An Assessment of the Role Urban Trees Play in Modifying Weather in a City Park

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Abstract:

Trees and weather affect many aspects of our local environment. To assess the role trees play in modifying microclimates, an investigation was developed to measure the size (height and DBH) of over 120 trees at a local city park in Dearborn, Michigan. In addition, PASCO weather station was used to determine how the trees modified selective weather parameters in two separate locations within the park. The GLOBE Observer App was used to collect and submit data. With the help of a professional forester, trees were identified by common and scientific names for future research. Furthermore, we collected weather data such as wind speed, temperature, dewpoint and relative humidity using two PASCO Weather Sensors. This allowed us to collect data on the same atmospheric parameters at two different sites, located in Levagood Park. Site 1 was located in an area centered among a group of trees, while Site 2 was located in an open short grass field with no trees surrounding the area. Everyday two people would go to their respective site, set up their devices and begin recording simultaneously for approximately 15 minutes. After 15 minutes they would end their recordings at the same time. The data would later be entered into an Excel spreadsheet to make graphs and compare the two data sets. After analyzing the data, multiple correlations were found between them. The data showed several similarities and differences between the two sites. This research was made in hopes of showing that the data collected can be used to prove trees cause variations to atmospheric conditions. Although the data was collected during the winter when tree leaves had already fallen, we hope to continue our research during the active growing season of 2020 to compare the effects of the trees with leaves to the data we collected in the winter without leaves.

Research Questions:

(1) What changes do trees make in modifying atmospheric parameters, such as temperature, wind speed, and wind chill?

(2) What causes these parameters to be different or similar in the two sites?

(3) How noticeable are the differences in the select atmospheric parameters between the two sites?

Hypothesis:

If the amount of trees in an area plays a significant role in atmospheric conditions, then the site with surrounding trees will show a difference in atmospheric conditions when compared to the site with no trees.

Importance:

Trees are an important part of the environment around us. They help maintain ecosystem stability and provide many ecosystem services. Deforestation, logging, and other methods of tree removal can negatively affect the environment. Trees can be used to improve passive solar energy effects. During the warmer seasons, trees have leaves that provide shade for cooler temperatures. Also, trees during colder seasons lose their leaves allowing more sunlight to reach homes for warmer temperatures. Having more trees also reduces soil erosion as they use their roots to hold and stabilize surrounding soil. In addition, trees also reduce the impact of rain by slowing it down with their leaves before it reaches the soil. Tree cover loss has been a global issue and can still be seen spreading its impact. The World Wildlife Fund (WWF) statistics show

a great increase of tree cover loss since 2016. By using parameters such as temperature, dew point, and wind speed, they will aid us to prove whether or not trees affect the atmospheric condition in an environment.

Investigation Plan:

A group of students began their research on February 20, 2020 by measuring the height and circumference of more than one hundred and twenty trees. Each tree was measured using a clinometer and the GLOBE Observer app. Both measurements were compared and then submitted through the GLOBE Observer app along with the circumference. The students then began measuring wind speed, temperature, humidity and dew point at two different sites starting March 1, 2020. Each site recorded approximately 15 minutes of atmospheric conditions at the same time to prevent variations. The data was then inputted into the GLOBE database and organized into an Excel spreadsheet to compare the sites' results.

Introduction and Review of the Literature:

With the rapidly growing global population, there is an increased demand for lumber. This has caused artificial phenomenon such as deforestation to become a major deconstructing problem in today's wasteful society. According to the World Wildlife Fund, "We're losing 18.7 million acres of forests annually, equivalent to 27 soccer fields every minute". Consequently, natural benefits acting as anchors to our biosphere have been, subsequently, lost . While there are arrays of academic journals concerning the role of trees in a diversifying system, ranging from published articles about the topics of trees to the effects they have on the environment, we focused on studies within a locality. For instance, a peer-reviewed journal from Bodnaruk and

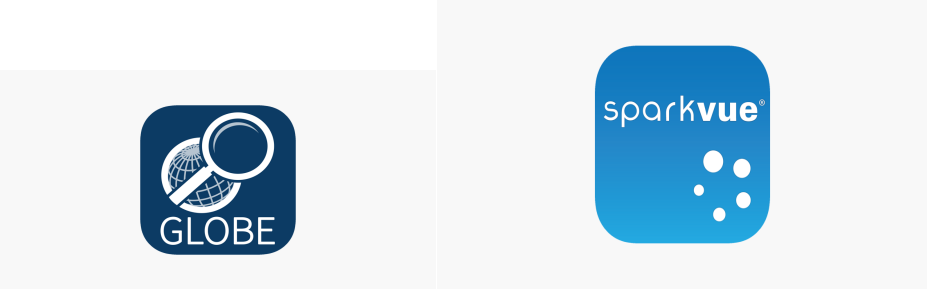
others addresses the benefits of trees in Baltimore, Maryland. Another peer-reviewed study alludes to the effects of trees in a park in Almada, Portugal. We hope to add to this area of study by researching our local park, offering much more comprehensive understanding of how trees affect the environment. Our studies will help set a path for future generations to improve our community by planting more trees. We can use our research to get the interest of our city and of deviating organizations to invest funds for further research opportunities, ultimately allowing us to better the number of vegetation (trees specifically) within our community.

Research methods and Materials:

Both of the two sites were picked in a suburban community, at a park named Levagood. The first site was an area surrounded by a group of trees. The second site was an open short grass field where we could test atmospheric parameters without the presences of any trees within a 15 meter range. We would measure the atmospheric parameters with a Pasco Weather Sensor. We had two Pasco machines and would take each one to their respective sites. Then they would start the Pasco Sensors at the same time, and leave them running for 15 minutes. We would be able to see the atmospheric parameters recorded in the app SPARKvue, which allowed us to compare the results of the two Pasco Sensors. We recorded 12 parameters using the Pasco Sensor. In addition to measuring atmospheric parameters, we measured the tree height of around 80% of the trees located at Levagood Park, this accounts to about 120 trees. To measure the trees, we used two different ways to achieve maximum accuracy. First, we measured out 100 feet (30.48 meters) perpendicularly from the tree base using an industrial tape measure. Then, at 100 feet away from our chosen tree, we aligned the Suunto Clinometer at the base of the tree, collecting data, and then repeated it on the top. Having done that, we would add those two results together, leading us

to an estimation of the tree's overall height. This was just one of the ways we measured the height of the tree. Another way was using the GLOBE Observer App. We would again measure out 100 feet away from the base of the tree, take a picture aligning the phone with the base of the tree and take another picture aligning the phone with the top of the tree. In addition, after this we would take a full photograph of the tree. Then, we would walk back to the tree and measure the circumference of the tree, by measuring 4 and a half feet up from the base of the tree. At this distance, we would use a Forestry Suppliers English Fabric Diameter Tape to measure the circumference of the tree, we would try to keep the tape as even leveled as possible and to be at the same height as the rest of the tape. After we acquired the circumference of the tree we would plug it into the GLOBE Observer App with the rest of the photos and it would give us an estimate of the tree's heights.

Figure 1-3: Figures 1,2,3 are the instruments that were used to measure tree height. From left to right: Forestry Supplies Fabric Diameter Tape to measure the circumference of the tree, Suunto clinometer to measure the percentage at the base and top of the tree, and an industrial tape measurer to measure 100 feet from the base of the tree.



Figures 4-5: Figures 4 and 5 show the different types of apps that were used to help us in our research. From left to right: GLOBE Observer App (helped us measure the height of trees and upload the trees height to GLOBE.) SPARKvue, helped us see the different atmospheric parameters measured by the Pasco Sensors and helped us compare the data between the two Pasco Sensors.

Figure 6-8: Figures 6-8 show students researchers following GLOBE protocol to collect measurements of different atmospheric parameters and tree heights.

Figure 9-10 (Above): Figures 9-10 show the two different sites where we measured the atmospheric parameters. Site 1 (top picture) shows where we placed the Pasco Sensor in a group of trees. Site 2 (bottom picture) shows where we placed the Pasco Sensor in an open field.

GLOBE Data/Data Entry:

Throughout January, data was taken through the SPARKvue app and then later transferred into an Excel spreadsheet, and after the measurements were inputted into the GLOBE website. This was done to guarantee that the results were safely stored and across multiple mediums.

Table 1-2: Table 1(top table) shows the data received from site 1 and the atmospheric parameters that were measured. Table 2 (bottom table) shows the atmospheric parameters data that was obtained from site 2.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Temperature	Barometric P	Ambient Air	Relative Hum	Dew Point (C	Absolute Hu	Wind Speed	Wind Chill (C	Humidex (Ce	Wind Direction (Degrees)		
2	3/1/2020 19:	6.4	991.9	6.4	48.7	-4.3	3.6	5.6	2.5	3.5	201		
3	3/2/2020 22:	11.2	982.5	11.2	53.8	1.4	5.5	1.1	11.2	9.6	217		
4	3/3/2020 22:	9	978.3	9	54.1	-0.6	4.8	7.6	5.6	6.9	243		
5	3/4/2020 22:	10.2	992	10.2	34.2	-5.7	3.2	5	8.8	7	250		
6	3/5/2020 22:	9.8	990.8	9.8	43.2	-2.9	4	3.2	7.6	7.2	164		
7	3/6/2020 19:	1.7	999.9	1.7	75.5	-3.9	3.8	8.8	-0.1	-1.2	303		
8													
9													
10													
11													

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Temperau	Barometri	Ambient A	Relative H	Dew Point	Absolute H	Wind Spee	Wind Chill	Humidex (	Wind Direction (Degrees)		
2	3/1/2020 1	6.8	991.7	6.8	48.1	-4.2	3.7	9.6	2.9	3.9	173		
3	3/2/2020 2	11.2	982.2	11.2	50.6	0.5	5.1	2.6	10.2	9.3	258		
4	3/3/2020 2	9.1	978	9.1	53.1	-0.8	4.7	6.6	5.9	6.9	288		
5	3/4/2020 2	8	991.4	8	35.9	-6.9	3	5.4	4.1	4.6	300		
6	3/5/2020 2	8.9	990.3	8.9	43.9	-3.5	3.8	4.6	5.9	6.2	188		
7	3/6/2020 1	2.4	999.5	2.4	68.9	-3.5	3.9	7.4	-0.1	-0.4	287		
8													
9													

Data Summary/Analysis:

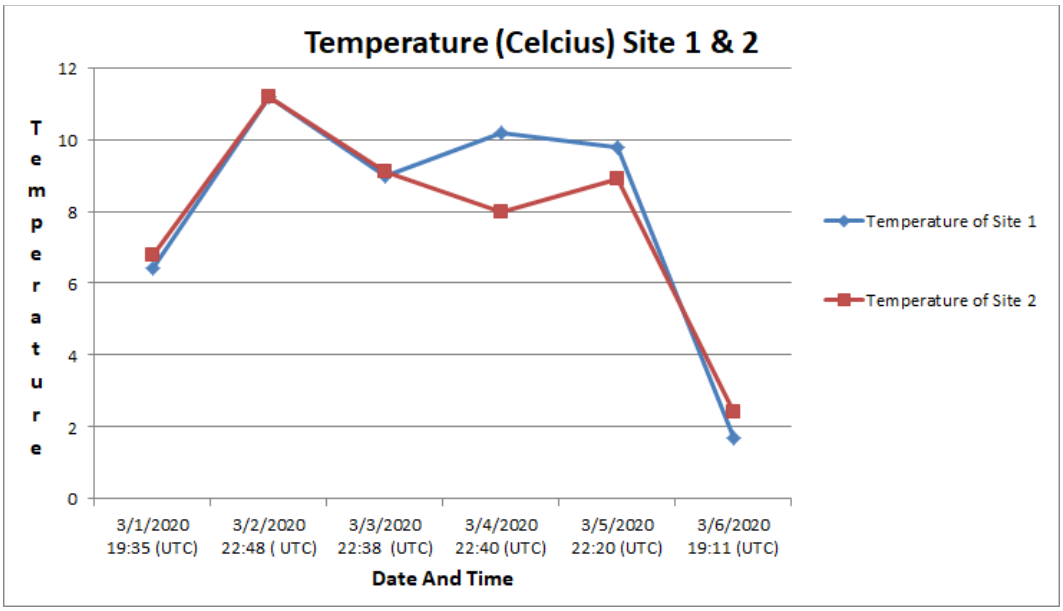


Figure 11 (Above): The temperature in site 1 is higher than the temperature in site 2 is likely caused by the light-colored sidewalk near the forested area where we measured. The light-colored sidewalk has a high albedo which means it will reflect much of its sunlight off to the area around it. This isn't a factor in site 2 as it is a short grassy field.

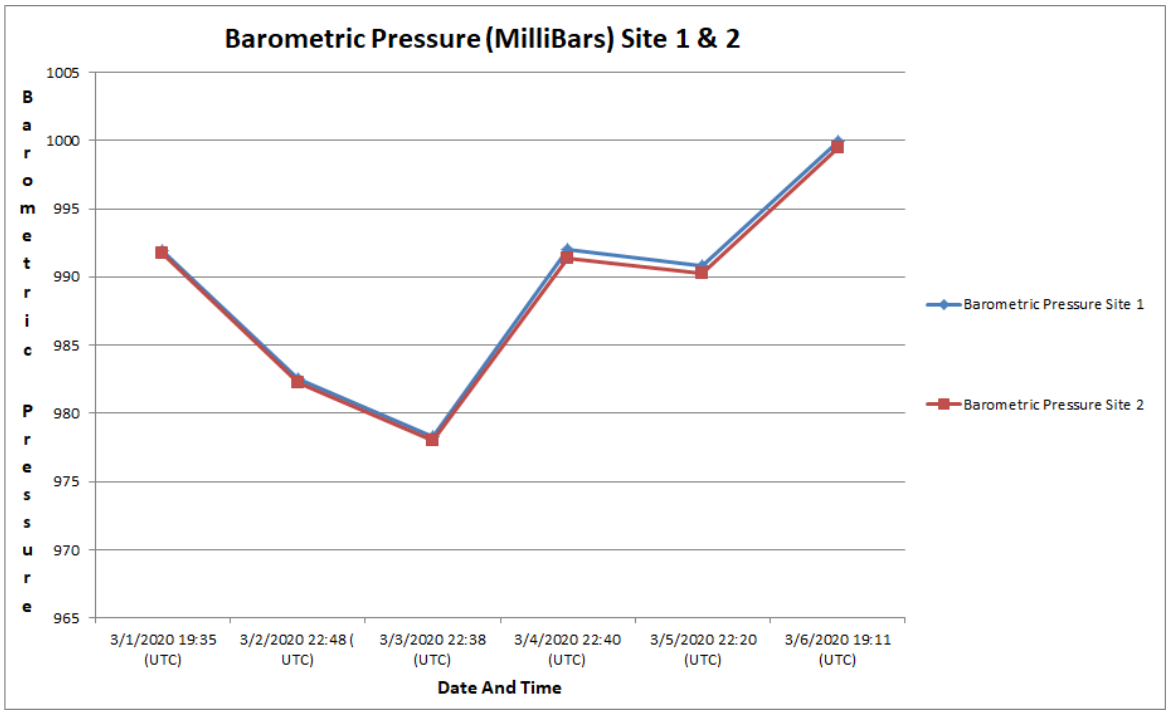


Figure 12 (Above): Site 1 and site 2 had similar barometric pressure, due to trees having no effect on the barometric pressure.

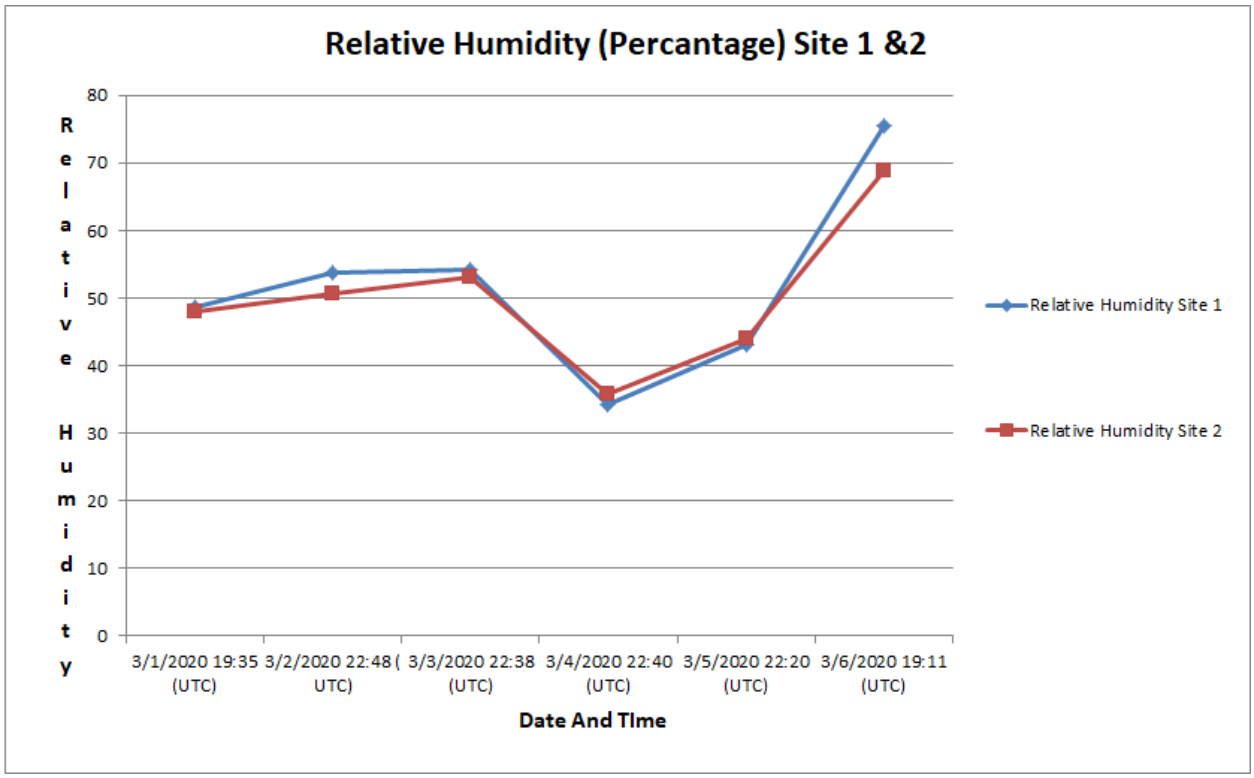


Figure 13 (above): The relative humidity in site 1 is higher than the relative humidity in site 2. This is due to the increased amount of evapotranspiration that occurs because of the trees.

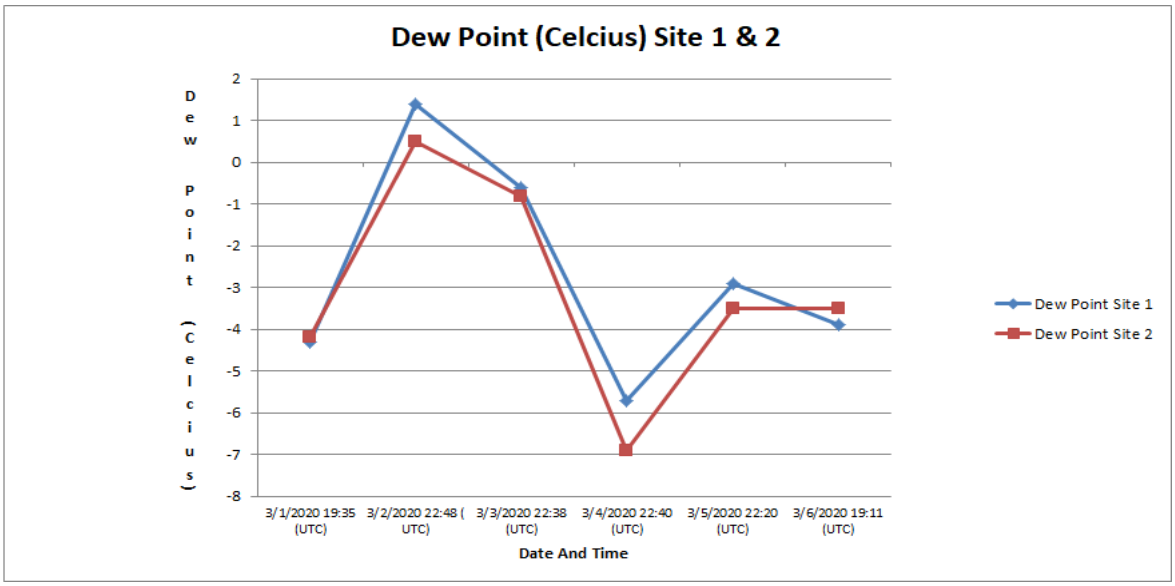


Figure 14 (Above): The dew point is increased because of the increased temperature and humidity. The temperature and humidity is increased by the trees because of the albedo of the asphalt near the trees and the increased rates of evapotranspiration by trees, leading to increased humidity.

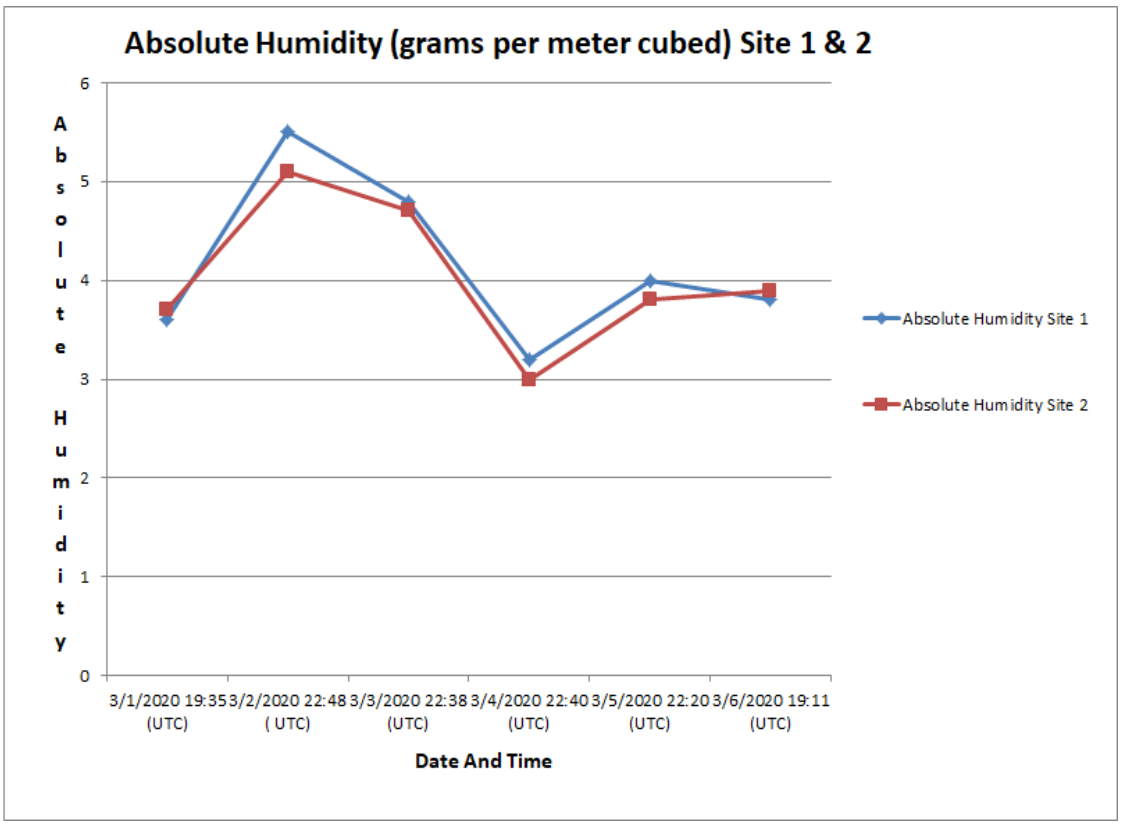


Figure 15 (Above): The absolute Humidity in site 1 is higher than in site 2 because of the increased evapotranspiration in site 1 due to the trees.

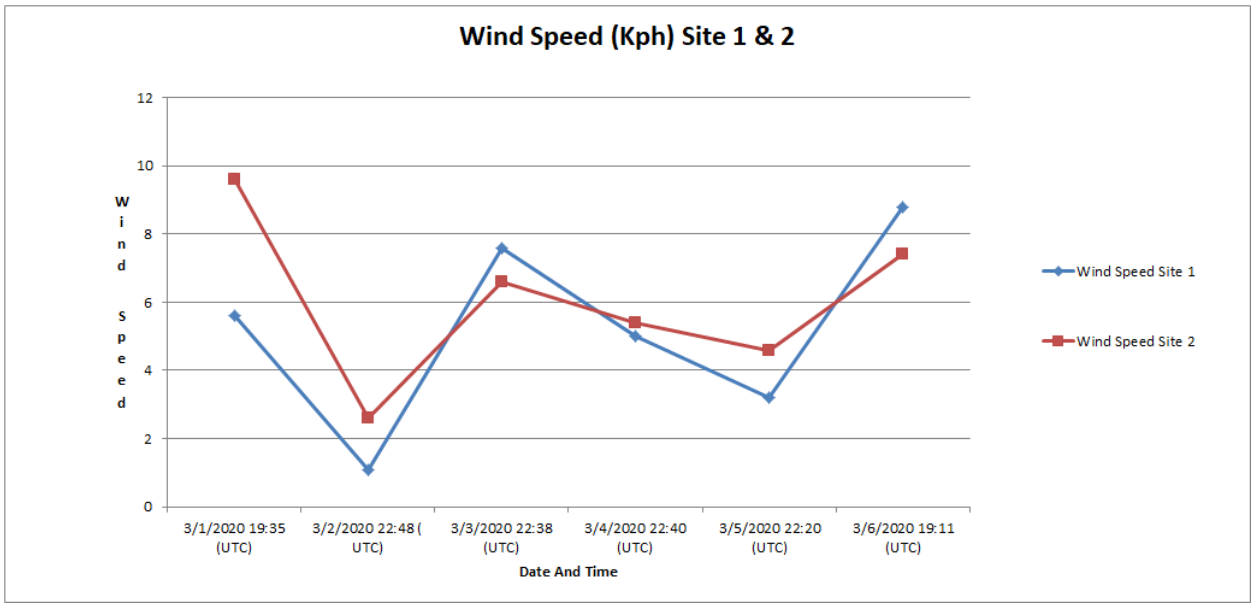


Figure 16 (Above): Wind speed was generally lower in Site 2 due to no trees there, though the wind speed sometimes was higher in Site 1. For example, on March 3rd the wind speed was higher to the possibility that the wind was coming from a direction where there was not a lot of leaves on the trees, so the wind speed did not decrease until it went through the other trees. This can be proven by further research in a season where leaves are present on the trees. Also, another possibility is the funneling of the wind around the trees increasing the speed of the wind.

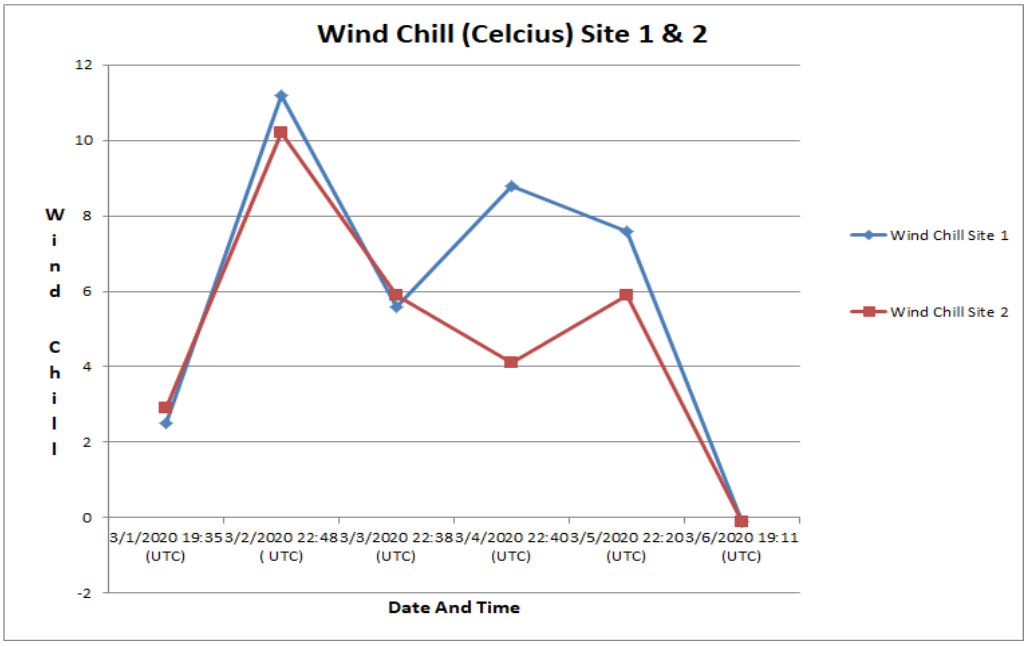


Figure 17 (Above): Wind chill directly correlates with wind speed. The higher the wind speed the lower the wind chill. Higher winds speed absorb more heat causing there to be colder temperatures in the atmosphere.

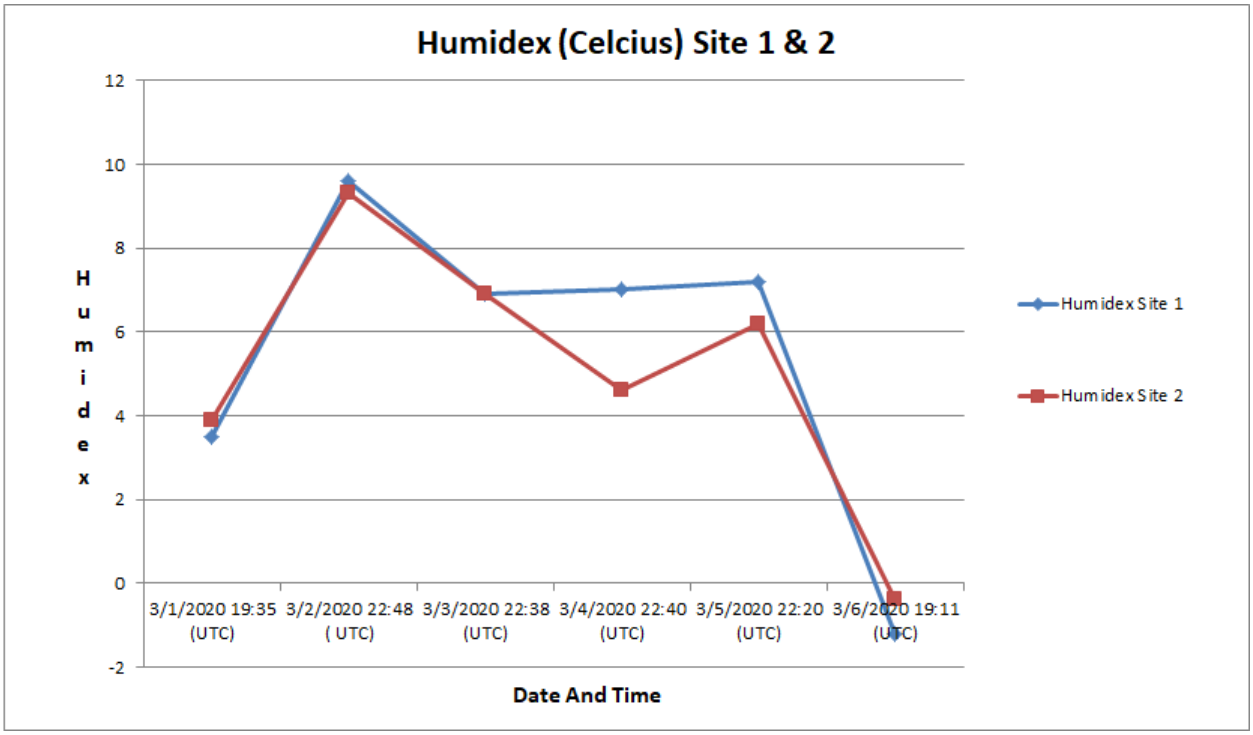


Figure 18 (Above): The humidex in site 1 is higher than in site 2. This is because site 1 has increased temperature and humidity compared to site 2.

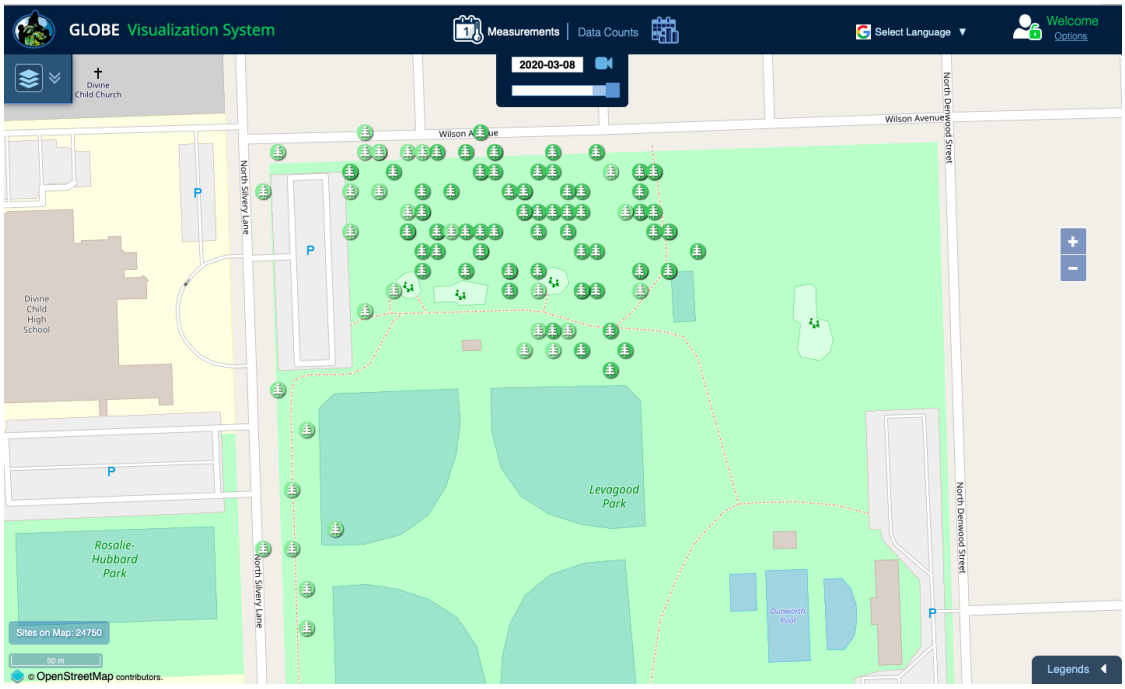


Figure 19: Figure 19 (above) highlights the trees we measured. The image shows all 123 trees that we have measured at Levagood Park. It shows the exact location of each, and allows us to see where the cluster of trees are located at Levagood Park.

Discussion:

After conducting research on the effects trees have on atmospheric conditions by comparing parameters of two different sites, we were able to validate our hypothesis. We have found a correlation between the levels of humidity and the amount of trees as site 1 had higher levels of humidity than site 2. Consequently, the dew point at site 1 was also higher than the dew point at site 2. This could be because site 1 had more trees and therefore had greater occurences of evapotranspiration within the area. However, there could be potential errors that may have affected our results. For instance, the wind vane of the PASCO devices could have been uneven. This would hinder the devices ability to redirect the device so that the wind vane is directly facing the wind. To get accurate wind speeds the wind vane should face the direction in which the wind is coming from. Many similar studies like Tersia Mexias and others and E.W. Bodnaruk and others have reached similar conclusions as us. In that trees reduce wind speeds, increase humidity, and dew point. Our results support our hypothesis. Trees do in fact cause changes in atmospheric parameters. These changes can be as small as something barely noticeable, or something that has a wide effect on the area of the trees and the areas surrounding them. Trees are truly something that scientists should investigate more. In the end, one of the biggest factors to fighting climate change is planting more trees.

Conclusion: Throughout the past years deforestation has been a major problem in the world. Millions of trees have been chopped down for lumbar or to make space for land. This has caused a multiple of problems. Ranging from climate change to glaciers melting. People around the world don’t know the benefits of trees, and what they provide for the environment. This is what has pushed our GLOBE team to research how trees affect atmospheric parameters. After

gathering measurements on different atmospheric parameters and analyzing them, we can see that trees have effects on certain atmospheric parameters. For instance humidex, wind chill, wind speed, absolute humidity, dew point, relative humidity, and finally temperature. Our hypothesis was correct in the sense that trees cause a change in the parameters. Trees cause a change in temperature, but it is not that noticeable. Also, in our area we had asphalt near our trees so that would have possibly increased the temperatures near our trees, by reflecting the heat of the sun to the trees. Also trees cause a major change in humidity, wind speed and chill. Trees higher relative humidity and absolute humidity through evapotranspiration, which releases more moisture in the air and evaporates the water in the area. We could clearly see this because site 1 had a higher amount of humidity compared to site 2. In regards to site 1 the relative humidity wasn't that much higher than site 2. But, in absolute humidity there was a noticable difference between the two sites. Site 1 had a much higher absolute humidity than site 2, because of the increased evapotranspiration. Wind speed and wind chill are directly correlated. In site 1 it generally had lower wind speeds than site 2, because of this site 1 had generally higher wind chill then site 2. Trees decrease the wind speed with their leaves, when wind speed is higher it draws heat from your body, and decreases the wind chill making the atmosphere much colder. Trees help reduce wind speed causing an increase in wind chill and hotter temperatures. In the future we could take longer measurements to see the extended effects of a tree over hours. We could also try different types of trees and see how every type of tree affects atmospheric parameters. In addition, we could measure other parameters such as cloud formation, to see how the evapotranspiration of the trees affects cloud formation and rainfall, also we could test ground parameters to see how trees affect soil texture and moisture. By working with Mr. Stanley Johns. We have learned so much. Mr. Johns has over 40 years of experience as a forester and has helped

us better accurately measure tree heights. He has taught us new ways to measure trees with more accuracy than our previous ways. He also showed us how to use the clinometer with mose accuracy.

Bibliography:

Bodnaruk, E.W., et al. "Where to Plant Urban Trees? A Spatially Explicit Methodology to Explore Ecosystem Service Tradeoffs." *Landscape and Urban Planning*, Elsevier, 16 Sept. 2016, www.sciencedirect.com/science/article/pii/S016920461630175X.

"Deforestation and Forest Degradation." *WWF*, World Wildlife Fund, www.worldwildlife.org/threats/deforestation-and-forest-degradation.

Lallanilla, Marc. "What Is Dew Point?" *LiveScience*, Purch, 11 Feb. 2014, www.livescience.com/43269-what-is-dew-point.html.

Mexia, Teresa, et al. "Ecosystem Services: Urban Parks under a Magnifying Glass." *Environmental Research*, Academic Press, 5 Nov. 2017, www.sciencedirect.com/science/article/pii/S0013935117316602?via%3Dihub.

Acknowledgments:

Thank you Mr. Stanley Johns, a professional forester who verified our methodology for accurately measuring tree height with a clinometer and how to use a diameter tape to precisely to measure the DBH (diameter breast height) of trees. Thank you also to the Mission Earth

Program of the University of Toledo for providing us with some of the resources needed to complete this investigation.

Badges:

We have earned the Stem Profesional badge because we worked closely with Stanley Johns. Stanley Johns, who is a professional forester, helped improve our methods of measuring trees. He taught us how to take more accurate measures when recording the height and diameter breast height (DBH) of the trees. He showed us how to identify a tree based on the physical feature like the bark instead of relying on leaves which are not present during the winter season. He also demonstrated to us how to calculate a trees height withoug using trigonometry which made us able to measure trees more accurately and effeciently.

We have earned the Data Scientist badge because we have graphed and compared all of the atmospheric perameters thoughroughly. We have also considered the limitations of our measurements and discussed how to improve our data for the future. In addidtion, we have compared our results to similar studies and we have reached similar conclusions on the role of urban trees in modyfing weather in a city park.