PROCEEDINGS

One Hundred Twelfth Annual Meeting

of the

AMERICAN WOOD PROTECTION ASSOCIATION

Condado Plaza Hilton
San Juan, Puerto Rico
May 1-3, 2016

VOLUME 112

AMERICAN WOOD PROTECTION ASSOCIATION
P O BOX 361784 • BIRMINGHAM, ALABAMA 35236-1784 • USA

ISSN 0066-1198

AMERICAN WOOD PROTECTION ASSOCIATION
P.O. BOX 361784
BIRMINGHAM, ALABAMA 35236-1784
USA

Colin McCown, *Editor*
Kenny Cheng and Beth Staula, *Assistant Editors*

David N. D’Hooge

AWPA President 2015-2016

(This page intentionally left blank.)

Table of Contents

Proceedings of the 112th Annual Meeting of the
American Wood Protection Association

May 1-3, 2016

2016 BUSINESS SESSION

OPENING SESSION

TECHNICAL SESSION 1
Keynote Session

TECHNICAL SESSION 2

The Colley-Hartford Memorial Lecture and Research Symposium

Tuesday, May 3, 2016

TECHNICAL SESSION 3

Rich Ziobro Memorial Symposium

TECHNICAL SESSION 4

EPA Regulations and Treated Wood Handling

TECHNICAL SESSION 5

Special Issues for Use of Treated Wood in Caribbean and Similar Environments

TECHNICAL SESSION 6

Recent Advancements in Hazard Modeling and its Future

AWPA Technical and Special Committees

Other Information

PROCEEDINGS

One Hundred Twelfth Annual Meeting

of the

AMERICAN
WOOD PROTECTION
ASSOCIATION

112th AWPA

San Juan

puerto rico

May 1-3

2016

Deadwood, Soil Biota and Nutrient Dynamics in Tropical Forests: A Review of Case Studies from Puerto Rico

Grizelle González
USDA Forest Service, International Institute of Tropical Forestry
Río Piedras, Puerto Rico

Wood is the main constituent of tropical forests (Zalamea-Bustillo, 2005). Woody debris provides habitat for animals and germinating plants, as well as contributing to soil moisture regulation and nutrient cycling (Figure 1, Harmon et al. 1986, Stevens 1997 and references therein). Dead wood is a temporary sink for atmospheric carbon, a source of soil organic matter, and a substrate for nitrogen fixation (Harmon and Hua 1991, Torres 1994, Creed et al. 2004). Yet the exact contribution of woody debris to global carbon storage is still unknown (Harmon et al. 1986). Most surveys of amounts and properties of woody debris have been performed within temperate systems as well as the mainland tropics where these collections are often limited to a few forest types encompassing large land areas (Delaney et al. 1998, Nascimento and Laurance 2002). Temperate, tropical, and island ecosystems vary in climate, species composition, decomposer community structure and rates of biomass production, resulting in variable amounts of carbon stored in persistent downed woody debris (González and Luce 2013). Detailed studies within a variety of tropical forest types are important for better understanding of the complexity and uncertainty associated to global carbon pools; particularly, given the importance of both natural and anthropogenic disturbances on the long term consequences in the functioning of these forested ecosystems (González and Luce 2013).

EFFECTS OF DECAYING WOOD ON SOILS

Puerto Rico is a tropical Caribbean island where large quantities of coarse wood debris are generated periodically during tropical storms and hurricanes. Decaying wood, through its effect on soil organic matter and nutrient dynamics, contributes to the spatial heterogeneity of soil properties in its subtropical forests, furthering affecting the process of soil formation and nutrient cycling (Zalamea et al. 2007, 2016). For example, Zalamea et al. (2007) studied twenty logs from two species with contrasting wood properties (*Dacryodes excelsa* Vahl. and *Swietenia macrophylla* King) and at two different decay stages (6 and 15 years after falling), and soil under and 50 cm away from decaying logs were sampled for soil organic matter fractions. They found decaying logs did influence properties of the underlying soil with differing effects according to the species since there was more NaOH-extractable carbon in the soil associated to *D. excelsa* logs and more water-extractable organic matter in the soil associated to *S. macrophylla* older logs. The higher degree of condensation of water soluble fulvic acids and other related poly-aromatic residues occurred in the soil associated with the youngest logs. More divalent cations were available in the soil influenced by younger logs and decreased as decomposition increased (Zalamea et al. 2007).

VARIATION ACROSS THE PUERTO RICAN LANDSCAPE

González and Luce (2013) characterized coarse woody debris and fine woody debris at 24 sites along an elevation gradient in northeastern Puerto Rico. These sites are representative of eight mature forest types that include Elfin woodland, Sierra palm *Prestoea montana*, Palo Colorado *Cyrilla racemosa*, Tabonuco *Dacryodes excelsa*, lowland moist, lowland dry, fresh water *Pterocarpus* swamps, and flooded mangrove forests. Along this gradient, they found significant differences in mean total woody debris, coarse woody debris, and fine woody debris among forest types. The mean total woody debris was significantly greater in the Palo Colorado forest than the low-elevation Dry (14.79 Mg ha^{-1}) and highest elevation Elfin (17.38 Mg ha^{-1}) forests, with the other forest types containing intermediate amounts of woody debris. In northeastern Puerto Rico, the total fine woody debris fraction was an important component of total carbon storage, representing 22–56% of total carbon stored in each forest. The forests of Puerto Rico vary in terms of age, plant community, and woody debris amount and composition. Yet in some cases, differences in the amounts of woody debris among forest types can also be explained by factors such as time since disturbance, the land use history of a particular site, or seasonality (González and Luce 2013). As elevation and mean annual precipitation (MAP) increased, a trend of increasing amounts of woody debris (until the Elfin forest was encountered) and decreased decay of coarse woody debris (CWD) was found.

DECAYING WOOD AND SOIL BIOTA

Decomposer organisms can be key determinants of decay in these forest types in northeastern Puerto Rico (e.g., González and Seastedt 2001). Yet the contribution of different groups of decomposers to the decay of coarse woody debris might vary among the different forest types located along elevation and environmental gradients (González and Luce 2013). For example, González and Luce (2013) found in the Elfin forest, the decay class of CWD was most strongly correlated with white rot fungi. Yet, across all forest types in this study, the decay class of CWD also correlated well with the average occurrence of brown rot fungi. Decreased decay as MAP increases and differential effects of organisms on decay would be consistent with results previously reported by Torres and González (2005) and González et al. (2008). Torres and González (2005) studied the decomposition of *Cyrilla racemiflora* logs over a 13-year period in tropical dry and wet forests in Puerto Rico. The mean mass loss, ratio of soft- to hard-wood, nutrient concentrations, and the diversity of wood-inhabiting organisms were greater in logs decomposing in the dry forest than in the wet forest. Termites were also more abundant in the logs collected from the tropical dry forest than the tropical wet forest. High moisture content and a low animal diversity on the logs in the wet forest seem to retard wood decay in this habitat. Wood decay rates in the tropical dry forest can be related to the high diversity of species and functional groups of wood-inhabiting organisms. González et al. (2008) set up a wood decomposition experiment to quantify the percent of mass remaining, decay constant and performance strength of aspen stakes (*Populus tremuloides*) in dry and moist boreal (Alaska and Minnesota, USA), temperate (Washington and Idaho, USA), and tropical (Puerto Rico) forest types. They conclude that moisture condition is an important control over wood decomposition over broad climate gradients; and that such relationship can be non-linear. Further, that the presence of a particular group of organism (termites) can significantly alter the decay rates of wood more than what might be predicted based on climatic factors alone; suggesting biotic controls on wood decay might be more important predictors of wood decay in tropical regions (rather than abiotic constraints).

CONCLUDING REMARKS

The results of these studies support findings on the important role of decaying wood on the diversity and functionality of soil organisms, soil formation, and soil organic matter dynamics. Decaying wood has a significant effect upon soils underneath. This could help explain spatial heterogeneity in soil properties, such as nutrient availability. Furthermore, the effects of decaying wood upon soil will also depend in changes in the disturbance regime; which might increase as for example, increments in hurricane frequency related to climate change might lead to increases of dead wood inputs to soil.

Figure 1. Decaying wood can be a cradle for seed germination and seedling development. Note how Sierra Palm (*Prestoea montana* (Graham) G. Nicholson) seedlings thrive on decaying wood in the Luquillo Experimental Forest, Puerto Rico. Photo by Marcela Zalamea-Bustillo.

LITERATURE CITED

1. Creed, I. F., Morrison, D.L., Nicholas, N.S. 2004. Is coarse woody debris a net sink or source of nitrogen in the red spruce Fraser fir forest of the southern Appalachians, USA? – Can. J. For. Res. 34: 716–727.
2. Delaney, M., Brown, S., Lugo, A.E., Torres-Lezama, A., Bello-Quintero, N. 1998. The quantity and turnover of dead wood in permanent forests plots in six life zones of Venezuela. – Biotropica 30: 2–11.

3. González, G., and Luce, M.M. 2013. Woody debris characterization along an elevation gradient in northeastern Puerto Rico. Ecological Bulletins 54: 181-193.
4. González, G., and Seastedt, T.R. 2001. Soil fauna and plant litter decomposition in tropical and subalpine forests. Ecology 82(4): 955-964.
5. González, G., Gould, W.A., Hudak, A.T., and Hollingsworth, T. 2008. Decay of aspen (*Populus tremuloides* Michx.) wood in moist and dry boreal, temperate, and tropical forest fragments. – Ambio 37: 588–597.
6. Harmon, M.E., Franklin, J.F., Swanson, F.J., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., et al. 1986. Ecology of coarse woody debris in temperate ecosystems. – Adv. Ecol. Res. 15: 133–302.
7. Harmon, M. and Hua, C. 1991. Coarse woody debris dynamics in two old-growth ecosystems. – BioScience 41: 604–610.
8. Nascimento, H. and Laurance, W. 2002. Total aboveground biomass in central Amazonian rainforests: a landscape-scale study. – For. Ecol. Manage. 168: 311–321.
9. Stevens, V., 1997. The ecological role of coarse woody debris: an overview of the ecological importance of CWD in B.C. forests. Res. Br., B.C. Min. For., Victoria, B.C. Work. Pap. Retrieved November 2005 from http://www.for.gov.bc.ca/hfd/pubs/docs/Wp/Wp30.pdf
10. Torres, J.A. 1994. Wood decomposition of *Cyrilla racemiflora* in a tropical montane forest. – Biotropica 26: 124–140.
11. Torres, J.A, and González, G. 2005. Wood decomposition in Puerto Rican Dry and Wet Forests: a 13-year case study. Biotropica: 37(3):452-456.
12. Zalamea-Bustillo, M. 2005. Soil biota, nutrients, and organic matter dynamics under decomposing wood. Master of Science in Tropical Biology Thesis, Department of Biology, Faculty of Natural Sciences, University of Puerto Rico, Río Piedras Campus, 117 pp.
13. Zalamea, M., González, G., Ping, C.L., and Michaelson, G. 2007. Soil organic matter dynamics under decaying wood. Plant and Soil 296: 173-185.
14. Zalamea, M., González, G., and Lodge, D.J. 2016. Physical, chemical, and biological properties of soil under decaying wood in a tropical wet forest in Puerto Rico. *Forests 7*(8), 168; doi:10.3390/f7080168