METHODS AND DATA SETS:

MODIS Eight Day Snow Products

The MODIS snow cover product has been available from the National Snow and Ice Data Center of the United States (NSIDC) since March 2000. The Normalized Difference Snow Index (NDSI) is used to differentiate snow and non-snow areas based on reflectivity in visible and near-infrared ranges in MODIS’ snow mapping algorithm. Level 3 eight day snow cover data (MOD10A2) provides the snow data in eight days interval with a spatial resolution of 500m. MOD10A2 is a composite of MOD10A1 data collected for 8 days and compiled such that the product has maximum snow cover and minimal cloud cover. According to several studies, it has been found that MODIS eight day maximum snow cover products and ground observation are in reasonable agreement. MOD10A2 has lower cloud coverage in the data as compared to MOD10A1. According to the manual provided by NSIDC, there are different pixel values representing distinct ground objects. 0 represents missing data, 1 represent no decision, 11 represents night, 20 represents no snow, 37 represents lake, 50 represents clouds, 100 represents lake ice and 200 represents snow. If a snow cover is detected on any of the 8 days, the pixel will be labelled as snow; however, if cloud is on all 8 days, the pixel will have cloud cover value. So the MOD10A2 provides highly reliable data that is being used to accurately investigate the spatial and temporal variation of snow cover over the Himalayan region.

For this study, a total of 6 years of MOD10A2 data is collected starting from February 26,2000 followed by 2005, 2010, 2015, 2015 and 2022. While downloading the data, the sinusoidal projection of MOD10A2 datasets were converted into Universal Transverse Mercator (UTM) projection on the World Geodetic System (WGS84). If the cloud cover for a specific day >15%, the linear interpolation is used to obtain the snow cover of that day.

To obtain the snow-covered areas of Ladakh, QGIS is used. Firstly, the shape file of India with the district borders was added by using Add layer menu in QGIS. Since the shapefile is a vector layer so vector layer was selected in Add layer menu. After adding the shapefile, the selection tool was used to select the required area, which in our case was Ladakh. Then in the Geoprocessing tools of Vector menu the clip tool was used and the selected feature was clipped. This created the new shapefile of Ladakh. After this, the raster layers were added using the Add Raster Layer in Add Layer Menu. This raster layer is the MODIS10A2 tile which cover the area of 1200km\*1200km. To obtain the required region of Ladakh, in the Extraction option of Raster Menu, clip Raster by Mask Layer is used. This Mask Layer is chosen as shapefile of Ladakh and it is overlayed on tile and Ladakh portion is clipped. This portion contain all the pixel values as discussed above. To get the snow data, pixel value is set to 200 in Raster Calculator of Raster Menu. The file is selected in calculator and expression is assigned as “File\_Name=200”\*”File\_Name”. This file is the used for the Raster Analysis in Processing toolbox . The Raster layer unique value report option provides the pixel count of pixel value 200. This pixel value is saved in excel file. The area corresponding to this pixel count is calculated by multiplying the area of one pixel (500m\*500m). This process is repeated for the other layers with 8 days interval for year 2000 and the excel file is completed. Then the average, lowest and maximum snowfall can be observed and the variation is plotted using the graph. The same procedure is performed for the years 2005, 2010, 2015, 2020 and 2022. The graphs of these years are also plotted and the yearly variation can be seen by this.