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Soil Biological Indicators and Caesium-137 to Estimate Soil Erosion in Areas with Different Forest System Management

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In natural forests, surface runoff and soil erosion are generally low because of the surface litter cover, but can be trigged by natural disturbances or anthropic interventions. Many researches have been carried out on the impact of natural disturbance on soil ecosystem service, but researches on the impacts of forest management activities on soil erosion and the subsequent effects on forest productivity are limited yet. Relationships between management and productivity are not simple but are rather extraordinarily complex, reflecting interactions among management system, soil biological activity, nutrient cycling, and climate. Therefore, the effect of a given forest management is highly dependent on site-specific soil properties and microclimate and may also be influenced by year-to-year variation in climate. Forest management if not properly settled can cause soil erosion process, reducing consequently soil productivity and environmental sustainability. In order to reduce these phenomena and to find useful countermeasures, we need to evaluate the intensity of the erosion process under forest management practices, and the reasons that cause it. Numerous attempts to prevent this phenomenon have been made, mainly based on models and calculation procedures however, their utilities remain limited to the geographic areas for which calibration and validation are possible. The aim of this work was to estimate if innovative thinning (preselect 50 trees/ha and removal of direct competitors) can induce soil erosion in beech forest in respect to traditional thinning (cutting of 45% total trees/ha) or control (no thinning). The soil erosion rate has been estimated by using the technique of the radionuclide cesium-137 (137Cs) jointly with soil biological indicators (soil organic matter, microbial biomass C, water soluble phenols, fluorescein diacetate hydrolase, and dehydrogenase activities) of soil ecosystem functioning. The aim was to individuate early warning indicators of soil erosion process and to find a connection between biological indices and the estimates of soil erosion rate provided by the radionuclide measurements. The experiments was carried out on a comparative basis in a beech forest, located in Calabria Apennine, Southern Italy and included in the Marchesale Biogenetic Reserve (VV), Natura 2000 site. Our results based on the cesium-137 technique showed that in both selvicultural treatments soil erosion rates were very low in respect to the undisturbed area. The innovative thinning increases soil water holding capacity, pH, cations and anions content in respect to the no thinning (unmanaged forest, control) and traditional thinning. EMI index was highest in both managed sites suggesting that the treatments increased soil biodiversity. Dehydrogenase activity was highest in soil under innovative thinning, conversely FDA activity was highest under traditional thinning. In short our data indicated that both selvicultural practices have not triggered soil erosion processes, even if they affected soil ecosystem functioning differently. In the traditional thinning prevailed the mineralization process and a hydrolytic soil activity instead, in the innovative thinning prevailed the oxidoreductasic activity and a balance between mineralization and humification process. Overall results suggest that cesium-137, DHA and FDA were the parameters that can be used to estimate early on the onset of erosive phenomena.