2. Climate and its role in Soil formation

(*a*) The principal climatic variables influencing soil formation are **effective precipitation** (*i.e.* **precipitation minus evapotranspiration**) and **temperature**, both of which affect the rates of chemical, physical, and biological processes. Temperature and moisture both influence the organic matter content of soil through their effects on the balance between primary production and decomposition.

(*b*) Climate is the **dominant factor** in soil formation, and soils show the distinctive characteristics of the climate zones in which they form, with a feedback to climate through transfer of carbon stocked in soil horizons back to the atmosphere. If warm temperatures and abundant water are present in the profile, the processes of weathering, leaching, and plant growth will be maximized. According to the climatic determination of biomes, **humid climates** favour the growth of trees. In contrast, grasses are the dominant native vegetation in subhumid and semiarid regions, while shrubs and bushes of various kinds dominate in arid areas.

(*c*) **Water** is essential for all the major chemical weathering reactions. For soil formation, water must penetrate the regolith. The **seasonal rainfall distribution**, evaporative losses, site topography, and **soil permeability** interact to determine how effectively precipitation can influence soil formation. The greater the depth of water penetration, the greater the depth of weathering of the soil and its development. Surplus water percolating through the soil profile transports soluble and suspended materials from the upper layers to the lower layers, including clay particles an dissolved organic matter. Percolating water stimulates weathering reactions and helps differentiate soil horizons. But a deficinecy of water is a major factor in determining the characteristics of soils of dry regions. **Soluble salts** are not leached from these soils, and in some cases they build up to levels that curtail plant and microbial growth. **Soil profiles** in arid and semi-arid regions also accumulate carbonates and certain types of expansive clays. In **tropical soils**, when the soil has been deprived of vegetation (**e.g.** by deforestration) and thereby is submitted to intense evaporation, the upward capillary

movement of water, which has dissolved iron and aluminium salts, is responsible for the formation of a superficial hard pan of laterite or bauxite, respectively, which is improper for cultivation, a known case of irreversible soil degradation (**laterilization, bauxitization**).

(*d*) **The direct influences of climate include:**

(*i*) A shallow accimulation of lime in low rainfall areas as **caliche,**

(*ii*) Formation of **acid soils** in humid areas,

(*iii*) Erosion of soils on steep hillsides,

(*iv*) Deposition of eroded materials downstream,

(*v*) Very intense chemical weathering, leaching, and erosion in warm and humid regions where soil does not freeze.

(*e*) Climate directly affects the **rate of weathering and leaching.** Wind moves away sand and smaller particles (dust), especially in arid regions where there is little plant cover. The type and amount of precipitation influence soil formation by affecting the movement of ions and particles through the soil, and aid in the development of different **soil profiles.** Soil profiles are more distinct in wet and cool climates, where organic materials may accumulate, than in wet and warm climates, where organic materials are rapidly consumed. The effectiveness of water in weathering parent rock material depends on seasonal and daily temperature fluctuations. Cycles of freezing and thawing constitute an effective mechanism which breaks up rocks and other consolidated materials.

(*f*) Climate also indirectly influences soil formation through the effects of vegetation cover and biological activity, which modify the rates of chemical reactions in the soil.