Soil carbon modelling

A simple dynamic multi-scale approach

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Outline

- Background and needs
- The Yasso approach
  - Hypotheses
  - Concept
  - Testing / Application
- Conclusions & Discussion

Background and needs (1/2)

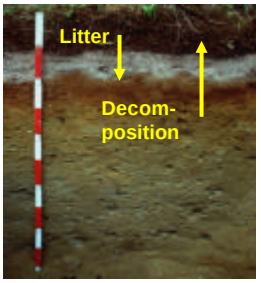
- Remarkable role of soil carbon in forest carbon budget
- Input data could be growth and yield tables, inventory data or other model output
- Too detailed model parameterisation needs would restrict applicability
- Need to develop an easy to apply but still dynamic multi-scale approach for soil carbon modelling

Background and needs (2/2)

- Reporting under UNFCCC
  - Reports must be “transparent and verifiable”
  - Five sectors of which one is on land-use, land-use change and forestry
  - The forestry sector includes: living biomass aboveground and belowground, dead biomass, litter and soil organic matter

Yasso soil carbon method

- Litter production via inventory-based data or model data
  - Foliage, branches, stem, coarse roots, fine roots
- Decomposition input information
  - Climate
  - Initial soil carbon stock



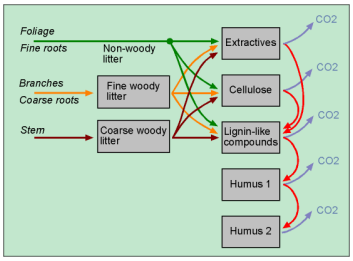
Yasso hypotheses (1/2)

- Litter consists of **different compound groups that decompose at their own typical rates** independent of their origin. The decomposition rate decreases in order extractives, celluloses, lignin-like compounds and humus.
- Unlike non-woody litter, **woody litter is not readily decomposable** according to its chemical composition, because microbes cannot invade it completely at once.
- Decomposing compounds **lose a certain proportion of their mass** in a unit time.

Yasso hypotheses (2/2)

- A proportion of decomposed mass **leaves the soil** while the rest **forms more recalcitrant compounds**.
- The rates of decomposition and microbial invasion of woody litter **depend on favourable temperature and moisture conditions**.
- **Decomposition of humus is less sensitive to temperature** than the decomposition of less more labile compounds.

The Yasso approach

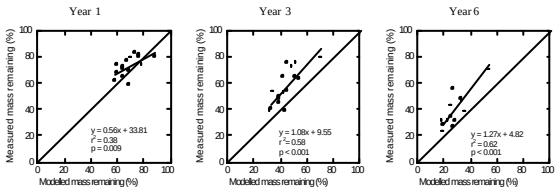


- Input variables
  - Litter amounts and quality (extractives, cellulose, lignin-like compounds)
  - Mean annual temperature **or** temperature sum
  - Drought index ($Prec_{5-9}$ - PET_{5-9})
- Output variables
  - Litter stocks
  - SOM stocks
  - Heterotrophic respiration

Testing and applications

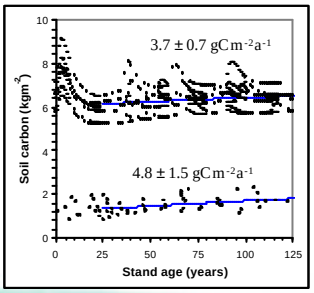
- Yasso has been tested with independent litter bag data (CIDET, LIDET)
- Yasso is the soil carbon model of the following models:
  - EFISCEN, CO2FIX, Motti
- National applications:
  - Switzerland, Norway, Finland

Comparison of model results with Canadian litterbag data



Palosuo, T., Liski, J., Trofymow, J.A. and Titus, B., 2004. Litter decomposition affected by climate and litter quality - testing the Yasso model with litterbag data from the Canadian Intersite Decomposition Experiment. Ecol Model., manuscript submitted in August 2004.

Comparison of simulated soil carbon with measurements



- Simulated and measured rate of carbon accumulation are parallel

Mineral soil carbon stock

Peltoniemi, M., Mäkipää, R., Liski, J. and Tamminen, P., 2004. Changes in soil carbon with stand age - an evaluation of a modeling method with empirical data. Global Change Biology, manuscript accepted in August 2004

Strengths and weaknesses

- Weaknesses/challenges
  - High uncertainty in model calculated values
- Strengths
  - Simplicity → transparency
  - Modelling approach highlights the needs for further study, helps to place various measurements and experimental work in wider framework
  - Applicability in different scales: stand level, forest area, country, etc.
  - Can be integrated into various methods that are used to estimate forest carbon budgets
  - One year time step

Future challenges for research

- Quantification of uncertainty related to this soil carbon modelling approach
- Impact of historic land-use on present soil carbon stocks
- Carbon dynamics in peatlands or poorly drained soils

Thank you for your attention!

http://www.efi.fi/projects/yasso/

References

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