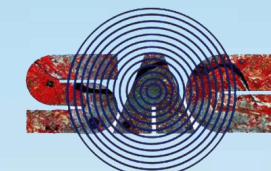


Concluding Remarks

Based on the analysis carried out, it is concluded that in 2021-22 winter period (Oct-April) an overall increase in the spatial distribution of the snow cover area of the order of 19.47% was observed in comparison to the total area under snow in 2020-21 winter period, which was about 18% less in comparison to 2019-20. Further during 2021-22, there was early snow fall in the month of October & November, there by leading to have positive trends in all basins. During peak winter months (December-February), two basins i.e. Chenab & Ravi have negative trends like that of the last winter, whereas the Beas and Satluj basins were characterized by positive trends and this variation may be due to the fact that the Chenab and Ravi which are adjacent basins along the Pir Panjal Range must have controlled the western disturbance in this region, whereas the Beas and Satluj which are on the south and south eastern side, reflecting positive trend may have the intersection of the another disturbance arising out from the southern side. The abrupt rise in temperature in different basins between 2021 & 2022 i.e. during the month of March in Chenab basin, the maximum temperature was increased by 1.3°C and 8.3°C in April and 3.0°C in May, in Ravi basin the temperature increase was 2.3°C in March, 6.1°C in April and 3.5°C in May at Chamba and at Dalhousie the increase was 2.1°C, 7.6°C, 5.0°C in March, April and May, in Beas basin, the increase was 3.0°C in March, 7.3°C in April and 4.0°C in May at Bhuntar and at Manali the increase was of the order of 3.7°C, 6.2°C and 2.6°C in March, April and May respectively.

Likewise, the temperature increase in Satluj basin was of the order of 2.8°C in March and 8.2°C in April and 2.9°C in May between 2021 & 2022. Due to this abrupt rise in temperature in 2022 between March and April in all the basins, the melting rate was accelerated in all the basins, thereby leading to reduction of snow cover area in each basin which ranges between 19-25% in 2021-22 in March & April in comparison to 4-10% in 2020-21 during the same period. Basin wise percentage area which would meet out the water requirement at the end of April was 66% (Chenab), 36% (Beas), 21% (Ravi) and 33% (Satluj) during the ablation season i.e., May onwards. Thus, concluded that the total area under snow during 2021-22 (Oct-April) was increased in early half i.e. October & November, which further reduced in peak winter months and further increased during late winter period i.e. February & March in comparison to 2020-21 winter period, but due to the rise in temperature in March & April, the snow cover area melted out fast in comparison to 2021.



Assessment of Spatial Distribution of Seasonal Snow Cover during the Year 2021-22 in Himachal Pradesh Using AWIFS Satellite Data

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Introduction

The State of Himachal Pradesh receives winter precipitation in the form of snow at the higher altitudes. About 1/3rd of the total geographical area of the State remains under thick snow-cover during the winter season. Most of the major rivers like Chenab, Beas, Parvati, Baspa, Spiti, Ravi, Satluj and their perennial tributaries originating from the Himalayas depend upon the seasonal snow cover for their discharge dependability. Besides this, the snow cover also helps in controlling the accumulation and ablation patterns of the glaciated regions in the State. Considering the importance of seasonal snow cover as a major input in controlling the hydrology of the river basins, seasonal snow cover assessment in terms of its spatial distribution is being carried out in different river basins in Himachal Pradesh during the winter season from October to May. In order to assess the spatial extent of seasonal snow-cover in Himachal Pradesh during the winters of 2021-22, and its comparative analysis with that of 2020-21, the total area under snow cover was estimated using AWiFS satellite data during 2021-22 and was compared with that of the values estimated during the period 2020-21 in Himachal Pradesh.

Methodology

Normalized Difference Snow Index (NDSI):

One of the important difficulties in snow cover monitoring is the presence of cloud cover. Cloud has strong reflectivity in visible, NIR and SWIR regions while snow absorbs in SWIR, and this difference can be utilized for snow/cloud discrimination. Normalized Difference Snow Index (NDSI) utilize the normalized ratio of green & SWIR and is used as an automated approach for snow mapping addressing the shadow and cloud problems in snow bound areas.

Normalized Difference Snow Index was calculated using the ratio of green wavelength (band 2) & SWIR (band 5) of AWiFS sensor:

◆ Normalized Difference Snow Index (NDSI): $(band2 - band5) / (band2 + band5)$

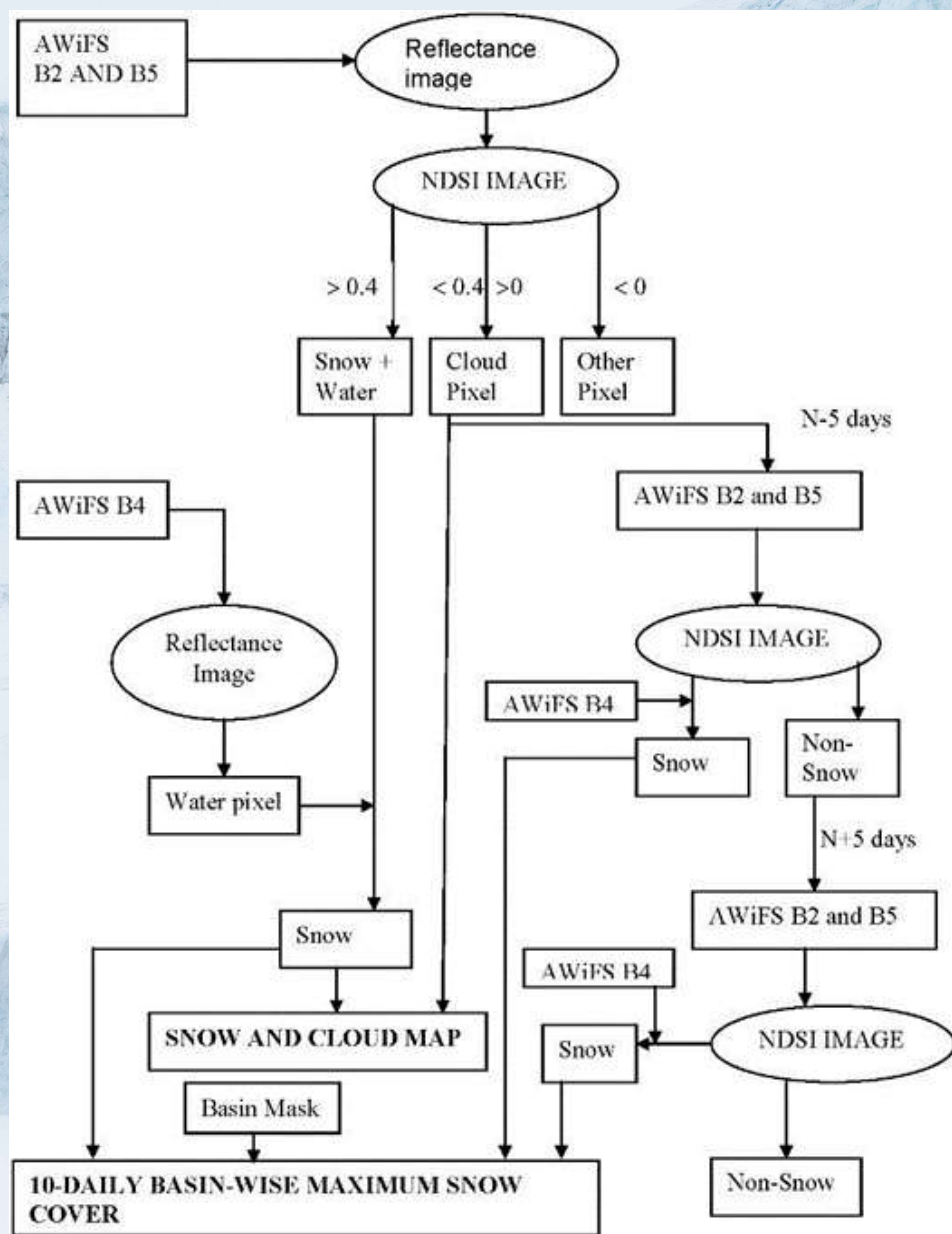


Fig. 1: Algorithm for snow cover mapping using AWiFS data

Results and Discussion

Snow is an essential resource present in the Himalayas. 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 meters w.e.f. October 2021 to April 2022. During 2021-22, snowfall was estimated and analyzed with reference to the average value of the total area under snow cover in each month from October to April using the following sets of available AWiFS data.

Month wise Distribution of Snow cover in Satluj Basin

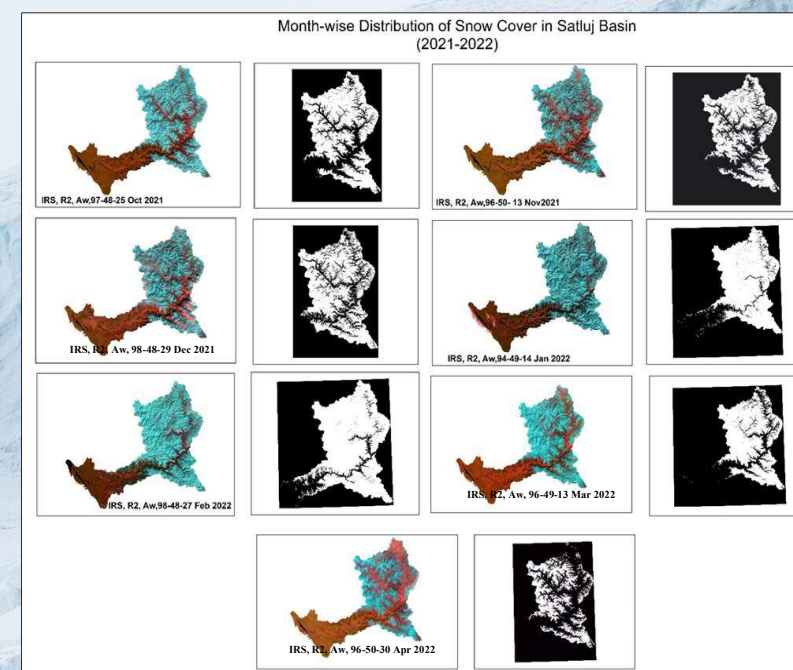


Fig. 2: Month-wise Distribution of Snow Cover in Satluj Basin

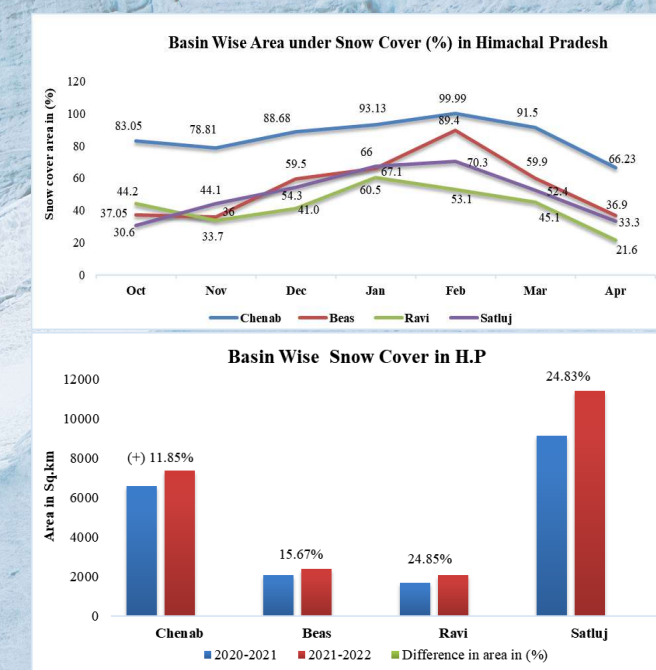


Fig. 3: Basin wise Area under Snow Cover

It is observed that during 2021-22, there is an overall enhancement of about 19.47% in total area under snow cover in Himachal Himalaya. It is analyzed that all the four major rivers basins of the state i.e. Chenab, Beas, Ravi and Satluj shows an increase in the snow cover area in 2021-22 in comparison to 2020-21. The dominant enhancement in terms of the total monthly average area (Oct to April) observed in case of Ravi (24.85%), Satluj (24.83%), Beas (15.67%) and Chenab (11.85%) in 2021-22 in comparison to 2020-21

Temperature Trend Analysis (2021 & 2022) in Himachal Pradesh

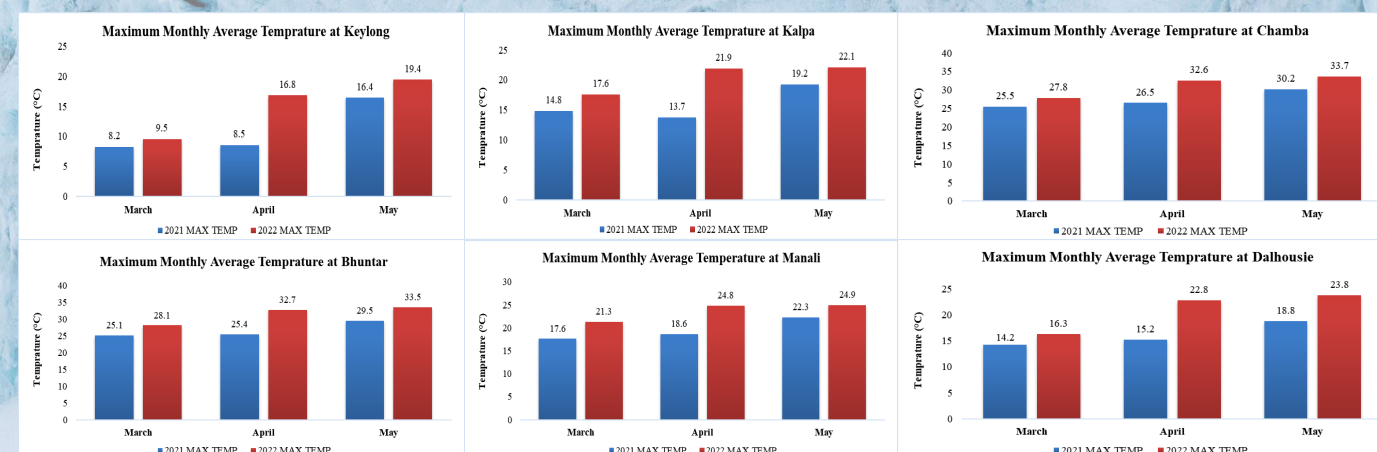


Fig. 4: Temperature Trend Analysis of Different stations in Himachal Pradesh