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MATHEMATICAL MODELLING OF ODOROUS AIR POLLUTANT DISPERSION USING AERMOD: FROM NATIONAL INDUSTRIAL CASE STUDIES TO INTERNATIONAL SIMULATIONS THROUGH THE TALENT PASS PROGRAMME

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Introduction

Unpleasant odors from industrial activity are among the most common causes of air-quality complaints. The smell is caused by specific pollutants released into the air, such as volatile organic compounds, hydrogen sulphide and ammonia. A key practical difficulty is that these pollutants cannot be measured everywhere in the surrounding air, at every moment and under every weather condition. The established solution, widely supported in the scientific literature, is mathematical modelling: computer simulations that statistically estimate how a pollutant is transported and diluted in the atmosphere. This paper presents the dispersion-modelling approach developed at INCD ECOIND using AERMOD, illustrated with national industrial case studies and extended to international sites through the Talent Pass programme.

The modelling approach

Mathematical dispersion modelling reproduces, in a computer, the physical processes that carry a pollutant away from its source. The approach has three simple steps (Figure 1). First, the source is characterized: the amount of odor or pollutant released is determined by standardized measurements. Second, this information is combined with the local conditions that control dispersion hourly weather data (mainly wind speed and direction, temperature and atmospheric stability), the shape of the terrain and the surrounding buildings. Third, the AERMOD model a steady-state Gaussian model recommended for regulatory use simulates how the pollutant spreads and estimates its concentration across the surrounding area. Results are expressed statistically for example, the concentration not exceeded during 98 % of the year and shown as dispersion maps and as values at chosen points such as nearby dwellings.

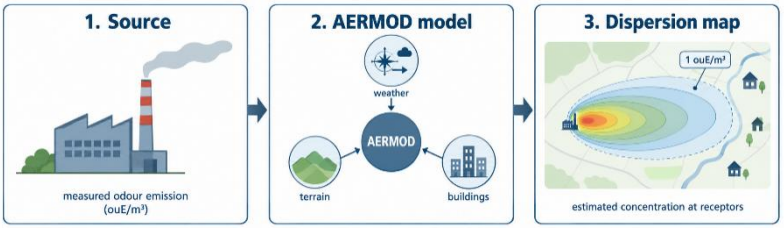


Figure 1 - The three steps of dispersion modelling: from source emissions, through the AERMOD model, to a dispersion map.

Results and conclusions

A key advantage of dispersion modelling is that it identifies the sources most responsible for pollution. By comparing the contribution of each source, the model shows where the odor actually originates, often sludge storage, wastewater treatment or biofilters so that mitigation is targeted effectively. On this basis, INCD ECOIND recommends emission-reduction measures, such as covering or deodorizing the dominant sources or improving stack dispersion.

The method has been applied to many national industrial sources, pulp and paper, refining, cement, wastewater and waste treatment, tobacco, composites, food and metal processing. In each case, source measurements were turned into maps of where, how often and how far the odor may be perceived (Figure 2): the strongest effects occur close to the source and in unfavorable weather, while concentrations usually fall below the perception threshold (about 1 odor unit per cubic meter) a few hundred meters away.

Through the Talent Pass programme, the next step is to model the pollutants from international partners, using their own emission data. Overall, AERMOD modelling predicts pollutants dispersion, pinpoints the main sources.

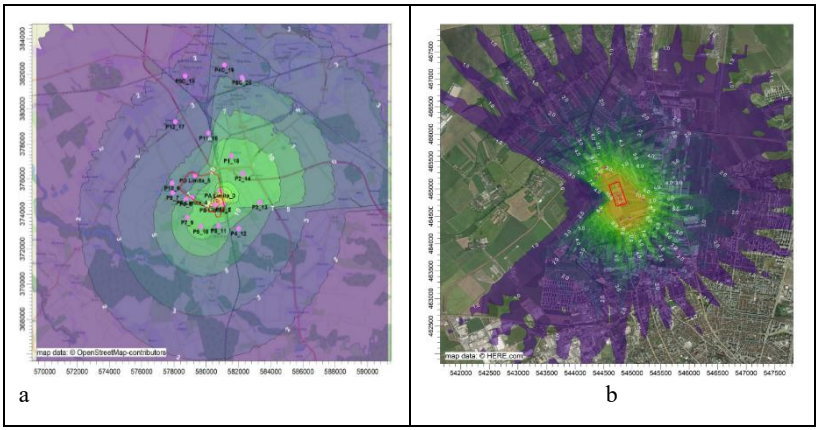


Figure 2 - Representative AERMOD dispersion maps for two sectors: **(a)** petroleum refining and **(b)** municipal wastewater treatment.