Possibilities to predict moisture content of peat soil at the moment of harvest operation

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Introduction

Soil moisture content has a significant influence on the bearing capacity of soil. Information on the level of soil moisture content prior to harvesting gives forest operations manager a possibility to assess the bearing capacity of soil and, in some cases, to advance or postpone the forest operation. Exact spatial information on soil moisture content also enables the harvester operator to place logging trails on locations most suitable from bearing capacity point of view. On peatlands, moisture content in each single point is known to be dependent on peat properties, presence of trees, relative elevation, distance to the nearest ditch and weather conditions (Haahti et al. 2012, Uusitalo & Ala-Ilomäki 2013).

In this paper we present preliminary results of an experimental study that examines variation of VWC within typical pine bogs in southern Finland and compares the most potential procedures to make predictions on the VWC prevailing during planned harvesting operation.

Materials and Methods

Field studies were conducted on six drained Scots pine (*Pinus sylvestris*) dominated peatland stands. The mean diameter of these pine bogs varied between 12 to 15 cm and the stands were all at the growth phase where first thinning is usually recommended. The stands were located in Keuruu and Multia in Central Finland. Six study trails were established in each stand. The study trails had five sample plots, 8 m in length and 16 m in width. Tree species and diameter at breast height were measured for each tree in study plots. Stand density, average diameter at breast height, average length, basal area of trees and volume of trees were calculated for each plot. Study material of the study stands were collected in different times of the year 2013. First two stands were measured in June, two next stands in August, the fifth in October and the sixth in November.

Soil sampling point, where soil samples were extracted and soil properties were measured located in the middle of the sample plot. Prior to measurements the living moss was first extracted. The moisture of peat layer down to the depth of 20 cm below upper level of the dead moss was measured with a portable, electronic soil moisture probe TDR100 using 20 cm long rods. Peat core samples were extracted with a box-corer having cross section 6 x 6 m^2. The cores were dived into two subsamples 10 cm long the first starting from the upper level of rooting zone, which corresponds the lower level of the living moss. The moisture content and bulk density of the samples were later in the laboratory analysed with the gravimetric methods.

Ground water table level was measured from perforated plastic ground water tubes in each plot. Thickness of peat layer was determined at four sample points per sample plot. Exact location of each soil sampling point was defined with a GPS receiver and their relative elevation and distance to the nearest ditch were later determined with relevant cartographic information and the ArcGIS tool.

Results and discussion

Means and standard deviations of VWC and bulk density of the topmost layer or the dead moss (20 cm) by study stands are presented in table 1. Although the stands have been measured in different time of the year, in early summer, in later summer and in autumn, there are rather small differences in the mean of VWC the study stands. Bulk density seems to have high variation. The standard deviation of bulk density within the stand is at its best 30%, while that of VWC content varies at maximum roughly 15%.

Table 1. *Mean and standard deviations of VWC and bulk density of the topmost layer of the dead moss (20 cm) in study stands.*

Study site	VWC, %		Bulk density, g/cm^3	
	Mean	Std. dev.	Mean	Std. dev.
1	76.2	10.9	0.134	0.030
2	88.6	6.6	0.142	0.023
3	85.7	8.4	0.099	0.026
4	81.7	5.3	0.101	0.016
5	77.9	13.0	0.133	0.039
6	77.9	9.5	0.175	0.021
Total	81.5	10.4	0.132	0.038

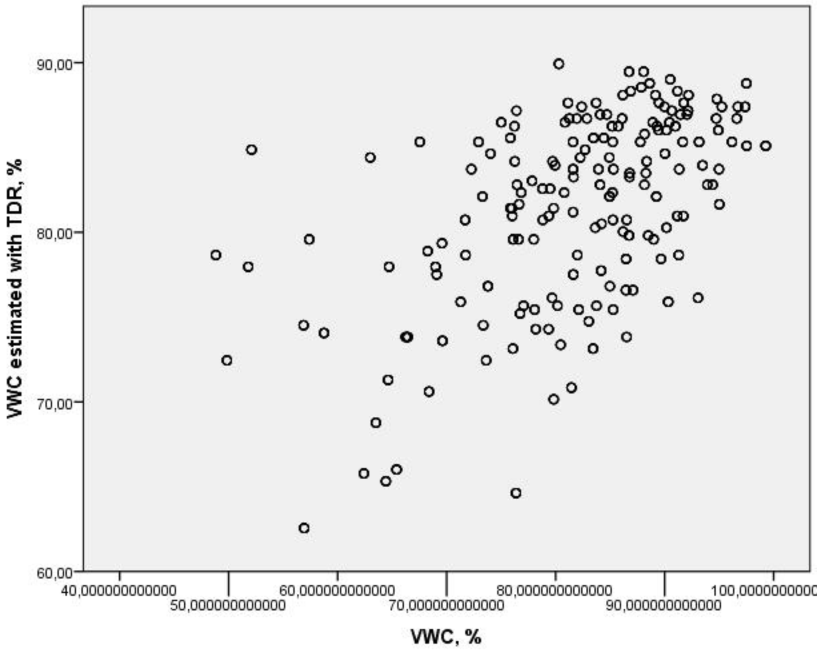

Figure 1. *Scatter plot describing trustworthiness of TDR device in predicting VWC of in uppermost layer of dead moss (20 cm).*

TDR device seems to be rather reliable in predicting VWC of peat soil samples (Figure 1). VWC measured with the TDR have statistically significant correlation with the real VWC values. However, standard errors of the predicted values are very high, in general 7-8 units, which is roughly 10 % of the mean values. It looks that high variation of bulk density samples within the stand makes predictability of VWC very challenging.

Volume of trees around the sample point, ground water table level and tree species composition seems to be the best predictors of VWC of peat soil. This result is in accordance with the previous works. On the other hand distance to the closest ditch did not have significant correlation with the VWC. The distance to the ditch where the sample were taken did not vary very much in this study which probably mostly explain this. The results confirm that accurate ALS data on tree species composition and volume of trees within the study linked with accurate weather data gives us possibilities predict general level of VWC at the moment of harvest operation. However, bulk density of the soil in the peat soil has considerable variation which hampers the possibility to make exact predictions of VWC in the uppermost layers of the peat soil. In general, season had less influence on the general level of VWC. The pine bogs seems to be always rather wet, also in summer time.

References

Haahti K, Koivusalo H, Hökkä H, Nieminen M , Sarkkola S. 2012. Vedenpinnan syvyyden spatiaaliseen vaihteluun vaikuttavat tekijät ojitetussa suometsikössä Pohjois-Suomessa. Summary: Factors affecting the spatial variability of water table depth within a drained forest stand in northern Finland. Suo 63(3-4):107-121.

Uusitalo J, Ala-Ilomäki J. 2013. The significance of above-ground biomass, moisture content and mechanical properties of peat layer on the bearing capacity of ditched pine bogs. Silva Fenn. 47(3):18.

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