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REMOTE SENSING AS A TOOL FOR MAPPING AND EVALUATING PEATLANDS AND PEATLAND CARBON STOCK IN NORTHERN FINLAND

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SUMMARY

The rates of greenhouse gas fluxes in northern peatlands are a sum of complex interactions between climate, temperature, hydrology, geochemistry, biochemistry and vegetation. Global change is predicted to have impacts on temperature and precipitation patterns, and therefore on peatland hydrology and vegetation. The resulting changes may act as a major triggering mechanism for greenhouse gas release. Thus understanding the species associations as a function of increasing trophic level and surface moisture would be important, as are spatial representations of species associations as inputs into models of greenhouse gas emissions. Remote sensing methods would become valuable in interpreting the vegetation structure and possible changes on northern peatlands. Geological Survey of Finland (GTK) has launched a prestudy to define the available cost-efficient remote sensing datasets to improve the regional scale peat resource and peatland site type mapping. Methods and datasets used would include pre-existing nationwide airborne radiometric data, LiDAR data and Landsat dataset, as well as the GTK's peat database (e.g. 1.7 million peat corings). Also, the benefits of spaceborne synthetic aperture radar and optical data with higher spatial and spectral resolutions are investigated. The National Forest Inventory database could be linked to new datasets in order to achieve a more detailed regional peatland site type distribution and resource information. The developed method will enable a cost-efficient mapping, resource and nature value evaluation of peatlands, especially in scarcely populated northern latitudes. This work is essential in responsible peat and peatland management and needed in questions related to carbon balance and in reconciliation of conservation and other land use activities.

***Keywords**: remote sensing, peat, peatland, Northern Finland*

INTRODUCTION

The main challenge in mapping and estimating the volume of peat reserves in northern peatlands in Finland is the high number and large areal distribution (Fig. 1 and 2). These areas are partially difficult to reach, and therefore the traditional peatland mapping has been either impossible or too expensive to carry out in these regions, and the amount of data is insufficient or there is no data available at all.

Practically only possible methods to carry out a peatland mapping program is using free or low-cost satellite data combined with airborne nationwide LiDAR data. In Finland the European wide CORINE landcover classification by Finnish Environment Centre (SYKE) and Finnish National Forest inventory by Natural Research Institute Finland (LUKE) already utilize satellite remote sensing datasets such as Landsat. These mapping products include peatlands, wetlands, forests, open forests soils, bedrock outcrops and water bodies. However, the idea is to withdraw more detailed information of peatland site types from the satellite data by utilizing additional satellite datasets and calibration of the remote sensed data by information in the peatland inventory database by the GTK which retains the site types and traditional coring data.

POSSIBLE METHODS

Optical and thermal remote sensing satellite methods have proven potential in interpolating the vegetation structure between fields plots through image interpretation a (aerial photographs, thermal, imaging radar, optical multispectral datasets). For example, the multispectral optical remote sensing data has been used effectively for classification of northern peatlands. Poulin *et al.* [2002] used a supervised per-pixel classification approach to distinguish thirteen different habitats within individual peatlands in Southern Quebec, Canada, from Landsat ETM+ data. The success in classification of peatlands with remote sensing is mainly determined by the level of class detail (number of classes and their ecological description) with which the dataset is processed. Mineral soils (uplands) can be well (80-90% accuracy) distinguished from peatlands with VIS-SWIR and imaging radar data and derivatives of a digital elevation model data. When the number of classes increases to the level of wetland site type or to high number of biotopes and higher resolution data is used (digitized aerial photographs, light detection and ranging: LiDAR, airborne hyperspectral data, SPOT satellite imagery, Landsat), overall classification success usually decrease to 60-80 %. However, it is also demonstrated that processing high spatial resolution optical satellite data into less detailed wetland classes can produce results with low classification accuracy. Application of airborne hyperspectral data in northern Finland showed that eutrophic fens could be mapped accurately along with bogs, fens and swamps (Middleton *et al.*, 2012).

Also, cases of successful application of Synthetic aperture radar (SAR) in satellite platforms have been reported on peatland classification worldwide (Touzi *et al.* 2007). SAR is sensitive to top soil moisture which provides a complimentary parameter to optical datasets, and concurrent use with optical data has shown to improve classification of northern peatlands (Grenier *et al.* 2007). The Sentinel-1A satellite carries a C-band Synthetic Aperture Radar (SAR) and was launched in 2014 by the European Space Agency as the first operational Copernicus mission. Data acquired by the Sentinel-1 C-SAR sensor is considered as a potential data for peatland site type classification as it available from the northern latitudes, and may be a significant data source used in the process.
Possibilities of unmanned aerial vehicles (UAV) technology must also be taken into account in the evaluation of the potential methods used in the remote sensing program of the northern boreal peatlands in Finland. Although these data acquisition platforms are rather small and the operating range is limited they may carry cameras and measuring devices. This may provide fast and cost efficient way to acquire spatial data but especially calibration data, for hyperspectral and satellite imagery. The value of this kind local scale data, collected from areas not easily reached by other data collecting methods, will be significant.

The significance of this work is related to the complementing the peatland inventory data in northern Finland (see Fig. 3) and the evaluation of the peatland site types, biodiversity and the peat resource itself. However, the importance of the estimation of the total carbon stock of Finland is increasing rapidly. The questions related to the possible climate change and its effects on the changes of the carbon storage of Finnish peatlands need to be answered when considering the wise use of peat and peatlands.

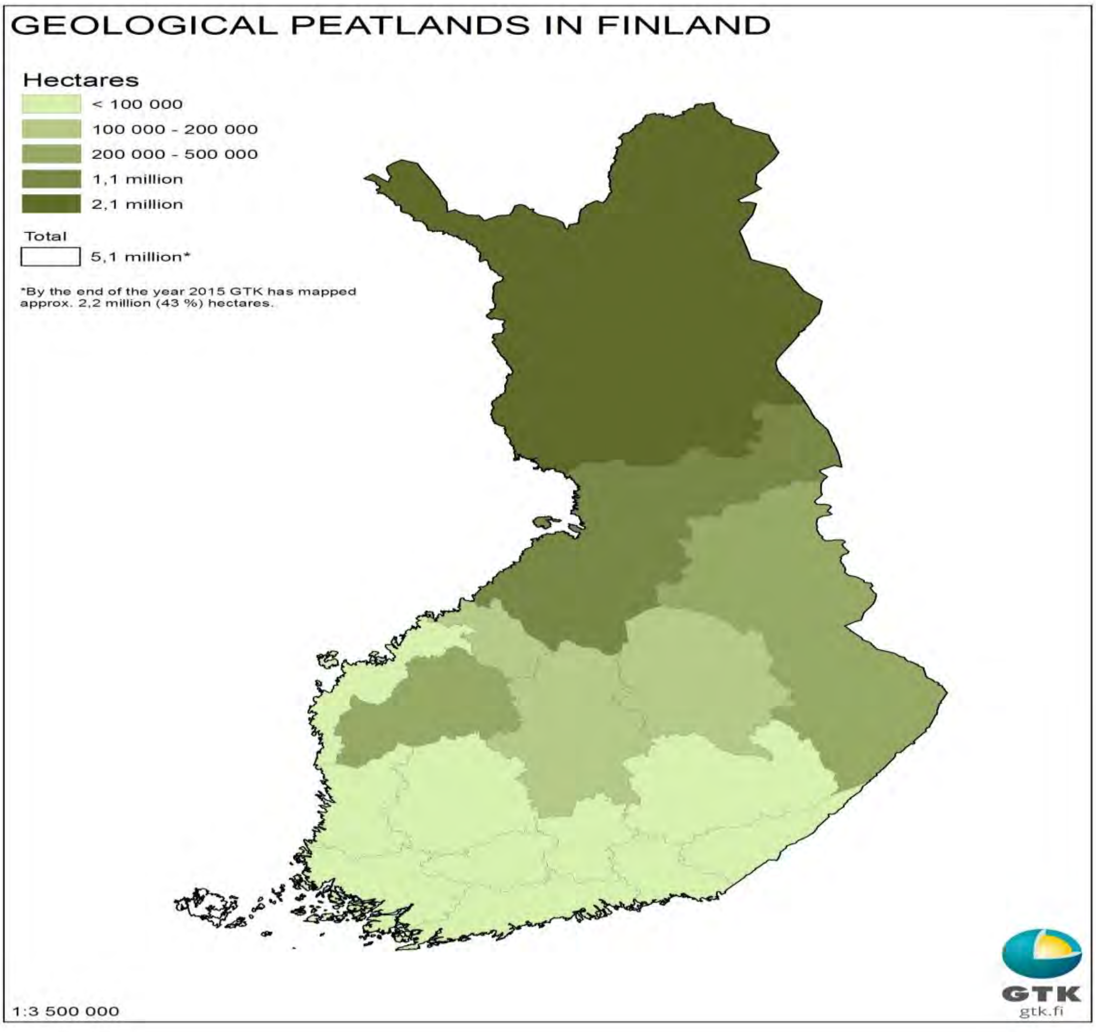

Figure 1: The amount (hectares) of geological peatlands in different provinces of Finland.

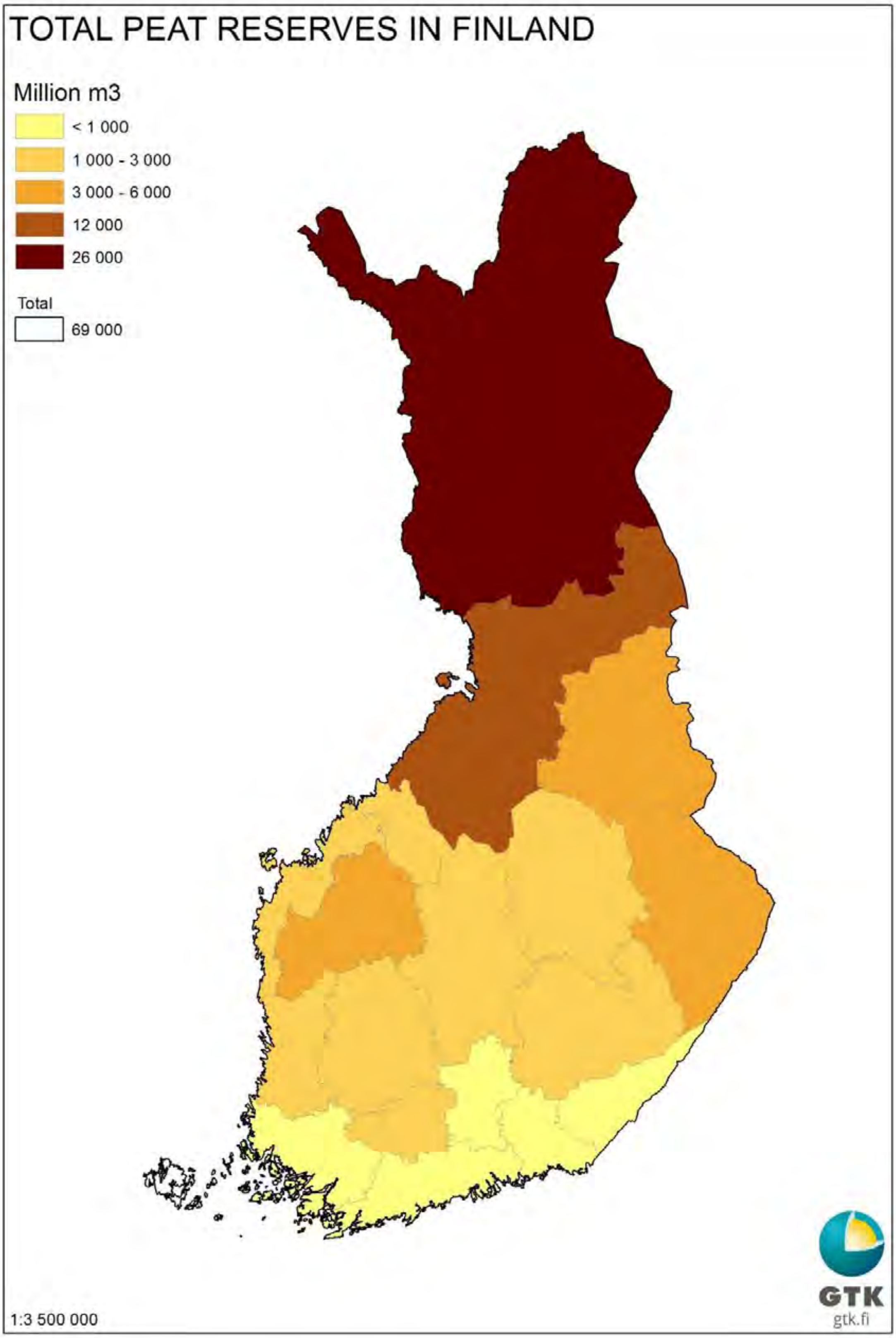

Figure 2: The amount (million m^3) of peat (*in situ*) in different provinces of Finland.

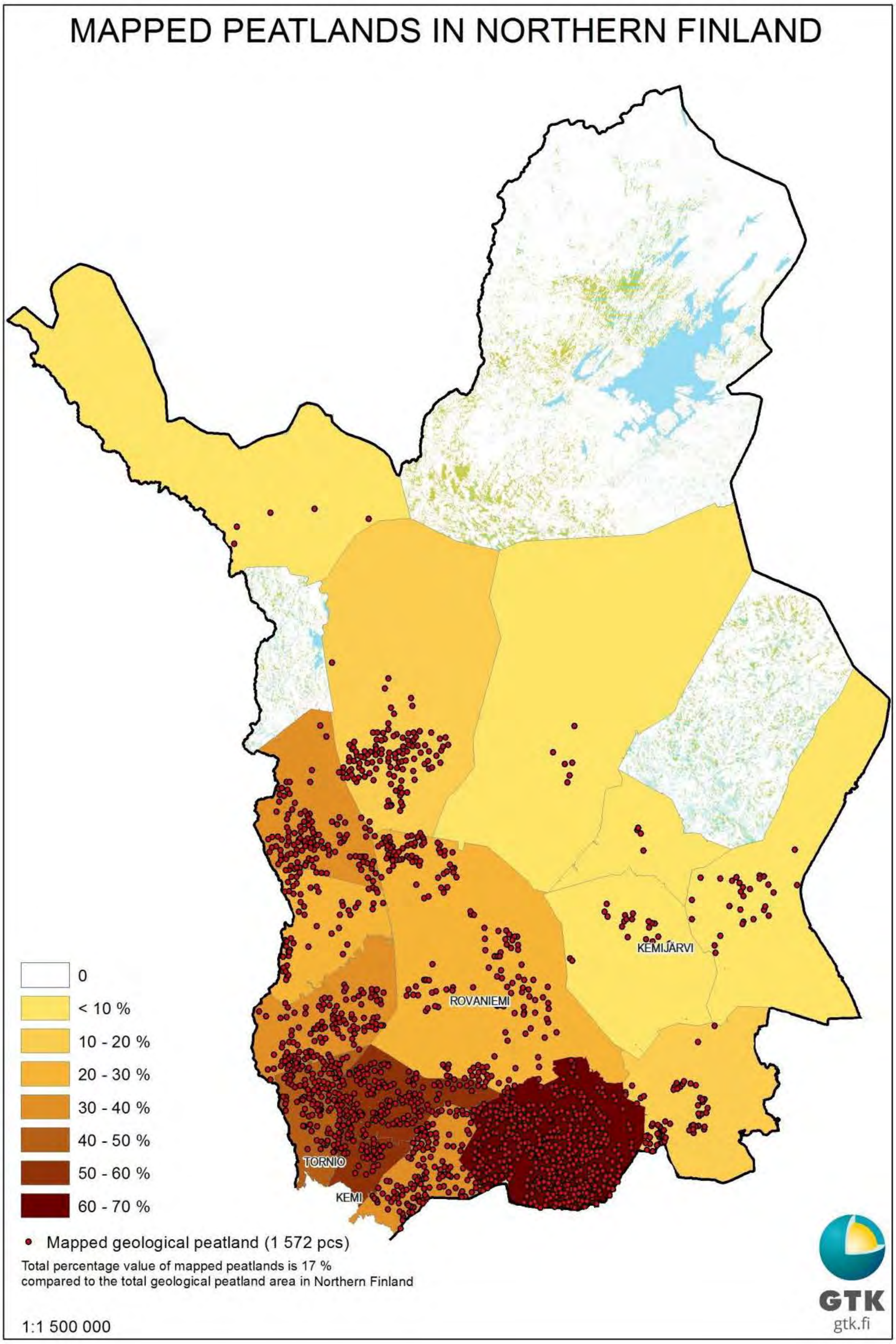

Figure 3: Percentage value of mapped peatlands in different municipality compared to their total peatland area.

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