

IWWT Impact Case Studies Submission

Title of the Impact Case Study: An early warning system for monitoring COVID-19 infections in South Africa

Submitting University: Durban University of Technology

Name, position, and email address of Contact Person:

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Summary of the impact

The COVID-19 pandemic was a global public health challenge of epic proportions, which necessitated an effective and responsive monitoring approach. The Institute for Water and Wastewater Technology (IWWT) at the Durban University of Technology (DUT) adapted cutting-edge technology using wastewater-based epidemiology methods (WBE) supported by novel molecular techniques such as droplet digital PCR (ddPCR) to monitor the progression of the pandemic in communities in the urban and peri-urban environments. This was the only instance of the application nationally and one of the few teams internationally.

The scale of the pandemic necessitated the participation of a multidisciplinary team of experts from the health and scientific disciplines, resulting in the formation of the SACCESS network and partners from the Department of Health (KZN), the National Institute for Communicable Diseases, water utilities, and municipal stakeholders.

In early 2021, IWWT started monitoring the virus by collecting wastewater samples from Wastewater treatment plants (WWTPs) in Durban and surrounding areas, which were a part of the SACCESS monitoring network of 87 plants across 9 provinces. Surveillance at wastewater treatment plants provided early warning signals, detecting viral load surges up to two weeks before increases in clinically reported cases, including detection of the second wave one week prior to official reports. This work directly supported public health authorities by enabling proactive responses and demonstrated WBE as a low-cost, non-invasive tool for large-scale public health surveillance with continuing relevance for future outbreaks. IWWT also contributed to national and international capacity building by sharing standard operating procedures for SARS-CoV-2 detection using ddPCR through the SACCESS network. Press coverage further highlighted the technology's role as an early warning system for tracking disease progression.

Underpinning academic work

International studies in China (Wang et al., 2020) and the Netherlands (Medema et al., 2020) demonstrated that SARS-CoV-2 RNA could be detected in stool and wastewater before symptom onset, supporting WBE as an early warning system. On par with global best practice at the time, our team responded by adapting ddPCR for the monitoring of SARS-CoV-2 in wastewater treatment plants in the eThekwin metro. This expertise enabled the institute to lead surveillance in KwaZulu-Natal and contributed to national COVID-19 monitoring efforts. This served as an early warning system for the successive waves of infection and helped to inform the public health authorities on the progression of the pandemic within communities. The information shared with the public health authorities was well received.

- **Department/Unit:** Institute for Water and Wastewater Technology, Durban University of Technology.
- **Field classification:** *Health and Natural Sciences* (interdisciplinary).

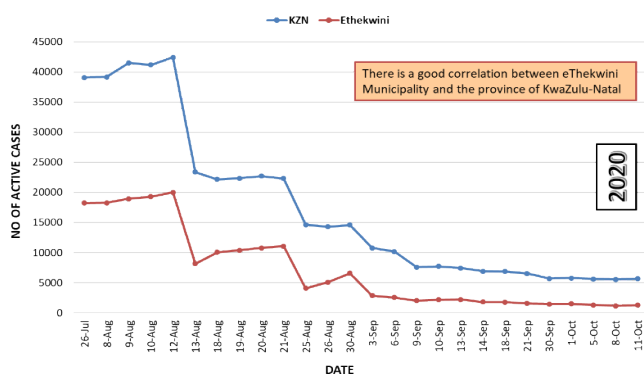
Narrative description of the impact

In the clinical setting in South Africa, the progression of the pandemic was largely underpinned by four significant waves followed by lockdown levels from March 2020 to April 2022. Applying the WBE approach, we were able to detect an increase in viral loads in wastewater at least a week before clinical cases were confirmed during the respective waves. This served as an effective early warning system and was well received by the public health authorities and contributed to mitigating the spread of the infections. The project has demonstrated the feasibility of integrating wastewater monitoring into national surveillance frameworks, providing an early warning system adaptable for future pandemics and environmental health threats.

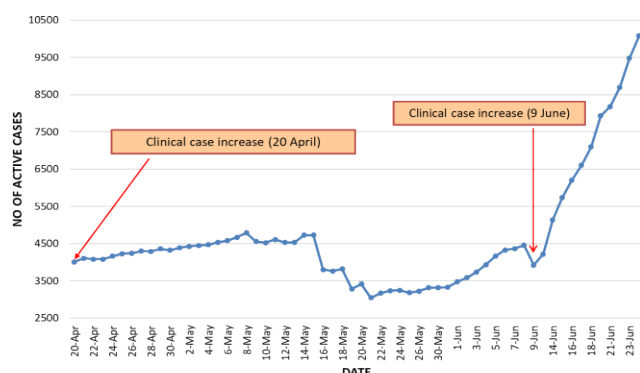
Key outcomes include:

- Providing the early warning data that could enable health authorities to anticipate waves and adjust interventions.
- Viral loads in wastewater rose as early as two weeks before clinical surges were reported, serving as an effective public health monitoring mechanism.
- Peaks in wastewater viral concentrations strongly correlated with changes in lockdown levels, confirming the influence of easing restrictions on transmission.
- WBE helped to overcome the challenges associated with clinical confirmation of cases due to asymptomatic individuals not being tested, highlighting the gap between clinical cases and actual community prevalence. This helped to give a more accurate representation of the presence of the virus when compared to clinical cases.
- ddPCR also provided an added advantage to detect viral loads in wastewater at lower concentrations, providing a sensitive detection tool.

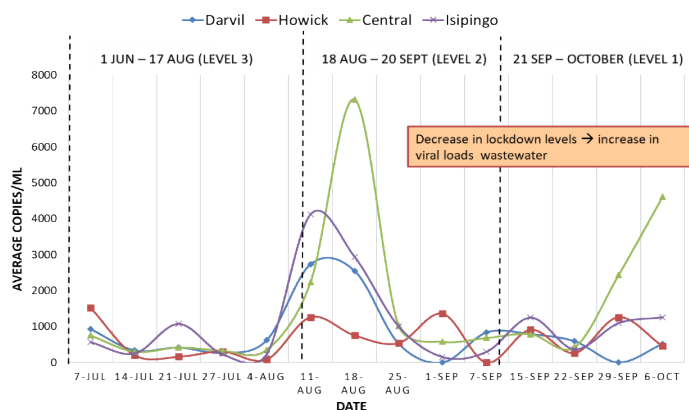
Impact of Lockdown Levels on COVID-19 Viral Loads in Wastewater



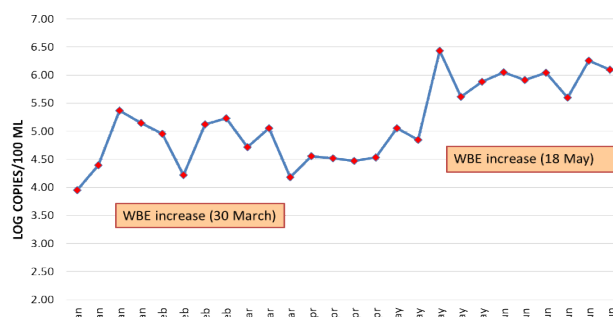
Number of active cases of SARS-CoV-2 in KZN and eThekweni municipality (July 2020 – October 2020)



Number of clinically active cases in KZN (20 April - 24 June 2021)



Presence of SARS-CoV-2 in wastewater treatment plants from July – October 2020



Monitoring of SARS-CoV-2 at Central WWTP by IWWT (January – June 2021)

The graphs illustrate fluctuations in SARS-CoV-2 viral loads detected in wastewater influent across selected treatment plants. Clear peaks in viral concentrations aligned closely with successive COVID-19 infection waves, while decreases reflected the impact of lockdown restrictions. In several instances, wastewater viral loads increased before reported clinical cases, demonstrating the effectiveness of wastewater-based epidemiology as an early warning tool for community-level infection trends.

Peer-reviewed outputs

- Amoah, I. D.; Kumari, S.; Bux, F. Coronaviruses in wastewater processes: Source, fate and potential risks. *Environment International* 2020, 143, 105962. <https://doi.org/10.1016/j.envint.2020.105962>.
- Amoah, I. D.; Pillay, L.; Deepnarian, N.; Awolusi, O.; Pillay, K.; Ramlal, P.; Kumari, S.; Bux, F. Detection of SARS-CoV-2 RNA on contact surfaces within shared sanitation facilities. *International Journal of Hygiene and Environmental Health* 2021, 236. <https://doi.org/10.1016/j.ijheh.2021.113807>.

- Pillay, L.; Amoah, I. D.; Deepnarain, N.; Pillay, K.; Awolusi, O. O.; Kumari, S.; Bux, F. Monitoring changes in COVID-19 infection using wastewater-based epidemiology: A South African perspective. *Science of the Total Environment* 2021, 786. <https://doi.org/10.1016/j.scitotenv.2021.147273>.
- Amoah, I. D.; Mthethwa, N. P.; Pillay, L.; Deepnarain, N.; Pillay, K.; Awolusi, O. O.; Kumari, S.; Bux, F. RT-LAMP: A Cheaper, Simpler and Faster Alternative for the Detection of SARS-CoV-2 in Wastewater. *Food and Environmental Virology* 2021, 13 (4), 447–456. <https://doi.org/10.1007/s12560-021-09489-7>.
- Amoah, I. D.; Abunama, T.; Awolusi, O. O.; Pillay, L.; Pillay, K.; Kumari, S.; Bux, F. Effect of selected wastewater characteristics on estimation of SARS-CoV-2 viral load in wastewater. *Environmental Research* 2022, 203. <https://doi.org/10.1016/j.envres.2021.111877>.
- Pillay, L.; Amoah, I. D.; Kumari, S.; Bux, F. Potential and Challenges Encountered in the Application of Wastewater-Based Epidemiology as an Early Warning System for COVID-19 Infections in South Africa. *ACS ES and T Water* 2022, 2 (11), 2105–2113. <https://doi.org/10.1021/acsestwater.2c00049>.

Conference presentation

- Bux, F. Application of wastewater-based epidemiology for monitoring of COVID-19 infections: A South African context. International Conference - BRICS NUs: Water Resources and Pollution Treatment [WRPT21] July 6-8, 2021.



IWWT Covid Task Team, pictured left to right: Dr Oluyemi Olatunji Awolusi, Mr Kriveshin Pillay, Prof. Sheena Kumari, Prof. Faizal Bux, Dr Leanne Pillay, Dr Isaac Dennis Amoah.

Media coverage

- Enca interview with Prof Bux- Discussion | Unrest behind spike of COVID-19 infections in KZN. <https://youtu.be/wql8wxmX13o?feature=shared>.
- Salaamedia- KZN #COVID19 spike increase due to the recent #UNREST. <https://www.youtube.com/live/iSzbSaaqg2E?feature=shared>.
- Prof Kumari shares ground-breaking research on COVID-19 - <https://www.dut.ac.za/prof-kumari-shares-ground-breaking-research-on-covid-19/>

Durban

eThekweni waste water analysis suggests Covid-19 third wave is already in KZN

A research team at the Durban University of Technology (DUT) believes KwaZulu-Natal is already experiencing a third wave of Covid-19 infections.

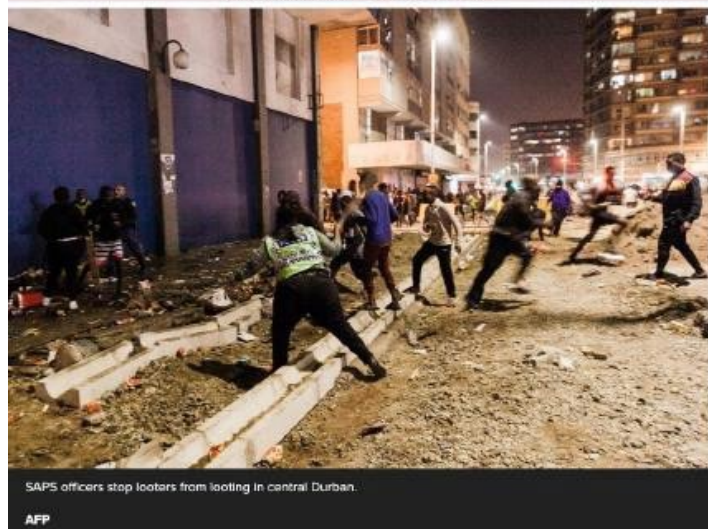


10 Aug 2021

Wastewater analysis shows KwaZulu-Natal unrest caused spike in Covid-19 cases

news24 Lwandile Bhengu

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Dut's Wastewater Analysis Indicates KZN May Already Be Experiencing The Third Wave Of Covid-19 Infections

"According to recent clinical data, the number of active cases in KZN and the eThekweni Municipality began to rise steadily since 20 April 2021.

June 2, 2021

Simangolile Zuma 7 minutes read



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DUT WASTEWATER ANALYSIS SHOWS KZN EXPERIENCING 3RD WAVE OF COVID-19 INFECTIONS

The Institute for Water and Wastewater said the peak of the COVID-19 second wave in South Africa occurred in January this year with an average of 40,000 cases in KwaZulu-Natal.



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Local news News

Covid-19: What DUT's wastewater analysis tells us about the third wave

According to the research team, monitoring the changes in viral loads in wastewater over time allows them to gain insight into the levels of infection within communities.

June 2, 2021

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Se-Anne Rall
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Sewage water analysis show KZN is in 3rd wave – experts



Source references

Medema, G.; Heijnen, L.; Elsinga, G.; Italiaander, R.; Brouwer, A. Presence of SARS-CoV-2 RNA in Sewage and Correlation with Reported COVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands. *Environmental Science & Technology Letters* 2020, 7 (7), 511–516. DOI: [https://doi.org/ 10.1021/acs.estlett.0c00357](https://doi.org/10.1021/acs.estlett.0c00357).

Wang, X.; Zheng, J.; Guo, L.; Yao, H.; Wang, L.; Xia, X.; Zhang, W. Fecal viral shedding in COVID-19 patients: Clinical significance, viral load dynamics and survival analysis. *Virus Res* 2020, 289, 198147. DOI: [https://doi.org/ 10.1016/j.virusres.2020.198147](https://doi.org/10.1016/j.virusres.2020.198147).

Signed off on behalf of the University by (Name, position, and email address):

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Date:

05 September 2025