Indirect Estimation via Dispersion Modelling of PM Emission Factors for Surface Phosphate Mining Activities

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Keywords: Dispersion modeling, emission from phosphate mining, AERMOD.
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Regardless of our current understanding of the risk of exposure to mineral PM, airborne particles emitted from surface phosphate mines cannot be unequivocally listed as benign and harmless. For example, Hamaiedth and El-Hasan (2011) reported that 40% of the patients who visited the Al-Hassa health center during 2008 (about 800 people) suffered from respiratory diseases that was attributed to exposure to phosphate dust. Indeed, when development of new mining area is considered the required environmental impact assessment (EIA) oftentimes contains also a health impact assessment (HIA) section. The latter can be done only by performing dispersion modelling, which requires emission factors as input. Emission factors for surface phosphate mining operations are not available due to complete absence of data on which they should base.

To tackle this problem, we developed methodology for estimating the missing emission factors for surface phosphate mining indirectly. This is done by implementing a range of plausible values, based on non-uniform distribution functions we constructed as part of the study, into a dispersion model. Model concentration predictions of different airborne PM fractions were compared to directly measured or to partially calculated concentrations around surface phosphate mines. We applied this approach in Khneifiss phosphate mine, Syria, and in Al-Hassa and Al-Abyad phosphate mines, Jordan. It is noteworthy that the study accounts for numerous model unknowns and for vast parameter uncertainties by means of applying prudent assumptions concerning the parameter values. For example, we simulated each scenario multiple times, using different parameterizations and emission factors.

Model results reveal that all the performance measures inspected (average concentrations ratio, fractional bias, fractional error, mean normalized bias and mean normalized error) were within their previously reported pertinent ranges when modelling TSP emissions from area sources (Tartakovsky et al., 2013; 2016). Our results suggest that “net” mining operations (buldozing, grading and dragline) contribute only little to the ambient TSP concentrations relative to phosphate processing and transport. In particular, applying both the USEPA AP 42 (1995) emission factors for phosphate transfer and for emissions from unpaved roads seems to better account for transport emissions in open surface mines than when using any of them solely. Regarding PM emissions that are due to wind erosion, the differences between the EPA and the NPI emission factors were found to have only small effect on the modelled ambient concentrations.

Based on our results, the common practice of deriving the emission rates for phosphate mining operations from the US EPA emission factors for surface coal mining or from the default emission factor of the EEA seems to be reasonable. Yet, since multiple factors affect dispersion from surface phosphate mines a range of emission factors, rather than only a single value, was found to satisfy the model performance. Nonetheless, our results suggest that health effects may arise from long term exposure to particulate matter emitted from surface phosphate mining activities.

D.L.T. would like to thank the Rieger Foundation PhD Fellowship Program for supporting his studies. The research was done at the Technion Center of Excellence in Exposure Science and Environmental Health, TCEEH.

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