Estimation of wood burning contribution to PM in Northern Italy: a review of recent results

Paola Fermo[a], A. Piazzalunga[a,b], V. Bernardoni[c], G. Valli[c], R. Vecchi[c]

[a] Department of Inorganic, Metallorganic and Analytical Chemistry, University of Milan, Italy
[b] Department of Environmental Sciences, University of Milan - Bicocca, Italy
[c] Department of Physics and INFN, University of Milan, Italy

Many studies have been carried out during the last years to highlight the contribution of biomass burning to the fine particulate matter (PM) because of the wood combustion impact on air quality, human health and climate change. The estimation can be achieved through the quantification of a specific tracer, i.e. levoglucosan. To apportion the wood burning source contribution to PM or organic carbon (OC) different approaches have been used. Among the more widespread methods are the macro-tracer approach (using anhydrosugars or radiocarbon measurements) and receptor models.

Recently in Italy an investigation was carried out at the national level in order to acquire information concerning the wood quantity combusted for residential heating and the kind of heating systems employed. The results showed that 19.9% of the Italian families commonly use wood as heating source. In Lombardy (Po valley, Northern Italy) - one of the major pollution hot-spot areas in Europe - residential wood-fired heating systems are quite widespread too, i.e. 31.8% of the families use wood as heating source. An estimation of wood burning impact on PM10 and OC concentrations in Lombardy were performed following the macro-tracer approach with weighed emission factors. They were calculated weighing the average emission factors reported in the literature with the percentage of wood types felled in Lombardy. The results obtained show that wood smoke in Lombardy represents one of the main sources of OC in ambient aerosol during the cold season. Indeed, in many cases the wood burning contributes for about or more than one third to OC concentrations. Estimates of the wood burning impact on PM and OC in Lombardy are comparable to those reported in the literature for other European locations. We have also proposed an alternative approach to estimate real world average emission ratios in ambient air, using the chemical profiles obtained by Positive Matrix Factorization (PMF). No differences were found in the estimates of the wood burning impact to OC values when using emission factors differently tailored. On the contrary, the contribution of wood smoke to PM (PMwb) is about 60% higher when using PMF-derived emission ratios. This result suggests that PMwb could be largely underestimated when using literature wood smoke emission factors, which do not consider correctly the ageing of wood burning aerosol. It is noteworthy the not negligible contribution of wood burning also in the large city of Milan (PM10wb = 6.0%–16.5%) especially in view of effective PM abatement policies, which are mandatory because of the very high PM levels registered during wintertime.

Wood burning is also an important source of PAHs. The contribution of wood combustion to benzo(a)pyrene (B[a]P) and polychlorodibenzo-p-dioxins and polychlorodibenzofurans (PCDD/F) concentrations was investigated in two sites placed in Piemonte region, using levoglucosan as a marker. In Piemonte, wood burning represents one of the main sources of PM. The wood burning contribution to B[a]P is about 60%. With respect to wood burning contribution to PCDD/Fs, in one of the two examined site (a typical Alpine site), the 2,3,7,8-fingerprints were similar to those characteristic of wood combustion. The quantification of wood burning contribution to particle-bound B(a)P has been also performed at ten stations in the North Italian Po Plain and Valtelline Valley. Four different methods such as levoglucosan tracer method, multi-linear regression analysis, PMF and chemical mass balance modelling have been applied. Biomass burning was demonstrated to contribute with more than 75% of the benzo(a)pyrene pollution in the Po Plain and Valtelline Valley during winter. In particular in one of the investigated stations, the EU limit of 1 ng/m^3 is exceeded. A full implementation of the residential heating plants with modern systems would be a significant step towards abating benzo(a)pyrene pollution in this highly populated area.