The role of moisture content on terrain trafficability

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Sensitive sites in Finland

- ¼ of growth in peatlands, mostly pine bogs
- Fine grain mineral soils (Clay-Silt), ~20% of mineral soils
  - > Roughly 40% of soils have at least seasonal problems in bearing capacity
Seasonal variation of forest work is still a big problem in Finland.
Low bearing capacity of peat soils

- Reduction of future growth
- Aesthetic problem

- Decrease in work productivity
- In worst cases sinkage of machines
Field studies on pine bogs

• Inventory of 25 typical pine bogs (2008)
  – Spatial variation of trees, moisture content and mechanical/physical properties of peat in relation to distance from the ditch

• Driving tests with two harvester/forwarder chain in one large pine bog (2009)
  – The most important characteristics in predicting rut depth after each forwarder drive

• Driving tests with two harvester/forwarder chain in six different pine bogs and in different time of the year (early summer, late summer, autumn) (2013)
Structure of soil in pine bogs

- Runoff, precipitation and evaporation
- Water movement controlled by gravimetric, adhesive and capillary forces which are affected by bulk density and degree of decomposition
Spiked shear vane as tool to measure strength of root mat
Traditional shear vane - strength of decomposed peat
Shear strength of peat according to VWC and Von Post – decomposition degree

Amarjanin (1972)
Components of bearing capacity

- Volume of trees
- Root mat (shrubs, trees, etc)
- Moisture content of peat
- Logging residuals
- Machine type/driver

The role of moisture content in predicting bearing capacity?

Seasonal and spatial variation?
Covariation of volume of trees and VWC of peat
VWC – predicted with distance from the ditch and BA, early June
On-line estimation of GWT level in pine bogs

Tree inventory data from ALS

Elevation of ditches

Distance to to the nearest ditch

Hydrological model by Hökkä et al.2013

• Basal area of trees
• Distance to nearest ditch
• Elevation
• Cumulative evaporation and precipitation
• Evaporation/precipitation of preceding 30 days

OUTPUT: Ground water table level
Clay soils in Finland
The effect of moisture content on soil strength

"Sand-box results from 1940’s"
Jokioinen - mineral soil experiment
Strength of soil

Portable FWD

Penetrometer

Shear vane
Moisture of soil

Soil scout sensors 15 cm below the surface

VWC (GWC) of the uppermost layers of the soil

Moisture profile probe, 40 cm below the surface
RLGIS - Analyses

Hydrological model grid created with RLGIS

IL Weather station less than 2 kms

On-line measurement of soil moisture content
Main tasks in the coming years

- Soil-specific moisture-strength models
- Driving tests on couple of large clear cut areas
  - Spring (wet) and summer (dry) conditions
- Soil-specific models for prediction of bearing capacity
- Usefulness of BIG DATA (topographical, geotechnical and weather data) in forest operations

- We have strong interest in international co-operation e.g. upcoming Horizon2020, Interreg Baltic Sea Region, etc.