

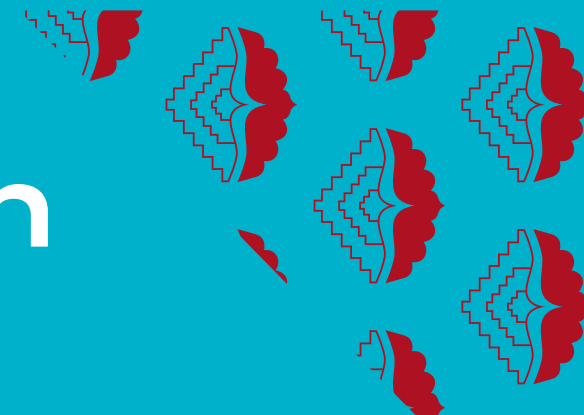


UK Research  
and Innovation

India  
भारत

September 2021

# UK-India: Partnerships for Growth with Research and Innovation





# contents

<b>Executive summary</b>	<b>2</b>	<b>1. Further Funding</b>	<b>67</b>
<b>Key findings</b>	<b>2</b>	Appendix A	71
<b>Foreword</b>	<b>4</b>	About	82
<b>Introduction</b>	<b>6</b>		
1. Methodology	7		
2. Projects Overview	10		
3. Theme: Climate, Energy and Environment	12		
4. Scholarly output	17		
5. Scholarly Impact and Excellence	25		
6. Theme: Healthy Societies	27		
7. Research Collaboration	32		
8. Contribution to the United Nations Sustainable Development Goals	34		
9. Theme: Innovation	36		
10. Impact summary of projects	42		
11. Databases, Models, Materials and Products	44		
12. Commercialisation of Research	47		
13. Theme: Societies and Culture	50		
14. Engagement Activities and Communication	55		
15. Policy Outputs	59		
16. Theme: Digital and Data	61		

# executive summary

**UKRI India joint funding resulted in 258 projects. Over £150 million in funding from the UK was matched by Indian counterparts, bringing the overall joint investment to the equivalent of over £330 million.**

The projects were funded by over 15 funding agencies, bringing together more than 220 lead institutions from the UK and India. These research projects have generated more than £450 million in further funding, mainly from public bodies but also from non-profit organisations and commercial entities, attesting the relevance of these projects.

The projects covered a wide range of subjects, from heritage to renewable energy, generating a large number of outputs in different formats and scholarly and societal impact in a multitude of forms.

Overall, 1,665 scholarly publications were identified as being indexed in Scopus. These publications had an average field-weighted citation impact of 2.2, which is more than twice the global average and higher than the UK and Indian averages as well. Of these publications, 5% were among the top 1% most cited publications globally, receiving the highest numbers of citations from China, the US, the UK, and India.

Most of the publications were in the subjects of Engineering, Energy, and Materials Science, although Energy was a focus area, comparatively. Nearly 27% of all UKRI India funded publications were in this area, which is seven times more than the global share of Energy publications (3.7%).

During the 2010–2019 period, the share of open access publications reached nearly 80%, with the share of gold open access publications increasing to nearly 25%. This is considerably higher than the global average of 31% overall and 10% gold open access publications in the same period.

The projects were highly collaborative, driven by collaboration between the UK and India, as well as including third-party countries. Nearly 55% of all publications were produced with international collaboration, having even higher citation impact than the average for UKRI India funded publications.



**258** projects funded  
by 15 funding agencies and government departments.



**1,665** publications  
indexed in Scopus resulted from UKRI India funded projects (2010–2019)



**Engineering, Energy, and Materials Science**  
were the top 3 subject areas for publications



**55%** of publications resulted from international collaboration  
with an average field-weighted citation impact of 2.6



over **200** technical products developed  
including 84 new databases, 40 improvements to research, and 20 new software products

UKRI India funded projects were very much aligned with the UN Sustainable Development Goals (SDGs) and contributed to these. Out of all publications, 43% were related to the SDGs, with a focus on SDG 7 (Affordable and Clean Energy) and SDG 3 (Good Health and Wellbeing).

The outcomes and impacts of projects took on a variety of forms, going beyond scholarly publications. The projects resulted in over 200 technical outputs, including 84 new databases, 40 improvements to research, and 20 new pieces of software. These include life-saving devices such as the Microlife CRADLE VSA, which has been recognised as one of the top 30 high-impact innovations in the Innovation Countdown 2020 (IC2030) inaugural report, Reimagining Global Health and received a US\$1 million grant from the Gates Foundation. Another output, Safarnama, is a free app through which digital heritage experiences can be downloaded and used to create an everyday, multi-media interface between the city of Delhi's present and many pasts.

In total, 9% of all publications were written via academic-corporate collaboration, which is three times more than the global average. Companies such as BT, National Grid, and Intelligent Energy were among the co-authors. Many corporate entities also acted as partner institutions for the actual projects. The projects had commercial impact beyond

co-publications. Research publications from joint projects were cited by more than 100 patents, and the projects themselves resulted in 13 patent applications, five granted patents, and two copyrights. Furthermore, four spin-offs were established as a result of projects.

Research outcomes were communicated through different forms, geographies, audiences, and media. The projects resulted in creative outputs, talks, presentations, and other forms of activities. A video on antibiotic use in shrimp farms was watched more than 1,800 times, while the urban future of India was staged as a photography exhibition. Overall, more than 1,500 instances of communication activities were recorded.

Researchers and research outcomes from the projects have influenced policy through their contributions to advisory committees, influencing training and providing guidelines, among other things. In total, 105 instances of policy-related outcomes were reported in relation to the projects. Advising the UK Global Food Security programme on wheat resistance or the Indian government on groundwater systems are among the many examples.



over **150m** funding from the UK  
matched by Indian counterparts



**Field-weighted citation impact of 2.2**

between 2010 and 2019, which is 120% better than the global average



**80%** of publications in 2019 were open access

with 25% being gold open access; the global average was 31% overall and 10% gold open access



**43%** of publications contributed to one or more SDGs

with a focus on SDG 7 (Clean and Affordable Energy) and SDG 3 (Good Health and Wellbeing)



**9%** of publications resulted from academic-corporate collaboration

including 100 patent citations, 13 patent applications, 5 patent grants, and 2 copyrights

# Foreword

## Professor Dame Ottoline Leyser DBE FRS, Chief Executive of UK Research and Innovation

**I am delighted to introduce UK-India: Partnerships for Growth with Research and Innovation, a report which illustrates the impact of a partnership facilitated by UKRI India since 2008.**

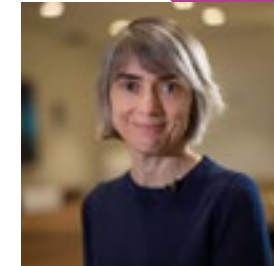
This report is testimony to the shared commitment of the Indian and UK research and innovation communities to work together towards continued excellence in innovation and research. It clearly demonstrates that this partnership is not only one of collaboration and strength, but of transformation which is impacting the lives of people in both our countries and across the globe.

UKRI and India have jointly invested over £330 million, funding over 250 projects and bringing together more than 220 lead institutions from the UK and India. Collaborations have included work on climate, energy, environment, health, societies and culture, and technology-driven innovation and have so far resulted in over 200 technical outputs, including new databases and software.

UKRI-India publications have an average field-weighted citation impact of 2.2, which is more than twice the global average, and 5% of these publications were among the top 1% most-cited publications globally.

The outputs include life-saving medical devices, such as the Microlife CRADLE VSA recognised as one of the top 30 high-impact innovations in the Innovation Countdown 2020 report, Reimagining Global Health. Another example is Safarnama, an app with images and site descriptions, providing a digital heritage experience of Delhi.

This report aligns with the 2030 Roadmap for India-UK future relations, launched by our Prime Ministers in May 2021, with its commitment to generating new knowledge for our economies, and it demonstrates our strong foundations for those ambitions. Our successes to date highlight the effectiveness of our partnership and pave the way for more joint research and innovation which will drive sustainable growth and prosperity for all in the years ahead.



# Foreword

## Professor VijayRaghavan, Principal Scientific Advisor to Government of India

**I welcome this report and congratulate UKRI India for commissioning this analysis.**



As the world battles the pandemic, scientific knowledge and international cooperation usher us into a new era, with greater emphasis on research and innovation.

This report evidences how the co-investments made by India and the UK have helped catalyze the research and innovation bilateral partnership. It sets out what we have done together, through active and continued collaboration between UKRI and Indian research funding partners, like the Department of Atomic Energy (DAE), Department of Biotechnology (DBT), Department of Science and Technology (DST), Indian Council of Historical Research (ICHR), Indian Council of Medical Research (ICMR), Indian Council of Social Science Research (ICSSR) and the Ministry of Earth Sciences (MoES).

These Departments bring together excellence and expertise, and promote transdisciplinary work at national and international frontiers, addressing shared challenges. I am delighted that the strategic visions of each of these departments mentioned above, and many others, are reflected so strongly in their research and innovation portfolios with the UK. Together these partnerships are leading the way to bring academia and industry closer, promote technology-driven innovation and investment in public-private models. The models for bilateral collaboration must also innovate and evolve into instruments which go beyond conventional joint R&D projects; in that sense the UKRI investment and the UKRI office in India allowed the Indian agencies to collaborate beyond the structured realm of bilateral and develop projects which went beyond the convention.

Some of such joint projects across a range of subjects like, environment, renewable energy, innovative solutions to agri-tech, are highlighted in the report, generating impressive outputs of scholarly and societal impact. The paradigm shift needed for bilaterals have been seeded in the India UKRI partnership and we hope to see more dramatic shift in the way bilateral partnership evolve in the future.

I believe this report provides evidence and impetus for continued cooperation and investment between India and the UK to build a secure and sustainable future as well as ways of sustainable and fruitful collaboration.



# introduction

**UKRI India plays a key role in enhancing the UK-India research and innovation relationship. Since 2008, UKRI India (formerly known as RCUK India ) has facilitated research and innovation programmes to the value of over £330 million, with co-funding from the UK, Government of India and third parties.**

For the UK, the projects have involved the seven disciplinary Research councils, InnovateUK and Research England, which now all form part of UK Research and Innovation (UKRI). For India, the departments involved were the Department of Atomic Energy (DAE), Department of Biotechnology (DBT), Department of Science and Technology (DST), Indian Council of Historical Research (ICHR), Indian Council of Medical Research (ICMR), Indian Council of Social Science Research (ICSSR), and Ministry of Earth Sciences (MoES).

UKRI India has commissioned Elsevier to conduct a data-based assessment on the impact of the research projects it has funded in collaboration with India.

The analyses conducted for this project are based primarily on Scopus and Gateway to Research data, discussed further below, complemented by desk research.

## 1.

## Methodology

In this section we outline the sources and processing of the underlying data that have been used in this report. The starting premise for this assessment has been the list of projects provided by UKRI India and the associated outputs from the UK Gateway to Research (GtR) system.

### Data on project overviews

UKRI India provided Elsevier with a list of 258 projects and associated overview data, including project titles, reference numbers, project dates, UK grant amount, lead UK and Indian funders, as well as lead UK and Indian institutions. Some of the projects on the list had more than one reference number and title. These projects were split into separate projects, contributing to the total of 258. Some projects did not list a reference number but were also included in the total. The projects analysed within the scope of this project constitute a large part of this investment (£284m) but not all of it.

### Data on GtR output

The GtR website was developed by UKRI to house information on publicly funded research so that it can be searched and analysed. The data published on GtR are collected from other systems used by the individual funders and include official information on the awarding of funding and inputs from individual researchers on each project. The funders supplying the information are the Arts and Humanities Research Council (AHRC); Biotechnology and Biological Sciences Research Council (BBSRC); Economic and Social Research Council (ESRC); Engineering and Physical Sciences Research (EPSRC); Medical Research Council (MRC); Natural Environment Research Council (NERC); Science and Technology Facilities Council (STFC); Innovate UK; and National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs).

As well as the basic information on each project (e.g., title, funding grant, contact, duration, abstract), GtR also allows input on multiple outcomes. The other outcomes include Artistic and Creative Product; Collaboration; Engagement Activities/Dissemination (Communication); Further Funding; Impact Summary; Intellectual Property; Policy Influence; Product Interventions and Clinical Trials; Publications; Research Databases and Models; Research Tools and Methods; Software and Technical Products; and Spin-offs.

There is a note of caution regarding analysing the GtR data. Because this system is based in the UK and the information came from UK investigators for their reporting purposes, the inputs may be weighted towards UK activity and outcomes. In this study the data on the GtR system have been used as reported. However, a closer inspection of the data sometimes indicates duplicate entries, outputs that may have been better classified within a different category, or inconsistently entered information. While the GtR system does not provide complete and clean data, this quantitative and qualitative output beyond bibliometric data is used to capture the breadth and insights in terms of project outputs, rather than providing a quantitative assessment of the outputs. The bibliometric data are more standardised and can therefore be used more quantitatively, although they have limitations as well. It should also be noted that UKRI projects are funded from core budgets and UKRI allocations under various funds, including the Newton Fund and the Fund for International Collaboration.



## 1.

## Data on bibliometric analyses

Publication data were taken from the GtR output and matched to the Scopus database. Scopus is Elsevier's abstract and citation database of peer-reviewed literature, covering 77.3 million documents published in over 39,000 journals, book series, and conference proceedings by some 5,000 publishers. Scopus coverage is also inclusive across all major research fields, with 13,300 titles in the Physical Sciences, 14,500 in the Health Sciences, 7,300 in the Life Sciences, and 12,500 in the Social Sciences (the latter including some 4,000 Arts & Humanities related titles). The titles covered are predominantly serial publications (journals, trade journals, book series, and conference material), but considerable numbers of conference papers are also covered from stand-alone proceedings volumes (a major dissemination mechanism, particularly in the Computer Sciences). Acknowledging that a great deal of important literature in all fields (but especially in the Social Sciences and Arts & Humanities) is published in books, Scopus began to increase book coverage in 2013. As of 2018, Scopus includes 1.75 million book items, 400,000 of which are in the Social Sciences and 290,000 of which are in Arts & Humanities.

Project reference numbers were also searched in the funding information in Scopus to identify further publications that had acknowledged funding from these projects, but which were not captured in the GtR. An additional 208 publications were identified through the funding acknowledgements.

Publications from the GtR system that were matched to Scopus and additional publications identified from Scopus were merged and deduplicated to obtain a unique set of publications, which formed the basis of the analysis.

## Bibliometric indicators used

Multiple bibliometric indicators were used to analyse the publications. These include the Field-Weighted Citation Impact, Relative Activity Index, publications in top 1% and citations.

**Publications:** Publications were sourced via the GtR website. Further publications were found via Funder Information in Scopus (searching by project reference number). Publications through 2019 were included, as 2019 is the last year of the full data available at the time of analysis.

**Field-Weighted Citation Impact (FWCI):** The FWCI is an indicator of the citation impact of a publication. It is calculated by comparing the number of citations received by a publication with the number of citations expected for a publication of the same document type, publication year, and subject. An FWCI of more than 1.00 indicates that the entity's publications have been cited more than would be expected based on the global average for similar publications; for example, an FWCI score of 2.11 is 111% higher than the world average. An FWCI of less than 1.00 indicates that the entity's publications have been cited less than would be expected based on the global average for similar publications; for example, 0.87 means 13% less than the world average.

**Relative Activity Index (RAI):** The RAI is defined as the share of an entity's output in a particular field relative to the share of the world's output in that same field. It therefore represents how concentrated an entity's output is in a particular area relative to the world average.

**Top 1% publications** are those among the top 1% based on the FWCI of all articles published and cited in a given period. An institution's number or share of highly cited articles is treated as indicative of the excellence of their research; thus, if an institution has more than 1% of its articles in the top 1% overall, this is considered a positive sign of research excellence.

**Topics:** A Topic is a collection of documents with a common focused intellectual interest, and it can be large or small, new or old, growing or declining. Over time, new Topics will surface, and because Topics are dynamic, they will evolve. Many Topics are multidisciplinary, and old Topics may be dormant yet still exist. In addition, researchers themselves are mobile and work in various different research areas, and they thereby contribute to multiple Topics. Scopus publications are clustered into Topics based upon a direct citation analysis. Where there is a weak citation link, there is a break and a new Topic is formed.

**Topic Clusters:** Topic Clusters are formed by aggregating Topics with similar research interests together to form a broader, higher-level area of research. These Topic Clusters can be used to get a broader understanding of the research being done by a country, institution (or group), or researcher (or group), before drilling down into the more niche underlying Topics. Each of the 96,000 Topics have been matched with one of the 1,500 Topic Clusters. As with Topics, a researcher or institution can contribute to multiple Topic Clusters, but a Topic can only belong to one Topic Cluster and a publication can only belong to one Topic (and therefore one Topic Cluster).

# 1.



Prominence gives an indication of momentum and is not a quality indicator. Due to the nature of certain research fields there are Topics that will never become “Prominent”; however, this doesn’t necessarily mean that the Topic is not important. Calculating a Topic’s Prominence combines three metrics to indicate the momentum of the Topic:

- Citation count in year n to papers published in n and n-1
- Scopus views count in year n to papers published in n and n-1
- Average CiteScore for year n

CiteScore metrics calculate the citations from all documents in year one to all documents published in the prior three years for a title.

### **Additional sources used**

SciVal offers quick, easy access to the research performance of over 12,000 research institutions and 230 nations worldwide. SciVal is based on output and usage data from Scopus, the world’s largest abstract and citation database for peer-reviewed publications. It offers a broad spectrum of industry-accepted and easy-to-interpret metrics including Snowball Metrics, which are global standard metrics defined and agreed by higher education institutions for institutional strategic decision-making through benchmarking. Metrics in SciVal help the institutions to measure an institution’s or a country’s productivity, citation impact, collaboration, subject disciplinaryity, and more.

PlumX Metrics provide insights into the ways people interact with individual pieces of research output in the online environment. Examples include research being mentioned in the news or tweeted about. These metrics are divided into five categories (citations, usage, captures, mentions, social media) to help make sense of the huge amounts of data involved and to enable analysis by comparing like with like. More information is available at <https://plumanalytics.com/learn/about-metrics>.

# 2.

## Portfolio Overview

**UKRI India joint funding resulted in 258 projects, with over £150 million in funding from the UK and matched resources from Indian counterparts.**



In this section we outline an overview of the projects based on the input from the GtR system. As a result, some of the data presented here will be limited to the UK, which will be indicated as such where appropriate.

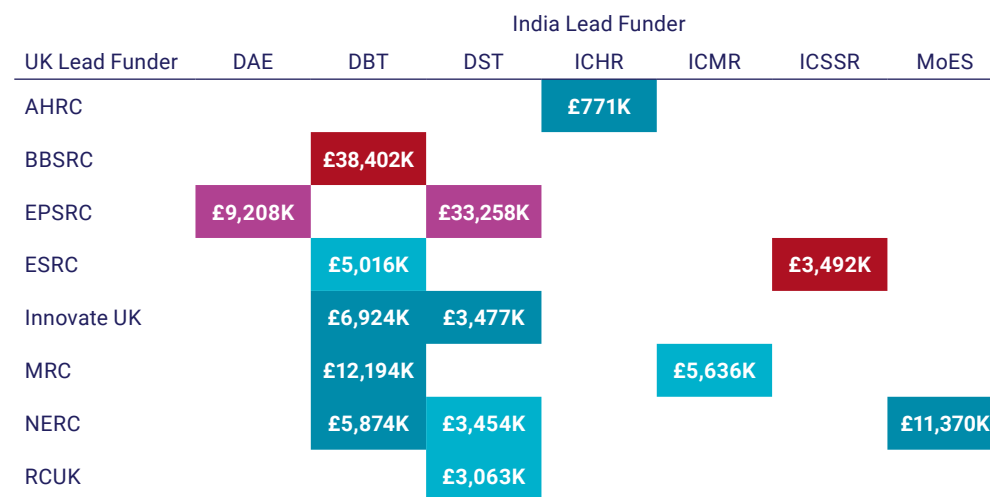
Overall, 258 projects were included in this analysis, starting from 2009. These projects received over £150 million in funding from the UK, with matched resources from Indian counterparts.

The highest number of projects were between BBSRC and DBT (44 projects) (FIGURE 1). In terms of the project funding received, BBSRC–DBT and EPSRC–DST funded projects received considerably more funding (FIGURE 2). Finally, ESRC–ICSSR joint funded initiative supported numerous exchange visits.

UK Lead Funder	India Lead Funder							
	DAE	DBT	DST	ICHR	ICMR	ICSSR	MoES	Sarai
AHRC				12				5
BBSRC		44						
EPSRC	26		30					
ESRC		4				45		
Innovate UK		14	12					
MRC		17			6			
NERC		11	8				17	
RCUK			3					
STFC	2		1					

**FIGURE 1:** Further funding raised by UKRI India projects, grouped by sector of funder. Note: Sarai at CSDS was part of AHRC’s (pilot) International Placement Scheme in India. Source: Gateway to Research

# 2.



**FIGURE 2:** Amount of UK project funding per funder pair. It should be noted that prior to the formation of UKRI, Research Councils together were known as Research Councils UK (RCUK). Some bilateral projects brought more than one council together and worked under the RCUK programme banners, such as RCUK Energy and RCUK Digital Economy *Source: Gateway to Research*

The diversity of the funders was also reflected in terms of participating institutions from both countries, across different sectors (academic, government, and corporate). Most of the UK universities among the top 10 project or funding receivers were also in top positions in terms of scholarly output in the UK (TABLE 1). For India, the Indian Institutes of Technology (IITs) positioned high both in terms of project numbers and funding, and this is aligned with the overall scholarly output from these institutions as well. Institutions such as the National Physical Laboratory and International Centre for Genetic Engineering and Biotechnology had fewer projects in number, but these projects received significant amounts of funding (TABLE 2).

Lead UK Institution	Lead India Institution
Imperial College London	Bhabha Atomic Research Centre
The University of Manchester	Indian Institute of Technology Madras
University of Nottingham	Indian Institute of Technology Delhi
University of Liverpool	Indian Institute of Technology Bombay
University of Edinburgh	Indian Institute of Science Bangalore
University of Cambridge	University of Delhi
King's College London	Indian Institute of Technology Roorkee
University of Southampton	Jawaharlal Nehru University
University of Birmingham	Indira Gandhi Centre for Atomic Research
Heriot-Watt University	Indian Institute of Technology Kharagpur

**TABLE 1:** Top 10 lead institutions by count of projects. *Source: Gateway to Research*

Lead UK Institution	Lead India Institution
Loughborough University	Indian Institute of Technology Bombay
Imperial College London	Indian Institute of Technology Delhi
University of Nottingham	Bhabha Atomic Research Centre
University of Cambridge	Indian Institute of Science Bangalore
University of Edinburgh	University of Delhi
University of York	National Physical Laboratory (Delhi)
University of Liverpool	Indian Institute of Technology Roorkee
The University of Manchester	Indian Institute of Technology Madras
King's College London	International Centre for Genetic Engineering and Biotechnology
Heriot-Watt University	Indian Institute of Technology Kharagpur

**TABLE 2:** Top 10 lead institutions by total amount of project funding. *Source: Gateway to Research*

## 3.

## Theme: Climate, Energy and Environment

**UKRI India funded projects contributed to the global discussion of climate change, with publications highly cited in relation to climate models, disasters, and solar energy.**

UKRI India collaborations had a significant focus on areas addressing climate change, focusing on areas such as green energy, environmental protections, and human–climate interaction. The importance of addressing climate change was underlined by the 2016 signing of the Paris Agreement. This legally binding international treaty on climate change, with the goal of limiting global warming, was signed by almost 200 parties, including the UK and India.<sup>1</sup> The UK was the “first major economy to legislate for net zero emissions by 2050”,<sup>2</sup> and India has also committed to cut its greenhouse emissions by 33%–35% from 2005 levels by 2030.<sup>3</sup> Reflecting the importance of addressing climate change, UKRI India projects had a strong focus on ways to combat climate change, especially in terms of Climate Action and Clean Energy, which matched with the Sustainable Development Goals (SDGs) of Affordable and Clean Energy (SDG7) and Climate Action (SDG13).

The UKRI India projects addressing climate change span multiple areas of research, indicating the complex and interlinked issues related to climate change. These projects can generally be grouped into three categories: clean energy, understanding the natural world, and agricultural intervention. For example, in agriculture, over the last decades, nitrogen-based fertilisers played an important role in increasing the yield of food crops; however, the overuse of these fertilisers also contributes to climate change. The CINTRIN project was an important collaboration in this area. It was funded by the BBSRC, NERC and DBT under the Newton Bhabha Fund, and led by the National Institute of Agricultural Botany, UK, and the International Crops Research Institute for the Semi-Arid Tropics, India, together with other partners. The project not only enabled the selection of new cereal crop varieties but also provided practical and accessible advice concerning the application of nitrogen, with the aim of reducing the inputs with minimal impact on productivity.

Understanding the actions of the environment, human and its impact on each other, is crucial to sustainable development. UKRI India projects had a strong emphasis on combating climate change through a deeper understanding of the natural world, addressing global concerns such as monsoons, air pollution, and sustainable water. Climate action related publications had a large impact in the academic sector. According to SciVal, the Topic Cluster of Climate Models: Model; Rainfall contained 68 UKRI India publications. These publications had an FWCI impact of 3.1, over twice as high as the world FWCI for this Topic Cluster (1.1), showing the high impact of UKRI India publications in this topic. The Topic Cluster Disasters; Floods; Risks contained only three UKRI India publications, but those three had a combined FWCI of 10.0, compared with a world FWCI of 1.2 for this Topic Cluster.

<sup>1</sup> <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

<sup>2</sup> <https://www.gov.uk/government/news/uk-sets-ambitious-new-climate-target-ahead-of-un-summit>

<sup>3</sup> <https://www.carbonbrief.org/the-carbon-brief-profile-india>

# 3.

These projects also produced outputs that moved closer to addressing the root causes of climate change and suggested ways to mitigate negative impacts. The monsoon projects investigated methods to forecast where, when, and how intensely monsoon downpours will occur, and to protect livelihoods and human life. Two databases were developed to provide technical readings to help researchers, and there were 25 engagement outputs, including a press release announcing the INCOMPASS project, a presentation at the UK House of Commons, and a press briefing at the Indian Ministry of Earth Sciences.

Creating new sources of clean energy is an essential part of contributing to the Paris Agreement and UN SDGs. UKRI India had a significant positive output in terms of Energy publications, with an RAI over seven times the world average in this subject.

The UKRI India Energy projects all approached the subject in a different way, but ultimately attempted to improve clean energy and energy stability. For example, UKRI India solar energy publications were highly impactful, with two Topic Clusters in SciVal showing higher than world average FWCI for the UKRI India publications. There were 77 UKRI India publications in the Topic Cluster Photocatalysis; Photocatalysts; Solar Cells, with an FWCI of 6.2 compared to the world FWCI of 1.1 in this Topic Cluster. The 44 UKRI India publications in the Topic Cluster Organic Light Emitting Diodes (OLED); Solar Cells; Conjugated Polymers had an FWCI 3.5, compared to a world FWCI of 1.4 in this Topic Cluster.

A significant factor for many of these UKRI India projects was the collaboration of multiple groups to combat climate change. For example, the Joint UK-India Clean Energy Centre (JUICE), funded by EPSRC and DST with the Newton Bhabha Fund, brought together experts to develop integrated solutions to ensure that the value of solar energy generation is optimised in both India and the UK. It consisted of a consortium of 10 UK universities, led by Loughborough University, in partnership with 14 Indian institutes, including the Indian Institute of Technology Bombay and Indian Institute of Technology Kharagpur. Similarly, the India-UK Water Centre was established to promote cooperation and collaboration between NERC and MoES in water security research, under the Newton Bhabha Fund. The centre brought together researchers for six workshops between 2016 and 2019, as well as 13 exchanges for researchers to share knowledge and develop further activities.<sup>4</sup>

UKRI India projects contributed research towards combating climate change, thereby also helping India and the UK meet the goals of the Paris Agreement. Much of the research started in these projects will inform future research and climate action. For example, the Development and Integration of Biomass and Concentrating Photovoltaic System for Rural and Urban Energy Bridge (BioCPV) project has an environment-related outcome through a spin-off company that sells a glass block for use in construction. The glass block generates electricity using solar energy<sup>5</sup> and has influenced further research through the BioCPV project, resulting in 30 publications that have been cited 702 times in 76 countries. The research from UKRI India projects will continue to pave the way for the development of clean, safe, affordable energy as well as greater understanding of the changing climate.

<sup>4</sup> <https://iukwc.org/>

<sup>5</sup> <https://www.buildsolar.co.uk/>



## 3.

## Case Study 3.1

### Drivers of Variability in the South Asian Monsoon

#### Background

South Asia's annual monsoon provides vital rainfall for well over a billion people, who depend on monsoon rains for subsistence agriculture and freshwater. At the same time, monsoons can also trigger deadly, destructive floods. The ability to forecast where and when intense downpours and breaks in the monsoon will occur could transform flood and drought planning. Similarly, in protecting lives and livelihoods, the ability to make accurate monsoon predictions months or years in advance would be a genuine game-changer. Making all of this possible means developing a much deeper understanding of the interface and interactions between sea and atmosphere in the Indian Ocean, with global implications for managing rainfall and climate.

#### Solution

The Drivers of Variability in the South Asian Monsoon programme integrated capabilities from the UK and India to gather land, sea, and atmospheric data to help deliver a decisive step forward in monsoon forecasting. Led by the UK's NERC and the Government of India's MoES, the programme comprised three distinct but interlinked projects: Bay of Bengal Boundary Layer Experiment (BoBBLE), Interaction of Convective Organization and Monsoon Precipitation, Atmosphere, Surface and Sea (INCOMPASS), and South West Asian Aerosol Monsoon Interactions (SWAAMI).

The programme has deployed aircraft, ships, and subsea robots to collect an extraordinary variety of physical, chemical, and biological data. It used a UK research aircraft provided by the Facility for Airborne Atmospheric Measurements (FAAM) and equipped with a range of high-tech sensing equipment, and India's multidisciplinary oceanographic research vessel the RV Sindhu Sadhana. The data collected, covering everything from atmospheric moisture to seawater salinity, temperature and chlorophyll content, will help unlock key mysteries surrounding the processes driving the monsoon system.

#### Outcomes

The monsoon projects provided an investigation in methods to forecast where, when, and how intensely monsoon downpours will occur to help mitigate climate change and to protect livelihoods and human life. As well as 26 publications indexed in Scopus, the projects resulted in the development of two databases providing technical readings to help researchers. The FAAM aircraft observations provided 22 datasets, providing raw and processed instrument data, as well as radiosonde and in-situ airborne observations. In total, 25 engagement outputs were reported, including a press release announcing the INCOMPASS project, a presentation at the UK House of Commons, and a press briefing at the Indian Ministry of Earth Sciences. During the course of the projects, trainings were provided for Indian scientists in the use of sea gliders for oceanographic research.



UK-India team with former Indian Science Minister Dr Harsh Vardhan. Photo credit: UKRI India

## 3.

## Case Study 3.2

# Atmospheric Pollution and Human Health in an Indian Megacity

Air pollution causes over 4 million deaths each year, and 9 out of 10 people breathe air that exceeds World Health Organization (WHO) guideline limits, making it a major concern for both the environment and human health.<sup>6</sup> UKRI India addressed this urgent problem with the Atmospheric Pollution and Human Health in an Indian Megacity programme. Made up of five projects funded by NERC and MoES, with additional funds from MRC and DBT, under the Newton Bhabha Fund, it researched the link between climate change, pollution, and health by researching various aspects of air pollution. With 18 publications and almost 40 other engagements, this project had both scholarly and community impact, including radio interviews on the BBC in the UK, television interviews on NDTV in India, and presentations at formal societies and conferences.

The *DelhiFlux* project presented at 14 national and international conferences and created a website, along with the other projects, as a channel to inform the general public, policymakers, and other academics about the research activities of the Atmospheric Pollution and Human Health in an Indian Megacity programme. The success of the *DelhiFlux* project also created further opportunities, with further funding of £17.5 million to establish the GCRF South Asian Nitrogen Hub.

The programme also had impacts in policy and technology, which could have immediate effect on the reduction of air pollution. The *CADTIME* project helped form new national guidelines on air pollution in the UK, contributing to NICE Guideline (NG70) Air pollution in 2017.<sup>7</sup> The *PROMOTE* project contributed to new research methods through a modelling system developed for Delhi to simulate air pollution in order to analyse options for reducing it in the city; the project also developed a novel low-cost optical particle counter to gain greater understanding of the spatial distribution of particulate matter.

The *DAPHNE* project collaborated with select non-academic partners to test unique wearable sensor technology for contemporaneous personal particulate matter exposure and respiratory rate/flow monitoring and sensor data analytics. The researchers collaborated with British Heart Foundation to provide the wearable

Airspeck monitors to a select number of MPs in the Westminster Parliament with an interest in environmental issues. The MPs could then collect personal exposure data in their constituencies and thereby make informed contributions to the debate on the second reading of the Environment Bill in February 2020. A second collaboration teamed with the World Resources Institute in two cities in Mexico, Leon and Guadalajara, to provide personal exposure data to inform policies in developing ultra-low emission zones in the city centres. The *Atmospheric Pollution and Human Health in an Indian Megacity* programme developed data, technology, collaborations, and methods that are helping to reduce atmospheric pollution and increase quality of life.

<sup>6</sup> [https://www.who.int/health-topics/air-pollution#tab=tab\\_1](https://www.who.int/health-topics/air-pollution#tab=tab_1)

<sup>7</sup> <https://www.nice.org.uk/guidance/ng70>



## 3.

## Case Study 3.3

### Sustainable Energy

An important factor in addressing climate change is the creation of clean energy and the reduction of energy demand. UKRI India had a significant output in terms of Energy publications, with a RAI over seven times the world average in this subject. Four projects funded by EPSRC and DST under the Newton Bhabha Fund<sup>8</sup> investigated energy from multiple angles. For example, the *JUICE* project brought together experts to develop integrated solutions to ensure that the value of solar energy generation is optimised in both India and the UK. **Funded as a £5 million programme, it raised a further funding of over £72 million** and produced over 75 publications and eight new databases or models. It also had strong outreach, conducting trainings for engineers in Chile and Malaysia, as well as participating in policy discussions as part of the EPSRC Energy Scientific Advisory Committee and a DFID scoping meeting on proposed international research funding on energy storage. UKRI India solar energy publications were highly impactful, with two Topic Clusters showing higher than world average FWCI for the UKRI India publications.

The *RESIDE* project tackled clean energy through developing a residential building code for high-quality, low-energy housing, and it has led to deep collaboration between UK and Indian partners for the development of bespoke solutions for tackling the growing residential energy demand and associated CO2 emissions in India. The project developed a new approach for gathering large-scale data on residential energy, creating an extensive database and finding that the sociology and psychology of energy use in dwellings needs attention, as much as measurement of residential energy use, in order to better understand the patterns of energy use and manage reductions. The *HEAPD* project investigated how DC networks can increase the efficiency of renewable energy-storage systems, creating four new pieces of software and four new databases, and participating in multiple committees and providing evidence to such as bodies as Ofgem, the UK energy regulator, and a submission to a UK House of Lords enquiry. The *HEAPD* project produced 63 publications as well as gaining £65.4 million in further funding to continue the work started with this £1 million project.

The *Mind the Gap* project focused on fuel cell research and development, and it developed intellectual property for a new fuel cell assembly, filing multiple patents. The results from this project are being used by industrial project partners in developing new fuel cells and modifying systems to operate in new environments. Developing clean energy sources and ways to decrease and stabilise energy consumption ultimately leads to a reduction in climate change as well as boosting the economy and improving lives.



FIGURE 3: Logos from UKRI India energy projects

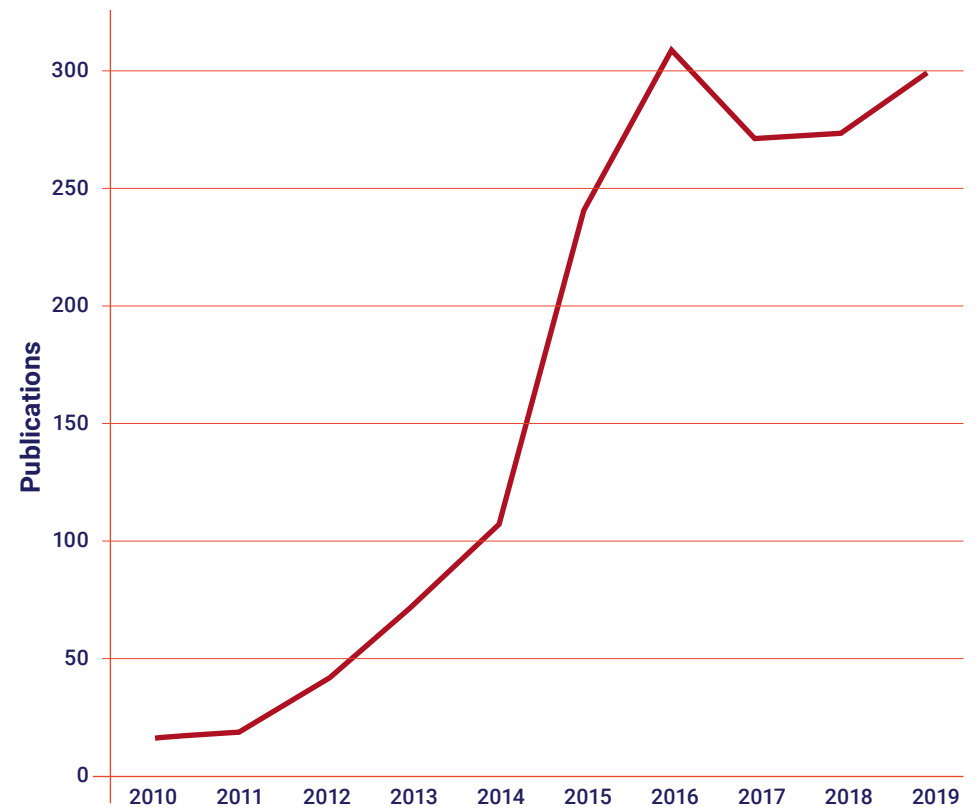
<sup>8</sup> Joint UK-India Clean Energy Centre (JUICE) (EP/P003605/1); High Energy And Power Density (HEAPD) Solutions to Large Energy Deficits (EP/K036211/1); Residential building energy demand reduction in India (RESIDE) (EP/R008434/1); "Mind the Gap" - jumping the hurdles limiting polymer fuel cell performance and commercialisation (EP/I037024/1)

## 4.

## Scholarly Output

Over 1,600 scholarly outputs were published, mainly in the fields of Engineering, Energy, and Materials Science.

The publication list received from GtR was matched against Scopus. Further publications were added to this list by querying Scopus funding acknowledgements, which led to a total of 1,665 publications between 2010 and 2019, with a growth trend (FIGURE 4). The number of publications grew significantly between 2010 and 2016, and stabilised thereafter, which may be linked to the project funding cycles and the associated outcomes.

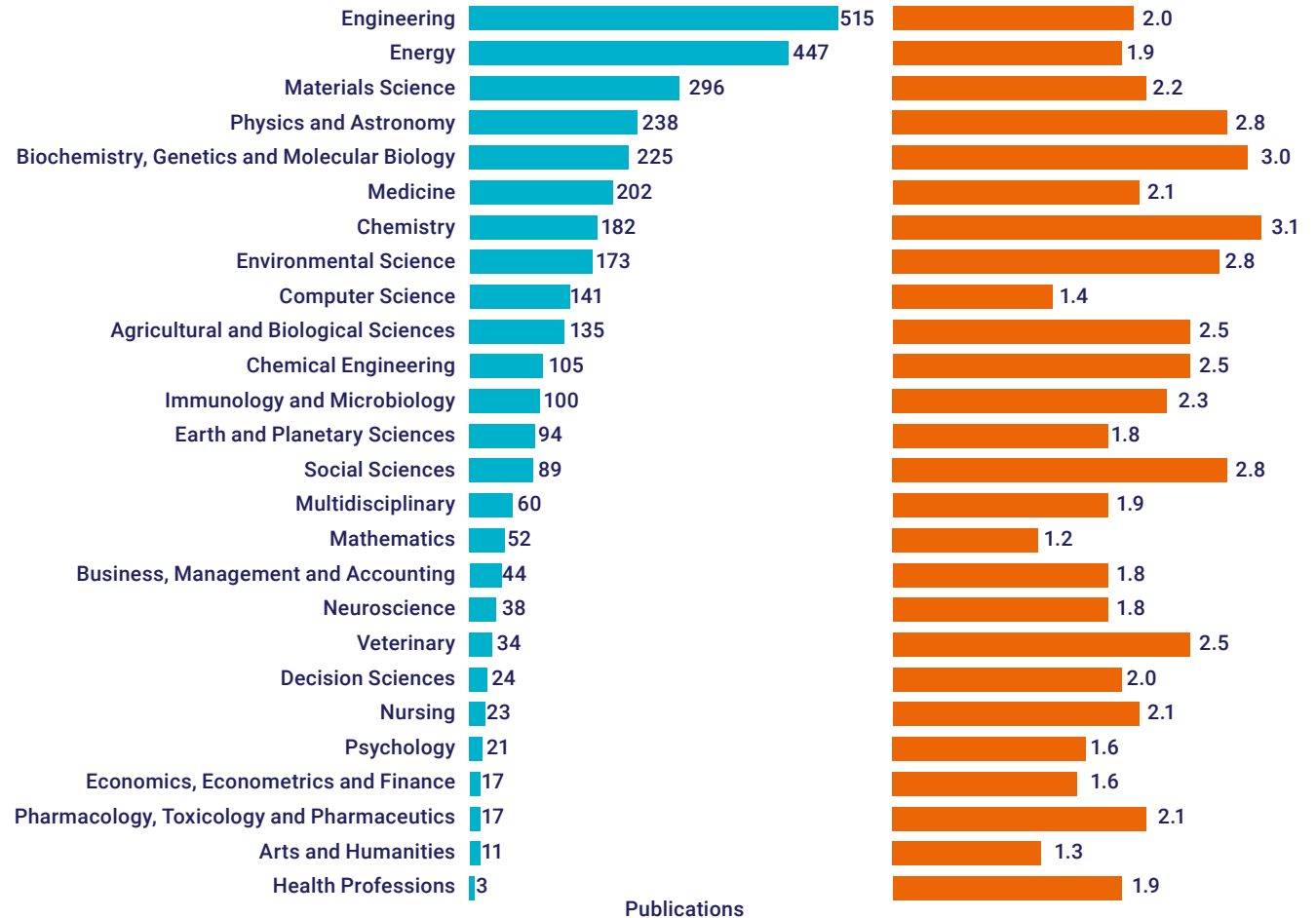


**FIGURE 4:** Annual number of publications per year, resulting from UKRI India funded publications, 2010–2019. (Source: Scopus)

# 4.

Most of the publications were in the subjects of Engineering, Energy, and Materials Science (FIGURE 5). Within these broader subjects, there was concentration around the subfields of Electrical and Electronic Engineering, Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, General Materials Science, and Mechanical Engineering. Overall, publications were spread across 228 subfields, from 334 existing categories. It should be noted that a publication can be assigned to more than one subject area, which is why the total of publications across different subjects will be larger than the total number of publications.

Scholarly impact was highest in Chemistry; Biochemistry, Genetics and Molecular Biology; Social Sciences; and Physics and Astronomy.

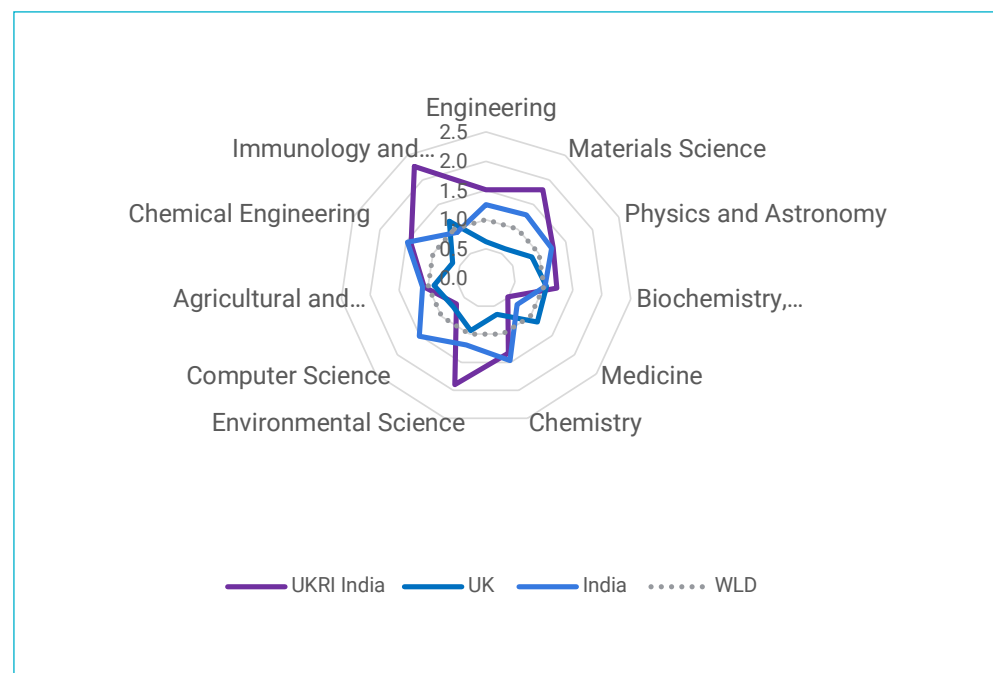
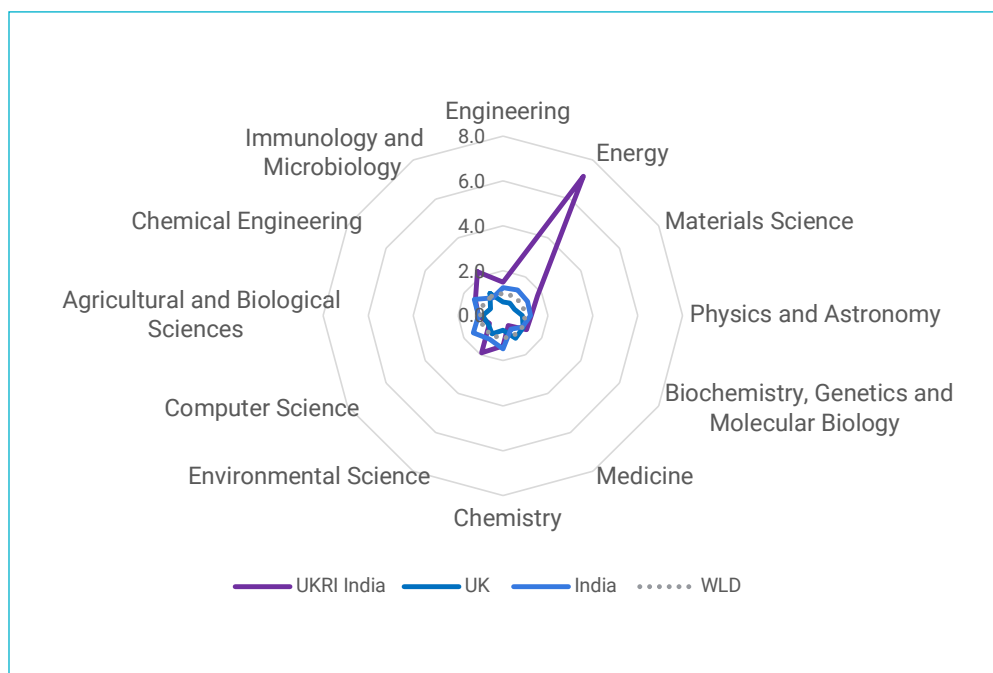


**FIGURE 5:** Number of publications and FWCI per All Science Journal Classification (ASJC) subject area, 2010–2019. Only subject areas with more than 10 publications were included. *Source: Scopus*

# 4.

As mentioned in section 1, the RAI is calculated by dividing the share of an entity's output in a particular field relative to the share of the world's output in that same field. It therefore represents how concentrated an entity's output is in a particular area relative to the world average.

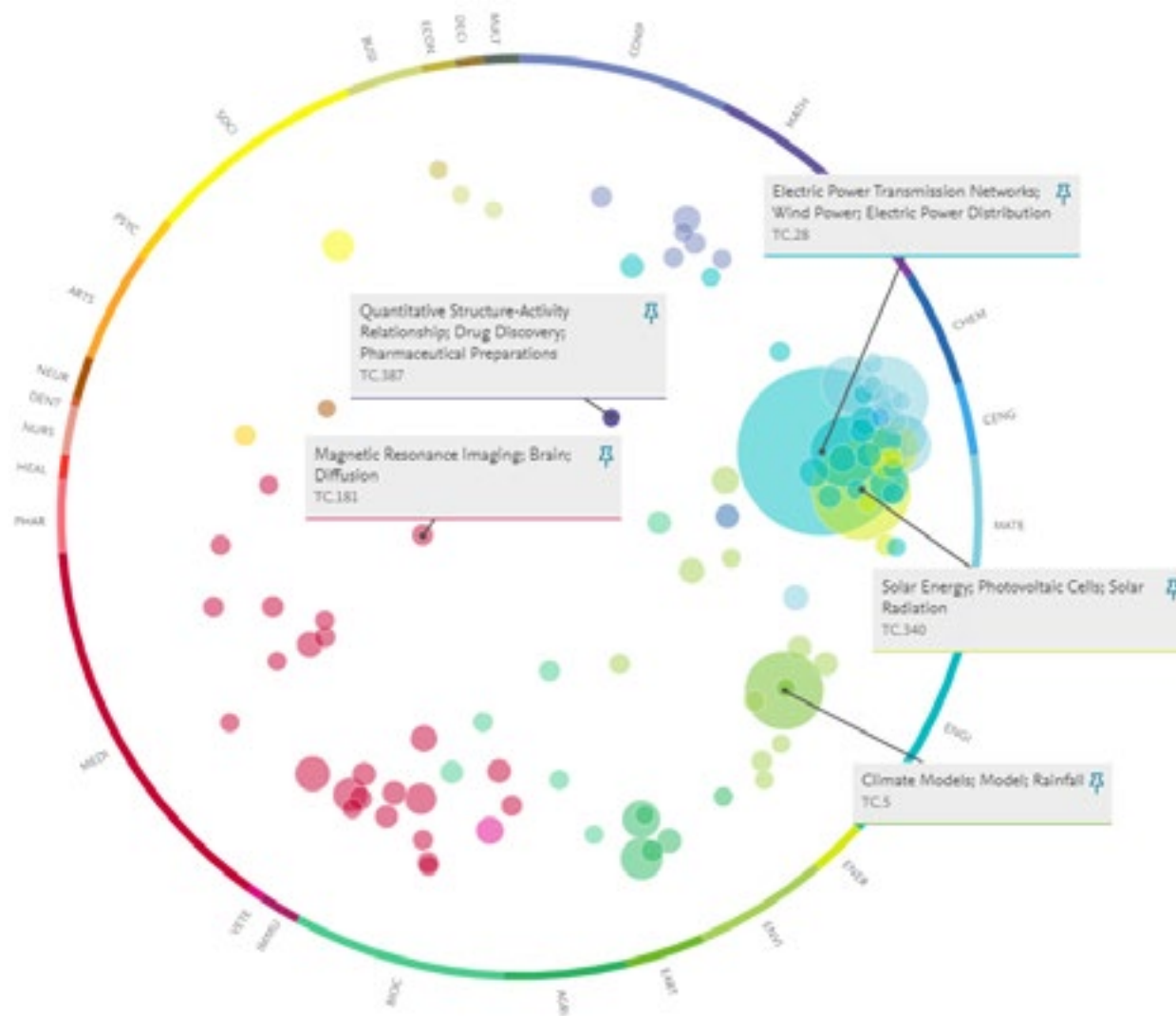
Looking at the RAI (FIGURE 6), we observe that publications resulting from UKRI India funded projects are seven times more concentrated on Energy compared to the world, which also suggests that UK and Indian counterparts are important contributors to global research in this field. During the 2010–2019 period, 3.7% of all publications globally were in Energy, whereas this figure was 26.8% for the UKRI India funded publications. After Energy, the next two subjects with a relatively high share of UKRI India funded publications were Immunology and Microbiology and Environmental Science.



**FIGURE 6:** Relative Activity Index of UKRI India funded publications compared to the UK, India, and world, 2010–2019. Bottom chart shows the RAI with the Energy subject removed. Source: Scopus

# 4.

A complementary view to the disciplinary subject classifications is the view from a Topics perspective. Publications resulting from UKRI India funded projects were associated with 304 Topic Clusters and 754 Topics. The largest Topic Cluster was Electric Power Transmission Networks; Wind Power; Electric Power Distribution, with 166 publications, followed by Solar Energy; Photovoltaic Cells; Solar Radiation, with 99 publications.



**FIGURE 7:** Representation of the top 100 Topic Clusters distribution for UKRI India funded publications. Each bubble represents a Topic Cluster, the bubble size indicates the scholarly output from this entity in that Topic Cluster, and the bubble position indicates proximity to ASJC subject areas. Source: Scopus data via SciVal

# 4.

Topic Cluster	Scholarly Output	FWCI	Prominence percentile
Electric Power Transmission Networks; Wind Power; Electric Power Distribution	166	1.99	99.40
Solar Energy; Photovoltaic Cells; Solar Radiation	90	1.64	94.58
Photocatalysis; Photocatalysts; Solar Cells	77	6.2	99.93
Climate Models; Model; Rainfall	68	3.1	99.00
Electric Potential; Electric Inverters; DC-DC Converters	59	1.59	98.46
Solid Oxide Fuel Cells (SOFC); Ytria Stabilized Zirconia; Perovskite	48	1	93.24
Organic Light Emitting Diodes (OLED); Solar Cells; Conjugated Polymers	44	3.53	99.13
Proton Exchange Membrane Fuel Cells (PEMFC); Electrocatalysts; Electrolytic Reduction	39	1.65	95.72
Microstructure; Steel; Austenite	30	1.38	97.46
Wheat; Triticum; Triticum Aestivum	29	4.92	59.24
Boiling Liquids; Heat Transfer; Two Phase Flow	25	1.15	84.14
Arabidopsis; Plants; Genes	24	3.02	98.66
Pregnancy; Pre-Eclampsia; Women	21	5.36	90.76
Vaccination; Vaccines; Immunization	20	2.32	75.97
India; Indian; Politics	18	1.31	41.97
Dengue; Viruses; Dengue Virus	17	1.22	94.85
Glass; Glass Ceramics; Silicates	17	0.7	60.11
Welding; Friction Stir Welding; Welds	15	1.82	87.55
Zirconium Alloys; Fuels; Nuclear Fuels	15	1.42	50.87
Ships; Offshore Structures; Navigation	15	0.84	39.63
Electric Power Transmission Networks; Wind Power; Electric Power Distribution	166	1.99	99.40

**TABLE 3:** Top 20 topics of publications resulting from UKRI India funded projects.  
Source: Scopus data via SciVal

Publications within Electric Power Transmission Networks; Wind Power; Electric Power Distribution were driven mainly by the following three projects, which were funded by EPSRC and DST.

- Advanced Communication and Control for the Prevention of Blackouts (ACCEPT), led by the University of Manchester and IIT Delhi: 68 publications
- High Energy and Power Density (HEAPD) Solutions to Large Energy Deficits, led by the University of Bath and IIT Roorkee: 44 publications
- Joint UK-India Clean Energy Centre (JUICE), led by the Loughborough University and IIT Bombay: 23 publications

Some of the other publications in the Energy-related Topic Clusters were also funded by EPSRC-DST.

# 4.

Publications from the projects represented over 6,000 authors, affiliated to over 1,100 institutions from 91 countries (FIGURE 8), indicating that the projects reached far beyond audiences in the UK and India.



**FIGURE 8:** Distribution of UKRI India funded publications per country. *Source: Scopus*

# 4.

When we look into the top institutions according to the number of publications resulting from joint funding, we see that more publications are reported for the UK than for Indian institutions. This is likely to be driven by the fact that GtR is a UK-based system, where the inputs are entered by UK researchers, which may result in the overrepresentation of UK outputs in the database. If we consider the top UK institutions that have published under joint programmes, we see that most of those institutions are among the top publishers for the UK in general and for UK-India joint collaborations in particular [TABLE 4]. Other institutions also, feature highly here, whereas these are not so visible in the overall UK-India collaborations, which may indicate that the joint funding is contributing to the expansion of research collaborations. For the Indian institutions, the same can be said for the Bhabha Atomic Research Center, Indian Veterinary Research Institute, and Academy of Scientific and Innovative Research [TABLE 5].

UK Institution	Scholarly Output
Imperial College London	248
University of Cambridge	130
University of Manchester	117
University of Nottingham	95
University of Exeter	92
King's College London	87
Loughborough University	86
University of Bath	72
University College London	70
University of Southampton	70

**TABLE 4:** Top 10 UK institutions by scholarly outputs resulting from UKRI India funded projects, 2010–2019/ *Source: Scopus*

Lead India Institution	Scholarly Output
Indian Institute of Technology, Delhi	38
Indian Institute of Technology, Madras	36
Bhabha Atomic Research Centre	25
Indian Institute of Technology, Kanpur	25
Indian Institute of Technology, Kharagpur	25
Indian Institute of Technology, Bombay	23
Indian Institute of Science Bangalore	22
CSIR- Indian Institute of Chemical Technology	17
Indian Veterinary Research Institute	17
Academy of Scientific and Innovative Research	17

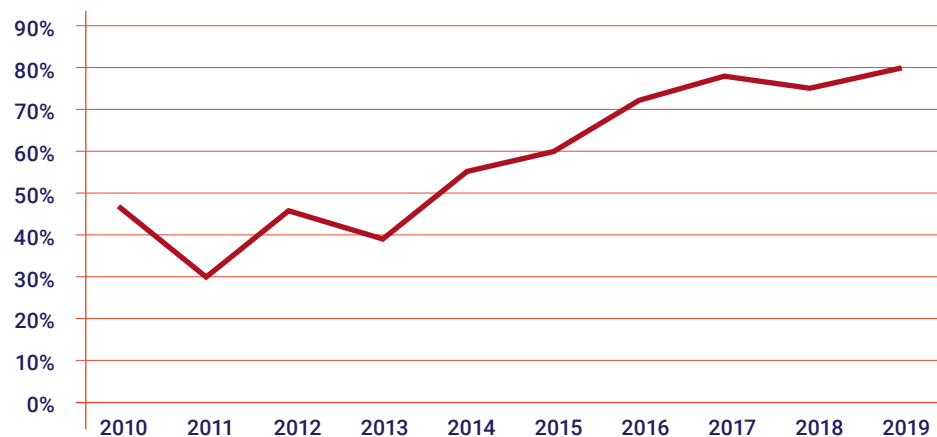
**TABLE 5:** Top 10 Indian institutions by scholarly outputs resulting from UKRI India funded projects, 2010–2019. *Source: Scopus*



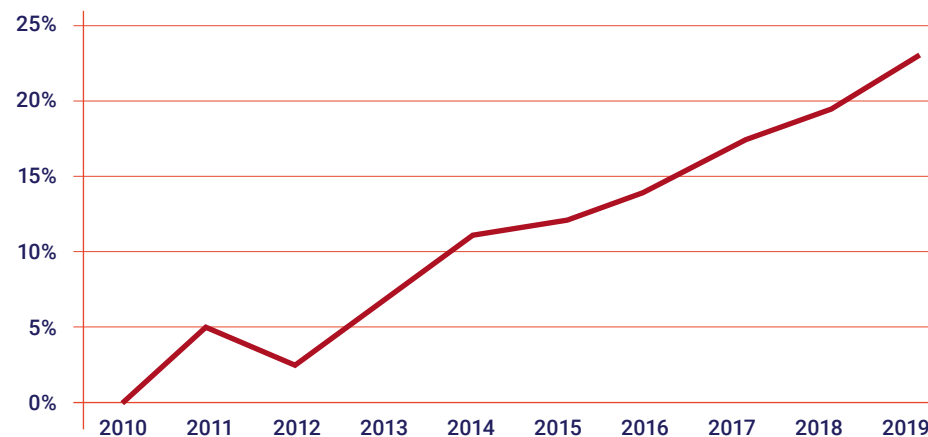
# 4.

## Open access

Overall, 69% of the UKRI India publications were available in open access, which is much higher than the shares for the UK, (49.4%), India (23.7%), and the world (31.1%). The share of open access publications among all UKRI India publications increased from 30% to 80% between 2011 and 2019 (FIGURE 9), and the share of gold open access publications increased from 6% to 23% in the same period (FIGURE 10). This is considerably higher than the global averages: during 2010–2019, 31% of global publications were open access, whereas 10% were published as gold open access.



**FIGURE 9:** Share of open access publications among all publications from UKRI India funded projects, 2010–2019. *Source: Scopus*



**FIGURE 10:** Share of gold open access publications among all publications from UKRI India funded projects, 2010–2019. *Source: Scopus*

## 5.

## Scholarly Impact and Excellence

**The scholarly impact of UKRI India funded publications was noted on average, twice as high as the global average. Furthermore, 5% of the publications were in the top 1% most cited publications globally, higher than both the UK and Indian averages.**

There were 1,665 UKRI publications extracted for bibliometrics, resulting in 39,726 citations. The publications had an average FWCI of 2.2, which is 120% better than the global average FWCI of 1.0. Almost 95% of publications have received at least one citation.

Publications resulting from joint-funded research were also cited at above the UK and India averages, again indicating the broader impact of the joint research. In all, 1,663 documents from the period 2010–2019 were cited over 35,000 times globally. China, United States, the UK, and India were the most cited countries, which is not surprising as these countries are also some of the most published countries globally. Overall, 160 countries have cited publications resulting from UKRI India projects (FIGURE 11).

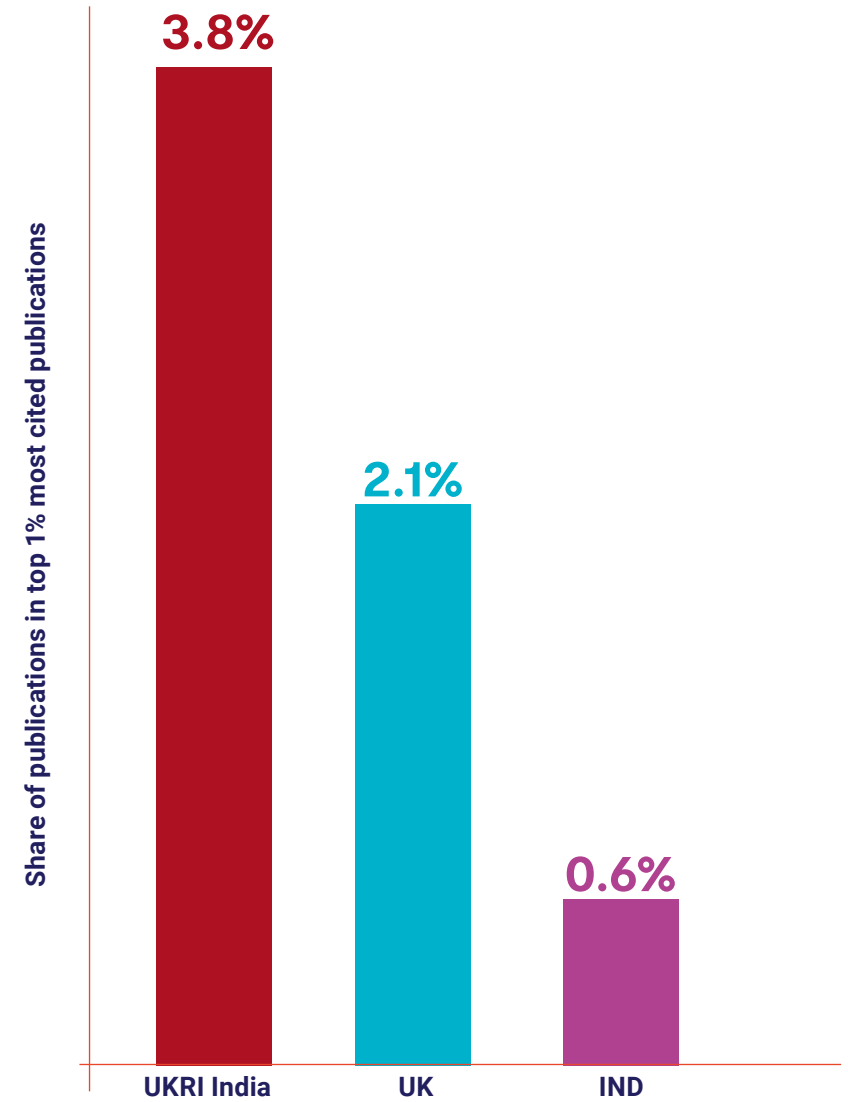
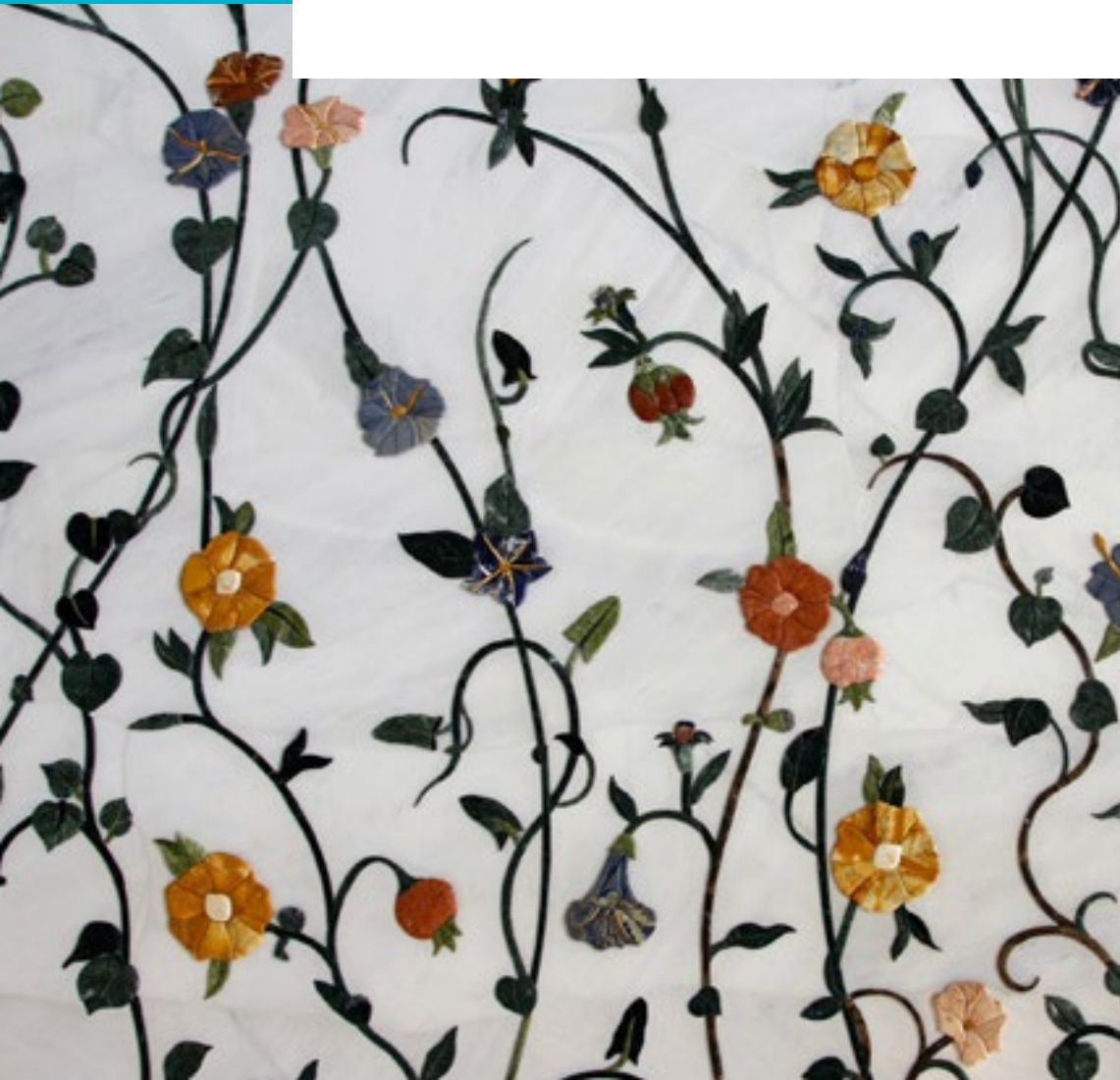


**FIGURE 11:** Global distribution of the citations made to the UKRI India funded publications. Size of the bubble indicates the number of citations from that country. *Source: Scopus*



# 5.

Another indicator of scholarly excellence is the share of publications that are among the top 1% most cited publications globally. The share of UKRI India funded publications that are among the top 1% most cited publications was 3.8%, which is much higher than the global average of 1% but also higher than the shares for the UK (2.1%) and India (0.6%) (FIGURE 12).



**FIGURE 12:** Share of UKRI India funded publications that are among the top 1% most cited publications globally, 2010–2019. Source: Scopus

# 6.

## Theme: Healthy Societies

**UKRI India funded projects contributed to a healthier society through conducting research, developing products, and providing guidance, and contributed to technological and societal development, gender equality, and economic enhancement.**

### Background

UKRI India projects investigated multiple ways to improve the health of people and societies. The COVID-19 crisis has underlined the importance of quality universal healthcare globally, and both India and the UK have invested in creating more integrated, progressive healthcare that benefits society. UKRI India collaborations work to ease the burden of disease and develop more robust and inclusive health outcomes in India and the UK, with global implications from many of the projects. Projects centred on health included medical interventions, such as those to help improve outcomes for pregnant women in rural locations, studies on the link between nutrition and children's mental health and uncovering vulnerability to addictions. A ground-breaking study created clinical trials to evaluate the effectiveness of a specially designed yoga-based cardiac rehabilitation programme compared to standard care, which combined traditional Indian practices with modern medical advancements. Another study looked to reduce the impact of second-hand smoke during pregnancy and the postnatal period. Large collaborations like the Atmospheric Pollution and Human Health in an Indian Megacity programme, funded by NERC and MRC in the UK and MoES and DBT in India, under the Newton Bhabha Fund, brought together five research projects that investigated air pollution in Delhi from five different aspects, ultimately uncovering causes of air pollution and developing ways to decrease it to enhance the quality of life for Delhi's population. Other projects have helped set global policy, such as the Phenotypic characterisation of non-smoking COPD project, funded by MRC and ICMR. Chronic obstructive pulmonary disease (COPD) affects over 300 million people worldwide. It is the fifth leading cause of death, and researchers from this project directly contributed to global guidelines for diagnosis and management of COPD. These varied UKRI India projects ultimately are working to increase the quality of life globally, reducing disease and increasing access to medical care through disseminating knowledge, creating new products, and impacting policy.



## A focus on UKRI India collaboration addressing Maternal and Infant Health

Within the many UKRI India research projects working to build healthy societies, there was a sustained focus on the health of children, adolescents, and maternal health. At least 14 UKRI India projects focused on issues related to pregnancy, infants, or early childhood. Every day approximately 800 women die in pregnancy or childbirth, with 99% of all these deaths occurring in middle- to low-income countries, and women in rural communities who have limited access to healthcare at the greatest risk.<sup>9</sup> Attending at least one antenatal care appointment resulted in reduced mortality and improved health outcomes post-birth for mother and child.<sup>10</sup> UKRI India research is improving the overall health of mothers and babies in lasting ways for mothers and children globally with projects that provide accessible technology to monitor health, research into early vitamin intervention, and mental health studies. The projects addressing these issues align closely to the SDGs of Good Health and Well-being (SDG3) and Gender Equality (SDG5).

In an effort to reduce infant mortality and increase maternal health, two projects addressing pre-eclampsia in pregnancy created a product, CRADLE-4, which has had impact in multiple countries. Developed by the *Evaluation of the introduction of a novel device in the management of hypertension and shock in pregnancy in low-resource settings* project, funded by MRC and DBT under the Newton Bhabha Fund, the CRADLE VSA is a handheld device to measure blood pressure and pulse. It was developed specifically to meet the WHO criteria for use in a low-resource setting. According to SciVal, the research from UKRI India in this area had high impact, with UKRI India publications in the Topic Cluster Pregnancy; Pre-Eclampsia; Women having an FWCI score of 5.3 compared to the world level FWCI of 1.2. The success of the project led to £15.8 million in further funding, including a subsequent collaborative research project on CRADLE-4 funded by MRC, ESRC and DBT under the Newton Bhabha Fund. A further technological intervention for pregnant women was developed by the project researching hypertension, diabetes, and antenatal care in primary care settings in India and Nepal, which worked with WHO to develop and test an electronic decision support system to improve the quality of routine antenatal care.

Two UKRI projects researched the impact of vitamin B12 on improving infant health from birth as well as maternal health. One, funded by MRC and ICMR, investigated the link between B12, folic acid, and homocysteine on diabetes and another, funded by MRC, ESRC, and DBT under the Newton Bhabha Fund, looked at links between B12 and neurodevelopment. Low vitamin B12 levels in mothers can cause high blood levels of a harmful metabolite (homocysteine), making it more likely for these mothers to

get diabetes in pregnancy leading to more likely low birth weight, as well as the baby developing more body fat and higher plasma insulin levels during childhood, which are signs of higher diabetes risk in later life. A B12 deficiency in a new born is also problematic because of the role vitamin B12 plays in neuronal health (brain and nerve cells health) and in the development of the foetal and infant brain. The findings of these two projects may help influence policy, such as informing nutritional policy in the UK, India and countries such as Brazil, Guatemala, the Philippines, and South Africa through the COHORTS collaboration.<sup>11</sup> The projects will also help to reduce childhood obesity and diabetes, and improve infant and child neurodevelopment in diverse sociodemographic settings. The projects have resulted in 49 publications (2011–2019), cited by over 1,200 documents from over 100 countries. The publications have a combined FWCI of 2.89, all indicating a strong use and impact in the field. The project also engaged with the community, with 54 instances of informal dissemination, including presentations, workshops, and media, as well as winning £1.8 million in further funding from the UK and India.

## Conclusions

The outcomes of UKRI India projects work towards building a healthy society, with a particular emphasis on improving maternal, foetal, and child health outcomes in simple but efficient ways. Even with contemporary issues, such as COVID-19, UKRI India research is making an impact. While the timeframe of publications was 2010–2019, which means no project directly researched COVID-19, further analysis showed that the research from UKRI India is having an impact in this field, with over 210 publications in 2020–2021 about COVID-19 citing a UKRI India publication. This demonstrates the wide reach and impact these quality publications achieve. The impact of UKRI India projects under this theme goes beyond healthcare to technological development, societal development, gender equality, and economic enhancement.

<sup>9</sup> <https://gtr.ukri.org/projects?ref=MR%2FN006240%2F1>

<sup>10</sup> Kuhnt, J., & Vollmer, S. (2017). Antenatal care services and its implications for vital and health outcomes of children: evidence from 193 surveys in 69 low-income and middle-income countries. *BMJ Open*, 7(11), e017122. doi: 10.1136/bmjopen-2017-017122

<sup>11</sup> <https://www.psych.ox.ac.uk/research/cap/recent-studies/child-development-and-adult-social-and-human-capital-cohorts>

## 6.

## Case Study 1.6.1

### Reducing pre-eclampsia

#### Background

Pregnancy hypertension contributes to 14% of deaths in pregnancy worldwide, representing an estimated 60,000 deaths annually worldwide.<sup>12</sup> Often the problem is recognised too late, but accurate blood pressure measurement is vital for detecting and monitoring pre-eclampsia, thereby allowing for medical therapy and appropriate transfer for delivery and care. Measurement of vital signs is also crucial to manage the other life-threatening maternal conditions including haemorrhage and sepsis. Given that these conditions can kill rapidly, early recognition is essential.

#### Solution

A key technical product, the Microlife CRADLE Vital Sign Alert (VSA) (FIGURE 13) was created to address the need to monitor women's blood pressure and pulse effectively, enabling necessary medical intervention before a situation becomes life-threatening. The project was funded by the UK's Department for International Development (former DFID and now Foreign Commonwealth and Development Office), MRC and ESRC under the Newton Bhabha Fund, with matching resources from DBT in India. The Cradle VSA is a handheld device to measure blood pressure and pulse; it is ideal for low- and middle-income countries due to its simplicity and accuracy. Developed to meet the WHO criteria for use in a low-resource setting, it is low cost, has low power requirements, and can be charged using a standard mobile phone charger. It is also robust, staying accurate even at extremes of temperature and humidity or after being dropped from a height of 20 metres or used more than 20,000 times at high pressures. The device is easy to use for any healthcare professional, requiring little training. It works on a traffic light system, as well as providing standard readings. An English-language video demonstrating the use of the device has been watched over 2,600 times on YouTube. It is also available in other languages, making the use of this device accessible to a wide range of health professionals in multiple countries.



**FIGURE 13:** Microlife CRADLE Vital Sign Alert (VSA). Source: Microlife website: <https://www.microlife.com/support/cradle-vsa>.

#### Outcomes

The research from UKRI India in this area had high impact in academic and practical terms. The CRADLE device has been adopted in over 35 countries and recommended in some hypertension guidelines (e.g., South Africa). The Red Cross has introduced the device into community settings in Mali, and Health Hope Action have adopted it in a number of refugee camps in Uganda. Clinical trials continue and further educational videos are being made and used to help participant understanding and the informed consent process. The 18 publications (2010–2019) from the two projects have produced over 150 citations from 60 different countries, indicating strong use and impact in further research.

<sup>12</sup> <https://gtr.ukri.org/projects?ref=MR%2FR021376%2F1>

## 6.

## Case Study 1.6.2

## Development and evaluation of a yoga-based cardiac rehabilitation programme

**Background**

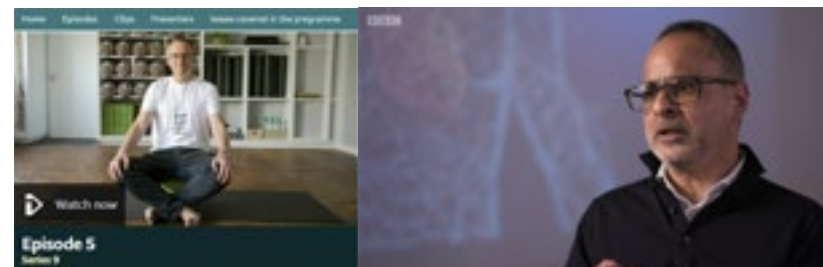
Cardiac rehabilitation (CR) programmes aim to reduce the risk of death or illness following a heart attack by improving the physical fitness of the patient, reducing stress levels, and encouraging long-term lifestyle changes. The practice of yoga, a traditional Indian mind-body discipline, has similar short-term objectives to a CR programme (improved physical fitness, stress reduction, and lifestyle change) and a similar method of delivery (combined exercise-education sessions). However, instead of the large multidisciplinary team needed for traditional CR, only a yoga teacher is needed to implement a yoga routine.

**Solution**

The development and evaluation of a yoga-based cardiac rehabilitation programme (Yoga-CaRe) for secondary prevention of myocardial infarction, funded by MRC and ICMR, combined two complementary studies: a large randomised control trial in India to evaluate the effectiveness of a specially designed yoga-based CR programme compared to standard care and a smaller in-depth study of the underlying physiological mechanisms, carried out in the UK using high-tech exercise laboratory facilities.

**Outcome**

The project produced materials outlining how to implement a yoga-based cardiac rehabilitation programme, including a booklet and DVD for patients and a manual for yoga instructors, all of which are available in English and in multiple Indian languages. Further, Primary Investigator Professor Sanjay Kinra was invited to design and conduct a small pre-post intervention study on the impact of yoga on blood pressure in healthy volunteers for the UK BBC TV show “Trust Me, I’m a Doctor” (FIGURE 14). The study and filming were conducted in 2019, and the show aired on 12 February 2020 on BBC Two to audiences nationwide and internationally.



**FIGURE 14:** Screenshots from BBC of “Trust Me, I’m a Doctor” programme.  
Source: BBC iPlayer

One 2019 article on the programme, which focused on secondary prevention of myocardial infarction, has an FWCI of 1.33; according to PlumX Metrics, it has also had nine interactions on social media and over 700 full-text views. The success of the Yoga-CaRe programme also led to the funding of a further research project, the Yoga programme for type-2 diabetes prevention (YOGA-DP) among high-risk people in India: intervention development and feasibility study.

## 6.

## Case Study 1.6.3

## Impact of maternally derived antibodies and infant microbiota on the immunogenicity of rotavirus vaccines in African, Indian and European infants

### Background

Rotavirus is a highly transmissible and contagious disease that causes severe dehydration and results in over 215,000 deaths annually.<sup>13</sup> While a vaccine exists, current vaccines are least effective in the countries where most deaths from diarrhoea occur, primarily in sub-Saharan Africa and in southern Asia.<sup>14</sup> It is not known why the vaccine is less effective in these cases, but the reasons are most likely complex and this inefficiency leads to unnecessary and untimely deaths, primarily of children under 5.

### Solution

A project funded by MRC and DBT under the Newton Bhabha Fund investigated the impact of maternally derived antibodies and infant microbiota on creating passively acquired immunity.<sup>15</sup> The project followed babies before and after rotavirus vaccination in three countries (Malawi, India, and the UK), from birth to 14–16 weeks of age. The levels of antibodies transferred from the mothers to the babies during pregnancy and after birth were compared by measuring the antibodies in the mothers' blood and breast milk and studying the composition of the gut microbiota from birth to the time of rotavirus vaccination in each of the three groups of babies. This will assess the impact of the infants' ability to respond to rotavirus vaccination and measure the levels of rotavirus antibody generated by the babies after vaccination.

### Outcome

The project investigators helped to influence policy through membership in the Advisory Committee on the Microbiological Safety of Food. Originally funded with an £855,000 grant, the project attracted an additional £15.8 million in funding to continue the work, including approximately £11.7 million from PATH, a global public health charity, to continue phase 3 trials on vaccine efficacy. The project also published seven papers between 2017 and 2018, including one 2018 publication with an FWCI of 8.4, showing high use in the field.<sup>16</sup>

<sup>13</sup> <https://www.mayoclinic.org/diseases-conditions/rotavirus/symptoms-causes/syc-20351300>

<sup>14</sup> <https://gtr.ukri.org/projects?ref=MR%2FN006259%2F1>

<sup>15</sup> Impact of maternally derived antibodies and infant microbiota on the immunogenicity of rotavirus vaccines in African, Indian and European infants (MR/N006259/1)

<sup>16</sup> Parker, E. P. K., et al. (2018). Influence of the intestinal microbiota on the immunogenicity of oral rotavirus vaccine given to infants in south India, *Vaccine*, 36(2), 264–272. doi: 10.1016/j.vaccine.2017.11.031



## 7.

## Research Collaboration

**Nearly 55% of UKRI India funded publications resulted from international collaboration. These publications had an average FWCI of 2.6.**

In this section, we will approach collaboration from two different perspectives: collaboration as defined by joint publications between authors from different countries and collaboration as it was reported in the GtR database.

A publication with international collaboration is defined as a publication that has at least two authors affiliated to two institutions from different countries. While one may expect that all publications from UKRI India funded publications should be international, with an author from the UK and an author from India, this is not the case. Authors from these countries may continue to publish on their own or with national collaborators, which may be driven (also partially) by the research they have conducted within a project.

Bearing this in mind, on average nearly 55% of the publications funded by UKRI India involved international collaboration during 2010–2019. This is much higher than the global average of 19% and higher than the international collaboration shares for the UK (48%) and India (17%) in the same period (FIGURE 15).

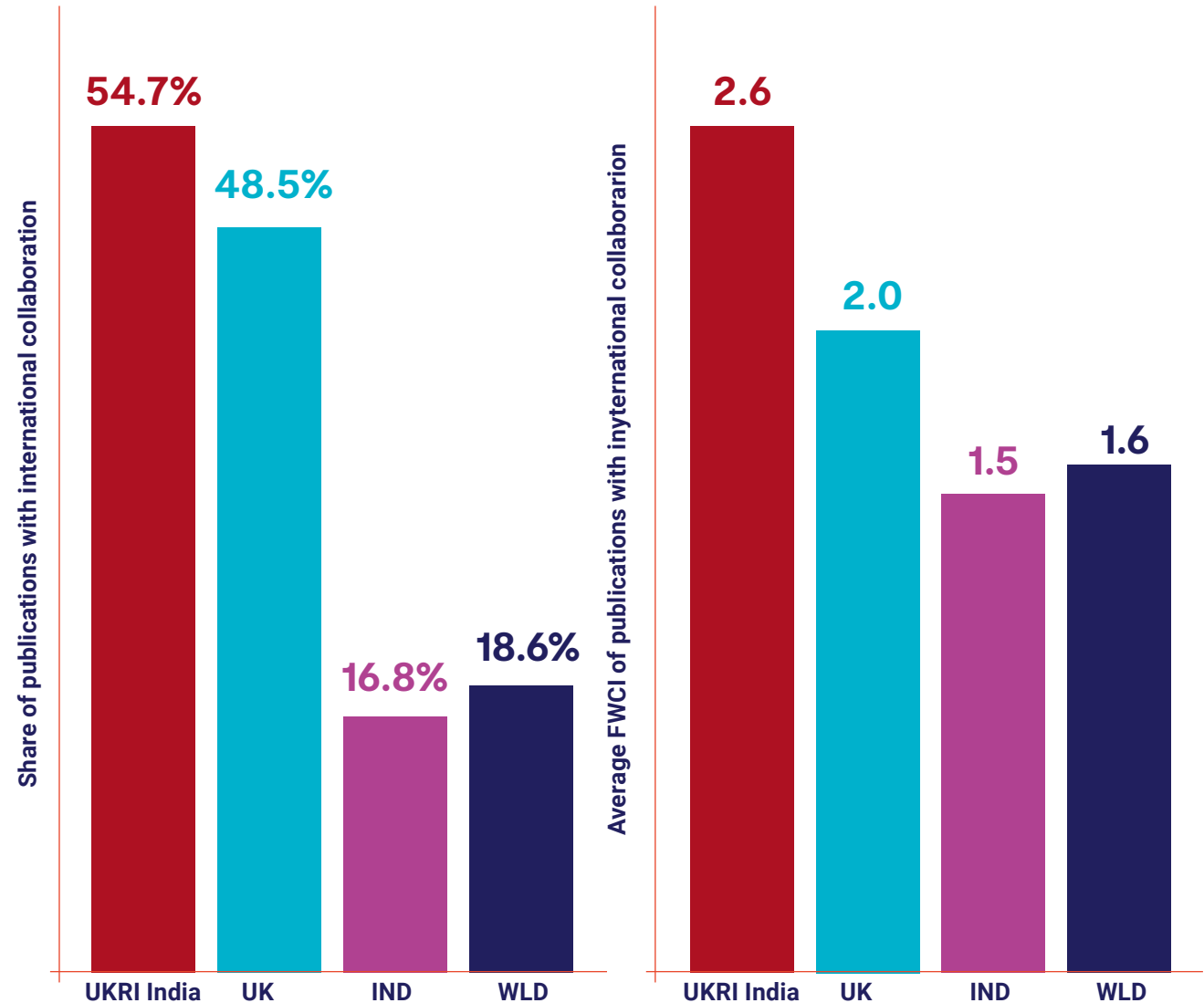
On average, publications produced through international collaboration had an average FWCI of 2.6, which is again higher than the averages for the world, the UK, and India. It is important to underline that these publications also resulted in a higher FWCI than the average FWCI of all UKRI India funded publications (2.2), showing that international collaboration results in higher scholarly impact.

The most frequently collaborating countries were, as to be expected, the UK and India, followed by the United States, China, and Germany, with the UK playing a central role within the collaboration network.



# 7.

According to GtR data, there were 530 instances of collaboration reported between 2006 and 2020. While some of these instances are duplicate entries, we see that the United States, Germany, and France were the countries with the most reported collaborations after India and the UK. This is in line with the bibliometric indicators of collaboration. However, there were also projects that resulted in collaborations with countries such as Kenya or Bangladesh but that didn't produce any co-authored publications, showing that collaboration can take a variety of forms.



**FIGURE 15:** Share and FWCI of publications with international collaboration for all UKRI India funded publications, the UK, India, and the world, 2001–2019. Source: Scopus

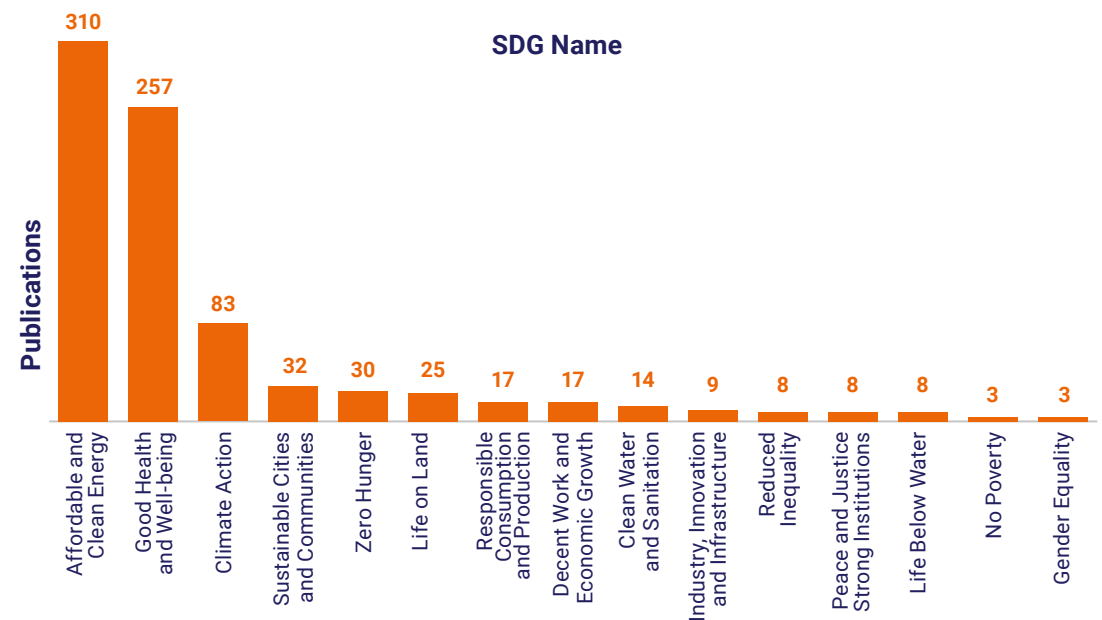
## 8.

## Contribution to the United Nations Sustainable Development Goals

**43% of the UKRI India funded publications were related to SDGs and most were focused on SDG 7 (Affordable and Clean Energy) and SDG 3 (Good Health and Wellbeing).**

In 2015, all United Nations member states adopted the 2030 Agenda for Sustainable Development, which at its core laid out the 17 SDGs that address global challenges including poverty, inequality, climate change, environmental degradation, peace, and justice. The SDGs were set to be a blueprint to achieve a better and more sustainable future for all. In this report we consider the contribution of UKRI India funded research to the SDGs, mainly from a publication perspective. To analyse if a publication contributes to the SDGs, we used a methodology developed by Elsevier, where publications in Scopus are matched against UN SDGs through search queries. For each SDG, a set of search queries have been defined in collaboration with subject matter experts. Detailed information about this methodology can be accessed at a dedicated website.<sup>17</sup> Some publications were related to more than one SDG.

UKRI India funded projects contributed to the progress of SDGs through publications in specific goal areas, especially in Affordable and Clean Energy (SDG7) and Good Health and Well-being (SDG3); overall, UKRI India publications contributed to 15 of the 17 SDGs (FIGURE 16).



**FIGURE 16:** UKRI India funded publications per Sustainable Development Goal, 2010–2019. Source: Scopus

<sup>17</sup> <https://data.mendeley.com/datasets/87txkw7khs/1>

# 8.

In all, 716 UKRI India publications could be matched to SDGs, which was 43% of total UKRI India publications. In contrast, at the world level 37% of publications could be mapped to an SDG. Affordable and Clean Energy (SDG7) was the most addressed SDG, focused on by 310 publications (19% of total publications), with 299 of the publications from UKRI–DST funded projects. The second most addressed SDG was Good Health and Well-being (SDG3) with 257 publications (15% of total publications), 144 from UKRI–DBT publications and 83 from UKRI–ICMR publications. Climate Action (SDG13) followed with 83 publications (5% of total publications).

The focus of UKRI India publications on Affordable and Clean Energy (SDG7) was almost nine times higher than the world level: 19% of UKRI India publications focused on SDG7, whereas only 2% of world publications focused on this SDG (compared to 3% of Indian publications and 2% of UK publications). Climate Action (SDG13), Zero Hunger (SDG2), and Clean Water and Sanitation (SDG6) also had a relatively high focus in UKRI India outputs, with Climate Action almost five times higher than world output. Zero Hunger and Clean Water and Sanitation, while only having 14 publications, had an RAI score just over three times higher than the world.

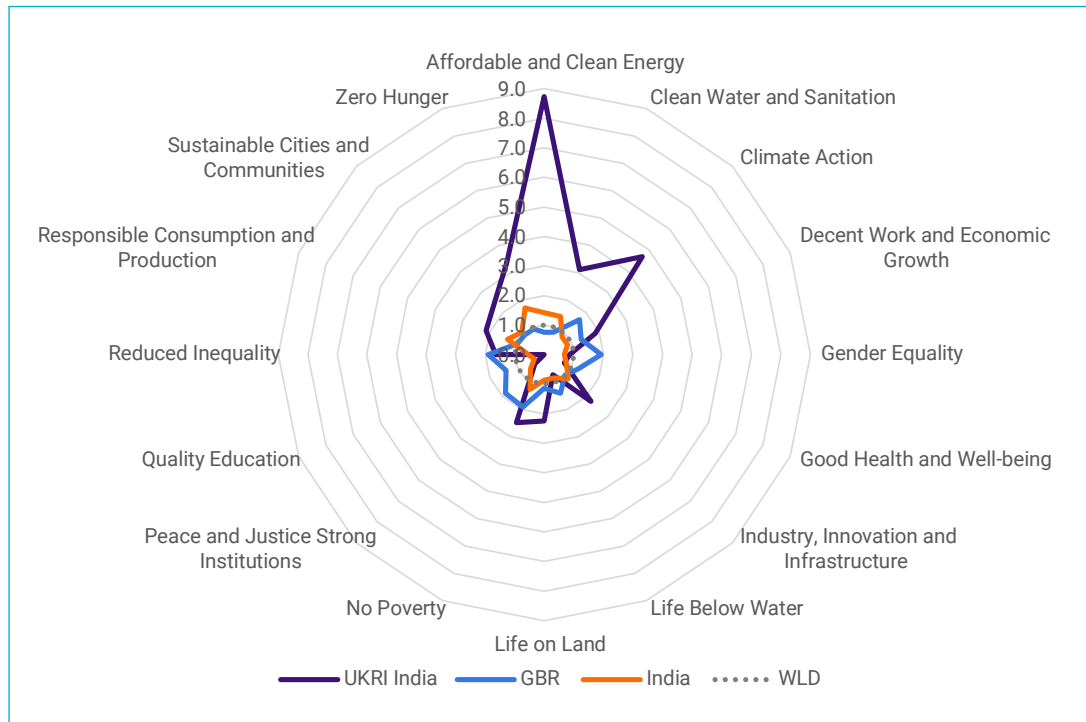


FIGURE 17: Relative Activity Index per Sustainable Development Goal, 2010–2019. Source: Scopus

## 9.

## Theme: Innovation

**UKRI India publications had an average share of academic–corporate collaborations three times the world average.**

### Background

Economic innovation and productivity featured highly in UKRI India projects, with an emphasis on agricultural innovations to improve resilience of crops to reduce global hunger, as well as developing cleaner, more efficient energy solutions and methods. The Indian economy is one of the fastest growing major economies in the world and is expected to be in the top five economies in the next 10 to 15 years, and the second largest economy by GDP by 2050.<sup>18</sup> There is a high level of investment from government, domestic industry, and foreign industry driving growth, and according to McKinsey Global Institute, “over the past three decades, the country has been one of just 18 outperforming emerging economies to achieve robust and consistent high growth”.<sup>19</sup> The research from UKRI India projects has produced research to help continue this growth with innovative ideas and continued collaboration. For example, the publication output from UKRI India projects shows the average share of UKRI India funded publications with academic–corporate authorship was around 9%, which is three times the World average and higher than both the UK and India shares. This high share of academic–corporate collaboration indicates that UKRI India research produces outputs with practical outcomes for the economy as well as society.

UKRI India projects produced over 200 reported technical outputs, resulting in 84 new databases, 40 improvements to research, and over 20 new pieces of software, many of these furthering innovation and economic development. Technical outputs included practical innovations, such as a fluorescent-based sensor for monitoring bacterial activity in freshwater systems, web applications to enhance agricultural productivity, a zero-emission transport refrigeration unit for cold chains and developing genetic capabilities to reduce plant disease. Other innovations included wider collaborations such as the Cambridge–India Network for Translational Research in Nitrogen (CINTRIN), funded by BBSRC, NERC, and DST under the Newton Bhabha Fund, and the Indo-UK Civil Nuclear Network, funded by EPSRC and DAE. UKRI India collaborations across academic disciplines produced research and outputs that furthered economic innovation and growth.

Another strong project in innovation was one looking at sustainable engineering supply networks, funded by EPSRC and DST and led by University of Cambridge and IIT Ropar. They investigated engineering-driven sustainable supply networks in four important industries—Aerospace, Automotive, Pharmaceutical, and Food Processing—combining the skills and experience of the Indian and British partners to develop methodologies that support optimal usage of key resources like energy, materials, water, and other inputs, while minimising the generation of waste.

<sup>18</sup> <https://www.ibef.org/economy/indian-economy-overview>; <https://www.pwc.com/gx/en/research-insights/economy/the-world-in-2050.html>

<sup>19</sup> Sankhe, S., et al. (2020). India’s turning point: An economic agenda to spur growth and jobs. McKinsey Global Institute. Available at <https://www.mckinsey.com/featured-insights/india/indias-turning-point-an-economic-agenda-to-spur-growth-and-jobs>

## A focus on UKRI India collaboration addressing agricultural innovation

The agricultural sector, including forestry and fishing, in India contributed approximately US\$276 billion gross value added to the economy in fiscal year 2020, with growth estimated at 4% in the year.<sup>20</sup> To continue to meet growing demand in agriculture and related areas, such as cold storage, it is essential to innovate in methods, crops, and training to improve yields, productivity, and environmental impacts. Over 40 UKRI India projects have been addressing a factor of agricultural innovation, and they have approached this challenge in several ways: from researching the use of nitrogen in planting, through genetic breakthroughs to improve crops, to developing new biofuel sources. According to Scopus, 135 UKRI India publications were categorised in Agricultural and Biological Sciences. They had an FWCI score of 2.48, compared to an FWCI of 0.98 in this area globally, and were cited by over 3,000 documents, showing a strong impact and influence. This impact is seen to be strong in areas such as the SciVal Topic Cluster Wheat; Triticum; Triticum Aestivum, where 20 UKRI India publications had an FWCI of 5.6, far above the global FWCI of 1.1 in this area. The importance of agriculture to the economic growth of India and the quality of academic output from UKRI India funded publications has also led to technological innovation coupled with community outreach to implement these innovations.

One example of agricultural innovation lay in the development of web applications. CINTRN produced two new research methods to enhance agricultural research and created two webtools to help farmers make informed decisions about their day-to-day work. The KisanHub and Punjab Agricultural University Urea Guide App enable farmers in the UK and India to make data-driven decisions on their farming practice simply and make essential fertiliser decisions quickly and with confidence, improving crop yield while reducing pollution. Another agricultural innovation project researched plant genomes to identify disease-resistant crops. Also funded by BBSRC and DBT, this project focused on producing three pieces of software related to gene sequencing and gene cloning and made a patent application for wheat stem rust resistance genes and methods of use. There were over 10 genomic projects looking to enhance crops—from tomatoes to soybeans to wheat to mung beans. These projects, as with many UKRI India projects, examined issues from multiple vantage points. For example, a project researching wild ancestor plants of rice, funded by BBSRC and DBT, tackled the need for

an increase in rice production by looking at genetic variability, climate change, and socio-economic factors that could influence farmers' decisions on crops. Several projects making up the Newton Bhabha Industrial Waste programme—funded by BBSRC, Innovate UK, EPSRC, and DBT under the Newton Bhabha Fund—looked at the other end of the agricultural process. The projects worked to develop novel industrial biotechnology processes to produce value-added products from waste streams such as sugar cane and paper mills, evaluating ways to reduce or to make agricultural waste into new products.

## Conclusions

Innovation is at the centre of many of UKRI India projects, with a strong focus on interdisciplinary solutions to improve growth. In the area of agricultural innovation, UKRI India projects developed technological, sociological, and manufacturing solutions to enhance economic performance. Within this, these projects also addressed environmental impacts, reducing poverty, and ensuring food production supply. Products such as the fluorescent-based sensor (V-Lux) for monitoring bacterial activity in freshwater systems, from a project funded by NERC, ESPCR and DST under the Newton Bhabha Fund, produce tangible outcomes that continue the collaborative, interdisciplinary economic growth from UKRI India funded projects.

<sup>20</sup> <https://www.ibef.org/industry/agriculture-india.aspx>

## 9.

## Case Study 1.9.1

### Nitrogen research for agriculture

#### Background

Nitrogen, applied to crops as a fertiliser, has played a vital role in maximising crop yields. However, nitrogen discharge—a common problem—pollutes the air, water, and land, accounting for a third of agriculture’s greenhouse gas emissions.<sup>21</sup> Improving the uptake and utilisation efficiency within a crop through genetic improvement, together with the precision application of fertiliser in the field, has been an ongoing effort. However, further improvements are required to face the challenges of increasing crop production for an expanding global population faced with increasing climate uncertainty.<sup>22</sup>

#### Solution

Four UKRI India projects researched the use of nitrogen and agriculture, focusing on improving agriculture and the impact and efficiency of nitrogen use.<sup>23</sup> Working together, these projects innovated new methods and tools to improve the nitrogen uptake and utilisation efficiency of crops through genetic means and biological nitrogen fixation mechanisms.

#### Outcomes

The four projects produced significant impacts through engagement, enhanced policy, and creating new methods and products, and won over £57 million in further funding to continue the research. CINTRIN, funded by BBSRC, NERC, and DST under the Newton Bhabha Fund, produced two new research methods to enhance agricultural research and created two webtools to help farmers make informed decisions about their day-to-day work.

KisanHub software has been extended and improved for the use of the agri-food industry, from the grower to the producer. It has supported over 10,000 growers and teams in seven different countries, with more consider adoption of the software. The Punjab Agricultural University-Leaf Colour Chart (PAU-LCC) measures leaf colour variations and provides nitrogen recommendations in major field crops. One of the many success stories is the village of Bassian, Ludhiana, where the entire village



**FIGURE 18:** Screenshots from KisanHub and PAU Urea Guide App.

adopted PAU-LCC for use with rice, leading to an average saving of 80kg of nitrogen per hectare.<sup>24</sup> The PAU-LCC is freely available to all farmers in the form of the PAU Urea Guide app (FIGURE 18).

The CerealsDB website, developed within the INEW project, provides a range of facilities to study the wheat genome. The site receives over 50,000 unique visits per month since launch in 2017, and the provided datasets have been downloaded nearly 50,000 times.

The NEWS India-UK project, funded by BBSRC, NERC, and DBT under the Newton Bhabha Fund, made an impact on innovation in multiple ways, including helping to shape international policy. Investigators from the project participated in four advisory committees to the United Nations Environmental Assembly as well as giving evidence to the Government of Scotland. With over 75 other engagements—including presentations, workshops, and media interviews—this project continually advanced innovation internationally and at an individual level.

Next to the contributions to real-life applications, the projects have resulted in highly impactful publications. Publications from INEW and NEWS India-UK were focused in the Topic Cluster of Wheat; Triticum; Triticum Aestivum, having an average citation impact nearly five times more than the average citation impact globally in that same topic.

<sup>21</sup> <https://www.unep.org/news-and-stories/story/three-ways-we-can-better-use-nitrogen-farming>

<sup>22</sup> <https://gtr.ukri.org/projects?ref=BB%2FN013360%2F1>

<sup>23</sup> Cambridge-India Network for Translational Research in Nitrogen (CINTRIN) (BB/N013441/1); Indo-UK Centre for the improvement of Nitrogen use Efficiency in Wheat (INEW) (BB/N013360/1); India-UK Nitrogen Fixation Centre (BB/N013387/1); Newton-Bhabha Virtual Centre on Nitrogen Efficiency of Whole-cropping Systems for improved performance and resilience in agriculture (NEWS India-UK) (BB/N013492/1)

<sup>24</sup> [https://www.sustainableagtzania.com/\\_webedit/uploaded-files/All%20Files/agronomy/PAU-LCC%20Leaflet.pdf](https://www.sustainableagtzania.com/_webedit/uploaded-files/All%20Files/agronomy/PAU-LCC%20Leaflet.pdf)

## 9.

## Case Study 1.9.2

# Vaccine Development Innovation

### Background

Peste des petits ruminants virus (PPR), or goat plague, is a widespread disease throughout India, Africa, the Middle East, and recently China.<sup>25</sup> It is a devastating disease affecting sheep and goats, with a mortality rate up to 90%. It causes immunosuppression, leaving infected animals to also be susceptible to further infections. This creates a strain on the economy of affected countries, with economic losses in India estimated to be at least US\$653 million annually and between US\$1.4 billion and US\$2.1 billion per year globally.<sup>26</sup> It is important to understand the pathogenesis of PPR to both develop effective vaccines and differentiate infection in vaccinated animals (DIVA) to create appropriate vaccination programmes.

### Solution

Combining medical and agricultural research, the Understanding the immune mechanism of host disease resistance and development of marker vaccines and DIVA tests for Peste des Petits Ruminants (PPR) project, funded by BBSRC and DBT,<sup>27</sup> used reverse genetics to develop two DIVA vaccines (two existing established vaccine strains; Sungri 96 and Nigeria/75/1) and two recombinant ELISA tests that can differentiate between vaccinated and infected animals. The teams were led by the Pirbright Institute in the UK and Tamil-Nadu Veterinary and Animal Sciences University, the Indian Veterinary Research Institute, the National Institute of Animal Biotechnology and the National Institute of Veterinary Epidemiology and Disease Informatics in India. The teams tracked the pathobiology of the disease, determined the primary and secondary routes of infection to stimulate enhanced immune response, and developed the vaccines.

### Outcomes

The results of this innovative project enable livestock owners to protect their animals while continuing to trade, enhancing their economic output. Primary Investigator Professor Satya Parida and his team have developed and filed a patent application for the first PPR vaccine that enables infected animals to be easily differentiated from vaccinated animals (DIVA) in the differentiation process. Industries have signed non-exclusive licencing agreements to commercialise these vaccines, and the use of the vaccines will reduce the period for disease eradication by identifying antibodies specific to vaccination or infection.

The project has attracted over £1.8 million in further funding from BBSRC, Innovate UK, and the charity GALVMED, which through the Gates Foundation funded to test the stability of PPR vaccine in the field in Jordan. The team made over 20 presentations or other public communications, including invited seminars at PPR GREN, a FAO/OIE forum, a vaccine producers meeting, a VIROCON and IAVMI meeting in India, and international conferences in Bangkok, Kenya, and Germany.

There has been substantial interest in the academic literature, and a publication from this project in the field of Veterinary Microbiology had a large impact, with an FWCI of 10.3.<sup>28</sup> The 20 publications have been cited by 240 further publications from 70 countries, showing a global impact of the research and innovation.



**FIGURE 19:** PPR scientists in the field. Source: <https://www.pirbright.ac.uk/news/2018/09/pirbright-scientists-run-vaccination-campaign-eradicate-peste-des-petits-ruminants>

<sup>25</sup> <https://www.pirbright.ac.uk/viruses/pprv>

<sup>26</sup> Bardhan, D., et al. (2017). The economic impact of peste des petits ruminants in India. *OIE Revue Scientifique et Technique*, 36(1), 245–264. doi: 10.20506/rst.36.1.2626; <https://www.pirbright.ac.uk/news/2019/03/pirbright-tackle-peste-des-petits-ruminants-all-fronts>

<sup>27</sup> Understanding the immune mechanism of host disease resistance and development of marker vaccines and DIVA tests for Peste des Petits Ruminants (PPR) (BB/L004801/1)

<sup>28</sup> Parida, S., et al. (2015). Peste des petits ruminants. *Veterinary Microbiology*, (181)1–2, 90–106. doi: 10.1016/j.vetmic.2015.08.009



## 9.

## Case Study 1.9.3

# Biotechnological Solutions for Tackling Industrial Waste

### Background

The sugarcane industry is the second largest agriculturally based industry in India, and it supports approximately 60 million farmers and their families. The sugarcane and associated industry, however, produces more than 100 million tons of solid and liquid wastes every year. The huge quantities of waste produced by sugar and associated industries pose a significant challenge to industry and the environment.<sup>29</sup> As part of the Biotechnological Solutions for Tackling Industrial Waste programme, funded by Innovation UK, BBSRC, and DBT under the Newton Bhabha Fund, three projects investigated ways to cut waste, reduce pollution, develop new methods of production, and enhance collaboration across multiple disciplines and institutes.<sup>30</sup>

### Solution

The three projects all considered the problem and opportunities from sugarcane waste in different ways. For example, the project focusing on reducing industrial waste from sugarcane processing in India worked to help sugar mills become more environmentally sustainable, improve working conditions for employees, and become more productive through diversifying activities. The project researching innovations in pre-treatment, biotransformation, and intensification investigated transforming waste biomass into energy and chemicals for providing technological solutions to address problem of waste generated by sugar and associated industries in India. The BIOREVIEW project aimed to develop novel industrial biotechnology processes to produce value-added products from waste streams of the Indian sugar industry. Both of the latter projects work on bagasse, and cross-project collaboration between these projects began shortly after the projects began and has continued throughout their duration.

### Outcomes

Despite not yet being completed, these three projects have produced outcomes that further innovation and manufacturing, helping to develop the economy as well as reduce the environmental impact of bagasse. The projects have attracted over £6 million in additional funding from public sources and have a high degree of collaboration with corporations, including the bioenergy companies Nova Pangaea Technologies and Green Fuels Research in the UK, and the apex R&D organisation of sugar mills, Vasantdada Sugar, as well as two large sugar mills (Dhampur and Lokmangal), and a start-up, Vivira, in India. Three spin-offs were developed. Asperchem is a spin-off organisation developed in the Reducing industrial waste project, through a collaboration between the University of York and Natems, to develop and maintain *Aspergillus* strains for citric acid production. Nova Pangaea Technologies (NPT), an industrial partner in the Valorising Waste project, have collaborated with Aberystwyth University, a BioReview partner, to develop novel fermentation processes that could lead to more commercially viable products for both projects. Aberystwyth University also incorporated the company ARCITEKBio Ltd in relation to the BIOREVIEW project to provide sustainable solutions for the manufacturing of xylitol through innovations in Industrial Biotechnology.

<sup>29</sup> <https://gtr.ukri.org/projects?ref=BB%2FS011951%2F1>

<sup>30</sup> Newton Bhabha Industrial Waste: Valorising Waste from Sugar Cane Industries via Innovations in Pretreatment, Biotransformation and Intensification (BB/S011951/1, 104333); Newton Bhabha Industrial Waste: Reducing Industrial Waste from Sugarcane Processing in India (BB/S01196X/1, 104336); Newton Bhabha Industrial Waste BIOREVIEW (BB/S011994/1, 104332).(181)1–2, 90–106. doi: 10.1016/j.vetmic.2015.08.009

## 9.

## Case Study 1.9.4

### Innovating for Clean Air (IfCA)

#### Background

Air pollution is extremely hazardous to human health, but it is an increasing problem globally, requiring innovative solutions to reduce emissions and exposure. Air pollution is caused by multiple sources including the burning of fossil fuels, industrial processes, agriculture, waste treatment, and natural emission sources.<sup>31</sup> While not all cities are the same, in general urban locations have higher levels of air pollution than rural areas, so are a site of particular concern.

#### Solution

In 2019, India and the UK launched a two-year Innovating for Clean Air programme to support firms in both countries to develop innovations to improve air quality and tackle pollution by addressing challenges related to electrical vehicle (EV) charging infrastructure, grid management, and the integration of renewable energy.<sup>32</sup> The programme is funded by Innovate UK through the Newton Bhabha Fund. The programme is delivered by the Energy Systems Catapult, Connected Places, and the Satellite Applications Catapult, with matched resources from various partners in Karnataka and elsewhere in India.

#### Outcomes

Through engagement with Indian stakeholders in Bengaluru, the Catapult network identified some of the key electric vehicle and air-quality challenge areas for the city, and launched an open call in the UK to find small and medium-sized enterprises (SMEs) who could deliver innovative solutions. In all, 17 high-potential UK and Indian SMEs will develop innovative clean air and electric vehicle solutions.

One pilot, launched in Bengaluru at the end of 2020, saw all traffic barred from a busy street in the central business district each weekend for three months. The pilot enabled research to gauge the impact on the quality of life of local residents as well as the

economic impact on businesses. A website and social media channels were set up to celebrate and publicise the initiative. Artists and musicians were asked to contribute to the traffic-free events, and clean air innovations were demonstrated to pedestrians.<sup>33</sup> The programme provides a unique business collaboration with Indian and UK innovators to reduce emissions and increases the evidence base for policy that delivers cleaner air while creating a replicable model that can be used in other cities and countries.



**FIGURE 20:** Pictures of the Clean Air Street pilot, launched by the Chief Minister of Karnataka, Shri B. S. Yeddyurappa.

<sup>31</sup> <https://www.eea.europa.eu/themes/air/intro>

<sup>32</sup> <https://es.catapult.org.uk/impact/projects/innovating-for-clean-air-india/>

<sup>33</sup> <http://churchstreetfirst.com/>

# 10.

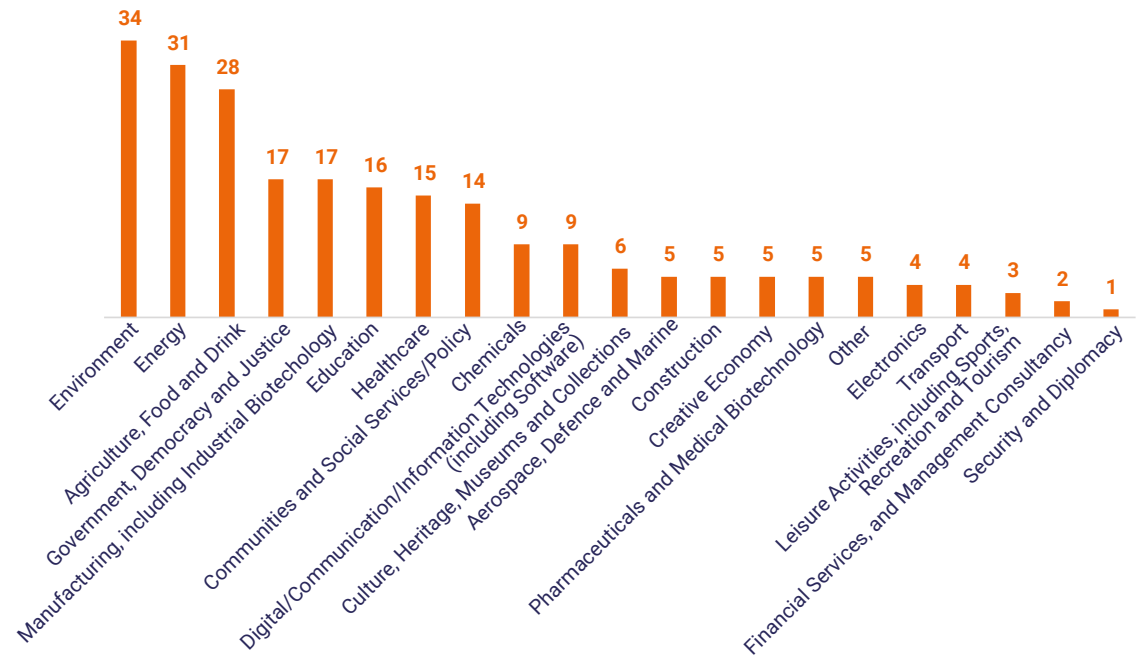
## Impact summary of portfolio of projects

**UKRI India projects had impact in 21 sectors across life science, physical science, social science, technology, and culture and had the largest impact in environment and energy.**



Impacts were defined as advances in understanding, methods, theory and application, and contributions made to society and the economy. While impact summaries were listed in this section, examples of impacts appear throughout the report.

Environment, Energy, and Agriculture, Food and Drink were the three sectors most impacted by UKRI India projects, as reported by project leads. In all, 97 projects reported a total of 235 impacts in 21 sectors. Impacts in Environment were noted in 35% of projects (34/97), for Energy in 32% of the projects (31/97), followed by Agriculture, Food and Drink impacts in 29% of projects (28/97) (FIGURE 21)



**FIGURE 21:** Impact summary by sector. Source: Gateway to Research

# 10.

One example of a key impact was from the REhabilitation of Vibrio Infested waters of VembanAd Lake: pollution and solution (REVIVAL) project, funded by NERC and DST, which had far-reaching effects in the environment and healthcare, as well as collaboration. During the project Kerala was struck by once-in-a-century floods, which displaced more than one million people and led to some 400 fatalities. Under the leadership of Dr. Anas Abdulaziz, the Indian team became consultants to ministerial-level authorities of the state throughout the emergency. The team's help was instrumental in devising and implementing a system of rapid testing for well waters, using the prototype mini Secchi disk, an optical system developed under the project that can be used by non-experts. The engagement with high-level officials of Kerala State, as well as with international observers on the ground throughout the emergency developed a mutual trust and respect to enhance collaboration in the future.

Another key impact example comes from the Intelligent MicroGrids with Appropriate Storage for Energy (IMASE) project, funded by EPSRC and DST. This project developed an AB2 alloy, which was used in an Innovate UK feasibility study to design a new prototype metal hydride store, in collaboration with industrial partners Luxfer, ITM Power, and Arcola Energy. This successfully demonstrated a new design for storage with an internal heat management strategy. The partners are collaborating with further industrial partners and the knowledge transfer is enabling the company to position itself as a manufacturer of metal hydride alloys.

A project that shows the potential for impacts across multiple sectors comes from the Newton Fund: Enhanced Rice Milling and Maximised Valorisation of Rice Milling By-products, funded by BBSRC and DBT. This project helped to develop highly efficient technology for rural rice processing for the rice farmer and the local supply chain. This will provide a 25% increase in output by minimising rice losses, while also providing rural communities the opportunity to mill their own rice to high standards, thereby tripling their annual income and effecting economic growth. Additional income will be generated by the exploitation and valorisation of other parts of the rice harvest—for example, the rice husks can become building products, thereby reducing energy demand for new building materials and CO2 emissions from the production company, and valuable nutrients can be produced from the rice bran. Further agricultural and nutritional impacts include the food company Quorn assessing the opportunity to utilise the bran and the protein within the bran to develop products for vegetarians and vegans, while the National Agri-Food Biotechnology Institute is identifying the health benefits of the fibre content of the bran. This one project has shown impacts in agricultural innovation, energy, food security, and economic growth.



## 11.

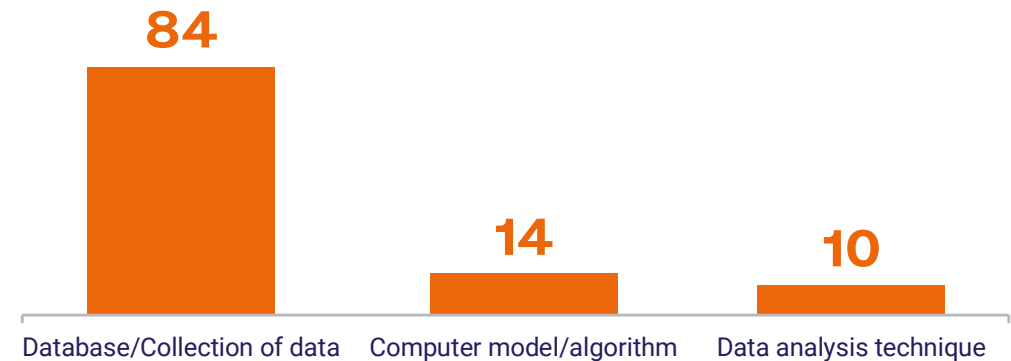
## Databases, Models, Materials and Products

Over 200 technical outputs were recorded from 77 projects, resulting in 84 new databases, 40 improvements to research and over 20 new pieces of software.

Technical outputs for the UKRI India projects were listed in multiple forms including research databases and models, software, technical products, product interventions, clinical trials, and research tools and methods. These technical outputs offer another dimension to the impact of a project than the scholarly publication output, highlighting practical outcomes.

### Databases and models

There were 108 outputs for a Research Database or Model from 41 projects. The majority of these outputs (78%) were in the form of a database or a collection of data, with some outputs in computer models or algorithms and data analysis techniques (FIGURE 22).



**FIGURE 22** Count of Research Databases or Models by type. Source: Gateway to Research

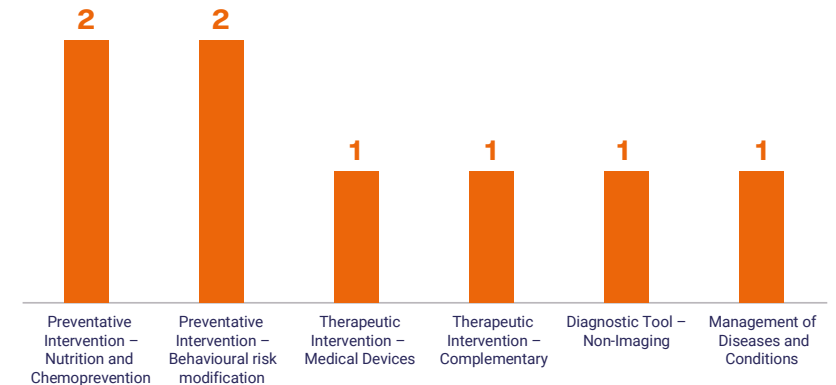
The databases and models were disseminated in public and proprietary ways—for instance, in articles, websites, or within specific institutions (e.g., Bhabha Atomic Research Centre) and communities. In all, 62% of the outputs were provided to external partners. Looking at alternative metrics via PlumX, some widely communicated projects were as follows:

- MapOptics, a lightweight cross-platform tool that enables the user to visualise and interact with the alignment of Bionano optical mapping, had 10 captures from the software site, and an article describing the tool had 11 captures, two citations, and two mentions on social media. (BBSRC/DBT)
- An article outlining an “easy-to-parameterise physics-informed battery model and its application towards lithium-ion battery cell design, diagnosis, and degradation” had the most social media activity (7 tweets), captures (114), citations (10), and use (29). (EPSRC-DST)
- An article describing the research and database INCOMPASS: Radiosonde measurements from the Indian Institute of Technology (IIT) airstrip, Kanpur, India received 16 captures, 33 uses, and five citations. (NERC-MoES)
- The West Bengal Heritage Photostories project, which is a database of videos, received six mentions on social media. (AHRC-ICHR)

Additionally, the Sustaining Himalayan Water Resources in a Changing Climate (SusHi-Wat) project (NERC-MoES) and the Identification of the molecular basis of differential host responses to rapidly evolving Avian Influenza viruses in different avian species (BBSRC-DBT) project both produced eight outputs. The SusHi-Wat outputs were all shared externally, while the avian influenza viruses’ outputs remained proprietary.

### Product interventions and clinical trials

Another technical output type was Product Interventions & Clinical Trials, for which there were eight records. These included Preventative Intervention – Nutrition and Chemoprevention (2 outputs), Preventative Intervention – Behavioural risk modification (2 outputs), Therapeutic Intervention – Medical Devices, Therapeutic Intervention – Complementary, Diagnostic Tool – Non-Imaging, Management of Diseases and Conditions (1 output each) (FIGURE 23). Of the outputs, 6 were from DBT funded projects, and 2 were from ICMR funded projects.



**FIGURE 23:** Count of Product Interventions and Clinical Trials by type.  
Source: Gateway to Research

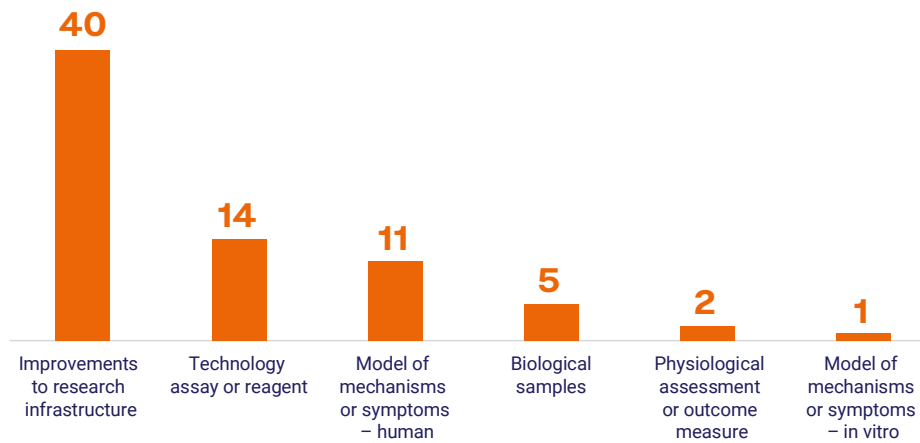
One highlight from the Product Interventions & Clinical Trials came from Maternal vitamin B12, folic acid and homocysteine as determinants of gestational diabetes, fetal growth and intergenerational programming of diabetes (MRC-DBT), which resulted in the development of the Microlife CRADLE VSA. The device can accurately measure the blood pressure and heart rate of expectant mothers and uses these values to calculate whether a woman is at risk of developing shock. It has been recognised as one of the top 30 high-impact innovations in global health in a recent PATH-led award to help accelerate progress towards the SDGs, and it received a US\$1 million grant from the Bill and Melinda Gates Foundation.<sup>34</sup> Also highlighted in Technical Products and Creative Products was a video for professionals on how to use the device, which has had over 2,600 views on YouTube since being posted in 2016.<sup>35</sup>

<sup>34</sup> <https://ish-world.com/news/a/The-CRADLE-Vital-Signs-Alert/>

<sup>35</sup> <https://www.youtube.com/watch?app=desktop&v=QainNBCHKAg&feature=youtu>  
Count of views as of 24 January 2021.

## Research tools

Research Tools and Methods was another output covering a wider range of subjects than clinical trials and product interventions. There were 73 outputs recorded in six areas for this category. (FIGURE 24). The most frequent outputs were Improvements to Research Infrastructure, with 55% of the total Research Tools and Methods.



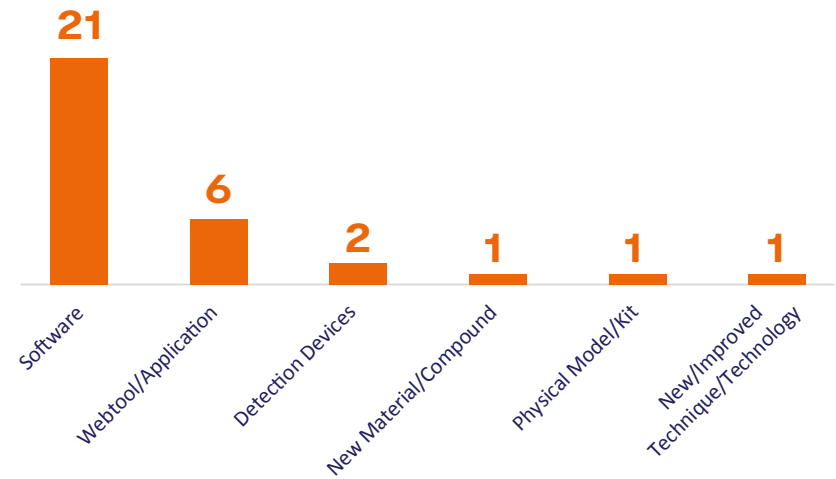
**FIGURE 24:** Count of Research Tools and Methods by type. Source: Gateway to Research

One “model of mechanisms or symptoms – in vitro” in the project Identification of the molecular basis of differential host responses to rapidly evolving Avian Influenza viruses in different avian species (BBSRC-DBT) was explained in an article that received 734 uses, 76 captures, three social media mentions, and 46 citations. An article for the project Smart on-line monitoring for nuclear power plants (SMART) (EPSRC-DAE), which outlined an improvement to research infrastructure, received 23 captures, 40 uses, and six citations.

## Technical Products

There were 32 Technical Product outputs from 17 projects, primarily in software (66%) followed by Webtool and Applications (19%) (FIGURE 25). The majority of the technical products came from EPSRC-DST (41%) and BBSRC-DBT (28%) funded projects. Two highlights from Technical Products were from the project Rapid identification disease resistance genes from plant genomes by resistance gene enrichment sequencing (RenSeq) of EMS-derived susceptible mutants (BBSRC-DBT): MutChromSeq, a method to clone genes in plants, and MutantHunter, a pipeline to identify NLR-type resistance genes using RenSeq and EMS mutagenesis screens. Both had multiple captures on GitHub. Each project led to further collaborations, with a PhD application from MutChromSeq and research agreements and further funding for the MutantHunter project.

Another highlight was from The Hugli River of Cultures Pilot Project, from Bandel to Barrackpore. They created the Safarnama app through which digital heritage experiences in Delhi—including images, geolocation data, and site descriptions—can be downloaded and used in Bengali and English. It has had over 500 downloads since launching in 2018.<sup>36</sup>



**FIGURE 25:** Count of Technical Products by type.. Source: Gateway to Research

<sup>36</sup> Downloads via Google Play as of January 2021.

## 12.

## Commercialisation of Research

**UKRI India funded publications show strong commercialisation potential, with three times the world average of academic – corporate collaboration on publications.**

UKRI India projects had multiple avenues to commercialise their research, including developing intellectual property, spin-off companies, and forming academic-corporate collaborations.

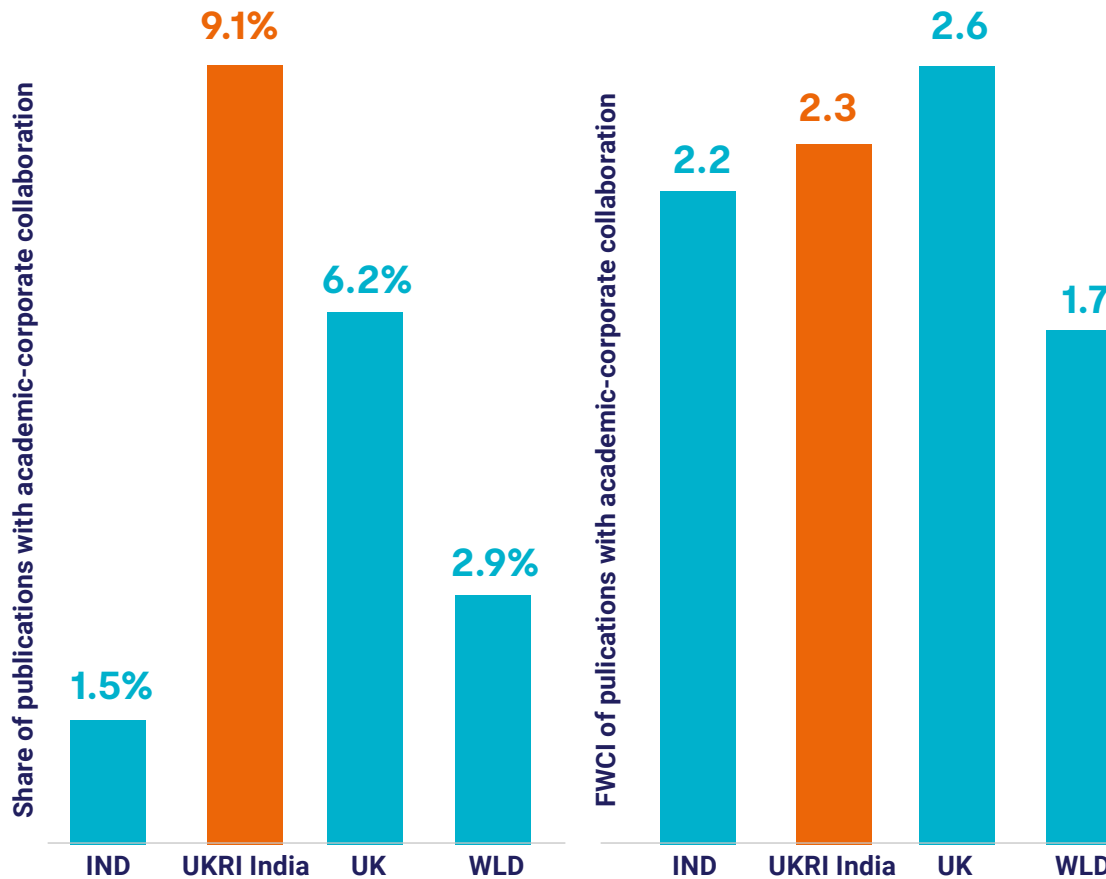
A way to gauge commercialisation opportunities is to measure the level of academic–corporate collaboration. UKRI India funded publications had an average share of academic–corporate authorship of around 9%, which is three times the world average (3%) and higher than the shares of both the UK (2%) and India (3%)(FIGURE 26). Academic–corporate collaboration is defined as at least one author on a publication having an academic affiliation and at least one author having a corporate affiliation. These publications also had an average impact (FWCI) of 2.3, which is slightly higher than the overall scholarly impact of India academic–corporate publications at 2.2, and higher than the world average of 1.7 for this type of publication.

Most of the corporate sector authors are from the UK companies such as BT, National Grid, and Intelligent Energy. The India-UK Advanced Technology Centre (IU-ATC) of Excellence in Next Generation Networks Systems and Services project was funded by EPSRC and DST and conducted between University of Ulster and BT from the UK and IIT Madras and five Indian corporates. The project not only led to nine publications but also to the development and testing of a solar-powered “virtual bank” for rural areas, mobile apps for monitoring crop diseases, wireless sensors for triggering landslide warnings and technologies for incorporation in unmanned aerial search-and-rescue vehicles.





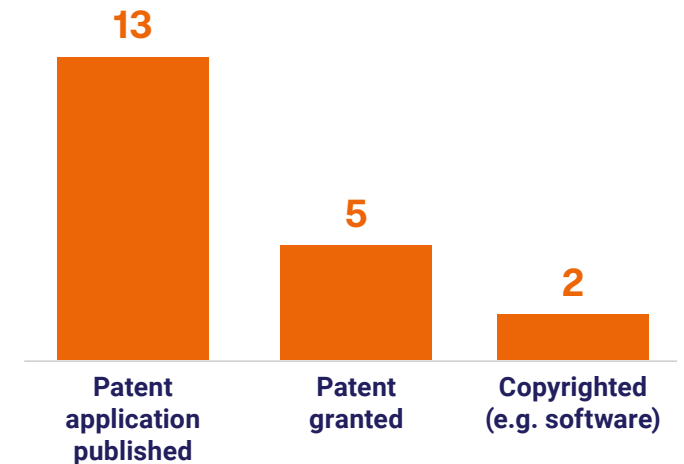
# 12.



**FIGURE 26:** Share and scholarly impact of publications with academic-corporate collaboration.  
Source: Scopus

There were more than 100 patents citing 40 publications resulting from UKRI India funded projects. Of the publications that were cited in patents, 10 resulted from the Advancing the efficiency and production potential of excitonic solar cells (APEX), Phase- II project led by Brunel University and the National Physical Laboratory in Delhi. These publications were cited by 12 patents from the UK, but also by patents from Saudi Arabia (5 patents) and Switzerland (5 patents), among other countries. These patents were mainly in electronics and chemistry.

There were 20 outputs in intellectual property from 10 projects. Published patent applications were the most common, with 65% of the outputs, followed by patent granted and intellectual property copyrighted (FIGURE 27).



**FIGURE 27:** Intellectual Property by type.  
Source: Gateway to Research

## 12.

The project “Mind the Gap” – jumping the hurdles limiting polymer fuel cell performance and commercialization, funded by ESPRC and DBT for £1 million, resulted in six patent filings, which were part of three patent families, two of which are still in force. In the project Understanding the immune mechanism of host disease resistance and development of marker vaccines and DIVA tests for Peste des Petits Ruminants (PPR), research teams have developed and filed a patent application for the first PPR vaccine that enables infected animals to be differentiated from vaccinated animals.<sup>37</sup>



**FIGURE 28:** Vaccination activity and information on patents. Source: <https://www.pirbright.ac.uk/news/2019/03/pirbright-tackle-pestes-des-petits-ruminants-all-fronts> and <https://epo.org/>

There were four spin-off companies listed from two EPSRC-DST projects and one Innovate UK-DBT project, all registered in the UK. Two spin-offs are currently active. ARCITEKBIO Ltd is a spin-off from Aberystwyth University and founded in 2018. It was formed as a result of a £1 million project, Newton Bhabha Industrial Waste BIOREVIEW, to commercialise a platform for the processing of agricultural waste into xylitol. A second spin-off from the project Development and Integration of Biomass and Concentrating Photovoltaic System for Rural and Urban Energy Bridge: BioCPV came from Exeter University. Founded in 2017 as a result of a £1.4 million funded project, it was established to develop and commercialise innovative construction materials by embedding advanced photovoltaic technology into them.



**FIGURE 29:** Spin-off examples. Source: Gateway to Research

<sup>37</sup> <https://www.pirbright.ac.uk/news/2019/03/pirbright-tackle-pestes-des-petits-ruminants-all-fronts>

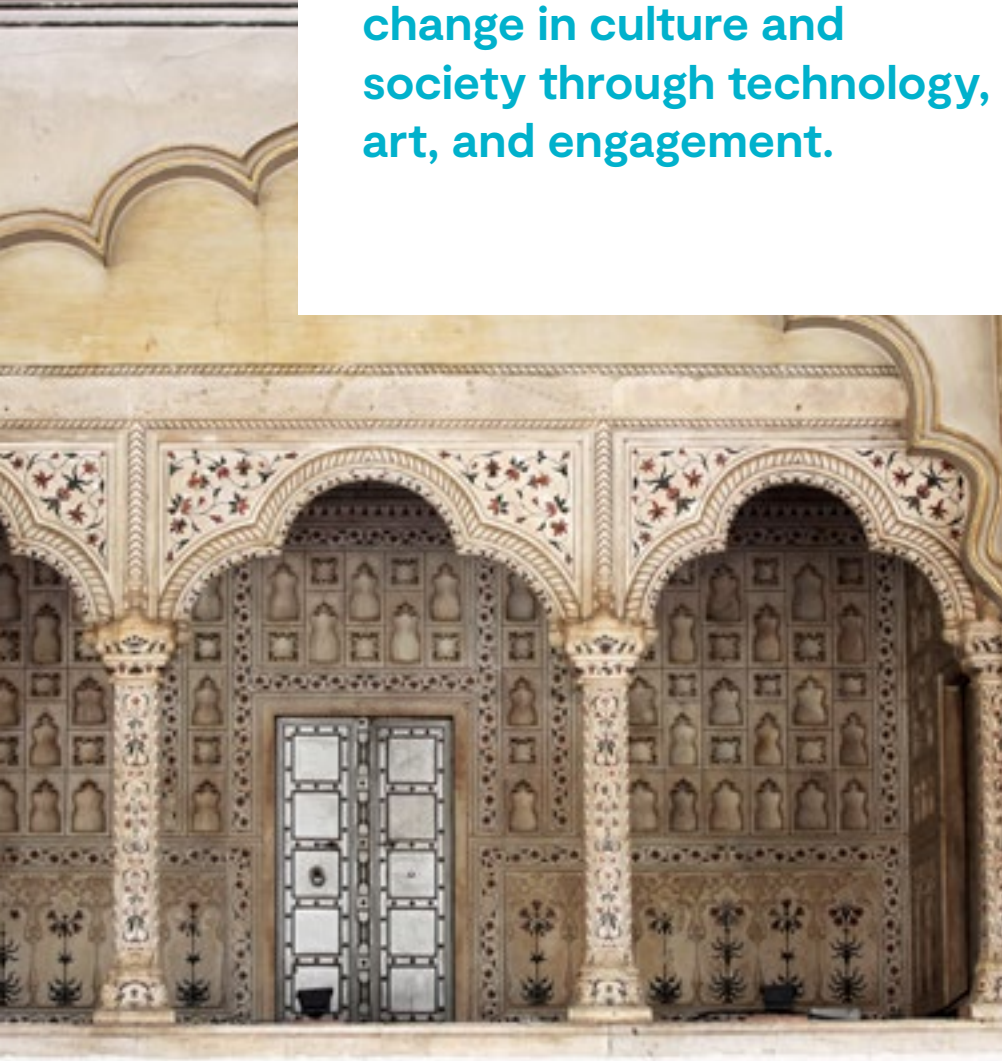
## 13.

## Theme: Societies and Culture

**UKRI India developed research that investigated change in culture and society through technology, art, and engagement.**

Many UKRI India projects examined the ways that society and culture interact with each other but also with other aspects such as health, business, and environment. Historically, Indian and UK populations are shifting and are generally becoming more urban and globalised. However, a desire to retain a hold of rural identity and traditional culture can be seen in some instances, despite shifts to urban locales. UKRI India projects focusing on society and culture tended to investigate these shifting and overlapping priorities, identifying the ways that changes in society impact multiple areas of life, economy, and health. There were multiple UKRI India projects that looked at the history of the urban city, cultural heritage, and rapid urbanisation in India, political changes, ageing, and changing lands and livelihoods. Most of these projects correlated with two SDGs: Sustainable Cities and Communities (SDG 11) and Peace and Justice Strong Institutions (SDG 16). Projects were varied, including one funded by ESRC and ICSSR that tracked multiple factors related to the changing nature of electoral politics in contemporary India and another funded by AHRC and ICHR that interrogated “meanings of the river” in urbanising India through writing, painting, poetry, mythology, plays, and archival materials. These projects provided a view on how society and culture are incorporated into the fabric of multiple aspects of contemporary life.

The shifting urban experience was explored by UKRI India projects through interrogations of culture, the environment, the political landscape, and the health of citizens. One theme that ran throughout many of these projects was the idea of connection. As of 2019, a third of India’s population lived in urban centres, with an increase of approximately 4% over the past decade, whereas in the UK almost 84% of the population lived in urban centres, with a growth of approximately 3% over the past decade. The continued urban growth provided the background of multiple UKRI India research projects. In considering the urban framework, Learning from the Utopian City, funded by AHRC and ICHR, focused on the perceptions of urban centres, how they grow, and how they change. This project produced two publications with an FWCI of 7.2 in the Research; Technology; Industry SciVal Topic Cluster; this score was much higher than the world FWCI of 1.3 in this Topic Cluster. The project used multiple methods to create a complex view of the modern urban experience: a photography exhibit on the changing urban city, influencing policy in the UN’s World Cities Report 2016 and contributing knowledge to the World Economic Forum.



## 13.



Urbanisation has been a topic of interest for India and the UK for many years, and the collaboration between the countries has enhanced the research and output of both countries. The Learning from the Utopian City project, funded by AHRC and ICHR under the Newton Bhabha Fund,<sup>38</sup> is a prime example of the knowledge exchange between the UK and India. Professor Ayona Datta, University College London, previously received funding through the British Council UK-India Education and Research Initiative, which has led to more extensive research and follow-on projects such as one funded by ESRC and ICSSR under the Newton Bhabha Fund that learned lessons from small cities,<sup>39</sup> continuing the research of the Utopian City project with a new focus, providing a wider view of urban culture and life.

While urban issues were studied, the changing social and cultural environment within rural communities was also a focus of research. The Coastal Transformations and Fisher Wellbeing project, funded by ESRC and ICSSR under the Newton Bhabha Fund,<sup>40</sup> explored changing societies due to economic pressures. This project conducted over 30 engagement activities to disseminate research, including 19 presentations and a three-day workshop to the field sites in Cuddalore district in Tamil Nadu, India. They also produced a video of UK fishermen based on the research, which has been viewed over 900 times since posting in January 2019. This project wove the Indian and UK experiences of the effect of coastal economies on people, demonstrating a truly collaborative approach to work. Further mapping changes to urban and rural identity from a political perspective was found in the Electoral Change in Rural and Urban India project,<sup>41</sup> funded by ESRC and ICSSR. It tracked multiple factors related to the changing nature of electoral politics in contemporary India, creating three new databases around voting, eight workshops and conferences, and contributing to the national press in India in the run-up to 2016 elections, as well as publishing a highly cited book, *Why regional parties?: Clientelism, elites, and the Indian party system* (FWCI 3.2).

The changing nature of society and culture are intertwined in climate change, economic change, and scientific discovery. UKRI India projects developed complex research studies that incorporated these myriad factors to determine how and why society changes, and the importance of society and culture in developing solutions to problems.

<sup>38</sup> [Learning from the Utopian City \(AH/N007395/1\)](#)

<sup>39</sup> [Learning from small cities: Governing imagined futures and the dynamics of change in India's smart urban age \(ES/R006857/1\)](#)

<sup>40</sup> [Coastal transformations and fisher wellbeing - synthesized perspectives from India and Europe \(ES/R010404/1\)](#)

<sup>41</sup> [From Identity to Interests? Quantitative and Qualitative Explanations of Electoral Change in Rural and Urban India \(ES/K005936/1\)](#)

## 13.

## Case Study 1.13.1

### Transforming the city

The shift between rural and urban life affects almost all aspects of life, including culture and identity. The UK has invested in the topic of cities for a long time, and in 2019 the Connected Places Catapult was established by Innovate UK to collect research on the city all in one place and support such research.<sup>42</sup> Urbanisation is also a topic of interest for India—for example, with the urbanisation area in the Centre for Policy Research.<sup>43</sup> Collaboration between the countries has enhanced the research and output of both countries. Professor Ayona Datta of University College London led two UKRI India projects that researched how the city impacts those living in it. These city projects are a good example of the knowledge exchange between the UK and India. Professor Datta previously received funding through the British Council UK-India Education and Research Initiative, which has likely led to more extensive research. The joint AHRC–ICHR funding of the project Learning from the Utopian City: An international network on alternative histories of India’s urban futures led to many tangible outcomes, including a policy citation from the UN’s World Cities Report 2016, as well as a mention in a World Economic Forum article. Direct engagement included establishing a Twitter account that communicated information about the research and connected the research to other projects, enhancing collaboration and dissemination (FIGURE 30).



**FIGURE 30:** Utopian Cities Project’s Twitter Profile. *Source: Twitter*

The smart cities network,<sup>44</sup> funded by ESRC under the Newton Bhabha Fund, also developed the concept of city-level Urban Observatories for India. They conducted workshops in Delhi, Chennai, Mumbai, Chandigarh, Kolkata, Visakhapatnam and Kochi that played a key role in raising awareness of the potential of Urban Observatories as a platform to make city-level data more visible and more useful for governance and as a mechanism to enable citizens and communities to have a voice in managing their city. These events included 828 unique participants from national and regional government, funding bodies, academia, and business. They also received press coverage, and three short videos were made to promote the observatories.

<sup>42</sup> <https://cp.catapult.org.uk/>

<sup>43</sup> <https://www.cprindia.org/urbanisation>

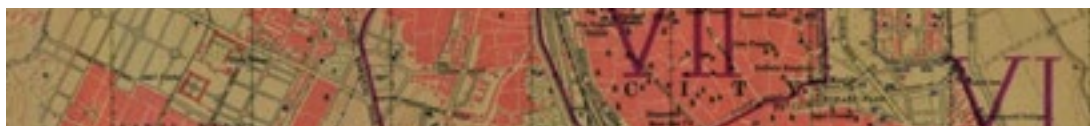
<sup>44</sup> SMARTIES Network for Sustainable Urban Futures (SMARTIES Net) (ES/P000517/1)

## 13.

## Case Study 1.13.2

### Preserving Cultural Heritage in Urban India

The importance of the preservation and celebration of traditional culture was featured in UKRI India research. In one project funded by AHRC and ICHR under Newton Bhabha Fund,<sup>45</sup> heritage activists along the Hugli River were upskilled to international standards in the documentation and promotion of both tangible and intangible heritage. The project involved creative output, as detailed below. It also created an app with Safarnama and the University of Lancaster that hosts images, geolocation data, and site descriptions in Bengali and English, through which digital heritage experiences in Delhi can be downloaded and used. It has had over 500 downloads since launching.



**FIGURE 31:** Screenshot from the Hugli AR App website. Source: <http://wp.lancs.ac.uk/dhIndia/safarnama/>

The project has created multiple creative and engagement projects, including photography exhibitions, heritage days with school children, five volunteer-led heritage walks, a film entitled “Reverberations: Voices from the Riverfront”, and a major art installation of five 10-foot by 3.5-foot silk banners depicting clusters of buildings and high points in cultural history in each of the five Hugli cities—Bandel, Chinsurah, Chandernagore, Serampore and Barrackpore—which hung along the river.

Another programme funded by AHRC and ICHR under the Newton Bhabha Fund<sup>46</sup> researched how to enhance cultural resilience in India by applying digital technologies to Indian heritage through technology. It produced nine engagement opportunities, including a symposium, newsletters, workshops, and a youth outreach programme. There was also a photography exhibit titled “Cultural Heritage of Surat Discovery”. The variety of methods to investigate and preserve cultural heritage demonstrate the richness of cultural heritage throughout society.

<sup>45</sup> The Hugli River of Cultures Pilot Project, from Bandel to Barrackpore (AH/R014272/1)

<sup>46</sup> IT INDIAN HERITAGE PLATFORM: Enhancing cultural resilience in India by applying digital technologies to the Indian tangible and intangible heritage (AH/R014183/1)

## 13.

## Case Study 1.13.3

### Ageing

#### Background

In 1980, just under 400 million people worldwide were aged 60 or over. By 2017, that figure had risen to just under 1 billion. By 2050, it is projected to exceed 2 billion. The changing structure of the global population has big implications for the provision and cost of health and social care, as well as for the individual well-being and happiness of older people. Comparing and contrasting their experiences around the world—not least in terms of inequality of opportunities and outcomes—is an essential stage in the process of ensuring that “healthy ageing” is not just an aspiration.

Ageing and urbanisation are also closely linked. By 2030, two thirds of the global population will be living in cities and at least a quarter of those urban populations will be aged over 60. Developing urban environments that support and promote healthy living for older people has become a key driver of urban policy and interventions at a local and national level, resulting in planning design concepts and guidelines to support an ageing population. However, current urban planning and development models have overlooked how environments can support a sense of place, articulated through supports for active living, social participation and making a positive contribution to the community. Ageing successfully at home and in the community requires that people are able to access “assets and resources” to support healthy ageing—for example, transport, adequate housing, healthcare services, and leisure opportunities alongside social networks and opportunities for lifelong learning.

#### Solution

How and where people live was another cultural and societal theme running through UKRI India research, and ageing within this context was another theme for some projects. The Ageing and well-being in a globalizing world project, funded by ESRC and ICSSR and part of an internationally collaborative project between the UK, India, and the Netherlands, explored “the wellbeing of older persons in the context of an increasingly globalising world”.<sup>47</sup> The initiative has investigated older people’s needs and circumstances in countries such as India, the UK, and China.

In another project, focusing on developing age-friendly cities and communities,<sup>48</sup> funded by ESRC and ICSSR under the Newton Bhabha Fund, there were further surveys, interviews, and photo diaries implemented in India, which were subsequently compared with data from the UK and Brazil. Cross-national workshops and visits led to an understanding of older adults across different urban, social, and cultural contexts.

#### Outcomes

Using qualitative research and an extensive network of researchers, this project produced extensive knowledge on ageing in different societies, shared through informal networks, talks, and 12 scholarly publications, which received 146 citations from 38 countries.

The findings from the second project have generated impact within India at an individual level (building skills and working alongside older adults as co-researchers), at a community level (findings being used by service providers and community organisations) and a national level (collaboration with HelpAge India to ensure findings impact on social outcomes for older adults). The work has led to improved attitudes amongst service providers and older adult organisations. The findings have been disseminated across different levels including community, policymaker, and practitioner audiences.

<sup>47</sup> [http://www.cpc.ac.uk/projects/39/Ageing\\_and\\_wellbeing\\_in\\_a\\_globalizing\\_world\\_AgeGlobe#overview](http://www.cpc.ac.uk/projects/39/Ageing_and_wellbeing_in_a_globalizing_world_AgeGlobe#overview)

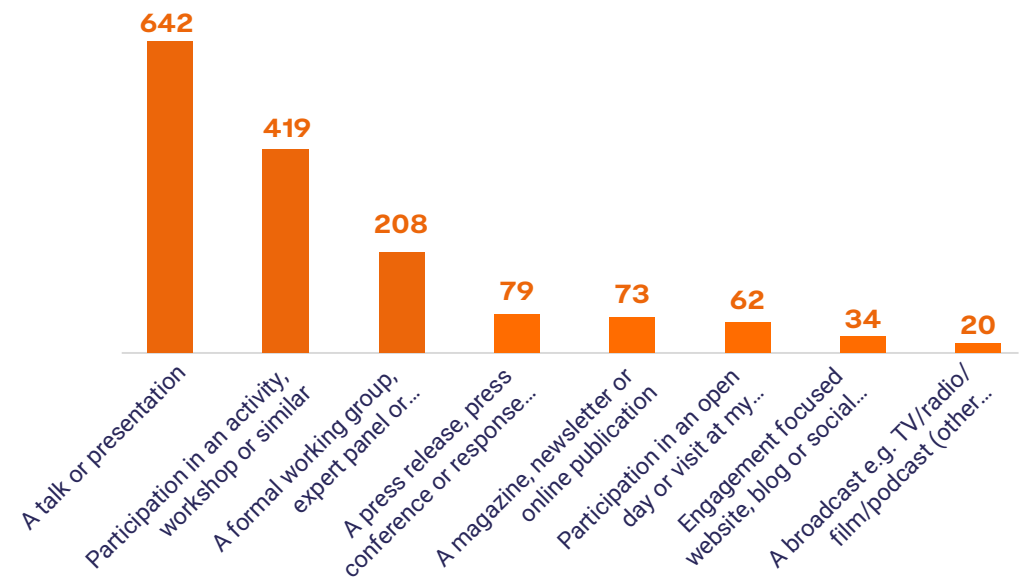
<sup>48</sup> Ageing Well in Urban Environments: Developing Age Friendly Cities and Communities (ES/R00692X/1)

## 14.

## Engagement Activities and Communication

**Results from UKRI India projects were widely shared, with over 1,500 instances of communication across multiple audiences and regions.**

Research projects have multiple ways to communicate findings and outcomes to various audiences. While scholarly publication is one way, other forms include presentations, workshops, media articles or interviews, or website material. There were 1,537 reported instances of communications outputs from 139 UKRI India projects. Talks and presentations were the most frequent type of engagement activity, accounting for 42% of such activity (FIGURE 32). Participation in an activity, workshop, or similar was the next most frequent, accounting for 27% of the activity, followed by a formal working group, expert panel, or dialogue (14%).

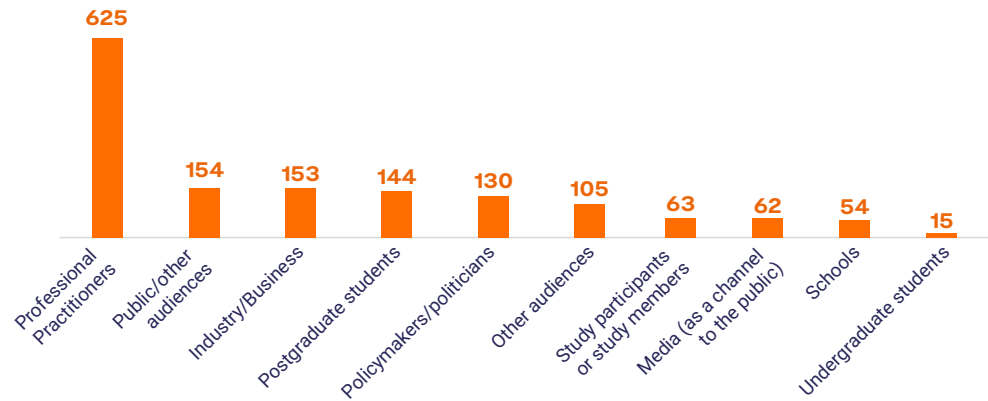


**FIGURE 32:** Count of communication activities by type. Source: Gateway to Research

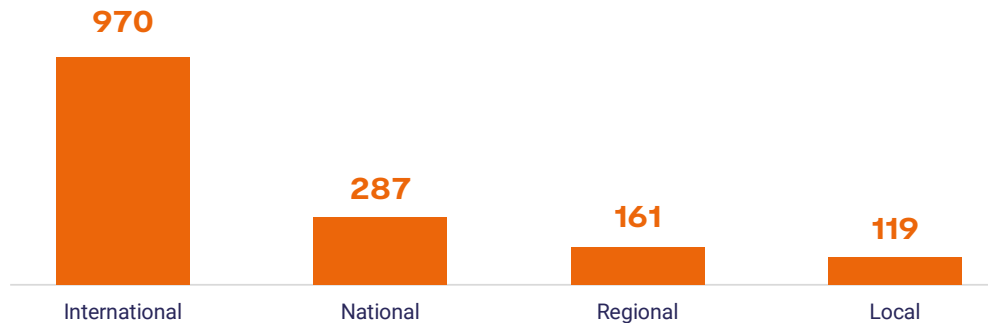


# 14.

For all activities, the largest audience by far was professional practitioners, with 42% of activities aimed at them (FIGURE 33). The activities aimed at this professional audience ranged across the types, with the most common activity aimed at professionals being a talk or presentation at 53%. Public/other audiences and industry/business audiences were the next highest audience groups, with 10% each, followed by postgraduate students (10%), and policymakers/politicians (9%). The majority of the activities were aimed at an international audience (63%), followed by a national audience (19%) (FIGURE 34).



**FIGURE 33:** Count of communication activities by primary audience. Source: Gateway to Research



**FIGURE 34:** Count of communication activities by geography. Source: Gateway to Research

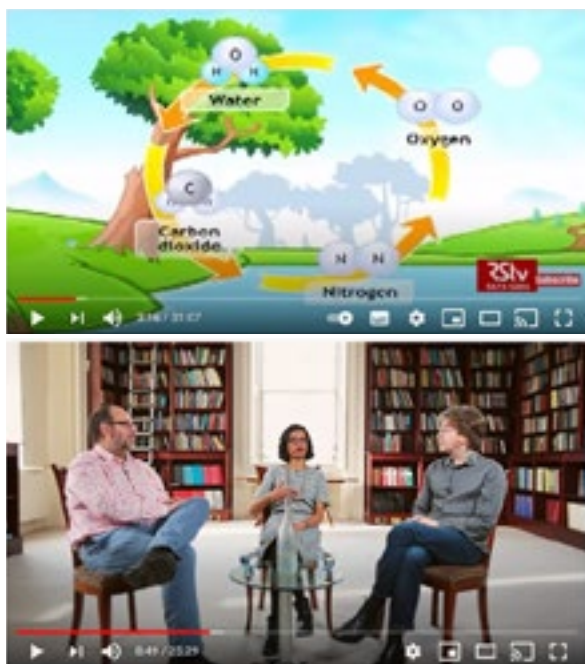
The Cambridge-India Network for Translational Research in Nitrogen project produced 102 communication items, of which 45% were a talk or presentation and 58% were for an international audience. A press release for the article “Association of Gestational Weight Gain with Adverse Maternal and Infant Outcomes” led to it having the highest overall engagement among articles, with 62 citations, 268 uses, 201 captures, and 479 social media activities. This article resulted from the project Maternal vitamin B12, folic acid and homocysteine as determinants of gestational diabetes, fetal growth and intergenerational programming of diabetes.



**FIGURE 35:** PlumX metrics for “Association of Gestational Weight Gain with Adverse Maternal and Infant Outcomes” Source: PlumX

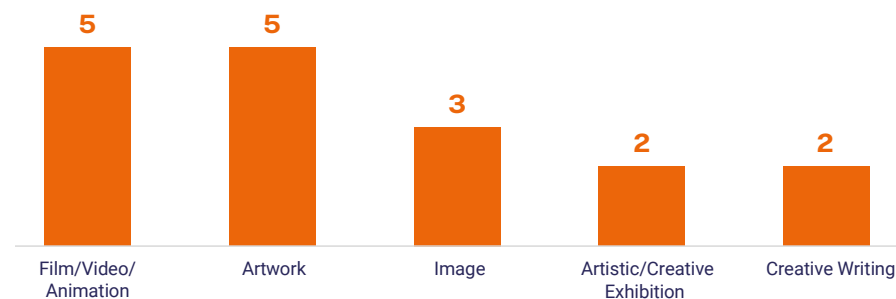
# 14.

One of the most cited engagement activities on social media was the article “Can the world find solutions to the nitrogen pollution crisis?”, from the NEWS India-UK project. The article resulted in 3,446 social media activities and 32 news/blog mentions, and a video from the project, titled “Balancing Nitrogen Cycle”, aired on Rajya Sabha TV (RSTV), a national cable news outlet in India. It featured Professor Mark A. Sutton, Chair, International Nitrogen Initiative, and the show subsequently had over 5,200 views on YouTube and was “liked” over 140 times, showing high viewing numbers and engagement. A video from the project Learning from the Utopian City: An international network on alternative histories of India’s urban futures, entitled “Habitat and Living in Plural Cities”, was embedded on the British Academy website and has had 1,015 views on YouTube since posting in April 2017.



**FIGURE 36:** Video stills from UKRI India communication outputs. Source: <https://www.youtube.com/watch?v=fn6oyLTQ1CQ>; <https://www.youtube.com/watch?v=3IK7ndXv4RM>

There were 17 outputs listed as Creative Products, from three funders. Film/ Video/Animation and Artwork made up the majority of creative product outputs (29% each) (FIGURE 37). While DBT-funded projects made up most of the outputs (71%, 12/17), UKRI-ICHR funded projects had the highest relative share of outputs. While they made up 5% of overall projects, they accounted for 21% of creative products.



**FIGURE 37:** Count of Creative Products by type. Source: Gateway to Research

## 14.

The most commented creative product on social media and the most watched video was from the project Novel Molecular Approaches for Advancing Prediction and Mitigation of Disease Outbreaks in Aquaculture for Small Scale Farmers (BBSRC-DBT). The video, which is on raising awareness of the impacts of antibiotic use amongst farmers in support of sustainable shrimp aquaculture in Bangladesh, has been watched over 1,800 times since being posted in May 2019. It also had 171 mentions, likes, or posts on social media.<sup>49</sup> The project Learning from the Utopian City: An international network on alternative histories of India's urban futures (AHRC-ICHR) staged a photography exhibition in Leeds, UK, of photography in the cities of Mumbai and Varanasi, providing depth of coverage to the project and leading to future collaborations for the artists



**FIGURE 38:** Creative outputs of video and photography (Tim Smith).

Source: <https://www.youtube.com/watch?v=p9UnMHLrjBk>; <https://utopiancities.wordpress.com/photo-exhibition/>

<sup>49</sup> <https://www.youtube.com/watch?v=p9UnMHLrjBk>

## 15.

## Policy Outputs

**UKRI India projects contributed to international policy discourse through advisory committees and training.**

There were 105 reported policy outcomes from 44 UKRI India projects. The most common policy outcomes were “participation in an advisory committee” (33%) and “influenced training of practitioners or researchers” (29%) (FIGURE 39). The majority of policy outcomes had an international audience (31%) or focused on a continent-wide audience (38%), with Asia being the most reported continent for policy outcomes (25%) (FIGURE 40).



**FIGURE 39:** Count of Policy Outputs by type. Source: Gateway to Research

# 15.

The following are some examples of policy outcomes.

- Participation in an advisory committee: The Principal Investigator of the Maximizing the potential for sustainable and durable resistance to the wheat yellow rust pathogen project, funded by BBSRC-DBT, is on the Advisory Board of the UK Global Food Security Science Advisory Board.
- Membership of a guideline committee: Co-investigator of the Electricity Engineering Standards Review Independent Panel Terms of Reference, funded jointly by EPSRC and DST, is a member of the UK Smart Systems forum.
- Implementation circular/rapid advice/letter to e.g., Ministry of Health: The Principal Investigator of the NERC-MoES funded project The structure and dynamics of groundwater systems in northwestern India under past, present and future climates has been a member of the Expert Committee to review the available information on paleochannels for the Government of India.
- Citation in other policies documents: The Principal Investigator of the Learning from the Utopian City: An international network on alternative histories of India's urban futures project, funded by AHRC-ICHR, was cited in the UN World Cities Report 2016, reaching a global audience.

The Joint UK-India Clean Energy Centre (JUICE) project reported the highest number of policy outcomes (10), such as being an expert on the EPSRC Scientific Advisory Committee, contributing to a DFID workshop on energy access pathways, and training engineers from Malaysia and Chile.

The NEWS India-UK project had seven policy outputs, which included participating in meetings at the Scottish Parliament and the United Nations Environment Assembly.

The Phenotypic characterisation of non-smoking COPD project resulted in the publication of guidelines for the diagnosis and management of chronic obstructive pulmonary disease.

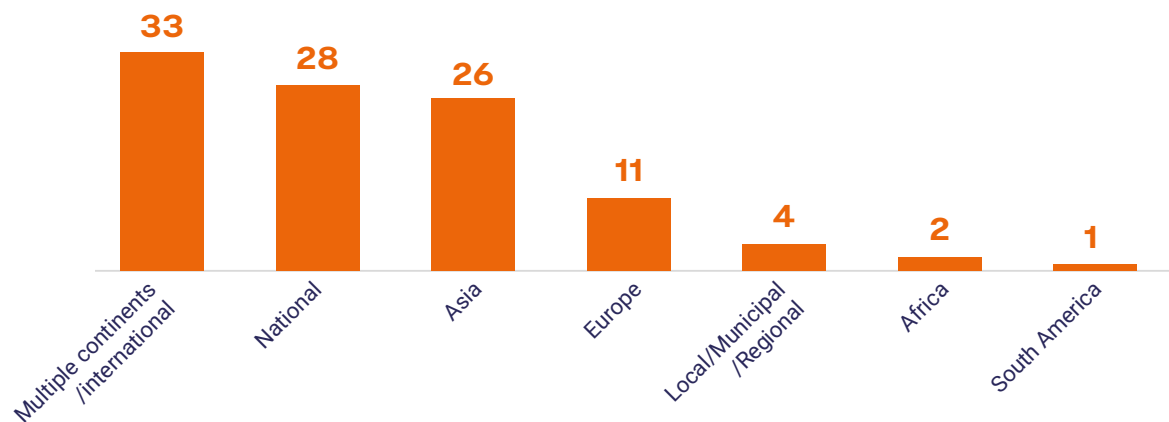


FIGURE 40: Count of Policy Outputs by geography. Source: Gateway to Research



FIGURE 41: Examples of policy bodies with UKRI India researchers as members. Source: <https://epsrc.ukri.org/research/ourportfolio/themes/energy/programme/further-information-about-the-programme/scientific-advisory-committee/>; <https://www.unep.org/environmentassembly/proceedings-report-ministerial-declaration-resolutions-and-decisions-unea-3>; <https://goldcopd.org/>

## 16.

## Theme: Digital and Data

**UKRI India produced technological solutions and data-led research across medical, cultural, social, economic, and environmental projects, resulting in 200 new databases, research tools, applications, or software.**

### Background

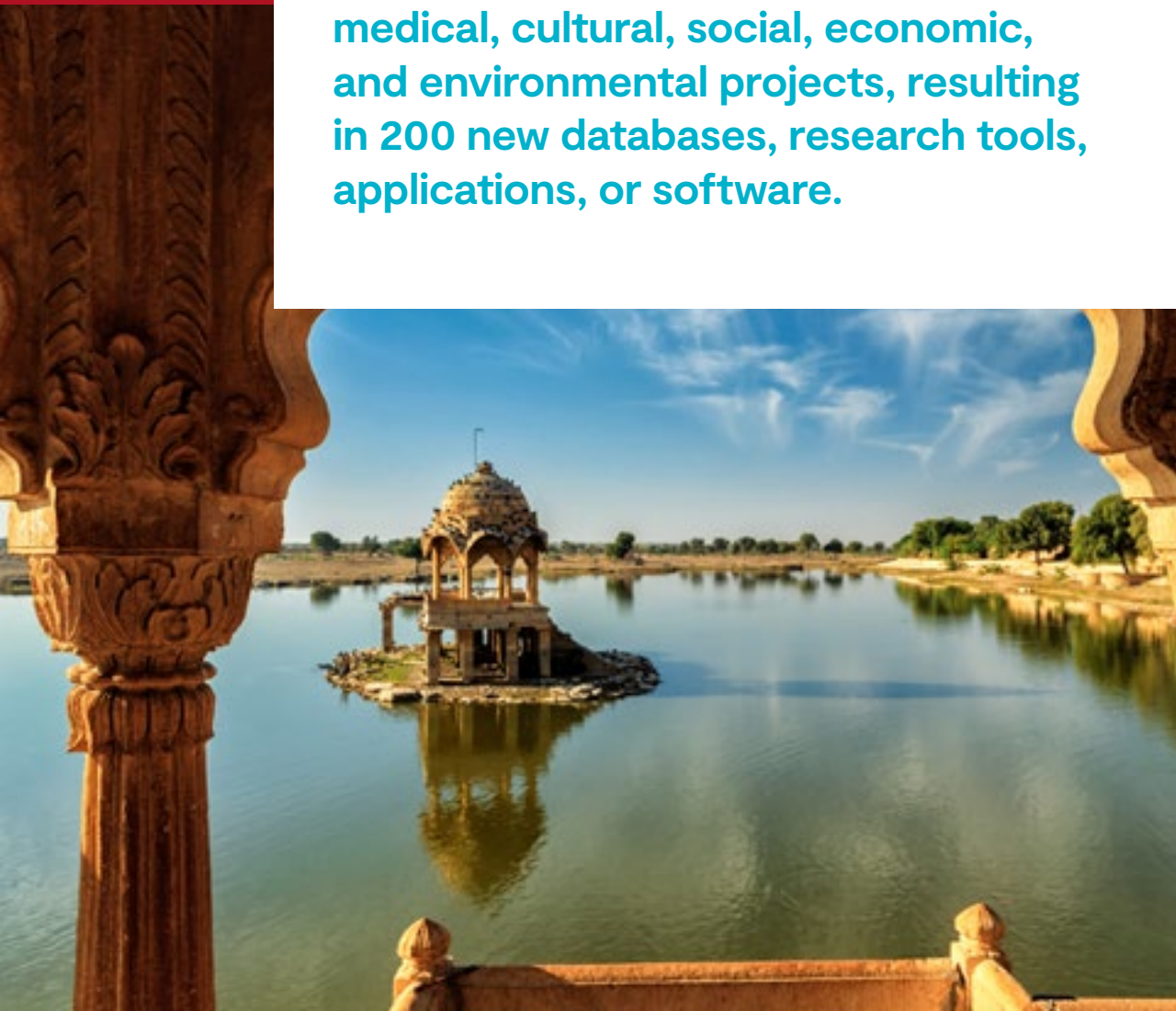
Technology, data, and digital solutions weave throughout UKRI India projects and their outcomes. The importance of using data and technology to enhance and promote research is paramount. UKRI India projects produced over 20 new pieces of software, six new webtools or applications, and 73 new research tools or methods, with the majority related to data and technology. Over a dozen new pieces of intellectual property, patents, or copyright-related material associated with technology or data were also listed. Additionally, there were over 100 new databases or models created by 41 projects. Applications ranged from providing actionable data to farmers, through a machine learning approach to predicting the impacts of mutations on protein stability and interactions, to crowdsourcing information on potable water in coastal areas of southern Kerala as well as the city of Chennai, India. Databases included survey results, transcription of genes, soil moisture and crop growth data, and a repository of residential energy and thermal comfort metadata.

Technical solutions were developed and tested by multiple projects across academic fields, including one developing a biosensor for low-cost thyroid testing,<sup>50</sup> funded by Innovate UK and DST under the Newton Bhabha Fund, which aimed to deliver a rapid, accurate, and simultaneous test for a range of indicator hormones, allowing point-of-care diagnosis. This would quickly identify those needing treatment, where before they may not have been found, leading to improved quality-of-life standards. Two other Innovate UK and DST funded projects under the Newton Bhabha Fund also aimed to develop portable medical tools to quickly diagnose disease in rural settings, including one to enhance breast cancer screening in India<sup>51</sup> and one that aimed to develop affordable, wearable bio-sensing and human motion monitoring suits and exoskeletons to assist essential human motions.<sup>52</sup> The proliferation of UKRI India funded projects aiming to improve livelihoods with technology and data demonstrates the forward-thinking, data-driven, innovative research that runs throughout the programme.

<sup>50</sup> PROTECTT PoRtable Organic Transistor based biosensor for low Cost Thyroid Testing (103707)

<sup>51</sup> The Development of a Portable THERMOgraphy-based Health DeTECTion Application (THERMOTECT) in breast cancer screening in India (103706)

<sup>52</sup> A-PATH: Affordable Preventative and Assistive Technology for Healthcare (103708)



## 16.

Another project that shows the potential of data and technology to enhance multiple fields is an mHealth project creating an integrated model of hypertension, diabetes, and antenatal care in primary care settings in India and Nepal. Funded by MRC, ESRC, and DBT under the Newton Bhabha Fund, it aims to enhance antenatal care (ANC) by working with WHO to develop a tablet-based electronic decision support system (EDSS) for frontline health workers in India and Nepal to enhance the detection and management of antenatal conditions such as pregnancy-induced hypertension and gestational diabetes. The data and experience of the team will not only influence healthcare practice in India: through the collaboration with WHO they will also influence policy and health outcomes globally. Results from the project's formative phase research was shared with the WHO team to provide a sense of the opportunities and challenges for EDSS use in the areas of Nepal and India. This represents a multidisciplinary collaboration, bringing together IT specialists, clinicians, qualitative researchers, and epidemiologists.

### A focus on UKRI India collaboration addressing artificial intelligence

A key and growing technology for the past decade has been artificial intelligence (AI). This large field touches almost all aspects of society and research, shaping a myriad of areas. India's National Strategy for Artificial Intelligence notes that "an integral part of India's strategy for AI involves tackling common and complex global challenges that can be solved through technology intervention, and India's scale and opportunity landscape provides the ideal test-bed to ensure sustainable and scalable solutions".<sup>53</sup> The United Kingdom is likewise planning to develop AI, "setting the conditions for AI to work in and with multiple disciplines and areas of society and the economy", including strategic international partnerships.<sup>54</sup> UKRI India projects have used and developed technology and AI in different ways to benefit multiple sectors. A total of 58 UKRI India publications discussed AI or machine learning,<sup>55</sup> with a combined FWCI of 2.0, above the FWCI in this area for the world (1.1), India (0.9), and the UK (1.7). The publications covered a range of disciplines from Computer Science to Medicine to Energy to Social Science, showing the importance of technological methods and solutions throughout UKRI India research. The most highly cited publication in this set, with an FWCI of 10.9, was "pkCSM: Predicting small-molecule pharmacokinetic and toxicity properties using graph-based signatures". This publication resulted from the Cambridge-Chennai Centre Partnership on Antimicrobial Resistant Tuberculosis project, funded by MRC with the Newton Bhabha Fund and DBT, which used machine learning and other novel techniques to combat drug-resistant tuberculosis.

<sup>53</sup> [https://niti.gov.in/writereaddata/files/document\\_publication/NationalStrategy-for-AI-Discussion-Paper.pdf](https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf)

<sup>54</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/949539/AI\\_Council\\_AI\\_Roadmap.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/949539/AI_Council_AI_Roadmap.pdf)

<sup>55</sup> Search: "Artificial Intelligence" OR "Machine Learning" OR "ML" in Scopus. Topic Clusters from SciVal.

# 16.

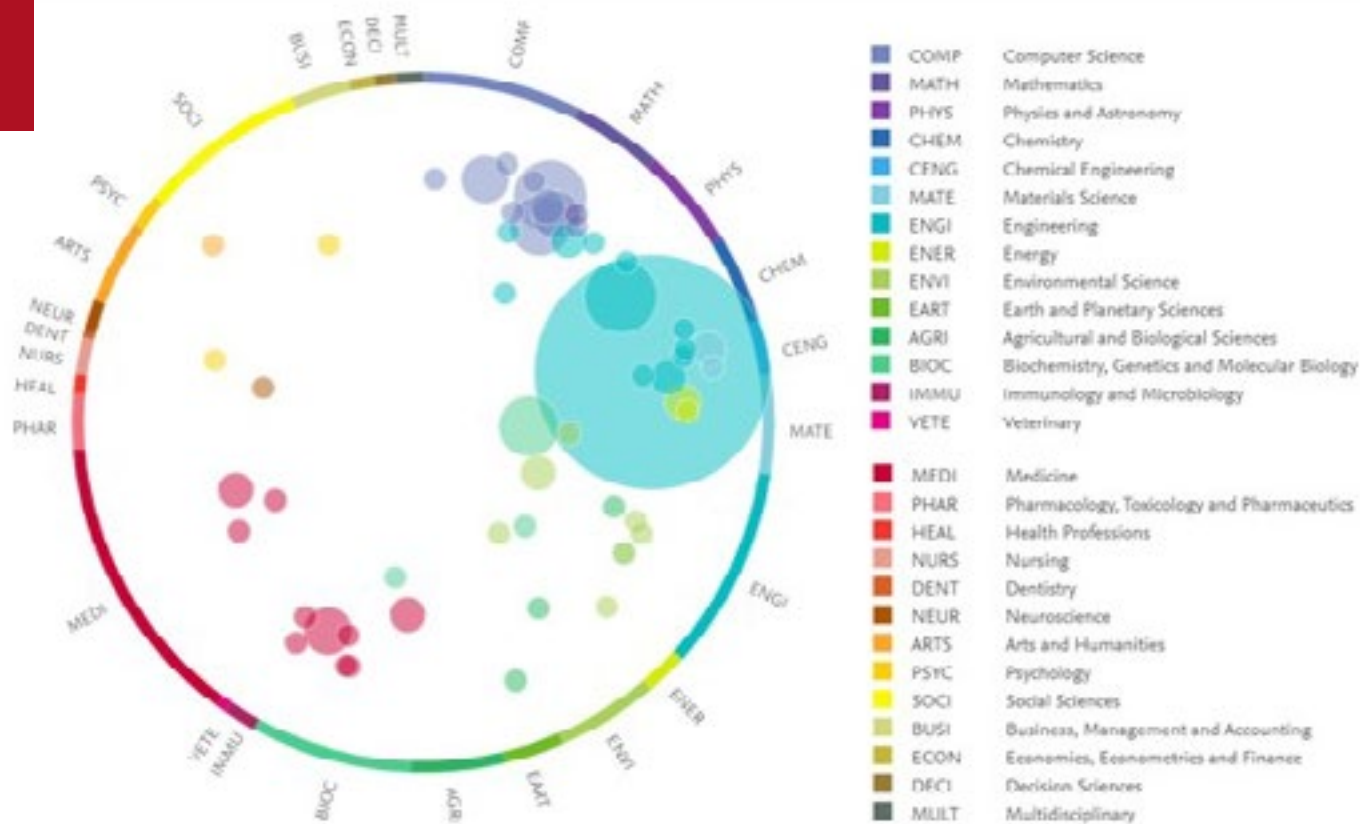


FIGURE 42: SciVal Topic Clusters for UKRI India artificial intelligence publications..Source: SciVal

Another highly cited paper in this publication set was “Distributed manufacturing: scope, challenges and opportunities” from the project Engineering Driven Sustainable Supply, funded by EPSRC and DST, which had an FWCI of 6.1. Using novel technologies such as AI, this project extended existing supply network configuration theories by integrating sustainability dimensions to the traditional cost, quality, and timely and dependable delivery analysis. Affecting multiple industries, especially Aerospace, Automotive, Pharmaceutical, and Food Processing, the project worked to enhance manufacturing but also addressed climate change and international cooperation.

## Conclusions

Technology, data, and digital methods and solutions were essential factors throughout UKRI India research across almost all disciplines, enhancing the quality of the research and development of productive outputs. New knowledge, products, research methods, and clinical advancements resulted from UKRI India projects. These outputs positively influence healthcare, climate change, food production, and more. Continued investment in UKRI India projects can only further develop the technological capabilities and outcomes of AI research.



## 16.

## Case Study 1.16.1

### Data and Technology Centres

#### Background

Explosive growth in advanced digital telecommunications networks is one of the defining features of our times. This extraordinary expansion has already touched every sphere of life, from education and healthcare to manufacturing and finance. But more can and must be done to unlock the incredible opportunities to boost prosperity and benefit lives, and to enable everyone, whatever their social or economic status, to enjoy the fruits of the digital revolution. Ensuring that data are documented, available, and accessible is also a key aspect in developing research and digital development. Achieving all this requires effective frameworks for cutting-edge collaboration embracing both the research community and industry and focusing squarely on delivering world-shaping technological advances.

#### Solution

Two collaborations were founded to address the need for collaboration in telecommunications and a collaborative approach to database storage and accessibility. The India-UK Advanced Technology Centre (IU-ATC), funded by EPSRC and DST,<sup>56</sup> was formed in direct response to a previous request from the British High Commission in India and was developed through a series of workshops. The initiative brought together UK universities, Indian Institutes of Technology, and major industrial partners from the UK and India, who put in place the support infrastructure to facilitate, develop, and enable the digital economy of both countries. A second project, funded by ESRC and ICSSR, launched a data centre that stored and made publicly available comprehensive sets of statistical datasets in social sciences that were generated and contributed to by the Ministry of Statistics and Programme Implementation, New Delhi.<sup>57</sup> It houses social science datasets from both academic and government sources for use by researchers.

#### Outcomes

The IU-ATC workshops brought together researchers and industrial partners from both countries, leading to the development of further projects such as the Transnational Testbed for Next Generation Networks. Success of Phase I of the project led to a second phase, which received a £10 million funding boost. Further successes of the project included development and testing of a solar-powered “virtual bank” for rural areas; mobile apps for monitoring crop diseases to improve food security; wireless sensors for triggering landslide warnings; and technologies for incorporation in unmanned aerial search-and-rescue vehicles. As one of the earliest major bilateral consortia, the successful policy frameworks for the collaborative agreements and intellectual property rights management from this centre have informed UKRI India and the UK Science and Innovation Network, with some best practices for future initiatives.

The ICSSR Data Centre covers topics such as healthcare, housing, business, employment, investment, tourism, debt, and consumer expenditure. The centre creates more than just a single repository for social science data; it also extracts and transforms the raw data before uploading them in the data repository with necessary documentation and provides training materials. This supplies more research material to a wider set of academics and policymakers, resulting in deeper and more impactful research and policy outcomes.

A senior Indian delegation from ICSSR visited ESRC’s UK Data Service to understand best practices for setting the Data Centre. This was led by ESRC through the Newton Bhabha Fund.

<sup>56</sup> India-UK Advanced Technology Centre (IU-ATC) of Excellence in Next Generation Networks Systems and Services (EP/G051674/1)

<sup>57</sup> <http://www.icssrdataservice.in/index.php>

## 16.

## Case Study 1.16.2

### Cambridge–Chennai Centre Partnership on Antimicrobial Resistant Tuberculosis

#### Background

Tuberculosis (TB) is a persistent threat to healthy societies, with approximately 10 million people infected globally in 2019, 1.2 million of them children, and 1.4 million deaths in that same year.<sup>58</sup> It is the deadliest infectious agent in the world. Despite a steady but slow decline in cases globally since 2015, multidrug-resistant TB is increasing, with a 10% increase globally from 2018 to 2019, going from over 186,000 cases to over 206,000 cases. As multidrug-resistant TB increases, the typical antibiotics used to treat it will not work, and it will be increasingly hard to treat and eradicate. New methods and techniques must be found.

#### Solution

The Cambridge–Chennai Centre Partnership on Antimicrobial Resistant Tuberculosis, funded by MRC and DBT with the Newton Bhabha Fund, was a collaboration between the University of Cambridge in Cambridge, UK, and the National Institute for Research in Tuberculosis (NIRT) in Chennai, India. The partnership brought together a multidisciplinary team to focus on novel diagnostics and therapeutics for TB. The partnership focused on increasing technological capabilities in the UK and India to find novel solutions including the use of emerging sequence-based diagnostics to improve the accuracy of individual patient treatment for multidrug-resistant and extensively drug-resistant TB; new drug targets for TB and prediction/investigation of the impact of resistance mutations based on modelling of bacterial genome data; the development of an in-depth understanding of the bacterial genes in diverse populations of *Mycobacterium tuberculosis* associated with “drug tolerance”; and novel approaches to the treatment of TB based on immunomodulation (enhancement of autophagy and novel enhancers of T cell responsiveness). This project also aimed to increase relevant and collaborative research experience for UK and Indian investigators and transfer scientific training and technology to enhance independent research capacity and foster future international collaborative projects.

#### Outcomes

From the technology-based research, multiple outcomes were formed including medical and technical advancements and the strengthening of international collaboration networks. The project produced two new publicly available databases that can be used to understand the druggability of targets for antibacterials for TB and to understand drug interactions with protein targets. They also developed a machine learning approach to understanding the mechanisms by which mutations affect human genetic disease, drug resistance in cancer, and antimicrobial resistance in human and infectious disease. The partnership also used machine learning techniques to further their research, including producing a new machine learning approach to understanding the mechanisms by which mutations affect human genetic disease, drug resistance in cancer, and antimicrobial resistance in human and infectious disease. Of the 24 publications through 2019, 4 included machine learning or artificial intelligence approaches, with one 2015 publication having an FWCI of 10.9 and a 2017 publication having an FWCI of 9.2, substantially higher than the FWCI of 2.0 for the publications overall. The success of this technologically driven health project can also be seen in its award of over £17 million in further funding to continue this research, including an almost £12 million UK Rapid Support Team grant from the National Institute for Health Research, despite having a starting grant of almost £1.5 million. The leveraging of novel technologies increased relevant and collaborative research experiences for UK and Indian investigators, with the transfer of scientific training and technology to India enhancing independent research capacity and fostering future international collaborative projects.

<sup>58</sup> <https://www.who.int/news-room/fact-sheets/detail/tuberculosis>

## 16.

## Case Study 1.16.3

## Engineering Driven Sustainable Supply Networks — A UK/India Collaborative Study

### Background

The design of supply networks is traditionally driven by operational drivers of cost, quality, and timely and dependable supply. However, sustainability considerations in network design are now becoming increasingly critical. The triple helix of sustainability—comprising economic, environmental, and social pillars—in industrial manufacturing has been largely tackled as separate considerations, with research focusing, until recently, on either the economics of production or environmental perspectives (e.g., environmental degradation) or societal impacts of resource-intensive industries. Often, these elements are considered in isolation and either qualitatively or quantitatively.<sup>59</sup>

### Solution

The Engineering Driven Sustainable Supply Networks project, funded by EPSRC and DST and led by University of Cambridge and IIT Ropar, investigated engineering-driven sustainable supply networks in four important industries: Aerospace, Automotive, Pharmaceutical, and Food Processing. This project combined the skills and experience of the Indian and British partners to develop methodologies that support optimal usage of key resources like energy, materials, water, and other inputs, while minimising the generation of waste. Methods supported trade-off analysis between sustainability practices, whilst simultaneously meeting the cost-, quality-, and responsiveness-related requirements. The resulting framework developed by the partners seeks to combine quantitative modelling techniques with qualitative frameworks to support the analysis and implementation of sustainable supply networks in both discrete-assembly and continuous-process industries. Key to this is the use of data and technology to inform and drive the new methodologies.

### Outcomes

This interdisciplinary project produced sophisticated and flexible methodologies that combine qualitative and quantitative analysis following a multi-layer approach to conceptualise, model, and outline supply network sustainability strategies at strategic, tactical, and operational levels. The project resulted in 30 publications, with an average FWCI of 2.2. Of these publications, three utilised machine learning or AI. A 2016 publication resulted in an FWCI of 5.9, and a 2017 publication resulted in an FWCI of 6.9. This project combined quantitative modelling techniques and big data with qualitative frameworks for analysing and implementing alternative sustainability-focused operations and strategies in industrial supply networks. The approach developed in this project has been taken forward in further large-scale projects including the UK CMAC Future Manufacturing Research Hub and TIGR2ESS (Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies).

<sup>59</sup> <https://gtr.ukri.org/projects?ref=EP%2FK02888X%2F1#/tabOverview>

# Further Funding

**UKRI India funded projects raised over  
£450 million in further funding.**

In order to understand the further funding generated, we consider both the funding acknowledgement data from Scopus and GtR data. The GtR system collects data on further funding raised by the projects. These data rely on the funding captured by the UK investigators due to the nature of the system and may or may not include the additional funding raised by their Indian counterparts. If we consider the funders acknowledged in the publications, we see that the top funders are from the UK and India. However, publications also acknowledged the European Commission's Seventh Framework Programme, the National Institutes of Health from the United States, as well as other European funders.

## 1.

## Further Funding

Funding sponsor	Publications
Engineering and Physical Sciences Research Council	730
Biotechnology and Biological Sciences Research Council	204
Medical Research Council	133
Natural Environment Research Council	79
Department of Science and Technology, Government of Kerala (India)	66
Research Councils UK	62
Seventh Framework Programme (European Union)	52
National Institute for Health Research (UK)	48
Economic and Social Research Council	43
National Institutes of Health (U.S.A)	39
Deutsche Forschungsgemeinschaft (Germany)	36
National Eye Research Centre (UK)	36
Wellcome Trust (UK)	35
Bundesministerium für Bildung und Forschung (Germany)	31
National Natural Science Foundation of China (China)	31
Svenska Forskningsrådet Formas (Sweden)	31
Fondation de France (France)	29
Fondation pour la Recherche Médicale (France)	29
South London and Maudsley NHS Foundation Trust (UK)	29
King's College London (UK)	27

**TABLE 6:** Top 20 institutions that have provided further funding to UKRI India funded projects. *Source: Scopus*

UKRI India had 90 projects report a total of £452 million in funding in addition to the initial grant amounts. Of this further funding, 89% came from the public sector, 5% from the academic and university sector, 4% from charity and non-profit sector, and just over 1% from the private sector (TABLE 7). UKRI-DBT funded projects accounted for 91% of charity/non-profit further funding and 75% of academic/university further funding for all UKRI India projects, showing a high level of non-profit and academic involvement in these projects. Of the private further funding, 82% went to UKRI-DST projects. In all, 13 countries plus the EU and global institutes awarded further funding to UKRI India projects. 87% of the funding came through the UK, followed by the EU, global entities, and Belgium (for the EU Commission) (TABLE 8). £225 million of further funding was awarded to 19 EPSRC-DST projects, 50% of the total. This was followed by 29 BBSRC-DBT projects awarded £106 million (24%).

Funding sector	Funding provided
Public	£402,118,893
Academic/University	£24,042,095
Charity/Non-Profit	£20,174,855
Private	£5,709,091

**FIGURE 7:** Further funding raised by UKRI India projects, grouped by sector of funder. *Source: Gateway to Research*

Funding Country	Funding provided	Original funder pair	Funding raised
United Kingdom	£394,093,152	EPSRC-DST	£225,239,520
European Union (EU)	£20,031,251	BBSRC-DBT	£106,330,710
Global	£15,384,575	MRC-DBT	£50,334,868
Belgium	£13,497,277	NERC-MoES	£23,703,446
United States	£2,729,317	EPSRC-DAE	£20,255,246
Netherlands	£2,322,058	Innovate UK-DBT	£9,762,323
India	£1,702,428	MRC-ICMR	£7,632,612
Denmark	£509,993	AHRC-ICHR	£6,879,858
France	£469,146	ESRC-ICSSR	£1,662,824
Switzerland	£467,836	NERC-DST	£165,616
Norway	£337,581	RCUK	£77,911
Spain	£193,162		
Malaysia	£180,400		
Libya	£110,400		

**TABLE 8:** Further funding raised by UKRI India projects, grouped by country of funder (table on the left) and by the original funder pair (table on the right). *Source: Gateway to Research*

Over 90 organisations or institutes contributed to the further funding of UKRI India projects. Of these, 11 organisations provided >£10 million each in further funding to UKRI India projects. EPSRC awarded the highest amount of further funding, providing 39% of the total. The largest charity funder was PATH, formerly known as Program for Appropriate Technology in Health (£11.7m), followed by Wellcome Trust (£2.8m). The largest corporate funder was BAE systems (£1.8m), followed by Pall Europe (£1.4m), and Western Power Distribution (£1.3m).

Funding organisations	Funding provided
Engineering and Physical Sciences Research Council	£177,929,595
Biotechnology and Biological Sciences Research Council	£67,427,606
Natural Environment Research Council	£37,469,932
National Institute for Health Research	£22,999,293
European Commission	£20,031,251
Government of the UK	£18,857,000
Royal Veterinary College (RVC), UK	£17,718,608
Innovate UK	£12,752,720
Medical Research Council	£11,925,823
PATH	£11,772,936
European Commission H2020	£10,640,064
Arts & Humanities Research Council	£5,605,079
JPND Research (EU)	£3,274,743
Economic and Social Research Council	£2,989,669
European Research Council (ERC)	£2,857,213
Wellcome Trust	£2,841,255
ESA – ESTEC	£2,190,943
BAE Systems	£1,830,000
Department of Energy and Climate Change	£1,600,000
Research Councils UK	£1,580,100
Royal Academy of Engineering	£1,468,690
PALL Europe	£1,393,742
Western Power Distribution	£1,247,122
Invest Northern Ireland	£1,200,000
Two Blades Foundation	£1,054,849

**FIGURE 9:** Further funding raised by UKRI India projects, grouped by funding organisation. *Source: Gateway to Research*

# 1.

The Joint UK-India Clean Energy Centre (JUICE) project, funded by EPSRC and DST through a £5 million programme, raised further funding of over £72 million through UK organisations, including EPSRC, the UK Government, BEIS, RAEng, and the British Council. The largest amount of funding raised was through the EPSRC, with £36 million for the Active Building Centre; the Modern Energy Cooking Services was funded by DFID (now FCDO), with £18.8 million.



**FIGURE 43:** Selected logos from projects with further funding.

The project *Impact of maternally derived antibodies and infant microbiota on the immunogenicity of rotavirus vaccines in African, Indian and European infants* raised the largest amount of funding outside the UK (US\$15m). The funding was secured through PATH, a US-based charity, for a Phase 3 multinational trial to assess the safety, immunogenicity, and efficacy of a trivalent rotavirus P2-VP8 subunit vaccine, in prevention of severe rotavirus gastroenteritis.

The largest amount of private funding was raised by the project *High Deposition Rate Additive Manufacture of Complex Metal Parts (HiDepAM)*. Originally funded for nearly £500,000, it raised £2.5 million from private companies, including BAE Systems, Schlumberger Limited, and Lockheed Martin, among others.

## 1.

## Appendix A

## List of project reference numbers used in this analysis

Reference	India Lead Funder	Project Title
102078	DST	Newton Fund – Sustainable Dengue Prevention
102557	DST	Newton Fund – Development of a novel combined arsenic filtration/monitoring system for community-scale water supplies
102560	DST	Newton Fund – Next-Gen Low Cost OCT
102723	DST	Newton Fund – Automated Telemedicine Enabled Screening for Eye Diseases Using an Affordable and Simple to Use Smartphone Based Imaging Device
102725	DST	Newton Fund – development of differentiated product concepts for insulin glargine
102726	DST	Newton Fund – Development of pearl millet hybrid seeds and novel food products: An affordable resource in the prevention of Type 2 diabetes
102727	DST	Newton Fund – Industrial research on a clean process for delivering arsenic free safe water to affected communities in India
102755	DBT	Newton Fund – Enhanced rice milling and maximised valorisation of rice milling by-products
102756	DBT	Newton Fund – Bio-based Packaging for Fresh Food (BIOFRESHPAK)
102757	DBT	Newton Fund – Electrolysed Water for Post-Harvest Washing (JadooJal)
102758	DBT	Newton Fund – GrainCare
102759	DBT	New Triton – ReNEWable and sustainable nu TRITION for food
102760	DBT	Development & Optimisation of Fresh Produce Supply Chain and Storage Systems
103705	DST	Newton Fund – Development of Smart Electronically Controlled Hybrid Energy Recovery Systems for Buses and Electric Vehicles
103706	DST	Newton Fund – The Development of a Portable THERMOgraphy-based Health DeTECTion Application (THERMOTECT) in breast cancer screening in India
103707	DST	Newton Fund – PROTECTT PoRtable Organic Transistor based biosEnsor for low Cost Thyroid Testing
103708	DST	A-PATH: Affordable Preventative and Assistive Technology for Healthcare
103709	DST	Newton Fund – Optimal Water Flow Management for Crop Irrigation (OPTIFLO)
104332	DBT	BIOREVIEW: BioREfining Value from Industrial Waste
104333	DBT	Valorising Waste from Sugar Cane and Associated Industries via Innovations in Pre-treatment, Biotransformation and Process Intensification [vWa]
104334	DBT	Economic non-food sugar from variable mixed solid waste for high value chemical products
104335	DBT	Integrated biorefinery for converting paper mill waste into chemical wealth
104336	DBT	Reducing industrial waste from sugarcane processing in India



## 1.

## Appendix A

Reference	India Lead Funder	Project Title
AH/N007220/1	ICHR	Community-led Heritage Regeneration in India
AH/N007328/1	ICHR	Reflecting on the river: rapid urbanisation and representations of Indian cultural heritage
AH/N007387/1	ICHR	The Historic City of Ajmer-Pushkar: mapping layers of history, use and meaning for sustainable planning and conservation
AH/N007395/1	ICHR	Learning from the Utopian City: An international network on alternative histories of India's urban futures
AH/R014183/1	ICHR	IT INDIAN HERITAGE PLATFORM: Enhancing cultural resilience in India by applying digital technologies to the Indian tangible and intangible heritage
AH/R014272/1	ICHR	The Hugli River of Cultures Pilot Project, from Bandel to Barrackpore
AH/R014302/1	ICHR	Tamil Temple Towns: Conservation and Contestation
AH/T004819/1	ICHR	Cultural Heritage Transformations of Weddings and Marriage among Women in the Tamil and Parsi diaspora communities in India and the UK
AH/T004940/1	ICHR	Holy lands: scoping the nexus between heritage, pilgrimage and diaspora in India
AH/T004959/1	ICHR	Gender and Intersectionality on India and its Diaspora's (GRID) Heritage
AH/T005009/1	ICHR	Digital urbanism & diasporas: walking the cultural heritage of Calcutta's riverfront
AH/T005084/1	ICHR	Cultural Heritage and Representation: (Mis)readings between India and the Indian Diaspora
BB/J011754/1	DBT	Wild rice MAGIC
BB/J011827/1	DBT	Exploitation of interspecific biodiversity for wheat improvement
BB/J011851/1	DBT	Using wild ancestor plants to make rice more resilient to increasingly unpredictable water availability
BB/J012017/1	DBT	Maximizing the potential for sustainable and durable resistance to the wheat yellow rust pathogen
BB/K020358/1	DBT	RICEFUEL: Engineering enzymes, bacteria and bioconversion processes for advanced biofuels from waste grain straw
BB/K020552/1	DBT	Transnational approaches to resolving biological bottlenecks in macroalgal biofuel production (SuBBSea)
BB/K020617/1	DBT	Using flow cytometry and genomics to characterise and optimise microalgal-bacterial consortia cultivated on Wastewater to produce biomass for Biofuel
BB/K020633/1	DBT	Sustainable bioenergy from microalgae: A systems perspective
BB/L004526/1	DBT	Attenuation of FMDV Serotypes/Strains to Develop Stable and Effective Live, Attenuated, Vaccines
BB/L004542/1	DBT	Hsp90 as a modulator of pathogenicity, virulence and transmission in veterinary infections caused by Theileria and Babesia species
BB/L004569/1	DBT	Development of recombinant BCG vaccine and complementary diagnostics for TB control in cattle
BB/L004623/1	DBT	Transcriptome analysis in Indian buffalo and the genetics of innate immunity

# 1.

## Appendix A

Reference	India Lead Funder	Project Title
BB/L00464X/1	DBT	Development of multiplexed diagnostic biosensor for infectious reproductive diseases of cattle and buffaloes
BB/L004666/1	DBT	Identification of the molecular basis of differential host responses to rapidly evolving Avian Influenza viruses in different avian species
BB/L004690/1	DBT	Development of diagnostic systems, reference collections and molecular epidemiology studies for important arboviral pathogens of livestock in India
BB/L004739/1	DBT	Molecular epidemiology of ticks and tick-borne disease, host resistance and development of novel pathogen vaccines
BB/L00478X/1	DBT	Controlling enteric pathogens of poultry: Host/microbiota interactions, risk assessment and effective management interventions
BB/L004801/1	DBT	Understanding the immune mechanism of host disease resistance and development of marker vaccines and DIVA tests for Peste des Petits Ruminants (PPR)
BB/L004828/1	DBT	An effective vaccination programme for the eradication of foot-and-mouth disease from India
BB/L004836/1	DBT	Combined use of novel diagnostic tools and strategic vaccination to control bovine brucellosis in endemic areas
BB/L011611/1	DBT	Genomics-assisted selection of Solanum chilense introgression lines for enhancing drought resistance in tomatoes
BB/L011646/1	DBT	Developing genetics and genomics interface to develop strategies for sustainable use of resistance to white rust in oilseed mustard ( <i>Brassica juncea</i> )
BB/L011700/1	DBT	A genomics-assisted synthetic hexaploid wheat gene isolation and pre-breeding platform for improved heat tolerance and sustainable production
BB/L011719/1	DBT	Detoxed grass pea: sustainable sustenance for stressful environments
BB/L011751/1	DBT	Broadening the genetic diversity underpinning seed quality and yield related traits in mustard rape and oilseed rape
BB/L011786/1	DBT	Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat
BB/L011794/1	DBT	Rapid identification disease resistance genes from plant genomes by resistance gene enrichment sequencing (RenSeq) of EMS-derived susceptible mutants
BB/N005031/1	DBT	Development of alternative sustainable fish feeds to promote human health using novel non-conventional indigenous ingredients
BB/N00504X/1	DBT	Novel Molecular Approaches for Advancing Prediction and Mitigation of Disease Outbreaks in Aquaculture for Small Scale Farmers
BB/N005058/1	DBT	Poverty alleviation through prevention and future control of the two major socioeconomically-important pathogens in Asian aquaculture
BB/N005082/1	DBT	Evaluating Costs and Benefits of Prophylactic Health Products and Novel Alternatives on Smallholder Aquaculture Farmers In Asia and Africa (IMAQulate)

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
BB/N013360/1	DBT	Indo-UK Centre for the improvement of Nitrogen use Efficiency in Wheat (INEW)
BB/N013387/1	DBT	India-UK Nitrogen Fixation Centre (IUNFC)
BB/N013441/1	DBT	Cambridge-India Network for Translational Research in Nitrogen
BB/N013492/1	DBT	Newton-Bhabha Virtual Centre on Nitrogen Efficiency of Whole-cropping Systems for improved performance and resilience in agriculture (NEWS India-UK)
BB/R019819/1	DBT	Genomics-led improvement of biotic and abiotic stress tolerance in mustard rape for economic and environmental sustainability
BB/R019827/1	DBT	An integrated genomics/genetics approach for development of mungbean varieties with improved disease resistance
BB/R019894/1	DBT	Exploring chemical “de-priming” and quantitative genetics to improve growth and yield of soybean under abiotic stress
BB/R019940/1	DBT	A strategy to exploit genomic selection for achieving higher genetic gains in groundnut
BB/S011684/1	DBT	Newton Bhabha Industrial Waste: Integrated biorefinery for converting paper mill waste into chemical wealth (waste-2-wealth)
BB/S011951/1	DBT	Newton Bhabha Industrial Waste: Valorising Waste from Sugar Cane Industries via Innovations in Pretreatment, Biotransformation and Intensification
BB/S01196X/1	DBT	Newton Bhabha Industrial Waste: Reducing Industrial Waste from Sugarcane Processing in India
BB/S011986/1	DBT	Newton Bhabha Industrial Waste: Bio-integrated Valorisation of India’s Municipal Solid Waste to Renewable Feedstocks
BB/S011994/1	DBT	Newton Bhabha Industrial Waste BIOREVIEW
EP/G051674/1	DST	India-UK Advanced Technology Centre (IU-ATC) of Excellence in Next Generation Networks Systems and Services
EP/H040218/1	DST	Advancing the efficiency and production potential of Excitonic Solar Cells (APEX)
EP/H040331/1	DST	Stability and Performance of Photovoltaics (STAPP)
EP/I01215X/1	DAE	JOINT: an Indo-UK collaboration in joining technologies
EP/I012214/1	DAE	Indo-UK Civil Nuclear Collaboration on Damage and Radiation Effects in Amorphous Materials (DREAM)
EP/I012346/1	DAE	Irradiation Effects on Flow Localisation in Zirconium Alloys
EP/I012400/1	DAE	Characterization of the atomic scale structure of yttria-based particles in oxide dispersion strengthened steels
EP/I012427/1	DAE	Validation & Verification for Critical Heat Flux and CFD
EP/I018425/1	DAE	Sustainability and Proliferation Resistance Assessment of Open Cycle Thorium-Fuelled Nuclear Energy
EP/I036338/1	DST	Performance Optimization of IT-SOFCs by Inkjet Printing on Porous Metal Substrates (JETCELL)
EP/I037016/1	DST	Advancing Biogas Utilization through Fuel Flexible SOFC

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
EP/I037024/1	DST	"Mind the Gap" - jumping the hurdles limiting polymer fuel cell performance and commercialisation
EP/I037059/1	DST	Modelling Accelerated Ageing and Degradation of Solid Oxide Fuel Cells (MAAD-SOFC)
EP/J000345/1	DST	Development and Integration of Biomass and Concentrating Photovoltaic System for Rural and Urban Energy Bridge: BioCPV
EP/J000361/1	DST	Rural Hybrid Energy Enterprise Systems
EP/J000604/1	DST	Scaling the Rural Enterprise
EP/J000728/1	DST	Distributing Industrial Optimization Tasks to Rural Worker
EP/J016748/1	DST	India-UK Advanced Technology Centre (IU-ATC) in Next Generation Networks Systems and Services (Phase Two Follow-on)
EP/K007580/1	DAE	Management of Nuclear Risk Issues: Environmental, Financial and Safety (NREFS)
EP/K007777/1	DAE	Thermal Hydraulics for Boiling and Passive Systems
EP/K007815/1	DAE	Transferability of small-specimen data to large-scale component fracture assessment
EP/K007866/1	DAE	DMW-Creep: Influence of Inhomogeneity on Creep of Dissimilar Metal Welds
EP/K007882/1	DAE	Atomistic modelling and experimental verification of vitrified matrices for waste encapsulation
EP/K00817X/1	DAE	Fundamental Properties of Thoria Based Mixed Oxides
EP/K027530/1	DST	Improvements in Gas Turbine Performance via Novel Plasma Spray Coatings offering Protection against Ingested Species
EP/K028316/1	DST	MAST: Modelling of advanced materials for simulation of transformative manufacturing processes
EP/K028553/1	DST	High-Performance Spinning Disc Atomisation Process
EP/K02888X/1	DST	Engineering Driven Sustainable Supply Networks – A UK/India Collaborative Study
EP/K028995/1	DST	Development of on-line, high temperature, non-destructive measurement/sensing techniques during manufacturing of power plant components
EP/K029010/1	DST	High Deposition Rate Additive Manufacture of Complex Metal Parts (HiDepAM)
EP/K029053/1	DST	Creation of a process understanding of chromatographic performance loss during biotherapeutic manufacture: A UK-India partnership
EP/K036173/1	DST	Advanced Communication and Control for the Prevention of Blackouts (ACCEPT)
EP/K03619X/1	DST	Reliable and Efficient System for Community Energy Solution- RESCUES
EP/K036211/1	DST	High Energy And Power Density (HEAPD) Solutions to Large Energy Deficits
EP/K036297/1	DST	Intelligent MicroGrids with Appropriate Storage for Energy (IMASE)
EP/K036327/1	DST	Reconfigurable Distribution Networks
EP/M017540/1	DAE	Effect of Zr on the microstructure of corrosion resistant ODS steels

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
EP/M018040/1	DAE	Extension to Transferability of Small-Specimen Data to Large-Scale Component Fracture Assessment (TRANSFER-EXT)
EP/M018210/1	DAE	Design and Maintenance of Nuclear Safety Systems for Life Extension (DaMSSLE)
EP/M018261/1	DAE	Indo-UK: Premature, Oscillation-Induced Critical Heat Flux ("Premature OICHF")
EP/M018296/1	DAE	Indo-UK Civil Nuclear Network
EP/M018369/1	DAE	From Processing to Simulated In-Reactor Performance of Zr Cladding
EP/M018466/1	DAE	Diffusion Bonding Titanium Alloys to Stainless Steels
EP/M018717/1	DAE	Smart on-line monitoring for nuclear power plants (SMART)
EP/M018733/1	DAE	Grace Time
EP/M018792/1	DAE	Glass-Ceramics: Damaging Bubble Formation
EP/M023532/1	DST	[Newton] Advancing the efficiency and production potential of excitonic solar cells (APEX), Phase-II
EP/P003605/1	DST	Joint UK-India Clean Energy Centre (JUICE)
EP/P025838/1	DBT	Newton Fund (Invitation Only) – Dearman liquid air TRU systems for cold chain in India
EP/P026206/1	DBT	Newton Fund: Enhanced Rice Milling and Maximised Valorisation of Rice Milling By-products
EP/R008434/1	DST	Residential building energy demand reduction in India (RESIDE)
EP/R008612/1	DST	Zero Peak Energy Building Design for India (ZED-i)
EP/R008620/1	DST	iNtelligent Urban Model for Built environment Energy Research (iNumber)
EP/R008655/1	DST	Community-scale Energy Demand Reduction in India (CEDRI)
EP/R020558/1	DAE	A Resilience Modelling Framework for Improved Nuclear Safety (NuRes)
EP/R021546/1	DAE	Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems
EP/R021805/1	DAE	Development and Validation of Thermal-Hydraulic ... in BWR's and PWR's: Can modern CFD models reliably predict DNB for nuclear power applications?
EP/R021961/1	DAE	Fault tolerant control for increased safety and security of nuclear power plants
ES/K005820/1	ICSSR	Mapping the cultural authority of science across Europe and India
ES/K005901/1	ICSSR	Advances in Research on Globally Accessible Medicine (AROGYAM)
ES/K00591X/1	ICSSR	Bullying, cyberbullying, and pupil safety and well-being
ES/K005936/1	ICSSR	From Identity to Interests? Quantitative and Qualitative Explanations of Electoral Change in Rural and Urban India
ES/K005979/1	ICSSR	Ageing and well-being in a globalizing world
ES/P000517/1		SMARt CitIES Network for Sustainable Urban Futures (SMARTIES Net)

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
ES/R006741/1	ICSSR	UNDERstanding Indian Urban Governance REFORM: A comparative analysis of the Smart City Mission reforms and their impact on sustainable urban mobility
ES/R006857/1	ICSSR	Learning from small cities: Governing imagined futures and the dynamics of change in India's smart urban age
ES/R006865/1	ICSSR	Rurality as a vehicle for Urban Sanitation Transformation (RUST)
ES/R00692X/1	ICSSR	Ageing Well in Urban Environments: Developing Age Friendly Cities and Communities
ES/R006997/1	ICSSR	From the margins: Exploring Low-income Migrant Workers' Access to Basic Services and Protection in the context of India's Urban Transformation
ES/R010404/1	ICSSR	Coastal transformations and fisher wellbeing – synthesized perspectives from India and Europe
ES/R010811/1	ICSSR	Challenging Inequalities: an Indo-European perspective
ES/R010978/1	ICSSR	Citizenship Futures: 'the Politics Of Hope' In India And Europe
ES/R011125/1	ICSSR	Displacement, placemaking and wellbeing in the city
ES/S000186/1	DBT	Does AMR in livestock contribute to AMR in people in NE India? An interdisciplinary study
ES/S000208/1	DBT	DOSA – Diagnostics for One Health and User Driven Solutions for AMR
ES/S000216/1	DBT	Chicken or Egg: Drivers for Antimicrobial Resistance in Poultry in India (DARPI)
ES/S000321/1	DBT	Smart regulation of antibiotic use in India: Understanding, innovating and improving compliance
MR/J000094/1	ICMR	Maternal vitamin B12, folic acid and homocysteine as determinants of gestational diabetes, fetal growth and intergenerational programming of diabetes
MR/J000108/1	ICMR	Phenotypic characterisation of non-smoking COPD
MR/J000175/1	ICMR	Development and evaluation of a yoga-based cardiac rehabilitation programme (Yoga-CaRe) for secondary prevention of myocardial infarction
MR/J000183/1	ICMR	A pragmatic and scalable strategy using mobile technology to promote sustained lifestyle changes to prevent Type 2 diabetes in India and the UK
MR/N000390/1	ICMR	Consortium on Vulnerability to Externalizing Disorders and Addictions [c-VEDA]
MR/N000870/1	ICMR	Psychosocial and nutritional predictors of child mental health: longitudinal study of shared and distinctive risk and protective factors in UK & India
MR/N006194/1	DBT	Childhood Maltreatment: Emotional Consequences and Potential Intervention
MR/N006208/1	DBT	Epigenetic mechanisms linking maternal pre-conceptional micronutrient supplementation with offspring health in India and The Gambia
MR/N006224/1	DBT	A multicomponent intervention to reduce home-exposure to second-hand smoke (SHS) during pregnancy and postnatal period: a randomised controlled trial

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
MR/N006232/1	DBT	Ethnic specific risk stratification in early pregnancy for identifying mothers at risk of gestational diabetes mellitus in India and Kenya
MR/N006240/1	DBT	Evaluation of the introduction of a novel device in the management of hypertension and shock in pregnancy in low-resource settings
MR/N006259/1	DBT	Impact of maternally derived antibodies and infant microbiota on the immunogenicity of rotavirus vaccines in African, Indian and European infants
MR/N006267/1	DBT	Impacts of Demand Side financing Instruments on the Continuum of Care for Maternal and Child Health in India and Bangladesh
MR/N501864/1	DBT	Cambridge-Chennai Centre Partnership on Antimicrobial Resistant Tuberculosis
MR/R020345/1	DBT	Pregnancy Interventions In Mothers Relating to Diabetes In Asian India and Low-income countries (The PRIMORDIAL Study)
MR/R020396/1	DBT	A randomised controlled trial to compare two different doses of maternal B12 supplementation in improving infant B12 deficiency and neurodevelopment
MR/R020485/1	DBT	Comprehensive Anaemia Programme and Personalized Therapies (CAPPT)
MR/R021376/1	DBT	CRADLE-4: Can Reduction of Adverse pregnancy outcomes occur with planned DeLivery vs.Expectant management in pre-eclampsia?
MR/R021392/1	DBT	Gestational diabetes in Uganda and India: Design and Evaluation of Educational Films for improving Screening and Self-management (GUIDES)
MR/R021686/1	DBT	Generating epidemiological, economic and attitudinal evidence to inform policy-making about HPV vaccine introduction in India and Ethiopia
MR/R022127/1	DBT	A cluster randomized trial of an mHealth integrated model of hypertension, diabetes and antenatal care in primary care settings in India and Nepal
NE/I022337/1	MoES	Mitigating climate change impacts on India agriculture through improved Irrigation water Management
NE/I022450/1	MoES	Hydrologic and carbon services in the Western Ghats: Response of forests and agro-ecosystems to extreme rainfall events
NE/I022558/1	MoES	Hydrometeorological feedbacks and changes in water storage and fluxes in northern India
NE/I022604/1	MoES	The structure and dynamics of groundwater systems in northwestern India under past, present and future climates
NE/I022841/1	MoES	South Asian Precipitation: A Seamless Assessment: SAPRISE
NE/L013827/1	MoES	BoBBLE: Bay of Bengal Boundary Layer Experiment
NE/L01386X/1	MoES	Interaction of Convective Organization and Monsoon Precipitation, Atmosphere, Surface and Sea (INCOMPASS)
NE/L013886/1	MoES	SWAAMI (South West Asian Aerosol Monsoon Interactions)
NE/N016394/1	MoES	Sustaining Himalayan Water Resources in a Changing Climate (SusHi-Wat)

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
NE/N016491/1	MoES	Upscaling Catchment Processes for Sustainable Water Management in Peninsular India
NE/N01670X/1	MoES	Coupled Human And Natural Systems Environment (CHANSE) for water management under uncertainty in the Indo-Gangetic Plain
NE/P016340/1	MoES	Delhi Air Pollution: Health aNd Effects (DAPHNE)
NE/P016391/1	MoES	Process analysis, observations and modelling – Integrated solutions for cleaner air for Delhi (PROMOTE)
NE/P016499/1	MoES	An Integrated Study of Air Pollutant Sources in the Delhi National Capital Region (NCR)
NE/P016502/1	MoES	Megacity Delhi atmospheric emission quantification, assessment and impacts (DelhiFlux)
NE/P016588/1	MoES	CADTIME: Clean Air for Delhi Through Interventions, Mitigations and Engagement
NE/R003106/1	DST	The development and implementation of sensors and treatment technologies for freshwater systems in India
NE/R003270/1	DST	Antimicrobial resistance and pollutants: interactive studies and novel sensor technologies
NE/R003289/1	DST	Innovative low-cost optical sensor platform for water quality monitoring
NE/R003351/1	DST	Impact of rainwater harvesting in India on groundwater quality with specific reference to fluoride and micropollutants.
NE/R003386/1	DST	Future Secular Changes & Remediation of Groundwater Arsenic in the Ganga River Basin
NE/R003521/1	DST	REhabilitation of Vibrio Infested waters of VembanAd Lake: pollution and solution (REVIVAL)
NE/R003548/1	DST	Fate and Management of Emerging Contaminants (FAME)
NE/R003645/1	DST	PATHWAYS and evolution of pollutants: Interactions between physical controlling effects, microbial community composition and pollutant biodegradation
NE/S01232X/1	DBT	Social-economic-environmental trade-offs in managing the Land-River-Interface
NE/S012478/1	DBT	Opportunities and trade-offs between the SDGs for food, welfare and the environment in deltas
NE/S012567/1	DBT	Pathways Of Dispersal for Cholera And Solution Tools (PODCAST)
NE/S012834/1	DBT	Opportunities for Climate Mitigation and Sustainable Development (OPTIMISM)
NE/S012850/1	DBT	Nature's contribution to poverty alleviation, human wellbeing and the SDGs (Nature4SDGs)
NE/S013172/1	DBT	PERI-CENE (Peri-urbanization & climate-environment change)
NE/T012986/1	DBT	Advanced Metagenomics, Sensors and Photocatalysis for Antimicrobial Resistance Elimination (AMSPARE)
NE/T01301X/1	DBT	SELECTAR – Selection for antimicrobial resistance by antimicrobial production waste
NE/T013184/1	DBT	Defining the AMR Burden of Antimicrobial Manufacturing Waste in Puducherry and Chennai
NE/T013222/1	DBT	AMRflows: antimicrobials and resistance from manufacturing flows to people: joined up experiments, mathematical modelling and risk analysis



## 1.

## Appendix A

Reference	India Lead Funder	Project Title
NE/T013230/1	DBT	Resolving the fate and studying the impact of pharmaceutical wastes on the environment and local community of a pharmaceutical manufacturing hub
RES-072-27-0023	ICSSR	Local Democracy in Karnataka
RES-072-27-0024	ICSSR	Maternal Care & Access to Health Services in India
RES-072-27-0025	ICSSR	Evolution of the Financial Systems Architecture in the Developing & Emerging Market Economies of the South & South East Asia
RES-072-27-0026	ICSSR	Children's Self-Presentation in India and the UK: Associations with Social Values, Peer Relations & Well Being
RES-072-27-0027	ICSSR	Household Incomes & Employment in Rural India: Case Studies of Three Andhra Pradesh Villages
RES-072-27-0030	ICSSR	Marketization and Democracy in South Asia
RES-072-27-0032	ICSSR	Translating Intentions into Behaviour: Identifying the Neural Correlates of Commitment and Imagery Perspective in the Formation of Implementation Intentions
RES-072-27-0033	ICSSR	Economic and Social Implications of Global Production Networks (GPNs): A Study of the UK Based Supermarket Food Retail Chains and Their Suppliers and
RES-072-27-0036	ICSSR	A Multilevel Study of Intergroup Contact, Social Identity, and Threat: Integrating Macro, Meso and Micro Variables
RES-072-27-0040	ICSSR	Reform, Asymmetric Organisation and Development: Theory and Practices of Formal-Informal Sector Linkages in India
RES-072-27-0041	ICSSR	Climate Change Induced Gully Erosion, Land Degradation and Socio-Economic Implications Study of a Ravennous Tract of Lower Chambal Valley, India Using
RES-072-27-0047	ICSSR	WHAT ARE THE CONSTRAINTS TO EMPLOYMENT INTENSIVE GROWTH IN INDIA? A study of the impact of economic reforms on labor intensive sectors
RES-072-27-0050	ICSSR	Possession and modification in the Great Andamanese language
RES-072-27-0058	ICSSR	The Bengal Migration in Comparative Perspective
RES-072-27-0059	ICSSR	Living in ambivalence: Punjabi migrant transnationalism in the U.K.
102754	DBT	Innovative zero-emission transport refrigeration unit for Indian cold chain
EP/G039496/1	DST	Sustainable Indo-UK Agricultural Initiative
EP/G039933/1	DST	BioPharm 2020: Entrepreneurial Opportunities in the Pharmaceutical and Biotechnology Industries
EP/G039992/1	DST	Bioenergy: Technology and Business Solutions for the UK and India
ES/J50032X/1	ICSSR	Towards disciplinary histories: Developmentalism and Social Science Agendas in post-1947 India
ES/R010617/1	ICSSR	FilmInd – The Indian film industry as a driver of new socio-economic connections between India and Europe

## 1.

## Appendix A

Reference	India Lead Funder	Project Title
ES/R010633/1	ICSSR	Towards a “fluid” governance: hydrosocial analysis of flood paradigms and management practices in Rhone and Ganges basins
MR/N501876/1	DBT	A Joint Centre for Cancer Biology & Therapeutics
MR/N501888/1	DBT	UK-India Centre for Advanced Technology for Minimising the indiscriminate use of Antibiotics (UKICAT-MA)
RES-072-27-0005	ICSSR	Local Asymmetric Ties and Capability Learning in Internationalizing Indian Small- & Medium- Sized Enterprises
RES-072-27-0010	ICSSR	Governance and Poverty Reduction in Bihar.
RES-072-27-0017	ICSSR	The Anthropology and Sociology in and of public health.
RES-072-27-0018	ICSSR	The Sociology of Human Rights
RES-072-27-0019	ICSSR	Developing Collaborative Research Projects on Reproductive Health in India
RES-072-27-0042	ICSSR	Developing a Measure for Inequitable Household Access to Water in Urban India
RES-072-27-0043	ICSSR	Eastern Punjabi Transnationalism, Social Equality and Development
RES-072-27-0044	ICSSR	Politics of Sustainable Development: Mobility and Development Along the Mumbai-Pune Expressway
RES-072-27-0045	ICSSR	A political economy of education in India
CLF	DAE	STFC CLF and Tata’s TIFR access agreement for joint project using UK’s Central Laser Facility
ISIS	DST	DST co-investment through JNCASR for access to STFC ISIS Nanomission programme
JCWS	MoES	The India-UK Water Centre
SARAI5	SARAI	Talking of law in colonial India
SARAI1	SARAI	Breaking Sense(ation) in Moving Image Art: in Search of a Method for Seeing Anew
SARAI4	SARAI	Exploring Crisis as Opportunity in Public Libraries, from South London to South Asia: Worlds Apart or Connected Communities?
SARAI2	SARAI	Curatorial Variations: working in between online and offline dimensions
SARAI3	SARAI	Researching image in Indian film traditions to illuminate the visual in sign language poetry
SE1	ICSSR	Conceptual Enquiry for the Design of a Survey of Schools
SE2	ICSSR	Global Entrepreneurs and Organisations
SE3	ICSSR	HRM practices and effectiveness in Indian software organisations
SE4	ICSSR	Voices and Choices: Educational environments enabling and responsive to young people with disabilities
EPIC	DAE	UK-India Extreme Photonics Innovation Centre

# about

## UKRI

Launched in April 2018, UKRI is a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS).

Our organisation brings together the seven disciplinary research councils, Research England, which is responsible for supporting research and knowledge exchange at higher education institutions in England, and the UK's innovation agency, Innovate UK.

Our nine councils work together in innovative ways to deliver an ambitious agenda, drawing on our great depth and breadth of expertise and the enormous diversity of our portfolio.

Through our councils we maintain and champion the creativity and vibrancy of disciplines and sector-specific priorities and communities. Our councils shape and deliver both sectoral and domain-specific support.

Whether through research council grants, quality-related block grants from Research England, or grants and wider support for innovative businesses from Innovate UK, we work with our stakeholders to understand the opportunities and requirements of all the different parts of the research and innovation landscape, maintaining the health, breadth and depth of the system.

[www.ukri.org](http://www.ukri.org)

## UKRI India

UKRI India plays a key role in enhancing the research and innovation collaboration between the UK and India. Since 2008, the UK and Indian governments, and third parties, have together invested over £330 million in co-funded research and innovation programmes.

This investment has brought about more than 258 individual projects. The projects were funded by over 15 funding agencies, bringing together more than 220 lead institutions from the UK and India. These research projects have generated more than £450 million in further funding, mainly from public bodies but also from non-profit organisations and commercial entities, attesting the relevance of these projects. [www.ukri.org/india](http://www.ukri.org/india)

## Newton Bhabha

The Newton-Bhabha partnership brings together UK and Indian scientists, researchers and innovators to find joint solutions to global challenges. It is delivered by seven UK delivery partners in collaboration with their Indian counterparts through equal partnership and matched resources. It includes capacity building programmes such as PhD partnerships, fellowships, trainings and networking opportunities; research projects led by UK and Indian researchers and; innovation projects led by industrial partners. Priority areas identified for research and innovation programmes are Public health and wellbeing, Food-Energy-Water Nexus, Sustainable cities and Urbanisation and Understanding oceans. These activities are strengthening the existing research and innovation partnerships between the two countries and developing new relationships between policy makers, government agencies, research organisations, higher education institutions, companies and enterprises of the UK and India.

The Newton Fund is a consortium of outstanding research and innovation partnerships between the UK and select countries in Africa, Asia and Latin America to support economic development and social welfare, tackle global challenges and develop talent and careers. The fund is managed by the UK's Department for Business, Energy and Industrial Strategy, and delivered by UK and international partners. [www.newton-gcrf.org](http://www.newton-gcrf.org)