CurieuzeNeuzen: monitoring air quality together with 20.000 citizens

Sam De Craemer[1*], Jordy Vercauteren[2], Frans Fierens[2], Wouter Lefebvre[3], Hans Hooyberghs[3], Filip Meysman[1]

1 Universiteit Antwerpen
Universiteitsplein 1
2610 Wilrijk, Belgium
**Corresponding author:*
sam.decraemer@uantwerpen.be

2 Vlaamse Milieumaatschappij
Kronenburgstraat 45
2000 Antwerpen, Belgium

3 VITO
Boeretang 200
2400 Mol, Belgium

KEYWORDS
CurieuzeNeuzen, nitrogen dioxide, citizen science, air quality, policy

1 INTRODUCTION

Traffic sources contribute a large portion of the ambient nitrogen dioxide, particulate matter and ozone concentrations, the three ambient air pollutants with the largest impact on human health in Europe (EEA, 2018). High spatial resolution air quality data capturing the high spatial variability of this traffic related pollution are necessary in order to inform policy. The approach of environmental protection agencies around the world to measure using expensive monitoring stations allows monitoring in high temporal, but not spatial, resolution (Snyder et al., 2013). Air quality models are used to achieve the necessary spatial resolution, but their full validation still requires a dense measurement set.

To obtain such a set for the traffic dense region of Flanders, Belgium, an unusual consortium, uniting the University of Antwerp, the Flanders Environment Agency, and the newspaper De Standaard as main partners, collaborated with citizens in the CurieuzeNeuzen project (CurieuzeNeuzen Vlaanderen, 2019). The involvement of citizens allowed to raise community awareness regarding air quality, and support for related research and measures.

2 METHOD

The aim was to recruit at least 20.000 participants using a multimedia campaign centred around a positive and motivating message. Despite requiring a contribution of €10 per participant due to budget restraints, many more people wanted to participate. A selection from the registrations was performed taking into consideration the spatial distribution and the different situations in which the model needs to be evaluated. In order to obtain high quality measurements, the straightforward principle of Palmes samplers (Palmes, Gunnison, Dimattio, & Tomczyk, 1976) was combined with an easy-to-use but reproducible measurement setup so citizens could measure nitrogen dioxide, a good marker of traffic pollution, at their façade window.

Measurements were carried out during the month of May. First, these results were calibrated using reference measurements of the Flanders Environment Agency. Next, a temporal extrapolation to yearly values that can be compared with health guidelines was performed, based on monitoring data of the Flanders Environment Agency. The dataset was submitted to several analyses to provide policy recommendations, and to test the ATMO-Street model (VITO, 2019) used for air quality monitoring and evaluating policy scenarios in Flanders.

3 RESULTS

In the end more than 52.000 people registered to participate. After measurement at 20.000 locations and data quality check more than 17.800 measurements were retained for analyses. The resulting map (Figure 1) reveals some intense local variations in air quality, visually highlighting traffic intense roads and street canyons, especially in urban areas.
2.3% of the measurement locations exceed EU/WGO yearly limit value of 40 µg/m³, and a modelling exercise confirmed that this is representative for the concentrations at all facades of the Flemish population. While these exceedances were more concentrated in cities and suburbs, also a quarter of the villages and small cities (inhabitants < 50.000) have at least one sampling location in exceedance. In all cases, a combination of traffic intensity, traffic flow, and street geometry seem to play a role, which is confirmed by statistical analysis.
Comparison of the calibrated concentrations for the month of May to ATMO-Street model results of the same period showed that the model is performing quite well (bias= -4µg/m³; root-mean-square-error= 6.13 µg/m³). Based on the measurement dataset, some further improvements to the model have been made. Some remaining problems, such as a remaining underestimation in traffic dense street canyons, are likely related to incorrect and outdated traffic data used as input for the model.

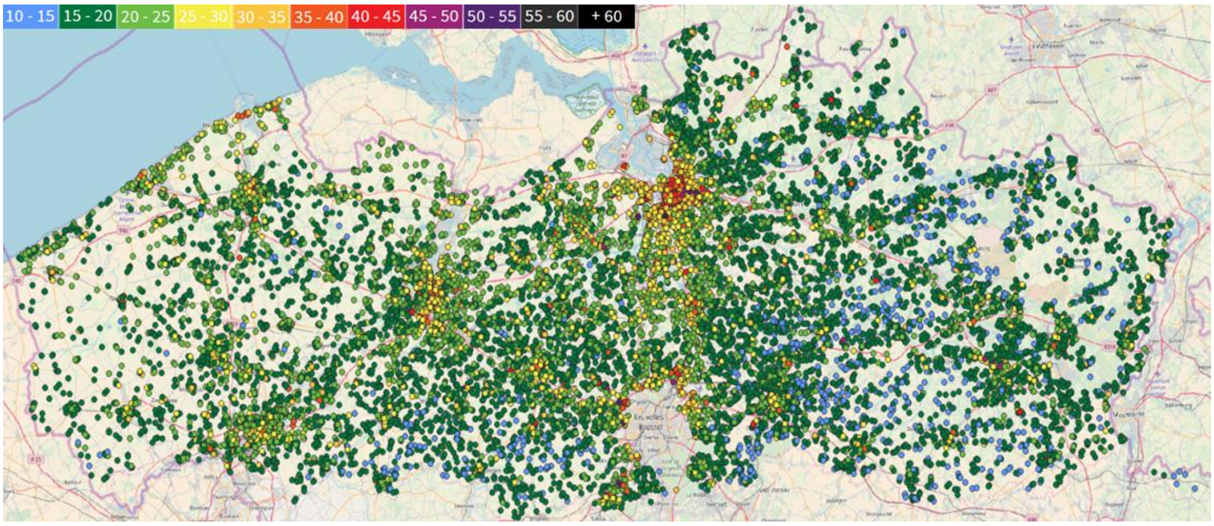

Figure 1: Map (background © OpenStreetMap contributors) of NO2 concentrations (µg/m³) measured in CurieuzeNeuzen Flanders

4 CONCLUSIONS

The recruitment strategy was a big success, and the motivation of the citizen scientists led to a high proportion of high-quality measurements, demonstrating that involving citizens in measurement can result in reliable data. The visual representation of the high variability in air quality linked to traffic intensity is useful to inform the public of ways to reduce their contribution to the problem and to reduce their exposure, including how to approach ventilation.
Exceedances of annual limit values in villages and smaller cities show that air quality is not only a problem of large city centres. Policy should take this into account, and the dataset indicates that smoother traffic flow and especially lower intensity should be priorities in this regard. A strengthening of urban centres will be important for the latter but achieving air quality standards in cities will always be harder than in less populated areas.
The good performance of the ATMO-Street model, even before any optimizations, demonstrates its reliability as a tool to inform policy and research, but underestimation of traffic dense street canyons should be considered. The largest potential for model improvement is likely to be better traffic data, possibly including traffic flow, should such data become affordable in the future.

5 ACKNOWLEDGEMENTS

We thank all citizens scientists involved for their enthusiasm and efforts, and all team members of University of Antwerp, De Standaard, the Flanders Environment Agency, VITO, HIVA KUleuven and Kariboo! for their contribution to planning, logistics and communication. We also acknowledge the citizen movement Ringland and Stad Antwerpen for their contribution the CurieuzeNeuzen Antwerpen project, which acted as a pilot for the present project.

6 REFERENCES

CurieuzeNeuzen Vlaanderen. (2019). Website CurieuzeNeuzen Vlaanderen. curieuzeneuzen.be

EEA. (2018). *Air quality in Europe - 2018 report*. Luxembourg.

Palmes, E. D., Gunnison, A. F., Dimattio, J., & Tomczyk, C. (1976). Personal sampler for nitrogen dioxide. *American Industrial Hygiene Association Journal*.

Snyder, E. G., Watkins, T. H., Solomon, P. A., Thoma, E. D., Williams, R. W., Hagler, G. S. W., … Preuss, P. W. (2013). The changing paradigm of air pollution monitoring. *Environmental Science and Technology*, *47*(20), 11369–11377.

VITO. (2019). Webpage ATMO-Street. https://vito.be/en/atmo-street