Unsupervised Neural Network Classification of Boreal Mire Biotopes with Hyperspectral Airborne HyMap

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Spatial information on mire biot0pes would be an asset in inventorying mires for protection purposes and in monitoring changes in mire diversity caused by artificial regulation of mire hydrology, atmospheric deposition, and global change. We took a data-driven approach to explore the potential of airborne imaging spectroscopy data in determining plant communities of pristine treeless northern boreal mires in Finland (65˚57'N, 24˚29'E). It was hypothesized that plant species distribution and soil nutrient regimes are determining factors in spectral reflectance of mires, thus mires could be classified in several plant associations from medium resolution (5 m) imaging spectroscopic data. The objective was to discover the optimal ecological meaningful mire class number for our remotely sensed dataset. Minimum noise fraction transformation of geocoded and atmospherically corrected hyperspectral HyMap data (437-2485 nm) was subjected to non-metric multidimensional scaling (NMDS) and further classified with neural networks. The performance was tested against a field inventory of plant species, dielectric (ε) measurements of soil water content and electrical conductivity (σ) of soil nutrient regimes. NMDS ordination revealed nutrient-poor *Sphagnum fuscum* bogs with abundance of *Sphagnum fuscum*, *Rubus chamaemorus*, *Empetrum nigrum* and *Vaccinium uliginosum* to be associated with high NIR and NDVI, and spectrally deviate from nutrient-rich sedge fens with *Betula nana*, *Carex lasiocarpa*, *Carex* sp., litter and *Menyanthes trifoliata*. The NMDS also indicates that *Sphagnum angustifolium*, *S. lindenbergii* and *S. papillosum* dominated low sedge fens could be distinguished separately by spectral data. Classification to seven classes with Kohonen's self organizing maps (SOM) outperformed the fuzzy neural networks and *k*-means clustering producing the highest separability of classes in plant species coverages. The SOM classes were combined to produce a three class ('nutrient-poor *Sphagnum fuscum* bog', 'nutrient rich sedge fen' and 'nutrient-poor low sedge fen') thematic presentation of boreal mires. The study serves as a step towards an operational mire surface monitoring system based on imaging spectroscopic data which further improvement could be geared towards subpixel analysis and scale dependency of ecological classification detail in pixel based approaches.