



Spatial variability of ^{137}Cs -driven total soil erosion rate and its driving factors at regional scale: a meta-analysis in China's Loess Plateau

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Soil erosion, contributing to land degradation, was identified as an essential driving factor for the evolution of Earth's critical zone. Although runoff plots along the slope and weirs on river valleys are often used to monitor short-term soil and water loss, it is usually difficult to evaluate the long-term soil loss rates across spatial scales. The ^{137}Cs tracer can effectively measure the long-term soil erosion rates but its capability to quantify regional soil erosion characteristics and the driving mechanisms remains a big challenge. To deal with this gap, we integrated and synthesized 61 peer-reviewed articles of soil erosion research by using ^{137}Cs tracer methods in the Loess Plateau of China to reveal the regional variability of soil erosion and the effects of land uses on (a) reference ^{137}Cs inventory, (b) ^{137}Cs soil profile distribution and (c) ^{137}Cs -derived total measured erosion rate. The results showed that reference ^{137}Cs inventory range from 900 to 1750 Bq/m² with a mean value of 1351 Bq/m². The reference ^{137}Cs inventory decreased significantly with the increase of latitude and longitude ($p < 0.001$), while it didn't change obviously with the mean annual precipitation and temperature. The assumption of ^{137}Cs tracing method was supported by ^{137}Cs soil profile distribution under tillage and un-disturbed land. Tillage land was considered to have uniform distribution in soil profile and a similar exponential distribution of ^{137}Cs content can be found in terrace and no-tillage land. Furthermore, ^{137}Cs loss percent had a significant positive relationship with soil erosion rate ($p < 0.001$). Average long-term soil erosion rate of cropland was more than 15000 t/(km²·a) and significantly higher than no-tillage land (5462.52 t/(km²·a) including that of grassland (3890.86 t/(km²·a)), forest (>6000 t/(km²·a)), and terrace (<5000 t/(km²·a)) ($p < 0.001$). The average long-term soil erosion rate of cropland presented high spatial variability and loess hill and gully region had significantly higher average long-term soil erosion rate on cropland due to the coupling effects between heavy rainfall and steep slope. Appropriate reference sites and soil erosion conversion models were important factors for accurately quantifying the long-term soil erosion while the variation of climate, land uses, and geomorphic types had significant impacts on the spatial distribution of erosion rates. Our study can facilitate

the understanding of the ^{137}Cs tracing method for long-term soil erosion rate and its spatial pattern, which can be supportive for soil and water conservation planning and relevant policy-making.