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Analysis of Composition and Properties of Natural Peat by Near-infrared Spectroscopy

Summary **The immense reservoir of carbon stored in global peatlands is at risk of being seriously impacted by climate change. Peatlands occupy more than 4,000,000 km^2 worldwide, an estimated 3% of the earth's land surface, and store more than 550 billion tonnes of carbon. The fate of peatlands can have tremendous impact on concentrations of greenhouse gases in the atmosphere yet they are poorly monitored at present. A small number of studies using NIRS for the analysis of peat show that the technology has potential to be an important analytical method and monitoring tool for peatlands.**

As peat warms and dries especially in the middle latitudes, there is increasing risk of peat fires resulting from forest wildfires. The drier the peat deposits, the longer they smoulder or burn, releasing carbon dioxide and impacting regional air quality. Impact on air quality was demonstrated vividly in 1997 in southeast Asia where peat fires, accidentally started by human activity for land clearing, burned out of control for months. This affected visibility and human health over an area of 3 million km^2 and resulted in a total cost estimated at US$9 billion in health care and disruption of air travel and business. Not only carbon dioxide but also mercury is emitted as peat burns. Recent estimates predict that wildfire activity in northern boreal forests will result in the release of 15 times more mercury from peatlands than previously expected.

Near-infrared spectroscopy is ideally suited to gathering detailed data on carbon inventories and dynamics in peatlands, as well as monitoring moisture levels that are critical in evaluating the risk

of fire. High-risk areas can be identified where fire observation can best be focused.

The literature on the application of NIRS for peat analysis is small but surprisingly comprehensive. In industrial milled Irish peat, moisture (34 – 71 %) was predicted with r^2 of 0.98 and RER of 23.1 and bulk density with r^2 of 0.88 and RER of 13.8. The r^2 is the coefficient of determination between NIR-predicted values and the values determined by conventional, wet chemistry methods. The RER is the ratio of the range of values divided by the standard error of prediction and should be above 10 for useful calibrations on environmental samples. In a second study, samples from an 80-cm long peat core from a blanket bog at Moor House National Nature Reserve, UK, were analyzed for physical and biological parameters. Predictions for bulk density, degree of humification, moisture content, per cent identifiable moss *Sphagnum*, unidentifiable organic material, *Sphagnum papillosum*, and *Sphagnum magellanicum* had r^2 of 0.95 to 0.98. *Sphagnum* section Cuspidata was predicted with r^2 of 0.92, and aggregate monocotyledons and *Ericales* roots with r^2 of 0.85 to 0.87. In peat from five Irish industrial bogs, gross heat, carbon, nitrogen and ash were predicted with r^2 from 0.97 to 0.99, hydrogen with r^2 of 0.90, and cellulose with r^2 of 0.84. In one of the most innovative studies, the rate of methane production was predicted. Swedish peat samples were incubated anaerobically and the rate of methane production by methanogenic bacteria measured using a gas chromatograph. The samples were scanned immediately after the incubation. The methane production was predicted with an r^2 of 0.83.

In conclusion, these results show that NIRS has considerable promise to reduce the cost of testing in programs on carbon dynamics of peat, carbon inventories in peat, and monitoring of peat moisture status. Confirmatory studies are needed that use larger sample sizes, more sampling locations, and a broader range of types of peat.

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