Suitability of different Fire Weather Indices for alpine conditions: an extensive evaluation with high resolution data

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ALP FFIRS
Alpine Forest Fire Warning System

PURPOSE

In the framework of the Alpine Space Interreg-project ALP FFIRS (Alpine Forest Fire Warning System) a platform for sharing historical series of forest fire and weather data is in place. The interpretation and communication of fire danger warning levels based on weather indices values is critical for fire management activities. Here we present the preliminary results on a common system for the evaluation of several fire weather indices calculated from the weather parameters versus the recorded forest fires.

Daily weather parameters (temperature, humidity, wind speed, precipitation) from 79 ground weather stations for six alpine regions (Carinthia, Friuli, Veneto, Ticino, Lombardia, Piemonte) were prepared for the period 2003-2009. Recorded forest fires are available in the same period.

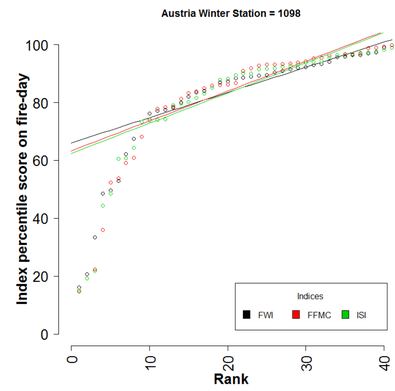
The evaluation technique has to have the following characteristics:

- to be non-parametric, to avoid the potential production of spurious results
- to distinguish skills of several indices in different seasons, different areas
- to permit the creation of a common Alpine Forest Fire Danger Scale, even if the regional services will use different fire weather indices

TECHNIQUE DESCRIPTION

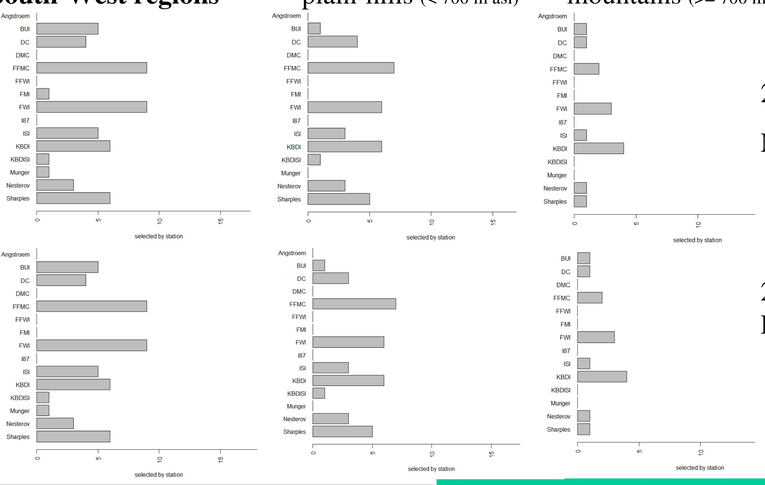
- For each warning area a wide set of fire weather indices is calculated from the weather data and the distribution of the results is compared with the distribution of the index values in case of forest fires (Arpaci et al, 2010).
- We used the slope of the ranked fire-day percentiles and the 'y' intercept of that slope as an additional criterion for interpreting the performance of FWIs.
- The daily values for each index are converted to individual percentiles across the full range of days in the dataset. Those index percentiles for fire-days are ranked from lowest to highest, and plotted on the 'y' axis, with the 'x' axis indicating the rank.
- A 'perfect' index on this plot would have a slope approaching zero and an intercept approaching 100, these two parameters together may usefully describe the performance of fire indices. For more details on the statistical approach please refer to Eastaugh et al. (2012).
- The data set was stratified according to seasonal differences (non-growing season: November to April, growing season: May to September), regional differences (Histalp regions SE and SW - Hiebl et al., 2009), altitudinal differences (> 700m, < 700m).

Example of Index Percentile Score of the best performing indices at a meteorological station in Austria for the Winter (December-April)



South-West regions

plain-hills (< 700 m asl) mountains (>= 700 m asl)

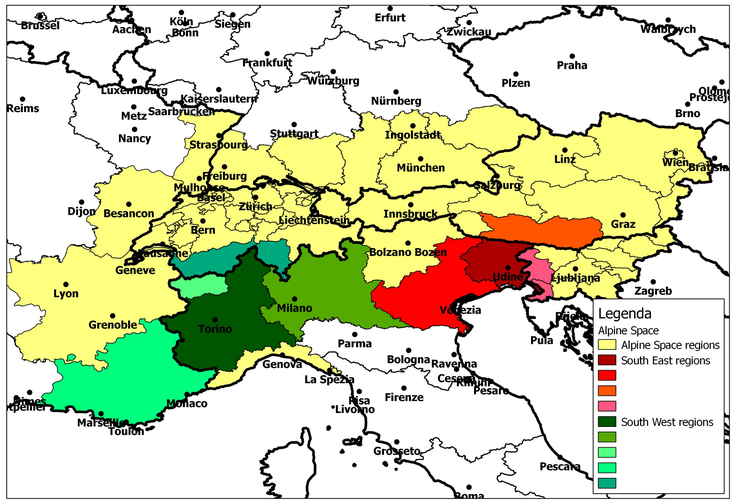


2003-2009
May-Nov.
2003-2009
Dec.-Apr.

	SW SUMMER	SW WINTER	SUMMER SW <700	WINTER SW <700	SUMMER SW >700	WINTER SW >700
UI	**251**	284	**185**	199	**66**	85
C	374	377	246	274	128	103
MC	309	283	230	206	79	77
FMC	278	**181**	214	**116**	**64**	**65**
FWI	531	553	389	403	142	150
MI	565	559	400	415	165	144
VI	**243**	**208**	**170**	**151**	73	**57**
I	**264**	**223**	193	**155**	**71**	68
BDI	322	408	234	280	88	128
BDISI	352	428	247	323	105	105
unger	483	392	362	265	121	127
esterov	370	276	270	200	100	**76**
harples	269	335	**176**	229	93	106

The graphs above show the frequency of first ranking for several fire weather indexes in the stations of the South-West regions. Data are stratified also for season (growing season: May-November, non-growing season: December-April) and for altitude ranges (below or above 700 m asl).

The table on the left summarizes the sum of ranking of each index over all the stations of the South-West regions. The best performing index (the one with lower rank sum) is identified in bold.

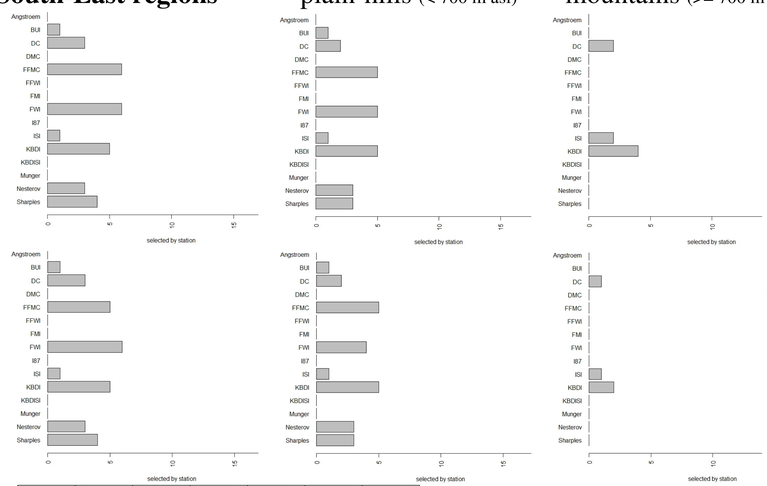


The map above shows the two study areas, according to the climatic areas defined by Histalp (Hiebl et al., 2009), here applied on a regional basis. Green regions are aggregated as the SW dataset (results are shown on the left) and red regions constitute the SE dataset (results on the right).

For ech sub-domain we show the number of stations for which each index is ranking as the best one, according to our classifying method.

South-East regions

plain-hills (< 700 m asl) mountains (>= 700 m asl)



2003-2009
May-Nov.
2003-2009
Dec.-Apr.

	SE-SUMMER	SE-WINTER	SUMMER SE <700	WINTER SE <700	SUMMER SE>700	WINTER SE >700
Angstroem	217	230	182	185	35	45
BUI	**133**	215	**118**	192	**15**	**23**
DC	225	261	192	234	33	27
DMC	**192**	205	**172**	181	**20**	24
FFMC	263	**144**	236	**121**	27	**23**
FFWI	274	247	231	205	43	42
FMI	**199**	216	**155**	170	44	**46**
FWI	221	**148**	199	**129**	**22**	**19**
I87	211	256	184	214	27	42
ISI	263	**160**	229	**136**	34	24
KBDI	**199**	311	168	276	31	35
KBDISI	217	295	193	265	24	30
Munger	359	266	311	234	48	32
Nesterov	276	183	245	165	31	**18**
Sharples	231	227	185	177	46	50

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DISCUSSION AND CONCLUSION

For the stratum of the HISTALP region the selection of an appropriate index is quite sensitive to the season.

Taking into account only the frequency of first ranks identified at the meteorological stations in that region the Canadian FWI and its sub-index FFMC are those, which are being selected mostly independently from the season. Looking at the total sum of rankings supports the selection of FWI and FFMC in the winter season as well. In the summer season the total sum of rankings indicates that the BUI and DMC are having a good performance in the SE-HISTALP region while the Canadian FWI, BUI, ISI and Sharples have a good performance in the SW-HISTALP region.

A large set of indices is not chosen as a top performing index at all, in the SE region these are Angström, DC, FFMI, I87, KBDISI, Munger, Nesterov and Sharples, whereas in the SW region these are DC, DMC, FFMI, FMI, KBDI, KBDISI and Munger.

While for the summer season in the SE and SW region at lower altitudes the Canadian FWI, the FFMC and the KBDI are best performing indices, in the winter season in the SE and SW region at higher altitudes the KBDI and the FWI are showing the best results. For the summer season this result is supported by the total sum of ranks as well. It's worth pointing out that with only the frequency analysis of first ranks the KBDI out competes the other indices at four stations but the total sums of ranks reveals his overall bad performance at the other stations in general.

In general it seems that the Canadian FWI is a much more reliable choice for stations in the SW-HISTALP region, independently from the classifications according to altitudinal and seasonal groups.

The results are quite dependent from the choice of weather stations: in the framework of the ALPFFIRS project a study is ongoing to establish the possible added value of using a spatialization technique (Haiden et al., 2009) on weather parameters to obtain a regular high resolution grid and then to calculate fire weather indices on the spazialized data.

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