Geophysical Research Abstracts
Vol. 21, EGU2019-2645, 2019
EGU General Assembly 2019

Application of the magnetic susceptibility to soil erosion estimation

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Soil loss is a global environmental issue, which has threaten food production and farmer living in the developing countries especially. In order to control soil loss effectively, the quantitative assessment of soil erosion is necessary. Traditionally, the data on soil loss can be collected by field plot observing, radionuclide tracing, rainfall simulating, remote sensing, field surveying and so no. Although plot observation and radionuclide tracing have been main method to collect soil loss data, it is difficult to link soil loss and soil redistribution that occurred during the earlier cultivation history using plot monitoring or costly 137Cs technique owing to plot maintenance or half-life period limitation. Sometimes, soil loss estimation in century-scale is necessary to understand the erosion process and its dominant trigger in a given region. Fortunately, magnetic susceptibility measurement can provide an economical tool to quantify soil loss over a large area and over a long cultivation duration. The objective of our studies is to identify soil redistribution patterns and to estimate soil loss rate using magnetic susceptibility in northeast China. The northeast China is an area covered by black soil with a rich-humus topsoil and a main food production region in China. However, soil loss has been significant intensified in decades owing to the intensive tillage activities. Compared with other region of China, the tillage history is shorter and easy to be dated in northeast region, which is significant to estimate erosion rate using magnetic susceptibility. To tracing soil loss using magnetic susceptibility, two verification are needed. Firstly, whether the distribution of magnetic susceptibility is coupled with soil erosion rate on a given slope. Secondly, whether the change of magnetic susceptibility is coupled with soil erosion rate on slopes with different cultivation period. If the above two steps obey the expected knowledge, magnetic susceptibility can be adopted to evaluate soil loss as a tracer. Based above ideas, farmlands with different cultivation period were selected and more than 4000 samples in total were collected on farmlands and reference sites using Eijkeamp aguer, and soil magnetic susceptibility of samples were measured using a Bartington Magnetic Susceptibility Meter (MS2) and dual frequency sensor (MS2B). The results showed that: 1) Soil magnetic susceptibility indicated similar pedogenic processes and minor soil redistribution on the reforested slope, while primary erosion and deposition slope segments on the cultivated slope. 2) In our case, magnetic susceptibility increased markedly in the topsoil on the forest slope, whereas the the difference in magnetic susceptibility between the topsoil and subsoil became increasingly slight on cropland slope with increasing in cultivation period. 3) An annual erosion depth of 1.1 cm and an annual deposition depth of 0.9 cm were calculated using magnetic as a tracer for a farmland with 40 years cultivation period. This amount corresponds to a soil loss rate of 4630.5 t/km2/yr. Finally, our case studies support strongly soil magnetic susceptibility as a tracer to estimate soil loss in century time scale for no data region.