Do logging residue piles trigger extra decomposition of soil organic matter?

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Biomass harvesting for energy – latest scientific knowledge on the ecological impacts in Nordic forests

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Logging residue may be harvested for energy... or left at the logging site, typically in small piles.
Composting soil organic matter?

Physical effects
- Shading, insulation

Chemical-biological effects
- Nutrients, fresh carbon

PEAT = lots of C to lose

HUMUS LAYER

Moist soil, stable temperature
- Nutrients and fresh carbon available

⇒ Increased decomposition in soil?
⇒ CO₂ emissions to the atmosphere!
Logging residue piles increased decomposition in soil by 680 g C m$^{-2}$ in two growing seasons after clearfelling!

- That’s a lot!!
- Decomposition of humus layer or peat?
- Physical or chemical-biological mechanism?
- How common is this phenomenon?
This study: Origin and mechanism of the observed emission?

- Decomposition of peat (0–10 cm + 10–20 cm) and humus (surface)
- Decomposition of cellulose (surface, 0–10 cm ... 30 – 40 cm)
- Control, pile and artificial pile plots
  - 3 sites + 5 plots/site/treatment + 3 decomposition replicates/plot
- One growing season (2013) + two years (2013–2015) after logging
<table>
<thead>
<tr>
<th>Site</th>
<th>Site type</th>
<th>Coordinates</th>
<th>Elevation (m a.s.l.)</th>
<th>WT±se (cm)</th>
<th>C/N±se</th>
<th>BD±se (kg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Dwarf shrub</td>
<td>61° 50.164’ N, 24° 12.597’ E</td>
<td>163</td>
<td>65±5</td>
<td>34.3±0.9</td>
<td>108±5</td>
</tr>
<tr>
<td>B</td>
<td>Blueberry II</td>
<td>61° 49.644’ N, 24° 12.874’ E</td>
<td>163</td>
<td>31±5</td>
<td>28.6±0.3</td>
<td>135±8</td>
</tr>
<tr>
<td>C</td>
<td>Dwarf shrub</td>
<td>61° 49.518’ N, 24° 12.336’ E</td>
<td>162</td>
<td>21±1</td>
<td>40.0±0.5</td>
<td>83±7</td>
</tr>
</tbody>
</table>

Clearfelling winter 2012–2013 by Metsähallitus.

Physical + chemical-biological effects:

Physical effects only (at site A):
Mean temperature and mean daily temperature amplitude (daily max – daily min) at control plots and treatment plots at the study sites during the growing season (June–September 2013).

On average 2 °C colder under logging residue piles

Lower diurnal temperature variation under logging residue piles
The diurnal cycle (hour interval on x axis) of relative humidity (%) at the moss layer–atmosphere interface at different sites and treatments during July 5th–September 30th, 2013.

Relative humidity does not drop under piles during afternoon hours.
Mean mass loss (% of initial mass) of the cellulose strips incubated in soil June–September 2013 with (LRP, crosses) and without (CTRL, squares) logging residue piles at sites A, B and C, and with artificial piles (ART1–3, circles) at site A. Error bars are standard deviations.

Piles increased significantly ($p = 0.0001$) decomposition of cellulose, on average by 40 %

Artificial piles did not affect decomposition of cellulose

$\Rightarrow$ Strong chemical-biological enhancement of decomposition in soil due to piles
Decomposition of humus and peat was not affected at all!

And we definitely should have seen something here!

Mean mass loss (% of initial mass) of the humus layer (surface) and peat incubated in soil with (LRP) and without LRP (CTRL) June–September 2013 (4 months) and June 2013 – May 2015 (2 years). Error bars are standard deviations.
Conclusion from the two studies: Big emission of CO$_2$ from soil, enhanced decomposition in soil, and no loss of soil C

• C was released, yet it is still there

• Some referees might find it hard to accept this!

• So where did the C come from?
• What’s going on in soil?
A possible explanation

Massive amounts of nutrients and fresh organic carbon compounds available in and under the piles

=> Decomposer fungi translocate resources from elsewhere

=> Growth, maintenance and turnover of hyphae releases CO₂

We did not consider the possibility of horizontal C transport

⇒ we did not try to measure it

⇒ this hypothesis needs to be tested
Conclusions

• Logging residue piles affect physical soil conditions
  • This alone does not enhance decomposer activity

• Added with chemical-biological effects:
  • We see enhanced decomposer activity

• Loss of soil carbon was not observed!

=> Perhaps no risk of CO$_2$ emissions after all?