



Quantitative physical and chemical variables used to assess erosion and fertility loss in tropical Dominican and Haitian soils

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The Pedernales province (Dominican Republic) has the main part of the only Biosphere Reserve in that Caribbean Island, including the Baboruco and Jaragua National Parks. In these Parks is possible to find almost the totality of tropical forest ecosystems (evergreen rain forest, latifoliated forest, dry forest and mangrove forest on mainland), as well as the most frequent soil uses in the Dominican country. The consulted bibliography about the soils is very scarce and it does not give any information relating to this natural resource, which is basic for a sustainable development management in this territory.

When Christopher Columbus reached the island, its plant cover constituted 95% of the land. This was largely because the limited, rudimentary tools used by the Indians to exploit the soil, allowed them to maintain a well-balanced ecological system. The initial type of agriculture practised by the indigenous inhabitants was scarcely destructive and based on vegetatively reproducing crops propagated through cuttings, but later forest burning was an especially significant management practice aimed at releasing nutrients into the soil, in an environment in which under natural conditions, particularly those of the rainforest, these were mostly locked within plant structures. The colonial system, on the contrary, brought with it more elaborate methods and utensils enabling them to cultivate cereals (somewhat unknown to the native Indians) and to rear livestock (cows, goats) yet contributed to the growth of deforestation. Agricultural activities were not confined to the plains; even the virgin woods of the mountains were exploited. The monocrops grown across vast expanses rapidly rid the soil of its productive capacity. Cutting down and burning forest for agricultural uses, and also industrial exploitation of bauxite and limestone produced also important alterations in the soil processes. Agricultural activities were not confined to the plains; even the virgin woods of the mountains were exploited. The monocrops grown across vast expanses rapidly rid the soil of its productive capacity.

The Factors affecting soil degradation in this territory may be generally divided into the three groups: physical-natural, political, and socio-economic. The climate and geomorphology are the natural factors mostly influencing the soils. Its relief means its soils are highly vulnerable and sensitive to erosion, and its different ecosystems are similarly sensitive to the actions of cyclones and hurricanes. Many of the lands have slopes exceeding 20%, and 40%. Since the colonisation another cause of the degradation of its soils has been a lack of political will to protect the natural resources. The situation of extreme poverty of the territory, especially in the rural areas, particularly affects plant resources and the soil: to meet needs, the population have to exploit the most marginal of territories rather than intensifying existing systems. Thus, the dynamics of poverty becomes a vicious cycle, with poverty as the cause and consequence of the deteriorated natural resources. As a consequence of all these factors, the expansion of agricultural boundaries following deforestation is one of the causes of soil erosion affecting mountain lands. On the other hand, climatic change including more irregular and less rainfall, along with an increased incidence of natural disasters (cyclones, hurricanes, floods), have placed this territory in a situation very difficult.

Our recent discovery of important levels of Al, Pb, Zn, Cu, Cr and Cd in the territory, especially on the superficial layer of river Pedernales Basin soils (Dominican Republic-Haiti), made us to investigate about the possible effects of the soil degradation and erosion produced on the toxicity of these metals. The source of these metals is linked to geodaphic processes more than to human impacts, in a region that comprises core, intensive agriculture and buffer areas of the reserve, harbouring mines (bauxite and limestone), crops and livestock. The hypothesis that heavy metals liberated by geochemical actions in some of these tropical ecosystems could be related both to

productivity and to human and animal health, led us also to assess metal bioavailability in the area's main crops as the primary source of food or fodder.

To establish the context of the heavy metal pollution, we characterized the geodaphic features of the region. The predominant rocks are sedimentary limestones: with limestone colluvial deposits dominant in the tropical conifer forest and rain forest of the Sierra de Bahoruco; crystalline limestones in the tropical latifoliated forest; and Quaternary detritic rocks and reefs (carbonates overlying alterites) in the dry tropical forest.

Across the territory, there is a marked predominance of soils that range from surface soils to shallow, poorly developed stony soils of low natural fertility. Most can be classified as entisols. Soils of recent alluvial origin lack pedogenetic horizons and are subjected to diverse humidity and temperature regimens. Slopes are pronounced and relief and altitudes vary. Their profiles include A-R horizons characterised by displaying an ochre epipedon over a fractured rock bed whose depth is shallow and A-C horizons of a sandy to clayey soil and subsoil texture, whose colours range from dark brown to grey and depths from very shallow to deep. Soils occur from the mountains to landscapes including rivers or sandy coasts. The ecosystems examined occur from an altitude of 1300-1200 m to sea level and the cultivated soils have the main food sources for human and animal consumption: bean, corn, sorghum, coffee, Guinea banana, fruit trees and tubers.

We present these data for 79 soil samples according to the corresponding landscape units (forests) along with their dominant lithologies (crystalline limestones, carbonated limestones on alterites and coral limestones). Our study describes edaphic processes linked to physical and chemical erosion in this region.

The main types of clay are: hematite, kaolin, bohemite (the most abundant) gibbsite and calcite. Textures range from sandy-silty to clayey. Sand and clay fractions seem more abundant than silt ones. Soil pHs are generally in the basic range with infrequent acid soils. OM and total Nitrogen levels are not low, especially OM in the dry forest and N in the latifoliated forest. Available K contents are low in mountain forests and high in dry forests. Available P contents are generally low to very low.

The topsoil layers (0-20 cm) of different types of wet and dry tropical forests and agroecosystems were assessed in terms of several physical factors related to erosion. These factors were: particle size, aggregate structural instability index (Is), and soil physical degradation index, erodibility index and erosionability index. This study reports also fertility loss, OM and heavy metal data obtained in the topsoil samples from both natural ecosystems and agroecosystems. Soil fertility also needs to be assessed since has been severely compromised by changes in the physical and chemical properties of the soil induced by the felling and burning of trees to make way for crops.

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