



Photo by Jason Cooper on Unsplash

# DUNDEE FOR DEVELOPMENT

Delivering transformation through the Global Challenges Research Fund





# Facing the challenge

At the cusp of the second decade of the 21st century, the world faced a major crisis - a global pandemic. Within a matter of months, a local health emergency in a distant Chinese city, had quickly taken on worldwide significance, forcing lockdowns in countries thousands of miles from the epicentre in Wuhan.



Photo by Manuel on Unsplash

The months that followed saw scientists of all disciplines, and policymakers, wrestle with this most wicked of problems.

Covid-19 may be the latest complex global challenge facing humanity, but it is one a many crises converging at this time: the impacts of global heating and accelerating climate change are already being felt around the world; biodiversity loss and resource depletion calls for major shifts towards more sustainable patterns of living; realising the benefits promised by a rapidly changing technological environment,

asks major questions about how we live with technology and how benefits can be shared more broadly.

If we are to thrive this century, these challenges must be met. Failure to do so presents an existential threat to humanity, accelerating deleterious impacts that will inevitably be felt hardest by low-and-middle income countries (LMICs), particularly those lacking material and institutional resource to adapt to these changes.





The University of Dundee recognises the role our academic community has to play in meeting these challenges. For years, our researchers have been heavily engaged in work relevant to the challenges facing LMICs, tackling issues ranging from global health to international migration.

In recent years, we have deepened this commitment to development, leveraging support from UK Overseas Development Assistance (ODA), through programmes such as the Global Challenge Research Fund (GCRF) and Newton Fund, to fund a variety of research collaborations with LMIC partners. These have not only helped broaden our understanding of many challenges facing developing nations, but also served to boost the research capacity of both LMIC partner institutions and their collaborators at the University of Dundee.

This document highlights just some of the University of Dundee's GCRF-funded projects supported by the Scottish Funding Council's ODA funding stream between 2017 and 2021. It details how our academic community has worked to overcome disciplinary and cultural

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barriers to establish meaningful research collaborations with colleagues in LMICs, with potential for further impact. At the heart of this work, is the University's core mission – to transform lives locally and globally.

We look forward to developing these collaborations further in the coming years and continuing our work facilitating a global transition towards a sustainable and equitable future.



# WORKING IN PARTNERSHIP

- 57 awards in over 25 countries
- Early career researchers empowered
- 4 fully-funded PhD studentships
- 3 multi-year programme awards
- Many pilot projects and networking awards
- Co-created projects with LMIC partners

- Ibero-American University - Mexico
- International Potato Center (CIP) - Peru

- Korle-Bu Teaching Hospital - Ghana
- KNUST - Ghana
- Nature Conservation Research Centre - Ghana
- Noguchi Institute - Ghana
- University of Ghana - Ghana
- University of Health and Allied Sciences - Ghana
- Covenant University - Nigeria
- Rural Electrification Agency - Nigeria
- University of Nigeria - Nigeria
- University of Lagos - Nigeria
- PAC Solicitors - Nigeria

- Amazonian Rural Federal University - Brazil
- Centre for Defence of Rights of Children and Adolescents - Brazil
- Federal University of Ceara - Brazil
- Institute of Applied Economic Research - Brazil
- Maria and Joao Aleixo Institute - Brazil
- Observatory of Favelas - Brazil
- Pontifical Catholic University - Brazil
- Rural Federal University of Amazonia - Brazil
- Sao Paulo State University - Brazil





- **Interdisciplinary collaborations**
- **New networks fostered**
- **Knowledge and capacity building events**
- **Engaging all UoD Schools**

• Al Rimal Health Centre - Gaza

• Addis Ababa University - Ethiopia

• Ethiopian Institute for Agricultural Research - Ethiopia

• Zhongnan Hospital - China

• Phil Rice - Philippines

• Chulabhorn Research Institute - Thailand

• Chulalongkorn University - Thailand

• Field Crop Research Institute - Vietnam

• Hanoi National University of Education - Vietnam

• Universitas Sultan Ageng Tirtayasa - Indonesia

• University of Malaya - Malaysia

• Resilience Solution - Bangladesh

• Christian Medical College, Vellore - India

• Commonwealth Human Rights Initiative - India

• Foundation for Research in Health Systems - India

• Indian Institute of Technology - India

• Institute of Technology (IIT) Delhi - India

• Modern Diagnostic & Research Centre - India

• National Institute of Design - India

• New Delhi and Bangalore - India

• Public Health Foundation - India

• Quicksand - India

• Rajiv Gandhi Biotechnology Centre - India

• Sitaram Bhartia Institute of Science and Research - India

• Kasetsart University - Nepal

• Kathmandu University - Nepal

• Nepal Health Research Council - Nepal

• St Xavier's College Tribhuvan University - Nepal

• Shaukat Khanum Hospital and Research Centre - Pakistan

• Sri Lanka University - Sri Lanka

• African Orphan Crops Consortium - Kenya

• National University of Lesotho - Lesotho

• College of Medicine Blantyre - Malawi

• Fisherman's Rest - Malawi

• Eco Concrete - RSA

• University of Witwatersrand - RSA

• University of Rwanda - Rwanda

• Makerere University - Uganda

• University of Zimbabwe - Zimbabwe



# FOOD SECURITY

The challenge of meeting global nutritional needs and achieving SDG 2 (Zero Hunger) is increasingly elusive. The UN estimates 1-in-10 are now undernourished globally, a trend that looks set to increase; food costs are rising higher than at almost any point in last six decades, with global production systems and supply chains disrupted by the global pandemic. Even before the Covid-19, the prospect of feeding a growing population sustainably, was increasingly daunting as climate change, environmental degradation and increasing input costs, conspire to limit crop production.

For LMICs, where food costs represent a large portion of the household budget, these rises present an existential challenge for some, and can undermine society. The transformation of food production, to achieve sustainable, resilient systems, is needed more than ever.

The GCRF enabled University of Dundee academics to use their expertise to address some of the most pressing food security challenges facing LMICs. Projects have ranged from developing mobile tools for Ghanaian smallholder cocoa producers, to applying

cutting-edge genomic techniques to help developing more climate resilient staples for LMICs. These collaborations have drawn expertise from the Schools of Life Sciences, Social Sciences and Duncan of Jordanstone College of Art and Design (DJCAD), as well as leveraging regional experience in crop science via links with the James Hutton Institute.

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# Orphan crops

In many LMICs, indigenous crops form an essential part of local diets. These plants are often called “neglected” or “orphan” crops, as they are not widely traded globally. As a result, they have been broadly overlooked by the global scientific community and subject to little research, despite the crucial role they play in local food systems.

There is a need to deepen our understanding of orphan crops, to help identify desirable traits, such as those relating to yield stability, nutritional quality and climate resilience. This knowledge can help breed improved crops better able to thrive in a changing climate and enhance food security in LMICs.

University of Dundee researchers led by Prof Gordon Simpson, Professor of Molecular Genetics and Deputy Head of Plant Sciences at UoD, to apply cutting edge genomic approaches to transform the annotation of

key orphan crop genomes. This work was undertaken in partnership with the **African Orphan Crop Consortium (AOCC)**; the **Rajiv Gandhi Biotechnology Centre (RGBC)**, India; and **University of Malaya**, Malaysia.

Through this collaboration, the University of Dundee has pioneered the use of nanopore direct RNA sequencing (DRS). This technology can sequence entire RNA molecules, which makes genomic annotation much more simple and accurate. This is the first time DRS has been used in plants and the first demonstration of its ability to map RNA modifications transcriptome-wide in any species. Using this approach, the team were able to produce an annotation of AOCC target crop and water yam.

The work has important implications for food security and trade in countries and regions reliant on these crops.





# Boosting barley research

Dundee is a global centre for excellence for barley research, with the ongoing construction of the International Barley Hub at the James Hutton Institute, the latest major milestone for Scottish barley research. The GCRF has enabled the University to leverage this expertise to support barley research relevant to LMICs.

## Ethiopia landraces

Ethiopia is considered a global biodiversity hotspot and its diverse landscape home to a variety of endemic species. Early agricultural domestication and relative isolation of the Ethiopian farming community from international trade routes, has led to unique genetic diversity among its crops, including barley – Ethiopia’s fifth most cultivated crop.

Ethiopian crop scientist, Girma Dinsa’s, doctoral research explored Ethiopian barley landraces. Using a collection of geo-referenced seed from across Ethiopia and Eritrea, Girma employed a

combination of phenotypic assessment and state-of-the-art genetic marker technology, combined with machine learning, to explore the genetic diversity of Ethiopian barley.

This work linked specific genes to traits, including one which has that enriches zinc – an important micronutrient widely deficient in Ethiopian children under 5. The genetic markers identified through this project will enable marker-assisted selection (MAS) within Ethiopia’s barley breeding program and ultimately help support food in the Horn of Africa in the long-term.



Photo: Girma Dinsa undertaking research at the James Hutton



## Climate resilient Syrian barley

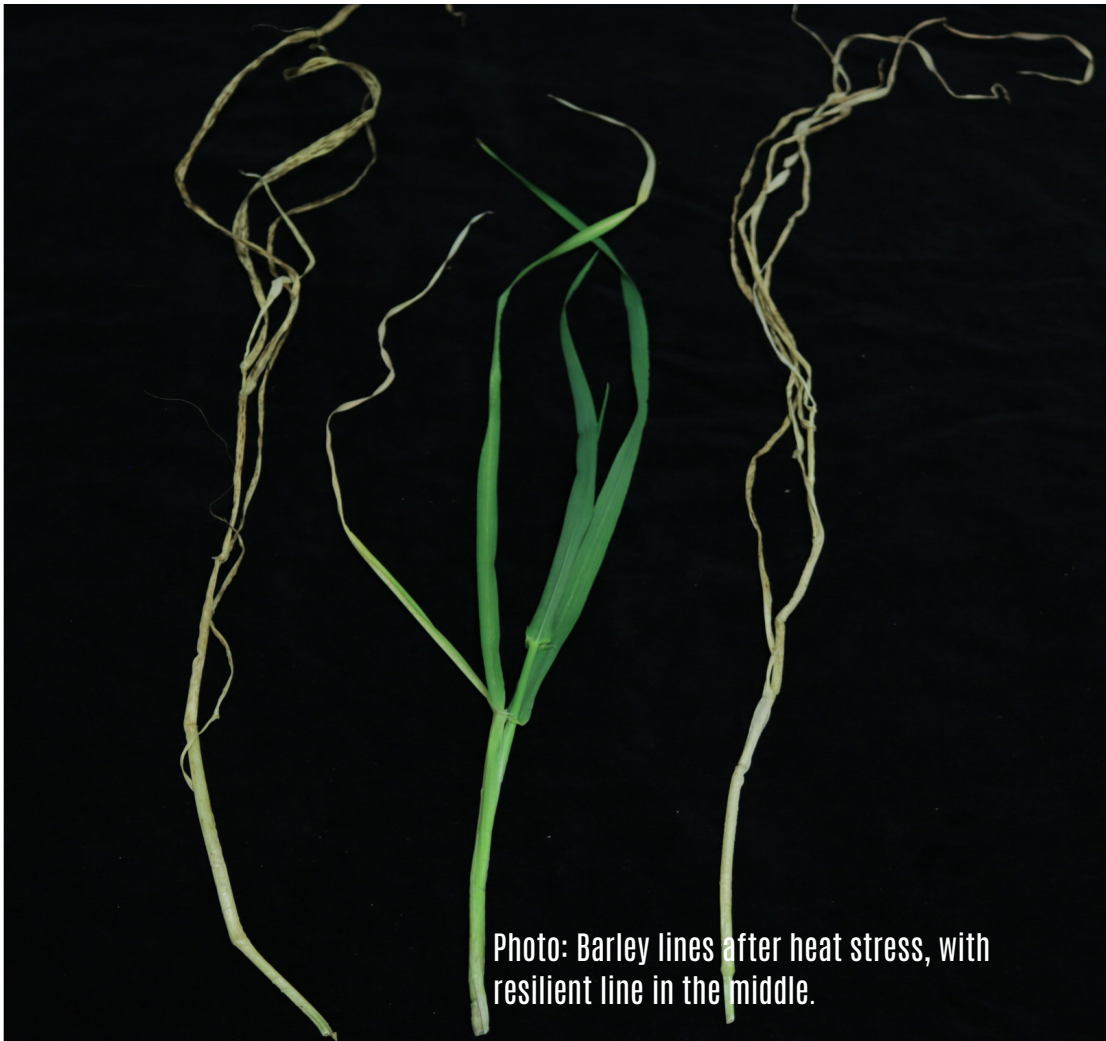
Syria's civil war has devastated its agriculture and scientific capacity. Many academics fled the conflict and important agricultural research has been curtailed as a result.

With support of the GCRF, Dundee plant scientist Dr Sarah McKim hosted displaced Syrian barley crop scientist Dr Mhmoud Eskan, as part of a **Council for at Risk Academics (CARA)** sponsored fellowship. The funding allowed Dr Eskan to continue his research in safety, while upskilling in the genetic control of crop traits, supported by Dundee's world-class barley genomics expertise at the James Hutton Institute.

Barley accounts for up to 40% of the cereals

cultivated in Syria. Yields are significantly impacted by heat stress and many elite barley cultivars are sensitive, or intolerant, to heat stress. Globally, heat stress is a major agricultural and food security challenge which negatively impacts crop yield.

Dr Eskan's research explored climate-stress resilience in barley. The work focuses on a version of gene (allele) associated with resilience to heat stress in barley. The research has clearly shown that the one version of the allele provides increased resiliency to heat and drought stress. The findings will help develop improved barley cultivars better able to withstand the effects of extreme episodic stress. This work is particularly relevant to Africa and the Middle East, where heat stress is expected to worsen with climate change.





# Peruvian potato partnership

Potato is the world's third most important food crop. It is a primary staple crop in a number of LMICs including Peru, Nepal and Rwanda. Globally, potato production is threatened by diseases such as late blight, nematodes and viruses that severely reduce crop yield and quality. Understanding and mitigating these threats is vital for food security, particularly in LMICs where potato is a significant part of the diet.

Peru is Latin America's largest potato producer and the ancestral home of the humble spud. The country also hosts **International Potato Centre (CIP)**, a global centre for excellence of potato research and part of **CGIAR** (Consortium of International Agricultural Research Centres) - an international network of research institutes working to improve global food security.

University of Dundee Plant Sciences researchers, led by Dr Ingo Hein, established a collaboration with CIP to help deliver improved

resistant potato varieties for LMICs. This project combined state-of-the-art resistance breeding technologies developed in Dundee, with CIP's Genebank - the largest potato collection in the world.

The team successfully assessed important germplasm material, selected from native landraces, pre-breeding materials, wild species, breeding lines and released varieties, with the goal to link phenotypic observations of disease resistance with the presence of known resistance genes.

The knowledge generated through the project supports a more informed breeding approach, helping breeders combine desired and complimentary disease resistance genes, relevant to a diverse range of pathogens found in LMICs. With CIP active in 20 countries across South America, Africa and Asia, the impact potential of this research is significant.



"Potatoes, potatoes, and more potatoes"  
 (CC BY-NC 2.0) by Anita363





Photo by Rod Long - Unsplash.



# GLOBAL

# HEALTH

Good health and wellbeing lie at the heart of sustainable development. In recent decades, major progress has been made to improve health outcomes in the Global South. Despite this, the disparity between rich and poor nations remains significant and much work is needed if we are to close this gap this.

The global pandemic threatens to undo much of the recent progress and serves as a stark reminder of how our health relies on broader systems with a complex web of interdependencies.

The University of Dundee has been at the forefront of tackling some of the most pressing global health challenges. The University boasts a diverse portfolio of research relevant to LMICs, ranging from research to identify drug candidates for neglected tropical diseases, to improving maternal and neonatal health.

Through the GCRF we have been able to enhance key areas of expertise, deepening research partnerships with Southern partners and establishing new collaborations.



Photo: Senyo in the lab - WCAIR



# Drug discovery for neglected tropical diseases

The University of Dundee hosts the Wellcome Centre for Anti-Infectives Research (WCAIR) - a world-leading drug discovery hub, working to develop methods, technologies and processes to make drug discovery for neglected tropical diseases faster and smarter. WCAIR also works to build capacity and train researchers in disease endemic countries. With the support of the GCRF, WCAIR academics have established a series of collaborations with LMIC partners.

## Cryptosporidium in Ghana

Cryptosporidium is a parasite that causes severe diarrheal disease in immunocompromised adults and young children, especially those malnourished or under the age of two. There is no vaccine, or effective treatment, for this disease. It is a leading cause of diarrheal disease of children in Ghana.

WCAIR Parasitologist, Dr Mattie Pawlowic worked with Dr Irene Ayi and her teams of researchers at Ghana's **Noguchi Memorial Institute for Medical Research (NMIMR)** to better understand the prevalence of Cryptosporidium in Ghana and to isolate and characterise local parasite strains.

Dr Pawlowic hosted and trained Ghanaian early career researcher Senyo Botchie, who spent 9 months at WCAIR before returning to Ghana to undertake the research project. This collaboration not only improved understanding of Ghanaian Cryptosporidium strains but also helped develop local capacity to undertake this type of lab-based research.

## Building drug discovery capacity in Ghana

Medicinal chemist, Professor Ian Gilbert partnered with Ghanaian universities and research institutes to foster drug discovery capacity in Ghana.

This collaboration saw Ghanaian researchers develop skills necessary to extract natural

products from plants and other sources, and to assess these for biological activity. The team also built a geo-referenced database to catalogue samples.

This work has laid a strong foundation for future Ghanaian drug discovery research, which will ultimately enable Ghanaian researchers to identify potential drug targets needed to develop the next generation of pharmaceuticals.

## Tackling AMR in India

Antimicrobial resistance (AMR) is a growing problem globally, particularly in India, where drug-resistant pathogens are increasingly common. In collaboration with colleagues from the University of Dundee's School of Medicine, Prof Gilbert established a partnership with **Christian Medical College (CMC)**, Vellore, to characterise multi-drug resistant bacteria derived from clinical isolates collected in India.

This project focused on two particular gram-negative bacteria - *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. The team first characterised these bacteria, before assessing resistance to common antibiotics. Using genetic sequencing, the researchers were able to pinpoint specific genes responsible for drug resistance. Finally, the team carried out combination screens to determine how the drug resistant isolates respond to specific drug combinations, identifying potential treatments for these challenging pathogens.



# Understanding arsenic exposure

Pollution is the largest environmental cause of disease and premature death, with populations of low- and middle-income countries (LMICs) at the highest risk of exposure. Inorganic arsenic (iAs), is a major pollutant, which can occur naturally in groundwater.

The World Health Organization (WHO) estimates at least 140 million people in 50 countries are exposed to arsenic contaminated drinking water. In Bangladesh alone, between 35 and 77 million of its 156 million inhabitants are thought to be at risk. The WHO describes this as ‘the largest poisoning of a population in history’.

Epidemiological studies have linked iAs exposure to the development of numerous diseases including cognitive impairment, cardiovascular failure and cancer. Due to socioeconomic factors, prevention of population exposure is not always possible.

Despite intense research, an effective therapy for chronic arsenicosis has yet to be developed. Laboratory studies have been of great benefit in establishing the pathways involved in iAs toxicity and providing insights into its mechanism of action. However, the in vivo analysis of arsenic toxicity mechanisms and the key molecular events leading to observed health effects has been difficult due to the lack of in vivo biomarkers of iAs toxicity at environmentally relevant levels.

This collaboration, between the University of Dundee (UoD) and **Chulabhorn Research Institute (CRI)**, Thailand, sought to address this issue by using UoD’s recently developed in vivo biomarkers of cellular toxicity to study iAs toxicity, an establish research interest of

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the Thai lab. The Dundee team demonstrated the utility of their in vivo toxicity reporters as a biomarkers of iAs exposure at environmentally relevant iAs concentrations. This has been the first time such changes have been observed in in vivo models at environmentally relevant concentrations. Moreover, the expression of the toxicity reporter revealed what specific cells are more susceptible to iAs, which helped to link some tissues with the clinical signs observed in exposed population (e.g. cardiac, liver and kidney cells). The team obtained pharmacological and genetic evidence proving that oxidative stress was the major toxicity mechanism involved in the observed iAs effects.

The researchers propose that their reporter model can be used as a surrogate biomarker of iAs-induced cellular stress, and it constitutes a first-in-class platform to develop treatments aimed to counteract the role of oxidative stress in arsenicosis. As a proof-of-concept experiment, the HOTT reporter mice were able to predict the therapeutic utility of the antioxidant N-acetyl cysteine in the prevention of iAs associated toxicity.





"Till the last drop" (CC BY-NC 2.0) by aftab.



# DESIGN

# FOR

# DEVELOPMENT

We are on the cusp of a major technological transition, which promises to reshape the socio-economic order and offers great potential to overcome some of thorniest development challenges. This 'Fourth Industrial Revolution' encompasses a wide range of tools and processes, such as genetic engineering, artificial intelligence (AI), quantum computing, advanced robotics, the Internet of Things (IoT) and 3D printing. While rapid technological advances offer scope to put humanity on a more sustainable trajectory, poorly considered technological solutions risk creating new problems. Design approaches,

that adopt a wholistic systems approach, can help avoid these pitfalls and have a key role in charting sustainable futures.

Through the GCRF, the University of Dundee supported a series of projects, drawing from expertise of designers and other creative practitioners, to explore and co-create new development pathways with LMIC partners. These projects have touched upon a diverse range of themes including makerspaces, the internet of things and integrating design into national economic development strategies.





# Making the future

Increased connectivity and technological advances have created potential for more decentralised manufacturing using new processes such as 3D printing and CNC (computer numerical control) tools. For LMICs, these offer the potential to create not only novel objects, but also new industries and creative communities able to address some of the most entrenched development challenges.

Around the world, creative communities are coalescing in Makerspaces, Hackerspaces and Fablabs. These have great potential to affect profound social and environmental change, by fostering alternative views of material culture and experimental fabrication methods.

In a world of resource depletion, energy crisis

and disrupted supply chains, decentralised methods of repurposing and remanufacturing may provide novel ways to utilise waste materials and provide environmentally ethical production methods for local communities.

Dr Katharina Vones, a Lecturer in Design and Making at DJCAD, undertook the most comprehensive survey of Indian makerspaces to date. This research documented communities of makers in Mumbai, New Delhi and Bangalore. It explored how sustainable practice is being used to aid local populations, and the role these spaces play in as incubators for a wider network of socially engaged entrepreneurs who, responsible for dispersing the ethos of sustainable practice at the centre of maker culture, to other parts of the subcontinent.



Photo: Katharina Vones





## Design Rwanda

Design is a process that harnesses creativity to address problems, capitalise on opportunities and create cultural, social and economic value. Businesses that invest in design frequently outperform those that fail to do so. The global trade in creative services has grown most strongly in emerging economies. The combination of an emerging middle class and a large youth labour market across Africa creates a strong opportunity to utilise creative industries and design to drive growth. This is particularly relevant to Rwanda's textiles and clothing sector - the second largest in Africa.

The textile sector is emergent in Rwanda and there is clear potential to improve the value chains that support it. It also provides specific opportunities for educating women and enabling them to engage in design-led creative entrepreneurship.

DesignRwanda, a collaboration between the **University of Rwanda** and designers from **DJCAD**, explored how design could be used to spur sustainable economic, social and cultural development in Rwanda and establish the country as an African design leader.

This project culminated in a symposium held in Kigali, which saw participants identify key topics of concern and co-define a pathway towards design-driven economic transformation in Rwanda.

The GCRF funding has acted as a springboard to enable the staff team in collaboration with the University of Rwanda to develop further research together that will look at textile/fashion enterprise comparatively in Kigali, Dundee and Liverpool.



# Decentralising Digital

Technology is already successfully contributing to socio-economic development in India but the narratives used to frame these successes, and the types of technologies implemented, are narrow and frequently urban-centric.

Often, these technologies are products of companies far removed from India and their business models extract value from the billions of people that use them while directing economic rewards to a small number of people. The asymmetric relationship between the makers of such technologies and the people that use them is sometimes referred to as Digital Colonialism.

Decentralising Digital, a research collaboration led by academics from **DJCAD**, sought to redress this imbalance, by working with rural communities in Karnataka, India, to co-create new narratives of decentralised digital futures.

The project explored how developments in emerging technologies such as the Internet of Things, the voice enabled Internet, machine learning and artificial intelligence might be harnessed to support rural communities in India.

The project employed design thinking and design-led research to build capacity around the co-creation and delivery of innovative, meaningful and desired new technologies, developing new narratives and communicating these through engaging case studies.

This work saw the DJCAD team partner with Indian design research studio, **Quicksand**, and **India's National Institute of Design**, and a range of community partners including the **Buffalo Back** farming collective and **Black Baza Coffee** collective and Janastu - an open source software non-profit.





**SUSTAINABLE**

**FUTURES**



# Renewable energy for resilient health

Many Nigerians lack access to adequate healthcare. This is a particular challenge in rural areas – home to around 48% of the Nigeria population. Limited medical provision undermines health outcomes and also the public health response to emergencies such as the coronavirus pandemic.

One of the key barriers to good rural healthcare delivery is access a reliable energy supply. Decentralised solar power generation offers great scope to meet this need, providing scalable, reliable electricity. Solar can help decrease electricity costs, reduce carbon emissions and can be deployed relatively quickly.

In 2020, shortly after the start of the global pandemic, off-grid energy impact investing company **All-On** and Nigeria's **Rural Electrification Agency (REA)**, launched a fund to provide emergency solar energy infrastructure, coupled with battery storage, to boost energy supply health facilities during the COVID-19 pandemic.

This technology has potential to transform rural energy supplies and healthcare provision. However, if further roll-out is to be sustained, new, innovative business models will be needed to attract investment.

A multidisciplinary research team led by academics from University of Dundee's **Centre for Energy, Petroleum and Mineral Law & Policy (CEPMLP)** set out to explore this challenge. Together with Nigerian partners, **Covenant University Centre for Economic Policy and Development Research (CEPDeR)**, Nigeria's **Rural Electrification Agency** and lawyers from **PAC solicitors**, the UoD researchers considered regulatory and economic factors relevant to renewable electrification of health care facilities in Nigeria. The team developed a set of tailored business models to overcome barriers to deployment.

Policy recommendations from this work has potential to shape Nigerian government policy and has implications for rural electrification of African healthcare more broadly.



"Solar panels" (CC BY-NC-ND 2.0) by World Bank Photo Collection



# Environmental impact of forced displacement

Around the world, the number of forcibly displaced people continues to rise, with many fleeing their homes to escape conflict, famine and persecution. According to the UNHCR, 82.4 million people were displaced at the end 2020, the vast majority hosted in developing countries, many of which are poorly resourced and ill-equipped to handle large groups of vulnerable people. Refugee populations can put pressure local resources and raise tensions with often already insecure host communities.

Uganda has one of the largest refugee populations in the world, hosting many displaced people from neighbouring countries, such as South Sudan and the Democratic Republic of the Congo. It is also one of the most biodiverse countries in the world, with natural habit of high conservation value. Much of this is under threat and growth of displaced communities has potential to exacerbate this problem by placing increased pressure on ecosystems.

Building on established links, a team led by

Dundee geographers Prof Mark Cutler and Prof Lorraine van Blerk, in collaboration with partners at **Makerere University**, sought to better understand how displacement impacts environmental degradation and the potential to develop more sustainable livelihoods. Combining on-the-ground fieldwork, with remote sensing data, the team explored the ways in which refugees and Ugandan nationals living in or around new and long-term refugee settlements interact with the environment and ecosystem services.

The project saw the establishment of an Advisory Board, chaired by the Commissioner of Refugees of Uganda's Office of the Prime Minister, including representatives from Ugandan Govt, Ministry of water and energy, National Environment Monitoring Agency, UNHCR and the NGO community.

Policy recommendations from the work, will help these stakeholders improve future refugee programming and Ugandan environmental policy.

