Numerical risk

Description

The Numerical risk index was developed by Sol (1990 in order to improve the prediction of fire occurrence and spread (in one overall number) in southern France (cf. Orieux index; Orieux 1974).

The Numerical risk takes air humidity, soil water reserve and wind speed into account (Sol 1990. It requires therefore daily air temperature, dew point temperature, cloud cover, wind speed and potential evapotranspiration (according to Thornthwaite 1948) as input variables.

In contrast to the Orieux index which was only suitable in summer, the Numerical risk allows for fire danger rating also in winter and spring.

Formula

The Numerical risk RN 'is calculated as follows (Sol 1990):

$$RN = 25 - \frac{FH \cdot WRF \cdot WF}{15} + RSF$$

where FH is false relative humidity, WRF the soil water reserve factor, WF the wind factor, and RSF the rate of spread correction factor.

FH is calculated as follows:

$$FH = 100 \cdot \frac{e_s(T_{dew})}{e_s(T_{soil})}$$

where $e_s(T_{dew})$ is the saturation vapor pressure [hPa] at the dew point temperature [°C], and $e_s(T_{soil})$ the saturation vapor pressure [hPa] at the soil (litter) temperature [°C]. The formula of saturation vapor pressure at temperature T can be found on the page concerning the vapor pressure deficit. NB: The saturation vapor pressure based on this formula has to be multiplied by 10 in order to be expressed in hPa.

The T_{soil} is derived as follows (temperature at the soil or litter temperature) (Camia & Bovio 2000):

$$T_{soil} = \begin{cases} 0.874 \cdot T - 0.189 \cdot U + 21.38, & \text{for } Cc \leqslant 2 \\ 1.36 \cdot T - 1.422 \cdot Cc - 0.22 \cdot T_{dew} + 13.42, & \text{for } Cc \geqslant 3 \end{cases}$$

where T is air temperature [°C], U wind speed [km/h], Cc cloud cover [Okta], and T_{dew} dew point temperature [Â°C].

The soil water reserve factor WRF is calculated as follows:

$$WRF = 3 + 2 \cdot \tanh\left(\frac{r - 50}{25}\right)$$

where $\tanh$ is the hyperbolic tangent and r the soil water reserve [mm] according to the Orieux (1974) definition (cf. Orieux index).

The wind factor WF is calculated as follows:

$$WF = 3 + 3 \cdot \tanh\left(\frac{45 - U}{50}\right)$$

The rate of spread correction factor RSF is determined as follows:

$$RSF = \begin{cases} -3, & \text{for } ROS \leqslant 600 \\ 0, & \text{for } 600 < ROS < 1000 \\ 2, & \text{for } ROS \geqslant 1000 \end{cases}$$

where ROS, the rate of spread [m/h], is calculated as follows:

$$ROS = 180 \cdot e^{T \cdot 1714} \cdot \tanh\left(\frac{100 - r}{150}\right) \cdot \left\{1 + 2 \cdot \left(0.8483 + \tanh\left(\frac{U}{30} - 1.25\right)\right)\right\}$$

NB1: In Camia & Bovio (2000), the exponent $T \cdot 1714$ of the exponential function in the ROS equation is written $T \cdot 0.06$

NB2: If the Numerical risk is calculated in winter or spring, the value of the soil water reserve r has to be set to 45 [mm].

The Numerical risk could also be calculated on a hourly basis. However the water reserve r is only calculated on a daily basis.

According to the conditions for the Orieux index, the computation should started when the water reserve r is saturated (150 [mm]), as e.g. after strong rainfall. The value of r is then set to 150.

Index interpretation

The Numerical risk has to be interpreted as follows:

Index values	Interpretation
< 10	low fire danger
10 -15	high fire danger
15 -20	very high fire danger

References

Original publication:
Sol (1990)

Other publications:
Thornthwaite (1948)
Orieux (1974)
Camia & Bovio (2000)
