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Citizen scientists map air pollution with smartphones

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Citizen scientists have helped to map pollution across the Netherlands using their smartphones. Their results, produced by thousands of volunteers, are presented in a study which shows how a combination of mass participation and smartphone technology can be a powerful approach to environmental monitoring.

The volunteers measured aerosols, which are liquid or solid particles suspended in air. Many of these particles, which include the particulate matter (PM) in vehicle exhaust and industrial emissions, are air pollutants and are regulated and monitored under the EU Air Quality Directive. This sets limits and reduction targets for PM concentrations.

Atmospheric aerosols are monitored from the ground, usually at professional measurement stations, or from space, by instruments on satellites. The collected data can be mapped to show aerosol distribution across a country or region and identify pollution hotspots.

However, measurements from professional monitoring stations only provide data for a limited number of locations. Remote monitoring is also limited for satellites that provide global mapping and characterise aerosols because they can only make observations once a day, while on the ground measurements can be taken continuously. Moreover, the resolution of satellite observations is low (around 10 km). Thus, it is difficult to create maps with high resolution, both in terms of space and time, and at the same time.

Citizen science approaches to aerosol monitoring provide a potential solution to both problems by drawing on large networks of volunteers. In the current study, 3187 citizen scientists contributed data collected by a small optical add-on attached to their smartphones, which makes use of several sensors inside the phone (e.g. GPS, compass). The data were submitted via an app, iSPEX.

The add-on makes aerosol observations by taking photos with the phone's camera. Although the precision of the device is much lower than in professional measurement stations, the large number of users allows many measurements to be averaged, which improves accuracy.

The volunteers followed the app's instructions to make and submit observations. One advantage of this approach is that, as with ordinary smartphone photos, the images can be automatically tagged with the date, time and location when/where they were taken.

The authors of the study organised three national measurement days in 2013. Citizen scientists across the Netherlands were asked to take images for the project on these days, during which they submitted nearly 10,000 observations.

Using the volunteer data, the authors created maps which showed how aerosol quantities varied across the country. The high density of observation locations meant that aerosol patches could be mapped with a resolution of around 2 km — compared with about 10 km using satellite observations. With the citizens' data, they were also able to show how aerosol amounts varied hour by hour in the cities of Amsterdam, Rotterdam, Eindhoven and Groningen.

To test the accuracy and time-sensitivity of the approach, they compared the measurements taken by citizen scientists within 20 km of the village of Cabauw with measurements collected in the same location at an atmospheric monitoring station. The iSPEX data showed very good agreement with the professional measurements.

The results suggest that participatory, smartphone-enabled monitoring could provide better resolution maps of aerosols than ground-based or satellite observations, in terms of both space and time. It is important to note that these 'crowdsourced' aerosol measurements do not replace professional measurements, however, but could complement them.

Through well-coordinated networks, it is feasible for communities to contribute to monitoring air quality in their own local areas, supporting the sparser and more focused professional monitoring techniques.