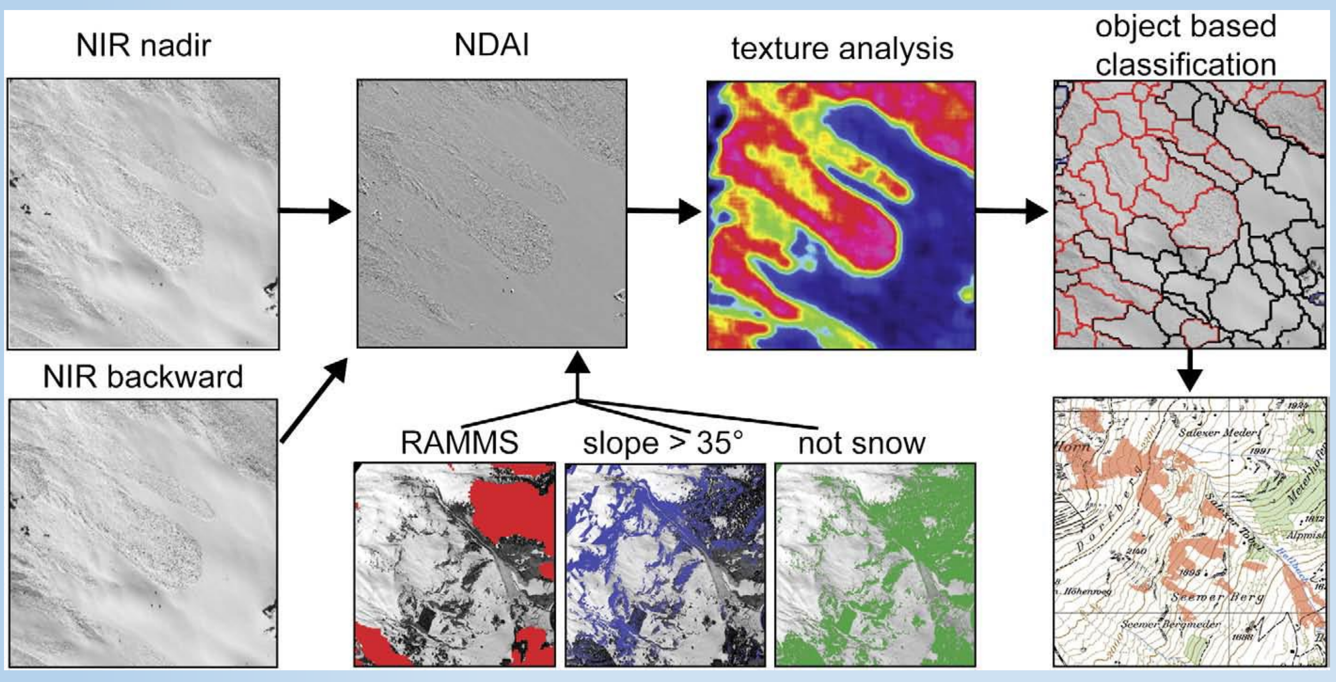
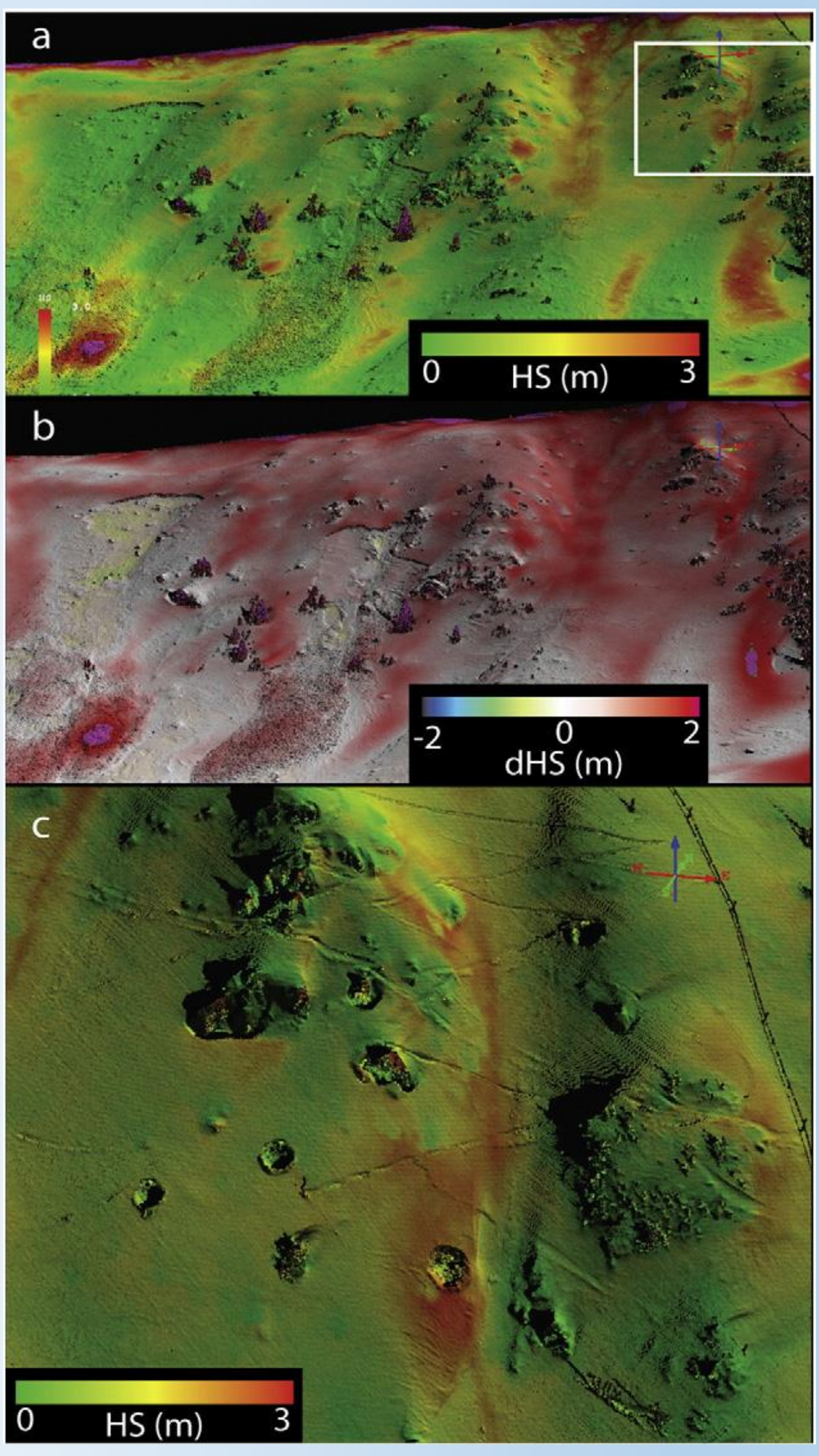
Remote Sensing and Avalanches

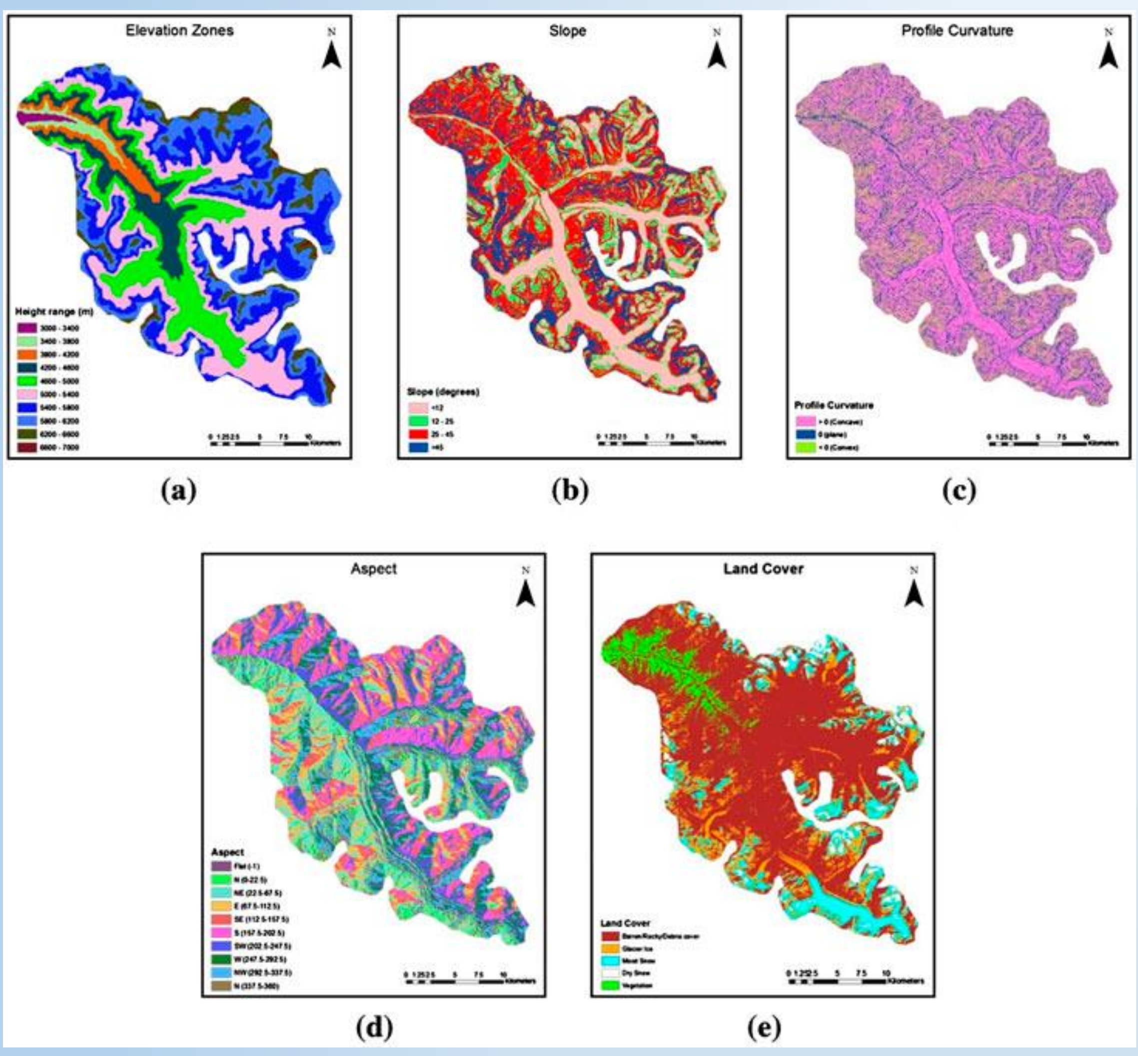
The current state of avalanche forecasting and control often requires professionals to collect a substantial amount of their data from sites in the field. This data, combined with meteorological data, the snowpack can be analyzed for potential weak layers that leading to avalanches. Field studies require experts to go into the mountains and expose themselves to potentially dangerous situations. Remote sensing offers a variety tools that can aid in data collection for avalanche research.



The image above was taken from a study done by Yves Bhuler et al. (2009). It shows a flow chart of the analysis used and how remote sensing was integrated into the authors research. The study was focused on using remotely sensed images from an aircraft to identify avalanches in the Swiss Alps. The study area was near an existing ski area, so that the results of the study could be validated in the field. The study was dependent on the different scattering properties of undisturbed snow versus the disturbed snow of avalanche paths and debris deposits. A smooth snow surface will often have a relatively uniform scattering compared to that disturbed snow that scatters in many directions and creates shadows on the surface. A classification scheme was used to distinguish the differences in textures of the snow surface created from the remote sensing images. The authors validation of their methods were quite successful for medium and large avalanches, but was less accurate with smaller sized avalanches. This study shows how avalanches can be identified and studied in remote areas without having to collect field data from the study area, but not without limitations.

Remote sensing can be used to study snow depth and distribution across a landscape. This information can be useful for studying starting zones and avalanche paths. Jeffrey Deems et al. (2015) used ground-based terrestrial-laser scanner remote sensing instruments to study these factors at Arapahoe Basin ski area in Colorado. Elevation data was recorded using the TLS instrument in the summer when there was no snow in the study area. They visited the same area again in the winter to collect elevation data to calculate snow depth. This allowed the authors to identify areas of wind loading, wind scouring, and cornice growth. All of which are important factors in avalanche forecasting. After avalanche control work had been done by the ski patrol at A-Basin the authors again recorded values taken from the scanner. This allowed them to measure crown depth in the starting zones of each individual avalanche. Combining this information with slope and aspect of the terrain creates a detailed record of information that can be used for understanding landscape features that contribute to the propagation of avalanche. This information will also help in recognizing areas prone to future avalanches. The images created from the data the authors accumulated are extremely powerful when it comes to how easy it is to distinguish the disturbed snow of avalanches and bomb holes from the avalanche control work. The purpose of the study was to validate the methods used and prove that they can be applied to backcountry settings.





Remote sensing can be especially useful for forecasting avalanches when integrated into Geographical Information Systems (GIS) models. Remote sensing is a great tool for classifying land cover types. Land cover has great influence on the potential for avalanches on a slope. Areas of heavy vegetation and trees are much less susceptible to avalanches, than areas of bare slopes. Bedrock and talus do not give ice and snow much to bond to and allow for full depth avalanche releases. The image to the left was created from multiple GIS layers from a model that identifies avalanche hazard zones in the Himalayan Mountains of northern India. The study was done by A. Bhardwaj et al. (2014). They used the land cover layer created from remote sensing images, along with elevation, slope, aspect, and profile curvature to create an output map of avalanche prone sites throughout the study area.

Remote sensing has many applicable uses that can aid to the research of avalanche forecasting and control. The use of remote sensing instruments allows for data collection from areas that are too remote and inaccessible for field studies. Remote sensing is capable collecting data at a scale that can be applied to entire mountain ranges, instead of point scale data obtained from in the field studies. It eliminates the hazard of experts going into avalanche terrain to study the snowpack. Repeated observations of a study area can be obtained over time. The number of sensors used in remote sensing are capable of measuring different properties of snow and the snowpack. This is great news for the field of snow science, but remote sensing does come with limitations. The tools used can be extremely expensive. The use of many of these instruments are entirely weather dependent. The use of these methods in remote areas are difficult or impossible to validate. So far, there has been very little research in the field of remote sensing and avalanches, but with the incredible fast advancement of remote sensing technology it has the potential for a bright future.

References

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