

Application of ^{137}Cs accumulation in soil in predicting soil erosion from different land uses in Huai Raen-Klongpid watershed, Eastern Thailand

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Abstract

^{137}Cs accumulation in soil profiles from 0-30 cm depth were measured in different land uses (forest, banana orchard, cashew orchard and pine apple plantation) in the Huai Raeng-Klongpid Watershed, Trat Province, Thailand. Soil samples from different land uses were selected at 3 sampling points at 5 cm intervals to 30 cm deep. The ^{137}Cs activity in the soil samples was determined by gamma spectrometry using a High Purity Germanium (HPGe) detector. The ^{137}Cs accumulation in soil in the forest, banana orchard, and cashew orchard and pine apple plantation were 16.4, 14.8, 12.3 and 11.2 Bq/kg, respectively. The results from this study implied that ^{137}Cs accumulation for different land uses is related to soil erosion. Therefore, ^{137}Cs technique could be used as a tool for soil erosion evaluation in Thailand.

Key Words

Caesium-137 (^{137}Cs), land use, soil erosion.

Introduction

^{137}Cs is a fallout product from the atmospheric testing of nuclear weapons carried out between 1945-1963. On reaching the earth's surface, ^{137}Cs is in most environments strongly and rapidly adsorbed by fine-grained particulate matter (Bachhuber *et al.* 1982) and its subsequent movement occurs in association with soil and sediment particles in response to accumulation, erosion, transport and deposition processes. The overall objective was a preliminary study of ^{137}Cs accumulation measurement in a small watershed, Huai Raeng – Klongpid, located in the eastern part of Thailand in Trat Province, with an area of 443 km² (Figure 1). This area is used for different agroforestry models of land development systems and also acts as a core demonstration unit at the agroforestry research station of Thailand Institute of Scientific and Technological Research (TISTR) on the use of the ^{137}Cs accumulation method and its comparison for basic information as a data base for further study of soil loss from erosion plots. The specific aim was to gather a reliable set of data on the erosion rates in conditions representing the undulating region of Thailand.

Methods

Study site

Huai Raeng – Klongpid watershed is located in Trat Province in eastern Thailand, which is 443 km² and is located in the monsoon region. The mean annual rainfall was 4,737 mm and the mean temperature in January was about 38.2°C.

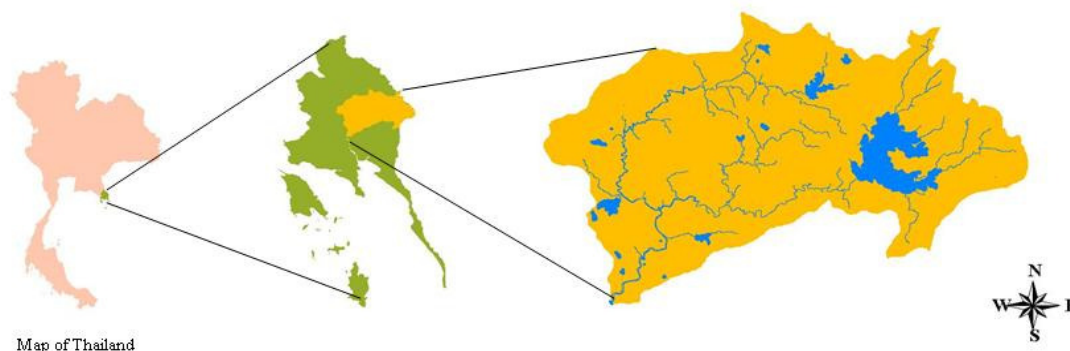


Figure 1. Huai Raeng - Klongpid Watershed study site.

The study area was divided by different slopes: the upland area land use was forest, the central and lowland area were in agriculture cropped to orchards, rubber, pineapple plantations, rice, etc. Some parts of the

lowland area also contained a small reservoir and an urban area. A topographic survey was done at the study site, about 72 soil samples for ^{137}Cs analyses were collected from different land uses (forest-3 sampling points, banana orchard-3 sampling points, cashew orchard-3 sampling points and pineapple plantation-3 sampling points). At each sampling point, 6 samples were taken at 5 cm intervals to 30 cm depth profile. Soil samples were dried at 60°C for 48 h, weighed and was passed through a 2 mm screen. Material (rocks, etc.) greater than 2 mm were discarded. The ^{137}Cs activity in soil samples was determined by gamma spectrometry with a High Purity Germanium (HPGe) detector. Calculated ^{137}Cs activity in soil samples is in unit Bq/kg.

Results

The relationship between ^{137}Cs (Bq/kg) accumulation in the profiles and different land uses are given in Table 1 and Figure 2 shows ^{137}Cs accumulation associated with different land uses in the Klongpid- Klonglod Watershed, Trat Province, Thailand.

Table 1. Relationship between ^{137}Cs (Bq/kg) accumulation and different land use.

| sampling site | ^{137}Cs (Bq/kg) |
|----------------------|------------------------------|
| forest | 16.40 |
| banana orchard | 14.82 |
| cashew orchard | 12.28 |
| pineapple plantation | 11.23 |

Table 1 shows ^{137}Cs accumulation of forest, banana orchard, cashew orchard and pineapple plantation were 16.40, 14.82, 12.28 and 11.23 Bq/kg, respectively. More detail data are in Table 2. The results from this study implied that ^{137}Cs accumulation for different land uses is related to with the soil erosion. Therefore, ^{137}Cs technique could be used as a tool for soil erosion evaluation in Thailand.

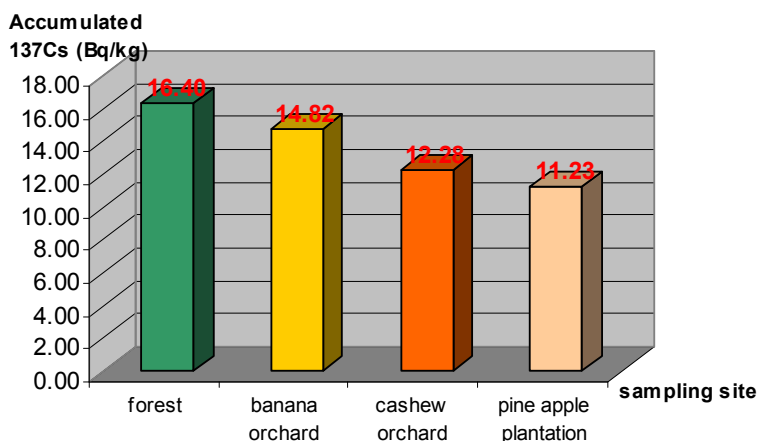


Figure 2. ^{137}Cs accumulation associated with different land use in study area.

Table 2. The ^{137}Cs accumulation in different land uses related with the different slope.

| Sampling site | Cs-137 (Bq/kg) | Slope (%) |
|----------------------|-------------------|--------------|
| Forest | | |
| A11 | 20.53 | 31.73 |
| A12 | 12.02 | 64.79 |
| A13 | 16.65 | 47.23 |
| Banana orchard | | |
| B11 | 12.30 | 3.20 |
| B12 | 19.86 | 2.96 |
| B13 | 12.30 | 2.42 |
| Cashew orchard | | |
| C1 | 14.41 | 5.89 |
| C12 | 13.92 | 6.03 |
| C13 | 8.50 | 5.75 |
| Pineapple plantation | | |
| D11 | 8.71 | 25.74 |
| D12 | 10.34 | 29.92 |
| D13 | 14.64 | 25.53 |

Conclusion

The land use type in Haui Raeng -Klongpid watershed affected on ^{137}Cs accumulation in soil in each area. The ^{137}Cs accumulation in soil profile upon difference agricultural practice can be applied further for soil erosion study in Klongpid- Klonglod Watershed, Trat Province. Erosion is an important problem for land resources conservation in Thailand. There is a need to obtain the quantitative data concerning erosion in the watershed for the management solutions. The sing ^{137}Cs technique would be useful tool to evaluate soil erosion. Use of the ^{137}Cs technique has been limited in Thailand. Therefore, the results from this study could contribute to the value information as a preliminary investigation of soil erosion of watersheds in Thailand.

References

- Bachhuber H, Bunzl K, Schimmack W, Gans I (1982) The migration of ^{137}Cs and ^{90}Sr in multilayered soils: results from batch, column, and fallout investigations. *Nuclear Technology* **59**, 291-301.
- Hien PD, Hiep HT, Quang NH, Huy NQ, Binh HT, Hai PS, Long NQ, Bac VT (2001) Derivation of ^{137}Cs deposition density from measurements of ^{137}Cs inventories in undisturbed soils. *Journal of Environmental Radioactivity* **62**, 295-303.
- International Atomic Energy Agency (1999) Reference Sheet: Reference Material IAEA-Soil-6. Radionuclides in Soil. (Analytical Quality Control Services: Vienna, Austria).
- Santisuk T (1988) An Account of the Vegetation of Northern Thailand. *Geocological Research* **5**, (Franz Steiner Verlag Wiesbaden Gmb.: Stuttgart).
- Timothy JF (1994) The Use of Cesium-137 Measurements of Soil Erosion and Farmers' Perceptions to Indicate Land Degradation Amongst Shifting Cultivations in Northern Thailand. *Mountain Research and Development* **14**, 229-244.