The New York Times | http://nyti.ms/1zg5B4K

ENERGY & ENVIRONMENT

Experimenting at Home With Air Quality Monitors

APRIL 15, 2015

Green Column

By **KATE GALBRAITH**

Two years ago, when Thomas Talhelm was a Fulbright scholar in Beijing, he built his own air purifier after growing concerned about the city's notorious pollution. To test his handiwork, he spent about $260 for a portable device that counts tiny particles in the air.

"I always had the intuition that indoor air was cleaner than outdoor air, and that's borne out in the data very clearly," he said. Mr. Talhelm, who used a device made by a California company called Dylos, also noticed that cooking could cause indoor pollution to spike.

Mr. Talhelm went on to found an enterprise that helps residents of China build cheap, do-it-yourself air filters. Now, scientists and hobbyists like him are increasingly experimenting with personal devices, including air pollution monitors.

The reason is simple: In any city, the amount of pollution varies from one area to the next, so residents' exposures can differ considerably. New devices are cheaper and more portable than big government monitors, and ultimately they could feed streams of information to interactive maps, helping people to

know what streets or neighborhoods are especially polluted. But experts caution that the field is young and changing quickly, so the technology is not always reliable or user-friendly.

“Currently, the air pollution sensors are still expensive and not easy to use, so it limits the number of people that can use them,” Mark Nieuwenhuijsen, a research professor at the Center for Research in Environmental Epidemiology in Barcelona, Spain, said in an email. However, the technology is improving, he said, and in a few years, devices like smart watches could contain air pollution sensors.

While the monitors — which can cost hundreds or thousands of dollars — have yet to become a mass-market item, their use by researchers is proliferating. In 2012 and 2013, Dr. Nieuwenhuijsen and other researchers outfitted 54 schoolchildren in Barcelona with air pollution monitors. These monitors measured black carbon, which consists of small sooty particles released by diesel engines and other sources. The children experienced the highest levels of black carbon when they were commuting to and from school, according to the study, which was published this year in the journal Environmental Science and Technology. The lowest levels of pollution were at their homes.

In Hong Kong, where the dense population is exposed to high levels of vehicle exhaust, a British researcher, Benjamin Barratt of King’s College London, is using portable monitors to study how pollution affects people living in skyscrapers. His team is measuring pollution in the city’s street canyons — streets lined with tall buildings. The idea is to understand how pollution from traffic gets trapped in such passages and how that may affect people who live high in the buildings, as damaging particles are dispersed.

Interpreting the data can be challenging, which is a central reason, in addition to cost, why few nonscientists have invested in monitors so far. For some machines, “You have to do a fair amount of research on air quality to

even begin to understand what these devices are telling you," said Jennifer Gabrys, a researcher at Goldsmiths, University of London who has tested portable monitors for Citizen Sense, a European project studying the use of environmental monitors.

She took about 15 people on a walk through London in 2013 to use the air monitoring devices, and in some cases, she said, "We were really questioning the numbers we were getting."

The readings from the portable machines sometimes differed from those by large official monitors nearby. Monitors may be more accurate, she said, when they are stable, as opposed to being moved around.

Monitors intended for use by ordinary citizens are starting to arrive. Last month, Airviz, a company spun off from Carnegie Mellon University in Pennsylvania, unveiled a device about the size of a fist that is designed to sit on a table and measure the fine particles in homes and to provide air quality information on an electronic display.

"You can look across the horizon, and you can see the haze, and you can tell it's bad when it's bad," said Illah Nourbakhsh, a professor of robotics at Carnegie Mellon whose team developed the device, which is called Speck. "But in your home, there is no cheap way to know how bad it is."

Professor Nourbakhsh's research group buys tiny dust sensors that scatter light and measure the particle content by seeing how the light bounces off it. Such sensors are cheap but often inaccurate, he said, so researchers then must adjust the calibration on each sensor by comparing the data with that of an established, expensive machine and creating an algorithm to correct its idiosyncrasies.

"We're compensating for a bad sensor with machine learning," he said.

The researchers also added a tiny fan to ensure a steady supply of air. A

display constantly updates the air quality reading, so users can see if the air in a home gets worse during cooking or other activities. The device, which costs $200, is sold out through April, and the company is ramping up to make 300 units a month, Professor Nourbakhsh said. He added that inquiries had arrived from as far afield as England, Germany and China. His group is moving to design a version that can be used outside.

So far, users say, small pollution-monitoring devices seem more successful at measuring how pollution increases or decreases day by day or hour by hour, and less attention should be paid to the exact numbers they give out.

Mr. Talhelm has tried out several monitors in Beijing, and he has been struck by how the count varies from day to day.

“I don’t recommend interpreting the numbers literally (e.g., ‘Oh, it’s 9 micrograms, so the air is safe!’), but relative changes are definitely meaningful,” he said in an email.

Current technologies also tend to be better at measuring small particles, than pollution in the form of gases, like nitrogen dioxide, researchers say. Gases are often measured by electrochemical sensors, in which the gas reacts at an electrode and an electric current results.

Ultimately, researchers hope that personal air pollution monitors, combined with the geographic data captured by cellphones, will lead to new pollution maps of big cities around the world. In September, Swedish researchers plan to start a project called Quantified Planet that will map air pollution measurements taken by individuals worldwide. Dr. Nieuwenhuijsen is also working on a project called CITI-SENSE that will map air pollution in eight European cities, aided by small-scale monitors.

But a few people are already using the devices to understand their own exposure. Richard Saint Cyr, a family physician in Beijing, spent about $400 a

few years ago for a Dylos particle monitor to test how well the air purifiers in his home were working. Data from the machine recently “showed that my home’s indoor air still wasn’t clean enough, despite every room having famous-brand, imported (i.e. expensive) air purifiers,” he wrote in an email. He did more testing and ultimately switched to new types of purifiers for his home.

“I think the market for micro-air pollution monitors is going to explode in China and other polluted countries,” Dr. Saint Cyr said. “Hopefully they will continue to get cheaper and more accurate.”
