations in the state of Himachal Pradesh. The monitoring commenced in the year 1969 with the establishment of 3 observation wells and since, then the number of monitoring station are being increased regularly so as to get the overall picture of ground water scenario in different hydrogeological set up of the state.

- Most of the area in Himachal Pradesh is hilly enclosing few small intermontane valleys. The traditional ground water structures under observation at present are dugwells and are mostly located in the valley areas only. Therefore, the ground water regime monitoring programme is concentrated mainly in valley areas of the state and some places in hard rock areas.

- All the 128 National Hydrograph Stations are located only in 7 districts out of the 12 districts in Himachal Pradesh. The reason being hilly terrain, hard approachability and insignificant number of structures available for monitoring.

- The average annual rainfall in the state varies from 600 mm to more than 2400 mm. The rainfall increases from south to north. Dharamshala in district Kangra, receives the 2nd highest rainfall of about 3000 mm in the Country.

- Water levels are being monitored four times in a year during the month of May, August, November and January. Water samples are collected during the month of May every year for chemical analysis of ground water quality.

- The depth to water level, recorded during May 2020 (Annexure - I), ranged between 0.30m (Mandi district) and 27.48 m bgl (Una district) . Out of 81 stations monitored, the majority of 68 NHS (83.95%) recorded DTWL, in the range between 2 - 20 m |bgl. 12 stations (14.81%), recorded shallow water levels, less than 2 m bgl and 1 stations (1.23%), recorded deep water levels, more than 20 m bgl in the state

- The depth to water level recorded during August 2020 ranges between (-0.70) m bgl (Hamirpur districts) to 37.75 m bgl (Sirmour district)

- The depth to water level recorded during November 2020 ranged between 0.41 m bgl in (Mandi district) to 29.02 m bgl in (Solan district).

- The depth to water level recorded during January 2021 ranged between 0.44m (Mandi district) to 31.04 m bgl (Sirmour district).

- Monsoonal fluctuation of water level was analyzed for 100 stations for the period May 2020 – November 2020. A perusal of Table-8 shows that out of the 79 stations, 48 stations (60.75%) have shown rise in water level and remaining 30 stations (37.97%) have shown fall in water level.

- Annual fluctuation data of water levels in May 2019 wrt May 2020 shows frequency distribution of rise and fall. Out of the 78 stations analysed, 47 stations (60.25%) have shown rise in water level ranging from 0.02 (Una) to 6.02 m (Una district), whereas 29 stations (37.17 %) have shown fall ranging from 0.06m (Kangra district) to 9.90 m (Kangra district).

- Annual fluctuation of water level has been worked out by comparing depth to water level of August 2019 with August 2020. Out of the 109 stations, 49 stations (44.95 %) have shown rise in water level ranging from 0.01 m (Hamirpur District) to 8.88 m (Sirmaur district) whereas 59 stations (54.12 %) have shown fall ranging from 0.01 m (Solan and Una district) to 13.62 m (Solan district).

- Annual fluctuation of water level has been worked out by comparing DTW of November 2019 with November 2020. Out of the 101 stations, 10 stations (9.90%) have shown rise in water level ranging from 0.08m (Kangra district) to 1.72 m (Una district) whereas 90 stations (89.10%) have shown fall ranging from 0.02 m (Kangra and Mandi district) to 3.19 m (Solan district).

- Annual fluctuation of water level has been worked out by comparing depth to water level of January 2020 with January 2021 . Out of the 99 stations analyzed, 15 stations (15.15%) have shown rise in water level ranging from 0.01 (Hamirpur district) to 0.85 m (Solan district) whereas 82 stations (82.82%) have shown fall ranging from 0.01 (Una district) to 3.37 m (Kangra district).

- Decadal water level fluctuation has been worked out by comparing water level data of May 2020 with the average mean of 10 years water level data of May (2010-2019) . A perusal of data shows that out of 82 stations analysed, 64 stations (78.04%) have shown rise and 18 stations (21.95%), have shown fall in water level. 48 stations (75.00%) are showing rise in water level between 0 to 2m, 13 stations (20.31%) between 2 to 4m. and 3 stations (4.68%), more than 4m.

- Decadal water level fluctuation has been worked out by comparing water level data of August 2020 with the average 10 years water level data of August (2010-2019) . A perusal of data shows that out of 109 stations analyzed, 61 stations (55.96%) have shown rise and 48 stations (44.03%), have shown fall in water level. 48 stations (78.68%) are showing rise in water level between 0 to 2m, 9 stations (14.75%) between 2 to 4m. and 4 stations (6.55%), more than 4m.

- Decadal water level fluctuation has been worked out by comparing water level data of November 2020 with the average water level data of November for 10 years (2010-2019) A perusal of data shows that out of 103 stations analyzed, 36 stations (34.95%) have shown rise and 67 stations (65.04%), have shown fall in water level. 32 stations (88.88%) are showing rise in water level between 0 to 2m, 2stations (5.55 %) between 2 to 4m. and 2 stations (5.55%), more than 4m.

- Decadal water level fluctuation has been worked out by comparing water level data of January 2021 with the average water level data of January for 10 years (2011-2020). A perusal of data shows that out of 103 stations analysed, 49stations (47.75 %) have shown rise and 11 stations (10.67%), have shown fall in water level. 41 stations (83.67%) are showing rise in water level between 0 to 2m, 6 stations (12.24%) between 2 to 4m. and 2 stations (4.08%), more than 4m. Out of 54 stations, 48 stations (88.88%) show fall in water level between 0 to 2m, 5 stations (5.24%) between 2 to 4 m and 1 stations (1.85%) more than 4m.

GROUND WATER YEAR BOOK
HIMACHAL PRADESH
2020-2021

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GROUND WATER YEAR BOOK
HIMACHAL PRADESH

(2020-2021)

1.0 INTRODUCTION

Himachal Pradesh is located between the north latitude 30°22'40" & 33°12'40" and east longitude 75°47'55" & 79°04'20". It falls in Survey of India topographic sheets Nos. 52D, 52H, 52L, 53A, 53B, 53F, 53E and 53I and covers an area of 55,673 sq km. It is one of the predominantly hilly states in India, which lies in the western Himalayas. The length of Himachal Pradesh is about 355 km i.e. from northwestern part of Chamba to southeastern part of Kinnaur. The breadth of the state is about 270 km i.e. from western part of Una to northeast part of Lahaul and Spiti disrtict. The state is bounded by the state of Jammu & Kashmir in north, Punjab state in west, Haryana state in south and Uttrakhand state in southeast and shares an international border with China (Tibet) in northeast.

Administratively, the state is divided in 12 districts, 76 tehsils, 34 sub-tehsils and 78 blocks. There are 20,690 villages, 3,226 Gram Panchayats, 59 towns, 28 Nagar Panchayats and 25 Nagar Parishads including Municipal Corporations. Lahaul & Spiti is the largest and Hamirpur is the smallest district of the state with geographical area of 12,835 and 1,118 sq km respectively.

The state has a population of 68,64,602 persons (Census 2011) having an average population density of 128 person per sq km. The male population in the state is 34,81,873 persons and female population is 33,82,729. The rural and urban population in the state is 61,76,050 and 6,00,552 persons respectively. The density of population in the state varies from as low as 2 persons/sq.km in Lahaul and Spiti district to 406 persons/sq km in Hamirpur district as compared to the state average of 128 persons/sq km.

Himachal region presents an intricate mosaic of mountain ranges, hills and valleys with altitude ranging from 350 m to 6500 m amsl. The Dhauladhar range looks in supreme majesty over the Kangra valley while the Pir Panjal, the Great Himalaya and the Zanskar ranges guard over Chamba, Lahaul & Spiti, Kullu and Kinnaur districts. The mountain slopes are covered with forests and meadows. The valleys below are interspersed with numerous streams, fields and quiet homesteads. There is general increase in elevation from east to west and from south to north. The physiographic divisions from south to north are the Outer Himalayas also known as Siwaliks (350 to 1500 m amsl), the Lesser Himalayan Range (1500-5000 m amsl), Great Himalayan Range (5000 – 6000 m amsl) and Zanskar Range (> 6000 m amsl)

Himachal state has a unique distinction of having drainage systems of both the Indus and the Ganga basin. The major river systems of the region are the Chandra-Bhaga or the Chenab, the Ravi, the Beas, the Satluj and the Yamuna. The catchments of these rivers are fed by snow and rainfall,

and are protected by fairly extensive cover of natural vegetation. Major rivers of the Indus river basin are the Chenab, the Ravi, the Beas and the Satluj. The Yamuna is the only river contributing water to Ganga basin.

The southwestern monsoon contributes about 70% of rainfall during monsoon period from July to September and about 30% occurs during non-monsoon period due to western disturbances and in the form of thunderstorm. Generally, rainfall increases from south to north. Western disturbances also shower rainfall in winters. Beyond Kullu towards Lahaul & Spiti and Kinnaur, rainfall decreases due to rain shadow effect. Spiti is the driest area with 50 mm rainfall because of being enclosed by High Mountain from all sides. The average annual rainfall in the districts of the state varies from about 600 mm in Lahaul & Spiti to more than 2400 mm in Kangra.

Central Ground Water Board, under part of its national ground water monitoring programme has established a network of observation stations in the state for periodic monitoring of ground water level and water quality. The ground water regime monitoring programme commenced during the year 1969 when the erstwhile groundwater wing of Geological Survey of India established 3 stations in the State. At present there are 128 Ground Water Monitoring Station (GWMS) in Himachal Pradesh. The year wise increase in GWMS in the State is given in Table-1.

Table-1: Year wise increase in GWMS, Himachal Pradesh

Year	Total Number of Ground Water Monitoring Stations
1969-73	3
1974-77	19
1978	32
1979	34
1980	35
1981	68
1982	69
1983-88	71
1989	72
1990-2000	79
2000-2010	86
2011-2013	102
2015-2016	111
2016-2017	128
2017-2018	128
2018-2019	128
2019-2020	128
2020-2021	128

The ground water monitoring is being carried out by Northern Himalayan Region, Dharamshala, since 1996. All the 128 GWMS are dug wells and are located in 7 districts of Himachal Pradesh out of the 12 districts. The reason for not monitoring other districts is being the hard approachability due to terrain conditions and non- availability of ground water monitoring structures. The district wise break up of Ground Water Monitoring Stations and their occurrence in different hydrogeological setup is given in Table-2.

Table-2: District wise GWMS & Hydrogeological setup

S. No	District	Number of GWMS			
		Total	Valley Area Porous Formation (Quaternary)	Fissured Formation (Tertiary)	Fissured Formation (Proterozoic to Mesozoic)
1.	Hamirpur	4	4	-	-
2.	Kangra	46	31	15	-
3.	Kullu	4	4	-	-
4.	Mandi	9	9	-	-
5.	Sirmaur	17	15	2	-
6.	Solan	16	16	-	-
7.	Una	31	31	-	-
8.	Chamba	1	-	1	-
TOTAL		**128**	**110**	**18**	**-**

2.0 HYDROGEOLOGY

The major part of Himachal Pradesh is hilly and mountainous with few small intermontane valleys covering about 15% of the area. These valleys comprise of alluvial deposits, which form extensive aquifers and thus represent porous formations. Major valleys in the state are Indora-Nurpur and Kangra-Palampur valleys in district Kangra, Una valley in district Una, Balh valley in district Mandi, Nalagarh valley in district Solan and Paonta valley in district Sirmaur.

The Siwalik and Sirmaur group represent the Tertiary formation in the state. These two groups occur in the western part of the state and have northwest to southeast trend. The Siwalik comprises of boulder, conglomerate, sandstone and clay while, Sirmaur group comprises of shale, sandstone and clay. The primary porosity and permeability in the Tertiary formation is low to moderate and hence, these aquifers do not form high yielding aquifers.

The older rock formations of Proterozoic to Mesozoic eras constitute of igneous and metamorphic rocks like granite, gneiss, slate, schist, phyllite, quartzite etc. Because of their consolidated nature,

these rock formations serve as poor aquifers. However, due to tectonic movements, they have been traversed by faults, thrust and joints, which have enhanced their ground water potential.

The quality of ground water in hard rocks and alluvial areas is by and large good and suitable for domestic and irrigational use. The distribution of the hydrogeological formations discussed above and their yield potential are given below in Table -3.

Table-3: Hydrogeological Formations and their Yield Potential, in Himachal Pradesh

Age	Rock Formation	Districts	Hydrogeological Characteristics
POROUS FORMATIONS			
Recent to sub Recent	Boulder, Cobble, Pebble, Sand, Silt, Clay,	Kangra, Una, Solan, Sirmaur, Mandi and Kullu	High Yield 30-75 m^3/hr
FISSURED FORMATIONS			
Tertiary	Boulder Conglomerate Sandstone, Clay	Kangra, Solan, Sirmaur Bilaspur, Una, Mandi, and Hamirpur .	Moderate to Low Yield < 30 m^3/hr
Proterozoic to Mesozoic	Shale, Slate, phyllite, Limestone, dolomite, Sandstone, Quartzite, Granite, Schist,	Lahaul & Spiti, Kinnaur, Chamba, Mandi, Simla, Kangra, Sirmaur, Solan, and Kullu	Moderate to Low Yield < 5 to 30 m^3/hr

2.1 Proterozoic to Mesozoic Formations

Older formations of Proterozoic to Mesozoic age are constituted by groups like Sundernagar group, Shali-Deoban-Largi group, Vaikrita group, Jutogh group, Simla group, Krol group, Tal group, Kuling group, Lilang group, Tandi group etc. These groups comprise of granites, gneisses, slates, schists, phyllites, quartzites etc. and occur in Kangra, Chamba, Lahaul & Spiti, Kinnaur, Simla, Sirmaur, Kullu and Solan districts. These rocks are dense and consolidated in nature therefore; they bear low primary porosity and permeability, thus forming poor yielding hard rock aquifers. Secondary porosities have developed due to the tectonic movements. Weathered, fractured and contact zones however, form potential ground water zones.

Groundwater in hard rocks area is either developed though bore wells or springs at favorable locations. Springs are the major ground water sources in these formations and its yield ranges from seepages to more than 25 lps and are utilized for both domestic and irrigation purposes. Weathered mantle in low topographic areas, also forms poor aquifers. In some areas, percolation wells are also

constructed. *Bowris* are also constructed in oozing out spring zones, for collection of water to fulfill the domestic water needs. Number of hot water springs also occurs in these formations.

2.2 Tertiary Formations

The upper Tertiary formations ranging in age from Middle Miocene to Lower Pleistocene are represented by the rocks of Siwalik group and extend from northwest to southeastern part of the state. It comprises of great thickness of cobbles, pebbles, detritus rocks, clays and conglomerates. The Siwalik chain is widest in the valley of river Beas. On paleontological grounds the Siwalik are subdivided into three subgroups namely upper, middle and the lower Siwaliks.

The lower Tertiary formations ranging in age from Eocene to Lower Miocene are represented by the rocks of Sirmaur group. The Sirmaur group has also been sub-divided into three formations namely Kasauli, Dagshai and Subathu. The group comprises of shale, sandstone and clay. The Sirmaur group is separated by a fault from the Siwaliks.

Fracture zones and contact zones form important aquifers in the low topographic areas with poor to moderate yields. Yields of the tube wells are less than $30m^3$/hr constructed along the fault/ fracture/contact zones. These fractures or faults zones form potential ground water zones for development.

2.3 Quaternary Formations

The Quaternary formations occur either as major or minor valley fills/piedmont/fluvio-glacial deposits and alluvium. The major valley fill areas are Nurpur – Jawali – Nagrota Surian, Pragpur – Dadasiba, Palampur – Kangra valley fills in Kangra district; Shathlai and Sirkhad in Hamirpur district; Balh valley in Mandi district; Una valley in Una district; Nalagarh valley in Solan district; Paonta valley in Sirmaur district; Spiti valley in Lahaul & Spiti district. Ground water occurs under phreatic to semi-confined conditions in these deposits. In some of the valleys like Indora – Nurpur valley in Kangra district and Balh valley in Mandi district, confined aquifers are encountered.

The thickness of valley fills in Paonta, Una, Nalagarh, Nurpur and Andaura are generally more than 100 m whereas, in other areas its thickness is within 100 m. Groundwater occurs under unconfined to confined conditions. In general, depth to water level varies from 5 to about 60 m bgl. Artesian conditions also exist in lower and central part of Una valley, lower part of Nurpur, Andaura and Balh valley fills.

Ground water occurs under unconfined conditions in shallow valley fills areas developed along the river/streams. Discontinuous aquifers system is observed in Kangra, Sirmaur, Solan and Una districts. Depth to water level varies from < 2 to 20 m bgl. Ground water is developed through open dug wells, shallow and deep tube wells. The discharge of the tube wells varies up to 40 lps but generally ranges between 15 to 25 lps. There are about 8000 tube wells constructed including

exploratory wells of CGWB in the valley fill deposits both for drinking and irrigation purpose. A large number of shallow boreholes fitted with hand pumps also exist in the state for developing groundwater.

3.0 GROUND WATER SCENARIO

The ground water level in the state is monitored regularly to have a review over the changes in ground water regime. The maps generated from these data help in identifying the areas, which are under water level rising and water level declining. With the help of these maps, suitable measures as per the demand of the area can be adopted for the sustainable ground water development. It also helps the planners to formulate the future strategy in various fields of ground water development.

For the purpose of presentation, the water levels and their changes are shown separately in alluvial and hard rock areas because of aquifer discontinuity. As discussed earlier, the major alluvial areas are Indura-Nurpur and Kangra-Palampur valley in district Kangra, Una valley in district Una, Balh valley in district Mandi, Nalagarh valley in district Solan and Paonta valley in district Sirmaur. In hard rock areas point values are given at places.

The water level is being monitored in the State four times in a year

1. May : 20^{th} to 30^{th} : represents water level of Pre-monsoon period
2. August : 20^{th} to 30^{th} : represents peak monsoon water level.
3. November : 1^{st} to 10^{th} : represents water level of Post-monsoon period.
4. January : 1^{st} to 10^{th} : represents the recession stage of water level

The data has been analyzed for each set of measurement and report has been prepared which include following maps to understand the groundwater regime in the area.

A. Depth to water level maps : Water level scenario for the month in the area.
B. Seasonal fluctuation maps : Water level fluctuation in comparison to Pre-monsoon.
C. Annual fluctuation maps : Water level fluctuation in comparison to same month in the previous year.
D. Decadal mean fluctuation maps : Water level fluctuation in the month of measurement with reference to the decadal average for the same month.

The depth to water level, seasonal fluctuation and annual fluctuation has been presented in Annexure-I, II and III. The decadal mean fluctuation has been tabulated in Annexure-IV. The ground water behavior in the seven districts of Himachal Pradesh has been discussed below.

3.1 Depth to Water Level

3.1.1 May 2020

The depth to water level, recorded during May 2020 (Annexure - I), ranged between 0.30m (Mandi district) and 27.48 m bgl (Una district) (Table-3). Out of 81 stations monitored, the majority of 68 NHS (83.95%) recorded DTWL, in the range between 2 - 20 m |bgl. 12 stations (14.81%), recorded shallow water levels, less than 2 m bgl and 1 stations (1.23%), recorded deep water levels, more than 20 m bgl in the state.

A perusal of the DTWL map of May 2020 shows that the shallow water level area of less than 2m bgl, occurs in northern and southern part of Kangra Palampur valley , northern part of kullu valley and southern part of Balh valley in Mandi district and western and southern part of Una Valley. 2-5 m bgl and 5-10 m bgl water level occupies in most of the monitoring area of all the valleys of Himachal Pradesh, mainly in Kangra-Palampur valley, Nurpur- Indora valley ,southern part of kullu valley and balh Valley. Water level 10-20m bgl in shown northern part of kangra Palampur valley and northern part of indora valley . Deeper water levels, between 20-40m bgl are shown in eastern part of Una valley.

Table-3: District wise number & % of NHS distribution, in different DWL of May 2020

2.1

Depth to Water Table
Distribution of Percentage of Observation Wells
2020/May

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	2.27	6.39	0	3 75.00%	1 25.00%	0	0	0
KANGRA	35	0.76	13.46	4 11.43%	21 60.00%	6 17.14%	4 11.43 %	0	0
KULLU	3	0.54	8.47	1 33.33%	0	2 66.67%	0	0	0
MANDI	8	0.30	12.00	2 25.00%	4 50.00%	1 12.50%	1 12.50 %	0	0
UNA	31	1.16	27.48	5 16.13%	14 45.16%	5 16.13%	6 19.35 %	1 3.23%	0
Total	81	0.30	27.48	12	42	15	11	1	0

3.1.2 August 2020

The depth to water level recorded during August 2020 (Annexure - I) ranges between (-0.70) m bgl (Hamirpur districts) to 37.75 m bgl (Sirmour district) (Table-5). Out of the 110 stations monitored the majority of 68 stations (61.81%) recorded DTW in the range between 2-20 m bgl, 39

stations (35.45%) have recorded shallow water level less than 2 m bgl, and only 3 stations (2.72%) have shown, more than 20 m bgl in the state.

A perusal of the DTW map for August 2020 indicates that the shallow water level area less than 2m bgl occurs in all the valleys of Himachal Pradesh, except Nalagarh and Paonta valley, mainly in Balh valley (Mandi district), all the valleys of Kangra district including Kangra Palampur valley and Nurpur Indaura valley , eastern & central part of Una valley and northern part of kullu valley . 2-5m bgl and 5-10 m bgl water level is recorded in couple of pockets in almost all the valley areas. 10 -20 m bgl water level is recorded in pockets in Una Valley, northern part of Paonta valley and Nalagarh valley . Deeper water levels are found at some places in Nalagarh and Una valley.

Table-5:– Depth to water level - August 2020

Depth to Water Table
Distribution of Percentage of Observation Wells
2020/Aug

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	-0.70	3.82	3 75.00%	1 25.00%	0	0	0	0
KANGRA	37	-0.47	7.40	16 43.24%	16 43.24%	5 13.51%	0	0	0
KULLU	3	0.40	8.47	1 33.33%	0	2 66.67%	0	0	0
MANDI	8	0.08	3.96	4 50.00%	4 50.00%	0	0	0	0
SIRMAUR	13	1.17	37.75	2 15.38%	5 38.46%	2 15.38%	3 23.08 %	1 7.69%	0
SOLAN	13	3.82	28.92	0	3 23.08%	2 15.38%	7 53.85 %	1 7.69%	0
UNA	32	0.11	27.42	13 40.63%	9 28.13%	4 12.50%	5 15.63 %	1 3.13%	0
Total	110	-0.70	37.75	39	38	15	15	3	0

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3.1.3 November 2020

The depth to water level recorded during November 2020 (Annexure - I) ranged between 0.41 m bgl in (Mandi district) to 29.02 m bgl in (Solan district) (Table-6). Out of 104 stations monitored, the majority of 85 NHS (81.73%) recorded DTWL, in the range between 2 - 20 m bgl. 16 stations (15.38%), recorded shallow water levels, less than 2 m bgl and 3 stations (2.88%), recorded deep water levels, more than 20 m bgl in the State.

A perusal of the DTWL map for November 2020 shows that the shallow water level areas of less than 2 m observed in southern part of Kangra Palampur valley and northern part of Kullu valley. Water level of 2-5m & 5-10 m bgl is observed in major part of Kangra Palampur valley, Indaura-

Nurpur valley, Balh valley, Una Valley, Nalagargh valley Paonta valley respectively. 10-20 m bgl water level is shown in Una, Nalagah, Kangra Palampur valley and Paonta valley only. Deeper water level more than 20m is confined mainly in northern part of Paonta valley in Sirmaur district, northern part of Nalagarh valley of Solan district and small part of Una valley.

Table- 6: Depth to Water Level – November 2020

Depth to Water Table
Distribution of Percentage of Observation Wells
2020/Nov

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min.	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	2.41	6.14	0	2 50.00%	2 50.00%	0	0	0
KANGRA	36	0.50	10.66	7 19.44%	20 55.56%	7 19.44%	2 5.56 %	0	0
KULLU	2	0.89	6.75	1 50.00%	0	1 50.00%	0	0	0
MANDI	8	0.41	6.21	2 25.00%	5 62.50%	1 12.50%	0	0	0
SIRMAUR	13	1.61	26.74	1 7.69%	2 15.38%	5 38.46%	4 30.77 %	1 7.69%	0
SOLAN	11	5.16	29.02	0	0	4 36.36%	6 54.55 %	1 9.09%	0
UNA	30	1.15	27.59	5 16.67%	12 40.00%	7 23.33%	5 16.67 %	1 3.33%	0
Total	104	0.41	29.02	16	41	27	17	3	0

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3.1.4 January 2021

The depth to water level recorded during January 2021 (Annexure - I) ranged between 0.44m (Mandi district) to 31.04 m bgl (Sirmour district) (Table-7). Out of 102 stations which are monitored, the majority of 81 NHS (79.41%) recorded DTW in the range between 2 - 20 m bgl, 17 stations (16.66%) recorded shallow water levels, less than 2 m bgl and 4 stations (3.92 %) recorded deep water levels, more than 20 m bgl in the state.

A perusal of the DTW map of January 2021 shows that the shallow water level area occurs mainly in south southern part of Kangra Palampur valley (Kangra district), northern part of Balh valley (Mandi district) and northern and southern part of kullu Valley . 2-5 m bgl & 5-10m bgl water level is depicted in all the valleys of Himachal Pradesh. 10-20 m bgl water level occupies Nalagarh, kangra Palampur Valley and Una valley. Deeper water level, more than 20m are confined mainly in southern part of Nalagarh and at few places of Una valley.

Table- 7: Depth to Water Level – January 2021

Depth to Water Table
Distribution of Percentage of Observation Wells
2021/Jan

State : Himachal Pradesh

District	No. of Wells Analysed	Depth to Water Table (mbgl)		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0.0 - 2.0	2.0 - 5.0	5.0 - 10.0	10.0 - 20.0	20.0 - 40.0	> 40.0
HAMIRPUR	4	1.84	5.72	1 25.00%	2 50.00%	1 25.00%	0	0	0
KANGRA	35	0.64	14.01	8 22.86%	19 54.29%	6 17.14%	2 5.71 %	0	0
KULLU	2	0.78	7.01	1 50.00%	0	1 50.00%	0	0	0
MANDI	7	0.44	4.68	2 28.57%	5 71.43%	0	0	0	0
SIRMAUR	13	1.76	31.04	1 7.69%	0	3 23.08%	7 53.85 %	2 15.38%	0
SOLAN	10	5.43	29.29	0	0	3 30.00%	6 60.00 %	1 10.00%	0
UNA	31	1.12	27.29	4 12.90%	14 45.16%	6 19.35%	6 19.35 %	1 3.23%	0
Total	102	0.44	31.04	17	40	20	21	4	0

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3.2 Seasonal Water Level Fluctuation

To study the effect of monsoon and subsequent utilization for various needs like agriculture, irrigation and domestic etc, changes in water level are studied and are discussed below.

3.2.1 May 2020 to November 2020

Monsoonal fluctuation of water level was analyzed for 100 stations for the period May 2020 – November 2020. A perusal of Table-8 shows that out of the 79 stations, 48 stations (60.75%) have shown rise in water level and remaining 30 stations (37.97%) have shown fall in water level.

The minimum rise in water level of 0.03 m was observed in kangra District and the maximum rise 10.30 m was noticed in Kangra District. Out of the 48 stations which have shown rise in water level, 41 stations (85.41%) show rise between the range of 0 to 2m, 4 stations (8.33%) between 2 to 4m and remaining 3 stations (6.25%) show rise more than 4m.

The minimum and maximum fall in water level of 0.01 m and 1.77 m was observed in Una and Kangra District. Out of them 30 stations (100%) have shown fall between 0-2 m, No stations has shown fall between 2-4 m and >4m.

A perusal of map for seasonal fluctuation shows a rise in water level in major part of Indora valley, Nurpur valley, Una valley, Balh valley. Except a fall which is noticed in eastern part of

Indaura valley, western and northern part of Una valley , Balh Valley and whole part of Kullu valley.

Table-8: Monsoonal Fluctuation - May 2020 to November 2020

2.1

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2020/May - To Year: 2020/Nov

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.25	0.78	0.26	0.69	2 50.00%	0	0	2 50.00%	0	0	2	2
KANGRA	35	0.03	10.30	0.07	1.77	21 60.00%	3 8.57 %	2 5.71%	8 22.86%	0	0	26	8
KULLU	2	-	-	0.35	0.41	0	0	0	2 100.00%	0	0	0	2
MANDI	8	0.10	5.79	0.02	0.36	2 25.00%	0	1 12.50%	5 62.50%	0	0	3	5
UNA	30	0.05	3.01	0.01	1.30	16 53.33%	1 3.33 %	0	13 43.33%	0	0	17	13
Total	79	0.25	0.78	0.01	1.77	41	4	3	30	0	0	48	30

3.3 Annual Water Level Fluctuation

Annual fluctuation in water level of GWMS during different monitoring periods were analysed and discussed below.

3.3.1 May 2019 to May 2020

Annual fluctuation of water level, has been worked out by comparing depth to water level of May 2019, with May 2020 and the data is presented in Annexure – III and its frequency distribution in various rise and fall ranges is given in Table-9.

Out of the 78 stations analysed, 47 stations (60.25%) have shown rise in water level ranging from 0.02 (Una) to 6.02 m (Una district), whereas 29 stations (37.17 %) have shown fall ranging from 0.06m (Kangra district) to 9.90 m (Kangra district).

Out of stations which have shown rise in water level, 43 stations (91.48%) show rise between the range of 0 to 2m, 2 station (4.25%) has shown rise between 2 to 4m and only 2 stations (4.25%) shown rise more than 4m.

Similarly, for the stations which have shown fall in water level, 25 stations (86.20%) show fall between the range of 0 to 2m, 3 stations(10.34%) has shown fall between 2 to 4m and 1 stations (3.44%) has shown fall more than 4m.

A perusal of map of Annual Water Level Fluctuation for May 2019 to May 2020 shows fall in water level in majority of monitoring areas. Fall of 0-2m in shown in Kangra-Palampur valley of Kangra district, Kullu Valley, major part of Nurpur and Indaura Valley and small pockets of Una Valley. Fall >4 m is noticed in small pockets of Nurpur valley and Indora Valley. Rise in water level is noticed in Kangra Palampur valley, small pockets of Una valley, northern part of kullu valley and southern of Part of Balh valley.

Table-9: District wise number & % of NHS distribution in different Annual W/L Fluctuation Range (May 2019 - May 2020)

2.1

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2019/May - To Year: 2020/May

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.25	1.00	1.23	1.23	3 75.00%	0	0	1 25.00%	0	0	3	1
KANGRA	33	0.09	2.59	0.06	9.90	11 33.33%	1 3.03 %	0	18 54.55%	1 3.03%	1 3.0%	12	20
KULLU	3	0.15	0.31	-	-	2 66.67%	0	0	0	0	0	2	0
MANDI	8	0.09	0.44	0.18	3.06	4 50.00%	0	0	3 37.50%	1 12.50%	0	4	4
UNA	30	0.02	6.02	0.12	2.79	23 76.67%	1 3.33 %	2 6.67%	3 10.00%	1 3.33%	0	26	4
Total	78	0.25	0.31	0.00	9.90	43	2	2	25	3	1	47	29

3.3.2 August 2019 to August 2020

Annual fluctuation of water level, has been worked out by comparing depth to water level of August 2019, with August 2020 and the data is presented in Annexure – III and its frequency distribution of rise and fall is given in Table-10.

Out of the 109 stations, 49 stations (44.95 %) have shown rise in water level ranging from 0.01 m (Hamirpur District) to 8.88 m (Sirmaur district) whereas 59 stations (54.12 %) have shown fall ranging from 0.01 m (Solan and Una district) to 13.62 m (Solan district).

Out of stations which have shown rise in water level, 40 stations (81.63%) show rise between the range of 0 to 2m, 7 stations (14.28 %) between 2 to 4m and remaining 2 stations (4.08%) show rise more than 4m.

Similarly, for the stations which have shown fall in water level, 48 stations (81.35%) show fall between the range of 0 to 2m, 6 stations (10.16%) between 2 to 4m and remaining 5 stations (8.47%) show fall more than 4m.

A perusal of map of Annual Water Level Fluctuation for August 2019 to August 2020 shows fall in water level in some of monitoring areas of central part of Kangra Palampur valley, northern and southern part of Indora-Nurpur valley, southern part of Nallagarh valley, southern part of Kullu valley and in small patch of Una valley. Areas are showing water level rise in all the valleys, under monitoring area.

Table-10: Annual Fluctuation August 2019 - August 2020

2.1

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2019/Aug - To Year: 2020/Aug

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.01	5.71	0.12	0.76	1 25.00%	0	1 25.00%	2 50.00%	0	0	2	2
KANGRA	37	0.04	2.88	0.06	6.85	18 48.65%	2 5.41 %	0	13 35.14%	3 8.11%	1 2.70%	20	17
KULLU	3	0.36	0.36	0.63	8.47	1 33.33%	0	0	1 33.33%	0	1 33.33%	1	2
MANDI	8	0.07	2.21	0.02	1.12	3 37.50%	1 12.50 %	0	3 37.50%	0	0	4	3
SIRMAUR	12	0.05	8.88	0.27	3.65	4 33.33%	1 8.33 %	1 8.33%	5 41.67%	1 8.33%	0	6	6
SOLAN	13	0.06	2.63	0.01	13.62	6 46.15%	1 7.69 %	0	4 30.77%	0	2 15.38%	7	6
UNA	32	0.03	2.85	0.01	9.20	7 21.88%	2 6.25 %	0	20 62.50%	2 6.25%	1 3.1%	9	23
Total	109	0.36	0.36	0.01	13.62	40	7	2	48	6	5	49	59

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3.3.3 November 2019 to November 2020

Annual fluctuation of water level has been worked out by comparing DTWL of November 2019 with November 2020 and data is presented in Annexure – III and its frequency distribution in various rise and fall ranges is given in Table-11.

Out of the 101 stations, 10 stations (9.90%) have shown rise in water level ranging from 0.08m (Kangra district) to 1.72 m (Una district) whereas 90 stations (89.10%) have shown fall ranging from 0.02 m (Kangra and Mandi district) to 3.19 m (Solan district).

Out of stations which have shown rise in water level, 10 stations (100%) show rise between the range of 0 to 2m, No stations between 2 to 4m and more than 4m.

Similarly, for the stations which have shown fall in water level, 86 stations (95.55%) show fall between the range of 0 to 2m, 4 stations (4.44 %) has shown fall between 2 to 4m and No stations fall more than 4m.

A perusal of map of annual fluctuation of November 2019 to November 2020 showing fall in water levels in majority of valley areas. Nallagarh valley of Solan district is completely under fall conditions. 0-2m fall is shown in some part of Paonta valley, una Valley, Indaura Valley and more than 4m is observed in the small pocket of Una, Kangra palampur valley .Similarly rise in water level 0-2m is noticed along the fringe areas of all monitoring valleys. Rise more than 4 m is shown in western part of Kangra Palampur Valley part of Una valley , small pockets of Nurpur and Indaura Valley.

Table-11: Annual Fluctuation -November 2019 to November 2020

2.1

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2019/Nov - To Year: 2020/Nov

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	-	-	0.58	1.52	0	0	0	4 100.00%	0	0	0	4
KANGRA	36	0.08	0.08	0.02	2.69	1 2.78%	0	0	33 91.67%	1 2.78%	0	1	34
KULLU	2	0.28	0.28	0.69	0.69	1 50.00%	0	0	1 50.00%	0	0	1	1
MANDI	8	0.23	0.77	0.02	0.84	2 25.00%	0	0	6 75.00%	0	0	2	6
SIRMAUR	11	-	-	0.02	1.78	0	0	0	11 100.00%	0	0	0	11
SOLAN	10	0.28	1.41	0.06	3.19	3 30.00%	0	0	6 60.00%	1 10.00%	0	3	7
UNA	30	0.75	1.72	0.21	2.71	3 10.00%	0	0	25 83.33%	2 6.67%	0	3	27
Total	101	0.75	0.08	0.02	3.19	10	0	0	86	4	0	10	90

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3.3.4 January 2020 to January 2021

Annual fluctuation of water level has been worked out by comparing depth to water level of January 2020 with January 2021 and data is presented in Annexure – III and its frequency distribution in various rise and fall ranges is given in Table-12.

Out of the 99 stations analyzed, 15 stations (15.15%) have shown rise in water level ranging from 0.01 (Hamirpur district) to 0.85 m (Solan district) whereas 82 stations (82.82%) have shown fall ranging from 0.01 (Una district) to 3.37 m (Kangra district).

Out of stations which have shown rise in water level, 15 stations (100 %) show rise between the range of 0 to 2m, No stations between 2 to 4m and No stations more than 4m.

Similarly, for the stations which have shown fall in water level, 79 stations (96.34%) show fall between the range of 0 to 2m, 3 stations (3.65 %) between 2 to 4m and No stations has shown fall >4m.

A perusal of map of annual fluctuation of January 2020 to January 2021 is showing fall in water levels in majority of valley areas. The fall in water level 0-2m is shown in few places of Indora valley, and central part of Kangra Palampur valley and a part of Paonta valley. Fall in water level, more than 4m is observed in northern part of Nalagarh valley only. Similarly rise in water level 0-2m is noticed in central & southern part of Indaura and Nurpur valley, northern part of Balh valley, northern part of Una valley and small pockets of Nalagarh valley.

Table-12: Annual Fluctuation, January 2020 to January 2021

2.1

District Wise - Fluctuation and Frequency Distribution From Different Ranges from One Period to Other

From Year: 2020/Jan - To Year: 2021/Jan

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation (m)				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.01	0.09	0.87	0.87	3 75.00%	0	0	1 25.00%	0	0	3	1
KANGRA	35	0.03	0.42	0.04	3.37	6 17.14%	0	0	27 77.14%	2 5.71%	0	6	29
KULLU	3	0.04	0.04	0.82	0.82	1 33.33%	0	0	1 33.33%	0	0	1	1
MANDI	7	0.14	0.14	0.10	0.51	1 14.29%	0	0	6 85.71%	0	0	1	6
SIRMAUR	12	-	-	0.09	1.54	0	0	0	11 91.67%	0	0	0	11
SOLAN	9	0.08	0.85	0.09	2.93	4 44.44%	0	0	4 44.44%	1 11.11%	0	4	5
UNA	29	-	-	0.01	1.95	0	0	0	29 100.00%	0	0	0	29
Total	99	0.14	0.04	0.01	3.37	15	0	0	79	3	0	15	82

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3.4 Decadal Fluctuations

The decadal variations were analyzed considering the decadal average of water level and the water level for the respective period.

3.4.1 Decadal average of May (2010-2019) to May 2020

Decadal water level fluctuation has been worked out by comparing water level data of May 2020 with the average mean of 10 years water level data of May (2010-2019) and is presented in Annexure-IV and frequency distribution in various ranges is presented in Table -13.

A perusal of Table-13 shows that out of 82 stations analysed, 64 stations (78.04%) have shown rise and 18 stations (21.95%), have shown fall in water level. 48 stations (75.00%) are showing rise in water level between 0 to 2m, 13 stations (20.31%) between 2 to 4m. and 3 stations (4.68%), more than 4m.

Out of 18 stations, 13 stations (72.22%) show fall in water level between 0 to 2m, 3 stations (16.66 %) between 2 to 4 m and 2stations (11.11%) more than 4m.

A minimum rise in water level of 0.01 m was noticed in kangra districts and the maximum rise of 10.23m is noticed in Kangra district. Similarly, the minimum and maximum fall of 0.01 m is noticed in Una district & maximum fall of 5.70 m is noticed in Kangra district.

A perusal of map of Decadal Variation - Average of May (2010 - 2019) with May 2020 reveals fall less than 2m, in all the valleys of Kullu district ,Mandi district & Una district except at some places in Indaura valley, Balh valley & Kangra-Palampur valley and Nurpur valley, which is showing rise. A fall is 2-4m and >4 m is shwon in Nurpur valley,central part of Kullu valley.

Table-13: District wise number & % NHS distribution in different Decadal W/L Fluctuation Range (May (2010-2019) to May 2020

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2010 May - 2019 May) - 2020/May

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.03	3.29	-	-	3 75.00 %	1 25.00%	0	0	0	0	4	0
KANGRA	36	0.01	10.32	0.07	5.70	22 61.11 %	4 11.11%	2 5.56%	6 16.67%	1 2.78 %	1 2.78%	28	8
KULLU	3	0.23	0.23	0.40	3.04	1 33.33 %	0	0	1 33.33%	1 33.33 %	0	1	2
MANDI	8	0.12	1.16	0.40	5.48	5 62.50 %	0	0	2 25.00%	0	1 12.50%	5	3
UNA	31	0.15	6.04	0.01	3.17	17 54.84 %	8 25.81%	1 3.23%	4 12.90%	1 3.23 %	0	26	5
Total	82	0.23	0.23	0.00	5.70	48	13	3	13	3	2	64	18

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3.4.2 Decadal Average of August (2010 - 2019) to August 2020

Decadal water level fluctuation has been worked out by comparing water level data of August 2020 with the average 10 years water level data of August (2010-2019) and is presented in Annexure - IV and frequency distribution in various ranges is presented in Table -14.

A perusal of Table-14 shows that out of 109 stations analyzed, 61 stations (55.96%) have shown rise and 48 stations (44.03%), have shown fall in water level. 48 stations (78.68%) are showing rise in water level between 0 to 2m, 9 stations (14.75%) between 2 to 4m. and 4 stations (6.55%), more than 4m.

Out of 48 stations, 39 stations (81.25%) show fall in water level between 0 to 2m, 4 stations (8.33%) between 2 to 4 m and 5 stations (10.41%) more than 4m.

A minimum rise in water level of 0.01 m was noticed in Mandi district and the maximum rise of 8.35 m is noticed in Sirmaur district. Similarly, the minimum and maximum fall of 0.01 m is noticed in Kangra district & maximum fall of 9.30 m is also noticed in Una district.

A perusal of map Decadal Average of August (2010 - 2019) to August 2020 shows fall in water level in Nurpur and Nalagarh valley except central part of Sirmaur district complete Nalagargh valley of Solan district, central part of Una valley of Una district, some part of Balh valley of Mandi district and north central part of Kangra Palampur valley of Kangra district. Fall in water level, >4 m is shown in Una valley and couple of pockets of Kangra-Palampur valley. Similarly rise in water level is noticed in Balh valley of Mandi district, Southern part of Una valley in Una district part of Kangra valley of Kangra district.

Table-14: Decadal Fluctuation August (2010-2019) to August 2020

2.1

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2010 Aug - 2019 Aug) - 2020/Aug

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells/Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min.	Max	Min.	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.36	6.22	0.20	0.25	1 25.00 %	0	1 25.00%	2 50.00%	0	0	2	2
KANGRA	37	0.09	3.06	0.01	2.48	19 51.35 %	1 2.70%	0	16 43.24%	1 2.70 %	0	20	17
KULLU	3	0.46	0.46	0.50	4.66	1 33.33 %	0	0	1 33.33%	0	1 33.33%	1	2
MANDI	8	0.01	3.33	0.03	0.88	4 50.00 %	1 12.50%	0	3 37.50%	0	0	5	3
SIRMAUR	12	0.40	8.35	0.40	2.49	2 16.67 %	1 8.33%	1 8.33%	6 50.00%	2 16.67 %	0	4	8
SOLAN	13	0.63	3.99	0.11	6.81	3 23.08 %	4 30.77%	0	4 30.77%	0	2 15.38%	7	6
UNA	32	0.04	5.94	0.10	9.30	18 56.25 %	2 6.25%	2 6.25%	7 21.88%	1 3.13 %	2 6.25%	22	10
Total	109	0.46	0.63	0.01	9.30	48	9	4	39	4	5	61	48

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3.4.3 Decadal average of November (2010-2019) to November 2020

Decadal water level fluctuation has been worked out by comparing water level data of November 2020 with the average water level data of November for 10 years (2010-2019) and is presented in Annexure - IV and frequency distribution in various ranges in Table 15.

A perusal of Table-15 shows that out of 103 stations analyzed, 36 stations (34.95%) have shown rise and 67 stations (65.04%), have shown fall in water level. 32 stations (88.88%) are showing rise in water level between 0 to 2m, 2stations (5.55 %) between 2 to 4m. and 2 stations (5.55%), more than 4m.

Out of 67 stations, 61 stations (91.04%) show fall in water level between 0 to 2m, 5 stations (7.46%) between 2 to 4 m and 1 stations (1.49 %) more than 4m.

A minimum rise in water level of 0.01 m was noticed in Mandi district and the maximum rise of 5.25 m is noticed in Una district. Similarly, the minimum and maximum fall of 0.01 m is noticed in Una district & maximum fall of 7.84 m is also noticed in Una district.

A perusal of map of Decadal average of November (2010-2019) to November 2020 reveals fall in water level less than 2m is shown in whole part of Kangra - Palampur valley & Indaura valley of Kangra district, major part of Nalagarh valley, Balh valley, a couple of places in Paonta valley. The

fall between 2 to 4 m was noticed in, Una valley, eastern part of Indaura Valley, Balh valley and Paonta valley. Similarly, rise is noticed in all the valleys from 0-2 m and 2- 4m except in major part of Una valley.

Table-15: Decadal Fluctuation November (2010-2019) to November 2020

2.1

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2010 Nov - 2019 Nov) - 2020/Nov

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.26	0.26	0.20	0.61	1 25.00 %	0	0	3 75.00%	0	0	1	3
KANGRA	36	0.12	2.36	0.00	2.42	8 22.22 %	1 2.78%	0	26 72.22%	1 2.78 %	0	9	27
KULLU	2	0.20	0.20	0.92	0.92	1 50.00 %	0	0	1 50.00%	0	0	1	1
MANDI	8	0.01	1.43	0.58	0.97	4 50.00 %	0	0	4 50.00%	0	0	4	4
SIRMAUR	12	0.12	4.06	0.13	3.96	2 16.67 %	0	1 8.33%	7 58.33%	2 16.67 %	0	3	9
SOLAN	11	0.48	3.73	0.10	3.27	3 27.27 %	1 9.09%	0	6 54.55%	1 9.09 %	0	4	7
UNA	30	0.03	5.25	0.01	7.84	13 43.33 %	0	1 3.33%	14 46.67%	1 3.33 %	1 3.33%	14	16
Total	103	0.20	0.48	0.00	7.84	32	2	2	61	5	1	36	67

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3.4.4 Decadal average of January (2011-2020) to January 2021

Decadal water level fluctuation has been worked out by comparing water level data of January 2021 with the average water level data of January for 10 years (2011-2020) and is presented in Annexure - IV and frequency distribution in various ranges is presented in Table -15.

A perusal of Table-15 shows that out of 103 stations analysed, 49stations (47.75 %) have shown rise and 11 stations (10.67%), have shown fall in water level. 41 stations (83.67%) are showing rise in water level between 0 to 2m, 6 stations (12.24%) between 2 to 4m. and 2 stations (4.08%), more than 4m. Out of 54 stations, 48 stations (88.88%) show fall in water level between 0 to 2m, 5 stations (5.24%) between 2 to 4 m and 1 stations (1.85%) more than 4m.

A minimum rise in water level of 0.04 m was noticed in Kangra district and the maximum rise of 4.76 m is noticed in Kullu district. Similarly, the minimum and maximum fall of 0.01 m is noticed in Mandi district & maximum fall of 10.45 m is noticed in Sirmaur district.

A perusal of map of Decadal average of January (2011-2020) to January 2021 reveals fall in water level less than 2m. is shown in central part of Kangra - Palampur valley & at small areas of Indaura valley of Kangra district, Balh valley, Una valley, Paonta valley and major part of Nalagarh valley. The fall between 2 to 4 m and >4 m was noticed in few places of Kangra Palampur valley and Nalagargh valley. Similarly, rise is noticed in all the valleys from 0-2 m and 2- 4m except in major part of Nallagah valley and Kangra Palampur valley.

Table –15: Decadal Fluctuation January (2011-2020) to January 2021

2.1

District Wise - Fluctuation of Water Level with Mean and Selected Period

10 Years Mean (2011 Jan - 2020 Jan) - 2021/Jan

State : Himachal Pradesh

District Name	No. of Wells	Range of Fluctuation				No. of Wells /Percentage Showing Fluctuation						Total No. of Wells	
		Rise (m)		Fall (m)		Rise (m)			Fall (m)			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
HAMIRPUR	4	0.14	1.61	-	-	4 100.00 %	0	0	0	0	0	4	0
KANGRA	35	0.04	2.74	0.02	2.22	12 34.29 %	2 5.71%	0	19 54.29%	2 5.71 %	0	14	21
KULLU	3	0.23	4.76	0.58	0.58	1 33.33 %	0	1 33.33%	1 33.33%	0	0	2	1
MANDI	7	0.05	1.59	0.01	0.59	2 28.57 %	0	0	5 71.43%	0	0	2	5
SIRMAUR	13	0.07	2.40	0.05	10.45	2 15.38 %	1 7.69%	0	8 61.54%	1 7.69 %	1 7.69%	3	10
SOLAN	10	0.40	2.36	0.07	3.91	3 30.00 %	1 10.00%	0	5 50.00%	1 10.00 %	0	4	6
UNA	31	0.07	4.45	0.04	4.00	17 54.84 %	2 6.45%	1 3.23%	10 32.26%	1 3.23 %	0	20	11
Total	103	1.59	0.40	0.00	10.45	41	6	2	48	5	1	49	54

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Annexure-I

Depth to water level of May 2020, August2020, Nov 2020& Jan 2021

State	Himachal Pradesh				
District	HAMIRPUR	Dtw May 2020	Dtw Aug 2020	Dtw Nov 2020	Dtw Jan 2021
1	Bagnalla	4.84	3.85	5.10	4.63
2	Bijari	3.19	1.66	2.41	1.84
3	Galore	2.27	1.68	2.96	2.27

4	Kangu	6.39	NA	6.14	5.72
District	**KANGRA**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
5	Indaura	2.86	1.90	2.56	2.72
6	Bandh	2.41	-0.47	1.47	2.11
7	Barota	6.72	4.56	5.12	7.39
8	Basa Bazira	8.50	6.80	8.50	8.41
9	Bhalad	2.26	0.35	2.54	1.81
10	Bhali	5.77	1.15	2.98	1.61
11	Bharmar	11.33	7.40	10.66	12.06
12	Bharoli	6.82	5.33	6.36	7.30
13	Bod	3.29	0.75	5.06	5.24
14	Chakban Ambari	4.55	2.75	4.06	4.08
15	Channaur	2.59	2.05	2.25	2.40
16	Darkati	3.13	0.65	2.39	2.00
17	Dehra Gopipur	4.62	2.74	4.02	4.47
18	Dehrian	1.56	1.10	1.47	1.58
19	Hardogri	4.43	3.33	3.91	4.08
20	Jagir	2.84	2.11	3.24	3.04
21	Jassur	3.19	2.17	2.51	2.67
22	Jwalaji	2.07	0.40	1.99	1.89
23	Kangra	12.62	3.37	8.03	8.22
24	Kathgarh	3.99	3.46	3.96	3.88
25	Kotla	2.29	-0.21	2.44	2.36
26	Manjgram	1.31	0.44	1.69	1.39
27	Mao	1.79	0.50	1.86	1.06
28	Mohtli	13.46	2.60	3.16	3.86
29	Nagrota Bagwan	NA	6.85	NA	NA
30	Old Kangra	3.71	0.52	4.05	3.48
31	Olherian	2.95	3.04	3.14	3.02
32	Pandtehr	0.76	0.36	0.50	0.64
33	Panjpir	4.23	1.50	3.52	3.19
34	Paprola	12.81	3.95	10.57	14.01
35	Rait	9.11	3.73	8.29	9.29
36	Raja-ka-talab	4.48	1.40	1.92	2.04
37	Rakar	2.68	3.42	2.91	3.01
38	Riali	4.13	2.18	4.09	4.24
39	Takipur	4.26	1.40	3.54	4.66
40	Thali	4.17	2.35	2.99	2.67
41	Thirtynine Mile	8.43	5.27	8.11	8.25
42	Bhatka	1.81	0.78	0.97	1.11
43	Parnalla	4.22	1.51	2.49	2.60
44	Lakhnaut	2.32	0.88	1.81	1.92
45	Ladhi	NA	NA	NA	NA
46	Naura	1.55	0.63	1.18	1.24
47	Changara	2.23	0.82	1.63	2.24
48	Barot	3.77	1.20	4.41	2.33
49	Kuth khana	8.73	7.98	8.89	9.51
50	Nagrota Gurudwara	NA	NA	NA	NA
District	**Kullu**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
51	Gadauri	6.34	6.34	6.75	7.01
52	Hathithan	Dry	Dry	Dry	Dry

53	Kullu	0.54	0.40	0.89	0.78
District	**MANDI**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
54	Bahangrotu	5.46	0.93	3.99	4.11
55	Gagal	2.33	1.71	2.69	2.27
56	GUTKAR	Dry	2.70	6.21	0.44
57	Jarl	0.30	0.32	0.41	4.40
58	Jhiri	4.35	3.96	4.57	0.94
59	Kaned	0.87	0.08	0.92	3.48
60	Lohara	3.45	3.10	3.35	4.68
61	Ratti	4.54	3.40	4.56	4.11
62	Dinak	5.55	1.11	3.12	3.24
District	**SIRMAUR**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
63	Ajiwala	NA	1.17	5.22	5.96
64	Akkawala	NA	10.06	11.21	11.28
65	Badripur	NA	8.95	11.59	12.76
66	Dhaulakuan	NA	3.84	3.56	6.56
67	Kala-Amb	NA	13.15	13.24	13.97
68	Khodawala	NA	2.43	15.04	15.69
69	Kiyarda	NA	2.78	7.17	9.72
70	Kolar	NA	2.93	9.57	12.41
71	Nayagaon	NA	4.12	9.69	12.42
72	Shambuwala	NA	7.32	9.81	10.58
73	Shibpur	NA	19.14	26.74	27.53
74	Trilokpur	NA	1.43	1.61	1.76
75	Miserwala	NA	1.93	4.84	6.88
76	Sainwala I	NA	0.99	3.71	3.83
77	Kodewala	NA	2.43	2.61	2.54
78	Kheri	NA	1.84	2.51	2.15
79	Sainwala II	NA	1.26	1.89	2.62
District	**SOLAN**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
80	Baddi	NA	4.25	5.69	5.92
81	Barotiwala	NA	19.11	19.41	19.79
82	Baruna	NA	28.92	29.02	14.10
83	Bhagheri	NA	13.32	12.34	12.12
84	BHATOLI	NA	11.37	10.82	12.31
85	Dhabota	NA	12.08	12.14	14.08
86	Jagatpur	NA	10.70	12.34	29.29
87	Jharmajri	NA	13.62	NA	NA
88	Khera-chak	NA	3.82	7.53	5.73
89	Mahadev	NA	8.87	11.81	11.21
90	Manjhauli	NA	7.00	5.16	NA
91	Panjahra	NA	18.51	18.68	19.36
92	Phalahi	NA	4.35	5.17	5.43
93	Maganpura	NA	Dry	Dry	Dry
94	Theda	NA	1.65	2.99	3.28
95	Nalagarh	NA	3.25	4.6	4.36
District	**Una**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
96	Amb	4.72	3.29	4.08	4.71

97	Ambota	27.48	27.42	27.59	27.29
98	Babehr	1.88	1.13	2.08	2.32
99	Bawal	1.19	0.94	1.22	1.14
100	Bhadsali	12.24	12.26	12.48	12.56
101	Bhangana	1.63	0.48	1.15	1.42
102	Daulatpur	5.90	4.97	5.61	6.13
103	Dharampur	2.26	1.86	2.18	2.24
104	Gagret	5.78	5.32	6.12	6.69
105	Ghaneri	7.49	6.04	7.41	8.33
106	Guglahar	3.04	1.70	2.99	3.18
107	Ishapur	1.91	1.19	1.99	2.08
108	Jankaur	4.31	2.57	4.68	4.11
109	Jawar	4.57	1.05	1.56	1.12
110	Jhalera	4.38	3.15	4.13	4.56
111	Khanpur	4.44	3.42	5.74	4.35
112	Khwaja	2.23	0.82	2.16	2.17
113	Kaluwal	NA	9.20	NA	NA
114	Kuthera Jaswala	6.03	4.22	5.89	5.68
115	Lalehri	11.23	8.90	10.67	11.49
116	Loharli	3.37	1.48	3.38	4.22
117	Mawa Kalan	14.99	13.34	14.82	15.52
118	Mubarikpur	3.22	2.54	3.08	3.48
119	Nangran	4.83	3.91	5.46	5.06
120	Panjawar	11.22	11.15	10.59	11.03
121	Panoh	2.25	0.83	2.62	2.59
122	Raipur Marwadi	11.88	10.55	11.00	12.07
123	Rajli Panjal	2.49	0.11	2.44	2.46
124	Santokhgarh	5.42	3.76	6.24	5.22
125	Singhnei	19.43	19.35	18.76	19.05
126	Tahliwala 1	1.16	0.44	1.96	1.27
127	Una	2.21	0.60	2.03	2.21
District	**Chamba**	**Dtw May 2020**	**Dtw Aug 2020**	**Dtw Nov 2020**	**Dtw Jan 2021**
128	Upper Thulel	3.68	1.02	2.88	3.83

Annexure-II

Monsoonal Fluctuation of - Pre and post for 2020

State	**Himachal Pradesh**	
District	**HAMIRPUR**	**Monsoon fl (may20-Nov20**
1	Bagnalla	-0.26
2	Bijari	0.78

3	Galore	-0.69
4	Kangu	0.25
District	**KANGRA**	
5	Indaura	0.30
6	Bandh	0.94
7	Barota	1.60
8	Basa Bazira	0.00
9	Bhalad	-0.28
10	Bhali	2.79
11	Bharmar	0.67
12	Bharoli	0.46
13	Bod	-1.77
14	Chakban Ambari	0.49
15	Channaur	0.34
16	Darkati	0.74
17	Dehra Gopipur	0.60
18	Dehrian	0.09
19	Hardogri	0.52
20	Jagir	-0.40
21	Jassur	0.68
22	Jwalaji	0.08
23	Kangra	4.59
24	Kathgarh	0.03
25	Kotla	-0.15
26	Manjgram	-0.38
27	Mao	-0.07
28	Mohtli	10.30
29	Nagrota	NA
30	Old Kangra	
31	Olherian	-0.19
32	Pandtehr	0.26
33	Panjpir	0.71
34	Paprola	2.24
35	Rait	0.82
36	Raja-ka-talab	2.56
37	Rakar	-0.23
38	Riali	0.04
39	Takipur	0.72
40	Thali	1.18
41	Thirtynine Mile	0.32
District	**KULLU**	
42	Gadauri	-0.41
43	Hathithan	Dry

44	Kullu	-0.35
District	**MANDI**	
45	Bahangrotu	1.47
46	Gagal	-0.36
47	GUTKAR	5.79
48	Jarl	-0.11
49	Jhiri	-0.22
50	Kaned	-0.05
51	Lohara	0.10
52	Ratti	-0.02
District	**SIRMAUR**	
53	Ajiwala	5.22
54	Akkawala	11.21
55	Badripur	11.59
56	Dhaulakuan	3.56
57	Kala-Amb	13.24
58	Khodawala	15.04
59	Kiyarda	7.17
60	Kolar	9.57
61	Nayagaon	9.69
62	Shambuwala	9.81
63	Shibpur	26.74
64	Trilokpur	1.61
District	**SOLAN**	
65	Baddi	5.69
66	Barotiwala	19.41
67	Barun	29.02
68	Bhagheri	12.34
69	Bhatoli	10.82
70	Dhabota	12.14
71	Jagatpur	12.34
72	Jharmajri	NA
73	Khera-chak	7.53
74	Mahadev	11.81
75	Manjhauli	5.16
76	Panjahra	18.68
77	Phalahi	5.17
District	**UNA**	
78	Amb	0.64
79	Ambota	-0.11
80	Babehr	-0.20
81	Bawal	-0.03
82	Bhadsali	-0.24
83	Bhangana	0.48

84	Daulatpur	0.29
85	Dharampur	0.08
86	Gagret	-0.34
87	Ghaneri	0.08
88	Guglahar	0.05
89	Ishapur	-0.08
90	Jankaur	-0.37
91	Jawar	3.01
92	Jhalera	0.25
93	Khanpur	-1.30
94	Khwaja	0.07
95	Kuluwal	NA
96	Kuthera Jaswala	0.14
97	Lalehri	0.56
98	Loharli	-0.01
99	Mawa Kalan	0.17
100	Mubarikpur	0.14
101	Nangran	-0.63
102	Panjawar	0.63
103	Panoh	-0.37
104	Raipur Marwadi	NA
105	Rajli Panjal	0.05
106	Santokhgarh	-0.82
107	Singhnei	0.67
108	Tahliwala 1	-0.80
109	Una	0.18

- data not available

Annexure-III

Annual Fluctuation of May 2019- May 2020, August 2019- August 2020 November 2019- November 2020 and January 2020- January 2021

State	**Himachal Pradesh**				
District	**HAMIRPUR**	**Annual fl may (19-20)**	**Annual fl Aug (19-20)**	**Annual fl Nov (19-20)**	**Annual fl Jan (20-21)**
1	Bagnalla	0.25	-0.79	-1.52	-0.87

2	Bijari	-1.23	0.01	-0.58	0.09
3	Galore	0.43	-0.12	-0.74	0.04
4	Kangu	1.00	5.71	-0.72	0.01
District	**KANGRA**	**Annual fl may (19-20)**	**Annual fl Aug (19-20)**	**Annual fl Nov (19-20)**	**Annual fl Jan (20-21)**
5	Andaura	-0.06	0.04	-0.31	-0.46
6	Bandh	-0.74	0.66	-0.36	-1.31
7	Barota	-0.98	-1.51	-0.73	-2.02
8	Basa Bazira		1.16	-0.25	0.09
9	Bhalad	-0.28	-0.12	-1.90	-1.42
10	Bhali	-3.92	0.42	-1.47	0.42
11	Bharmar	0.13	-1.07	-1.88	-3.37
12	Bharoli	0.21	-2.02	-0.85	-1.07
13	Bod	-0.70	0.32	-2.69	
14	Chakban Ambari	0.32	0.34	-0.03	-0.09
15	Channaur	-0.07	0.10	-0.06	-0.27
16	Darkati	-1.06	0.53	-1.37	-0.44
17	Dehra Gopipur	-0.30	-0.47	-1.24	-0.81
18	Dehrian	0.00	-0.17	-0.14	-0.19
19	Hardogri	-0.10	-2.01	-1.06	-0.44
20	Jagir	0.25	0.43	-0.62	-0.24
21	Jassur	-0.07	0.64	-0.03	-0.74
22	Jwalaji	2.59	-0.11	-0.39	-0.37
23	Kangra	-1.70	2.88	0.08	0.36
24	Kathgarh	-0.21	-0.14	-0.27	-0.34
25	Kotla	0.09	0.62	-0.74	-0.42
26	Manjgram	-0.39	-0.06	-0.20	-0.40
27	Mao	0.44	0.16	-0.85	-0.15
28	Mohtli	-9.90	-0.24	0.00	-0.60
29	Nagrota		-6.85		
30	Old Kangra		0.71	-1.49	-0.04
31	Olherian	0.21	-0.48	-0.67	-0.86
32	Pandtehr	-0.14	-0.06	-0.02	-0.12
33	Panjpir	0.13	0.45	-0.09	-0.88
34	Paprola	-0.33	2.45	-0.26	-1.23
35	Rait	-0.17	1.13	-0.47	-1.00
36	Raja-ka-talab	-0.77	0.24	-0.04	0.03
37	Rakar	0.29	-2.76	-0.55	-0.97
38	Riali		0.40	-0.25	-0.27
39	Takipur	0.65	-0.77	-1.26	-1.92
40	Thali	-1.19	0.68	-0.45	0.20
41	Thirtynine Mile	0.11	-0.40	-0.91	0.41
District	**KULLU**	**Annual fl may**	**Annual fl Aug**	**Annual fl Nov**	**Annual fl Jan**

		(19-20)	(19-20)	(19-20)	(20-21)
42	Gadauri	0.15	-0.63	-0.69	-0.82
43	Hathithan	Dry	Dry	Dry	Dry
44	Kullu	0.31	0.36	0.28	0.04
District	**MANDI**	**Annual fl may (19-20)**	**Annual fl Aug (19-20)**	**Annual fl Nov (19-20)**	**Annual fl Jan (20-21)**
45	Bahangrotu	0.35	2.21	0.77	-0.36
46	Gagal	-0.35	0.00	-0.84	0.14
47	GUTKAR	-3.06	0.69	0.23	NA
48	Jarl	0.44	-0.02	-0.03	-0.10
49	Jhiri	-0.18	-1.12	-0.54	-0.40
50	Kaned	0.14	0.13	-0.02	-0.51
51	Lohara	0.09	-0.16	-0.17	-0.38
52	Ratti	-1.00	0.07	-0.22	-0.47
District	**SIRMAUR**	**Annual fl may (19-20)**	**Annual fl Aug (19-20)**	**Annual fl Nov (19-20)**	**Annual fl Jan (20-21)**
53	Ajiwala	NA	2.15	-0.48	-0.62
54	Akkawala	NA	0.21		-0.09
55	Badripur	NA	-1.30	-1.78	-0.78
56	Dhaulakuan	NA	-0.34	-0.06	-1.54
57	Kala-Amb	NA	-3.65	-0.55	-0.65
58	Khodawala	NA	8.88	-0.49	-0.10
59	Kiyarda	NA	0.05	-1.57	-0.42
60	Kolar	NA	-0.62	-1.19	-1.37
61	Nayagaon	NA	0.48	-0.47	-0.75
62	Shambuwala	NA	-0.71	-0.07	-0.99
63	Shibpur	NA	0.79	-1.08	0.00
64	Trilokpur	NA	-0.27	-0.02	-0.37
District	**SOLAN**	**Annual fl may (19-20)**	**Annual fl Aug (19-20)**	**Annual fl Nov (19-20)**	**Annual fl Jan (20-21)**
65	Baddi	NA	-1.72	-0.62	0.57
66	Barotiwala	NA	-0.47	-0.60	NA
67	Barun	NA	1.39	1.41	0.85
68	Bhagheri	NA	2.63	NA	-2.93
69	Bhatoli	NA	0.79	-0.07	NA
70	Dhabota	NA	-0.01	-0.09	-0.09
71	Jagatpur	NA	0.43	0.28	-0.75
72	Jharmajri	NA	-13.62	NA	NA
73	Khera-chak	NA	-0.20	-3.19	-1.05
74	Mahadev	NA	1.86	-0.50	0.28
76	Panjahra	NA	1.75	-0.06	0.08
77	Phalahi	NA	0.06	0.47	-0.38

District	UNA	Annual fl may (19-20)	Annual fl Aug (19-20)	Annual fl Nov (19-20)	Annual fl Jan (20-21)
78	Amb	0.24	-0.90	-1.62	-1.55
79	Ambota	1.24	1.17	-0.37	-0.28
80	Babehr	1.10	-0.06	-0.46	-1.26
81	Bawal	-0.12	-0.02	-0.21	-0.02
82	Bhadsali	0.97	0.18	-0.77	-0.58
83	Bhangana	0.12	0.03	-0.24	-0.61
84	Daulatpur	1.86	-0.41	-0.42	-0.84
85	Dharampur	0.28	2.85	-0.22	-0.39
86	Gagret	2.02	1.97	1.67	-0.38
87	Ghaneri	-1.41	-2.88	-1.54	-0.94
88	Guglahar	0.04	-0.29	-0.47	-0.89
89	Ishapur	0.19	-0.38	-0.57	-1.15
90	Jankaur		-0.33	-1.40	-0.85
91	Jawar	-2.79	-0.06	-0.55	-0.10
92	Jhalera	0.12	-0.69	-2.71	-0.84
93	Khanpur	0.14	-0.29	-1.97	
94	Khwaja	0.05	-0.08	-0.55	-1.12
95	Kuluwal	NA	-9.20	NA	NA
96	Kuthera Jaswala	0.33	-0.23	-0.46	-0.25
97	Lalehri	0.23	-2.33	-2.31	-1.74
98	Loharli	0.02	-0.40	-1.25	-1.70
99	Mawa Kalan	6.02	2.37	1.72	-0.01
100	Mubarikpur	0.81	-0.60	-0.49	-0.76
101	Nangran	0.44	-0.25	-1.15	
102	Panjawar	0.34	-0.27	0.75	-0.51
103	Panoh	0.12	-0.29	-1.06	-1.65
104	Raipur Marwadi	5.08	1.32		-1.32
105	Rajli Panjal	0.61	-0.03	-1.38	-1.95
106	Santokhgarh	-0.20	-1.47	-1.85	-0.70
107	Singhnei	1.07	0.42	-0.25	-0.36
108	Tahliwala 1	0.67	-0.01	-1.11	-0.82
109	Una	0.73	0.25	-0.26	-0.52

Annexure-IV

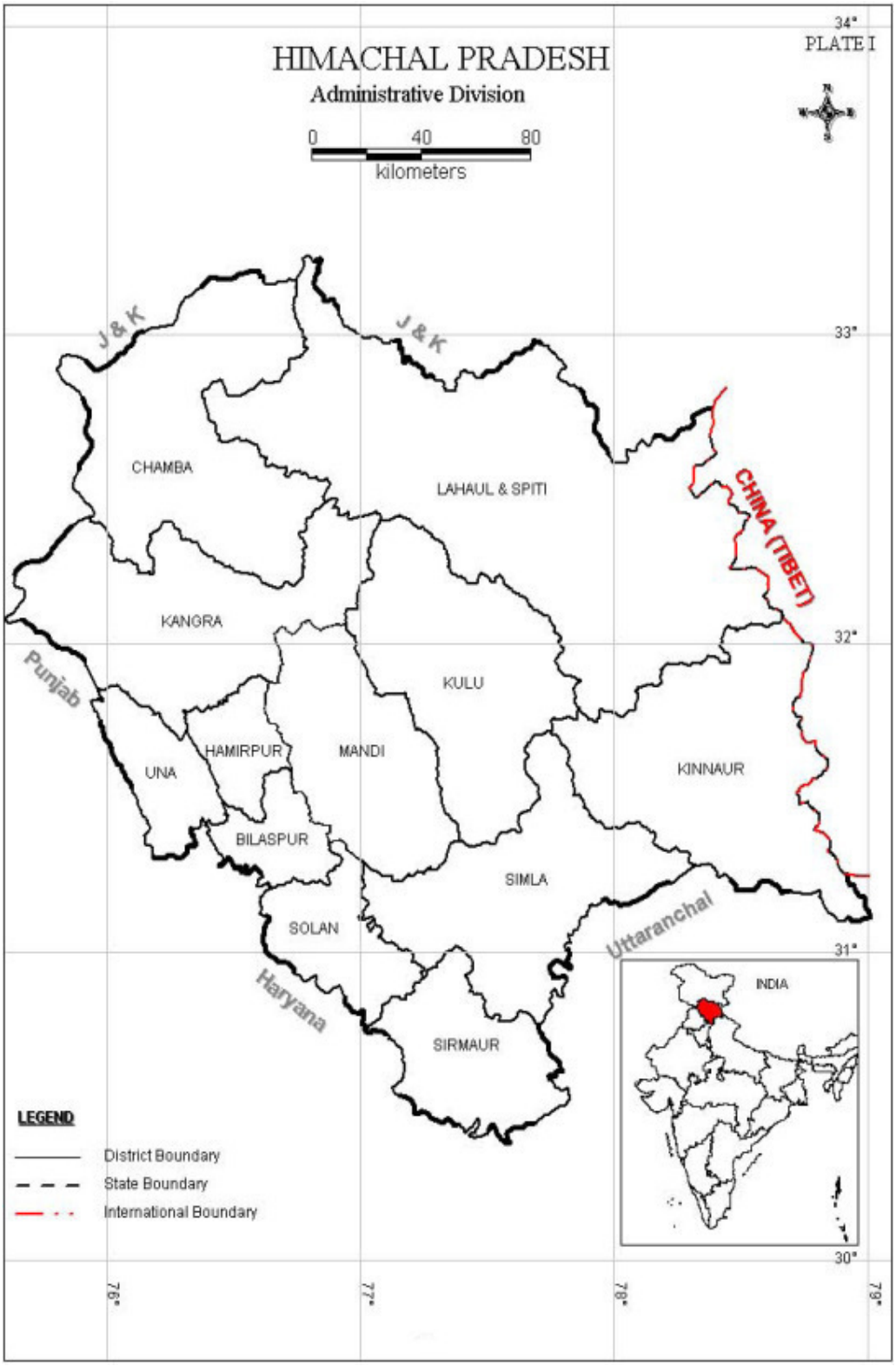
Decadal mean Fluctuation May (2010-2019 with May 2020), August (2010-2019 with Aug 2020) November (2010-2019 with Nov 2020) January 2011-2020 with Jan 2021)

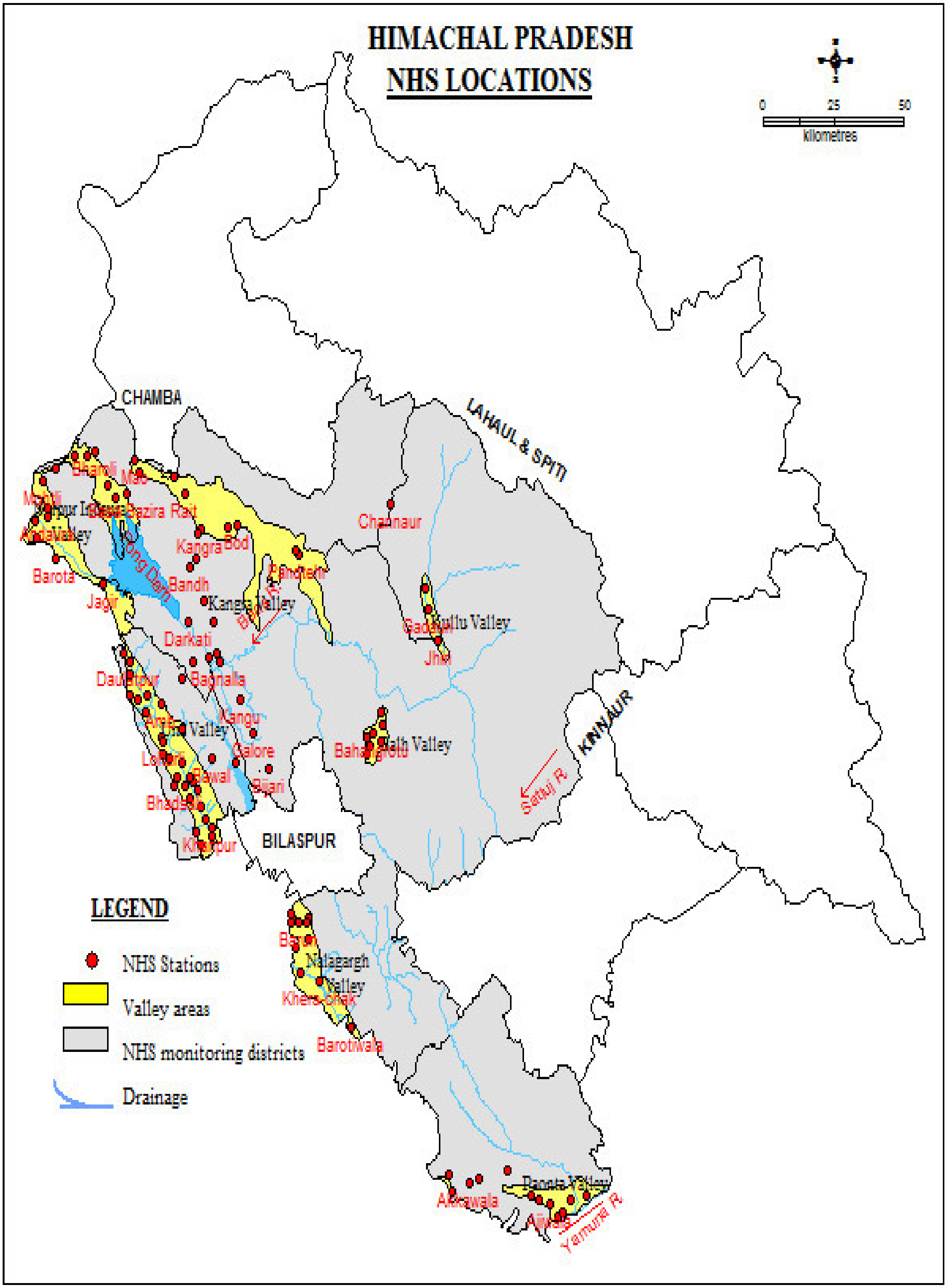
State	**Himachal Pradesh**				
District	**HAMIRPUR**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
1	Bagnalla	1.36	0.36	-0.2	0.57
2	Bijari	0.03	-0.25	-0.2	0.14
3	Galore	0.62	-0.2	-0.61	0.3
4	Kangu	3.29	6.22	0.26	1.61
District	**KANGRA**				
5	Andaura	1.49	0.9	0.77	0.88
6	Bandh	0.52	1.27	0.5	0.92
7	Barota	0.37	-1.41	-0.78	-2.19
8	Basa Bazira	-0.5	-0.29	-1.18	-0.02
9	Bhalad	0.93	-0.08	-1.31	-0.42
10	Bhali	-2.44	0.09	-1.3	0.53
11	Bharmar	2.72	-1.7	-1.66	-1.57
12	Bharoli	1.59	-1.62	-1.06	-0.86
13	Bod	0.35	0.21	-2.42	0
14	Chakban Ambari	0.47	0.54	0.18	0.34
15	Channaur	0.78	0.73	1.23	0.98
16	Darkati	-0.7	0.18	-1.06	-0.16
17	Dehra Gopipur	0.47	0.29	-0.52	-0.6
18	Dehrian	0.85	-0.02	0.12	0.22
19	Hardogri	0.11	-0.56	-1.04	-0.71
20	Jagir	0.41	0.19	-0.34	-0.09
21	Jassur	1.4	0.47	1.04	1.87
22	Jwalaji	2.29	0.24	-0.47	-0.27
23	Kangra	-0.66	1.13	0	2.13
24	Kathgarh	0.51	-0.64	-0.46	-0.26
25	Kotla	0.46	0.29	-0.9	0.04
26	Manjgram	0.01	-0.06	-0.65	-0.2
27	Mao	2.6	-0.02	-0.42	1.07
28	Mohtli	-5.7	3.06	2.36	2.74
29	Nagrota	10.32	-1.98	0	0.15
30	Old Kangra	0	1.39	-1.15	-0.24

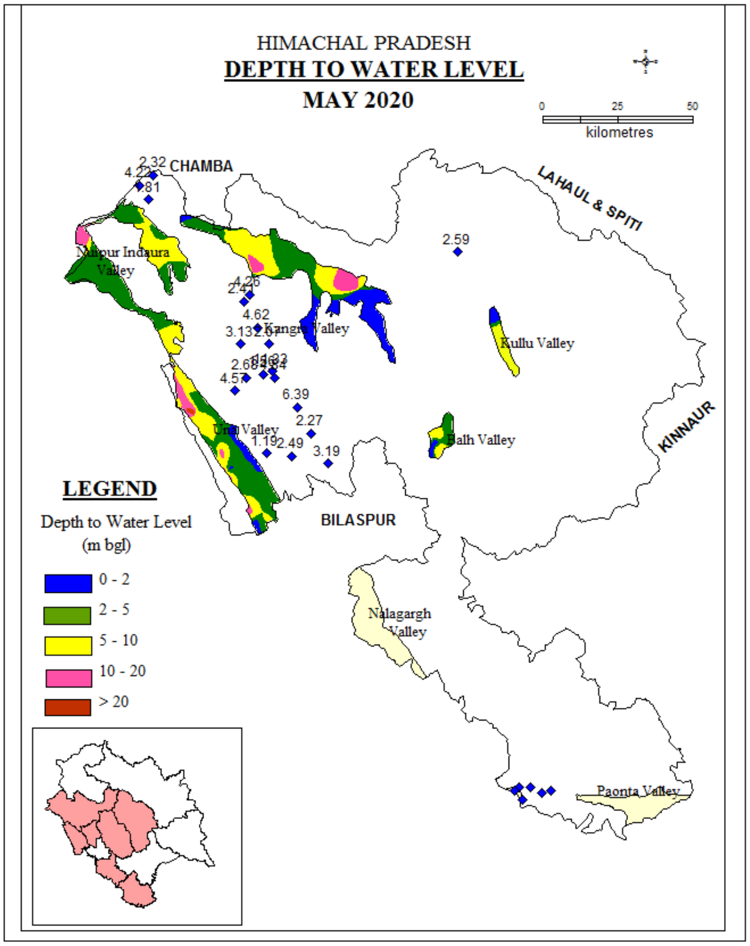
31	Olherian	0.78	-0.27	-0.48	-0.08
32	Pandtehr	0.08	-0.01	-0.02	0.44
33	Panjpir	0.4	0.25	0.16	0
34	Paprola	-0.07	0.57	-0.53	-2.22
35	Rait	0.84	0.31	-0.46	-0.43
36	Raja-ka-talab	-0.14	-0.22	0.65	1.43
37	Rakar	4.25	-2.48	-0.23	-0.05
38	Riali	0.08	0.54	-0.47	-0.47
39	Takipur	2.39	-0.86	-0.84	-0.53
40	Thali	-0.28	0.28	-0.47	-0.02
41	Thirtynine Mile	0.41	-1.07	-0.8	-0.07
District	**KULLU**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
41	Gadauri	-0.4	-0.5	-0.92	-0.58
42	Hathithan	0	0	0	0
43	Kullu	0.23	0.46	0.2	0.23
District	**MANDI**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
44	Bahangrotu	1.16	3.33	1.43	1.59
45	Gagal	-0.4	-0.22	-0.97	-0.22
46	GUTKAR	-5.48	0.45	-0.89	0
47	Jarl	0.29	0.01	0.01	-0.01
48	Jhiri	0.12	-0.88	-0.62	-0.25
49	Kaned	0.55	0.4	0.1	0.05
50	Lohara	0.37	0.01	0.1	-0.02
51	Ratti	-0.41	-0.03	-0.58	-0.59
District	**SIRMAUR**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
52	Ajiwala	NA	1.58	-0.64	-0.78
53	Akkawala	NA	-1.14	0.33	0.07
54	Badripur	NA	-2.16	-3.96	0.63
55	Dhaulakuan	NA	-0.65	0.12	-0.53
56	Kala-Amb	NA	-2.49	-0.18	-0.47
57	Khodawala	NA	8.35	-3.36	-2.23
58	Kiyarda	NA	-0.46	-1.65	-0.77
59	Kolar	NA	3.46	4.06	2.4
60	Nariwala	NA	NA	NA	10.45

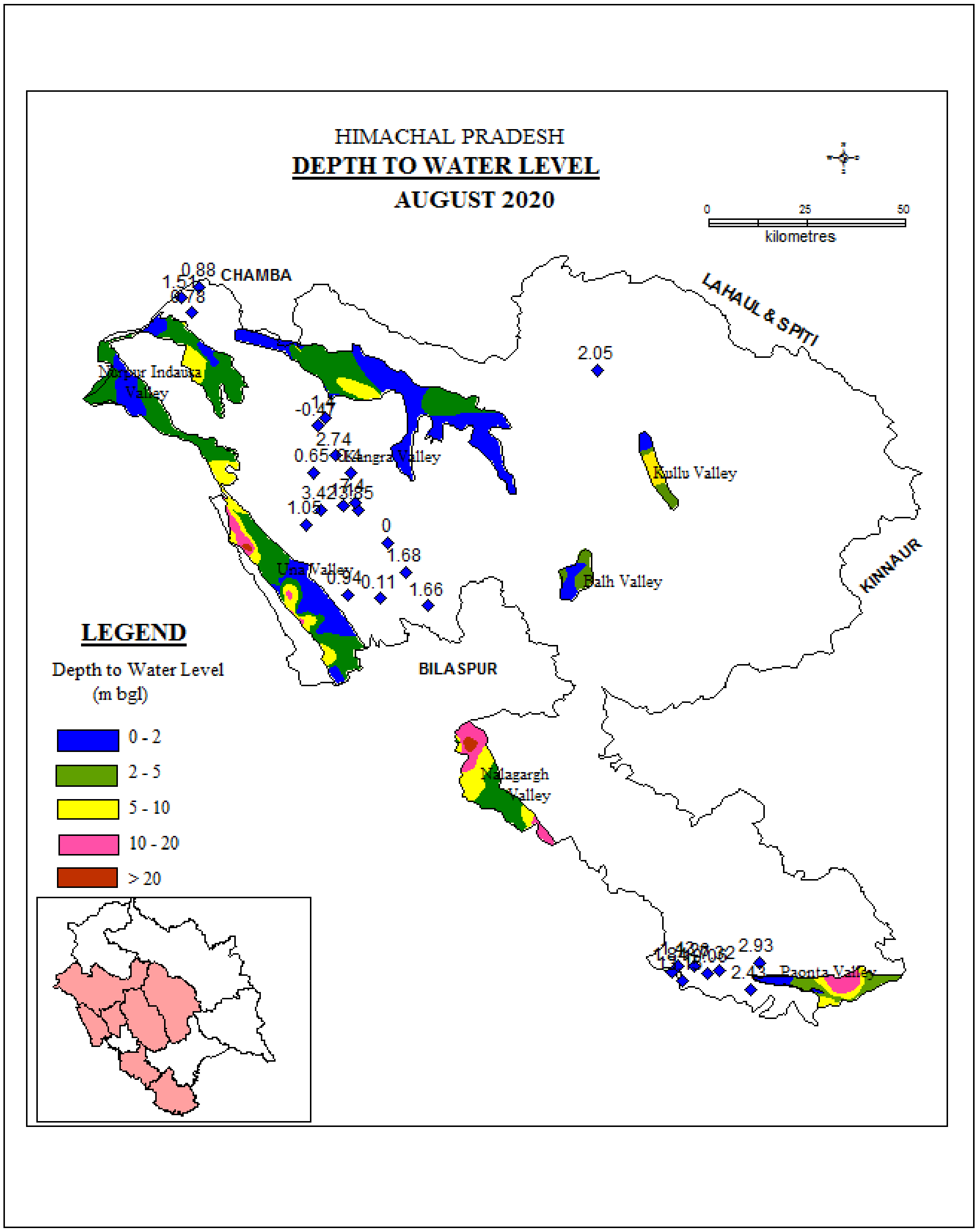
61	Nayagaon	NA	-0.45	-1.15	-1.02
62	Shambuwala	NA	-1.2	-1.44	-1.32
63	Shibpur	NA	0.4	-1.04	-0.18
64	Trilokpur	NA	-0.4	-0.13	-0.05
District	**SOLAN**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
64	Baddi	NA	-0.11	-1.56	-0.88
65	Barotiwala	NA	3.68	3.73	
66	Baruna	NA	0.63	-0.26	-3.91
67	Bhagheri	NA	3.28		0.4
68	Bhatoli	NA	-0.96	-0.3	-1.21
69	Dhabota	NA	-1.94	-0.1	-0.07
70	Jagatpur	NA	3.99	1.34	2.36
71	Jharmajri	NA	-6.81	0	0
72	Khera-chak	NA	-0.11	-3.27	-0.86
73	Mahadev	NA	0.96	-1.5	0.83
74	Manjhauli	NA	-4.33	-1.73	0
75	Panjahra	NA	2.56	1.19	1.63
76	Phalahi	NA	0.74	0.48	-0.29
District	**UNA**	**Decadal fl may(2010-2019)wrt May 20**	**Decadal fl Aug(2010-2019)wrt Aug20**	**Decadal fl Nov(2010-2019)wrt Nov20**	**Decadal fl Jan(2011-2020)wrt Jan21**
77	Amb	1.78	0.62	-0.01	-0.08
78	Ambota	-1.85	-9.3	-7.84	-4
79	Babehr	2.62	0.06	-0.06	0.42
80	Bawal	0.15	0.1	0.03	0.36
81	Bhadsali	3.01	2.24	1.1	2.04
82	Bhangana	0.66	0.2	0.78	-0.15
83	Daulatpur	2.55	1.97	1.18	1.04
84	Dharampur	1.31	1.55	0.33	0.39
85	Gagret	2.73	2.44	1.11	1.02
86	Ghaneri	0.79	-0.76	-0.88	-0.52
87	Guglahar	1.2	1	-0.03	0.36
88	Ishapur	1.36	0.75	0.23	0.2
88	Jankaur	-0.15	-0.81	-2.25	-1.29
89	Jawar	-3.17	-0.18	-0.62	-0.04
90	Jhalera	0.97	0.51	-0.03	0.13
91	Khanpur	0.53	0.08	-1.29	0.84
92	Khwaja	0.18	0.04	-0.5	-0.41
93	Kuluwal	NA	NA	NA	NA
94	Kuthera Jaswala	0.97	1.27	0.52	1.21

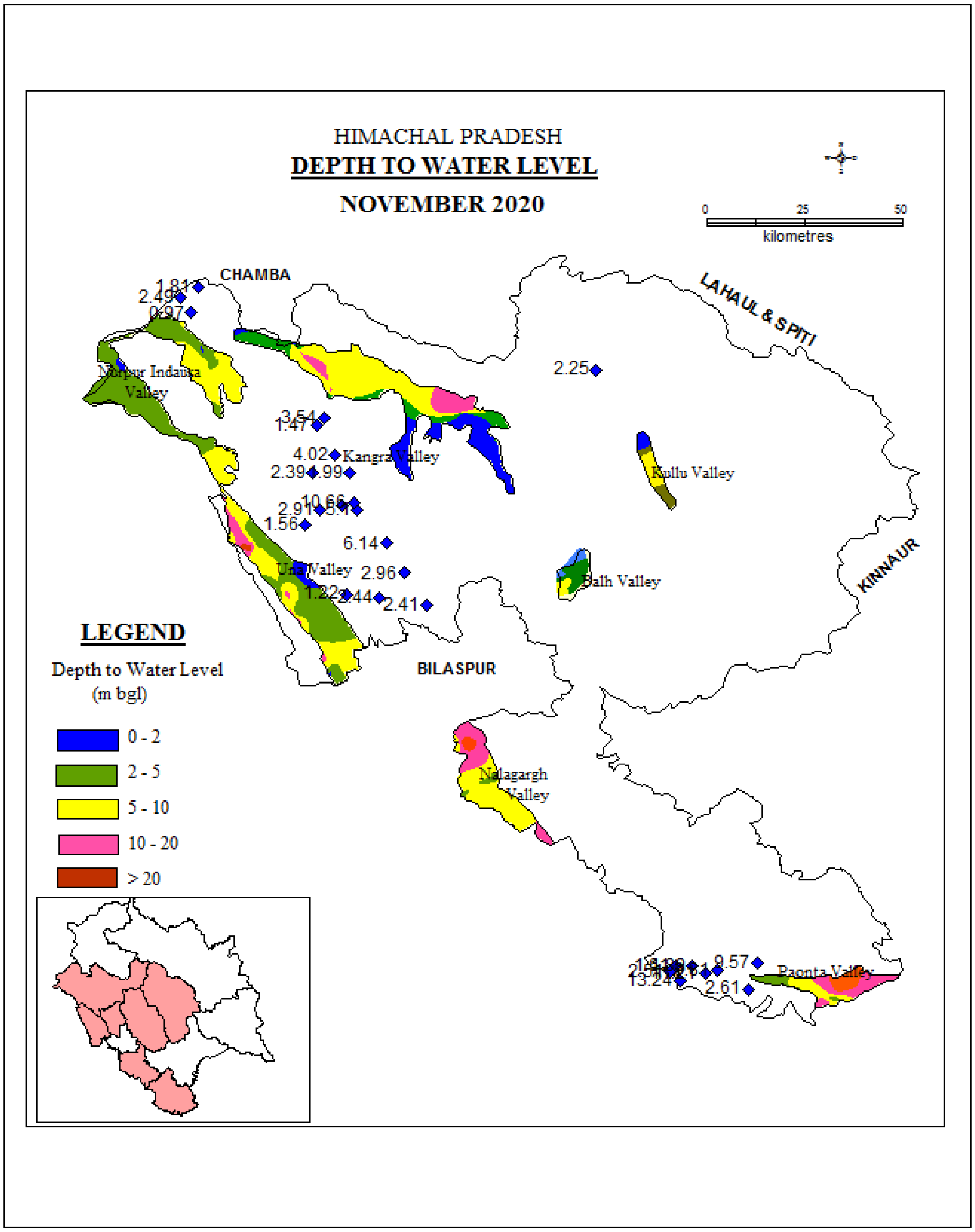
95	Lalehri	0.89	-0.22	-1.36	-0.75
96	Loharli	1.01	0.35	1.37	-0.69
97	Mawa Kalan	3.07	5.94	5.25	4.45
98	Mubarikpur	2.6	1.06	0.46	0.53
99	Nangran	0.56	0.37	-0.87	0.07
100	Panjawar	2	-0.75	1.89	1.7
101	Panoh	0.69	-0.1	-0.65	-0.48
102	Raipur Marwadi	6.04	5.09	0	3.35
103	Rajli Panjal	2.5	0.63	-0.83	0.13
104	Santokhgarh	-0.01	-0.1	-1.74	-0.33
105	Singhnei	-1.08	-2.23	1.58	1.65
106	Tahliwala 1	1.22	1.3	-0.72	0.11
107	Una	1.27	1.01	0.13	0.35

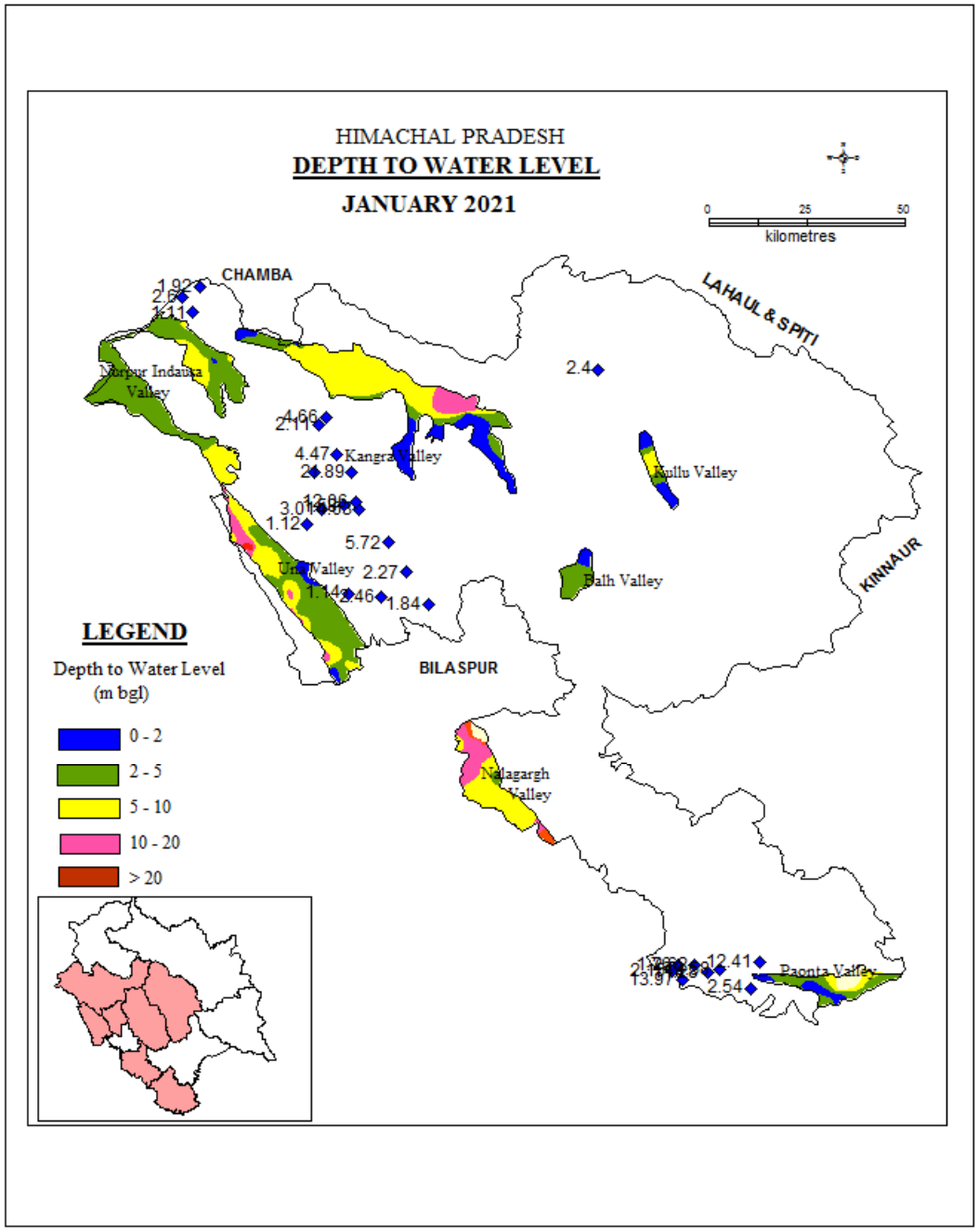

HIMACHAL PRADESH
Administrative Division
PLATE I
0 40 80
kilometers
34°
33°
32°
31°
30°
76°
77°
78°
79°
J & K
J & K
CHAMBA
LAHAUL & SPITI
CHINA (TIBET)
KANGRA
Punjab
KULU
HAMIRPUR
MANDI
UNA
KINNAUR
BILASPUR
SIMLA
SOLAN
Uttaranchal
Haryana
SIRMAUR
INDIA
LEGEND
District Boundary
State Boundary
International Boundary

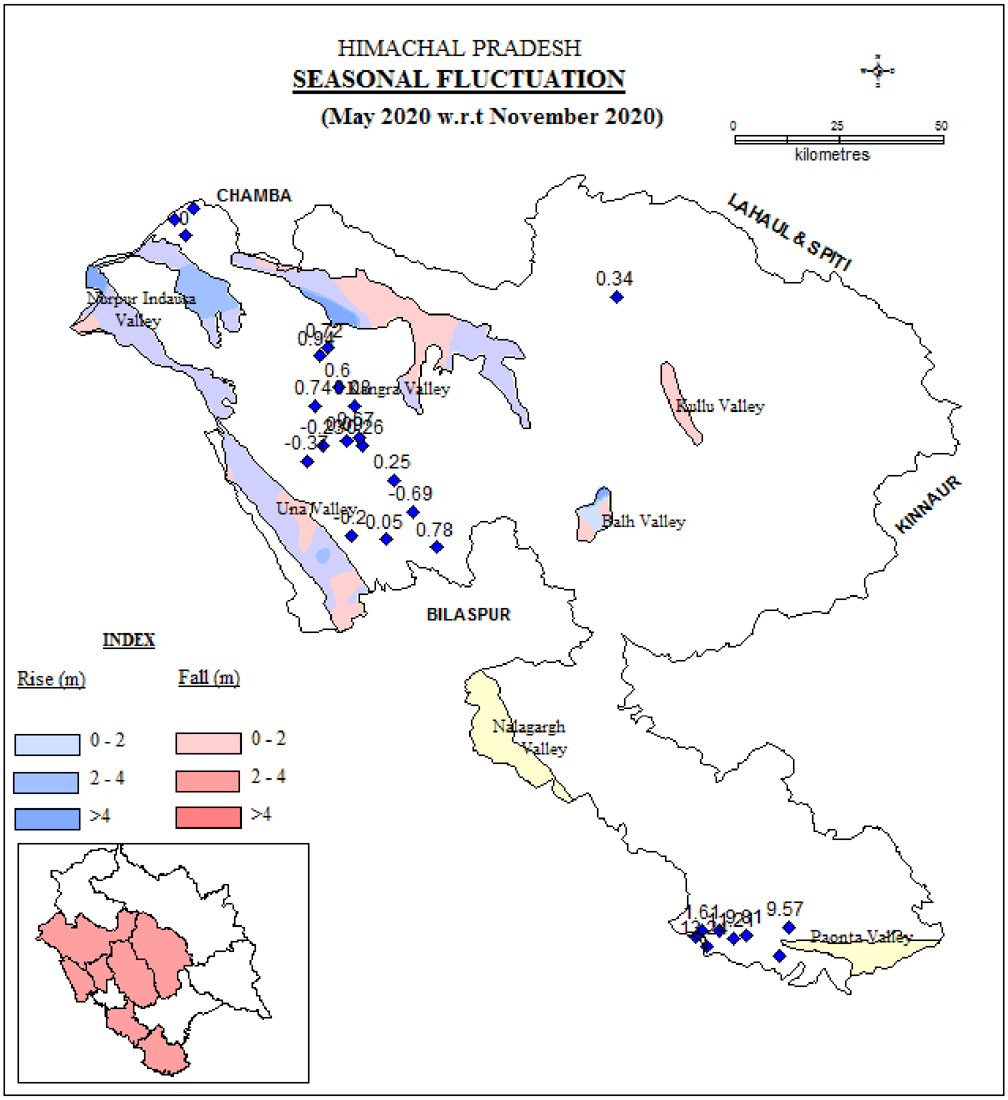

HIMACHAL PRADESH
NHS LOCATIONS
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Chamba
Bharoli
Barota
Jagir
Bandh
Kangra
Bod
Kangra Valley
Darkati
Bagnalla
Kangu
Galore
Bijari
Bawali
Bhadsali
Lohara
Daulatpur
Una Valley
Kullu Valley
Jhiri
Balh Valley
Satluj R.
Nalagargh Valley
Barotiwala
Akrawala
Paonta Valley
Yamuna R.
LEGEND
NHS Stations
Valley areas
NHS monitoring districts
Drainage

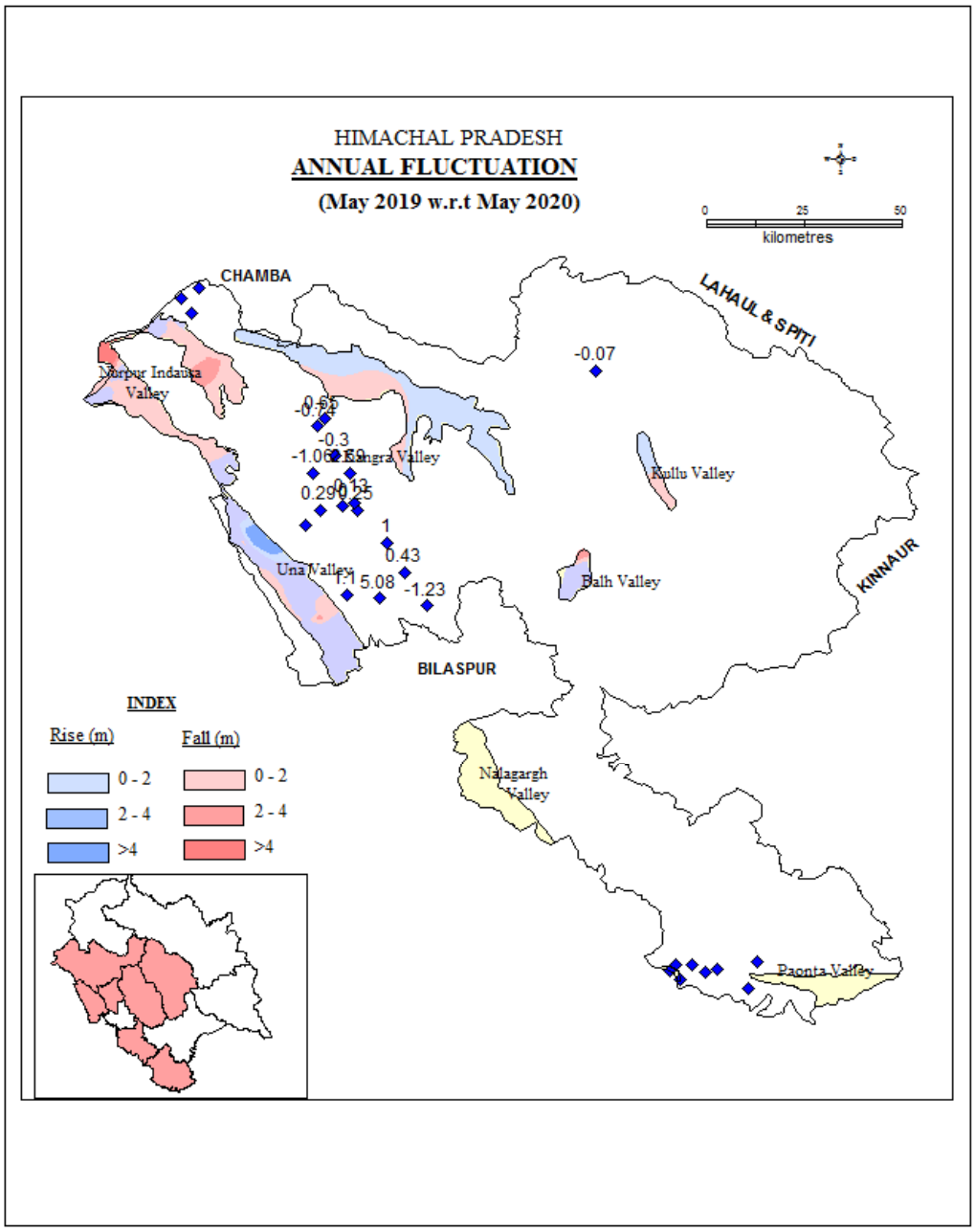

HIMACHAL PRADESH
DEPTH TO WATER LEVEL
MAY 2020
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Balh Valley
Nalagargh Valley
Paonta Valley
LEGEND
Depth to Water Level
(m bgl)
0 - 2
2 - 5
5 - 10
10 - 20
> 20

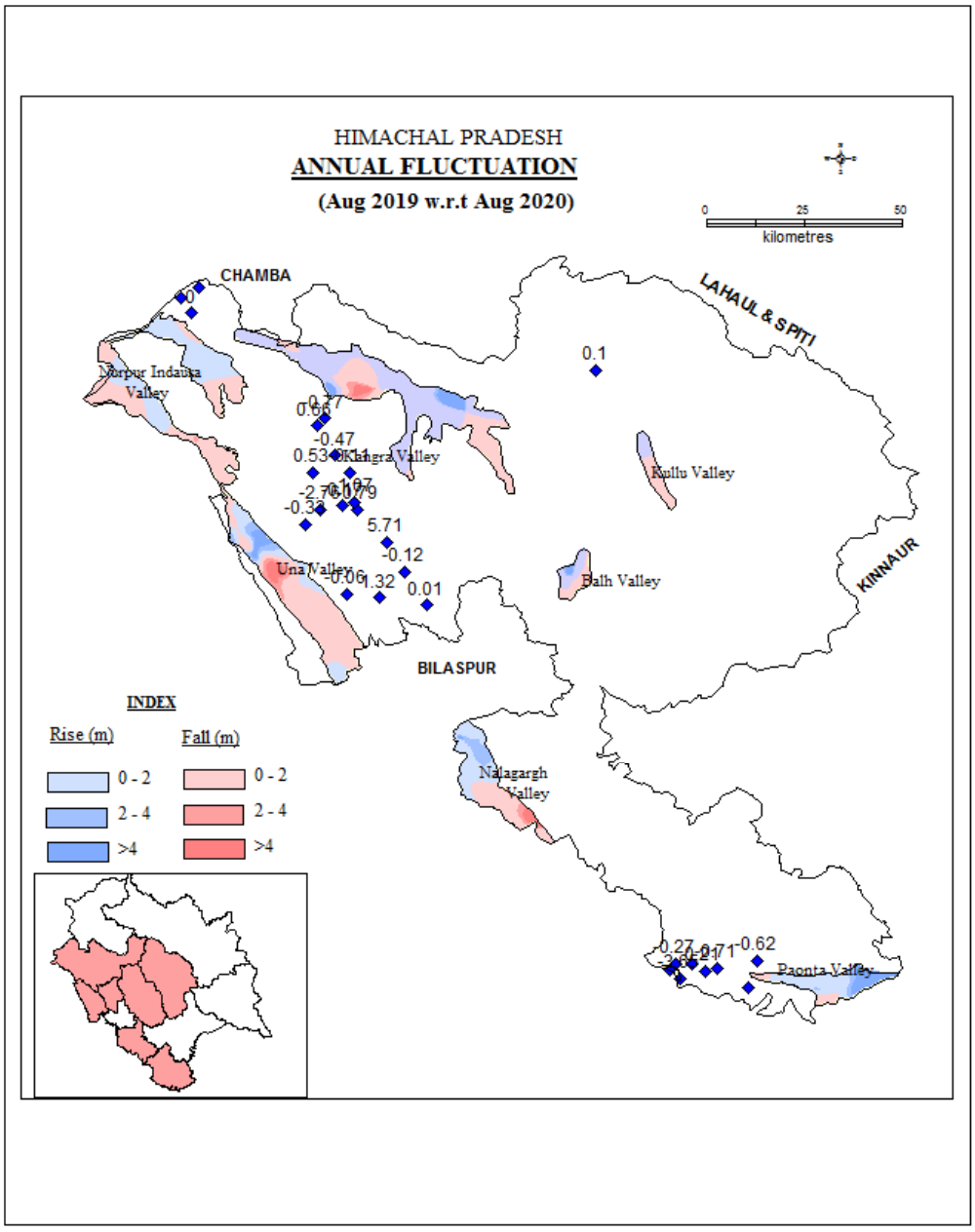

HIMACHAL PRADESH
DEPTH TO WATER LEVEL
AUGUST 2020
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Balh Valley
Una Valley
Nalagargh Valley
Paonta Valley
LEGEND
Depth to Water Level
(m bgl)
0 - 2
2 - 5
5 - 10
10 - 20
> 20

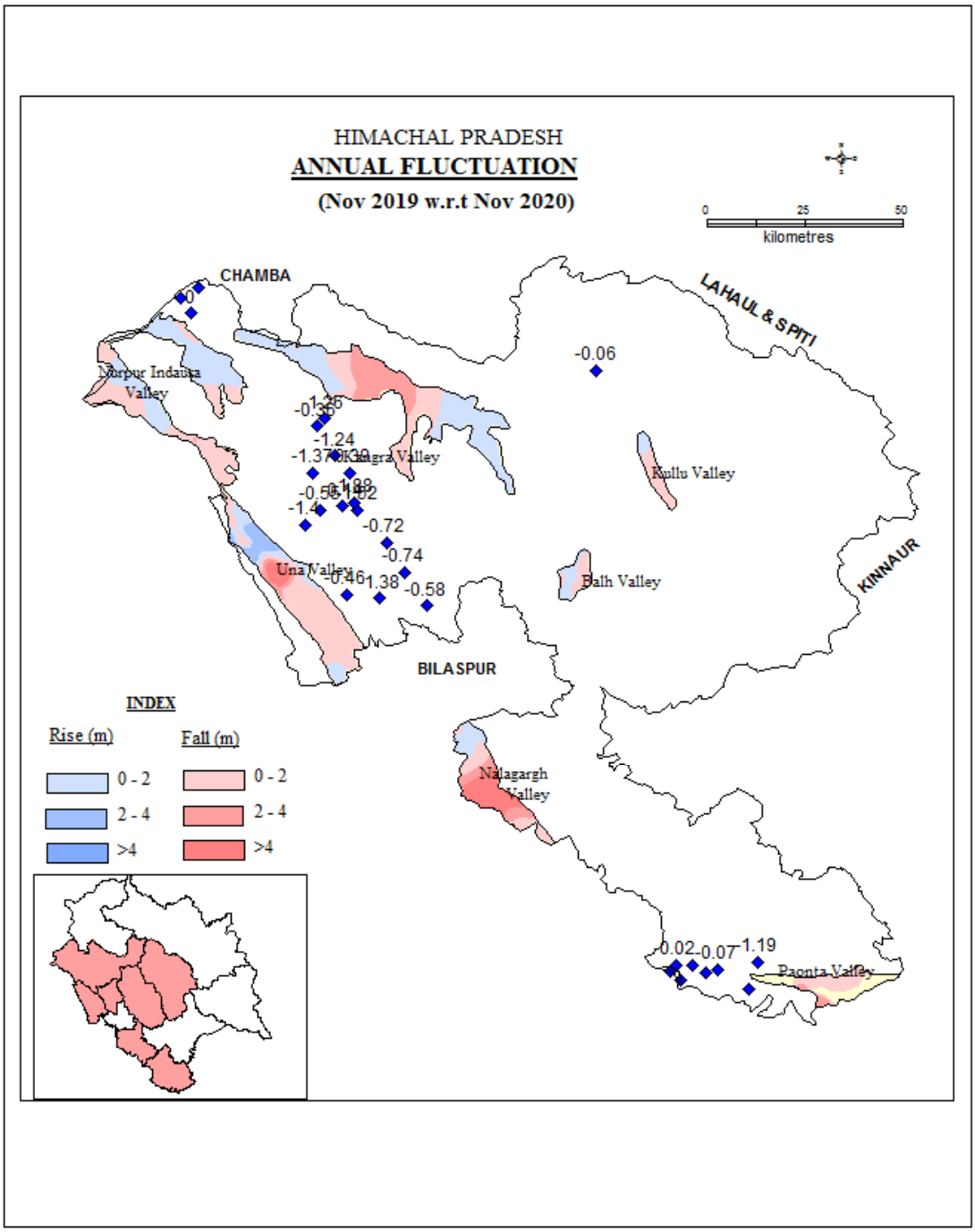

HIMACHAL PRADESH
DEPTH TO WATER LEVEL
NOVEMBER 2020
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Balh Valley
Nalagargh Valley
Paonta Valley
2.25
4.02
2.39
6.14
2.96
2.41
2.61
LEGEND
Depth to Water Level
(m bgl)
0 - 2
2 - 5
5 - 10
10 - 20
> 20

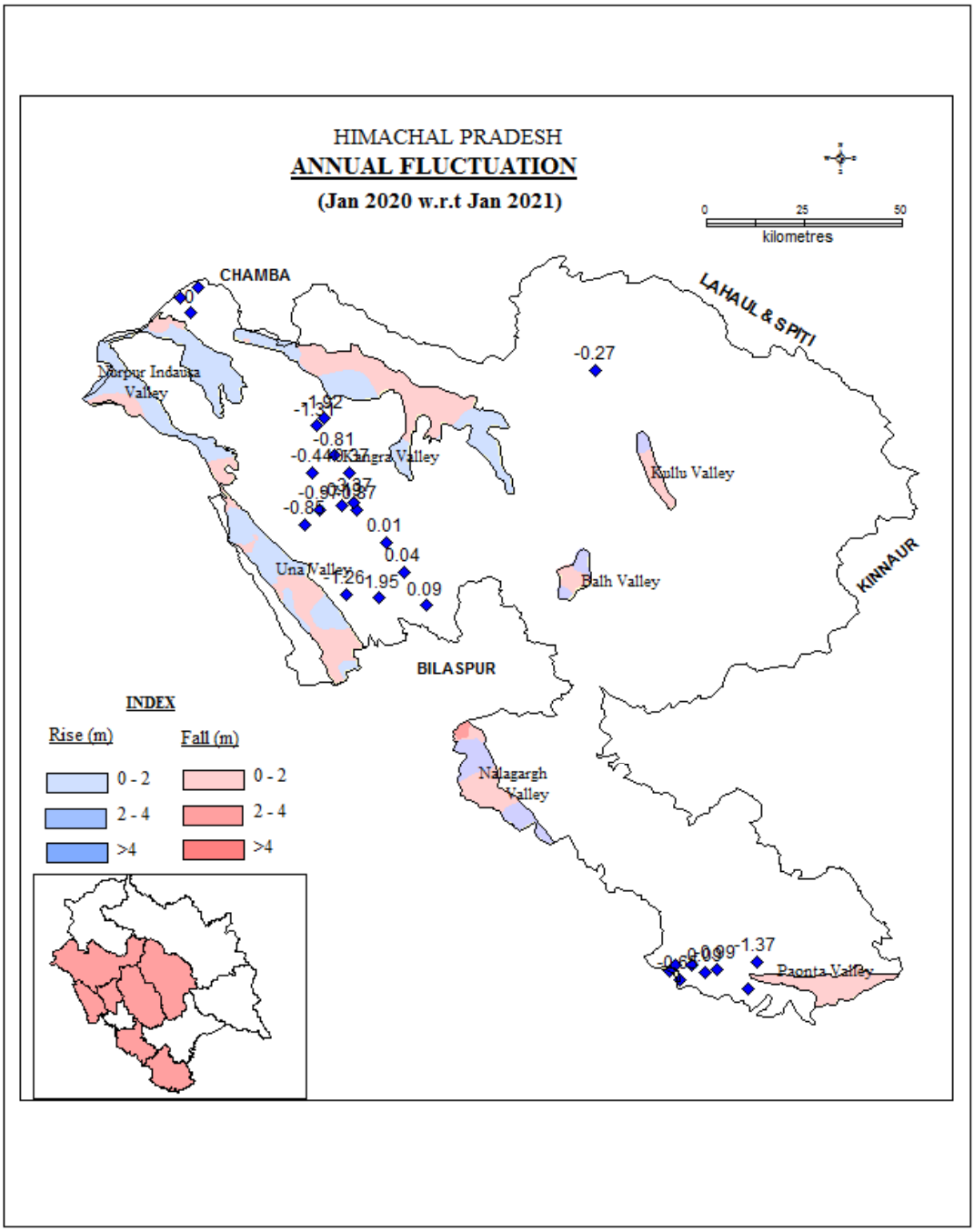

HIMACHAL PRADESH
DEPTH TO WATER LEVEL
JANUARY 2021
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Balh Valley
Nalagarh Valley
Paonta Valley
2.4
5.72
2.27
1.84
12.41
2.54
LEGEND
Depth to Water Level
(m bgl)
0 - 2
2 - 5
5 - 10
10 - 20
> 20

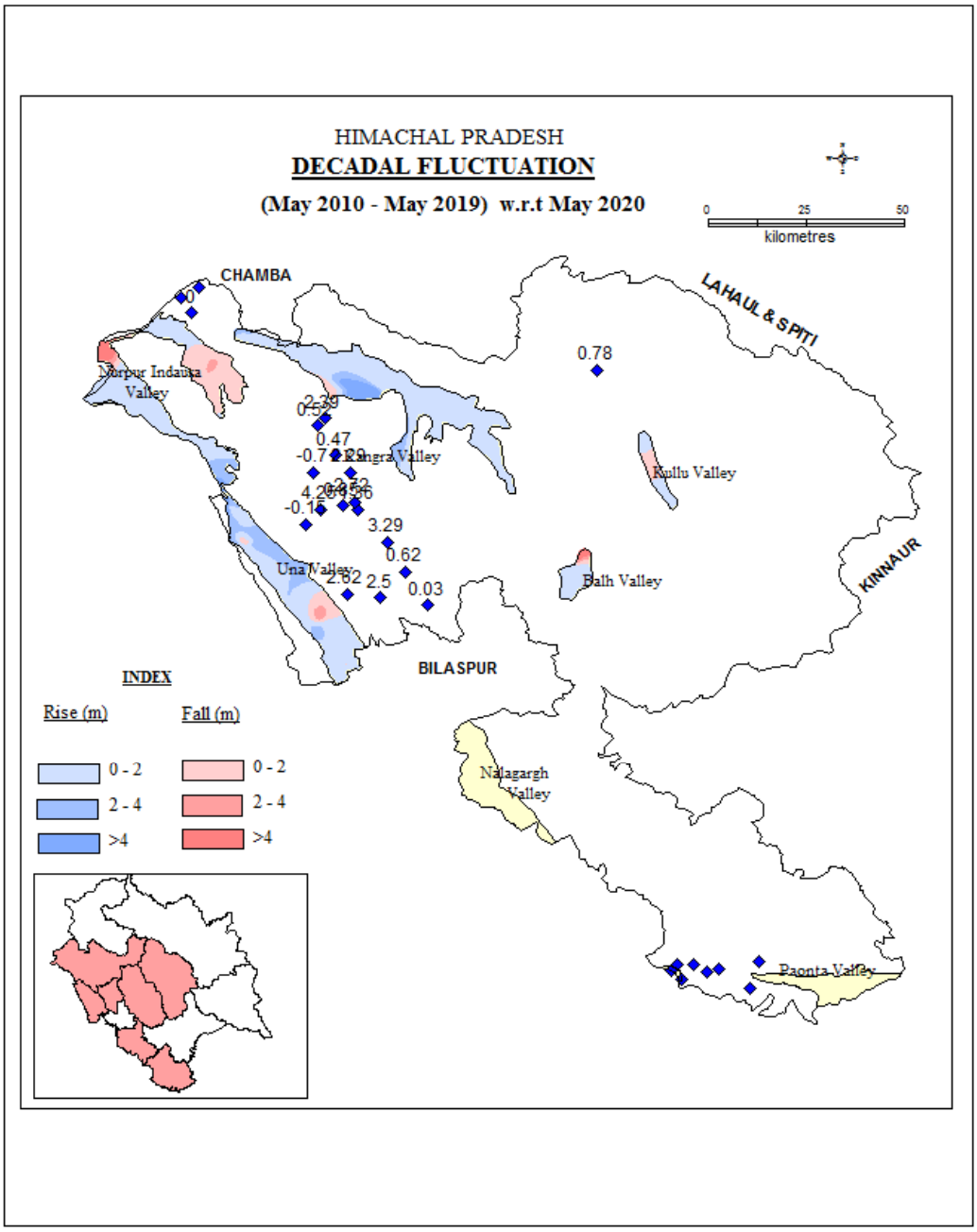

HIMACHAL PRADESH
SEASONAL FLUCTUATION
(May 2020 w.r.t November 2020)
0 25 50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Nurpur Indaura Valley
Kangra Valley
Kullu Valley
Balh Valley
Una Valley
Nalagargh Valley
Paonta Valley
0.34
0.6
0.25
-0.69
0.05
0.78
9.57
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4

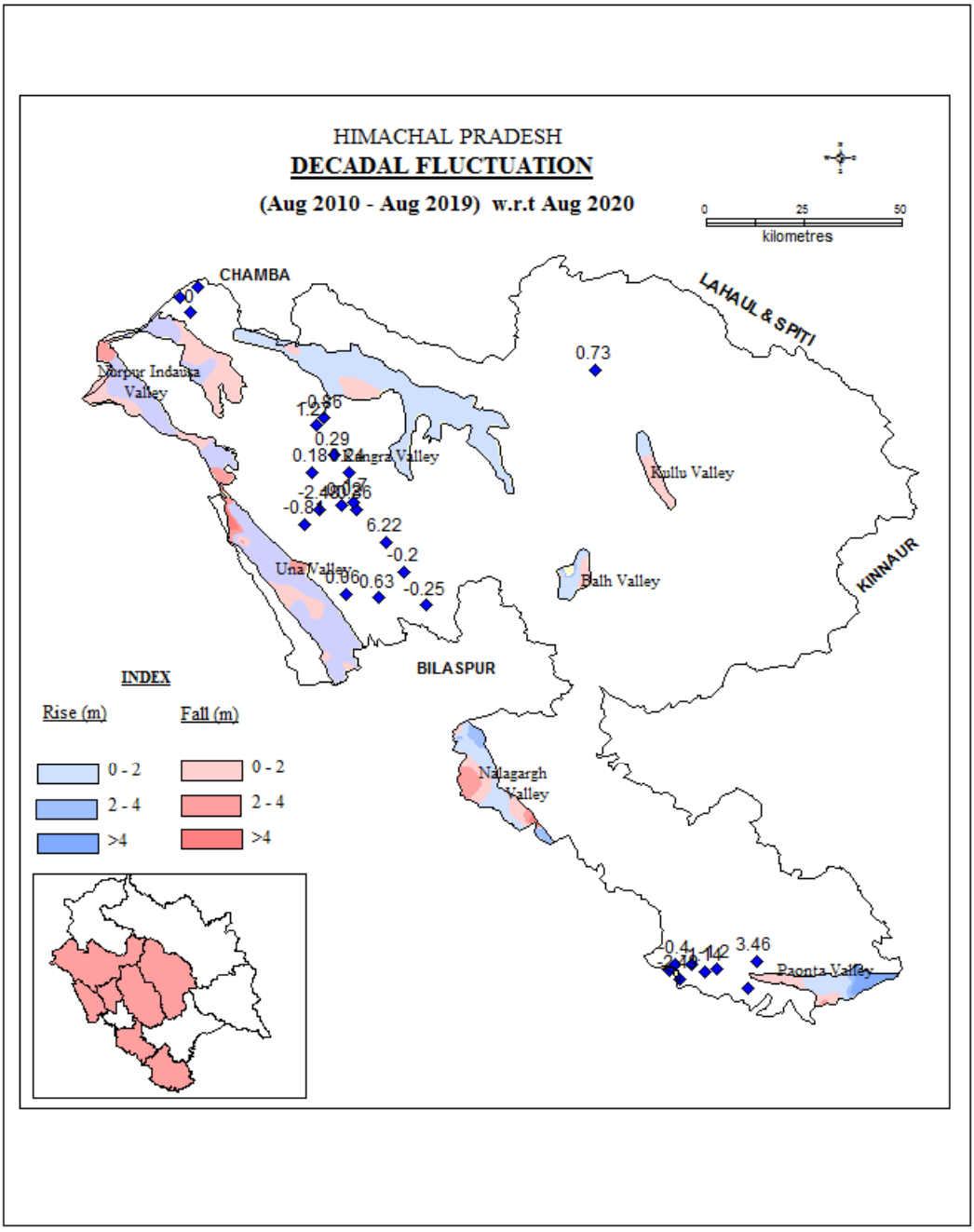

HIMACHAL PRADESH
ANNUAL FLUCTUATION
(May 2019 w.r.t May 2020)
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Nurpur Indausa Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
-0.07
-0.65
-0.74
-0.3
-1.06
0.29
0.13
0.25
1
0.43
-1.15
5.08
-1.23
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4

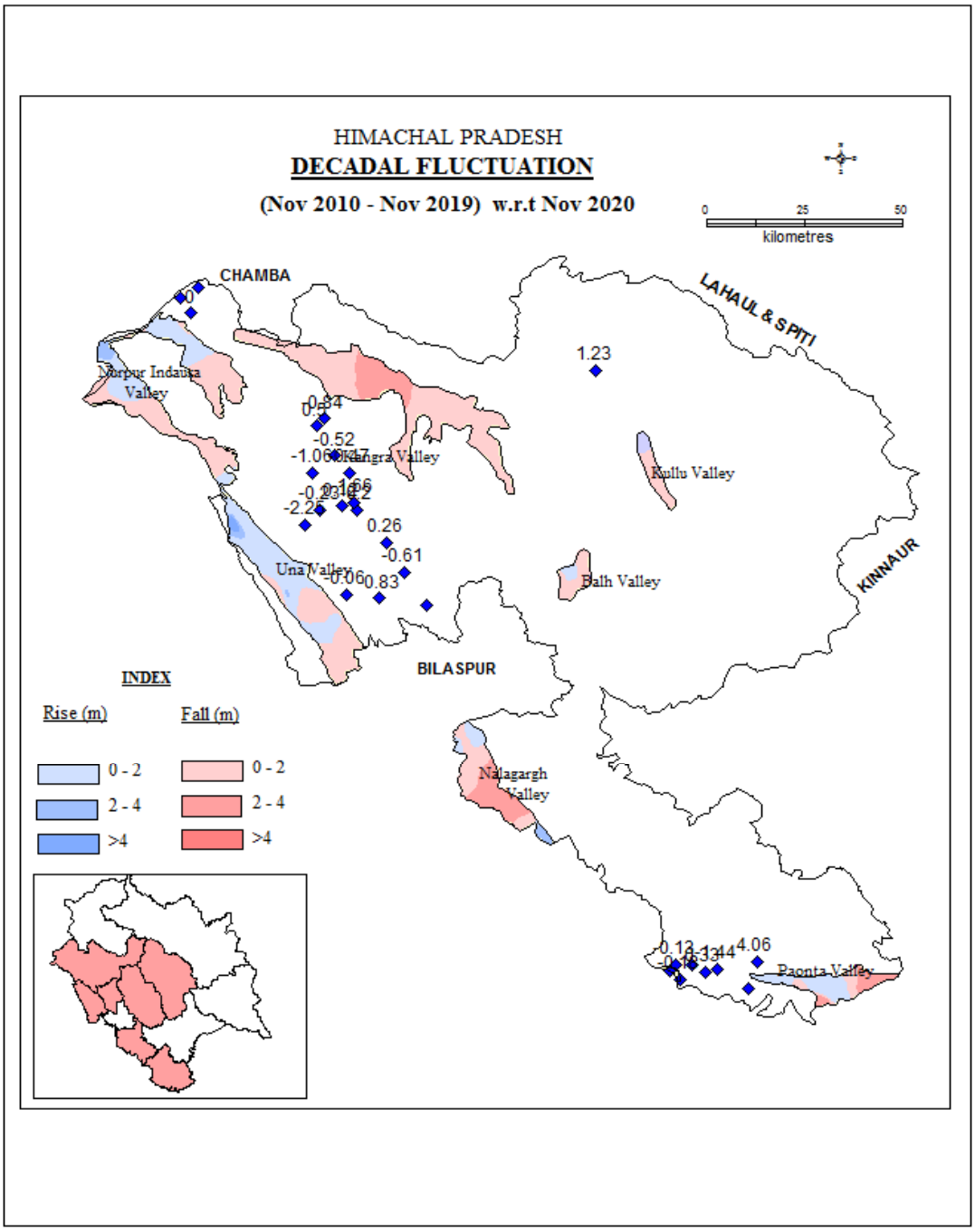

HIMACHAL PRADESH
ANNUAL FLUCTUATION
(Aug 2019 w.r.t Aug 2020)
0 25 50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
Nurpur Indaura Valley
0.1
5.71
-0.12
1.32
0.01
-0.62
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4

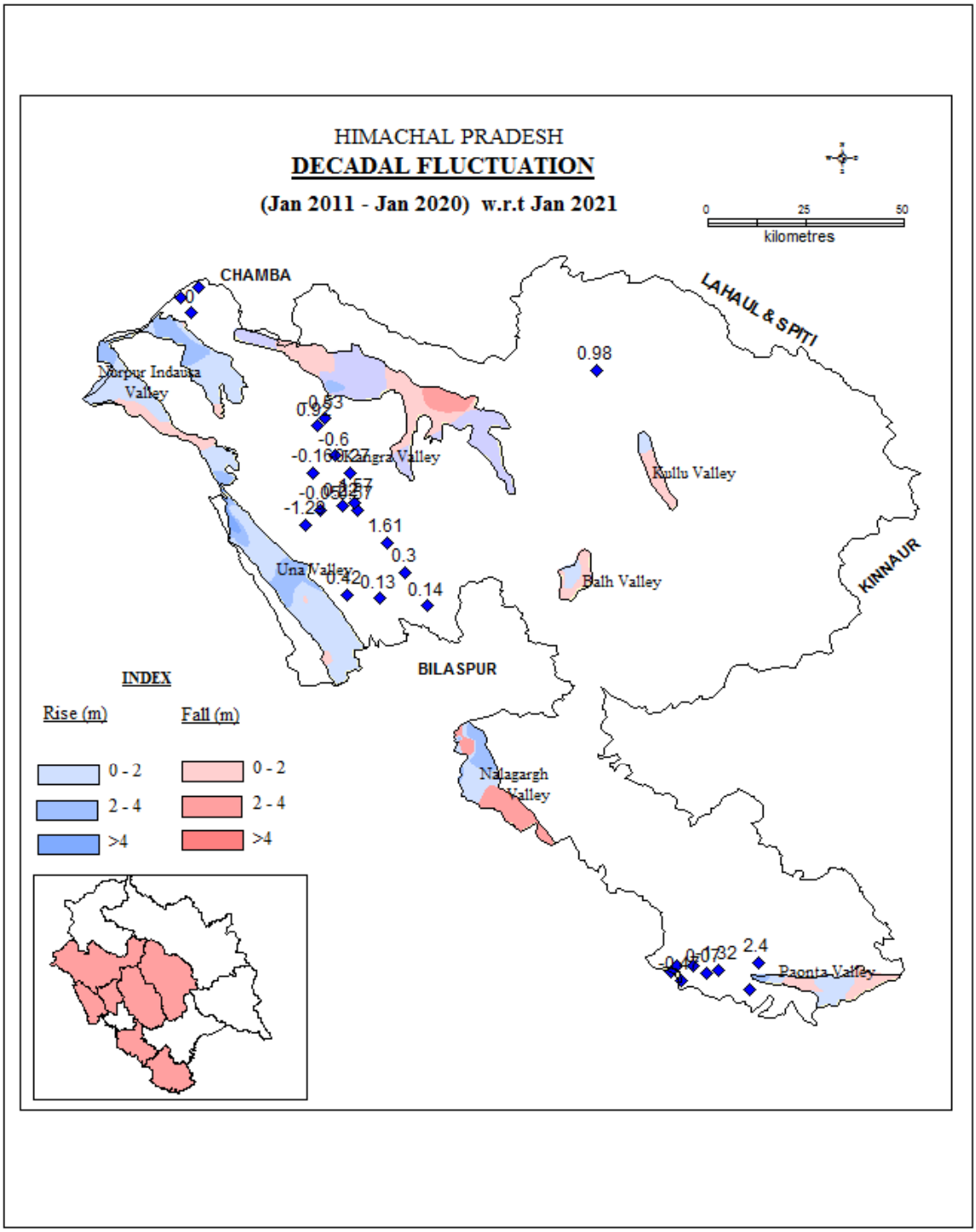

HIMACHAL PRADESH
ANNUAL FLUCTUATION
(Nov 2019 w.r.t Nov 2020)
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
-0.06
-1.24
-0.72
-0.74
-0.46
1.38
-0.58
0.02
-0.07
1.19
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4


HIMACHAL PRADESH
ANNUAL FLUCTUATION
(Jan 2020 w.r.t Jan 2021)
0 25 50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Morpur Indaura Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
-0.27
-1.92
-0.81
-0.44
-0.97
-0.87
-0.85
0.01
0.04
-1.26
1.95
0.09
-1.37
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4


HIMACHAL PRADESH
DECADAL FLUCTUATION
(May 2010 - May 2019) w.r.t May 2020
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Nurpur Indaura Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
0.78
0.47
3.29
0.62
2.62
2.5
0.03
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4


HIMACHAL PRADESH
DECADAL FLUCTUATION
(Aug 2010 - Aug 2019) w.r.t Aug 2020
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Morpur Indaura Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
0.73
1.22
0.29
0.18
-2.48
-0.84
6.22
-0.2
0.06
0.63
-0.25
3.46
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4


HIMACHAL PRADESH
DECADAL FLUCTUATION
(Nov 2010 - Nov 2019) w.r.t Nov 2020
0 25 50
kilometres
CHAMBA
LAHAUL & SPITI
Murpur Indaura Valley
1.23
-0.52
Kangra Valley
Kullu Valley
0.26
-0.61
Una Valley
-0.06
0.83
Balh Valley
KINNAUR
BILASPUR
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4
Nalagargh Valley
4.06
Paonta Valley


HIMACHAL PRADESH
DECADAL FLUCTUATION
(Jan 2011 - Jan 2020) w.r.t Jan 2021
0
25
50
kilometres
CHAMBA
LAHAUL & SPITI
KINNAUR
BILASPUR
Nurpur Indaura Valley
Kangra Valley
Kullu Valley
Una Valley
Balh Valley
Nalagargh Valley
Paonta Valley
0.98
0.53
-0.6
1.61
0.3
0.42
0.13
0.14
2.4
INDEX
Rise (m)
Fall (m)
0 - 2
2 - 4
>4
0 - 2
2 - 4
>4