AIRFRESH

Newsletter #5

Editorial

We are pleased to present the second Newsletter of the project **AIRFRESH "*Air pollution removal by urban forests for a better human well-being*"**. The main objectives, core actions, and performed activities are presented here.

The Project Team

The project AIRFRESH, which started in September 2020, aims to estimate and quantify the **environmental and socio-economic benefits** provided by urban trees.

Tree canopy cover and air pollution-related mortality in European cities

In urban areas, fine particles ($PM_{2.5}$), nitrogen dioxide (NO_2), and tropospheric ozone (O_3) are the most harmful air pollutants for human health. Urban greening is seen as a win-win strategy co-benefitting air quality, climate, and citizens well-being. Here, we assessed trends in tree cover and a quantitative health impact assessment of the effect of mean tree cover on $PM_{2.5}$-, NO_2-, and O_3-related mortality (all ages) in 744 European urban areas, with more than 50,000 inhabitants, across 36 European countries. We did all analyses at a high-resolution grid-cell level (30×30 m).

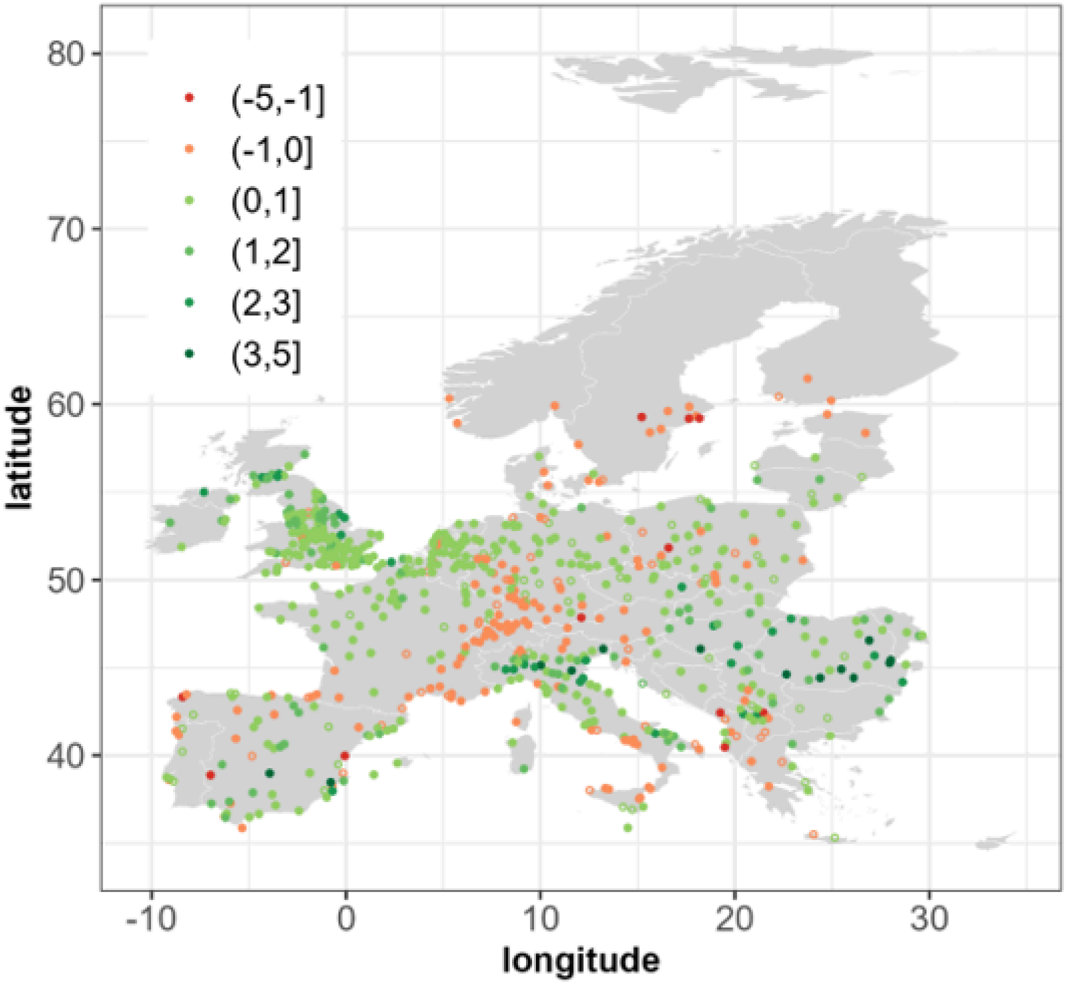

Fig 1 - Slope of the trends of yearly tree canopy cover (in % per year) per city from 2000 to 2019. Closed circles represent significant trends ($p < 0.05$) and open circles not significant ones ($p > 0.05$).

In 2019, 25% of the total population lived in areas with a mean tree canopy coverage over 30%. Between 2000 and 2019, the averaged **tree coverage increased by 0.76%-point**, with 73.5% of the urban centers showing greener coverage. Compared to the current tree cover, **each 5%-point increase in tree canopy cover** could facilitate an air quality improvement of 2.8% and 1.4% for annual $PM_{2.5}$ and NO_2 mean concentrations, and 1.2% for summertime mean of the daily maximum 8-hours values (O_3 MDA8).

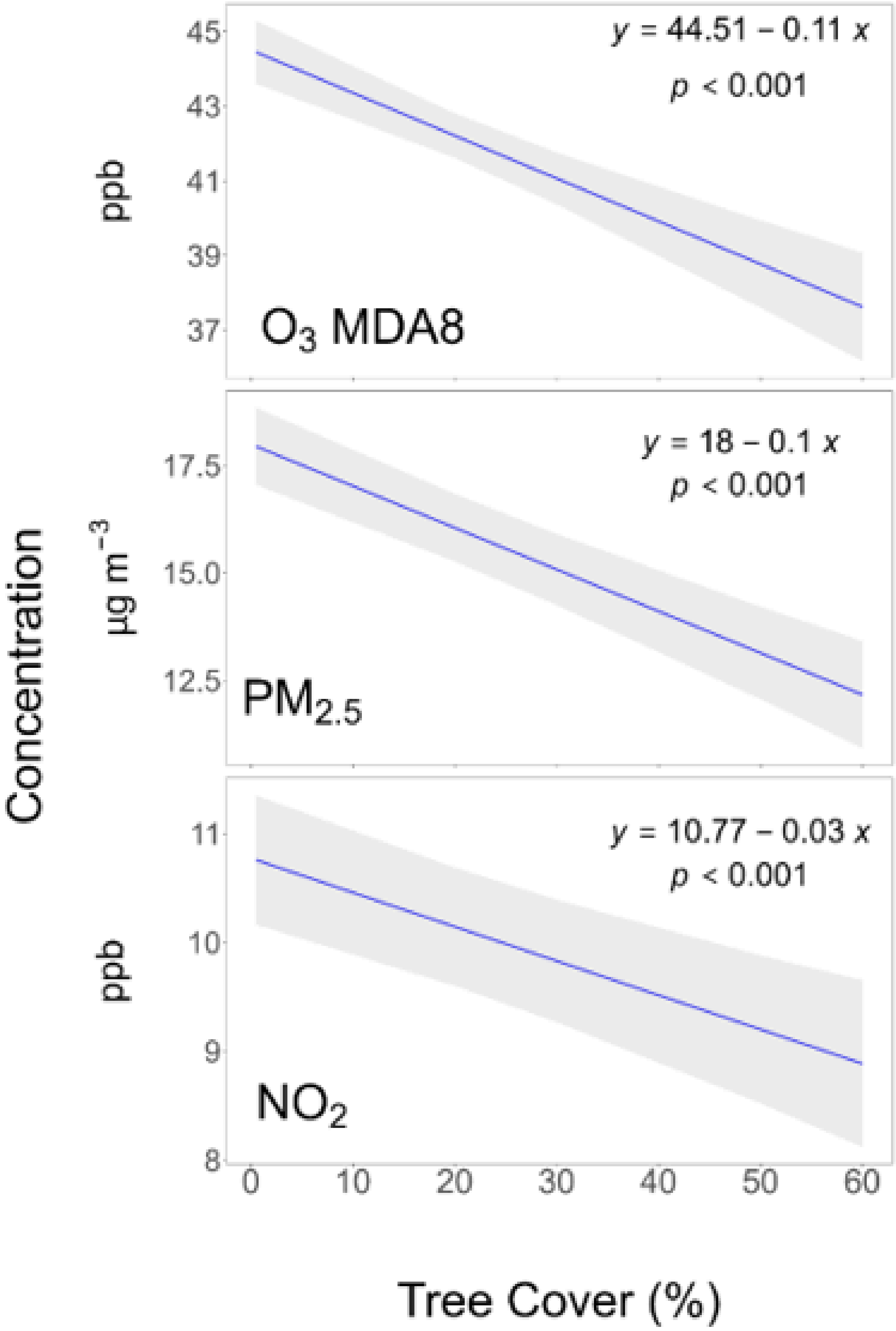

Fig. 2 - Changes in the annual PM2.5 and NO2 mean concentrations and the summertime average of the daily 8-hour maximum ozone concentration (O3 MDA8) due to the increase in the yearly tree cover as estimated by the linear mixed model. The strips represent the 95% confidence limits.

Increasing the tree cover from the current tree cover conditions to 30% **could prevent 11,974 [95% CI: 7,775; 14,390] premature deaths** across the 744 urban areas each year, corresponding to 8.9% of all premature deaths attributed to air pollution, while contributing to sustainable, liveable and healthier cities

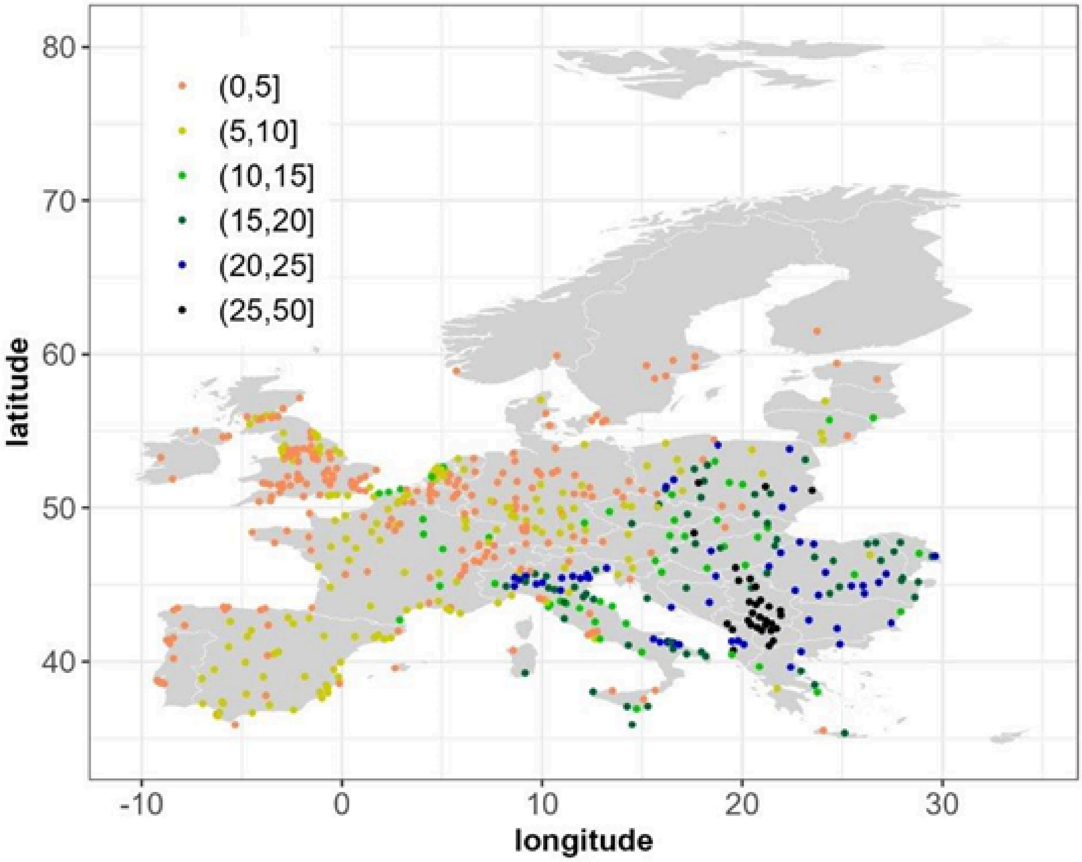

Fig. 3 - Number of prevented deaths (per 100,000 people) by increasing tree coverage from the current tree cover (year 2019) to a mean tree coverage of 30% for each urban area.

The **key findings** from this study are that the air pollutants levels and related non-accidental mortality were consistently lower with higher tree canopy cover. **Compared to the year 2019, each 5pp increase in tree canopy cover for each urban area was associated with a 3.6% mean reduction of natural-cause mortality annually**. A large number of premature deaths (8.9% of the natural-cause mortality) could be prevented by expanding tree coverage to 30% for each urban area compared to the year 2019 coverage scenario, while contributing to sustainable, liveable and healthy cities. A canopy cover of at least 30% resulted in higher health benefits. Our study provides **new evidence** on the extent to which premature deaths could be prevented by protecting, restoring, and increasing tree canopy in cities. While authorities have historically been in charge of managing public green spaces, citizens as major actor should be involved in the development and management of greening programs to meet the recommended 30% tree canopy cover, by planting trees throughout private spaces, e.g., residential yards, combined with other strategies such as green roofs and blue spaces.

Leveraging peri-urban forests to reduce urban mortality

As the majority of the world's population lives in cities or suburban areas, **assessing the mitigation potential of urban and peri-urban vegetation is crucial for designing strategies** to enhance urban resilience and reduce mortality. Here we used a coupled climate-chemistry model to evaluate the effectiveness of different peri-urban afforestation strategies in reducing heat- and pollution-related mortality. We found that **peri-urban afforestation primarily reduces mortality linked to extreme temperatures and, to a lesser extent, mortality associated with air pollution**. However, the efficacy of reforestation initiatives is influenced by several factors, including the type of trees planted as well as the meteorological and chemical conditions of the city of interest. Our results also demonstrated that removing vegetation consistently increases the number of attributable deaths.

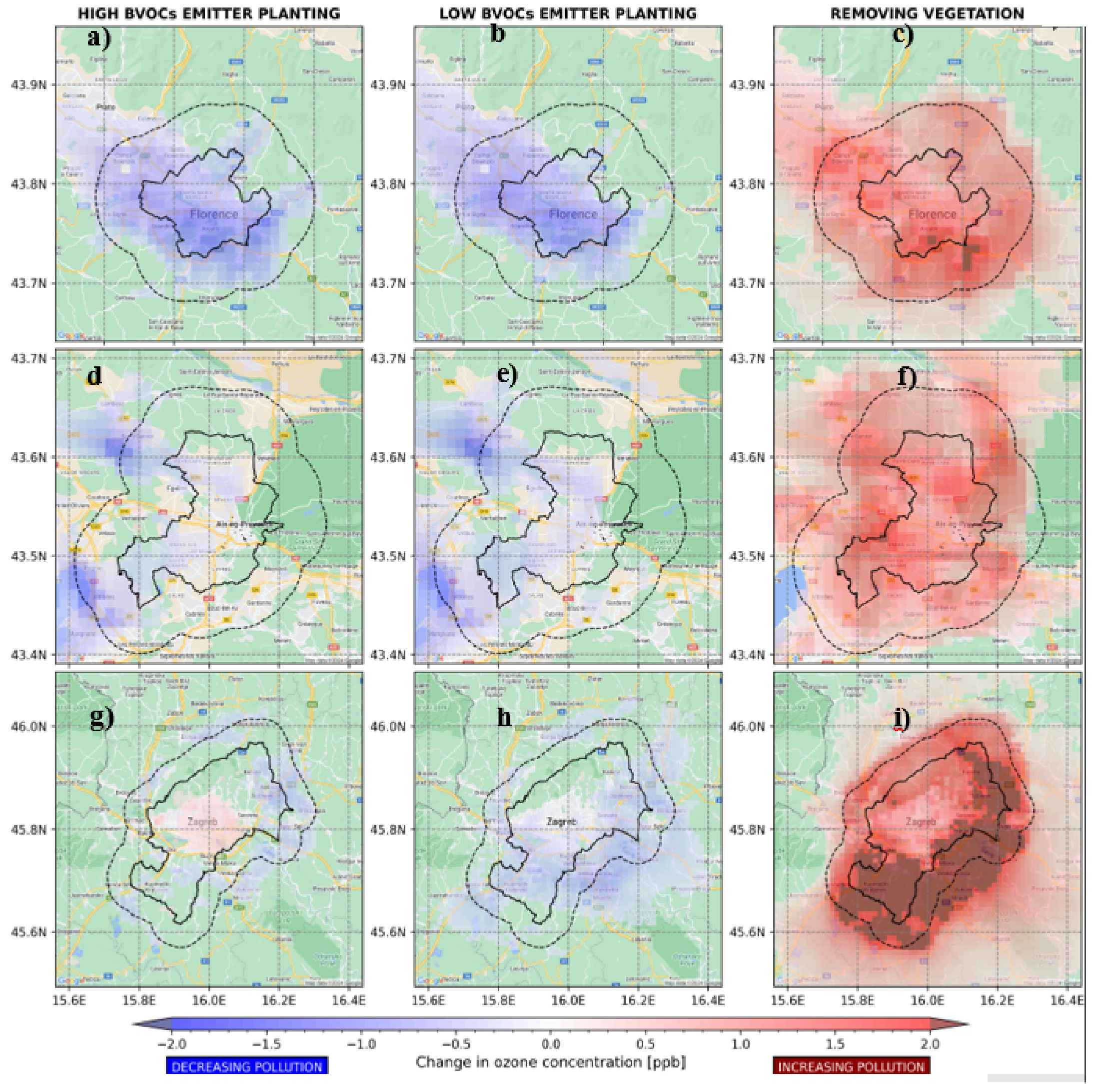

Fig. 5 - Changes in surface O_3 concentration considering different tree planting scenarios. Difference in mean summer O_3 concentration between the control run with current vegetation and three different planting strategies for the cities of Florence (a-c), Aix-En-Provence (d-f) and Zagreb (g-i).

Consistently with previous analysis on UHI intensity, results show how the removal of vegetation increases the number of attributable deaths across the three analyzed cities, with a mean city-scale increase per 1,000 inhabitants of 0.13 for Florence, 0.03 for Aix-en-Provence, and 0.60 for Zagreb. Excess mortality is primarily associated with an increase in the number of days when temperatures exceed or fall below the local minimum mortality temperature. While there is general agreement on this pattern, most of the additional deaths in Florence and Aix-en-Provence are attributed to warm temperatures, whereas excess mortality in Zagreb is more strongly linked to cold days. On the other hand, the substantial O_3 reduction has a negligible effect, likely because the 8-hour moving average concentrations are already below the harmful threshold of 30 ppb. Conversely, the decrease in $PM_{2.5}$ contributes to reducing the number of attributable deaths, as does the NO_2, at least in Florence and Zagreb. Anyway, the effects of air pollutants on attributable deaths are remarkably lower than those caused by heat stress.

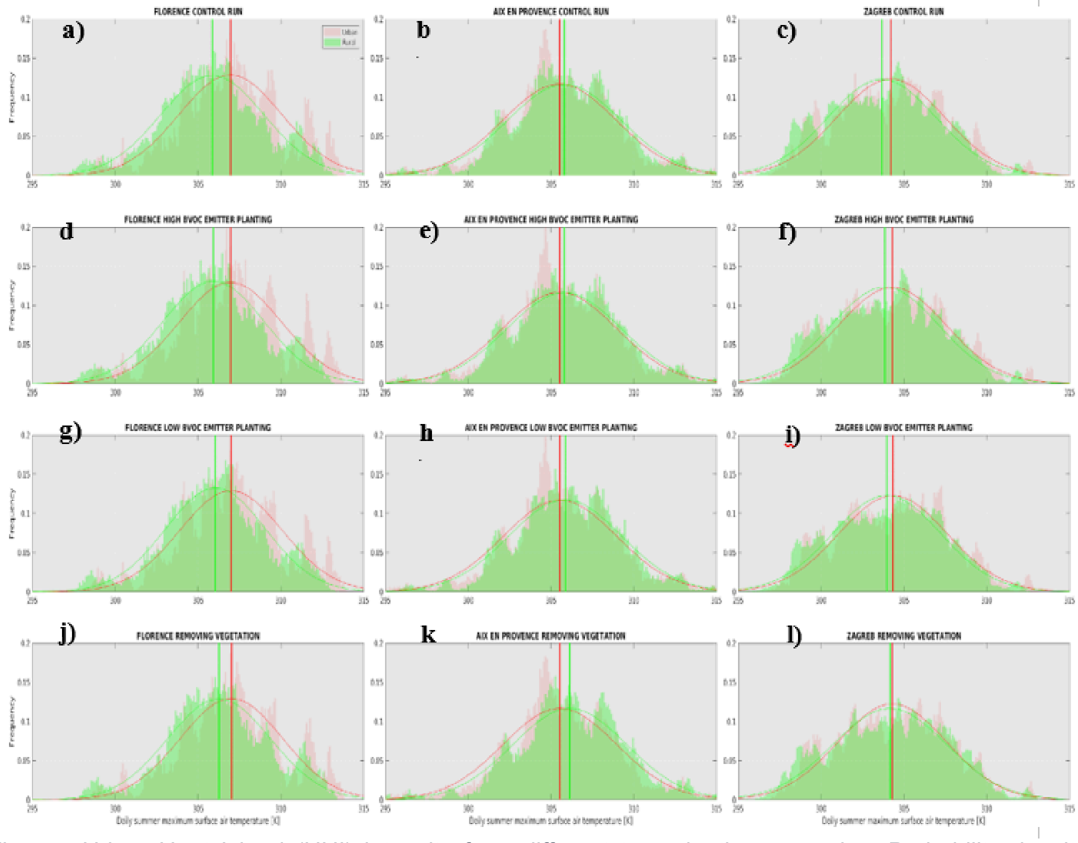

Fig. 5 - Urban Heat Island (UHI) intensity from different tree planting scenarios. Probability density functions of summer daily maximum temperature for urban (red) and rural (green) areas around the three test cities of Florence (a, d, g, j), Aix-En-Provence (b, e, h, k) and Zagreb (c, f, i, l) computed following different tree planting strategies.

Considering the different reforestation strategies, the greatest reduction in attributable deaths is observed in Aix-en-Provence, where planting low-emitting species remarkably reduces the mortality associated with cold temperatures. In this case, the number of preventable deaths per 1000 inhabitants is -0.0237, which is considerably larger than the -0.0068 achieved with high-emitting species. Similarly, in Florence, planting low-emitting species results in a reduction in avoidable deaths of 0.0094, primarily due to decreased mortality from high temperatures; this scenario is slightly more effective than the high BVOC-emitting scenario, which leads to a decrease of 0.0043. Conversely, in Zagreb, the largest reduction in attributable deaths is achieved by planting high-emitting species, which primarily decrease the number of additional deaths due to warm temperatures, with a reduction of 0.0769. On the other side, planting low emitting species results in a net increase of mortality equal to 0.0058.

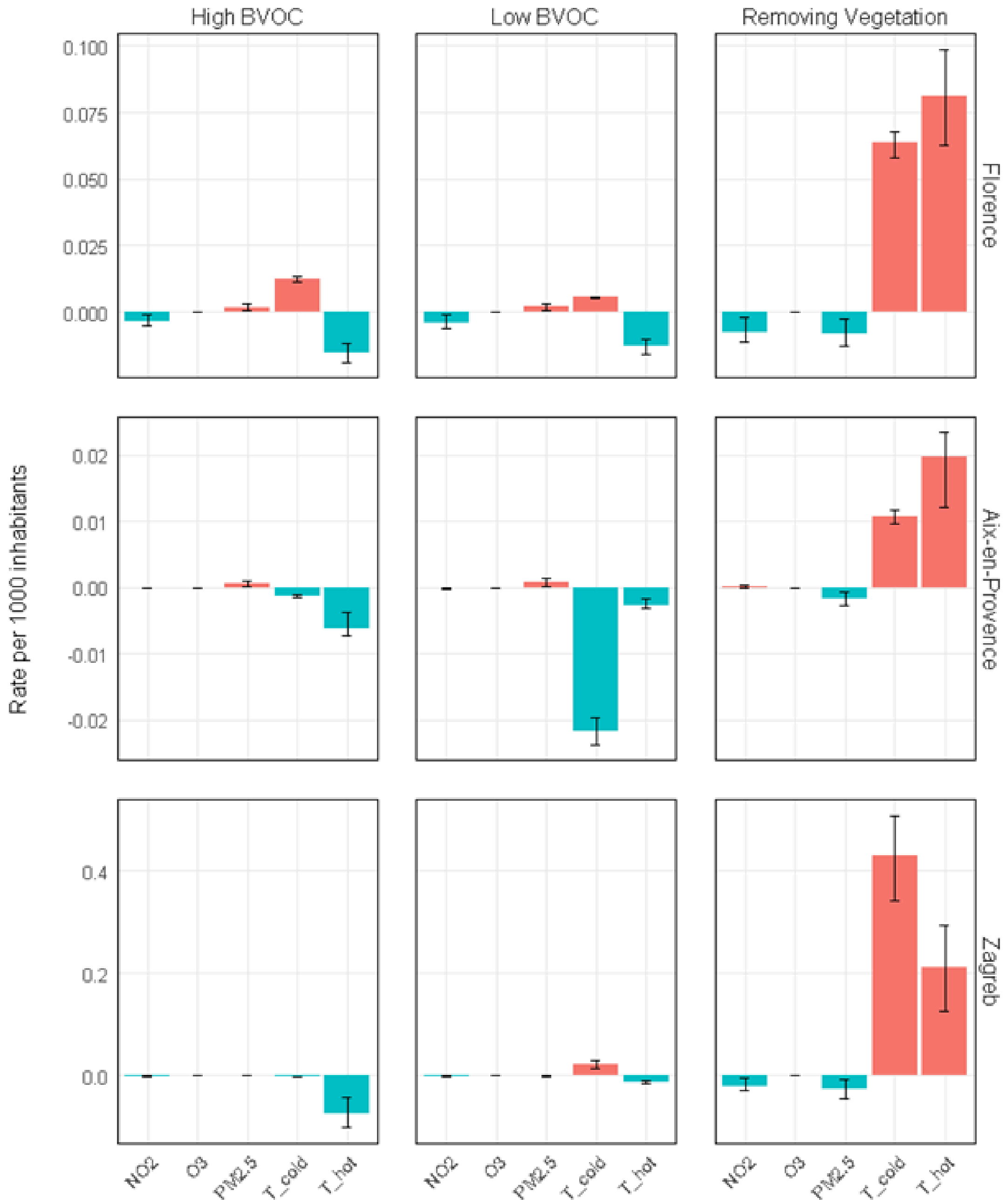

Fig. 6 - Changes in the number of attributable deaths considering different tree planting scenarios. Change in mortality rates due to nitrogen dioxide (NO_2), ozone (O_3), fine particulate ($PM_{2.5}$), cold (T_cold) and warm temperatures (T_hot) between the scenarios and the control run in the three analyzed cities. Red columns represent enhanced mortality rates, while blue ones are associated with decreased mortality. Data are reported as mean values with the error bars indicating minimum and maximum associated with relative risk variability.

According to the increased mortality burden, the scenarios without vegetation are also associated with higher costs. The highest values are found in Zagreb, where the health burden cost ranges from €331 million to €708 million, followed by Florence with **€240 million to €560 million**, and finally Aix-en-Provence with **€67 million to €157 million**. In all scenarios, the highest costs are linked to non-optimal temperature-related mortalities. Regarding air pollution, the results indicate that cost reductions can be achieved in all cities by planting both high- and low-BVOC-emitting trees, primarily through a decrease in costs associated with NO_2.

Upcoming events

European Forum on Urban Forestry
24-26 May 2023
Kraków, Poland
https://efuf.org

Partners

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