GCRF project award summaries 1920/21

Tanya Monaghan, Clinical Associate Professor, Anne McLaren Fellow and Honorary Consultant in Gastroenterology, Faculty of Medicine and Health Sciences

Local evaluation of RT-PCR vs NGS for early detection, surveillance and prevention of communicable viral diseases in Central India: a wastewater-based epidemiological study.

There is now substantial evidence to demonstrate viruses are ubiquitous and persistent in raw and treated sewage as well as receiving water bodies. The presence of potentially pathogenic viruses in wastewater is of major concern since it can pose risks to human health. One of the main sources of viruses in wastewater, including viral pathogens is from human faecal matter, particularly from infected persons. In addition to human pathogenic viruses, waterborne viruses such as adenovirus, rotavirus, and hepatitis A that originate from food production, animal husbandry and seasonal surface runoff are also present in wastewater. These may lead to symptoms of nausea, vomiting and fever. Researchers have recently shown that the novel coronavirus SARS-CoV-2is excreted via faeces and can thus be introduced into untreated wastewater.

Wastewater-based epidemiology(WBE) has been identified as a population-wide infectious disease surveillance and early warning tool for the detection of infectious diseases outbreaks. Efficient monitoring of viral transmission is critical to prevent and manage viral disease outbreaks and has particular importance during the present global pandemic crisis. aims to improve understanding of population exposure to communicable viral diseases including COVID-19 in rural and urban catchment areas in Nagpur Central India, an area which has seen exponential growth in SARS-CoV-2infections. Using established methodologies, we will specifically identify and track the transmission of coronavirus and other viruses through the detection of viral genetic components in wastewater samples. These will be collected longitudinally from urban, slum and rural village areas and analysed in country. Real-time information on potential outbreak hotspots for SARS-CoV-2 and other pathogens will be shared with public health authorities to instigate appropriate public health measures

Doreen Boyd, Professor of Earth Observation, School of Geography

BORIPI: Brick Kilns of the south Asia Brick Belt: Optimising a research and impact platform to address objects of UN SDG Intersectionality (SDGs 3, 5, 8, 15 and 16)

The GCRF BORIPI project led by Doreen Boyd (Rights Lab, Geography) will focus on the Bull's Trench brick kilns of the south Asia Brick Belt. Our previous mapping of these kilns was the first ever (locating over 66, 000), yet they are objects of material risk for a number of United Nations SDG Targets (3 (Health), 5 (Gender), 8 (Decent Work), 15 (Life on Land) and 16 (Peace)). Our mapping has already prompted UNDP India Accelerator Lab to partner with

us to develop a mobile app which is being used by the Indian Environmental Inspectorate to visit kilns for the purpose of environmental compliance (SDG 3 and 15). In the BORIPI project we extend the functionality of this app by providing up-to-date mapping and richer data on the kilns through innovative image processing and geospatial analyses and (ii) to add another module to the app that focuses primarily on providing a risk measure of exploitative labour (bonded and child labour) occurring at a kiln (SDG 5, 8 and 16). The new and improved app will then be showcased to NGOs within India and the other countries for whom we have mapped the kilns (i.e., Bangladesh, Nepal and Pakistan) via the UNDP Accelerator Lab network. Learnings in both research and impact activity from this project will be submitted for publication as well as feedback to satellite companies who have shown great interest in our work as a demonstrator application.

Giles Foody, Professor of Geographical Information Science, School of Geography

Validating sargassum detection.

The brown seaweeds Sargassum fluitans and S. natans (sargassum) cover large areas of the North Atlantic Ocean, providing habitat and feeding areas for many marine species. In recent years, however, the arrival of massive amounts of sargassum along Caribbean coasts has become a major problem affecting marine ecosystems (mangroves, corals and seagrasses) and local economies through its effect on fisheries and tourism. Decaying sargassum on beaches emits noxious gases and cause visual pollution. In Mexico, half of GDP comes from tourism along its Caribbean coastline (>US$ 11.5 billion in 2018), which has been severely affected by this sargassum beaching. Predicting the arrival and managing the impact of sargassum is a priority for the Mexican government and society.

Limited understanding of what controls sargassum beaching, when and where it will arrive means that scarce resources are being spent inefficiently and ecosystems and livelihoods are being damaged unnecessarily. The dynamic nature of coastal zones and unpredictable arrival of sargassum, make conventional ground-based monitoring difficult. The use of satellite imagery offers tools to track, quantify and understand sargassum movement and beaching remotely Deploying Satellite technology will help to develop a monitoring system that will enable government agencies and hotels to allocate resources efficiently, thereby minimising economic, social and environmental impacts and enhancing the resilience of local communities

Julie King, Professor of Cereal Genetics, School of Biosciences

Utilisation of wild wheat relatives to develop novel, resilient, high-yielding wheat varieties adapted to environmental change for low and middle income countries.

Wheat yields throughout much of the world are plateauing at a time when food production needs to increase to support growing populations in low- and middle-income countries. This is a direct result of environmental change and a lack of genetic variation in the gene pools of bread and durum wheat. A major game changer for future wheat production will be to increase the gene pools available for breeding superior environmentally adapted varieties by exploiting genetic variation found in wild related species.

In this proposal, the Nottingham BBSRC Wheat Research Centre will work with Lilongwe University of Agricultural and Natural Resources in Malawi and The International Maize and Wheat Center (CIMMYT) in Mexico to exploit genetic variation from the wild relatives to

develop superior Malawian wheat varieties adapted to climate change and also for the development of both bread and durum wheat varieties resistant to Fusarium Head Blight, a major disease of these crops worldwide. This work builds on long-term funding provided by the BBSRC and the University of Nottingham.

Iain Stewart, Assistant Professor, Medical Statistics, Faculty of Medicine and Health Sciences

INKLUDE: Defining the regional barriers to healthcare in Brazil during the COVID-19 global pandemic

SARS-CoV-2 is the second coronavirus to cause mass hospitalisations and, around the world, services are slow to adapt to widespread infection. Vulnerable communities living in cramped and poor conditions will continue to be exposed to future viral threats. Brazil is a developing nation that has seen over 5M confirmed COVID-19 cases, and nationwide clinical trials are underway to assess the possibility of repurposing classes of affordable drugs to reduce severity of disease.

We aim to undertake telephone survey of 1500participants recruited into COVID-19 clinical studies from northern to southern regions of Brazil, for details related to possible difficulties in attending the service for COVID-19 therapy. We will also explore the individual's attitudes toward potential digital routes to healthcare resource and information. To broaden the perspectives of barriers to healthcare, we will adapt the survey to an electronic format for distribution within Brazilian industries in which workers are vulnerable to respiratory disease and COVID-19 related absences. We will host a virtual workshop of regional healthcare professionals involved in COVID-19 clinical study recruitment to document their experiences of delivering services to vulnerable communities, particularly in the context of a global pandemic. With diverse evidence across different regions in Brazil, we will design bespoke guidance for health services to facilitate access in the communities being served.

Andy Salter, Professor of Nutritional Biochemistry, School of Biosciences

Achieving a sustainable protein economy in Malawi

The majority of the world's most protein deficient countries are in Africa. Malawi represents one such country, and its population is predicted to increase 6-fold by the end of the century. There is an urgent need to ensure the sustainable development of food systems to meet this challenge. Furthermore, the protein consumed is often of poor quality, increasing the risk of essential amino acid deficiency. By contrast, in many wealthy, industrialized countries,a large proportion of the population consumes2–3 times the amount of high quality protein requiredto maintain health. Much of this is derived from animal-based foods, the production of which is contributing significantly to environmental damage and climate change. The future challenge is to ensure sufficient high-quality protein for the global population, without further adding to this environmental burden. We have recently analysed dietary protein and amino acid intake from Malawi, using data from a nationally representative household survey (IHS3: 2010–2011) which is conducted every 4–5 years. We identified a large range of intakes across the country with the poorest households frequently consuming insufficient protein and specifically, insufficient amounts of the essential amino acid, lysine. Up to50% of protein was coming from cereal crops (generally low-quality protein) with fish and legumes

(high-quality sources) each contributing about 15%. Animal sources (which frequently contribute over 50% of protein in richer countries) provided only 6% This project seeks to

Extending the same analysis to the most recent survey for an updated status of protein and amino acid supply and to track the trends in supply .•Exploring these data at a household and socioeconomic level. •Mapping of protein supply: Regions with the least protein supply can be identified and this can be used by policy makers to target interventions. •Identifying regionally produced, underutilized high protein sources and investigating how these may be further introduced into the local diet. •Identifying sources of data from other African countries which will allow similar analysis of vulnerable population. •Developing a fellowship application for a UoN ECR to work jointly with LUANAR and other regional partners.

Tania Dottorini, Associate Professor in Bioinformatics, School of Veterinary Medicine and Science

Fighting Covid-19 in Bangladeshi and Rohingya populations with endemic bacterial diarrhoea and antimicrobial resistance.

In Bangladesh, gastroenteric infections –such as cholera –are endemic. The impact of COVID-19 in populations already hit by these infections is currently unknown. Evidence has also emerged that COVID-19 leads to alterations of the gut microbiome (microorganisms living in the gastrointestinal tract) which may lead to longer-term effects in an individual's ability to fight other infections, including further gastroenteric diseases. To make the matter worse, gastroenteric infections of bacterial origin are commonly treated with indiscriminate use of broad-spectrum antibiotics, promoting the rise of dangerous multi-drug resistant bacteria. COVID-19 has led to further increase in the use of broad-spectrum antibiotics with unknown effects on antimicrobial resistance. The long term post-covid and post-treatment effects on the gut microbiome may be disastrous and even more impactful than COVID-19 itself. Vulnerable populations include not only the Bangladeshi, but also the Rohingya refugees, segregated in camps in poor health conditions, representing a major humanitarian crisis. As COVID-19 spreads in Bangladesh, it is crucial that we understand: a) how pre-existing enteric infections may influence COVID-19 severity; b) how COVID-19 itself may promote further enteric infections due to alteration of the gut microbiome; and c) how the increased use of broad-spectrum antibiotics may contribute to further spread of antimicrobial resistance, causing potential long-term health and welfare damage well beyond COVID-19 alone.

Knowledge generated by the project should help shed light on how both COVID and current COVID treatments, administered to Bangladeshi and Rohingya patients, may create further alterations of the gut microbiome and affect disease progression in populations already heavily hit by enteric diseases, and may contribute to further spread of bacterial infections and AMR. The research has therefore a clear pathway to impact on treatment practices in Bangladesh for COVID-19patients in presence of endemic, enteric bacterial co-infection

David Salt, Professor of Genome Enabled Biology, School of Biosciences

Coupling local crops and new technologies to improve livelihoods and nutrition in Africa and the Caribbean

Mineral nutrient deficiencies (e.g. iron, zinc and selenium) producing poor health are widespread globally. Alleviation of this 'hidden hunger' through crop biofortification, dietary

diversification and poverty reduction to access better diets, are sustainable solutions. The first part of this project will scale-up capacity for soil mineral nutrient analysis. There is an immediate opportunity to retool these soil labs to support R&D in ionomics, to quantify mineral nutrients in local crops and new varieties. Support is needed for breeding and deployment of more nutritious crops. At present, crop samples need to go overseas for analysis. Working with partnering soil labs of Malawi, we will increase capacity for high-throughput ionomics R&D more widely in Southern Africa, enable institutions to develop cost-recovery and business models to drive R&D investment, and strengthen lab visibility atregional and global scales.

Food diversification is critical to enhance mineral nutrition and is a major opportunity in Africa. This is particularly evident in Kenya, which suffers severe regional nutrient deficiencies. A major cause of this is overreliance on low mineral nutrient staples like maize and cassava. Diversifying local diets to incorporate nutrient-rich indigenous plants offers a practical solution. The baobab tree sustainably produces fruit, leaves and tubers high in mineral nutrients. Working with PU, we will assess the natural genetic and nutritional diversity in baobab to facilitate its widespread adoption as a food crop in Africa.

The Caribbean produces top quality cocoa beans, which provide an important source of income for smallholder farmers. UoN is working with smallholder cocoa producers, chocolate makers and researchers in Latin America and the Caribbean to help enhance the quality and value of smallholder cocoa. Small lots of cocoa beans supplied directly by farms from specific origins are in demand, requiring producers to maintain high quality beans. Occurrence of the heavy metal cadmium in cocoa beans from some regions threatens this opportunity. Working with the UWI we will improve the quality and traceability of smallholder produced cocoa, through improving flavour, reducing cadmium, and helping establish cocoa provenance in supply chains.

Dr Lara Bianchi, Nottingham University Business School

I am my dignity: A Moral Capability Assessment Tool (MCAT) for women's rights in fragile context

Women experience multiple and intersecting forms of inequality, vulnerability and marginalization throughout their life course, and they are often disproportionate victims of the consequences of conflicts. Fragile contexts reinforce discriminatory social norms which normalise, in the minds of women, that they are subject to fewer rights, exacerbating their social and economic exclusion. The intersection between gender inequality and conflict erodes women's opportunity to fulfil their potential and undermines the prospect of sustainable development for all and the UK development assistance commitment "to contribute to reducing inequality between persons of different gender

This project responds to this challenge by creating an innovative Moral Capability Assessment Tool (MCAT) that analyses how the intersection between gender inequality and context fragility influences women's moral capability, that is the extent to which theyare aware of being holders of rights and can mobilise such rights for their social and economic development. Reconstruction and development policies are currently based on the assumption that there is a homogeneous level of moral capability among recipients, without a clear understanding of the interplay between structural gender inequalities, the normalisation of rights-abuse and sustainable development. Therefore, thereis a clear gap in

understanding how women's awareness of their rights impacts their agency and how this can be integrated into the design of developmental measures.

Professor Volker Wedekind, School of Education

Reimagining Agricultural Extension through a Learning Lens (RAELL)

Agricultural extension services in low and medium income countries(LMICs)require critical reimagining. Agriculture remains core to most LMIC livelihoods, and is central to ensuring food security. Yet the ongoing skills development of farmers is peripheral to current attempts to reinvigorate technical and vocational education and training (TVET);focused as they are on formal industrial sectors. Farmer training is typically tied to outdated systems of extension focusing on scientific knowledge diffusion or takes place in agricultural colleges disconnected from the TVET system(UNESCO-UNEVOC 2020). These institutions typically focus on conventional formal agriculture and practicing farmers, while evidence suggests that the greatest need is in small-scale, informal systems and value chains, farming start-ups and conservation agriculture.

This project connects these networks to explore how the preparation and ongoing training of agricultural extension officers (AEOs) can be strengthened by linking them with training providers and their curriculum. Through scoping activities and case studies, this project will pilot instruments, identify existing practices, and provide the basis for:1.Development ofpolicy proposals for reimagining and revitalising existing agricultural education provision, and aligning extension services to this educational offering 2.Provision of processes and exemplar options for new AEO preparation models

The project will do this by: a) Scoping existing agricultural research and training entities (public, private, NGOs, CBOs) in South Africa, Uganda and Zimbabwe b) Understanding existing practices, links with extension services and perceived training needs; informed by contextual understandings of evolving challenges such as climate change, water scarcity, failing market systems, new technologies, etc. c) Developing AEO occupational role profiles through pilot studies in South Africa, Uganda and Zimbabwe using interviews with AEOs, key agricultural education and training system actors, and individuals and organisations in the agricultural system d) Curriculum analysis of South African, Ugandan and Zimbabwean agricultural qualifications based on provider databases

Bagus Muljadi, Assistant Professor, Department of Chemical and Environmental Engineering

Roadmap for Indonesia's sustainable transport system via techno-socio-economic assessment of integrated EV and battery industry

The award will allow UoN to harness research excellence to address challenges pertaining to the adoption of electric vehicle (EV) in Indonesia, which will help improve air quality, health and wellbeing, stimulate welfare and economic growth, and increase societal resilience and mobility. Given the highly multidisciplinary nature of the challenges our project seeks to address, this award provides the platform in which researchers of various disciplinary background — including geology, engineering, chemistry, business and management — can work together. The UoN had established the Indonesia Doctoral Training Partnership to support researchers across the university to engage in Indonesia-related research. Through this award, we will build on our existing critical mass to incentivise

more researchers to develop their research portfolio in the region and achieve impacts in an overseas development context. This award will support the creation of a multidisciplinary research consortium, in collaboration with the Indonesian embassy in London, to help lever research funding through collaborations with Indonesian funding bodies

Ola Oluwafunmilola, Leverhulme Early Career and Nottingham Research Fellow, Faculty of Engineering

Point-of-care-Based Electrochemical Sensing for Human Papillomavirus Detection

Human papillomavirus (HPV) is a common viral infection of the reproductive tract with a small proportion of infections progressing to cervical cancer. In 2018, cervical cancer was reported as the fourth most frequent cancer in women globally with an estimated 570,000 new cases where 7.5% of these cases led to premature death[1]. Of the estimated 311,000 deaths arising from cervical cancer every year, more than 85% of these have been observed in less developed regions[1]. In South Africa, cervical cancer is the most common cancer observed in women aged 15 to 44 years, with estimated 12,983 new cases and 5,595 deaths reported in 2018[2]. Cancer prevention can be achieved via HPV vaccination. However, regular cervical cytology screening or testing where early detection of pre-cancerous lesions can be identified and treated is required. Early intervention can manage progression to invasive cancers while preventing 80% of deaths[1]. Due to improved sensitivity, HPV testing identifies more cases of precancerous cervical changes in comparison to cytology screening. The coverage of cancer screening is lower in rural areas, which are generally poor and lack access to the basic health services found in urban areas[3].A point-of-care (PoC) diagnostic test can reduce cost of analysis, save time, and enable developing regions with limited resources to perform healthcare diagnostics without the need for off-site analysis, complex operational procedure, or professionals with special training[4]

This project seeks to develop novel electrochemical sensor for the rapid analytical detection of high-risk HPV strains (HPV-16 and HPV-18)with low detection time (< 30 minutes)when benchmarked against Xpert® HPV. The sensing layer will be made from nanocomposites derived from minerals such as manganese, titanium, and copper, to which South Africa has access to cheap and abundant reserves in the Northern Cape and Limpopo Province. In this way, the project seeks to apply natural resources of South Africa to solving a problem affecting a substantial number of the most disadvantaged sector of the population whilst simultaneously delivering a localised healthcare provision with major impact on their health and well-being.