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Partner Country Case Study: China

Final Evaluation of The Newton Fund

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TETRA TECH
International Development

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Disclaimer

The views expressed in this report are those of the evaluators. They do not represent those of the Department for Business, Energy and Industrial Strategy, the Newton Fund or of any of the individuals and organisations referred to in the report.

Contents

Abbreviations

AH	Award Holder
AMR	Antimicrobial Resistance
ANSO	Alliance of International Science Organizations in the Belt and Road
ATCNN	Agri-tech in China: Newton Network+
BBSRC	Biotechnology and Biological Sciences Research Council
BEIS	Department for Business, Energy and Industrial Strategy
BRI	Belt and Road Initiative
CAS	Chinese Academy of Sciences
CCP	Chinese Communist Party
CDZ	Sino-German Center for the Promotion of Science
CIMMYT	International Centre for Maize and Wheat Improvement
CMA	China Meteorological Administration
CNCC	China National Climate Centre
CNSA	Chinese National Space Agency
CNY	Chinese yuan renminbi
CSSP	Climate Science for Service Partnership
DAC	Development Aid Committee
DEFRA	Department for Environment, Food and Rural Affairs
DFG	German Research Foundation
DP	Delivery Partner
EFSA	European Food Safety Authority
EU	European Union
ESRC	Economic and Social Research Council

FIC	Fund for International Collaboration
GBP	Great Britain Pound (Sterling)
GCRF	Global Challenges Research Fund
GDP	Gross Domestic Product
GDI	Global Development Impact
GERD	Gross Domestic Expenditure on R&D
IAP	Institute of Atmospheric Physics
ICAI	Independent Commission for Aid Impact
ICT	In-country Team
ICT	Information Communications Technology
IP	Intellectual Property
JRC	Joint Research Centre
MIIT	Ministry of Industry and Information Technology
MOE	Ministry of Education
MOST	Ministry of Science and Technology
MoU	Memorandum of Understanding
MRC	Medical Research Council
NERC	Natural Environment Research Council
NERCITA	National Engineering Research Centre for Information Technology in Agriculture
NKP	National Key R&D Programmes
NSFC	National Natural Science Foundation of China
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PAFiC	Precision Agriculture for Family-farms in China
PI	Principal Investigator

R&D	Research & Development
RCUK	Research Councils UK
S&I	Science and Innovation
SDG	Sustainable Development Goals
STEM	Science, Technology, Engineering and Mathematics
STFC	Science and Technology Facilities Council
UK	United Kingdom
UKRI	UK Research & Innovation
USA	United States of America
WCSSP	Weather and Climate Science for Service Partnership
WMO	World Meteorological Organization
WP	Work Package

Executive Summary

The UK-China Research and Innovation Partnership Fund

- Launched in 2014, the partnership brings together researchers and innovators from the UK and China to tackle global challenges and generate development impact – aiming to benefit the poorest people and contribute to achieving the UN's Sustainable Development Goals.
- It recognises that many of the complex development challenges that China faces are relevant to other countries, including rapid aging, building an effective health system, and addressing climate change.
- The partnership covers six mutually identified priority areas including agriculture, climate, energy, health, natural environment, and sustainable cities.
- The UK-China Research and Innovation Partnership Fund' Delivery Partners (DPs) consist of ten government ministries and agencies and has activities funded by all the participating UK Delivery Partners.

The case study

This study was produced by Tetra Tech International Development as part of a wider set of studies to inform the Final Evaluation of the Newton Fund.[1] It is one of 11 partner country case studies that investigates the Fund's implementation and its results. It serves as a deep dive into the development, relevance, additionality, and results of (a) the programme activities; and (b) their success factors and barriers that affected their implementation.

The case study sampled three calls under the UK-China Research and Innovation Partnership Fund, and from each a project was selected for in-depth analysis:

- **Weather and Climate Science for Service Partnership (WCSSP) China** which focuses on research for the development of climate services that support climate-resilient economic development and social welfare. The case study focussed specifically on WCSSP's Work Package 5, which aims to form new collaborations; identify user needs in priority sectors; and develop prototype climate services to respond to user needs.
- **Newton Advanced Fellowships (Year 4 round 2)** which provides funding for early- to mid-career international researchers to collaborate with a UK institution. This case study focussed on a collaboration between Xiamen University and the University of Oxford to study the dynamics of a specific protein in relation to cancer and other diseases and thus inform the development of drugs to treat cancer growth.
- **Joint development of remote sensing technologies and techniques for agricultural and environmental monitoring.** The study focused on the Precision Agriculture for family

[1] In this report, 'UK-China Research and Innovation Partnership Fund' refers to the joint UK-China initiative through which funding calls were issued. 'The Newton Fund' refers to the broader UK programme financing activities in 17 countries, including China. The UK-China Research and Innovation Partnership Fund was financed by UK Newton Fund contributions and local Chinese funding partners (match contribution).

farms in China (PAFiC) project which promotes best practice for environmentally and profitably sustainable production on commercial family farms through improved resource-use efficiency.

The research took place between November 2020 and January 2021. It included a desk-based review of project- and fund-level documents, and remote interviews with 21 Chinese and UK stakeholders, including Delivery Partners, Award Holders (AHs), senior staff from partner organisations as well as the programme team and UK Embassy staff.

This case study is a self-contained investigation and its findings are not intended to be generalised to the entire Newton Fund in country. Case studies were limited to three projects per study, which were conducted remotely due to restrictions pertaining to the Covid-19 pandemic. In some cases, the logistical challenges of remote research limited the number and range of stakeholders consulted. The findings reflect the data provided by each project and available information online. The volume of documentation provided varied by project, thus limiting the possibility of triangulating findings. In terms of total Newton Fund expenditure, the projects selected represent a very small proportion of an estimated 5,400 projects. While this case study is not representative of all Newton Fund activities it does It provide valuable depth and illustration of Newton Fund activities. This study alone does not provide generalisable evidence.

Key findings

Effectiveness

- **The partnership has funded high-quality, advanced science research on topics of global importance, which has brought together complementary expertise from the UK and China.** All respondents were positive about the quality of the research, emphasising the mutual exchange of expertise. Funding received was appreciated within the Chinese research community and it has contributed to raising the profile of UK research and innovation. The partnership is seen as a well-run programme with no significant operational challenges – despite early teething problems related to planning and the alignment of activities with funding cycles.

Emerging signs of impact

- **There are early signs project activity is beginning to influence policy or practice in China, although it is too early to determine the full extent of impact**. Respondents shared some early examples of policy level influence including research into antimicrobial resistance (AMR) which has contributed to a ban in China on antibiotics as animal feed growth promoters. Sampled projects all have clear goals with expected links to positive socioeconomic outcomes.

- **The partnership has strengthened relations with Chinese partners, scaled up research activity and paved the way for the first UK-China bilateral science and innovation strategy.** The partnership was felt to be 'expanding' and 'diversifying' existing research collaborations and using different modes of collaboration (joint centres and multilateral/regional programmes). The bilateral nature of the Fund has strengthened relations with Chinese institutions, including the Ministry of Science and Technology (MOST), the National Natural Science Foundation of China (NSFC) and the China

Meteorological Administration (CMA) - paving the way for the first formal UK-China bilateral science and innovation strategy in 2017 - Joint Strategy for Science, Technology, and Innovation Cooperation.

Sustainability

- **Sustainability has been built into the design of the sampled projects through the production of academic publications and applied technology**. Respondents cited plans to build on the research generated with one (completed) project having secured follow-on grants. Concerns pertaining to future funding were not highlighted by the respondents – this may reflect the advanced nature of the sample or the availability of funding opportunities within the context. There are indications of interest in continuing collaborations on both sides however, concerns were raised over the longevity of relationships in the absence of continued funding.

Complementarity and coordination

- **The high-profile nature of Chinese Award Holders and the strong links between Chinese collaborators and government institutions helped translate research into practice.** Respondents shared examples of how some of the policy influences they had observed from projects (CSSP and PAFiC) were because of their involvement with bodies affiliated with government enabling the translation of findings into policy and practice. Respondents sampled also felt that the scale of partnership had enabled the National Natural Science Foundation of China (NNSFC) to 'experiment' in ways it has not done before - to design coordinated, integrated programmes, and contribute to the institution's decision to establish a new interdisciplinary science team.

Lessons learned

- **Time-limited funding periods for larger projects resulted in some planning issues and risks**. Large projects struggled to hire and retain staff, and more generally, projects experienced challenges with time difference and language barriers.

- **Uncertainty on the continuity of funding and UK spending cycles restricted projects to certain durations and their ability to plan long term**. Uncertainty in the UK political landscape because of delayed spending reviews and COVID-19 has caused disruption by delaying decisions on the future of the Fund. This is posing a risk to relationships at fund level by preventing negotiations and decisions on future collaboration.

- **Intellectual property (IP) concerns were addressing by a strong top-down drive in the Joint Strategy for Science, Technology, and Innovation Cooperation.** A key factor to resolving IP concerns was engaging with the UK IP attaché early and setting out clearly in written documentation and negotiations how IP arrangements would be set for different projects.

Considerations and recommendations for the Partnership

- **Future funding schemes should consider alternative sources of mixed or non-ODA funding to build on the collaboration and maximise the value of learning for both countries**. The partnership is appreciated by the UK research base. However, ODA requirements were considered to be limiting some areas of work, both in terms of the type of projects that could be funded and the extent to which UK stakeholders could build reciprocal learning and applications to the UK context into project plans.

- **Future partnerships, or similar schemes, should consider having clear conversations on potential future phases, exit plans or any likely future direction**. The lack of clarity on future funding has brought some levels of uncertainty at both a fund and call level. Although there appears to be interest from both sides in continuing the collaboration, discussions for further partnership have somewhat been affected by the lack of certainty on the UK side. Exit plans, or clearer communication could help manage the relationship with Chinese partners and encourage more innovative research collaborations through forward time-planning.

- **The Fund could consider additional measures to build on its brand and increase its sustainability.** This could be done, for example, by exploring further measures to engage Newton alumni and by linking alumni to additional opportunities for funding to build on Newton projects and continue collaborations with UK researchers. This could include exploring and further applying best practice from Newton activity within China, such as building on the alumni database and learning from non-Newton programmes, such as the strong alumni identity created by Chevening scholarships.

1 Introduction

1.1 Aim and purpose of the case study

This report presents the findings for the China Partner Country Case Study under the UK-China Research and Innovation Partnership Fund. While these findings will inform the Newton Fund's final evaluation, they are specific to the country under investigation and not to be generalised to the broader Fund. The strength of evidence (Section 1.5) for this case study should guide the reading of the results set out in Sections 3- 6. Remote research was carried out between November 2020 and January 2021.

The purpose of the case study is to examine:

- the relevance of the country-level work to Newton Fund's theory of change, including the ways in which funded projects have supported the Newton Fund to achieve its stated outputs and outcomes.
- the effects of Newton funding in terms of the scale and type of results delivered by the sampled projects, and their potential impact on the socio-economic challenges identified in the country and more widely.
- the likely sustainability of the activities and results of the sampled projects and by the Newton Fund.

We also aim to better understand the overarching significance and impact of the UK-China Research and Innovation Partnership Fund, such as on the internationalisation of research institutions, the relationship between the partner country and the UK, and in the sharing of best practice between the two countries.

1.2 Scope

This case study focussed on the activities under the UK-China Research and Innovation Partnership Fund. Specifically, it assessed the following:

- the **development of each activity** – examining its origins, how engagement with the Newton Fund occurred, and an overview of the process of securing Newton funding.
- the **relevance of each activity** to China's development needs and to Newton Fund and official development assistance (ODA) goals.
- the **additionality of each activity.**[2]
- the **results of each activity** in terms of the outputs, outcomes and impacts generated to strengthen the science and knowledge base, innovation capacity and influencing policy in China and beyond.

[2] In the context of the Newton Fund, additionality aims to assess whether a given call or project could have happened in the absence of the Newton Fund (for example, through funding for similar activities provided by other programmes).

- the **success factors (and barriers) which affected each activity**, as well as the potential benefits from each activity that might be expected to arise in the future.

The case study included a mix of ongoing and completed activities. When assessing these activities' results, we considered their ambitions as well as early signs of achieving impacts recognising that impacts of research and innovation take time.

To understand how sustainable solutions to economic development and poverty reduction have emerged from Newton Fund activities, our enquiry focussed on the factors that facilitate specific research activities, increase the quality of research outputs, enhance international collaboration for higher-level education and translate research into innovative practices.

1.3 Case study selection

As part of our sampling methodology for the Newton Fund country case studies, we shortlisted case study calls for each country based on three measures: size, pillar, and sector (see Annex 2 for details). Project selection considered thematic areas of focus, aiming to include priority areas for the Newton Fund in each country. We also sought to achieve a spread of Delivery Partners (DPs) and activity types across the countries in our sample. Following consultations with in-country teams (ICTs), DPs and the Newton Fund Central Team, we selected **three calls per country**. This selection allowed us to include a call under each of the Newton Fund's core activity pillars: People, Research, and Translation.

The next step is the sampling of one specific project from each of these three calls to ensure as broad geographical and partner coverage within the country case study's short timeframe. We also considered the relevance of their specific research areas to the Newton Fund's priorities in China when the projects were selected.

In China, the sampled calls and projects analysed in depth in this report are:

Calls	Projects
Climate Science for Service Partnership (CSSP) China	Work Package 5
Newton Advanced Fellowships (Year 4 round 2)	Small molecule inhibitors targeting the 2OG-oxygenase JMJD6 – towards a new breast cancer therapy
Joint development with China of remote sensing technologies and techniques for agricultural and environmental monitoring	PAFiC: Precision Agriculture for family farms in China

1.4 Methodology

The research for the country case studies included desk-based review documentation and remote key informant interviews (see Annex 1). For the China case study, we consulted 21 UK and Chinese stakeholders including UK Delivery Partners, award holders (AHs) and UK

Embassy staff. However, for this case study, we could not speak with some key Chinese organisations, which should be considered a limitation (see Annex 1 for further details).

Due to COVID-19-related travel restrictions, we had to switch to a purely remote approach. We assured the quality of our interviews by building rapport with stakeholders by email prior to the interviews, reviewing documents thoroughly to identify the most important gaps to keep the sessions brief amongst other steps. Details of the limitations of this approach and our mitigation actions are set out further in Annex 1.

1.5 Strength of evidence assessment

Tetra Tech used a traffic light system to assess the case study's strength of evidence (see figure 1 below).[3] The rating assesses the evidence supporting the conclusions reached given the methodological limitations outlined in Annex 1. Table 1 details the main sources of evidence used for this case study and the rating assigned to it.

Figure 1: Strength of evidence ratings

G	Green – robust and reliable evidence triangulated from multiples sources	G A	Green/Amber – good quality evidence with some limitations in coverage, sample size and ability to triangulate
A R	Amber/Red – evidence limitations in availability of corroborating sources, coverage or representativeness	R	Red – evidence limited due to absence of data, lack of corroboration and in some cases because it is too early to draw firm conclusions

Table 1: Strength of evidence for the UK-China Research and Innovation Partnership Fund

Strength of Evidence	
Green/ Amber G A	There are gaps in the evidence, which limited the assessment of relevance, effectiveness, emerging signs of impact and sustainability. This is due to the relatively small sample of interviews conducted which limits the extent to which it is possible to assess if the partnership has produced results and benefited its intended recipients. In addition, the extent, type and structure of monitoring data and documentation varied across DPs, limiting the extent to which outputs and outcomes can be reviewed and triangulated.

[3] Our aim was to achieve a sufficient degree of confidence about the extent to which outcomes have occurred, Newton Fund's level of contribution to the outcomes and our theory about how the Newton Fund has contributed or failed to contribute. Confidence is affected by the extent of triangulation across sources and the position, knowledge, analytical capacity, and potential biases of primary informants. The ratings are not designed to be a rigid framework, but rather a way to ensure evaluative judgements were made systematically across the Evaluation Questions.

1.6 Report structure

The report is structured as follows:

- **Section 2** introduces the China context, including political and economic developments and trends in the R&I landscape.
- **Section 3** discusses high-level emerging results of the Newton Fund in China based on findings from the three sampled projects and broader consultations undertaken with the programme team.
- **Sections 4 to 6** analyse three specific projects more in-depth, providing an assessment of the relevance, effectiveness, emerging impact, and sustainability of the sampled activities.

2 Context

2.1 Overview of the Partnership

The UK-China Research and Innovation Partnership Fund represents an opportunity to engage with China's science-led growth strategy and its appetite for international collaboration. Even though China ranks as one of the Newton Fund's most advanced partner countries in terms of S&I landscape – with existing high levels of science capacity and relatively advanced innovation systems – China is keen to see its R&D sector benefit from foreign skills and expertise through international initiatives.[4]

In line with China's priorities, areas of focus for Fund projects have been very broad and included issues related to China's rapid industrialisation. These include the environment, health, sustainable food, urbanisation, energy, air quality, economic development and water, but also extended to cultural heritage, future leaders and natural hazard studies.[5] All UK Delivery Partners have been involved, and projects and programmes have so far involved over 120 UK and over 260 Chinese institutions. In terms of size, the Fund covers both small and large projects, including a £4.5 million investment in antimicrobial resistance (AMR) research by the Medical Research Council (MRC), Biotechnology and Biological Sciences Research Council (BBSRC), and Economic and Social Research Council (ESRC). It has also supported regional cooperation programmes such as the Rice Research Initiative with China, Thailand, the Philippines and Vietnam supported by BBSRC.

The Fund's 2016 China Country Strategy specifies that the partnership's objectives are to 'tackle global challenges relevant to China, as solutions for China will also benefit the poor around the world.' Examples provided are: progress in food security, water quality, and renewable energy to protect the population and natural environment, the commercialisation of research in areas such as healthcare and urbanisation, and to establish joint centres of research, including in the fields of AMR and agri-tech.[6] Secondary objectives are to influence Chinese R&I policy to enable further collaborations and encourage China to adopt and conform to UK standards.[7] There are additional long-term goals to support the UK as an S&I leader (including access to Chinese talent, research data and facilities) and to contribute to increased trade opportunities between the UK and China.[8] In the later years of the Fund, there has been a renewed emphasis on global challenges in line with the BEIS Global Development Impact (GDI) policy.

Key risks for the UK-China Research and Innovation Partnership Fund were identified as limited Chinese coordination, limited capacity on both sides to match the level of demand (necessitating prioritisation) and potential overlap with other ODA funds active in China (necessitating coordination).[9]

In addition to the core team in Beijing, one UK-China Research and Innovation Partnership Fund programme officer is stationed in Guangzhou, South China. This is to facilitate the

[4] Coffey (2018). *Thematic Impact Study Report – China*. Available at: https://www.newton-gcrf.org/wp-content/uploads/2020/10/Newton-Fund-evaluation-China-report.pdf
[5] Newton Fund (n.d.).'China country strategy'. Internal document.
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] Ibid.

programme links in the South China region (which boasts a concentration of industry and technology hubs), including a joint call between Innovate UK and local authorities in Guangzhou.[10]

A distinctive feature of the Newton Fund is the requirement for matched effort from partner countries, which usually equates to matched funding or in-kind contributions. Matched effort is expected to help jointly accelerate the impact of the Fund's work through the joint agreement of funding priorities and mutual interests, which differentiates it from traditional bilateral development assistance.

2.2 Research and innovation landscape in China

China has significantly increased its science, technology and innovation (STI) capacity in recent decades along with its rapid economic growth, and science and innovation (S&I) remain a key pillar of China's economic strategy.

China's centralised, top-down governance system is well-known for its rapid translation of government research priorities into practical applications. This, combined with China's commitment from the highest level to be a world leader in S&I, means science and technology are a top priority.[11]

China has undergone a period of rapid growth spurred on by the central government's decision to open the country to foreign markets at the start of the 1980s. This strategy turned China into an industrial powerhouse, lifted millions of people out of poverty, and supported the development of a prosperous middle-class.[12] Despite China's fast rise, some regional and social inequalities persist, as well as challenges relating to the impact of climate change and the socio-economic effects of China's rapid industrialisation and urbanisation.

The government's growth strategy is driven by applied science and innovation. This was enshrined in the 13th Five-Year Plan for 2016 to 2020[13] (the 14th Five-Year Plan is under development at the time of writing) and it's 2006 Science and Technology Strategy, which set ambitious R&D targets for the period up to 2020.[14] This strategy put science as the impetus behind China's transition away from poverty and in tackling the problems arising from this rapid exit, such as environmental degradation and an ill-equipped workforce for the tertiary industry. The strategy lists a number of priority areas, including national priorities (such as agriculture and energy) and 'frontier' science, such as advanced energy technologies, biotechnology, and advanced materials science. The complementary Plan on National Medium- and Long-Term for the Development of Talent (2010 to 20) also focused on developing human factors to further these development priorities, both by nurturing domestic talent and attracting talent from overseas.[15]

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[10] Hong Kong is not included in Newton Fund programming and is covered by a separate UK Consulate.
[11] The Economist (2019). 'How China could dominate science *The Economist* [online], 12 January 2019 ed. Available at: https://www.economist.com/leaders/2019/01/12/how-china-could-dominate-science
[12] World Bank (n.d.). 'The World Bank in China' Available at: http://www.worldbank.org/en/country/china/overview
[13] Ministry of Science and Technology (2016). 'CHINA SCIENCE AND TECHNOLOGY NEWSLETTER'. No. 17, 15 September 2016. Available at: http://www.cistc.gov.cn/upfile/842.21.pdf
[14] The State Council of the People's Republic of China (2006). 'The National Medium- and Long-Term Program for Science and Technology Development (2006- 2020): An Outline'. Available at: https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/China_2006.pdf
[15] Cao, C., Baas, J., Wagner, C. S., & Jonkers, K. (2020). Returning scientists and the emergence of China's science system. *Science and Public Policy*, *47*(2), 172-183.

In 2013, Chinese President Xi Jinping set out the Belt and Road Initiative (BRI)[16], which positions China as a regional leader to create the world's largest platform for economic cooperation, trade and financing collaboration between Asian and European countries. Over 70 countries currently engage with the initiative.[17] Scientific collaboration and innovation are emphasised as an important part of the BRI initiative. It includes a network of 27 research institutions through the Alliance of International Science Organizations in the Belt and Road (ANSO) (none of which presently are in the UK), data-sharing initiatives and the opening of new research and training centres in Africa, Asia and South America.[18] The Chinese Academy of Sciences (CAS) reports that 1.8 billion yuan (approx. £205 million) had been invested in science and technology projects as of 2019.[19]

Although it is expected to graduate from the OECD Development Aid Committee (DAC) list in the coming years, China remains an eligible beneficiary of ODA funds. China is one of a small number of countries that is both beneficiary and a provider of development assistance.

Science and innovation landscape

China has high levels of science capacity and advanced innovation systems and has continued to invest heavily in its science and technology capacity in recent years. Research in China receives strong public support, particularly in terms of S&I research, with the main national funders being the Ministry of Science and Technology (MOST), the National Natural Science Foundation of China (NSFC), the Chinese Academy of Sciences (CAS), and the China Scholarship Council under the Ministry of Education (MOE).

China's expenditure on research and development (R&D) as a percentage of gross domestic product (GDP) in 2018 was 2.19%, placing the country 13th globally out of countries for which there is data (and higher than the UK figure of 1.72%).[20] As shown in Figure 2, this is also significantly higher than fellow Newton Fund partner countries India (0.65% in 2018) and Brazil (1.26% in 2017). There has been a continued upward trend in Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP in China (up from 1.37% in 2007), reflecting the importance of R&D in science and innovation as part of the country's growth strategy. In 2018, the majority of R&D spending came from business (76.63% of total spend), with the government providing 20.22% and just 0.36% arriving as funds from abroad.[21]

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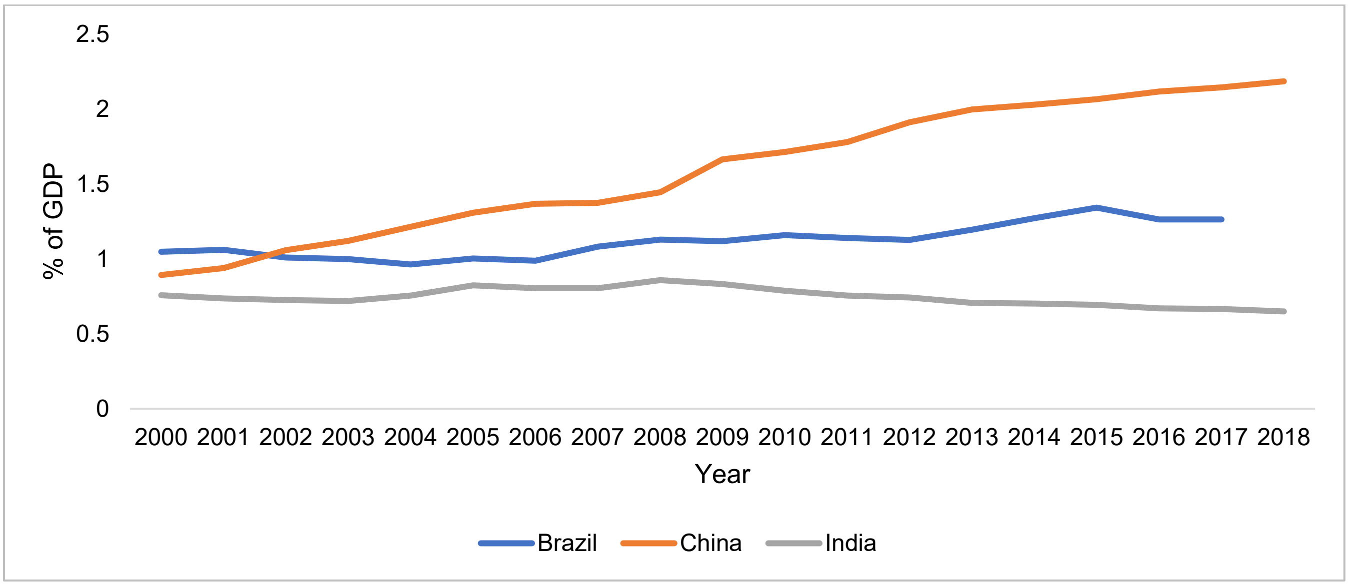
[16] Originally termed the 'One Belt One Road' initiative, a title still frequently used within China.
[17] European Bank for Reconstruction and Development (n.d.). 'Belt and Road Initiative'. Available at: https://www.ebrd.com/what-we-do/belt-and-road/overview.html (Accessed: 23/10/20).
[18] ANSO (n.d.) 'What is ANSO' Available at: http://www.anso.org.cn/about/anso/
[19] Masood, E. (2019). How China is redrawing the map of world science. *Nature*, *569*(7754), 20-24.
[20] World Bank indicator 'Research and development expenditure (% of GDP)' [GB.XPD.RSDV.GD.ZS]. Downloaded 23 December 2020.
[21] UNESCO Institute for Statistics, indicator GERD by source of funds (%). Available at: http://uis.unesco.org/en/country/cn?theme=science-technology-and-innovation

Figure 2: R&D spend in China, Brazil and India, 2000 to 2018



Source: World Bank[22]

Twelve Chinese academic institutions were included in the QS global top 100 universities in 2020.[23] Research funding in China is dominated by the 'C9 League' of universities – comparable to the UK Russell Group or US Ivy League – a group of nine of the 2,542 higher education institutions in China which collectively receive 10% of the national research budget.[24] In recent years, the government has invested in upgrading universities through the formal '211' and '985' improvement programmes, which merged to become the 'Double First-Class University Programmes' in 2017.[25] Outbound mobility of students has long been encouraged to increase science, technology, engineering and mathematics (STEM) capacity among Chinese citizens, with an increasing proportion returning to China after their studies amidst policy measures to encourage returns.[26]

As shown in Table 2, China's research output is highly specialised in chemistry, materials, information and communications technology (ICT), engineering, and natural resources and conservation. Less specialisation is observed in astronomy, health services, psychology, and the social sciences. Over the evaluation period, China has not recorded significant changes in specialisation in any field, with the largest decrease recorded in maths, where it went from being more to less specialised than the global average, and agricultural science in the opposite direction. The largest decrease was recorded in the materials field, for which China's specialisation rate decreased markedly, although it remains above the global average.

[22] World Bank indicator 'Research and development expenditure (% of GDP)' [GB.XPD.RSDV.GD.ZS]. Downloaded 23 December 2020.
[23] Xinhua (2019). '12 Chinese universities enter global top 100 in latest QS rankings'. *Xinhuanet* [online], 19 June 2019. Available at: http://www.xinhuanet.com/english/2019-06/19/c_138156421.htm
[24] Times Higher Education (2020). 'Best universities in China 2021'. Available at: https://www.timeshighereducation.com/student/best-universities/best-universities-china#survey-answer
[25] Cao et al (2020) op. cit.
[26] Ibid.

Table 2: Extent of specialisation of articles across selected research fields

	2013	2014	2015	2016	2017	2018
Agricultural Science	0.98	0.98	1.01	1.07	1.20	1.10
Astronomy	0.36	0.35	0.36	0.36	0.35	0.36
Biology and Biomed	0.74	0.78	0.82	0.84	0.83	0.82
Chemistry	1.49	1.57	1.56	1.54	1.50	1.55
Geosciences, Atmospheric, and Ocean Sciences	0.93	0.95	0.95	0.98	1.07	0.95
ICT	1.23	1.16	1.06	1.13	1.11	1.24
Engineering	1.64	1.58	1.60	1.56	1.53	1.50
Health Services	0.55	0.58	0.58	0.58	0.58	0.55
Materials	2.15	2.09	2.05	1.94	1.80	1.55
Maths	1.18	1.16	1.00	0.92	0.90	0.87
Physics	1.07	1.09	1.10	1.06	1.09	1.10
National Resources and Conservation	1.28	1.27	1.34	1.34	1.29	1.32
Psychology	0.12	0.14	0.16	0.18	0.19	0.20
Social Sciences	0.18	0.18	0.18	0.19	0.21	0.22

Source: Scopus (data sourced from U.S. National Science Foundation).
Note: the figure represents a measure of concentration of a country's publications in a field by dividing the fraction of publications in a country that are in a certain field by the equivalent global fraction. A score higher than 1 shows that the country is more specialised than the global average, and a score lower than 1 shows that the country is less specialised.

More recently, in a sign of adapting for development and growth, China has moved from its traditionally strong areas of expertise and combined them with other areas such as health and agriculture and an emphasis on applied science. Space science is another area where China is keen to develop, as demonstrated by its space station programme and the landing of *Change 4* on the far side of the moon in January 2019.[27]

Industries of particular export-strength include consumer electronics, other electronic and technical machines and textiles, while its major imports include electronic and technical machines, commodities, chemicals and transportation products.[28] However, China's technology industries may face some restrictions on overseas trade as a result of security restrictions on the use of its technology in sensitive networks, such as restrictions on the use of communications technologies from Chinese company Huawei in some countries in response to allegations of spying and intellectual property theft.[29]

Research funding structure

There has been a significant reorganisation of funding structures in China over the evaluation period to streamline and bring strategic oversight to science and technology research funding.

China's top-down research funding structure is highly centralised to cope with vast growth in the quantity of research outputs in recent years. Science policy is overseen by MOST, which also provides funding for large, strategic scientific projects,[30] while MOE administrates and funds higher education institutions. Key institutions that contribute to S&I projects include:[31]

- The CAS, a national research organisation and science 'think tank' comprising over 100 research institutes, two universities and associated bodies. CAS is funded by a central grant from the Ministry of Finances and through competitive research grants.
- The NSFC, a key research funding body and the primary partner of UK research and innovation (R&I) in China.

A number of government-affiliated bodies also exist to represent research in specific fields, including the China Association for Science and Technology, the Chinese Academy of Engineering, the Chinese Academy of Social Sciences, the Chinese Academy of Medical Sciences, Chinese Academy of Agricultural Sciences, and the Chinese Meteorological Administration.

Research funding in China was reorganised in 2014 to attempt to streamline what, until then, had been dozens of different agencies with overlapping mandates.[32] This included the creation of an Inter-Ministerial Joint Council of 31 government bodies (led by MOST) to provide strategic direction in S&I funding across ministries.

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27 Ibid.
28 Observatory of Economic Complexity (n.d.), 'China'. Available at: https://oec.world/en/profile/country/chn
29 Bowler, T. (2020). 'Huawei: Why is it being banned from the UK's 5G network?' *BBC News* [online], 14 July 2020. Available at: https://www.bbc.co.uk/news/newsbeat-47041341
30 Cyranoski, D. (2018). Chinese leaders create science mega-ministry. *Nature*, *555* (7697).
31 UKRI (n.d.a). 'Research landscape in China'. Available at: https://www.ukri.org/research/international/ukri-international-offices/ukri-china/research-landscape-in-china/
32 Chinainnovationfunding.eu (n.d.a). 'The reform of the Chinese national STI funding system'. Available at: https://web.archive.org/web/20200419224011/http://chinainnovationfunding.eu/the-reform-of-the-chinese-national-sti-funding-system/ (Page as of: 19/04/20).

The reorganisation also brought existing S&I research programmes under five 'pillars':[33]

- the National Natural Science Fund, run by the NSFC, which provides funding for basic and applied scientific research.
- the National S&T Major Projects ('Megaprojects') programme, administered by MOST[34], to fund 16 'strategic' projects relating to specific technologies (for example, to develop nuclear reactor technology and design a domestic passenger aircraft).
- the National Key R&D Programmes (NKPs), administered by MOST but set up as individual programmes,[35] incorporating a number of programmes providing funding in line with economic and social development objectives. These include some bilateral and intergovernmental programmes, including the EU-China Co-Funding Mechanism for Research and Innovation (see below). In 2016 and 2017, 42 NKP programmes were established, which funded 2,288 projects.[36]
- the Technology Innovation Guidance Fund(s), three funds governed by a cross-government council that provide investment and financing in technology projects (primarily geared to small and medium-sized enterprises (SMEs) and start-ups[37]) and aim to nurture the commercialisation of new technologies.
- the Bases and Talents Programme split into seven main programmes (administered by different government branches[38]), which provides funding and support for key 'talents' and scientific clusters.

The reorganisation also led to the creation of a National Science and Technology Information System Public Service Platform, which aims to act as a central information point about S&I research funding and calls across China.[39] Some research funding is also granted and administered by other central government bodies, ministries and local governments,[40] as per their specific priorities.

A further reorganisation occurred in 2018, through which the NSFC, which was independent of any ministry and reported directly to the State Council, was brought under the remit of MOST. **This means MOST has been significantly expanded,** and the move was cited as an opportunity to improve the strategic direction of research activities, improve international

[33] Ibid.
[34] Chinainnovationfunding.eu (n.d.b). 'National S&T Megaprojects'. Available at: https://web.archive.org/web/20200419234639/http://chinainnovationfunding.eu/national-st-megaprojects/
[35] Chinainnovationfunding.eu (n.d.c). 'Interim Measures for the Management of National Key R&D Programmes'. Available at: https://web.archive.org/web/20200807211047/http://chinainnovationfunding.eu/dt_testimonials/interim-measures-for-the-management-of-national-key-rd-programmes-2/
[36] Chinainnovationfunding.eu (n.d.d). 'National Key R&D; Programmes'. Available at: https://web.archive.org/web/20200420003110/http://chinainnovationfunding.eu/national-key-rd-programmes/
[37] Chinainnovationfunding.eu (n.d.e). 'Technology Innovation Guiding Fund in China'. Available at: https://web.archive.org/web/20200419230201/http://chinainnovationfunding.eu/technology-innovation-guiding-fund/
[38] Chinainnovationfunding.eu (n.d.f). 'Bases and Talents Programme'. Available at: https://web.archive.org/web/20200420001249/http://chinainnovationfunding.eu/bases-and-talents-programme/
[39] See the National Science and Technology Information System, Public Service Platform. Available at: https://service.most.gov.cn/
[40] Chinainnovationfunding.eu (n.d.g). 'Chinese local funding programmes'. Available at: https://web.archive.org/web/20200623101716/http://chinainnovationfunding.eu/chinese-local-innovation-funding-programmes/

coordination and support technology adoption and commercialisation.[41] Both MOST and NSFC remain UK-China Research and Innovation Partnership Fund partners, and no operational changes were reported during the previous fieldwork period.

2.3 International collaborations

UK-China relations in research and innovation span almost 40 years, with the first China-UK bilateral science cooperation agreement signed in 1978. In a sign of the UK's interest to engage Chinese R&I, the UK published its first bilateral UK-China Cooperation Framework in 2009. This mutual interest was formalised with the UK-China Research and Innovation Partnership Fund (Newton Fund in China) in 2014.[42] The UK-China Research and Innovation Partnership Fund represents an important milestone in bilateral R&I cooperation, building on Research Councils UK's (RCUK, now UK Research & Innovation, UKRI) local presence in China since 2007.

In 2017, the UK and China launched a Joint Strategy for Science, Technology and Innovation Cooperation, the first bilateral science and innovation strategy between the two countries.[43] The Strategy is a sign of the UK and China's political willingness to further formalise and deepen their science and innovation cooperation. The strategy sets out three key principles for collaboration:

- mutual respect for intellectual property rights and collaboration to develop global regulations in this area, while recognising the need to avoid restricting innovation.
- 'project-focused bilateral cooperation' focusing on priority areas of common interest.
- implementation at an operational level by research and innovation institutions, within the policy and regulatory framework agreed at the governmental level.

The collaboration is structured across three areas:

- basic research.
- innovation, including joint commercialisation of technology.
- UK-China Global Partnerships, collaborations potentially involving third or further countries to address identified global challenges.

The UK-China Research and Innovation Partnership Fund was identified in the strategy as a key implementation mechanism, alongside establishing further bilateral mechanisms, 'Flagship Challenge' programmes (the first of which, in 2018, focused on agri-tech), joint laboratories and research centres, data access initiatives and mutual access to research infrastructure.

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[41] Sharma, Y. (2018). 'Science ministry expands power over research funding' *University World News* [online], 21 March 2018. Available at: https://www.universityworldnews.com/post.php?story=2018032117551180

[42] UK Department for Business, Energy and Ministry of Science and Technology of the People's Republic of China (2017). *UK-China Joint Strategy for Science, Technology and Innovation Cooperation*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/665199/uk-china-strategy-science-technology-innovation-cooperation.pdf

[43] Department for Business, Energy & Industrial Strategy (2017). 'Press release: Joint UK-China strategy for science, technology and innovation cooperation sets new horizons for closer international collaborations'. Available at: https://www.gov.uk/government/news/joint-uk-china-strategy-for-science-technology-and-innovation-cooperation-sets-new-horizons-for-closer-international-collaborations

In addition, a UK-China Joint Commission on Cooperation in Science, Technology and Innovation meets every two years, involving the relevant ministers at both sides. The planned 2020 meeting was postponed as a result of the COVID-19 pandemic (to be held virtually in spring 2021). The Commission is an opportunity for the UK and China to review science collaboration and set priorities for future collaboration initiatives.[44] Besides the UK-China Research and Innovation Partnership Fund, the UK cooperates with China through the Prosperity Fund (ODA), the Global Challenges Research Fund (ODA) and the Industrial Strategy Research Fund (which is not ODA).

There are a number of other international funds providing joint funding for S&I in China. The European Union (EU) and China have had a Science and Technology Cooperation Agreement since 1998, which is renewed periodically and overseen by a Joint Steering Committee.[45] The EU and China have participated in a series of Innovation Cooperation Dialogues since 2013, and a roadmap for S&I cooperation is also planned.[46] China has become one of the EU's key international partners in research and innovation through the previous Framework Programme, FP7, and the dedicated Dragon Star initiative within the EU’s Horizon 2020 programme.[47] The EU-China Co-Funding Mechanism for Research and Innovation also supported joint research under the Horizon 2020 Work Programme 2018-2020.[48]

The EU-China ‘flagship initiatives’ and priority areas for the period 2018 to 2020 agreed at the 19th EU-China Summit in 2017 were:[49]

- food, agriculture, and biotechnologies.
- sustainable urbanisation.
- surface transports.
- biotechnology for environmental ends.
- Aviation.

[44] British Embassy Beijing / Science and Innovation Network in China (2018). ‘Press release: UK and Chinese ministers celebrate 40th anniversary of scientific relations’, 29 November 2018. Available at: https://www.gov.uk/government/news/uk-and-chinese-ministers-celebrate-40th-anniversary-of-scientific-relations
[45] European Commission (n.d.a). ‘China: Policy background, bilateral science and technology agreements, funding, projects and contact.‘. Available at: https://ec.europa.eu/research/iscp/index.cfm?pg=china
[46] European Commission (2019a). ‘EU and China met for 4th innovation cooperation dialogue in Brussels’. Press release, 09 April 2019. Available at: https://ec.europa.eu/info/news/eu-and-china-step-cooperation-research-and-innovation-2019-apr-09_en
[47] European Commission (n.d.b). ‘CORDIS Dragon - Sustaining Technology And Research Plus (EU-China Collaboration)’. Available at: https://cordis.europa.eu/project/id/645775
[48] Chinainnovationfunding.eu (n.d.h). ‘EU-China Co-Funding Mechanism’. Available at: https://web.archive.org/web/20200428030841/http://chinainnovationfunding.eu/eu-china-co-funding/ ; European Commission (2019). ‘International Cooperation: China’. Available at: https://web.archive.org/web/20200811010629/http://ec.europa.eu/research/iscp/index.cfm?pg=china
[49] European Commission (n.d.a) op. cit.

The Joint Research Centre (JRC) the European Commission's science and knowledge service, also established a Research Framework Arrangement with CAS in 2017 to expand collaboration in key areas of scientific interest, including, in particular, the field of remote sensing and earth observation.[50]

There are also many area-specific bilateral operations in place with EU Member States and between EU and Chinese universities.[51] Notably, this includes the Sino-German Center for the Promotion of Science (CDZ), a joint venture of the German Research Foundation (DFG) and the NSFC, which aims to promote cooperation in natural sciences, life sciences, management sciences and engineering sciences through research exchanges.[52] There are also Sino-French cooperation projects in the fields of infectious diseases and satellites.[53]

China itself has set up a number of programmes to attract overseas research talent,[54] including the 2008 'Thousand Talents' plan (replaced in 2019 by the similar 'National High-end Foreign Expert Recruitment Plan'), which targets top-level science and innovation researchers to encourage them to undertake a period of research in China.[55]

In contrast to China's well-performing R&D sector, its level of international collaboration exposure in R&D ranks much lower (although it should be considered in the context of China's mature domestic innovation capacity). However, China's appetite for international collaboration is important and regarded as a means to achieve the country's political emphasis on R&D promotion. Interviews previously conducted for this evaluation showed that international collaborations are seen as prestigious and therefore encouraged by state funding bodies.

[50] European Commission (2017). 'Expanding scientific cooperation with China: JRC and Chinese Academy of Sciences sign a research framework arrangement'. Press release. Available at: https://ec.europa.eu/jrc/en/news/expanding-scientific-cooperation-china-jrc-and-chinese-academy-sciences-sign-research-framework

[51] Euraxess (n.d.). 'Europe-China Joint Research Structures; Directory' Available at: https://euraxess.ec.europa.eu/worldwide/china/directory-europe-china-joint-research-structures

[52] Das Chinesisch-Deutsche Zentrum für Wissenschaftsförderung (n.d.) 'Chinesisch-Deutsche Zentrum für Wissenschaftsförderung'. Available at: http://www.sinogermanscience.org.cn/de/index.html

[53] Ministère de l'Europe et des Affaires Étrangères (n.d.). 'France and China'. Available at: https://www.diplomatie.gouv.fr/en/country-files/china/france-and-china/

[54] Cao et al (2020) op. cit.

[55] Chinainnovationfunding.eu (n.d.i). 'Thousands Talent Plan'. Available at: https://web.archive.org/web/20200607151150/http://chinainnovationfunding.eu/thousand-talents-plan/

3 Emerging results for the UK-China Research and Innovation Partnership Fund

The emerging results presented in this section are based on the three calls selected as part of the case study as well as the broader consultations undertaken with the programme team (see Section 1.4 for details of the methodology).

3.1 Key findings

The Fund's work in China builds on a long tradition of science and research collaboration. The UK and China have a long history of science and innovation co-operation and a Joint Commission for research collaboration which pre-dates the Newton Fund. Chinese research institutions are interested in international collaborations as part of a broader research development strategy – gaining more focus since relations with the United States (US), the largest collaboration partner, have been challenging in recent years. On the UK side, there is interest among academic stakeholders to develop relations with a leading science superpower, particularly as the quality of China's science has increased in recent years. The UK-China Research and Innovation Partnership Fund has taken place in the context of institutional reforms in China which include MOST taking a stronger coordination role with Chinese Delivery Partners, including the NSFC, which has enabled joint priority sectors, and increased investment in R&D.

The partnership has strengthened relations with Chinese partner bodies and scaled up research activity. The partnership has provided funding for collaborations that had not previously been available, in part due to strained budgets for international collaboration among UK research councils. In contrast to other sampled countries, respondents highlighted the scale of funding, rather than enabling collaborations per se, which is indicative of the ready access of Chinese AHs to domestic funding. The partnership has 'expanded' and 'diversified' programmes, enabling UK researchers to do more with China and widen the breadth and ambition. The partnership also enabled funding in areas that would not otherwise be prioritised such as creative industries. The partnership has provided continuity and a 'space' for UK actors without competing for funding with domestic or UK-centric programmes – as the quality of science among the Chinese research community was increasing. Respondents noted the diversification of the portfolio and models of research collaboration. For example, joint centres and multilateral, regional programmes such as the UK-China-Thailand-Philippines-Vietnam Rice Initiative and the UK-China-Thailand-Philippines Swine and Poultry Programme.

The bilateral nature has strengthened relations with Chinese institutions. The partnership enabled the UK to strengthen ties with MOST – with tangible offers which improved informal relations between institutions. The partnership initiated the joint programme aspect – which made it easier for other smaller bilateral programmes to take place as a precedence was set. The UK was the first country to have a systematic strategy with MOST – following the Joint Strategy in 2017. The partnership has enabled the UK to establish a solid basis of research collaboration, which may have taken longer to establish in the absence of the Fund. This was attributed to both sides investing in the programme and collaborating in a 'serious and structured' way:

"Newton has created a lot of solid ground for our scientific collaboration. That's the difference between the collaboration before Newton, which I think was quite variable, different levels of depth... it's become quite a deep scientific relationship, Newton's very much the bedrock of that."

Respondents also cited the expansion and strengthening of existing relations with Chinese institutions (see, for example, the PAFiC and CSSP projects in Sections 4 and 6), including new collaborations with Innovate UK and the Guangdong Dept of Science and Technology. Working in partnership and participating in reciprocal exchanges was a major achievement of the Fund, which enabled institutions to better understand each other and learn more about how the other country and its funding mechanisms worked.

The partnership successfully focused on China's priority topics. Early priorities were agreed in the 2013 Memorandum of Understanding (MoU) – but were also allowed to develop from the bottom-up, based on existing relations and prior interactions between Delivery Partners. Over time, a more top-down strategy has evolved, including a detailed set of priority sectors being developed centrally based on consultations with DPs. The bilateral design ensured a focus on work of interest to both sides. Match funding and joint priority-setting were also cited as a 'fairer' way to work but were not dominant themes which may reflect a more balanced existing relationship between the countries. A move towards focusing on broader global challenges has evolved over the course of the partnership reflecting the introduction of BEIS Global Development Impact (GDI) policy and a shift within China towards prioritising the Sustainable Development Goals (SDGs) in order to be seen as taking a proactive role as a global power. However, we were not able to speak with Chinese Delivery Partners for this review to verify this.

The partnership has funded high-quality, advanced science on topics of global importance, which has brought together complementary expertise. Respondents were positive about the strength and quality of the science and emphasised the mutual exchange of expertise. Examples of successful project outcomes included the CSSP programme's contribution to climate science, the development of a vaccine for avian flu, and research into AMR, which resulted in a ban in China on antibiotics as animal feed growth promoters[56] while recognising that the impact of a number of the programmes was still expected to be in the future. The Fund's flexibility was cited as a useful feature in its ability to fund diverse activities such as capacity building and basic research.

Strong links between Chinese collaborators and government institutions has helped translate research into practice. Personal relationships with senior figures were important in the translation of science into policy in China which was enabled by the high-profile nature and the inclusion of senior and elite researchers in the research projects. Respondents shared examples of key policy impacts they had observed – which were the result of existing senior connections between Chinese collaborators and Chinese government officials, including the AMR feed ban (for which the Chinese AH knew the policymaker responsible for this field), and strong links between the Chinese AH and the Beijing and national governments for a prominent project on air pollution. This was apparent in both the CSSP and PAFiC case studies, where the involvement of bodies close or affiliated to government enabled the translation of findings into policy and practice (see Sections 4 and 6).

[56] See for example: GOV.UK (2018). 'Tackling drug resistance: UK-China funding competition opens' Available at: https://www.gov.uk/government/news/tackling-drug-resistance-uk-china-funding-competition-opens

The Chinese research community appreciated partnership funding. The partnership has created opportunities for early-career researchers to collaborate with the UK that would have taken them many more years to secure otherwise. Some awardees secured second grants. Awardees valued the opportunity to conduct research within China itself, rather than having to travel to the UK as is often required for international collaborations. Newton funding was more attractive to awardees than the GCRF, as it enabled Chinese partners to carry the title of principal investigator (PI), unlike the GCRF.

The Newton Fund has become a well-known brand in China. The partnership has raised the profile of UK research, and is prized by Chinese researchers (with 'fierce' competition) who see it as a prestigious award. UK DPs also reported benefitting from better establishing their 'brand' in China. Alumni are also interested in further collaboration opportunities although the COVID-19 pandemic had limited the ability for them to offer firm plans in this regard. An alumni database created by the in-country team was also cited as a strength in this regard. It has captured data on over 1000 participants, enabling the in-country team to share newsletters about funding opportunities, collaborations, and provide networking opportunities. This is considered a potentially effective way of maintaining links should the Partnership framework cease.

The partnership has led to an increased focus on interdisciplinary working methods among Chinese institutions. The scale of funding has enabled NSFC to 'experiment' in ways it may not have done before to design coordinated, integrated programmes and learn from UK partners on interdisciplinary working methods. This has had a 'major' impact on NSFC as an organisation and contributed to (if not exclusively) NSFC's decision to start a new interdisciplinary science team. However, we could not speak with the NSFC as part of this case study to verify this. Collaboration has improved the management of funding calls - with opportunities with regional authorities or prioritising researchers from a broader range of research institutions during the selection processes being considered. The involvement of senior researchers with strong links to policymakers has enabled the successful translation of research into policy (see above). A focus on choosing the 'best' people and institutions was also part of maximising the Fund's contribution to global challenges, rather than solely on China:

"What we're doing is working with best scientists and innovators in China and [the] UK to do something greater than [institutional capacity-building]. I don't think the point of the Newton Fund is to develop the capacity of less able institutions, it should be about global knowledge for global benefit at the top end… So, the fact that we choose the best projects, and the best institutions, is a benefit."

3.2 Challenges and lessons learned

The lack of a 'planning year' was a challenge for the Fund. The need to plan and launch complex programmes in a short timeframe, resulted in a lot of demands in terms of delivery capacity among DPs on both sides which resulted in a reliance on existing DP relations to plan activities. Respondents also reported this at midterm[57], when they felt that the pre-existing Delivery Partner presence enabled a more efficient start for the Fund. Respondents highlighted that this has restricted the Funds ability to take a more proactive, top-down approach to coordinating research in key challenge areas, such as climate change. Early implementation challenges were, however, not considered to have affected project success.

[57] Coffey International Development (2018) Midterm Evaluation.

UK spending cycles and uncertainty over funding also posed a challenge. The UK spending cycle restricts projects to a time-limited period, despite the long-term nature of some S&I partnerships which has led to a lack of clarity over long-term plans. Its cyclical nature required spending to be completed by the end of the spending cycle – which led to a gap or delay in commission future programmes. Uncertainty in the UK political landscape, delayed spending reviews, and COVID-19 has caused disruption by delaying decisions on the future of the Fund, which has prevented negotiations and decisions on future collaboration, despite interest among Chinese DPs to continue.

"It's unfortunate, as we've built up goodwill on the Newton Fund, it's become the gold standard of collaboration as far the Chinese are concerned, and they are ready to do more at greater levels, but the UK are now not ready."

"I wonder if it may be one of the weaknesses in ODA funding from government for this type of scientific research, because science research really depends on having that long-term baseline funding that means you can really plan ahead… it's not quite as well-suited to short-term project work."

Lack of funding to continue collaborations is a risk to the sustainability of relationships. Respondents noted a potential risk to long-term collaboration prospects (at project and fund level) if funding were to end. Future collaboration is likely dependent on securing further funding, as this has enabled joint work, allowed scientists to focus on collaboration, and provided funding for engagement activities (such as reciprocal visits). The role of the in-country team is important for any future transition from ODA to non-ODA programming, as they are a permanent resource for sustaining operations.

"Depends if anything replaces it. The relationships will be there. If we can't sustain a minimal level of partnership, one to two calls a year, obviously it becomes much more difficult to say you're actually doing anything with the relationship. Similarly, academics may stay friends… but they follow the money."

"Will miss lots of tricks if we stop programming altogether – keeping those doors open on a wish and a prayer is not going to work here. If going to demonstrate that… seriousness about the relationship, we need to have those joint work plans, the reasons to engage... [We've] got to be thinking of a transition to non-ODA, but it's got to be a responsible, slow transition."

Other collaborative mechanisms (such as the MoU between Guangdong Dept of Science and Technology and Innovate UK to promote exchanges) might enable future collaborations. Government relations and small-scale collaborations have been continuing in recent years and people-to-people relations are expected to continue given the increased familiarity with the research systems.

The Fund's ODA designation has limited the areas the Fund has been able to work in, despite interest to collaborate on advanced science topics. While universities could collaborate on a bilateral basis, the 'strategic' funding available for collaborations with China is primarily ODA, which has restricted advanced topic research areas such as artificial intelligence, advanced manufacturing, chemistry, and basic science.

In some instances, Chinese partners were dissatisfied because there were not enough non-ODA funding mechanisms at government level to cover the collaborative activities they wanted to do. Respondents cited the existence Fund for International Collaboration (FIC)

- a non-ODA fund for international research collaboration with leading research countries - but this is considered relatively new and much smaller than the Newton Fund. The German government has set up a new partnership fund as a direct response to the Newton Fund.[58] It has a similar joint funding and priority-setting structure but is structured more as an open competition and not limited by spending review cycles. Targeted calls were useful to build a research community and allow UK researchers to meet Chinese partners at the beginning, but open calls have advantages, as it leaves topics open to scientists. However, stakeholder feedback highlights that the Newton Fund is a unique model compared to other countries' focus on university-level collaborations. Concerns were raised at the implicit ODA narrative of 'helping' the Chinese, given their strong scientific capabilities, there is a risk of coming across as condescending.

Some coordination issues were reported, although these were not considered significant. In China, DPs hold their own budget, so coordination is through individual partners rather than a single organisation such as BEIS. Aligning project funding periods and financial years has been a challenge. Delays and misalignment resulted in funding not being available for projects at the point at which they needed to hire staff or meant that projects could not close simultaneously. The time-bound nature of projects in relation to financial years has also caused difficulties by limiting duration. Flexibility is necessary on both sides. The short timeframe to set up the Fund created some uncertainty, however, there were no major process-level issues once the Fund was past the 'learning curve', with calls running smoothly once the team were familiar with the MOST system.

Project level challenges included time difference, language barriers, visa approvals and travel distance. Such operational challenges mean that funding streams like the Newton Fund cannot be considered a general substitute for EU partners, where collaboration is simpler and cheaper by virtue of physical proximity. In some instances, visas for Chinese scholars were rejected due to confusion in relation to the 'Academic Visitor' visa. This was mitigated by providing support letters for applications; it was a 'technical issue' rather than an 'attitude problem'. The in-country team worked with the UK Visas & Immigration section to produce a guidance and improve internal processes.

While intellectual property (IP) issues were flagged as potential issues by some stakeholders, in practice, no major challenges were reported on this point among reviewed projects and interviewees. One interviewee felt that there was a stereotype that IP was not protected in China, meaning they had to work to assuage concerns among UK business about IP protection. IP was also flagged as a potential issue by stakeholders engaging in the early STFC Newton Agri-Tech call Fund briefing meeting.[59] This was mitigated by engaging with the UK IP attaché and setting out clearly in written documentation and negotiations about how IP arrangements would be set for different projects, meaning that interviewees did not indicate that it had been a significant challenge in practice. Shared IP principles were also set out in the 2017 Joint Strategy for Science, Technology, and Innovation Cooperation.[60]

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[58] Chinesisch-Deutsche Zentrum für Wissenschaftsförderung (n.d.) Available at: http://sinogermanscience.dfg.nsfc.cn/

[59] Science and Technology Facilities Council (2014). *The STFC Newton Agri-Tech Fund Briefing Meeting Summary – 9th September 2014*. Available at: https://www.ralspace.stfc.ac.uk/Pages/TheSTFCNewtonAgriWorkshopSummary.pdf

[60] Department for Business, Energy & Industrial Strategy (2017) op. cit.

4 Project: Precision Agriculture for Family-farms in China (PAFiC)

Summary

Project title	Precision Agriculture for Family-farms in China (PAFiC)
Call title	Joint development with China of remote sensing technologies and techniques for agricultural and environmental monitoring.
Short description	The PAFiC project aims to promote best practice for environmentally and profitably sustainable production on commercial family farms in China through improved resource-use efficiency.
Objective(s)	Improvements in agricultural production efficiency have accompanied China's rapid socio-economic development. Heavy fertiliser use significantly improved crop production, but it also led to unsustainable agricultural practices. PAFiC's main goal is to contribute to achieving the sustainable intensification of China's agriculture using remote sensing technology to enable 'precision agriculture': the 'final-scale, within-field management of crops based on spatial data collection'. In doing so, it aims to reduce the environmental footprint of the practice of fertiliser use as well as increasing production efficiency (and so profitability).
Pillar	Research
Action value (total budget allocated in country, in GBP)	UK: £1,288,830 China: ¥3,000,000 and in-kind contributions (¥8,100,000 audited mid-term estimate; end of project matched resource finance audit in progress).
Start/end date	May 2016 to April 2019
DP UK and overseas	Science and Technology and Facilities Council (STFC), National Natural Science Foundation (NSFC)

Award holders/ grantees	Newcastle University (UK); China National Engineering Research Centre for Information Technology in Agriculture (NERCITA) Additional collaborators included: Tsinghua University (China), Southwest University (China), China Academy of Space Technology (China), International Centre for Maize and Wheat Improvement (CIMMYT) (Mexico)

Description of the project

Agricultural production efficiency improvements have accompanied China's rapid socio-economic development. Heavy fertiliser use has significantly improved crop production, but it also led to unsustainable agricultural practices, including large volumes of synthetic nitrogen fertiliser wasted annually.[61]

The Newton agri-tech call was a joint STFC-NSFC call (*Joint development with China of remote sensing technologies and techniques for agricultural and environmental monitoring*), which launched in 2014 and ultimately funded 32 research activities (including PAFiC) and an associated network (see below).[62] The call was a £12m (UK funding) window managed by STFC RAL Space (named after its location at the Rutherford Appleton Laboratory, one of six STFC-managed sites), which focuses primarily on space-related research, technology and projects.[63]

The agri-tech call aimed to draw on the UK's expertise in space technologies such as satellite imaging, remote sensing and modelling around agricultural technology (agri-tech) to benefit agriculture in China.[64] This programme aims to provide real solutions for sustainable intensification (improving yields, minimising environmental impacts), climate smart farming (reducing emissions from agriculture, climate change resilience), and pests and diseases (detection and monitoring; modelling and predicting). The call provided 'pump-priming' funding[65] for a number of smaller projects and subsequently larger funding grants for projects which showed promise.

In addition to the main call, a network-building initiative, the £2m Agri-tech in China: Newton Network+ (ATCNN), was commissioned by the STFC to draw synergies across projects funded under the call, facilitate dissemination and translation into policy-relevant outputs, and facilitate interactions between UK and Chinese researchers, stakeholders and end-users in relevant

[61] UKRI (n.d.b). 'PAFiC: Precision Agriculture for Family-farms in China'. Available at: https://gtr.ukri.org/projects?ref=ST%2FN006801%2F1
[62] See also Coffey (2018) op. cit.
[63] See UKRI, 'RAL Space' Available at: https://stfc.ukri.org/about-us/where-we-work/rutherford-appleton-laboratory/ral-space/
[64] RAL Space (n.d.). 'The STFC Newton Agri-Tech Fund'. Available at: https://www.ralspace.stfc.ac.uk//Pages/The-STFC-Newton-Agri-Tech-Fund.aspx
[65] Examples of pump-priming activities could include: networking; partnership building; workshop development and delivery; design studies; proofs of concept; or other pilot approaches. See: https://stfc.ukri.org/files/opportunity-call-2019/

fields.[66] This was implemented by a consortium led by Rothamsted Research, a non-profit specialist agricultural research organisation.[67]

The ‘Precision Agriculture for Family-farms in China’ (PAFiC) project’s main goal was to contribute to achieving the sustainable intensification of China’s agriculture using remote sensing technology to enable ‘precision agriculture’: the ‘final-scale, within-field management of crops based on spatial data collection’.[68] In doing so, it aimed to reduce the environmental footprint of the practice of fertiliser use and increase production efficiency (and so profitability). The project aimed to develop a set of enabling technologies and conduct research to address the key ‘technological, agricultural and social or economic barriers’ to the use of precision agriculture methods on commercial farms in China.[69] These include the high cost of technology, a lack of awareness among farmers and administrative authorities, and a lack of data, services and quantified financial benefits to incentivise uptake. PAFiC involved partners both from the business world and universities – including 4 UK and 2 Chinese partners.

PAFiC was sampled for the Newton Fund evaluation Mid-Term Report,[70] so this case sought to follow up on progress since then. However, as we were unable to engage with the UK AH for this report, some sections below draw on findings from the Mid-Term Report.

Pathway to impact

PAFiC is a research pillar project with a translation component. As shown in Annex 4, Figure 3, this collaboration fits within the Theory of Change for Newton Fund Research Pillar activities.

This project's inputs were financial and labour resources, which enabled a series of research activities to be carried out by the collaborating institutions in China and the UK.

The project **activities** focused on addressing the key ‘technological, agricultural and social or economic barriers’ to the use of precision agriculture methods on commercial farms in China. PAFiC’s work was structured around 4 work packages that aim to address the main barriers to the use of precision agriculture in commercial farming:[71]

- **Develop precision agriculture technologies:** the project aimed to develop new and improve existing technologies by using advanced camera and spatial positioning technologies and improved data for analysis, including methods to analyse satellite data and combine it with other sources (such as airborne and ground sensors). The improved data was then used to develop models of crop growth to improve agricultural decision-making and allow for more efficient resource use.

- **Apply the technologies to family farms in China:** the models were tested on farms in China, involving a range of regions and crop types.

- **Assess the socio-economic impact of applying precision agriculture:** Social scientists collected qualitative data through interviews with farmers to improve the relevance of the

[66] UKRI (n.d.c). *‘Agri-Tech in China Network+’* Available at: https://gtr.ukri.org/projects?ref=ST%2FN003527%2F1
[67] See: Rothamsted Research, ‘Collaborations in China’ Available at: https://www.rothamsted.ac.uk/international/china/atcnn
[68] UKRI (n.d.b.) op. cit.
[69] Ibid.
[70] Coffey (2018) op. cit.
[71] Ibid,

technology. This ensured that technologies are suited to farmers' needs by drawing on local expertise and views on farmers' needs, barriers to uptake and the delivery of project outputs.

- **Transfer knowledge gained to farmers and policymakers**: the project conducted a series of public engagement and policy translation activities to promote the uptake of improved methods.

The project resulted in the following **outputs,** as detailed in UKRI data. However, given the large number of outputs produced by this collaboration, there may be additional outputs which have since arisen (for example, additional publications) not covered below.

- At least 48 publications were published as a result of the project.[72]
- The project team produced a number of models and data analysis techniques for improved analysis of sensor data and images.[73] In addition, at least three software/ technical products were produced:[74]
    - hyperspectral imaging software for processing data from advanced cameras without the need for proprietary software.
    - CropSense, a portable sensor used to estimate crop growth parameters. UKRI data reports that CropSense is being used by over 150 users across 15 provinces in China and has been used to collect over 100K samples.
    - Multi-temporal Satellite Imagery analysis, a new methodology to process multi-satellite sensor images to analyse features at different time periods.
- At least 55 outreach events were carried out by the project team, of which 18 were primarily targeted at policymakers/politicians, 23 at professional practitioners, six for industry/ business, and eight for public/other audiences. These included:[75]
    - 14 instances of participation in 'a formal working group, expert panel or dialogue', including PAFIC project meetings, the UK-China Science and Innovation Forum and the Defra Tree Health and Safety Committee Meeting.
    - 19 instances of 'participation in an activity, workshop or similar', including training, bilateral visits and conference attendance.
    - 12 instances of 'a talk or presentation', primarily at international conferences.
    - Eight instances of 'participation in an open day or visit at my research institution', such as hosting visits by policymakers.
    - One radio interview with ABC (Australia).
    - the launch of a bilingual project website.

[72] Full list available at UKRI, PAFiC: Precision Agriculture for Family-farms in China. Available at: https://gtr.ukri.org/projects?ref=ST%2fN006801%2f1
[73] Full list available at UKRI, PAFiC: Precision Agriculture for Family-farms in China
[74] Full list available at UKRI, PAFiC: Precision Agriculture for Family-farms in China
[75] Full list available at UKRI, PAFiC: Precision Agriculture for Family-farms in China; one duplicate entry identified and discounted.

Based on these outputs, PAFiC primarily targets two of the three **outcomes** identified in the Theory of Change: an increase in the number of high-quality research outputs and providing practical solutions that might influence policymakers and prove useful for China's agricultural sector.

At **impact** level, PAFiC aimed to develop innovative agricultural technologies intended to be useful to and accessible by Chinese farmers by engaging them and a range of stakeholders to facilitate their uptake. Ultimately, the increase in the efficiency of fertiliser and resource use could help reduce the use of artificial fertilisers and environmentally damaging practices, improve food security, and provide economic benefits for actors within China.

Specifically, the project aimed to engage with the following end-users:[76]

- **the precision agriculture community:** a range of agricultural technologies will be developed for use on family farms in China, which will be of relevance to farmers themselves, small companies who specialise in precision agriculture, and the wider precision agriculture academic and agronomy community.
- **geospatial service providers:** the products developed, such as soil brightness maps, vegetation indices and crop health maps, were expected to have a 'considerable commercial and societal value'.
- **agricultural service providers**: agronomic services in China are usually delivered by public bodies. The project engaged with local service providers and growers through local workshops to disseminate learning and involve stakeholders in the project's social science aspects and engaged with them to encourage uptake and use of the geospatial products.
- **government institutions:** the project aimed to 'exploit networks across the consortia partnership' to ensure uptake of the learning among government institutions responsible for agriculture, particularly learning relating to the barriers.
- **the public:** the project aimed to engage with the public through broadcast and television channels, popular articles, blogs and lectures
- **academic community:** the project intended to publish in journals and present at conferences to ensure findings were disseminated to the academic community.

4.1 Emerging project results

Relevance of Newton Fund activities

Relevance of the collaboration to China's socio-economic priorities

Priority areas for the agri-tech call were set in consultation with NSFC. Successful bidders were selected by a peer-review panel involving researchers from both China and the UK and jointly coordinated by NSFC and STFC RAL Space. China is experiencing large-scale use of fertilisers creating environmental issues such as soil and water pollution through contamination. The use of 'smart' agriculture to mitigate agricultural challenges is one of China's policy priorities highlighted in its most recent development blueprint – the 13th Five-Year Plan (2016 to 2020; the 14th Five-Year Plan was in development at the time of writing). This project also closely

[76] UKRI (n.d.b.) op. cit.

matches Fund priorities in China, one of which is sustainable food, energy and water.[77] Interviewees similarly reported that the project was well-aligned with government priorities in this area, noting that 'smart farms' and agricultural productivity were key areas of interest.

PAFiC is targeting both issues through the use of precision agricultural methods to significantly reduce fertiliser use and its impact on the environment and help sustain rural populations and economies. It does so by rendering the use of nutrients and agrichemicals more efficient through the analysis of data for agricultural decision-making (for example, using satellite imagery to assess soil health) and enabling the use of autonomous systems for farming tasks. Sustainable intensification of agriculture through increases in crop productivity is intended in turn to increase farming income and the socio-economic welfare of farmers, helping to keep farming activities profitable. The use of precision agriculture technology could also support the transition to management of larger farming areas.

ODA relevance

This collaboration aims to make a clear contribution to China's economy and food security by encouraging the development of improved and more environmentally friendly agricultural practices. This is particularly relevant to SDG 2 (*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*), in particular targets 2.4 (ensure sustainable food production systems and implement resilient agricultural practices) and 2a (increase investment, including through enhanced international cooperation, in agricultural productive capacity in developing countries).[78]

In addition, as some of the technology and techniques developed through the project are effectively context neutral, these techniques may be applicable to other countries, including low- and middle-income countries.

Origins and quality of the collaboration

In the first stage of this process, STFC identified potential interested UK parties in a workshop in London. This led Newcastle University to be selected and receive funding for a small feasibility study under the call. This study brought the UK AH, who specialised in remote sensing, into the field of precision agriculture and who otherwise would probably not have had this opportunity. He stated that: "*before the Newton Fund, we didn't know anything about agriculture*". The success justified the project being given a larger grant (£500,000) and ultimately receiving over £1m of UK funding. A networking event organised by DPs linked both the UK and Chinese AH, who then worked together to propose the second project, which then led to the third upscaling of the project, which is when it became known as PAFiC.

The collaborative nature of the project – in particular between Newcastle University and NERCITA – was actively promoted by STFC. A so-called 'sandpit event' was organised to bring together potential partner organisations during the project selection phase to foster collaborations in the field of precision agriculture. Such events enabled PAFiC collaborators to identify research gaps that would form the basis of their collaboration. Working together with other relevant institutions and with NERCITA in particular – a leading Chinese player in precision agriculture research with decades of experience – was decisive in upscaling PAFiC from a relatively small initial feasibility study to a large-scale project. The combination of

[77] Newton Fund (n.d.). op. cit.
[78] See: United Nations, 'Goal 2' Available at: https://sdgs.un.org/goals/goal2

Newcastle University's remote sensing expertise and NERCITA's precision agriculture expertise was considered to be a strength of the collaboration.

Chinese stakeholders considered that the collaboration had gone very well and established a foundation for further and deeper collaboration. The researchers had remained in contact following PAFiC and were engaging in other research activities together. Interviewees also felt that the collaboration had also generated useful learning for other UK-China collaborations. In particular, interviewees noted that implementing the project was a useful opportunity to learn more about data sharing and transfers with the UK, and the processes put in place to facilitate this provided a good foundation for navigating data sharing in other collaborations with the UK. Similarly, one interviewee noted that they had gained valuable experience regarding navigating customs processes to fast-track necessary equipment. This was considered particularly important for research in the agricultural field, given the time-limited nature of growing seasons.

At a call level, interviewees felt that relations between DPs were positive and that NSFC's input and support for the call were excellent. However, we could not speak with the Chinese Delivery Partner as part of this case study to verify this.

Additionality

As noted above, the collaboration was established specifically to respond to the agri-tech call. In this regard, the additionality of the UK-China Research and Innovation Partnership Fund is twofold: the Fund brought the UK AH into a new field of work, and it linked the UK and Chinese partners to jointly develop the PAFiC project.

One interviewee also noted that the structure of research funding in China – in which researchers are often fully funded by government, rather than partially relying on grant funding as in the UK – meant that money committed to the projects could go into direct recruitment for new staff, or used for equipment, data or technology development, meaning the ultimate contribution was 'above and beyond' the value of matched resource.

4.2 Effectiveness of Newton Fund activities

Capacity building for Chinese individuals and institutions

Interviewees noted that the project was important to NERCITA as its first major international funding project. It provided a good foundation for later collaborations with other countries and boosted the influence of NERCITA itself by enabling it to engage with new areas of research, including logistics and consumption (rather than just agricultural production). Taking part in an international collaboration through the Fund was also seen to have played a role in raising NERCITA's profile with Chinese authorities at the Midterm Evaluation of the Newton Fund in 2018. According to the researchers, it was especially the improvement of NERCITA's management capacity achieved through participation in PAFiC that supported it in leveraging more funds within China's competitive national funding landscape.

Individually, researchers at midterm reported that the collaborations led to professional development. Chinese researchers – both experienced and early career as well as PhD students – felt they had benefitted from exposure to different academic culture and cooperation styles as well as new research methodologies such as the social science component of the project.

Capacity building for UK researchers and institutions

At midterm, interviewees reported that for UK researchers – in this case, the engineering department of Newcastle University – participating in PAFiC expanded the application of their expertise in remote sensing and data processing into the field of precision agriculture. Before the project, the AH from Newcastle University had never delved into that field. This provided them with a completely new field of expertise and prompted a formal collaboration at internal level with the University's agriculture department (with whom they had never cooperated before). Newcastle University's agriculture department gained experience in this technological approach to agriculture.

In addition, one respondent felt that the multidisciplinary nature of the agri-tech call had also enabled relationships to be built between different research communities within the UK (including through the Network+ call). While this was not unique in the UK context, it would help connect the space technology field to other research communities.

New international partnerships

The PAFiC project created new partnerships, in particular between Newcastle University and NERCITA. The STFC selection procedure linked the various project partners together and opened the door for Newcastle University to apply their remote sensing expertise to agriculture. One interviewee reported that they felt there had been lots of opportunities through the collaboration to establish connections between UK and Chinese researchers at different levels, including reciprocal visits and the participation of early-career researchers.

UKRI data records at least 16 instances of additional funding secured by the project team for associated research work, totalling several million pounds. One interviewee noted that this project had resulted in a 'significant return to investment' in terms of additional research funding. This includes:

- £137,004 from the UK NERC for the project 'DRIER-China: Drought Resilience in Ecosystem services and Rural communities in China' (2016 to 2017).
- ￥1,600,000 from the Chinese Ministry of Science and Technology for research on nutrition diagnosis and variable fertilisation management for wheat and maize in North China based on low altitude remote sensing techniques (2016 to 2020).
- ￥4,750,000 from the Chinese Ministry of Education for Research on real-time monitoring and predicting of maize growth and productivity (2016 to 2020).
- £10,000 from the STFC for travel scholarships to attend the European Conference on Precision Agriculture for Early Career Chinese Researchers (2017).
- A £10,000 Pump Priming BBSRC Award to Professor Lynn Frewer and Dr Glyn Jones (2017 to 2018).
- £43,200 from the Chinese Academy of Space Technology for work on Satellite Radar Seminars (2017 to 2018).
- A grant addition of £254,654 from the STFC to participate in a cross-call Sentinels of Wheat follow-on project (2017 to 2019).
- £127,937 from the STFC for research on Earth observation for the improved management of tree health in urban and peri-urban settings (2017 to 2019).

- £5,000,000 from the UK Department for Environment, Food and Rural Affairs (DEFRA) for research on exploring remote sensing for early disease detection (2017 to 2019)
- ￥750,000 from the National Natural Science Foundation of China for research on ‘Effects of canopy vertical heterogeneity on canopy reflectance characteristics and remote estimation of crop parameters of winter wheat’ (2017 to 2020).
- €703,000 from the European Food Safety Authority (EFSA) for a project on the ‘Smart monitoring of airborne pathogens - supporting risk-based plant health surveillance’ (2017 to 2020).
- An uplift of £54,531 to the original grant from the GCRF (2018).
- £80,000 from the STFC ODA Institutional Award (2018).
- £8,000 from the UK BBRSC for ‘investigating farmer acceptance of precision agriculture technologies’ (2018).
- ￥230,000 from the National Science Foundation China for research on Predicting Winter Wheat Quality by Integrating of Remote Sensing Assimilation and Weather Forecast into the DSSAT Model (2018 to 2020).
- £1,281,346 from the UK BBRSC for a project on ‘Remote sensing and decision support for apple tree precision management, production and global traceability (RED-APPLE)’ (2019 to 2022).

A joint application between the UK team and the International Centre for Maize and Wheat Improvement (CIMMYT) in Mexico was submitted to the GCRF but was unsuccessful in securing funding.[79]

At a wider level, UK DPs felt that they had strengthened existing relations with Chinese counterparts as a result of managing the call. STFC RAL Space has had a relationship with China on space-related research for a decade. However, this was the first time RAL Space had a bilateral budget for international work and the first opportunity for a big international programme in applying space science to a development context (other than the UK’s participation in the European Space Agency). Interviewees felt that engaging with Chinese partners to administer the agri-tech programme (which is the largest of the STFC Newton portfolio) had strengthened relations. A RAL Space representative felt that it had ‘*completely changed*’ the relationship and enabled them to develop strong links. Both interviewees attributed this to having funding to actually engage on an international programme, rather than smaller exchanges or ‘talking shop’ contacts prior to 2014. Here, UK-China Research and Innovation Partnership funding enabled them to have more conversations and thus move to a different level of relationship, in a way that traditional STFC funding (which is committed significantly in advance to large activities and thus without flexibility or scope for smaller bilateral activities) did not allow. However, one interviewee noted that as China as not a major partner of STFC, this is unlikely to have a major impact on the rest of the research community.

[79] UKRI (n.d.b.) op. cit.

Equally, one interviewee felt that these relationships had expanded to include NSFC, particularly relations with the Chinese National Space Agency (CNSA), given CNSA's own similar interest in using space technologies for development purposes in China's ODA activities.

One interviewee noted that one enabling factor had been the presence of a UKRI office in China, who could do a lot of the groundwork to liaise with NSFC, establish the necessary contacts and apply UK processes within the local funding systems.

Secondary benefits for the UK

Secondary benefits for the UK included being able to build on China's data generation capabilities and expertise in data processing. In this regard, one interviewee felt that it was less a matter of complementary skills, as both China and the UK have good satellite technologies and data processing capabilities, but rather that they could do research more 'quickly and effectively' together. Similarly, one interviewee noted that, more generally, advances in agricultural science made by projects funded by the call would, in many cases, be able to be translated back to the UK.

In addition, one interviewee felt that the UK space sector would benefit more broadly from programmes such as this which sought to utilise and normalise space datasets – many of which are generated by UK satellites or using UK technologies – thus extending the reliance on space data as a 'commodity' in daily lives. At midterm, interviewees reported that UK industry representatives would also be included in PAFiC's advisory group to encourage the translation of research outputs into industry-relevant solutions and that the project expected to engage with service providers in the UK through the North East Satellite Applications Catapult Centre of Excellence. However, as we were unable to interview the UK AH for this review, we cannot verify whether this occurred in practice.

4.3 Emerging signs of impact

PAFiC is an ongoing research project, and impacts will only be observed in the long-term. Nonetheless, interviewees were positive about the potential impact of the project. The scale of additional funding secured by the project, including from Chinese funding bodies, provides one indication of confidence in the potential application and impact of research findings (although for the purpose of this case study, we cannot link this directly to socio-economic impact).

In addition, one interviewee highlighted three key outputs they considered would have a significant impact:

- a technique to improve geolocation within agricultural fields by enabling the triangulation of a precise location using a moveable device rather than a static (and often expensive) aerial. They noted this would have applications for precision agriculture and have wider spin-off applications for autonomous systems and vehicles that rely on precise positioning.
- an app for farmers to gather and submit agricultural data (for example, data on yields and crop problems) and submit this directly to local government inspectors ('agricultural extension workers'). This would enable them to provide direct support to the farmers in question and monitor farming issues across the wider area.

- the knowledge generated by the project about farmers' views on the use of precision agriculture. They expected this would have wider benefits by providing critical knowledge for future work in this field.[80]

Signs of sustainability

The outputs from the project were a series of academic publications and applicable technologies, so some level of sustainability was built into the project by design. In addition, the fact that the team has secured follow-on funding provides a promising indication that results and learning from this project will be built upon further in subsequent projects.

As noted above, interviewees felt that the call had strengthened UK Delivery Partner relations with institutions in China. However, one interviewee felt there could be a risk concerning these relationships' sustainability if these kinds of bilateral calls were no longer funded (and thus the need for interaction diminished), particularly as the STFC budget is primarily committed towards larger, long-term calls. For this reason, they also felt it was difficult to judge whether the relationships developed between individual researchers would be sustainable, as there may not be opportunities for funding through STFC (although there could potentially be relevant opportunities through other research councils).

Complementarity and coordination

At midterm, interviewees reported that PAFiC project partners have also actively engaged the Chinese policymaking community and informed them about PAFiC outputs and results. This included government and high-level officials. In 2017, over 10 government officers attended the agri-technology training course at the PAFiC annual meeting. PAFiC was presented to the Vice-Prime Minister of China (Yang Wang) at an agriculture conference in Suzhou in 2016 and the China Secretary of Agriculture (Changbin Han) at NERCITA in 2017. While it is difficult to know at this stage whether this will have direct results, informing Chinese officials is nonetheless paving the way for results to be applied to government actions in the future.

Similarly, one UK end line interviewee noted that Chinese stakeholders were promoting a lot of the project outputs (including NERCITA white papers). NERCITA's role as the largest national agricultural research institute in China, with close links to the relevant ministries, had enabled dissemination in this regard. Interviewees also felt that the PAFiC project, amongst others, had informed NERCITA's thinking on smart agriculture and smart farms, which in turn had informed NERCITA's response to the public consultation for the 14th Five-Year Plan during its development stage.

4.4 Conclusions

- **PAFiC was an ambitious project which sought to bring together advanced technical expertise from both the UK and Chinese sides to develop technologies relevant to Chinese priorities and wider interest in space technologies**. The collaboration carried out research in the agri-tech field to develop a set of enabling technologies for the use of

[80] See for example Li, W., Clark, B., Taylor, J.A., Kendall, H., Jones, G., Li, Z., Jin, S., Zhao, C., Yang, G., Shuai, C. and Cheng, X. (2020). A hybrid modelling approach to understanding adoption of precision agriculture technologies in Chinese cropping systems. *Computers and Electronics in Agriculture*, *172*, p.105305; and Clark, B., Jones, G., Kendall, H., Taylor, J., Cao, Y., Li, W., Zhao, C., Chen, J., Yang, G., Chen, L. and Li, Z., 2018. A proposed framework for accelerating technology trajectories in agriculture: a case study in China. *Frontiers of Agricultural Science and Engineering*. DOI: 10.15302/J-FASE-2018244.

precision agriculture methods on commercial farms in China and address barriers to their use. It resulted in at least 48 publications and a series of models, data analysis techniques and software/technical products, and at least 55 outreach events with farming, industry, and policy stakeholders.

- **The scale of follow-on and additional funding secured by the research team is a strong indication of the wider academic community's interest in the project findings and their potential applicability both in China and elsewhere**. Interviewees were able to articulate clear pathways to socio-economic impact. However, for this case study, we were unable to assess the extent to which impacts have been or expect to be felt by family and smallholder farms. In addition, the interdisciplinary nature and involvement of key Chinese institutions such as NERCITA indicate a clear route for translation of findings into impact for policy and practice within China.

Lessons learned and points to consider going forward

- The staged nature of the call, in which projects were provided with smaller **'priming'** grants before competing for full project funding, was considered a useful approach to commissioning strong research projects. The Fund could consider whether there are wider lessons from this approach to call development that would be of interest to other Delivery Partners.
- **Interdisciplinary working was highlighted as one of the key strengths of this project and call**. It enabled projects to take a holistic approach to developing new technologies and addressing barriers to how they could be applied in practice. However, one interviewee felt that there was limited coordination between different research councils working on agri-tech issues in China (noting that BBSRC, Innovate UK and the Met Office were all funding separate work on this issue). In this regard, they felt that Newton could potentially have a stronger management and centralised objectives to coordinate activity in priority areas across the research councils, particularly to address international challenges that require interdisciplinary activities (that are likely to come under the remit of different research councils). Future funding schemes of this kind could review whether there are additional ways to support coordination between research bodies working on similar topics, to maximise learning and allow for synthesis across disciplines and portfolios.
- As in other projects reviewed for this and other case studies, one interviewee reported that one challenge about the call were restrictions on carrying over budgets across financial years, meaning a lot of money had to be spent quickly at the start of the programme with limited time to plan. **Future funding schemes could review processes to consider whether some administrative changes or approaches could mitigate this issue.**

5 Project: Small molecule inhibitors targeting the 2OG-oxygenase JMJD6 – towards a new breast cancer therapy

Summary

Project title	Small molecule inhibitors targeting the 2OG-oxygenase JMJD6 – towards a new breast cancer therapy
Call title	Newton Advanced Fellowships (Year 4 Round 2)
Short description	The Royal Society Advanced Fellowship programme provides funding for early- to mid-career international researchers to collaborate with a UK institution. This collaboration was a collaboration between Xiamen University and the University of Oxford to study the dynamics of a specific protein in relation to cancer and other diseases and thus inform the development of drugs to treat cancer growth.
Objective(s)	The Advanced Fellowship programme's objectives are to support the development of the research community in partner countries, strengthen research excellence in partner countries by supporting the development of early- to mid-career researchers, and establish long-term links between research groups and networks in the UK and the partner country. This collaboration aimed to study the dynamics of a specific protein called JMJD6, a potential determinant in cancer cell growth processes. It aimed to identify molecule inhibitors to the growth of breast cancer cells and thus inform the development of drugs to treat cancer growth, in addition to informing the wider understanding of the role of JMJD6 in cancer and other diseases.
Pillar	People
Action value (total budget allocated in country, in GBP)	£111,000 (£37,000 per project year)

Start/end date	March 2018 to March 2021
DP UK and overseas	Royal Society, National Natural Science Foundation (NSFC)
Award holders/grantees	Xiamen University; University of Oxford

Description of the project

The Royal Society Advanced Fellowship programme provides funding for early- to mid-career international researchers who "have already established (or are in the process of establishing) a research group or research network and have a research track record" to formally collaborate with a UK institution for up to three years. The AH continues to conduct research in their own country throughout the award period. The award can cover salary top-ups, research and training costs and travel and subsistence costs relating to the collaboration.[81]

The stated objectives of the scheme are to support the development of the research community in partner countries, strengthen research excellence in partner countries by supporting the development of early- to mid-career researchers, and establish long-term links between research groups and networks in the UK and partner country to 'ensure that improvements in research capacity are sustainable in the longer term'.[82]

As per the Royal Society's remit, researchers working in the natural sciences are eligible for awards.[83] An award application is submitted alongside a proposal by the partner country and UK research groups. Assessment of applications includes a review of the suitability of the individual, the quality of the research proposal, the suitability of the UK co-applicant, and 'the extent to which the award will contribute to advancing economic development and welfare of the country by transferring new skills and creating new knowledge.'[84] Applicants must also propose a training programme to 'address specific gaps relevant to the Overseas Applicant's own development and that of their research group'.[85] Funds are transferred to the UK institution, which then transfers the funding to the partner institution.

The Royal Society received a large number of applications from China for the Advanced Fellowship programme. There were more queries from China than other funding rounds at the time (Turkey and Brazil), which one interviewee felt may have been in part due to the Royal Society being well-known in China. In addition, the Royal Society noted that there was continued interest in the scheme among prospective applicants in China, and they were receiving email queries from Chinese applicants about when a new round of funding might be launched.

The project reviewed for this case study is a collaboration between Prof Wen Liu of Xiamen University in Fujian Province and a research group led by Professor Christopher J. Schofield

[81] Royal Society (2020). *Newton Advanced Fellowships 2020 Round 2*. Available at: https://royalsociety.org/-/media/grants/schemes/newton-advanced-fellowship-scheme-notes.pdf (Accessed: 03/03/21)
[82] Ibid.
[83] Ibid.
[84] Ibid.
[85] Ibid.

(CJS laboratory) at the University of Oxford. The CJS laboratory's work focuses on analysing the chemical processes underlying certain biological systems, including a research focus on the biochemistry of human 2OG oxygenases. These enzymes are involved in determining genetic 'instructions' in human biological systems (such as the instruction for the body to produce proteins or cell growth). The CJS laboratory has previously had funding for work in this area from donors such as BBSRC, Wellcome Trust, the EU and Cancer Research UK, and has collaborated on basic research with pharmaceutical companies.

One cause of certain breast cancer subtypes is the activation of genes involved in cell proliferation in breast tissue caused by imbalances in the level of oestrogen.[86] Treatment for this cancer often involves anti-oestrogen endocrine therapy, although some patients may experience drug resistance. Understanding and mitigating this drug resistance, therefore, requires developing an in-depth understanding of the underlying dynamics of oestrogen production as they relate to oestrogen receptors (proteins that pick-up hormone signals that 'direct' the cells to grow). A protein named JMJD6 is considered a potential determinant in these cell growth processes. The collaboration aims to study the dynamics of JMJD6 activity and identify molecule inhibitors to the growth of breast cancer cells, thus informing the development of drugs to treat cancer growth and informing the wider understanding of the role of JMJD6 in cancer and other diseases.

Specifically, the project aims at the 'screening, design, synthesis and optimisation' of molecule inhibitors to JMJD6 activity, understanding their role in relation to breast cancer cells, and evaluating the activities of the molecule inhibitors in animal models of breast cancer.[87]

Pathway to impact

As shown in Annex 4, Figure 4, this collaboration fits within the Theory of Change for Newton Fund People Pillar activities by aiming to provide an opportunity for an early-career researcher (Professor Wen Liu) to conduct research in collaboration with a group in the UK. In addition, the project has some elements of Research Pillar activities by providing funding for a well-defined collaborative research project with a clear research objective.

This project's **input** was the funding to enable Dr Wen Liu to conduct research at Xiamen University in collaboration with the team at the University of Oxford. This totalled £111,000 / £37,000 per year:[88]

- an annual salary top-up of £5,000 for the Chinese AH (£15,000).
- consumable costs, including laboratory supplies, necessary chemicals and materials, and necessary technologies (£80,000).
- travel and subsistence costs to cover a visit by the Chinese AH to the UK in year one, and a reciprocal visit by the UK AH to China in the second year (£12,000).
- training costs, comprising costs for a workshop on epigenetics[89] hosted by the Chinese and UK AHs during respective reciprocal visits (£4,000).

[86] Royal Society application form
[87] Royal Society application form
[88] Royal Society application form
[89] Epigenetics is the study of processes that alter gene activity without changing the DNA sequence. See Weinhold, B. (2006), Epigenetics: the science of change. *Environmental Health Perspectives* 114 (3), A160-A167.

The **activity** of this project comprised of joint research to investigate the dynamics of JMJD6 activity. Both research groups are pursuing independent strands of research based on their areas of expertise (Xiamen's expertise in cell biology, and Oxford's in biochemistry), while bringing these strands together to jointly explore the dynamics of JMJD6. As part of this collaboration, the activity involved a series of formal and informal training activities.

This project's **outputs** are expected to primarily be a series of academic publications and potentially patents relating to the compounds. At the time of writing, a patent application for a compound produced during the research has been submitted in China. Any intellectual property and commercial interests arising from the collaboration would be governed by agreements between the universities.[90] In addition, the collaboration intends to develop the Chinese AH's research capacity through collaboration with the senior researcher.

The **expected outcomes** for this project are that collaboration will "*provide [the AHs] an opportunity to further exchange their complementary expertise and resources"* and allow them "*to immerse themselves into the overseas scientific environments, provoking new thoughts and ideas*".[91] In addition, there are specific expected outcomes in relation to the research project, namely an improved understanding of the role of JMJD6 in cancer and other diseases to inform the development of treatments. It is hoped that if compounds are found which can inhibit JMJD6 in animal models, the researchers can apply for funding to conduct clinical trials. In addition, the collaboration aims to establish long-term links between research groups and networks in the UK and China to 'ensure that improvements in research capacity are sustainable in the longer term'.[92]

In terms of **potential impact**, this collaboration aims to support the development of the research community and research excellence in China and establish long-term links between the research groups and networks in the UK and China. In addition, better treatment decisions based on the research findings may contribute to decreased ill health and preventable death associated with the diseases, notably breast cancer.

5.1 Emerging project results

Relevance of Newton Fund activities

Relevance of the collaboration to China's socio-economic priorities

Breast cancer is one of the most common cancer types worldwide. The collaboration is intended to produce findings that will inform drug development to treat breast cancer and produce evidence on the role of JMJD6 and associated molecule inhibitors in cancer dynamics.[93] In turn, this is expected to provide useful findings to inform the treatment of cancers in China and worldwide, thereby decreasing the medical burden. The research proposal suggests that the success of a joint collaboration such as this could potentially increase attention on breast cancer research from the pharmaceutical industry in China, therefore encouraging more support from the industry for basic research.[94]

[90] Royal Society application form
[91] Royal Society application form
[92] Ibid.
[93] Royal Society application form
[94] Royal Society application form

The selection process for Advanced Fellowship awards is conducted as a joint process, in which applicants apply to both the Royal Society and NSFC. The Royal Society review includes a review by panel assessors. However, as we were unable to speak with the NSFC for this evaluation, we have not been able to clarify the extent to which Chinese assessors were involved in the review and selection process. Projects were selected based on both research excellence and the proposed training programme, with a background document for Royal Society panel assessors providing guidance on how to review applications. In addition, the application form asks about potential secondary benefits for the UK.

ODA relevance

The Royal Society performs ODA compliance checks as part of the project selection process.

This research collaboration is intended to promote positive health outcomes. In this regard, it is relevant to SDG 3: *Ensure healthy lives and promote well-being for all ages* and specifically target 3.1: reducing mortality from non-communicable diseases. In addition, the nature of the project as a People Pillar activity is intended to support wider socio-economic priorities through further development of the academic sector.

Origins and quality of the collaboration

The Chinese AH had previously worked at the University of California, San Diego, before returning to China in 2013 to take up a position at Xiamen University.[95] He is on the editorial board for a number of journals and has previously received a number of scholarships and awards within China, including participating in the National Natural Science Foundation of China for Excellent Young Scientist programme in 2015 and the 'Thousand Young Talents Program' in 2013.[96] At the time of application, his position was the 'Thousand Young Talents Program' of China, 'Min-Jiang' Distinguished Professor, Xiamen University School of Pharmaceutical Sciences.[97]

The Fellowship is the first scientific collaboration between the School of Pharmaceutical Sciences at Xiamen University and the University of Oxford.[98] Both the Chinese and UK AHs had conducted research into JMJD6 with their respective research groups, including data generated by Prof Liu's group, which indicated the role of JMJD6 in activating breast cancer cell growth.[99] The joint interest in JMJD6 was the driver behind the proposal, which sought to build on this preliminary data generated by Prof Liu's group. Before the collaboration, the AHs were known to each other, given their work on the same protein family, and they had previously exchanged emails to discuss emerging research and data. However, neither had met before the collaboration.

Both sides felt the collaboration was positive, and no significant challenges were reported (other than disruption due to COVID-19).

[95] Royal Society application form
[96] Royal Society application form
[97] Royal Society application form
[98] Royal Society application form
[99] Royal Society application form

Additionality

Interviewees felt that it was unlikely that the collaboration would have happened without the UK-China Research and Innovation Partnership Fund. While one interviewee noted that it was likely that both parties would have worked on JMJD6 separately had funding not been available, the Fund enabled their joint work. While some other programmes support joint research, such as the Human Frontier Science Program,[100] these tend to be larger projects. Interviewees felt there were few similar funding sources for network-style collaborations such as this, which provide funding for teams to collaborate on their separate research streams, rather than financing just core research itself. A different interviewee noted that they were not aware of any similar funding schemes focusing on training.

At a wider level, one interviewee noted the value of funding for international collaborations such as this. Given the niche, technical subject area, it was considered unlikely that the right collaborator for the project (for example, a cell biologist working on JMJD6) would be found in the UK. One interviewee felt that something similar to the Advanced Fellowship programme could have been introduced in the absence of the Fund, but they were unsure how successful this would have been given how well-known the Newton brand is.

5.2 Effectiveness of Newton Fund activities

Capacity building for Chinese individuals and institutions

The Advanced Fellowship programme is a People Pillar initiative, and applicants needed to propose a training programme as part of the application process. For this reason, one explicit objective of the collaboration is to enable Chinese researchers to develop their career in collaboration with more experienced UK scientists.[101] This intends to encourage learning of 'soft skills', such as research group management and grant writing, and broader career 'lessons learned', rather than simply focusing on the technical area of collaboration. Training plans are proposed in the application form. However, one interviewee noted that the broader mentorship and coaching elements would also be expected to evolve naturally over the collaboration.

The Chinese AH noted that one attraction of the funding was that it supported early-career researchers, as he had just set up his own research lab at the time. The proposal envisaged that "*Training will be provided within a variety of settings including structured sessions, informal meetings, individualised meetings, and collaborative/ group meetings with scientists at the institutions including Oxford University and Xiamen University*".[102] The training programme was expected to give various opportunities to members of the research groups, rather than just the award holder. This included a monthly joint meeting to review latest research in fields related to the collaboration topic involving participants from both collaborating research groups and hosted by both laboratories in turn, attendance by individuals from both sides of the partnership in wider seminars and discussions relevant to the research field, attendance at a bioethics seminar series, and sharing of complementary laboratory resources across groups (notably the molecular and cell biology platform in Prof. Liu's lab and the drug development platform in Prof. Schofield's lab).

In practice, a number of these activities were disrupted by COVID-19. While regular collaboration progress meetings were taking place remotely, and the teams were sharing

[100] See: Human Frontier Science Program, 'Our Mission' Available at: https://www.hfsp.org/
[101] Royal Society application form
[102] Royal Society application form

literature and publications, the visit of Prof Liu to Oxford had to be cancelled due to the pandemic, although this was not considered a huge impact as they could continue communication over video. Nonetheless, the Chinese AH felt that he had benefited as a researcher through discussions with the UK AH, such as learning from the UK AH's experience managing a research lab and wider project management. Other early-career researchers in the Chinese team had also benefited by participating, for example, by gaining technical knowledge through the collaboration.

At a wider level, one interviewee noted that while Prof Liu was the first person to be awarded an Advanced Fellowship grant at Xiamen University, others in the university had also applied on the back of this and been successful. This was felt to have wider benefits for the university, as the grants are seen as prestigious. Similarly, the UK DP noted they had received positive feedback from Chinese AHs about how the scheme had opened doors for them and led to further funding opportunities.

Capacity building for UK researchers and institutions

Interviewees noted that UK researchers would also benefit from working on the research topic and accessing technical inputs from the Chinese team. In addition, the collaboration was felt to have benefited early-career researchers from the UK side as a good 'basic science problem' for them to work on and so develop their skills.

The University of Oxford was also felt to benefit through the production of high-quality science and academic publications.

In addition, the Advanced Fellowship scheme was felt by one interviewee to have increased awareness of the Royal Society in China. However, as interest in funding schemes such as this was already high within China, it was unclear whether this would result in any additional benefits for the Royal Society's work.

Research outputs

The project expects to produce three to four academic publications from the collaboration. Both UK and Chinese researchers were positive about research findings to date and their potential utility to inform further health research in this area. A patent application for a compound (a basis for future drug development) produced in the course of the research has been submitted in China.

New international partnerships

This collaboration was the first between the Chinese AH and the UK. They noted that without the funding, it is more likely that they would have collaborated within their own countries' than with other countries, given the relative ease of doing so compared to international collaborations.

Although the collaboration is still in progress, both sides noted that they would be happy to collaborate again in the future. One interviewee noted that in the absence of UK-China Research and Innovation Partnership funding, it was likely that for further international collaborations, they would have to find separate funding streams at each side to fund the respective research activity.

Additional or unexpected benefits

Interviewees noted that should the collaboration be successful in producing relevant findings, they would also be relevant to improving healthcare outcomes in the UK and other countries. In the UK, breast cancer is responsible for 15% of all cancer deaths among women, the second-highest cause of cancer death.[103] The UK team have been collaborating on some aspects with the Institute of Cancer Research, a specialist cancer research institute (and part of the University of London), which will increase awareness of the findings among UK stakeholders.

5.3 Emerging signs of impact

This collaboration is still underway, and so the impact of the project cannot yet be assessed. However, both UK and Chinese researchers were positive about research findings to date and expected the collaboration to ultimately produce learning relevant to drug development and meet its objectives.

Signs of sustainability

As the project's outputs will be a series of academic publications, the findings will enter the public domain and be available for research activity.

As noted above, both sides were keen to continue a collaboration if possible but were unsure whether relevant funding would be available for joint work. Nonetheless, the researchers indicated they would continue to apply for other funds to continue work in this field otherwise.

One interviewee also noted that they would be likely to keep in touch on an informal basis in the absence of funding.

Complementarity and coordination

As this collaboration focuses on fundamental science, there are no immediate policy applications. However, if the results are promising, the researchers expect this to ultimately have some impact on healthcare treatment.

5.4 Conclusions

- The collaboration has reportedly established a **strong partnership** that brings together high-level specific expertise in both countries to produce basic science, which interviewees expect to ultimately be relevant for treating a common cancer. Although the focus of the collaboration appears to primarily be on research, the partnership's training element was valued by the Chinese AH.
- While the research itself is context-neutral, and so a collaboration in this field would not necessarily have to involve a Chinese collaborator, UK-China Research and Innovation Partnership funding enabled the AHs to bring together their complementary expertise to focus on a specific technical subject without having to find separate funding streams. For

[103] Cancer Research UK (n.d.). 'Breast cancer mortality statistics'. Available at: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/breast-cancer/mortality#heading-Two

this reason, interviewees felt that it was unlikely that a ‘network-style collaboration’ such as this could have happened without the Fund.

- Although the project experienced some difficulties as a result of COVID-19 disruption, it has managed to mitigate these using remote communication technologies, and it is expected that **the project will achieve its objectives even in the absence of an extension**.

Lessons learned and points to consider going forward

- Interviewees were confident of securing further funding for research in the field, although this may be separately or with different collaborators if funding cannot be found to support similar joint work. In this regard, one interviewee felt that it **would be useful if Newton could include an additional funding stream** (for example expanding the Newton Impact Scheme) to provide follow-on funding for collaborations that show particularly promising results, as they expect this one to do. Future funding schemes could consider whether there are ways of drawing synergies between different funding streams, to ‘off-board’ and ‘on-board’ collaborations to other bilateral funding opportunities. This would allow the continuation of successful collaborations, and thus build on the partnerships established through the Fund.

- The Advanced Fellowship is a People Pillar project. For this reason, the project focus and ODA eligibility is concentrated on the training programme, although the selection of projects is balanced between this and an assessment of research excellence. Future funding schemes could consider additional ways of monitoring and evaluating the outcome of training programmes, analysing the social impact for partner countries, and drawing out useful lessons to maximise the partner country benefits of these kinds of collaborations.

6 Project: Climate Science for Service Partnership Work Package 5

Summary

Project title	**Climate Science for Service Partnership China Work Package 5: Met Office**
Call title	Climate Science for Service Partnership China
Short description	The Climate Science for Service Partnership (CSSP) China is a collaborative climate science initiative between research institutes in the UK and China. It focuses on research that is fundamental to the development of climate services that support climate-resilient economic development and social welfare around the world.
Objective(s)	Through a partnership between UK-China scientists, CSSP China aims to improve understanding and predictability of climate patterns in East Asia. Work package 5 (WP5) aims to '*form new collaborations between China and UK; identify user needs in priority sectors in China (energy, agriculture and food security, urban environments, air quality and water resource management); inform CSSP China science and pull-through the science; and develop prototype climate services to respond to user needs.*'[104] WP5.5, *Climate Risk Assessment Tool for Infrastructure in Chinese Cities*, aims to develop a tool to allow city planners and policymakers in Chinese cities to review climate scenarios and information on key climate risks for use in risk assessments for infrastructure and suggests potential measures to build resilience.
Pillar	Translation
Action value (total budget allocated in country, in GBP)	UK contribution to WP5: £7, 487, 533.99 (FY 2014/15 – FY2020/21).

[104] Met Office (2020). 'Climate Science for Service Partnership China Work Package Summary Report'. Internal document.

	Of which WP5.5: £400,000[105]
Start/end date	2014 – present
DP UK and overseas	UK Met Office, China Meteorological Administration (CMA), Institute of Atmospheric Physics (IAP) (part of the Chinese Academy of Sciences – CAS)
Award holders/ grantees	University of Reading, University of Leeds, University of Exeter, University of Edinburgh, ARUP, Imperial College, Plan8 and School of Oriental and African Studies

Description of the project

The Climate Science for Service Partnership (CSSP) China project is a scientific research programme that aims to apply UK expertise to support the development of Chinese climate services, and in doing so contribute to climate-resilient economic and social welfare in China and increase global understanding of climate variation and predictability. CSSP China is part of the Met Office's larger Newton Fund Weather and Climate Science for Service Partnership Programme (WCSSP), which also includes projects with Brazil, India, South Africa, and south-east Asia. The Met Office is both a Delivery Partner and implementor of the project, as it is uniquely placed to carry out some of the expertise required in climate modelling and climate science.

The Met Office, in partnership with the Chinese Meteorological Administration (CMA) and the Institute for Atmospheric Physics (IAP), aims to deliver its objectives through 5 work packages (WP):[106]

- Work Package 1 (Monitoring, attribution, and reanalysis) aims to improve the availability and use of data for understanding climate patterns in China.
- Work Package 2 (Global dynamics of climate variability and change) aims to improve regional climate predictions of extreme events.
- Work package 3 (East Asian climate variability and extremes) aims to increase understanding and predictability of climate variability and extremes in East Asia.
- Work package 4 (Development of models and climate projection systems) aims to improve capacity for climate simulations through the development of underpinning models and climate projection systems.
- Work package 5 (Climate Services) aims to support climate-resilient development and social outcomes through applied science and services.

[105] Met Office data
[106] Met Office (n.d.). 'CSSP China'. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/newton/cssp-china/index

The intended outcome of CSSP China is increased preparedness for climate and extreme weather events by supporting China to develop more evidence-based decision-making using more accurate climate models. This should help better predict extreme weather events in various areas of China and reduce the negative consequences of floods or droughts on China's population, agriculture, and industry. CSSP also aims to establish strategic partnerships between UK and Chinese scientists.

Considering the large scale of the CSSP China project, and to provide a deeper understanding of the Newton Fund's impact, this project case study focuses on Work package 5 (WP5). WP5 seeks to *"form new collaborations between China and UK; identify user needs in priority sectors in China (energy, agriculture and food security, urban environments, air quality and water resource management); inform CSSP China science and pull-through the science; and develop prototype climate services to respond to user needs*".[107]

This is done through a series of activities across three workstreams[108]:

- Supporting the National Framework for Climate Services in China.
- Developing prototype climate services for priority sectors.
- Translational science for climate services.

The activities aim to develop tools to translate CSSP China findings into user-friendly products, including climate factsheets for city planners, hydrological projections with regard to the Yellow River and Yangtze River basins for local decisionmakers, climate information for the 2022 Beijing Winter Olympics, and a series of communication products to explain and communicate the outputs of the CSSP China project.

In particular, this case study focuses on WP5.5: Climate Risk Assessment Tool for Infrastructure in Chinese Cities. This workstream was led by Arup, a UK-based professional services firm. It aims to develop a climate risk assessment tool, drawing from global climate models, to allow city planners and, secondarily, policymakers in Chinese cities to review climate scenarios for 30, 50 and 100 years in the future, including information on key risks such as extreme temperatures, increasing average temperatures, and extreme rainfall and flooding. The tool is intended to enable users to use this information to undertake risk assessments for infrastructure against different climate hazards and suggests potential measures to build resilience and mitigate risk for the infrastructure sector (drawing from a database of potential protection and adaptation measures).

CSSP China was sampled for the Newton Fund evaluation Mid-Term Report, with the report focusing on WP3.[109] This report sought to follow up on progress since the earlier report, although focusing on a different work package. For this reason, some sections below also draw on findings from the Mid-Term Report.

Pathway to impact

CSSP China is a Newton Fund Translation pillar project that aims to use its research outputs to inform the support provided to Chinese climate services. CSSP's expected pathway to impact

[107] Met Office (2020). 'Climate Science for Service Partnership China Work Package Summary Report'. Internal document.
[108] Ibid.
[109] Coffey (2018) op. cit.

(for WP5 only) is shown in Annex 4, Figure and reflects the fact that the project is intended to contribute to both Research and Translation pillars of the Fund.

The **inputs** for this work package were the financial inputs and engagement by researchers at both the Chinese side (primarily IAP and CMA and collaborating organisations) and UK (Met Office and collaborating organisations).

- The inputs for the specific WP5.5 were the financial resources provided by the UK and China to support the collaboration, in addition to labour and other inputs.

The **activities** of this project comprised a series of sub-projects designed to translate CSSP China findings and data into user-friendly products and develop other climate services. These were a mix of projects conducted internally by the Met Office and CMA, and some put to external tender and selected through open calls.

- The activity for WP5.5 comprises the development, testing and launch of a tool for city decisionmakers. To date, this has included:
    - completing a scoping study to inform the tools' development, including technical input from Arup and Met Office experts and feedback from stakeholders.
    - a series of workshops with city officials across 4 pilot cities (Beijing, Shanghai, Wuhan and Shenzhen) to understand their needs in relation to the planned risk tool.
    - development of a prototype tool, which is currently undergoing user testing and refinement.

The initial prototype has been developed and was undergoing the final review and testing phase at the time of writing. A series of stakeholder engagement events, including workshops with Chinese city stakeholders, is set to take place in the first quarter of 2021.

The **outputs** for WP5 are expected to include a range of tools and initiatives to translate CSSP findings and global climate data into user products. This includes climate factsheets for city planners, hydrological projections with regard to the Yellow River and Yangtze River basins for local decisionmakers, climate information for the Beijing Winter Olympics, and a series of communication products to explain and communicate the outputs of the CSSP China programme.

- The specific output for WP5.5 is expected to be a climate risk assessment tool for city planners and decision-makers, accompanied by a user manual and training guide for them to use to undertake risk assessments for infrastructure against different climate hazards. A user manual and training package will also accompany the tool.

The **expected outcomes** for the WP5 project are that through various tools and engagement mechanisms, end-users in China will be able to better engage with and utilise climate data in decisions.

- The expected outcome for WP5.5 specifically is that the tool will enable city decision-makers to account for climate hazard risk when planning and making decisions in relation to city infrastructure, such as rail and roads. In addition, the tool by design requires input from different teams within city authorities. It is hoped that encouraging these kinds of interactions will have a wider benefit for resilience by encouraging relevant departments to engage with one another and reduce siloed ways of working.

- In terms of **potential impact**, a better understanding and preparedness to manage extreme weather events is expected to lead to impact in a number of areas, including reducing the direct threat to human life from such events and better managing associated risks from floods and drought, including health risks, economic shocks, and food insecurity.
- The expected impact for WP5.5 is that by using the tool and better engaging with climate hazard scenarios, city decision-makers will be able to better plan and build resilience into city infrastructure, thus reducing its susceptibility to damage as a result of extreme or changing climate conditions (and thus reducing the economic and human costs of damaged infrastructure).

6.1 Emerging project results

Relevance of Newton Fund activities

Relevance of the collaboration to China's socio-economic priorities

Interviewees considered developing capability in this area to be a priority for China, given the economy's vulnerability to extreme weather and hazards. Additionally, interviewees noted that China was keen to further develop its national framework for meteorological services and raise its profile among the World Meteorological Organization (WMO).

WP5, in particular, was designed based on discussions between the Met Office and CMA on climate services. There was no collaboration in this area before CSSP. However, interviewees felt that there was keen interest among Chinese collaborators on applications for climate science, and CSSP was seen as a mechanism and opportunity to advance this, resulting in a dedicated work package. The design of the work package was shaped jointly by CMA and the Met Office, building on earlier discussions on focus areas for climate services work, and to reflect the CMA's six priorities for climate services: agriculture and food security, energy, urban areas, water, disaster reduction, and health. The CMA interviewee felt this process had been successful in selecting projects which met the needs of decisionmakers. In addition, studies were undertaken as part of WP5 to gain a deeper understanding of Chinese stakeholders' needs in relation to climate services, plan project activity, and future climate services work accordingly.

The Climate Assessment Tool (WP5.5) project arose out of engagements with city-level meteorological offices (which are part of CMA) and acknowledgement of the interest among cities to engage with climate services. The project is a continuation of an earlier project to develop a similar tool for cities in the Yangtze Delta region, which was developed for the Shanghai Meteorological Service and the British Embassy in Beijing. WP5.5 further developed this tool by integrating climate datasets to enable the immediate use of data by decisionmakers, rather than having to source their own climate datasets (as in the earlier iteration). The new tool has been designed based on consultations with Chinese stakeholders and a scoping phase with relevant authorities in four pilot cities (Wuhan, Shenzhen, Shanghai, Beijing). For example, the decision to include highways in addition to railways in the tool scope was based on feedback from Chinese stakeholders.

ODA relevance

The Met Office undertook thorough ODA compliance checks for project activities. This involved some revision to work plans and activity to ensure compliance.

The programme's potential impact - a better understanding and preparedness to manage extreme weather events - is expected to lead to impact in a number of areas. This includes reducing the direct threat to human life from such events and better managing associated risks arising from storms, floods and drought, such as health risks, economic shocks, and food insecurity. These are of relevance to various ODA objectives.

Origins and quality of the collaboration

Relations between the Met Office and the CMA, and IAP predate the Newton Fund. They were institutionalised with an MoU signed between the Met Office and CMA in the 1990s and between the Met Office and IAP in 2013. CSSP China was the first CSSP programme established under the Newton Fund and was later expanded to other countries (Brazil, South Africa, India, and a regional south-east Asia programme). CSSP China is the CMA's largest bilateral collaboration.

Interviewees on both sides felt that the quality of collaboration was excellent, attributed by one interviewee, to strong personal relationships between project researchers and leadership. UK interviewees noted that enthusiasm at the Chinese side was high, and there had been good buy-in among senior levels at the CMA and city and regional stakeholders. This had resulted in 'incredible' access to people and facilities across China to implement the collaboration.

An interviewee from Arup also reported that the collaboration with the Newton Fund in-country team and the Met Office teams was very positive and provided valuable support to engage with Chinese cities.

Challenges cited by interviewees included some cultural and language barriers (although English was spoken well), differences in ways of working, and distance for travelling. In addition, the COVID-19 pandemic (and ensuing travel limitations and lockdown measures) has disrupted some activities throughout 2020.

Additionality

While the existing collaborative links were considered essential for ensuring high-level buy-in once CSSP could be established, a lack of funds available for collaboration prevented the cooperation from taking off. The Fund's additionality here can be seen as twofold. It filled a gap in funding without which cooperation could not have taken place, and the large amount of funds it offered was also an opportunity to upscale the existing collaboration to include more fields of interest and to more comprehensively address climate and weather issues by using climate models and climate projection systems.

In addition, one interviewee noted that a barrier to cooperation before the CSSP programme was that there were limited existing contacts between the UK and Chinese institutions. The fact that Chinese researchers were nominated as co-leads for programmes meant that UK researchers could connect with an 'instant counterpart' and thus engage with their research activities and groups. For this reason, it was considered that none of the collaborations could have happened without CSSP China, as the contacts were not available.

6.2 Effectiveness of Newton Fund activities

Capacity building for Chinese individuals and institutions

On the technical side, institutions on both sides were felt to have benefited from improved computer models and projections as a result of the collaboration. One interviewee noted that the CMA would benefit from the improved understanding of climate science topics, enabling them to enhance technology development and climate services delivery.

End line interviewees also felt that a particular benefit had been developing early-career researchers on both the Chinese and UK sides and the ability to establish relationships between the next generation of climate scientists. Chinese researchers interviewed at midterm similarly reported their skills had improved scientifically and in terms of their professional development as researchers (for example, through strengthened English language skills).

One UK End line interviewee felt that a further benefit for the CMA and IAP was stronger relationships with the Met Office and UK universities, noting they knew of a number of links between the CMA/ IAP and Chinese and UK research institutions which had developed through the collaboration. In addition, they noted that, like the UK, the Chinese researchers would benefit from high-quality publications and also being able to publish in Western journals that they may otherwise struggle to access.

However, some Chinese researchers regretted the discrepancy of opportunities they received compared to UK researchers due to matched funding limitations. They were, for example, not able to have long research stays in the UK. While this was due to the rules of their research institution, it was felt to be contradictory to the Fund's partnership approach.

Capacity building for UK researchers and institutions

The project was considered to foster a mutual exchange of expertise, and the Met Office increased its capability as a result. Interviewees considered Chinese meteorological capability in this field to have been increasing rapidly in recent years, in part as a result of investment in researchers, with particular strengths in computer modelling (which has also been improved through CSSP China) and expertise in the regional Asian climate. In addition, China was considered particularly effective at climate services and delivering forecasts to users.

UK researchers were also able to increase their understanding of the regional Asian climate by engaging with Chinese expertise and draw upon this for the Met Office’s climate models. One specific example shared at midterm was that having access to Chinese climate data enabled improvements in the modelling of the monsoon system, which has been, so far, relatively under-researched outside of China. This improved understanding of East Asian climate is essential for improving the UK’s global climate models as the climate is a global system. In relation to WP5, the Met Office learned from China’s structure for climate service delivery, in which information could be cascaded effectively by the CMA through to regional, provincial and city authorities.

At midterm, UK researchers also reported having built their capacity through these collaborations and having developed professionally by being exposed to new data and research approaches. Interviewees also reported that the project increased the Met Office’s visibility in China, with local researchers now more aware of the institution and its scientific output.

Research outputs

As of March 2021, CSSP China had published over 350 peer-reviewed science papers[110] (including a special issue of the *Advances in Atmospheric Sciences* journal[111]) involving more than 200 UK and Chinese scientists.[112]

Interviewees were positive about the potential impact of the science being developed and the potential impact on Chinese forecasting and meteorological capabilities (and, thus, the improved resilience and disaster risk reduction, which are expected to arise from this). For example, one interviewee shared an example of using a model to see if it would predict actual extreme events (such as typhoons) in retrospect, which it did successfully, providing evidence that the model could be used to estimate the intensity of future similar events.

Similarly, at the time of the midterm country case study, scientists working on CSSP China observed that the UK seasonal forecasting system has significant skill in predicting summer rainfall and river flow in the Yangtze River basin. In 2016, this led to concrete results when real-time seasonal forecasts were issued through the CMA for the Yangtze River basin to key stakeholders, which helped inform planning ahead of the high rainfall season to be better prepared for potential flooding. This initial work was well received by stakeholders and has continued.[113]

Translation of research

As CMA was both a collaborator and DP for this project, CSSP China was structured by design to directly inform Chinese climate modelling capabilities and thus climate policy decisions. The design of WP5, to develop climate services for end-users, was included specifically to enable this. WP5 activities are being designed on an iterative basis to provide feedback from end-users to scientists to ensure the science best served the societal need. The potential for translation of research activities into policy decisions is therefore high. The CMA interviewee felt that the project had successfully developed tools that would be of use to decisionmakers, noting that some were already in use. In addition, they felt that the science produced by the project would contribute, alongside other scientific work, to informing policy in this field.

Furthermore, one respondent felt that the collaboration would have a broader impact on the development of the climate services field itself:

"Developing climate services is very challenging, and CSSP China has done a huge amount in actually just developing the field – climate services itself is relatively young as a discipline, and CSSP China is providing a lot of development of that as a discipline."

For WP5.5 (Climate Assessment Tool), the intention is for city officials to use the new tool to assess climate risks and make better decisions on infrastructure design. The tool will be provided on an open-source basis to encourage dissemination. In addition to engaging with city stakeholders, the team also plan to engage with think-tanks in China (including the National

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110 Met Office (n.d.). 'CSSP China scientific highlights'. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/newton/cssp-china/cssp-china-scientific-highlights

111 Special Issue on the Climate Science for Service Partnership China (CSSP China), Volume 35, issue 8, August 2018

112 Met Office (2019). 'Climate Science for Service Partnership China' [infographic]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/wcssp/cssp_china_infographic_final0919.pdf

113 Met Office (2019). 'Seasonal forecast service for the Yangtze River Basin' [infographic]. Available at: See: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/wcssp/yangtze-river-flood_infographic_final.pdf

Center for Climate Change Strategy and International Cooperation) and with Chinese businesses through a series of workshops hosted with the China-Britain business council. One interviewee also shared an example of how the Shanghai city government had used projections from CSSP to feed into their multi-year plan for development and had updated the city plan based on CSSP research.

New international partnerships

As noted above, the Met Office and CMA had a long-standing collaboration before CSSP China. However, interviewees felt that the programme has significantly boosted relationships. Researchers and universities now have personal, regular contacts with other researchers in the partner country as a result of the programme. (One interviewee noted that a number of UK researchers were now engaging with their Chinese counterparts on a personal level through WeChat groups.) One interviewee estimated they knew of 100 people who had expanded their networks across universities and the Met Office. As explained by one respondent:

“We started with nothing with the collaboration, and we now we have very good collaboration, lots of enthusiasm. It sounds like a long time, but it’s not. It’s been very impressive, and that’s certainly been helped by engagement on the Chinese side.”

Multiple interviewees cited the in-country team as providing very useful support for projects by being able to carry out engagement activities both from the central embassy and in consulates around the country.

This was also apparent in the midterm case study. Here, the willingness to ensure the sustainability of the partnerships built with the Fund was expressed by several Met Office and CMA/IAP researchers. For example, one Met Office researcher at midterm expected to be involved in an upcoming CMA project on extreme weather in South China.

Secondary benefits for the UK

The UK was felt to have benefited through access to Chinese expertise and learning generated through the project. For example, an analysis technique developed for CSSP had been used to inform the UK National Flooding Resilience Review.[114] One interviewee noted that they were keen to use techniques developed through CSSP and apply these to modelling and forecasting activity in the UK.

Similarly, Arup expects to draw on the learning and work developing the climate assessment tool for WP5.5 in other contexts. While the data used in the tool is specific to Chinese cities, the tool itself could be used in other locations by adapting questions and datasets to local contexts. It thus could also potentially to be applied in Arup’s wider engineering and consultancy work.

In addition, the UK was expected to benefit from the collaborative network and links developed through the project and from the strong academic papers produced for the collaboration.

[114] See: Newton-GCRF (2018), ‘UK-China innovation reveals current risk of record-breaking weather and climate extremes to inform resilience’ Available at:: https://www.newton-gcrf.org/impact/stories-of-change/uk-china-innovation-reveals-current-risk-of-record-breaking-weather-and-climate-extremes-to-inform-resilience/ ; See also: Thompson, V., Dunstone, N. J., Scaife, A. A., Smith, D. M., Slingo, J. M., Brown, S., & Belcher, S. E. (2017). High risk of unprecedented UK rainfall in the current climate. *Nature communications*, *8*(1), 1-6.

6.3 Emerging signs of impact

It is difficult to establish whether a science programme aimed at improving climate prediction models has had a visible impact at this stage, as many of these impacts, such as socio-economic development, increased resilience and hazard reduction, are expected to only arise in the long term. Similarly, as the intention is to reduce vulnerability to future hazards arising from climate change, it is difficult to assess the counterfactual of what would occur in the absence of a programme such as this.

Nevertheless, there are signs that CSSP is putting in place adequate measures and channels for its desired impacts to be achieved at a later stage. As noted above, interviewees at both sides were positive about the quality of the science produced by the programme. Indeed, one interviewee reported that they felt CSSP science had probably contributed to a recent change in perspective on climate change policy within China. This was because CSSP science had provided updated and better estimates of earlier climate change models to demonstrate that more warming had occurred in China than would have been predicted by earlier forecasts.

In terms of WP5, interviewees were similarly positive about the potential impact of climate services, noting good buy-in from end-users such as city officials, and they had seen the tools being employed by decision-makers and by CMA.

The impact of the Climate Risk Assessment Tool (WP5.5) cannot be assessed at this stage, as the tool is still in development and has not yet been disseminated to the target audience.

Signs of sustainability

The project outputs have been published as academic papers or applied in practice (e.g. improved computer models), so there is an element of sustainability by design for the research findings themselves.

In terms of the relationships developed as a result of the programme, the continuity of funding provided by the Fund was understood by the Met Office at midterm (and the panel of independent reviewers who looked at the project before it was launched) as a crucial factor supporting the building and cementing of collaborations which are given longevity by UK-China Research and Innovation Partnership funding. End line interviewees similarly hoped that personal relationships would last, although concerns were raised by two interviewees that they may weaken or that collaboration would undoubtedly be less due to researchers being diverted onto other projects should the collaboration end. In addition, it was felt by one interviewee the strong enthusiasm for the collaboration might wane if CSSP ended, in part as the size of the programme (and the fact it was well-known) had opened doors for stakeholders and been an incentive for scientists to engage.

Another noted that collaboration specifically on user engagement activities (such as those in WP5) in particular relied on physical travel to China and in-person meetings and might therefore be challenged if funding were to end, as there would be fewer opportunities for scientists to develop those relationships.

Complementarity and coordination

As noted above, the close involvement of CMA and IAP in project design, the inclusion of WP5, and widespread engagement by local authorities and other policy stakeholders mean learning from CSSP China will likely be applied to other meteorological activities and downstream decision-making in China. An email from the British Embassy reviewed by the research team provided evidence that joint research produced by the CSSP and a relevant Prosperity Fund project was being used in policy briefings produced by key state administrative coordination institutions, the China National Climate Centre (CNCC, part of the CMA) for the General Office of the State Council and the General Office of the Chinese Communist Party (CCP) Central Committee. These briefings are also sometimes shared with members of the Politburo Standing Committee (the senior leadership of the CCP).

IAP stakeholders at midterm noted that the UK-China Research and Innovation Partnership Fund and the collaboration with the Met Office had contributed to raising their work's profile and attracting funding from NSFC – one of China's main institutional research funders – for several new projects. This is significant because, in the Chinese research context, more than 150 research institutions under the Chinese Academy of Science have to compete for funding from a limited body of government institutions, including MOST and NSFC.

6.4 Conclusions

- **CSSP China is considered by numerous interviewees to be producing strong science and to have developed and built on relationships across different levels of the meteorological institutions and associated research community**. The project has produced over 350 peer-reviewed scientific papers and is developing a series of tools and service applications to translate climate science and data into products for decisionmakers in China. This includes, for example, climate factsheets for city planners, hydrological projections with regard to the Yellow River and Yangtze River basins for local decisionmakers, climate information for the Beijing Winter Olympics, and a series of communication products to explain and communicate the outputs of the CSSP China programme
- Interviewees were able to articulate **clear links between the research and benefits for China**, including examples of services developed under Work Package 5 being used in practice by Chinese policy stakeholders.
- Relationships developed through the project were considered strong, and widespread enthusiasm for the project was attributed in part to the prominence and large-scale nature of the collaboration. However, concerns were raised that they may weaken in the absence of future funding.

Lessons learned and points to consider going forward

- The opportunity to **build long-term collaborations is one of the projects' main areas of added value**. While the relationships built are likely to remain, their sustainability at an institutional level, however strong, depends on the Fund's financial contribution. Sustainability risks being jeopardised once the Fund comes to an end. This was already highlighted at midterm, and interviewees at End line also expressed concern over continued uncertainty on the future of funding. One interviewee noted they were unable to respond to Chinese partners' questions about the future of the collaboration. While acknowledging the difficulty of aligning the programme with UK spending cycles, interviewees noted that greater advance warning about programme duration would be valuable. As highlighted at midterm, an exit strategy would be beneficial for DPs to plan appropriately and retain the Fund's benefits.

- Interviewees also reported some **difficulties with the limited timeframes** of some UK-China Research and Innovation Partnership Fund funding contracts, which do not necessarily align with university processes (given the time required to recruit project staff). This presents a challenge to the recruitment and retention of skilled staff, who might otherwise seek roles with longer contracts or be actively preparing for their next role during project implementation. In this regard, multi-year funding was considered important to reduce this risk and provide stability to projects. Similarly, it was felt that a one-year funding window during any upcoming Newton transition phase could potentially pose a risk to project operations given the challenges of aligning project timelines with the specific funding window. Future funding schemes could review processes to consider whether some administrative changes or approaches could mitigate this issue.
- Stakeholders identified numerous secondary benefits for the UK through the collaboration, including strengthened relationships, access to Chinese expertise and the production of strong research. However, one interviewee noted that the programme’s ODA designation had influenced project directions and scope. It was felt there might have been additional secondary benefits from the science for the UK had the project been designed from the inception to focus on benefits for both regions. Future funding schemes may consider **alternative sources of mixed or non-ODA funding** to build on the collaboration and maximise learning value for both countries.

Annex 1: Methodology

Research methods and data collection approach

Partner Country Case Studies are central to the Final Evaluation approach and involved an intensive period of remote research by the evaluation team.

Preparation for the research included a document review of country-specific documents on China's research and development context. Documents reviewed include the China End line Report and the updated Country Situation Note. We also conducted a literature review of additional documentation on China's science and innovation landscape, and existing UK-China collaboration activities. Project-specific documentation, such as application forms, progress, and final reports, were reviewed for each action included in the study, where provided by the Delivery Partner, local partners or researchers.

The document review was accompanied by **remote research with respondents in China and the UK** between November 2020 and January 2021. Three main categories of stakeholders were interviewed: i) in-country UK representatives and Newton Fund in-country team; ii) UK and local funders; and iii) participating researchers. In some cases, additional university staff, such as university leadership or other research teams, were also interviewed.

Our data collection was complemented by an analysis of the pathway to impact for each action, which can be found in Annex 4. Here, we analysed each project's trajectory to impact by placing it within the Newton Fund Theory of Change. This allowed us to visually represent the pathway to outputs, outcomes, and impact of each activity, and highlight its (potential) contribution to broader Newton Fund goals.

Limitations of the research approach

Case studies were limited to three projects per case study, which were conducted remotely owing to the Covid pandemic. In some projects, the added logistical challenge of remote research limited the number and range of stakeholders consulted. The volume of documentation provided varied by project, thus limiting the possibility of triangulating findings. The case study findings reflect the data provided by each project and what is available online. The case study is not representative of all Newton Fund activities. Whereas it provides valuable depth and illustration of Newton Fund activities, the case study alone does not provide generalisable evidence.

Research findings have been triangulated across different stakeholder groups and various sources of documentation (project documents and online resources such as the UKRI's Gateway to Research portal). However, the research team could not independently verify statements by all the different contributing stakeholders or verify what was reported in the documentation.

Specifically, to the China case study, we were unable to source interviews with some key stakeholders, including MOST, the NSFC) and the UK PI for the PAFiC project. This may partly be because the research took place during a key administration period within China (including the development of the 14th Five-Year Plan and associated institutional reorganisation of priorities), resulting in limited capacity for stakeholders to engage with the evaluation. We sought to mitigate this by undertaking additional interviews with UK stakeholders. In addition, some interviews were undertaken with active translation between English and Mandarin, thus effectively reducing the time available in the interview. However, this limited engagement with Chinese stakeholders has affected the conclusions that we are able to draw for this case study, notably about the impact of the Fund within China and for Chinese institutions.

Additionally, the COVID-19 pandemic has resulted in the need to revisit our approach for data collection, particularly in terms of our 11 country case studies. The case study research was originally scheduled to take place in three waves of partner country visits between March and August 2020. The inability to travel internationally and the closure of offices, embassies, universities and research centres required switching to a **remote-based approach**, as agreed with BEIS in March 2020.

In revising our case study approach, we recognised that switching to a remote-based approach would have likely implications on the quality of data collected, as outlined in our April 2020 Concept Note. The quality of interviews could have been affected for several reasons, including:

- problems with connectivity, technical issues and limited telephone or internet coverage, which posed the risk of lowering the quality of calls and cause loss of rapport, creating abrupt feelings in interviews and affecting the depth and quality of our findings.
- the absence of visual or nonverbal cues, inability to observe behaviour and body language, with the risk of telephone interviews becoming mechanical and cold.
- having little opportunity to establish rapport with respondents and having potentially shorter times for interviews as respondents may more easily become fatigued by telephone compared to face-to-face interaction.
- limited engagement, low response rates and little interest in participating in our research, which might limit the breadth and depth of our findings.
- the inability to visit laboratories or facilities, and limited scope for unplanned interviews with additional staff members, researchers, or others in the same institution.
- fewer opportunities for check-ins and informal conversations with in-country teams (ICTs), who are a rich source of data.

We mitigated these issues in several ways, where:

- we included additional time for document review prior to interviews so that conversations moved on to speaking about results, emerging impact, and challenges (to take into account for shorter interview times and potentially lower quality interviews). However, it is important to consider that availability and quality of project data and information varied considerably across sampled interventions.
- we favoured video interviews wherever possible to limit the lack of nonverbal cues and to help establish rapport with respondents.
- we had several email exchanges prior to interviews to create an initial connection and rapport with participants, and to set out the objectives and areas covered in the interviews by sharing topic guides prior to our calls.

- we organised follow-up interviews wherever possible to fill any remaining information gaps brought about by having shorter interview times. We also gathered interviewee insights on additional respondents and carried out additional interviews which emerged from email exchanges and interviews.
- we organised regular check-ins with ICTs via email or telephone and delivered online presentations and validation sessions with each ICT to share emerging findings after having carried out all interviews. This allowed us to ensure we had accurately reflected the Newton Fund's experience in each country.

Annex 2: Case Study Sampling Overview

This Annex summarises the sampling approach used for the country case studies which inform the Final Evaluation of the Newton Fund. Detail on the approach and criteria used to develop the sample for the case studies is annexed to Tetra Tech's Newton Fund Final Evaluation Report.

Final evaluation country sample

A total sample of 11 countries with three calls per country (totalling 33 calls) was agreed with the Department of Business, Energy, Innovation and Science (BEIS).

The countries selected for the country sample were; China, Malaysia, Chile, Turkey, South Africa, Brazil, India, Philippines, Jordan, Peru and Kenya. The sample includes three additional countries (Jordan, Kenya and Peru)[115] due to the Newton Fund's expanded scope. Six of these countries were included in the Mid-Term Evaluation (MTE)[116] of the Newton Fund case study research.[117]

The criteria used for the country selection were:

- coverage of all regions covered by the Newton Fund.
- coverage of different levels of existing innovation and capacity of partner countries (as defined by the 2015 Global Innovation Index rankings and BEIS' initial assessment of capacity).
- learning opportunities from new ways of working regionally in countries that either graduated from the DAC list or have ODA sensitivities; or operating in/ recovering from crises.
- the inclusion of Peru, Jordan, Kenya (countries that have not been explicitly included in the evaluation scope until now).

Non-selection of countries (or calls) does not reflect significance, quality or importance.

Proposed sample of calls and projects

Data from BEIS' Newton Fund Activity Tracker (January 2020)[118] enabled the evaluation to determine 'call' activity and identify three 'calls' per country, giving a total of 33 calls in the sample. The following criteria were used to develop the call sample:

- ensuring coverage of all DPs.
- ensuring coverage of the three different pillars.

[115] Jordan, Kenya and Peru were not included in the MTE data collection, as they had just joined the Newton Fund. BEIS agreed to carry out in-depth case studies in the three new countries to ensure coverage of activities there.
[116] Mid-Term Evaluation of Newton Fund (December 2018). Accessible here.
[117] These were: China, Malaysia, South Africa, Brazil, India and the Philippines. Mexico and Egypt, which were part of our MTE sample, have been replaced with Turkey and Chile respectively to increase opportunity for learning.
[118] The BEIS 'Activity Tracker' is an Excel-based internal monitoring tool by BEIS and updated quarterly by the UK Delivery Partners.

- reflecting emphasis on spending/thematic priorities in each country.
- allowing for longitudinal analysis by including 6 projects analysed as part of the MTE.

The outcome of the call sampling approach allowed for the identification of specific projects under each selected call. This was achieved in consultation with DPs, BEIS ODA Research and Innovation and ICTs.

The project sample allows for coverage of all DPs and pillars within the Newton Fund portfolio. Six projects were analysed as part of the MTE and again at Final Evaluation to allow for longitudinal analysis. The sample list of 33 calls and projects is annexed to Tetra Tech's Newton Fund Final Evaluation Report.

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Research Participants

Precision Agriculture for Family-farms in China (PAFiC)

- Two representatives of UK Delivery Partners.
- Two representatives of stakeholders in China.

Newton Advanced Fellowship

- Professor Wen Liu, Xiamen University.
- Professor Christopher J. Schofield, University of Oxford.
- Emma Lawes, Scheme Manager (International Grants), Royal Society.

CSSP China

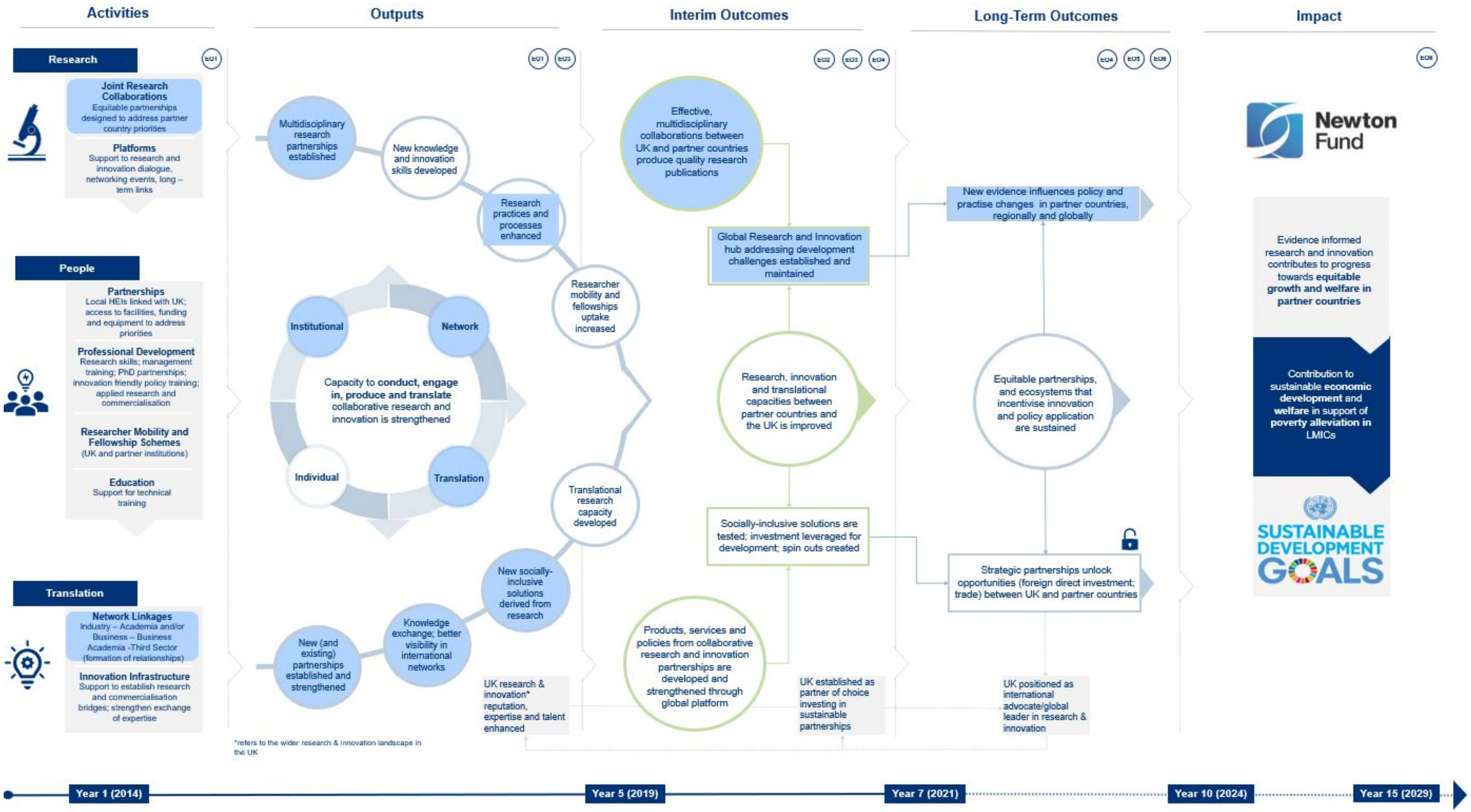
- Dr Tyrone Dunbar, CSSP China WP5 co-lead, Met Office.
- Professor Chris Hewitt, Head of International Climate Services and CSSP China WP5 co-lead, Met Office
- Representative of the UK Met Office
- Representative of the China Meteorological Administration (CMA).
- Representative of a UK-based delivery stakeholder.

Other

- Ming Liu, Head of Science and Innovation, British Consulate General Guangzhou
- Zhang Zhan, Newton Fund Programme Officer, British Embassy Beijing.
- Richard Baker, Newton Fund Strategic Manager, British Embassy Beijing.
- Sha Mengwei, Newton Fund Programme Officer, British Embassy Beijing.
- Three further representatives of the FCDO in China.
- Maggie Hu, Newton Fund Programme Manager, UKRI China.
- Dr Glen Noble, Deputy Director, UKRI China.

Annex 4 – Theories of Change per Action[119]

Figure 3: PAFiC



[119] The figures present the pathways to impact for the three projects reviewed in this case study, set within the overall Newton Fund theory of change. Specific pathways to impact for each project are indicated by the blue shaded shapes in each figure.

Figure 4: Newton Advanced Fellowship

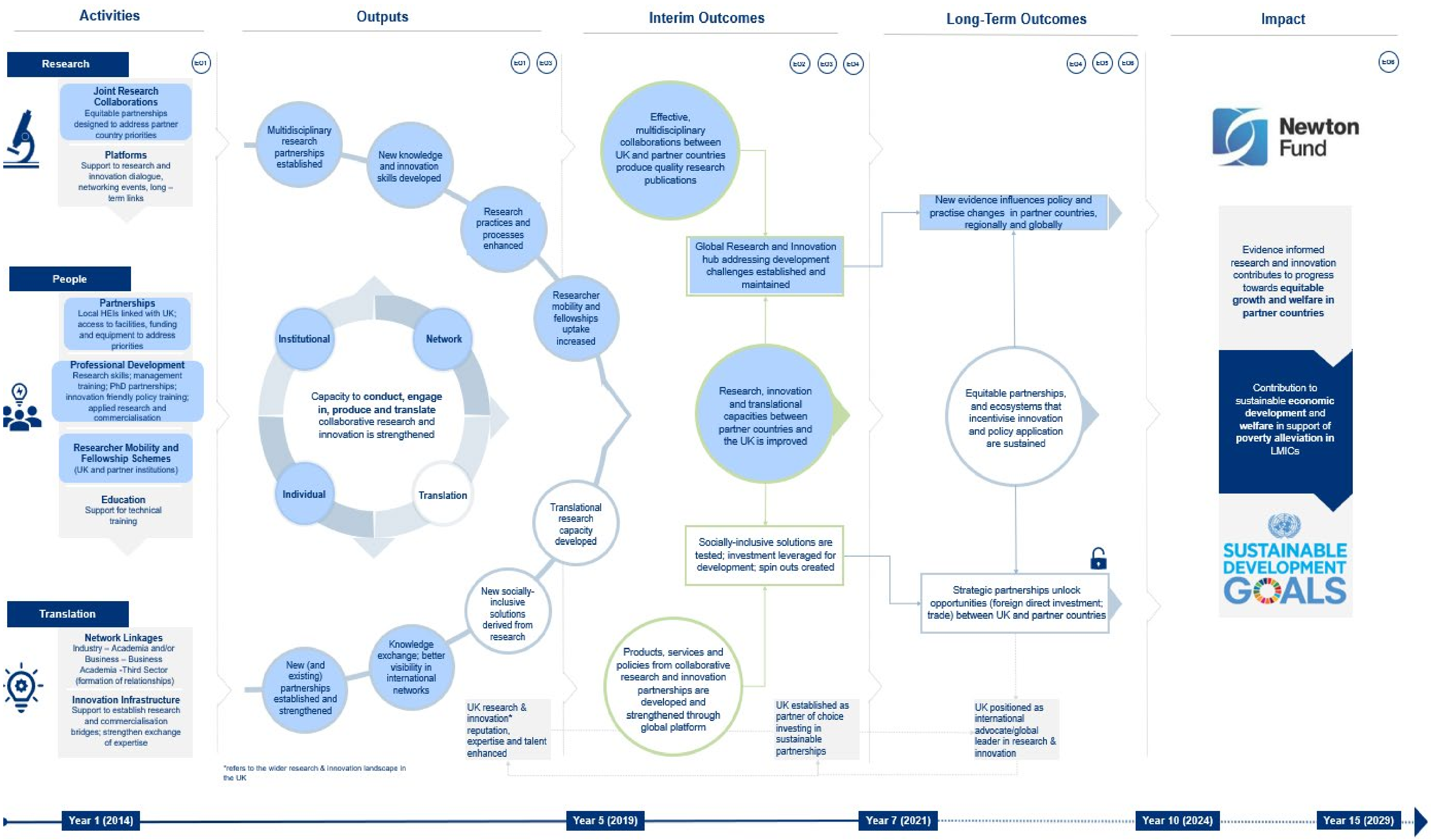
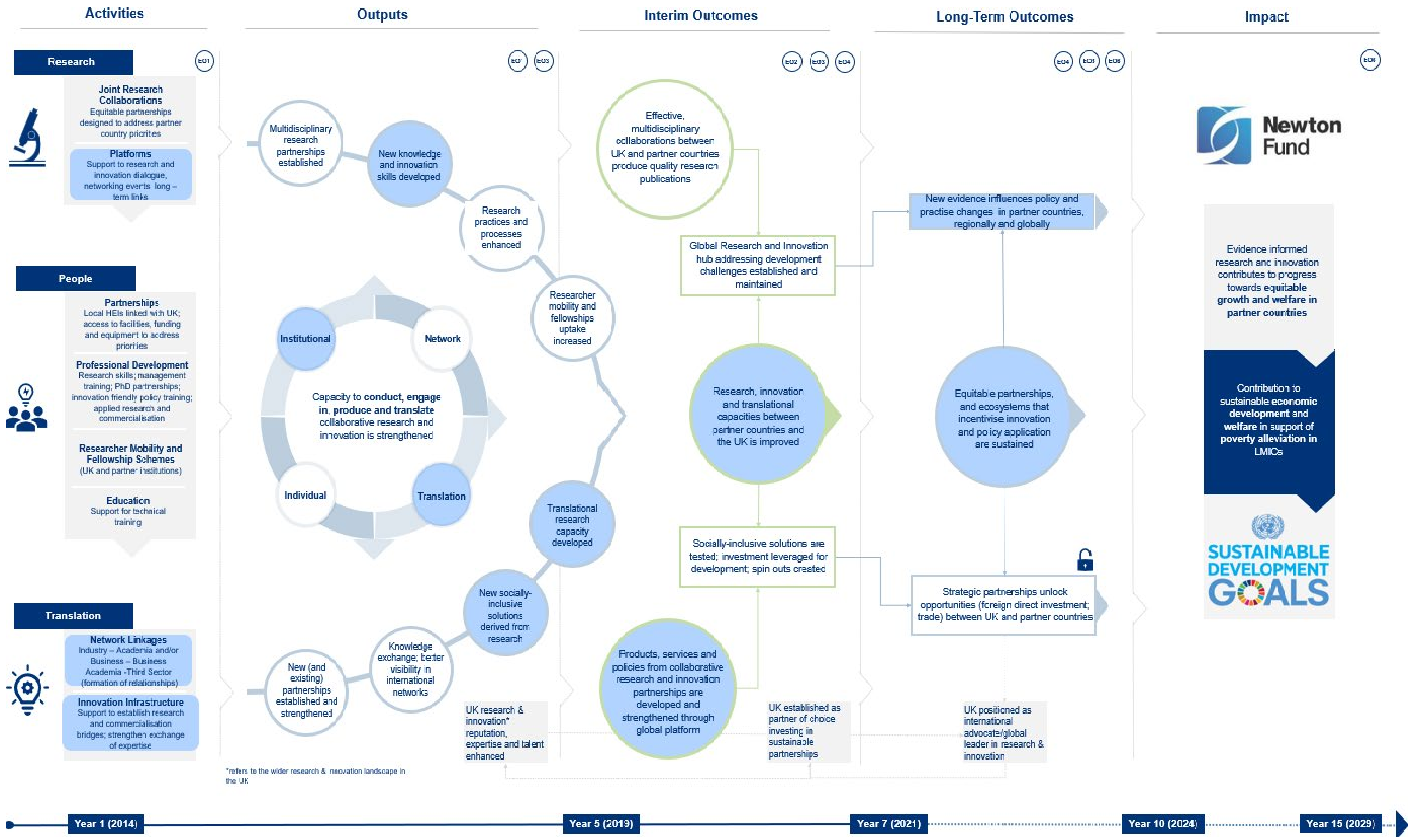


Figure 5: CSSP (work package 5)



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