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Wildfires: under control or out of control?

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Short answer

- It depends
- …on what control means
- …on what region we are talking
- …on what criterion of success

Fire suppression vs fire management

- Goal is the same: minimize the fire-related damage of all kinds
- Fire suppression
  - minimize fire occurrences, put down discovered fires as fast as possible
  - resources for fire fighting brigades
  - agriculture practices
  - application mostly in wildland-urban interface
    - tempting as an overall strategy, disproven
- Fire management
  - forest management
  - fuel management
  - agriculture practices
  - education and prophylactics

Fires are part of natural ecosystem

- Key functions
  - Cleaning the debris
  - Regulating the plant population and composition
  - Fertilizing soils
  - …
- Small-scale vs mega-fires
  - Small fires destroy dry debris and, partly, small plants
    - big trees survive with minor/moderate stress
    - soil is next to intact: sterilization of few mm at most
    - recovery within days/weeks
  - Mega fires wipe out vegetation completely
    - no plant survivors
    - soil sterilization of a few cm
    - long recovery, irreversible changes in plant composition

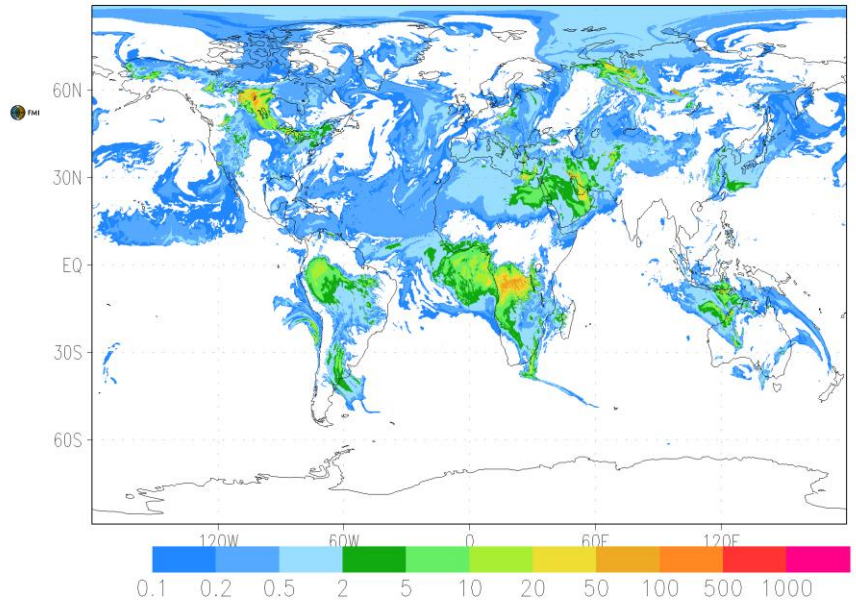
By Ian Sutton from Collinsville and Oberon, Australia - A flame in the forest
Uploaded by berichard, CC BY 2.0,
https://commons.wikimedia.org/w/index.php?curid=9980430
On the photo: *Telopea speciosissima (waratah)*

IS4FIRES-SILAM fire smoke forecast and reanalysis

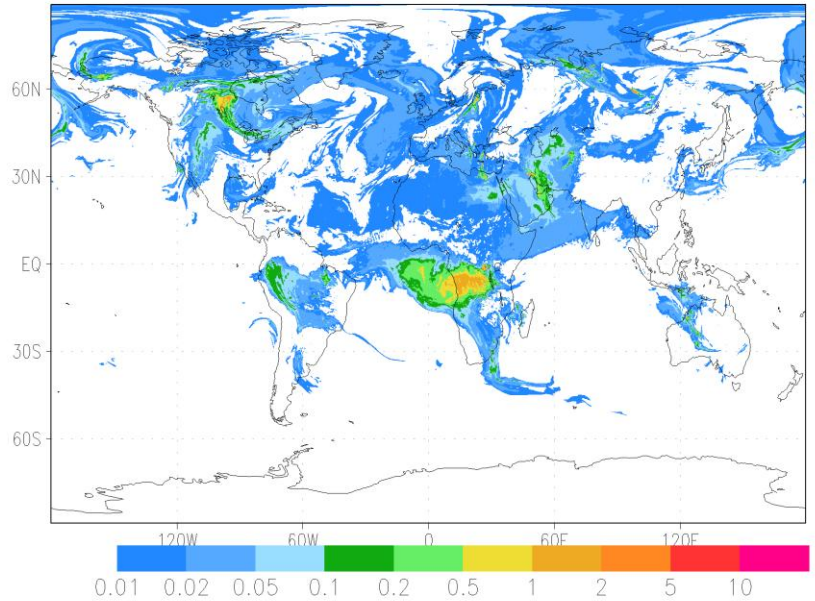
- Fire information: satellite hot-spot observations
  - processing and emission calculation: IS4FIRES
  - smoke dispersion: atmospheric composition model SILAM
- Daily fire smoke forecast, global
  - Resolution:
  - 0.1° (10 km) fire smoke
  - 0.2° (20 km) all pollutants, air quality
- Reanalysis / climate predictions
  - 1980-c.m. Detailed reanalysis
  - 1900-2100 Climate-scale analysis

http://silam.fmi.fi

PM concentration, μg m^{-3}, 14:00, 4.07.2025

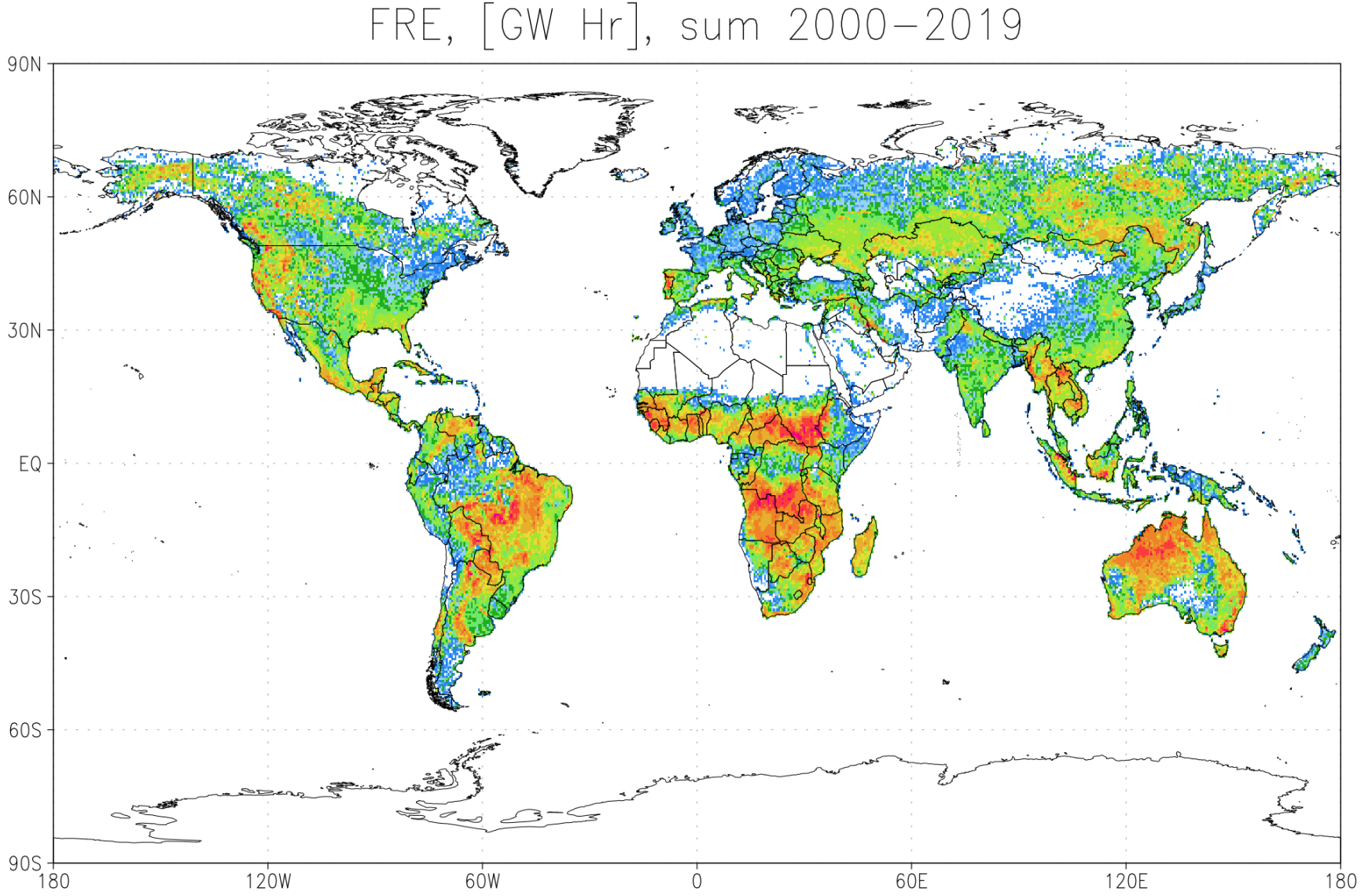


Optical column thickness



Fires: a socio-environmental issue

- About-90% of fires are ignited by humans
  - Agriculture practices
  - Industry, including but not limiting to forest industry
  - Land-use modification
  - Leisure and recreational activities
- Natural fire ignition: practically only lightning
- Fire propagation is driven by nature but affected by human intervention
  - Heat and wind are the key promoters of fires
  - Rain and humidity are the main suppressors of fires
  - Fire fighting is the main way humans control the fires
- Fire mitigation in the long term: forest management and societal development



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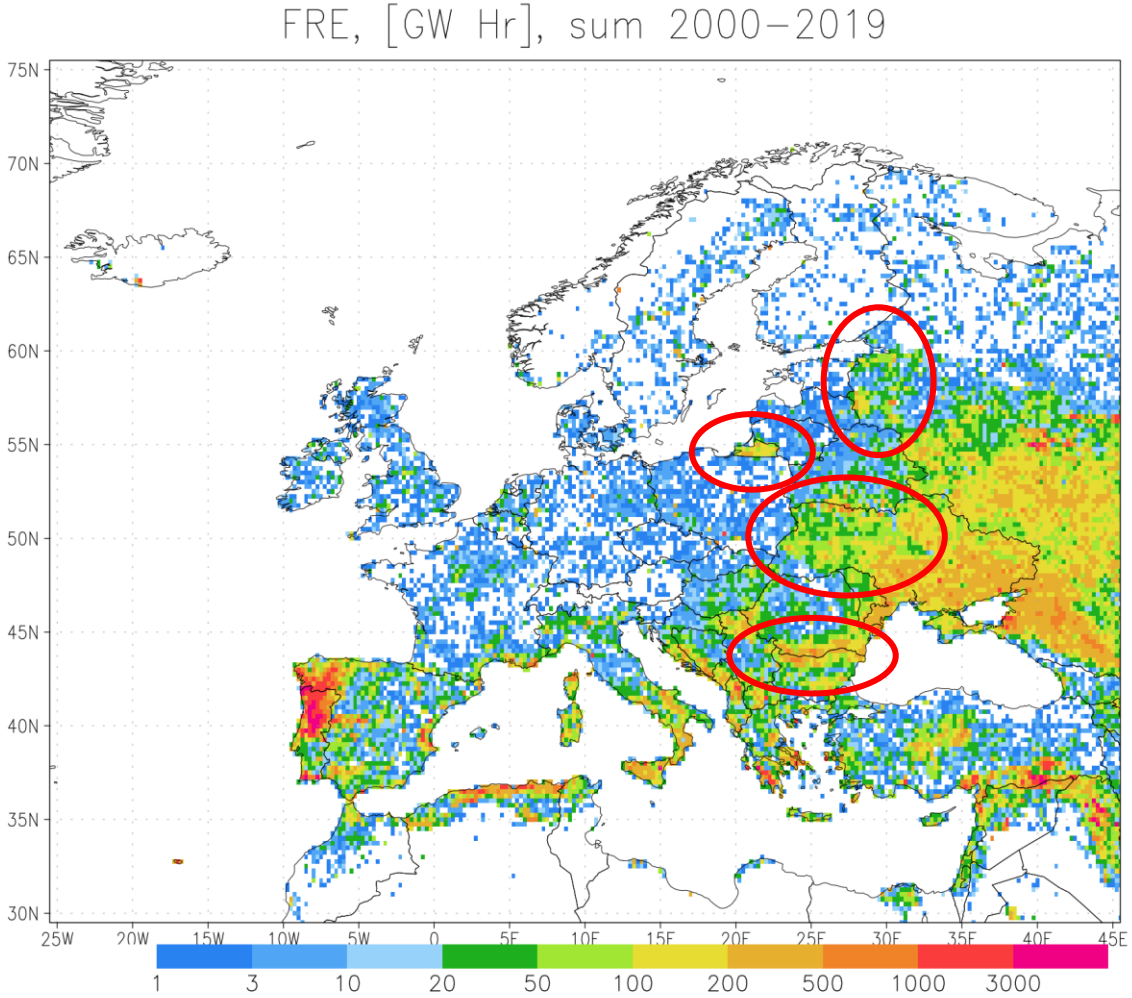
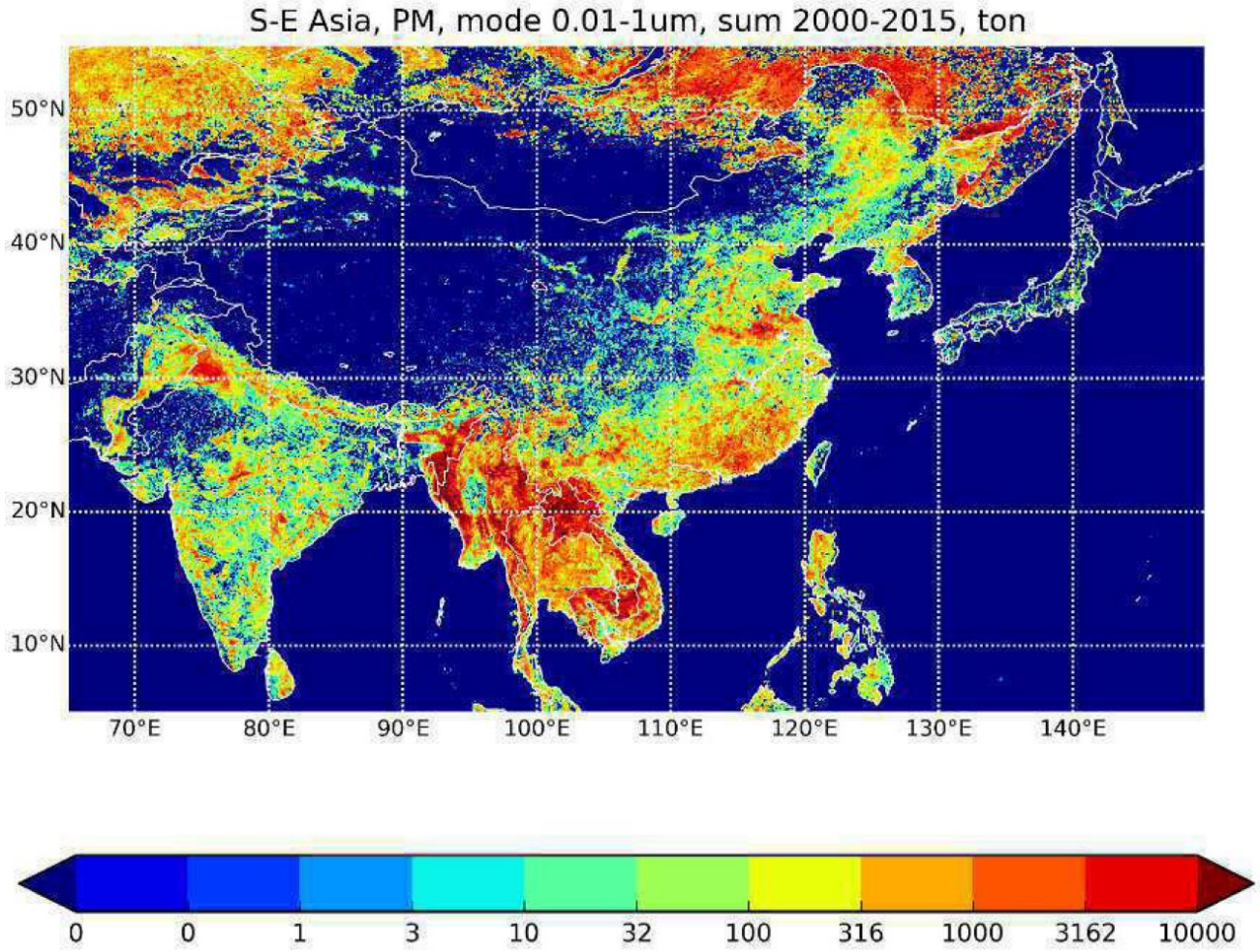
Fires: a socio-environmental issue





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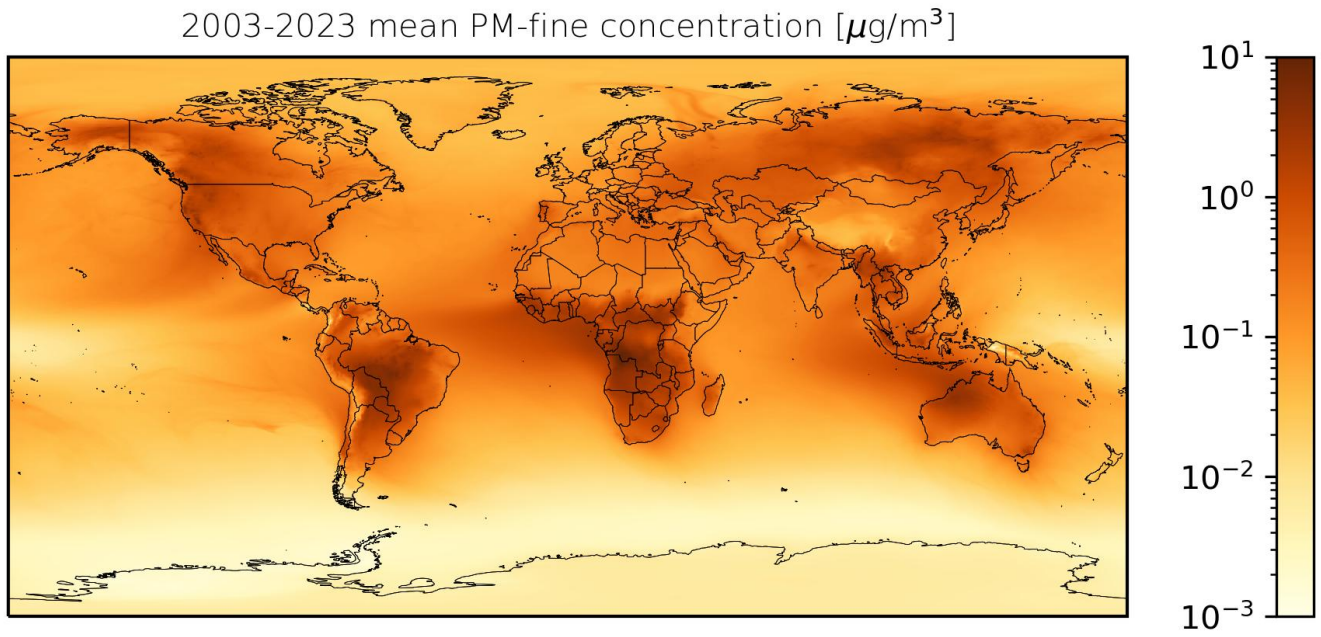
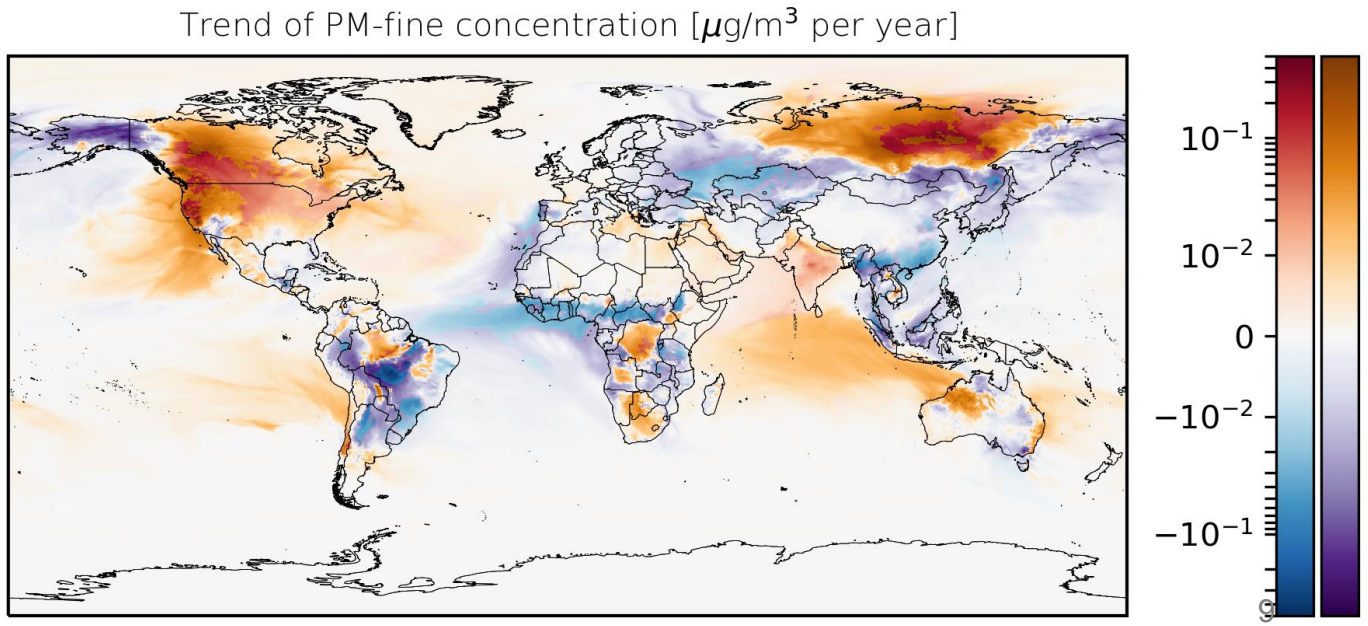
Exposure to fire smoke

- Mean exposure to fire-induced $PM_{2.5}$, 2003-2020 IS4FIRES + SILAM

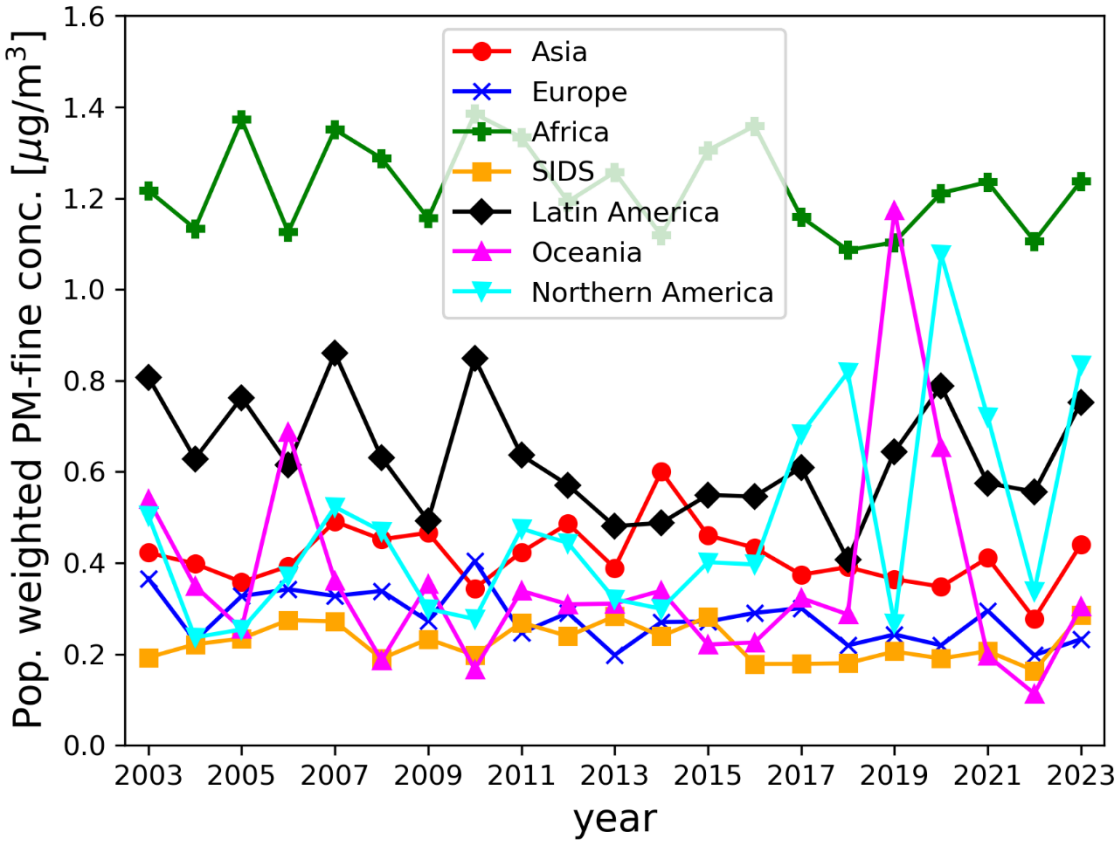
- Trend of exposure blue-red: $p < 0.1$, significant violet-brown: $p > 0.1$, not significant

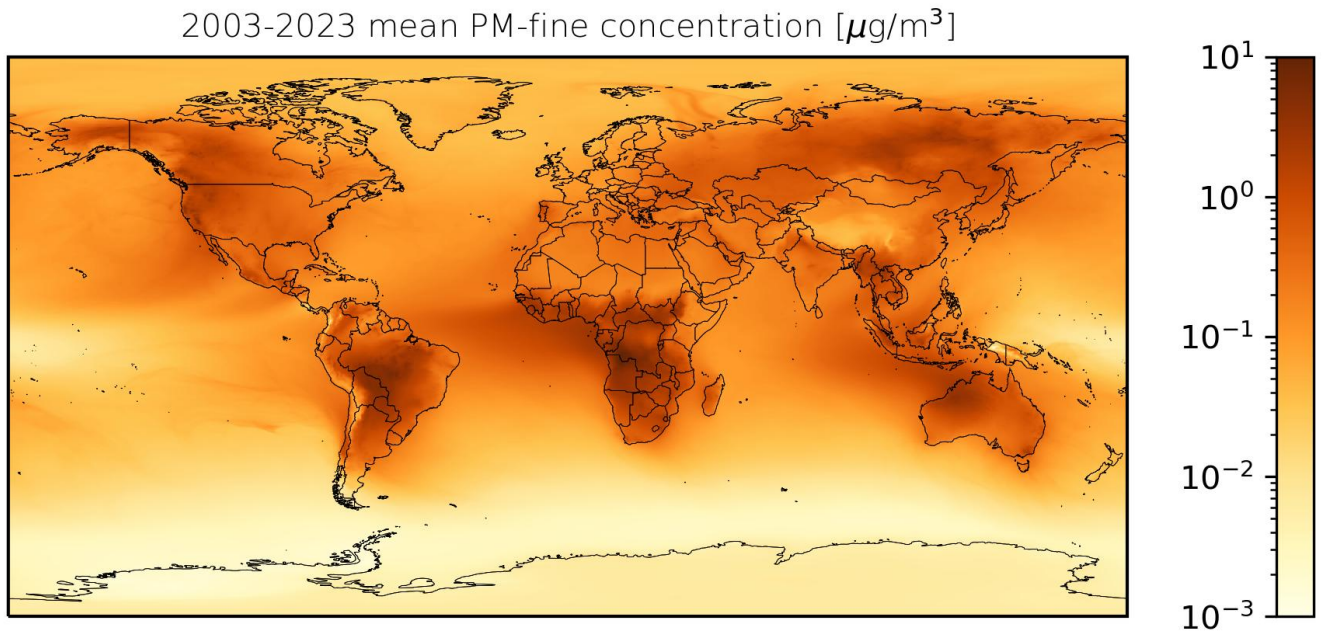


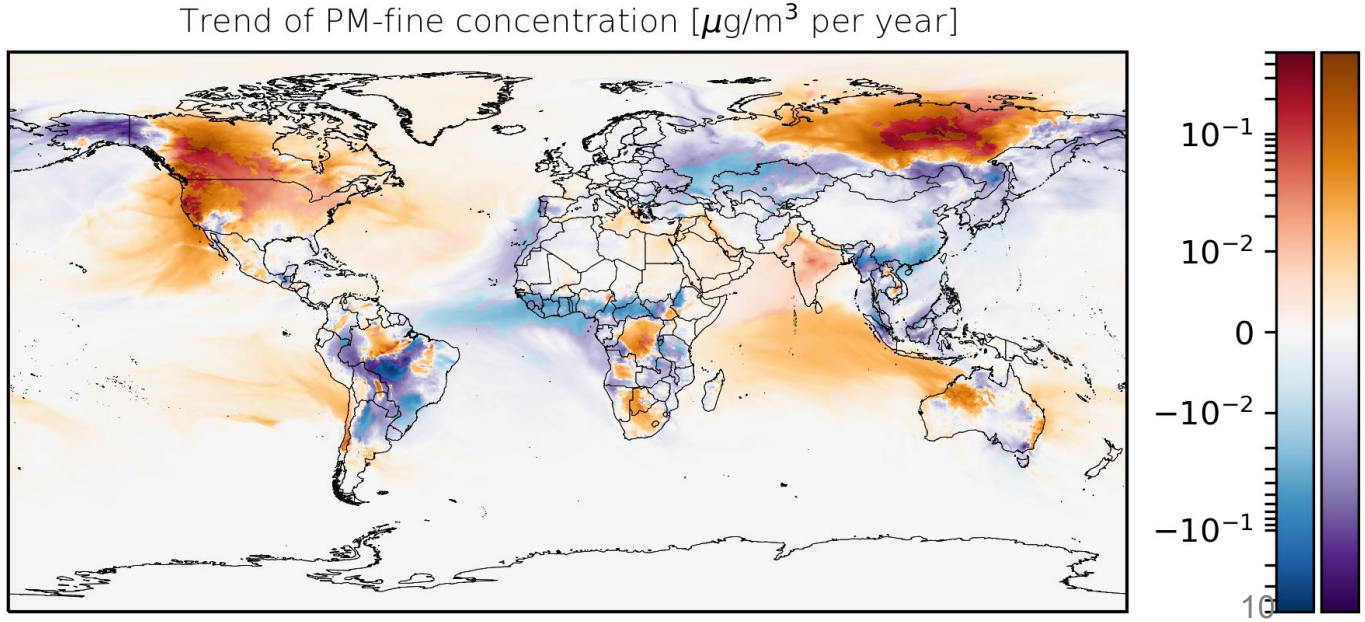


Romanello et al, 2024. The Lancet.
doi: 10.1016/S0140-6736(24)01822-1

Exposure to fire smoke







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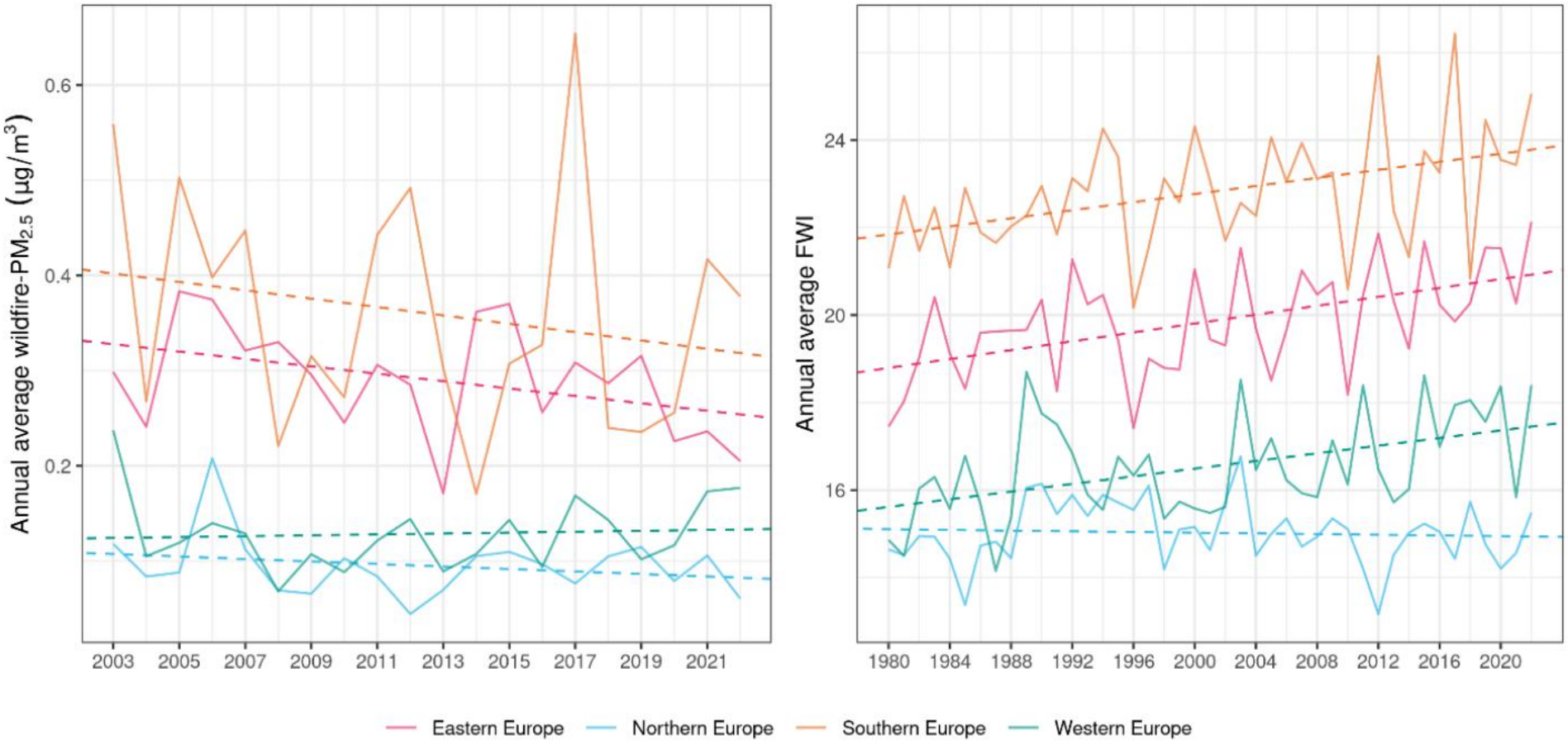
Trends in Europe



- Left: fire smoke exposure, 2003 – 2022
- Right: fire risk (Fire Weather Index), 1980-2022

Van Daalen et al, 2024. The Lancet Public Health. https://doi.org/10.1016/S2468-2667(24)00055-0

Fire management in the US

- US National Emission Inventory
  - prescribed fires in the east
  - wildfires on the west
- Total emission (calculated) is lower for prescribed fires
- Total burnt area (reported) is lower for wildland fires
- Criterion of success?

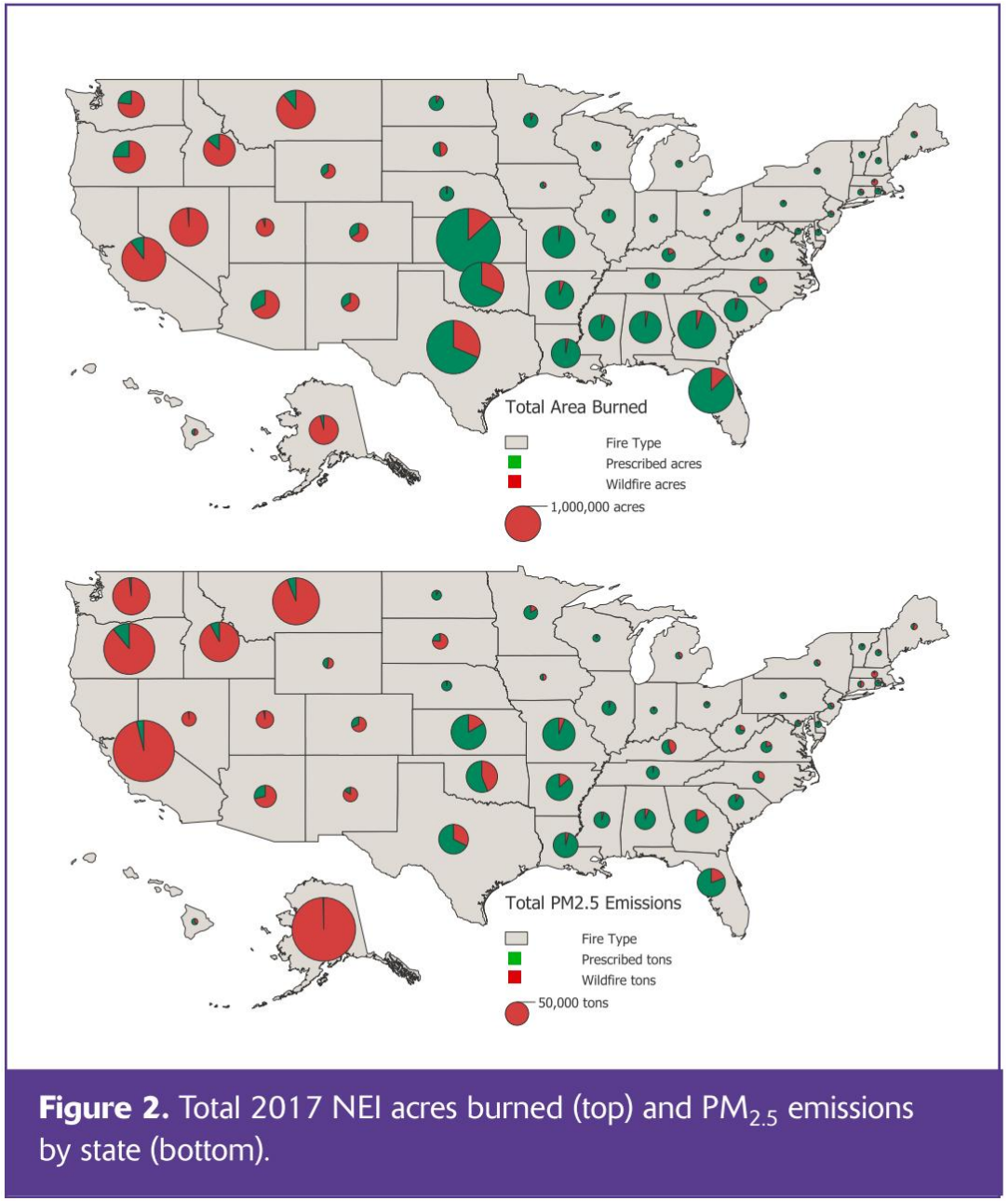


Figure 2. Total 2017 NEI acres burned (top) and $PM_{2.5}$ emissions by state (bottom).

Baker et al, 2020. The Magazine for Envir.Managers, also in US EPA, 2021. (rep. No. 600/R–21/044),

Conditions and actions

- Forest management with fire safety in mind
  - prescribed fires where safe (Northern Europe, Eastern US)
    - smoke may be even worse than that of wildfires due to lower burning intensity
  - landscape planning
  - handling the deadwood
- Agriculture practices with less reliance on fires
  - expensive and laborious
  - possibly more climate impact (machinery fuel use)
- Year-round preparedness in some regions
  - multi-annual droughts mean permanent fire risk (California fires were in January)
- Information, education, and compliance
  - “evacuate” (US) vs “stay and defend” (Australia)
  - professional actions vs unprepared volunteers

Summary

- Till now, fires, both intensity and trends, can be kept under control over most of the world (a bold wishful thinking?)
- Fire management is a multi-dimensional problem with few shortcuts
- Fire suppression policy alone seems to be not sufficient
  - fuel accumulation nearly uncontrolled
  - lower preparedness of the society
  - eventually, disastrous fires overwhelm suppression efforts eliminating all apparent savings
- Changing climate requires changes in the mitigation/adaptation efforts
  - In many places the “fire season” is turning to “permanent fire season” (California fires in 2025 were in January)