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Spatial and temporal variations in lichen forage biomass as estimated from LANDSAT 5 satellite images

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We conducted our study at the Hardangervidda reindeer population in southern Norway. This population has fluctuated more than five fold during the last 40 years and has suffered previous periods of overgrazing. Managers have deliberately reduced population numbers by subscribing high hunting quotas aiming to recover pasture quality and reindeer body condition. We therefore wanted to estimate the spatiotemporal distribution of lichen winter forage and to test for possible trends and changes in lichen biomass. We used a LANDSAT 5 scene recorded in August 2003 as our master data set. This image was classified into a land cover map with 9 different habitat classes. In this process we used a supervised classification method (KNN) and approximately 5000 ground truths were taken as training points. In our land cover map lichen ridges could be classified with a user accuracy of approximately 80%. In order to estimate lichen biomass we later reduced our land cover map to a 1 bit information mask (lichen ridge, not lichen ridge) and tested for linear relationships between spectral properties in areas classified as lichen ridges and measures of lichen biomass taken in the field. We found that lichen biomass could be estimated on the basis of a simultaneous application of two different indices (NDLI), and a normalized index derived from band 4 and 5 ($R^2 = 0.70$, $P < 0.001$). Estimates of the lichen biomass revealed large spatial variation with less biomass in central and more heavily grazed parts of the area. Since the 1980s the reindeer population has been reduced from approximately 25 000 animals to approximately 6000 animals in 2003. By comparing our analysis of the 2003 scene to LANDSAT 5 images recorded in 1983 and 1994 we found an overall increment in lichen biomass of approximately 82%, but also that re-growth of lichens had a significant spatial component with less increment in central areas.