Using GIS and Metagenomics to Enhance Wastewater Surveillance

Victoria Love Franklin[1*] ; Todd Gary[1], PhD; Bishnu Sarker[1], PhD; Reginald Archer[2], PhD.

[1]School of Applied Computational Sciences, Meharry Medical College ; [2]Department of Environmental Sciences, Tennessee State University

***Victoria Love Franklin** (victoria.franklin@mmc.edu)*

Background

- **Clinical data limitations:** Traditional surveillance depends on individuals seeking care and follow-up testing, which presents reporting delays, especially for cases like SARS-CoV-2.
- **Reporting delays distort data:** Reporting delays have the potential to significantly distort the relationship between reported and real disease incidence in communities and can result in miscalculation of the illness burden.
- **GIS and metagenomics framework:** We propose a conceptual framework for Using GIS and Metagenomics to Enhance Wastewater Surveillance to address these clinical data limitations and improve disease outbreak monitoring.

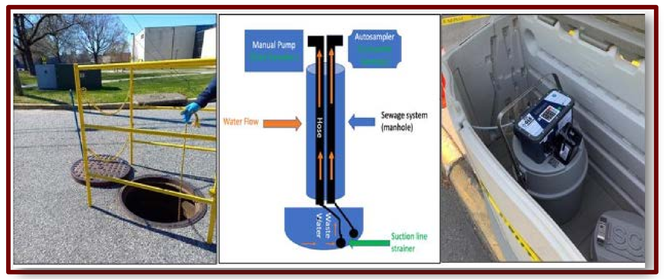

Figure 1: ***Materials:*** *showing the set-up for grab and composite sampling strategies. Grab setup with a direct flow from the manholes (left) was collected using a collection bottle while composite autosampler (right) collected water continuously.*

Photo Credit: Dongyeng Deng, Liesl Jeffers-Francis North Carolina A&T State University. https://www.osbm.nc.gov/documents/files/redacted-covid-19-wastewater-project-progress-report/open

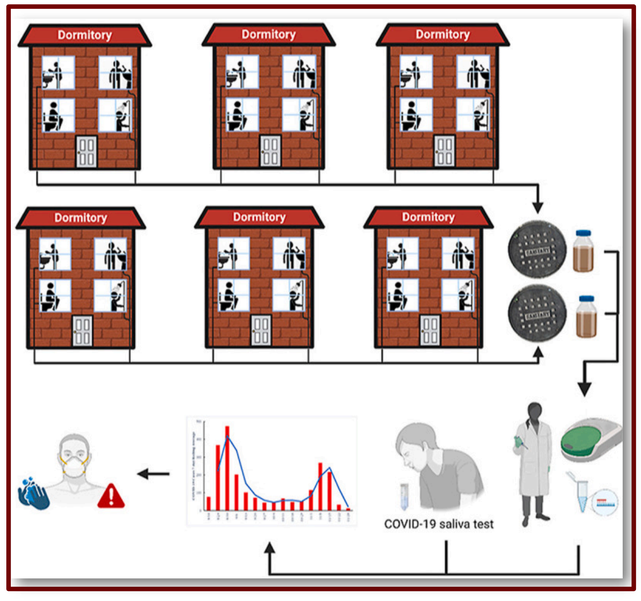

Figure 2: *showing sampling process flow for dormitories wastewater surveillance.* **Photo Credit**: (Lu et al., 2022)

Methodology

Step 1: Sampling **Step 2: Analyzing** **Step 3: Mapping**

ArcGIS

Figure 3: *After collecting grab samples from sewer access points (manholes), send them to Lab for Processing. Use R Language for statistical analysis, and data visualization. Use GIS for spatiotemporal analysis and predictive modeling of pathogen identification and distribution*

Figure 4: ***Study Site:*** *Campus Map of Meharry Medical College.* ***Propose Sampling Site****: Campus Dormitories (Morena* ***12A,*** *and* ***12B*** *Building, Royal Towers* ***11****, and Constellation Hall.*

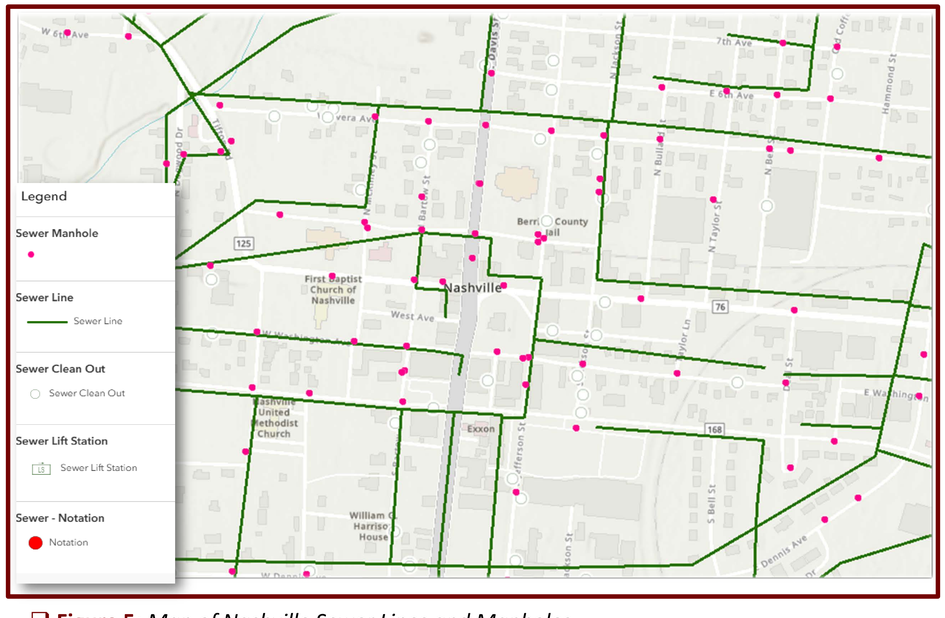

Figure 5: *Map of Nashville Sewer Lines and Manholes*

Expected Results

- Implement a wastewater surveillance program at SACS, Meharry Medical College
- Map the locations of wastewater sampling sites with corresponding sewer access sites (manholes), closes wastewater treatment facilities, and lift stations.
- Identify distinct spatial patterns in the distribution of targeted pathogens, correlating patterns with secondary data.
- Pinpoint hotspots where pathogen concentrations are highest.
- Create a real-time Wastewater Surveillance GIS Dashboard to contextualize sewage, map and evaluate viral activity, and the potential impact of detected pathogens.

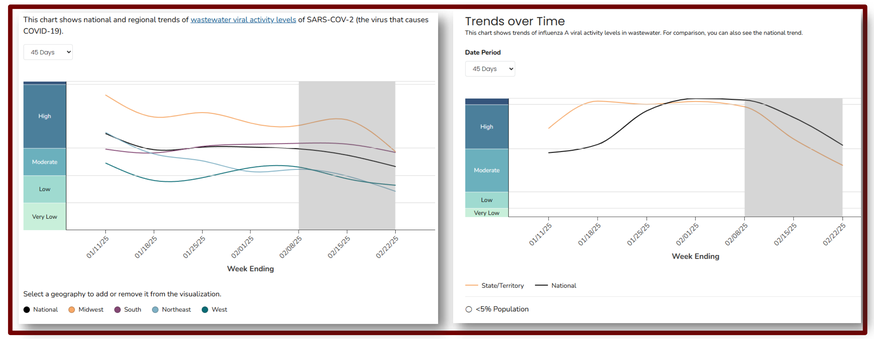

Figure 6: *This chart shows CDC national and regional trends of wastewater surveillance viral activity levels of SARS-COV-2 (the virus that causes COVID-19), and Influenza A within 45-day timeframe in Tennessee.* ***Source:*** *CDC .gov/nwss*

Discussion

- **GIS Implementation Challenges:** A limitation identified is the lack of specific location data for Meharry Medical College on existing *Nashville sewer maps*. The Map of Nashville Sewer Lines and Manholes shows a total of 1,000 manholes throughout Nashville, but Meharry is not indicated on the map, making it difficult to locate the corresponding manholes. To address this issue, a request will be made to obtain the Sewer Plumbing Plan for Meharry to verify the locations of the sewer access points (manholes). This information will help to determine whether to focus on a sample population such as residents living in dormitories or the broader campus population. **Sources:** Nashville Sewer Map (Figure 5)

Future Plans

- Obtain Institutional Sampling Approval
- Obtain Meharry Medical College Sewer Plumbing Plan
- Seek Bioinformatics & GIS Mentorship & Oversight
- Obtain Laboratory Agreements for Sample Processing

Acknowledgements

We would like to acknowledge Lubna Pinky, PhD for her assistance which included discussions and helpful comments, and Reginald, Archer, Ph.D., GISP, Department of Environmental Sciences, Tennessee State University

References

- Marinović, A. B., Swaan, C., Van Steenbergen, J., & Kretzschmar, M. (2015). Quantifying reporting timeliness to improve outbreak control. Emerging Infectious Diseases, 21(2), 209–216. https://doi.org/10.3201/eid2102.130504
- WebGIS-Based Real-Time Surveillance and Response System for Vector-Borne infectious diseases. International Journal of Environmental Research and Public Health, 20(4), 3740. https://doi.org/10.3390/ijerph20043740