Analyzing and Influencing Carbon Sequestration in Harvested Wood Products

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Abstract

WOODCARB3 expands the capabilities of the WOODCARB2 spreadsheet model by changing to an R package platform. The conversion brings increased capability for data manipulation, analysis, and reporting. It also increases the ease of integration with other datasets. This poster describes some of the results and demonstrates some of the potential for the WOODCARB3 model. Examples of the types of analysis possible include uncertainty analysis, sensitivity analysis, alternate model dynamics, alternate pathways.

Introduction

WOODCARB2 is used to document and calculate the total carbon stocks from harvested wood products (HWP). The statistics package R offers a wide variety of tools and interfaces with other software packages.

Sequestration of carbon in forests accounts for 87% of total $\mathbf{CO_2}$ removals in 2014. Carbon mitigation efforts have thus focused much attention on reforestation, forest management,and forest based products. According to the most recent report to the **UNFCCC**, an estimated 18.7% of the total carbon in woody materials is contained in harvested wood **(HWP and SWDS).**

The amount of carbon in **HWP** and **SWDS** depend on how much wood is harvested, what types of products are produced, how the products are use, the lifetime of the wood products, and how the wood is processed at the end of its primary product lifetime.

Sources of Data and Equations

I. Input data from reports by Hair, Ulrich, Howard, Ince, etc.

II. The Production Approach is:

$$\frac{44}{12} * \left(-\Delta C_{\text{HWP IU DH}} - \Delta C_{\text{HWP SWDS DH}} \right) \quad (1)$$

III. $\frac{44}{12}$ converts Carbon to CO_2

IV. $\Delta C_{\text{HWP IU DH}}$ is change in stock of HWP in use from domestic harvest

V. $\Delta C_{\text{HWP SWDS DH}}$ is change in stock of HWP in SWDS from domestic harvest

Methodology

- Most analysis done using the Production approach
- The Production approach focuses on carbon

Uncertainty Analysis

- Error sources and distributions were defined previously by the USFS and introduced using the WOODCARB3 package
- These included error in production and stock reporting, carbon conversion factors, percentage subject to decay, etc
- Uncertainty was modeled using a Monte Carlo simulation with one thousand repetitions

Projected Carbon Contribution

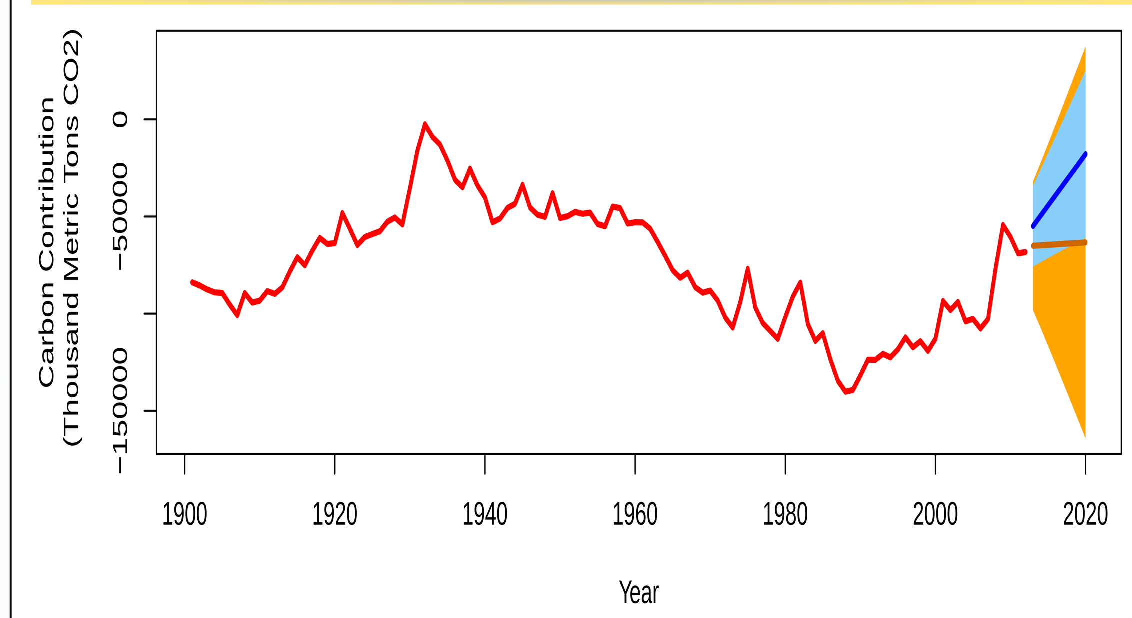

Figure: Projections based on 5-year (orange) and 10-year (blue) simple linear regression

Total HWP Carbon Stocks with Uncertainty

UncertaintyPlot.pdf

Figure: Default carbon contribution produced by WOODCARB3 (red) surrounded by results from Monte Carlo simulation (blue)

Decay

- Decay functions are based on the gamma distribution:
$$\int_0^n \frac{1}{\Gamma(k)\theta(k)} x^{k-1} e^{-x/k} dx$$
- WOODCARB2 used an exponential decay where $k = 1$ in the gamma distribution
- Two alternate decay functions, $k = 2$ and $k = 10$, were calculated by altering k in the gamma distribution and introduced in the WOODCARB3R package

Shape of Decay Functions

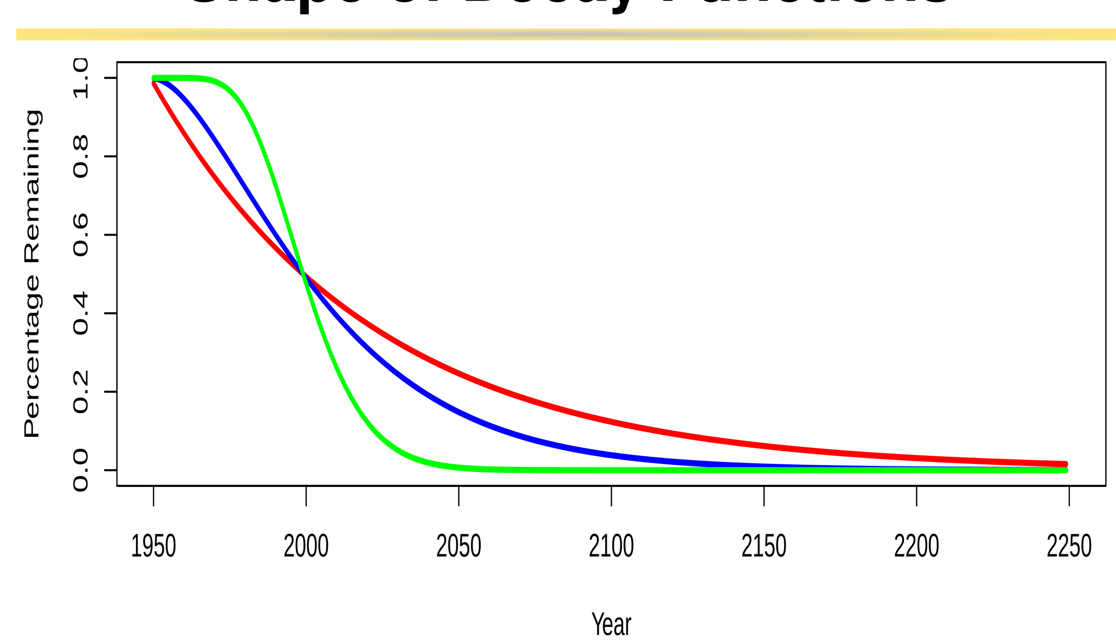

Figure: Decay of a product with 50-year half-life using exponential (red), $k = 2$ (blue), and $k = 10$ (green) functions

Half-lives of End Products

	Half Life	1990	2000	2010
Single Family	78	49326.24	68293.97	68979.34
Multi Family	47.69	98724.8	2380.01	1756.76
Shipping	38.03	10878.75	13989.01	11874.62
House Furn	38.03	5175.2	9369.04	8638.16
Comm. Furn	38.03	1180.03	3612.24	3657.69
Industrial	38.03	34036.33	31405.34	26583.78
Other	38.03	12834.98	18264.28	16991.37
Resid Upkeep	23.13	167096.43	172797.32	114967.8
Paper	2.53	6391552.25	3603762.53	139374.49

Figure: End product half-lives and their total product

Effect of Decay Functions

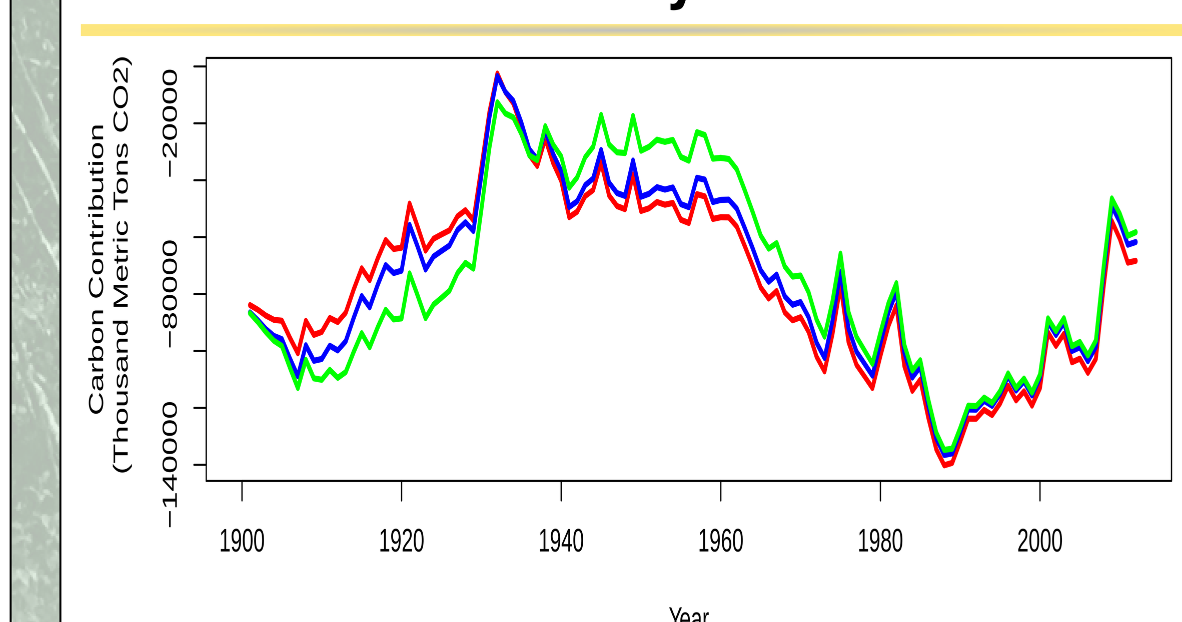

Figure: Overall carbon storage of harvested wood products using exponential (red), $k = 2$ (blue), and $k = 10$

Sensitivity Analysis

- Halflife role in final carbon contribution calculation.
- Error is assumed to be N(1,.2).
- Assume how well halflifes hold with applied error.
- Results can be used to improve half-lives.
- Results can also show which half-lives are concerete.

Sensitivity Plot

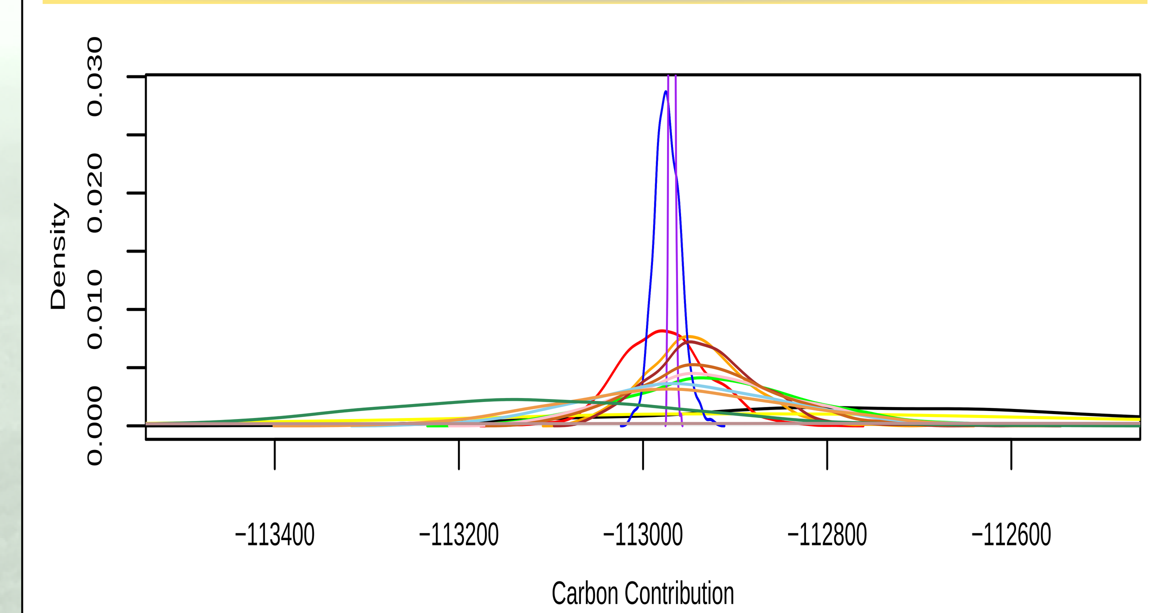

Figure: Figure New.Nonres.Rties and New.Nonres.Rcar.Repair have the least variance.

Half-life Sensitivity Effect

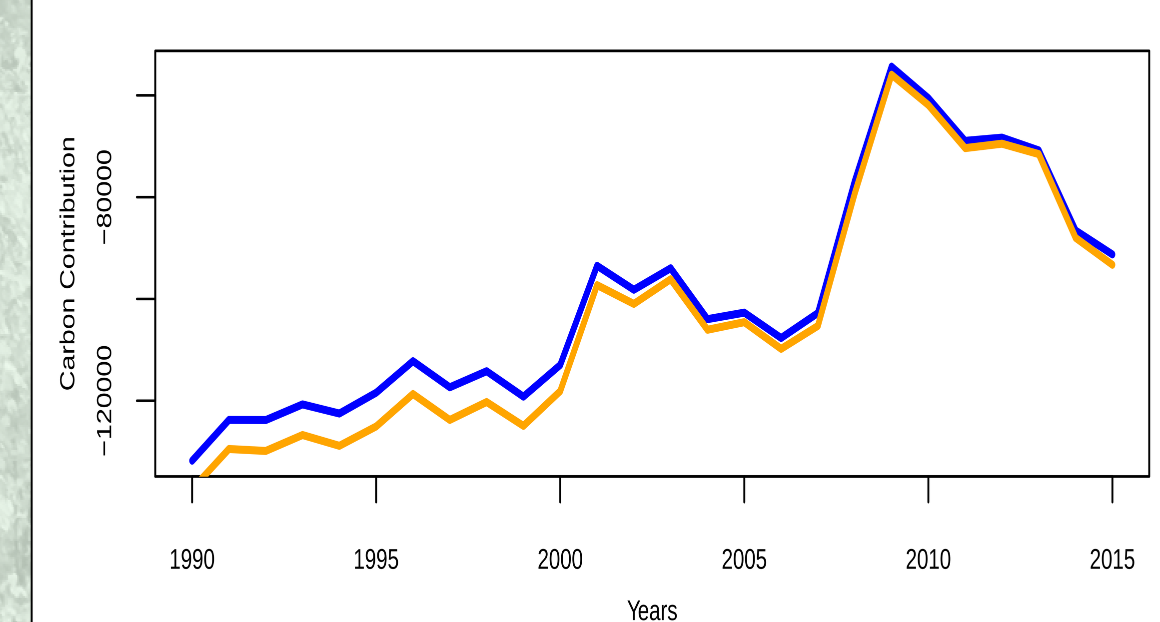

Figure: Standard paper half-life (orange) compared to a 50-percent increase (blue)

Discussion

- Targeted changes in average half life can increase total stocks.
- End of life dynamics make a big difference in stock size.
- Sensitivities help channel reductions in uncertainty.

Acknowledgements

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Contact Information and Package