Investigating the Effect of Soil Moisture on Net Ecosystem Exchange in Shale Hills

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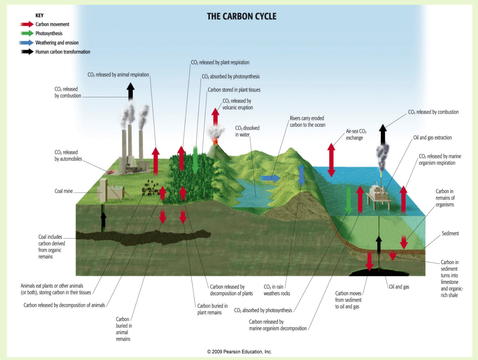
INTRODUCTION

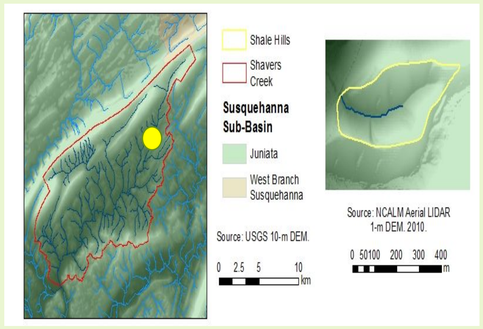
- The terrestrial biome acts as a large sink for the greenhouse gas carbon dioxide(CO_2)..
- The ability of this biome to act as a carbon sink is dependent upon environmental factors.
- **Hypothesis: The net ecosystem exchange(NEE) will become more negative as soil moisture increases, i.e., the forest will absorb more carbon dioxide when the soil is more moist.**
- This will help in understanding the processes, such as respiration and photosynthesis, that govern the carbon cycle in the terrestrial biome.



Source(https://www.e-education.psu.edu/meteo469/node/160)
Figure 1: Showing carbon cycle

AREA OF STUDY

- Shale Hills is a forested, first-order catchment of shale bedrock. It has an area of about 0.08 km^2, and is located in the central Pennsylvania.
- The climate represents a humid continental climate. The vegetation cover of Shale Hills is dominated by deciduous broadleaf forest, with some evergreen needle-leaf trees along the stream.



Source: (Shale Hills CZO Website)

DATA AND METHODS

- Data was collected from the Shale Hills CZO website then manipulated and analyzed using MATLAB and Minitab.
- Data for May to August from 2011-2016 was used in this study. Additionally, this study focused on times between 10a.m. and 4p.m.




Figure 3: Measurements of carbon flux, photosynthetically active radiation(PAR) and temperature were taken from the flux tower.
Flux Tower
Figure 4: Soil moisture was obtained from the COSMOS Probe.
COSMOS Probe (data courtesy of Dr. Marek Zreda)
Figure 5: Respiration carbon fluxes were obtained from an automated respiration chamber located on the lower northwest side of the slope.
Automated Soil Respiration Chamber (data courtesy of Dr. David Eissenstat and Dr. Thomas Adams)
Figure 6: Sap flow was used an indirect measure of photosynthesis
Sap Flow Instrumentation (data courtesy of Dr. David Eissenstat and Dr. Thomas Adams)

RESULTS

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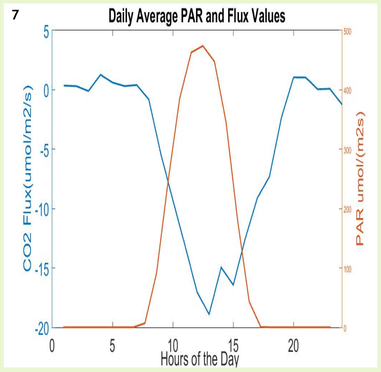

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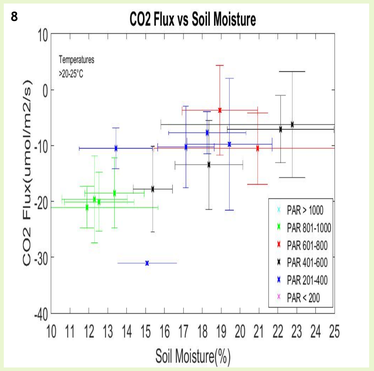

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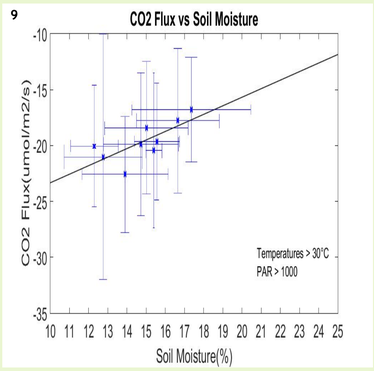

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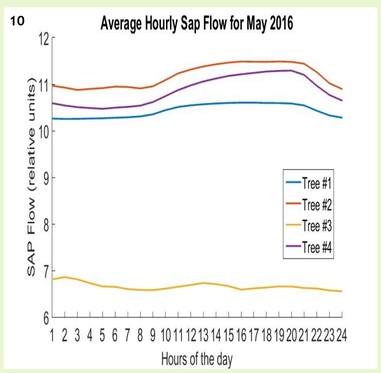

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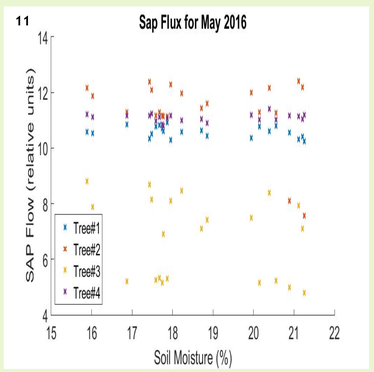

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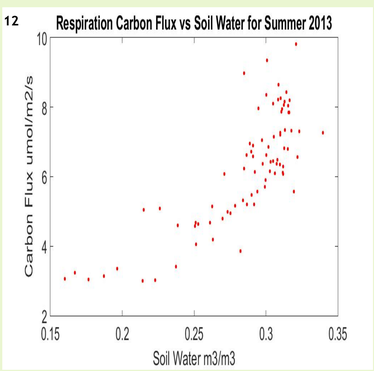

- PAR has an effect on the amount of CO_2 released in a forest. An increase in PAR resulted in more absorption of carbon dioxide(carbon flux become more negative), [see Figure 7]. To study the effect of soil moisture on NEE, temperature and PAR were isolated and sorted into similar groups(since they both have an effect on fluxes). More carbon dioxide was released (carbon fluxes become more positive) in wetter soils, [see Figure 8 & 9], [see Table 1 for significance of slopes].
- To further investigate this, the effect of soil moisture on photosynthesis and respiration was looked at separately.
- Sap flow showed an increase during the afternoon hours for all four trees (times when photosynthesis is most active), [see Figure 10]. Generally, sap flow general decreased with increasing soil moisture, [see Figure 11], [see Table 2 for significance of slopes].
- Respiration increased and more carbon dioxide was released with increasing soil moisture, [see Figure 12].

STATISTICS

The following values were obtained using a P-value at a 90% confidence interval to see if the slopes produced were statistically significant.

PAR (umol/m²s)	Temp < 15 (°C)	Temp 16-20 (°C)	Temp 21-25 (°C)	Temp 26-30 (°C)	Temp >30 (°C)
> 1000	NED	NED	NED	NED(-)	0.026(+)
801-1000	0.749(+)	0.586(+)	0.072(+)	NED(-)	NED
601-800	0.03(+)	0.776(+)	NED	NED	NED
401-600	0.076(+)	0.145(+)	0.001(+)	NED	NED
201-400	0.152(+)	0.35(+)	0.485(+)	NED	NED
<200	0.609(+)	0.974(+)	NED	NED	NED

Table 1: P-test for NEE flux values

Trees	P-Value
1	0.157(-)
2	0.092(-)
3	0.27(-)
4	0.575(-)

Table 2: P-test for sap flow values

Guide:
NED = Not Enough Data
= did not satisfy 90% confidence interval
= satisfied 90% confidence interval
= close to satisfying 90% confidence interval
(-/+) = direction of slope

CONCLUSION

- Generally, NEE fluxes became *more positive* with increasing soil moisture, therefore wetter soils *reduced the ability of this forest to act as a carbon sink*. This is counter to the initial expectation.
- Sap flow decreased with increasing soil moisture.
- Respiration increased with increasing soil moisture.

FUTURE PROJECTS

- Compare the results from the data collected with results obtained from the model Biome-BGC
- Look at the effect of soil moisture on sap flow for different tree species.
- Investigate the relationship between COSMOS soil moisture and in situ measurements.

REFERENCES

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ACKNOWLEDGEMENTS

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