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The Feasibility of Using WBE and GIS to Monitor COVID-19 in a Small Town or Rural Setting

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I am a recent graduate of WTAMU's Masters program. My degree is in environmental engineering and this poster is a summary of the work I did for my thesis.

Feasibility of Tracking COVID-19 Spread Through Rural Wastewater using WBE & GIS

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Abstract

As COVID-19 spread throughout the United States and the world in general, researchers and officials tried to monitor the spread of the pandemic. Much of this research focused on municipalities and not rural areas or small towns. This research was done to see if using wastewater-based epidemiology (WBE) and graphical information systems (GIS) could be feasible in a rural/small town setting.

A definition of feasibility for this context was established samples of wastewater were collected from Canyon, Texas and analyzed, with the results plotted on map using ArcGIS Pro. Other factors of feasibility such as accuracy of results, demand, acceptability, costs, time, practicality, and how to implement and integrate the process were analyzed using the experience of collecting and testing the wastewater samples.

The results sided with the prospect that it is feasible to track COVID-19, and other pathogens, through wastewater using WBE and GIS. However, the ones doing the sample collection, testing, and mapping should be trained. Finally, the local officials should weigh the benefits against the practicality, demand, and acceptability of using WBE and GIS to decide if the method should be used.

Methodology

- A definition for feasibility was created using eight aspects that covered a range of economic, social, and political concerns.
- Wastewater samples were taken from 6 lift stations around Canyon. This was done for 5 weeks.
- The samples were tested in a BSL2 lab using a RT-qPCR model of PCR machine and reagent kit from LuminUltra. The kit extracted COVID-19 RNA using magnetic beads
- A map of Canyon was created using ArcGIS Pro as its tools allowed for creation of Canyon's sewer system and its divisions. Sample locations were placed on the map with the markers adjusted based on results.
- The results along other data collected were analyzed alongside the experiences of collecting and testing wastewater to understand the aspects feasibility for using WBE and GIS in a rural setting.

Feasibility

Feasibility Aspect[1]	Definition
Limited Efficacy	How accurate is the process?
Demand	Is there a need for the process?
Practicality	To what extent is the process viable based on current funds, resources, and time?
Acceptability	How will the method be received by the public, and those conducting the method?
Integration	How can the method be integrated into current routines of those conducting the method?
Implementation	How will the method be conducted?
Adaptation	Can the method undergo a change in format and still be reliable?
Expansion	Can the method be used for other needs outside of tracking COVID-19?

Figure 1: The Eight Aspects of Feasibility

Results

Lift Stations	5/3/2022	5/11/2022	5/18/2022	5/24/2022	5/31/2022
Lift Station 1	Below Limit	Below Limit	Below Limit	Below Limit	Below Limit
Lift Station 2	Below Limit	Below Limit	Below Limit	Below Limit	Detected
Lift Station 3	Below Limit	Below Limit	Detected	Below Limit	Below Limit
Lift Sation 4	N/A	Below Limit	Below Limit	Below Limit	Below Limit
Lift Station 5	N/A	Detected	Below Limit	N/A	Below Limit
Treatment Plant Lift Station	Below Limit	Below Limit	Below Limit	Below Limit	Below Limit

Figure 2: Results of wastewater Analysis from Canyon, Texas for COVID-19.

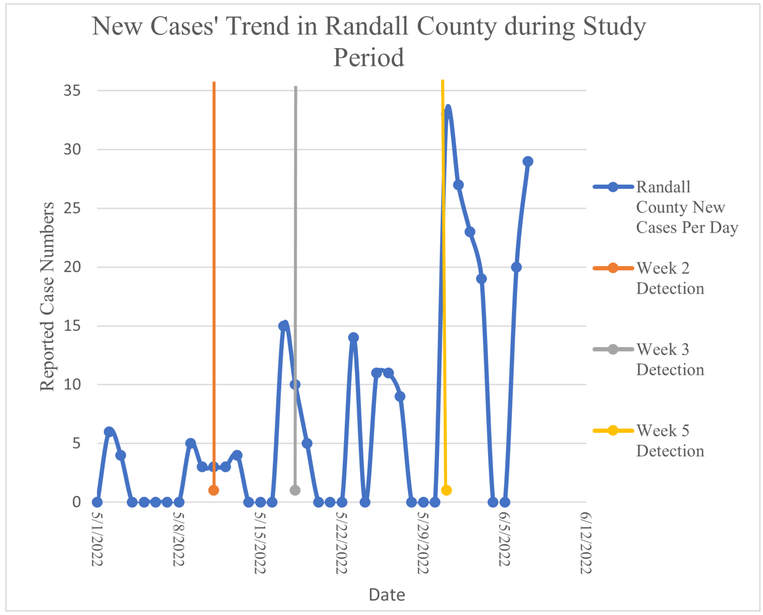

Figure 3: Detection Results verses Randall County Case Trends.

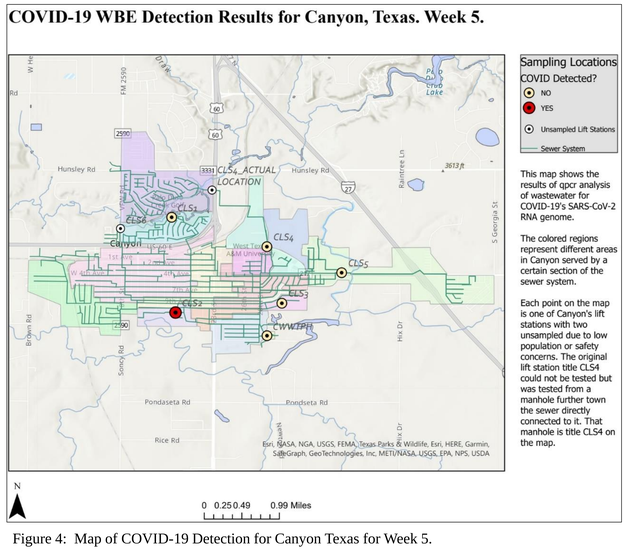

Figure 4: Map of COVID-19 Detection for Canyon Texas for Week 5.

Discussion

Feasibility Aspect	Definition
Limited Efficacy	Predicts case trends about a week in advance
Demand	Demand will increase during a pandemic.
Practicality	Using the kit costs $42 a sample versus $500 for an out of state laboratory. Results are within a day versus over a week.
Acceptability	Depends on location. Local officials will have a feeling for the acceptability of the method.
Integration	Treatment Plant works have to take samples and check lift stations as part of their routine. A town, even a small one may have a GIS system setup that can be used for mapping.
Implementation	Collect the samples with the preferred method of the collectors, follow the steps for the kit/RT-qPCR, plot results on map.
Adaptation	Other studies have used the same kit in other cities in different states.
Expansion	WBE and GIS have been used in other studies to track different pathogens.

Figure 5: Quick Overview of Feasibility Aspect Results..

Conclusion

The research concluded that it possible to track COVID-19 spread even in a rural/small town setting. As for feasibility, that depends more on the area. If the area does not use a public sewer system, then it becomes unfeasible. Also, the more spread out the sampling area is, the more time it will take to conduct the sampling. Finally, if case numbers are low for the area, then sampling may not be practical except to monitor for future surges in COVID-19.

The limitations to this method is that it is extremely difficult to get accurate case number data from WBE alone, thus it should be a monitoring system first and foremost. Second is that COVID-19 does not spread through wastewater evenly due to the media type. This can cause either large quantities of COVID-19 seen in a sample or none at all unless the sample is a composite or taken from a well mix source such as a lift station.

Of final note is that WBE and GIS can be used to monitor other pathogens as well, so even if COVID does not resurface as a pandemic, this method for feasibility can be used for other pandemics. The main change would be to the reagents used to conduct the wastewater analysis and RNA extraction.

Reference

[1]: Bowen, Deborah J., Matthew Kreuter, Bonnie Spring, Ludmila Cofta-Woerpel, Laura Linnan, Diane Weiner, Suzanne Bakken, et al. "How We Design Feasibility Studies." *American Journal of Preventive Medicine* 36, no. 5 (May 2009): 452–57. https://doi.org/10.1016/j.amepre.2009.02.002.

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