

4 Slope processes and alpine soils: Overview of the main soil formation factors

Time:

The formation of soils is a continuous process and generally takes several thousand years for significant changes to take place. The length of time required for a soil to develop depends on the other factors of soil formation. Less time is required for a soil to develop in a humid, warm region covered with lush vegetation than in a dry, cold region that has sparse vegetation. In the mountains, soil development is frequently disturbed by geomorphic processes (solifluction, rock fall, avalanches, etc.), climate change or human impact, often leading to a fine mosaic of soils of different ages.

Climate:

Climate affects the physical, chemical, and biological relationships in the soil, primarily through the influence of precipitation and temperature. Water is necessary for biological activity. It dissolves minerals and transports them and organic residues through the soil profile. Temperature influences the kind and growth of organisms and the speed of physical and chemical reaction in the soils. On Earth, the distribution of rainfall and temperature varies greatly and hence influences soil formation strongly. From a global perspective, this factor is the most important, since it defines the general soil distribution worldwide. In addition, climate conditions also change at short distance in mountainous areas. The so-called microclimate in the mountains is influenced by relief, exposition, altitude, snow-cover, vegetation, etc.

Geology:

The geologic underground provides the parent material, the mass from which a soil is formed. It is primarily responsible for the chemical and mineralogical composition of soils. The parent material includes not only hard rocks like granites or limestones, but also loose sediments like eolian deposits (loess, sand), moraines, solifluction lobes, alluvial cones or rock falls.

Relief:

Relief is largely determined by the underlying rock formation and the geologic history of the region, which includes tectonic activity, dissection by rivers and streams, and landscape evolution through slope retreat. Relief influences soil formation through its effect on moisture, erosion, temperature, and plant cover. The influence of topography is modified by the other factors of soil formation.

Vegetation:

The type of vegetation is influenced by the soil type, but also other factors, above all climate. Vegetation, however, also influences the soil because of its preferences of water and mineral supply, type of roots, etc.

Soil fauna:

The soil is alive! Plant and animal life modify to some extent the formation of the soil. The type and number of organisms that exist are mainly determined by the climate and to a varying degree by parent material, relief, and age of the soil. Bacteria, fungi, and other micro-organisms aid in weathering rock and decomposing organic matter. The larger plants and animals furnish organic matter and transfer elements from the subsoil to the surface layer. Earthworms and other small invertebrates carry on a slow, continued cycle of soil mixing, also mostly in the upper few inches of soil.

Human impact:

Human activities also influence the properties of soils in various ways. Agricultural land use, for example, often leads to soil compaction and to a strong infiltration of fertilizers. Acid rainfall increases the acidity of the soils, and recreational activities like skiing also result in soil compaction and erosion due to the impact of slope preparation.