WEBINAR SERIES
Utilities Fight **COVID-19**

GWOPA — Global Water Operators' Partnerships Alliance

UN◉HABITAT — FOR A BETTER URBAN FUTURE

Moving towards The 4th **Global WOPs Congress**

giz — Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of

Federal Ministry for Economic Cooperation and Development

Wastewater-based Epidemiology (WBE)

Although wastewater has been monitored for viruses and pollutants for years, the practice rose to prominence sharply during the outbreak of the COVID-19 pandemic. Studies have shown that environmental surveillance of SARS-CoV-2 signals, or biomarkers (typically RNA), helps determine both the prevalence of disease and the overall health of a community. As such, it could act as a low-cost early warning system to monitor resurgences or reimportations of disease into communities as a complementary tool to medical testing.

In June 2020, as part of its COVID-19 webinar series, GWOPA and BMZ/GIZ facilitated a discussion between water utilities on wastewater monitoring. Check out the takeaways from that discussion here. The second session in September 2021 focused on wastewater-based epidemiology (WBE) and brought together researchers in the urban sanitation and wastewater fields as well as water and wastewater utilities from different regions. Participants heard about good practices, sampling methods, and (low-cost) tools to monitor wastewater for epidemiological purposes, in cooperation with local health authorities.
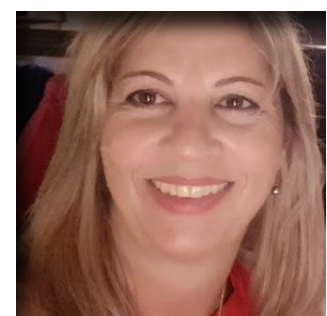
"Wastewater-based Epidemiology is not a new concept. We have been looking at waste as a way of understanding disease for a long time already. "
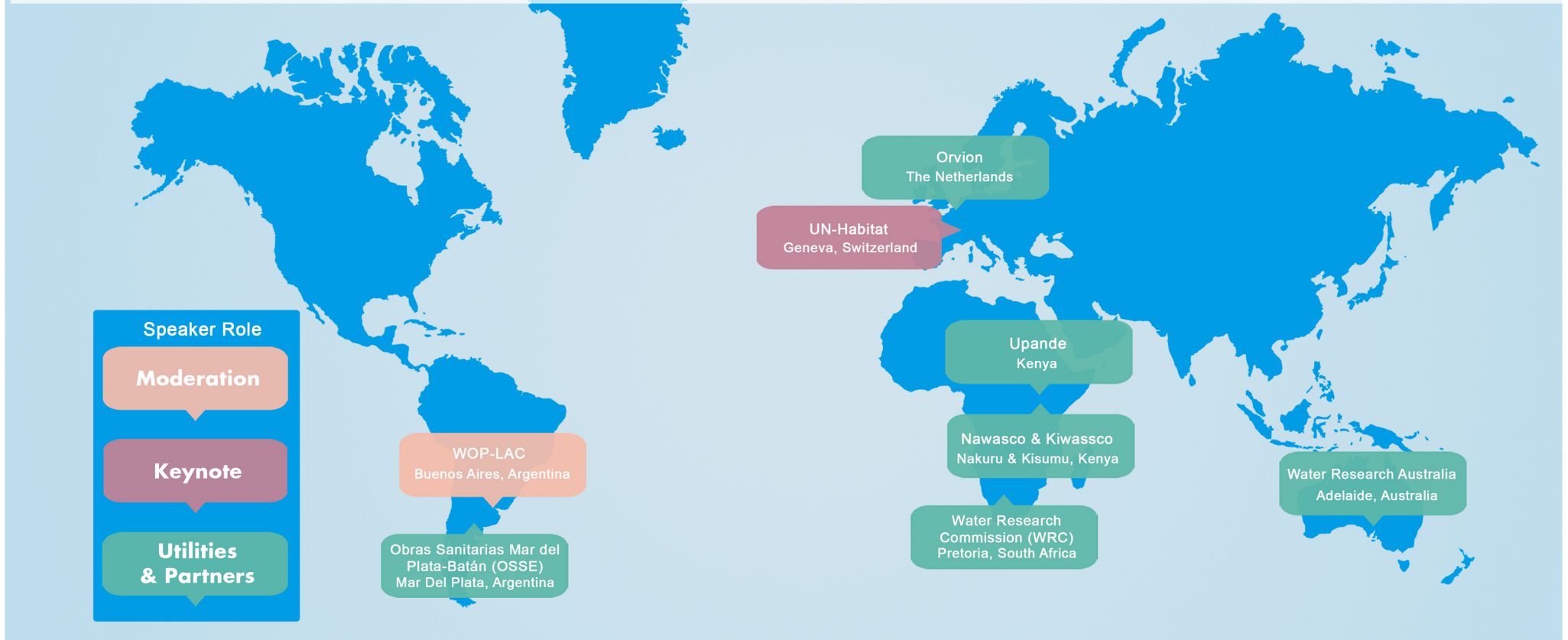
Dr. Graham Alabaster
UN-Habitat

"In all cases, in relation to sampling, the participation of the operators is essential due to the knowledge they have of the operation of the sewage network."

Ana Paula Comino
Obras Sanitarias Mar del Plata-Batán (OSSE), Mar del Plata, Argentina

COVID-19 National Surveillance Programme (website)

- Phase I: Proof of Concept (completed)
- Phase II: Pilot Scale Monitoring (almost completed)
- Phase III: National Wastewater Surveillance
- Programme Impact: Early Warning System Pilot Development & Model for National Wastewater Quality Surveillance
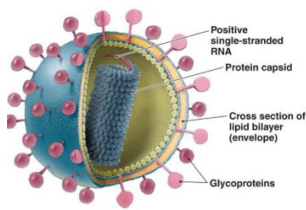

Image 1: SARS-CoV-2 virus

Ongoing work in Phase II: Pilot Scale Monitoring

- Starting with tracking on an Excel Spreadsheet, establishing a National Surveillance Dashboard, working together with the National Institute for Communicable Diseases
- Scale up to monitoring in 50 wastewater treatment plants (WWTP).
- Look into different Variants of Concern (VoC)/Variants of Interest (VoI).
- Create a network of labs and establish multi-lab partnerships and analyses to compare results, and use variety of methodologies (see overview on this slide).
- Production of local heatmaps, reflecting the viral RNA copies/ml. Darker colors indicate higher viral load detected for that week.
- Evaluation of health risks associated with occupational exposures to biological and chemical contaminants at WWTP and recycled water use sites.

Image 2: Proof of concept study (here), compendium of testing methodologies (here).Click on the cover pages to access. Find more resources from WRC on the topic here.


WBE and the SARS-CoV-2 Virus

- Wastewater-based epidemiology (WBE) can give an indication of the health status of communities, such as illicit drug use, use of pharmaceuticals and other substances, diet choices, genetic markers, and biomarkers. It is thus useful in determining levels of risk in communities, especially occupational human health risks, and supporting decision-making on mitigation interventions.
- Several studies have found RNA fragments of SARS-CoV-2 in faecal matter during illness and after recovery. Risk of transmission of the virus from the faeces of an infected person appears to be low. Hence, detecting SARS-CoV-2 in sewage is important, not necessarily because it will reduce the spread of COVID-19, but because it can help determine the presence of infected individuals in a community.

Phase 1: Proof of Concept

- Sampling of wastewater treatment plant influent and rivers as a non-invasive, preliminary surveillance method to establish the spread of SARS-CoV-2 in South African communities
- SARS-CoV-2 RNA was detected in 98% of wastewater samples from upstream and downstream wastewater treatment works (WWTW) of prisons, hospitals, industries, and mines.
- Wastewater surveillance is a cost-effective, non-invasive, continuous screening approach. There is a correlation between increase in viral load and increase in case numbers from clinical samples
- Method efficiencies – Skimmed milk flocculation and Al(OH)3 adsorption-flocculation proved more cost-effective and faster than PEG/NaCl precipitation.
- In phase 1, Wastewater-based Epidemiology has proven to be a useful complementary surveillance tool for management of COVID-19.
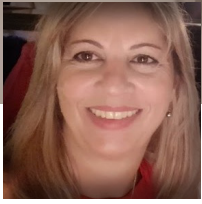
Listen to the presentation by Ana Paula Comino, Deputy Quality Manager, Obras Sanitarias Mar del Plata-Batán (OSSE), Mar del Plata, **Argentina**, here.

About OSSE

- Total population in the service area: 731,248
- 5% of people in the service area living in informal settlements
- 97% Coverage ratio for water
- 95% Coverage ratio for sanitation
- No. of connections: 277,439 water / 247,515 sewerage
- No. of employees: 770
- Number of cases amongst utility employees: 180 (as of Sept 2021)

Learnings from OSSE on COVID-19 tracing in wastewater

- In the case of specific samples, or 4-hour composite samples in sewer manholes, E. coli-grams can be considered. This technique shows the highest composition of the sewage effluent and the lowest composition of the industrial effluent, which may have components that interfere with the determination of SARS-Cov2 residues by PCR.
- In the case of 24-hour composite samples, automatic samplers are required. The analysis of the samples should be carried out as soon as they are taken.
- In all cases related to sampling, the participation of the operators is essential due to the knowledge they have of the sewage network.
- To ensure governance, institutions should not interfere in the work lines of others, neither the health authorities in the management of the effluents nor the operators in the management of the health authorities. Furthermore, the dissemination of the results from the monitoring should be the responsibility of the health authorities.
- The way to ensure an open and collaborative association with health authorities and other government partners in wastewater monitoring is by setting clear guidelines from the beginning. It is detrimental to base the objectives of the investigation on the epidemiological study to the effects of collaborating with the management of the pandemic and not altering the management of the effluent - which is the sole responsibility of the operators.

Peer-to-peer learning on WBE

- In March 2020, OSSE became aware that SARS-CoV2 residues had been found in effluents. With this finding, the utility forsaw that wastewater could be used as a sensitive and early surveillance system to indicate whether the virus was circulating in the population.
- OSSE contacted the National Institute of Epidemiology (INE) to evaluate the possibility of making a joint contribution on the subject. The National Commission for Scientific and Technical Research (CONICET) also approached them and jointly started exploring the topic.
- OSSE also contacted colleagues from their peer operator Agua y Saneamientos Argentinos (AySA) who were working with colleagues from Murcia, Spain, developing a technique for concentrating the effluent by centrifugation. It was then when OSSE decided to apply the same technique as AySA for the concentration of the samples, and the PCR technique used by INE for the analysis of the concentrated samples.
- In the meantime, OSSE was invited by WOP-LAC to join the Isle Water Action Platform. The utility attended webinars and started participating in a WhatsApp group whose objective has been to share knowledge, experiences and inquiries on the subject between colleagues from more than 60 countries.
- Every Sunday, to avoid interference in the processing of samples from the industrial sector, OSSE takes composite 24-hour samples of the effluent that enters their treatment plant. The sampling is optimised by making six-fold samples. The results obtained weekly in each sampling are reported to the authorities of the company. Likewise, the evaluation of the results is periodically presented to the Ministry of Health, CONICET, and INE authorities.
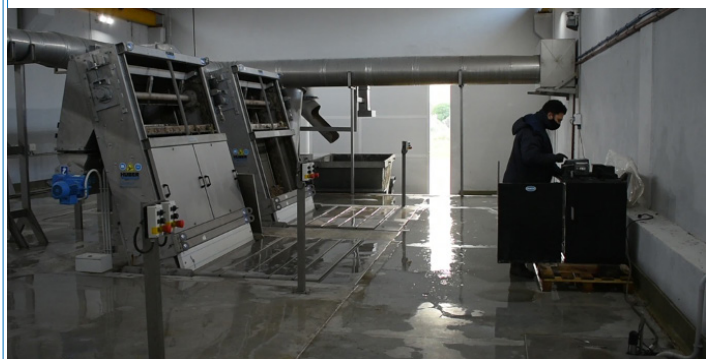
Placement of the automatic sampler at the entrance of the effluent to the WWTP.

## MoCOMo: Mobile COVID-19 Monitoring in Sewage

A consortium made up of Orvion, Upande, Kenya Medical Research Institute (KEMRI), KI-WASCO, and NAWASSCO is working on the MoCOMo pilot project to analyse Covid-19 in wastewater using
Orvion Udetect® (a mobile and in-field qPCR technology) and the customized Upande software (to allow the visualisation, analysis, and sharing of the data). This pilot is supported by AquaforAll and UN-Habitat.

Analysing Wastewater in the Field

The Udetect® method was developed to analyse the DNA of bacterial species in surface water, drinking water, and groundwater. For the MoCOMo project, it was necessary to detect the SARS-COV-2 viral particles containing RNA molecules in sewage water. With adjustments, it is possible to detect the presence of two SARS-CoV-2 target genes, E gene and N2 gene, in a sewage sample. The three-step analysis includes: filtration (10 min), DNA isolation (20 min), and qPCR analyses (<1h).
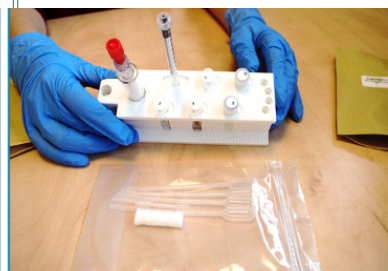
| Filtration (± 10 min) | DNA isolation (± 20 min) | qPCR analysis (± 50 min) |

Data transmission and georeferencing

Through the integration with the Upande software, the generated data is input for Geographical Information Systems (GIS) and can be provided to local institutions and authorities. The web-based platform also enables combinations with other data and visualization in a dashboard as a map.

Experience in using the Udetect in Kenya right side

- The mobile test kits have been tested in the field in Nakuru and Kisumu, Kenya, together with Kenya Medical Research Institute (KEMRI) and the local water and sanitation utilities NAWASSCO & KIWASCO.
- 60 samples were collected between June and August 2021 in health clinics/hospitals and sewage treatment plants in Nakuru and Kisumu. 45 samples were analysed, 15 used for training.
- Fast results obtained (< 2 hours). The first two steps do not require electricity, the third step works e.g. via a car battery in the field.
- No E gene and relatively few positives for N2 gene (both SARS-CoV-2) were found in the first round, possibly because of mutations and/or absence of cases.

Listen to the presentation by Dan Deere, Project Manager, Collaboration of Sewage Surveillance for SARS-CoV-2 (ColoSSoS), speaking on behalf of the Australian and New Zealand collaboration and representing Sydney Water, Melbourne Water, South Australia Water, Water Corporation of Western Australia, South East Water, Yarra Valley Water, Greater Western Water, Power Water Corporation of the Northern Territory, TasWater and other smaller participating water utilities around **Australia** and **New Zealand**, and Paul Monis, Manager, Research Stakeholders and Planning, South Australia Water, here.

Collaboration of Sewage Surveillance for SARS-CoV-2 (ColoSSoS) (website)

- A collaborative, multi-disciplinary Australia-wide investigation that aims to integrate reliable results of sewage testing for the SARS-CoV-2 virus with health data for COVID-19 on a national basis
- The program focus is on a low prevalence use case aimed at informing clinical testing priorities, providing early warning, providing public and government confidence, and informing decisions on travel.

### Effective WBE needs a multidisciplinary approach

- The multidisciplinary ColoSSoS project works with sewer operators, water utility scientists working in the laboratory, as well as Health Departments and researchers.
- Water authorities have been testing which sewage treatment plants, sewer access points, or buildings are best suited for collection. The health departments take the results from the water utility lab and interprets them along with other results from clinical testing for COVID-19.

Communicating the results

- To the rights, there is an example weekly report from the Government of New South Wales. Green reflects no cases detected, red reflects detection of SARS-CoV-2 virus. This helps to guide where Health Departments need to focus their testing capacities.
- The health department of Victoria provides info about detections on a public webpage (see below). In the case of detections, the community is also alerted via the newspapers, the media, and short messaging services on telephones to encourage testing in those areas.
- The purpose has been to test the wastewater in small quantities in small catchments to try to get early warning of cases in those catchments.

WBE experience from SA Water

- SA Water in Adelaide have their own testing laboratories for sample processing and SARS-CoV-2 PCR testing. They 3D printed their own reusable passive sampling device for composite sampling (multiple samples spread over different points in time). This was found to be more useful than grab sampling (single sample at one specific time).
- Within their treatment plants, SA Water applies composite samplers, but within the sewers there are no mobile samplers available. Hence, the passive samplers are deployed throughout the week to continuously monitor with two samples per week and locations across Adelaide.
- For the RNA extraction process, kits from Qiagen or Thermo were predominantly used (see overview and details in publication below).
- SA Water is part of a multi-utility partnership between utilities of Australia and Thailand, Vietnam, Laos, Cambodia, possibly Myanmar and Fiji, and is sponsored by Australian Aid to support other countries in setting up similar wastewater monitoring programs.
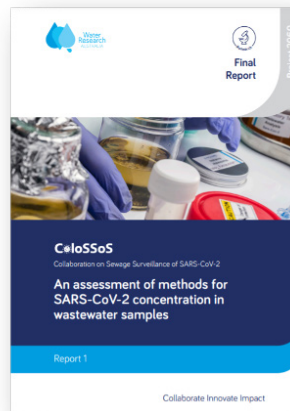
Left: WaterRA Project 2060 – ColoSSoS – An assessment of methods for SARS-CoV-2 concentration in wastewater samples - Final Report

Below: Public display of SARS-CoV-2 wastewater testing results in the states of New South Wales (left) and Victoria (right), Australia

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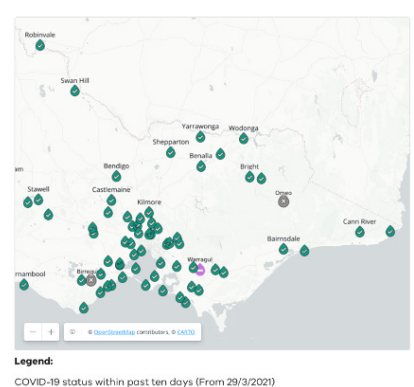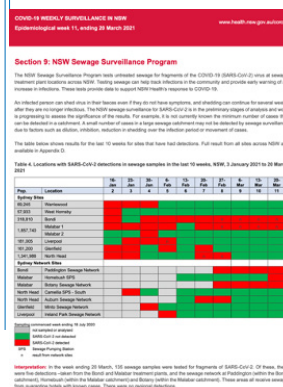
Listen to the keynote by Graham Alabaster, Chief, Sanitation and Waste Management, UN-Habitat, [here](#).

It is not new that we have looked at waste and its indicator bacteria as a way of understanding diseases. As the threat from disease is increasing globally, especially at the urban level, these types of risk assessments are important. Many water and health authorities around the world have implemented wastewater-based epidemiology (WBE) as a rapid and complementary tool for the COVID-19 surveillance system, and more recently for variants of concern emergence tracking.

Takeaway messages

- A major advantage to WBE is that it is anonymous – yet able to capture data from a wide cross-section of the population. Depending on the wastewater treatment facility size, upwards of a million people could be monitored in a single day.
- Need to assess the risk at the urban level using existing information & capacity available at the city level, appreciating that national-level blanket approaches will not achieve the desired outcomes.
- Better mapping critical diseases, including COVID-19, to the corresponding environmental and social determinants at the city level is needed.

A rare positive outcome of the pandemic might be that it will normalize the use of wastewater in monitoring public health — be it for future pandemics or to track other health indicators.

Promising opportunities

- Data is available at the local level on wastewater and sanitation infrastructure. To account for the varying estimated fecal load over time and possible dilution due to rain, human-specific fecal viruses can be quantified to normalize the SARS-CoV-2 concentrations.
- Studies have shown that during an emerging epidemic, a time lag of 3-9 days is observed from the onset of symptoms to case reporting, depending on the testing capacity and method, and reporting speed. Hence, if we can perfect wastewater monitoring effectively, we can get a good lead advance notice of where the hotspots are and reduce the lag time of information by several days.
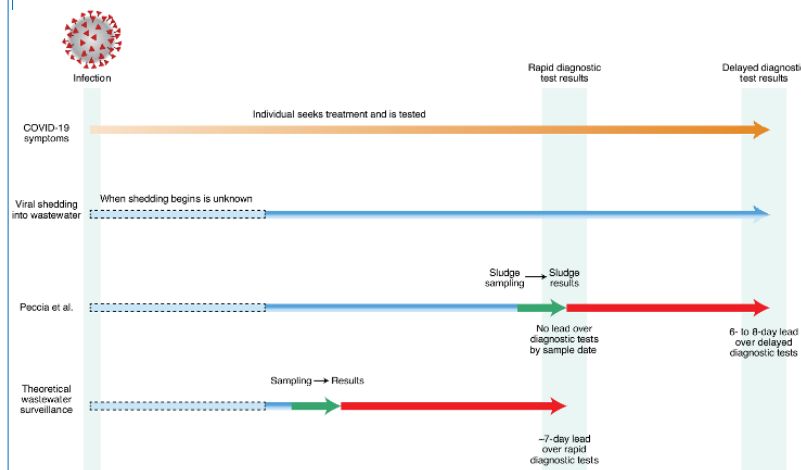

Image: Observed and theoretical time lags between infection and detection of increasing SARS-CoV-2 transmission in wastewater and the health system from: Larsen, David A., and Krista R. Wigginton. "Tracking COVID-19 with wastewater." Nature Biotechnology 38.10 (2020): 1151-1153.

- Although WBE can provide unbiased samples of the community by aggregating population health information, wastewater is known to have relatively high day-to-day variation in sewage flow and fecal strength. Combined sewers, those containing high proportions of trade effluents, runoff, and rainwater all affect the analysis. One of the biggest challenges has also been to quantify the size of the population contributing to the sample taken. Further, in many parts of the world, sewer coverage is very low and capturing samples from on-site systems is inconsistent and needs more research.

A discussion to be continued

in the Global WOPs Community

GWOPA aspires to operate as an effective global alliance on Water Operators Partnerships (WOPs) and by creating an online GWOPA Community space, strives to enhance itself as a strong and fruitful water solidarity network.
We invite you to join our Global WOPs Community on Workplace where you can connect to peers working in the water sector, network, share experiences and best practices, discuss problems and jointly brainstorm on possible solutions. You will also find resources shared in this webinar series, meet many webinar panellists and participants and learn answers to the questions that were left unanswered. Soon, the Community will feature active moderation by experts committed to accelerating creation of key thematic hubs at the utility-sustainability nexus. The membership in the Community is free of charge.

If you are interested in joining, please use this link and take an active role in supporting water operators across the globe in improving their performance and ensuring access to all.

And by joining the Global WOPs Alliance

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