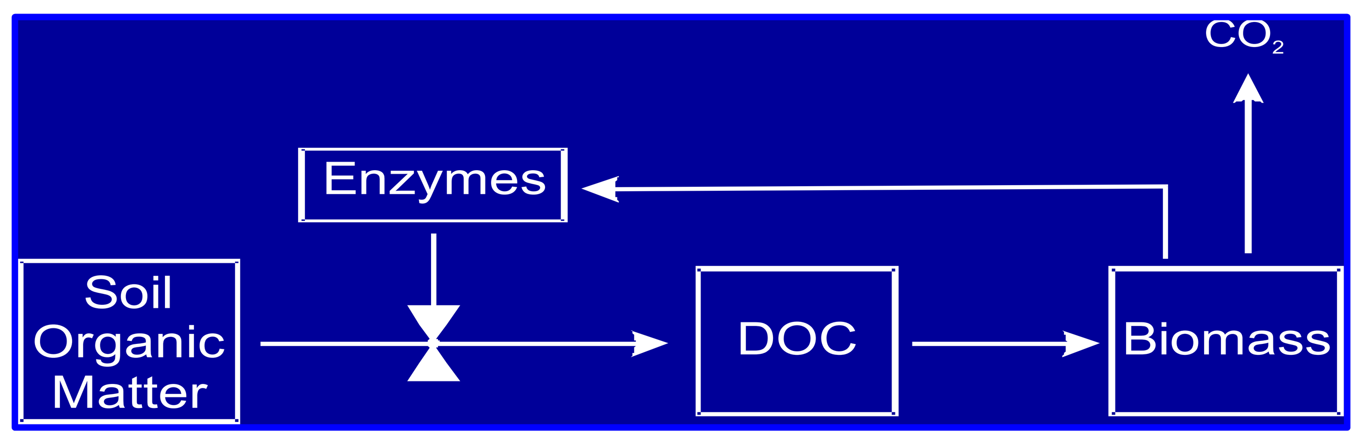
Dynamics and Control of DOC Generation Across an Arctic Tundra Hillslope

Shinichi Asao, Keri Holland, Josh Schimel, & Allen Doyle
University of California, Santa Barbara

Overview

Generation of dissolved organic carbon in soils is thought to be mediated by direct microbial activity and/or by exoenzymes that persist in soils for longer periods of time. Based on a two step decomposition model that allowed decomposition to be a function of microbes and their enzymes, we evaluated the role of these factors in generating water soluble organic carbon in footslope and upslope arctic tundra soils.

Two step decomposition model



Specific questions

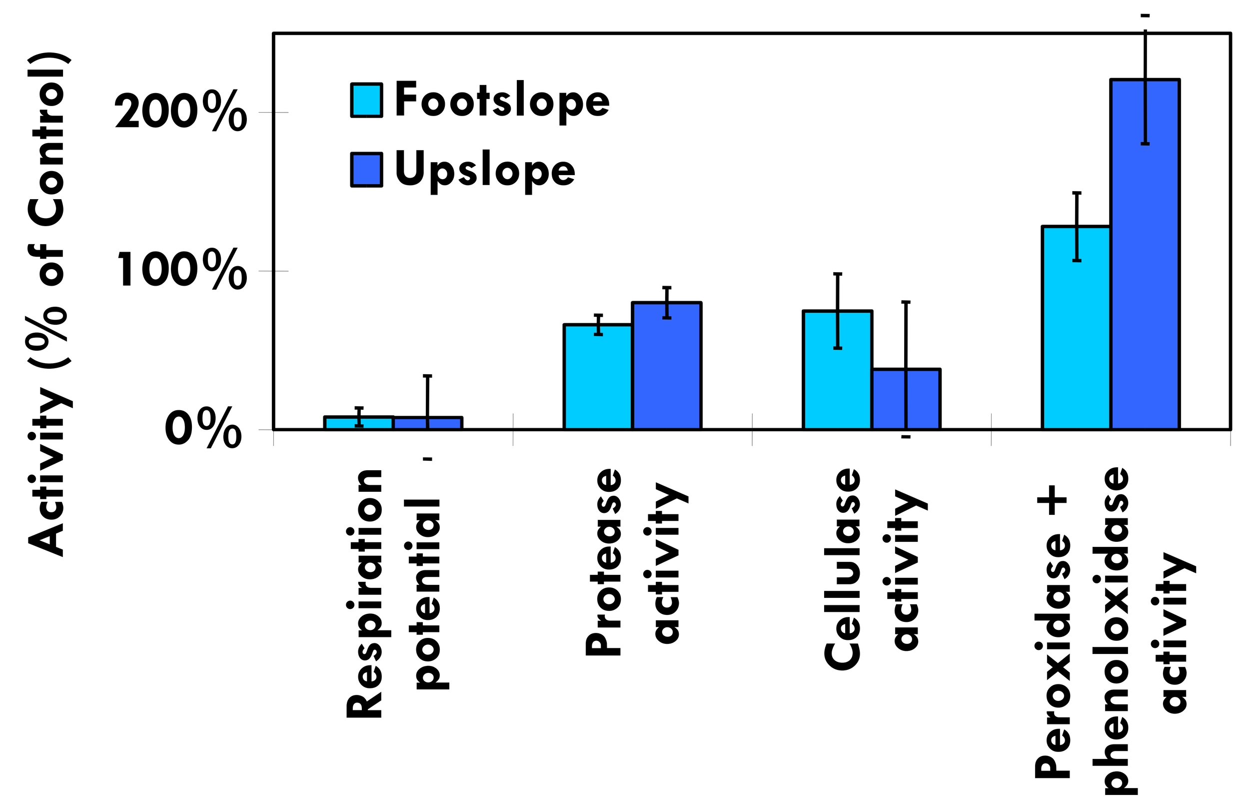
3. What is the amount and quality of DOC (Water soluble organic carbon WSOC), and does this vary by landscape position?
4. What is the mechanism for WSOC generation, and the rate of generation?
5. What is the fate of WSOC?

Extraction apparatus

Methods

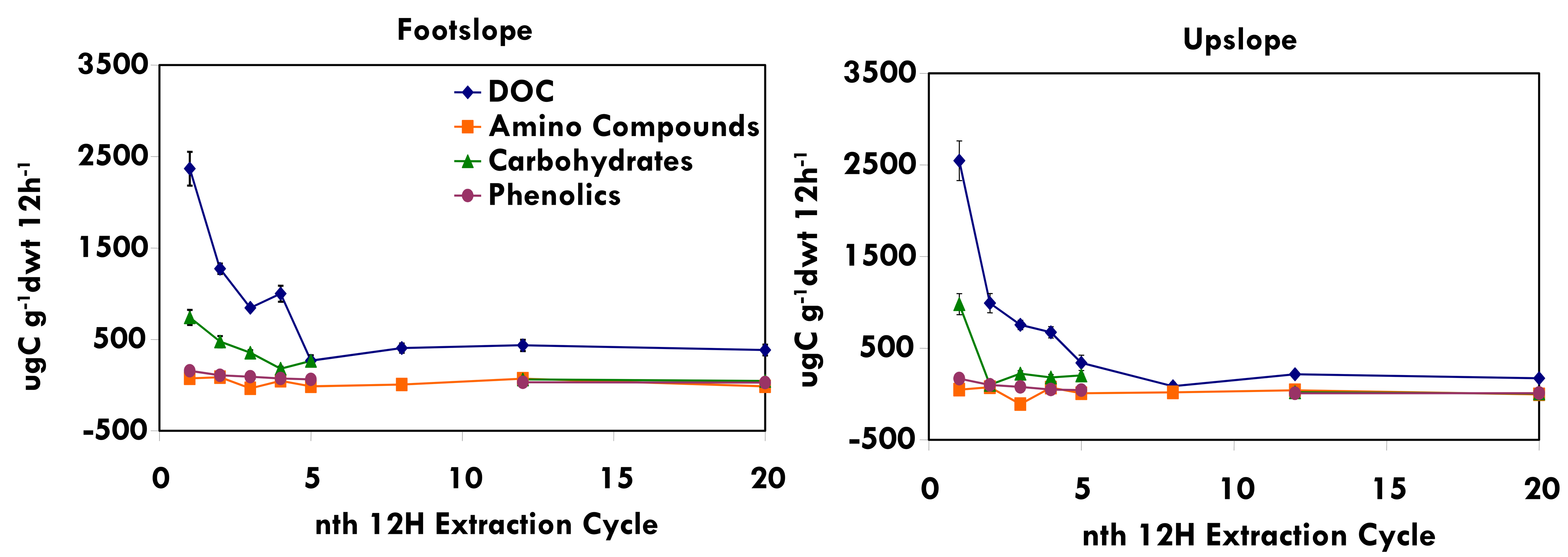
Soils incubated under chloroform fumigation and untreated controls were sequentially extracted to examine the rate of generation, chemical composition, and bioavailability of WSOC.

Effect of chloroform on microbial and enzymatic activity



- *Chloroform fumigation reduces microbial activity without reducing enzymatic activity.*

Landscape position and chemical composition of WSOC



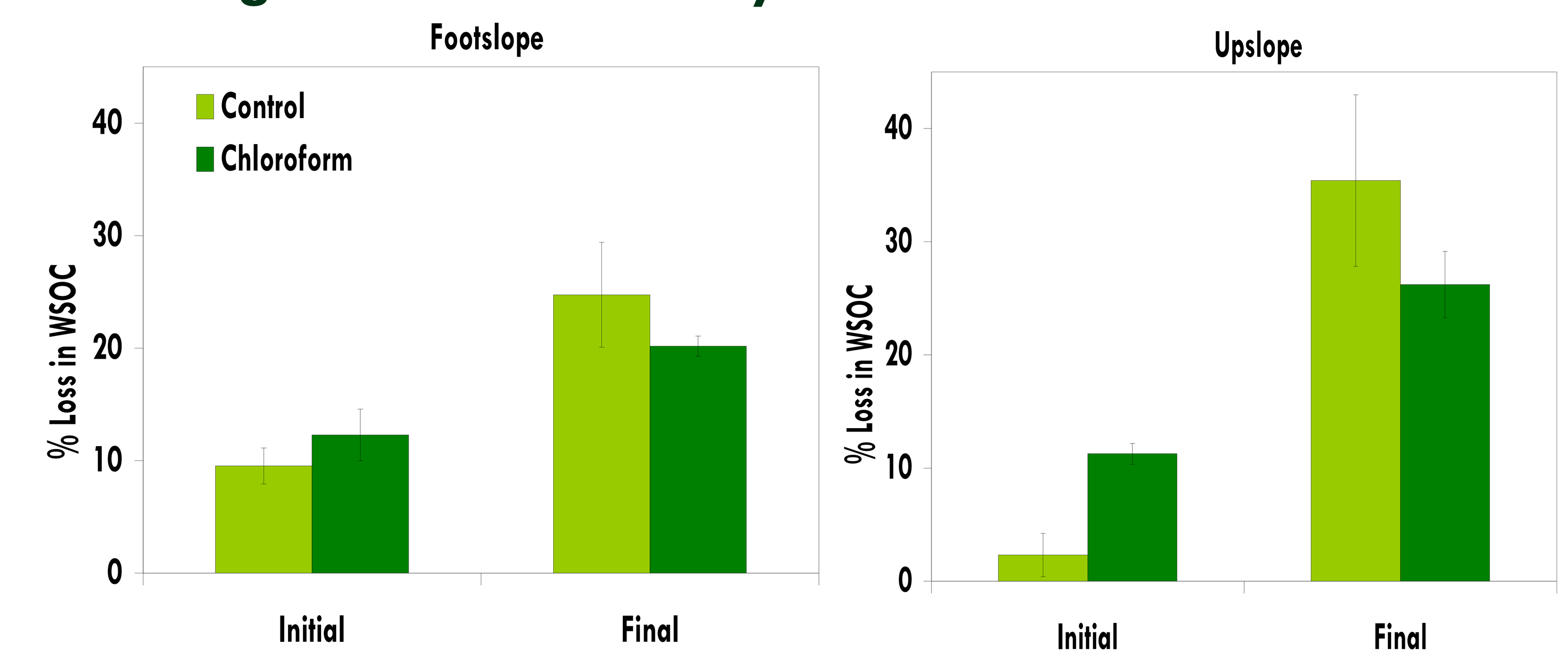
Specific composition of carbohydrates

(ugC g⁻¹dwt)		Footslope	Upslope
alginic acid		1.1	0.9
arabinose	**plant**	***6.5***	***5.9***
fucose		2.8	2.8
galactose	**not plant**	***19.7***	***22.2***
galacturonic acid		3.6	2.5
glucose		28.2	28.3
glucuronic acid		1.1	1.2
mannose	**not plant**	***17.2***	***16.4***
rhamnose		10.2	9.1
ribose		0.8	1.6
xylose	**plant**	***10.1***	***9.7***
Total carbohydrates		**351.2**	**447.8**
Total by phenol-sulf acid		**740.6**	**980.0**
(G+M)/(A+X)		***2.2***	***2.5***

< 0.5: higher plants

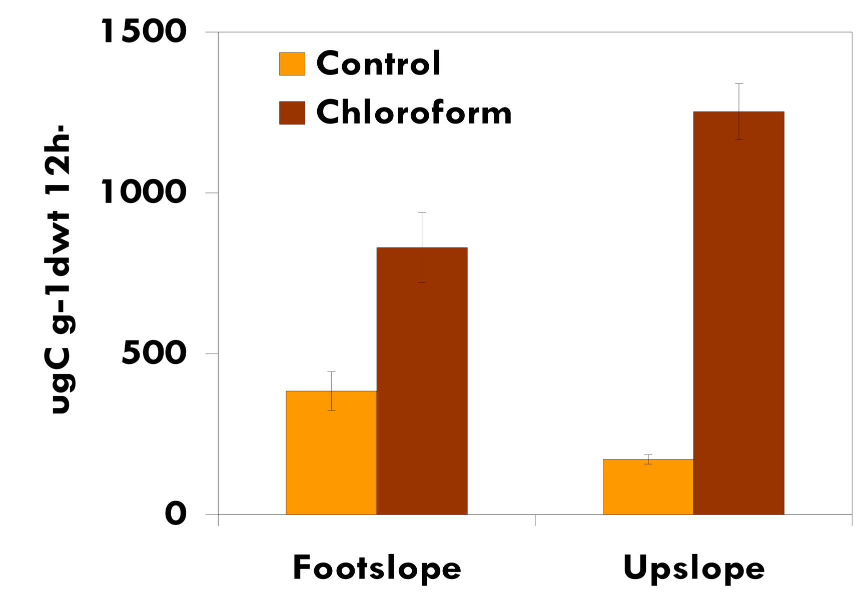
- *WSOC rapidly declines with extractions and then reaches stable baseline.*
- *Patterns are similar between the two landscape positions.*
- *40% of initially extracted WSOC is carbohydrates.*
- *Specific carbohydrate composition indicate the source as mosses.*

Change in bioavailability of WSOC



- *Initially extracted WSOC is not labile despite being 40% carbohydrates.*
- *Stable base level WSOC is more labile.*

Effect of chloroform on stable baseline WSOC



- *Removing microbial activity increases WSOC levels.*
- *Consumption of this material is rapid.*

Conclusions

Initially extracted WSOC is largely "moss tea" and is surprisingly non-bioavailable, but WSOC extracted at later stable baseline stage is more bioavailable. This later stage material is likely generated by exoenzyme activity and is an immediate substrate to microbes. If exoenzymes are a key pathway for labile DOC generation, then clay associated stabilized exoenzymes in Califronia glassland soils could play a similar role in WSOC generation.