Determination of the long term decrease of ^{137}Cs bioavailability in French pastures based on 25 years of field monitoring

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Both atmospheric nuclear weapons tests and Chernobyl accident have resulted in a long-lasting contamination of semi-natural environments by Cesium 137 (^{137}Cs) in western Europe, including French pastures. The contamination of the food chain is primarily controlled by the bioavailability of cesium for plant uptake, which in turn is controlled by a number of physico-chemical processes such as ^{137}Cs adsorption, fixation or lixiviation in the root soil layer. All these mechanisms contribue to the short and long term decreases of the bioavailable pool in soils (i.e. ageing of ^{137}Cs in soil) and its uptake by plants. Ageing is a key process in radiological risk assessment studies; it is often modeled as a first order kinetic process. The rate of ageing (day^{-1}) is required as an input to a variety of transfer models such as the model of Absalom et al. (1999) [1]. The aim of this communication is to estimate the most likely values of the long term decrease of ^{137}Cs contamination in pasture ecosystems, and the corresponding ageing rate, based on more than 25 years of monitoring programs at 10 different sites located in eastern France. In this study, we used the long term time series of ^{137}Cs activity in soil, grass and cow's milk to estimate the distributions of the effective half-lives at each site, from which the corresponding ageing rates of ^{137}Cs in soil could be deduced. Results suggest that the decrease of ^{137}Cs bioavailability may range from 3.1×10^{-5} to 14.7×10^{-5} day^{-1} (i.e. effective half lives ranging from 13 to 61 years in soil). We observed that the long term soil to grass transfer of ^{137}Cs was quite sensitive to the uncertainties related to this parameter estimation .

[1] Absalom et al. (1999) J.Environ.Radioact.52, 31-43