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Quantification Of Erosion Rates Of Agriculturally Used Soils By Artificial

Abhinand Jha
University of Bremen, Bremen, Germany

0.0.1 1. Introduction to soil erosion measurement by radionuclides

Soil erosion by water, wind and tillage affects both agriculture and the natural environment. Studying this phenomenon would be one of the advancements in science. Soil erosion occurs worldwide and since the last two decades it has been a main topic of discussion all over the world. The use of environmental radionuclides such as ^{90}Sr, ^{137}Cs to study medium term soil erosion (40 yrs) started in the early 1990's. Using these new techniques better knowledge about erosion can be gained and this knowledge can be implemented for erosion risk management.

The erosion and sedimentation study by using man-made and natural radioisotopes is a key technique, which has developed over the past 30 years. Fallout ^{137}Cs and Cosmogenic ^{7}Be are radionuclides that have been used to provide independent measurements of soil-erosion and sediment-deposition rates and patterns [1] [2] [3] [4].

1. ***Erosion measurements using radionuclides ^{137}Cs, ^{7}Be***

Caesium-137 from atmospheric nuclear-weapons tests in the 1950s and 1960s (Fig.1) is a unique tracer of erosion and sedimentation, since there are no natural sources of ^{137}Cs. Unique events such as the Chernobyl accident in April 1986 caused regional dispersal of ^{137}Cs that affects the total global deposition budget. This yearly pattern of fallout can be used to develop a chronology of deposition horizons in lakes, reservoirs, and floodplains. ^{137}Cs can be easily measured by gamma spectroscopy. Using ^{137}Cs is a fast and cheap method to study erosion-deposition processes compared to the traditional methods like silt bags.

Figure 1: Global 137Cs fallout (Modified from SAAS Bulletin 353, Part E, DDR, 1986)

When ^{137}Cs, ^{7}Be reach the soil surface by wet and dry deposition, they are quickly and strongly adsorbed by ion exchange and are essentially non exchangeable in most environments. Each radionuclide is distributed differently in the soil because of differences in half-lives (30 yrs for ^{137}Cs and 53 days for ^{7}Be), delivery rates, delivery histories, and land use (Fig. 2). An Physical processes, such as water and wind, are the dominant factors moving ^{137}Cs, ^{7}Be tagged soil particles within and between landscape compartments.

Figure 2: Generalized sketch illustrating the distributions of ^{137}Cs and ^{7}Be in tilled and undisturbed soils

2 Erosion study at Young Moraine regions of Germany

Recently, a study had been performed to evaluate erosion rates in a typical pattern of landscapes in the Young Moraine regions of North-East Germany [5]. The ^{137}Cs concentrations were measured at selected sampling points of various study sites. Among the areas selected for sampling was Basedow, which is a cultivated area, situated north of Berlin. During a master thesis study at university of Bremen in the academic year 2008-2009 [6] a second sampling campaign was performed at the same study site and ^{137}Cs and ^{7}Be concentrations were measured. Two

mathematical models (a proportional model and a mass balance model) were applied to estimate erosion or deposition rates giving a distinction between uncultivated or essentially undisturbed soils and cultivated or soils under permanent pasture (Fig.3A). An improved depositional model was developed during this study. The simulation results from this model are presented in Fig.4. Due to the half-life (53.2 days) of ^{7}Be, a mass balance model was developed and used to calculate erosion rates from ^{7}Be (Fig.3B).

Figure 3: A: Erosion rates for ^{137}Cs calculated by mass balance model.

B: Erosion rates calculated with mass balance model using the ^{7}Be data at Basedow (2008).

The results verify that there is long term erosion as a result of wind, water and agricultural practices. The annual erosion rates at Basedow calculated using a mass balance and a proportional model were in the range between 30-50 t ha^{-1}yr^{-1}. These values were comparable to the erosion rates calculated in the previous study [5] by the models mentioned above.

Figure 4: Profiles of sediment calculated for different erosion rates by Cs-137 within the ploughed soil

3 Conclusions and outlook

Erosion rates for agricultural soils at Young Moraine regions of North-East Germany were determined by using two radionuclides, ^{137}Cs and ^{7}Be. In combination, the two radionuclides provide a valuable means of investigating soil erosion and assessing erosion risk in the study area. Potentials and limitations of the erosion measurement techniques using radiotracers are discussed in this study. The models used to quantify erosion rates using ^{137}Cs and ^{7}Be were studied. Erosion rates calculated by theses models are difficult to measure over a period of 50 years. A validation of these erosion rates for the time period (50 years) used in the ^{137}Cs-based models will give a new perspective to the use of soil erosion modeling.

Most of the regions in India are suffering from high erosion rates [7]. By using the new techniques in erosion quantification the land management practices can be improved and the erosion risk can be reduced in India.