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# Using Haines Index coupled with fire weather model predicted from high resolution LAM forecasts to asses wildfire extreme behaviour in Southern Europe..

Jean Baptiste Filippi

Albert Simeoni

*Systèmes physiques pour l'environnement*

*CNRS, University of Corsica*

*Corte, France*

(filippi,simeoni)@univ-corse.fr

Francesco Gaetani

Mirko D'Andrea

*CIMA Research Foundation, Savona, Italy*

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## Abstract

Haines Index (HI) was developed by USDA Forest Service to measure the atmosphere's contribution to the growth potential of a wildfire. The Haines Index combines two atmospheric factors that are known to have an effect on wildfires: Stability and Dryness.

As operational tools, HI proved its ability to predict plume dominated high intensity wildfires. However, since HI does not take into account the fuel continuity, composition and moisture conditions and the effects of wind and topography on fire behaviour, its use as forecasting tool should be carefully considered. In this work we propose the use of HI, predicted from HR Limited Area Model forecasts, coupled with a Fire Weather model (i.e., RISICO system) fully operational in Italy since 2003. RISICO is based on dynamic models able to represent in space and in time the effects that environment and vegetal physiology have on fuels and, in turn, on the potential behaviour of wildfires.

The system automatically acquires from remote databases a thorough data-set of input information both of in situ and spatial nature. Meteorological observations, radar data, Limited Area Model weather forecasts, EO data, and

fuel data are managed by a Unified Interface able to process a wide set of different data. Specific semi-physical models are used in the system to simulate the dynamics of the fuels (load and moisture contents of dead and live fuel) and the potential fire behaviour (rate of spread and linear intensity). A preliminary validation of this approach has been conducted with reference to Sardinia and Corsica, two major islands of the Mediterranean Sea frequently affected by extreme plume dominated wildfires.

A time series of large wildfires burnt in Sardinia and Corsica in 2007, 2008 and 2009 have been used to evaluate the capability of HI coupled with the outputs of the FireWeather model to forecast the actual risk in time and in space.

**Keywords:** Meteorology, boundary layer, risk, fire, atmosphere, Index, Haines.

## 1. Introduction

Haines Index (HI) was developed by USDA Forest Service to measure the atmosphere's contribution to the growth potential of a wildfire. The Haines Index combines two atmospheric factors that are known to have an effect on wildfires: Stability and Dryness.

As operational tools, HI proved its ability to predict plume dominated high intensity wildfires. However, since HI does not take into account the fuel continuity, composition and moisture conditions and the effects of wind and topography on fire behaviour, its use as forecasting tool should be carefully considered. In this work we propose the use of HI, predicted from HR Limited Area Model forecasts, coupled with a Fire Weather model (i.e., RISICO system) fully operational in Italy since 2003. RISICO is based on dynamic models able to represent in space and in time the effects that environment and vegetal physiology have on fuels and, in turn, on the potential behaviour of wildfires.

## **2. Non-stationary reduced rate of spread model**

The wildfire Risk assessment model.

Since 2003 RISICO provides Italian Civil Protection with 7/7 72 hours forest fire risk forecasts.

(see EGU2010-11102 RISICO: A decision support system (DSS) for dynamic wildfire risk evaluation in Italy form more details)

Every 100 m grid cell is represented by:

Center coordinates;

Vegetation parameters (dead and live fuel);

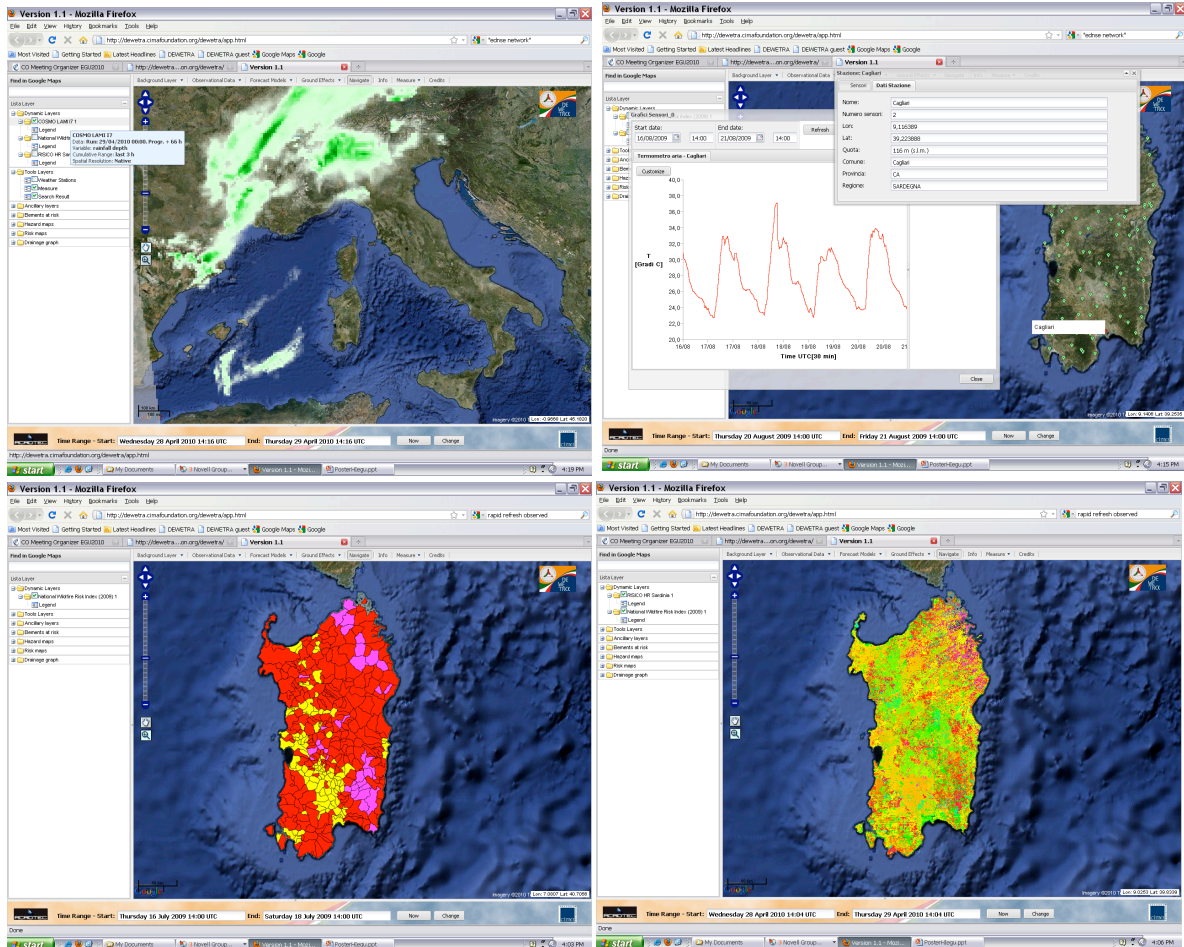
Topography (slope and aspect).

Static and dynamic input data feed the system:

Static: topography and vegetation high resolution cover data (GIS)

Dynamic: meteorological fields (rainfall, RH, temperature and winds) obtained from the deterministic 72 hours forecasts of 00.00 and 12:00 runs of COSMO I7 LAM and High Resolution Rapid Refresh (HRRR) near real time hourly updated data observed from by dense (local) networks of RAWS.

A specific experimental version of RISICO has been implemented for Corsica and Sardinia. A daily municipal risk index has been considered using the weighted values of linear intensities provided by RISICO. Such index represented the reference value (benchmark) for a further evaluation of the system with HI.



## HI implementation and first evaluation and validation of the outputs.

### Haines Index

The Haines Index (HI) (Haines 1988), is intended to provide a simple number (0 for low to 6, high) that indicate the potential for a wildfire to become a large fire by measuring the stability and dryness of the air. It appears that correlates well with large fire growth, (Potter 2001) in particular in large uniform forests such as found in Northern America.

The idea behind the use of HI is that a dry and unstable atmosphere might induce the development of large wildfires even in the case of low to average wind as such fire might become large plume dominated fires.

HI of historical wildfires in Corsica and Sardinia from 2007-2009

Figure 2 presents the size vs 4 day average HI for all fires that burnt an area greater than 1 Ha, in low wind (<4 m.s<sup>-1</sup>) condition. From this figure we can HI is not a relevant index to asses the occurrence of wildfires, nevertheless, there is no large wildfires low HI (< 4.5) days. Moreover, over 1500 fires, less than 200 occurred in days where HI was greater or equal to 5.

Validation of LAM HI with observation

In order to assess the ability of a LAM to predict HI we used the next day forecast of COSMO to compute the HI over Corsica and Sardinia for the summer 2009 in an approach similar to In and Zhong (2005) but with a very limited dataset. These value were then compared to the radio soundings of the day from Cagliari and Ajaccio (Figure 3). It appears

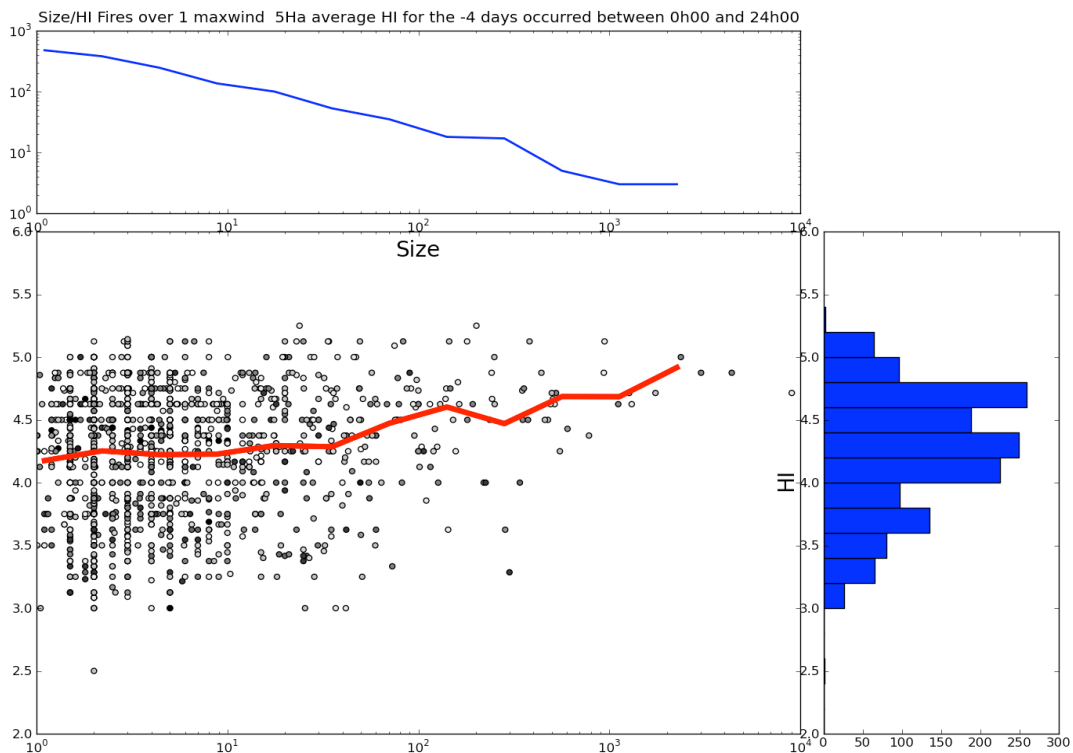
that observed HI is often higher than the forecasted HI (+0.3 in average with std = 0.7) but the maximum error is rarely greater than 1.

The 23/07/2009

On the 23/07/2009 a series of large wildfires occurred in Corsica and Sardinia, burning more than 20 000 ha in total. The wind condition was relatively weak (5 m.s-1), but the air temperature was high ( $> 40^{\circ}$ ) as well as a very low air humidity (8 %). Because of the weak wind condition, the fire risk index was not forecasted as “extreme” (Figure 4) at the location of the fires that occurred in Sardinia. The situation was similar in France, with an elevated (but not extreme) risk index due to the relatively low wind conditions. Figure 5 present the Taravu fire that occurred on that day in Corsica, with a large column suggesting a plume dominated fire. For all these fire, the HI was at least 5 which indicate severe atmospheric instabilities.

Future steps

This experimentation has been performed on a very limited dataset location of the fires that occurred in Sardinia and Corsica. It appears that HI may be a good index to predict the potentiality of a fire to become large, even in low wind condition. It may enhance the existing risk index that are not directly taking into account atmospheric instabilities. Nevertheless, the approach must be validated on a larger dataset covering several years, with multiple large fire events.



**Figure 2:** Size/HI scatter plot of all fires greater than 1 ha that occurred on days with less than 5 M.s-1 wind



**Figure 5:** Taravu Fire plume  
(Courtesy of Corse-Matin) and  
Modis image of the 23/07/2009

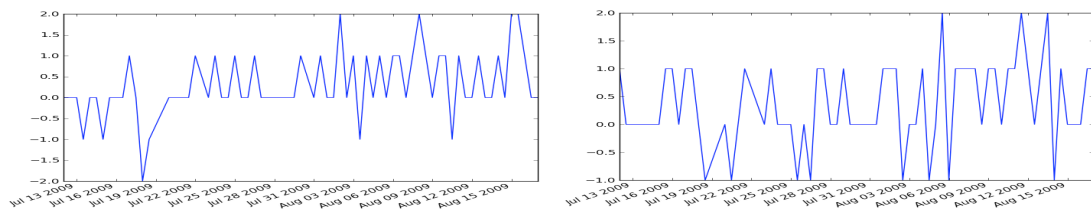


Figure 3. Observed-Simulated HI for Ajaccio (left) and Cagliari stations

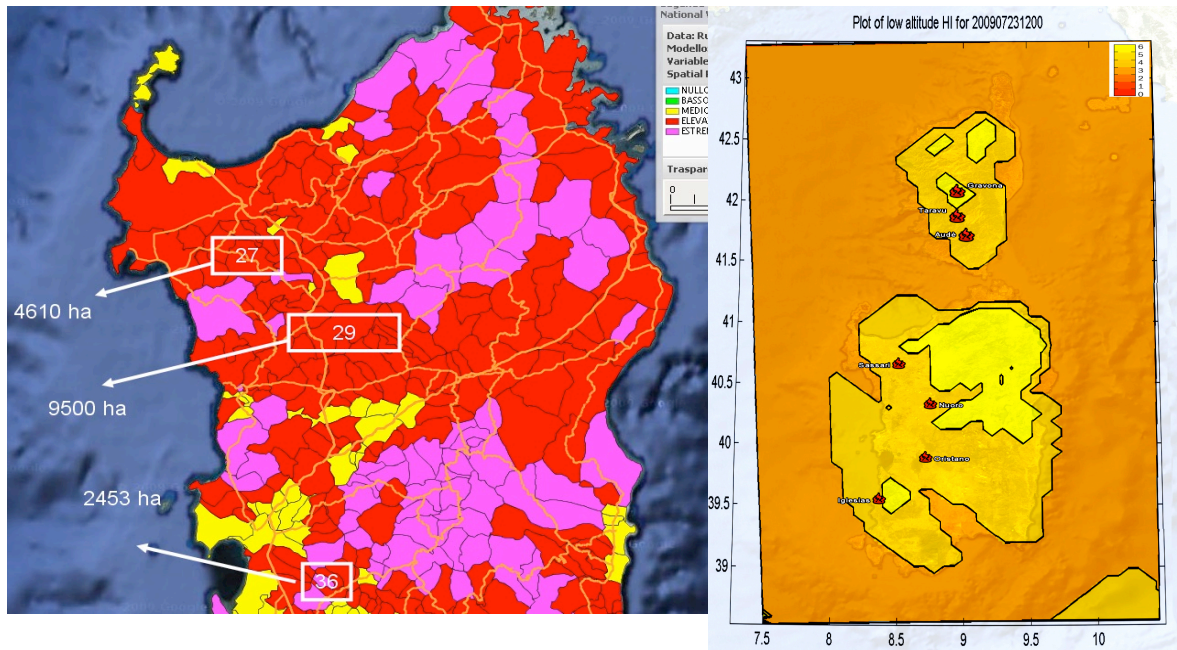


Figure 4. Risico fire index (left) and LAM HI on the 23/07/2009. Dots are the large fire locations.

### Acknowledgements

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