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UNDERWORLDS

MIT researchers are developing a smart sewage platform to monitor urban health

Cambridge, MA – A team of MIT researchers have developed a system to collect and analyze biochemical information from sewage water – what could be thought of as a "smart sewage platform". The project, called Underworlds, is being tested in the city of Cambridge, MA, and will be awarded a $4-million grant by the Kuwait Foundation for the Advancement of Sciences through the Signature Research Program of the Kuwait-MIT Center for Natural Resources and the Environment (CNRE) to support work over the next three years in collaboration with Kuwait Institute for Scientific Research and Kuwait University. Underworlds will allow the study of different species of bacteria, viruses, and chemical compounds that live in the human gut and converge in the city's sewage – our collective microbiome. Tapping into this vast reservoir of information can help monitor urban health patterns, shaping more inclusive public health strategies, and pushing the boundaries of urban epidemiology.

Underworlds began as a conversation between professors Carlo Ratti, Director of the Senseable City Lab in the Department of Urban Studies and Planning, and Eric Alm, Director of a laboratory in the Department of Biological Engineering - before evolving into a multi-departmental research endeavor, involving Civil and Environmental Engineering and the Computer Science and Artificial Intelligence Laboratory. The first application of Underworlds will be contagious disease monitoring and prediction. Early warnings in relation to the presence of enteric disease outbreaks in urban centers could ultimately reduce a community's medical costs and even help mitigate outbreaks. "The MIT project is extremely ambitious and pioneering," said Christian Daughton, a chemist with the U.S. Environmental Protection Agency. "If this project proves successful in demonstrating some sort of proof of principle, it could represent a significant, seminal advancement in the prospects for quickly and inexpensively monitoring public health in real time."

Underworlds is a proof of concept that cities can make use of their wastewater system to improve public health. A broad array of human activity is reflected in a city's wastewater, and as such a host of applications can emerge from sampling and analyzing sewage. Cities could study the way non-communicable diseases develop, as biomarkers for diseases such as obesity and diabetes could be measured at unprecedented scale and temporal resolution. "We can reveal the invisible in a city," explains Professor Ratti. "For every cell in the human body there are around ten bacterial cells, constituting the human microbiome which has recently been recognized as a key determinant of an individual's health and wellness – how can we measure something like the microbiome at the scale of an entire city, such as Cambridge?"

The MIT team imagines a future where sewage is mined for information that can inform health practitioners, policy makers, and communities alike. "The availability of real-time or near real-time data that measures the presence of important pathogens could change how public health responds to these threats," says Sam Lipson, of environmental health for the City of Cambridge. "Early intervention provides leverage to reduce these impacts, but this kind of surveillance information has generally not been available to public health in the past." The implications of Underworlds extend beyond just surveillance to the development of a new type

of human population census. Analyzed in tandem with demographic data, a front-end data platform will be created to better understand and visualize the particular health of a neighborhood. It's about the underworld we don't see but that lives with us.

With the anticipated funding through the Kuwait-MIT Center for Natural Resources and the Environment, the research team has grown to include many labs at MIT in addition to the Senseable City Lab and the Alm Lab: Computer Science and Artificial Intelligence Laboratory, Runstadler Lab, Polz Lab, and the Eltahir Research Group. The six labs will collaborate with the Kuwait Institute for Scientific Research and Kuwait University, to develop the platform at full-scale and transfer expertise to Kuwait.

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