



A short history of the development of the Turc-Mezentsev water balance formula

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In the 1950s, a formula linking long term average evaporation to long-term average precipitation and potential evaporation was quasi-simultaneously proposed in France and in the Soviet Union. However, because Turc and Mezentsev published in French and Russian respectively, their work has received limited attention, and the formula they proposed is often given different names.

• Work of Lucien Turc in France (1954)

Lucien Turc, a French soil scientist, worked at the Versailles soil science laboratory of the French National Agronomical Research Institute. For agronomic purposes, he was interested in developing a formula to estimate actual evapotranspiration from precipitation and temperature data. Since lysimeter data were so scarce at that time, he had the idea to derive such a formula from catchment water balance. With the help of the hydrologist Maurice Pardé, he assembled a set of data on 254 catchments from all over the world. He derived long-term average actual evapotranspiration (E) from estimates of long-term average precipitation (P) and long-term average discharge (Q). Then, Turc looked for a mathematical function linking two non-dimensional terms: the aridity index (the ratio of precipitation P and potential evapotranspiration E_0) and the evapotranspiration rate (the ratio of E and E_0). He proposed the following formulation:

$$E/P = 1/[1 + (P/E_0)^n]^{1/n}$$

in which n is an exponent to estimate. Turc graphically looked for the most convenient value for n, and concluded that the best fit was "with $n=3$, or may be $n=2$ " (Turc, 1954, p.563).

• Work of Varfolomeï Mezentsev in the Soviet Union (1955)

Mezentsev (1955) worked at the University of Omsk in Siberia. He started his analysis from a formula proposed by Bagrov (1953):

$$dE/dP = 1 - (E/E_0)^n \quad (\text{Eq.1})$$

This formula presents the interesting property to integrate into the Schreiber (1904) water balance formula for $n=1$: and into the Ol'Dekop (1911) water balance formula for $n=2$. But it had no analytical solution for other values of n.

Mezentsev (1955) complexified Bagrov's formula by rewriting it as follows:

$$dE/dP = [1 - (E/E_0)^n]^{1+1/n} \quad (\text{Eq.2})$$

which keeps the same interpretation as Eq. 1.

Eq. 2 can be integrated analytically and yields Eq. 3:

$$E/P = 1/[1 + (P/E_0)^n]^{1/n} \quad (\text{Eq.3})$$

which is identical to the general formulation proposed by Turc. Based on a set of 35 catchments of the Siberian plateau, Mezentsev suggested using the value of 2.3 for parameter n, which is close to the value advised by Turc.

References

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