During epidemics, access to GPS data from smartphones can be crucial

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A new EPFL and MIT study into the interplay between mobility and the 2013 and 2014 dengue outbreaks in Singapore has uncovered a legal void around access to mobile phone data—information that can prove

vital in preventing the spread of infectious diseases.

Researchers from EPFL and MIT have shown that human mobility is a major factor in the spread of vector-borne diseases such as malaria and dengue even over short intra-city distances. In a paper published in *Scientific Reports*, the team compares different mobility models and concludes that having access to mobile phone location data can prove crucial in understanding disease transmission dynamics—and, ultimately, in stopping an outbreak from evolving into an epidemic. Yet, according to the researchers, this kind of information is hard to come by. They recommend bringing in new legislation to fill a legal void and enable scientists, NGOs and political decision-makers to access people's phone location data for public health purposes.

"Urbanization, mobility, globalization and climate change could be all factors in the emergence of vector-borne diseases, even here in Europe," explains Emanuele Massaro, the paper's lead author and a scientist at EPFL's Laboratory for Human-Environment Relations in Urban Systems (HERUS), which is led by Claudia R. Binder. "Until now, most research has examined how mobility affects the spread of infections in larger areas such as countries or regions. In this study, we focused on the same question, but this time in towns and cities. We also wanted to explore when people's mobile phone location data might prove useful."

The authors studied the interplay between human mobility and the 2013 and 2014 dengue outbreaks in Singapore. They found that even low levels of mobility can cause the epidemic to spread, underscoring the need for an effective spatial distribution model.

Dengue is a viral disease carried by the Aedes aegypti mosquito. It occurs in the tropics and subtropics, and is particularly prevalent in rural areas and poor urban communities. Symptoms include headache and fever, and mortality rates vary from 1 percent when treated to as high as

20 percent when left untreated. According to the World Health Organization, the incidence of dengue has increased 30-fold worldwide over the past 50 years. Some 3.9 billion people in 128 countries—almost half of the world's population—are exposed to the virus.

Comparing models

The researchers used an agent-based transmission model in which humans and mosquitoes are represented as agents that go through the epidemic stages of dengue. Using digital simulations, they compared how the system responded to an outbreak against actual reported cases from 2013 and 2014 in Singapore, where a further spike in cases has been recorded this year.

The team then compared four different mobility models, each using different datasets: mobile phone location data, census records, random mobility, and theoretical assumptions. In each model, citizens were assigned two locations—home and work—as places they visit daily and could potentially become infected. The mobile phone model was based on anonymized device data sourced from a Singaporean mobile operator, using call, text and other activity records to pinpoint users' home and work addresses.

Useful during an outbreak

The researchers demonstrated that the mobile phone data and census models were effective at predicting the spatial distribution of dengue cases in Singapore, and that such data could be obtained without infringing on people's privacy. Their findings invite further discussion about the merits and drawbacks of using mobile phone data to model disease outbreaks, as well as other potential applications. "In an emergency, having accurate information makes all the difference," says

Massaro. "That's why phone location data is better than annual census records. The problem is that the data is owned by private companies. We need to think seriously about changing the law around accessing this kind of information—not just for scientific research, but for wider prevention and public health reasons."

The team's model could equally be applied to other vector-borne diseases, which, led by malaria, together account for 17 percent of all infectious diseases. The UN estimates that over 80 percent of the world's population is exposed to at least one vector-borne disease, with over 50 percent exposed to two or more.

More information: Emanuele Massaro et al. Assessing the interplay between human mobility and mosquito borne diseases in urban environments, *Scientific Reports* (2019). DOI: 10.1038/s41598-019-53127-z

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