Topic 7 Fire and weather relationships: present climate

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The relationships between weather/climate conditions and fire through the analysis of historical meteorological data and fire records were investigated using different algorithms and methodologies at several scales, from the Euro-Mediterranean level, through national, NUT02, and local scale. In spite of the use of such a wide range of methodologies and spatial scales, the importance of similar concurrent (and precedent) fire season climatic factors was observed. In particular, seasonal droughts in the months prior to the fire season peak, occurrence of heat waves, and strong winds during the fire season have a strong influence on fire occurrence and seasonal severity across scales.

Implications for policy and management

- *Dry spells and other weather anomalies (heat waves, strong winds) play a driving role in fire outbreaks.*
- *Progress in weather forecasting may allow improvements in fire danger and risk prediction.*
- *Climate anomalies (e.g. long drought periods) are causal factors of severe fire season. Long-range predictions can be thus used to anticipate fire season dynamics, helping in planning activities such as resource allocations and strategic fuel management.*
- *Trends of meteorological variables at larger scales do not necessarily reflect what happens at smaller scales. Improvements of local knowledge would enhance all fire management phases, from prevention to firefighting activities.*

The problem: Fire occurrence in the Mediterranean region varies considerably from year to year, suggesting a strong dependence on meteorological conditions. In fact, climate and weather are two key fire drivers acting directly and indirectly on fuel biomass and moisture, which are among the main factors of fire ignition and behaviour. However, these relationships must consider the anthropogenic component, particularly in areas where most ignitions are human caused. Specific analysis of the driving forces of fire regime across countries and scales are still required in order to better anticipate fire occurrence and also to advance our knowledge of future fire regimes.

The approach: FUME project attempted to unravel the relationships between fire and weather using several statistical approaches and data for at least the last two decades (1985-2005). The analyses were performed at several scales (Fig. 7.1) in different Mediterranean climate areas of the world, ranging from the Euro-Mediterranean level, through national (Portugal, Spain, Italy, Greece, Finland) and NUT02 scales (North Morocco, Comunidad Valenciana, Languedoc-Roussilon, Sardinia, Tuscany, Peloponnese, Attika, Antalya, S. Central Chile, Western S. African Cape), to very local level (Mt. Parnitha and Mt. Penteli, Greece).The main variables collected were: fire number (FN) and burned area in hectares (BA), precipitation, temperature, relative humidity, and wind, mainly at daily/monthly time resolution. A series of common analyses were firstly done across areas to investigate the relationship between the series of data, followed by more sophisticated non-linear algorithms. In few study areas, synoptic conditions forcing fire occurrence were also investigated.

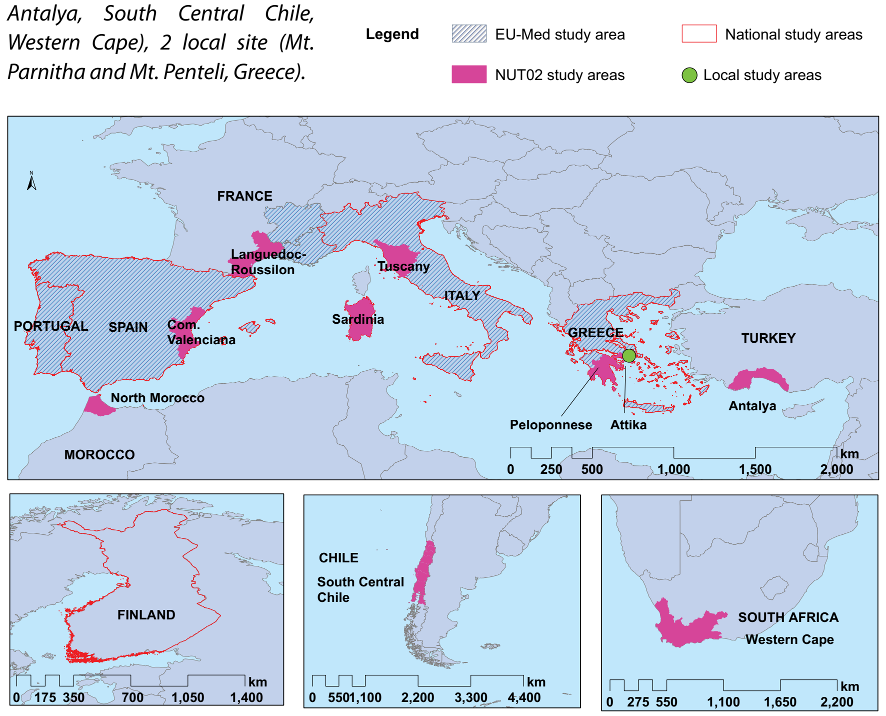
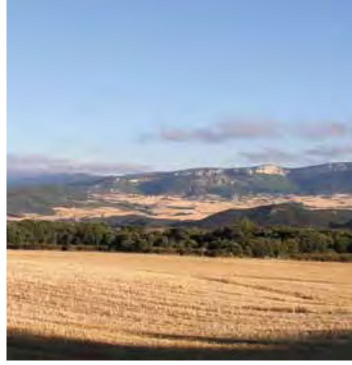


Fig. 7.1: FUME project study areas: EUMed (Portugal, Spain, South France, Italy, Greece), 5 countries (Portugal, Spain, Italy, Greece, Finland), 10 NUT02 regions (North Morocco, Comunidad Valenciana, Languedoc-Roussilon, Sardinia, Tuscany, Peloponnese, Attika, Antalya, South Central Chile, Western Cape), 2 local site (Mt. Parnitha and Mt. Penteli, Greece).

Achievements: EUMed scale: Precipitation was the variable that more influenced the multiple linear regression models at this scale. National scale: In general, severe years in terms of burned areas were related to anomalies in precipitation, both before and during the fire season, and anomalies of temperature (Fig. 7.2 and Fig. 7.3). Northern Italian areas showed a significant negative correlation also with minimum temperature. In Finland, annual precipitation and relative humidity correlated more strongly with annual BA. On the Iberian Peninsula, warm and dry fluxes associated with anticyclonic regimes were found to be the typical synoptic configurations favouring large burned areas. Regional scale (NUT02): both antecedent and concurrent fire season weather conditions appeared to be well correlated with the number of fire outbreaks and BA. In general, the total area affected by fires during wet summers tends to be small, while during dry summers it could be either small or large. On the other hand, in Antalya (Turkey), highest correlations were found with mean and minimum temperature. In Valencia (Spain), dry situations associated with Atlantic frontal and continental backward advections are responsible for a greater extent of BA per day. In South Central Chile, strong relationships between fires and large-scale climatic oscillation patterns (e.g., ENSO) were found. In South Africa, the focus on event-driven fires (e.g. foehn wind conditions) provided more insight than exploring mean annual fire risk conditions. Local scale: significant relationships between BA and summer precipitation were found in Mt. Parnitha and Mt. Penteli (Attica, Greece); however, accounting only for a small part of the BA variability.

Lessons learned and implications: Meteorological conditions, both antecedent (such as droughts) and during the fire season (such as strong wind, heat waves), seemed to have a strong influence on seasonal severity (i.e., area burned). Several results suggested the dual role of precipitation in fuel build-up and dryness. The simple statistical models developed in FUME and the identified synoptic conditions can reproduce a great part of the inter-annual fire variability and the circumstances triggering large or extreme fires. They could be easily incorporated in short-term predictive models of fire risk, long-term planning strategies, as well as inputs for the construction of future fire scenarios (see topic 12).



Los Arcos (Navarra, Spain). Photo: B. Pérez

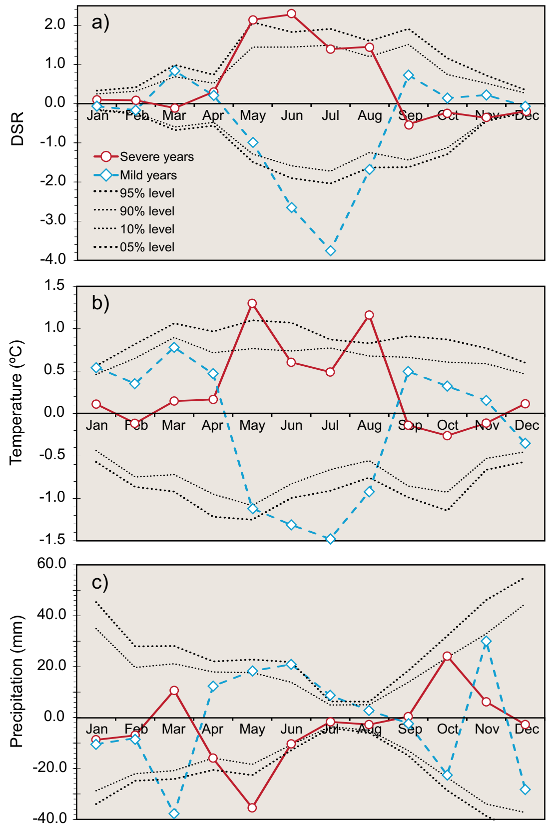


Fig. 7.2: Monthly anomalies of a) the daily severity rating (DSR), b) temperature, and c) cumulated precipitation for composite of severe (Severe years) and mild (Mild years) fire season within the 1980-2011 period in Portugal. Dotted lines: 95, 90, 10, and 5% statistical significant level (from Pereira et al., 2013).

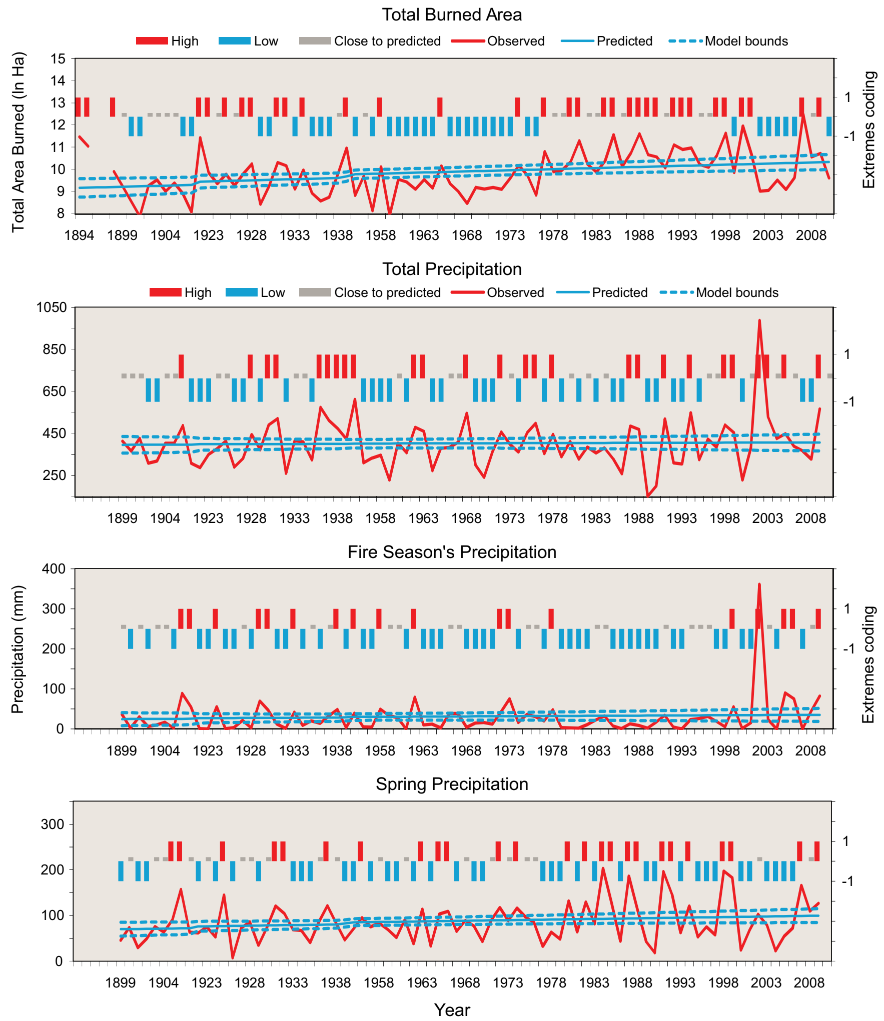


Fig. 7.3: Trend lines and 95% confidence intervals of the trend line of fire occurrence statistics (burned area) and the trend line of precipitation related meteorological parameters (total, spring and fire season precipitation). These are used as bounds to define strongly positive (red columns), strongly negative (blue columns), and close-to-predicted (grey columns) values of fire occurrence (modified from Xystrakis et al., 2013).

Forest fires

under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world

FUME

Lessons learned and outlook

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