Effect of climate change and forest management on soil carbon sequestration in southeastern US loblolly pine forests

Yang Zhang, Jason West and Jason Vogel
Department of Ecosystem Science and Management, Texas A&M University

Introduction

It is predicted that average temperature may rise 4.5 °F by 2080 and precipitation may decline by 10-30% (IPCC 2007). In addition, low levels of available soil N limit the growth of pine forests in the southeastern US which may limit an important C sequestration path. Soil carbon sequestration has two primary components: 1) processes that stabilize SOM and 2) accumulation of new carbon. Previous studies have shown that multiple factors will impact soil C sequestration: temperature, moisture, substrate chemistry, nitrogen availability and soil organisms through effects on organic matter decomposition rates and soil respiration rates. Litter decomposition and soil respiration are key factors in C loss pathways from the soil pool. Our experiments are conducted in Tier 3 sites allowing an intensive assessment of climate and geography which span nearly the entire native range of loblolly pine forest. Our primary objective is to study the relationship between soil C and N cycling processes and how soil moisture availability impact those relationships.

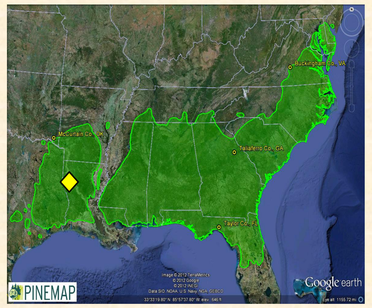
Hypothesis

Substrates usually decompose positively with temperature, soil moisture and nitrogen availability. Soil organism community is another key factor that impact substrates decomposition. We hypothesed that:

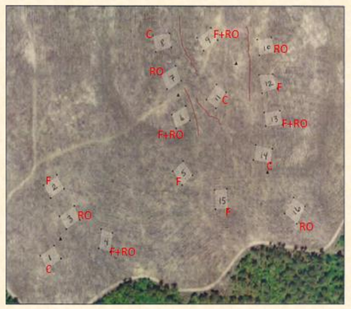
(1) Common substrates will decomposed faster in fertilized plots and slower in throughfall plots;

(2) Substrates closed to the tree will decompose faster for higher nitrogen availability; if temperature is a more important factor, substrates furthest to the tree will decompose faster.

Figure 1 : Sites of Tier 3 and experimental plots in Idabel, OK

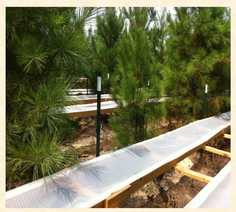


Distribution of *P. taeda* and locations of all Tier 3 sites. Our site indicated with diamond.



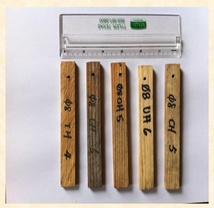
C: Control RO: 1/3 rain out
F: Fertilization

Figure 2: experimental site and wood sticks



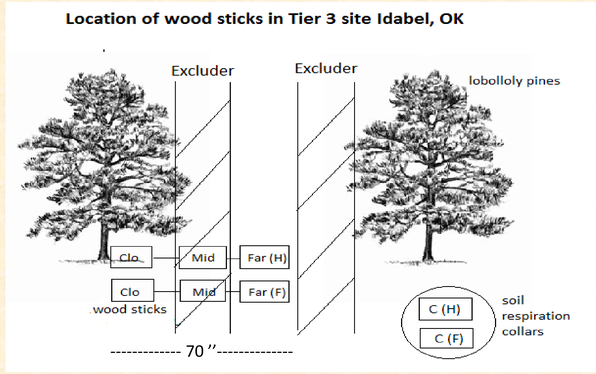
Throughfall excluders

Placement of substrates



Southern pine wood used as common substrate

Figure 3: Location of wood sticks



Location		Incubation time	
Clo	Close to tree	H	Half year
Mid	Under excluder/middle distance	F	Full year
Far	Between excluders/furthest from tree		
C	Inside respiration collars		

Study Design & Methods

The experimental design is factorial combination of soil moisture (throughfall) reduction and fertilization. We have two levels of rainfall reduction: control (C) and 1/3 rain out (RO) and two levels of fertilization: optimum and high (F). To assess the response of decomposition to treatments and spatial variation a common substrate (southern pine wood sticks) was placed as shown in Figure 3. Prior to placement, sticks (5" x 0.75" x 0.25") are dried (105 °C) and weighed. On removal, sticks are cleaned, dried and weighed. Wood with clear termite impacts (52 sticks) were removed during analysis.

Results

Table 1: Analysis of Variance results

Source	DF	F Ratio	P
Treatment	3	9.297	<0.0001
Location	3	20.580	<0.0001
Treatment*Location	9	0.67	0.7351

Figure 4

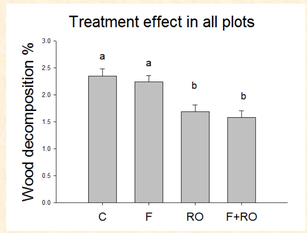


Figure 5

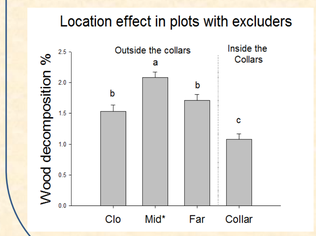
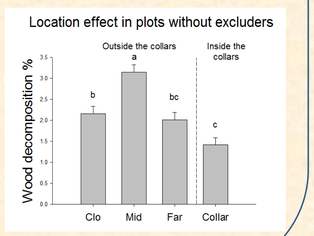


Figure 6



Preliminary conclusions

(1) Throughfall removal and combination of rainout and fertilization decreased wood decomposition during the half year (Fig. 4).

(2) The substrate placed inside the collars decomposed more slowly than that outside the collars.

(3) Substrates in the middle location (under the excluder or not) decomposed faster than those near the tree and far to the tree (Figs. 5 & 6).

Future Work

(1) Measure nitrogen mineralization using ion exchange membranes by determining soil NH_4^+ and NO_3^- concentration every three months

(2) Measure soil respiration monthly in Tier 2 sites to determine fertilization effect and family genetic effect on autotrophic and heterotrophic respiration

(3) Using both root exclusion and stable isotope method to separate soil respiration