

Detection of human induced disturbances and grazing impacts on tundra vegetation state: preliminary results of a large scale comparative remote sensing study



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Background

Despite being a relatively pristine region, the Arctic zone is characterized by a multitude of natural and anthropogenic disturbances. Remote sensing provides an efficient tool to investigate human induced changes in land cover and land use. Our main objective has been to investigate local to landscape/regional scale impacts of human activities on the tundra ecosystems in Russia, Canada and Alaska.

Methods

We analyze very high resolution remote sensing images (Quickbird-2, GeoEye and WorldView 2), in concert with Landsat imagery and old Corona imagery, to assess how traces of human use like infrastructure and ATV-tracks around settlements influence local habitat transformation. Furthermore, we assess the impact of different grazing regimes, in particular the presence of semi-domestic or wild reindeer on vegetation states, such as the abundance and configuration of shrub/willow thickets and state of lichen cover. The study is comprised (Fig. 1) of 18 of a total 36 areas surrounding settlements in Russia, Alaska and Canada (ca 10 x 10 km), which were chosen according to a design of spatial contrasts in governance and socio-economic conditions. In addition to the areas directly surrounding the settlements, which are likely to be intensely used, areas of extensive use (ca 9 x 9 km) were chosen at a distance of 30 km from the settlements. The images were searched systematically for traces of human use such as ATV-tracks, roads, air fields, land-fills, garbage deposits, fences, camps, activity areas, buildings and mines. All observed objects were digitized using ArcGIS. Satellite image classification using both unsupervised (clustering) and supervised (max-log-likelihood and spectral unmixing) has been carried out on the imagery. Also phenological and biomass studies using MODIS and GIMMS-3g data will be carried out in the near future.

Results

Roads, driving tracks and ATV tracks are the main traces of human use identified on the images likely to impact habitats such as wetlands and mires. For instance, in Brevig Mission 48.2 km of tracks in the intensive use area (Fig. 2) and 18.2 km in the extensive use area have been documented. In Chesterfield Inlet in Nunavut, Canada, the numbers are respectively 28.3 km and 0 km. In the extensive used area in Lovozero (Russia) we detected 79.6 km of ATV tracks (Fig.3). Apart from a clear connection to settlements and activity areas near the settlements, it is a tendency that the tracks are related to activities around water bodies such as rivers and lakes (fishing activities). This is the case both in the intensive and extensive use areas, in North America and Russia. Vegetation classifications on the different images from Russia, Alaska and Canada indicate that there are tendencies of wear to the heather and lichen heath vegetation around the settlements (intensive use) compared to the extensive used areas. Anthropogenic influenced vegetation and grass-dominated vegetation are more frequent in the intensive used areas compared to the extensive used areas (Fig. 4). Our results are relevant to land use management and will contribute to the understanding of how tundra vegetation will change under the joint influences of climate change and human use.



Fig. 1. Selection of tundra settlements.

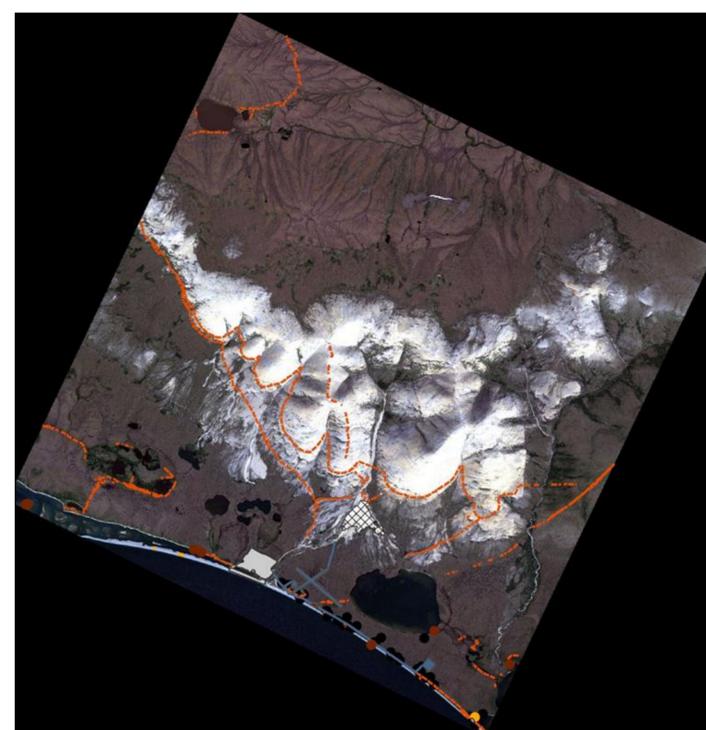


Fig. 2. Example of digitized , roads and ATV-tracks from Brevig Mission, Alaska, U.S.A. Quickbird-2 image from 2011-07-21.

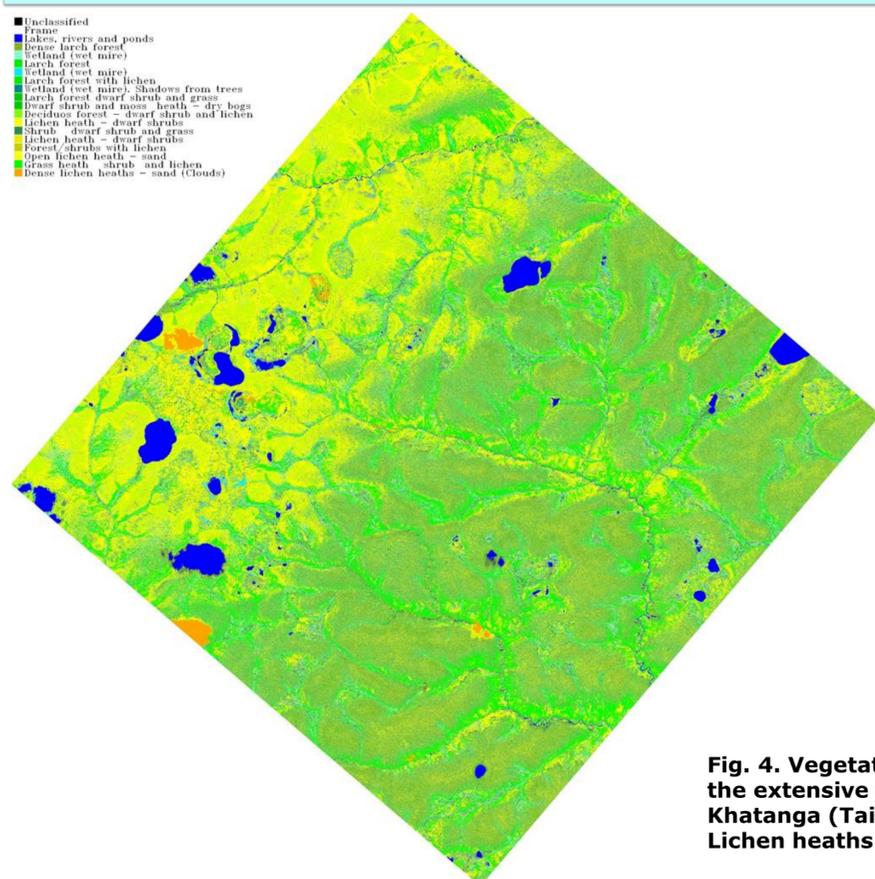


Fig. 4. Vegetation map from the extensive used area in Khatanga (Taimyr-Russia). Lichen heaths in yellow.

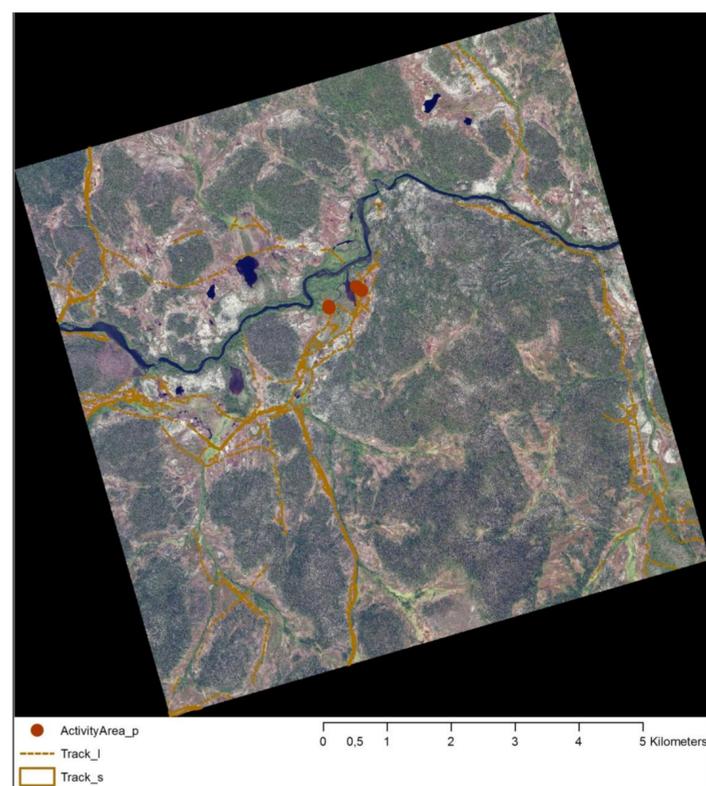


Fig. 3. Digitized tracks and activity areas in the extensive are Lovozero, Russia. Track_l = light damage. Track_s= medium to strong damage. WorldView-02 image from 2011-08-21.

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