Estimating the benefits provided by trees in Chesapeake Bay Watershed states and identifying opportunities to expand tree canopy

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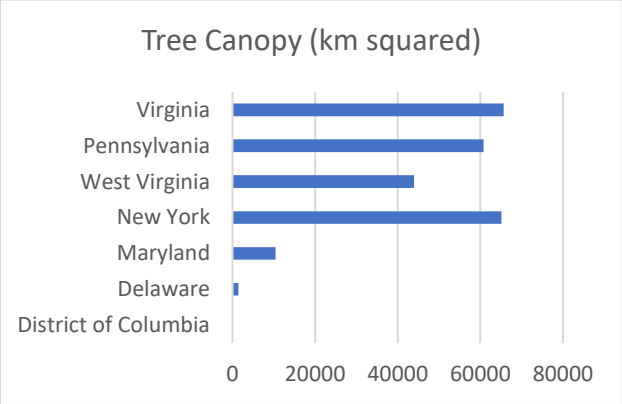
Background

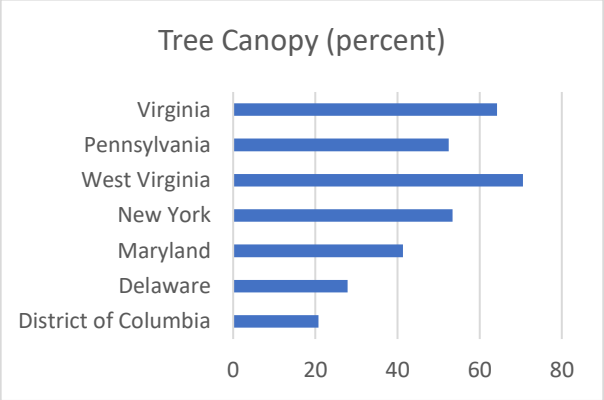
Forests are the predominant natural land cover in the Chesapeake Bay Watershed. Although forests are the most beneficial land use for reducing nutrient and sediment pollution delivered to the Chesapeake Bay, many forests have been lost or fragmented as a result of rapid development. In this analysis, I used i-Tree Landscape to evaluate the carbon storage, air pollution removal, and hydrology benefits that trees provide for each of the states in the Chesapeake Bay watershed. I also assessed the economic and human health benefits of these ecosystem services.

In addition to evaluating the benefits trees currently provide in Chesapeake Bay Watershed states, I also did a more detailed analysis of tree canopy coverage within Maryland census places. Identifying communities that currently have low tree canopy could help inform state and local forestry agencies about where there are the greatest opportunities to expand tree canopy. For this analysis, I ran a prioritization to look at the communities that have low tree canopy coverage, high planting space, and a high minority population density. This prioritization could be used to target tree planting efforts to historically underserved communities and advance DEIJ efforts in the watershed.

Tree Canopy in the Chesapeake Bay Watershed

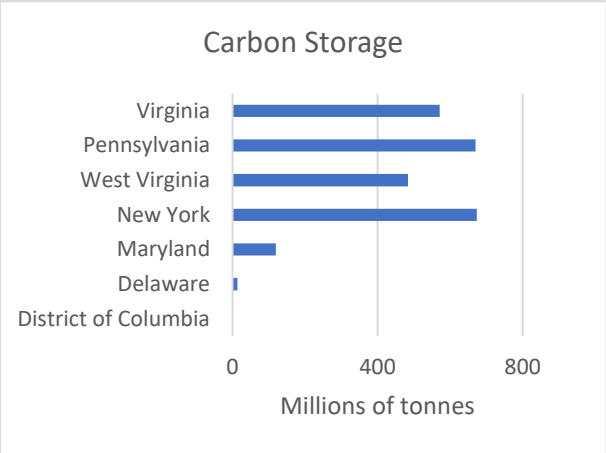
Chesapeake states include Maryland, Delaware, Pennsylvania, Virginia, West Virginia, New York and D.C. Although these states are not entirely within the watershed, the analyses were run at a state level, as i-Tree landscape does not currently have the capacity to use larger watersheds as an analysis boundary. High resolution data was only available for D.C., Delaware, and Maryland, so NLCD 2011 data was used for the remaining states. Understanding the amount of tree canopy in each of these states will help contextualize the data presented on the ecosystem services benefits of trees in each state. Virginia, Pennsylvania, New York, and West Virginia all have a relatively large amount of tree canopy.

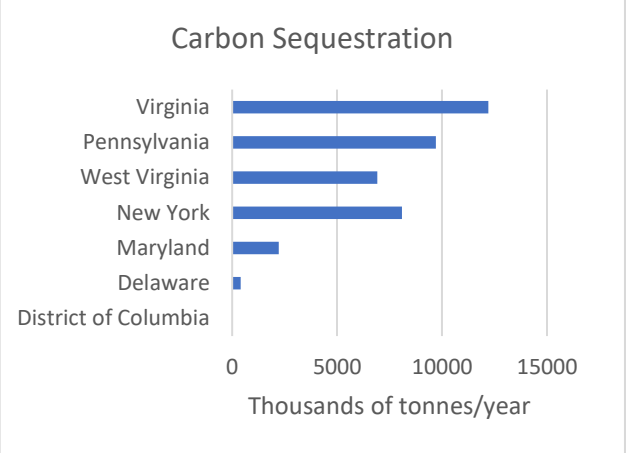




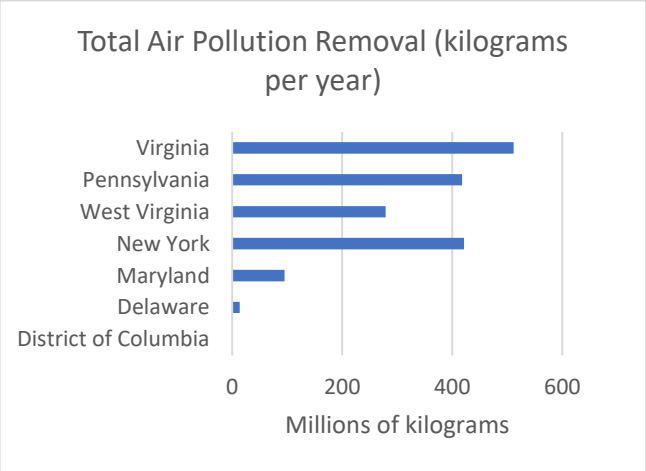
Ecosystem Services Provided by Trees in the Chesapeake

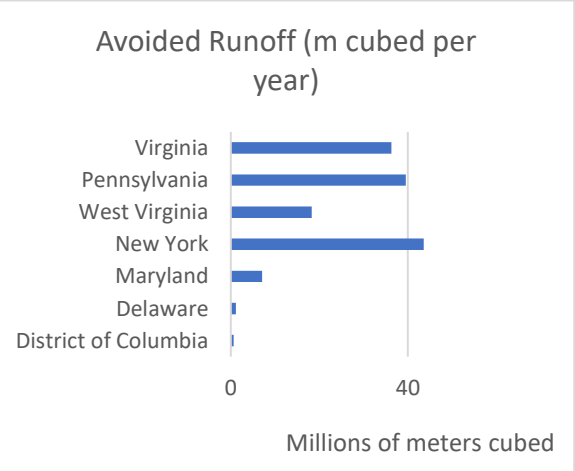
Climate change is already significantly impacting Chesapeake ecosystems and communities, with an increased incidence of extreme heat, flooding and late-season flash droughts. Trees can play an important role in mitigating the impacts of climate change, both by sequestering carbon from the atmosphere and by storing carbon in the trees themselves. Across all of the Chesapeake states (including areas outside of the watershed), i-Tree estimates that there is over 2.5 billion tonnes of carbon stored and over 39.5 million tonnes per year of carbon sequestration.





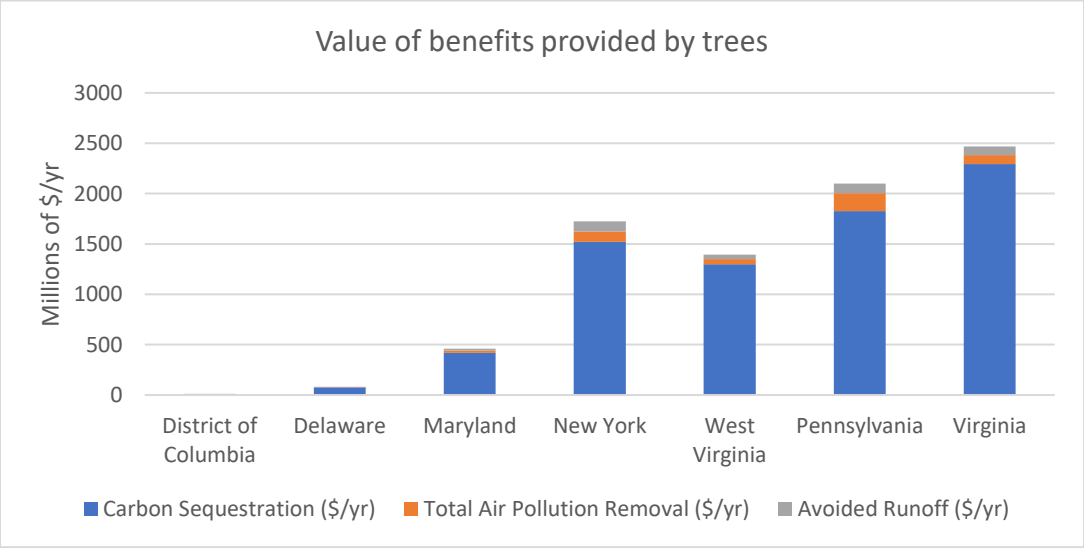
Trees can also provide other important air quality and stormwater regulation benefits. Air pollution, particularly in dense urban areas, can be a major concern for human health. Trees can improve air quality by reducing temperatures and filtering pollutants directly out of the air. Across all Chesapeake states, i-Tree estimates that trees remove over 1.7 billion kilograms of air pollutants every year (including CO, NO_2, O_3, $PM_{2.5}$, SO_2, and PM_{10}). Stormwater can be another concern in urban areas, as impervious surfaces can prevent the natural infiltration of polluted runoff. Incorporating trees into urban landscapes can help intercept precipitation and stormwater runoff so it can be filtered naturally into the soil. Across all Chesapeake states, i-Tree estimates that trees reduce runoff by 146 million m^3 every year.



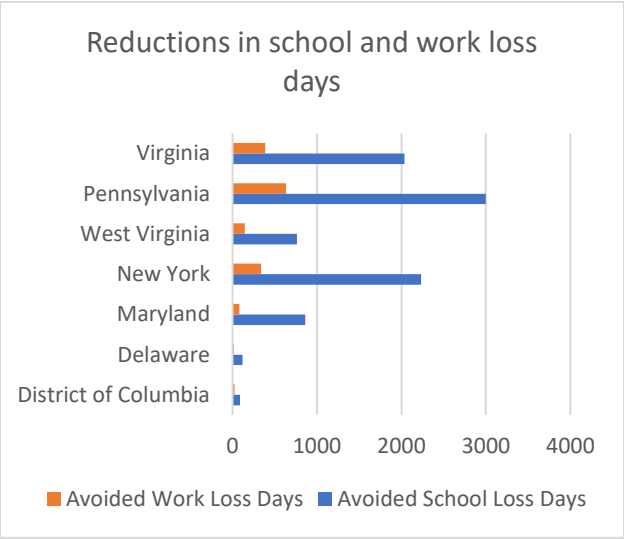


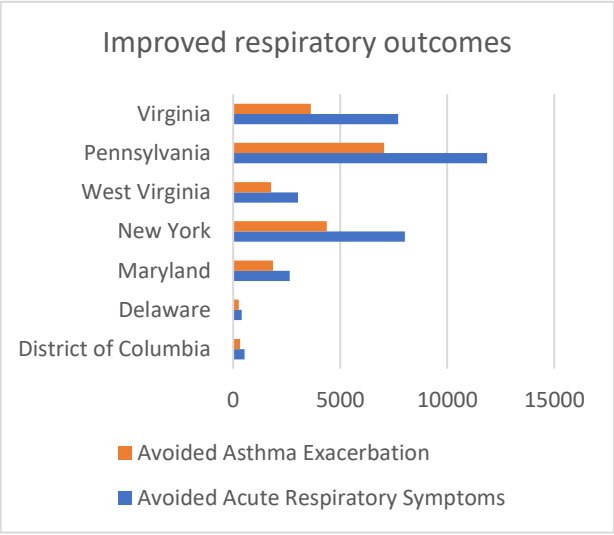
Economic and Human Health Benefits of Trees

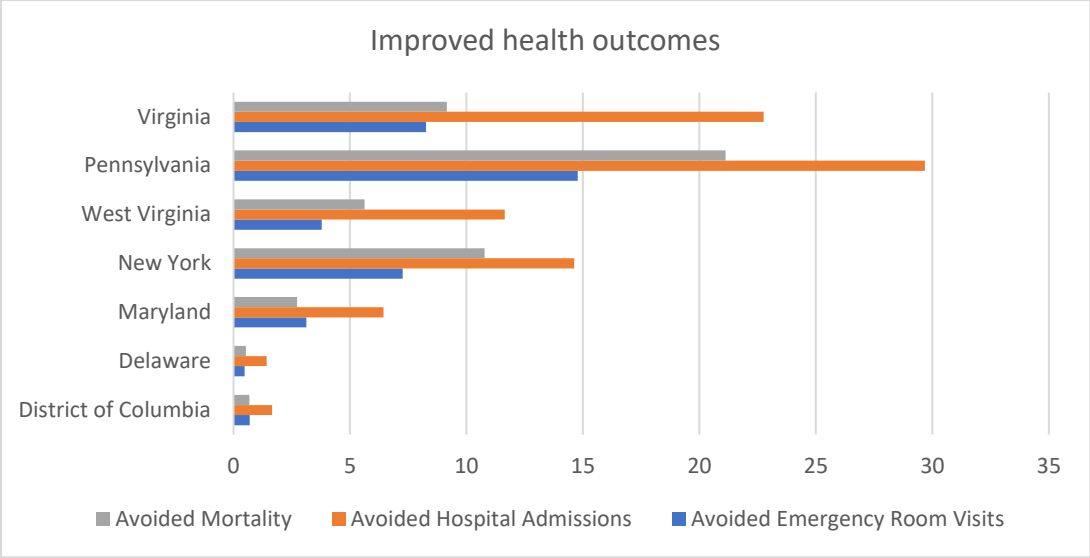
The value of carbon sequestration is estimated at $188 per metric ton (Interagency Working Group, 2016), the estimated value of the air pollution reduction is based on local health impact estimates from the US EPA BenMap model, and the value of avoided runoff is estimated using the iTree Eco model. Taken together, these ecosystem services provide significant economic benefits to the states in the Chesapeake watershed.



In addition to the economic benefits, by removing air pollution, trees can also generate benefits for human health. The values shown below are estimates from i-Tree, which were derived from local health impact estimates from the US EPA BenMap model. An appendix includes the precise health estimates for each state, as well as total values across all states. A few notable findings are that every year, i-Tree estimates that trees help prevent over 50 deaths, 9099 school loss days, and 1624 work loss days across all watershed states.







Opportunities to Expand Tree Canopy in Maryland

i-Tree landscape can also be used at a finer scale to provide additional information about the relative amount of tree canopy in communities to identify areas where there may be the greatest opportunity to expand tree canopy and generate additional ecosystem services benefits. I analyzed all 553 census places in Maryland using high-resolution data. On average, Maryland communities have 46.9% coverage of tree canopy. However, there is a lot of variation, with some communities having as little as 1.28% tree canopy coverage and others having 89.3% coverage. Sorting the communities by tree canopy coverage revealed that some of the low canopy communities are also in low-lying coastal areas, where trees are unlikely to thrive given current and future sea level rise conditions. In these areas, existing forests are gradually turning into “ghost forests” as saltwater intrusion and increased inundation times result in widespread tree mortality.

The table below lists Maryland communities that may be ripe for future investments in tree canopy. The list on the left identifies communities that currently have the lowest amount of tree canopy in the state, filtering out coastal communities that will be submerged by 1 ft or more of sea level rise (based on i-Tree landscape outputs). The list on the right is based on a prioritization within i-Tree landscape to identify communities that have low tree canopy coverage, high planting space, and a high minority population density. Each of these criteria was equally weighted in the prioritization.

Many of the communities that currently have low tree canopy are either on the eastern shore of Maryland or in Central Maryland, which tend to be more rural, agricultural areas. In these areas, the best opportunities to expand tree canopy will likely involve working with farmers to incorporate trees into farms, especially along the edges of their fields and in riparian areas.

However, when prioritizing based on multiple criteria, including tree canopy coverage, the amount of plantable space and the relative size of the underserved population in a community, many of the highest priority communities are in more urban areas northeast of Washington, D.C. This suggests that to advance DEIJ objectives while expanding tree canopy, more emphasis would need to be placed on urban forestry efforts in these areas.

MD census places with high opportunity to expand canopy cover. Census places are listed in order of priority.

Communities with low tree canopy (% canopy)	Priority planting communities (% canopy)
Kennedyville (6.65%)	Friendship Heights Village (28.07%)
Maugansville (7.47%)	Langley Park (41.27%)
Adamstown (8.84%)	Mount Rainier (43.69%)
Ridgely (9.26%)	Chillum (43.8%)
Goldsboro (10.01%)	Bladensburg (38.42%)
Cearfoss (10.44%)	Kennedyville (6.65%)
Worton (10.81%)	Maugansville (7.47%)
Whaleyville (12.67%)	Ridgely (9.26%)
Hurlock (12.95%)	Goldsboro (10.01%)
Preston (12.98%)	Cearfoss (10.44%)

Conclusions and Next Steps

This preliminary analysis of tree canopy in Chesapeake Bay watershed states demonstrates that in addition to the water quality benefits, trees are also cleaning the air, removing and storing carbon, and reducing stormwater runoff. Across the Chesapeake Bay region, these ecosystem services are generating significant economic and human health benefits for communities. However, a finer-scale analysis reveals that, at least in Maryland, the benefits of tree canopy are not evenly distributed. There are significant opportunities to expand tree canopy in both rural and urban communities. Expanding urban forestry efforts, particularly in the communities neighboring Washington, D.C. may present particular opportunities to increase tree equity by expanding tree canopy in historically underserved communities.

One limitation of this analysis is that the land use data incorporated into i-Tree landscape is somewhat outdated. The high-resolution dataset is from 2013/2014 and the NLCD data is from 2011. The Chesapeake Conservancy is currently completing an updated 2017/2018 land use dataset. If it is possible to incorporate this dataset into i-Tree Landscape, we would like to replicate this analysis with the newer high-resolution data. We would also like to explore ways to do a more targeted analysis of the Chesapeake Bay watershed, as some of the states included in the analysis only have a small portion of their land area within the watershed. Updated state and/or watershed level statistics on the ecosystem services and health benefits of trees may be incorporated into county-level tree canopy fact sheets that are currently in development. These fact sheets will be used to communicate with local government officials about the benefits of trees in their communities and the implications of tree canopy loss and gain. Identifying communities that have low tree canopy could also help inform state and local forestry agencies about where there are the greatest opportunities to expand tree canopy.

Appendix: Estimated Health Benefits of Trees by state

Estimated annual health benefits of trees resulting from improvements in air quality. Estimates are for the entire state (not just within the Chesapeake Bay watershed)

	D.C.	DE	MD	NY	WV	PA	VA	Total
Avoided Emergency Room Visits	0.7	0.47	3.12	7.26	3.78	14.78	8.26	38.37
Avoided Hospital Admissions	1.65	1.42	6.43	14.63	11.64	29.68	22.75	88.2
Avoided Acute Respiratory Symptoms	529.43	392	2647.2	8017.63	3034.8	11862	7709	34192.01
Avoided Asthma Exacerbation	317.44	260.2	1861.3	4367.8	1769.5	7045	3625.2	19246.1
Upper Respiratory Symptoms	1.54	1.58	8.9	34.34	14.19	64.68	27.85	153.08
Lower Respiratory Symptoms	1.87	1.94	10.93	43.9	17.46	80.1	33.71	189.91
Avoided Mortality	0.68	0.53	2.73	10.78	5.62	21.12	9.16	50.62
Avoided School Loss Days	88.49	118.2	861.99	2231.33	763.65	3000	2036.7	9099.88
Avoided Work Loss Days	25.66	14.6	80.57	336.98	143.69	634.8	388.32	1624.65