Evaluation of soil erosion and ecological rehabilitation in Loess Plateau region in Northwest China using plutonium isotopes

Soil erosion is a critical threat to the agriculture and ecosystem in the Chinese Loess Plateau area. Ecological rehabilitation has been applied in large area for reduction of the soil erosion. Six soil depth profiles were collected from Nanxiaohegou watershed in the Loess Plateau in northwest China and analyzed for the activity concentrations of plutonium isotopes. The measured $^{240}\text{Pu}/^{239}\text{Pu}$ atomic ratios in all these samples (0.186±0.017) showed that the global fallout was the dominant source of plutonium in this region. An exponential decline of $^{239,240}\text{Pu}$ activity concentrations with depth was observed in most of soil profiles. The total inventory of $^{239,240}\text{Pu}$ in the reference site was calculated to be 110 Bq/m², agreeing well with the reported total fallout value in this latitude. The soil erosion rates were estimated by comparison with the reference site to be 538–941 t/km²/yr in the most of sites. While an excessive inventory of $^{239,240}\text{Pu}$ (186 Bq/m²) compared to the reference site was observed in one site in the base area, indicating a significant accumulation of soil occurred in this area. The soil erosion depths were estimated to be 2.4–4.6 cm in most of sites during 1963–2016, which can be classified as minor erosion. Compared with the erosion rates in the Nanxiaohegou watershed in 1963–2012 which was estimated by other methods, it is suggested that the natural grass is better for long-term ecological restoration, especially in slope area.