PROJECT TITLE: Development of diagnostic tools to measure indicators of disease and antimicrobial resistance via urban water profiling

DTP Research Theme(s): Changing Planet

Lead Institution: University of Bath
CASE Partner: Stellenbosch University

Lead Supervisor: Prof Barbara Kasprzyk-Hordern, Department of Chemistry, University of Bath
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Project Background

In today's increasingly global and interconnected world, over half of the world's population lives in urban areas. The coming decades will bring further profound changes to the size and spatial distribution of the global population with a projected increase to 66% living in urban areas by 2050 and nearly 90% of the increase concentrated in Asia and Africa[2]. As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities[1]. This unprecedented speed of urbanization constitutes substantial risks to the resilience of cities with public health and welfare being the most critical concern. Urban environments affect public and environmental health in various ways. Air, water and food are more likely to be contaminated with mixtures of chemicals. Cities are also powerful drivers of population mobility, which increase regional and global communicable disease risks. The 21st century has already seen the epidemic of SARS (2003), H1N1 (2009), Ebola (2014) and Zika virus (2015). This highlights global vulnerability to infectious diseases and shared global responsibility for surveillance and disease control[2,3]. The recent O'Neill report commissioned by the UK government urges that "*by 2050, 10 million lives a year and a cumulative 100 trillion USD of economic output are at risk due to the rise of drug resistant infections*"[1].

In order to increase sustainability of urban environments, there is a need for evidence based early warning system that can rapidly and objectively identify and respond to public health and environmental risks in urban environments, and in view increasing global-wide mobility. It is therefore essential that our methods for surveillance are developed and evaluated in different geographic areas.

Project Aims and Methods

This PhD studentship will focus on the development of a diagnostic framework to measure indicators of disease and antimicrobial resistance (antibiotics and their metabolites, resistance genes and other physicochemical indicators) via urban water fingerprinting of two contrasting catchments: the Avon Catchment in the UK and the Eerste River Catchment in Stellenbosch (South Africa). Urban water fingerprinting postulates that water from urban dwellings reflects the health status of contributing population and surrounding environment as it pools the endo- & exogenous products of that population. Real-time spatiotemporal measurement of these community derived products (biomarkers) allows for rapid evaluation of public and environmental health status, prediction of future crises, and enables mitigation strategies for city's stressors, even before they manifest themselves with characteristic end-points (e.g. mortality in the event of pandemics). Thus mortality can be reduced and resilience of the surveyed urban system significantly increased.

The project will address above via the three main objectives:

1. To understand the mechanisms of persistence and transformation of antimicrobial agents in the environment at both nanocosm and macrocosm scale.
2. To assess the degree to which antimicrobial agents in the environment are associated with the higher prevalence of specific resistant bacterial strains in reveiving water, and how their usage can be associated with prevalence of infectious disease at the community level.
3. To develop a diagnostic framework to measure indicators of disease and antimicrobial resistance (antibiotics and their metabolites, resistance genes and other physicochemical indicators) via urban

[1] United Nations, World Urbanization Problems, 2014
[2] Michael St. Louis, Global Health Surveillance in the 21st Century' CDCP, MMWR 2012, 61, 15-19
[3] Nsubuga, P. et al., (2006). Public Health Surveillance: A Tool for Targeting Monitoring Interventions' in Disease Control Priorities in Developing Countries

water fingerprinting.

Indicators of disease and antimicrobial resistance (antibiotics and their metabolites, resistance genes and other physicochemical indicators) will be measured with state-of-the-art hyphenated chromatography, mass spectrometry techniques and digital PCR technology

This project will feed into a much larger initiative, a Global Challenges Research Fund ReNEW Project (https://www.gcrf-renew.co.uk). ReNEW aims to develop an early warning system for environmental and public health diagnostics via urban water fingerprinting in the city of Stellenbosch in South Africa. The student will benefit from this broader programme, in terms of research context and resources.

Candidate Requirements

This exciting studentship opportunity is aligned with ReNEW, an interdisciplinary Global Challenges Research Fund initiative between the University of Bath and Stellenbosch University.

The successful candidate should have, or expect to have, an Honours Degree at 2.1 or above (or equivalent) in Chemistry (Analytical, Environmental, Pharmaceutical, Physical), Microbiology or Biochemistry.

CASE or Collaborative Partner

The student will get a first-hand experience of both the differences and similarities of the phenomenon of AB resistance, and to contribute to the development of an approach that is globally applicable. In addition, the student will work at the interface between analytical chemistry and environmental microbiology, and will acquire expertise in the running of microcosms.

The student will work with two internationally renowned environmental chemistry and microbiology groups at the University of Bath and Stellenbosch. This exposure will give the student an understanding of research work undertaken at an international level, a skill that is critical to tackle global challenges.

Training

The student will receive extensive training in a range of modern analytical and bioanalytical techniques including state-of-the-art chiral chromatography coupled with tandem mass spectrometry techniques. In addition, he/she will join interdisciplinary teams at the University of Bath and Stellenbosch University with substantial research expertise in the area and excellent research infrastructure, that include comparable analytical facilities, and complementary tools such as confocal scanning laser microscopy, lab-on-the-stage, and real-time measure of microbial activity when exposed to antimicrobials. Experience of academic / industrial research, interdisciplinary and international working and development of state-of-the-art analytical techniques and applications, will provide an exciting opportunity for further professional development. Two secondments at Stellenbosch University are envisaged to undertake both laboratory work and fieldwork sampling trips in the environment of Stellenbosch.

References / Background reading list

[1] United Nations, World Urbanization Problems, 2014

[2]Michael St. Louis, Global Health Surveillance in the 21st Century' CDCP, MMWR 2012, 61, 15-19

[3] Nsubuga, P. et al., (2006). Public Health Surveillance: A Tool for Targeting Monitoring Interventions' in Disease Control Priorities in Developing Countries

Useful links

Enquiries relating to the project should be directed to the lead supervisor (see email address above for Project Enquiries). Enquiries relating to the application process should be directed to doctoraladmissions@bath.ac.uk

In order to apply, you should select the relevant University of Bath PhD online application form found here: https://www.bath.ac.uk/study/pg/applications.pl. When completing the form, please state in the 'Finance' section that you wish to be considered for GW4+ DTP funding and quote the project title and lead supervisor's name in the 'Your research interests' section.

Further information about the application process may be found here: http://www.bath.ac.uk/topics/postgraduate-research/

The application deadline is 1600 hours GMT Monday 7 January 2019 and interviews will take place between 4 and 15 February 2019. For more information about the NERC GW4+ DTP, please visit https://nercgw4plus.ac.uk.