Christopher A. Dada, PhD.

Water Quality /Microbiology Specialist

Education

PhD – Water Microbiology, National University of Malaysia (UKM), 2014

M. Sc (Hons) – Water Science, Policy and Management, University of Oxford, United Kingdom, 2007

B.Sc. (First Class)– Microbiology, University of Ado-Ekiti, 2004

Dr Dada is an environmental health microbiologist, specializing in the fate, transport, detection, and control of pathogens in environmental media. He completed a Masters degree in Water Policy at Oxford University's Center for the Environment, which adequately equipped him to provide high-level advisorial support to decision makers, managers and policy makers in water policy and management. His PhD research focused on the molecular characterization of faecal indicator bacteria and antibiotic resistant pathogens in aquatic environments. Dr Dada has gained extensive experience in environmental science research with a focus on projects that assess/predict the effect of past/future management decisions on water quality. As a Research Officer under the leadership of Prof David Hamilton, he honed his modelling skills (nitrogen/phosphorus species and pathogens) using a variety of catchment, hydrodynamic and empirical models. In his current role he provides specialist expertise in microbiology, quantitative risk assessment, predictive modelling and big data analysis to a range of commercial projects.

Specialty areas:

Microbiology- Drinking and Bathing Water Bacteriological Quality

Quantitative Microbial Risk Assessment (QRMA) for Pathogens in Waterways

Antibiotic Resistance in the Environment

Environmental Impact Assessment

Predictive Microbial Modelling

Employment History

- Research Officer, Environmental Research Institute, University of Waikato, Hamilton, April 2015-April 2017

- More than 11 years' experience working in scientific consultancy, research and education roles in South-East Asia, Africa and New Zealand

- More than 5 years of hands-on experience working in Microbiology laboratories in South East Asia, Africa and the United Kingdom.

- 6 months volunteering experience with the United Nations as Water and Sanitation Officer, UNMIL/UNV, Monrovia, Liberia

Selected examples of recent experience

Assessment of ecological and human health effects on the Waikato River associated with the discharge of untreated wastewater from the Bridge Street wastewater pump station, 2018. Hamilton City Council 2018. Dr Dada was engaged to assess the effects of a 19-hour raw wastewater discharge from the Bridge Street pump station into the Waikato River. It also included an assessment of potential public health risks from microbial pathogens present in wastewater. Using mass balance dilution modelling and Monte Carlo Simulations, raw wastewater concentrations of key analytes were combined with quantitative water quality data for receiving waterbody to predict how the spilled wastewater would affect water quality. Despite the high contaminant concentrations in the raw wastewater, dilutions in the receiving water allowed for significant reductions in the final concentration of nutrients, faecal indicator bacteria (E. coli), heavy metals, biochemical oxygen demand and total suspended solids in the Waikato River following the wastewater discharge. Given that the projected concentrations in the receiving water following the

discharge were not significantly different from the baseline concentrations, the wastewater discharge was expected to have "no adverse effect".

Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River, Southland. Alliance Group/Aquatic Environmental Sciences Ltd. 2018. Alliance Group is seeking renewal of consents to continue discharging treated meatworks wastewater into the Mataura River. To support the new discharge consent application, Alliance Group, with guidance from AES, engaged Dr Dada to conduct a microbial assessment that provided scientifically-robust information as to whether or not the Alliance Plant Mataura discharges have a 'more than minor' effect on the state of the receiving environment for recreational uses. Quantitative microbial risk assessment modeling (QMRA) was done utilizing predefined dose-response functions for zoonotic bacterial and protozoan pathogens relevant to human health *(Salmonella, Campylobacter, E.coli 0157: H7, Giardia, Cryptosporidium).*

Quantitative Microbial Risk Assessment for the discharge of treated wastewater into Whitford Embayment through Turanga Creek. Le Coz Ltd (LCL). 2018. The developers of a proposed residential development in Whitford, Auckland is in the process of applying for a variation of current consent conditions for discharge of MBR-treated wastewater into Turanga Creek. As part of the technical input into the AEE report, LCL requested that Dr Dada conduct a quantitative microbial risk assessment (QMRA) of the proposed discharge in relation to the risk of illness to swimmers and individuals who consume harvested raw shellfish. The QMRA was conducted utilizing predefined dose-response functions for pathogens relevant to human health. Dilution data were provided by a third-party three-dimensional ocean dispersion model for five exposures sites in the Turanga Creek and Whitford embayment. The QMRA was able to determine treatment requirements (in terms of effluent virus concentrations) sufficient to reduce the risk of illness to swimmers and individuals who consume harvested raw shellfish to acceptable levels.

Quantitative Microbial Risk Assessment for the discharge of treated wastewater at Army Bay WWTP. Watercare Services Ltd. 2018. A projected 4x increase in the population of the Hibiscus Coast area north of Auckland over the next 35 years will necessitate significant investment in new wastewater infrastructure. One option being considered is to retain the existing discharge location for the Army Bay Wastewater Treatment Plant (WWTP). Watercare Services Ltd need new discharge consents before expansion of the treatment plant can proceed. To support the new discharge consent application, Dr Dada was engaged to conduct a quantitative microbial risk assessment (QMRA) of the proposed discharge in relation to the risk of illness to swimmers and individuals who consume harvested raw shellfish. The QMRA was conducted utilizing predefined dose-response functions for pathogens relevant to human health. Dilution data were provided by a third-party three-dimensional ocean dispersion model for five exposures sites, Huroa Point, Whangaparaoa Head, Bollons Rock-Tiritiri Matangi, Army Bay, and Te Haruhi Bay. The QMRA was able to determine treatment requirements (in terms of effluent virus concentrations) sufficient to reduce to acceptable levels, the risk of illness to

swimmers and individuals who consume harvested raw shellfish from exposure sites impacted by current and future WWTP discharge scenarios.

Assessment of Ecological Effects for MBR WWTP treating sewage discharging to Lake Waikare. Lakeside Developments Ltd 2017. Dr Dada was part of an SEL team assessing the potential effects of discharging Membrane Bioreactor (MBR) treated effluent to Lake Waikare (near Te Kauwahata, TeK) from a proposed 194 ha residential development (Lakeside Development). Dr Dada compared the microbial risk of the current Te Kauwhata township WWTP discharge (Aquamat pond-based) with an MBR-treated discharge from the combined TeK township + Lakeside Development. Microbial pathogens (noroviruses, enteroviruses, adenoviruses, and faecal indicator bacteria (*E. coli*)) were measured in TeK WWTP effluent and in Lake Waikare to inform a QMRA comparing the two scenarios. A combination of monitoring for specific microbial pathogens) and hydrodynamic modelling coupled with QMRA was used to estimate public health risk during recreation (swimming and duck shooting) at selected sites in Lake Waikare. The study provided clear evidence that risks to public health from the combined MBR-treated discharge were much lower than the existing WWTP, despite the influent load being ~3x the current load treated by the Aquamat/pond system. Dr Dada will give evidence on the microbial risk assessment at forthcoming hearing for the discharge consent application later in 2018.

Assessment of ecological effects from discharge of wastewater and stormwater on the receiving environment associated with the development of Whitford Manor Estate. Le Coz Ltd (LCL). 2017. Dr Dada was part of the team engaged to prepare an AEE to assess the environmental effects of Membrane Bioreactor (MBR) treated-wastewater discharge from a new development near the Whitford township, Auckland. Dr Dada used mass balance dilution models and predictive faecal indicator bacteria models to show that the proposed MBR discharge will export significantly lower nutrient and microbial loads to the receiving environment than is currently the case. Microbial monitoring for specific microbial pathogens (faecal indicator bacteria -*E. coli* and *Enterococci*) informed a microbial assessment that was used to determine, with reference to specific policy directives, whether the proposed discharge is likely to result in any significant adverse effects on the receiving environment.

Microbial evidence for Waikato Regional Plan Changes 1 (WRPC1). Beef & Lamb New Zealand. 2017-18. Dr Dada has been engaged by Beef & Lamb New Zealand to provide a variety of services relating to the forthcoming WRPC1 hearing scheduled for later in 2018. As part of those services Dr Dada has drafted evidence relating to E coli standards proposed for different parts of the Waikato and Waipa system, and the rules proposed to   achieve those standards. By carefully reviewing national and international literature, reports commissioned in the preparation of WRPC1, and undertaking data analysis on regional datasets, Dr Dada has crafted evidence that will challenge generally-accepted norms about fate and transport of pathogens form pastoral land to receiving waters and methods to mitigate those effects.

Predictive E.coli models for* Waitetī, Utuhina, and Ngongotahā bathing sites, Rotorua*. Bay of Plenty Regional Council. 2017. Dr Dada was engaged to calibrate predictive models for real-time prediction of *E.coli* concentrations that complements the current monitoring approach to recreational water risk

assessment. The study used easily measured meteorological and hydrological parameters to reliably predict the concentrations of faecal indicator bacteria (FIB] at three selected recreational sites characterized by a high prevalence of exceedances. The models were built into an interactive platform (GoFIB) that is user-friendly and could be readily used by Council staff with no specialist training. The developed models performed well when assessed against already published minimum performance sensitivity, specificity and accuracy standards for FIB models. The calibrated and validated GoFIB model lends itself to possible integration with real-time water quality processing systems to generate continuous FIB nowcasts and time series plots.

Predictive E.coli models for **Rai Fall, Totara Flats and Waihohai bathing sites. Marlborough District Council. 2017.** Dr Dada was engaged to calibrate predictive models for real-time prediction of *E.coli* concentrations that complements the current monitoring approach to recreational water risk assessment. The study used easily measured meteorological and hydrological parameters to reliably predict the concentrations of faecal indicator bacteria (FIB] at three selected recreational sites. The models were built into an interactive platform (GoFIB) that is user-friendly and could be readily used by relevant Council staff with no specialist training. The developed models performed well when assessed against already published minimum performance sensitivity, specificity and accuracy standards for FIB models. The calibrated and validated GoFIB model lends itself to possible integration with real-time water quality processing systems to generate continuous FIB nowcasts and time series plots.

WWTP Environmental Impact Assessment: Effect of Proposed Treated Waste Water Discharge into Lake Rotorua, Rotorua Lakes Council, 2016-2017. Dr Dada led a study which sought to provide expert opinion on the potential impact (nutrients/pathogens/pH/metals) of the proposed, treated wastewater discharge through Te Arikiroa Stream into Sulphur/Puarenga Bay, when the current discharge consent expires in 2019. This EIA project also involved collaboration with experts at MWH (now part of Stantec) and culminated in the collation of an 'Assessment of Environmental Effects' report.

Calibration of a one-dimensional water quality model for Lake Ellesmere, Environment Canterbury, 2015-2017. The goal of the project was the calibration of a one-dimensional water quality model that predicted the influence of various catchment management options and lake opening scenarios on salinity and nutrient levels in Lake Ellesmere, Canterbury.

Modelling the impact of sewage reticulation on water quality of Lake Tarawera, New Zealand, Lake Tarawera Ratepayers Association, 2015. Dr Dada was the lead investigator on a Lake Tarawera Sewage Reticulation study to assess the potential impact of sewage reticulation on lake water quality. From a public health perspective, this study highlighted the need for efforts aimed at investigating and curbing potential sources of faecal contamination of drinking water sources within the catchment. The study concluded that the implementation of a reticulated sewage system could curtail the influx of manageable sources of nutrients from the lake catchment, as well as reduce public health risks associated with poorly performing on-site treatment systems.

Analysis of high frequency buoy data, New Zealand, MBIE, 2015-2017. This data-exploration project involved quality assurance and quality control, and exploratory analysis of high-frequency buoy data. This project aimed to assess drivers of variations of *E. coli* abundance in Lake Rotorua as well as to develop multivariate statistical approaches for water quality prediction. The study formed the basis for the publication of an article in a leading environmental science journal on the Development of Predictive Models for Faecal Indicator Bacteria in New Zealand.

Bacteriological quality of recreational waters in Malaysia, South East Asia, National University of Malaysia, 2010-2011. These studies were supported by a Malaysian government grant (Science Fund 04-01-02-SF0754) under the auspices of the School of Bioscience and Biotechnology. Dr Dada led a series of studies that assessed the validity of multiple indicator organisms for bacteriological beach quality monitoring in Malaysian waterways using a multivariate approach. The study provided policy makers with an evidenced-based approach to parameter streamlining for optimized beach sampling and sustainable bacteriological quality monitoring.

Occurrence of antibiotic resistance in aquatic environments in Malaysia, South East Asia, National University of Malaysia, 2012-2014. These studies were supported by internal funding from the National University of Malaysia (UKM-GUP-2011190) with a view to conducting bio-surveillance, detection, speciation and reporting of antimicrobial resistance incidence in faecal indicator bacteria (FIB) in Malaysia waterways. In these studies, Dr Dada successfully used several advanced molecular techniques (e.g. Random Amplified Polymorphic DNA-based [RAPD-PCR] and Multilocus sequence typing [MLST]) to elucidate the presence of genetically diverse fecal bacteria with associated virulence traits and a background of recombination events in surface recreational water. The findings identified potential public health risks and also formed the basis for several scientific publications, many of which are in top (Q1 and Q2) international journals.

Selected Peer Reviewed Publications

Dada, A.C. Hamilton, D.P. (2016) Lake Management, A restoration perspective. Chapter 28. In: Advances in New Zealand Freshwater Science, New Zealand Hydrological Society. P.G. Jellyman, T.J.A. Davie, C.P. Pearson, J.S. Harding (eds). Pp. 696.

Dada, A. C., & Hamilton, D. P. (2016) Predictive Models for Determination of *E. coli* concentrations at Inland Recreational Beaches. Water, Air, & Soil Pollution, 227(9), 347-360.

Ahmad, A., Dada A.C, Usup, G., Heng, L.Y (2014) Occurrence of Enterococcus Species with Virulence Markers in an Urban Flow-Influenced Tropical Recreational Beach. Marine Pollution Bulletin, 82(1-2): 26-38.

Ahmad, A., Dada A.C, Usup, G., Heng, L.Y (2014) Application of Multilocus Sequence Analysis for the Molecular Characterization of Enterococci with Putative Virulence Factors Recovered from a Tropical Recreational Beach, Southeast Asian Journal of Tropical Medicine and Public Health Journal (SEAMEO), 43(3): 700-712

Ahmad, A., Dada A.C, Usup, G., Heng, L.Y (2014) Biofilm production, esp and asa gene carriage among beach enterococci. Global Journal of Health Science, 6(5), 241-253.

Ahmad, A., Dada, A. and Usup, G. (2014) Survival of Epidemic, Clinical, Faecal and Recreational Beach Enterococci Strains with Putative Virulence Genes in Marine and Fresh Waters. Journal of Environmental Protection, 5, 482-492.

Dada, A. C., Ahmad, A., Usup, G., & Heng, L. Y. (2013). Occurrence of virulence determinants among enterococci from recreational beaches in Malaysia, International Journal of Antimicrobial Agents, 42 (S2): S59-S60

Ahmad, A., Dada A.C, Usup, G., Heng, L.Y (2013) Validation of the Enterococci indicator for bacteriological quality monitoring of beaches in Malaysia using a multivariate approach. SpringerPlus. 2(1), 1-18.

Ahmad, A., Hamid, R., Dada, A. C., & Usup, G. (2013). Pseudomonas putida Strain FStm2 Isolated from Shark Skin: A Potential Source of Bacteriocin. Probiotics and Antimicrobial Proteins, 5(3), 165-175

Dada A.C, Ahmad, A., Usup, G., Heng, L.Y (2012) Speciation and antimicrobial resistance of Enterococci isolated from recreational beaches in Malaysia. Environmental Monitoring and Assessment, 185(2): 1583–1599

Dada A.C, Ahmad, A., Usup, G., Heng, L.Y (2012) Antibiotic Resistance and Virulence among Enterococci Isolated from Teluk Kemang Beach, Malaysia. Water Quality, Exposure and Health, 4(2):113-122

Dada, A. C., Ahmad, A., Usup, G., & Heng, L. Y. (2012). Virulence characteristics and antibiotic resistance among Enterococci isolated from Bagan Lalang beach, Malaysia, International Journal of Infectious Diseases, 16 (S1): e412.

Dada, A. C., Asmat, A., Gires, U., Heng, L. Y., & Deborah, B. O. (2012). Bacteriological monitoring and sustainable management of beach water quality in Malaysia: problems and prospects. Glob J Health Sci, 4(3), 126-138.

Dada, A. C., Ahmad, A., Usup, G., & Heng, L. Y. (2012). High-level aminoglycoside resistance of Enterococci isolated from recreational beaches in Malaysia. Environmental Monitoring and Assessment, 185(9):7427-43.

Selected Reports

Dada, A.C. (2018) Assessment of ecological and human health effects on the Waikato River associated with the discharge of untreated wastewater from the Bridge Street wastewater pump station, February 20, 2018. Report HCC1801, Streamlined Environmental, Hamilton, 20 pp.

Dada, A.C (2018) Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River. Report AES1704, Streamlined Environmental, Hamilton, 59 pp.

Dada, A.C. (2018) Quantitative Microbial Risk Assessment for the discharge of treated wastewater into Whitford Embayment through Turanga Creek, LCL1702, Streamlined Environmental, Hamilton, 41 pp.

Dada, A.C. (2018) Quantitative Microbial Risk Assessment for the discharge of treated wastewater at Army Bay. Report WSL1701, Streamlined Environmental, Hamilton, 73 pp.

Stewart, M, Cooke, J, Dada, A.C. (2017) Assessment of ecological effects on the receiving environment associated with the discharge from the proposed membrane bioreactor wastewater treatment system. Option 1: Treatment of all wastewater generated by Te Kauwhata (current and future), Springhill Prison (current and future) and the Lakeside development. Report LDL1701–FINAL, Streamlined Environmental, Hamilton, 168 pp.

Dada, A. C., Stewart, M. (2017) Assessment of ecological effects from discharge of wastewater and stormwater on the receiving environment associated with the development of Whitford Manor Estate. Report LCL1701–FINAL, Streamlined Environmental, Hamilton, 142 pp.

Dada, A. C. (2017) Development of Predictive Models for *Escherichia coli*: Rai Fall, Totara Flats and Waihohai bathing sites. Report MDC 1701–1, Streamlined Environmental, Hamilton, 14 pp.

Dada, A. C. (2017) Development of Predictive Models for *Escherichia coli*: Waitetī, Utuhina and Ngongotahā Streams. Report BPR 1701, Streamlined Environmental, Hamilton, 25 pp.

Hamilton, D.P., Dada, C.A., McBride, C.G. (2017) Water Quality Modelling of Te Waihora/Lake Ellesmere. ERI Report No. 100. Environmental Research Institute, Faculty of Science and Engineering, The University of Waikato, Hamilton, New Zealand.

Dada, A.C., Hicks, B. J. M., Ling, N., Kusabs, I.A., Hamilton, D. P. 2017. Assessment of Effects of Proposed Treated Wastewater Discharge to the Te Arikiroa Thermal Channel and Sulphur Bay (Lake Rotorua). ERI Report No. 91. Client report prepared for Rotorua Lakes Council. Environmental Research Institute, Faculty of Science and Engineering, The University of Waikato, Hamilton, New Zealand.

Dada, A.C. Hamilton, D.P. (2017) Modeling the impact of discharge of treated wastewater through Te Arikiroa Stream into Sulphur/Puarenga Bay, Lake Rotorua (draft). UoW Environmental Research Institute Client report in preparation for Rotorua Lake Council, 120pp.

Dada, A.C., McBride, C.M., Verburg, P., Hamilton, D.P. (2016) Modeling the impact of sewage reticulation in the Lake Tarawera catchment. Client report prepared for the Lake Tarawera Ratepayers Association. Environmental Research Institute Report No. 85, The University of Waikato, Hamilton.