Ecosystem engineers become predominant and accumulate their biogenic in their respective functional domains of influence. These are especially earthworms of the anecic and endogeic groups that exhibit deep burrowing activity and mix the soil (known as 'bioturbation'). The same activity is also carried out by other organisms, such as ants, termites and beetle. The dominant group of organisms performing this function varies among ecosystems. Root systems penetrate into deeper soil horizons using channels created by these invertebrates. This improves the resilience of tree communities. Natural soil fertility is at its maximum, as is the provision of other soil system services, such as:

a) hydrological functions, including enhanced infiltration and water retention in deep soils, facilitated by numerous connected biopores
b) climate regulation promoted by carbon accumulation in woody biomass and soil organic matter, since biomass production and sequestration of organic matter in stable bio-aggregates are at their maximum
c) plant growth support and biological control are maximised due to the dense populations of generalist predators and diversity in pest communities which limits the impact of the most aggressive ones; increased robustness of plants due to optimal development of mutualist organisms, such as mycorrhizal fungi and symbiotic bacteria in their rhizosphere

Stage 4

In Stage 4, soil becomes impoverished due to accelerated migration of critical elements of fertility, such as organic matter and iron oxides, to deeper soil horizons. Plant communities change and shift back toward less exigent forms, such as coniferous forests or heathland shrubs. Earthworms and most other ecosystem engineers are progressively eliminated by increasing acidity and low quality of the remaining organic matter.

Later on, highly weathered soils no longer sustain high levels of biomass production, and soil communities progressively lose elements, returning to patterns comparable to those observed at initial stages, although with much deeper soils. Ecosystem services are provided at lower rates, although with large differences among the different ecosystem service categories. While support to plant production significantly decreases, hydrological function may still be at its highest due to soil depth. Biological control may still be supported at relatively high levels due to the high biodiversity of specialist organisms selected through stressful conditions.

Distribution of soil development stages across the Earth

The evolution of soils is a very slow process. Under temperate conditions it can take about 20 000 years to create one metre of soil. When the climate is less favourable, evolution is even slower and can even stop at early stages when drought or excessively cold temperatures limit the progress of biological activity and other processes. Soil formation, scientifically known as 'pedogenesis', may also change its course when natural or human-induced events modify any of the three major drivers involved in the process. As a result of different soil communities, geological histories and climatic conditions, soils of the world show a wide diversity in their stages of development.

To be continued…

Soil Lovers say: ***Essential Soil Succession Knowledge***

Ref: **A Global Atlas of Soil Biodiversity p110**