Uncertainty assessment of carbon sinks of forest vegetation and soil: Key factors affecting the uncertainty and the role in national GHG inventory

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Introduction

- Forest carbon sinks remarkable in comparison to emissions of other sectors
- How precise are these estimates?
- Uncertainties of sinks reported to UNFCCC - aims at improving inventories
Key objectives

- To estimate how uncertain are the carbon sink and stock estimates of forests and what are the key factors of uncertainty
- To assess what is the role of forests in the total uncertainty of national greenhouse gas budget
  - Comparison of sectoral uncertainties
Calculation of forest carbon

METHODS

Trees

\[ VEG \ C_t \]

\[ Volume \ (t, D, GI) \]

\[ A_t \ (t, A_1, A_2) \]

\[ \cdot BEF_{TOT} \]

\[ \cdot C\% \]

Ground veg.

\[ \cdot BA \]

\[ \cdot C\% \]

Soil

\[ TREES \]

\[ L_i \]

\[ \cdot C\% \]

\[ GROUND \ VEG. \]

\[ L_{gv} \]

\[ \cdot C\% \]

\[ SOIL \ C_{t-1}/A_{t-1} \]

\[ \cdot \Delta A_{t,t-1} \]

\[ AC_t \]

CO₂

SOIL C_{t} (I, Drought, soil model parameters)
Method to estimate uncertainties

\[ X = \text{Any operator} \]
\[ P_{i,j} = \text{Any parameter, input or variable in the system} \]
\[ X = \text{Any operator} \]
Outputs

• Uncertainties for carbon sinks and stocks in Finland during 1988-2004
  • vegetation
  • soil (mineral soils only, litter + som down to 1m)
  • forest as a total
• Key factors of these uncertainties
Carbon stocks in 1990 (Tg)

RESULTS

Forest C stock 1990 (Tg)

Soil C stock 1990 (Tg)

Veg. C stock 1990 (Tg)

CV. 0.31

CV. 0.46

CV. 0.03

0 1000 2000 3000 4000

1000 2000 3000 4000 5000

550 600 650

550 600 650
RESULTS

Average carbon sinks (Tg)

- Avg. forest C sink (Tg)
  - CV. 0.26
  - SD. 1.2
  - no soil init:
    - CV. 0.14
    - SD. 0.6

- Avg. veg. C sink (Tg)
  - CV. 0.12
  - SD. 0.4

- Avg. soil C sink (Tg)
  - CV. 0.81
  - SD. 1.1
  - no soil init:
    - CV. 0.35
    - SD. 0.5
Vegetation sink 1990-2003

RESULTS

Vegetation

Carbon sink (Tg)

0 5 10 15


Year

- 2.5% C.I.
- 25%
- 50%
- 75%
- 97.5%

METLA
RESULTS

Soil sink and model initialization

<table>
<thead>
<tr>
<th>Year</th>
<th>Soil C sink (Tg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>-8</td>
</tr>
<tr>
<td>1992</td>
<td>-6</td>
</tr>
<tr>
<td>1995</td>
<td>-4</td>
</tr>
<tr>
<td>1998</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>2</td>
</tr>
<tr>
<td>2004</td>
<td>4</td>
</tr>
</tbody>
</table>

Median C.I of 2.5 or 97.5%, without soil init. state uncert.

C.I of 2.5 or 97.5% with soil init. state uncert.
Comparison between sectors

Fig. CO2 emissions and removals (error bar is 95% CI). From: Monni, Peltoniemi, Palosuo, Lehtonen, Savolainen, Mäkipää. Climatic Change, accepted
Key factors: vegetation

RESULTS

Biomass, mean, gr. veg.
Area
Natural mortality
Biomass, mean change, gr. veg.
BEF, stand total
BEF change, stand total
Carbon density
Growing stock
Drain
Upland drain-%
Growth indexes

Approx. share of variance
Key factors: soil sink

RESULTS

Combined effect in the 1st run
Discussion

• Model or sub-model structure or validity not assessed
  • by definition, it is not possible to assess what you don't have in a model
  • e.g. no data on correlations between system components
• Precision estimated, not accuracy
• Subjectivity of initial uncertainties
Conclusions

- Current data and methodology support better sink averaging
  - Inventory data compiled for long periods of time
  - Sub-models developed as averages of long periods (no other kind of data available)
  - Uncertainty related to inter-annual changes of ecosystem unknown.
Thank you, see you at Koli?