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MONITORING OF SEASONAL SNOW COVER IN YAMUNA BASIN OF UTTARAKAHND HIMALAYA USING REMOTE SENSING TECHNIQUES

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ABSTRACT

Himalaya has one of the largest resources of snow and ice, which act as a freshwater reservoir for all the rivers originating from it. Monitoring of these resources is important for the assessment of availability of water in Himalayan rivers. Therefore a study was taken up with the objective to monitor snow cover in the sub-basins of Ganga. Snow cover was monitored for Yamuna basins for beginning from 2003 by using the algorithm based on Normalized Difference Snow Index. These basins are selected on the basis of different climatic zones. The snow accumulation and ablations curves are different for each basin, depending upon climatologically sensitive zones and altitude distribution of the basin. NDSI Algorithm was used to generate snow cover products in every five and ten daily intervals. The present result gives the current status of Snow cover area of five and ten daily products. The AWiFS data of Resourcesat satellite was analyzed to estimate snow extent. The snow cover was monitored for a period between October and June from year 2003 to 2010 A total 156 AWiFS scenes were analyzed during this period. Snow cover was not monitored during June-September due to cloud cover. The various parameters as maximum and minimum radiances, mean solar Exo-atmospheric spectral irradiances in the satellite sensor bands, satellite data acquisition time, solar declination, solar zenith and solar azimuth angles, mean Earth-Sun distance was used to estimate reflectance. Sensitivity analysis has shown that a NDSI value of 0.4 can be taken as a threshold to differentiate between snow and non-snow pixels. Results obtained during this investigations suggest presence of snow cover in different months vary from October to June.

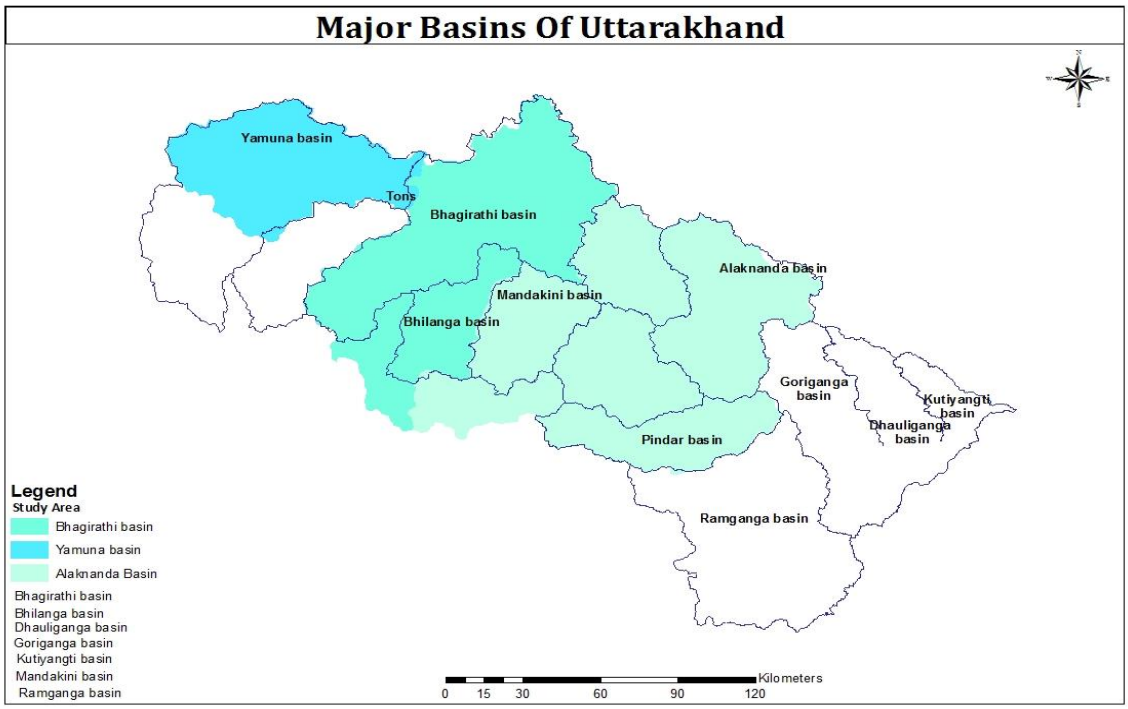
KEYWORDS: *NDSI, Snow cover, Yamuna Basin*

I. INTRODUCTION

Glaciers and snow fields together form one of the most crucial freshwater resources for Indian economy. Animal and plant life of the Himalayas and foothills depends on the melt water of these frozen reservoirs. There are several thousand of glaciers in Himalayas which feed to Indus, Ganga and Brahmaputra river systems but glaciers studies have been very limited due to the efforts and logistics required to carry out the field studies. Remote sensing technique has proved to be most viable alternative to monitor snow and glaciers. Mapping and monitoring of seasonal snow cover can be used by remote sensing because of large area is covered, high temporal frequency data are available and snow has distinct signatures in optical remote sensing data which makes it easily identifiable and map able. Therefore remote sensing can provide faster information on accumulation or ablation of snow cover than any other conventional means. This even becomes much more useful in a terrain like Himalayas where accessibility to remote areas is highly difficult and hazardous. The present result gives the current status of Snow cover area of five and ten daily products. The AWiFS data of Resources at satellite was analyzed to estimate snow extent. The snow cover was monitored for a period between October and June from year 2004 to 11. A total 152 AWiFS scenes were analyzed during this period. Snow cover was not monitored during June-September due to cloud cover. To

generate snow cover products, initially master template was prepared using control points from 1:250,000 scale maps and then basin boundaries were delineated using drainage map. The various parameters as maximum and minimum radiances, mean solar Exo-atmospheric spectral irradiances in the satellite sensor bands, satellite data acquisition time, solar declination, solar zenith and solar azimuth angles, mean Earth-Sun distance was used to estimate reflectance. Sensitivity analysis has shown that a NDSI value of 0.4 can be taken as a threshold to differentiate between snow and non-snow pixels. Inventory of glaciers in three basins was carried out on 1:50,000 scale using AWIFS data of 2004-2011. Results obtained during this investigations suggest presence of snow cover in different months vary from October to June. Snow cover of different basins is combined to estimate snow cover of Ganga basin. In the winter of 2006 and 2007, for a period between October and mid-December, snow cover was less than 50 percent and increased to 82 percent by the end of January. Snow extent remained more than 80 percent till beginning of April and retreat of snow cover continued till the end of June. By the end of June snow cover was only 37 percent.

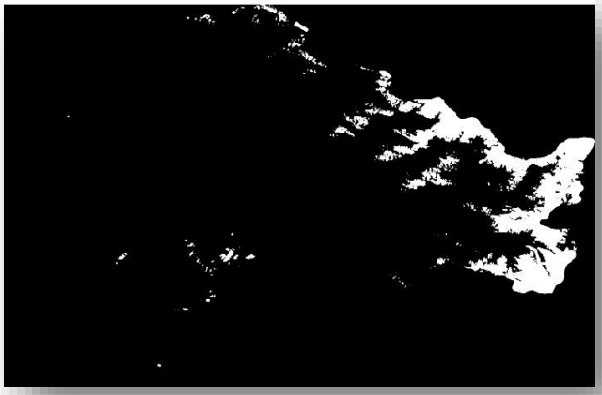
Study Area and data used

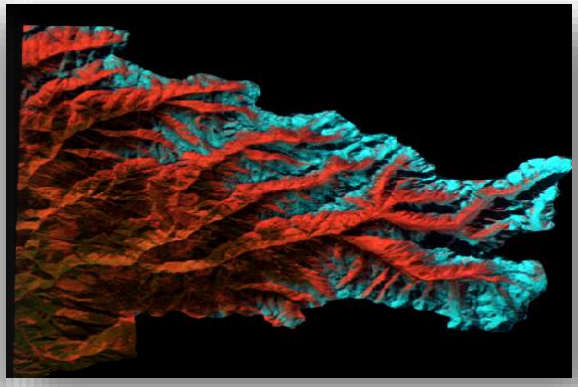


Uttarakhand is located between the latitudes 28º 43'-31º 27'N and longitudes 77º 34'- 81º02'E with a maximum dimension of east - west 310 km and 255 km north - south covering an area of 53,484 km^2 with the elevation ranging from 210 to 7817 masl.

This study gives distribution of snow cover in the Yamuna basins of Uttarakhand. Extensive snow monitoring has been carried out in this basin. Yamuna basin covers area of 3527 km^2. IRS-P6, RESOURCESAT-1 satellite AWiFS sensor (multispectral), with spatial resolution of 56 meters Approximately 156 AWiFS scenes from the year 2004-2005 to 2010-2011 were analyzed in this investigation.

AWiFS image Yamuna basin **Snow cover image of Yamuna basin**

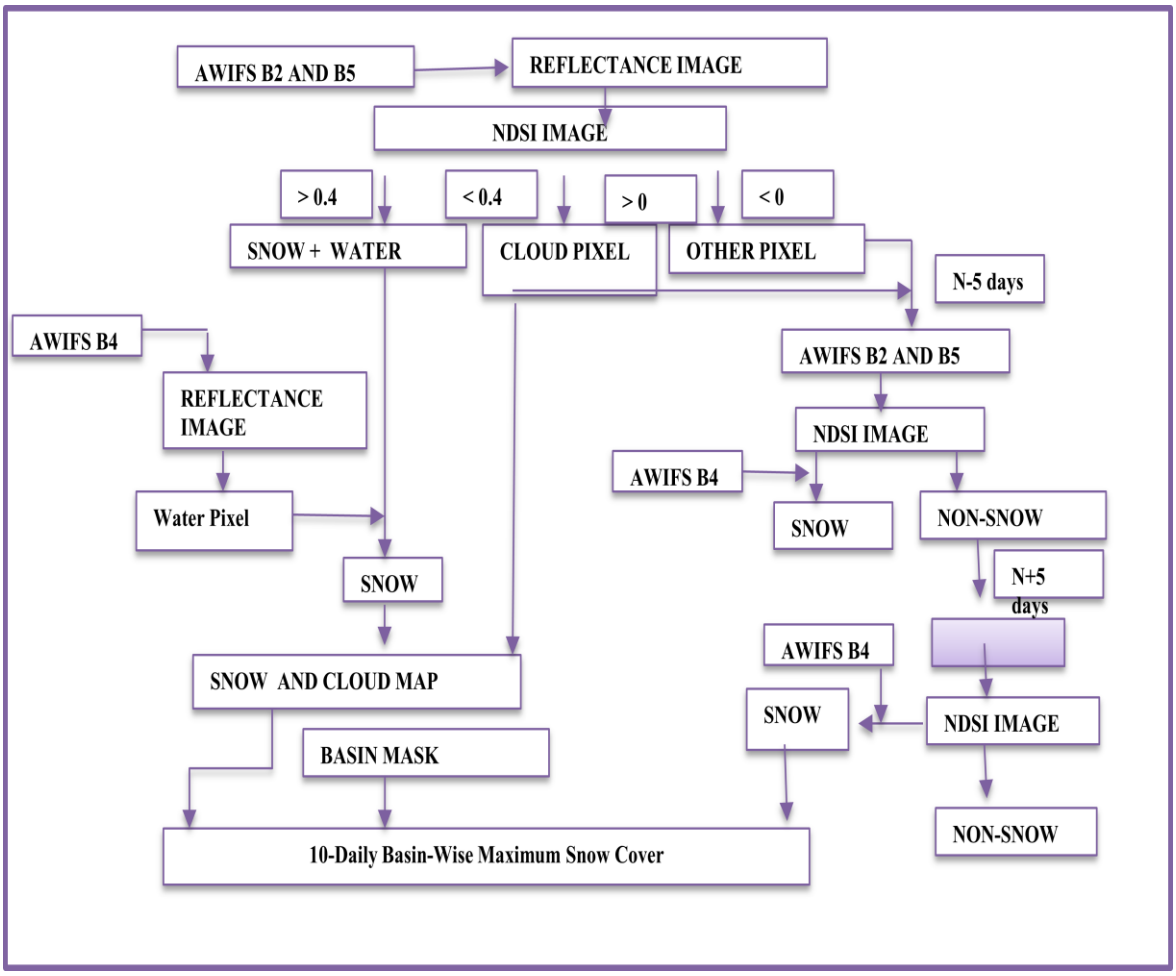




II. METHODOLOGY

The AWiFS data of Resources at satellite was analyzed to estimate snow extent. The snow cover was monitored for a period between October and June for one years from 2010-11. A total 74 AWiFS scenes were analyzed. Snow cover was not monitored during June-September due to cloud cover. The algorithm based on Normalized Difference Snow Index (NDSI) was used to map snow cover (Kulkarni et al, 2006). NDSI was calculated using the ratio of green (band 2) and SWIR (band 5) channel of AWiFS sensor. NDSI is established using following method as given in equation 1.

Normalized Difference Snow Index (NDSI) (band2/band5) /(band2/band5) ... (1)

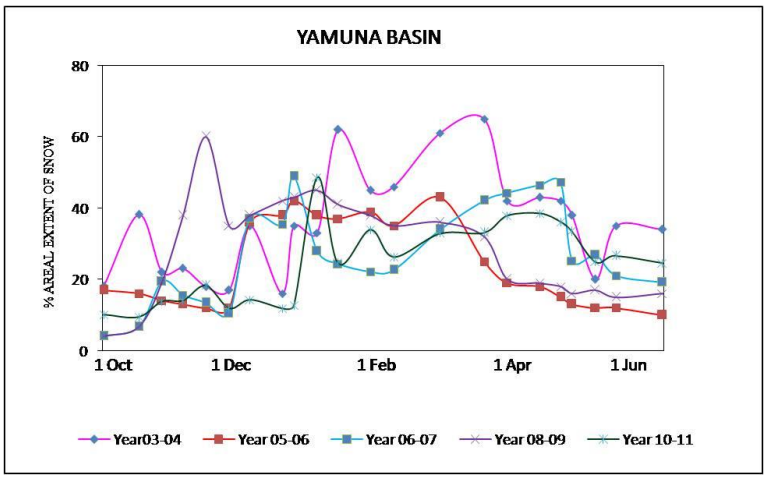


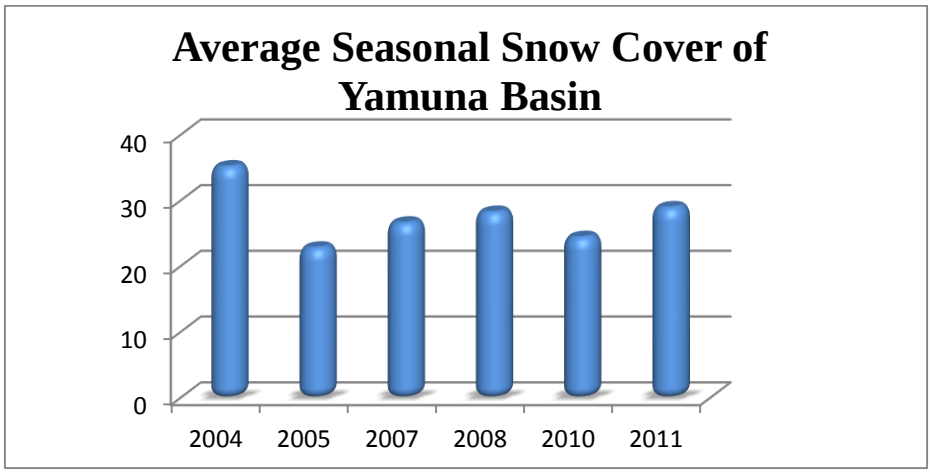
Algorithm for Snow Cover Monitoring

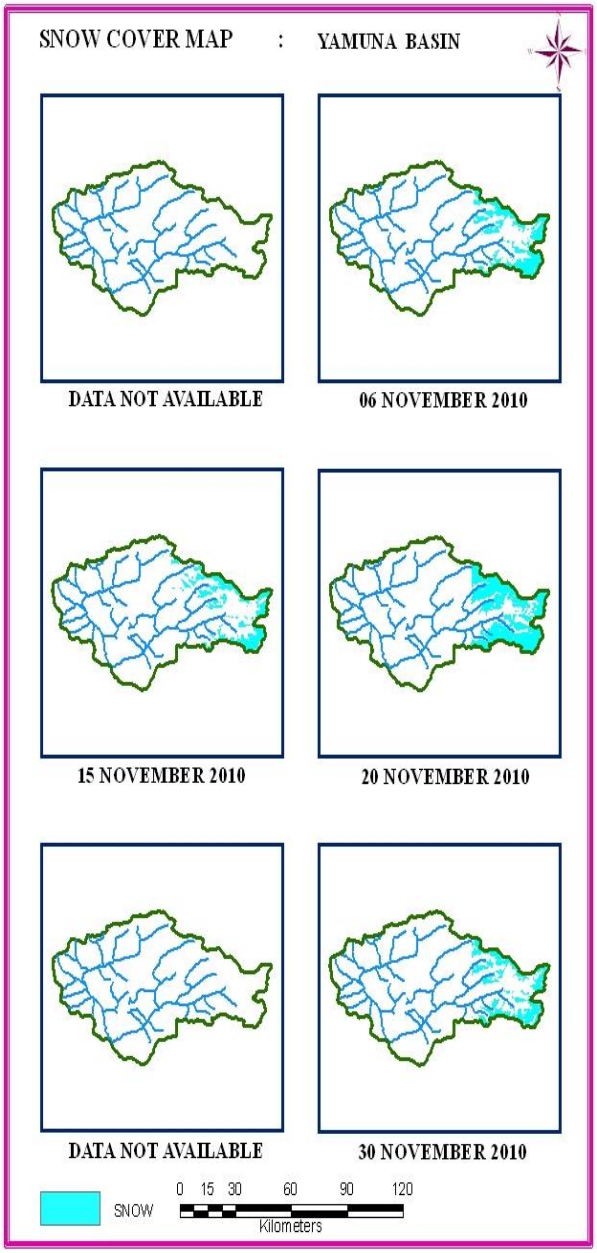
To estimate NDSI, DN numbers are converted into top-of-atmosphere (TOA) reflectance. This involves conversion of digital numbers into the radiance values, known as sensor calibration, and then reflectance is estimated. Various parameters needed for estimating spectral reflectance are maximum and minimum radiances and mean solar Exo-atmospheric spectral irradiances in the satellite sensor bands, satellite data acquisition time, solar declination, solar zenith and solar azimuth angles, mean Earth-Sun distance etc. Sensitivity analysis has shown that a NDSI value of 0.4 can be taken as a threshold to differentiate snow/non-snow pixels. Exo-atmospheric reflectance of band 2 and band 5 of AWiFS sensor are used to compute the NDSI. Field investigations have suggested that NDSI values are independent of illumination conditions i.e. snow/non-snow pixels can be identified under different slopes and orientations, even under mountain shadow region. Data was checked manually after geocoding and scenes were rejected if ice clouds were observed in the basin area. Manual separation between snow and ice cloud is possible due to textural differences.

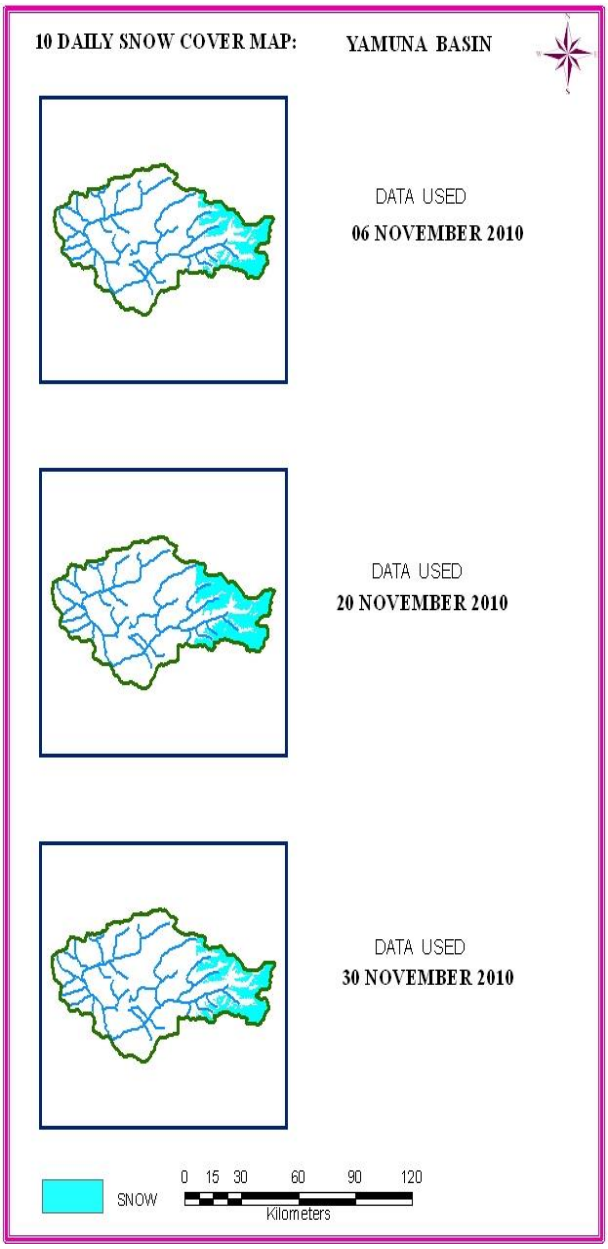
III. RESULT AND DISCUSSION

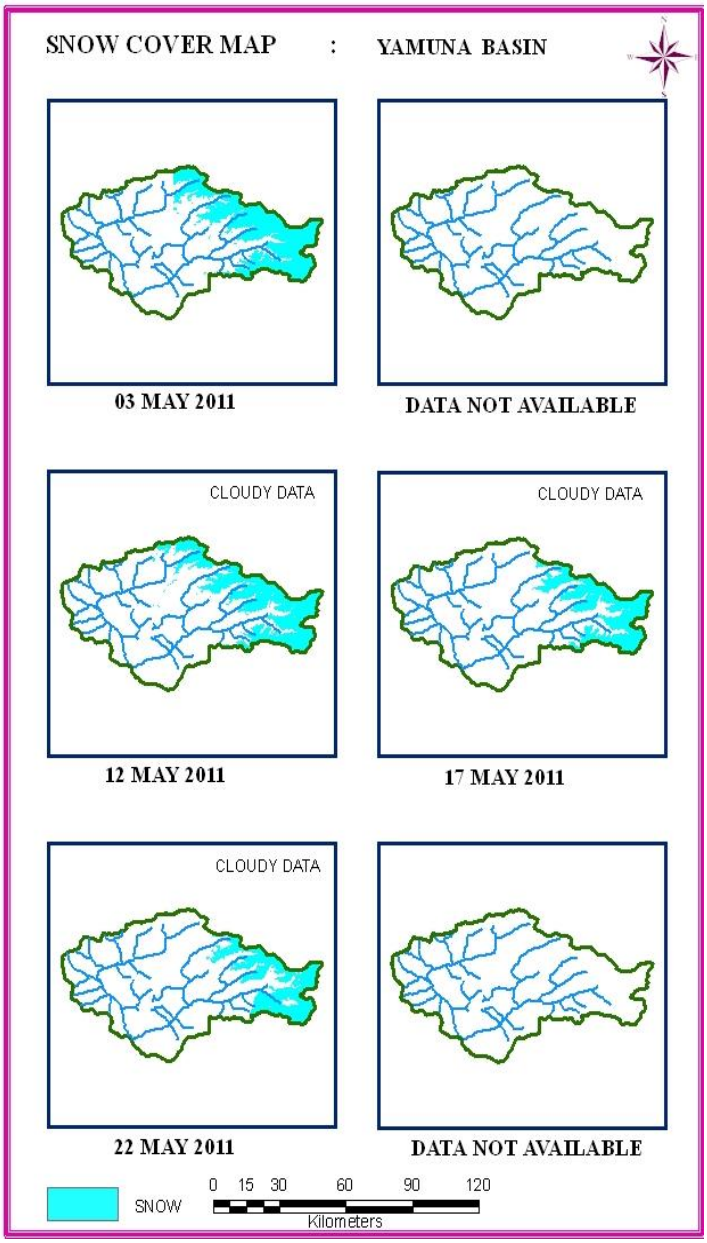
After analyzing the fluctuation of snow cover for Yamuna basin from the year 2004-2005 to 2010-2011 we will see a slow but steadily rate of decline rate of snow cover in this basin. what interesting we have seen that during the month of October in the year 2004-2005 the percentage of snow is much more, while there is a tremendously decline in the snow extent in the year 2006-2007 in the month of October. If we see the overall snow cover fluctuation snow cover is decline, but for the month of May and June for 2010-2011 snow cover is comparatively high from previous years, which show a good snowfall in the monsoon months.

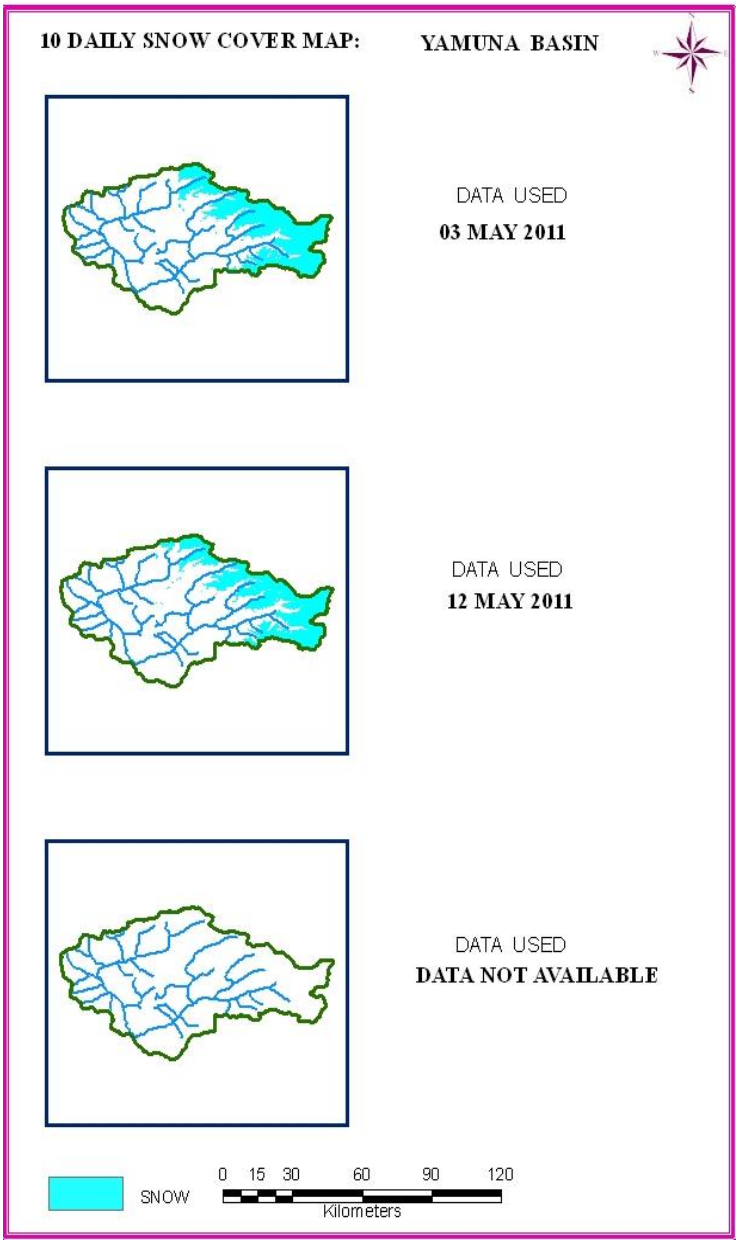





SNOW COVER MAP : YAMUNA BASIN
DATA NOT AVAILABLE
06 NOVEMBER 2010
15 NOVEMBER 2010
20 NOVEMBER 2010
DATA NOT AVAILABLE
30 NOVEMBER 2010
SNOW
0 15 30 60 90 120
Kilometers


10 DAILY SNOW COVER MAP: YAMUNA BASIN
DATA USED
06 NOVEMBER 2010
DATA USED
20 NOVEMBER 2010
DATA USED
30 NOVEMBER 2010
SNOW
0 15 30 60 90 120
Kilometers





IV. CONCLUSION

In Yamuna basin the maximum snow cover is 76% in the month of January and February which is around 2700 sq km of basin area. Maximum snow precipitation in February suggests that Uttarakhand receives higher snow precipitation in winter months from Western disturbances than North East Monsoon It has been observed that rainfall, air temperature and snow precipitation are very closely interrelated and a slighttrigger in any one could drastically influence the pattern of snow accumulation. Due to heavy cloud cover, data was not available for May, June and July. With development of newer microwave technique, RISAT data would be of prime importance for thorough month wise analysis for snow monitoring.

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