Ecosystem Benefits of Tree City USA Cities in West Virginia

Prepared by:

Arboriculture & Urban Forestry Program

Davis College, School of Natural Resources

West Virginia University

Matthew Walker, Angela Sakazaki, Robert Eckenrode & Gregory Dahle

June 2017

Table of Contents

Executive Summary

The objective of this report was to estimate the urban canopy cover (both public and private) of the 16 cities and towns in West Virginia that were named as Tree City USAs in 2016. Tree City USA is a national program that provides the framework for community forestry management in the United States. To qualify as a TCUSA community, a town or city must meet four standards: creation and maintenance of a tree board or department, creation of a community tree ordinance, minimum of $2 per capita annual budget for urban forestry, and proclamation and celebration of Arbor Day. We used i-Tree Canopy to estimate the canopy cover in these cities and to calculate some of the ecosystem services (both material and monetary) provided by their urban trees. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that is comprised of urban forestry analysis and benefit assessment tools. This study estimated that the urban forests that are part of the TCUSA program provide annual ecosystem services of $6,441,179 by capturing 4,348,592 pounds of pollutants. The trees that make up these urban forests have sequestered an estimate 2,847,190 tons of carbon thus providing a benefit of $53,308,328. Our results suggest that WV's TCUSAs fall into one of three categories: cities with greater than 40% canopy, cities between 30-40% canopy coverage, and cities with less than 30% canopy coverage. These categories are designated to help urban forest managers set management objectives, budget, and bolster urban canopy coverage.

Introduction

Urban trees have long been recognized and appreciated for their aesthetic value. They provide a visual break from the monotony of hard asphalt and angular buildings in the urban environment. The obvious benefits of urban trees have long been known: shading sidewalks, parks and gardens for recreation, and their ability to beautify the landscape. Recently, there has been an increased interest in quantifying and assessing the economic and environmental benefits of urban trees. These benefits are collectively referred to as ecosystem services.

While shade and aesthetics are important services provided by urban trees, there are a number of less obvious benefits provided by urban trees. They absorb pollutants from the atmosphere and release back oxygen. Trees are also beneficial for stormwater control and soil stabilization. When planted near houses, trees provide shade from the sun, decreasing the consumption of energy from air conditioners in summer months; and provide a windbreak to decrease heating costs in the winter. Even the physical structure of trees, branches and leaves collect particulate matter from the air. All of these ecosystem services increase with the tree cover, often exponentially.

The amount of healthy and functioning leaves (canopy cover) is a simple measure of the magnitude of services provided by the forest (Nowak and Greenfield 2012). Thus, tree cover is a good measurement for the ecosystem services provided to the community. It is recommended the optimal canopy coverage for cities and towns is 40%. Currently 9 of the 16 TCUSA communities in West Virginia surpass this optimal target. Manzo *et al*. (2017) recommended that West Virginia communities should set an achievable target for canopy coverage goal of 35%.

Yet, measuring the actual canopy cover of a city is a time consuming venture and, ultimately, is estimated via a survey or sub-sampling. Several studies have been conducted based on satellite data to measure the canopy cover. Satellite-based cover analysis approaches have some limitations based on the resolution of images, which can lead to inaccurate classification. Images with high resolution can overcome these limitations, but still do not have the ability to make detailed comprehensive cover change maps (Nowak and Greenfield 2012). Imagery from Google Earth is becoming a popular tool to verify land cover data. Google Earth images are available worldwide and have been used when some data are questionable, inconsistent, incomplete, or even nonexistent (Nowak *et al*. 2010).

The objective of this report was to estimate the urban canopy cover (both public and private) of the 16 cities and towns in West Virginia that were named as TCUSAs in 2016. We used i-Tree Canopy to estimate the canopy cover in these cities and to calculate some of the ecosystem services (both material and monetary) provided by their urban trees. The iTree Canopy software used in this study is limited in that it cannot quantify stormwater benefits of urban trees. Although there are other programs within the i-Tree suite which can quantify these benefits. What i-Tree Canopy does provide are estimations about the pollution removal, carbon sequestration, and the associated monetary values trees can bring. This enables us to see the benefits trees provide to the community. Benefits come in many

forms, such as energy conservation and the improved physical and psychological health of the people within these urban environments. Land cover of The United States is 96.4% rural and about 96.3% of the pollution removal takes place in the rural areas (Nowak et al. 2014). However, the cumulative health benefits from pollution removal is greatest in the urban areas (Nowak et al. 2014). Thus, good management of rural trees is important for the larger task of overall pollution removal, and good urban tree management is critical to providing health benefits to urban populations.

This report provides: a snapshot of the current state of each of West Virginia's 16 Tree City USA's canopy coverage, an estimate of the economic and environmental value of the ecosystem services provided by each community's urban forest, and evidence that the TCUSA program serves an economically and environmentally valuable role in the active management of the urban forest resources in the state.

Methodology

For this study 16 cities were chosen (table 1). They include: Bath, Bluefield, Elkins, Follansbee, Harpers Ferry, Hinton, Huntington, Lewisburg, Morgantown, Parkersburg, Ronceverte, Shepherdstown, Summersville, Vienna, Wheeling, and Williamstown. The selection of these cities was made based on their great potential to serve as models for good urban forestry management. With the exception of Wheeling, all other cities are TCUSA's. Additionally, the campus of West Virginia State University was evaluated as it has been a Tree Campus USA campus since 2013.

TCUSA is a national program that provides the framework for community forestry management in the United States. The participating cities and towns demonstrate a commitment to caring for and managing their public trees. To qualify as a TCUSA community, a town or city must meet four standards established by the Arbor Day Foundation and the National Association of State Foresters. This ensures that every qualifying community would have a viable tree management program. The four standards for recognition are:

- Creation and maintenance a tree board or department
- Creation of a community tree ordinance
- Minimum $2 per capita budget for urban forestry
- Proclamation and celebration of Arbor Day.

The city of Morgantown data was chosen to compare results generated from this inventory against a previous study made in 2004, with i-Tree Eco model (formally Urban Forest Effects [UFORE] model), by Nowak and Greenfield (2012), and the results obtained from a full inventory made in 2011. The city of Wheeling was chosen as it is developing potential in terms of urban forest management.

To estimate the contribution of trees in the urban environment, i-Tree software was used. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that is comprised of urban forestry analysis and benefit assessment tools. i-Tree tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the environmental services that trees provide while giving insight about the structure of the urban forest.

Developed by the USDA Forest Service and cooperators, i-Tree is a free tool, available for public use and download at the website (www.itreetools.org). A cooperative partnership to develop, disseminate and provide technical support for this suite were made by the US Forest Service, Davey Tree Expert Company, National Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, and Casey Trees. The i-Tree suite includes various applications that can be used for different purposes. It has been used by communities, non-profit organizations, consultants, volunteers, and entire states (Cumming, 2011). The application used in this study was i-Tree Canopy version 6.1. Data was collected from June – Aug 2015 for all communities, while WVSU was collected in June 2016.

i-Tree Canopy offers an easy, statistically valid way to estimate the land cover of a given

area. The classification of the cover type is made by plotting random points on an aerial image provided by Google Maps. The results provided by i-Tree Canopy can be used as an input in a wide variety of analyses and other applications within i-Tree where land cover data is necessary. The data produced is used in i-Tree Canopy to estimate the environmental benefits that trees provide.

Table 1. Demographic information about the cities analyzed in the study. Population is derived from the 2010 US Census.

City	Acres	Population	Years in TCUSA
Bath	154	624	12
Bluefield	5,590	10,447	22
Elkins	2,006	7,094	9
Follansbee	1,336	2,986	22
Harpers Ferry	394	286	9
Hinton	1,946	2,676	17
Huntington	11,616	49,138	27
Lewisburg	2,437	3,830	15
Morgantown	6,519	29,660	19
Parkersburg	8,005	31,492	19
Romney	635	1,788	1
Ronceverte	936	1,765	16
Shepherdstown	204	1,734	16
Summersville	2,711	3,572	8
Vienna	2,434	10,749	19
Wheeling	10,114	28,486	*
Williamstown	1,120	2,908	33
WVSU Campus	102	2847**	4

* Wheeling is not currently a TCUSA city.

** West Virginia State University is part of the Tree Campus USA program and the reported population is that of the 2014 student population.

i-Tree can be used in any part of the globe, as it uses imagery from Google Maps. Hirabayashi (2014), describes the methodology used in i-Tree canopy to calculate the environmental benefits provided by tree cover and its monetary values. The user can define any category of land cover and define which of them will provide the benefits. Air pollutants removed are broken into six categories: Carbon monoxide (CO), Nitrogen dioxide (NO_2), Ozone (O_3), Sulfur dioxide (SO_2), Particulate matter less than 2.5 microns (PM2.5), and Particulate matter greater than 2.5 and less than 10 microns (PM10), defined by the U.S. Environmental Protection Agency (EPA). Default values for United States, Canada and Australia are used to calculate the pollutant removal. Locations outside these three

countries also can be studied. In these cases, the default values to calculate the benefits would need to be provided and entered into the application.

Table 2. Ecosystem benefits quantified in this study.

Abbreviation	Description
CO	Carbon Monoxide removed annually
NO2	Nitrogen Dioxide removed annually
O3	Ozone removed annually
SO2	Sulfur Dioxide removed annually
PM2.5	Particulate Matter less than 2.5 microns removed annually
PM10	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually
CO2seq	Carbon Dioxide sequestered annually in trees
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)

The land use was divided in ten different categories. Trees (Tr), Shrub (Sh), Lawn (Lw), Ground (Gw), Building (Bu), Parking lot (Pl), Street (St), Driveway (Dw), Other impervious (Imp), and Water (Wa). Vegetation more than two meters in height was classified as trees. Vegetation 2 meters or less in height was assumed to be shrubs. Grass, ballfields, athletic turf, and any mowed areas were classified as lawn. The ground classification included bare ground, mulched beds, and unmaintained porous surfaces. Any raised structures including houses, garages, and sheds were considered buildings. Parking lots included any improved parking space, made from asphalt or crushed stone. Streets, roads, and paved airstrips were classified as Street. Other impervious consisted of any impervious surface that didn't fit the previous classifications. Some examples include: artificial turf, sports courts, train tracks, and walkways. Water included rivers, small water courses, and lakes.

To delineate the area of study, we obtained an ESRI polygon shapefile of each city's boundary with the accurate coordinates of latitude and longitude. The geographic coordinate system WGS 1984 was used. For the city of Morgantown, the polygon shapefile was provided by the City Engineer of Morgantown. This shapefile required a conversion from NAD 1983 projection to the WGS 1984. This conversion was completed using ESRI's ArcGIS. The remaining cities' boundaries were obtained from the Urban Natural Resources Institute [UNRI] assessment of 2010. Through UNRI database it is possible to find the boundaries of most cities and towns in West Virginia. Yet, since all the boundaries are stored in a single shapefile, it was necessary to extract the boundary of each city and town and convert the shapefiles from NAD 1983 UTM Zone 17N projection to WGS 1984. Again, the conversions were completed using the ArcGIS program.

For the Romney and the WVSU campus, a polygon was created within the i-Tree software using a Google Maps overlay with the campus boundary and city limit boundary. This was necessary due to the lack of an accurate shapefile to capture the area of interest.

Once the area of interest was established in i-Tree, several variables needed to be configured within the program. The state, county, and whether the area was urban or rural were entered into the program. Since our area of interest was within city limits, urban was used for all sampling. All cities were in West Virginia, so the only changing variable was "county".

The aerial photographs used in this study from Google Maps vary by date. For each city, i-Tree google maps imagery were compared to the most recent images on Google Earth Pro to be sure the most recent imagery was being analyzed. Some of the images of the cities assessed are composed of more than one aerial photograph, taken on different dates. This can influence the classification of cover types. Other factors that influence classification were resolution of the imagery and season. Leaf on imagery is preferred for this type of analysis. Imagery from late fall and winter led to some issues at the classification level of randomized points generated in i-Tree. These issues arose from lack of leaves on trees, misleading dry lawn areas, and snow cover. For these cases the judgment of the interpreter was used to determine which kind of land cover most represented the point to be classified.

The Google Maps imagery for some areas offered a 45° aerial view. This resource allowed clarification of cover type when the 90° aerial photograph was not clear. This was useful when the aerial photograph had some resolution problems, or when the point was located in the shade. In places where the 45° aerial view was not available, the judgment of the interpreter was used to determine the land cover. In cases of doubt, decision making was based mostly on the cover of the surrounding area and observed land cover patterns.

The number of sampling points necessary in a study to obtain a good estimate of land cover type is determined by the researcher. We selected a 5% standard error for our study. To determine the number of sample points, a comparison between the results obtained from 500 sample points and 1000 sample points for the city of Morgantown. Both sampling levels achieve 5% standard error target, and no appreciable differences was found in the results. As such we select 500 sampling points for the communities in this study.

Results

Of the 16 communities analyzed the following results concerning the cover classes were obtained (table 3). Tree canopy coverage ranged from 57.0% in Bluefield to 23.6% in Williamstown. Shrub cover ranged from 5.7% in Morgantown to 0.4% in Elkins. Lawn cover ranged from 35.8% in Lewisburg to 8.4% in Hinton. Ground cover ranged from 7.2% in Lewisburg to 1.6% in the cities of Hinton and Vienna. Building cover ranged from 16.7% in WVSU and 16.2 in Bath to a low of 4.0% in Harpers Ferry. Parking lot cover ranged from 14.7% in WVSU and 7.2% in Vienna to a low of 0.8% in Harpers Ferry and Ronceverte. Street cover ranged from 11.6% in Bath to 3.6% in Harpers Ferry. Driveway cover ranged from 4.6% in Bath to 0.4% in Wheeling. The percentage of other impervious surfaces ranged from 13.6% in Follansbee to 1.6% in Lewisburg and Vienna. The total impervious surface (building, parking street, driveway, other impervious) percentage ranged from 45.2% in WVSU and Bath to 12.6% in Harpers Ferry. Water cover ranged from 2 % in Hinton to zero percent in Vienna and Bath.

When considering the area that each cover class occupies in every city, the results often vary with the size of the city or town (table 4). Tree cover varied from a low of 17 acres at WVSU and 62.8 acres in Bath to a high of 4429.8 acres in Wheeling. Shrub cover varied from 1.9 acres in Bath to 371.6 acres in Morgantown. Lawn cover varied from 22.2 acres in Bath to 2,457.7 acres in Parkersburg. Ground cover varied from 4.3 acres in Bath to 513.5 acres in Huntington. Building cover varied from 15.8 acres in Harpers Ferry to 1,335.9 acres in Huntington. Parking lot cover varied from 3.2 acres in Harpers Ferry to 417.09 acres in Parkersburg. Streets cover varied from 2 acres in WVSU and 14.2 acres in Harpers Ferry to a high of 1,028.1 acres in Huntington. Driveway cover varied from 2.0 acres in WVSU and 3.7 acres in Harpers Ferry to a high of 208.9 acres in Parkersburg. The cover from other impervious varied from 5.9 acres in Bath to 513.5 acres in Huntington. The amount of water varied from zero acres in Bath and Vienna to 1,498.52 acres in Huntington.

The largest city analyzed was Huntington with 11,616.5 acres as opposed to Bath, the smallest town with only 154 acres, and the WVSU campus was estimated to be 102 acres (Table 1). According to the 2010 Census, Huntington was the most populated city surveyed with 49,138 inhabitants, and the least populated was Harpers Ferry, with only 286 inhabitants.

The environmental benefits that tree canopy can provide for each city were determined by i-Tree Canopy calculations, based on standard values at the application level for each county in the United States, and the percentage of tree cover related with the total area of each city and town. The application gives the amount of each substance removed annually and the monetary value of this contribution to the city. This study estimated that the urban forests that are part of the TCUSA program provide annual ecosystem services of $6,441,179 by capturing 4,348,592 pounds of pollutants. The trees that make up these urban forests have sequestered an estimate 2,847,190 tons of carbon thus providing a benefit of $53,308,328. The most significant amount for pollution removal was for carbon storage (CO_2stor) that reaches 548,745.3 T in Wheeling, providing a benefit of $10,832,400.4 annually to the city.

The Carbon Monoxide (CO) removed annually ranged from 29.2 lb ($0.35) in Bath, to 2,803.4 lb ($2,803.4) in Wheeling (table 5). The Nitrogen Dioxide (NO_2) removed annually ranged from 204.5 lb ($2.27) in Bath, 33,1201 lb ($6,706.5) in Wheeling. The Ozone (O_3) removed annually ranged from 2,360.0 lb ($146.00) in Bath to 171,780 lb ($212,960.82) in Wheeling. The Particulate Matter less than 2.5 microns (PM2.5) removed annually ranged from 23.65 lb ($432.91) in Ronceverte, to 14,040 lb ($744,996.61) in Wheeling. The Sulfur Dioxide (SO_2) removed annually ranged from 153.7 lb ($0.60) in Bath to 22,940 lb ($1,574.74) in Wheeling. The Particulate Matter greater than 2.5 microns and less than 10 microns (PM10*) removed annually ranged from 288.3 lb ($16.40) in Bath to 78,820 lb ($246,158.97) in Huntington. The Carbon Dioxide (CO_2seq) sequestered annually ranged from 248.7 lb ($4,816.00) in Bath to 17,532.2 lb ($339,480.94) in Wheeling (tables x and y). Finally, the Carbon Dioxide (CO_2stor) stored in trees ranged from 7,936.3 lb ($153,672.51) in Bath to 559,428.4 lb $10,832,400.36) in Wheeling.

Table3. Estimated percent (%) of cover class derived from i-Tree Canopy. Total impervious (total imp.) was derived by adding % cover for buildings, parking lots, streets, driveways and other impervious (other imp.).

City	Tree	Shrub	Lawn	Ground	Building	Parking lot	Street	Driveway	Other Imp.
Bath	40.8	1.2	14.4	2.8	16.2	4.6	11.6	4.6	3.8
Bluefield	57	2	16.6	4.4	5	2.8	5.8	1.6	4.6
Elkins	32.4	0.4	29.4	5.8	10.6	4.8	9.6	3.4	2.8
Follansbee	32.4	3.4	15.6	6.8	7.4	2	5	2.2	13.6
Harpers Ferry	56.2	1.8	14.2	2.2	4	0.8	3.6	0.8	3.4
Hinton	49.5	1.2	8.42	1.6	4.41	1.4	3.81	1.6	5.01
Huntington	34.6	0.96	17.7	4.42	11.5	3.08	8.85	1.54	4.42
Lewisburg	33.2	2	35.8	7.2	5.8	4.6	7.6	1.8	1.6
Morgantown	37.3	5.7	23.3	3.3	10.3	5.3	6.9	1.6	3.5
Parkersburg	25.5	4.41	30.7	4.41	11.8	5.21	9.22	2.61	3.41
Romney	40.8	2	25.2	2	11	6.8	8.4	2	1.8
Ronceverte	53.8	1.6	20.2	3.2	5.2	0.8	6	2.2	5.6
Shepherdstown	45.6	1.4	15.4	3.2	13	5.8	8.2	1.8	4.4
Summersville	45	5.4	23.4	4.6	6.2	4.6	7.2	0.8	1.8
Vienna	36.2	1.2	26.2	1.6	15.6	7.2	8.4	2	1.6
Wheeling	43.8	3.4	16.4	2	7.8	3.6	7.2	0.4	2.6
Williamstown	23.6	1.6	22.8	4.8	9.2	3.2	6.4	2.6	4

Table 4. Estimated number of acers for each cover class, derived from i-Tree Canopy.

City	Tree	Shrub	Lawn	Ground	Building	Parking lot	Street	Driveway	Other Imp.	Water	Total
Bath	62.8	1.9	22.2	4.3	25.0	7.1	17.9	7.1	5.9	0.0	154.0
Bluefield	3,186.2	111.8	927.9	246.0	279.5	156.5	324.2	89.4	257.1	11.2	5,589.8
Elkins	646.0	8.0	589.8	116.4	212.6	96.3	192.6	68.2	56.2	16.1	2,006.1
Follansbee	432.8	45.4	208.4	90.8	98.9	26.7	66.8	29.4	181.7	155.0	1,336.0
Harpers Ferry	221.4	7.1	55.9	8.7	15.8	3.2	14.2	3.2	13.4	51.2	394.0
Hinton	963.0	23.4	163.8	31.1	85.8	27.2	74.1	31.1	97.5	447.5	1,945.5
Huntington	4,019.3	111.5	2,056.1	513.5	1,335.9	357.8	1,028.1	178.9	513.5	1,498.5	11,616.5
Lewisburg	809.1	48.7	872.5	175.5	141.4	112.1	185.2	43.9	39.0	9.8	2,437.1
Morgantown	2,431.7	371.6	1,519.0	215.1	671.5	345.5	449.8	104.3	228.2	182.5	6,519.2
Parkersburg	2,041.4	353.0	2,457.7	353.0	944.7	417.1	738.1	208.9	273.0	225.0	8,005.5
Romney	250.7	12.3	154.8	12.3	67.6	41.8	51.6	12.3	11.1	0.0	614.4
Ronceverte	503.6	15.0	189.1	30.0	48.7	7.5	56.2	20.6	52.4	13.1	936.1
Shepherdstown	93.1	2.9	31.4	6.5	26.5	11.9	16.7	3.7	9.0	2.5	204.1
Summersville	1,220.0	146.4	634.4	124.7	168.1	124.7	195.2	21.7	48.8	27.1	2,711.0
Vienna	881.3	29.2	637.8	39.0	379.8	175.3	204.5	48.7	39.0	0.0	2,434.4
Wheeling	4,429.8	343.9	1,658.6	202.3	788.9	364.1	728.1	40.5	263.0	1294.5	10,113.6
Williamstown	264.4	17.9	255.5	53.8	103.1	35.9	71.7	29.1	44.8	244.3	1,120.4

Table 5. Annual ecosystem services of urban trees, list as both estimated monetary value and estimated amounts in pound (lbs) except sequestered and stored CO2 values which are presented are in tons. Data was derived from iTree Canopy.

		CO	NO2	O3	PM2.5	SO2	PM10	CO2seq**	CO2stor**
Bath	Value ($)	0.35	2.27	146.00	319.82	0.60	16.40	4,816.00	153,672.51
	SE	0.02	0.12	7.87	17.23	0.03	0.88	259.44	8,278.32
	Amount (lb)	29.2	204.5	2,360.0	118.7	153.7	288.3	248.7	7,936.3
	SE	1.6	11.0	120.0	6.4	8.3	15.5	13.4	427.5
Bluefield	Value ($)	1,027.62	2,606.12	202,107.71	552,624.01	1,389.35	53,525.76	244,335.08	7,796,418.19
	SE	39.92	101.23	7,850.45	21,465.53	53.97	2,079.10	9,490.69	302,835.60
	Amount (lb)	1,546.7	13,060.0	147,260.0	11,000.0	22,160.0	17,140.0	12,618.4	402,638.1
	SE	60.1	500.0	5,720.0	420.0	860.0	660.0	490.1	15,639.6
Elkins	Value ($)	199.95	686.71	33,108.20	86,931.04	160.98	16,615.67	49,823.92	1,589,817.12
	SE	12.92	44.36	2,138.71	5,615.53	10.40	1,073.33	3,218.50	102,698.24
	Amount (lb)	301.0	2,800.0	25,760.0	1,703.2	2,640.0	5,320.0	2,573.1	82,104.5
	SE	19.4	180.0	1,660.0	110.0	180.0	340.0	166.2	5,303.8
Follansbee	Value ($)	273.91	455.54	17,956.49	73,737.67	248.60	11,829.65	33,169.58	1,058,398.73
	SE	17.69	29.43	1,159.94	4,763.27	16.06	764.17	2,142.67	68,369.93
	Amount (lb)	412.3	2,600.0	14,820.0	1,393.2	3,880.0	3,780.0	1,713.0	54,659.9
	SE	26.6	160.0	960.0	90.0	260.0	240.0	110.7	3,530.9
Harpers Ferry	Value ($)	115.35	165.23	6,793.23	16,723.55	27.61	3,662.80	16,969.48	541,474.36
	SE	4.55	6.52	268.20	660.26	1.09	144.61	669.97	21,377.74
	Amount (lb)	173.6	892.2	9,460.0	517.7	610.9	1,172.8	876.4	27,963.9
	SE	6.9	35.2	380.0	20.4	24.1	46.3	34.6	1,104.0
Hinton	Value ($)	323.47	1,267.38	87,367.85	242,619.58	677.00	29,065.75	73,843.01	1,178.12
	SE	14.63	57.31	3,950.51	10,970.52	30.61	1,314.27	3,338.96	106,541.84
	Amount (lb)	486.9	3,400.0	37,460.0	2,580.0	5,920.0	9,300.0	3,813.6	121,685.4
	SE	22.0	160.0	1,700.0	120.0	260.0	420.0	172.4	5,502.3
Huntington	Value ($)	2,515.23	3,921.57	210,105.72	700,883.71	1,107.95	246,158.97	308,278.68	9,836,776.26
	SE	151.59	236.35	12,663.08	42,242.29	66.78	14,836.01	18,579.97	592,862.97
	Amount (lb)	3,780.0	17,500.0	149,520.0	12,380.0	19,020.0	78,820.0	15,920.7	508,010.4
	SE	220.0	1,060.0	9,020.0	740.0	1,140.0	4,760.0	959.5	30,617.8
Lewisburg	Value ($)	263.96	529.97	28,630.68	698.73	46.93	24,396.61	62,039.57	1,979,603.01
	SE	16.74	33.62	1,816.21	44.32	2.98	1,547.62	3,935.53	125,577.63
	Amount (lb)	397.3	2,820.0	27,720.0	38.0	931.2	7,820.0	3,204.0	102,234.6
	SE	25.2	180.0	1,760.0	2.4	59.1	500.0	203.3	6,485.3
Morgantown	Value ($)	1,755.82	2,070.14	67,285.39	121,346.61	385.26	67,962.20	192,550.91	6,144,051.90
	SE	71.99	84.87	2,758.67	4,975.16	15.80	2,786.42	7,894.51	251,903.52
	Amount (lb)	2,640.0	11,360.0	85,820.0	4,980.0	8,780.0	21,760.0	9,944.1	317,303.4
	SE	100.0	460.0	3,520.0	200.0	360.0	900.0	407.7	13,009.3
Parkersburg	Value ($)	1,404.89	618.75	54,870.34	94,414.83	845.49	65,065.44	156,173.91	4,983,308.69
	SE	107.64	47.41	4,203.94	7,233.68	64.78	4,985.05	11,965.42	381,801.06
	Amount (lb)	2,120.0	4,140.0	67,700.0	3,760.0	20,280.0	20,840.0	8,065.4	257,357.9
	SE	160.0	320.0	5,180.0	280.0	1,560.0	1,600.0	617.9	19,717.7

Table continued

	Abbr.	CO	NO2	O3	PM2.5	SO2	PM10	CO2seq**	CO2stor**
Romney	Value ($)	138.86	172.43	8,724.85	23,207.59	62.93	7,260.67	33,564.10	1,071,115.70
	SE	8.12	10.09	510.44	1,357.74	3.68	424.78	1,963.63	62,664.48
	Amount (lb)	209.0	952.3	8,480.0	582.3	1,185.4	2,320.0	927.6	29,599.9
	SE	12.2	55.7	500.0	34.1	69.4	140.0	54.3	1,731.7
Ronceverte	Value ($)	164.30	329.87	17,820.51	434.91	29.21	15,185.11	38,615.11	1,232,158.36
	SE	6.81	13.67	738.52	18.02	1.21	629.31	1,600.30	51,063.59
	Amount (lb)	247.3	1,758.9	17,260.0	23.7	579.6	4,860.0	1,994.2	63,633.6
	SE	10.3	72.9	720.0	1.0	24.0	200.0	82.7	2,637.1
Shepherdstown	Value ($)	48.49	69.46	2,855.77	7,030.32	11.61	1,539.78	7,133.71	227,627.49
	SE	2.37	3.39	139.49	343.41	0.57	75.21	348.46	11,118.77
	Amount (lb)	73.0	375.1	3,980.0	217.6	256.8	493.0	368.4	11,755.6
	SE	3.6	18.3	200.0	10.6	12.6	24.1	18.0	574.2
Summersville	Value ($)	339.99	726.30	46,552.75	103,701.30	366.68	34,390.15	93,530.18	2,984,427.66
	SE	16.81	35.91	2,301.63	5,127.13	18.13	1,700.29	4,624.26	147,554.05
	Amount (lb)	511.7	3,700.0	41,620.0	2,520.0	6,760.0	11,020.0	4,830.3	154,127.8
	SE	25.3	180.0	2,060.0	120.0	340.0	540.0	238.8	7,620.3
Vienna	Value ($)	607.64	267.62	23,732.26	40,835.85	365.69	28,141.79	67,547.59	2,155,356.81
	SE	36.08	15.89	1,409.00	2,424.45	21.71	1,670.79	4,010.34	127,964.71
	Amount (lb)	914.6	1,793.9	29,280.0	1,622.0	8,760.0	9,020.0	3,488.4	111,311.2
	SE	54.3	106.5	1,740.0	96.3	520.0	540.0	207.1	6,608.6
Wheeling	Value ($)	2,803.38	6,706.52	212,960.82	744,996.61	1,574.74	189,587.81	339,480.94	10,832,400.36
	SE	142.01	339.74	10,788.12	37,739.87	79.77	9,604.10	17,197.35	548,745.29
	Amount (lb)	4,220.0	33,120.0	171,780.0	14,040.0	22,940.0	60,700.0	17,532.2	559,428.4
	SE	220.0	1,680.0	8,700.0	720.0	1,160.0	3,080.0	888.1	28,339.4
Williamstown	Value ($)	182.32	80.30	7,120.81	12,252.71	109.72	8,443.88	20,267.51	646,710.23
	SE	14.67	6.46	572.97	985.91	8.83	679.44	1,630.82	52,037.38
	Amount (lb)	274.4	538.3	8,780.0	486.7	2,640.0	2,700.0	1,046.7	33,398.7
	SE	22.1	43.3	700.0	39.2	220.0	220.0	84.2	2,687.4
WVSU Campus	Value ($)	9.57	11.89	601.41	1,599.71	4.34	500.48	2,313.59	73,832.55
	SE	1.39	1.72	87.15	231.82	0.63	72.53	335.27	10,699.35
	Amount (lb)	14.4	65.6	584.5	40.1	81.7	160.3	63.9	2,040.3
	SE	2.1	9.5	84.7	5.8	11.8	23.2	9.3	295.7

**Sequestered/Stored CO2 values presented are in tons

Table 6. Estimated total carbon stored in trees, amounts derived from iTree Canopy.

City	Amount (tons)	Value ($)
Bath	7,936	153,673
Bluefield	402,638	7,796,418
Elkins	82,105	1,589,817
Follansbee	54,660	1,058,399
Harpers Ferry	27,964	541,474
Hinton	121,685	1,178
Huntington	508,010	9,836,776
Lewisburg	102,235	1,979,603
Morgantown	317,303	6,144,052
Parkersburg	257,358	4,983,309
Romney	29,600	1,071,116
Ronceverte	63,634	1,232,158
Shepherdstown	11,756	227,627
Summersville	154,128	2,984,428
Vienna	111,311	2,155,357
Wheeling	559,428	10,832,400
Williamstown	33,399	646,710
WVSU Campus	2,040	73,833
TOTAL:	2,847,190	$53,308,328

Table 7. Estimate annual pollution removal benefits. The values were obtained by summing the annual benefits (CO, NO^2, O^3, $PM_{2.5}$, PM_{10}, CO^2_{Seq}) calculated by i-Tree Canopy.

City	Benefit ($)
Bath	5,301
Bluefield	1,057,616
Elkins	187,526
Follansbee	137,671
Harpers Ferry	44,457
Hinton	435,164
Huntington	1,472,972
Lewisburg	116,606
Morgantown	453,356
Parkersburg	373,394
Romney	73,131
Ronceverte	72,579
Shepherdstown	18,689
Summersville	279,607
Vienna	161,498
Wheeling	1,498,111
Williamstown	48,457
WVSU Campus	5,041
TOTAL:	$6,441,179

Individual City / Town

Bath

The town of Bath, also known as Berkley Springs, is located in the eastern panhandle of West Virginia, in Morgan County. The geographic coordinates are 39°37'37" N & 78°13'37" W. According to the United States Census Bureau, the town of Bath had a population of 624 people at the year 2010. The analyzed area of the town was 154.01 acres. The Google maps imagery used for sampling was taken September, 23 of 2013. The town of Bath has been a Tree City USA since the year 2005.

At the level of Morgan County, it was not possible to select just the urban area to calculate the benefits that tree cover provide, so the results about pollution removal at town level might be underestimate.

A number of concerns arose during the work with iTree Canopy during the project. The ecosystem services calculated for the town of Bath (Berkley Springs) are considerably low (table 5). While these low values are in part due to the geographical size of the town (154 acres, table1), it is still only half the size of Harpers Ferry (394 acres) and larger than the WVSU campus (102 acres). These low numbers are most likely a result that the input values for the ecosystem services were from rural and not urban values. Urban areas provide the most valuable benefits per area in the software, as it is assumed more pollutants are produced in urban than in rural areas. Utilizing rural values decreases the importance of the pollutant removal provided by the trees at the city level. It is important to note that Bath has a strong canopy coverage (40.8%, table 3) and to realize that the ecosystem services are likely underestimate of the true value of the urban forest in Bath.

Bluefield

The city of Bluefield is located at the Mercer County, in the New River / Greenbrier Valley, in the southern part of the state. Bluefield is a city with 10,447 people according to 2010 Census data. The city is located at coordinates 37°15'41" N & 81°12'59" W. The area of Bluefield used to calculate the cover type was 5,589.81 acres. The city of Bluefield has been a Tree City USA since 1994.

The Google Maps imagery used for point sampling was taken on November, 09 of 2013. Since this image were taken at late fall/early winter, some environmental aspects might have influences on the analysis and classification of points. The trees were in leaf off condition, so the canopy cover might underestimate the true canopy cover. Also some areas that would be classified as lawn in summer time have a greater probability of being underestimated and classified as ground. In these cases, the interpreter best judgment was used to make the decision on cover type.

Elkins

The city of Elkins is located in the Potomac Highlands, in Randolph County. Elkins had, in 2010, when the Census were taken a population of 7,094 people. The study area for Elkins was 2,006.05 acres located at 38°55'33" N & 79°50'78" W. The city of Elkins has been a Tree City USA since 2008.

The imagery used on Google Maps to analyze this city was taken on November, 13, 2013. There was snow cover on the ground a trees were in leaf off condition in imagery. These factors likely impacted sampling point classification. The tree cover might be underestimated, and the cover at ground level had to be classified with the judgment of the interpreter, considering the surrounding area and the experience acquired with the previous classifications

Follansbee

The city of Follansbee had 2,986 inhabitants in 2010, according to the Census Bureau. Follansbee is in Brookes County, in the Northern Panhandle on the Ohio river. Follansbee is on the border with Ohio. Its geographic coordinates are 40°19'39" N & 80°35'45" W. The area considered to be the city of Follansbee comprises 1,335.93 acres. The imagery used from Google Maps is from May, 16, 2012. Follansbee has been a Tree City USA since 1995.

Follansbee had a largest area of land cover classified as 'other impervious' (13.6 %) This is due to the presence of the Follansbee Plant and the Wheeling-Pittsburgh Steel, which covers most of the west side of the city. The Ohio River, which separates the state of West Virginia from the state of Ohio, pass through the limits of Follansbee, and represents most of the area covered by water (10.17%).

Harpers Ferry

The town of Harpers Ferry is in Jefferson County, at the Eastern Panhandle of the state. Harpers Ferry is a small town of 393.93 acres and 286 inhabitants in 2010, according to the Census data. Its geographic coordinates are 39°19'11" N & 77°44'19" W. Harpers Ferry is located at the West Virginia, Maryland and Virginia borders. The imagery provided by Google Maps of the town of Harpers Ferry was taken May 25, 2013. Harpers Ferry was chosen for this study because it is one of the Tree City USA in the state. Harpers Ferry has been a Tree City USA since 2008.

About 13% of this area is cover by water. Most of this is represented by the Shenandoah River. Also, Harpers Ferry has more than half of its cover composed by trees, 56.2 %.

Hinton

Hinton is a city Summers County, located in the New River / Greenbrier Valley. The geographic coordinates of the city are 37°40’26” N to 80°53’21” W. Hinton had a population of 2,676 people in 2010, according to the Census. Of the 1,945.51 acres surveyed in Hinton, about 23% of its cover is water. Much of this is due to the presence of the New river, which covers the entire east side of the city area. Hinton has been a Tree City USA since 2000.

The Google Maps imagery of Hinton was from two different dates. The northern part of the city was taken September 05, 2013. The central and southern part, (the majority of the city) is from November 08, 2013. There are canopy differences as a result of the different image dates. The first image presents a very green cover, in contrast with the second one, where the trees were without leaves. This factor might influence land classification which may underestimate tree canopy results.

Huntington

Huntington is in Cabell County, in the Metro Valley, which makes the division between West Virginia and the state of Kentucky with the Ohio River. The city of Huntington is one of the first cities to have received the title of Tree City USA in the state. Huntington has been a Tree City USA since 1990.

Huntington, which geographic coordinates are 38°25’09” N & 82°26’42” W, had a population of 49,138 in 2010, making it one of the most populated cities at West Virginia. The area surveyed at the city of Huntington was 11,616.46 acres.

The Google Maps imagery of this area was taken on April 14, 2011. This is the oldest image used in this study. However, the Huntington imagery also featured 45 degree views available in the i-Tree program. This diagonal view is very useful in case of shade, low image resolution, or when there are possible doubts at the classification level. The point would be classified based on the 90-degree image, and 45 degree imagery was used for clarification. In some instances, the 45-degree view offered distortions or inaccurate imagery.

The cover area of Huntington is greatly influenced of the Ohio River, which represents most of the 12.9% of the area classified as water cover.

Lewisburg

Lewisburg is in Greenbrier County, in the New River / Greenbrier Valley. Lewisburg is a city with 3,830 inhabitants in 2010 and encompasses a 2,437.07 acre area. It is located at 37°48'06" N & 80°26'42" W. Lewisburg has been a Tree City USA since 2002.

The classification of the cover type of Lewisburg was made based on Google Imagery from November 13, 2013. At this date, the deciduous trees were without leaves, which made the classification of the cover type on this city more difficult than others.

At the input data set given by i-Tree Canopy application at the PM2.5 annually removed the default values are negative, it can be explained by the weather conditions at the moment of measurement of hourly values for PM2.5.

Morgantown

Morgantown is a city home of the West Virginia University, in Monongalia County, with geographic coordinates of 39°37'46" N & 79°57'21" W. The study area for Morgantown was 6,519.24 acres. The total population according to the United States Census Bureau in 2010 was 29,660 permanent residents. In addition to permanent residents, Morgantown has a large student population. Fall 2013 enrollment was 29,707 students. Morgantown has been a Tree City USA since 1997.

The Google Maps aerial photography used by i-Tree Canopy to classify land cover of Morgantown was from June 09, 2013. For most of Morgantown area, Google Maps also provided a 45-degree option of view, which was very useful for clarification of points in shady areas.

In 2004, a study using i-Tree Eco was conducted by Nowak *et al*. (2012) utilized 136 one-tenth acre field plots to measure the urban canopy structure. The number of trees was estimated to be 658,000 trees, covering 35.5 % of Morgantown's urban area, with a tree density of 119.2 trees/acre. The tree most common species were sugar maple (14.9 %), black cherry (7.9 %) and hawthorn (4.8 %).

Comparing the 2004 inventory with data from the current study, suggests that the urban forest in Morgantown might be increasing, from 35.5% in 2004 to 36.8%. Yet the variation in the 2013 estimate (standard error = 2.16%) eclipses the 2004 estimate. Hence it will be important to conduct similar estimates in the future to determine if the trend is holds, especially with all the added development pressure that continues to take place.

In 2011, the city of Morgantown, through the Urban Landscape Commission and the Morgantown Tree Board, assisted by the USDA Forest Service, conducted a street tree inventory. This inventory utilized both i-Tree Streets and i-Tree Canopy and found that there were 1,315 street trees (Cummings 2011). Maples (3 species), comprised 18.48 % of the Morgantown street tree population, plum (6.80 %) and Norway spruce (5.17 %). The tree canopy cover was estimated to be 33% of municipal land.

The benefits provided by trees were calculated in all the three studies using the same calculation method, which is provided by i-Tree software, and uses the same source of

default values for benefits calculations. However, the study made in 2011 only calculated benefits from street trees using i-Tree Streets, leaving aside areas where trees are not at the roadside such as: parks, forests, arboretum and private property. Those areas are places where trees are more concentrated and have great influence on the pollutant removal estimates. So the estimates observed in the year of 2011 are not compared with 2004 and 2013 data in this report.

Comparing the analysis made in 2004 and 2013 it can be observed that the Air quality, represented by the annual reduction in air pollutants (CO, O_3, NO_2, SO_2, and Particulate matter less than 10 microns, includes the PM10 and PM2.5 in the study of 2013), the values changes from US$711,000.00, from removal of 104 tons of pollutants per year in 2004, to US$260,805.42, from 67.67 tons of pollutants removed in 2013, representing a decreasing on the estimates through the years.

Annual carbon sequestration rates increased from 2,900.00 tons/year($60,000,000/year) removed in 2004, to US$192,550.91, of 9,944.10 tons/year ($192,551/year) in 2013.The values estimated for CO_2 storage move from, of 93,000 tons ($1,900,000) of carbon stored in the trees in 2004, to 317,303.36 tons ($6,144,052) of CO_2 stored in 2013. The CO_2 storage is not an annual value; it is the accumulation of the carbon dioxide absorbed by trees for growth.

Parkersburg

Parkersburg is a city in the eastern part of the state, in the Mid-Ohio Valley in Wood County. Parkersburg had 31,472 inhabitants in 2010 with 8,005.49 acres of area. The geographic coordinates are 39°`16’00” N & 81°33’45” W and is at the border with Ohio. The city of Parkersburg has been a Tree City USA since 1998.

Google Maps imagery was from October 9, 2013. For this city, the Google Maps provide the 45 degree ground view, which helped clarify ground cover classification.

Romney

Romney is a city in Hampshire county located at 39°20’42” N & 78°45’25” W with a population of 1848 according to the 2010 census. Imagery used was from May 25, 2013.Most recently Romney has been a Tree City USA since 2016. Romney covers 614.4 acres.

Ronceverte

Ronceverte is a city of 1,765 inhabitants, according to 2010 Census data. Ronceverte is in Greenbrier county, at the New River / Greenbrier Valley, and its geographic coordinates are 37°44'59" N & 80°27'46" W. Ronceverte is a Tree City USA since 2001.

The area analyzed from the city of Ronceverte was 936.06 acres. The aerial images available for cover type classification in i-Tree is from November 13, 2013. In late fall, vegetation was showing signals of the coming winter. The trees were without leaves and the lawn was not as green as it used to be in summer, when compared with earlier Google earth images. Lawn cover may be underestimated and ground cover may be over represented for this reason.

As with the city of Lewisburg, Ronceverte presented a negative value to the parameter PM2.5 removed annually, caused by climate adverse conditions at the time of the imagery was captured.

Shepherdstown

Shepherdstown is one of the smallest towns in this study. At ony 204.10 acres, it is only larger than the town of Bath. At the coordinates 39°25'48" N & 77°48'14" W, Shepherdstown is a town in Jefferson County, in the Eastern Panhandle, forming the West Virginia Maryland border. According to the 2010 Census, Shepherdstown had a population of 1,734 habitants, which is the latest official data. The images captured from the Google Maps used on the i-Tree application is from May 25, 2013. Shepherdstown has been a Tree City USA since 2001.

Summersville

Summersville, in Nicholas County, is settled at the region of Mountain Lakes. The geographic coordinates of this town is 38°16'52" N & 80°51'09" W. The population in the year of 2010 was 3,572. The town of Summersville has been a Tree City USA since 2008.

The area analyzed in the town of Summersville was 2,710.98 acres. The images provided from Google Maps used for the i-Tree Canopy application was from two different dates. The first image, that cover the extreme north part of the area was taken on October 17, 2011. The second one, which cover most of the city is from September 06, 2013. The older image had lower resolution, making precise classification more difficult. The classification of some points was made according to the surrounding area and the previously observed patterns of cover type.

Vienna

The city of Vienna, in the Mid-Ohio Valley, is settled in Wood county. Vienna is at north side of Parkersburg and also forms the border of West Virginia and Ohio, at coordinates 39°19’37” N 81°32’54” W. Vienna had a population of 10,749 habitants in 2010, according to the Census Bureau. The area surveyed in the city of Vienna was 2,434.39 acres. Google Maps provided city 90 degree aerial images taken on October 09, 2013, as well as 45 degree images. Vienna has been a Tree City USA since 1998.

West Virginia State University Campus

West Virginia State University is a historically black public university in Charleston WV. It’s coordinates are 38°22’57” N & 81°45’56” W. WVSU had 2847 students according to fall 2014 enrollment data. The imagery used was from November 15, 2014. There appeared to be large areas on the western part of campus under construction at the time the photographs were taken. This may lead to land cover data that may not be applicable today in some places. It may have increased ground and other impervious counts and decreased true building counts. WVSU has been a Tree Campus USA since 2013 and is the first campus to earn this honor in West Virginia.

Wheeling

Wheeling is the only city in this study that is not a Tree City USA, yet this analysis was conducted as the city is interested in joining the TCUSA program. Wheeling is a city with 28,486 people as of 2010, in Ohio County, in the Northern Panhandle. The geographic coordinates are 40°03’50” N & 80°43’15” W. The area of Wheeling analyzed in the study was 10,113.59 acres, the second largest area of study after Huntington. The images used from Google maps were taken on September 06, 2013.

Williamstown

Williamstown is a city in the Mid-Ohio Valley, in Wood County. This city borders the Ohio River, which has a great influence on the total area of this city. Its geographic coordinates are 39°24’02” N & 81°26’53” W. The study area in Williamstown used in this study is 1,120.43 acres. Williamstown had a population of 2,908 people in 2010. Williamstown is the first city in the state of West Virginia to receive the title of Tree City USA in 1984.

The images used to analyze the city of Williamstown was from two different dates. The east side of the city were analyzed with a imagery from June 04, 2013, and the west side of Williamstown was analyzed with photography from October 09, 2013.

Williamstown has water cover of 21.8%, most of this area is from the Ohio River that borders the northern side of the city.

Discussion

The study found that 11 of the TCUSA communities are meeting the goal of 35% canopy coverage (Table 3, including Huntington at 34.6%), 8 of those communities also clear the 40% canopy coverage goal (Table 3), with the remaining 5 below both targets (Elkins, Follansbee, Lewisburg, Parkersburg, and Williamstown). The latter two, (Parkersburg and Williamstown), fall below the goal of 35% canopy coverage by more than the 5% standard error we set for the study. Thus, this study would suggest that WV's TCUSAs fall into one of three catergories:

1. >= 40% Canopy Coverage
    - Budgeting primarily for maintenance, optimization and maximization of ecosystem services; with new plantings playing a secondary role.
    - Managing for Santamour's rule, removal of invasive species, staggered age distribution, equal access to urban forest resources across demographics, bolstering canopy coverage of 51% in riparian areas.

2. >=30%-<40% Canopy Coverage
    - Budgeting for both new plantings and maintenance of existing canopy.
    - Managing to obtain the goal(s) of 35% canopy coverage, followed by 40%, canopy coverage; while maintaining current canopy.

3. <30% Canopy Coverage
    - Budgeting primarily for establishment of new plantings and the creation of increased urban canopy; routine and emergency maintenance should be accounted for appropriately.
    - Managing for increased canopy coverage through achieving realistic, incremental, target canopy coverage goals (ex. towns name, will increase canopy coverage by 5% over the next ____ years .
    -

Furthermore, as emerald ash borer continues to move through West Virginia, existing canopy will suffer. As new satellite images become available, communities may wish to investigate the impact of EAB at the city level with a re-assessment using protocols from this baseline study.

Another concern was the satellite imagery used by Google Maps. The images for a given community are often composed of multiple satellite photographs, with some images being from different dates and/or resolutions which affect interpretation of sample points. While this is an inherent issue with remote sensed data, it is important to acknowledge. Another factor is the time of year the photos were taken. Some photographs, taken during the leaf off season, might result in estimation errors when the trees are in the dormant state (without leaves). We feel that the availability of the 45° aerial view tool improved the ability classify the cover type at a given sample point.

Conclusion

To review, many programs have been created to improve and maintain urban tree cover. Nowak and Greenfield (2012) cited the Million Trees NYC, Million Trees LA, as programs that plant large numbers of trees and protect existing trees. Cities like Pasadena CA, Chapel Hill NC, Seattle WA, and the state of Maryland have developed tree canopy goals. One of the longest running national programs dedicated to protecting and increasing urban canopy cover is the Tree City USA (TCUSA) administered by the Arbor Day Foundation in conjunction with each state urban forestry coordinator. TCUSA encourages cities to create and implement plans to meet these goals.

Enhancement of tree canopy cover requires a significant investment in urban forestry varies between cities. The decision to allocate funds for urban forest management is typically cost based to control expenditures while building better urban forests. The consequences of the investment made also plays heavily into the decision making process (McPherson *et al*. 2005). By emphasizing the importance of trees in the urban environment and monetizing tree benefits, a greater public interest and appreciation of urban trees can be achieved.

The analysis made in this study describe just a portion of the many benefits that trees within the urban environment provide to the community. In this study, the ecosystem services provided by trees were emphasized, but the urban forest can also influence the aesthetic value and psychological aspects of a community. Trees also yield good learning opportunities and bring inner peace to many people. When people close their eyes and think of a “nice” downtown landscape, trees are usually part of that mental image. Trees are multifunctional organisms living in an urban environment and need care, as all living organisms do. Active urban forestry management programs will ensure that city trees continue providing ecosystem services and improving the quality of life for all citizens.

References

Cumming, A. 2011. Street Trees of Morgantown. Structure, Management, and Benefits.

Hirabayashi, S. 2014. I-Tree Canopy Air Pollutant Removal and Monetary Value Model Descriptions. https://canopy.itreetools.org/resources/i-Tree_Canopy_Air_Pollutant_Removal_and_Monetary_Value_Model_Descriptions.pdf accessed 10-25-2016.

Manzo, J., G.A Dahle, R. Hannah. 2017. Assessing the effect of tree canopy stocking on home energy use savings during peak cooling months in West Virginia USA. International Journal of Horticulture and Floriculture 5:295-300

McPherson, G.; Simpson, J. R.; Peper, P. J.; Maco, S. E.; Xiao, Q. 2005. Municipal Forest Benefits and Costs in Five US Cities. Journal of Forestry. 411 – 416.

Nowak, D.J., S. Hirabayashi, A. Bodine and E. Greenfield. 2014. Tree and forest effects on air quality and human health in the United States. Environmental Pollution 193:119-129.

Nowak, D.J., R.E. Hoehn III, D.E. Crane, J.C. Stevens, J. Cumming, S. Mohen, A.B Cumming. 2012. Assessing urban forest effects nad values: Morgantown's urban forest. USDA FS Research Bulletin NRS-70.

Nowak, D. J.; Crane, D. E.; Stevens, J. C. 2006. Air Pollution Removal by Urban Trees and Shrubs in the United States. Urban Forestry & Urban Greening. 4: 115 – 123.

Nowak, D. J.; Greenfield, E. J. 2012. Tree and Impervious Cover Change in U.S. Cities. Urban Forestry & Urban Greening. 11: 21 – 30.

Nowak, D. J.; Greenfield, E. J. 2010. Evaluating the National Land Cover Database Tree Canopy and Impervious Cover Estimates Across the Conterminous United States: A Comparison with Photo-Interpreted Estimates. Environmental Management. 46: 378 – 390.