Modelling wood decomposition and N mineralizaiton in ramin wood dowels (*Gonystylus bancannus*) using a common climate function for the LIDET sites across the USA

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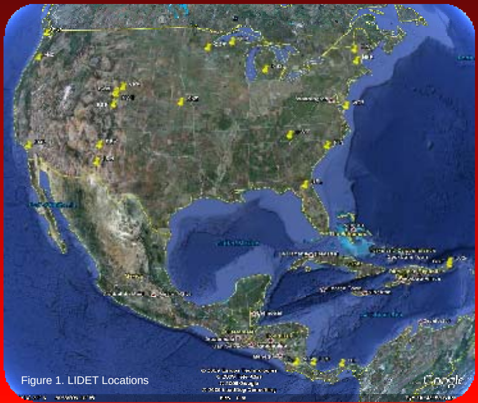

Figure 1. LIDET Locations

Quantifying the rate of wood composition and N dynamics is essential for modeling forest conditions within changing climate and forest management contexts. This presentation focuses on modelling mass and N dynamics in LIDET (Longterm Intersite Decomposition Experiment) ramin dowels (*Gonystylus bancannus*, 61cm long; 13mm diameter; oven-dry wood density =1.62g/cm^3), with data generated over 15 years for tropical to boreal forests as well as grasslands and tundra, at 28 USA locations (Figure 1). Dowels were placed vertically with one half below and one half above the ground (Figure 3).

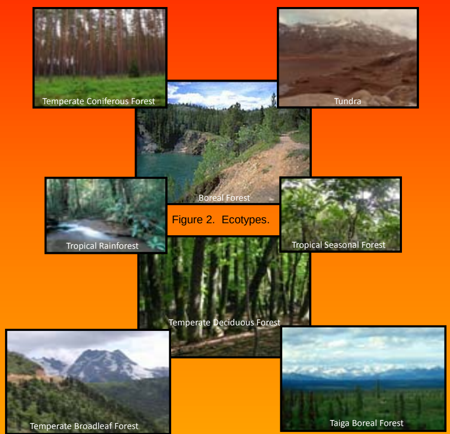

Figure 2. Ecotypes.

Figure 3. Dowel placement.

Figure 4. Model principle.

$$\frac{dMass}{dt} = -k_s \, f(climate) \, Mass$$

k_s: climate-independent decomposition coefficient

The data for mass in either half were analyzed and modelled by way of a simple exponential decay model, and a single climate function, (Figure 4) for the decay coefficient, with annual precipitation (150 to 3914mm) and mean July (8.2 to 27.7°C) and January (-24.9 to 25.2°C) temperatures as local climate indicators.

Figure 5. Decomposition model and parameterization.

$$f(climate) = \left[\frac{ppt(1+\Delta)}{1000}\right]^{p_1} \cdot \left[1 + p_3 \min\left(0, \frac{T_{Jan}}{abs(T_{July} - T_{Jan})}\right)\right]^{p_2} \cdot \exp\left[-\frac{Ea}{8.31}\left(\frac{1}{T_{July}+273} - \frac{1}{288}\right)\right]$$

	LIDET	
	Surface	Buried
Ea (J/mole)	72,200±4,500	
k_s (1/yr)	2.33±0.16	5.74±0.41
p_1	0.88±0.03	
p_2	2.31±0.21	
p_3	1	

While the model calibrations are LIDET specific, it provides a framework for parameterizing wood decay (Figure 5) and N mineralization (Figure 6 & 7) for other wood types and field-placement conditions.

Figure 6. N model.

$$\frac{d[N]}{dt} = n_{exo} \frac{100-[N]}{[N]_{final}} e^{\frac{Ea}{8.31}\left(\frac{1}{T_{July}} - \frac{1}{288}\right)} - n_{min} \frac{[N]}{[N]_{final}} f(climate)$$

n_{exo}: parameter for adjusting exogenous N addition to wood dowel
n_{min}: N mineralization parameter
$[N]_{final}$: final N concentration of decomposing wood, %

Figure 7. N parameterization.

Least-squares fitted n_{exo}, n_{min}, $[N]_{final}$

	LIDET	
	Surface	Buried
$[N]_{final}$	3.60	
n_{exo}	0.0051	0.035
n_{min}	0.064	

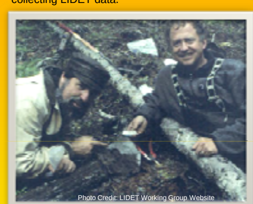

Figure 8. Mark Harmon (left) and Jay Sexton collecting LIDET data.

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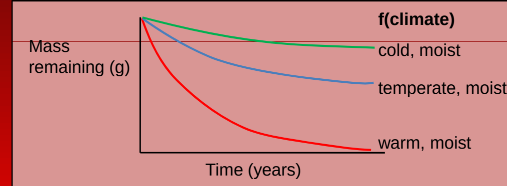

Figure 9. Model base conclusions.

It was found that the buried halves decayed about 2.5 times faster than the below-ground halves (Figures 10 a & b). The best-fitted model captured about 72% of the mass remaining variations, with decomposition rates being lowest under cold and dry conditions, and fastest under warm and moist conditions (Figure 9. While mass loss would generally be due to microbial (fungal) activities, some of it would also be due to surface abrasion, especially for the exposed dowel portions under the harsh arctic winter conditions.

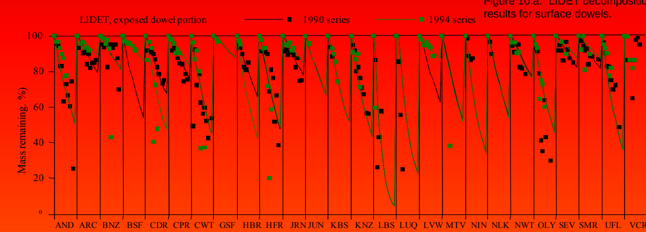

Figure 10.a. LIDET decomposition results for surface dowels.

model
actual

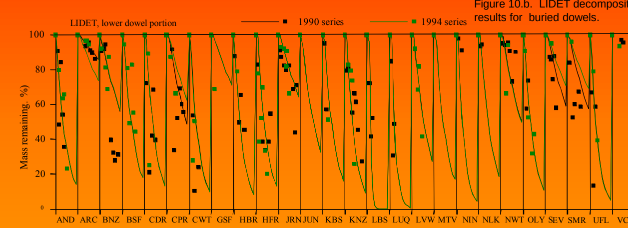

Figure 10.b. LIDET decomposition results for buried dowels.

Nitrogen concentrations in the decaying wood generally increased over time. This was modelled by assuming that: (i) there would be exogenous N uptake, related to the C/N ratio of the decaying wood, and the amount of wood still available for decay, (ii) N loss would be proportional to the amount of remaining N, but this would occur more slowly than mass loss.

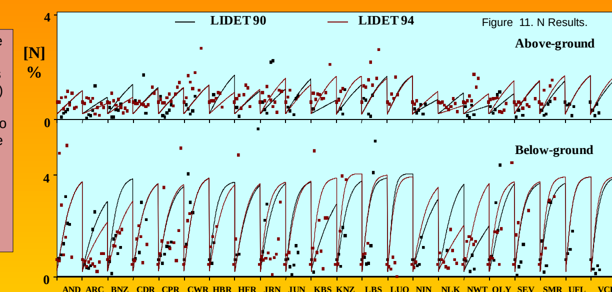

Figure 11. N Results.

Conclusions: Simple wood decomposition model explains about 80% (R^2)of mass loss from and 61% of the N concentrations in decaying wood across LIDET sites
- -Six parameters were needed, with five of these are common across LIDET locations
- -One parameter accounts for sub-zero exposure differences (abrasion versus non abrasion, p_2)
- -Two parameters account the surface-exposed vs. the soil buried dowel portion (k_{min}, n_{min})

The wood decomposition and N acquisition are relatable to a simple climate function
Buried wood decomposes and mineralizes faster than surface exposed wood, as to be expected, but this difference is quantifiable across a wide climate range
Buried wood acquired exogenous N 10 times faster than the buried wood

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