This project has received funding from the European Union's H2020 Framework Programme under grant agreement No - 690105

ICARUS Policy Brief

Integrated Climate forcing and Air pollution Reduction in Urban Systems

The ICARUS project

ICARUS is a Horizon 2020 project, whose main objective is to develop integrated tools and strategies for urban impact assessment in support of air quality and climate change governance in EU Member States leading to the design and implementation of appropriate abatement strategies to improve the air quality and reduce the carbon footprint in European cities. The project will develop detailed policies and measures for air pollution and climate control for the short and medium term (until ca. 2030). For the long term perspective (2050 and beyond) ICARUS will develop visions of green cities and explore pathways on how to start realizing these visions.

On board are experts of 19 Partner Institutions from 10 European countries, all with multidisciplinary expertise and experience in intersecting and complimentary research in research areas related to the climate and the environment and their interactions with health and wellbeing. The high scientific quality of the ICARUS team is based on the extensive and long-term experience of the partners, which include leading scientists and risk health research institutes in Europe.

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Covid-19 and climate change

Covid-19 has affected everyday life in several ways, while the respective morbidity and mortality figures are of increasing concern. COVID-19 is the largest public health problem of today, with a strong interplay with the core of the environmental concerns targeted by ICARUS, namely climate change and air pollution with particular emphasis on urban settings.

Climate change and Covid-19

Climatic parameters and transmissibility

Covid-19 spread depends on climate; based on ICARUS findings corroborated by various studies worldwide, it has been now verified that higher temperatures, total humidity and UV radiation, reduce transmissibility and the respective basic reproduction rate over time (R_t) as well as the effective reproduction rate (R_f). The effect of climatic conditions within the different periods of the year on the parameters that describe Covid-19 spread as a function of meteorological conditions for Greece, is illustrated in the figure below. Thus, climatic conditions and the way they are affected by climate change, can significantly modulate the epidemic curve. This in turn would provide useful input for alerts regarding the second wave dynamics; if the winter of 2020-2021 is expected to be cold, additional measures have to be taken to flatten as much as possible the epidemic curve. This includes both containment of the pandemic and active disinfection of the air indoors.

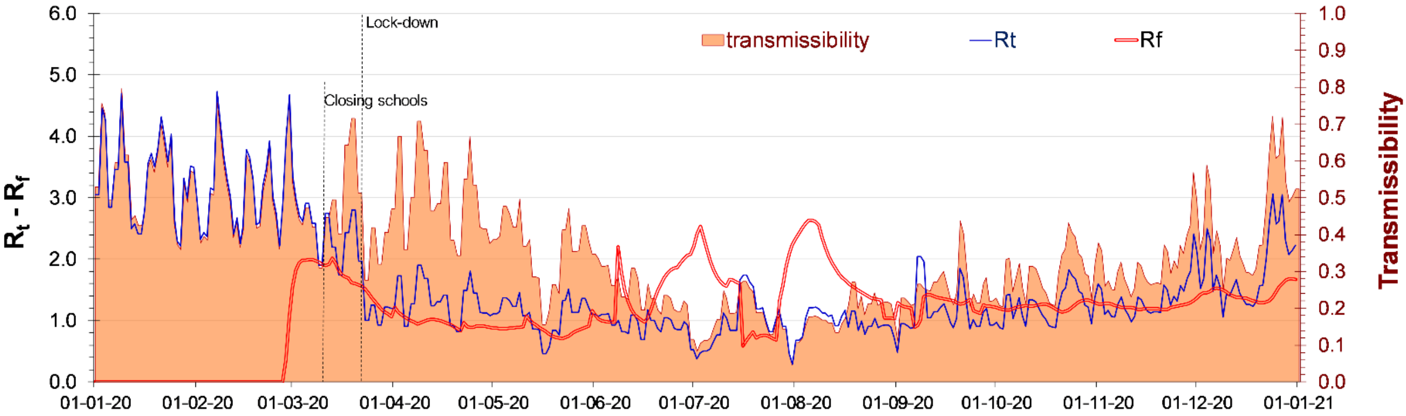

Figure 1. Transmissibility, basic reproduction rate (Rt) and effective reproduction rate (Rf) annual variability as a result of climatic parameters

Do climate change mitigation policies affect Covid-19 spread?

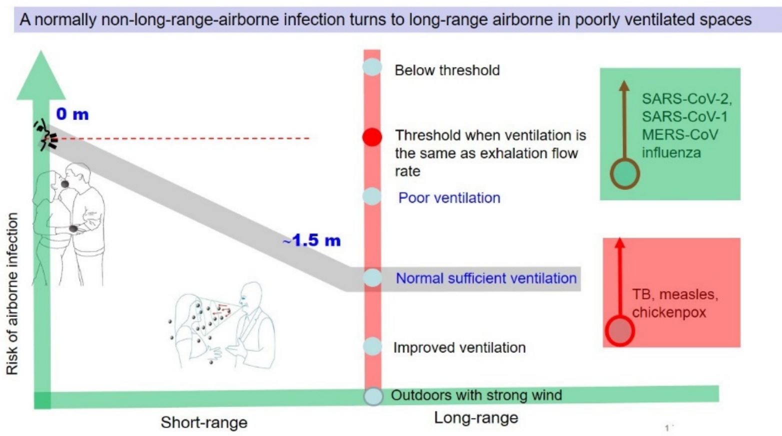

Figure 3. Ventilation is a key parameter for reducing the COVID-19 spread, in contrast to energy conservation principles for minimizing carbon footprint requires low ventilation rates and limited indoor outdoor air exchange

Figure 2. Using public transportation is more sustainable in terms of carbon footprint, however, it has also been proven as a main source of increasing conductivity rate and consequently transmission. Overcrowded public transport means have been identified as one of the main sources of transmission

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Covid-19 and air pollution

Does Covid-19 affect air pollution levels?

Aiming at flattening the epidemic curve of the Covid-19 outbreak during spring of 2020 complete or partial lockdowns have been applied across various areas in Europe. This resulted in a significant reduction of the daily activities, which in turn, was clearly reflected in air pollution levels. This is illustrated across the EU when comparing the NO_2 pollution levels for the same periods of the year between 2019 and 2020 (Figure 4), or the PM levels in the city of Thessaloniki, according to the measurements carried out in the frame of ICARUS. However, the same measurements showed that PM levels in the months following the lockdown were 25-30% higher than the corresponding values of 2019 due to the reticence of the population to use public transport from fear of contamination.

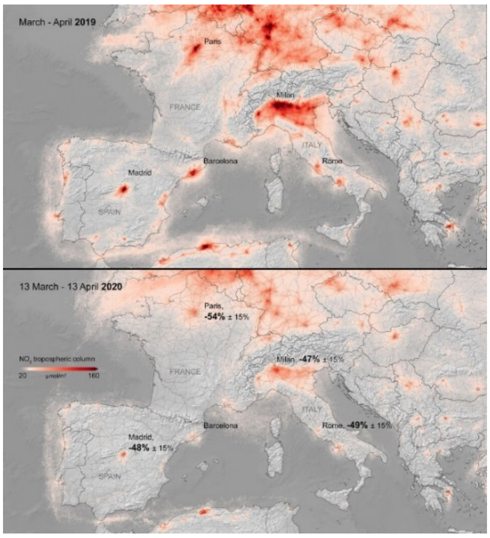

Figure 4. Copernicus Sentinel data (2020), processed by ESA, across the EU

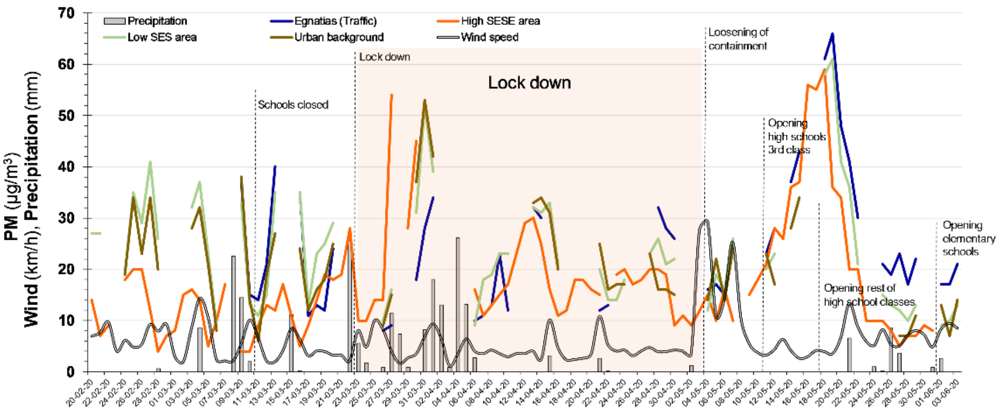

Figure 5. PM reduction across the various areas of the city of Thessaloniki, before, during and after the lock-down

Does air pollution affects air Covid-19 morbidity and mortality?

Exposure to polluting agents alters the immune response of the lung cells and induces an increase in oxidative and inflammatory stress. This condition of the cell facilitates the attack of viruses and increases the severity of viral infections in exposed subjects. Reduction of PM and NO2 emissions in cities from transport, domestic heating and industrial and power production is particularly important this winter to alleviate the severity of COVID-19 morbidity and mortality.

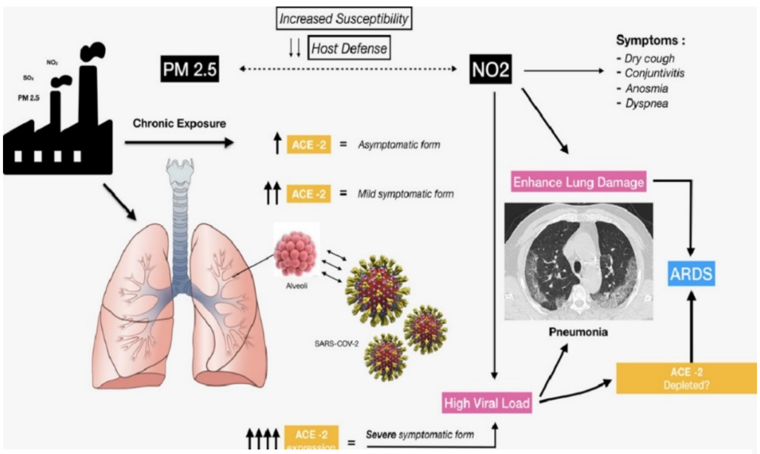

Figure 6. Synergies of inflammatory responses between air pollution and Covid-19

NO_2 has a strong independent correlation with raising a person's susceptibility to death from COVID-19. A 4.6 parts per billion (ppb) increase of NO_2 in the air has been associated with 11.3% and 16.2% increases in COVID-19 case-fatality and mortality rate, respectively. At the same time, 1 μg/m^3 increase in PM2.5 concentration has been associated epidemiologically with an increase in COVID-19 related mortality by 8%.

Overal, 15% of COVID-19 deaths worldwide are associated with air pollution; this percentage rises to 19% in Europe, to 17% in North America, while in East Asia, where pollution is very high, it reaches 27%.

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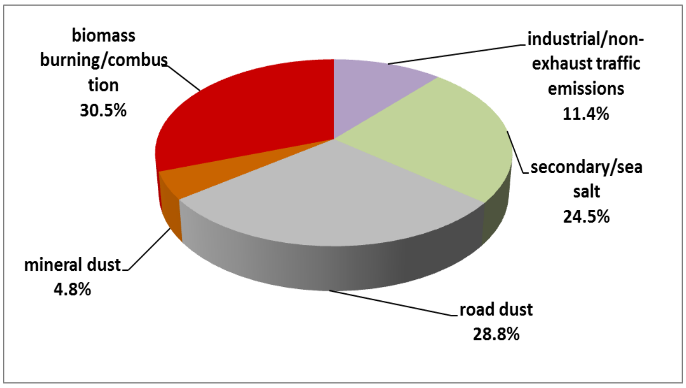
Where do air pollution emissions come from?

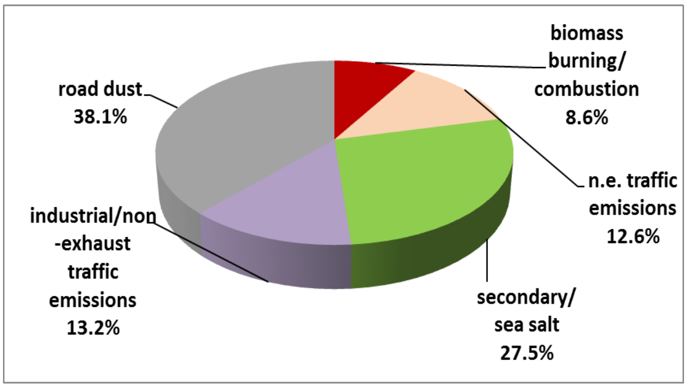
In order to dwell into the effect of airborne particles on Covid-19-attributed spread and health effects, an extensive monitoring field campaign took place in six European cities (Athens, Thessaloniki, Madrid, Stuttgart, Ljubljana, Brno) at three sites (urban background, traffic and regional) for one month during both the winter and summer seasons. $PM_{2.5}$ samples collected during the ICARUS measurement campaigns were analyzed for 27 PAHs, 24 trace elements, anions (Cl^-, NO_3^-, SO_4^{2-}) and elemental and organic carbon (EC, OC).

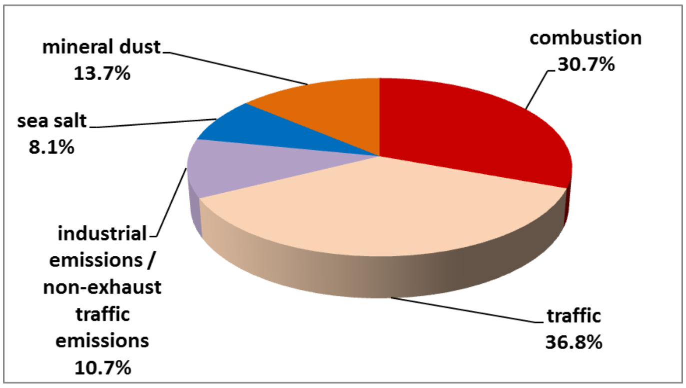
Figures 7a-c. Contribution of the emission sources to the measured PM2.5 concentration for Athens, Ljubljana and Thessaloniki traffic sites.

(a)



(b)





(c)

The prevailing source at traffic sampling sites was traffic-related source, which appears in three forms (either separately or combined): exhaust, non-exhaust and road dust sources. The contribution of traffic in total is 40.2% for Athens traffic site, 46.7% for Brno traffic site, 40.7% for Ljubljana traffic site and 48,5% for Thessaloniki traffic site. Traffic source contribution at urban background sites was significantly lower (indicatively: 25% at Brno, 27% at Athens urban background sites). At rural sites, it was road dust that prevailed (indicatively: 34% at Athens, 41.9% at Ljubljana). The biomass combustion contribution ranged between 8% (traffic and urban background at Ljubljana) and 31% (traffic sites at Athens and Thessaloniki). Soil dust contribution ranged between 5% (traffic site Athens) and 19% (rural site Athens). Secondary aerosol contributed more at urban background sites (34% Ljubljana, 37% Thessaloniki, 40% for Athens and Brno). Secondary aerosol source percentages may include the natural source of aged sea salt.

ICARUS results demonstrate the importance of controlling the emissions of fine and ultrafine particulate matter for mitigating the health risk from Covid-19. Reduction of urban traffic and biomass burning for domestic heating, maintenance of depollution technologies in industrial facilities and use of air purifiers indoors are key facets of preventive measures against the SARS-CoV-2 spread and alleviation of the morbidity and mortality effects of Covid-19.