PROJECT INFORMATION

Project title:	**Temporal trends of soil carbon stock in intact systems and the role of climate**
Project ID:	297
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PROJECT DESCRIPTION

Motivation

Rising levels of carbon dioxide (CO2) and other greenhouse gases in the atmosphere are the main contributors for today's climate change. During the recent decades, ecosystems on land have acted as a natural carbon sink that absorbs about 30% of human-caused CO2 emission. Soil represents the largest terrestrial organic carbon pool and has enormous potential for mitigating climate change. However, how much of the carbon sequestered on land is accumulated in soils as opposed to vegetation biomass is uncertain, and there is still no consensus on the net effect of climate change on soil carbon storage in recent decades. Questions remain to be answered include: Are global soils a sink or a source of carbon dioxide? Which ecosystems sequester more carbon in soils and why? While some studies suggest that rising levels of CO2 may enhance vegetation growth, increasing carbon inputs into soils and mitigating climate change, others suggest that global warming may stimulate soil respiration, releasing CO2 back to the atmosphere. Because soil carbon sequestration has significant potential as a cost-effective solution to climate mitigation, these knowledge gaps limit our ability to develop effective global change strategies.

Aims

To address these questions, my project seeks to analyze the temporal changes in soil carbon stocks in recent decades, with ongoing rising levels of carbon dioxide and global warming. By collecting hundreds of published field measurements and applying machine learning techniques, I plan to map out the change in soil carbon stock globally. Our result aims to quantify the amount of carbon absorbed by soil in recent decades, identify hotspots for carbon sequestration, analyze the drivers for soil carbon accrual in natural ecosystems, and provide insights to the effect and potential of different soil carbon sequestration practices with high-resolution predictions.

Current work

To inform the changes in soil carbon (C) under climate change, we are developing the first global dataset that features long-term observations and repeated samplings of soil carbon at hundreds of sites in different undisturbed natural ecosystems. We have already gathered data of over 1000 entries representing more than 260 sites from published databases and literature, and have expanded our search by reviewing over 2500 relevant peer-reviewed articles from our online search. We hope this dataset can fill the gap in existing global soil datasets, which mainly focus on one-time measurements of soil organic carbon and do not provide information to understand soil carbon accrual or loss. Our preliminary results show that grassland experienced a significant increase in soil carbon in recent years compared to forest, possibly because of the large amount of carbon partitioning into grassland root systems.

Future work

After constructing the dataset, we will employ statistical tools to investigate the relationships between SOC accrual rate and various covariates, such as temperature, precipitation, soil type, ecosystem type, and soil nitrogen content.

We will use techniques such as Random Forest and Neural Network to train a machine learning model with our dataset as input. This model will enable us to predict the change in SOC stocks at any applicable location in the world in the form of a high-resolution map. Since the SOC accrual rate is expected to vary significantly depending on local environmental factors, our high-resolution predictions will allow us to quantify the total amount of carbon absorbed by soil over the recent decades with relatively low uncertainty, improving our understanding of the global carbon cycle.

Our high-resolution map will enable us to investigate the effect of soil carbon sequestration in two ways. First, we can identify three types of zones: carbon sequestration zones that are absorbing carbon in soil due to climate change, carbon loss zones that are already experiencing soil carbon loss, and vulnerable zones that will likely lose carbon soon if not intervened. Second, by combining our results with recent land use maps, we can more precisely quantify the carbon emissions that could be avoided if natural ecosystems in a particular location are not converted into other land uses.

Broader impacts

We will create the first open-access global dataset for the temporal change in soil carbon content, which will enable researchers to answer additional questions in soil carbon dynamics. We will aim to publish the results in a high impact journal to increase the awareness of soil as a climate solution. Our findings will offer policymakers and land managers insights into implementing soil carbon sequestration practices.