The effects of solar construction on soil respiration dynamics in former forest and agricultural land

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Introduction

- According to the Solar Energy Industries Association (SEIA), Massachusetts currently has 3,607.36 MW installed (408.52 MW total in 2020)
- Continuing this rising trend of solar development for 2050 could lead to a loss of 150,000 acres of land (Ricci, E. et al)
- As we make the move toward "clean" energy, it is important to consider effects of solar construction on soil microclimates
- This study examines soil respiration rates, carbon dioxide (CO_2) released from the decomposition of organic material, and root metabolism, across different land types within a solar site
- This can provide a consideration for future solar implementation, in terms of location

Figure 1: Aerial view of site before solar construction

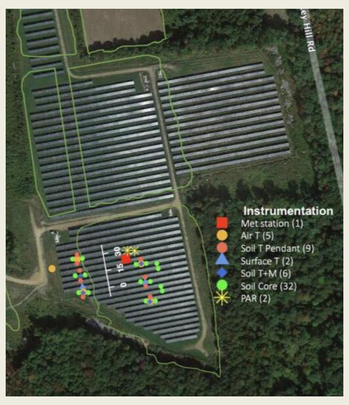

Figure 2: Solar site after construction of array in 2017 (former forest and agricultural land)

Figure 3: Solar site picture

Results

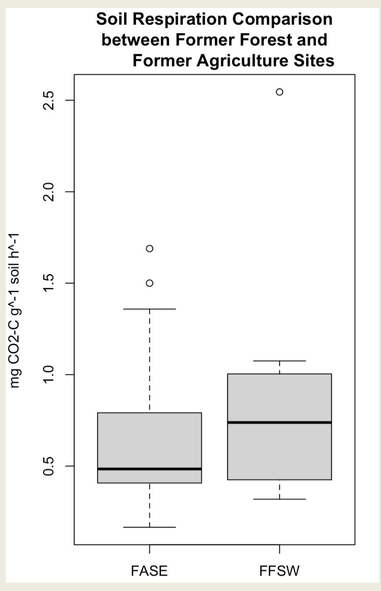

Figure 6: Higher soil respiration rate in sampling from former forest than former agricultural land

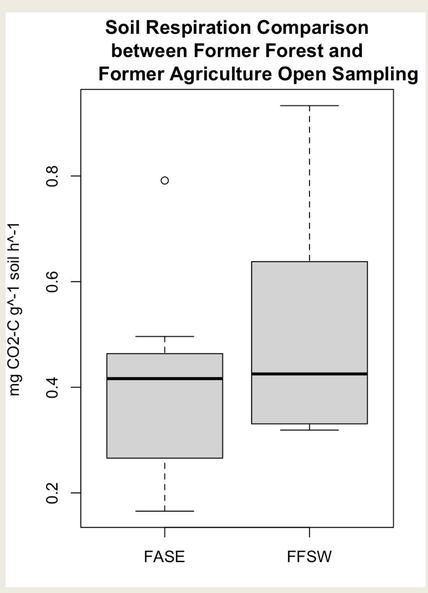

Figure 7: Higher soil respiration rate in FF Open than FA Open

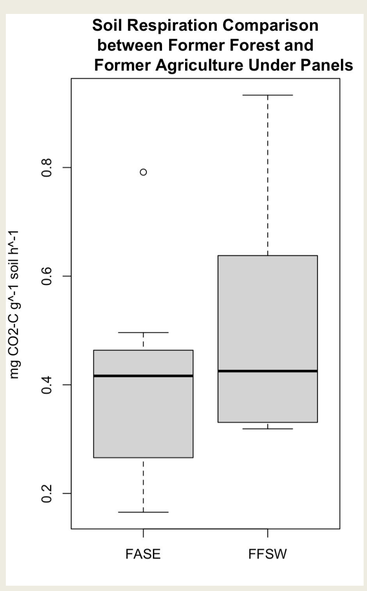

Figure 8: Higher soil respiration rate in FF Under than FA Under

groups	diff	p adj	sig
FASE_under-FASE_open	-0.4497719	0.1598909	
FFSW_open-FASE_open	0.3165827	0.5109046	
FFSW_under-FASE_open	-0.343949	0.4402336	
FFSW_open-FASE_under	0.7663546	**0.0161844**	*
FFSW_under-FASE_under	0.1058229	0.9695613	
FFSW_under-FFSW_open	-0.6605317	**0.066233**	*

According to a Tukey's HSD test, there is a significant relationship between:

1. FF Open and FA Under
2. FF Under and FF Open

Also, respiration under the solar panels is almost identical in both sites

Methods

Jar Incubation Method

- Bulk density was calculated by sieving and separating the soil by three properties
  - Soil
  - Roots
  - Rocks
- All samples are weighed and a recorded/known value of soil is placed in a tin
- Tin is placed in sterile jars to incubate in intervals of 15 minutes (0, 15, 30, 45, 60) to measure respiration rate
- Each jar is labeled depending on soil classification
  - Former land use (agriculture or forest)
  - Coordinates indicate location
  - Taken in the open or under solar panel
  - OA or A Horizon

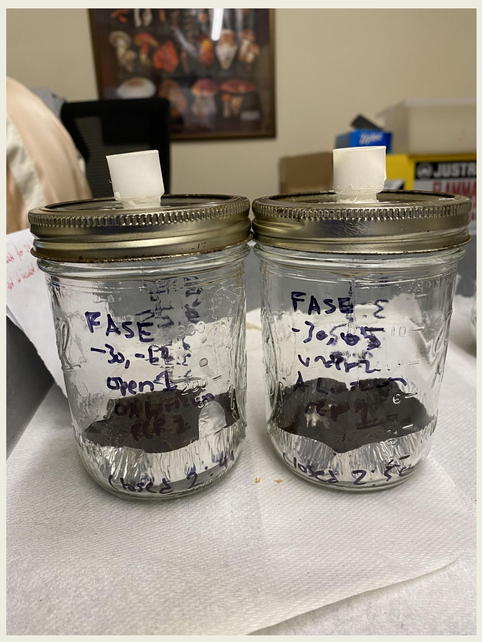

Figure 4: Setup of Jar Incubation Method

Method of Measuring Microbial CO_2 Respiration

- When the ambient CO_2 level stabilizes, measure initial CO_2 in jar (using a 10 mL syringe)
- In intervals of 15 minutes, measure CO_2 in jar - data was recorded on computer via GAS software

Figure 5: Setup for Collecting Soil Respiration Data (CO_2 ppm) Using an IRGA (Infrared Gas Analyzer)

Discussion/Conclusions

- Results show that soil respiration rate in samples taken from former forest land is higher than those taken from former agricultural land (Figure 6)
- Soil respiration was higher in FF Open and FF Under than FA Open and FF Under (Figures 7 and 8)
- Before future implementation of solar panels, it is important to consider potential effects on the environment
  - Solar panels constructed in former forest lands requires trees to be removed
  - Vegetation removal releases above ground stored carbon into the atmosphere and prevents future carbon sequestration
- When considering locations for solar deployment, former land use will have long-lasting effects on the soil carbon dynamics
  - CO_2 emissions can be minimized by selecting non-forested sites
- Higher soil respiration rate = more CO_2 emitted into the atmosphere
  - In undisturbed forests ecosystems, vegetation photosynthesis absorbs a large portion of soil respiration
  - In disturbed ecosystems, such as the solar site in this study, once the trees were removed, the carbon equilibrium was disturbed

References

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