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Decision tree analysis to map glacial lakes with Sentinel-1 and 2-comparison with existing methods

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The Normalised Difference Water Index (NDWI) is a commonly used method in optical remote sensing data to map open water bodies due to its simplicity and efficiency. While the NDWI has been used to identify high altitude glacial lakes its optimal performance is often challenged by topographic, limnologic, and atmospheric factors, particularly in high mountains regions such as the Himalayas. Hence, an alternative approach is needed. Here, we present a decision tree algorithm using top of atmosphere (TOA) reflectance Sentinel-2 Multispectral Instrument (MSI) data, and Sentinel-1 Synthetic Aperture Radar (SAR) backscatter with a digital elevation model (DEM) to identify and map glacial lakes. In addition, we apply this method to Landsat TOA reflectance corrected data. The results of this method are then compared with previously proposed methods such as band ratios, indices, and raw digital number (DN) dataset. The preliminary results from the two study sites (Pamir and South-East Himalaya) indicate that the proposed method is able to perform better than existing methods. The algorithm is able to identify and remove challenging factors of glacial lake identification and mapping such as cast shadows stemming from mountains and clouds. Furthermore, those glacial lakes which are highly turbid, and frozen can be classified. Even glacial lakes fully obscured by clouds can be identified and mapped using Sentinel-1 SAR data with slope analysis. Combining operational optical and SAR data with a high resolution DEM, an accurate classification and mapping of glacial lakes in high mountains could be facilitated irrespective of time and space conditions.