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On the accuracy of glacier outlines derived from satellite data

F. Paul and the Glaciers_cci Team
Department of Geography, University of Zurich, Switzerland (frank.paul@geo.uzh.ch)

The determination of the accuracy of glacier outlines as mapped from satellite data is a mandatory task, in particular when change assessment is performed. However, this is often not correctly done as a direct comparison with a reference data set can give misleading results. Though it is widely accepted that glacier outlines as derived from a higher-resolution data set (e.g. aerial photography) can be used to determine the accuracy of outlines derived from a lower resolution data set (e.g. Landsat TM), this is not generally true and several details have to be considered. At first, changing glacier extents require to compare images acquired in the same year and rapidly changing snow conditions require to use images from the same week or at least with identical snow conditions (i.e. no snow outside of glaciers). Secondly, differences in interpretation result from the higher-spatial resolution itself and the missing shortwave infrared band in high-resolution data. In particular, the determination of the glacier boundary on panchromatic imagery can locally be impossible (when the ice and the surrounding rock have the same reflectance). Thirdly, for natural objects like glaciers the change of the resolution alone results in a change of the area covered by the respective outline. Finally, the required manual correction of debris-covered glacier parts is done differently by different analysts and also by the same analyst when digitized several times.

To overcome these challenges and provide an accuracy assessment for a larger data set, we will perform a combined round robin and validation experiment in the framework of the ESA project Glaciers_cci. This will include the manual and automated digitization of glacier outlines on high and low resolution satellite data (e.g. Quickbird / Ikonos vs. Landsat TM / ETM+) in different parts of the world (Alaska, Alps, Himalaya), as well as multiple digitizations of the same set of glaciers (with and without debris cover) by different and the same analysts. First results indicate that the accuracy of the glacier outlines (clean ice) as derived from automated techniques (TM3/TM5 band ratio) is similar to the standard deviation resulting from multiple digitizing experiments. Regions with low contrast in high-resolution imagery show a large variability in interpretation by different analysts. For an internal accuracy assessment it is recommended to digitize a couple of debris-covered glaciers several times and provide the mean of the standard deviations as the accuracy. An overlay of the digitized outlines is most helpful to identify the problematic regions.