Nesterov ignition index

Description

The Nesterov ignition index was developed in the USSR (cf. Nesterov 1949). It is a simple daily fire danger rating index requiring daily air temperature, dew point temperature and precipitation as input data.

This index is cumulative and resets to zero when daily precipitation exceeds 3 [mm]. The dryness of the fuel is estimated assuming that the drying rate is related to vapour saturation and therefore takes dew point temperature into account. It is therefore particularly appropriate for capturing fine fuel moisture, and thus predict fire ignition, but is less appropriate for predicting fire behavior or spread (Stocks et al. 1996).

Largely used for prevention and research purposes in Central and Eastern Europe and Siberia (e.g. Stocks et al. 1996), it has also been implemented in other regions, such as the Mediterranean basin (e.g. Venevsky et al. 2002).

Formula

After Chandler et al. (1983)

This is the standard formulation used in most recent publications.
The Nesterov index NI is calculated as follows:

$$NI_t = \sum_{i=0}^{w-1} (T_{15_{t-i}} - T_{dew_{15_{t-i}}}) \cdot T_{15_{t-i}}$$

where T_{15} is air temperature [°C] at 15:00, $T_{dew_{15}}$ dew point temperature [°C] at 15:00, and w the number of days since last daily rainfall greater than 3 mm.

After Käse (1969)

After the description in Käse (1969), the Nesterov index is corrected differently, according to different precipitations, and is calculated as follows:

$$NI_t = k_1 \cdot NI_{t-1} + k_2 \cdot (T_{15_t} - T_{dew_{15_t}}) \cdot T_{15_t}$$

the index is calculated from the 1 March, with

$$k_1 = \begin{cases} 1, & \text{if } P_i = 0 \\ 0.5, & \text{if } 0 < P_i \leqslant 1 \\ 0, & \text{if } P_i > 1 \end{cases}$$

$$k_2 = \begin{cases} 0.25, & \text{if } P_{i-1},\, P_{i-2},\, P_{i-3},\, P_{i-4} \text{ or } P_{i-5} > 5 \\ 1, & \text{if } P_{i-1},\, P_{i-2},\, P_{i-3},\, P_{i-4} \text{ and } P_{i-5} \leqslant 5 \end{cases}$$

The Nesterov index is supposed to be calculated on a daily basis. The meteorological data used for its calculation have to be recorded at 3 pm.

Wet conditions (daily rainfall > 1 [mm]) are required on the day preceeding the start of the index calculation. The starting value of the index has to be set to 0.

Index interpretation

The output values of the Nesterov index can be classified in five fire danger classes (Shetinsky 1994):

Index values	Fire danger class	Interpretation
0 - 300	1	no fire danger
301 - 1000	2	low fire danger
1001 - 4000	3	medium fire danger
4001 - 10000	4	high fire danger
>10000	5	extremly high fire danger

The threshold values of these danger classes were determined by comparing fire occurrence to the index values over a period of 10 years. For instance, the "no fire danger" class upper limit (300) corresponds to the index values during the reference period under which there was no fire occurrence. The "low fire danger" class upper limit (1000) corresponds to the index values under which 25 % of all fires occurred, and the "medium fire danger" class upper limit (4000) to the index values under which 65 % of all fires occurred. According to this method, the Nesterov index can be adjusted for every region under consideration (Chandler et al. 1983).

Modifications

Many modifications and improvements of the Nesterov index have been undertaken. One frequent type of modification is the use of other temperature data than the temperature at 15:00 for reasons of data availability or improvement of the index performance. For example, Venesky et al. (2002) used the mean of the daily minimal and maximal temperature in order to obtain T.

Other more substantial modifications were performed. For example, a modified version of the Nesterov index, which includes wind velocity and daily values of rainfall, is in use in Portugal (refered to here as the Portuguese index; Instituto Nacional de Meteorologia e Geofisica 1988). Venesky et al. (2002) published an approximation of the Nesterov index, where *w* take into account minimum temperature and soil moisture.

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$M68$ (Käse 1969) is a based on the Nesterov index as well. It has to be noted that Käse (1969) proposes a formulation of the Nesterov index which slightly differs from the usual - simpler - formulation proposed or used by most authors (e.g. Chandler et al. 1983). Indeed, Käse asserts that the Nesterov index should be corrected for the rainfall occurring on the current calculation day, as well as on the five previous days (cf. above).

References

Original publication:
Nesterov (1949)

Other publications:
Chandler et al. (1983)
Instituto Nacional de Meteorologia (1988)
Käse (1969)
Shetinksy (1994) [in Russian]
Stocks et al. (1996)
Venesky et al. (2002)
