

Shumate Middle School - Three Year Volumetric Soil Moisture Study

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Abstract

This research study was conducted by Shumate Middle School students Dylan Davis (Sixth Grade), Bradley Eves (Sixth Grade), and Reagan Stec (Eighth Grade). Shumate Middle School (Gibraltar School District) is located in Gibraltar, Michigan (United States of America). For this project, we chose to study volumetric soil moisture, and compare it to measurements taken at the same study site over the course of three years. The data used in this study was collected from September 2016 through March 2019. All data is broken up into three school year periods to make for easier analysis. For our hypothesis, we believed that the 2018 - 2019 average volumetric soil moisture would not vary more than 0.10 ml per ml from 2017 - 2018 school year's average volumetric soil moisture value. Our data revealed that our hypothesis was correct. We also compared our results to the volumetric soil moisture data collected by students at III. Osnovna Skola Varaždin school in Varaždin, Croatia. To say the least, we were very surprised by the variations in the volumetric soil moisture measurements when analyzed over a three year period.

Research Question

Our research team decided to build upon the work started last year by Shumate Middle School students Quinn Burgei and Brady Jaskula. During the 2017 - 2018 school year, Burgei and Jaskula created a study titled, "Shumate Middle School - Soil Moisture Study." In their research, our group noticed that there was a significant difference in the average, maximum, and minimum volumetric (ml per ml) soil moisture measurements between the 2016 - 2017 and 2017 - 2018 school years. This variation encouraged our group to take a closer look at a single study site over a period of three years. For this study, our research question is, "How does soil moisture in the same location vary over the course of three years?"

Introduction

According to the GLOBE Program SMAP (Soil Moisture Active Passive) Soil Moisture (Pedosphere) e-training module, measuring soil moisture is important because it informs us of how much water is available in the ground. Farmers use this data to forecast crop productivity. The data can also be used to predict droughts, floods, thunderstorms, and vector-borne diseases. This data is also important to the residents in Gibraltar, Michigan as the Shumate Middle School/Carlson High School campus is adjacent to a wetland area that is (potentially) at risk for floods.

Hypothesis:

We believe that the 2018 - 2019 average volumetric soil moisture (ml per ml) will vary no more than 0.10 ml per ml from the 2017 - 2018 average volumetric soil moisture (ml per ml).

GLOBE BADGES

We would like to apply for the following GLOBE International Virtual Science Symposium Badges:

- **Collaborator** - During our research, we connected with Mr. Brian Campbell (NASA and The GLOBE Program). We discussed how the variables we are testing will make an impact on the experiment. Additionally, we discussed how these measurements will have an impact on our community.
- **Make an Impact** - Soil moisture data is important for forecasting crop production, improving public health (preventing vector-borne diseases), and for predicting floods, droughts and wildfires. Shumate Middle School is located adjacent to a wetland and is in a higher risk flood zone.

Research Methods

Shumate Middle School – Gibraltar, Michigan (United States of America)
 Latitude 42.08583, Longitude -83.20972, Elevation 176.7m



III. Osnovna Skola - Varaždin, Croatia

Latitude 46.28485, Longitude 16.33224, Elevation 200.0m



GLOBE Protocols Utilized in this Study:

- Pedosphere - Soil Moisture Active Passive - Block Pattern
- Study Site - Shumate Middle School - Gibraltar, MI (United States of America)
 - o 2016 - 2017 - 6th Hour - 300 Hallway Sidewalk
 - o 2017 - 2018 - 5th Hour - Mr. DeAngelo's Sidewalk
 - o 2018 - 2019 - GLOBE Advisory - Mr. DeAngelo's Sidewalk
 - This is a three-year study. While the site locations have different names, all measurements have been taken in areas within close proximity of one another.
- Comparison Study Site - III. Osnovna Skola Varaždin - Varaždin (Croatia)
 - o SMAP 2
 - This data was not collected by Shumate Middle School students.
- Time Frame - September 2016 - February 2019
 - o 2016 - 2017 - September 21, 2016 - May 26, 2017
 - o 2017 - 2018 - September 15, 2017 - May 25, 2018
 - o 2018 - 2019 - September 25, 2018 - February 7, 2019

Materials:

- Pink GLOBE Flags - Used to identify the study site.
- Shovel - Used to loosen the top layer of grass.
- Garden Shovel - Used to extract the 5 cm soil sample.
- 5 Gallon Bucket - Used to carry tools and needed materials.
- GLOBE Soil Moisture Data Sheet - Used to record data.
- Aluminum Cans - Used to hold/dry the soil sample.
- Soil Oven - Used to dry soil samples (approximately 75 - 95 degrees Celsius).
- Digital Scale - Used to measure soil samples in grams.
- Thick Gloves - Used to take the samples out of the oven (safety).
- Computer - Used to record and enter GLOBE data to the GLOBE website.

Methods:

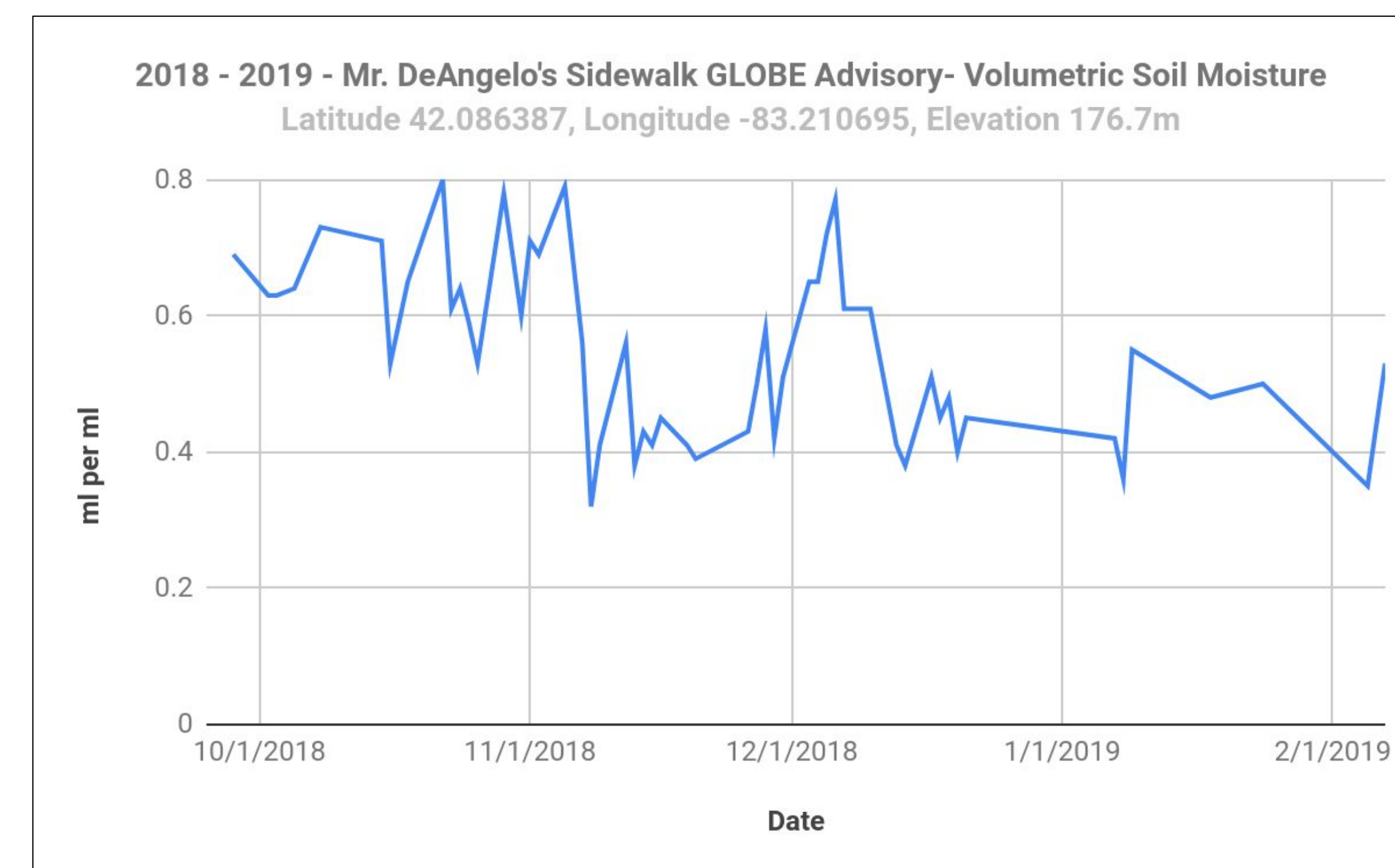
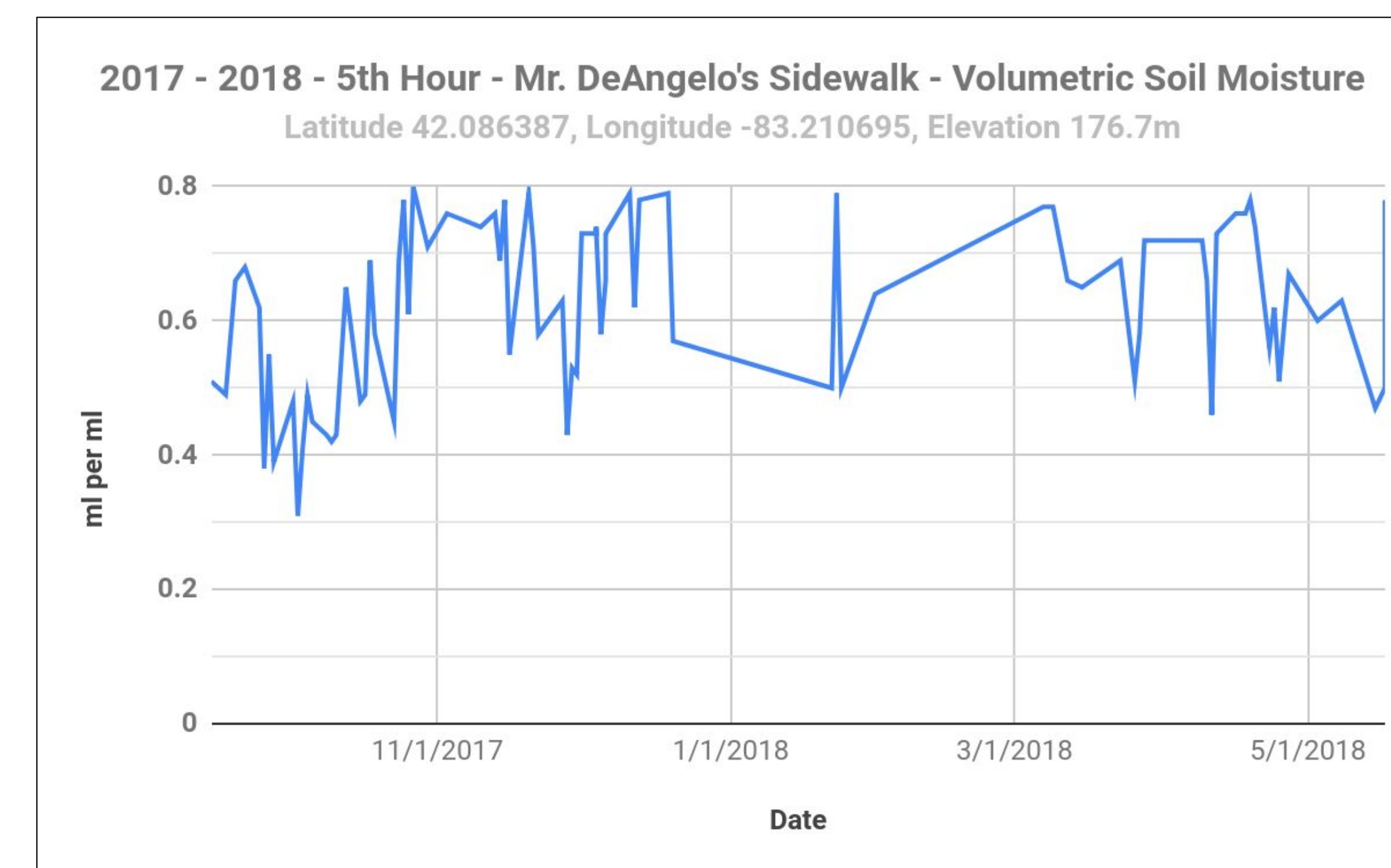
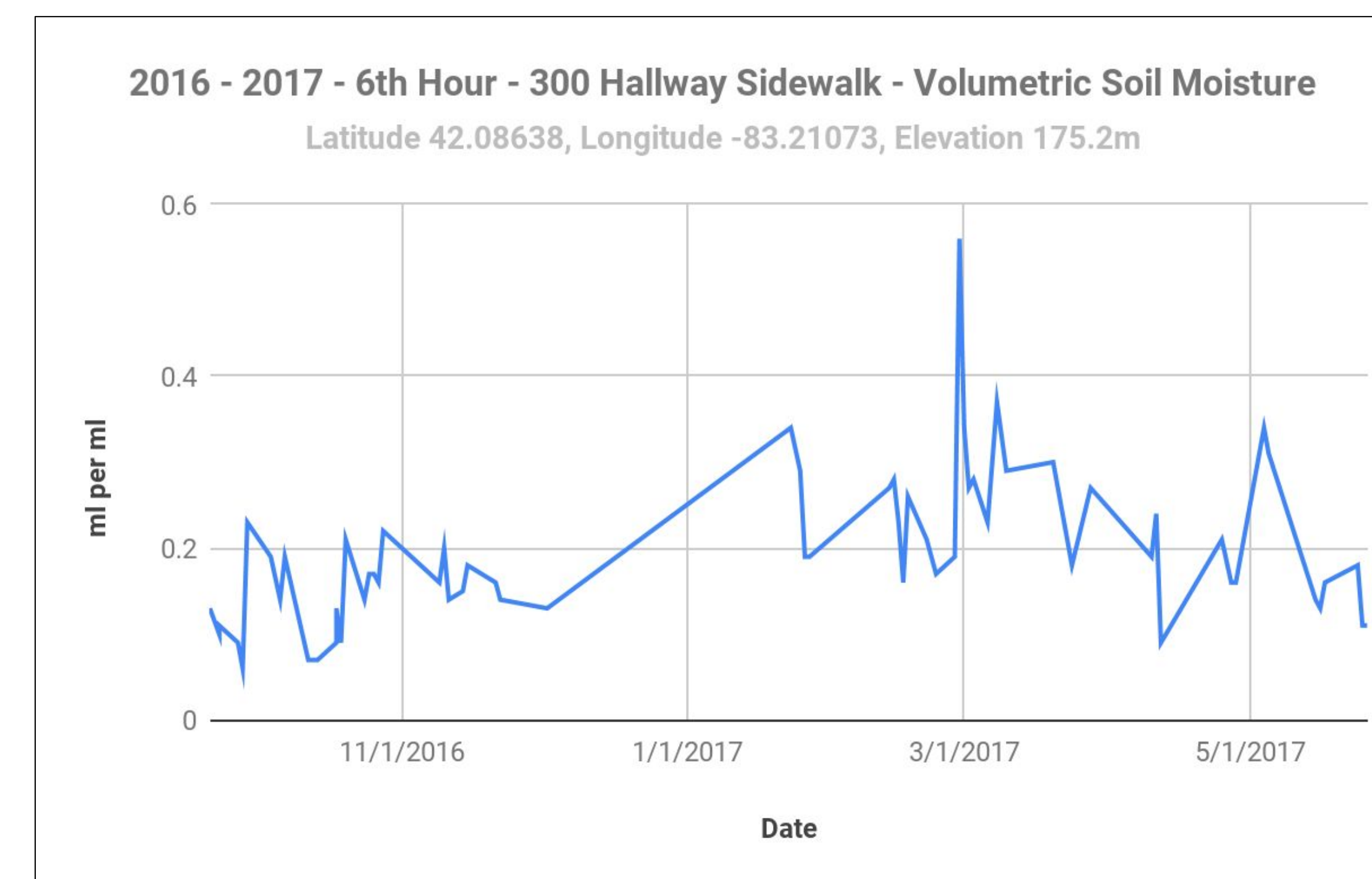
For Collecting Daily Samples

- Gather your tools (5-gallon bucket, shovels, aluminum can, and digital data sheet).
- Before heading outside, weigh the empty aluminum can on the digital scale and then record the weight in grams on the data sheet.
- Travel with your group outside to your designated GLOBE study site.
- Use the shovel to loosen the top layer of grass to access the soil.
- Place aluminum can upside down touching the top layer of soil.
- Push the can down into the soil layer using your foot.
- Use the garden shovel to fill the aluminum can with soil and to extract the can from the ground.
- Take the can out of the ground with the soil sample in it.
- Make sure all loose dirt on the outside of the can is removed.
- Return to the classroom and weigh the newly collected sample on the digital scale.
- Record all other data needed on our SMAP datasheet.
- Place the newly collected sample in the soil oven. The oven temperature should range from 75 degrees Celsius to 95 degrees Celsius.
- Allow the sample to dry for a minimum of 24 hours.
- Remove the dried sample from the soil oven. Make sure you are wearing thick gloves when handling the hot sample.
- Place the dried sample on the digital scale and record its weight in grams.
- Go to the GLOBE website and enter your data into the GLOBE database. Also, enter it into a personal data sheet/spreadsheet.
- Return the dried soil sample to its original location (the spot it was collected from).

Results

Data Table 1 - Gibraltar, Michigan (3 Year Study)

Site Location	School Year	Average (ml per ml)	Maximum (ml per ml)	Minimum (ml per ml)
2016 - 2017 - 6th Hour - 300 Hallway Sidewalk	2016 - 2017	0.19	0.56	0.06
2017 - 2018 - 5th Hour - Mr. DeAngelo's Sidewalk	2017 - 2018	0.62	0.8	0.31
7th Grade (Mr. DeAngelo's) Sidewalk SMAP - GLOBE Advisory	2018 - 2019	0.55	0.8	0.32



Data Table 2 - Varaždin, Croatia (3 Year Study - Comparison)

Site Location	School Year	Average (ml per ml)	Maximum (ml per ml)	Minimum (ml per ml)
III. Osnovna Skola Varaždin - SMAP 2	2016 - 2017	0.18	0.35	0.03
III. Osnovna Skola Varaždin - SMAP 2	2017 - 2018	0.16	0.36	0.01
III. Osnovna Skola Varaždin - SMAP 2	2018 - 2019	0.04	0.09	0.01

Discussion

Overall, we believe that our study went well. Our group was successful in analyzing three years worth of volumetric soil moisture data. We believe that we were able to take accurate measurements, make sense of our data, and compare our data to a school in Varaždin, Croatia.

For comparison, we compared our average, maximum, and minimum volumetric soil moisture data to the data collected at III. Osnovna Skola Varaždin school in Varaždin, Croatia (see Data Table 2). We found that the III. Osnovna Skola Varaždin school had a study site name SMAP 2 where students have been taking soil moisture measurements at one location for at least three years, similar to our school. Our average, maximum, and minimum volumetric soil moisture measurements were all larger than the measurements in Varaždin, Croatia.

To improve our study, we would like to examine other variables that might impact soil moisture. For instance, we could pull precipitation data to see how precipitation amounts and rain rates impact soil moisture. Also, does humidity impact soil moisture? Mr. Brian Campbell made mention of this variable during our webinar. Third, similar to Burgei and Jaskula's study, our group did not calculate the soil infiltration rate of our study site. Looking back at our research, we should have calculated soil infiltration. According to the GLOBE Program Soil Infiltration training protocol, soil infiltration rate is determined by measuring the time it takes for water sitting on soil to drop a fixed distance. This rate changes with time as the soil pore spaces, filled originally with air, fill with water. Also, if the soil is dense and/or compacted, the water will likely move through it more slowly (2016). Having a better understanding of soil infiltration would help us better understand how water drains in a given area.

Conclusions

In conclusion, we discovered that our hypothesis was correct. The average volumetric soil moisture collected during the 2018 - 2019 school year (0.55 ml per ml) was closer to the average volumetric soil moisture collected during the 2017 - 2018 school year (0.62 ml per ml). The average volumetric soil moisture varied 0.07 ml per ml. Looking at the data, our group wondered why there is such a difference in average, maximum, and minimum volumetric soil moisture measurements when comparing the 2017 - 2018 and 2018 - 2019 school years to the 2016 - 2017 school year. The average, maximum, and minimum volumetric soil moisture measurements collected during the 2016 - 2017 school year are considerably lower.

Additionally, for this study, we had to stop taking soil moisture measurements at the end of February 2019 to give us ample time to prepare our data for this report. We wish we would have been able to include more data from the Spring 2019 months.

Bibliography

- Burgei, Q. and Jaskula, B. (2018) Shumate Middle School - SMAP Soil Moisture Study. Retrieved from <https://www.globe.gov/do-globe/research-resources/student-research-reports/projectdetail/globe/shumate-middle-school-smap-soil-moisture-study>
- Trachtenberg, I., Butler, D., and Low, R. (2016) The GLOBE Program - Pedosphere - SMAP Soil Moisture Protocol [PowerPoint slides]. Retrieved from <https://www.globe.gov/get-trained/protocol-etaining/etraining-modules/16867724/1227.6>.