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Contact:
alexandra.monteiro@ua.pt

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1. See: https://www.mmm.ucar.edu/weather-research-and-forecasting-model.
2. Lacressonnière, G., Peuch, V., Vautard, R., Arteta, J., Déqué, M., Joly, M., Josse, B., Marécal, V. and Saint-Martin, D. (2014). European air quality in the 2030s and 2050s: Impacts of global and regional emission trends and of climate change. *Atmospheric Environment*, 92: 348–358.

European Commission

Science for Environment Policy

Portugal's air pollution levels to worsen, exceeding WHO guidelines by 2050

Air quality standards worldwide are facing increasing scrutiny as countries struggle to meet World Health Organisation (WHO) air-quality guidelines (AQGs), particularly regarding ozone (O_3) and particulate matter (pollutant particles with diameters of less than 10 or 2.5 micrometres — PM_{10} and $PM_{2.5}$ respectively). A new study aimed to evaluate whether WHO guidelines are being met in Europe; the researchers focused on Portugal, using recent data alongside climate change and background air pollution predictions. At present, Portugal frequently exceeds legislated values for ozone and PM_{10}.

Climate change and anthropogenic emissions influence air quality, and are thus a focus for policymakers committed to lowering air pollution in European cities. WHO AQGs provide an assessment of health effects of air pollution and thresholds for health-harmful pollution levels. They aim to help countries move towards healthier air quality — particularly in cities, many of which currently exceed WHO standards — to prevent such effects. This research highlights the likely trajectory for Portugal's air quality in the future, and emphasises an urgent need to create European strategies to manage air quality.

The researchers used the Representative Concentration Pathway (RCP) RCP8.5 scenario — an emissions scenario developed by the Intergovernmental Panel on Climate Change (IPCC) that assumes high populations, slow income growth, and modest technological and energy improvements, leading to the most pessimistic pathway with the highest greenhouse gas emissions. RCP8.5 is consistent with global warming of nearly 5 °C. Countries' current pledges under the Paris Agreement (NDCs) are estimated to lead to around 3 °C, while the Paris goal is well below 2 °C or 1.5 °C. Meteorological data for Portugal was obtained from data spanning the North Atlantic and Europe, which was downscaled using the Weather Research and Forecasting (WRF) Model[1] — a weather prediction system for use in atmospheric research and forecasting. Two time periods were used: the reference historical period, 2005-2011 (REF), and the future five-year period, 2046-2050 (FUT).

The study builds on simulations already conducted extensively over Europe using the RCP8.5 scenario, which explored the combined effects of climate change and anthropogenic emissions on air quality using the WRF-CAMx modelling system[2]. CAMx is a chemistry transport model that considers emission, dispersion, interaction, and removal of chemical pollutants in the atmosphere. This study used these high-resolution simulations to pinpoint where WHO AQGs were exceeded across Portugal, and to determine pollutant emissions for both REF and FUT scenarios.

For the REF scenario, the researchers applied a top-down methodology (working from the general to the specific) using data from the Portuguese national emission inventory (INERPA) for the main pollution source categories; bottom-up (working from the particular to the general) and top-down approaches were used for traffic emissions, with the former approach used for main highways and the latter for other roads. For the FUT scenario, EmiPro-RCP (emission projections under the RCP scenario) software was used for Portugal for RCP8.5; using information about the study period, this model calculates the factors to be multiplied by current emissions in order to estimate emissions for 2050.

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The resulting ground ozone levels for the FUT 2050 scenario — versus those of the REF time period — show a reduction in O_3, due to a reduction of ozone precursors in emission projections (50% for nitrogen oxides and 43% for volatile organic compounds). For the future scenario, almost all of Portugal would be below the 120 µg/m^3 (Directive 2008/50/EC[3]), but, when considering the recently revised WHO AQG of 100 µg/m^3, then ozone levels are exceeded across all of Portugal in both scenarios. However, the ozone levels are below the interim target set by the WHO for the current scenario.

The adverse health effects of particulate matter largely affect the respiratory and cardiovascular systems, and there is little to suggest that there is a 'safe' threshold below which no damage occurs. The levels of PM_{10} and $PM_{2.5}$ derived from the RCP8.5 model indicate that both exceed the WHO's acceptable annual average level (50 µg/m^3 for PM_{10} and 25 µg/m^3 for $PM_{2.5}$), and that PM_{10} also exceeds the EU limit (also 50 µg/m^3), for both the REF and FUT scenarios.

A seasonal analysis found winter to show the highest PM levels — this is thought to be associated with winter combustibles. The trend for long-term exposure is of greater concern for $PM_{2.5}$, but in the short term (daily mean levels), the opposite is true, with over 50% of days seeing levels of PM_{10} expected to exceed the WHO's AQGs in the REF case, and 80% in the FUT case. The deterioration of air quality by 2050 is due to a predicted warmer, drier climate, coupled with an increase in the background concentration of air pollutants.

These results highlight that poor air quality is likely to stay a significant problem in the future, particularly with regard to PM, and may impact the health of not only the Portuguese population but, if extrapolated, that of Europe. The researchers recommend designing strategies for air quality management, with all EU Member States cooperating in their implementation.

3. See: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050.