Depicting the Inscrutable: Satellite-based Mapping of a Spatially Complex Region of northern European Russia

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Comparatively little detailed, recent information is available about land cover characteristics in Arctic European Russia compared, for example, with northern Scandinavian regions, and this is especially true for more technical data and assessments. The satellite vegetation map of an area in the Nenets Autonomous Okrug (NAO) in northern Russia, developed in this project, and other such data have many potential uses and applications, particularly in this region of Russia: 1) natural resources are plentiful and with easier access comes increasing pressure and competition so an improved understanding would aid decision making; 2) reindeer grazing is the dominant livelihood in much of the region and understanding the relationship between pasture and vegetation more thoroughly can provide useful information for herders, managers and government alike; and 3) while not limited to this region, potential climate change has already begun to influence and modify the terrestrial landscape and having early knowledge of the land before significant changes might occur is critical. In addition, the development of a vegetation map for this specific area, the northern coastal drainage of the Pechora River and surroundings, presents significant technical challenges and allows an interesting examination of the possibilities of satellite-based mapping. This region of tundra vegetation is particularly heterogeneous and is also heavily influenced by a variety of influential topographical and meteorological characteristics, making it a difficult area to adequately map. It is also almost devoid of infrastructure, so the collection of training and validation data is awkward and expensive. Under these circumstances, traditional supervised-unsupervised classification of remotely sensed imagery has to be modified to produce satisfactory vegetation maps. We describe the development of such a map using a Landsat-7 ETM+ image from 2000, trained and validated using field data collected from over 250 locations in 2003 and 2004. A wide range of classification methods, including spectral-spatial algorithms and spectral unmixing as well as unsupervised k-means clustering and supervised maximum likelihood inference, was employed in order to derive an acceptably robust map. Robustness was increased by merging classes, of which there were initially 24. In its simplest form the final map represented five categories of land cover. The results clarify the strong topographical and meteorological influences on the vegetation distribution and characteristics. The long-term presence of reindeer within the area also appears to have an effect on certain vegetation distributions, such as lichens. It is suggested that further satellite maps could be developed for the surrounding regions based on the methods used in this study without the need for significant additional fieldwork. However, the acquisition of more data would allow for testing of the map, thereby improving its reliability.