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The Use of Microbiological Soil Properties as Indicators of Soil Status in Forestry

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Natural ecosystems provide the basic conditions without which humanity could not survive. Good and services provided by ecosystems include for example provision of food, fibre and fuel, purification of water and air, cultural and aesthetic benefits, stabilization and moderation of the Earth's climate, generation and renewal of soil fertility, including nutrient cycling or maintenance of genetic resources as key inputs to crop varieties and livestock breeds, medicines, and other products. However, the ability of natural ecosystems to continue performing these services is seriously threatened since plant species diversity or soil are being seriously deteriorated, and in some cases destroyed. While loss of species has always occurred as a natural phenomenon, the pace of extinction has accelerated dramatically as a result of human activity. Ecosystems are being fragmented or eliminated, and innumerable species are in decline or already extinct. At the same time, various studies worldwide have shown that soils do not support intensive annual plant cultivation without fertilizer applications and even these may not maintain sustainability. Inappropriate silvicultural operations or the use of land for intensive agricultural purposes is one of the main causes of soil degradation, and there is therefore worldwide interest in quantifying the loss of soil quality generated by incorrect agricultural operations or forest management practises. This can only happen if people have the right information, skills, and organizations for understanding and dealing with soil and plant diversity issues.

Soil plays an important role in the fertility and stability of the forest by highlighting microorganisms, which accomplish reactions to release soil nutrients for vegetation development [1]. Therefore, biotical components are significant soil-plant system elements [2]. Soil microorganisms influence both biogeochemical soil cycles and soil structure. Moreover, mineralisation (organic matter degradation) and humification (organic matter stabilisation) are important processes controlled mainly by the soil microbial community. As changes in some soil properties may occur very slowly, some properties are not suitable for estimating soil quality and properties that respond rapidly to environmental stress must be used. Thus, many authors have proposed the combined use of several variables as early indicators of stress or soil restoration [3,4]. Specific indicators of microbial activity, such as the variables related to nutrient cycles (nitrogen, carbon and phosphorus) and extracellular enzymatic activities (urease, β-glucosidase and phosphatase, respectively), have been proposed to assess soil status. Particularly, biochemical and microbiological variables related to soil microbial activity are of paramount importance. Among them, it is worthy to mention different enzyme activities, both specifically related to the cycles of N, P and C (urease, phosphatase and β-glucosidase, respectively) and some general microbial indicators such as dehydrogenase activity and soil respiration. These soil parameters are sensitive indicators of soil quality and more precise than gross measurements of soil organic matter.

As different studies have demonstrated, soil biochemical properties and microorganism play an essential role in organic matter decomposition and nutrient cycling and it can be concluded that these parameters may be useful in monitoring temporal and spatial ecological changes and the relation between microbiological activity and plant development [5]. Wic et al. [6] pointed that microbiological soil properties were affected by silvivultural treatment and season, which supports the hypothesis that fire and silvicultural operations alter the soil environmental conditions resulting in a decrease of enzymatic and microbiological activity. Also the season of the year is a main factor to be considered in sampling since changes in soil moisture and temperature have a direct influence on soil biological activity. Hedo et al. [7] demonstrated that microbiological soil properties are generally affected by site, but not by thinning or by the 15% reduction of the natural rainfall under dry and semiarid condition. They concluded that twelve years after the post-fire silvicultural treatment, physico-chemical and microbiological soil properties achieve similar levels, reaching a medium-long term recovery. Forest management guidelines should consider the effect of thinning treatments, climate change trends and forest site in order to preserve plant diversity and soil properties under the adaptive forest management context.

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