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Soil Degradation

Soil is the most fundamental and basic resource. Although erroneously dubbed as “dirt” or perceived as something of insignificant value, humans cannot survive without soil because it is the basis of all terrestrial life. Soil is a vital resource that provides food, feed, fuel and fibre. It underpins food security and environmental quality, both essential to human existence. Essentiality of soil to human well-being is often not realized until the production of food drops or is jeopardized when the soil is severely eroded or degraded to the level that is loses its inherent resilience. World soils are now managed to: 1) meet the ever increasing food demand, 2) filter air, 3) purify water, and 4) store carbon (C) to offset the anthropogenic emissions of CO_2.

Soil is the earth’s fragile skin that anchors all life on our planet. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to human beings. Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields and pastures. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually increase soil erosion beyond the ability of the soil to maintain itself.

Soil degradation is a global process, but sub-Saharan Africa is affected most of all, with arid and semi-arid zones being particularly affected. Depletion of nutrients and soil organic matter and erosion are the principal forms of soil degradation. Overgrazing and cultivation practices that are not adapted to local environments are the principal causes of soil degradation. Overgrazing is often the result of the loss of pastures to agriculture. Producing crops without compensating the nutrient losses by removing plants also leads to soil degradation.

Soil degradation is a serious global environmental problem and may be exacerbated by climate change. It encompasses physical, chemical and biological deterioration. Examples of soil degradation cited by Charman and Murphy (2005) are loss of organic matter, decline in soil fertility, decline in structural condition, erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants or excessive flooding [3].

Many environmental issues directly affect soils and many environmental issues are influenced by land and soil management. These issues include: soil carbon, soil biodiversity, acid sulphate soils, salinity, wind erosion, gully erosion, sheet erosion, soil acidification, structure decline, and land capability.

Soil carbon is the last major pool of the carbon cycle. The carbon that is fixed by plants is transferred to the soil via dead plant matter including dead roots, leaves and fruiting bodies. This dead organic matter creates a substrate which decomposes and respires back to the atmosphere as carbon dioxide or methane depending on the availability of oxygen in the soil. Soil carbon is also oxidized by combustion and returned to the atmosphere as carbon dioxide.

Soil carbon improves the physical properties of soil. It increases the cation exchange capacity (CEC) and water-holding capacity of sandy soil, and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. Soil organic matter, of which carbon is a major part, holds a great proportion of nutrients cations and trace elements that are of importance to plant growth. It prevents nutrient leaching and is integral to the organic acids that make minerals available to plants. It also buffers soil from strong changes in pH. It is widely accepted that the carbon content of soil is a major factor in its overall health [1].

Biodiversity is “the variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part” (Department of the Environment and Water Resources, 2007). Biodiversity and soil are strongly linked – soil is the medium for a large variety of organisms and interacts closely with the wider biosphere; conversely, biological activity is a primary factor in the physical and chemical formation of soils.

The correlation of soil and biodiversity can be observed spatially – for example, both natural and agricultural vegetation boundaries correspond closely to soil boundaries, even at continental and global scales.

The wind erosion process detaches soil particles from the land surface and transports them by wind. It occurs when forces exerted by wind overcome the gravitational and cohesive forces of soil particles on the surface of the ground.

Soil acidification is the build-up of hydrogen cations, also called protons, reducing the soil pH. This happens when a proton donor gets added to the soil. The donor can be an acid, such as nitric acid and sulphuric acid (these acids are common components of acid rain). It can also be a compound such as aluminium sulphate, which reacts in the soil to release protons. Many nitrogen compounds, which are added as fertilizers, also acidify soil over the long term because they produce nitrous and nitric acid when oxidized in the process of nitrification.

Acidification also occurs when base cations such as calcium, magnesium, potassium and sodium are leached from the soil. This leaching increases with increasing precipitation. Acid rain accelerates the leaching of bases. Plants take bases from the soil as they grow, donating a proton in exchange for each base cation. Where plant material is removed, as when a forest is logged or crops are harvested, the bases they have taken up are permanently lost from the soil [2].

References:

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