mobil.TUM 2024 – The Future of Mobility and Urban Space, April 10-12, 2024

Are Parents driving air pollution around schools?

Henrik Grythe[a] *, Gabriela Sousa Santos[b], Arkadiusz Drabicki[c,d], Anna Nicińska[d] and Nuria Castell[a]

[a]The Climate and Environmental Research Institute NILU, *Norway*
[b]Department of Transportation Systems, Cracow University of Technology, Krakow, *Poland*
[c]Chair of Transportation Systems Engineering, Technical University of Munich, Munich, *Germany*
[d]Faculty of Economic Sciences, University of Warsaw, Warsaw, Poland

---

Keywords: *Air pollution, emissions, road traffic, school driving*

This work addresses the following topic(s) from the Call for Contributions:
(Please check at least one box)

☐ Placemaking to integrate urban spaces and mobility
☒ Promoting sustainable mobility choices in metropolitan regions
☐ Governing responsible mobility innovations
☐ Shaping the transition towards mobility justice
☒ System analysis, design, and evaluation
☐ other: ________________________

Extended Abstract

Problem statement

Driving and picking up kids at school is common across the western world. At the same time children in most urban areas suffer from adverse effects due to air pollution. Children are particularly vulnerable to air pollution due to their higher respiration rates, ongoing lung development, and shorter breathing pathways (Osborne et al. 2021). For many children, the drop-off and pick-up periods at school, often during peak hours, represent a large portion of their exposure to air pollution.

Research objectives

In the project CoMobility, we raised the question of how parents driving affects air pollution at schools, and what can be done about it. At the core of our research are 3 schools in Warsaw, Poland, one urban and 2 suburban. Surveys of parents and field observations were carried out to collect detailed data on each school regarding driving habits and traffic information, as well as to estimate school-related traffic generation rates in the morning (drop-off) and afternoon (pick-up) periods. At each school a diverse range of activities were conducted, including: interventions to reduce parents' reliance on private car for bringing and collecting their kids and children engagement in monitoring air quality around their school using low-cost sensors.

Methodological approach

In order to understand the response in traffic patterns and air pollution around the schools due to differences and changes in use of private cars, we set-up an environmental modelling system for the Greater Warsaw, that included:

1) Macroscopic traffic model MTAW (Warsaw Municipality, 2016) (*Model Transportowy Aglomeracji Warszawskiej* in Polish). It is the main strategic transport model for the Greater Warsaw area, developed

* *Corresponding author. Tel.: +xx-xxx-xxxxx; fax: +xx-xxx-xxxxx.*
E-mail address: nameexample@example.edu

during the 2015 comprehensive travel survey in Warsaw (Polish: WBR 2015 - *Warszawskie Badanie Ruchu* 2015) and updated for our study.
2) Emission model NERVE, which calculated the exhaust emissions from vehicles (Grythe et al, 2022).
3) Meteorological model WRF (Weather Research and Forecasting Model) to produce the fields necessary for the dispersion model like wind speed and direction, air temperature, cloud cover, etc. (Skamarok et al., 2019)

Urban dispersion model EPISODE (Hamer et al., 2020), which estimated ambient concentrations. Besides the emissions from NERVE, emissions for other sources came from the Central Emission Database by the Environmental Protection - National Research Institute (IEP-NRI) in Poland (Gawuc et al., 2021). The background concentrations were taken from the Copernicus Atmospheric Monitoring Services (CAMS) ensemble forecast for 2019 (Marécal et al., 2015).

(Expected) results
Through this environmental modelling system, air quality was modelled for Warsaw, with specific focus on the three schools pick-up zones. We developed a framework for modelling the specific emissions of the parents' vehicles in the pick-up zone, with details on parking, idling and congestion effects, which normally are not included in the NERVE model. Both idling and parking are specific activities that have only a small effect on total emissions of vehicles, though need to be described in detail in a parking zone to account for all emissions. And as was demonstrated by the modelling, showed that parents have a disproportionate effect on the air quality in the area compared to other passing vehicles.

Preliminary modelling findings indicate that without any parents' activity in the pick-up zone, the levels of NOx are not necessarily vastly reduced, because the response from the traffic model is that other drivers adjust their routing options to the freed-up roads and thus the number of vehicles is not significantly reduced. This interesting finding reaffirms the self-equilibrating paradoxes of urban road capacity systems (Goodwin, 1996; Mogridge, 1997), underlining the need for supply-side interventions. Hence, in further modelling scenarios, where the adjacent street network in the pick-up zone was subject to traffic calming measures or completely closed to car traffic, a significant reduction in NOx emissions and ambient air concentrations was found for all three schools. However, this comes at the cost of increased emissions and concentrations in other areas, as a consequence of increased driving distance and congestion.

Neither of these results consider yet the effects of the actions of the parents in the pick-up zone. During peak hours, according to the field observations done, an average of about 5-6 cars would be idling in the pick-up zone of each school, contributing significantly to pollution levels. In addition, significant emissions occur from engine operations when parking. Moreover, parking causes disruption to traffic, causing congestion and thus increasing passing vehicles emissions. It is expected that including these vehicle behaviors in the pick-up zone in our emission calculations will significantly influence air quality outcomes.

The study highlights the difficulty faced by policymakers if trying to reduce air pollution without reducing overall road traffic. It also highlights how attitudes to driving (and idling) must change to reduce emissions. There is a well of yet to be analyzed data from the schools which may reveal other aspects not discussed in this abstract.

References:
Gawuc, L., Szymankiewicz, K., Kawicka, D., Mielczarek, E., Marek, K., Soliwoda, M., Maciejewska, J. (2021). Bottom-up inventory of residential combustion emissions in Poland for national air quality modelling: Current status and perspectives. Atmosphere, 12: 1460. https://doi.org/10.3390/atmos12111460

Goodwin, P. B. (1996). Empirical evidence on induced traffic: A review and synthesis. Transportation, 23, 35-54.

Grythe, H.; Lopez-Aparicio, S.; Høyem, H.; Weydahl, T. Decoupling Emission Reductions and Trade-Offs of Policies in Norway Based on a Bottom-Up Traffic Emission Model. *Atmosphere* **2022**, *13*, 1284.

Hamer, P.D., Walker, S.-E., Sousa Santos, G., Vogt, M., Vo-Thanh D., Lopez-Aparicio, S., Schneider, P., Ramacher, M.O.P., Karl, M. (2020). The urban dispersion model EPISODE v10.0 - Part 1: An eulerian and subgrid-scale air quality model and its application in Nordic winter conditions. Geosci. Model Dev., 13, 4323-4353. https://doi.org/10.5194/gmd-13-4323-2020

Marécal V., et al. (2015). A regional air quality forecasting system over Europe: the MACC-II daily ensemble production, Geosci. Model Dev. 8: 2777-2813. https://doi.org/10.5194/gmd-8-2777-2015

Mogridge, M. J. (1997). The self-defeating nature of urban road capacity policy: A review of theories, disputes and available evidence. Transport policy, 4(1), 5-23.

Osborne, N. J., Fairchild, R., & MacKenzie Ross, S. J. (2021). School air pollution interventions: A systematic review. International Journal of Hygiene and Environmental Health, 232, 113692. doi: 10.1016/j.ijheh.2021.113692

Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Liu, Z., Berner, J., et al. (2019). A description of the advanced research WRF model version 4. National Center for Atmospheric Research: Boulder, CO, USA, 145, 145.

Warsaw Municipality (2016). Greater Warsaw Transport Model [MTAW – Model Transportowy Aglomeracji Warszawskiej.] https://transport.um.warszawa.pl/-/model-ruchu
.