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

Jian Hu[1], Da Lü[2,3], Yihe Lü[2,3], Bojie Fu[2,3], Alexis J Comber[4], Lianhai Wu[5], Paul Harris[5]

[1] Institute of Qinghai-Tibetan Plateau, Southwest Minzu University, China ;

[2] State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China;

[3] University of Chinese Academy of Sciences, Beijing, China;

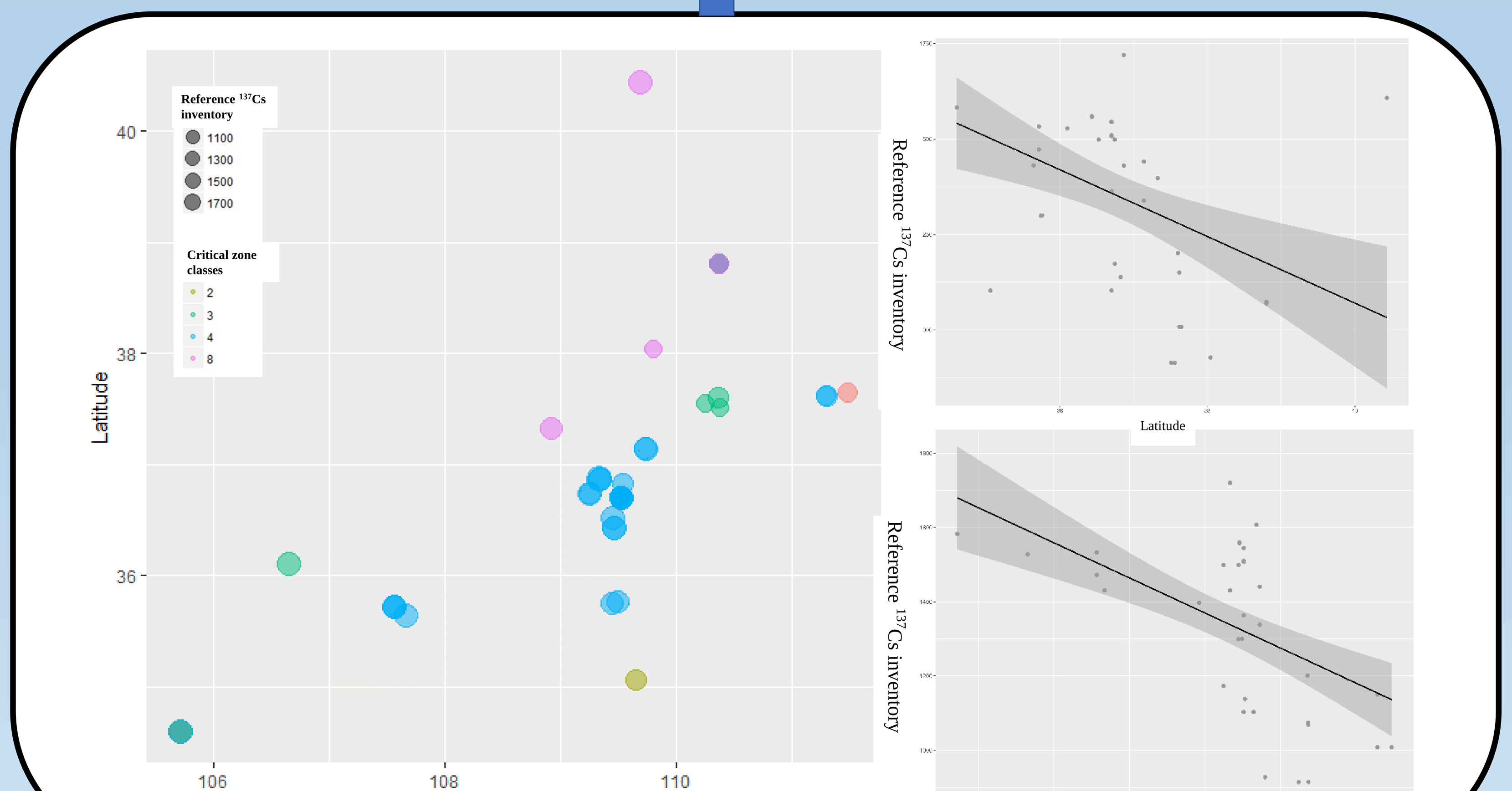
[4] Leeds Institute for Data Analytics (LIDA) and School of Geography, University of Leeds, UK;[5] Sustainable Soils and Grassland Systems Department, Rothamsted Research, UK

Introduction

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. In order to dealing with this gap, we conducted a meta-analysis for 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 ^{137}Cs-derived total erosion rate.

The spatial distribution of reference ^{137}Cs inventory

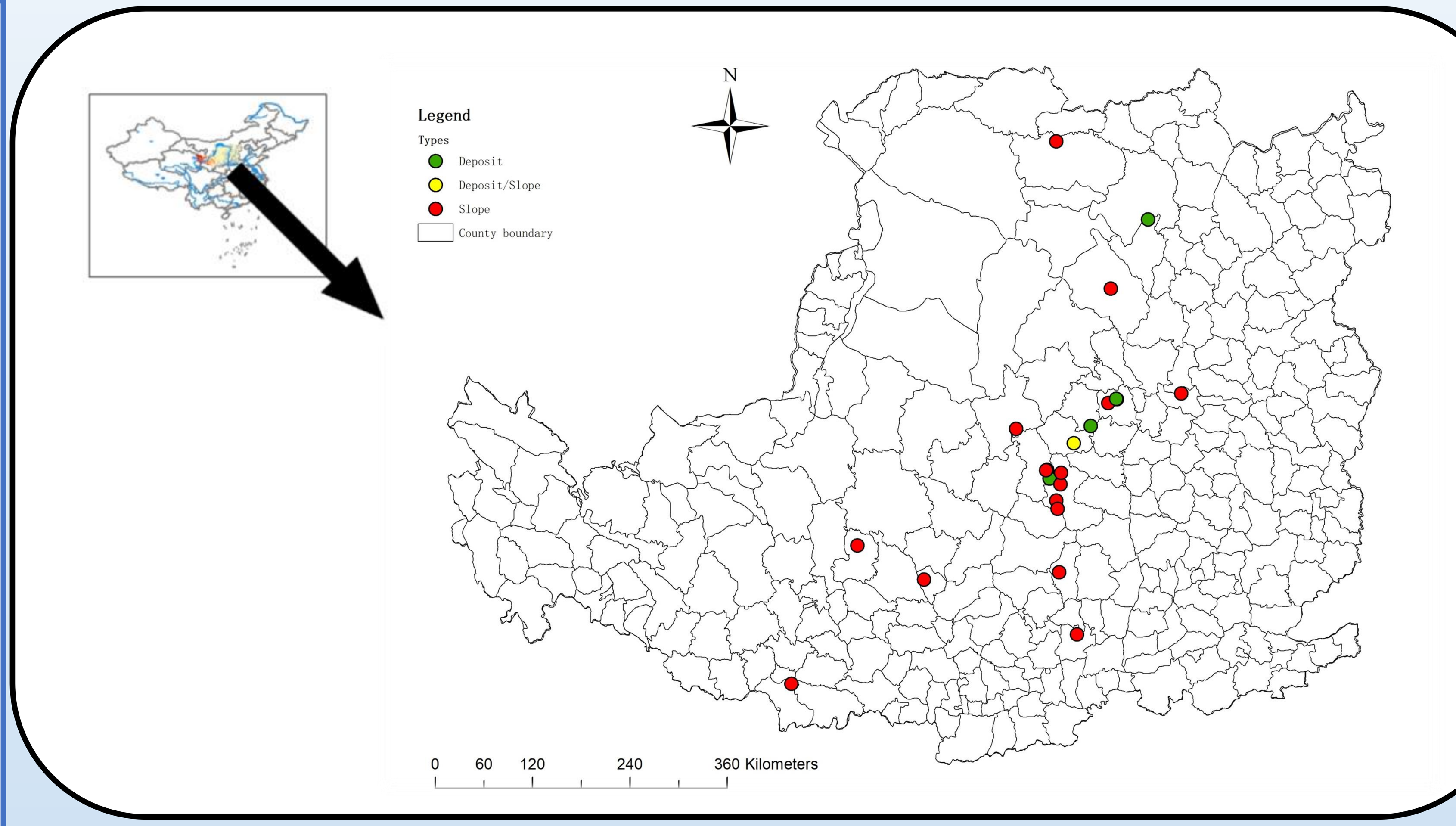
The reference ^{137}Cs inventory range from 900 to 1750 Bq/m^2 with the mean value of 1351 Bq/m^2. The reference ^{137}Cs inventory decreased significantly with the increase of latitude and longitude (P<0.001), while it didn't change obviously with the mean annual precipitation and temperature.



(Lü et al., 2019)

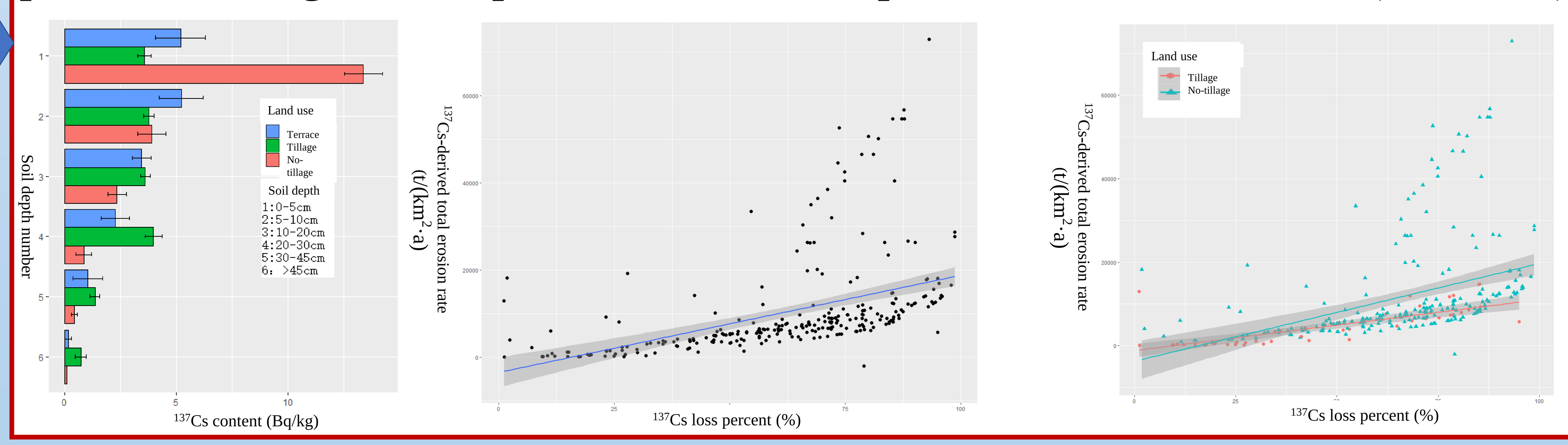
Methods

We searched peer-reviewed journal articles published both in English and in Chinese using the Web of Science and China National Knowledge Infrastructure (CNKI)(from January 1990 to October 2017). We used the following search-term combinations: "Cesium + erosion+ Loess Plateau"、"Cesium + soil+ Loess Plateau"、"Cs-137+erosion+ Loess Plateau"、"Cs-137+soil+ Loess Plateau"、"^{137}Cs+erosion+ Loess Plateau"、"^{137}Cs+soil+ Loess Plateau". Finally, we integrated and synthesized 61 peer-reviewed articles of slope soil erosion research by using ^{137}Cs tracer methods in the Loess Plateau of China. GetData Gragh Digitizer was used to help with extracting numerical data from figures. Site location, reference ^{137}Cs inventory, ^{137}Cs soil profile distribution and ^{137}Cs-derived total measured erosion rate were used to construct the database.



Validating the assumption of ^{137}Cs tracing method

The ^{137}Cs soil profile distribution of 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 significant positive relationship with soil erosion rate (P<0.001).



Conclusions

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

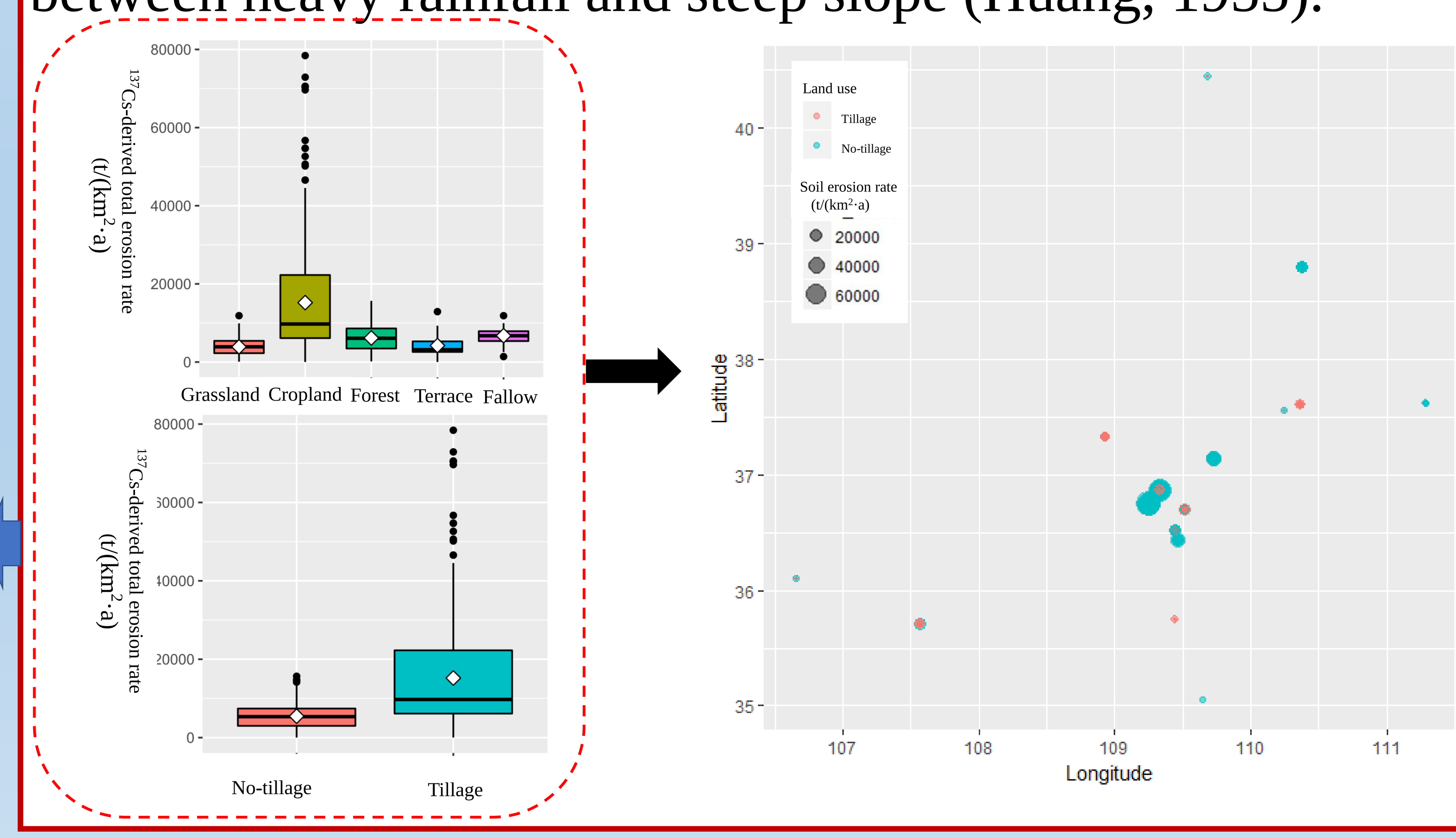
References:

Huang BW. Experience and lesson of mapping soil erosion region in middle reaches of Yellow River. Bulletin of Science 1955, 12: 15-21.

Lü, Y. H., J. Hu, B. J. Fu, P. Harris, L. H. Wu, X. L. Tong, Y. F. Bai, A. J. Comber. A framework for the regional critical zone classification: the case of the Chinese Loess Plateau. National Science Review, 2019, 1(1): 14-17.

The spatial pattern of long-term soil erosion rate

Average long-term soil erosion rate of cropland was more than 15000 t/(km^2·a) and significantly higher than no-tillage land (5462.52 t/(km^2·a) including that of grassland (3890.86 t/(km^2·a)), forest (>6000 t/(km^2·a)), and terrace (<5000 t/(km^2·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 (Huang, 1955).



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(CONTACT: Jian Hu (Jianhu@swun.edu.cn)