Geophysical Research Abstracts
Vol. 19, EGU2017-2519, 2017
EGU General Assembly 2017

Mechanisms control the soil organic carbon loss with grassland degradation in the Qinghai-Tibet Plateau

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Grassland in the Qinghai-Tibet Plateau (QTP) provides tremendous carbon (C) sinks and is the important ground for grazing. Grassland degradation, the loss of plant coverage and the emergence of sand activities, results in substantial reduction in soil organic carbon (SOC). To demonstrate the specific degradation pattern of SOC and elucidate underlying mechanisms, a sequence of five degradation stages over the whole grassland in the QTP were investigated. The survey and laboratory data were analyzed by three structural equation modeling (SEM) analysis. One of the analysis focused on the biological processes while the other two included both the biological and physical processes. Soil temperature had no significant change but soil moisture decreased in all layers. The above and the below-ground plant production decreased and the dominant plant functional group shifted from sedge and grass to forbs. The SOC concentration declined about 40-50% in the very severely degraded comparing with intact alpine grassland.All the three models were successfully fitted with R2 about 0.50. Three biological processes can explain the SOC change. The decrease in soil moisture suppressed C output through soil respiration (Rs) thus lower the SOC loss with land degradation. Decline in the plant production due to a decrease in coverage or to the change in relative abundance of sedge, forbs and grass directly or indirectly reduce the C input and finally lead to the 40-50% loss in SOC.
The significant pathways from soil microclimate and soil properties to SOC in the black box model, only one significant pathway from soil properties to SOC indicate that physical processes like the wind and water erosion might control the SOC loss with land degradation in the alpine grassland in the QTP.