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Nutrient Cycling Studies: A New Approach for Assessing Reclamation Processes of Tropical Degraded Lands and Restoration of Ecosystem Functions

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Nutrient cycling studies have been performed throughout the world for over fifty years. The earliest of these studies were carried out in natural forests of temperate regions, and focused on small number of processes related to litterfall (*e.g.* nutrient return, nutrient release). Due to increasing interest in tropical forests and an apparent lack of knowledge about their functioning, nutrient cycling studies were later progressively located in tropical and subtropical forests, and began to incorporate other nutrient cycling pathways as well, such as those related to hydrological fluxes and edaphic processes. Pioneer studies that supplied valuable knowledge of nutrient cycling in tropical forests can be attributed to a long list of scientists, among whom could be mentioned H. Jenny, C.F. Jordan, H. Nye, P.J. Edwards, F. Golley, J. Proctor, B. Lundgren, S.N. Rai, J.J. Ewel, and F. Bernhard.

The supply of ecosystem services depends on the structure and processes of ecosystems and is reduced with ecosystem degradation [1]. De Groot et al. [2] proposed that ecosystem functions have associated goods and services that are valued for humans. From that perspective, they are defined as the capacity of natural processes and components to provide goods and services that satisfy, directly or indirectly, human needs. The conversion of natural ecosystems to other land alters ecosystem functions that normally provide services critical to human well-being. Among these functions could be mentioned regulation functions, which involve the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other biospheric processes (*e.g.* nutrient regulation, water supply, water regulation, soil retention, soil formation). The impact derived from ecosystem degradation on these ecosystem functions is enhanced when the deforestation figures in tropical countries are considered, where FAO estimated that 10.4 million hectares of tropical forest were permanently destroyed each year in the period from 2000 to 2005.

Land and environmental planning agencies in tropical countries need to develop proper knowledge of both structural and functional ecosystem parameters so that they can use this knowledge as a tool for measuring degrees of land degradation. One of these groups of parameters, regulation functions includes the nutrient cycling function, which provides a wide range of meaningful services that have both direct and indirect benefits to humans. As per the utilization of a new perspective of integrative ecosystem management, many of the restoration-reclamation interventions on degraded lands could be redirected towards re-establishing ecosystem health and human well-being, which can be achieved through nutrient recycling activation.

Some nutrient cycling studies have revealed a higher nutrient supply to soils from native forests than from tree plantations. This appears to be an ecological advantage for recovering and maintaining the main ecosystem functioning features, which needs to be taken into account in restoration programs in highly degraded lands. Passive and active restoration models for the recovery of degraded lands have been designed following structural and functional aspects of native and non-native ecosystems. Although passive restoration models based on natural regeneration processes are simple and cheap, they are not always successful [3,4]. As an alternative, active restoration models permit the accelerated restoration of ecological processes, such as nutrient cycling and carbon seizure, in addition to restoring the habitat for biodiversity [5]. The most common active restoration model involves planting trees in high densities, which has been proved to be advantageous for the recovery of soils and biological diversity in degraded tropical lands. This recovery occurs as a result of the reactivation of the biogeochemical cycle of litterfall production and decomposition [6,7]. Regardless of the model, within the soil, the processes reactivated in these ecosystems through nutrient cycling increase organic matter and nutrients, regulate the pH, improve aggregate stability and provide greater water storage capacity [8,9].

Nutrient cycling studies that examine these restoration models could include processes such as fine litterfall and litter decomposition rates, nutrient release rates and nutrient release patterns, above ground litter and nutrient accumulation, soil microorganism respiration, nutrient canopy exchange (leaching and washing processes), and nutrient losses (deep drainage and runoff). An adequate approach for evaluating these and other meaningful functional ecosystems parameters related to nutrient cycling would provide scientific guidance to decision-makers involved in the complex field of reclamation/restoration of tropical degraded lands.

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