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Development and Evaluation of a New "Snow Water Index (SWI)" for Accurate Snow Cover Delineation

Abhilasha Dixit and Ajanta Goswami
Indian Institute of technology Roorkee, Centre of excellence in Disaster management and management, ROORKEE, India (adixit@dm.iitr.ac.in)

The current study started by examining the three most established snow indices, namely the NDSI (normalized difference snow index), S3, and NDSII-1 (normalized difference snow and ice index), based on their capabilities to differentiate snow pixels from cloud, debris, vegetation, and water pixels. Furthermore, considering the limitations of these indices, a new spectral index called the snow water index (SWI) is proposed. SWI uses spectral characteristics of the visible, SWIR (shortwave infrared), and NIR (near infrared) bands to achieve significant contrast between snow/ice pixels and other pixels including water bodies. A three-step accuracy assessment technique established the dominance of SWI over NDSI, S3, and NDSII-1. In the first step, image thresholding using standard value (>0), individual index theory (fixed threshold), histogram, and GCPs (ground control points) derived threshold were used to assess the performance of the selected indices. In the second step, comparisons of the spectral separation of features in the individual band were made from the field spectral observations collected using a spectroradiometer. In the third step, GCPs collected using field surveys were used to derive the user's accuracy, producer's accuracy, overall accuracy, and kappa coefficient for each index. The SWI threshold varied between 0.21 to 0.25 in all of the selected observations from both ablation and accumulation time. Spectral separability plots justify the SWI's capability of extraction and removal of the most critical water pixels in integration with other impure classes from snow/ice pixels. GCP enabled accuracy assessment resulted in a maximum overall accuracy (0.93) and kappa statistics (0.947) value for the SWI. Thus, the results of the accuracy assessment justified the supremacy of the SWI over other indices. The study revealed that SWI demonstrates a considerably higher correlation with actual snow/ice cover and is prominent for spatio-temporal snow cover studies globally.