Shumate Middle School - Three Year Volumetric Soil Moisture Study

Dylan Davis
Bradley Eves
Reegan Stec

Shumate Middle School (Gibraltar School District)
30778 W. Jefferson - Gibraltar, Michigan 48173
United States of America

Mr. Jeffrey Bouwman, Science Teacher
Mr. Eric Cassie, Principal

Wednesday, March 27, 2019

Abstract

This research study was conducted by Shumate Middle School students Dylan Davis (Sixth Grade), Bradley Eves (Sixth Grade), and Reegan 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.

Table of Contents

International Virtual Science Symposium Badges

These are the GLOBE Badges our group would like to apply for:

- **Collaborator -** During our research, we connected with Mr. Brian Cambell (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 Question and Hypothesis

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 entitled, "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. Our research question is, "**How does soil moisture in the same location vary over the course of three years?**"

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).

Materials and Methods

GLOBE Protocols Utilized in this Study:

- Pedosphere - Soil Moisture Active Passive - Block Pattern
- Study Site - Shumate Middle School - Gibraltar, MI (United States of America)
  - 2016 - 2017 - 6th Hour - 300 Hallway Sidewalk
  - 2017 - 2018 - 5th Hour - Mr. DeAngelo's Sidewalk
  - 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)
    - SMAP 2
        - ***This data was not collected by Shumate Middle School students.***
- Time Frame - September 2016 - February 2019
    - 2016 - 2017 - September 21, 2016 - May 26, 2017
    - 2017 - 2018 - September 15, 2017 - May 25, 2018
    - 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:

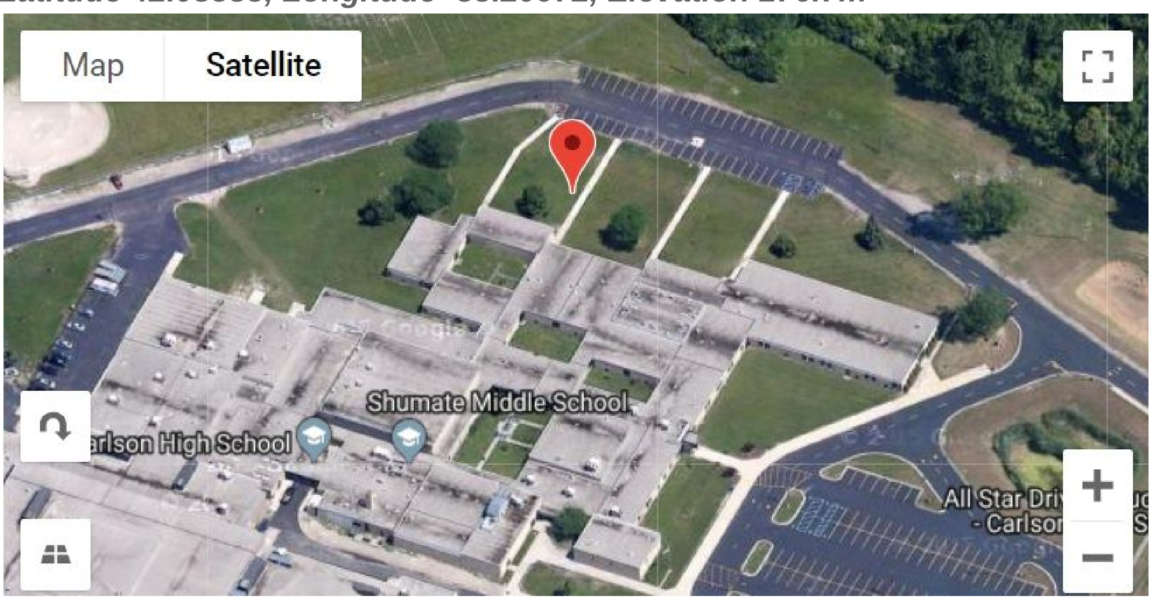
- Gather your tools (5-gallon bucket, shovels, aluminum can, and digital data sheet).
- Before heading outside, weigh the empty aluminum can on the digital scale and then record the weight in grams on the data sheet.
- Travel with your group outside to your designated GLOBE study site.
- Use the shovel 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).

Study Site:

Aerial Image 1 - Project Study Site

Latitude 42.08583, Longitude -83.20972, Elevation 176.7m



Aerial Image 2 - Comparison Study Site

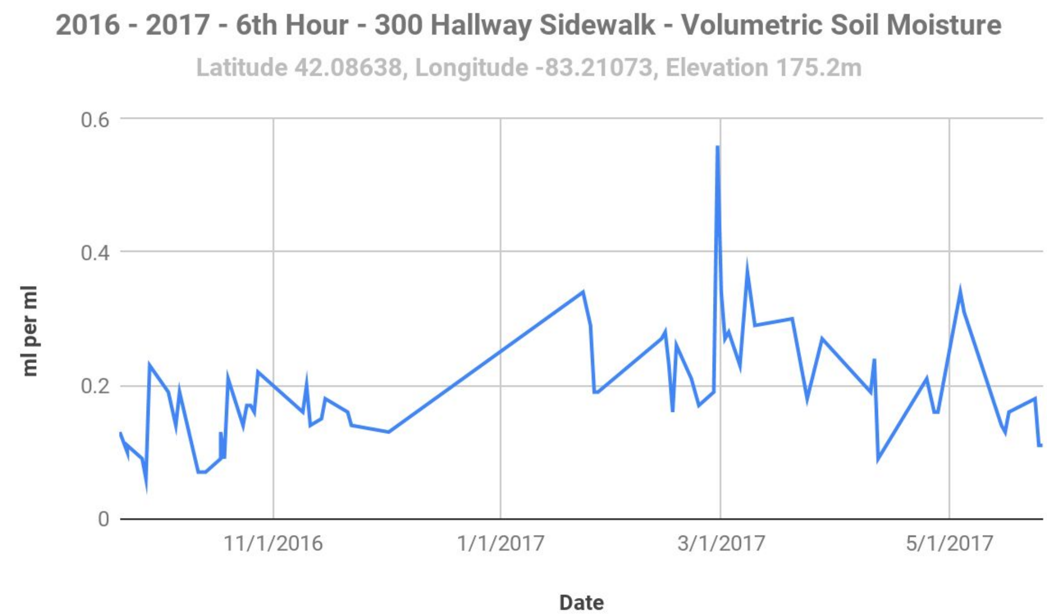
Latitude 46.28485, Longitude 16.33224, Elevation 200.0m

Data Summary

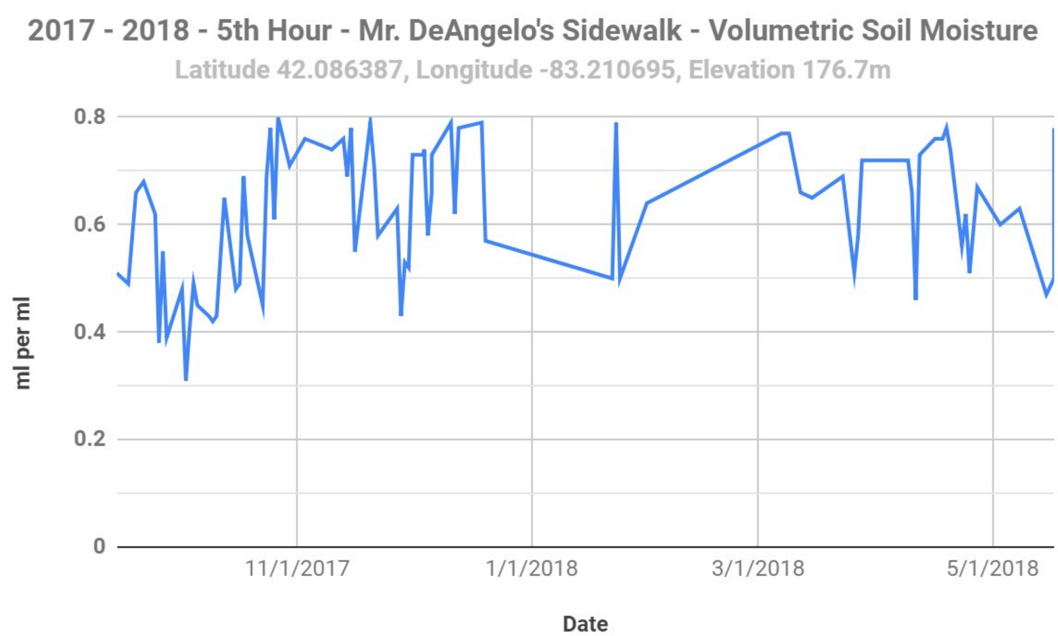
Data Table 1 - Gibraltar, Michigan (3 Year Study)

Site Location	School Year	Average (ml per ml)	Maximum (ml per ml)	Minimum (ml per ml)
6th Hour - 300 Hallway Sidewalk	16 - 17	0.19	0.56	0.06
5th Hour - Mr. DeAngelo's Sidewalk	17 - 18	0.62	0.80	0.31
GLOBE Advisory - Mr. DeAngelo's Sidewalk	18 - 19	0.55	0.80	0.32

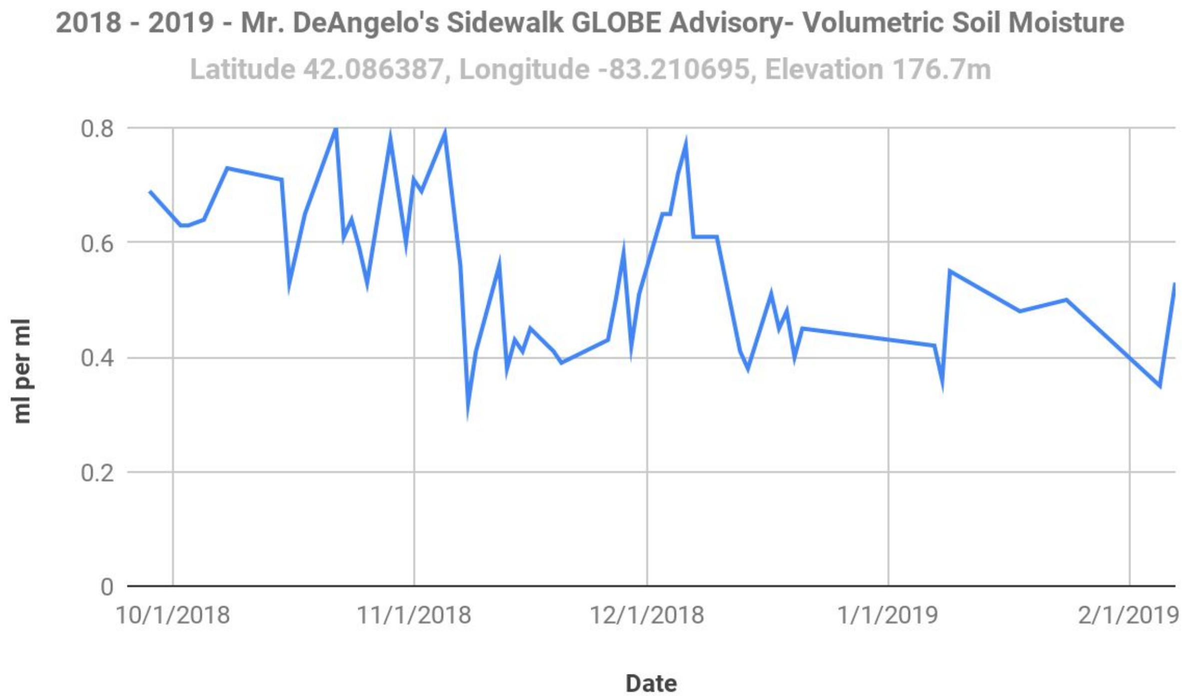
Graph 1 - 2016 - 2017 - 6th Hour - 300 Hallway Sidewalk



Graph 2 - 2017 - 2018 - 5th Hour - Mr. DeAngelo's Sidewalk



Graph 3 - 2018 - 2019 - Mr. DeAngelo's Sidewalk GLOBE Advisory



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

Analysis and Results

After analyzing the data from the past three years (see Data Table 1), we can see that there is a significant difference between the results collected each year. During the 2016 - 2017 school year (see Graph 1), the average volumetric soil moisture was 0.19 ml per ml. The site had a maximum volumetric soil sample(s) of 0.56 ml per ml, and a minimum volumetric soil sample(s) of 0.06 ml per ml. The year 2017 - 2018 (see graph

2) had an average volumetric soil moisture of 0.62 ml per ml, a maximum volumetric soil sample(s) of 0.8 ml per ml, and a minimum volumetric soil sample(s) of 0.31 ml per ml. This year's data (2018 - 2019) had an average volumetric soil moisture of 0.55 ml per ml, a maximum volumetric soil sample(s) of 0.8 ml per ml, and a minimum volumetric soil sample(s) of 0.32 ml per ml (see Graph 3). Looking at this data, we observed that the highest average volumetric soil moisture was measured during the year 2017 - 2018 school year. The soil sample(s) with the maximum volumetric soil moisture (0.80 ml per ml) was measured during both the 2017 - 2018 and 2018 - 2019 school years. The soil sample with the lowest minimum volumetric soil moisture sample(s) (0.06 ml per ml) was measured during the 2016 - 2017 school year.

Mathematics Equations Utilized - We used an average (mathematics) equation, as well as maximum and minimum functions, on the data tables to better analyze the data.

Possible Uncertainties Present in the Data - Human and/or technology error(s).

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.

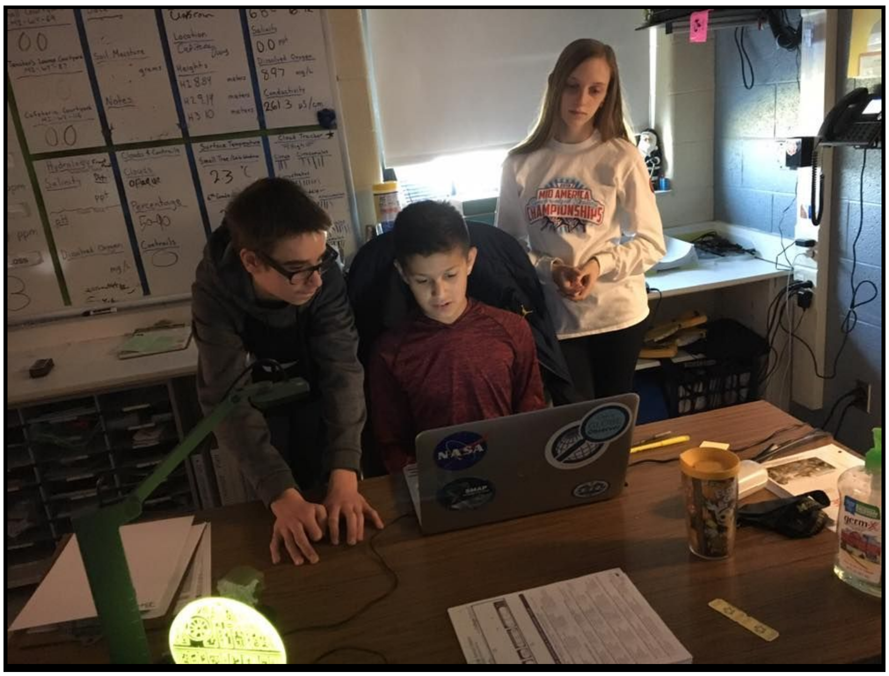
Additionally, for this this study, we had to stop taking soil moisture measurements at the end of February 2019 to give us ample time to prepare our data for this report. We wish we would have been able to include more data from the Spring 2019 months.

Discussions

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.

Image 1 - Webinar with Mr. Brian Campbell



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 (see Image 1 above). 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.

Acknowledgments

We would like to give a huge thank you to all of these people who helped us during our research.

- Thank you to **Mr. Brian Campbell** for assisting us with our research.
- **Dylan Davis (6th Grade - Shumate Middle School)** - Thank you, Mr. Bouwman, for pushing me to be a better scientist by spending lunches making graphs and writing this paper. I would also like to thank my amazing mom and dad for getting me to the point I'm at in my life.
- **Bradley Eves (6th Grade - Shumate Middle School) -** Thank you to Mr. Bouwman for pushing me to be my best during GLOBE Advisory.
- **Reegan Stec (8th Grade - Shumate Middle School)** - Thank you to Mr. Bouwman for giving me the opportunity to be a better scientist and pushing me to be my best. Also, thank you to my parents for helping me get to this point in my life.

References

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-etraining/etraining-modules/16867724/1227.6.