

# Chapter 1

## The tropical environment

### SOILS AND CLIMATIC RESOURCES

The tropics cover about 40% of the earth's surface and have a wide range of climates. Water availability to plants is undoubtedly the most important factor governing the characteristics of tropical climates and, in combination with temperature, it is used to characterize them.

Köppen (1936) distinguished two broad categories of tropical climates: tropical rainforest (Af, Am) and periodically dry savannah (Aw) (Figure 1). These two categories are further subdivided depending on the rainfall amount and its effectiveness on the basis of several indices (Thornthwaite, 1948; Budyko, 1974; Hargreaves, 1977; Bailey, 1979).

A more detailed climatic characterization was developed by FAO (1978) in the context of defining agro-ecological zones for the developing world. In this system the length of the available growing period is used as a moisture availability index and defined as the period measured in days during the year when precipitation exceeds half the potential evapotranspiration plus a period required to evapotranspire an assumed 100 mm (or less if 100 mm is not available) of water from excess precipitation stored in the soil profile. The period during which the daily mean temperature is less than 6.5°C is subtracted from the length of the period during which water is available.

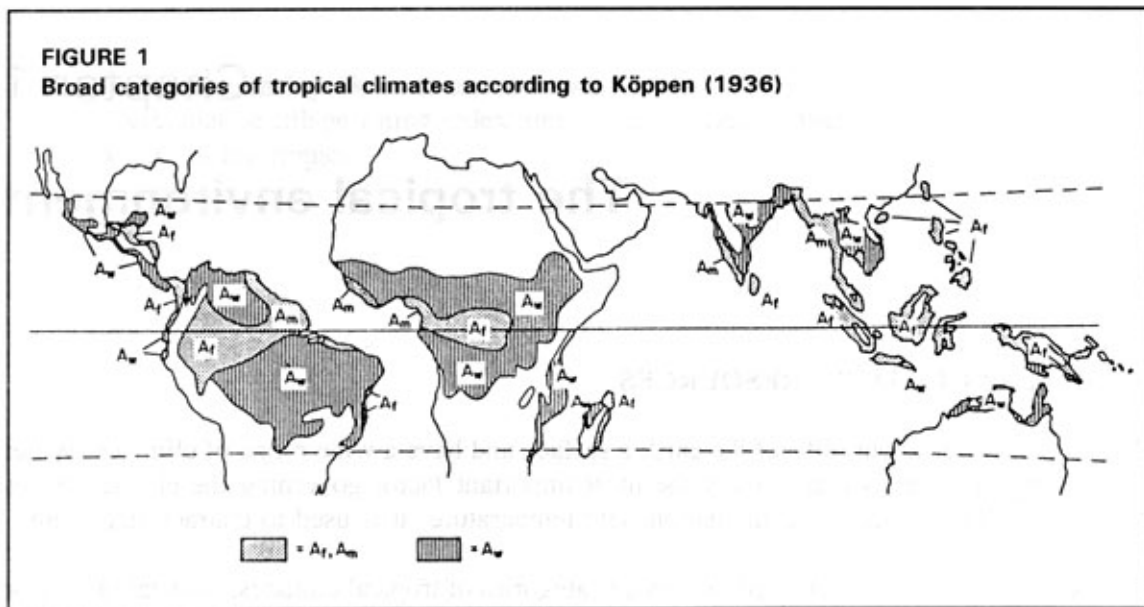
FAO (1993) simplified and broadened the above agro-ecological zoning method described to illustrate the distribution of the major soils resources globally (Figure 2). In the context of the tropical environment only four subdivisions are relevant. These are described below.

#### **Arid zone**

The arid climatic zone is characterized by an LGP of less than 75 days.

This climate is typical for approximately 3 000 million ha, which is about a quarter of the earth's land surface that is not covered by ice. Major arid areas include the Sahara, the Kalahari, the Namibian desert and the Horn of Africa; they are also widespread in the Arabian Peninsula, central Asia, the western part of the United States, the northwestern part of Brazil and along the southwestern part of Latin America, and central Australia.

When the LGP is so short, almost no agricultural crops are able to complete their normal growth cycle, severely limiting yields, if any yield is obtained at all. In addition, both rainfall and the LGP are often unreliable, and may vary considerably from year to year resulting in major difficulties in planning agricultural operations. In these



arid climates, crop and tree productivity is marginal or virtually zero, unless groundwater or surface water is available for irrigation in the warmer climates. Some grazing possibilities exist at the wetter fringes of this zone but usually of a nomadic type.

Soil characteristics are also affected by the non-availability of soil moisture for most of the year, so the weathering process proceeds very slowly in such conditions. The migration and accumulation of soluble salts, calcium carbonate and gypsum are often the only ongoing pedogenetic process, resulting in soils such as Solonchaks and Solonetz, Calcisols and Gypsisols, depending on which salts are involved.

Another phenomenon typical of this climate is the constant wind erosion, resulting in shallow soils (Leptosols) and shifting sand dunes, or exposure of rock outcrops (miscellaneous lands) and a general loss from the soil of the finer particles, which can be carried by the wind over long distances, leaving behind soils that are predominantly sandy (Arenosols). Other soils are very gravelly, or show only the beginnings of or no horizon development (Cambisols, Regosols).

### Seasonally dry tropics and subtropics

The tropics and subtropics where the dry season lasts between 90 and 285 days and the rainfall is not concentrated in winter belong to this type of climate.

This zone extends over about 2 475 million ha and is the prevailing climate in large areas of South and Southeast Asia, northern Australia, the major part of Africa, and South and Central America, between the deserts and the tropical rain forests.

Given the wide range in the length of the dry period, the natural vegetation in this climatic zone varies widely, but is generally dominated by what is commonly called savannah, a term that embraces all the mixed tree and grass types of vegetation found in the subtropics and tropics.

The climate-dependent agricultural potential of this zone is largely determined by the length and the intensity of the dry season. In general the grazing potential is high, provided animal diseases can be kept under control. A wide range of agricultural crops can be grown, from millet, sorghum and cassava in the drier parts to maize and cotton in the wetter areas. The forestry potential is largely constrained by the length of the dry season, but adapted species yield reasonably well. The relatively high temperatures throughout the year, combined with the occurrence of a more or less pronounced wet season, favours the weathering of the soil parent material, liberating silica, iron and aluminium, with consequent formation of kaolinitic clays. This clay mineralogy is typical for the Ferralsols and Acrisols that occur in the wettest part of this climatic zone, and for the Lixisols that occur in what is now the drier parts of this zone, but that started their development with more pronounced weathering under wetter conditions.

Where parent rocks are rich in calcium and magnesium, formation of smectites (swelling clays) occurs by the alternation of dry and wet seasons, and results in Vertisol formation.

The Arenosols of this climatic zone are mostly relatively young soils in coarsely textured alluvial, lacustrine or aeolian deposits, and their development is barely influenced by the climate.

### **Humid tropics and subtropics**

This climatic zone is characterized by high temperatures throughout the year and only a short to very short dry season, and is typical of some 1 925 million ha, mainly located in central and coastal West Africa, the Amazon basin, Southeast Asia and the islands of the Pacific Ocean.

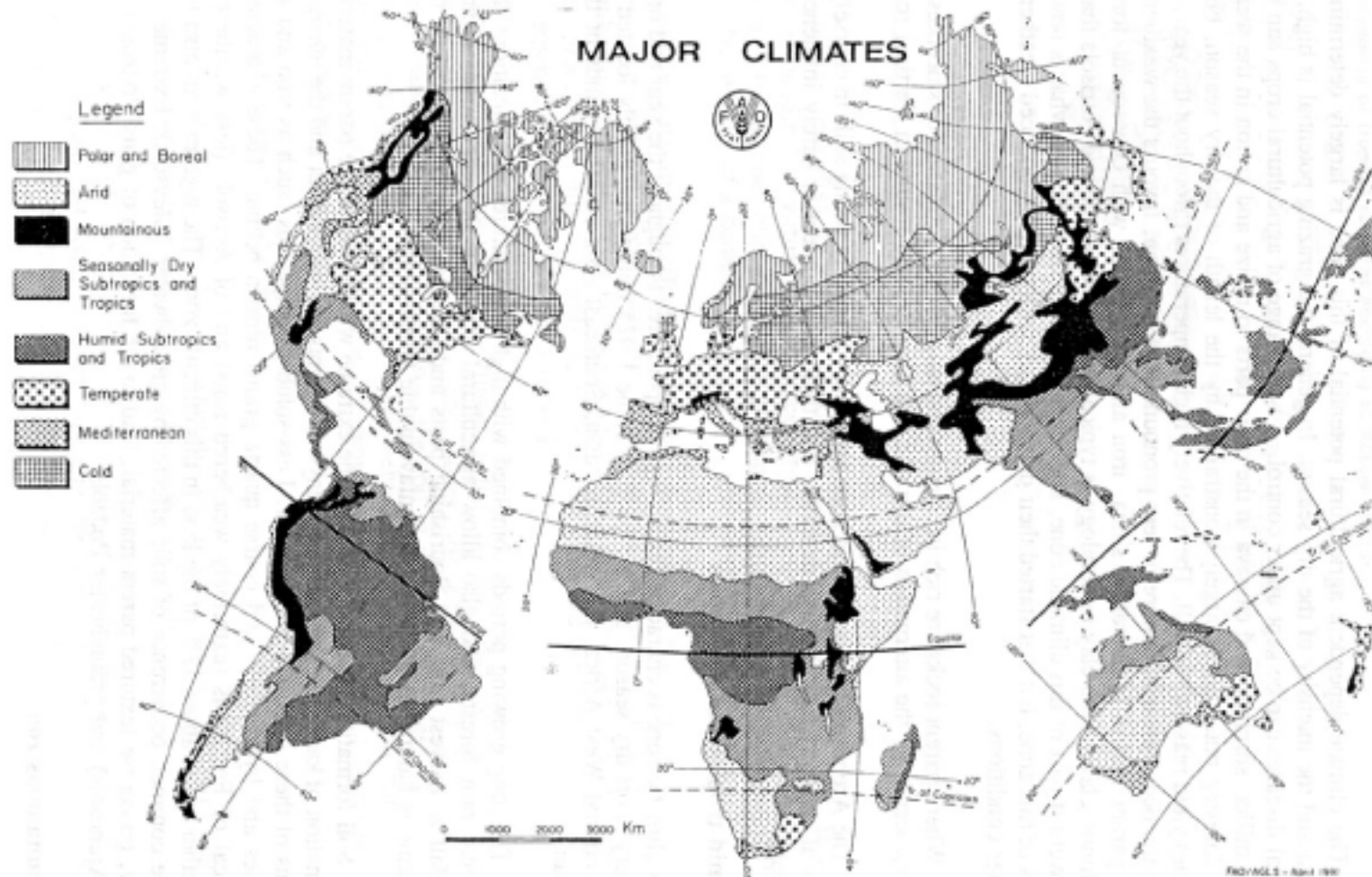
The long growing periods combined with high temperatures are conditions that favour tropical rain forests, and also allow agricultural activities all year round, although high rainfall at harvest time and flourishing pests and diseases may be a moderate constraint. Grazing is hampered by the rather unfavourable temperatures.

Soil formation is characterized by the extreme weathering of the parent material and the formation of kaolinitic (low activity) clays. Nutrients are leached out and the inherent fertility status of these soils is generally poor. Less-soluble compounds, such as iron and aluminium oxides and hydroxides, and coarse quartz grains remain behind. These characteristics are typical of Ferralsols (extremely weathered soils) and of Acrisols (less weathered), which together cover about 57% of the land in this climatic zone. The high rainfall also favours the quite common occurrence of soils affected by groundwater (Gleysols). Extreme weathering may, on coarse textured parent material, lead to the formation of giant Podzols (considered as Arenosols) and groundwater Podzols.

### **Mountainous zone**

This climatic zone is typified by a great variability in temperature and rainfall over short distances due to large and sudden differences in altitude and aspects of slopes. The temperature is lower than in the surrounding lowlands and

**FIGURE 2**  
**Major climates**



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