The Emberger index

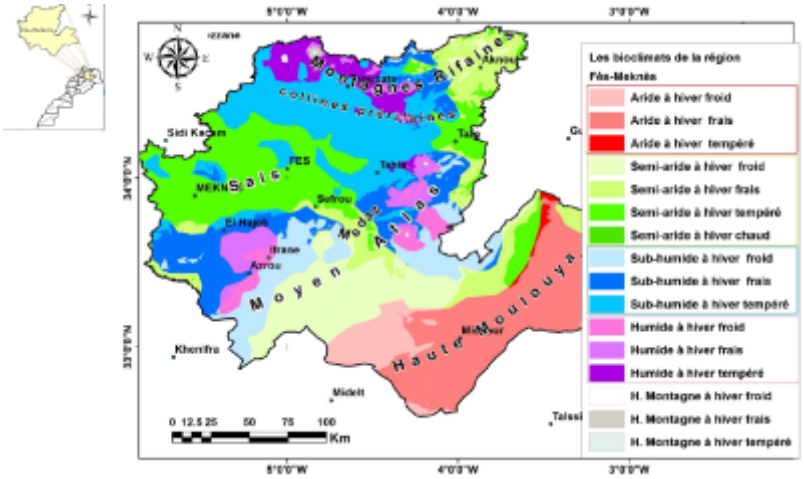

Figure 1. Bioclimate of the Fes-Meknes region. (Source © Kessabi Ridouane (2024), see ref [1])

The Emberger index (1932), also known as the Emberger quotient (Qe), is used to define the bioclimates of a region (Figure 1, [1]) based on three parameters: annual precipitation (P), the average maximum temperature of the hottest month (M) and the average minimum temperature of the coldest month (m). This index is particularly suitable for Mediterranean regions, where it allows different bioclimatic levels to be distinguished.

Emberger observed that the temperature range (M-m), which reflects atmospheric water vapour demand or evaporation, plays a key role in plant distribution. Indeed, at the same average temperature, evaporation is all the greater the higher the temperature range. The water supply is quantified by the product of the number of rainy days per year (n) and the average annual rainfall total (P). Thus, Emberger's quotient Qe reflects both the supply of water and the atmospheric demand for water vapour, the state of equilibrium between the two of which ensures the availability of water to plants. Emberger also proposed a Q2 climatic index which is used to define the different bioclimatic stages ranging from Saharan to perhumid or humid high mountains (Figure 2). The simplified formula for this quotient is as follows:

where, P = Mean annual precipitation (in mm); M: Average of the maxima of the hottest month (in °C); m: Average of the minima of the coldest month (in °C). It is important to emphasize that, for the calculation of Q2, the temperatures of M and m must be expressed in degrees Kelvin [2].

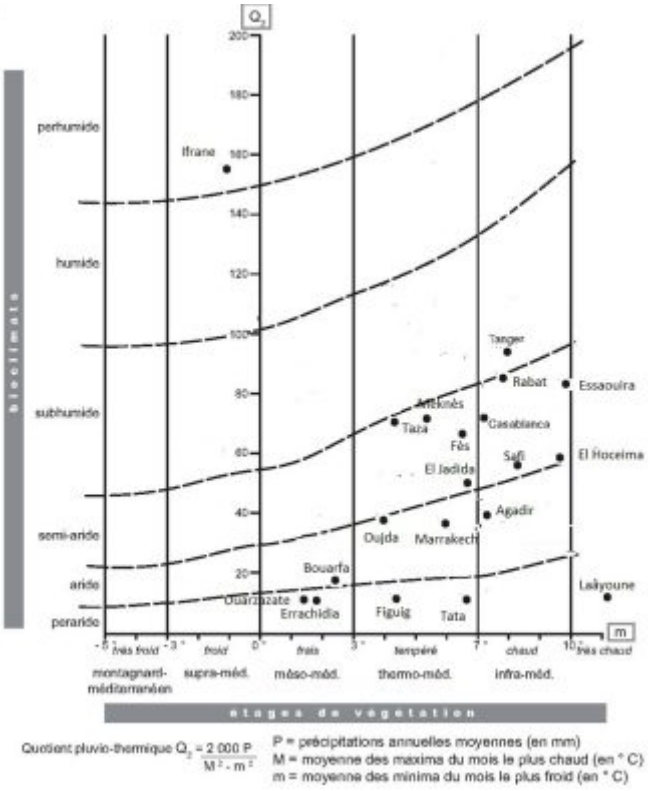

Figure 2. Emberger ombrothermal index (Figure adapted from Tassin, 2012) [Source of stations' datas : © Hanchane Mohamed].

It makes it possible to determine the bioclimatic stage of a given station. Emberger specified five bioclimatic stages: perhumid, humid, sub-humid, semi-arid, arid and Saharan or perarid, and four thermal variants that also correspond to the vegetation stages:

- Very cold winter: -5<m < -3°C (Mediterranean mountain vegetation level)
- Cold winter: -3 < ***m*** < 0°C (Supra-Mediterranean vegetation stage)
- Cool winter: 0 < ***m*** < 3°C (Meso-Mediterranean vegetation stage)
- Temperate winter: 3 <m < 7°C (Thermo-Mediterranean vegetation stage)
- Warm winter: 7 <m< 10 °C (Infra-Mediterranean vegetation stage)
- Very hot winter: m > 10 °C (Infra-Mediterranean vegetation stage)

Notes & references

[1] Kessabi R. (2024). *Contribution à l'étude de la variabilité des précipitations dans la région de Fès- Meknès : analyse des tendances et connexions atmosphériques*. Thèse de Doctorant en géographie (spécialité : Climatologie) soutenue le 25 novembre 2024 à la Faculté des Lettres et des Sciences Humaines Dhar El Mehraz (Fès) sous la Direction du Pr Hanchane Mohamed. 347 p.

[2] The Kelvin is a unit of the International System (SI) with symbol K. It corresponds to an absolute measure of temperature. It was introduced from the third law of thermodynamics, according to which it is impossible to reach absolute zero in practice. Absolute zero (0 K) corresponds to −273.15 °C. It represents the lowest possible temperature, where particles cease all motion. This scale was designed in the nineteenth century by the British mathematician and physicist Sir William Thomson Kelvin. The conversion from the degree Celsius to the degree Kelvin is as follows: T K = 273.15 + T°C
