

# Validation of prediction models for estimating moisture content of small diameter stem wood

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Forest engineering: Making a positive contribution  
FORMEC 2015 Symposium: October 4 - 8, 2015  
Linz, Austria

- The most important factor influencing the quality and calorific value of fuel wood is moisture
- The latest methodology for moisture change monitoring has been constant weighing of piles in racks built on load cells.
- Drying models for estimating the optimal storage time based on average moisture change in fuel wood stacks stored outdoors have been developed for different energy wood piles.
- Especially in Finland, thinning wood from young stands has been increasingly used for energy. From 2010 it has been the major source of forest chips for energy, (2014 almost 50%)
- In this study, **stem wood models** were validated against data from forest companies.

- The results of the validation are promising.
- The difference between measured and modelled moisture was on average only 0.3% with covered piles and 2.5% with uncovered piles.
- The models presented can be implemented in every location in Finland, because the Finnish Meteorological Institute has a database for interpolated meteorological observations covering whole country in a 10 km x 10 km grid.
- For international use, model parameters need to be estimated case by case, but it should also be possible to implement the approach itself worldwide.





# Drying models

Roadside storage models				
DMC = coef * (evaporation – precipitation) + const				
Moisture content (i) = moisture content (i-1) – DMC				
Model	coef	const	R <sup>2</sup>	SE
Stem wood, covered (pine)	0.062	0.051	0.70	0.2
Stem wood, uncovered (pine)	0.062	0.039	0.64	0.2

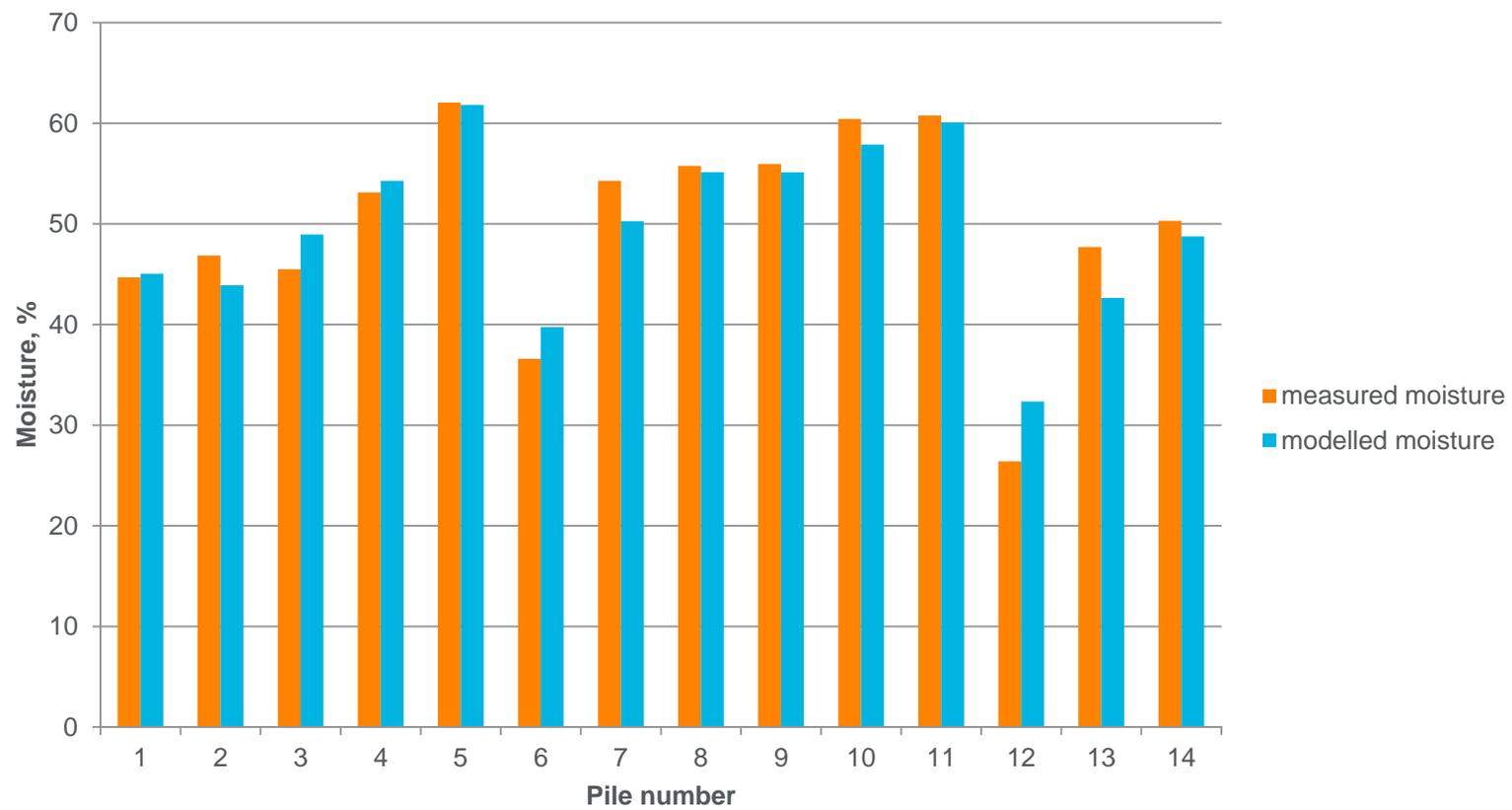
## Validation data

- The validation data for covered small diameter pine stem wood has been collected in central Finland.
- The sampled piles were selected so that they represent average energy wood storages in Finland. The materials of the piles were typical of first thinning.
- All the storage piles were covered with the Walki cover paper.
- Uncovered pine stem wood was delivered by the Tornator Company.
- The stems were from cuttings, which were implemented 2–21 months ago.

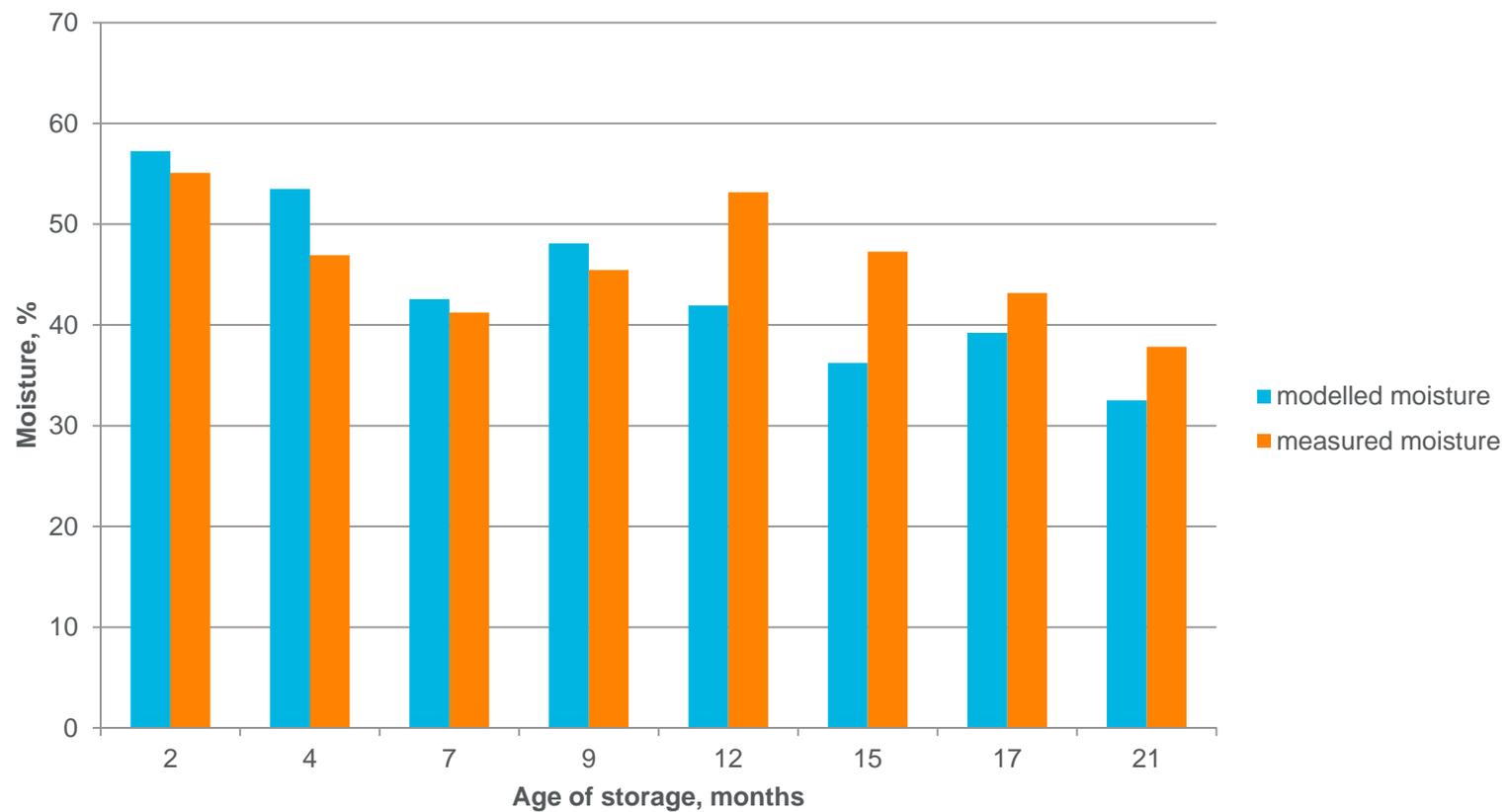


The moisture samples were taken from piled chips; 6–8 samples were taken with ladle sampling to a big plastic tub. All the samples were spilled onto a table, where chips were divided into four parts. One part was put into a duplicate plastic bag (5 litres). Plastic bags were delivered immediately to the laboratory, where the moisture content was measured using the oven dry method. The sampling method closely followed the solid biofuel standard EN 14774.

## Results of validation covered piles



# Results of validation uncovered piles



- Modelling is an easy option to make an estimate of the moisture content of an energy wood pile if compared with sampling and measuring the moisture of samples.
- Models are also a considerably more reliable method for allocation and prioritisation of piles than the “educated guesses” used earlier.
- In practice, piles are often kept in storage too long “just to be sure” that they are dry enough. This increases storages levels and due to that, the capital costs of supply. In addition, dry matter losses increases due to too long storage times.

- The practitioners of the forest energy business have stated that their requirement of the moisture estimate accuracy for enterprise resource planning purposes would be  $\pm 5\%$  of the moisture content. In this study, 77% of observations meet this limit.
- Some forest companies have already started to use models as a part of their Enterprise Resource Planning (ERP) systems, and the feedback has been encouraging; models work well enough to give added value.
- A need for further development is still recognized, especially concerning the varying weather conditions of autumn and the effects of snow during winter. Some fuel chip reception stations on heating plants are already using automated continuous moisture metering. If the chain-of-custody is proof, this information can be used effectively to develop models in the future.

- Routa, J., Kolström, M., Ruotsalainen, J., and Sikanen, L. 2015. Validation of prediction models for estimating the moisture content of small diameter stem wood. *Croatian Journal of Forest Engineering*, 36 (2): 111-119.

Thank you!

Kiitos!

