State Centre on Climate Change

Annual Progress Report

2021-22

State Centre on Climate Change

H.P. Council for Science, Technology & Environment (HIMCOSTE)

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SNOW & GLACIERS STUDIES

MONITORING OF GLACIAL LAKES/WATERBODIES IN SATLUJ CATCHMENT USING RS & GIS TECHNIQUES (2020)

Snow is an essential resource present in the Himalyas. Therefore, monitoring of snowfall changes over a time period is important for hydrological and climatological purposes.Considering the present trend of winter snowfall in Himachal Pradesh, the winter precipitation was mapped in all the basins viz Chenab, Beas, Ravi and Satluj Basins in H.P. using AWIFS satellite data having spatial resolution of 56 mts w.e.f October 2020 to May 2021. During 2020-21, snowfall was estimated and analyzed with reference to the averaged value of the total area under snow cover in each month from October to May using the following sets of available AWIFS data.

Table 1 Area under snow in Himachal Pradesh

Basin wise Snow Cover in H.P (Km^2)			
Basin	**2019-20**	**2020-21**	**% Change**
Chenab	7154.11	6515.91	-8.92
Beas	2457.68	2002.03	-18.54
Ravi	2108.13	1619.82	-23.49
Satluj	11823.1	9045.50	-23.16
Total	**23542**	**19183**	**-18.52**

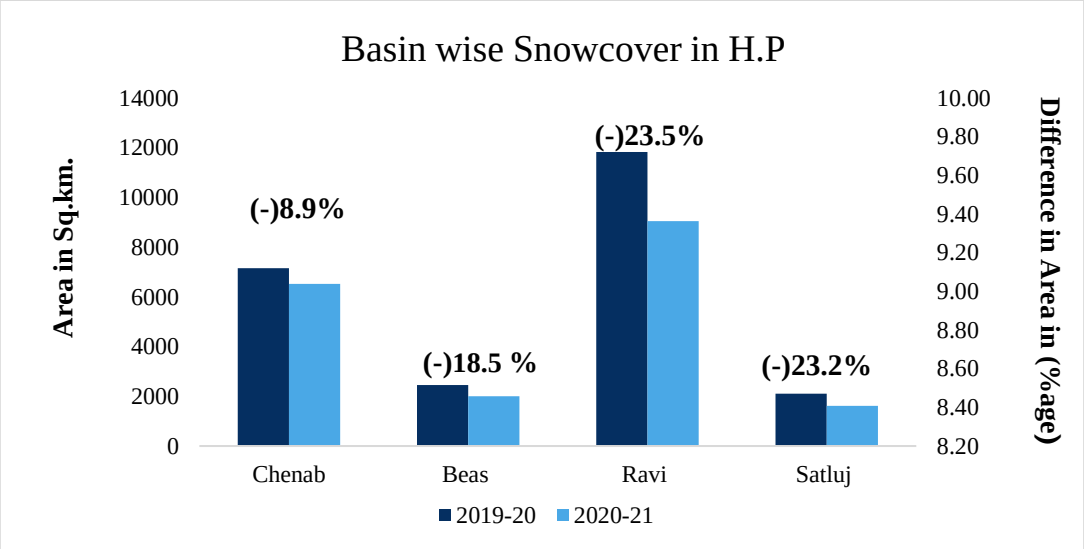

Figure 1 Basin wise snow cover in Himachal Pradesh

CONCLUSION

The present study has been carried out using IRS–RS2, AWIFS, IRS RS2 & RS2A LISS-III and IRS RS2A LISS -IV satellite data products having spatial resolution of 56mts, 23.5mts and 5.8mts for the year 2020 from April to November. The catchment area in the Satluj River basin was studied from upstream of Jhakri to Mansarovar Lake in the Tibetan Himalayan Region from where the Satluj River originates. The study was carried as part of the disaster preparedness plan of Satluj Jal Vidyut Nigam Ltd (SJVNL) to assess the threat from the moraine dammed glacial lakes/water during the year 2020. This study is being carried out regularly since 2009 during the ablation season (April to October) every year. During this year, the catchment area was studied during the ablation period from April to November using visual interpretation techniques and an inventory based on AWIFS and from LISSS III and LISS IV satellite data products was prepared in the Satluj River catchment and thereby assessing any change in their water spread area w.r.t the previous year.

In the present study, analysis has been carried out in the study area by using 10 AWIFS data products from April to November and LISS III coverage within the path row 96-48,96-49,97-48,97-49,98-48,98-49,99-49,100-49 using IRSRS2/RS2A LISS-III data products and 96-48a, 96-48b,96-48c, 96-48d, 97-48a, 97-48b,97-49b,99-49b using LISS IV data products. During April 2020, which is generally considered as the start of ablation season, very limited information could be obtained as most of the catchment area was under the snow cover impact, so no information could be derived. Due to non-availability of good quality cloud free and snow free AWiFS data products during May to August, no information of the catchment could be derived.

During September 2020, the study area was investigated using data for six different dates i.e., 2,5,10,12,21 and 29 September, which reveals the presence of 162,47,355,361,138,259 lakes/wetlands in the entire study area, whereas in October 03 data sets were used mainly for 1st, 16 and 30th October 2020 and a total of 248,288 and 172 lakes/wetlands were mapped. Based on the satellite data quality, cloud free and snow free coverage, the data procured on 12 September 2020 seems to be the best one and the information derived from this data has been considered as the maximum number of lakes during 2020 from AWIFS data. Based on the results obtained for 12 September 2020, maximum of 361 lakes could be mapped in the study area comprising 278 from the Upper Satluj basin i.e., sub basin 3, 63 from the Spiti basin i.e., sub basin1 and 20 form the Lower Satluj basin i.e., sub basin2. Further out of 361 lakes, 218

lakes are the small one with area less than 5ha, 81 lakes are within the aerial range of 5-10 ha and 62 lakes are the big one with are more than 10ha.The analysis based on classification suggest that out of 361 lakes, 40 are the high-altitude wetlands comprising 13 with area more than 10ha and thus 49 lakes are from glacial origin from the total 62 lakes mapped with area more than 10ha.Temporally 39 lakes/wetlands show a positive trend whereas 25 lakes/wetlands shows a negative trend in their spatial distribution out of 64 lakes which were compared with reference to 2019 for spatial distribution.

The comparative analysis of the maximum number of lakes/wetlands that have been delineated from 12 September 2020 wherein 361 lakes/wetlands have been delineated in comparison to 229 lakes/wetlands as mapped on 09 September 2019 reveals that the Spiti basin shows an increase of 44 lakes i.e., 18 (2019) increased to 62(2020) indicating an overall increase of about 244% in the Spiti basin as a whole between 2019 and 2020. Likewise, in Lower Satluj basin, an increase of about 185% w.r.t 2019 and in Upper Satluj basin, an increase of about 36% w.r.t 2019 could be seen in the total number of lakes mapped in 204(2019) to 278(2020). Thus, from the analysis we can say about 77% of the total lakes falls in the Upper Satluj basin, 5% that from the Lower Satluj basin and 17% from the Spiti basin. Thus, we can say that basin number 3 i.e., Upper Satluj basin of the study area within Tibetan Himalayan Region is more susceptible for such changes due to climatic variations as a result of which the basin 3 has more number of moraine dammed/supra glacial lakes in the area under investigation. Based on the areal distribution of lakes/wetlands on 12 September 2020, the bigger lakes with area >10ha, number of lakes falling in this category varies from 69(2018) to 31(2019) to 62(2020) out of which 13 are the high-altitude wetlands. The percentage increase/decrease in terms of the lakes with area more than 10ha is reflected by about 200 % (6 lakes/wetlands) increase in basin 1 i.e., Spiti basin, Lower Satluj basin i.e., basin 2 does not show any lake in 2019 whereas, there are 2 lakes/wetlands in 2020 and about 47% (23 lakes) increase in basin 3 as far as the lakes/wetlands with area more than 10ha as mapped on 12 September 2020 are concerned. Likewise, the total number of lakes in 2020 with area between 5-10 ha constitutes about 22% of the total number of the lakes i.e., 81(2020) and shows an increase by about 138% in comparison to 2019 i.e., 34 (2019) and by about 30% in comparison to 2018 i.e., 62(2018). The lakes with area <5ha vary from 142(2018) to 164(2019) to 218(2020) reflecting an increase of about 53% (76) w.r.t. 2018 and 32% (54) with reference to 2019.

Further, the increase in the total number of lakes with area more than 10ha with respect to the base line data of 2007(NRSC Hyderabad, 2007), it is found that this number has increased from

40(2007) to 85(2016) to 79(2017) to 69(2018) to 51(2019) to 62(2020) based on AWIFS data reflecting an overall increase of about 112% between 2007-2016 and about 97% increase between 2007-2017 and 72% between 2007-18 and about 27% between 2007-19 and about 55% between 2007-20 and about 16% between 2019-20 and 71% between 2007-2020 and 39% between 2019-20 and in case when the number of lakes mapped is 51 on 16 October 2020. Thus, we can say that the formation of the lakes with area more than 10ha reflects an increasing trend with respect to the base line data of 2007 i.e., 40 lakes with area more than 10ha.Likewise there is an increasing trend in the total number of lakes with reference to the base year i.e., 196(2007) based on AWIFS data have been observed which indicates an increase of about 42% w.r.t the base year i.e., 2007(196) to 2017(280), 39% in 2018(273) about 16% in 2019(229) and about 84% in 2020(361). Thus, we can say the total number of lakes in Satluj catchment is on the increasing side. Further Classification of lakes based on their origin suggest that 40 lakes i.e., about 11% lakes are mainly the high-altitude wetlands and 321 lakes i.e.,88% lakes are from the glacial origin i.e., the lakes which are either formed at or near the glacier snouts known as Moraine Dammed Glacier Lakes or more commonly known as (GLOFs) or within the glacier body in the ablation zone known as Supra glacier lakes (SG).

Further based on the LISS-III satellite data analysis for 2020, a total of 993 lakes have been delineated out of which about 88% (878) lakes are the small one with area less than 5ha, about 6% (63) falls within the aerial range of 5-10ha and about 5% (52) are the big one with area more than 10ha. The comparative analysis based on LISS-III satellite data reveals that total number of lakes varies from 642(2017) to 769(2018) to 562 (2019) to 993(2020) indicating an overall increase of about 19% between 2017-18 and reduction of about 26% between 2018-19 and further an enhancement by about 76% between 2019-20 respectively, which is mainly due to the non-availability of good quality LISS III data products in 2019. From the analysis, it is clear that the maximum number of lakes (about 71%) are being formed in the Upper Satluj basin, about 8% in the Lower Satluj basin and about 19% in the Spiti basin of the study area reflects that the Upper Satluj basin is more susceptible for undergoing climate induced changes resulting to have higher number of such lakes than the Lower Satluj and Spiti basin. As far as the big lakes with area more than 10ha are concerned, total number of big lakes varies from 55 (2017) to 49(2018) to 51(2019) to 52(2020) indicating a fluctuating trend in the lakes/wetlands with area >10ha, but are very close to each other.

The Parechhu Lake in the Tibetan Himalayan Region was also monitored separately during the ablation period of 2020 and does not show any major change in its water spread and seems to

be stable based on the observations made which have been reported to SJVNL as well as to the Government during 2020 for June and August. Besides this, the landslide on the upstream side of the lake depression was also monitored in order to assess any change in the water level by virtue of the landside which may block the river course causing major threat like that of the Parechhu formation during the year 2004. On 27 June 2020, another landslide from the right bank of Parechhu River encroaching the river course could be seen, by virtue of which slight accumulation was noticed, but the outflow was normal

Along the course of main Satluj River, few isolated pockets have also been observed which shows accumulated water in the upper catchment of the Tibetan Himalayan Region and within the Spiti basin i.e., sub basin 1. In Spiti basin the lakes with ids 1682RS(0.51ha), 1683RS(0.58ha), 1684RS(1.75ha),1686RS(1.09ha) and 1687RS(1.17ha) are some of the water bodies which have been developed along the nala section coming along the village Chicham just upstream of Kaza on the left bank formed in series. All these water bodies are although small but needs monitoring as this is along the river course and can cause major damage in case if it bursts. Thus, the lakes/water bodies coded with abbreviation RS with their ids are some of the locations where accumulated water could be seen and these are the permanent features which needs regular monitoring in order to assess any temporal change in their behaviour in the time to come.

Further based on the analysis carried out using LISS-IV(5.8mts) data, a very precise and more detailed information about the glacial lakes and the wetlands has been generated for the Satluj basin for 2020.Based on the above mentioned LISS-IV satellite data, a total of 1359 lakes/high altitude wetlands could be delineated comprising 225 (16%) from Spiti basin i.e., basin1, 542 (39%) from the Lower Satluj basin i.e., basin2 and 592 (43%) from the Upper Satluj basin i.e. basin3, out of which 55 lakes have been classified as high-altitude wetlands and the remaining 1304 as from the glacial origin. The comparative analysis based on three different sets of data reflects that in Spiti basin, the number of lakes delineated has been enhanced from 62 with AWiFS sensor to 197 with LISS III sensor and 225 with LISS IV sensor. Likewise, in Lower Satluj basin, the 20 lakes delineated from AWiFS sensor increased to 89 in LISS III and 542 with LISS IV sensor. Similarly, in Upper Satluj basin, the 279 lakes as delineated from AWiFS sensor has increased to 707 with LISS III and 592 with LISS IV and the variation is mainly due to the data gap in LISS IV which mainly covers the areas falling in Upper Satluj basin. Thus, from the above analysis based on LISS IV sensors, it is inferred that the level of information in the catchment has increased and more detailed information could be seen which

would form the base line data for future investigations with higher resolutions satellite data. Further based on the basin wise analysis and distribution of the lakes, it is found that the basin 3 i.e., the Upper Satluj basin, the number of lakes is quite high in all the cases either in AWIFS (77%) or LISS III (71%) or LISS IV (43%) followed by Lower Satluj basin (5%, 8% and 39%) and Spiti basin (17% ,19% and 16%) and thus basin 3 i.e., Upper Satluj basin seems to be more susceptible than the Spiti and the Lower Satluj basin as far as moraine dammed lakes/water bodies are concerned in the study area.

Thus based on the analysis carried out using AWIFS , LISS III and LISS IV data products in the catchment area of Satluj Jal Vidyut Nigam Ltd. on upstream of Jhakari up to the Mansarover lake in the Tibetan region, it is concluded that the frequency of lake formations varies in each basin, which is evident from the different comparative analysis in all the three basins identified in the Satluj catchment, especially the Tibetan Himalayan Region i.e., the Upper Satluj basin(basin 3) wherein the number of lakes is comparatively very high, which may be due to the more pronounced effect of climatic variations in this region, as a result the small category lakes are coming at a very fast pace. Thus, using space data, the variation in the spatial extent of different category of lakes can be estimated, which would help in assessing their vulnerability if any arising out of the increasing water spread considering the Guidelines on Management of Glacial Lake Outburst Floods (GLOFs) Landslide Lake Outburst Floods (LLOFs) of NDMA (MHA)-2020 of Govt of India. The recent tragedy of 2013 in the Uttrakhand Himalaya has also been correlated with the bursting of a lake having a total area of about 08 hectare in front of the snout of the Chorabari glacier that caused widespread damage in the downstream areas besides the heavy rainfall (Dobhal et.al.2013) and the recent tragedy of 2020. Thus, the magnitude of such lakes as far as the destruction is concerned cannot be overruled. Hence the lakes with area >10 hectare and the area between 5-10 hectare can be seen as the potential vulnerable sites considering the present trends in the climate science and the climate induced hazards threat thereof, for causing damage in case of bursting of any one of them. Thus, a proper monitoring of all such lakes using high resolution space data is essential, which is not possible by any other conventional methods in order to avoid any eventuality like Parechhu and other instances of GLOFs (Glacier Lake Outbursts Floods) in the Himalayan Region of Nepal and Bhutan and the recent tragedy of Uttrakhand Himalaya, which will not only save the precious human lives but also the public and the Govt. property.

CRYOSPHERE, SCIENCE & APPLICATION PROGRAM (CAP), SAC AHMEDABAD

The project Cryosphere, Science & Application Program (CAP) is a joint study in collaboration with SAC Ahmedabad. The satellite data is procured from SAC, Ahmedabad.

OBJECTIVES

1. To carry out inventory of glaciers of Chenab and Satluj basins with recent suitable data of ablation time at 1:25000 scale, using IRS LISS III data/ Landsat ETM+ DATA/ Sentinel optical data. This will include:

a) Mapping of outlines
b) Mapping of snow line at the end of ablation season overlaying of glacier outlines on DEM to extract altitude of snout
c) Mean altitude of snow line
d) Mapping of moraine dammed lakes/ Proglacial lakes
e) Drainage from glaciers, major rivers & major locations of villages and towns

2. To carry out change detection of glaciers at 1:10000 scale using high resolution data of sample glaciers.

3. To carry out Ground truth of one Glacier corresponding to high resolution data. Estimation of volume of Glaciers of Chenab and Satluj Basins by one of the recent methods.

4. Study of spatio- temporal variability of glacier changes with respect to glacier and climate parameters.

ACHIEVEMENTS

Sr. No.	Basin Name	LISS-IV (5.8mts)
1	Spiti Basin (1)	225
2	Lower Satluj (2)	542
3	Upper Satluj (3)	592
4	Total Satluj Basin	1359

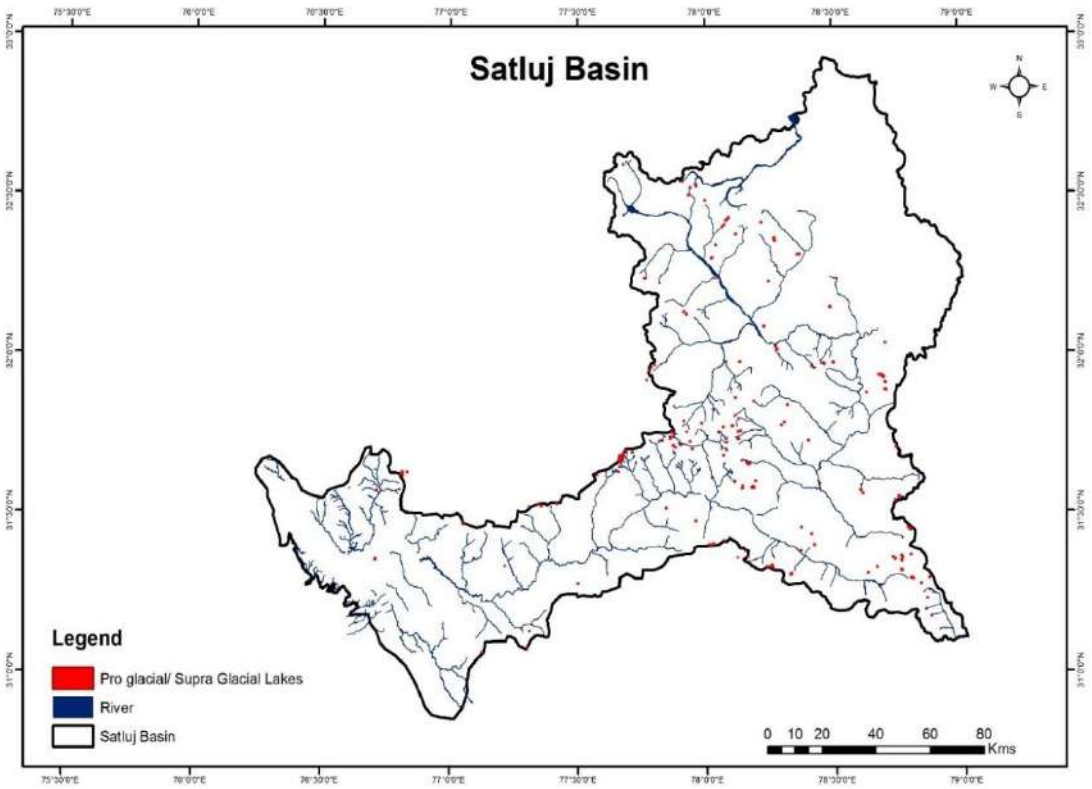

Figure 2 Mapping of moraine dammed lakes/ Proglacial lakes of Chenab and Satluj Basin

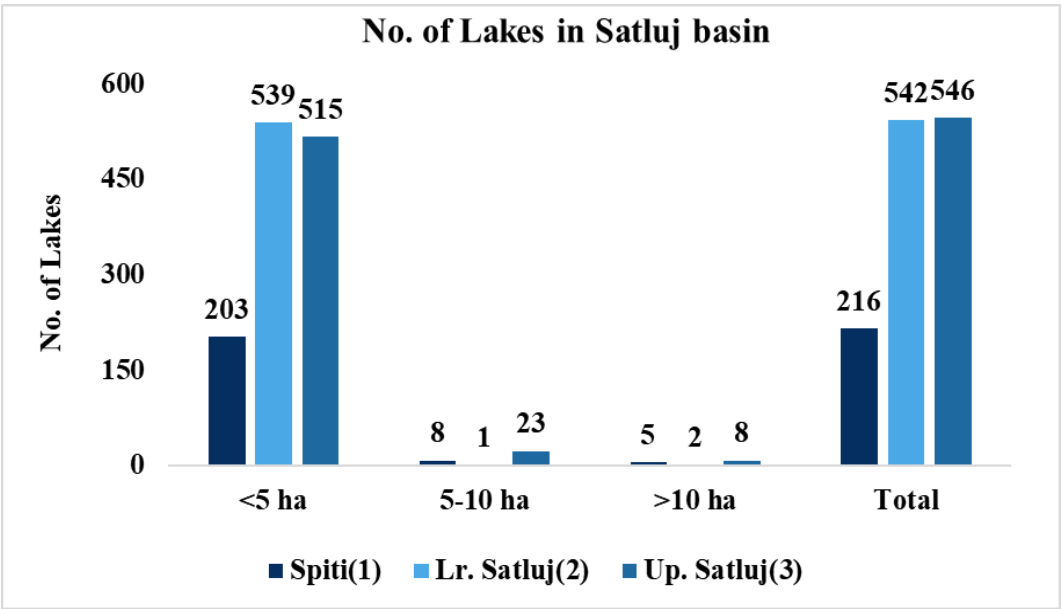

Figure 3 No. of Lakes in Satluj Basin

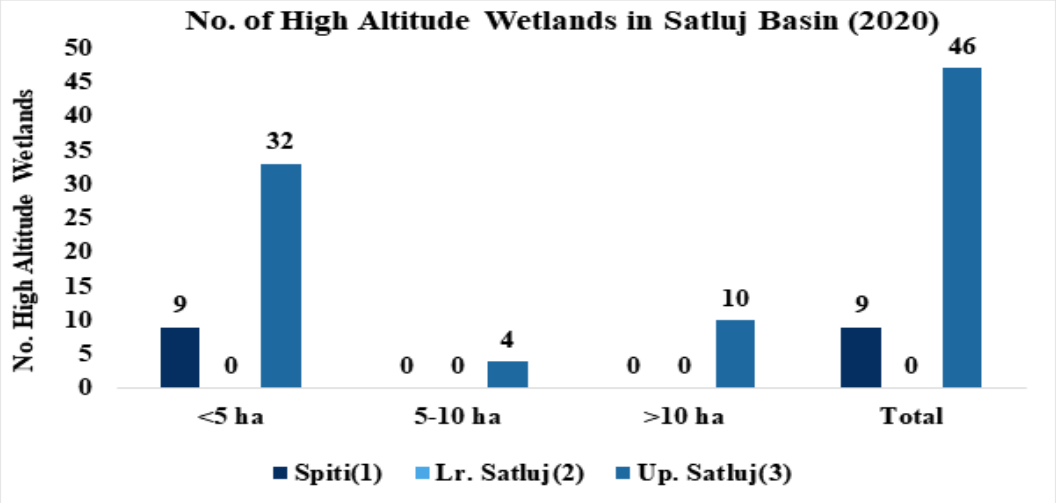

Figure 4 No. of High-Altitude Wetlands in Satluj Basin (2020)

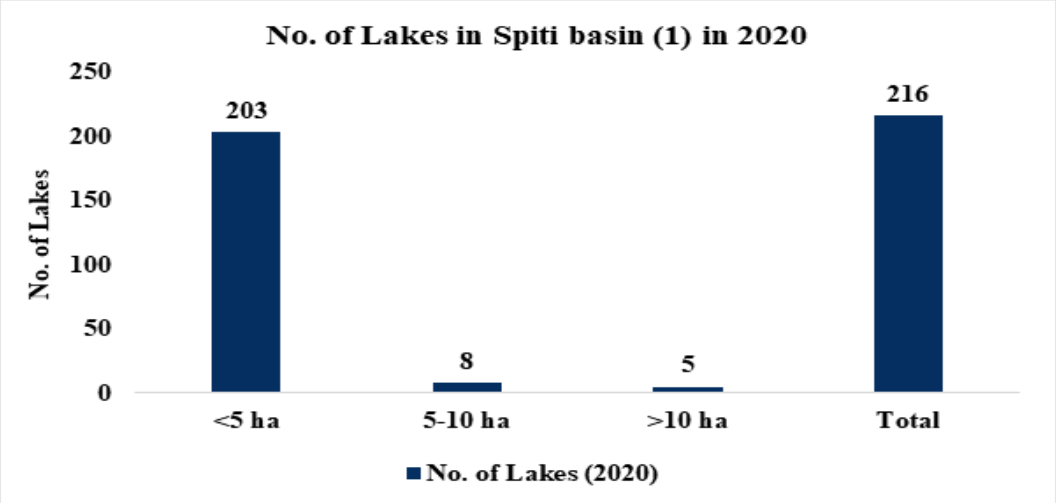

Figure 5 No. of Lakes in Spiti basin (1) in 2020

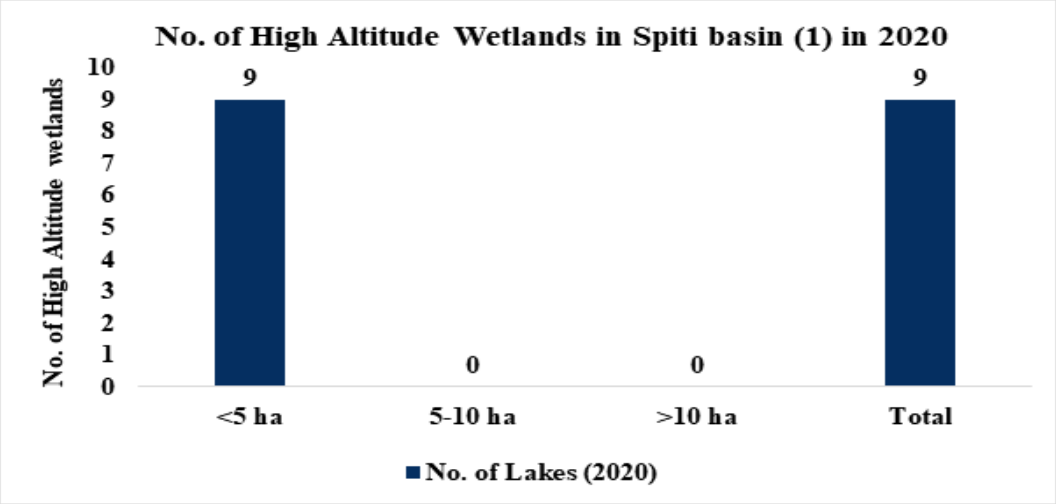

Figure 6 No. of High-Altitude Wetlands in Spiti basin (1) in 2020

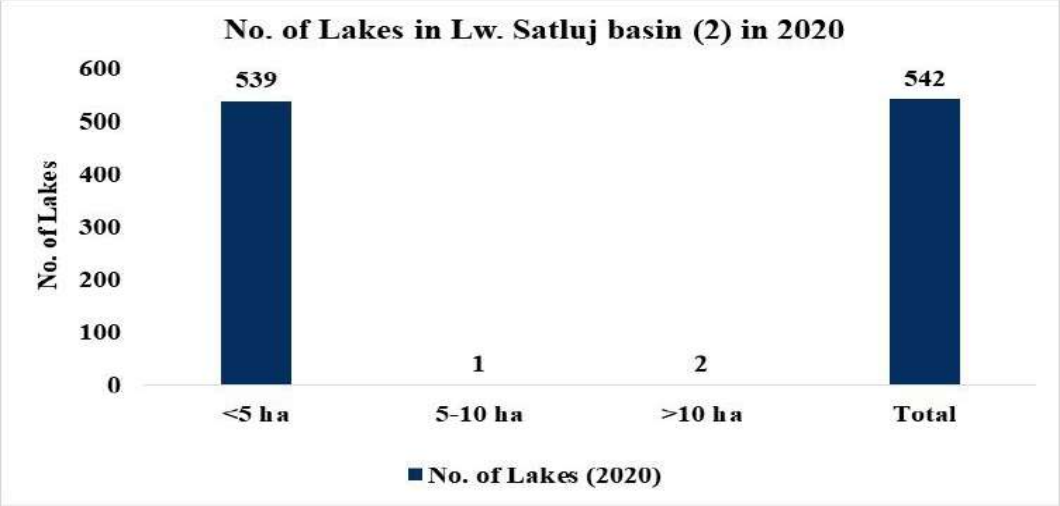

Figure 7 No. of Lakes in Lw. Satluj basin (2020)

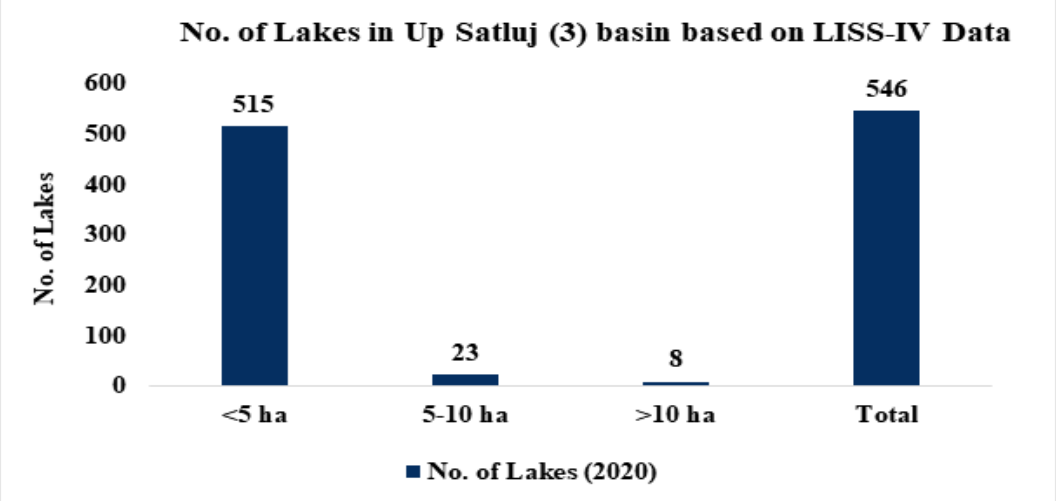

Figure 8 No. of Lakes in Up Satluj (3) basin based on LISS-IV

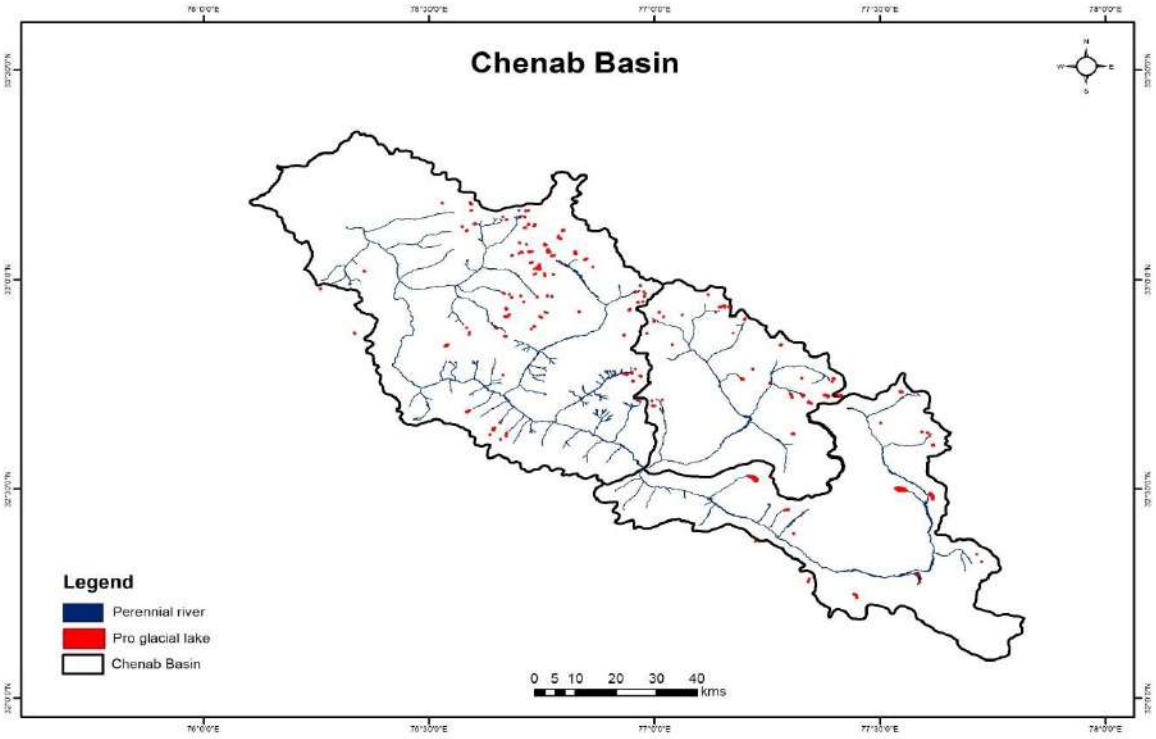

Figure 9 Mapping of moraine dammed lakes/ Proglacial lakes of Chenab and Satluj Basin.

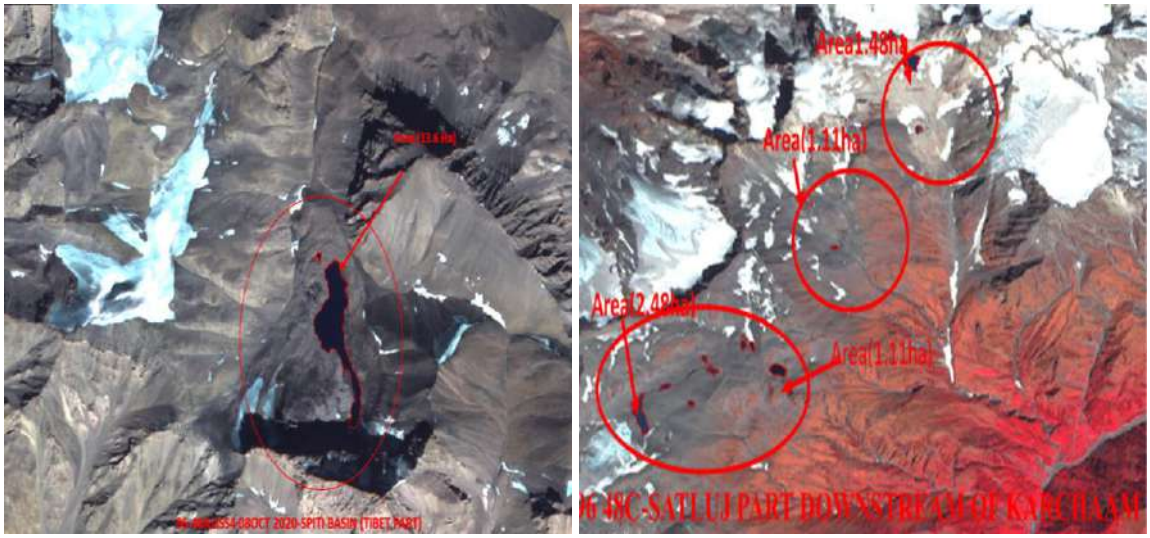

Figure 10 Satellite view of Lakes in Satluj Basin

Figure 11 Field Survey at Batal Glaciers, Chandra Basin, district Lahaul & Spiti

CONCLUSION

The analysis has been made from the AWIFS satellite data for 2020-21 for assessing the total area under snow during the period October to May and its temporal analysis with that of the monthly averaged values of the total area under snow 2019-20, the following inferences are drawn:

- Basin wise analysis from October to May in 2020-21 and its comparative analysis with that of 2019-20 reveals that at the beginning of winter i.e., during the month of October 2020, all basins have been characterized by less snow cover area and the decrease is of the order of about 51% in Chenab, 64% in Beas, about 77% in Ravi and about 72% in Satluj basins in 2020-21 in comparison to 2019-20.

- Likewise, in November, the decrease in area under snow cover was of the order of about 31% in case of Chenab, 6% in Beas, about 52% in Ravi and about 21% in Satluj basin could be observed in 2020-21 in comparison 2019-20.

- Likewise In December i.e., the peak winter month, all basins again have shown a reduction in the surface area under snow by about 2% (Chenab), 9% (Beas), 18 % (Ravi) and 24 % (Satluj) basins respectively in 2020-21 in comparison to 2019-20.

- In January, the Chenab basin shows a decrease of about 2%, the Beas basin by about 27%, Ravi basin by about 16% and in Satluj basin, the reduction in surface area decrease is of the order of about 24% respectively in 2020-21 in comparison to 2019-20.

- During February 2021, all basins again show a decrease in their area under snow cover and the decrease is of the order of 7% in Chenab, 25% in Beas, 24% in Ravi and about 29% in Satluj basin respectively. It is reflecting that there is a decrease in snow cover area in 2020-21 winter period especially the peak winter months from December to February in comparison to 2019-20.

- In March, Chenab basin shows a reduction of about 2% in its surface area under snow, the Beas and Ravi basins shows decrease in surface area under snow by about 6% (Beas) and Ravi about 1%, whereas Satluj basin shows a reduction of about 20 % less snow cover area in 2020-21 in comparison to 2019-20.

- Thus, during early winter months (October to November) and the peak winter months (December to February), we can say that there is less snowfall in 2020-21 winter in the State covering all the basins viz. Chenab, Beas, Ravi and Satluj respectively as a result of which the area under snow cover is reduced in 2020-21 in comparison to 2019-20.

- The analysis of summer months i.e., April and May, the Chenab and Satluj basins shows a positive trend in the area under snow cover in May and shows an increase of about 8% in Chenab and about 1% in Satluj basin, where as in April a reduction of about 2% (Chenab) and about 20% (Satluj) could be seen in 2020-21 in comparison to 2019-20. The other two basins i.e., Beas shows a reduction of about less than 1% in April and about 22% in May whereas, Ravi shows reduction of about 32% and 8% in April & May 2020-21 in comparison to 2019-20 respectively.

- Analysis of summer months further reveals that in Chenab basin, about 85% of the total basin area in April and about 71% as in May is still under the impact of snow reflecting that about 14% of the total basin area has been melted out between April and May which further reduced to about 52% in early June reflecting that about 20% basin area in Chenab basin has vacated of snow between May and early June. In other words, we can say that about 52% of the total basin area would melt during the next ablation month (June to August) meeting the discharge dependability from the Chenab basin.

- Likewise, the Beas Basin in the month of April ,has about 49% of the total basin area and in May about 35% is under snow cover impact, which further reduced to 28% in early June reflecting that about 14% of the total basin area has been melted in Beas basin between April and May and further 7% between May and early June and thus about 28% of the total basin area of Beas basin would be available for meeting the water requirements from snowmelt during the next ablation months in summer after 12th June 2021.

- The Ravi basin, shows that about 29% of the total basin area in April and about 24% in May of the total basin area is under snow cover impact, which further reduced to 15% in early June reflecting that about 5% of the total basin area has been melted out between April and May and further 9% between May and early June, as a result only 15% of the total basin area would be available for meeting water requirements from snowmelt of the Ravi basin during next ablation months after early June 2021.

- Likewise, the Satluj basin comprising of Baspa, Pin and Spiti and Lower Satluj in Himachal part, indicates that about 41% of the basin area in April and about 37% in May and further about 19% in early June is under the snow cover impact, which may have some error due to cloud cover in the Satluj basin in June reflecting that about 4% of the basin area in Satluj has been melted between April and May and about 18% between May and early June and the large variation may be due to cloud during this period as a result on 19% of the total basin area would be available for meeting the water requirements from snow melt during next summer months in 2020-21.

- Thus, based on the analysis carried out, it is observed that there is an overall decrease in area under snow in 2020-21 winter, wherein Chenab basin (9%), Beas basin (19%), Ravi basin (23%) and Satluj basin (23%) reflects less area in 2020-21 (October to May) in comparison to 2019-20 period with a considerable overall decrease in total area under snow by about 18.5% in Himachal Pradesh on 2020-21 winters in comparison to the total area during 2019-20.

DISASTER MANAGEMENT IN HIMACHAL PRADESH

MONITORING OF PARECHHU LAKE

In continuation to the monitoring of the Parechhu Lake using high resolution satellite data, the observation based on the analysis carried out from IRS–R2A –LISS III-96/48- 8th October 2021.

OBSERVATIONS

- The water flow in the lake depression mainly confined along the peripheral channels and flow seems to be comparatively higher than the previous month.
- The central part of the depression is comparatively free from any accumulated water expect small path on the frontal side and few streamlets on the uppermost side.
- The inflow and the outflow seem to be normal however, based on the tonal difference volume of water seems to be slightly more in the downstream part near the landslide than the outflow below the landslide reflecting slight accumulation of water because of the landslide.
- In the lake depression, no braiding of the channels could be observed and the water is flowing from its usual path.
- Based on the satellite data interpretation, there does not seem to be any threat from the Parechhu Lake as on day but need regular monitoring till it freezes.

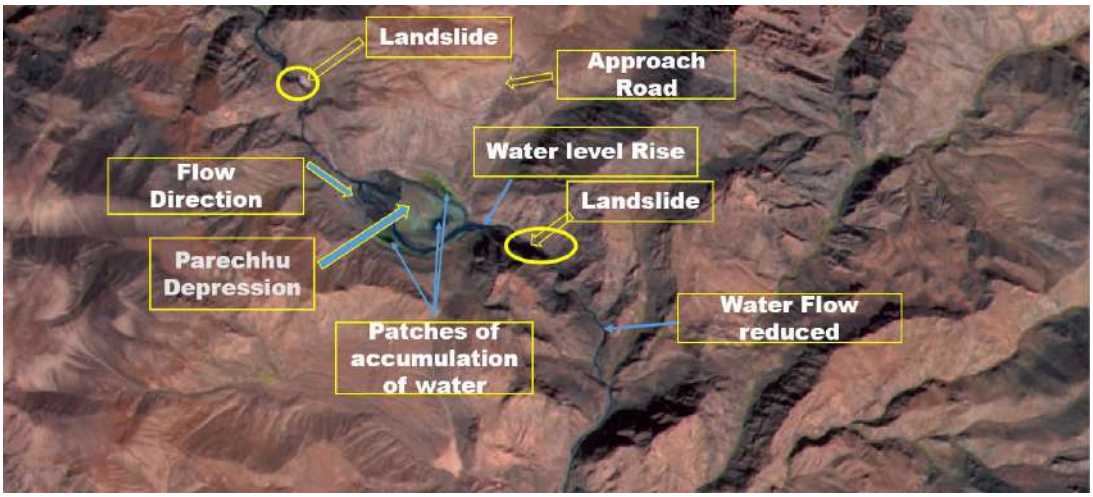

Figure 12 Satellite view of Parechhu Lake as on 8th October 2021 through IRS-R2A-LISS-III-96-48 Image

CONCLUSION

Overall distribution of Quaternary deposits in Himachal Pradesh as per the preliminary work delineated on LISS III and Landsat satellite data is 4481 km^2 which is only 8% of total geographical area of the state. Valley fill has highest contribution almost 50% (2440 km^2) in Quaternary deposits whereas alluvial fan has lowest contribution. As per the table 1.2 in Kangra district, 1103 km^2 of area lies under valley fills which is highest among all the districts followed by Una district (448km^2) and Mandi district (257 km^2). Whereas in Shimla district (3.69 km^2) contributed lowest among all the district just next to the Kinnaur district (6.33 km^2). In Himachal Pradesh 363km^2area lies under the category of flood plains out of 4481 km^2 area of Quaternary deposits. Lahaul and Spiti district of the state comprises 110 km^2 is the highest among other districts whereas Shimla district (4.62 km^2) has lowest.

The quaternary deposits formed by fluvio-glacial are moraine complexes, alluvial fan, piedmont moraine and glacial outwash plains. Moraine complexes are found in higher altitude regions in Chamba Kullu, Kinnaur, Lahaul & Spiti and Shimla district of the State. The total area of moraine complexes of Quaternary deposits of the state is approximately 718 Km^2. Alluvial fanis a triangle-shaped deposit of gravel, sand and even smaller pieces of sediment, such as silt. This sediment is called alluvium. Alluvial fans are usually created as flowing water interacts with mountains, hills, or the steep walls of canyons. The total area of Alluvial fan of Quaternary deposits of the state is approximately 113 Km^2.

In geology, a terrace is a step-like landform. Hill cut terrace formed in mountainous region near river valleys where slope of the hills is less. Hill cut terraces are found in Kinnaur (46 km^2) and Lahaul and Spiti (28 km^2). The glacial out wash plains are large areas of glacial sediment deposited by meltwater streams furthest away from the glacial snout. They are formed from gravels, sands and clays, the clays being furthest away from the snout because the smaller particles are carried furthest. These glacial out wash plains are found in Kinnaur and Lahaul & Spiti comprising of 6.48 km^2 and 9.22 km^2 respectively.

GLOFS

Based on the IRS-RS2-LISS-III satellite data having spatial resolution of 23.5mts and Landsat 8 MSS satellite data having spatial resolution of 30mts for the year 2018, the study area was analysed in order to make an updated inventory of moraine dammed glacial lakes known as GLOFs (Glacial Lake Outbursts Floods) in Himachal Himalaya comprising the Satluj, Chenab, Beas and Ravi basins. The Satluj basin has been studied in detail right from its origin from the Tibetan Himalaya, whereas the other basins have been analysed for their areas of interest in Himachal Pradesh. The results based on the analysis thus obtained reveals that in Satluj basin, a total of 769 lakes from the Satluj catchment covering 8 satellite imageries (96-48,96-49,97-48,97-49,98-48,98-49,99-49,100-49) having spatial resolution of 23.5 mts. have been mapped during 2018. Based on the analysis of the LISS III results obtained, it is found that total number of lakes has increased from 390(2015) to 581(2016) to 642(2017) to 769(2018) indicating an increase of about 97% with respect 2015 and about 19% increase with reference to 2017 data based on LISS III analysis. The large increase with reference to 2015 is mainly due to the non-availability of complete satellite data coverage covering the entire study area during 2015 as a result of which, there was a data gap because of 96-49 path row and thus the inventory information was not complete. Further distribution of these 769 lakes suggests that maximum number of lakes i.e., 495(64%) forms part of the Upper Satluj basin is sub basin 3, 98(12%) from the Lower Satluj basin i.e., sub basin 2 and 176(22%) from the Spiti basin i.e., sub basin 1 in 2018. Based on the areal distribution, 663(86%) of the total lakes are the small one with area <5ha, 57(7%) are with areal range 5-10ha and 49(6%) are the big one with area >10ha. The comparative analysis based on LISS III data reveals that total number of lakes varies from 581(2016) to 642(2017) and 769(2018) indicating an overall increase of about 10% between 2016 & 2017 and about 19% between 2017-& 2018 in terms of the total number of lakes. Likewise, the comparative analysis based on the areal distribution suggest that total number of lakes with area >10ha varies from 55(2017) to 49(2018) indicating an overall reduction of about 3% in the study area. Further classification of the lakes based on the analysis from LISS III data, it is found that 66 lakes are mainly the high-altitude wetlands out of 769 total lakes mapped in 2018 and the remaining lakes are the lakes from the glacial origin i.e., either these are formed at or near the glacier snouts known as Moraine Dammed Glacial Lakes or more commonly known as GLOFs or the Supra Glacial lakes i.e., within the glacier body in the ablation's zones of the glaciers.

The Chenab basin comprising mainly of (Chandra, Bhaga, Miyar) as sub basins has a total of 254 lakes comprising (64 lakes in Chandra sub basin, 84 lakes in Bhaga sub basin and 106 in

the Miyar sub basin) respectively. Thus, the Chenab basin as a whole has 254 lakes (2018) in comparison to 220 (2017),133(2016) and 192 (2015), which is about four times more than the lakes which were identified earlier using 2001 (55) satellite data (Randhawa et.al. 2005) and about 15% increase w.r.t 2017. When these 254 lakes seen based on their aerial range, it has been found that maximum lakes (240) falls in the category where the area is less than 5 hectare, 10 lakes where area is between 5-10 hectare and only 04 where area is more than 10 hectare indicating a reduction of about 20% in case of bigger lakes i.e., lakes with area more than 10ha and about 25% increase in case of the lakes with area between 5-10ha w.r.t 2017(Fig 11.2) and an increase of about 15% in case of the lakes with area less than 5 ha

The Beas basin (Upper Beas, Jiwa, Parbati), has a total of 65 lakes comprising (23 lakes in Upper Beas, 15 lakes in Jiwa and 27 lakes in Parvati sub basins) have been delineated during the year 2018 indicating a reduction of about 35% less lakes mapped in 2018 in comparison to 2017 which is mainly due to the fact that the cloud cover in case of Jiwa basin is comparatively on higher side as a result of which the area is not fully exposed. Further analysis of these 65 lakes reveals that 58 lakes are smaller one having area less than 5 hectare, 04 lakes with aerial range between 5-10 hectare and 03 lakes which are having area more than 10 hectare in 2018 indicating an overall reduction of about 36% in case of the lakes with less 5ha and about 25% reduction in case of the bigger lakes with area more than 10ha in comparisons to 2017, whereas the lakes with area 5-10 ha does not show any change. Likewise in Ravi basin, a total of 66 lakes have been mapped in 2018 in comparison to 54 lakes that of 2017. When seen based on aerial distribution, it is found that 03 lakes are having area more than 10 hectare, 02 lakes are having area between 5-10 hectare and 61 lakes are such which have area less than 5 hectare

As far as the temporal variation of all such lakes with area more than 10ha is concerned, there has been a considerable increase in their total number in Satluj basin i.e., the total number of such lakes has increased from 40(2013) to 42(2015) to 55(2016) to 52(2017) and 49(2018) respectively. Likewise in other basins, i.e., in Chenab, the number of lakes varies from 3(2013) to 4(2015) to 2(2016), 5(2017) and 4(2018), in Beas basin the number varies from 2(2013) to 2(2015) to 3(2016) to 4(2017) and 3(2018) and the Ravi basin, the number of lakes varies from 2(2013) to 3(2015) to 3(2016) to 3(2017) and 3(2018) respectively. Thus, it is very important that since these lakes are the big one and needs to be monitored regularly in terms of their spatial behaviour, so that any eventuality arising out of these lakes could assessed well in advance in order to a minimize the post disaster effects in the catchments. Besides this, the

other category of lakes in each basin with area between 5-10ha are also potential sites which can cause considerable damage in if any one of these bursts.

Based on the above analysis carried out for 2018, it is found that there is a considerable increase in the total number of lakes in each basin with respect to the preceding years which reflects that formation of such lakes i.e., moraine dammed glacial lakes or the lakes due to the melting of Himalayan glaciers in the Higher Himalayan region is on the increasing side. The analysis further reveals that the higher number of smaller lakes i.e., the lakes with area less than 5 hectare indicates that the effect of the climatic variations is more pronounced on the glaciers of the Himalayan region resulting in the formation of small lakes in front of the glacier snouts due to the damming of the morainic material resultant of the melting of the glaciers. The recent tragedy of 2013 in the Uttrakhand Himalaya has also been correlated with the bursting of a lake having a total area of about 08 hectare in front of the snout of the Chorabari glaciers that caused widespread damage in the downstream areas besides the heavy rainfall (Dobhal et.al.2013). Thus, the magnitude of such lakes as far as the destruction is concerned cannot be overruled. Besides this, the lakes with area >10 hectare and the area between 5-10 hectare can be seen as the potential vulnerable sites for causing damage in case of bursting of any one of them. Thus, a proper monitoring of all such lakes is very much essential in the Himalayan region in order to avoid any eventuality like in Uttrakhand in future, which will not only save the precious human lives but also the public and the Govt. property.

SNOW COVER

- The analysis has been made from the AWIFS satellite data for 2019-20 for assessing the total area under snow during the period October to May and its temporal analysis with that of the monthly averaged values of the total area under snow 2018-19, the following inferences are drawn:

- Basin wise analysis from October to May in 2019-20 and its comparative analysis with that of 2018-19 reveals that at the beginning of winter i.e., during the month of October 2019, all basins have been characterized by less snow cover area and the decrease is of the order of about 36% in Chenab, 11% in Beas, about 39% in Ravi and about 31% in Satluj basins in 2019-20 in comparison to 2018-19.

- Likewise, in November, a positive trend could be seen in Ravi and Satluj basins respectively wherein the Ravi basin shows an increase of about 5% and the Satluj basin indicates an increase of about 46% in 2019-20 than 2018-19. The other two basins i.e., Chenab and Beas recorded about 9% and 2% less snow cover area in 2019-20 than the previous year.

- In December, all basins have shown an increase in the surface area under snow by 13% (Chenab), 28% (Beas), 45% (Ravi) and 41% (Satluj) basins respectively in 2019-20 in comparison to 2018-19.

- In January, the Chenab basin shows an increase of about 7%, the Beas basin by about 72%, in Ravi basin the increase is of the order of about 95% and in Satluj basin the increase is of the order of about 30% respectively.

- During February 2020, all basins show a decrease in their area under snow cover and the decrease is of the order to 3% in Chenab, 4% in Beas, 38% in Ravi and about 4% in Satluj basins respectively reflecting that maximum decrease observed is in the Ravi basin whereas the other basins does show a marginal reduction in their area under snow in comparison to 2018-19.

- In March, Beas and Ravi basins shows more decrease in surface area under snow i.e., Beas (28%) and Ravi (45%), whereas Chenab and Satluj basins shows a reduction of about 7% and 8 % less snow cover area in 2019-20 in comparison to 2018-19.

- Thus, during winter months (November to January), we can say that there is more snow in 2019-20 winter in the southeastern part of the Pir Panjal Range in Himachal Pradesh covering mainly the Satluj basin than the other basins i.e., Beas and Ravi basins respectively, whereas Chenab basin does not show much change in 2019-20 than 2018-19. The other winter months i.e., October, February and March, all basins show less snow cover area in 2019-20 in comparison to 2018-19.

- The analysis of summer months i.e., April and May reveal that in Chenab basin, about 87% of the total basin area in April and about 65% as in May is still under the impact of snow reflecting that about 22% of the total basin area has been melted out between April and May.

In other words, we can say that about 65% of the total basin area would melt during the next ablation month (June to August) meeting the discharge dependability from the Chenab basin.

- Likewise, the Beas Basin in the month of April has about 49% of the total basin area and in May about 45% is under snow cover impact reflecting that about 4% of the total basin area has been melted in Beas basin between April and May and thus about 45% of the total basin area of Beas would be available for meeting the water requirements from snowmelt during the next ablation months in summer.

- The Ravi basin shows that about 44% of the total basin area in April and about 26% in May of the total basin area is under snow cover impact reflecting that about 18% of the total basin area has been melted out between April and May and thus only 26% of the total basin area would be available for meeting water requirements from snowmelt of the Ravi basin during next ablation months.

- Likewise, the Satluj basin comprising of Baspa, Pin and Spiti indicates that about 72% of the basin area in April and about 50% in May is under the snow cover impact reflecting that about 22% of the basin area in Satluj has been melted between April and May and the remaining 50% would be available for meeting the water requirements from snow during next summer months in 2019-20.

- As a whole based on the analysis carried out from snow cover mapping in Himachal Pradesh during 2019-20 (October to May) a marginal decrease of the order of about 0.72% in the area under snow cover has been observed in Himachal Pradesh in comparison to the total area during 2018-19.

SPRING

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, Sirmour 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.

Mineral Wealth of Himachal Pradesh

Himachal Pradesh, with an area of 55,673 Sq. km, has the potential for the occurrence of economic minerals but has not brought to light any worthwhile metallic-mineral deposits so far. Though there are old workings of metallic mineral but, there is no major metal mine in the whole State. The situation however, is different in respect of non-metallic minerals having abundant reserves of cement to chemical grade limestone, dolomite, and also small reserves of barytes and gypsum. Himachal Pradesh is the only State in the Indian Union to have a working rock salt mine. The slate and building materials are also important minerals of the state. In the foot hill areas, despite having natural gas in Palaeogene -Neogene strata, exploration by drilling has not so far brought out encouraging results. In the Tethys Himalayan zone problems are much more severe due to poor logistics, inaccessibility and limited period of working owing to adverse climatic conditions.

About 37 minerals are reported in Himachal Pradesh and except for limestone, baryte, shale, rock salt, silica sand, magnesite, gypsum, quartzite, slate, building stone, bajri & sand, other minerals have only academic importance.

AGRI-HORTICULTURE SECTOR

IMPACT OF CLIMATE CHANGE IN HORTICULTURE CROPS OF SIRMOUR DISTRICT, H.P.

CURRENT CLIMATE TRENDS

Temperature (min, max, diurnal) and rainfall (quantity and days) are used as explanatory indicators to capture the crux of climatic changes in the district. A highly significant shift in climatic factors was noticed in the pre-flowering season, flowering season, and fruit setting season, according to the statistical analysis, the Mann Kendall trend test. Observations showed the Mann Kendall test findings for minimum, maximum, diurnal temperature, and rainfall for the years 1995-2019 at a 95% confidence level. Analysis revealed that for temperate fruit crops, the diurnal temperature scaled significantly at a rate of 0.096^{o}C per year during the pre-flowering stage and the average minimum temperature declined significantly by -0.046°C per year, during the fruit setting stage. For subtropical fruit crops, the average minimum temperature decreased significantly at -0.059^{o}C per year whereas, the diurnal temperature shows a significant increase at 0.209^{o}C per year during the pre-flowering stage (1995-2019).

CROP PRODUCTIVITY TRENDS

As per the Mann-Kendall Test analysis, a significant increase was observed in the case of Peach (0.039 t ha-1yr-1), and a highly significant increase was seen in Apricot (0.041 t ha-1yr-1), pear (0.038 t ha-1yr-1) and Dry Fruits (0.028 t ha-1yr-1). Other temperate crops like Apples and Plums also showed increased productivity, but it was statistically nonsignificant. In the case of subtropical fruit crops, productivity was also increased, except for Orange/Kinow, Mango, and Guava, which are nonsignificant. The fruit crops where the productivity was highly significant were Malta (0.145 t ha-1 yr-1), Kagzi Lime (0.050 t ha-1 yr-1), Galgal (0.049 t ha-1 yr-1) and Litchi (0.105 t ha-1 yr-1).

CLIMATE-FRUIT CONNECTION

In nutshell, among all the analysed crops, to the increased crop yield of Malta/Kinow the contribution of climatic variables was 48.2%, 44.4%, and 31.6% for pre-flowering, flowering and fruit setting stage respectively. The contribution of climatic variables towards the increased crop yield of Orange/Kinnow, Malta/Mausami, Kagzi lime, Galgal, and Galgal were 25.7%, 48.2%, 56.2% (very high), and 30.3% respectively during the pre-flowering stage. Whereas the decreased crop yield of guava was impacted 16.6% by climatic variables. The climatic correlation for other crops did not show any remarkable change.

For flowering stage, the increased productivity of Apple, Orange/Kinnow, Malta/Mausami, Kagzi lime, Galgal, Mango, and Litchi was impacted 24.5%, 32%, 44.4%, 24.3%, 23.6%, and 23.1% respectively by climatic variables. Although, the crop yield of Guava was decreased due to 31.2% impact of climatic variable during the flowering stage. The other crops during this stage showed a negligible change in correlation. For fruit setting

stage, correlation with high percentage was observed for pear (31.7%), Malta/Mausami (31.6%), Mango (23.8%), Litchi (21.5%) and Guava (22.6%). However, the percentage was low for the remaining crops of Sirmour district.

IMPACT OF CLIMATE CHANGE IN HORTICULTURE CROPS OF SIRMOUR DISTRICT, H.P.

CURRENT CLIMATE TRENDS

To capture the nerve of climatic changes in the district, temperature (min, max, diurnal), and rainfall parameters are considered as explanatory indicators. Based on the statistical analysis, Mann Kendall trend test, the average maximum temperature and annual rainfall showed highly significant increase at the rate of 0.035°C and 81.600mm per year during the *Kharif* crop season in last 28 years (1995-2018). Meanwhile, the average minimum temperature during the rabi crops season increased at the rate of 0.173°C per year while the diurnal temperature decreased at the rate of -0.215°C per year. However, the other climatic variables did not register any significant change during kharif and rabi season.

CROP PRODUCTIVITY TRENDS

As per the analysis from Mann Kendal Tests (as per interpretation of *p*-values at 95% confidence intervals), the crop yield of Wheat was decreased at the rate of -0.018t $ha^{-1}year^{-1}$. The crop yield of Maize and Total Pulses showed a highly significant increase at the rate of 0.037t $ha^{-1}year^{-1}$, and 0.008t $ha^{-1}year^{-1}$ respectively. The other agriculture crops like Barley, Rice, Black Gram, Masur and Horse Gram didn't show any significant variations.

CLIMATE-FRUIT CONNECTION

To ascertain the relationship between climatic variability and crop productivity, a correlation analysis was performed using the statistical tool- Pearson's coefficient. Relationship revealed that maximum temperature for Wheat showed significant moderate positive correlation whereas for rainfall a positive correlation was observed. However, the overall impact of these climatic variables is 32.6% to the decreased productivity of Wheat. For Barley crop, highly significant moderate negative correlation was observed with average minimum and diurnal temperature, depicting 43% as an overall impact on this crop. Rice was impacted 7.2% by the climatic variables whereas the crop yield of Maize was impacted 21.1%.

FORESTRY SECTOR

UNDERSTANDING THE NATURE OF ALPINE TIMBERLINES OF HIMALAYA: INTEGRATING ECOLOGICAL AND SCENARIO STUDIES FOR ASSESSING THE IMPACT OF CLIMATE CHANGE

Two people perception-based survey was conducted in LTER site of project at Kinnaur, Lahaul & Spiti and Chamba district. The first survey was conducted at Chitkul, district Kinnaur in September 2021. During this people perception-based study, it was observed that most of the people of the village were aware of climate change and especially conservation methods. For conservation of nature, people show their majority towards protections measures of the biodiversity resources in the area. No human interference is allowed in the forest area without permission of gram Panchyat. Agriculture practices had been shifted from traditional to cash crops in the area. A total of 57 people were consulted under this survey at Chhitkul village.

Figure 13 Perception based survey at Chhitkul village, district Kinnaur

In September 2021, a second field study was undertaken in the districts of Lahaul and Spiti and Chamba. Shipting, Bargul, and Mooling villages were studied at the Mooling LTER site. For the perception and history of the location, 47 people were interviewed. According to the survey, Mahila Mandal activities have helped to conserve the forest around the village for a long time. In the forest, tree felling is forbidden, and residents are not even allowed to take dried wood from the forest. The agriculture crops have been shifted from traditional to cash crops. Few people also grow some medicinal crops like Puskarmool (*Inola racemossa),* Kuth (*Saussurea costus*).

Figure 14 Field survey at Mooling Mahila Mandal and Shipting village district Lahaul & Spiti

Figure 15 View of Dargul and Mooling village in district Lahaul & Spiti

The Khanjar LTER site was also covered under survey. Challing, Changut, Udgosh, Shukto and Karpat villages were covered under Khanjar LTER site. A total of 62 individuals were consulted under perception-based survey. A similar pattern of conservation is also present in the area. The agriculture crops have been shifted from traditional to cash crops. Few people also grow some medicinal crops like Puskarmool (*Inola racemossa)*, Kuth (*Saussurea costus*). Forest are being conserved through Mahila Mandals.

Figure 16 Survey at Khanjar and Shukto village district Lahaul & Spiti

The Sural Bhaturi LTER site was also covered under study. In exercise, a total of 51 individuals were consulted from Tai and Sural Bhaturi village. A similar pattern of conservation of forest was seen in Sural also. In agriculture people had shifted to cash crops but also traditional crops like Fafra (*Fagopyrum esculentum*), Potato, Barley, Black Pea and Wheat.

Figure 17 View of Sural Bhautri LTER Site Pangi Valley district Chamba

Three LTER sites were also visited for monitoring & sample collection from *Betula utilis.* 100 leaves from each tagged trees were collected in three LTER site and samples from litter bags were also collected.

Figure 18 Leaf sample collection from Betula utilis and litter bags and traps in LTER sites

InVEST MODEL

Scenario studies have been performed using the InVEST Model (Integrated Valuation of Ecosystem Services and Trade-offs) V-3.9.2 in the four LTER (Long Term Ecological Research) sites of Himachal Pradesh, namely Chhitkul, Mooling, Khanjar, and Sural Bhaturi. The QGIS software was used for the final image processing and interpretation to highlight the visual changes in the terrain of identified LTER sites. Using the Scenario Generator: Proximity Based Tool of the InVEST Model, the data on people's perceptions of climate change acquired from different LTER sites helped in visualizing the future landscape of LTER sites. The model's basic functionality, including input requirements (shapefiles of location, watershed

border, area and values, and so on), output files, and intermediate files, was investigated in this work (Figure 8).

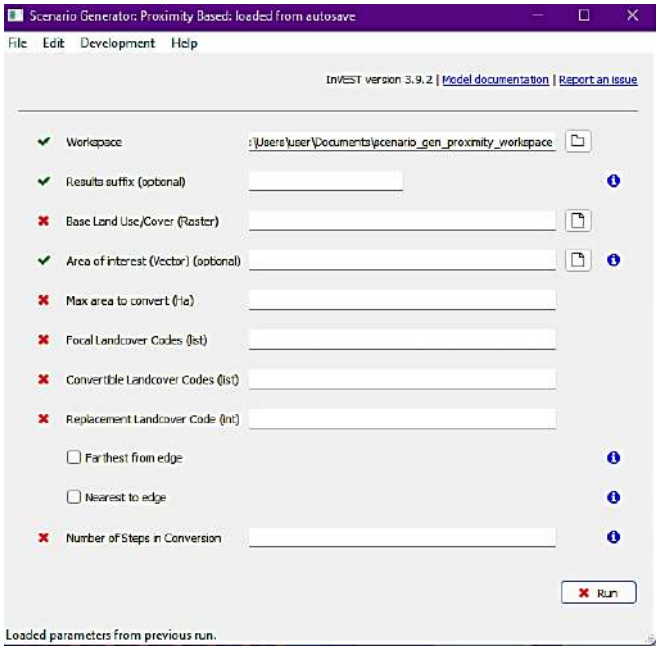

Figure 19 Showing Scenario Generator Tool: Proximity Based tool of InVEST Model.

The proximity-based scenario generator creates a set of contrasting land use change maps that convert habitat into different spatial patterns. The user determines which habitats can be converted and what they are converted to, as well as the type of pattern, based on proximity to the edge of a focal habitat. In this manner, an array of land-use change patterns can be generated, including pasture encroaching into forest from the forest edge; agriculture expanding from currently cropped areas; forest fragmentation; and many others. The resulting land-use maps can then be used as inputs to InVEST models or other models for biodiversity or ecosystem services that are responsive to land use change. Scenarios for the specified LTER site were created to depict how land use transitions, such as agriculture, forest, and snow cover, have changed in the present and future landscape. Some of the output files representing changes in land use cover are shown below (Figure 9 and 10).

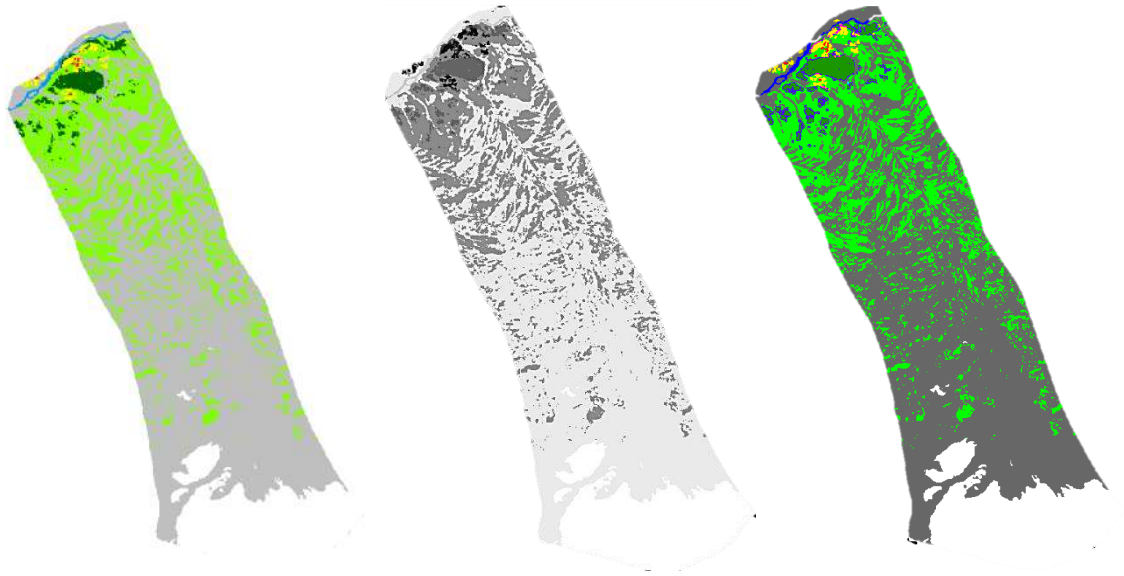

Figure 20 In the left showing the original Land Use land Cover (LULC) of Khanjar LTER site: figure in the center showing LULC file generated in InVEST software but without change detection and left figure showing the change in the landcover with different color for agriculture and forest

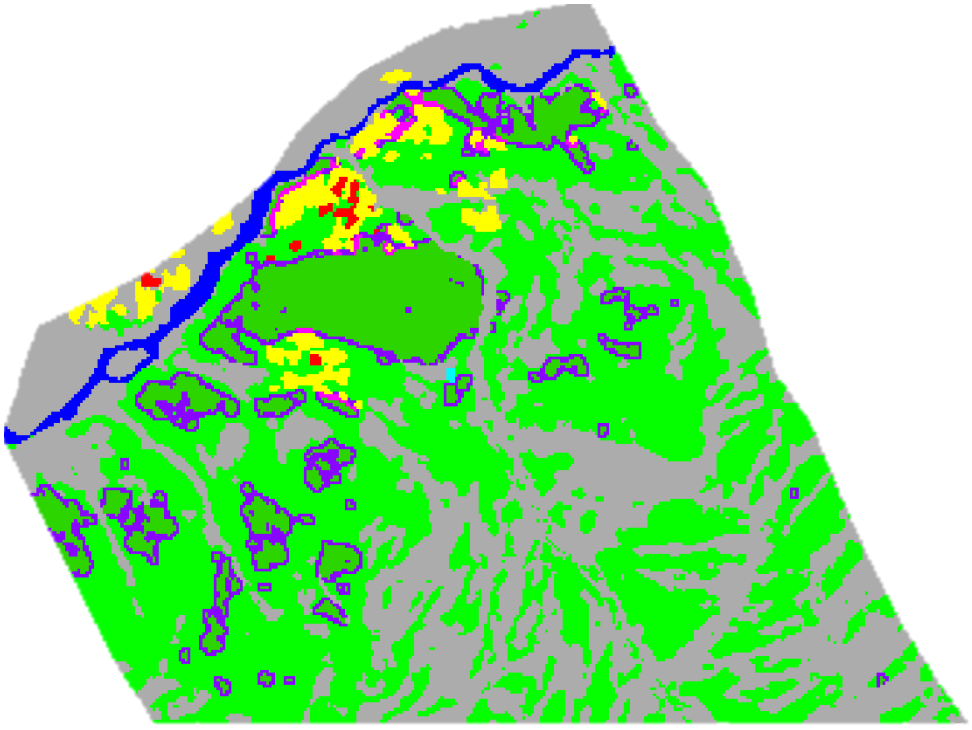

Figure 21 Closeup of the output generated in InVEST Software after change detection of Khanjar LTER site of Lahaul & Spiti, showing the different scenarios of site like forest and agriculture expansion based on the people perception and other climatic factors. Indications- (dark color: barren land; light green: pastures/grassland; dark green: Forest (blue pine and birch); yellow: agriculture; red: settlements; blue: river; pink: agriculture expansion; purple: forest expansion)

HIMALAYAN KNOWLEDGE NETWORK (HKN) ACTIVITIES

Under NMHS programme of MoEF&CC entitled **"Himalayan Knowledge Network (HKN)"** wherein G.B. Pant National Institute of Himalayan Environment & Sustainable Development (GBPNIHESD) Kosi-Kataramal, Almora-Uttrakhand has been identified as the Nodal Institute for the implementation of the programme across the Indian Himalayan Region (IHR). The Himachal Pradesh Council for Science, Technology & Environment (HIMCOSTE), Shimla has been identified as the Nodal Regional Partner under this programme and would compile the database pertaining to Himachal Pradesh.

Under "Himalayan Knowledge Network" two state specific thematic reports on **"Biodiversity"** & **"Water Resource Conservation and Management"** would be compiled based on stakeholder's consultations. Under this study stakeholder's departments would be given due recognition for their consultation provided.

A thematic report on **"Biodiversity"** has been compiled and submitted whereas report on **"Water Resource Conservation and Management"** is under process.

PUBLICATIONS

1. Climate Vulnerability Assessment of Farming Systems in Himachal Pradesh, Indian Himalayas
   Journal: Mountain Research and Development (MRD)
   Authors: Ranbir Singh Rana[1]*, Vaibhav Kalia1, Sharda Singh[1], S. S. Randhawa[2], Ramesh Chauhan[3], Anup Katoch[4], Anupama Sandal[5], Rajesh Kumar Thakur[4], and S. K. Upadhyay[6]

2. Recent glacier area changes in Himalaya–Karakoram and the impact of latitudinal variation
   Journal: Current Science
   Authors: Ishmohan Bahuguna[1]*, Bhanu Prakash Rathore[1], Avtar Singh Jasrotia[2], Surjeet Singh Randhawa[3], Santosh Kumar Singh Yadav[4], Sadiq Ali[2], Nishtha Gautam[3], Joyeeta Poddar[4], Madhukar Srigyan[1], Abhishek Dhanade[1], Purvee Joshi[1], Sushil Kumar Singh[1], Dhani Ram Rajak[1] and Shashikant Sharma[1]

WORKSHOPS/TRAININGS/SURVEY

TRAINING OF MASONS ON HAZARD RESISTANT CONSTRUCTION AT APPROPRIATE TECHNOLOGY CENTRE, SUNDERNAGAR BLOCK DISTRICT MANDI AND GRAM PANCHYAT NIHRI, DISTRICT MANDI, H.P.

INTRODUCTION

Training of masons on hazard resistant construction was organized in a series at Appropriate Technology Centre, Sundernagar Block, district Mandi and Gram Panchayat Nihri, Up-tehsil Nihri, district Mandi, H.P. in collaboration with State Disaster Management Authority (SDMA), Shimla, H.P. under the guidelines of National Disaster Management Authority (NDMA), GoI. The three days training programme was organized w.e.f. 16th to 18th December 2021 and 15th March to 17th March 2022 respectively. A total of 40 masons in ATC Sundernagar and 33 in Gram Panchyat Nihri were trained under this programme.

This training made masons aware not only of the critical principles of hazards resistant construction but also provide some practical skills in appropriate and relevant details of Rural Housing Technologies that people use in different regions of India. The objective of this training curriculum is to strengthen the practicing Masons on Hazard Resistant Construction Techniques and features through theoretical and practical sessions.

This training is meant to guide Masons on construction of engineered houses up to two stories and does not cover construction of engineered buildings with reinforced concrete frame for multi storey buildings.

TRAINING METHODS

This training module was envisaged to be for 3 days. Each training day was designed such that there would be ample time for hands-on training of Masons. The classroom sessions were planned using participatory methods with discussions, audio visual presentations models etc. Sessions provided enough time and scope for the trainees to discuss their concerns, questions and issues. The practical construction sessions were to get hands-on experience of hazard resistant features and details used in construction work.

GALLERY

Figure 22 Certificate distribution to masons during 3 days training programme at Gram Panchyat Nihri, district Mandi

Figure 23 Certificate distribution to masons during 3 days training programme at Appropriate Technology Centre, Sundernagar Block, district Mandi

TWO DAYS AWARENESS-CUM-DEMONSTRATION PROGRAMMES ON EARTHQUAKE RESISTANT CONSTRUCTIONS IN HIMACHAL PRADESH FOR THE ASSISTANT ENGINEERS & JUNIOR ENGINEERS OF DISTRICT CHAMBA

INTRODUCTION

Himalaya are considered to be the youngest mountain chains in the world are still in building phase and are seismically very active. Himachal Pradesh which forms a part of the North-western Himalaya is highly vulnerable to different kinds of natural disasters. The state as a whole is prone to prominent natural disaster such as earthquakes, landslides, flash floods, avalanches, droughts etc. and the state experiences the fury of one or the other disaster every

year. From the seismicity point of view Himachal Pradesh is considered to be very sensitive as it falls in zone V and IV as per the Seismic zoning Map of India.

OBJECTIVES

In order to create awareness on the construction of earthquake resistant houses in Himachal Pradesh, the State Council for Technology & Environment has been conducting training programmes at different platforms across the State. In order to sensitize the Assistant Engineers, Junior Engineers of different departments involved in construction activities was organized at Chamba for the officers/officials of Chamba district form 24-25 November 2021.

The workshop was organized jointly by HIMCOSTE Shimla, DDMA Chamba in technical collaboration with CBRI Roorkee. The workshops were organized with the following objectives:

- To create awareness about the disasters in general and the earthquakes in particular amongst the grass root level Assistant Engineer and Junior Engineers of Development Blocks, HPPWD, IPH, Development Blocks, Town & Country Department, National Highway of District Chamba.
- To impart hands-on training to the Assistant Engineer and Junior Engineers about the different earthquake resistant features to have earthquake resistant houses in rural areas of Himachal Pradesh.
- Capacity building of trained human resource development in having earthquake resistant constructions in Himachal Pradesh.

APPROACH

The two organizations, HPCST&E Shimla and CBRI Roorkee accordingly shouldered the responsibilities jointly and worked together for successful organization of the training programmes. CBRI on its part provided full technical support, faculty, Readers and course materials and planning & arranging of technical sessions, demonstrations, hands on practice sessions, film show etc. The training was organized at Bachat Bhawan Chamba wherein District Disaster Management Authority (DDMA) provided full logistic support.

PARTICIPANTS

The trainees of the programme were Assistant Engineers and junior engineers derived mainly from various departments of District Chamba participated in the programme. The programme

was attended by about 69 trainees consisting of Assistant Engineers and Junior Engineers from HPPWD, Jal Shakti Department Rural development department, Town & country Department, DIET & Municipal council etc. Interestingly the attendance kept on increasing every subsequent day as news of the programme spread by newspaper publicity and word of mouth.

GALLERY

Figure 24 Inaugural programme at Bachat Bhawan Chamba, District Chamba

Figure 25 Demonstration session under training programme and group photograph of trainee officers

TRAINING PROGRAMME ON "RETROFITTING OF BUILDINGS" AT CSIR-CENTRAL BUILDING RESEARCH INSTITUTE ROORKEE, U.K.

INTRODUCTION

To reduce the risk from natural hazards in existing building retrofitting and repairs of the structure can be undertaken. This demands proper planning, design, construction methods, use of innovative materials and trained manpower. CSIR-CBRI is one of the leading institutions in the country which has developed innovative technologies for architectural and structural design of multi-hazard resistant construction. These building technologies have been demonstrated in field, and hands-on training has been provided of grass root level functionaries in different parts of the country. It is essential to mass implement disaster-resistant innovative technologies developed by different institutions. This demands development of skills and capacity building among the administrative and technical functionaries at the state/district level for its systematic implementation.

Recognizing the need to develop a pool of trained professionals in the construction of disaster resistant building risk mitigation; CSIR-Central building research institute conducted a training course on "Retrofitting of Buildings in Himachal Pradesh Projects" w.e.f. 28th March to 2nd April, 2022 at its premises. This training course particularly aimed at enhancing knowledge and skills of the implementing archives to incorporate disaster resistant techniques in design and construction of buildings to mitigate the risk in existing buildings through lectures, demonstrations and hands-on exercises. 10 Assistant Engineers & Junior Engineers from district Kangra and Chamba participated the training programme at CBRI, Roorkee.

OBJECTIVES

- To understand various reasons for damage of structures
- Mechanism of damages
- Assessment of structural damage
- To enable participants to perform retrofit of structures
- To understand methodology/techniques of retrofitting
- To improve skills of participants related to construction quality, and improvement methods for the same

GALLERY

Figure 26 Distribution of certificates to trainee officers from Himachal Pradesh

PERCEPTION BASED SURVEY ON "IMPACT OF CLIMATE CHANGE IN AGRI-HORTICULTURE AND FORESTRY SECTOR IN 5 DEVELOPMENT BLOCKS IN SHIMLA DISTRICT"

To study the impact of climate change on different sectors like agriculture, horticulture and forestry in Shimla district, a survey was conducted in five development blocks of Shimla district i.e., Jubbal-Kotkhai, Rohru, Chauhara, Rampur and Basantpur w.e.f. 7th March to 11th March 2022. From Each development block 2-3 villages were selected depending upon the availability and accessibility. The villages covered under survey were: Sirthi (Jubbal), Hatkoti, Patsari (Jubbal-Kotkhai Development Block); Dhagoli, Tangnu, Kharshali (Chauhara Development Block); Rohru, Arhal, Batari (Rohru Development Block); Bhadhwari, Shingla, Nirath (Rampur) and Sunni, Shakrodi, Basantpur & Neen (Basantpur Development Block). Total individuals covered under this survey program were 350.

The assessment revealed that the ecology and landcover in the aforementioned developmental blocks of Shimla district is considerably changed over the last three decades.

Figure 27 Field survey at Tangnu village of Chauhara Development Development of district Shimla, HP

Figure 28 Field survey at Shingla village and Gram Panchyat Bhadwali, Rampur Development Block district Shimla, H.P.

SCIENCE, TECHNOLOGY & INNOVATION POLICY (STI) POLICY

The Science Technology & Innovation Policy (STIP) has been formulated and notified the for the state. Himachal Pradesh became the first state amongst the Himalayan states to have STI Policy and second in the Country. The STI Policy was released in public on the occasion of National Science Day- 28th February, 2022 at Gaiety Theatre Shimla by Sh. Govind Thakur, Hon'ble Education Minister, GoHP.

Figure 29 Release of Science Technology & Innovation Policy (STIP) Himachal Pradesh

MAPPING OF S&T NEEDS OF THE STATE OF HIMACHAL PRADESH

The S&T mapping has been done to convert Himachal Pradesh into a prosperous Himalayan Bio business hub through S&T empowerment of human resource for enhancing efficiently, productivity, cost effective, products, processes and technologies as well as to upgrade infrastructural support to R&D and educational institutions to generate highly skilled human resource.

The present scenario of the State with respect to S&T is to conserve and commercially utilize bio-resources of the State for sustainable development and to create awareness about the investment opportunities in Biotechnology, Genomics, Bioinformatics, Biofuels, Contract research, Entrepreneurship and Industrial investment in the state. Inculcating scientific temper across the society through science communication and fostering innovations and entrepreneurship for societal benefit.

S & T CLUSTER FOR PUNJAB, HARYANA, HIMACHAL PRADESH & CHANDIGARH

BACKGROUND

Advancements in the application of Science and Technology (S&T) have raised the expectations of people in every walk of life. S&T inputs assume greater significance in the hill states like Himachal Pradesh in view of its geographical constraints and the challenges for its development. The S&T is advancing at a rapid pace, affecting the physical infrastructure, skills and competence. Different problems/issues do exist across the different sectors in the state, which can be addressed by having possible solutions through S&T inputs. The S&T has huge potential in different sectors such as tourism, agriculture, horticulture, hydro power, animal husbandry, biodiversity, forestry, environment, climate change, energy/power, solid waste management, traditional/indigenous knowledge, industry and MSME providing best solution.

The present scenario of the state with respect to S&T is to conserve and commercially utilize bio-resources of the state for sustainable development and to create awareness about the investment opportunities in Biotechnology, Genomics, Bioinformatics, Biofuels, Contract research, Entrepreneurship and Industrial investment in the state. By inculcating scientific temper across the society through science communication and fostering innovations and entrepreneurship for societal benefit, will serve as resource capacity centre for promoting the frontier areas of S&T. The key sectors of S&T interventions relevant to the State include Horticulture, Agriculture, Health, Education, Natural Resource Management, Climate Change, Communication, Tourism and Transportation. Inputs and investments in these sectors would have a multiplier effect. The COVID-19 pandemic has underscored the pressing need for the state to focus more on elevating S&T in both policy as well as in practice. The role of S&T at this time of pandemic, is not limited to prevention or treatment of the disease but also closer to productive sectors.

ACCOMPLISHMENTS

The proposals in the 4 thematic area i.e., Agriculture and Food Processing, Animal Husbandry, Clean Energy and Disaster Management and Forecasting has been submitted to nodal agency. The academic institutions to carry out the projects are Indian Institute of Technology (IIT) Mandi; CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur; College of Veterinary-

CSKHPKV, Palampur and Himachal Pradesh State Disaster Management Authority (HPSDMA), Shimla.

CELEBRATION OF AZADI KA AMRIT MAHOTSAV UNDER 75 YEARS OF INDEPENDENCE

Azadi Ka Amrit Mahotsav is an initiative of the Government of India to celebrate and commemorate 75 years of independence and the glorious history of its people, culture and achievements. The official journey of Azadi ka Amrit Mahotsav commenced on 12th March 2021 which started a 75-week countdown to our 75th anniversary of independence and will end post a year on 15th August 2023. The programme is being organized through webinar monthly and speakers from universities, departments, institutions, NGOs and successful start-ups in Himachal Pradesh are invited to talk on themes.

ONE MONTH ONE THEME

S. No.	Month	Theme
1.	September	STI Institutions at State Level
2.	October	Human Capacity Building
3.	November	R&D Infrastructure
4.	December	Indigenous Technology
5.	January	Innovation & Start-up
6.	February	Science Communication & Popularization
7.	March	Women Scientist
8.	April	Science & Society
9.	May	Future Technologies
10.	June	Basic Science for Atmanirbharat
11.	July	Atmanirbharat & Industry
12.	August	Intellectual Property Rights

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