

Without strong adaptation measures the extended heatwaves and increased drought will strongly increase the appearance of fires and air pollution from fires in Europe already by the middle of the century.



## Smoke concentrations from fires may double by the middle of the century

- Even under the most ambitious mitigation scenario, SSP1-2.6, the increase in future temperature and drought duration will induce more fires and expose people to larger amounts of harmful fine particulate matter (PM<sub>2.5</sub>) originated from fires.
- In the European region, without strong climate-change mitigation, fires are expected to increase everywhere, with the result that air pollution concentrations from fire (PM<sub>2.5</sub>) would double in most European regions by the mid-century, when compared to mean between 1980-2000.
- The largest absolute increase in air pollution (PM<sub>2.5</sub>) from fires is expected to appear in southern and eastern Europe, special hotspots being for example Western Türkiye, Northern Italy, and Sicily.

### Mitigation scenarios

In EXHAUSTION, we have adopted the Shared Socioeconomic Pathways (SSP) used in the 6th Assessment Report (AR6) from the Intergovernmental Panel on Climate Change (IPCC). We have used SSP1, SSP2, and SSP3 scenarios, where SSP1 and SSP3 define various combinations of high or low socio-economic challenges to climate change adaptation and mitigation, while SSP2 describes medium challenges of both kinds and is intended to represent a future in which development trends are not extreme but rather follow middle-of-the-road pathways.

In this White Paper, we use the following terminology: A Sustainability scenario (SSP1), a Middle of the road scenario (SSP2) and a Regional rivalry scenario (SSP3), the first representing the scenario with the highest emission reductions. These are coupled with Representative Concentration Pathways: RCP 2.6, RCP 4.5, RCP 7.0, and the white paper also refers to SSP1-2.6, SSP2-4.5 and SSP3-7.0

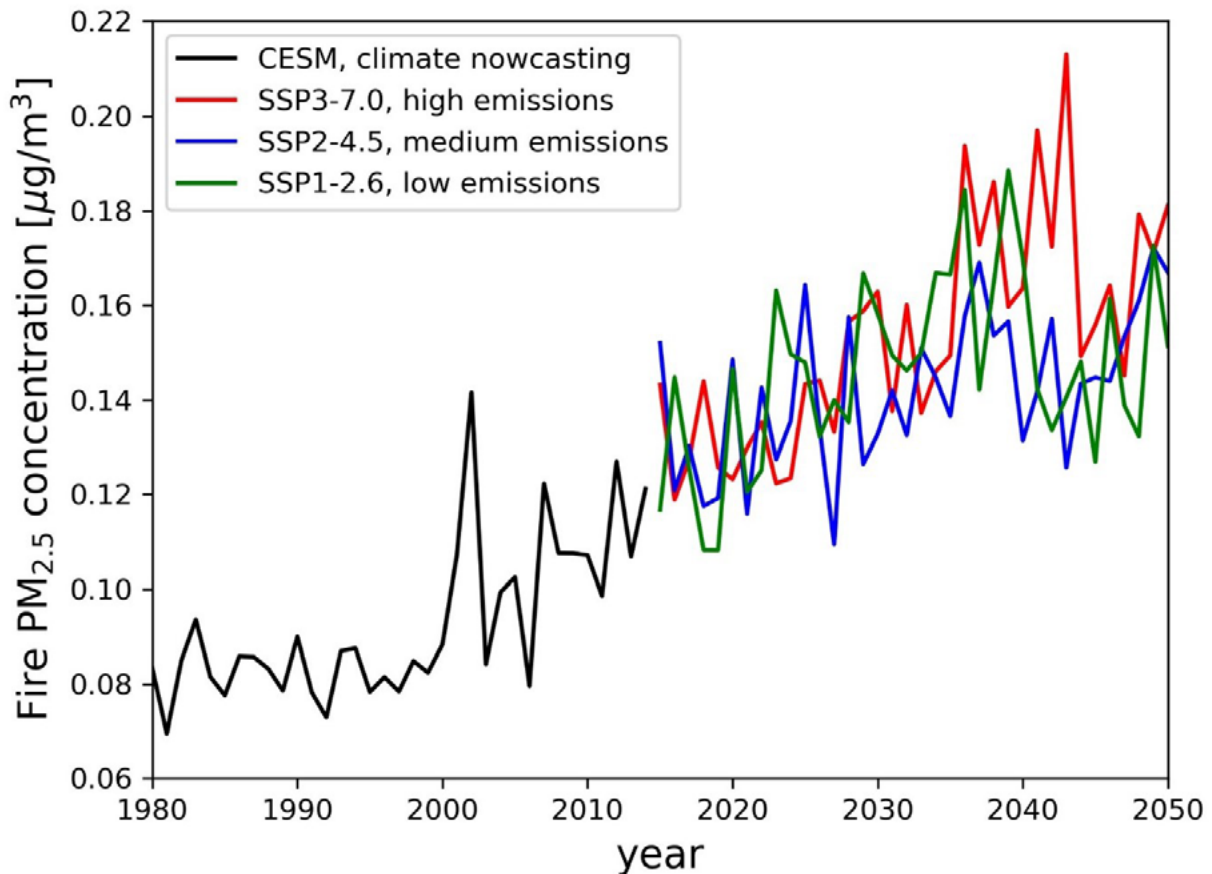


Figure 1: In all three future scenarios considered, the yearly mean concentration of air pollution ( $PM_{2.5}$ ) originating from fires would increase similarly till middle of the century, when the concentrations are expected to be about twice compared to values between 1980 and 2000.

## ! Research findings

Whereas the levels of air pollution from anthropogenic particulate matter are predicted to continue their decreasing trend, the fire smoke concentrations are predicted to rise till the mid-century.

The absolute levels will increase mostly in regions where the concentrations are already higher than average (Figure 2). The largest increases are in southern and eastern Europe. Special hotspots appear in Northern Italy (Po Valley), Sicily, western parts of Türkiye and the Moscow region, where the yearly mean fire originated  $PM_{2.5}$  concentration may exceed the level of one microgram per cubic meter ( $1.0 \mu\text{g}/\text{m}^3$ ), especially in the Regional rivalry scenario (SSP3-7.0).

If considering the whole European region (Figure 2), the mean fire smoke concentration during 1980-2009 is approximately  $0.09 \mu\text{g}/\text{m}^3$ . By the mid-century, this value will be increased by  $0.06 \mu\text{g}/\text{m}^3$  in the Sustainability and Middle of the road scenario, while the increase will be  $0.08 \mu\text{g}/\text{m}^3$  in the Regional rivalry scenario.

While the anthropogenic air pollution ( $PM_{2.5}$ ) levels keep decreasing, the fire smoke will become relatively more important source of particulate matter, causing increasing health risks.



### Fires include:

- Agricultural fires
- Wildfires
- Fires on other vegetated lands

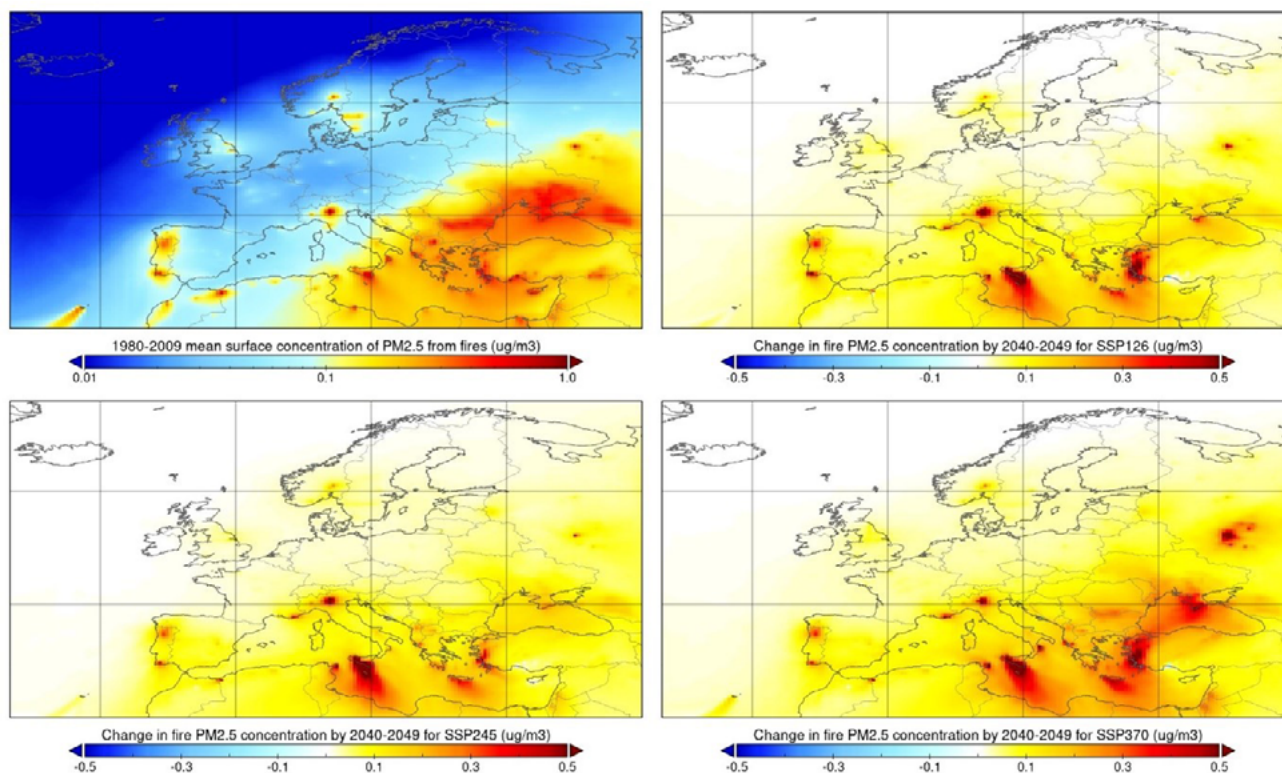


Figure 2: (top-left) Mean fire originated  $PM_{2.5}$  during the historical period of 1980-2009 illustrating that especially South-East Europe is suffering from the fire smoke. Predicted changes at the middle of the century for three different scenarios: SSP1-2.6 (top-right), SSP2-4.5 (bottom-left), and SSP3-7.0 (bottom-right) showing that wildfire smoke concentrations are increased essentially everywhere in Europe, but the increases are typically largest at areas where the concentrations are already large.



## Key policy recommendations

- Mitigation of fire smoke exposure refers to: (i) adequate forest management, (ii) introduction of appropriate legislation and (iii) ensuring its acceptance by the society, and (iv) introduction of fire-safe procedures in forestry and agriculture, both at legislative and behavioral levels.
- Strong adaptation measures are required to reduce the impact of fire smoke on health, in a context of increasing risk of wildfires, driven by rising temperatures and more severe droughts.
- More attention should be paid to particulate matter from fires since its contribution to health impacts will rise, compared with particulate matter from anthropogenic origin, whose levels are decreasing.
- Since fire smoke episodes are regularly combined with heatwaves, the combined health effects require even stronger healthcare preparedness in the future climate.



## Key research recommendations

- Further research and development of fire forecasting models would increase their capacity to predict future fires and increase preparedness for future fire incidents.
- Including the effect of social and political changes in the fire forecasting models, in addition to weather parameters, would allow to increase their reliability.

Wildfire. Photo: Istock/milehightraveler



Publication date	First author	Last author	Title	Journal
20/09/2023	Rongbin Xu	Shanshan Li	Global population exposure to landscape fire air pollution from 2000 to 2019	Nature
28/03/2022	Yuanyu Xie	Roland Séférian	Tripling of western US particulate pollution from wildfires in a warming climate	PNAS
09/2021	Gongbo Chen	Shanshan Li	Mortality risk attributable to wildfire-related PM2.5 pollution: a global time series study in 749 locations	The Lancet Planetary Health
05/03/2021	Rosana Aquilera	Tarik Benmarhnia	Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California	Nature Communications

