Extreme fire weather conditions in Spain and Portugal now common due to climate change

Authors

Theodore Keeping, *Centre for Environmental Policy, Imperial College, London, UK*
David García García, *Dpto. Matemática Aplicada e Ingeniería Aeroespacial, Universidad de Alicante, Alicante, Spain*
Ricardo Trigo, *Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal*
Filippe LM Santos, *Universidade de Évora, Center for sci-tech Research in EArth sysTem and Energy, Évora, Portugal*
Clair Barnes, *Centre for Environmental Policy, Imperial College, London, UK*
Maja Vahlberg, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands; Swedish Red Cross, Stockholm, Sweden (based in Ubmeje/Umeå, Sweden)*
Renate Meyer, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands (based in Cape Town, South Africa)*
Friederike Otto, *Centre for Environmental Policy, Imperial College, London, UK*

Review authors

Sjoukje Philip, *Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands*
Roop Singh, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands (based in New Jersey, USA)*
Sara Casas Osorio, *Spanish Red Cross, Madrid, Spain*
Marta Neves, *Portuguese Red Cross, Lisbon, Portugal*
Paula Haro, *International Federation of Red Cross and Red Crescent Societies (IFRC), Regional Office for Europe, Budapest, Hungary*

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The event

As of 1st September, around 380,000 hectares (ha) have burned across Spain since the start of the year, according to the Copernicus European Forest Fire Information System (EFFIS). So far, 2025 is the fifth year with the largest area burned since 1961, when records began. The year with the largest burned area was 1985 with nearly 485,000 ha; 1978 with about 439,000 ha; 1994 with nearly 438,000 ha; and 1989 with almost 427,000 ha (SGR, 2015; 2023). In the two decades from 1975 to 1994, the average annual area burned was around 232,000 ha (SGR 2015). In the last two decades, 2006-2024, the annual average fell to around 80,000 ha (EFFIS data), mainly thanks to improved prevention measures and harsher sentences for those responsible for starting fires. However, in 2025, one region burned to a degree not seen for three decades, with the area affected being four times greater than the annual average for the previous two decades. Neighbouring Portugal has also experienced an extreme fire season, with 260,000 ha burned, nearly five times the average for this time of year. Portugal is proportionally the country most affected by fires in Europe, with a mean annual burnt area of around 115,000 ha since 1980 (Ramos et al., 2023). As in Spain, the average annual burned area has reduced in recent decades with an average of 100,000 ha from 2006-2024 (EFFIS), although there is large inter-annual variability, including particularly severe years such as 2003 (425,000 ha), 2005 (350,000 ha), and the all-time record value of 2017 (540,000 ha). In absolute terms, Portugal is also the country with the most hectares burned during the period 2006-2024, with more than 1.8 million ha, followed by Spain with more than 1.5 million ha, and Italy and Greece with around 1 million ha each (EFFIS).

Together, the fires have consumed 640,000 hectares - an area roughly four times the size of Greater London, representing around 1% of the Iberian Peninsula's surface - with the majority of damage occurring in just a two-week span (BBC, 2025). At a European level, one million hectares of land have burned, which is the worst figure since EFFIS records began in 2006. Spain and Portugal account for two-thirds of this total. At least eight people have lost their lives (France 24, 2025), and the evacuation of many villages prevented a higher death toll. As of 28th August, almost 36,000 people have been evacuated in Spain (El País, 2025a), and around 1,000 people in Portugal as of 21st August (El País, 2025b) .

The fires have been most intense in forested regions of northern Portugal and northwestern Spain, particularly in Galicia, Asturias, and Castile and Leon. In Castile and Leon alone, more than 8,000 people were evacuated (Le Monde, 2025). Protected natural areas, including Picos de Europa (Spain) and Gerês (Portugal) National Parks, have been affected. The habitat of 395 endangered, vulnerable or specially protected species has been partially destroyed. In particular, 2,400 hectares critical to capercaillie, 773 hectares critical to black storks and 1,751 hectares critical to brown bears have been lost (SER, 2025). Significant stretches of the Camino de Santiago pilgrimage routes, which typically draw over 100,000 visitors during the summer have also been affected (BBC, 2025).

For the first time, Spain has activated the EU Civil Protection Mechanism to request assistance in fighting forest fires. By 15th August, the Mechanism had been activated 17 times - more than the total number of requests made during the 2024 fire season - with requests from Spain, Portugal, Greece, Bulgaria, Montenegro and Albania being issued within an eight-day period (EuroNews, 2025; Portugal.gov, 2025; EU Commission, 2025).

The fires occurred at a time when the whole of the Mediterranean region was gripped by a heatwave, meaning that the atmospheric conditions were such that vegetation would dry out extremely quickly, providing a lot of fuel for fires (Swain et al., 2025), a factor that is next to longer term droughts a key factor in large and hard to control fires to break out in the region (Carmo et al. (2023)). The heatwave in Spain was the longest on record, lasting 16 days (3rd–18th August), and the most intense, with a positive anomaly of 4.6 °C, exceeding the 4.5 °C anomaly recorded in July 2022 (AEMET, 2025) and at its peak, producing the hottest ten-day period recorded in Spain since at least 1950 (Guardian, 2025). Since 1975, there have been 77 heatwaves (not counting the Canary Islands), of which only six have had an anomaly of 4 °C or more. Five of these have occurred since 2019. The fires occur at the peak of the fire season, after years of increasingly large fires (Fernandes et al., 2016; Fernandes, 2019).

WWA performed a super rapid analysis of trends in fire-conducive weather conditions in the affected area, analysing observations only. To capture the extent and duration of the extreme fire weather across the region, we use the cumulative daily severity rating (DSR). The DSR is a scaled power transformation of the Canadian Fire Weather Index (FWI), and reflects how difficult a fire is to suppress once ignition has occurred; it is commonly used for assessing fire weather on multi-day timescales. Both indices (FWI and DSR) have been used extensively to characterize fire risk in Iberia (e.g. Calheiros et al., 2020; Silva et al., 2023). Here we focus on the DSR for the 10 days of most intense fire weather conditions in the region of Northern Portugal and Northwestern Spain with maritime forests (Figs. 1 and 2). In addition we look at trends in maximum 10-day summer temperatures in the same region.

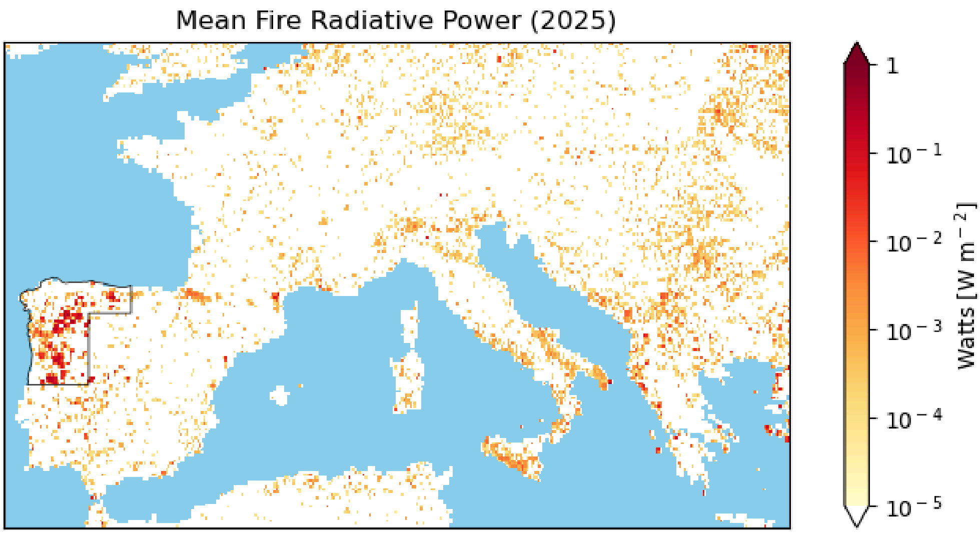

Figure 1*: Mean Fire Radiative Power [W m^{-2}] over southern and central Europe over 2025 up to 26th August 2025. Data sourced from the Copernicus Atmosphere Monitoring Service Global Fire Assimilation System (GFAS) (Kaiser et al., 2012). The study region is outlined in grey.*

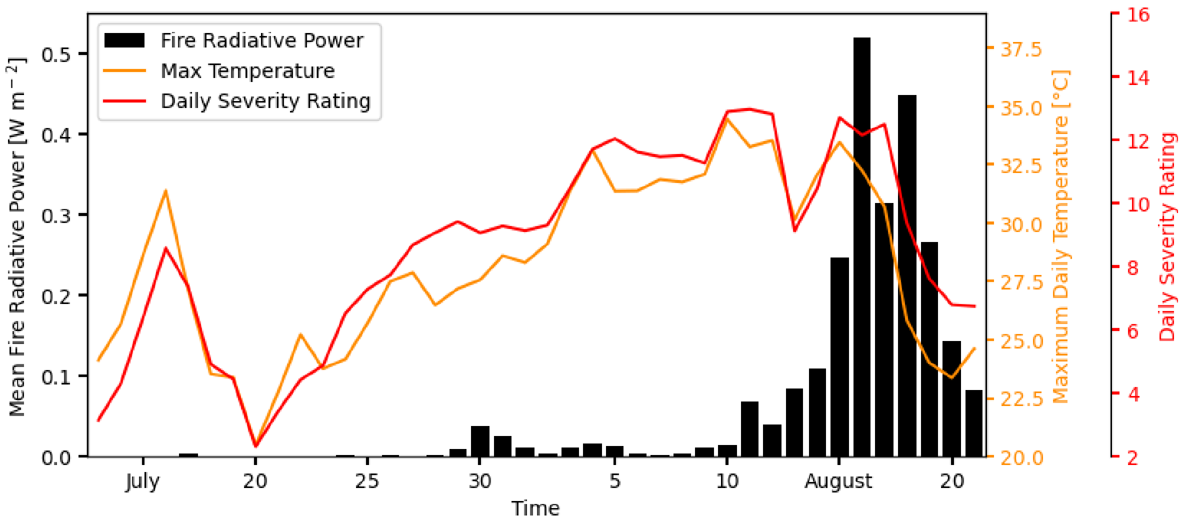

Figure 2*: The days leading up to the major wildfire event from 15-19th August (shown by fire radiative power [GFAS] – black) were characterised by a run of exceptionally hot days (maximum daily temperature [ERA5] - yellow) with high wildfire risk (daily severity rating [ERA5] - red).*

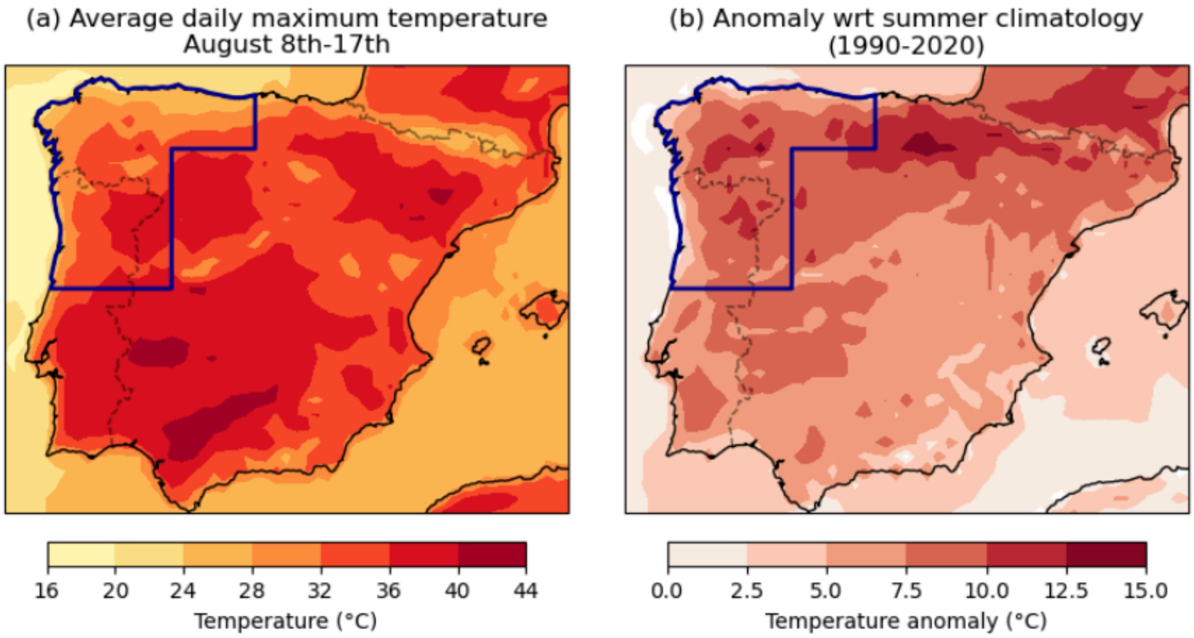

Figure 3: *(a) Average daily maximum temperatures during the 10-day heatwave from 8th-17th August (the hottest period over Spain since 1950 – [Guardian, 2025](#)); (b) temperature anomaly during the heatwave when compared to average daily maximum temperatures over the summer months (June-August) from 1990-2020. The study region is outlined in dark blue. All data: ERA5.*

Key Messages

- The fires in Spain in 2025 were the worst in 30 years, almost quadrupling the average annual area burned during that period. In Portugal, the area burned was 2.3 times larger than the annual average since 1980. In total, more than 1% of the Iberian Peninsula's surface area has burned in 2025, and more than 5% of the study region. The fires occurred during the 16-day heatwave, the longest since records began.
- Rural depopulation and an ageing population across parts of Portugal and Spain have left forest land unmanaged, creating dense fuel loads. With fewer people and less traditional grazing, natural vegetation control has sharply declined.
- Empirical weather data suggest that, in today's climate, which has warmed by 1.3°C since preindustrial times, the extreme conditions that drove the recent wildfires are expected to occur approximately once every 15 years. Compared to a 1.3°C cooler climate, this is an increase in likelihood of about a factor of 40 and an increase in the intensity of the meteorological fire conditions of about 30%. This means the event would only be expected to occur less than once per 500 years without climate change.
- In the present climate, maximum 10-day temperatures as hot as those recorded over the hottest period, coinciding with the fires, are expected to occur approximately once every 13 years. Before humans warmed the atmosphere, such high temperatures would have been extremely rare, only expected less than once every 2500 years. The intensity of the observed ten hottest days in the area has increased by just over 3°C. In other words, what is now a 1-in-13 year heat event in a 1.3°C cooler climate would have been 3°C cooler.
- These findings are in line with a large body of scientific literature showing strong drying trends and a sharp increase in temperature as well as increasingly fire conducive weather conditions in the Mediterranean.

- The simultaneous occurrence of highly impactful wildfires across Europe highlights the current strain on firefighting resources in the current climate with 1.3°C of warming. This year, the EU Civil Protection Mechanism, responsible for coordinating aid and support during emergencies, has been activated 17 times during the 2025 fire season, in response to wildfires, including in Greece, Albania, Bulgaria, Portugal and Spain. With further warming, more extreme, concurrent fire-weather will continue to challenge firefighting resources and push the limits of adaptation in some places.

Analysis of trends in extremes

The large inter-annual variability of burned area in western Iberia is controlled to a large extent by summer meteorological conditions that explain about 70% of the total variance (Pereira et al., 2005; Sousa et al., 2015). To understand the changing risk of extreme wildfires like those observed in northern Portugal and northwestern Spain in August 2025, we analyse changes in the overall fire weather conditions in those parts of Portugal and Spain, and the long spell of extreme temperatures that contributed to those conditions. We characterise the fire weather conditions using the DSR (Daily Severity Rating), a rescaling of the Canadian Fire Weather Index (FWI) intended to capture the overall impact of meteorological conditions on the likely wildfire hazard in an ecologically similar region. The FWI accounts for long term precipitation and evapotranspiration conditions in the build up of dry fuels - separately modelling the moisture response of heavy fuels such as logs, mid-sized twigs and buried organic matter, and fine fuels such as pine needles. These fuel conditions are then combined with daily heat, humidity and wind to estimate the likely severity of a wildfire, were an ignition to be successful. The DSR combines FWI conditions across the landscape, weighting extreme values more highly to capture the overall difficulty in suppressing wildfires over the wider region and multiple days. The FWI and DSR are widely adopted in the Mediterranean to characterise fire risk, including by the European Forest Fire Information System (EFFIS). For the temperature trend, maximum daily temperatures are examined - as these extreme values drive the short term atmospheric drying demand (Swain et al., 2025), causing extremely dry fine fuels. As the event occurred in the peak of the wildfire season, we compared this year's conditions to the maximum fire weather and temperature conditions in all previous years. We examine two time periods here: 5 days, corresponding to the extreme wildfire outbreak that occurred from 15th-19th August, and 10 days, corresponding to the intense heatwave (Guardian, 2025) that affected the region from 8th-17th August - which contributed to the exceptionally dry fuel conditions that resulted in the most extreme wildfire outbreak from the 15th.

To analyse trends in aspects of the weather associated with fire-prone conditions, we follow the World Weather Attribution protocol (Philip et al., 2020). For each time series we estimate the parameters of a statistical model in which the index depends on the global mean surface temperature (GMST). This model is then used to estimate the return period and intensity of the event under study for the 2025 GMST and for a 1.3°C cooler counterfactual climate: this allows us to compare the expected intensity and frequency of similar events now and in the preindustrial past (1850-1900, based on the Global Warming Index), by calculating the probability ratio (PR; the factor-change in the event's probability) and change in intensity of the event. A nonstationary generalised extreme value (GEV) distribution is used to model the 5-day fire weather conditions (DSR5x), the 10-day fire weather (DSR10x) and the 10 day average of daily maximum temperatures (Tx10x). In each case, the distribution is assumed to shift linearly with the GMST covariate, while the variance remains constant. The parameters of the statistical model are estimated using maximum likelihood.

At the time of writing, the DSR5x were about a 1-in-9 year event, the Tx10x a 1-in-13 year, and the DSR10x a 1-in-15 year event. In short, in the present climate (1.3°C above pre-industrial) the fire weather and heat conditions that strongly contributed to this year's wildfires are not particularly rare. However, these conditions were rare before the onset of anthropogenic climate change. The best estimate for the change in the likelihood of the fire weather conditions we saw this year was an increase in the likelihood of the DSR5x conditions by about 21 times, and DSR10x by about 39 times. The likelihood of this year's temperature conditions (which contribute to the DSR) has increased by approximately 220 times. Annual max 10-day period of maximum daily temperatures at this year's return period (13 years), has increased by 3.1°C compared to the pre-industrial climate. The DSR has also increased in intensity by about 30% (DSR5x by 31% and DSR10x by 29%). The full results, including 95% confidence intervals estimated by bootstrapping, are shown in Table 1, while the fitted trends are in Figures 3-5. We focus on the communication of DSR10x and Tx10x because the results of DSR10x and DSR5x are quite similar.

Table 1: *Return period and magnitudes of the 5-day fire weather event, and 10-day fire weather and temperature events in the ERA5 datasets. The probability ratio and change in intensity associated with a 1.3°C increase in global mean surface temperature (GMST) are estimated for each dataset, with bootstrapped uncertainties. Finally, the synthesised results for all datasets are shown in the final row. Statistically significant (at the 95% level) results are highlighted in bold text.*

	Event Magnitude	Return Period	Change in intensity	Probability Ratio
DSR5x	12.3	8.6 (4.3, 32.5)	**30.9% (10.7, 56.1)%**	**21.3 (3.52, Inf)**
DSR10x	11.9	15.2 (6.7, 162)	**29.4% (9.1, 56.8)%**	**38.7 (4.36, Inf)**
Tx10x	32.5°C	13.3 (5.2, 187)	**3.1°C (1.9, 4.4)°C**	**221 (7.61, Inf)**

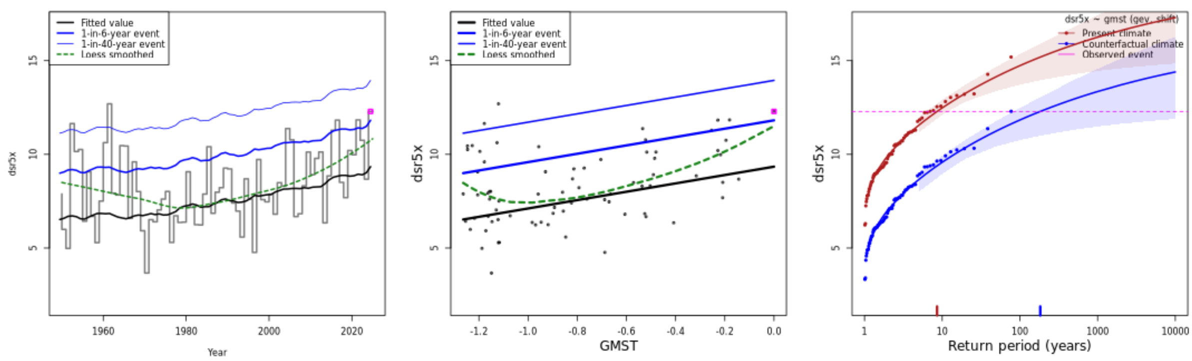

Figure 3*: (Left) the trend against time in the annual maximum 5-day DSR. (Centre) the trend against GMST in the annual maximum 5-day DSR. (Right) the log-normal shift of the annual maximum 5-day DSR distribution to GMST, return periods are shown for the 2025 climate (red) and a climate with*

GMST 1.3ºC cooler (blue). The reanalysis data are shown twice: once shifted up to the current climate and once shifted down to the climate of the pre-industrial era. The markers show the data and the lines show the fits and uncertainty from the bootstrap.

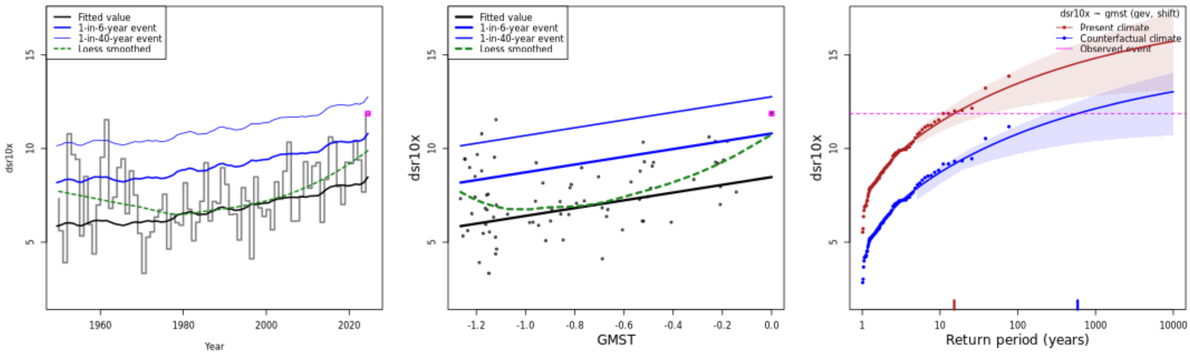

***Figure 4**: (Left) the trend against time in the annual maximum 10-day DSR. (Centre) the trend against GMST in the annual maximum 10-day DSR. (Right) the log-normal shift of the annual maximum 10-day DSR distribution to GMST, return periods are shown for the 2025 climate (red) and a climate with GMST 1.3ºC cooler (blue). The reanalysis data are shown twice: once shifted up to the current climate and once shifted down to the climate of the pre-industrial era. The markers show the data and the lines show the fits and uncertainty from the bootstrap.*

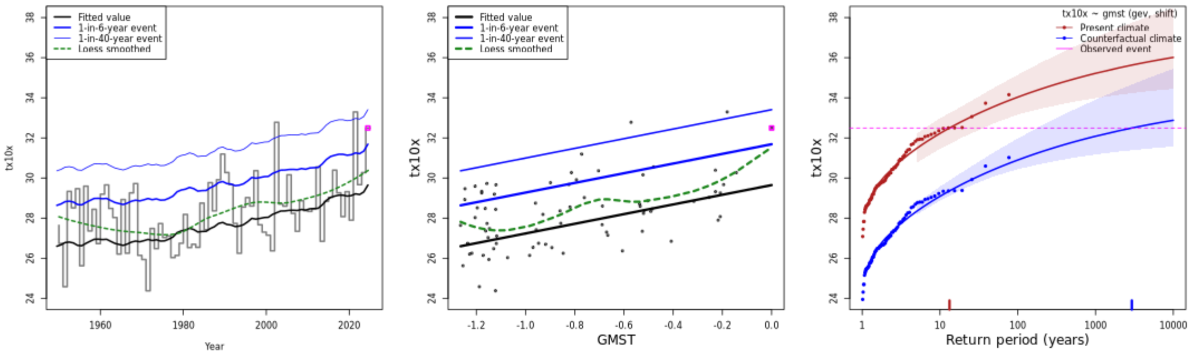

***Figure 5**: (Left) the trend against time in the annual maximum 10-day average of maximum daily temperatures (Tx10x). (Centre) the trend against GMST in the annual maximum Tx10x. (Right) the log-normal shift of the annual maximum Tx10x distribution to GMST, return periods are shown for the 2025 climate (red) and a climate with GMST 1.3ºC cooler (blue). The reanalysis data are shown twice: once shifted up to the current climate and once shifted down to the climate of the pre-industrial era. The markers show the data and the lines show the fits and uncertainty from the bootstrap.*

Fire weather in the scientific literature

In a recent review paper on trends in fire weather and the relationship to burned area Jones et al., (2022) analysed the Canadian Fire Weather Index (from which the DSR used here is derived) and found strong correlations between FWI and burned area (BA), indicating that it is indeed a good measure for fire risk in this area. These findings also align with previous findings where strong relationships between the FWI and burned area have been consistently observed in the Mediterranean (e.g., Carvalho et al., 2008; Fox et al., 2018; Papaiannaki et al., 2020; Ruffault et al., 2018). Carvalho et al. (2008) showed that FWI explained over 80% of monthly BA variability in Portugal. Urbieta et al. (2015) found that models including fire weather outperformed those using only long-term drought indicators across several Mediterranean countries, underscoring the key role of short-term weather conditions, in particular high temperatures. Other studies similarly highlight the influence of heatwaves and summer droughts on fire activity (Parente et al., 2018; Turco et al., 2017).

Studies focusing on analysing the influence of climate change in the Mediterranean have found consistently strong trends. Venäläinen et al. (2014) reported a significant rise in average FWI in southern Europe from 1980 to 2012, along with a ~5% increase in the likelihood of extreme FWI values (>45). Similar trends in fire weather extremes have been noted by others. Bedia et al. (2012) found increasing seasonal severity ratings (accumulated DSR) over the Iberian Peninsula (1989–2011). More recently, Giannaros et al. (2021) identified rising frequencies of extreme FWI values over the Iberian Peninsula. These trends can be seen in Figure 6, which shows the relative change in 10-day maximum DSR over the Iberian peninsula (estimated from ERA5), along with the reduction in summer rainfall and increase in summer temperatures that are key to this increase in fire-prone conditions. Several studies assessing the future evolution of the meteorological component of fire risk in the future for Iberia have all stressed the inevitable increment, although dependent on the climate change scenario adopted (Trigo et al., 2016; Ruffault et al., 2020). In particular a recent study by Bento et al. (2023) stresses that Northwestern Iberia, including northern Portugal and northwestern-to-central Spain, is projected to experience the largest increases in fire danger.

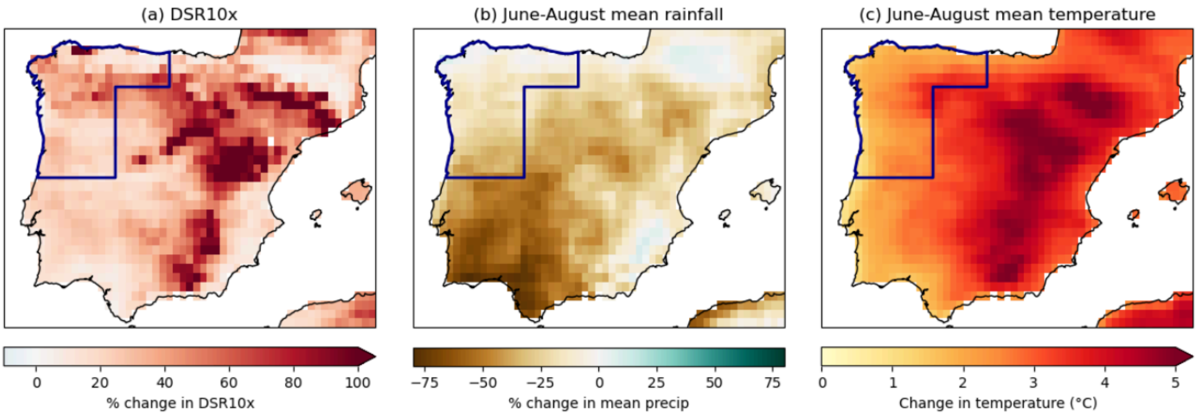

***Figure 6**: Change in fire-conducive conditions associated with 1.3°C of global warming, estimated at each grid cell independently: (a) DSR10x; (b) mean summer rainfall; (c) mean summer temperatures. The study region is outlined in dark blue. Data: ERA5.*

Vulnerability and Exposure

In August 2025, catastrophic wildfires blazed across western Iberia, exacerbated by a parched spring that left abundant dry ground vegetation and intensified by a record 16-day heatwave in early August that further reduced remaining moisture and, under strong winds, fueled rapid fire spread (Al Jazeera, 2025; Gore et al., 2025). In Portugal a recent blaze which spread across seven municipalities took 12 days to extinguish and was the largest fire ever recorded in Portugal, according to the Institute for Nature and Forest Conservation (Reuters, 2025; Belga, 2025). The scale is immense with 380,252 Hectares (Ha) burned in Spain and 262,745 Ha in Portugal as of September 2, compared with 2006-2024 annual averages of 79,380 Ha and 96,349 Ha, respectively (EFFIS, 2025). These wildfires form part of the worst wildfire season on record in the EU, with over a million Ha of land consumed overall, surpassing the devastating 2017 wildfire season (EFFIS, 2025).

Smoke from wildfires also presents a risk to populations near and far from direct burning. Recent studies have shown that smoke from wildfires can be deadly, linking it to 1.53 million deaths per year globally between 2000 and 2019 (Xu et al., 2024). Wildfire carbon emissions, a component of the fine particulate matter (PM2.5) that can be harmful to people as they can penetrate the lungs and bloodstream, reached record levels in Spain and near record levels in Portugal recently (NASA, 2025). Even short-term exposure to air pollution from wildfires has been associated with an increased risk of mortality (Chen et. al., 2021).

There are a variety of factors that can either exacerbate or moderate the risk of wildfires. Weather and climate related-factors can aggravate fires through intensifying heatwaves and conducive fire weather-such as high temperatures, strong winds and low relative humidity-occurring more frequently and both earlier and later in the fire season (Giannaros et al, 2023). This coupled with the accumulation of combustible vegetation in forests, shrublands, and grasslands amplify fire potential (Quishpe-Vasquez et al., 2024). Population and environmental factors also contribute towards fire risk. These include vegetation stress (induced by prolonged warm and dry conditions), loss of native species which can promote higher ignition (e.g. eucalyptus, acacia and silver wattle), and increased urbanisation into wild land which increases road density and electrical infrastructure creating a heightened potential for fire hazard (DaCamara, 2024; Ferreira et al, 2024; Meira Castro et al., 2020; Fernandes, 2016).

Across parts of Portugal and Spain, there has been a trend of rural depopulation (e.g. due to livelihood opportunities in urban areas), combined with an ageing population, contributes to plots of unmanaged forest land and dense fuel loads (Canadas and Novais, 2019). This trend has reduced traditional agricultural practices such as extensive livestock grazing that once acted as a mechanism of vegetation clearance to reduce fuel loads. Oftentimes the costs of maintaining forests is higher than their profitability, resulting in an economic issue that could be mitigated through strategies such as increasing local tourism opportunities (Ferreira et al, 2024, Parente et al, 2024). Both Spain and Portugal have legal frameworks that mandate populations to clear potential fuel around homes and businesses to create defensible space and these have been strengthened in recent years as a result of recent catastrophic wildfires (Soares, 2025; Ager et al, 2025).

The causes of wildfires are often unknown, but of the identified cases, human ignition accounts for around 90% of fires (Liz-Lopez et al., 2024). On average, between 2019 and 2023, 68% were accidental fires (e.g. certain agricultural activities, discarded cigarettes, barbecues or broken glass) and 24% were arson (e.g. deliberate fires) (2024 report of the Attorney General's Office). In Portugal, wildfire causes were mostly associated with social factors and a lack of knowledge and awareness of the risks involved in the use of fire. A review of fires in 2023 by public authorities in Portugal found that 62.1 % were due to accident or negligence, while less than 2% of forest fires with known causes were due to natural causes (Ferreira et al, 2024). Combined with high fuel loads and extreme meteorological conditions, even minor human actions can trigger catastrophic outcomes.

At the same time, recent improvements and longstanding experience with wildfires in Portugal and Spain are likely to have moderated impacts and supported containment. For example, vegetation management strategies such as prescribed burning, thinning, and reforestation with less flammable species are increasingly recognized as essential tools to reduce fuel loads and mitigate both wildfire spread and the associated degradation of air quality (Quishpe-Vasquez et al., 2024). In Portugal there was a shift in wildfire governance following the 2017 wildfires from a focus on suppression to prevention, as evidenced by Portugal's National Prevention strategies (Soares, 2025; Pandey et al., 2023). Measures such as improved satellite monitoring and advances in fire weather forecasting have strengthened early warning systems and in turn enabled quicker detection and response. As a result of all these measures, around two-thirds of fires have been less than 1 hectare in size over the last two decades in Spain (SGR, 2015; 2023). Tactical interventions, such as the intentional ignition of controlled burns have been used to redirect advancing flames and protect settlements.

Public engagement and institutional measures also play a role in addressing the social dimensions of wildfire risk. Awareness campaigns, local volunteer brigades, and evacuation protocols have enhanced community preparedness, while the Spanish government has signaled intent to strengthen long-term prevention through a national fire-prevention pact. The Portugal Chama (Portugal is Calling) campaign, for example, raises awareness of the measures to reduce wildfire risk and impacts for the general public and has been widely disseminated through major media and public billboards (OECD, 2023).

During recent fire crises, rapid mobilization of ground and aerial resources, supported by EU and national funding, has been critical (ECHO, 2025). Spain has deployed 5,600 military personnel, more than 2,000 vehicles and pieces of equipment, 640 forest firefighters, 5,000 Civil Guard officers, 350 National Police officers, along with 190 personnel from nine countries under the European Civil Protection Mechanism (Europa Press 2025a; 2025b). In Portugal, over 3,200 firefighters and hundreds of ground and aerial assets have battled concurrent fires (ECHO, 2025; O'Sullivan, 2025). Beyond supporting the firefighting efforts, the Red Cross Societies in Portugal and Spain have also rolled out critical humanitarian response spanning shelter, food, water, volunteer mobilization, as well as awareness raising on fire prevention and preparedness. These interventions complement ecological restoration measures, ensuring a people-centered recovery that strengthens local resilience to climate risks.

Further, cross-border smoke transport underscores the need for coordinated international approaches. Beyond immediate fire management, some sectors are already adapting: for example, agricultural producers are relocating olive and wine cultivation to higher altitudes in anticipation of ongoing climate pressures.