Report on climate change and air quality interactions

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Contributing reference data for their city: University College Dublin, University of Surrey, University of Hasselt, Dortmund Technical University

Summary

Cities occupy less than 1 % of the global land surface, and their direct effect on the global climate is probably not very large. However, the presence of the built environment strongly modifies the climate and therefore air quality at local to regional scales. As approximately 40 % of European people live cities (Eurostat, 2011), climate and climate change in built-up areas is an urgent subject of study.

Future climates in the ISCAPE cities depend both on the growth, design and development of each city, on natural climate variability at all scales, and on the evolution of emissions into the atmosphere of greenhouse gases and aerosols. Abundant concentrations in the air of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and tropospheric ozone (O_3) strengthen the natural greenhouse effect, whereas sulphates and nitrates tend to cool the atmosphere.

Pollutant concentrations have different impacts due to meteorological, geographical and structural features of the single city, but also as a result of local air quality policies. In general traffic-induced emissions (NO_2 and PM_{10}) have an influence on total concentration at street level, but not at urban scale. Residential heating systems also contribute again at street level, but its signal is weaker. Two pollutants, NO_2 and PM_{10} have a dependence on emissions at the street scale, while $PM_{2.5}$ is more homogeneous in the urban environment. Concerning the risks on human heath connected to exposure to high level of $PM_{2.5}$ has led to a decrease and an adjustment of concentrations at WHO suggested level for human health which is stricter than the European limit. Only Bologna, among the target cities requires to improve its efforts to mitigate the $PM_{2.5}$ concentrations. Ozone concentrations is quite homogeneous at the city scale. In rural areas ozone concentrations sensibly grow, supported by

favourable conditions.

At European scale, the climatological variables that mostly affect air quality are surface temperature, precipitation and sea level pressure. Climate is warming in all the iSCAPE cities. The projected summertime increase in temperature is largest in Bologna and smallest in Dublin. In winter, and also in spring and autumn, the most pronounced increases in temperature are likely to take place in Vantaa. For precipitation and air pressure, even the signs of the trend deviate from region to region. The general trend is towards wetter in northern Europe and drier in southern Europe. Sea level air pressure is projected to increase in southern and central Europe in most seasons, but decrease in the north. Increasing temperatures together with reducing summertime precipitation amounts yield an example of climate change impacts on air quality: larger biogenic emissions, higher photochemical rates and smaller wet removal facilitate an increase in air pollutant concentrations. Temperature scenarios, coupled with precipitation pattern projection, facilitate an increase in pollutants such as ozone due to increased biogenic emissions and photochemical rates and reduced wet removal. Changes in meteorological variables can modify global sea level pressure patterns, with consequences on local circulations and distribution of air masses. In the end, climate change induced by enhanced pollutant emissions will in turn increase pollutant concentration. So, a positive feedback is established, leading to an intensification of climate changes in those regions highly affected by pollution. It is important to underline that these connections between climate and pollutants concern the larger scales (global, or at least European). Specific studies at local scale have to be provide to achieve a better understanding on the future livability of our cities.

The full report will be published in autumn 2017.

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