# Evaluation of Snow Avalanche hazards zones in the Himalayan region using Satellite Remote Sensing

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Satellite data obtained from different sensors (AWiFS and MODIS) in multi-spectral (Visible, NIR and SWIR) and Hyper-spectral (Visible, NIR, SWIR and Thermal) bands are used to retrieve various snow physical parameters (reflectance, albedo, surface temperature, air temperature and energy fluxes). Quantitative estimation of these parameters are compared with the ground observations and models are validated up to precise accuracy (error <=5%). Qualitative analysis for the changes in snow-covered region was carried out for the snow fall seasons. Detailed field measurements of spectral characteristics have been carried out. The snow moisture content is found to be very sensitive to the spectral reflectance in the SWIR band (1550nm - 1750nm). Based on the detailed spectral response, snow classification (dry snow, moist snow and wet snow) index has been developed for the classification of Himalayan snow. Surface temperature of the snow is one of the important parameters in controlling the morphology and state of the snow. The surface temperature is estimated using two window channel technique using thermal bands in the wavelength range from 10 mm to 12 mm as the emissivity in this region is unaffected by atmospheric hindrances. Ambient air temperature was estimated by regression analysis with correlation coefficient of 0.9. Short wave and long wave radiation flux is estimated using albedo and Stefan's law. Terrain parameters (slope, aspect and altitude) are retrieved using digital elevation model generated. Using various parameters retrieved from satellite remote sensing data, we have implemented Saaty's method to forecast snow avalanche hazards with pair wise comparison of snow and terrain parameters using multi criterion decision making and also in mapping the most vulnerable snow avalanche zones in the Himalayan region.