Assessment of population exposure to $PM_{2.5}$ and PM_{10} in the Athens metropolitan area

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PM_{10} levels have dropped significantly during the last decade in the Athens metropolitan area, however still are areas where the EU Air Quality Standards (AQS) for the protection of human health are frequently exceeded (Aleksandropoulou *et al.* 2012). Moreover, the average exposure indicator for $PM_{2.5}$ concentrations exceeded the target value of 25 μg/m^3 in 2010. The objective of this work is to evaluate the population exposure to PM_{10} and $PM_{2.5}$ at local outdoor and indoor residential environments in Athens, during the period 2000 – 2010. A preliminary assessment of the exposure to local outdoor PM_{10} during 2010 is presented.

The methodology used for the spatiotemporal allocation of PM_{10} concentrations is based on a data interpolation approach thus probably cannot capture the spatial variation within the urban area. However, it is based on common procedures and is appropriate in calculating population exposure estimates (Horalek *et al* 2007). The variables were selected based on evaluation of model performance. In particular, the exposure concentration was estimated using monitor and modelling data. Monitor data were available from the Hellenic Ministry for the Environment, Energy and Climate Change, whereas the PM_{10} background levels were retrieved from the EMEP Unified model results database (EMEP/MSC-W). The metropolitan area was divided to rural and urban/suburban land based on the Corine Land Cover (CLC) 2000 database and the geographical distribution of population of the EEA dataset was used. Multivariate statistical analysis was used for the spatiotemporal allocation of PM_{10} concentrations at rural areas, using as variables the anthropogenic primary emissions of PM_{10} (compiled based on Aleksandropoulou *et al* 2011), the variation in rural monthly averaged PM_{10} concentrations and the day-to-day variation in background suburban concentrations. At artificial surfaces, the local outdoor PM_{10} levels were estimated using the inverse-squared-distance weighted average of the background suburban monitor values scaled with anthropogenic primary PM_{10} emissions. Monitor values at traffic stations affect the PM_{10} concentration gradient only in their vicinity.

The results, as regards the model performance were 0.88 and 0.79 index of agreement (IA) for the annual averaged concentrations and the number of exceedences, respectively. Likewise, the root mean squared error (RMSE) is equal to 4.15, 0.81, 0.01 and 2.2 for the annual averaged concentrations at all monitoring stations, at background and traffic stations and for the number of exceedences, respectively.

It was found that the annual averaged concentrations over rural and urban areas were 19 μg/m^3 and 45.4 μg/m^3, respectively. More than 69% of the population living in the area is exposed to PM_{10} concentrations above the annual AQS of 40 μg/m^3, whereas 83% of the population lives in areas where the daily AQS of 50 μg/m^3 was exceeded more than 35 times during 2010. The estimated probability of exceedence of the daily AQS in the area during 2010 is shown in Figure 1. The hot spots correspond to urban areas and areas with significant primary PM_{10} emissions. In addition, the distribution of the normalised population load (Walker *et al* 1999) is depicted in Figure 2 which reflects populated areas with concentrations above the daily AQS.

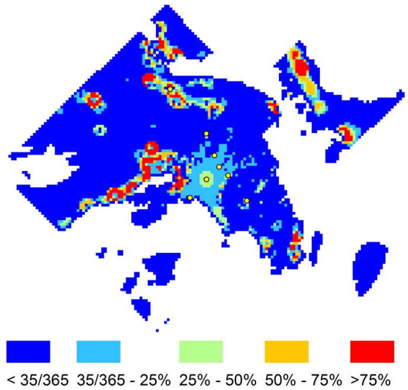

Figure 1. Probability of exceedence of daily AQS.

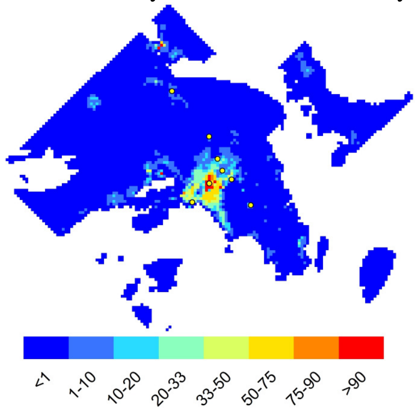

Figure 2. Normalised population load distribution (%).

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