Supplementary Material

Forest water use is increasingly decoupled from water availability even during severe drought

Katie McQuillan 1, Mirela Tulbure 1,2, Katherine Martin 1,2

1 Center for Geospatial Analytics, North Carolina State University, Raleigh, NC, 27695, USA

2 Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC, 27695, USA

Corresponding author email address: kmcquil@ncsu.edu

Submitted to Landscape Ecology

Included in this document:

1. Validation methods and results of forest composition map
2. Fig. S1
3. Fig. S2
4. Table S1

Validate forest composition maps

Since the Riley tree-level model was not developed with the goal of predicting species BA, we compared the results with a forest composition model specifically developed to predict species BA at 250m resolution (Wilson, Lister, Riemann, & Griffith, 2013) as well as plot-level total BA from the literature. The Wilson (2013) forest composition maps were treated as reference maps and the same methods were applied to calculate pixel-wise percent diffuse-porous BA. The Riley (2021) percent diffuse-porous BA map was resampled to 250m resolution to facilitate comparisons of cell-wise differences in predicted diffuse-porous BA. Since total BA values from the literature did not include exact plot coordinates, a visual comparison was used to assess the ability of Wilson (2013) compared to Riley (2021) to capture total BA across the landscape.

Across the continuously forested area, MODIS diffuse-porous BA ranged from 8.8% to 84.5% with a mean of 34.9% and Landsat diffuse-porous BA ranged from 0% to 100% with a mean of 34.9%. The percent diffuse-porous BA maps created from the reference Wilson (2013) and Riley (2021) forest composition products had an average absolute cell-wise difference of 11.4% (Fig. S2). Compared to the Wilson percent diffuse BA map, the Riley % diffuse BA map tended to over-predict percent diffuse BA in the southern part of the study area and under predict in the northern and central parts (Fig. S2). Comparing the products at the species level, 80% of the top 10 most abundant species on the landscape and 90% of the top 50 most abundant species on the landscape identified by Riley were also identified by Wilson (Table S1). Plot-level estimates of total BA range from 290 ft^2/ha (Caldwell et al., 2016) at Coweeta Hydrologic Laboratory to 344 - 484 ft^2/ha at other plots across western, NC (Caldwell et al., 2020). The pixel-wise total BA for each product (summation of 50 most abundant species BA) revealed in a visual inspection that Wilson significantly underestimated total BA (max total BA at Coweeta = 176 ft^2/ha) while the 30m resolution Riley maps came closer to matching observed total BA (max total BA at Coweeta = 295 ft^2/ha). These checks suggest that the Riley tree-level model is capturing the spatial distribution of the percent diffuse-porous BA across the landscape.

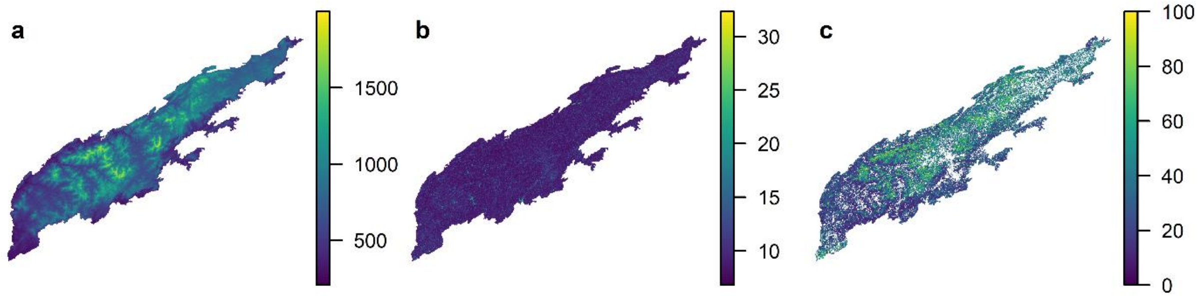

Fig S1 a. Elevation, b.TWI, and c. percent diffuse-porous BA maps of the study area at 30m resolution.

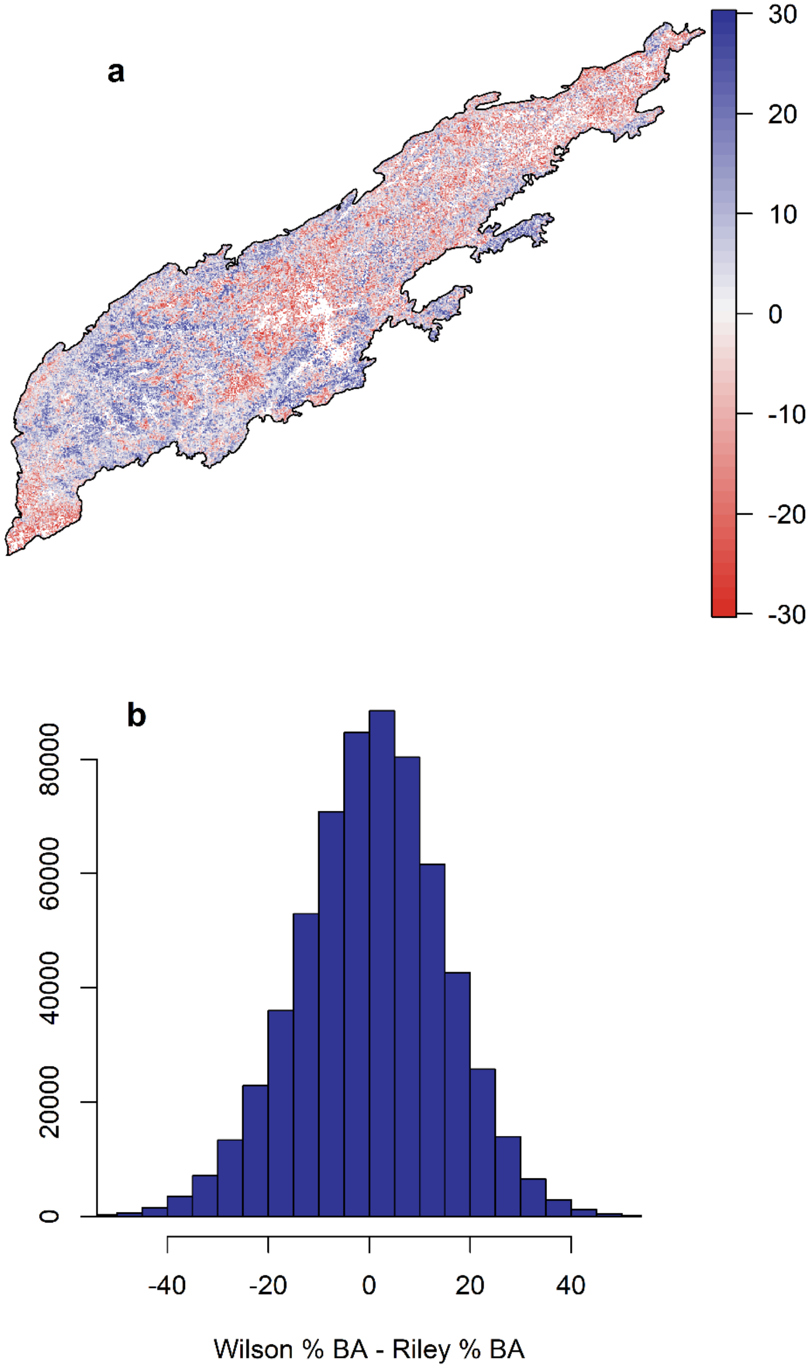

Fig S2 a.Difference between Wilson percent diffuse-porous BA and Riley percent diffuse-porous BA. b. Histogram of the distribution of cell-wise differences between Wilson % diffuse-porous BA and Riley % diffuse-porous BA.

Table S1. Top 50 most abundant species across Blue Ridge ecoregion used to calculate the percent diffuse-porous BA.

SPCD	Scientific Name	Common Name	Xylem Anatomy	% Total BA
832	Quercus prinus	Chestnut Oak	Ring	13.09
316	Acer rubrum	Red Maple	Diffuse	9.66
621	Liriodendron tulipifera	Yellow-Poplar	Diffuse	8.76
802	Quercus alba	White Oak	Ring	7.28
806	Quercus coccinea	Scarlet Oak	Ring	6.67
833	Quercus rubra	Northern Red Oak	Ring	4.74
711	Oxydendrum arboreum	Sourwood	Ring	4.65
129	Pinus strobus	Eastern White Pine	Tracheid	4.13
837	Quercus velutina	Black Oak	Ring	3.52
318	Acer saccharum	Sugar Maple	Diffuse	2.82
693	Nyssa sylvatica	Blackgum	Diffuse	2.63
531	Fagus grandifolia	American Beech	Diffuse	2.51
261	Tsuga canadensis	Eastern Hemlock	Tracheid	2.35
132	Pinus virginiana	Virginia Pine	Tracheid	2.19
403	Carya glabra	Pignut Hickory	Ring	2.11
372	Betula lenta	Sweet Birch	Diffuse	1.93
131	Pinus taeda	Loblolly Pine	Tracheid	1.43
762	Prunus serotina	Black Cherry	Ring	1.35
901	Robinia pseudoacacia	Black Locust	Ring	1.22
812	Quercus falcata	Southern Red Oak	Ring	1.15
409	Carya alba	Mockernut Hickory	Ring	1.12
110	Pinus echinata	Shortleaf Pine	Tracheid	1.12
97	Ulmus alata	Red Spruce	Tracheid	1.11
541	Fraxinus americana	White Ash	Ring	1.05
371	Betula alleghaniensis	Yellow Birch	Diffuse	0.99
126	Pinus rigida	Pitch Pine	Tracheid	0.99
655	Magnolia fraseri	Fraser Magnolia	Diffuse	0.71

611	Liquidambar styraciflua	Sweetgum	Diffuse	0.69
835	Quercus stellata	Post Oak	Ring	0.65
951	Tilia americana	American Basswood	Diffuse	0.58
332	Aesculus flava	Yellow Buckeye	Diffuse	0.55
651	Magnolia acuminata	Cucumbertree	Diffuse	0.51
931	Sassafras albidum	Sassafras	Ring	0.5
491	Cornus florida	Flowering Dogwood	Diffuse	0.46
356	Amelanchier spp.	Serviceberry spp	Diffuse	0.38
544	Fraxinus pennsylvanica	Green Ash	Ring	0.31
407	Carya ovata	Shagbark Hickory	Ring	0.28
68	Juniperus virginiana	Eastern Redcedar	Tracheid	0.27
123	Pinus pungens	Table Mountain Pine	Tracheid	0.26
315	Acer pensylvanicum	Striped Maple	Diffuse	0.23
581	Halesia carolina	Carolina Silverbell	Diffuse	0.23
16	Abies fraseri	Fraser Fir	Tracheid	0.19
591	Ilex opaca	American Holly	Diffuse	0.17
975	Ulmus rubra	Slippery Elm	Ring	0.17
731	Platanus occidentalis	American Sycamore	Diffuse	0.16
402	Carya cordiformis	Bitternut Hickory	Ring	0.15
602	Juglans nigra	Black Walnut	Ring	0.15
972	Ulmus americana	American Elm	Ring	0.13
471	Cercis canadensis	Eastern Redbud	Ring	0.13
952	Tilia americana var. heterophylla	White Basswood	Diffuse	0.11

References

Caldwell, P. V., Miniat, C. F., Elliott, K. J., Swank, W. T., Brantley, S. T., & Laseter, S. H. (2016). Declining water yield from forested mountain watersheds in response to climate change and forest mesophication. *Global Change Biology*, *22*(9), 2997-3012. doi:10.1111/gcb.13309

Caldwell, P. V., Elliott, K. J., Liu, N., Vose, J. M., Zietlow, D. R., & Knoepp, J. D. (2020). Watershed-scale vegetation, water quantity, and water quality responses to wildfire in the southern appalachian mountain region, united states. *Hydrological Processes, 34*(26), 5188-5209. doi:10.1002/hyp.13922

Riley, K. L., Grenfell, I. C., Finney, M. A., & Wiener, J. M. (2021). TreeMap, a tree-level model of conterminous US forests circa 2014 produced by imputation of FIA plot data. *Scientific Data*, *8*(1), 1-14. doi:10.1038/s41597-020-00782-x

Wilson, Barry Tyler; Lister, Andrew J.; Riemann, Rachel I.; Griffith, Douglas M. 2013. Live tree species basal area of the contiguous United States (2000-2009). Newtown Square, PA: USDA Forest Service, Rocky Mountain Research Station. https://doi.org/10.2737/RDS-2013-0013