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The impact of land use on the adsorption of fluoroquinolone antibiotics: a study on bulk soils and organic matter pools

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Fluoroquinolone antibiotics are widely used in animal husbandry and human medicine and are therefore released into environmental systems in significant quantities. Because of its targeted antibacterial action, it directly disrupts the soil microbial ecosystem and alters soil carbon fixation. In order to maintain soil microbial communities and prevent groundwater pollution, it is essential to know what physicochemical properties a soil must have to be safe for sewage sludge application and irrigation with treated wastewater. To understand the effects of land use on the adsorption properties of Luvisols, three different land use areas (arable land, grassland, and forest) and two organic matter (OM) pools (fast and slow) were investigated. The soils were separated to a > 53 µm fraction related to the fast OM pool and a < 53 µm fraction containing the slow OM pool, to investigate the physicochemical properties that affect adsorption capacity. Ciprofloxacin, norfloxacin, and ofloxacin were chosen for adsorption experiments because they are widely detected in environmental systems. The effect of land use on adsorption was only observed in the slow pool in the ascending order of arable land, grassland, and forest. Principal component analysis showed that OM content and composition influenced adsorption in the slow pool. However, the adsorption of bulk soils and fast pools is primarily controlled by the physical soil properties rather than by soil OM. These findings indicate that the OM composition of the < 53 µm fraction with the slow pool can determine the adsorption of bulk soils. However, in the present study, this did not affect the adsorption of bulk soils because either 1) the ratio of the slow pool was small, but its adsorption capacity was high, as in the forest, or 2) the ratio of the slow pool was large but its adsorption capacity was low due to its OM composition, as in arable land and grassland. Therefore, irrigation with treated wastewater and sludge discharged on agricultural lands is more likely to leach pollutants into groundwater. Consideration should be given to the disposal of sludge in an area with a high aliphatic soil OM content, where the slow pool rate is high.

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