CONTENT

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SAWLOGS ARE IMPORTANT
Storage over a longer time can cause

- Discoloration
- Fungal decay
- Cracks

BUT THE VALUE MAY DETERIORATE
THE PROBLEM: LOSS OF MOISTURE CONTENT

Moisture content

- 60%
- 50%
- 40%
- 30%
- 20%
- 10%

Time

Fungal infections
Difficult barking
Less process friendly
Splitting
FSP (≈23%)
SPRINKLING HELPS, BUT…

Photo: Per Österman
IS NOT ALLOWED IN MANY PLACES

Photo: Adam Gustafsson
WEATHER DETERMINES THE DRYING PROCESS
DRYING-RATE OF ROUNDWOOD CAN BE PREDICTED

\[ MC_l = c_1 \sum_{1}^{n} (\text{daytemp}_i \times \text{daydry}_i) + c_2 \times \exp \sum_{1}^{n} (\text{daytemp}_i \times \text{daydry}_i) \]

where

\( MC_l \): Loss of moisture content

\( \text{daytemp}_i \): Average temperature during day \( i \) (0 if < 0)

\( \text{daydry}_i \): 100\% - average relative air humidity (%) during day \( i \)

\( \exp \): Exposure to sun and wind (can vary between 0\% and 300\%)

\( c_1 \): Constant = 0.000216

\( c_2 \): Constant = 0.000253

from Persson et al. 2003
YOU CAN CHANGE THE EXPOSURE

Photo: Juha Rikala

Above figures: U-C Coatings Corporation
MODEL SAWMILL:

- Central Finland
- Total production: 220,000 m³/a
- Total roundwood consumption: 440,000 m³/a
- Production 11 months / year (closed July)
SUPPLY CHAIN

Storage
Time: On site 3 days

Roadside Varying

Sawmill 2 weeks

Operation:
Harvest
Forwarding
Road transport
MONTHLY HARVESTING OF SAWLOGS

Percentage of yearly cutting of sawlogs 1995-2014

from LUKE 2015
WEATHER DATA
## USED EXPOSURE RATES

<table>
<thead>
<tr>
<th>Place of storage</th>
<th>Exposure [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>On harvest site</td>
<td>200</td>
</tr>
<tr>
<td>Exposed pile</td>
<td>80</td>
</tr>
<tr>
<td>Covered pile</td>
<td>20</td>
</tr>
<tr>
<td>At sawmill</td>
<td>80</td>
</tr>
</tbody>
</table>
## COSTS USED IN STUDY

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost [€/m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover pile</td>
<td>1</td>
</tr>
<tr>
<td>MCI* 5–10%</td>
<td>5</td>
</tr>
<tr>
<td>MCI 10–15%</td>
<td>10</td>
</tr>
<tr>
<td>MCI &gt;15%</td>
<td>15</td>
</tr>
</tbody>
</table>

*MCI = Moisture content loss
OPTIMIZATION: GOAL PROGRAMMING MODEL

\[ \min z = \sum_{d=1}^{#D} \sum_{i=1}^{#I} \sum_{t=1}^{#T} s_{dit} y_{di} x_i p_t + \sum_{i=1}^{#I} \sum_{t=1}^{#T} s_{dit} w_i x_i p_t + \sum_{i=1}^{#I} c_i \]

#D = total number of days
#I = total number of piles
#T = total number of penalties

\[ x_i = \text{quantity of timber at pile } i \text{ (harvested at time } i) \]
\[ y_{di} = \text{fraction of pile } i \text{ processed at day } d \]
\[ p_t = \text{penalty associated with threshold } t \]
\[ s_{dit} = \begin{cases} 0 & \text{if } \text{MCl}_{di} < t \\ 1 & \text{otherwise} \end{cases} \]
\[ w_i = \text{proportion of pile } i \text{ left unprocessed} \]
\[ c_i = \text{cost associated with covering pile } i \]
RESULTS
CONCLUSIONS

• By covering a portion of piles in May – August the effects of drying could be controlled
• The amount needed to be covered was 2.3%
• The maximum Moisture Content loss was 12%
• Technical solutions for changing the exposure needs to be developed and studied
THANKS FOR YOUR ATTENTION!