Fighting deadly air pollution in cities with sensors and satellites

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To reduce air pollution, cities and municipalities first need to measure it. Credit: Jacek Dylag via Unsplash

Urban smog is a major threat to human health. New sensors and data-collection techniques will help to improve air quality.

Each day, we take about 20,000 breaths. The oxygen in the air nourishes the cells in our bodies. But when the air we breathe contains harmful particulate matter and chemicals, those contaminants can also find their way into our body.

Air pollution is one of the greatest threats to human health and kills millions of people worldwide every year. According to estimates from the World Health Organization (WHO) in 2019, 99% of the global population lived in places where air quality failed to meet WHO guidelines.

In the European Union the same year, 307,000 people died prematurely as a result of chronic exposure to tiny particles of pollution, according to the European Environment Agency's report on air quality in Europe.

Minimal measuring

To reduce air pollution, cities and municipalities first need to measure it. But the traditional equipment is expensive and bulky.

"It's a big container, three by four meters, with its own aircon and electricity 24/7," said Leonardo Santiago of Bettair Cities, which coordinated a project to spur a more nimble measuring technology. "And then they have to have specialized people to do maintenance."

Coming up with better methods to gauge and map air pollution can't come soon enough.

Cost benefits

If an EU city has more than 100,000 inhabitants, European rules require that it monitor air quality. The expense and hassle of traditional

monitoring stations mean that many smaller cities free of the obligation to do the checking don't—and that bigger cities use only a handful, according to Santiago.

"With the number of stations that a city usually has, it's not enough for them to create an actual map," he said. "They normally use mathematical models to estimate what is happening, but they don't see the reality."

Called MappingAir, the Horizon project created a platform that draws on data from a network of less-expensive sensors developed by Spain-based Bettair Cities. The company's helmet-like sensors sit underneath the bulbs of smart streetlights, checking the air for pollutants.

Traditional monitoring stations cost upward of €200,000, while the smaller sensors have a price tag of about €4,000 and do not require frequent, specialized maintenance.

In addition to establishing the monitoring platform, the project, which ended last month after three years, enabled Bettair Cities to transform its sensor from a prototype into a ready-to-use product.

Nimble sensors

The device is currently used in street and traffic lights in a number of European and South American cities, with the biggest test in Rome. Some of these sensors are part of trials to showcase their efficacy, while others are commercial installations. More metropolises have shown interest, Santiago said.

Inside its plastic shell, the sensor contains electrochemical cells that detect the presence of pollutants. However, these cells also react to humidity and temperature, which can distort their readings.

"What we have done is to use artificial intelligence to analyze how all of these variables affect the sensor," Santiago said. The AI algorithms effectively strip out the noise in the data caused by other variables including humidity and temperature.

When the sensor data are fed into the company's "blackbox full of artificial intelligence," the output is pollution information that tallies with that produced by the traditional container-sized stations about 94% of the time, according to Santiago.

Owners need to replace the cells only every two years—much less than regular maintenance for traditional stations. An added benefit of the sensors is that they contain noise-pollution monitors too.

Sky-high

Researchers are also taking to the skies to tackle urban air pollution.

Using satellites along with monitoring stations, a separate research project has generated maps of air quality for various cities around the world.

"When we combine Earth observation data with socio-economic data, including health data, we come so much closer to the real problems, or the real reasons for the problems," said Evangelos Gerasopoulos, leader of the Health Surveillance Air Quality Pilot. "We are then also one step closer to decision-making."

His work is part of e-shape, a Horizon project harnessing the glut of data from Europe's Earth observation infrastructure for the benefit of people in fields ranging from agriculture and energy to health and water.

"E-shape was built with and for users," said Thierry Ranchin, director of

the Center Observation, Impacts, Energy at MINES ParisTech in France and scientific coordinator of e-shape.

The air-quality pilot's Teaser platform gives users—municipalities, companies and individuals, for example—a taste of what is possible by combining Earth observation, health and socio-economic data from 2018 to 2020.

For dozens of cities around the world, the cloud-based platform offers an aggregated risk index—used to assess the impact of air quality on health.

For example, during the winter months, major arterial roads in Athens are a source of air pollution, but these also happen to be highly populated areas. The map shows not just the extent of the pollution but also the exposure of people at risk.

"We provided a one-stop shop," said Gerasopoulos, who works at the National Observatory of Athens in Greece.

Tailored data

For a handful of cities, the project teamed up with local users to tailor data to their needs. Eleni Athanasopoulou, also working at the National Observatory of Athens, provided the following examples of such co-design experiences.

In Athens, the Health Surveillance Air Quality Pilot team worked with the city and other stakeholders to map the public's street-level exposure to the common chemicals coming from vehicles. In response to the pilot's findings, the Greek health ministry, faced with data illustrating the extent of air pollution risk, bolstered its environmental monitoring.

In Helsinki, the pilot worked with the Finnish government and private sector to determine how industries around the city affected air quality for residents. In Munich, the focus was the spatial distribution of air pollution, allowing users to zoom in on specific postcodes. And in Bari, Italy, air pollution data was combined with population density and linked to sustainable development goals.

These examples showcase both the many ways that Earth observation information can be applied and the power of combining data, said Gerasopoulos.

"If we go to different communities like the health community, they might have no clue where they can find our type of Earth observation data and we don't know how to get hold of their data," he said. "The project demonstrates the capacity, perspectives and potential of having them all together."

More information:

- MappingAir
- e-shape

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