EGU2020-18446
https://doi.org/10.5194/egusphere-egu2020-18446
EGU General Assembly 2020

Soil organic carbon dynamics as affected by climate warming in a semiarid alpine region

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An evaluation to soil organic carbon (SOC) stock dynamics in alpine regions is crucial for the adaptive management of regional carbon budget under the elevation-dependent warming in mountainous regions. Here, we evaluated the dynamics of SOC stock to 60 cm depth in the Qilian Mountains (1700~5100 m a.s.l.) by combining systematic measurements from 138 sampling sites with a machine learning technique (i.e. random forest, RF). Our results revealed that the combination of systematic measurements with the RF model allowed spatially explicit estimates to be made. The average SOC density (SOC amount per unit area, SOCD) in the middle Qilian Mountains will decrease under future climate change. However, the size and direction of carbon change are elevation- or vegetation-dependent. Specifically, in comparison with the baseline year (1970~2000), the mean annual precipitation will increase by 18.37, 19.80 and 30.80 mm, and the mean annual temperature will increase by 1.9, 2.4 and 2.9°C, respectively, under the RCP2.6 (representative concentration pathway), RCP4.5 and RCP8.5 scenarios in 2050s. Accordingly, the mean SOCD decreased by 0.59, 0.93 and 1.05 kg C m^{-2}, the SOC stock decreased by 6.23, 9.75 and 11.07 Tg C, respectively under the RCP2.6, RCP4.5 and RCP8.5 scenarios. In addition, the mid-elevation zones (3100-3900 m), especially the subalpine shrub-meadow zone, will be characterized by the strongest carbon loss due to the high standing organic carbon stock under climate warming. By contrast, the high elevation zones (> 3900 m), especially the alpine desert zone, which will experience increase in accumulative temperature, prolongation in growing season, and consequently enhancement in plant productivity due to future climate warming, will be characterized by significant carbon accumulation in the future. Thus, the mid-elevation zones, especially the subalpine shrub-meadow zone should be given priority in terms of reducing CO_2 emissions under future warming in alpine regions.