The impact of roads on peatland carbon dynamics

Róbert Ívar Arnarsson (robert@nattsa.is)

South East Iceland Nature Research Center

Introduction

Peatlands are important. They provide numerous ecological services such as habitat for a great deal of biodiversity and as carbon sinks. Hydrology plays an important role in peatland function and the disruption of peatlands, including hydrology, can lead to degredation of its ecological services. This study investigates the impact of a recently constructed road (<5 years) on the carbon dynamics of a peatland in Mýrar, Hornafjörður (figure 4).

This study asks the following questions:

1. Does road presence increase CO_2 emissions from peatland soil?

2. Does road presence influence mineral content in peatland soil?

3. Does road presence influence the soil water table?

Methods

4 transects were selected (figure 1), which were divided by the road into north and south segments. Soil respiration was measured at 6 points (0, 2, 5, 10, 30 and 60 meters) and soil hydrological and physical properties were sampled at 4 points (0, 5, 30 and 60 meters). Soil respiration was measured using PP-Systems EGM-5 CO_2 analyzer and mobile collars. Total emitted CO_2 was recorded after 2 minutes. Hydrological measurements were recorded from dug pits left to fill over time. Also from the pits bulk density samples were harvested using a soil corer and processed with loss on ignition (550°C).

Response variables (CO_2 ppm, watertable depth, soil carbon content and volume) were analyzed using linear models in R using roadside (North vs south), proximity to road and their interactions as predictors. The model was then ran through a type III ANOVA test to assess the significance of the results. Log transformation of CO_2 results was applied to improve normality. All statistical analysis were done in R (v. 4.4.2).

Results

- CO_2 emissions were significantly higher on the south side of the road ($F = 32.85$, $p < 0.0001$) (figure 2).
- CO_2 emissions were significantly impacted by proximity on the south side of the road ($F = 4.23$, $p = 0.0417$) (figure 2).
- CO_2 emissions were not significantly impacted by proximity alone ($F = 0.14$, $p = 0.7117$).
- Watertable height was not significantly impacted by side ($F = 2.35$, $p = 0.1276$), proximity ($F = 1.6$, $p = 0.2079$) nor side:proximity ($F = 2.09$, $p = 0.1511$) (figure 3).
- Carbon stock was not significantly impacted by side ($F = 0.66$, $p = 0.4207$), proximity ($F = 1.66$, $p = 0.2009$) nor side:proximity ($F = 0$, $p = 0.9860$) (figure 3).
- Carbon content was not significantly impacted by side ($F = 0.1$, $p = 0.74788$), proximity ($F = 3.4$, $p = 0.06963$) nor side:proximity ($F = 1.6$, $p = 0.20577$) (figure 3).

Conclusion

CO_2 emissions were impacted by the road construction in a significant way. One side shows a clear trend of increased emissions in proximity to the road, reducing with distance. Although none of the results can explain this, it was evident through observation that the road construction disturbed hydrological processes through impediment and pooling of water was observed on the north side in close proximity to the road (>0 cm) while the south side retained water in the top soil horizons (=<0 cm). It is possible that the soil hydrology is not an influencing factor and that the north-side pooling acts as a dampener on the soil respiration while the south-side displays the true impact of the road construction. Soil carbon was not significantly affected although a weak trend is seen with increasing carbon stocks with distance from the road. It is possible that this is due to an influx of mineral material into the soil or as a result of increased emissions. Further research is needed to sufficiently determine the exact cause of the increased CO_2 emissions.

Funded by the Icelandic Road and Coastal Administration Research Fund.

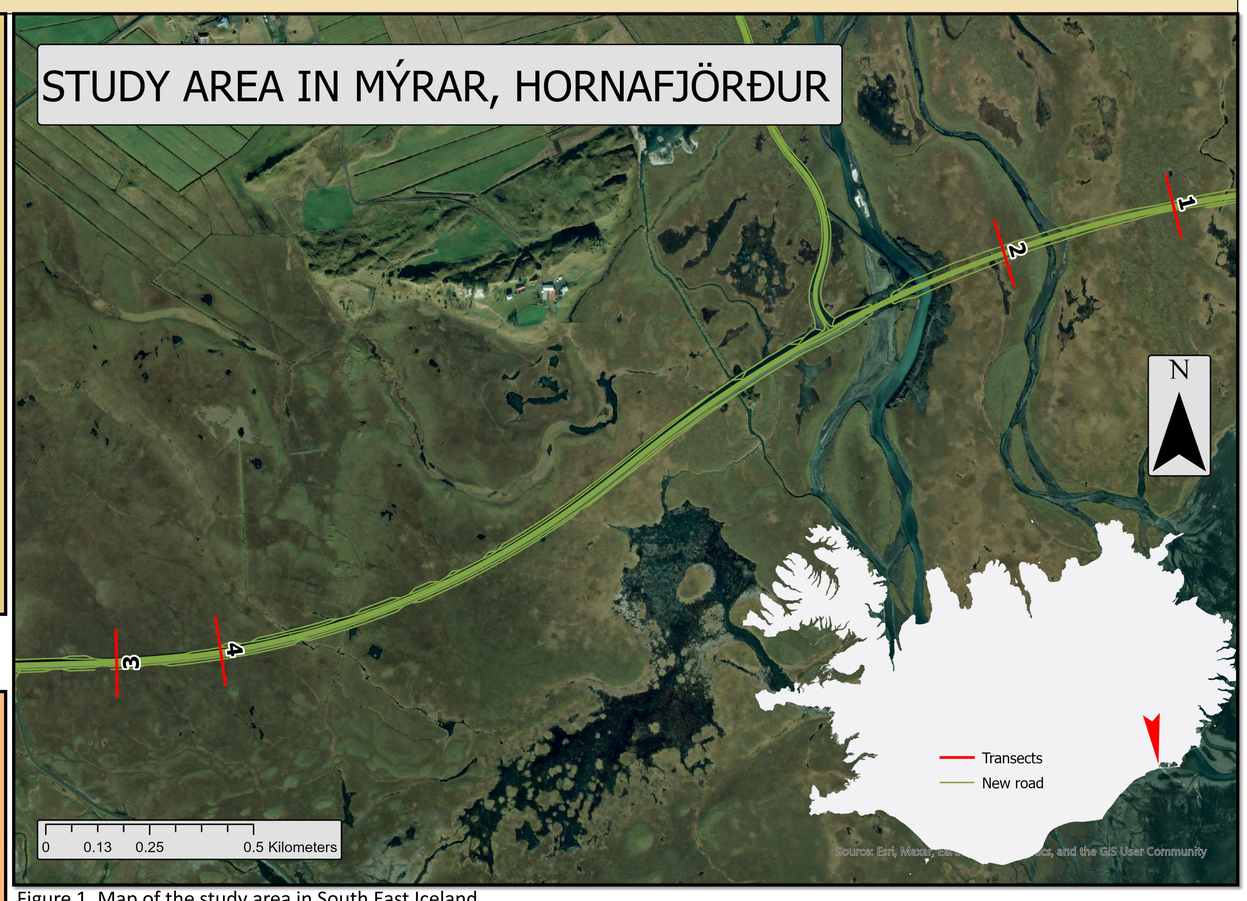

Figure 1. Map of the study area in South East Iceland.

Effect of side and distance from road on soil respiration

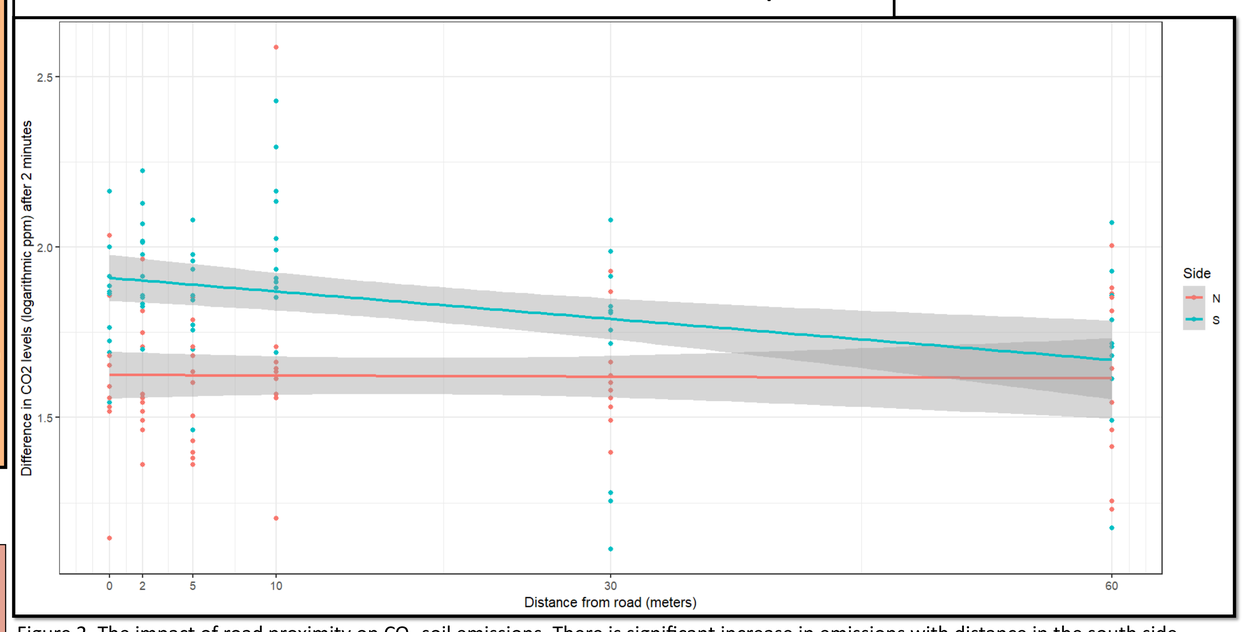

Figure 2. The impact of road proximity on CO_2 soil emissions. There is significant increase in emissions with distance in the south side.

Water table and soil carbon vs side and distance from road

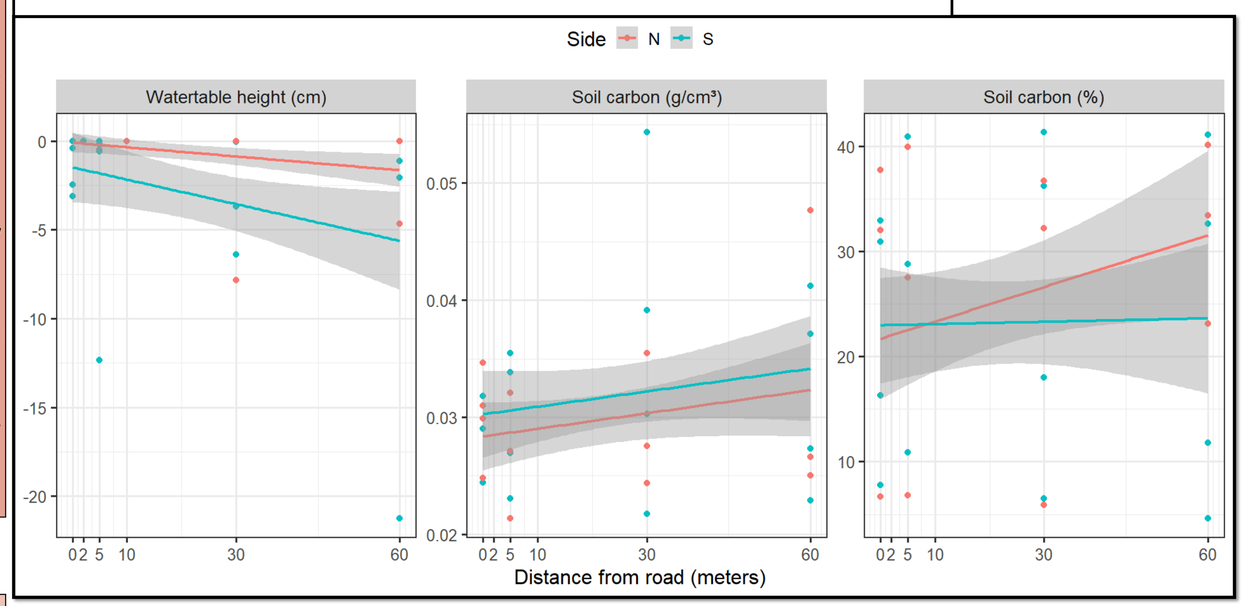

Figure 3. The impact of proximity to the road on water table height, soil carbon stocks and content. The results shown are all insignificant but soil carbon stocks indicate a weak trend with increased stocks with distance from road.

Figure 4. An aerial photograph of the road construction and the impacted peatland. Photo by Lilja Jóhannesdóttir/South East Iceland Nature Research Center (2021). Roadwork is near finished today.