Wastewater- Based Epidemiological surveillance of COVID-19 in KwaZulu Natal, South Africa

Institute for Water and Wastewater Technology

Durban University of Technology

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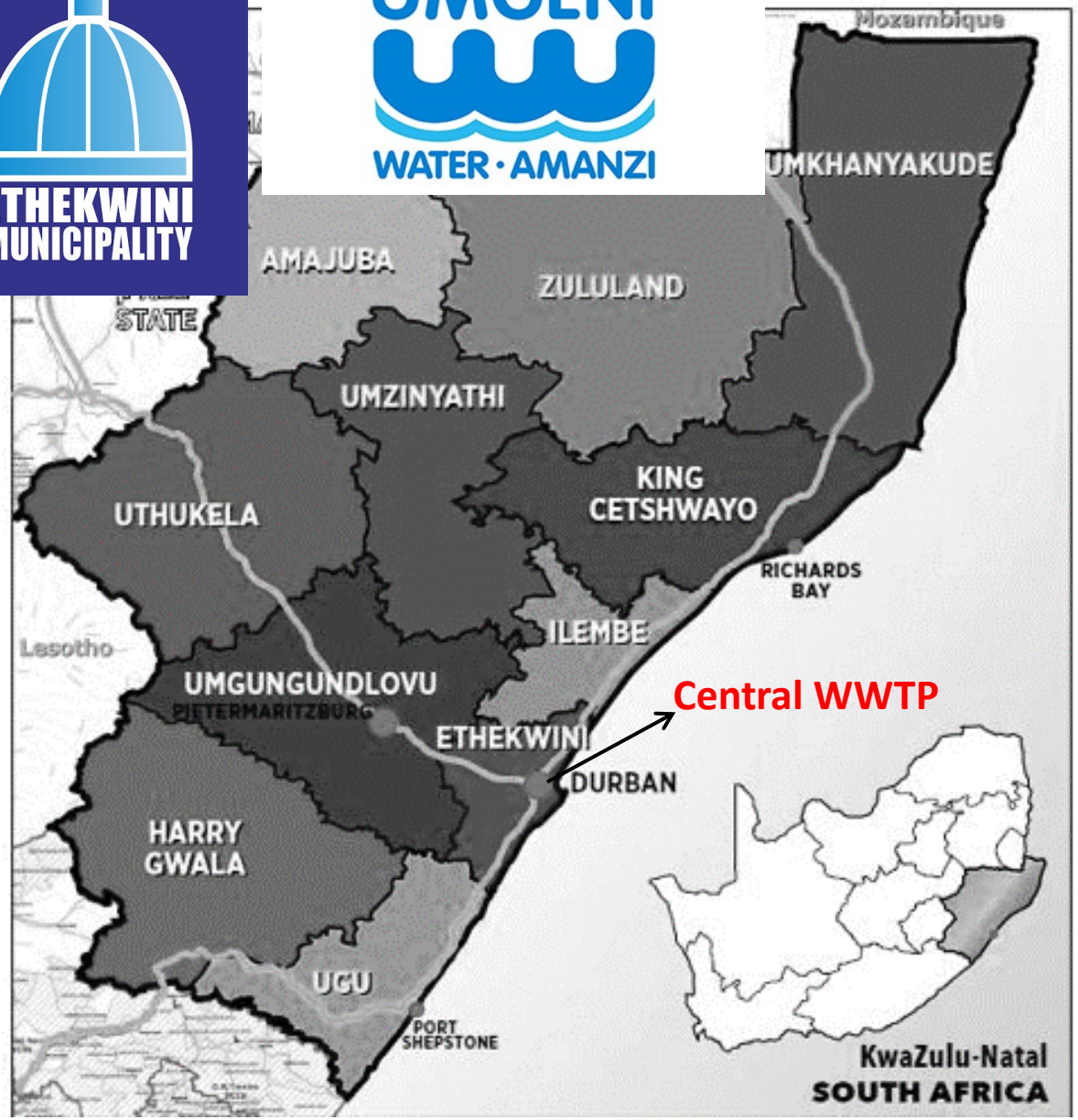
WBE in KwaZulu-Natal

- Carried out by the Institute for Water and Wastewater Technology (**IWWT**) in the cities of Durban and Pietermaritzburg since July 2020.

- Focus for 2021 - Central WWTP (Durban)

- Services over 61 suburbs



Desired outcomes of the WBE approach for IWWT

- Baseline of Covid-19 infections based on SARS-CoV-2 load in untreated wastewater.
- Detection of spike in infections (To predict future waves).
- Surveillance system in place for monitoring other infections etc.

Methodology

1

Wastewater Influent

Grab sample collection

2

Low speed centrifugation

3

Concentration

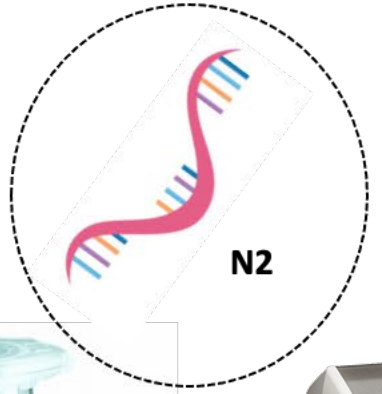
Centricon 70 Ultrafilter

4

RNA extraction

Qiagen QiAMP Viral RNA Mini-Kit

RNA



5

Droplet Digital PCR

Sample collection and processing

Detection, Quantification and Analysis

Method verification: Recovery efficiency

1. Determining **limit of detection** (LOD) → **0.2 copies** per microliter

2. Determining recovery efficiency

- Determination of recovery efficiency was done by spiking raw wastewater and sterile MilliQ water with known amounts of inactivated SARS-CoV-2.

$$\textbf{Recovery \%} = \frac{C_{SW} - C_{UW}}{C_{SC}} * 100$$

Where Csw is the concentration of SARS-CoV-2 in spiked water, Cuw is the concentration of SARS-CoV-2 in un-spiked water and Csc is the concentration of SARS-CoV-2 that was spiked into the wastewater

Recovery efficiency: Wastewater: 62.86 % (±12.84)

MilliQ water: 78.62 % (±1.79)

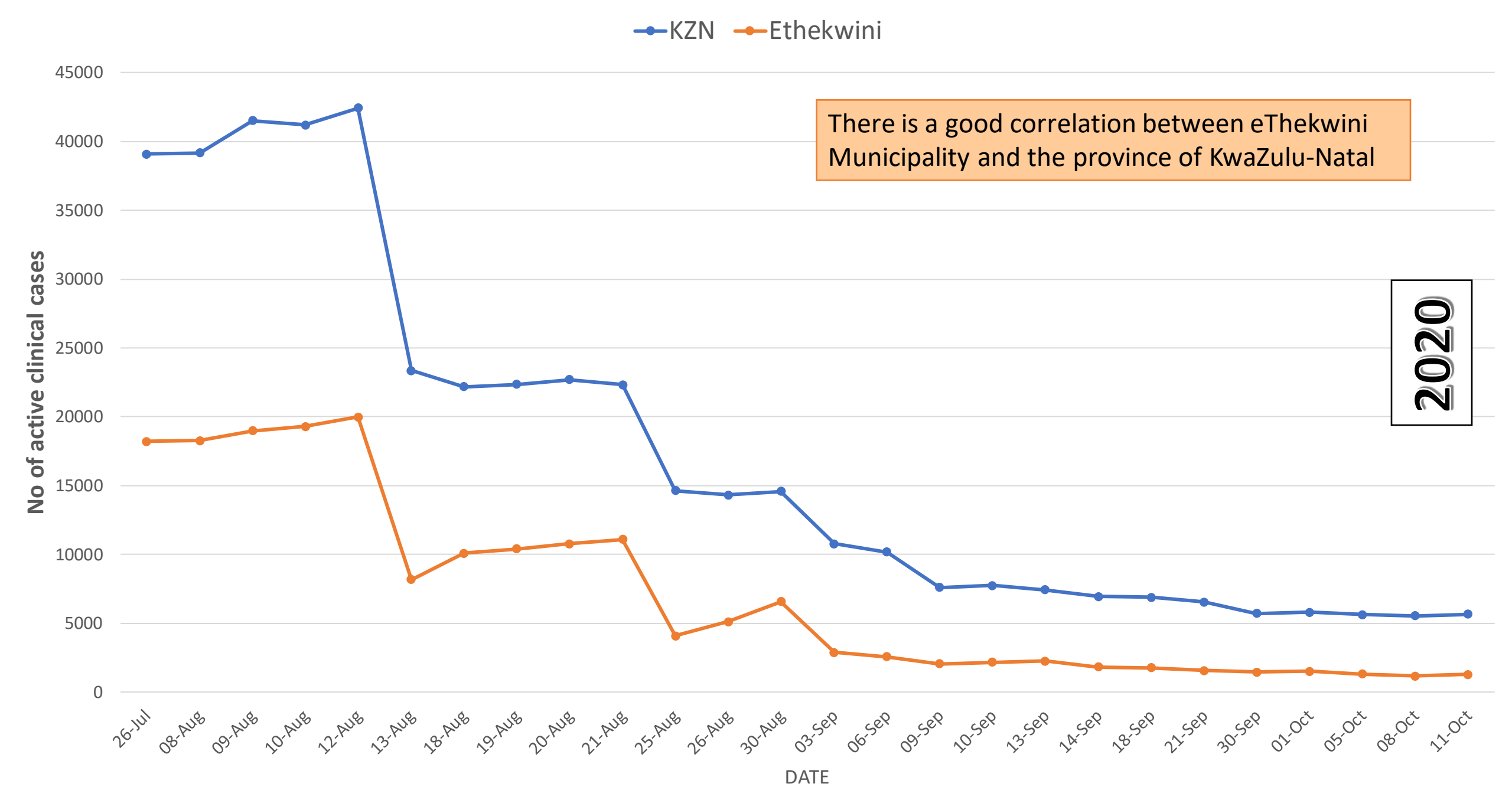


Figure 1: Number of active clinical cases of SARS-Cov-2 in KZN and eThekwini municipality (July 2020 – October 2020)

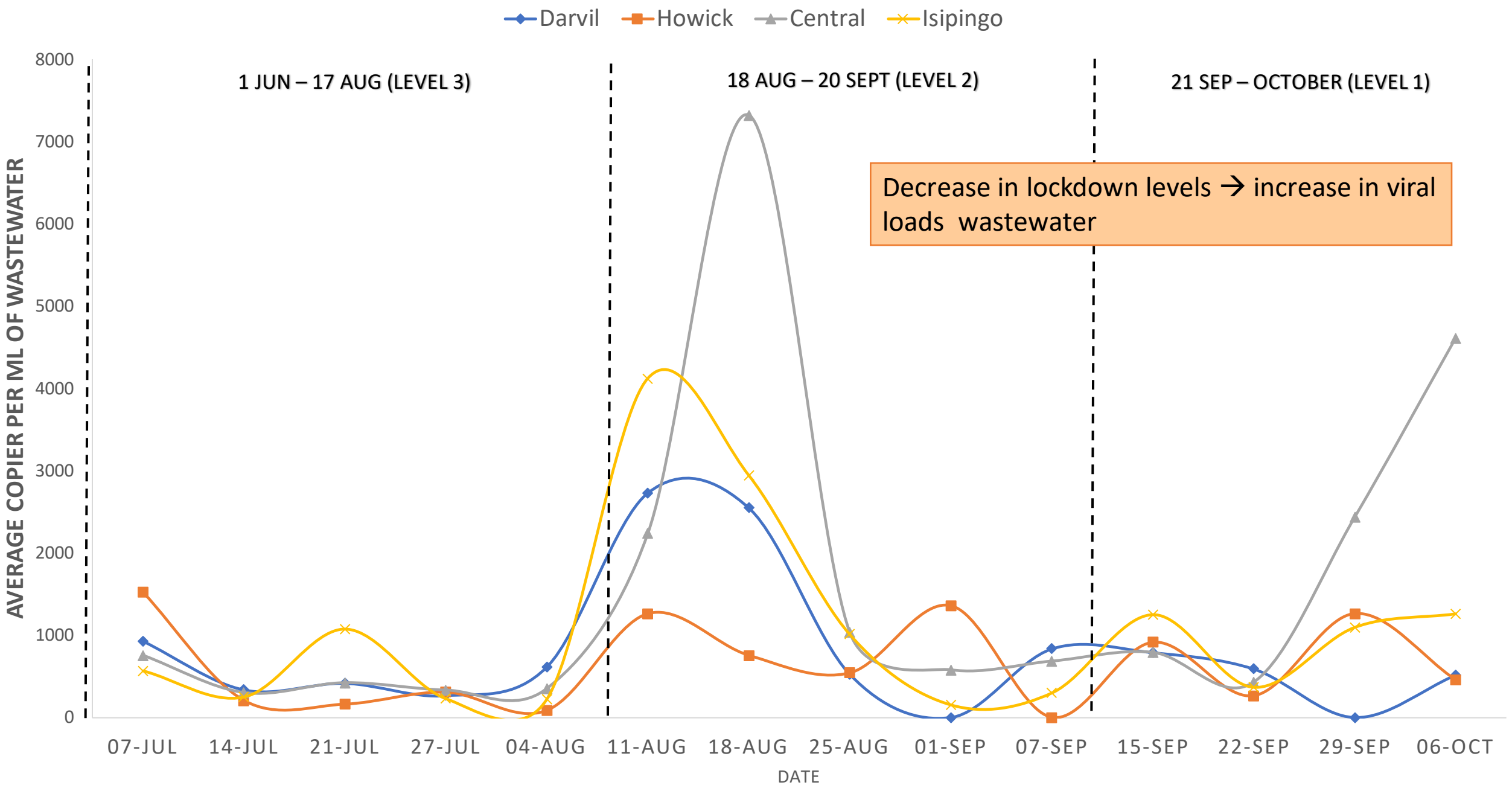


Figure 2: Presence of SARS-CoV-2 in wastewater treatment plants from July – October 2020 (WBE Data)

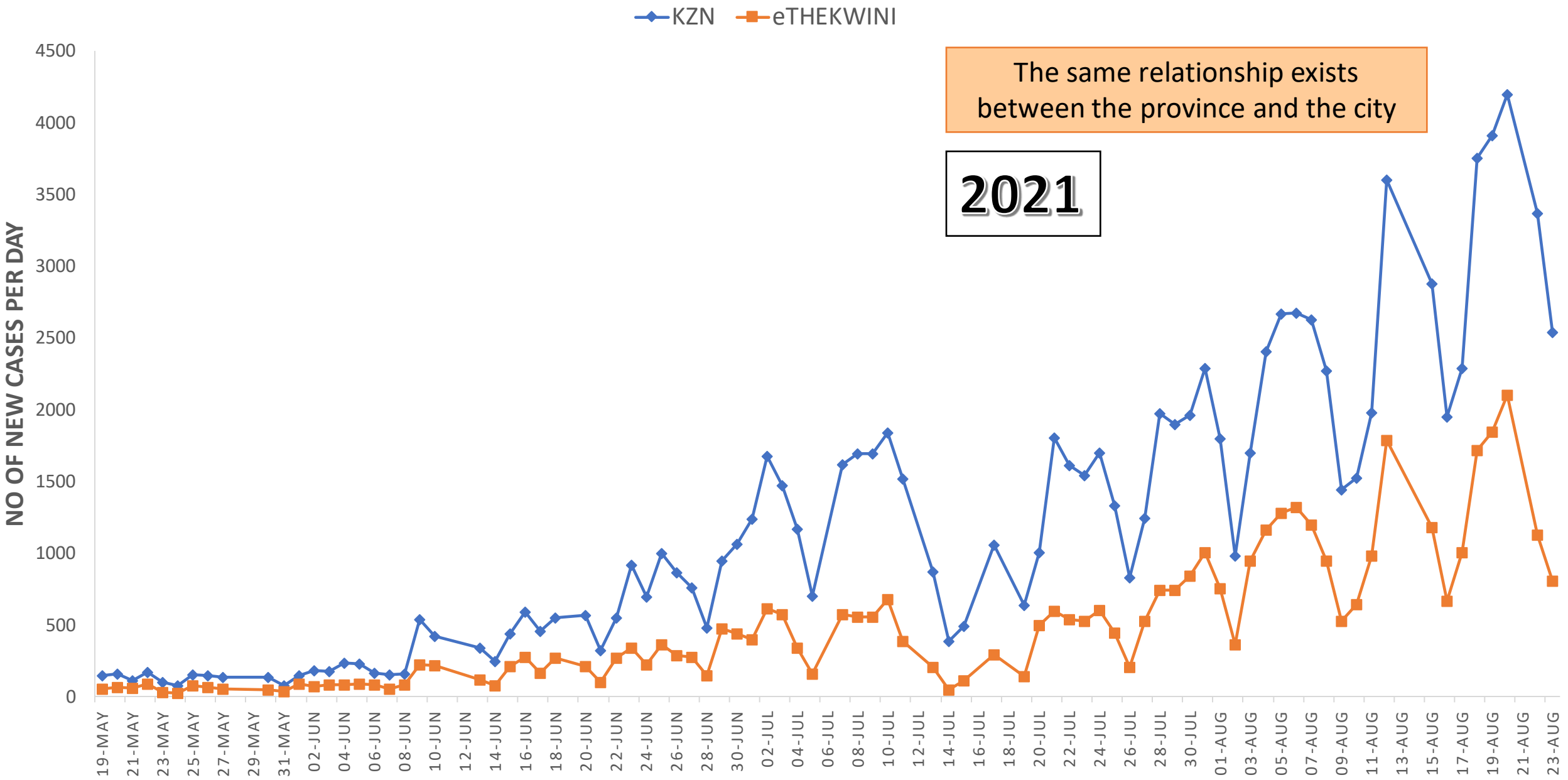


Figure 3: No of new cases per day for KZN and eThekwini municipality (May - August 2021)

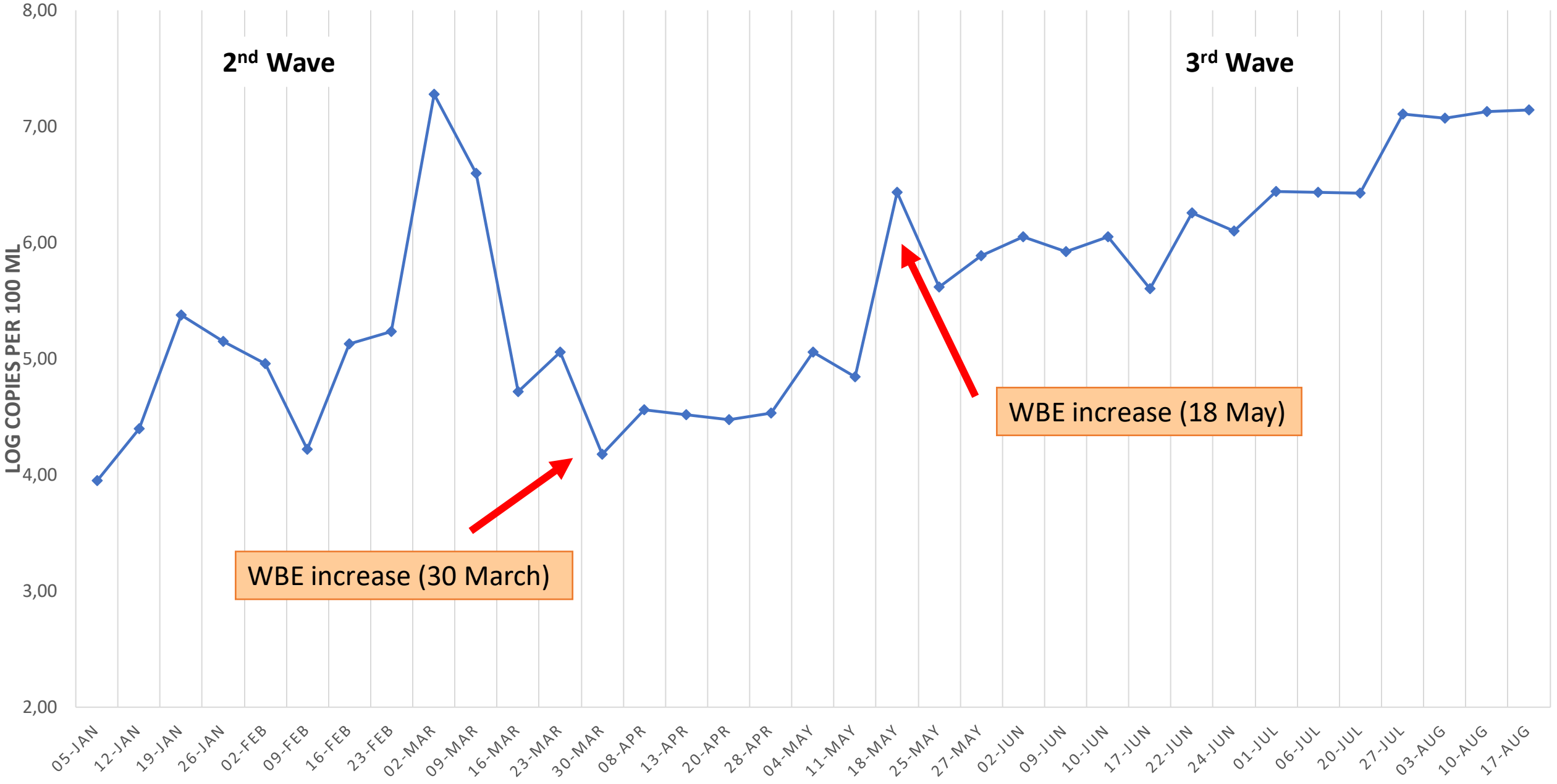


Figure 4: Monitoring of SARS-CoV-2 (N2) at Central WWTP by IWWT (January – August 2021)

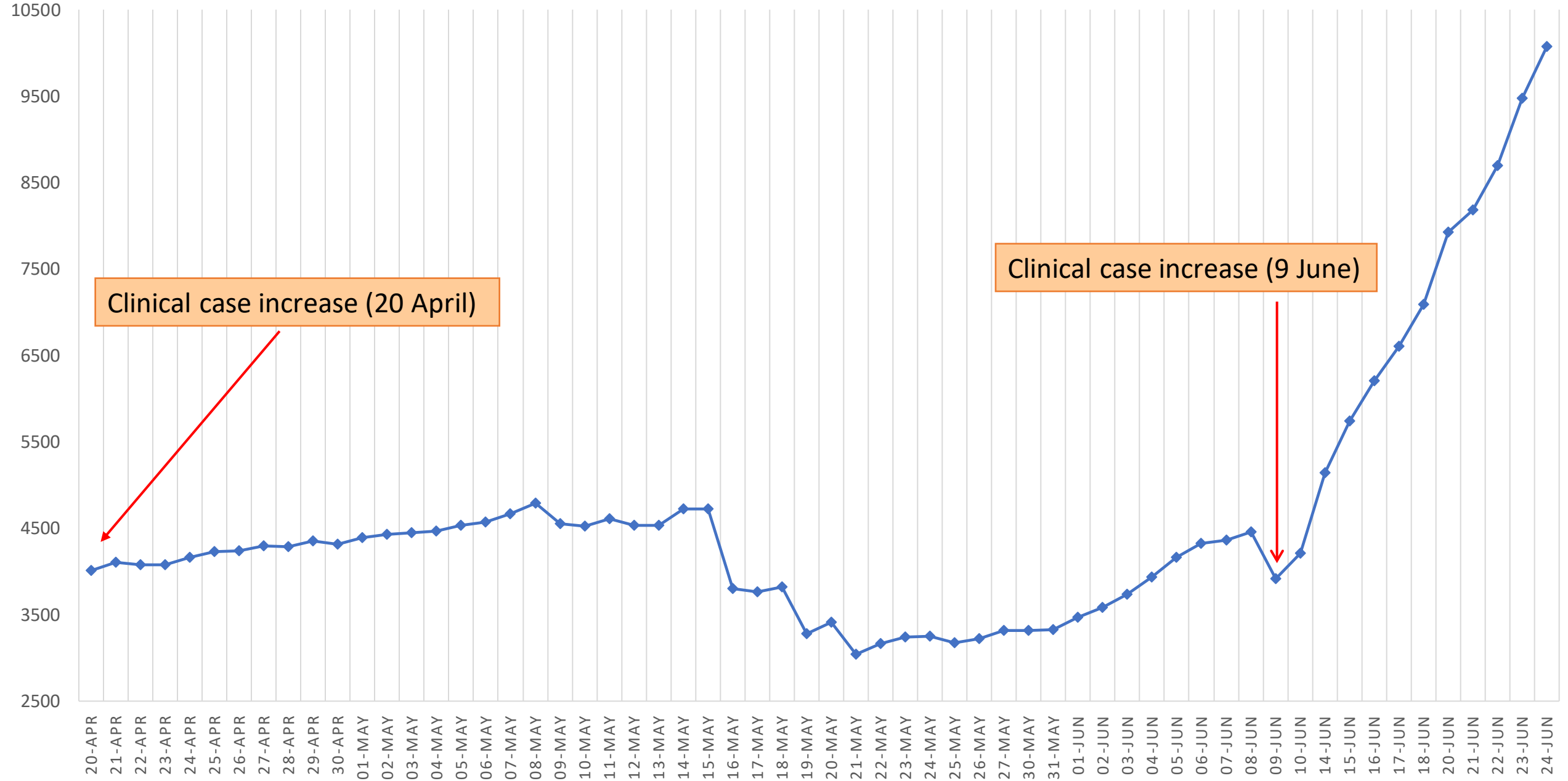


Figure 5: Number of clinically active cases in KZN (20 April - 24 June 2021)

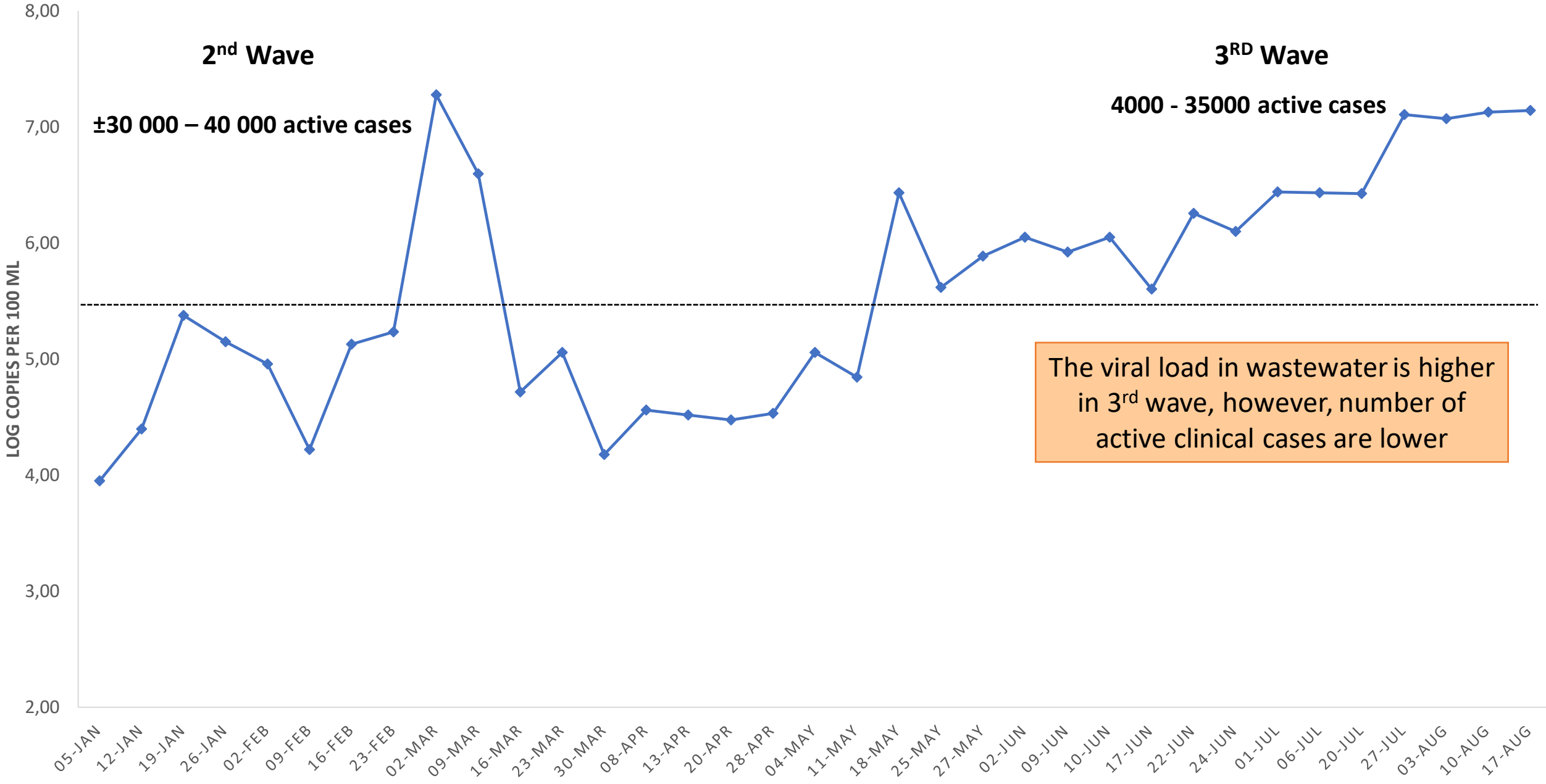


Figure 6: Monitoring of SARS-CoV-2 at Central WWTP by IWWT (January – June 2021)

The effect of civil unrest on Covid-19: A super spreader event

- On the 9th of July 2021, thousands of people took to the streets to protest- no forms of social distancing (confined to small spaces and no masks)
- Closure of diagnostic laboratories - significant underreporting of the number of COVID-19 infected individuals in KZN from 9 July – 17 July 2021.
- Any backlog in clinical data would have been reported from 19 July onwards - when laboratory personnel returned to work.
- The effect of the civil unrest on COVID-19 infections will have only manifested itself in clinical data 7-14 days later.

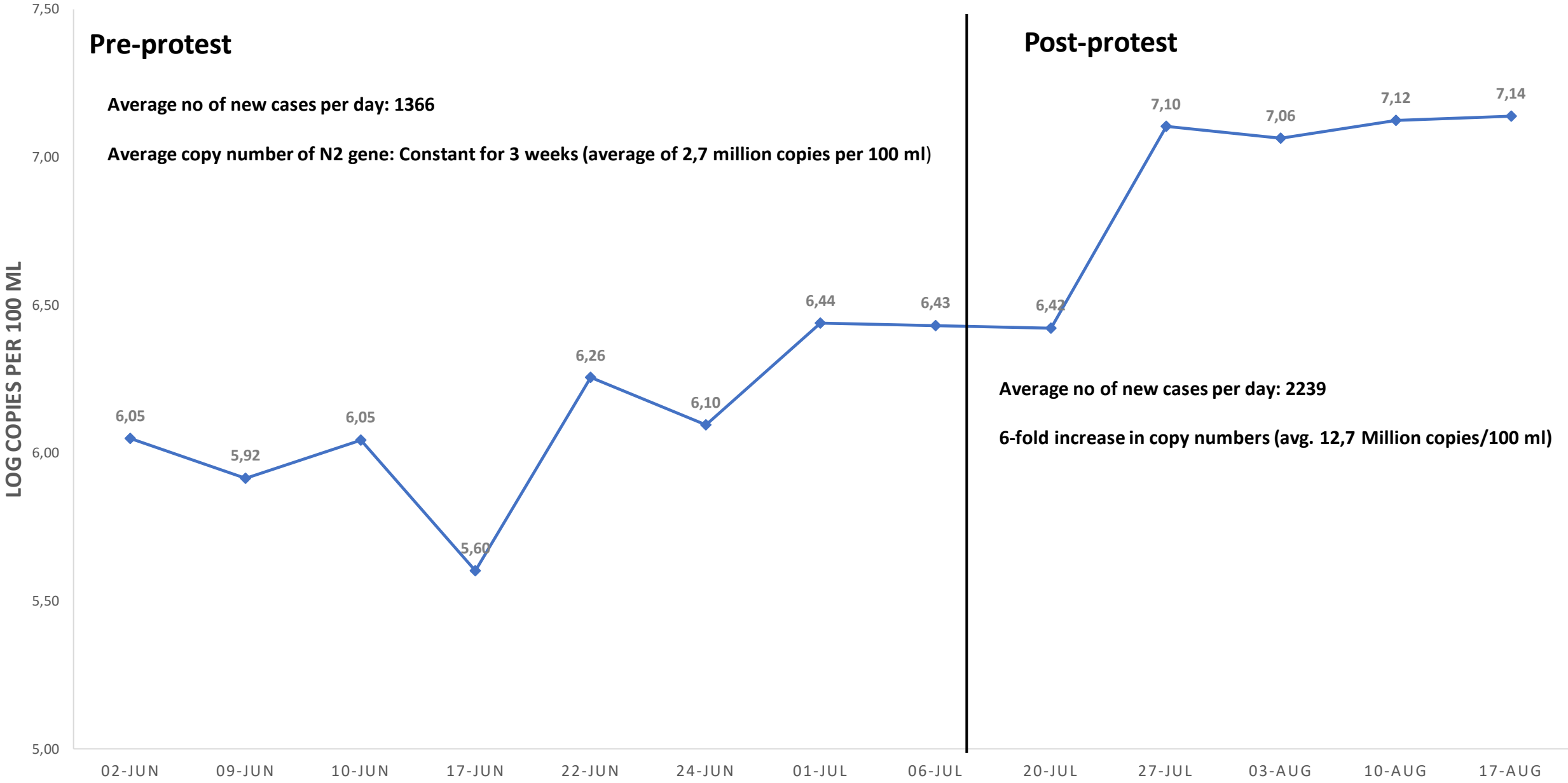


Figure 7: Monitoring of SARS-CoV-2 at Central WWTP by IWWT (June – August 2021)

Summary and Key Findings

- A Metro (eThekwini municipality) is a good reflection of the viral trends in the province – follows the trajectory of the pandemic
- Viral loads in wastewater are dynamic and respond to changes in lockdown levels
- WBE findings suggests that there may be more infected individuals than what is clinically reported (Jan/Feb vs June 2021)

Summary and Key Findings

- WBE data was able to predict the surge in clinical cases that happened on 20 April, 3 weeks prior - 30 March
- The second surge in clinical cases (9 June) could also be predicted 3 weeks prior (18 May).
- Civil unrest in the city contributed significantly to the number of Covid-19 infections in the community.
- WBE data should be considered a more accurate representation of Covid-19 infections at the community level than clinical data as clinical testing came to a halt during the unrest while WBE testing did not.

Challenges with achieving desired outcome

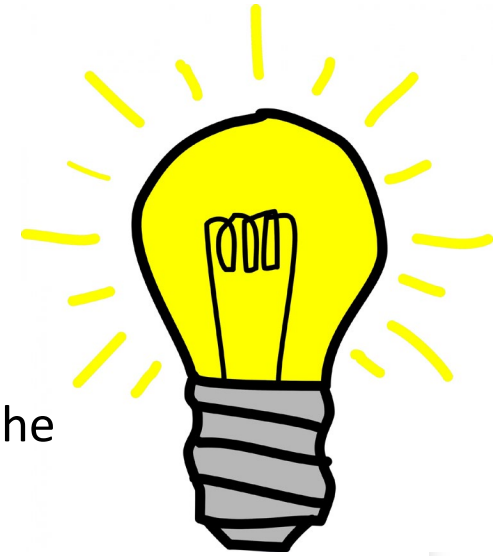
- Difficult to correlate viral load in wastewater with clinical data
  - The amount of virus a person sheds is unknown
  - Population equivalent of sewer shed is unknown
  - Lack of sub-district data
- Decrease in the number of tests being carried out
  - Focus is now placed on vaccination
  - Only symptomatic individuals are referred for clinical testing

Challenges with achieving desired outcome

- Technical variability
  - variability in sewer systems across communities
  - Dilution due to rainfall events
  - Viral inhibition caused by industrial discharge

- Questions on viral shedding
  - When does a person start/stop shedding the virus in their stool

Future research



- Wastewater-Based epidemiology for monitoring of SARS-CoV-2 variants and the impact of vaccination on variants
  - To develop bacterial and viral assays for the normalization of WBE data
  - To monitor the types of SARS-CoV-2 variants in wastewater
  - To determine the impact of vaccination on the proportion of the different SARS-CoV-2 variants

- Application of WBE approach to include sewer networks in suburbs and in buildings→ better hotspot detection

- Monitoring of wastewater for Delta and Delta plus variants

WBE Focus Study

ELSEVIER

Science of The Total Environment

Available online 23 April 2021, 147273

In Press, Journal Pre-proof

Monitoring changes in COVID-19 infection using wastewater-based epidemiology: A south African perspective

Leanne Pillay, Isaac Dennis Amoah, Nashia Deepnarain, Kriveshin Pillay, Oluyemi Olatunji Awolusi, Sheena Kumari, Faizal Bux

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https://doi.org/10.1016/j.scitotenv.2021.147273

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Highlights

- SARS-CoV-2 viral loads ranged from 0 to 7.32×10^5 copies/100 ml in wastewater influent
- Viral loads corresponded to number of active clinical cases in associated catchment areas
- The easing of lockdown regulations by authorities corresponded to increased SARS-CoV-2 detection
- The use of predictive models could potentially estimate number of people infected with COVID-19
- WBE can be used to detect surges of Covid-19 in communities

Publications on SARS-CoV-2

Published

- Coronaviruses in wastewater processes: Sources, Fate and potential risks (Environment International)
- Prospective options of algae-derived nutraceuticals as supplements to combat COVID-19 and human coronavirus diseases (Nutrition)
- Monitoring changes in COVID-19 infection using Wastewater-Based Epidemiology A South African perspective (Science of the Total Environment)

- RT-LAMP: A cheaper, simpler and faster alternative for the detection of SARS-CoV-2 in wastewater (Food and Environmental Virology)
- Detection of SARS-CoV-2 RNA on contact surfaces within shared sanitation facilities (International Journal of Hygiene and Environmental Health)
- Influence of selected wastewater characteristics on estimation of SARS-CoV-2 viral load in wastewater

Acknowledgements

THE IWWT TEAM

- **Prof Faizal Bux (Director)**
- **Prof Sheena Kumari**
- Dr Isaac Dennis Amoah
- Dr Oluyemi Awolusi
- Dr Leanne Pillay
- Mr Kriveshin Pillay


THANK
YOU