AIRUSE-LIFE+: Are dust binders efficient in Southern Europe? Alternatives for efficient urban and industrial dust mitigation in Mediterranean areas

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Resuspension is an important air quality issue in Southern Europe. PM emissions from road dust and soil dust resuspension increase considerably levels of PM10 in urban atmosphere and in industrial settings, hampering the attainment of EU limit values and WHO guidelines.

While in Scandinavian and Alpine regions, where studded tires and road sanding are used, dust binders (such as Calcium Magnesium Acetate, $CaCl_2$, $MgCl_2$ and K-formate) have been proven to be effective in reducing road dust resuspension, lower or negligible efficiencies have been found in Central and Western Europe such as UK and Germany (Barratt et al., 2012; Reuter, 2010), where the road dust loadings are lower due to high humidity and the ban of studded tires.

No information is available for the Mediterranean countries, where the high road dust loadings and solar radiation make a very specific scenario for resuspension emissions and need to be evaluated exhaustively. AIRUSE-LIFE+ tested the efficiency of street cleaning (washing and sweeping), CMA, $MgCl_2$ and nano-polymer, at diverse environments in Spain namely:

- Urban road
- Industrial paved road
- Industrial unpaved road
- Unpaved urban park

Street washing (combined with a preliminary sweeping) was found to be the most effective measure in all the tested roads (urban paved, industrial paved and unpaved). Reduction on mean PM10 levels was estimated at 7-10% (daily mean), 18% (daily mean) and >90% (first hour) respectively, as measured at kerbside monitoring sites. CMA and $MgCl_2$ were not found to reduce PM10 levels with statistically significance and, in any case, reduction was lower than that of water only (e.g. 8% for CMA versus 18% for water at the industrial paved road). The low or null effectiveness of CMA and $MgCl_2$ in Southern Europe (in contrast with Central and Northern Europe) is attributed to the high solar radiation, rapid evaporation of road moisture of the Mediterranean climate and consequently to the lower capacity of CMA and $MgCl_2$ to keep a high road moisture and bind road dust particles. A side-effect of CMA spraying was found consisting in the stripping of NH_3 from road surface due to the sensible (CMA induced) increase of pH.

From the review of a number of studies AIRUSE suggests the use of a tandem operation, where the streets are first vacuumed-swept and then washed with water, since street sweeping alone resulted ineffective in reducing PM concentrations in the short term. The effectiveness of street washing is proportional to the magnitude of road dust contribution to total PM10. The higher the share of PM10 due to road dust, the higher the effectiveness of street washing. Street washing should be performed at the early morning (5-6 h am), before the rush traffic hour. This is due to the fact that the effectiveness of street washing is related to the higher road humidity and being generally short-lived (few hours). Street washing should be prioritized at roads with medium-high vehicle intensity (>10,000 vehicles per day), during dry periods (for example after 15 days without precipitations) and right after African dust intrusion events, when road dust emissions are sensibly higher. Non-drinking phreatic water should be preferred.

From a scientific point of view, it can be recommended that, before planning street washing, local authorities support research studies aimed at:

1. Selecting those streets more critical for the road dust emissions (high traffic volume, high road dust load, proximity of sensible receptors such as hospitals, schools etc.)
2. Estimating the accumulation rate of road dust (i.e. how rapidly the steady state between deposition and emission is reached), and
3. Determine the most effective cleaning criteria (frequency, timing etc.). In this context, analysis of rainfall statistics are also important to ensure street washing is compatible with the frequency of rainfall events and therefore optimize the air quality effectiveness.

For urban unpaved areas such as public parks, unpaved parking lots and access to construction sites, the use of the tested nano-polymer is recommended. As shown in Barcelona, the application of a 3 L/m^3 dosage was found to reduce PM10 levels at one monitoring site located within the park by 2.9 $\mu g/m^3$ on a daily mean.

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