Soil Moisture In Regards to Wind Speed and Precipitation

Jimmiry Lloyd, Jean Mead, Kenneth Sattler

Abstract

To begin the project, the hypothesis was precipitation would heighten soil water content and higher wind speed would lower it. When comparing the data collected on precipitation amounts, wind speed, and soil moisture in three different spots of soil, conclusions were drawn based on the hypothesis. Data shows when the wind speed is higher, the soil moisture drops slightly, but factors like humidity also play a part in these results.

Center Statement

Wind speed has a minute effect on the water content in the soil

Introduction

Soil moisture, as Peretti et al. put it, "is a key variable of the climate system as it interacts with the atmosphere through complex feedbacks by means of the energy and water balance." The water content of soil is important to many communities, as it is a key ingredient in growing the food we eat everyday. When talking about what changes soil moisture, Li et al. state, "the sensible heat transferred by the wind…not only exacerbates droughts in areas where precipitation has been significantly reduced, but also causes areas with slightly reduced or even increased precipitation to become drier." This leads to the question–does wind speed have a direct correlation with soil moisture content. This project aims to explore the impact of wind speed on soil water content, with precipitation being the reset button on the data.

Hypothesis

The hypothesis was wind speed would lower soil water content with precipitation being a reset on the data

Objective

The objective is to find any correlation between precipitation levels, wind speed, and soil moisture.

Methods

Soil Moisture

- ➔ Gather tools; Labquest 3, Rain Gauge, Soil Moisture Sensor, and Shovel and go to site of data collection
- ➔ Dig holes 2” for soil moisture collection and follow standard procedure to collect data
- ➔ Set up rain gauge on a post in correspondence to GLOBE protocol
- ➔ Record soil moisture and rain data in Engineer’s Notebook, following all necessary procedures
- ➔ Upload data into the GLOBE website
- ➔ Use Stats.Blue website to make graphs to compare data

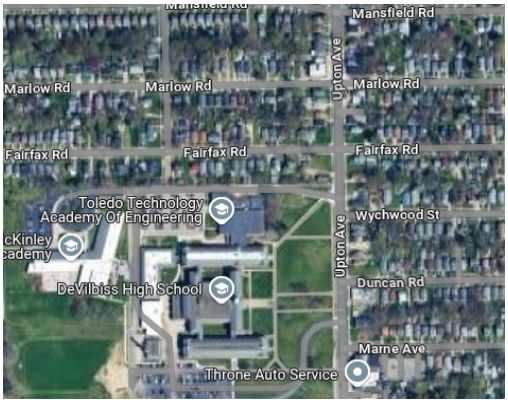
Wind Speed and Turbine

- ➔ Gather tools; Labquest 2 or 3, Anemometer, and Wind Turbine and go to site of data collection.
- ➔ Using anemometer, hold facing the wind for a set amount of time of your choosing
- ➔ Hook labquest to the wind turbine
- ➔ Record V, A, and W from wind turbine and m/s in Engineer’s Notebook
- ➔ Upload data to the GLOBE website
- ➔ Use Stats.Blue website to make graphs and compare data

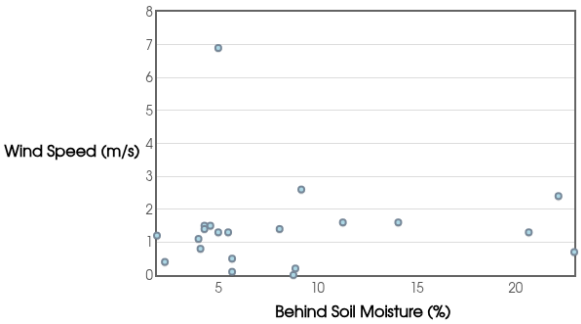
Results

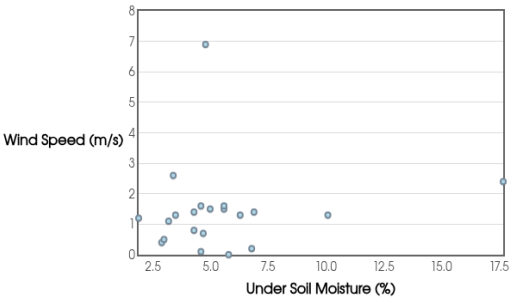
The five weeks of data collection provide many points to look at. For starters, as seen in the Wind Speed vs. Front Soil Moisture graph, there isn't a huge correlation between wind speed(ws) and soil moisture(sm). It seems to mainly have to do with the amount of precipitation in the near past, with wind speed only at extreme highs to make a change to the sm; additionally, where sm was recorded didn't change the results much, either.

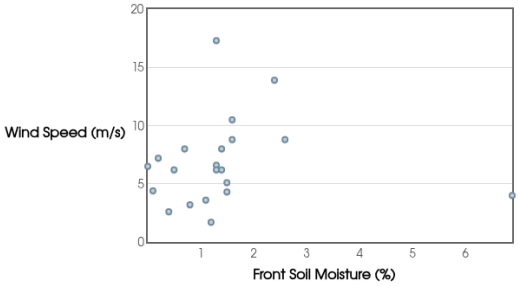
Graphs/Photos/Maps

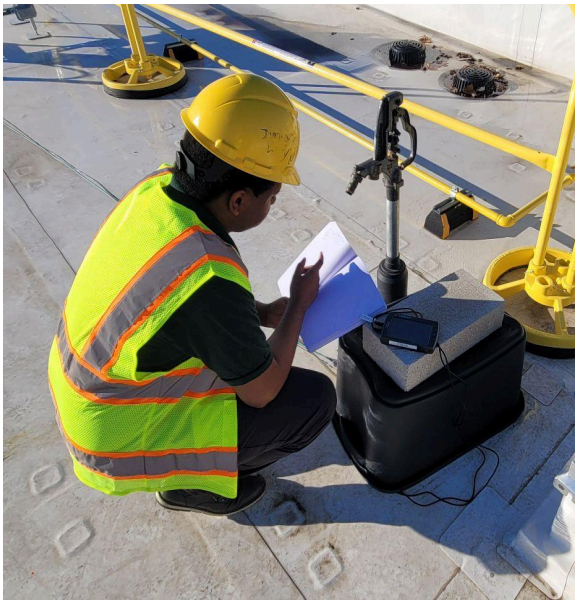


			Soil Moisture (%)			Wind Speed (m/s)						
Time:	Date	Soil depth (in)	Infront	Under	Behind	Low	High	Wind Wattage (mW)	Wind Amperage (mA)	Wind Voltage (V)	Humidity (%)	Percipitation (cm)
1 hour	Oct 7, 2024	2	3.2	4.3	4.1	0.7	0.8	0.1	2.8	0.05	51.4	0
1 hour, 10 mins	Oct 8, 2024	2	2.6	2.9	2.3	0.2	0.4	0.1	2.7	0.007	50.3	0
30 mins	Oct 9, 2024	2	1.7	1.9	1.9	0.9	1.2	0.1	2.9	0.05	66.5	0
30 mins	Oct 14, 2024	2	13.9	17.7	22.2	2	2.4	39.1	3.8	9.45	N/A	0
30 mins	Oct 15, 2024	2	6.2	6.9	8.1	1.2	1.4	0.2	4.2	0.05	42	0
30 mins	Oct 16, 2024	2	6.6	6.3	5.5	1	1.3	0.2	3.5	0.8	57.6	0
30 mins	Oct 17, 2024	2	6.5	5.8	8.8	0.01	0.002	0.5	3.7	0.1	N/A	0
30 mins	Oct 18 2024	2	7.2	6.8	8.9	0.1	0.2	0.5	2.2	0.24	65.4	0
30 mins	Oct 21 2024	2	4.3	5.6	4.3	1	1.5	0.4	3.2	0.11	48.1	0
30 mins	Oct 23 2024	2	5.1	5	4.6	1.2	1.5	0.3	2.6	0.09	48.1	0
30 mins	Oct 24 2024	2	4.4	4.6	5.7	0	0.1	0.2	3.9	0.07	55.6	0
30 mins	Oct 25 2024	2	6.2	3	5.7	0.1	0.5	0	3.3	0.1	92.4	3.4
30 mins	Oct 28 2024	2	4	4.8	5	6.7	6.9	4660.5	941	5.09	39.8	0
30 mins	Oct 31 2024	2	4.3	4.2	5.7	n/a	n/a	n/a	n/a	n/a	71.5	0
30 mins	Nov 1 2024	2	3.6	3.2	4	0.5	1.1	n/a	n/a	n/a	59.5	0
30 mins	Nov 6 2024	2	17.3	10.1	20.7	1	1.3	0.1	1.4	0.05	77.3	9.2
30 mins	Nov 8 2024	2	6.2	3.5	5	1	1.3	0.3	33.2	0.09	N/A	0
30 mins	Nov 11 2024	2	8.8	4.6	11.3	0.9	1.6	0.1	1.5	0.05	N/A	12.4
30 mins	Nov 12 2024	2	8	4.3	4.3	1.1	1.4	0.1	1.8	0.06	64.6	0
30 mins	Nov 13 2024	2	8.8	3.4	9.2	2.2	2.6	0.2	4.7	0.05	59.5	0
30 mins	Nov 14 2024	2	8	4.7	23	0.5	0.7	0.2	4.2	0.04	88.5	13.2
30 mins	Nov 15 2024	2	10.5	5.6	14.1	1.3	1.6	0.3	4.7	0.06		2.8

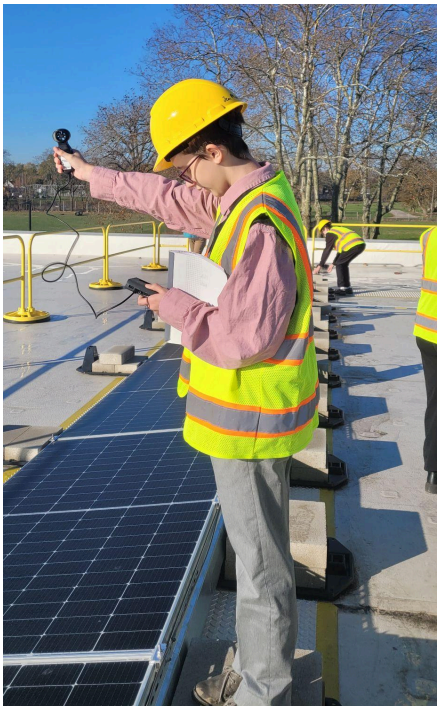

Wind Speed (m/s)
0
1
2
3
4
5
6
7
8
5
10
15
20
Behind Soil Moisture (%)


Wind Speed (m/s)
0
1
2
3
4
5
6
7
8
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Under Soil Moisture (%)


Wind Speed (m/s)
0
5
10
15
20
1
2
3
4
5
6
Front Soil Moisture (%)




Anemometer
ANM-BTA



Conclusion

Upon conduction of a series of tests near school grounds using wind speed, precipitation, and soil moisture–It was found that wind speed only has a small effect on the amount of soil moisture found in the ground. Precipitation was the middle ground factor that helped determine this result. Along with the small correlation between soil moisture and wind speed, is the belief that this data is able to be used for determining the average moisture in plants for agricultural purposes.

Message of Hope: While weather is changing due to emissions causing climate change, this research contributes to the solution.

Badges

I am a Student Researcher - The project has been submitted to the IVSS.

I am a Data Scientist - There are multiple labeled graphs and the correlations of the graphs and their data are explained in the results and conclusion sections.

I work with a STEM Professional - The project was done with the help of multiple mentors, such as Grant Wilson of UT and Geoff Bland of NASA.

Acknowledgments

Mrs. Kubiak-Solar Wind Energy Instructor, Mr. Richardson-Solar Wind Energy Co-instructor/Instructor, Mr. Best-Composition Instructor, Ms. Kania-Algebra Instructor, Mission Earth-Project Hosts, University of Toledo team, Grant Wilson-Guest, NASA AREN Project, Geoff Bland- NASA Scientist

References

Peretti, M., Spennemann, P. C., & Long, M. E. F. (2023). Trends in soil moisture content and water deficits in Argentina and the role of climate contribution. Theoretical & Applied Climatology, 152(3/4), 1189–1201. https://doi.org/10.1007/s00704-023-04428-x

Li, X., Ren, G., You, Q., Wang, S., & Zhang, W. (2021). Soil Moisture Continues Declining in North China over the Regional Warming Slowdown of the Past 20 Years. Journal of Hydrometeorology, 22(11), 3001–3015. https://doi.org/10.1175/JHM-D-20-0274.1