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Rapid reduction of 137Cs caused by soil erosion on a typical agricultural
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The large amount of 1.5 x1017Bq of 137Cs was released into the environment by the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident in March 2011. Knowledge of the initial fallout distribution and the postdepositional Cs mobility in agricultural land is essential, as due to the biological uptake food is contaminated and health threatened. The fate of 137Cs in agricultural land depends on its radioactive decay, the downward diffusion in the soil and redistribution by soil erosion. In this study we document a.) diffusion in a typical agricultural field located 40km northwest of the FDNPP, b.) redistribution of 137Cs within the field by the soil erosion types interrill erosion, rill erosion and gully erosion, and c.) calculate 137Cs export for a period of five months since the FDIPP accident.

The study field with an area of 0.66ha consists of sandy loam highly susceptible to soil erosion. Few days before the accident the field was prepared for tobacco plantation with a ridge-furrow topography, but left abandoned due to radioactive contamination. During the rainy season in early summer the field was invaded by natural vegetation and by the end of the typhoon season the field was covered.

In order to document the diffusion of 137Cs, sectioned soil samples were taken at six ridge locations within the study field and at one undisturbed location outside to estimate initial contamination. A scraper plate was used in 5mm increments for the top 5cm and in 10mm increments for the depth of 5cm to 10cm. 137Cs inventories (Bq/m2) were computed on the basis of the dry mass of soil (<2 mm). All activities were corrected for decay from the time of soil sampling. The depth distribution of the undisturbed site was used to calculate redistribution of 137Cs within the field by interrill erosion attributed. Rills and gullies were mapped. The 137Cs redistribution of rills is based on cross-section measurements in 10m spacing of five representative rills with lengths between 50 and 120m. Activity of in-channel sediment was taken into account. The cross sections of gullies were taken in intervals between 4 and 8meters.

Results indicate an initial contamination of 392.7kBq/m2 with a diffusion of 95% in the uppermost 4cm. Soil erosion processes produced a high spatial variability of 137Cs content. Depending on slope angles interrill erosion reduced the activity by 33.9% to 50.5% with an average of 41% for the whole field. At upslope positions rill erosion reduced the activity up to 80%, as highly contaminated topsoil was eroded. Due to the storage of highly contaminated sediment on midslope locations the activity there was up to1.5 times higher compared with the undisturbed location. Rills in the lower slopes as well as the two incipient gullies were eroded below contamination depth. As rills and gullies covered only 4.7% and 0.4% of the field respectively, the total 137Cs export was 43% for a period of five months results. These findings help practitioners to evaluate the spatially distributed 137Cs contamination on field scale and to assist in decision making for usage restrictions.

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