Measurement of root inputs: Allt a' Mharcaidh, Invercauld and Indonesia

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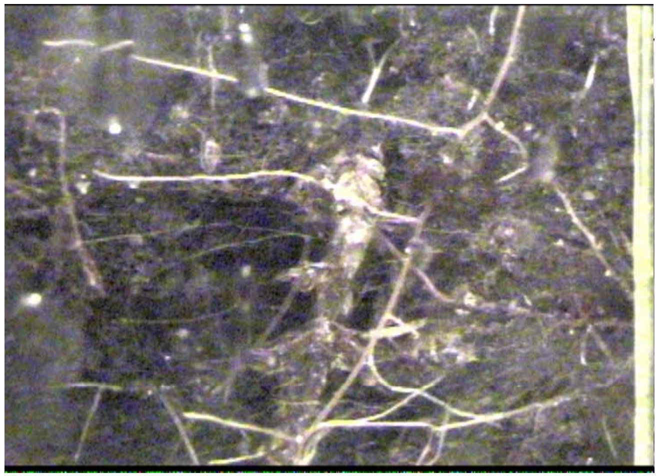

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Five/six habitats along a boreal-alpine toposequence

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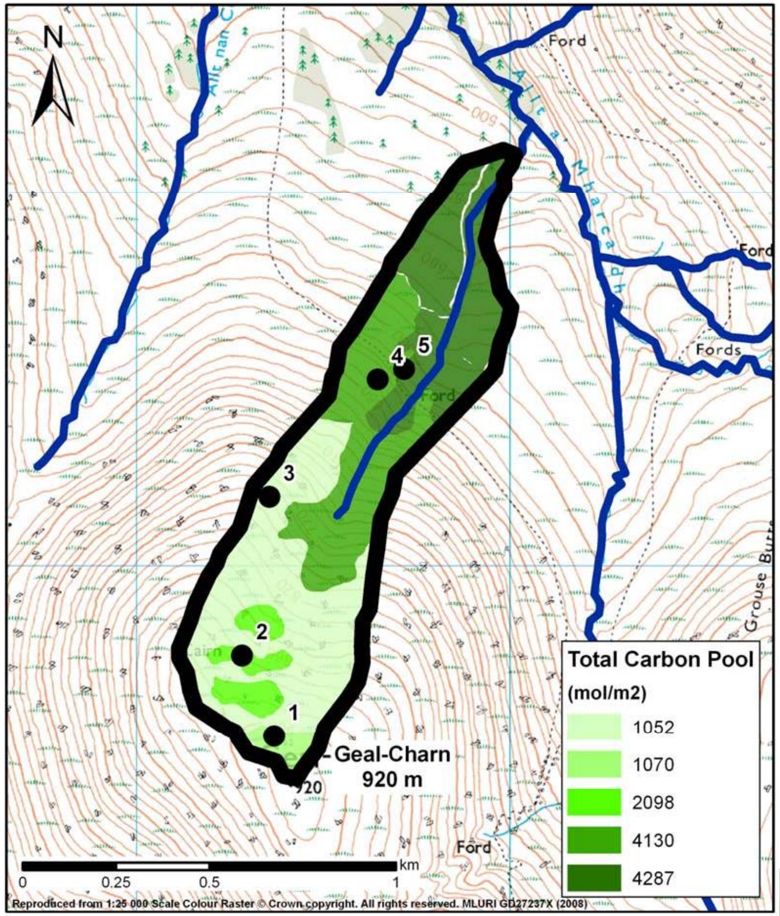

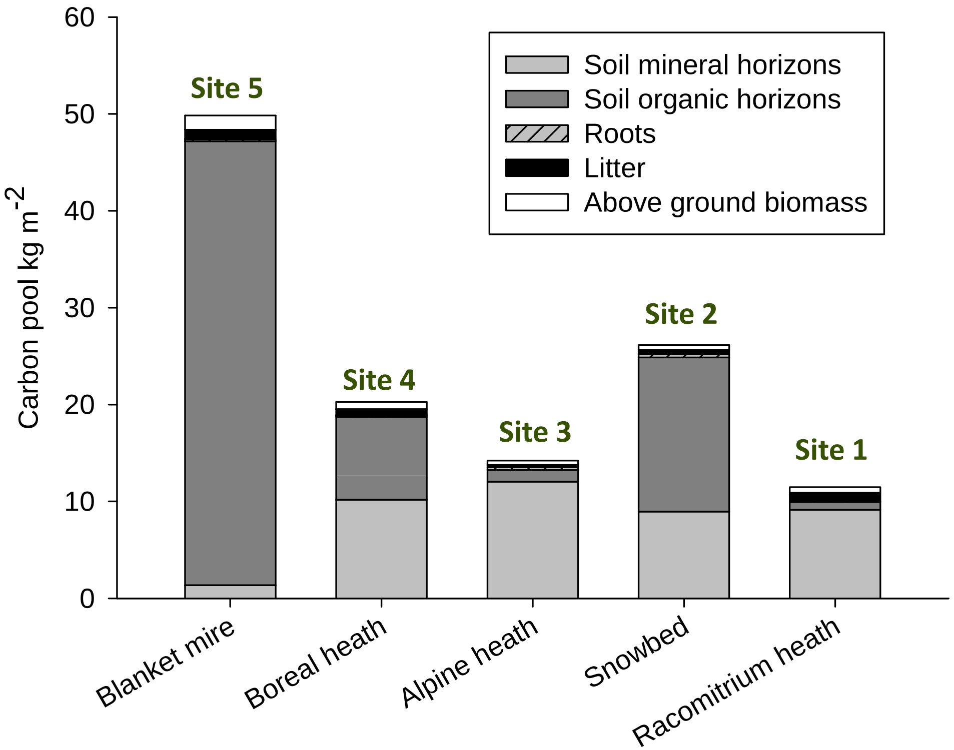

*Britton, A.J.; Helliwell, .C.; Lilly, A.; Dawson, L.A.; Fisher, J.M.; Coull, M.C.; Ross, J 2011.*An integrated assessment of ecosystem carbon pools and fluxes across an oceanic alpine toposequence. - . - *Plant and Soil, 345, 287-302.*

C storage

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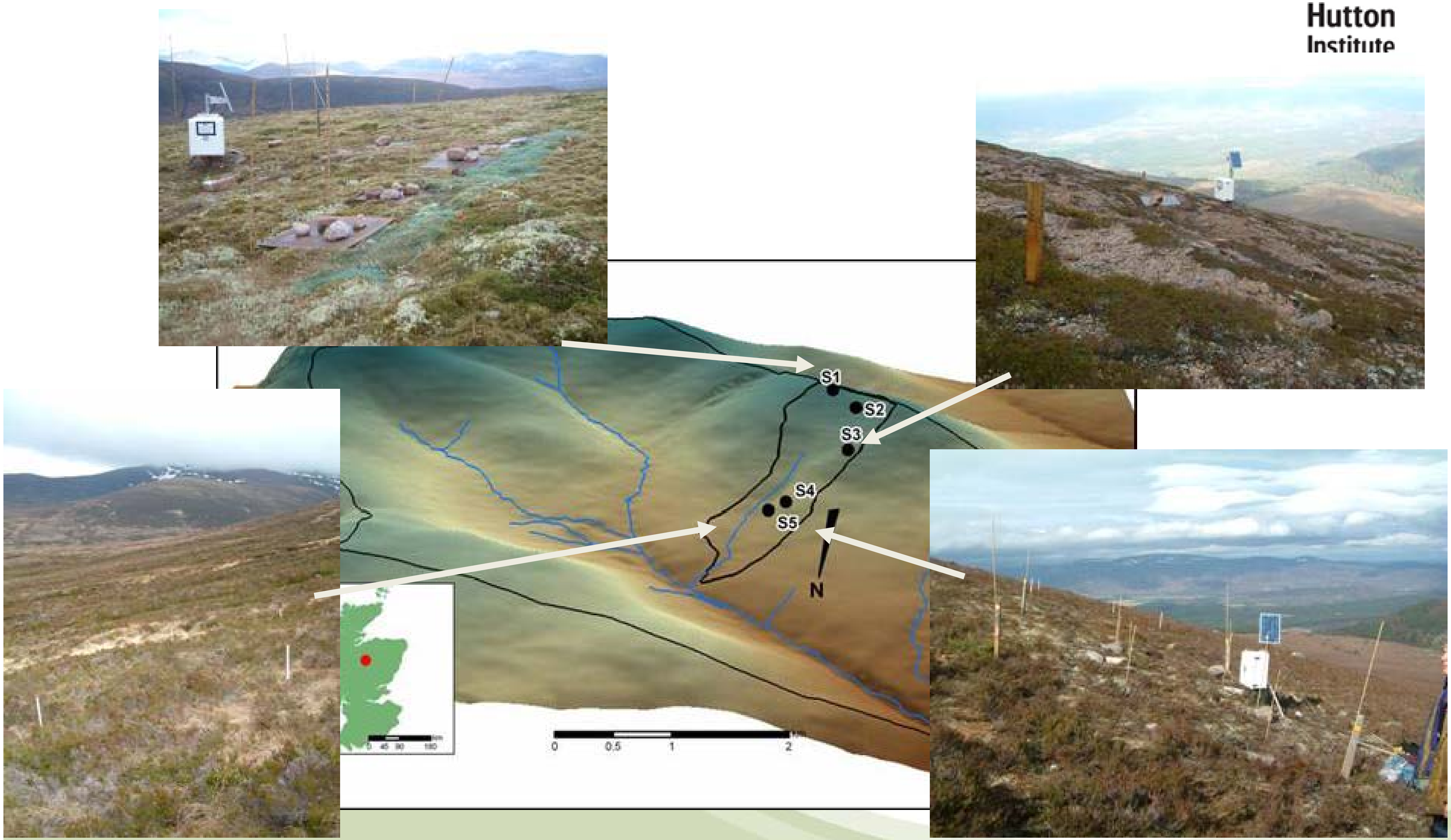
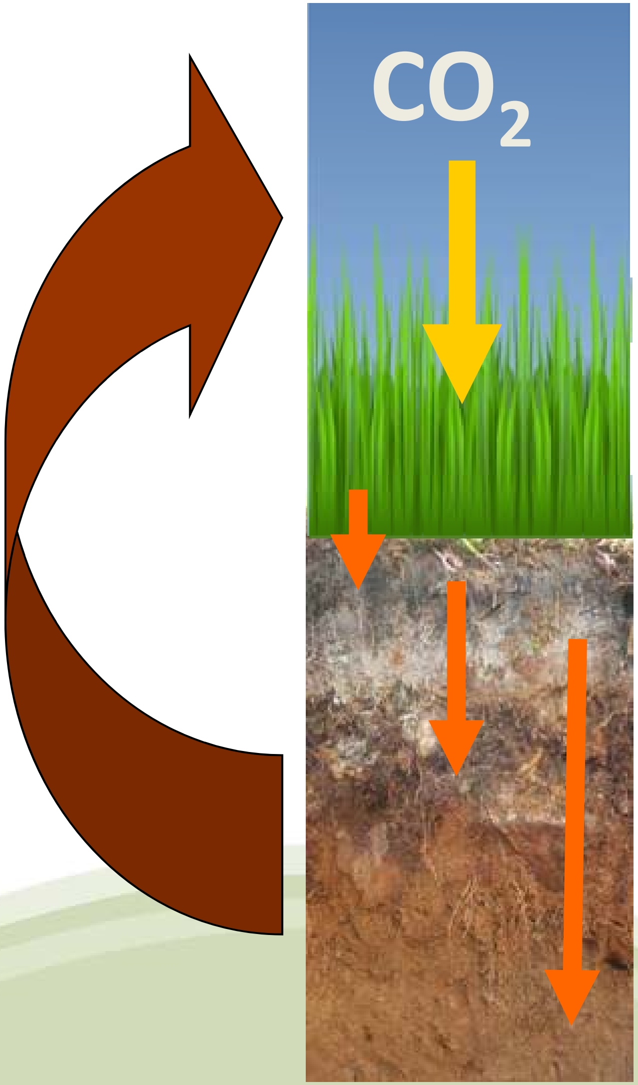




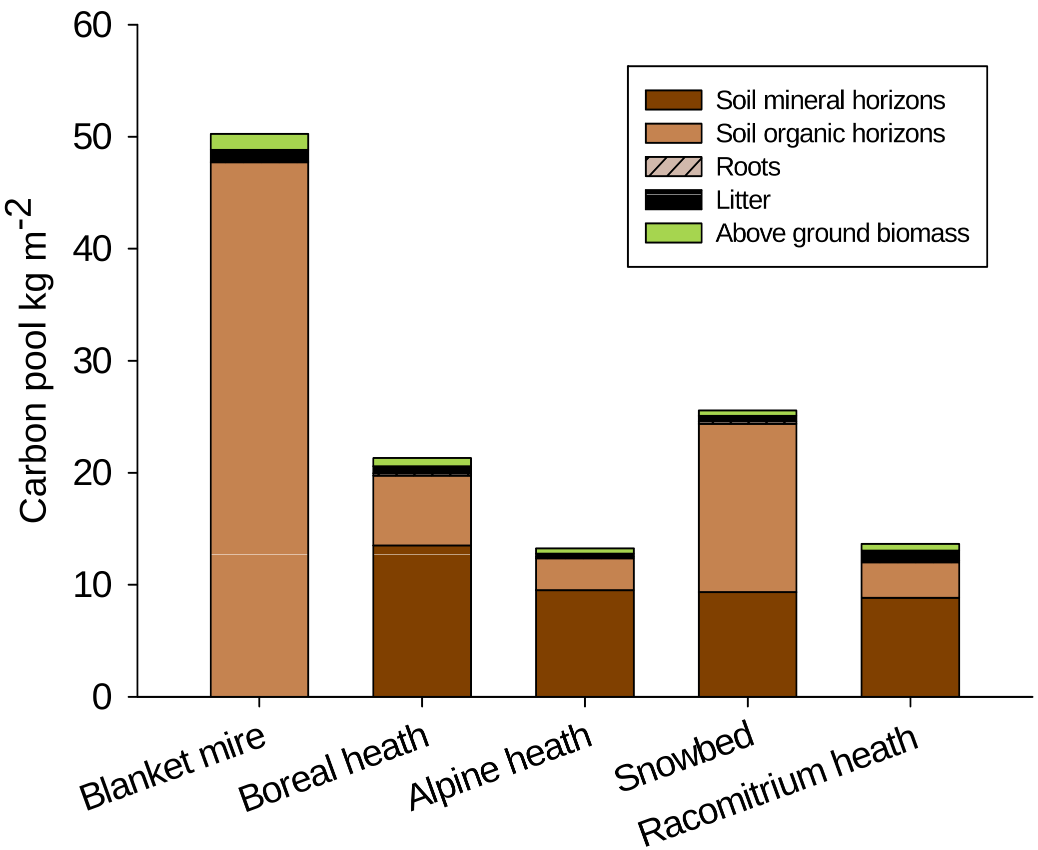
How C storage works

- Plants fix CO_2
- C moves into soil pool as litter
- C stored in litter, organic & mineral horizons
- Soil animals & microbes use organic matter as food source & produce CO_2
- C storage depends on balance between fixation & decomposition

Factors controlling C storage

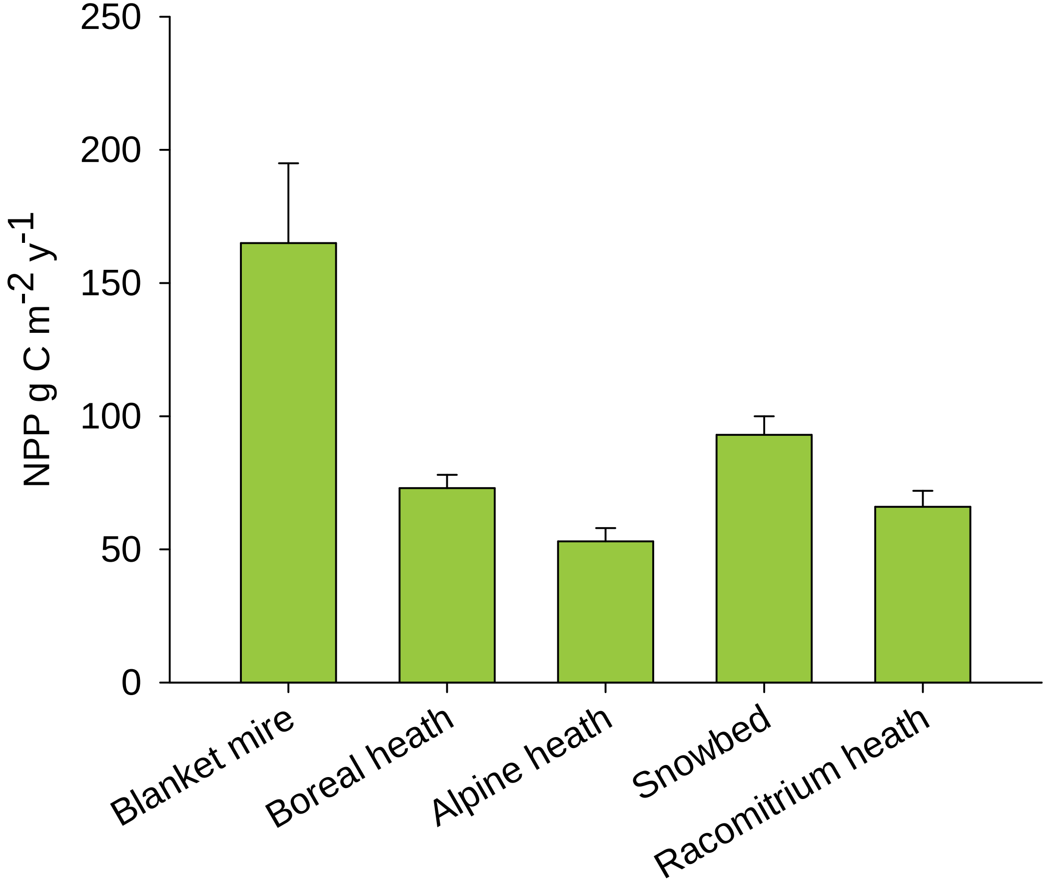
- Litter quality – plant species vary in terms of nutrients (C, N, P) in litter
- Soil biota – community size, composition & activity
- Climate – soil temperature & moisture & their variability directly affect chemical processes, leaching & erosion
- Pollution – N deposition and acidification affect chemical processes
- Interactions – climate & pollution alter microbial community activity, plant litter quality, species present (plants & microbes)

C storage = Fixation - Decomposition



- All habitats hold large soil C stores
- Mire is most important store overall
- Alpine zone holds more than previous estimates
- Snowbed holds largest C store in alpine zone

C Storage = Fixation - Decomposition



- Matches pattern of C storage
- Soil C store = 200-300 times annual production
- Wet habitats most productive
- Alpine habitats can be as productive as boreal

C storage = Fixation - Decomposition

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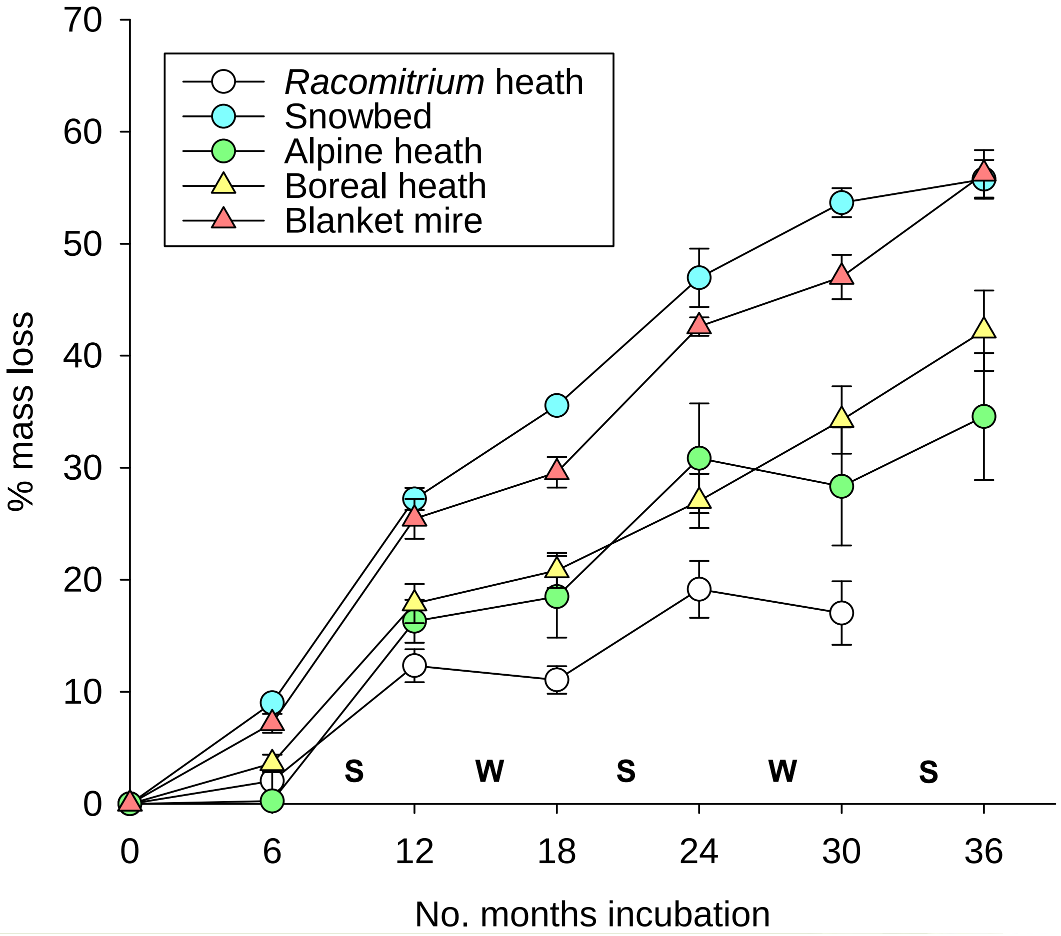


- Surface-placed litter
- Rates vary greatly between habitats
- Alpine habitats include fastest & slowest decomposition
- Habitat type more important than temperature gradient (ca. 2°C)

Projected climate change in Scotland

(2080 – Medium high emissions)

- Temperature: +2 to +3.5°C
- Rainfall: 0 to -10% (↑ winter, ↓ summer)
- Soil moisture: 0 to -20% (↑ winter, ↓ summer)
- Snowfall: -50 to -90%

Impacts of climate change: short term

Change	Fixation	Decomposition	C store
↑Temperature	↑	↑	?
↓Soil moisture (dry habitats)	↓	↓	?
↓Soil moisture (wet habitats)	↓ ↑	↑	?
Loss of snow cover (snowbeds)	↑	=	?

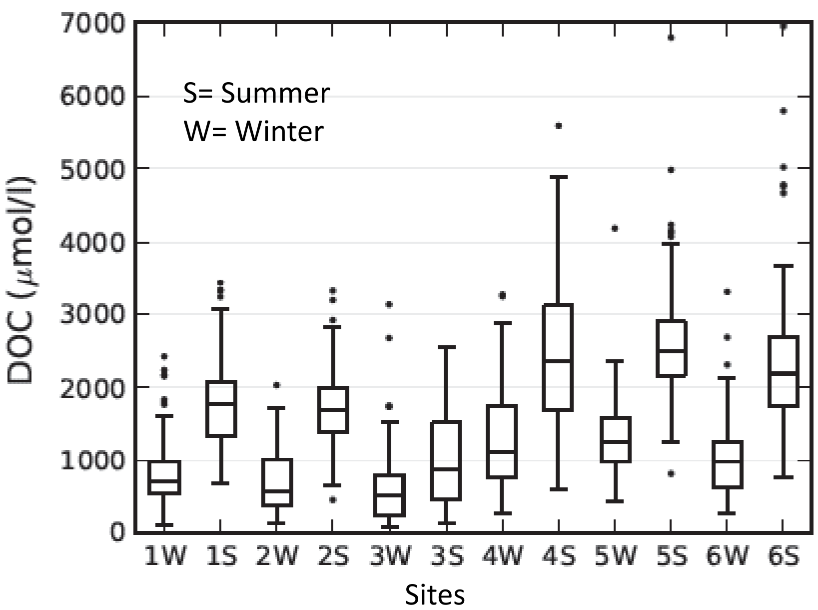
There are many uncertainties – we need to understand more about how species & processes will respond above and belowground

Conclusions

- Alpine habitats in oceanic areas such as UK hold considerable C stocks
- C stocks are spatially variable, wet habitats such as **snowbeds** and **blanket bog** are important
- Climate change effects on habitat distribution will impact C storage
- Control of other factors such as N deposition will be important in maintaining C stocks

Soil Properties and soil water DOC : Allt a' Mharcaidh transect

Site	Organic soil (cm)	Above-tray		
		Mass C (kg/m²)	%C	C:N (molar)
1	8	4.6	13.1	54.1
2	22	6.4	32.2	26.1
3 vegetation	6	3.5	8.3	39.5
3 gravel	0	2.0	4.3	31.6
4	30	11.4	39.0	38.0
5	96	6.9	49.0	63.9
6	9	7.2	29.8	38.7



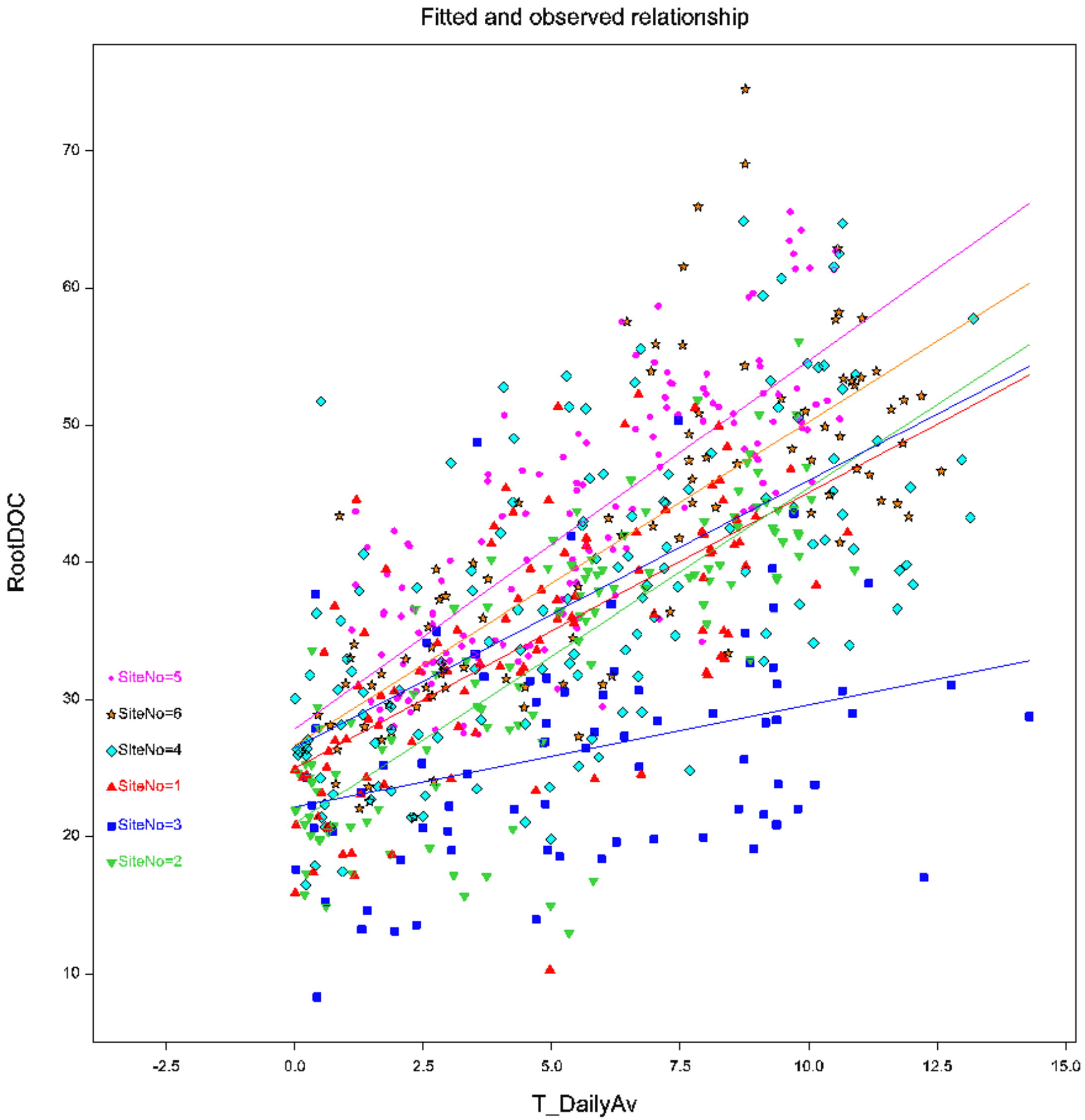
Key messages:

The weak relationship between soil water DOC and above-tray soil carbon pools highlights the potential pitfalls of using DOC as a proxy for C pool

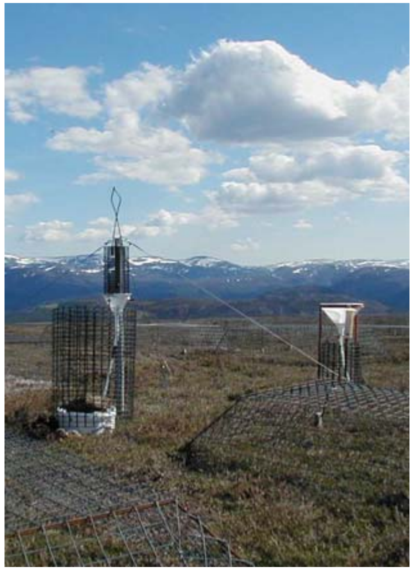
Clear seasonal signal in DOC, with maximum concentrations observed in the warmer months reflecting microbial breakdown of organic matter

An inter-site comparison demonstrates a strong relationship between DOC and net primary productivity with the greatest NPP (at the warmer lower altitude sites) generally showing a more pronounced increase in DOC

Relationship between temperature and root DOC



Sample collection and monitoring: Invercauld



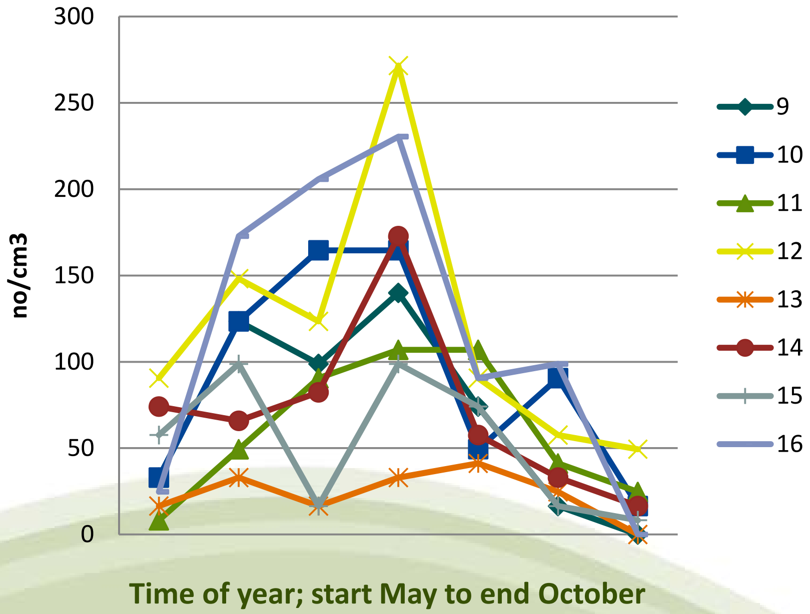
Precipitation volumes and chemistry, temp, moisture

Zero-tension lysimeters used to collect soil solution from HE horizon at 10cm

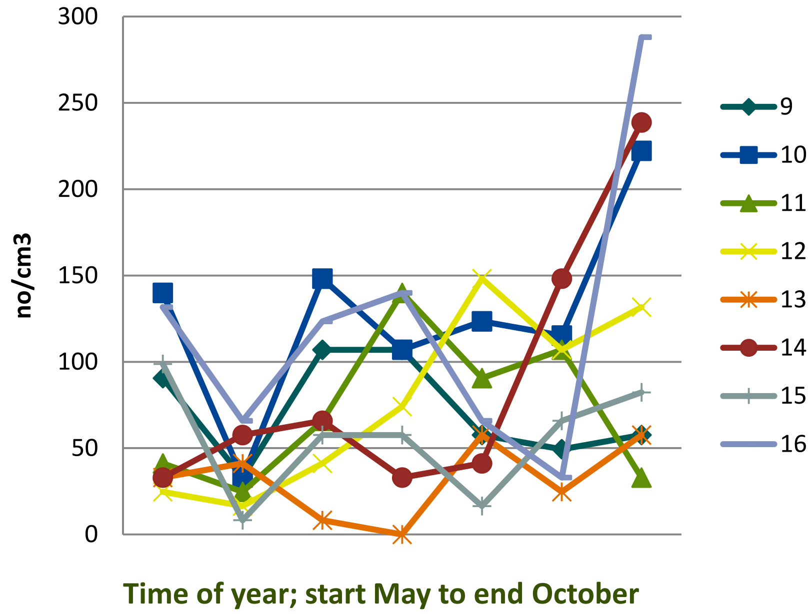
Root dynamics

Root appearance and death

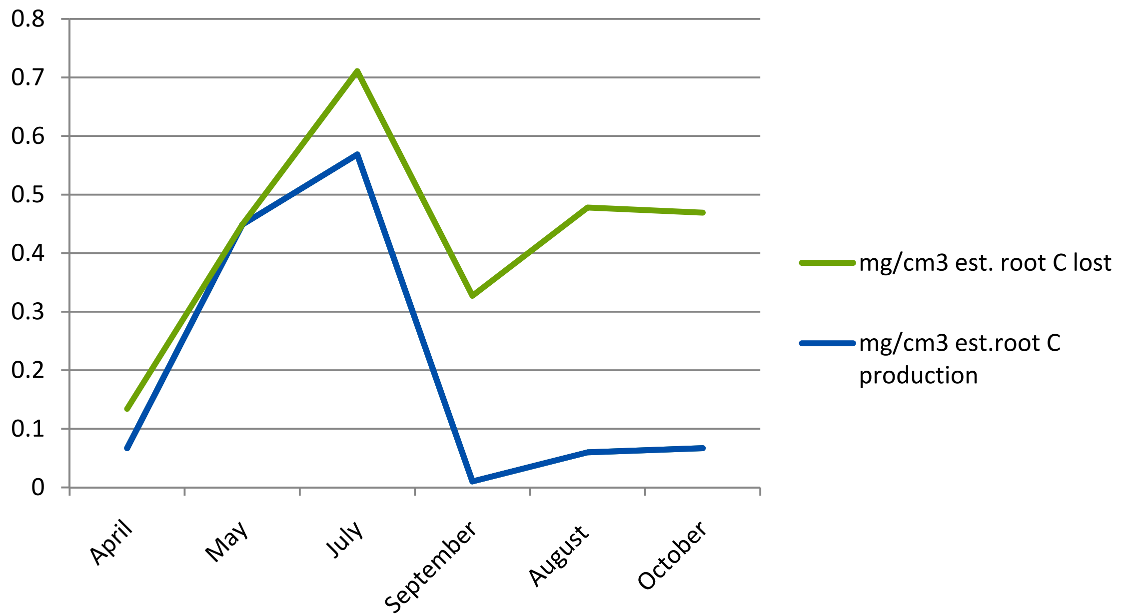
Site 4 root production 2009



Site 4 root death 2009



Root Carbon dynamics- site 3



Invercauld

Invercauld

Experimental set up

•4 blocks

•Within each block a grazed and ungrazed treatment (plot)

•Within each grazed or ungrazed plot 3 treatments:
•Heather control
•Planted birch
•Planted pine
•Each pine, birch, heather plot is 19 x 16m

Measurements made:

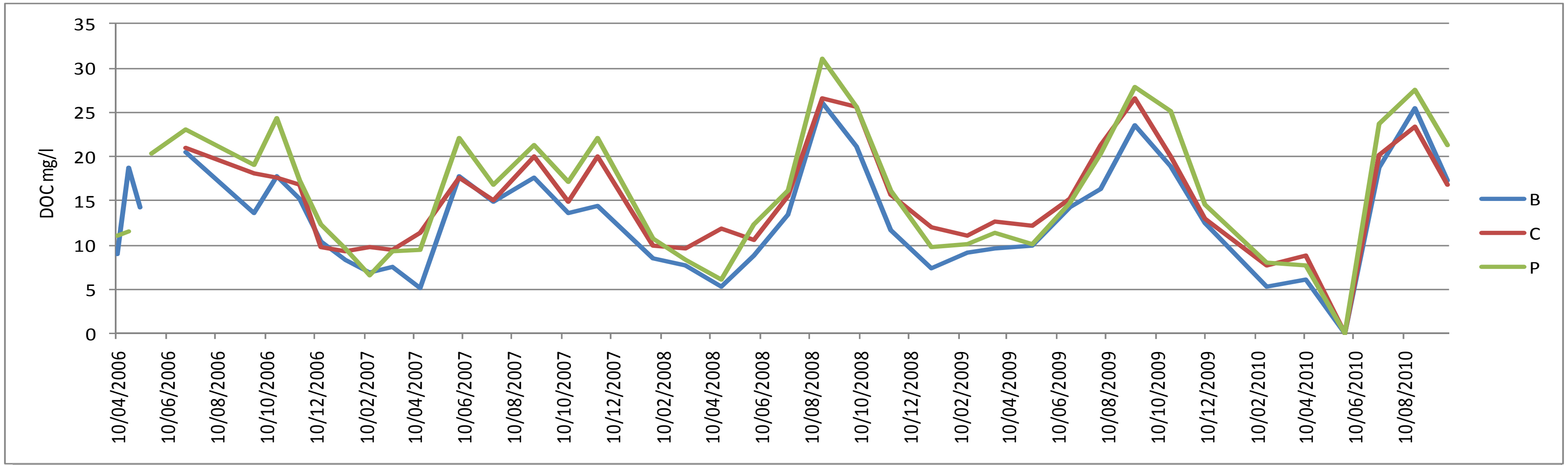
•Soil respiration

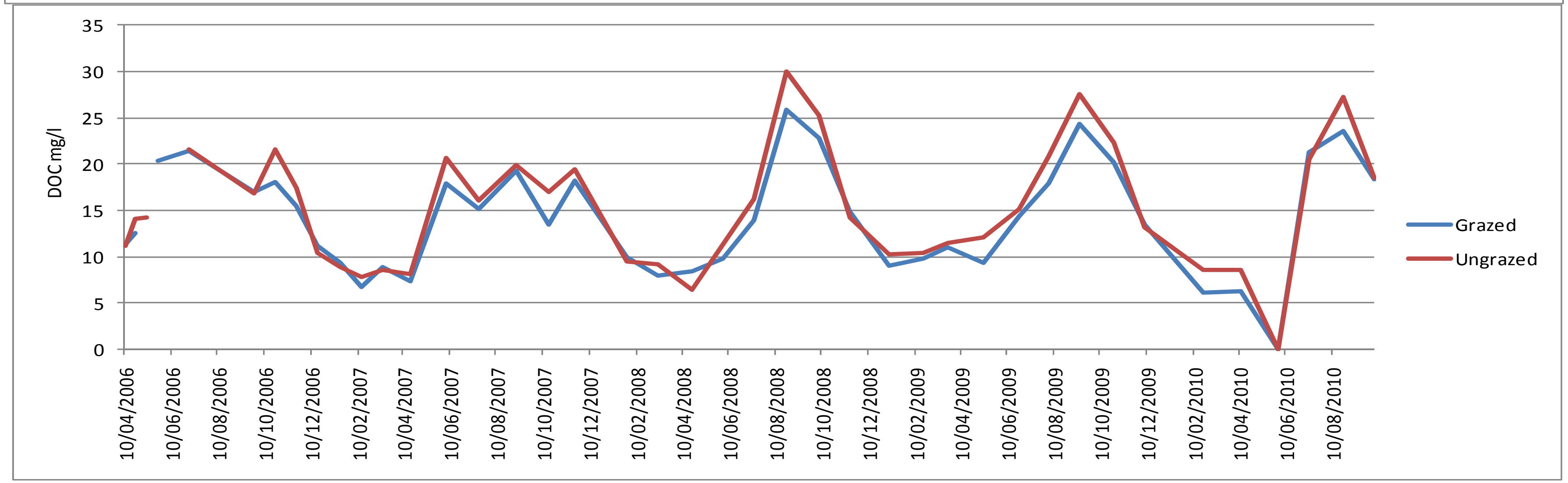
•Soil water chemistry (DOC) plus other chemical content (data on volume is a bit variable as bottles often over-flowed)

•Root growth

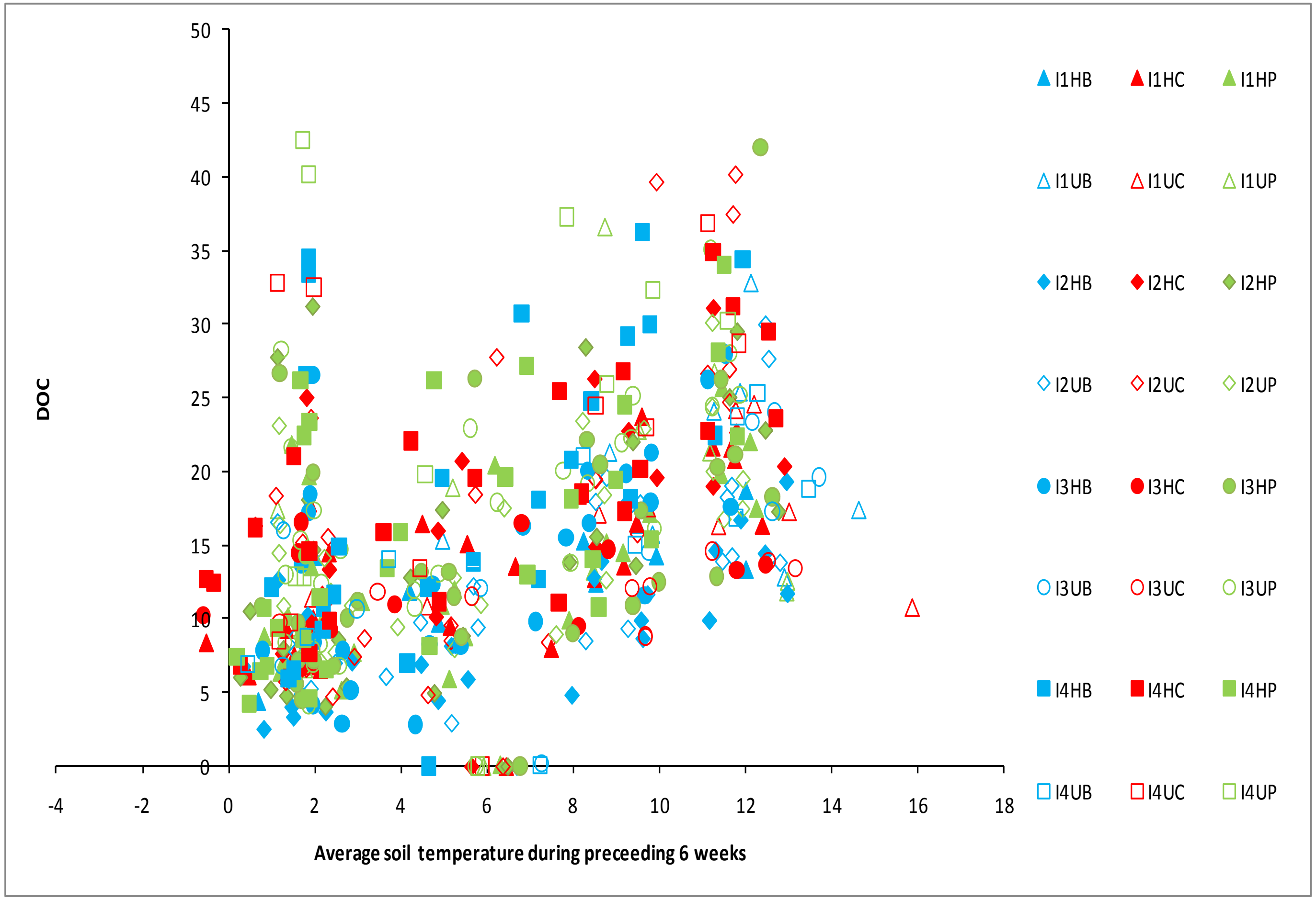
•Root C and N
•Soil temperature
•Soil moisture
•Weather data

DOC time trends

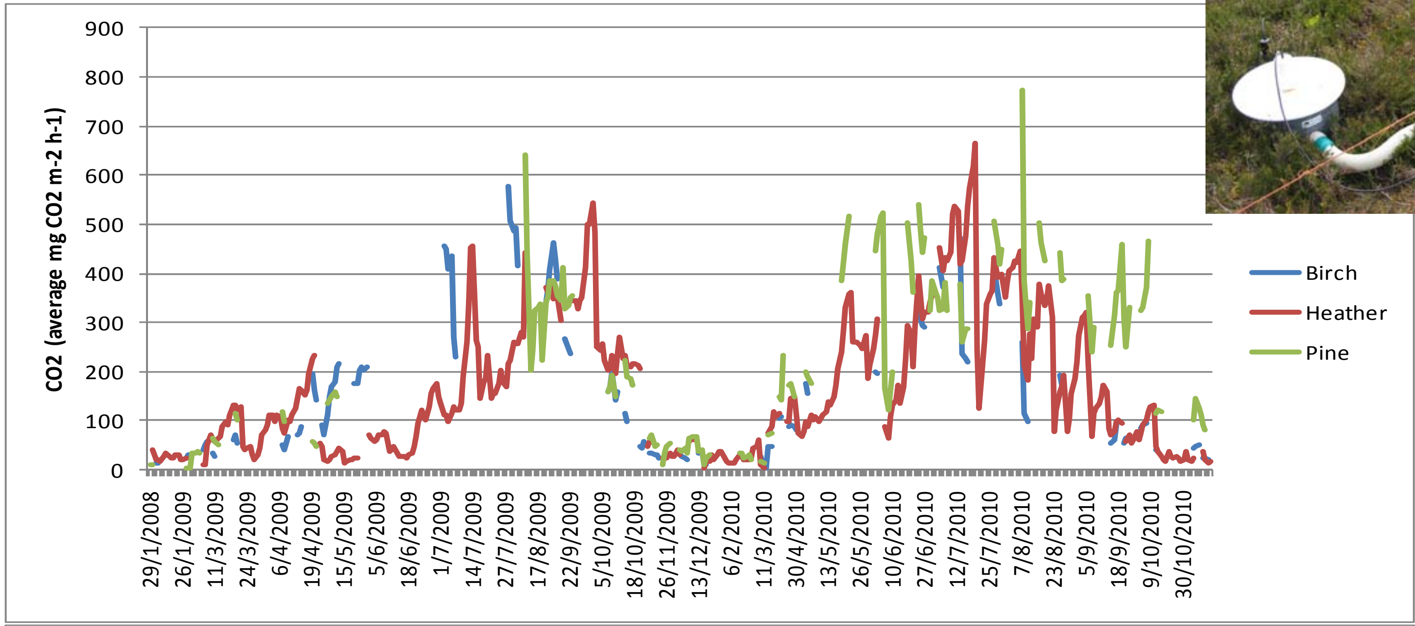




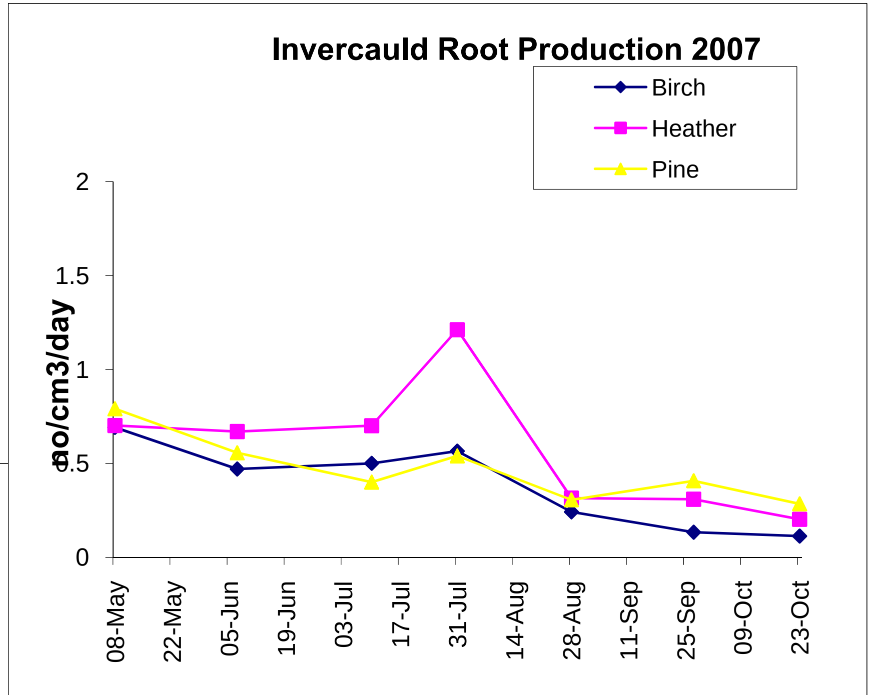
Relationships between DOC and soil temperature

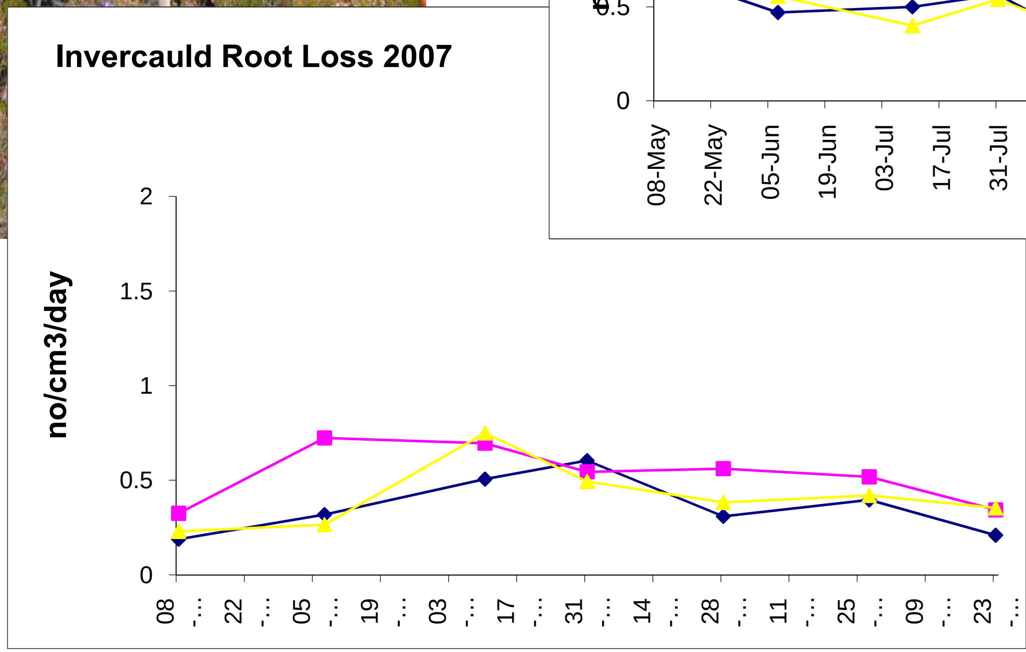


CO2 and soil temperature



Root measurements





Indonesia- Sebastian's PhD

The objective of this study is to assess how the transition associated with logging a primary peat swamp forest and establishing oil palm plantation affects the contribution of fine roots to the ecosystem carbon cycle.

The aims are

- (i) to estimate the fine root production, mortality, decomposition and exudation in an intact primary forest, a logged forest, and an oil palm plantation, and
- (ii) to assess the contribution of the fine roots to the total CO_2 emissions from land use change.

Transition with logging a primary peat swamp forest and establishing oil palm plantation

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Primary forest

Secondary logged forest

Oil palm plantation

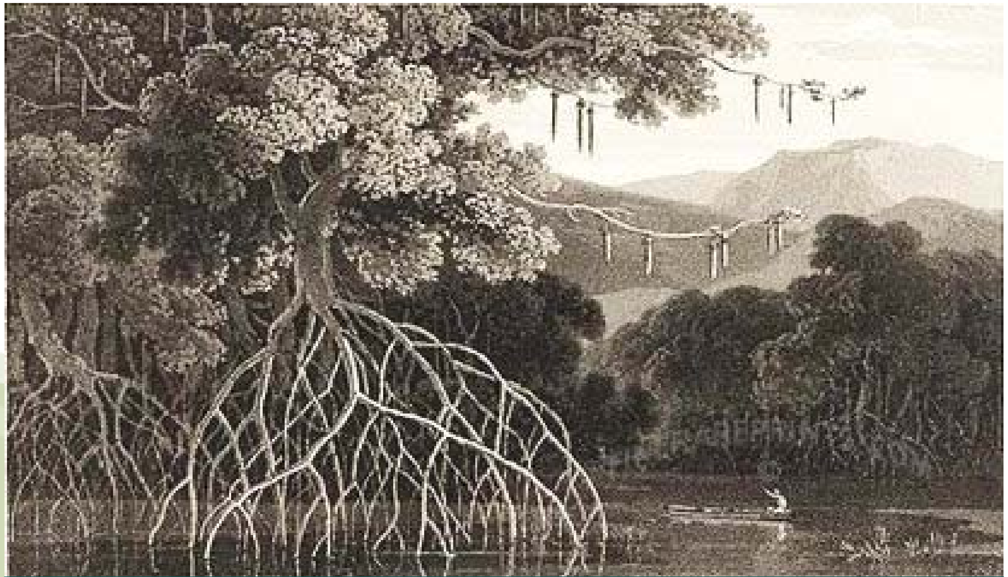
The research components:
(1) Fine root turnover (i.e. production and mortality), (2) fine root decomposition

Sampling

- In each treatment a stratified sampling will be carried out using hollows and hummock as strata in the 2 forest treatments and different distances from the trunk in the oil palm treatment (i.e. close to the trunk (0.5m), quarter-distance (2.25m), and mid-distance between to palms (4.5m)).
- 10 transparent tubes (per site)will be placed at randomly selected points in the forest treatments and at randomly selected palms in the OP treatment. (5 per stratum, 70mm in diameter, 118cm length [to cover the first 50cm of soil depth] installed in an angle of 45˚)
- Analyzing program: WinRHIZO will be used and will be carried out in parallel with filming
- Calculation of root turnover rate
- Relative root length increase and relative root length loss (RRLL)
- Relative annual root loss rates (RRLR) as according to Nadelhoffer (2000):
- RRLR= (mean RRLL*12)/100
- Annual root loss rate = root turnover
- Root longevity as the inverse value of annual root loss rate

Thank You

- Biomass coring
- Necromass coring
- Litterbag decomposition
- And relationships to other variables and integration in models……………………



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