Multi-criteria ranking and source apportionment of airborne particles

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Source apportionment studies have become very widespread since the availability of EPA PMF. Some of the drivers for such studies include the desire for (a) source identification and (b) quantification of the contribution of each of the identified sources to the pollution level at a receptor site. In addition to the information on source profile and source contribution obtained from receptor modeling such PMF analyses, the results can be coupled with meteorological data, in order to estimate the location of each of the sources resolved by the receptor model.

Based on the above outcomes, it may be necessary to devise source control strategies and where there are multiple sites, the next logical step is to work out which of the affected sites should be addressed first. Fortunately, formal procedures for multi-criteria decision-making are available (e.g. Massart *et al* 1997). One of these multi-criteria decision making methods, the Preference Ranking Organization METHods for Enrichment Evaluation (PROMETHEE) and Graphical Analysis for Interactive Assistance (GAIA) PROMETHEE was originally developed to aid the selection of the best location for factories (Brans & Mareschall, 1989) but it is finding increasing application in air quality research. PROMETHEE is an outranking method that ranks alternatives on the basis of a set of criteria. GAIA (Graphical Analysis for Interactive Assistance), on the other hand, is a visual display tool.

This paper reports the application of multicriteria decision making techniques, PROMETHEE and GAIA, and receptor models (such as Principal Component Analysis/ Absolute Principal Component Scores (PCA/APCS) and Positive Matrix Factorization (PMF) to data air quality data collected at various locations. The data consisted of the concentrations of elemental species, gaseous species or particle number concentration and meteorological data.

Each factor obtained by PCA/APCS and PMF had distinctive compositions that suggested that motor vehicle emissions, controlled burning of forests, secondary sulfate, sea salt, and road dust/soil were the most important sources of fine particulate matter in the sites. The most plausible locations of the sources were identified by combining the results obtained from the receptor models with meteorological data.

Then the air quality data were further analysed with PROMETHEE to facilitate multi-criteria ranking and the choice of the least and the most polluted sites based on several air quality indicators. This procedure compared all objects (e.g. sites or years that sampling was conducted) based on the values of the variables (e.g. chemical species, particle number concentrations), and ranks the objects (e.g. sites) from the least to the most polluted (Ayoko et al., 2004; Friend and Ayoko, 2009).

The overall results provided insights which can aid the prioritization mitigation measures not only for outdoor (Friend and Ayoko, 2009, Friend et al, 2011a, Friend et al, 2011b) but also indoor (Ayoko et al, 2004) microenvironments. In addition, the studies demonstrated the potential benefits of combining results from multi-criteria decision making analyses with those from receptor models to enhance the development of air pollution control measures.

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