A Science Gateway for Wastewater-based Epidemiology - a Case Study of the World's Largest Wastewater Treatment Plant in Chicago

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***Abstract*— Wastewater-based epidemiology (WBE), got its start with polio and ascended in acceptance with COVID-19 pandemic has reaffirmed its potential to sound the alarm on both old opponents and new threats like monkeypox, which has been stated a public health emergency by the World Health Organization [Nelson 2022; Taylor 2022]. The revelations in our sewage have offered evidence for why developing and maintaining the infrastructure necessary for wastewater-data analysis, modeling, and visualization should be an urgent public health priority. Critical to success for WBE is the capability to rapidly translate data into results that are visualized and presented such that public health officials can make timely decisions, where the officials are typically accustomed to clinical data, and rarely have data science, microbiology, genetic sequencing, or environmental science experience.**

Science gateways uniquely equip research communities with shared data, applications, and resources, usually in a graphical user interface, that can be further customized to meet the requirements of a specific project. In the current study, we present the design of a science gateway-based WBE data analysis and visualization framework for accomplishing Centers for Disease Control and Prevention (CDC) standard weekly (or short-term) pandemic/disease reporting and an effective investigation report. This framework incorporates heterogeneous datasets that come in many varied formats from different organizations like sewer-specific information from the water resources department, wastewater treatment geographical details from wastewater treatment plants (WWTPs), clinical information from the health department, sequencing data and PCR data. The challenge is to clean up the data, check whether the values make sense or might have errors included to create profiles with information for CDC and in a further step to the public. Currently, we have developed a set of data analytic scripts and visualizations via Python, which can be started manually on command line. The logical workflow and the different data sources are complex to integrate. Thus, we have designed a framework based on Galaxy to automate steps and support the researchers in the project to access data and analysis without needing to use the command line. The design uses access via RESTful APIs or via FTP to different resources where appropriate. To demonstrate the feasibility of the proposed framework, a case study is presented with wastewater data collected from OCT 2020 to AUG 2021 in one of the world's largest WWTP, Stickney WWTP, Chicago, USA. The Stickney WWTP serves 2 million residents in the central part of Chicago as well as 46 other communities within a 260-square-mile-area. Once deployed, the proposed framework can be immediately utilized by WBE scientists and commercial vendors as an on-demand science gateway for providing COVID-19 WBE services. This can also be further customized for adding new services for opioids, polio, monkeypox, etc.

Keywords*— *Science Gateway, Wastewater-based Epidemiology (WBE), COVID-19, Wastewater Treatment Plants (WWTPs)

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