Effects of increased biomass removal on the biogeochemistry of two Norwegian forest ecosystems

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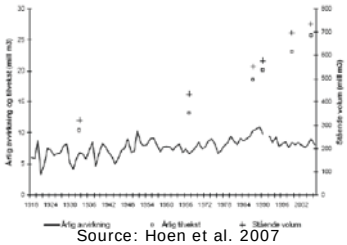
INTRODUCTION

Forests in Norway and in Europe generally are growing faster than ever, whereas harvest intensity is without obvious trend (**Fig. 1**). This opens the possibility to increase the use of forest products for (bio-)energy production. The Norwegian Government made a commitment to double the biofuel-related production to 14 TWh until 2020. For this purpose, it is economically meaningful to take out all plant parts except stumps (Whole Tree Harvest, **WTH**) instead of Conventional Harvest (**CH**) leaving tree crowns, branches, leaves and needles on the ground.

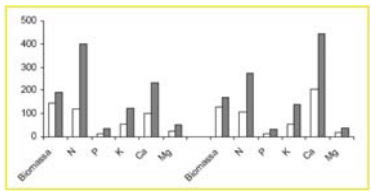
At the same time, these parts of the trees are notoriously nutrient-rich. Thus, WTH takes out a disproportionately large fraction of nutrients (**Fig. 2**). The freshly started Norwegian research project **ECOBREM** (2009-2012) is investigating the ecological implications of WTH as compared to CH. Nutrient and carbon balance, decomposition, root dynamics, soil and soil solution chemistry changes, ground vegetation and biodiversity are investigated. As a result, forest areas are classified according to the severity of ecological impacts of WTH, and recommendations given.



Source: Hoen et al. 2007

FIGURE 1

Standing stocks (crosses, right axis), growth (squares) and harvest (solid line) in Norwegian productive forest.



Source: Swedish Energy Agency 2006

FIGURE 2

Biomass (t/ha) and nutrient (kg/ha) removal due to CH (white) and WTH (grey) in Swedish spruce sites

METHODS

- Two research sites will be established in in southwest and southeast Norway which represent rather distinct landscape types.
- At each site, pre-harvest measurements are made, and then CH and WTH plots will be compared (**Fig. 3**).
- Biomass and nutrient content of harvest products, soil chemistry, soil solution, ground vegetation (**Fig. 4**), roots, soil fungi and other variables will be monitored at the two sites.
- The consequences of different harvesting regimes will be traced over long time periods (**Fig. 5**).
- Accumulation of soil carbon will be compared according to harvest type (**Fig. 6**).
- Existing long-term field trials (dating back to the 1970s, in total 20 plots) will be used to constrain the modelling approach (**Fig. 7**). After calibration, the models will be run according to prescribed harvesting regimes (scenarios).

FIGURE 3 *Conventional harvest (left, plant residues remaining on the ground) at a reference site and whole-tree harvest at one of the research sites (right).*

FIGURE 4 *Detailed monitoring of ground vegetation (e.g. species distribution, abundance, biomass).*

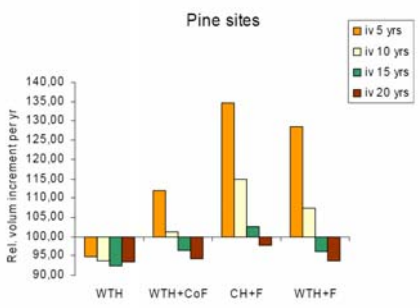


FIGURE 5 *Long-term consequences of harvest regimes for pine - relative volume increment. The effect of fertilization (F) after harvest vanishes after 10-15 years.*

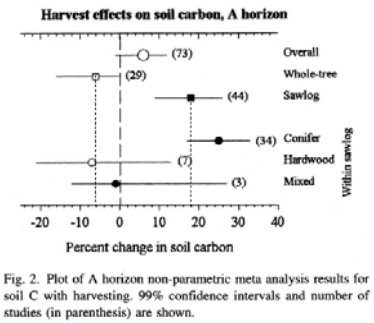


Fig. 2. Plot of A horizon non-parametric meta analysis results for soil C with harvesting. 99% confidence intervals and number of studies (in parenthesis) are shown.

FIGURE 6 *A metastudy (Johnson and Curtis 2001) indicates that CH tends to increase, whereas WTH tends to decrease the carbon in soils. However, the results vary greatly, depending e.g. on tree species.*

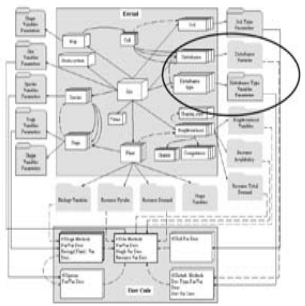


FIGURE 7 *Architecture of the modelling framework to be developed. Models where explicit harvest scenarios can be prescribed are focal.*