Particulate organic carbon (POC) export from soil and vegetation in temperate mountain regions

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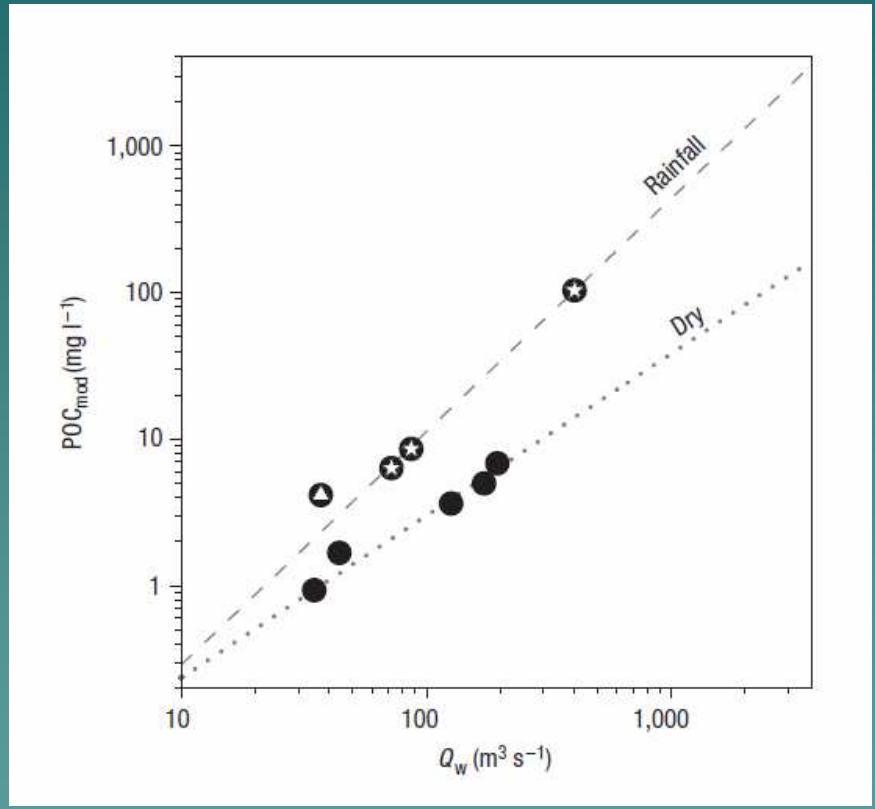
Precipitation-driven POC export?

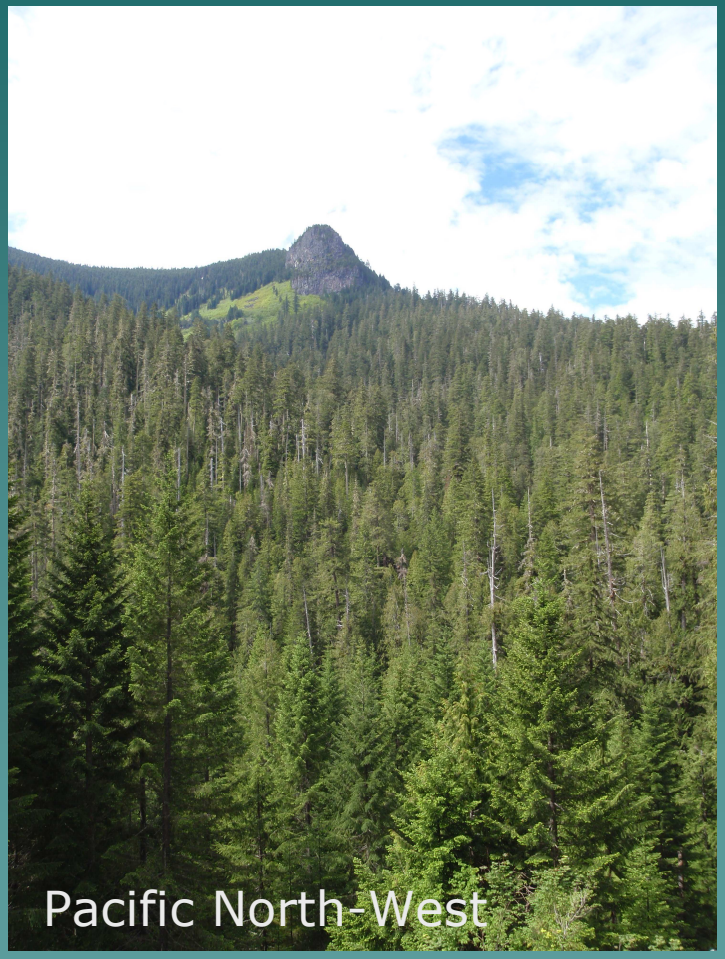
- POC erosion is important in global C cycle, especially in active mountain belts

- Total POC and non-fossil POC increase with suspended sediment (erosion)
- Non-fossil POC preferentially mobilised during rainfall



Hilton et al, 2008 (Nature Geoscience)

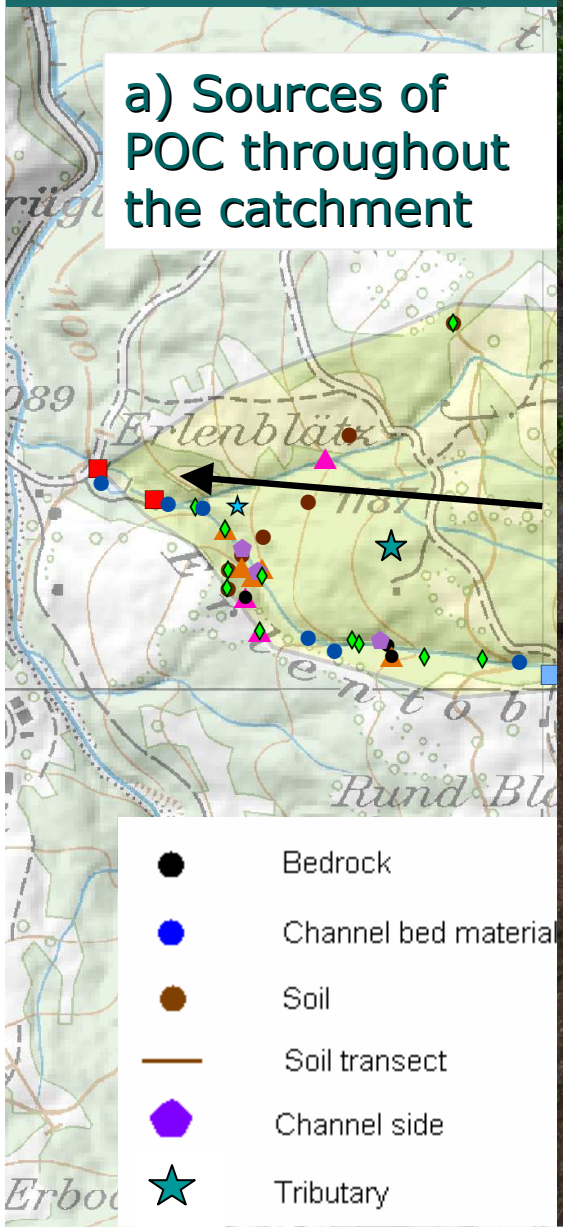
Project aims

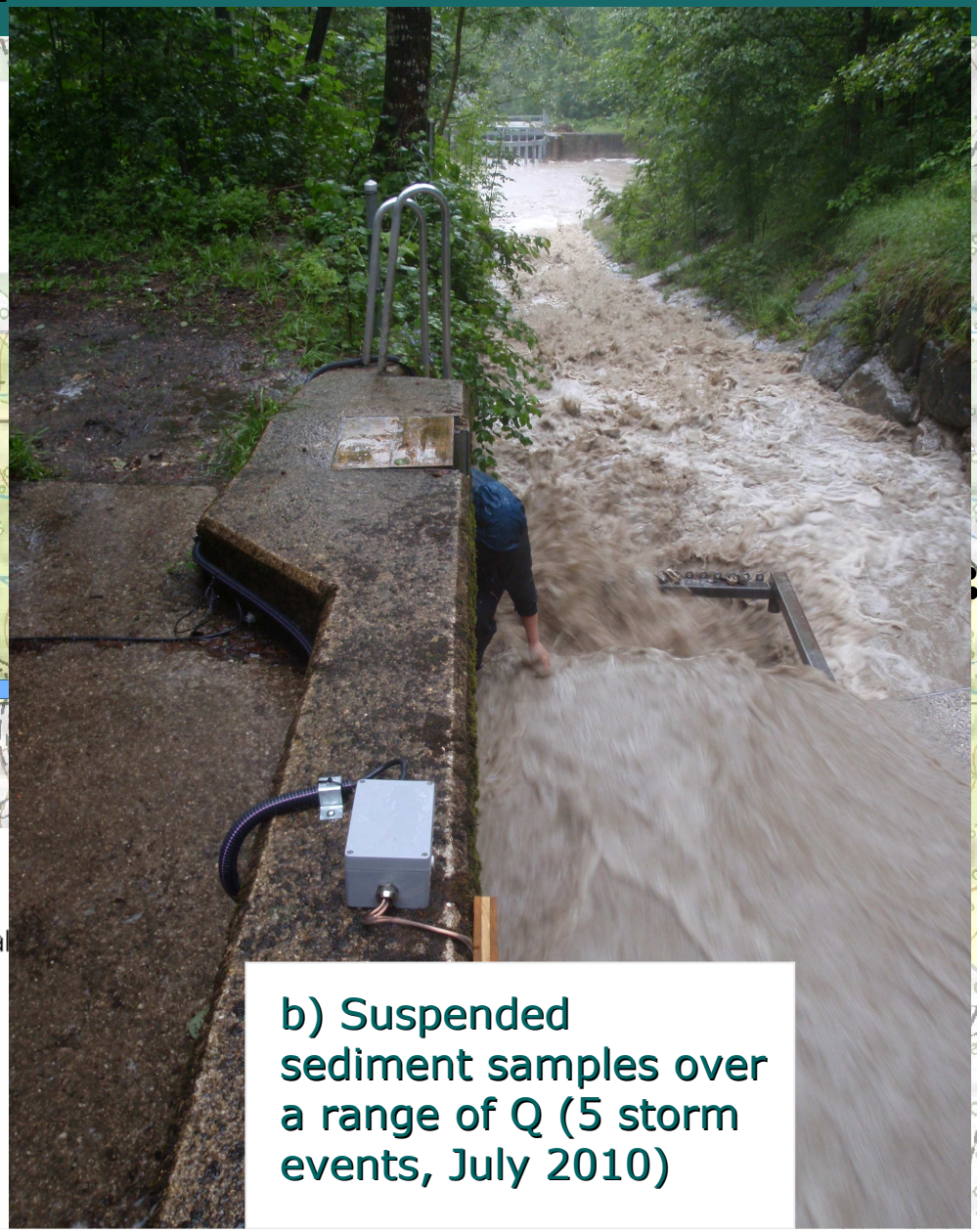


- Understand sources of POC and processes which mobilise it in areas where there is precipitation but no extreme mass-wasting
- Quantify long-term export of total-POC and non-fossil-POC from these settings
- Two case studies in forested uplands outside the tropics: Switzerland and western Oregon

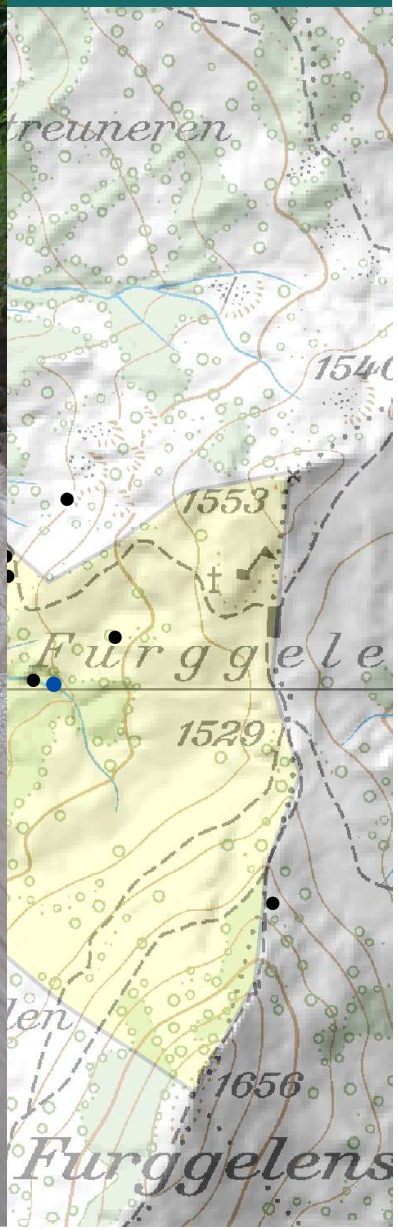
1. Alptal, Switzerland: sampling

a) Sources of POC throughout the catchment



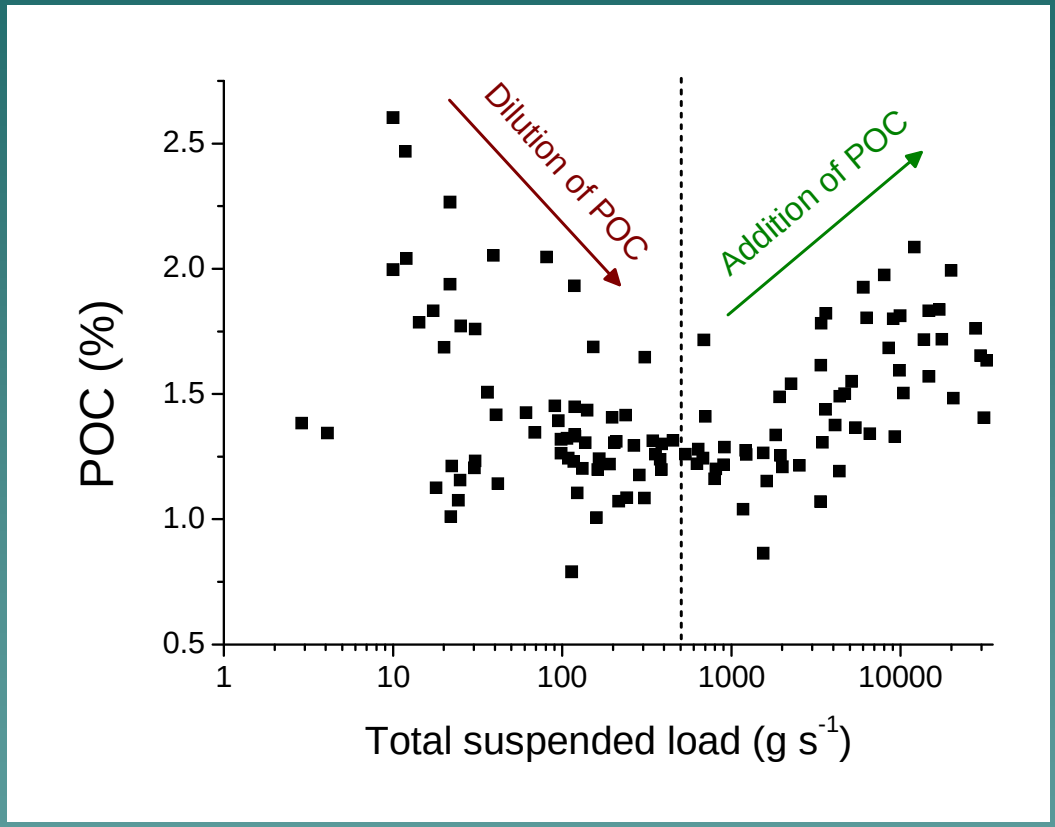


b) Suspended sediment samples over a range of Q (5 storm events, July 2010)



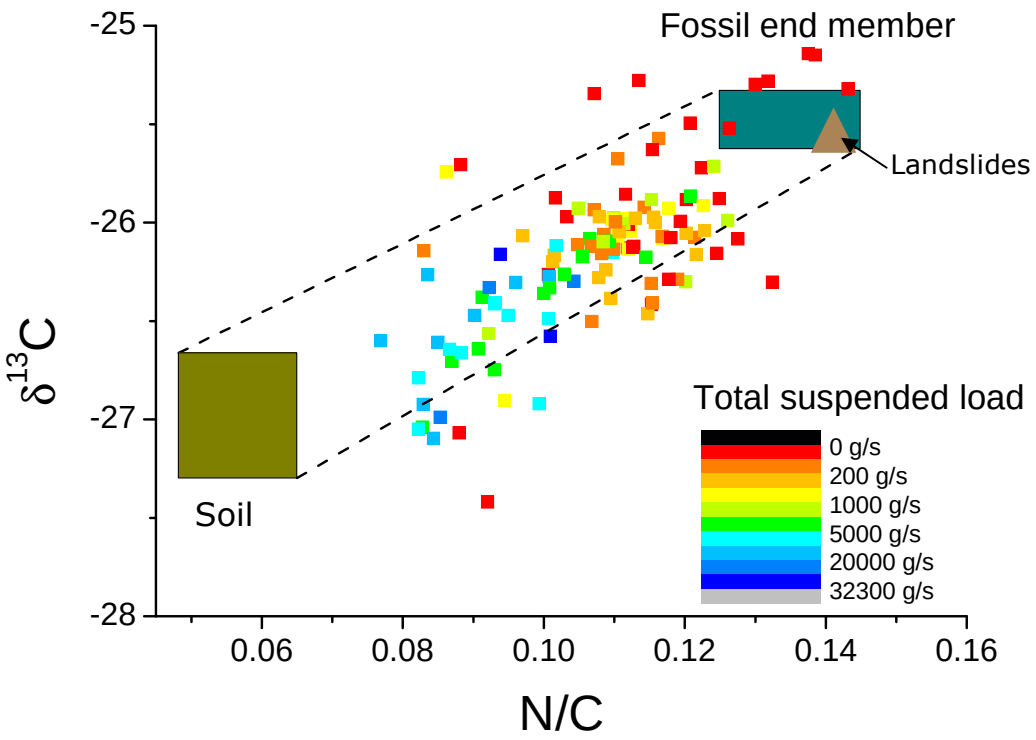
1. Alptal, Switzerland: POC load

- Relatively high POC concentrations
- Initial dilution by POC-poor lithic material in channel
- Threshold at ~500 g s^{-1} (~1600 mg l^{-1}; ~400 l s^{-1}): moderate conditions
- Switch to POC addition at higher Q & SSC as landscape is activated

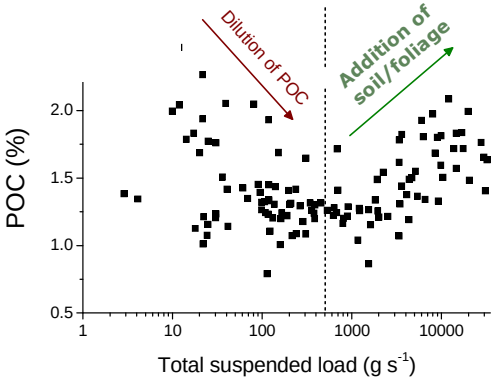


(Total suspended load scales with discharge and SSC)

1. Alptal, Switzerland: POC sources



(scales with discharge and SSC)



- When landscape is activated, POC is mobilised from soil and/or vegetation, NOT landslides
- Delivered by overland flow rather than deeper-cutting mass wasting

2. Oregon: Cascades and Coast

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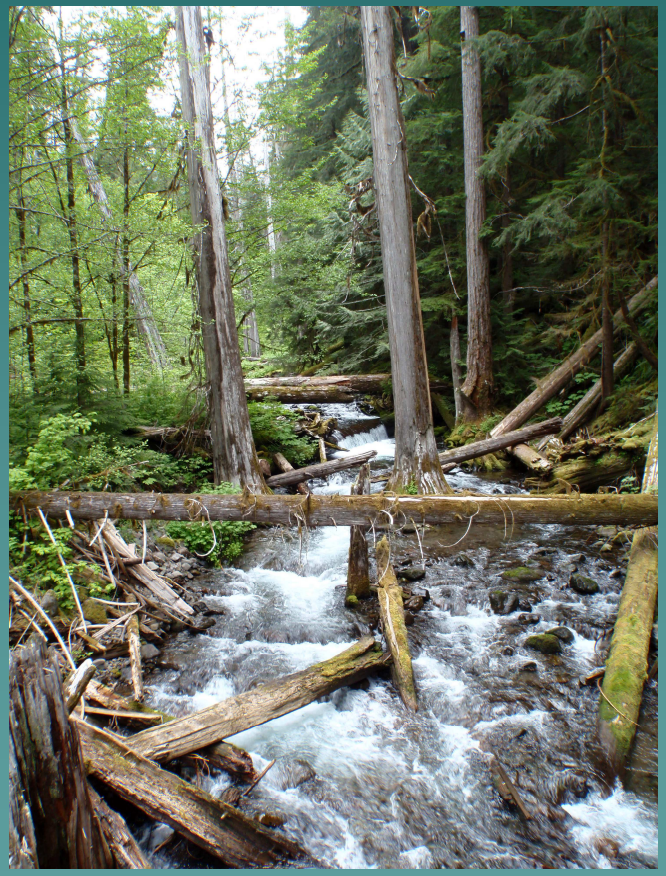
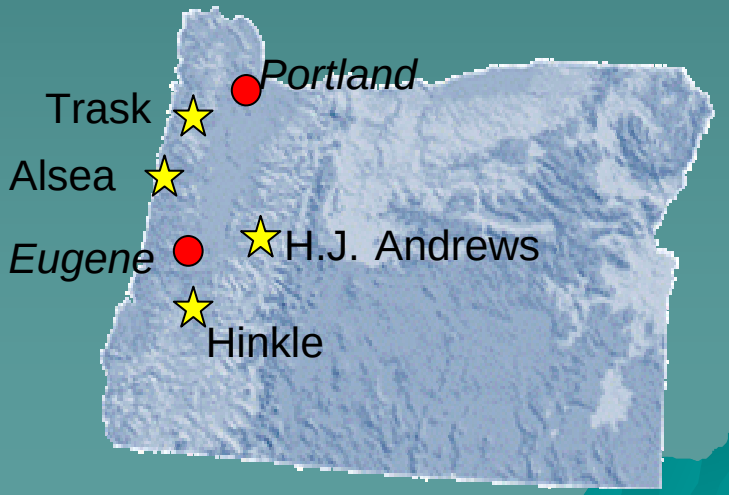
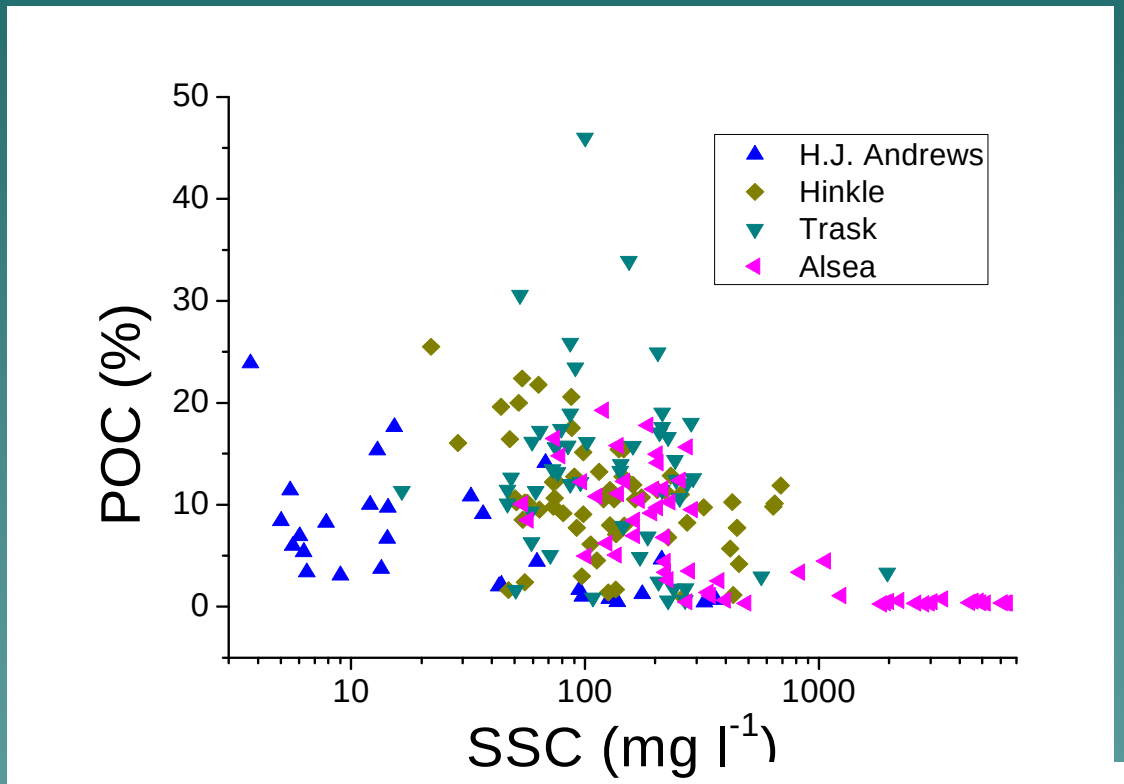


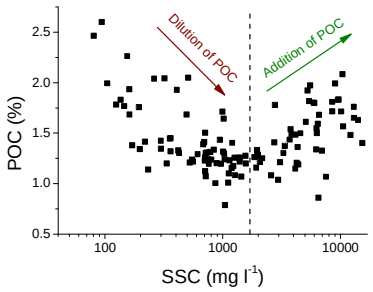
Can these conclusions be extrapolated to other sites?



2. Oregon: POC load

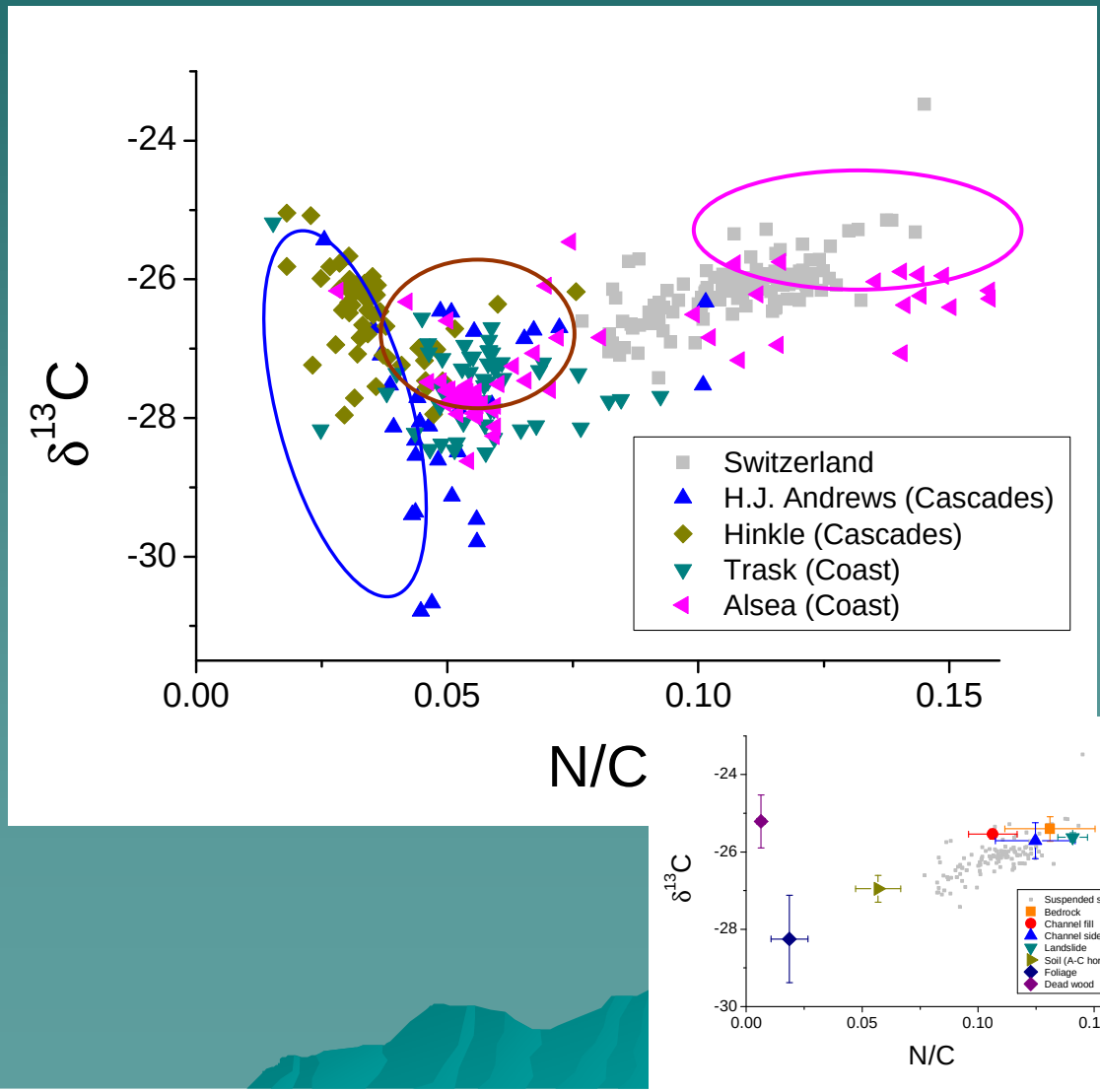
- Compared to Switzerland:
  - 10x lower SSC
  - Much higher & more variable %POC
- Similar dilution as Q increases but on this timescale (<5 years) no subsequent POC addition





2. Oregon: POC sources

- Little evidence of fossil POC (except in Alsea)
- Vegetation directly sourced by streams
- Possible soil mobilisation in Coast Range



Alptal vs. Cascades

Two points on a continuum

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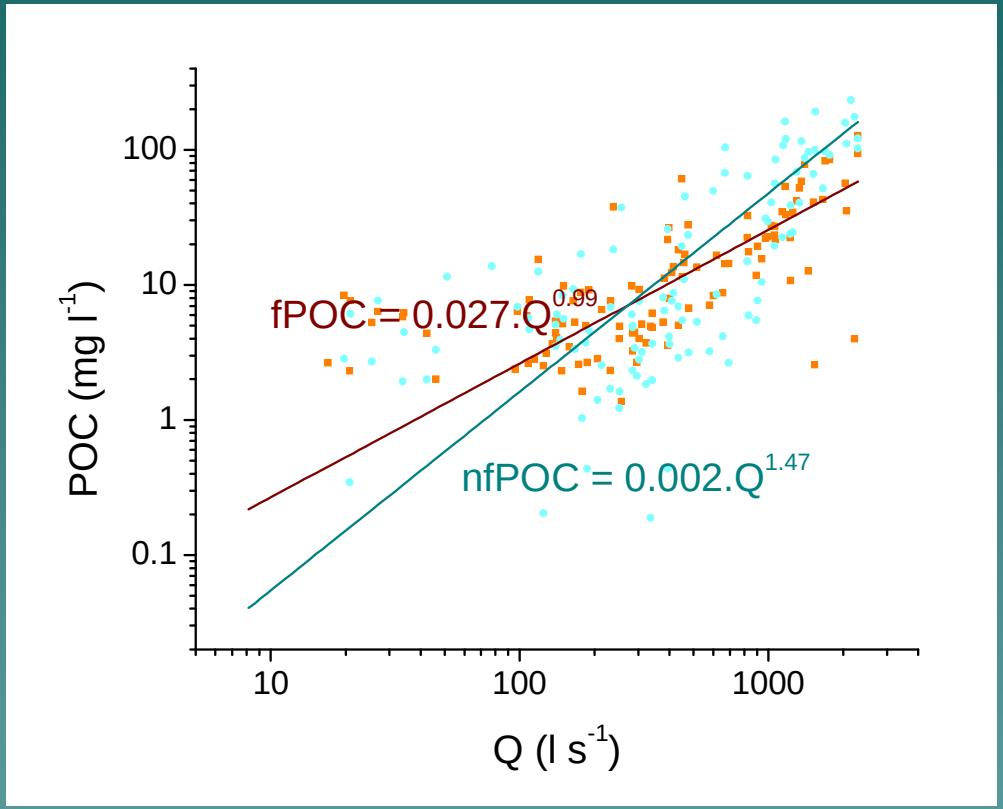
- Steep slopes rising from narrow channel
- Strong channel-hillslope coupling
  - Frequent overland flow under moderate conditions
    - High SSC; low %POC
    - Mixture of fossil & non-fossil POC
    - Increase in %POC at high Q due to activation of soil reservoir

- Wide valley bottom
- Riparian vegetation & alluviation decouples hillslope & channel
  - Overland flow rarely occurs
    - Low SSC; high %POC
    - Nearly all POC is non-fossil
    - No increase in %POC at high Q under moderate conditions – hillslope inactive

Long-term POC fluxes

- Alptal:
  - Rating curves: relatively more non-fossil POC exported at high Q than fossil POC (and SS)
  - Long-term flux modelled using 10-min discharge records 1983-2009
  - Yield of non-fossil POC: 17±5 tonnes km^{-2} yr^{-1} (~60% of total POC export)



- Oregon: work-in-progress, but current data suggests non-fossil POC export flux is likely to be around an order of magnitude less than Alptal – *minimum estimate*

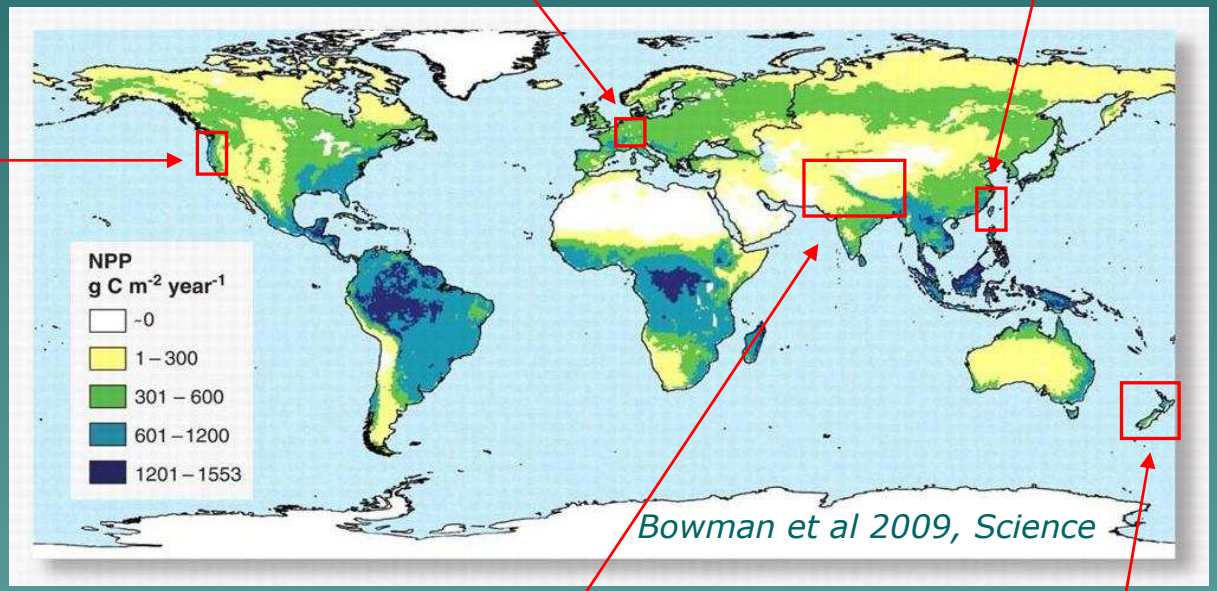
The global picture:

non-fossil POC and total suspended sediment yields (all in t km^{-2} yr^{-1})

Alptal, Switzerland: ~17; ~1780

Taiwan: ~31; 13000-77000 *(Hilton et al 2008, Nature Geoscience)*

Western Oregon: ~1; ~30



Bowman et al 2009, Science

Ganges-Brahmaputra: ~3; ~600 *(V. Galy et al 2007, Nature; 2008, GCA; M. Lupker, PhD thesis 2011)*

New Zealand: ~34; 8770 *(Hilton et al 2008, Glob. Biogeochem. Cycles)*

Potential global area for precipitation-driven POC export >> global area of active mountain belts – BUT must be accompanied by high clastic yield for efficient burial

Thanks

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