Dissolved organic carbon and nitrogen leaching from soil formed in grass, oak and pine ecosystems of California

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1) Introduction

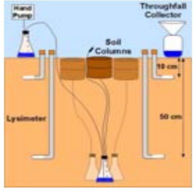
- The leaching of dissolved organic matter (DOM) from the litter layer on the soil surface is an important flux that influences biogeochemical processes, ecosystem health, and has consequences for C sequestration in soils
- DOM is operationally defined as being < 0.45 μm and consists of dissolved organic carbon (C), nitrogen (N) and phosphorus (P).
- As DOM percolates through the soil, it can be used as a C and nutrient source for microbes, sorbed onto soil constituents or lost from the ecosystem in drainage. Typically, DOM leaching from natural watersheds is low.
- The objective of this study was to determine how DOC and DON retention and function varies in grass, oak and conifer ecosystems.
- The experiment shown here is part of a larger study that will examine the influence of soil mineralogy, ecosystem soil microbial communities and organic inputs on DOC and DON retention in the soil in contrasting ecosystems

2) Study Sites

- Each site has 9 *in-situ* columns (10 cm diameter, 10 cm depth) of soil (3 pine, 3 oak 3 grass soil) leaching to collection flasks at 50 cm. In addition, each site has 6 lysimeters at 10 cm, 6 lysimeters at 50 cm and 3 throughfall collector. Column leachate, throughfall & lysimeter solution is collected biweekly

Table 1 - Site Characteristics

	Oak Woodland	Grassland	Conifer Forest
Location	Sierra Field Station	Sierra Fields Station	Challenge, CA
Soil Type	Typic Halpoxeralf	Typic Halpoxeralf	Typic Halpoxeralf
Soil Texture	Silty Clay Loam	Loam	Clay
Elev. (ft)	1540	1540	2720
Parent Material	Metavolcanic	Metavolcanic	Metavolcanic
Soil Fe Content	Med	low	High
Precip. (mm)	730	730	1727
Soil pH	5.7-6.2	5.5-6.0	5.9-5.6
Nitrogen 0-10 cm (%)	0.2	0.3	0.2
Carbon 0-10 cm (%)	4.4	2.3	6.7



Mixed Conifer Field Site

Grassland Field site

Oak Field Site

3) In-situ leaching columns

- **Methods:** Cores and lysimeters were installed in the field in mid-December. Cores were packed with 2mm sieved soil collected from 0-10 cm depths at each site. Columns and lysimeters were allowed to equilibrate for 6 weeks with sampling beginning January 15, 2005. All DOM solutions are measured for volume, pH, DOC, TN, NH_4^+ and NO_3^-. DON is assumed to be the difference between total dissolved N (TDN) and inorganic N (NH_4^+ &. NO_3^-)
- **Results:** DOC concentrations in column leachates do not show clear relationships with ecosystem inputs. Continued leachate collection may show annual trends. In contrast to DOC, DON is consistently low in pine soil leachates regardless of litter inputs (Fig. 1)

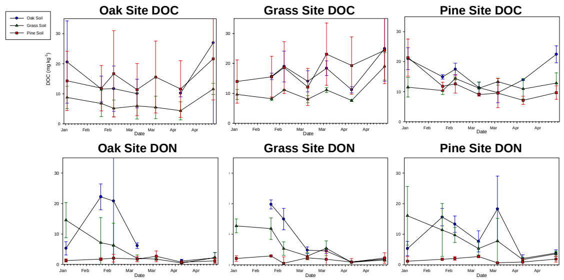


Figure 1 – DOC and DON concentrations from in-situ column leachates

4) Laboratory column leaching

- **Methods:** 10 cm columns of 2mm sieved soil from the pine, grass and oak site were all leached with pine, grass and oak DOM. DOM from each site was made by mixing 500g of surface litter with 1 L distilled water. Columns were leached over a 6 hr period with 500 mL DOM under unsaturated conditions (no ponding on the soil surface). All DOM solutions, including the initial DOM solutions were measured for volume, pH, DOC and TDN.

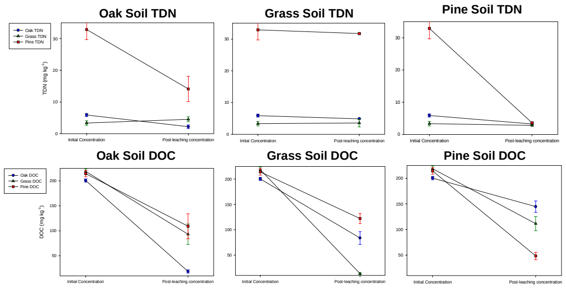


Figure 2 – Initial and final DOC and TDN concentrations after leaching through soil columns

Table 2 - Column Soils after leaching with oak, pine or grass DOM

Sample	% C	S.E.	% N	S.E.
Oak Soil				
Control	3.30	0.0	0.23	0.0
Oak DOM	4.25	0.3	0.28	0.0
Pine DOM	3.70	0.1	0.24	0.0
Grass DOM	4.89	0.5	0.31	0.0
Pine Soil				
Control	6.66	0.3	0.24	0.0
Oak DOM	6.98	0.4	0.26	0.0
Pine DOM	8.53	0.3	0.28	0.0
Grass DOM	6.30	0.5	0.24	0.0
Grass Soil				
Control	2.27	0.2	0.22	0.0
Oak DOM	3.45	0.1	0.27	0.0
Pine DOM	1.54	0.1	0.15	0.0
Grass DOM	1.55	0.1	0.15	0.0

- **Results:** Data on percent soil C and N indicate that leaching soil with oak DOM consistently increases % C and N regardless of the soil's origin (Table 2). Figure 2 shows that pine soil was able to significantly reduce the large TDN concentrations in pine DOM. All soils significantly reduced DOC concentrations. DOC in leachate solution was reduced the most by the soil from its original ecosystem. These results suggest that the microbial community in each soil is best adapted to mineralize DOC from its own ecosystem.

5) Conclusions

Column Leaching Experiment

- Each soil adsorbs their own DOC best
- Pine soil retains TDN better than the oak and grass soil
- Grass soil appears to lose soil C and N when leached with pine and grass DOM
- Pine and oak soil never lose soil C or N with DOM leaching

Field Experiment

- Laboratory leaching results do not reflect reusits found in field core leachates
- Pine soil retains high amounts of DON regardless of ecosystem inputs

6) Future Plans

- Determine the effects of different forest thinning techniques (manipulations to the understory and organic horizon) on DOC and DON leaching.
- Use attenuated total reflectance infrared (ART-FTIR) and ^{13}C nuclear magnetic resonance (NMR) spectroscopy to characterize DOC structure. The chemical structure of DOM will be analyzed since structural changes can impact adsorption phenomenon, decomposition rates and subsequent retention in the soil.
- Fractionate the collected DOC solutions into hydrophilic and hydrophobic fractions to determine the fate and importance of each fraction during leaching.
- Examine the influence of ecosystem soil microbial communities on DOC and DON mineralization with microbial incubations of DOM from each site with microbial inoculum from each site.
- Analyze the influence of abiotic retention of DOM by leaching sterilized soil columns.

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