A new glacier inventory for the Svartisen area (Norway) from Landsat ETM+: Methodological challenges and first results

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Glacier changes in Norway exhibited a considerable regional variability in recent decades. As the last glacier inventory for northern Scandinavia is based on aerial photography from the 1960s and 1970s (1980s for southern Norway), today's overall state of these glaciers is not well known. To get an overview of their present state, the Norwegian Water Resources and Energy Directorate (NVE) has decided to create a new inventory from Landsat TM/ETM+ data within the framework of the Global Land Ice Measurements from Space (GLIMS) initiative. The techniques for automated glacier mapping from thresholded ratio images and the following GIS-based data processing are well established and straight forward. However, the assessment of glacier changes with respect to a former inventory poses several challenges.

The most severe one is the delineation of glacier basins (ice divides) according to the former inventory to obtain the correct changes in area per glacier. In the Svartisen region with its several large ice caps this is a particular challenge. Moreover, the digitally available hydrologic catchments which are based on recent digital elevation models (DEMs) are often not compatible with the ice divides used for the 1970s inventory as they are partly based on military maps from the 1940s with a much lesser topographic accuracy. In consequence, we have decided to create two new inventories, one with the old ice divides to assess changes per glacier and one with the new basins for the GLIMS database. As the artificial glacier changes due to different basins are several times larger than the real changes, the study clearly reveals the necessity for a global two-dimensional (outlines) and digitally available glacier inventory.

Another challenge is related to seasonal snow that covers possible glaciers. While manual delineation might help to exclude such regions for larger valley and mountain glaciers, it fails for most of the small snow patches without any bare ice. The associated area changes are often random in such cases and should not be used as a climatic signal. However, our new inventory shows clearly that several of the small ice/snow patches have meanwhile disappeared while several others have not been registered or maybe newly formed. In any case, the number of glaciers counted in the 1970s inventory was too small. For the larger ice masses there is a considerable scatter of the observed changes, quite often side-by-side: From small advances to little retreat for the Vestisen ice cap and no changes to strong retreats in Østisen, to complete disappearance for small glaciers at the glaciation limit. Our analysis confirms, that only changes that are assessed for a large sample of glaciers provide a reliable estimate of ongoing cryospheric changes and that special care has to be taken for correct glacier delineation (ice divides, seasonal snow).