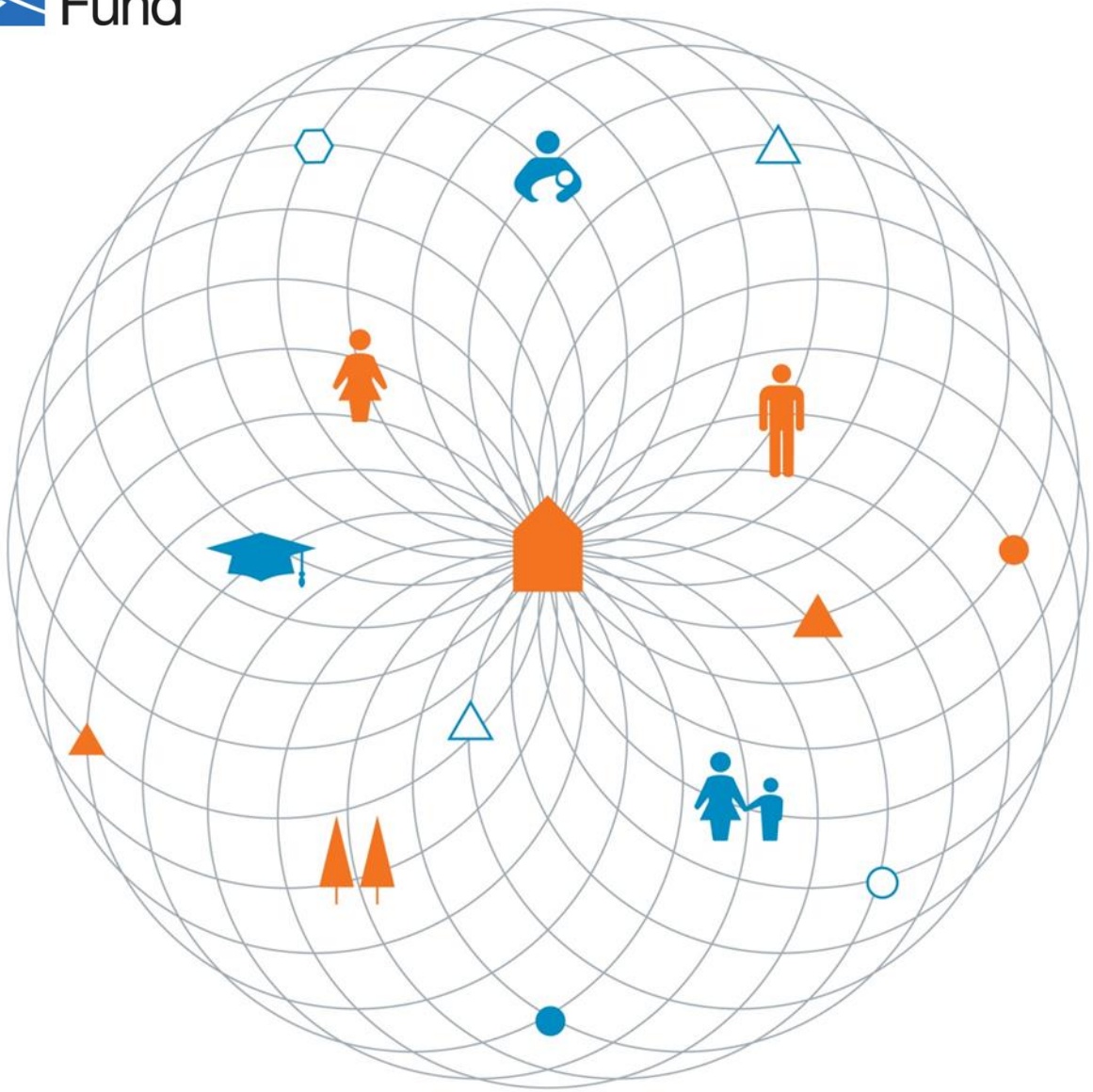
Thematic Impact Study Report - China

Newton Fund Evaluation
May 2018



Thematic Impact Study Report - China

Newton Fund Evaluation

Department of Business, Energy and Industrial Strategy (BEIS)

Newton Fund Evaluation

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This document has been approved for submission by Coffey's Project Director, based on a review of satisfactory adherence to our policies on:

- Quality management
- HSSE and risk management
- Financial management and Value for Money (VfM)
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- Performance Management and Monitoring and Evaluation (M&E)

Jamie Fotheringham, Project Director

Signature:

Disclaimer

Acronyms

AMR - Antimicrobial Resistance

APHH - Atmospheric Pollution & Human Health in a Chinese Megacity

APIC-ESTEE - An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology

BBSRC - Biotechnology and Biological Sciences Research Council

BEIS - UK Department for Business, Energy and Industrial Strategy

BRICS - Brazil, Russia, India, China and South Africa

CAS - Chinese Academy of Sciences

CMA - Chinese Meteorological Administration

CNY – Chinese Yuan Renminbi

CSSP - Climate Science for Service Partnership-China

DFID – Department for International Development

FCO – Foreign & Commonwealth Office

IAP - Institute of Atmospheric Physics

ICT – In-country Team (Newton Fund)

IOM - Institute of Occupational Medicine

MoST - Ministry of Science and Technology (China)

MoU – Memorandum of Understanding

MRC - Medical Research Council

NERC – Natural Environment Research Council

NERCITA - China National Engineering Research Centre for Information Technology in Agriculture

NSFC - National Natural Science Foundation of China

ODA – Official Development Assistance

PAFiC - Precision Agriculture for Family-farms in China

PI – Principal Investigator

PPP - Precise Point Positioning

RCUK – Research Council UK

R&D – Research and Development

S&I – Science and Innovation

S&T – Science and Technology

STEM - Science, Technology, Engineering and Mathematics

STFC - Science and Technology Facilities Council

WP – Work Package

Contents

1 Introduction

1.1 Purpose of this report

This report presents the findings of the Thematic Study of Newton Fund activities in China, which operates under the title of the UK China Research and Innovation Partnership Fund. Our findings emerged from an in-depth review of documentation; in-country interviews; and UK-based consultations (as outlined in Section 1.2). Findings from this and the other seven country studies will help inform our Mid-term Evaluation report.

As outlined in our evaluation strategy, thematic impact studies were carried out in eight countries: Brazil, China, Egypt, India, Malaysia, Mexico, the Philippines and South Africa. Concentrating on these countries allows for a breadth of coverage across Newton partner countries and regions of focus. It also allows for broad coverage in terms of the existing innovation capacity and infrastructure of Newton partner countries. The in-country visit to China took place in November 2017.

As part of our thematic studies, we conducted a comparative analysis of the factors that contributed to the Fund's outcomes across different contexts (such as type of local funding agencies, size of universities, local research structures, etc.). This helped us map the **pathways of change and capture early signs of the Newton Fund's impact**. By focusing on the factors which facilitate specific research activities, increase the quality of research outputs, enhance international collaboration and translate research into innovative practices, the thematic impact studies help us understand how sustainable solutions to economic development and poverty reduction have emerged so far from Newton Fund activities.

Case study selection

For each country, we shortlisted potential case studies on three measures: size, pillar and sector. The selection of projects took thematic areas of focus into consideration, aiming to include Newton Fund priority areas in the country. We sought to achieve a spread of Newton Fund Delivery Partners (DPs) and action types across the countries in our sample. We also consulted the in-country teams (ICTs) to identify potential impact 'stories'. Following additional consultations with delivery partners and the Newton Fund Central Team, we selected **three cases per country** to be explored in more depth.

In China, the shortlisted case studies were:

- NERC-MRC-NSFC Atmospheric Pollution & Human Health in a Chinese Megacity (APHH);
- Met Office-CMA-IAP/CAS Climate Science for Service Partnership-China (CSSP-China); and
- STFC-NSFC Precision Agriculture for Family-farms in China (PAFiC).

This allowed for inclusion of two Research pillar projects and one Translation pillar project. Within these, the specific award-holders were selected to ensure as broad a scope and diversity of partners as possible within the timeframe of the thematic study. When selecting the award holders, we also considered the relevance of the specific project's research area to the Newton Fund's priorities in China.

Two of the projects studied – CSSP-China and APHH China - are larger programmes composed of several work packages/sub-projects with a different thematic focus and therefore a large number of researchers or stakeholders involved. A specific work package within each of these programmes was selected in consultation with the UK Department for Business, Energy and Industrial Strategy (BEIS) and the delivery partners.

For the CSSP-China programme, Work Package 3, entitled "East Asian climate variability and extremes", was selected with a specific focus on WP 3.1 East Asian monsoon and regional water cycle. For the APHH China programme the "Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology (APIC-ESTEE)" was chosen.

The selected activities are all based in Beijing. The geographical focus of case studies was not a deliberate choice but to some extent reflects the concentration of Chinese partners – universities and research institutions – in the capital.

1.2 Research approach

Research scope

The thematic impact studies involved wide-ranging in-country consultations, with the inclusion of as many diverse interview respondents as possible within the timeframe of the fieldwork activities. This was combined with consultations with UK-based partners and researchers involved in the activities included in the study.

This thematic study explored:

- The **development of each action**: examining its origins; how engagement with the Newton Fund occurred; and an overview of the process of securing Newton funding
- The **relevance of each action** to China's development needs and to Newton Fund and ODA goals
- The **additionality of each action**
- The **results of each action:** the outputs, outcomes and impacts generated in terms of strengthening the science and knowledge base, innovation capacity and influencing policy in China and beyond
- The **success factors (and barriers) of each action** and examination of possible future benefits from each action that might be expected to arise in the future

We took into account that all three activities included in this study are still ongoing and that the impact of projects can often take years or even longer to unfold. Our research approach was adapted to reflect this and includes an assessment of potential future impact.

Research methods and data collection approach

The thematic impact studies are central to our contribution analysis approach. They involved an intensive period of in-country research by members of the evaluation team and local science and innovation experts. Preparation for the in-country research included a country-specific document review on China's research and development context. Documents reviewed include the evaluation China Baseline Report, Country Situation Note, and findings from the Process Evaluation. We also conducted an additional literature review on China's science and innovation landscape and existing UK-China collaboration activities. Project-specific documentation, such as progress reports, final reports and project presentations were reviewed for each action included in the study where provided by the delivery partner, local partners or researchers. We also sourced data from the projects' dedicated website and the Gateway to Research website.

The document review was accompanied by **one week of data collection in country**¸ as well as data collection in the UK prior to and following the fieldwork. During the week-long in-country visit, three main categories of stakeholders were targeted:

i) In-country delivery partners (and Newton in-country team)

ii) Funders

iii) Participating Newton award holders.

For greater contextual understanding of the Newton Fund and its wider impact, we also interviewed other stakeholders involved in the Newton Fund in China such as UK Embassy personnel.

Our data collection both in-country and in the UK was complemented by an analysis of the pathway to impact for each action, which can be found in Annex 2. 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 action, and highlight its (potential) contribution to broader Newton Fund goals.

Limitations of the research approach

The short timeframe for in-country research meant that we were only able to include three projects within our study. These are not representative of Newton Fund activities as a whole. The timeframe also limited the number of stakeholders we were able to interview in China.

More specific limitations acknowledged include:

- No interviews were conducted with the main Chinese S&I funder. The NSFC is a funder for two of the three actions studied but we were not able to secure an interview with them during the field visit. This was also the case for MoST (the main Chinese counterpart to UK DPs). As a result, their views could not be taken into account for this report.
- For the APHH project, no in-country interviews could be conducted due to the lack of availability of project partners at the time of the field visit. This was mitigated by conducting three telephone interviews as well as receiving written feedback from one respondent.

Research findings have been triangulated across different stakeholder groups and across various sources of documentation. However, the research team was not able to independently verify statements by all the different contributing stakeholders or to verify what was reported in documentation. Where findings could not be verified we have made this clear in the text.

2 Newton Fund in China

2.1 Context and evolution of the Fund in China

China – Current Situation

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 a supported the development of a prosperous middle-class[1]. By Purchasing Power Parity[2] China is considered the world's largest economy, with growth historically driven by labour intensive manufacturing[3]. Despite China's fast rise, regional and social inequalities persist. However, in recent years, the Chinese government has placed emphasis on developing the R&D and innovation sectors. This is now enshrined in China's latest Five Year Plan and its Science and Technology strategy, with ambitious R&D targets to turn China in an 'innovative society' by 2020[4].

The Newton 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 Newton Fund's most developed partner countries – with 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 international initiatives such as those offered by the UK's Newton Fund[5].

China – UK Scientific Co-operation

On research and innovation, UK-China relations span almost 40 years, formally starting in 1978. In a sign of the UK's interest to engage Chinese R&I, in 2009 the UK published its first bilateral UK-China Cooperation Framework. The mutual interest was formalised with the UK-China Research and Innovation Partnership Fund (Newton Fund in China) in 2014[6].

The UK-China Research and Innovation Partnership Fund represents an important milestone in bilateral R&I cooperation, building on the Research Council UK's (RCUK) local presence in China since 2007. The RCUK is the partnership of seven Research Councils and has been an important cooperation facilitator, supporting more than 130 British and Chinese academic institutions and more than 120 industries.

In 2017 the UK and China launched a Joint Strategy for Science, Technology and Innovation Cooperation, which is the first bilateral science and innovation strategy between the two countries[7]. The Strategy is a sign of political willingness of both the UK and China to further formalise and deepen their science and innovation cooperation. It was launched at the UK-China Science and Innovation Forum and prominently featured the UK-China Research and Innovation Partnership Fund.

Besides the Newton Fund, the UK cooperates with China through the Prosperity Fund as well as - together with the US - the Global Innovation Initiative, which supports international mobility in innovation.

Science and innovation landscape / infrastructure in China

China has high levels of science capacity and advanced innovation systems. Its ambition is to become a R&D powerhouse and rely on the sector as a significant driver of its economic growth. China's political commitment to the promotion of Science, Technology and Innovation (STI) resulted in a 428% increase of its Gross Expenditure

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[1] According to the World Bank, China has lifted 800 million of its people out of poverty. See http://www.worldbank.org/en/country/china/overview
[2] https://www.weforum.org/agenda/2016/12/the-world-s-top-economy-the-us-vs-china-in-five-charts/
[3] https://www.weforum.org/agenda/2015/07/brief-history-of-china-economic-growth/.
[4] MOST website
[5] Ibid
[6] See UK-China Joint Strategy for Science, Technology and Innovation Cooperation, available here https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/665199/uk-china-strategy-science-technology-innovation-cooperation.pdf
[7] UK government Press release. See https://www.gov.uk/government/news/joint-uk-china-strategy-for-science-technology-and-innovation-cooperation-sets-new-horizons-for-closer-international-collaborations

on Research and Development (GERD) between 2000 and 2010[8]. In 2009 China had the second largest R&D expenditure after the USA[9]. By 2020, China aims catch up with the EU's 3% target for R&D intensity by increasing its R&D as a percentage of GDP to above 2.5%[10].

Research in China receives strong public support and its STEM research receives strong state support, with the three main national funders being: the Ministry of Science and Technology (MoST), the National Natural Science Foundation of China (NSFC), and the Chinese Academy of Sciences (CAS). China is prolific in terms of research publications and has historically been very strong, especially in the field of engineering and physics. However, it lags behind – measured in citation of its papers – compared to international standards in some areas of research[11]. 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. This supports applied science research and develops the innovative practical solutions needed in the country such as dams, satellites or hybrid crops.

International research

In contrast to China's well performing R&D sector, its level of international collaboration exposure in R&D ranks much lower. The Newton Fund Baseline Report pointed out that this could reflect a more mature science and innovation capacity, the low proportion of co-authored research pieces (considered a sign of excellence in academia) is an indicator of less developed international collaborations. China's appetite for international collaboration is however important and regarded as a means to achieve the country's political emphasis on R&D promotion. Interviews showed that international collaborations are seen as prestigious and therefore encouraged by state funding bodies.

In this spirit, China has been open to developing international collaborations. China has become one of the EU's key international partners in research and innovation through the previous Framework Programme, FP7 and continues to benefit from programmes such as Horizon 2020. With Germany, China benefits from the DAAD student exchange and researcher mobility programme. Germany also recently launched a programme similar to the Newton Fund involving bilateral funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) and the National Natural Science Foundation of China (NSFC) which aims to support collaborative research projects, build the capacity of researchers, and accelerate the exchange of scientific knowledge among researchers.

There are also many area-specific bilateral operations in place on topics like energy, computer science, automation and mathematics (France) or research promotion (Germany). China itself has set up the Yangtze River Scholars programme to encourage its scholars to get involved in international collaborations. China's 2013 One Belt One Road development initiative for its Western regions and trade connections with its neighbours has the potential to further encourage international collaborations.

The UK-China Research and Innovation Partnership Fund

Through the Newton Fund, over £200 million had been allocated to joint research projects by the end of 2016, fully matched with funding from China. In line with China's priorities, areas of focus for Newton Fund projects have been very broad and included issues related to China's rapid industrialisation (such as the environment, health or sustainable food, urbanisation, energy, and water) but also extended to social sciences, biology, manufacturing and natural hazard studies. All UK delivery partners[12] have been involved and 488[13] individual projects and partnerships and 43 strategic programmes have been funded so far involving a total of 101 UK and 161 Chinese institutions.

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[8] Coffey Baseline Report – China, p. 60.
[9] OECD. See https://www.oecd.org/sti/outlook/e-outlook/sticountryprofiles/china.htm
[10] The Medium and Long-term National Plan for Science and Technology Development (2006 – 2020), it is one of China's main scientific policy document.
[11] International Comparative Performance of the UK Research Base 2016 Report; Elsevier; https://www.elsevier.com/__data/assets/pdf_file/0018/507321/ELS-BEIS-Web.pdf p12 and p13
[12] The Royal Society of Chemistry was involved in the Newton Fund through a British Council project, adding to this an extra delivery partner who is not usually involved in the Newton Fund (source: in-country team email).
[13] Correct as at the time of fieldwork in November 2017.

Cooperation projects span the three Newton Fund pillars – People, Research and Translation. The People pillar includes PhD placement grants, Newton Researcher Links Workshops and Academies' Fellowships and Mobility Grants. The Translation pillar funds, among others, the Industry-Academia Partnership Programme and Research and Innovation Bridges. The Research pillar has projects such as the Sustainable Rice Programme and Urban Transformations in China. In terms of size, the Fund covers small projects to much larger ones such as the Antimicrobial Resistance (AMR) project; a £4.5 million Newton Fund investment by the Medical Research Council (MRC), Biotechnology and Biological Sciences Research Council (BBSRC), Economic and Social Research Council (ESRC). It also supports regional cooperation programmes such as the Rice Research Initiative with China, Thailand, the Philippines and Vietnam supported by the BBSRC.

Emerging findings on the UK-China Research and Innovation Partnership Fund

A range of interviews with stakeholders with a more general or political view on the Newton Fund's impact in China showed the Fund has started to have a positive effect on the UK's role as a science and innovation actor in China.

Findings

The Newton Fund has raised the UK's profile in China for S&I cooperation. There is now a wider awareness in China's research sector of the UK's contribution. Respondents felt the Newton Fund significantly increased the UK's profile in China exemplified by one respondent's statement saying that "the collaboration is thriving due to the Newton Fund". The level of funding offered by the Newton Fund in particular helped brand the UK's S&I cooperation and gave it greater visibility, which helped the UK gain advantage over other countries competing to engage China in S&I. We could not confirm this view with Chinese funders directly, but RCUK did mention the NSFC having prioritised their cooperation with the UK.

Pre-existing delivery partner presence in China enabled a quicker and more efficient start for the Newton Fund. Both the RCUK and the British Council had offices in China before the start of the Newton Fund. This enabled the Newton Fund projects to benefit from the relationships already developed with Chinese funders to make a quick start; relations and trust having already been established, less time was required to negotiate Newton Fund implementation plans. This was also true for other partners who already had relationships with China to varying degrees.

The delivery partners' coherent approach to S&I cooperation in China was key to better engaging Chinese research institutions. Delivery partners' long established presence in China also helped take a collaborative approach through joint calls, enabling fewer but more focused funding calls. RCUK felt this was essential to better engage Chinese funders as it allowed them to target resources and not overwhelm their partner – mainly the NSFC - with multiple demands. It efficiently leveraged the capacity of Chinese funders, who are in high demand with other countries, while channelling UK resources through joint effort.

Challenges and Limits

Collaboration drivers between the UK and China are not always aligned. China sees cooperation as result-driven while for the UK it is challenge-led and it is steered by the UK's ODA commitment. Some respondents felt a disconnect with MoST, which sometimes created tensions within the cooperation but was generally resolved by the in-country team's mediation.

Consistency issues around cross-ODA Fund available in China. Respondents felt local partners were confused over the various UK ODA funds on offer to them (of which the Newton Fund is one). They serve different purposes and have different qualifying criteria. The confusion was attributed to a lack of clear messaging and communication on the different funds and their intended purposes.

3 Atmospheric Pollution & Human Health in a Chinese Megacity (APHH China)

3.1 Summary

Action title	Atmospheric Pollution & Human Health in a Chinese Megacity (APHH China) Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology (APIC-ESTEE).
Short description	APHH China - Comprehensive evaluation of air pollution health impacts on cardiopulmonary health through integration of exposure, epidemiology, and toxicology/toxicogenomic studies. APIC-ESTEE is one component of the APHH China call. Through eight work packages (WP), APIC studies several aspects of air pollution. The project entails conducting modelling and mapping of air pollution of concentrations (WP1 and 2); analysing biological effects of exposure on humans through blood and urine sampling (WP3) and tests the effect of using facemasks (WP4); conducting a cohort study of long-term exposure among Beijing residents (WP5); using animal models to explore the development of several cardiovascular and pulmonary diseases (WP6); studying early life effects on a birth cohort (WP7); and developing some exposure control strategies (WP8).
Objective(s)	APHH China aims to provide better understanding of the role of specific pollutants and sources, their mechanisms of action, and the likely effectiveness of interventions to reduce personal exposures. Within that, APIC-ESTEE aims to get a better understanding of the effects of pollution on humans, as well as test the effectiveness of coping strategies. It aims to generate knowledge which can help develop more effective exposure control strategies.
Pillar	Research
Action value (total budget allocated in country, in GBP)	UK - £5.5 million[14] China - £4.5 million of which APIC-ESTEE £997,368
Start / end date (Status: ongoing or complete)	January 2016 - January 2020
DP UK and overseas	NERC - Natural Environment Research Council MRC - Medical Research Council NSFC - National Science Foundation China
Award holders / grantee	**APHH China** 27 institutions in both China (11) and the UK (16) **APIC-ESTEE project** UK

[14] This is with £3 million from the Newton Fund (£2 million for NERC and £1 million for MRC) and £2.5 million from NERC's own baseline funding

	Heriot Watt University – HWU Institute of Occupational Medicine – IOM London School of Tropical Medicine- LSHTM Natural Environment Research Council - NERC University of Edinburgh China Capital University of Medical Sciences - CCMU Peking University – PU Tsinghua University

3.2 Description of the programme

Atmospheric Pollution & Human Health in a Chinese Megacity

The main subject of this case study is the Atmospheric Pollution & Human Health in a Developing Megacity (APHH China) programme, taking specific examples from one of its five components called 'Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology' (APIC-ESTEE).

APHH as a whole (APHH India and APHH China comprising five components each) looks at urban air pollution and its impact on public health in developing countries. Rapid development in China has created severe air pollution problems threatening public health and public finances. The programme has two streams of activity: one focusing on China; and the other on India. The rationale behind the APHH China programme is to better understand the specific causes of air pollution to be able to suggest tailored solutions to the problem, which differs from the pollution problems experienced by Western countries in the past. This is because air pollution in developing cities is of different composition than the Westen world's sulphur-based smogs of the 19th and 20th century. It is also likely affected by factors such as a city's geography, which would differ from Western cities as well[15]. Within this programme, APIC-ESTEE is a research collaboration which investigates air pollution impacts on cardiopulmonary health through exposure, epidemiology and toxicology studies. APIC is studying the effects of air pollution in the long-term through a cohort study and in the short-term through a panel study. It is also studying life effects based on a birth cohort. The project also includes an intervention study with volunteers wearing face masks and being exposed to pollution.

Pathway to impact

The project's planned pathway to impact can be found in Annex 2, Figure 1. APHH China is a Research pillar project with **research inputs** consisting of five different programme components. Once combined these should comprehensively increase the understanding around sources and concentrations of air pollution in Beijing and their impact on human health. Activities are specific to each component as they each address a different aspect of air pollution. The five components are[16]:

1. Sources and Emissions of Air Pollutants in Beijing (AIRPOLL-Beijing);
2. An Integrated Study of AIR Pollution PROcesses in Beijing (AIRPRO);
3. Effects of AIR pollution on cardiopuLmonary disEaSe in urban and peri-urban reSidents in Beijing (AIRLESS);
4. Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology (APIC-ESTEE);

[15] NERC's APHH website. See http://www.nerc.ac.uk/research/funded/programmes/atmospollution/
[16] Project spelling reflects the choice of the project stakeholders as found in project documents.

5. Integrated assessment of the emission-health-socioeconomics nexus in Chinese megacities (INHANCE).

Within APIC-ESTEE, inputs take place along eight work packages:

1) Exposure monitoring;
2) Exposure modelling;
3) Human panel study 1: biological effects of exposure;
4) Human Panel Study 2: 'Intervention' study;
5) Cohort study of long-term exposure;
6) Cardiovascular and pulmonary toxicity and mechanistic study;
7) Early life effects; and
8) Exposure control strategies.

The programme's expected **outputs** include the production of international scientific publications resulting from the five collaborative research components within APHH China and their work packages. APHH China's collaborative approach is intended to lead to an improved capacity to deliver authoritative research outputs on the causes, factors and effects on human health of air pollution in Beijing. More specifically, APIC-ESTEE aims to generate research which can help determine the contribution of specific activities, environments and pollution sources to human exposure, and on the link between exposure and health issues of the lungs and heart.

The main anticipated **outcome** is the creation of new knowledge on the kind of impact air pollution has had on the human population of Beijing. The new knowledge created aims to be directly useful to the city of Beijing and should serve to suggest possible solutions to policymakers to alleviate the issue. The design of APHH China includes a dedicated policy meeting with relevant national and Beijing policymakers. This policy dialogue mechanism offers an avenue to present and discuss research findings and potential solutions to health problems caused by air pollution. In turn this should allow for research findings to translate into policy in the future.

The project's **expected impact** is an increased preparedness to deal with China's air pollution challenges through new evidenced-based policies. It is expected that the findings of the APHH China programmes, and APIC-ESTEE therein, will yield results that will better control air pollution. It is expected that APIC-ESTEE's findings from the study on the effectiveness of anti-pollution face masks can be used to inform policy and product development which can limit human exposure (as it is unlikely pollution will be reduced in the short-term).

3.3 Answers to the evaluation questions

3.3.1 Relevance

Activity targeting and contribution to ODA

APHH China's thematic focus on air pollution addresses one of China's major public health challenges. The thematic focus of this call and project also closely match the Newton Fund's priority area of Urbanisation, which includes air quality. The overall aim of this initiative is to understand the sources of air pollution and better understand the extent of its impact on human health. The research is policy-oriented, and seeks to generate findings which can inform the government's response.

Air pollution levels in China are some of the highest in the world and affect the health of millions of citizens on a daily basis. They are a direct consequence of China's rapid industrialisation, which started in the early 1980s. In recent years the problem has been met with a sense of urgency, especially in Beijing where measures are in place to reduce air pollution levels and its adverse effects on public health and citizens' welfare[17]. Focusing on Beijing, APHH China aims to understand the concentrations and sources of air pollution as well as their impact on human health. It will use these results to inform air pollution policy and ultimately, reduce its adverse health effects.

One of the programme's main characteristics is its multifaceted approach to air pollution research; advancing air pollution science and producing evidence-based recommendations for Chinese policymakers. As one respondent

[17] https://www.economist.com/the-economist-explains/2018/01/25/how-china-cut-its-air-pollution

said: "*APHH is a rare opportunity to look at various problems under a single umbrella*". The programme looks at air pollution from five different angles under five different research components[18]. APHH China's solution-driven approach, which aims to use its scientific output to inform policy, has been part of the programme from the initial design through to its implementation. With an original approach to air pollution research, APHH China targets the support on China's economic development and welfare by aiming to provide science-based measures to deal with some of the negative consequences of the country's rapid development.

Within this broader initiative, APIC-ESTEE has several components which analyse, model and test the short and long term health impacts of exposure to pollution. More specifically, APIC aims to generate knowledge on the relationship between pollution and the development of cardiovascular diseases. It also seeks to generate knowledge on potential strategies to limit exposure among Beijing's residents. In particular, one of the study's components seeks to test the effectiveness of face masks against pollution, the use of which has recently been recommended by the government of Beijing. The project aims to communicate research findings through workshops and stakeholder consultations with regulatory authorities and non-governmental organisations, as well as other relevant stakeholders. It also aims to generate information materials which can be distributed in hospitals and medical centres, so as to help inform patients' choices and decrease their health risks. Ultimately, this seeks to provide a short-term coping mechanism to the issue of pollution, which can complement longer-term studies and strategies.

3.3.2 Additionality

The Newton Fund provided a financial contribution for the APHH China. Newton funding complements the £2 million already secured by NERC to work on air pollution in China. The level of additional funding was such that it significantly scaled up the programme, its expected impact and its profile. It brought together the previously competing five different strands of air pollution research under one coherent programme umbrella and created the basis for an interdisciplinary approach to air pollution, coordinated to feed into policy translation initiatives.

By expanding the scope of the programme, the Newton Fund helped increase the relevance of expected results for air pollution science and for policymakers. Institutionally, the increased level of funding justified formally establishing links between UK and Chinese research institutions with a MoU between NERC, the MRC and the Chinese funding agency NSFC.

Though the programme as a whole was an existing initiative prior to Newton, in terms of the APIC component, it was reported that the relationship between the UK and Chinese PIs emerged through a speed networking event organised by NERC and MRC, without which the researchers would have probably not worked together. Therefore, the Newton Fund created the necessary connection for the research teams to begin collaborating.

3.3.3 Effectiveness

Research collaborations

The APHH China programme brought competing yet complementary components to collaborate under one programme and facilitated collaborations between research institutes and universities from the start. Establishing collaborations was facilitated from the start of the programme when NERC and MRC organised a workshop with 'speed-dating' events for researchers to meet and form these collaborations. Without this, certain researchers said they would probably not have worked together.

Collaborations are intended to make a direct contribution to help solving China's air pollution issues by bringing together the complementary knowledge base and techniques of UK and Chinese research. For example, UK researchers have developed an advanced technique to measure emissions while Chinese researchers have created an air quality predication model the UK lacks. Ultimately as stated by one UK respondent: "*by working*

[18] As a reminder, the five projects are: Sources and Emissions of Air Pollutants in Beijing (AIRPOLL-Beijing); An Integrated Study of AIR Pollution PROcesses in Beijing (AIRPRO); Effects of AIR pollution on cardiopuLmonary disEaSe in urban and peri-urban reSidents in Beijing (AIRLESS); Air Pollution Impacts on Cardiopulmonary Disease in Beijing: An integrated study of Exposure Science, Toxicogenomics and Environmental Epidemiology. (APIC-ESTEE); Integrated assessment of the emission-health- socioeconomics nexus in Chinese megacities (INHANCE)

together we improve their database and then use it to better predict the air pollution model directly used by policymakers."

The **main activities** conducted so far as part of APIC are the design of the study, fieldwork and data analysis of the pilot study on face masks, and the preparation of the formal panel study. As of November 2017, the project had mostly focused on WP4, which studies the effect of anti-pollution masks, with the running of trials and the collection and analysis of preliminary data. At the time the research was conducted, no research outputs were ready for dissemination, though several research papers were being produced on the outcome of the panel study.

Participating researchers on both the UK and Chinese sides spoke positively on the **complementarity of skills** within the team, and its effects on improvements in research. While the UK side brought a strength in measuring emissions using advanced techniques, China developed an advanced air quality prediction model which did not exist in the UK. In the words of a Chinese researcher, "*in our former studies, the part of exposure assessment was comparatively rough. But we improved our exposure assessment technologies and methods after collaborating with UK partners. Collaborating with the UK also gave us more opportunities to communicate with international scholars and enhanced our perception of the UK and the UK funding landscape.*"

The programme was selected as part of a joint call between NERC and the NSFC. This led to the signature of a Memorandum of Understanding (MoU) which also included the MRC signifying formalised institutional collaboration between funding bodies. While this certainly played a role in encouraging Sino-UK research collaborations to form, some respondents regretted the lack of integration in the application process. Instead of presenting one single application, both UK and Chinese teams had to submit applications tailored to the requirements of their national funding bodies, duplicating a lot of the work.

New international partnerships

APHH China brought a large number of researchers together where there was previously very little collaboration between universities (except for occasional personal connections). It is difficult to establish whether this holds true across the many participating research institutions in all five APHH China components. However, institutions interviewed from the APIC component said it helped them either establish completely new institutional links with participating research institutions (in their own country or with their UK/Chinese partner) or to cement a previously only personal relationship.

Regarding future partnerships, while there are no immediate plans to look for further funding (considering that the programme is at a relatively early stage) respondents from both China and the UK showed their interest and openness to look for further funding and opportunities to work together. This could be either applying for a funding extension to look at the impact of the APHH China programme or for follow-on studies of the research currently conducted.

Benefits to UK researchers

On a scientific level, accessing China's air pollution emissions database was particularly valuable. As China has a long-standing air pollution issue, the country developed long-term expertise that the UK does not have. The collaboration with Chinese partner institutions opened access for UK participants which would otherwise have been difficult. As one respondent stated: "*the UK could not have that, (it) would take a decade to catch-up*".

Anecdotally, for one institution in particular, APHH China's support for new institutional collaborations helped raise the profile of the research both with Chinese policymakers and within the scientific community. The UK PI of APIC said: "*it opened a network within the UK […]. It opened up a lot of collaborations and exchanges within the UK. For the IOM, it gave us more visibility for air pollution work*". Among APIC's components, the study on the use of face masks (WP4) was mentioned as having drawn particular attention in the scientific community, as well as some media coverage[19]. It also introduced UK institutions to new methods or techniques developed in collaboration with

[19] https://www.theguardian.com/environment/2018/may/10/pollutionwatch-how-effective-are-face-masks-beijing; https://uk.reuters.com/article/us-health-airpollution-masks/face-masks-available-to-consumers-may-be-ineffective-against-air-pollution-idUKKBN1I426I; https://www.airqualitynews.com/2018/05/15/face-masks-may-be-inadequate-protection-against-air-pollution/.

both UK and Chinese APHH China partner institutions. This increased the range of research tools, which contributes to keeping up with research excellence.

For the Chinese researchers, APHH China was an efficient tool to expand their UK-based network through collaborating with UK universities and researchers. Relationships established even led to other research collaborations. Establishing collaborations is vital for a majority of research programmes as are the intercultural working skills developed. Learning to deal with a foreign working culture was mentioned by respondents as a benefit of APHH China. This should increase the capacity to lead successful research collaborations in the future through better relationship management.

3.3.4 Impact

Demonstrable link to development improvements

The APHH China programme as a whole was designed with the aim of achieving impact and the intention of producing scientific findings that would inform Chinese policymakers. Taking Beijing as a case study and putting in place a large variety of studies – field trips, birth cohorts and both short and long-term studies – was intended to ensure results would be directly relevant for the Chinese context because the data and result reflect the city's situation. Its interdisciplinary approach to air pollution – as a "*health effects study nested within an air quality study*"[20] – aimed to produce more comprehensive results, which would be of greater value for decision-makers managing the impact of air pollution on public health. According to a participating researcher, the APIC project could be useful for both academia and industry – with research findings potentially taken up to develop more effective methods of personal protection and the development of higher-quality face masks.

The APHH China programme included in its design direct and regular consultations with relevant Chinese policymakers (such as the Beijing Environmental Protection Bureau or the Chinese Research Academy of Environmental Sciences and the Air Pollution Bureau, who are both under the Chinese Ministry of Environmental Protection). Similarly, in the case of APIC, it is expected that the main beneficiaries will be environmental and health regulatory agencies in China (the State Environment and Health Working Group, the Ministry of Environmental Protection and the National Health and Family Planning Commission). These bodies will be targeted in dissemination workshops and consultations. Citizens will also be reached through the publication of journal articles, as well as the dissemination of information pamphlets through hospitals and doctors. Through these activities, it is thought that Chinese citizens will ultimately gain health and well-being benefits from mitigation actions implemented as a result of findings from this project.[21]

The first APHH China policy meeting conducted in 2017 gave researchers guidance on expectations from the programme. When results start emerging, APHH China researchers' plan to share them with policymakers followed, at the end of the programme, with stakeholder meetings to discuss the possible policy implications of the findings. Considering the difficulty in accessing government and policymakers, this is a noteworthy step towards potential outcome-level results in the future. However, as this was reliant on the high profile of some of the Chinese APHH researchers, which facilitated access to policymakers, the sustainability of these relations is questionable as they might be dependent on individual connections.

Potential impact of the programme, and of the APIC project therein, extends beyond China to an extent. According to participating researchers, the work is applicable and relevant in other countries with high levels of pollution, such as India, where the team is involved in a similar ongoing project as part of APHH China. The China and India teams have collaborated to share lessons and inform each other's projects. However, collaboration has not been extensive so far and there is scope for further lesson-sharing. The University of Birmingham is also working on an air pollution research project in African countries. It was pointed out by a member of the research team that the research as part of APHH China can help inform this debate as well, in terms of helping countries avoid the same air pollution problems experienced in India and China following strong economic growth.

[20] http://www.nerc.ac.uk/research/funded/programmes/atmospollution/
[21] http://gtr.ukri.org/projects?ref=NE/N007182/1

3.3.5 Complementarity and coordination

Catalytic effects

The APHH China programme stemmed from NERC's interest in health pollution in megacities and has been concurrently developed for both China and India. There have been some exchanges between the two actions. In addition, models developed in the China programme for programme management and data sharing were used to inform discussions in India. This limited interaction is, however, to be expected. Programmes in India and China are distinct and do not share the same protocol or equipment and transferability is limited by the fact that the range of emissions and meteorological regimes are quite different between Beijing and Delhi, limiting scientific comparability of the two cases. The differences in local context and institutions further limit the potential for transferability.

In the UK, there have been encouraging signs of transferability of the APHH China intervention. The Department for Environment, Food and Rural Affairs (DEFRA) recently funded the UK part of the AIRLESS consortium to trial the personal exposure measurements they have developed in China in the UK with a view to assessing how useful they will be to inform UK air quality policy.

Leadership effects

The prospect of working on the APHH China programme prompted the Chinese research institutions to invest in large infrastructure improvements – more than £125,000 according to the UK coordinator of APHH China – such as upgrading the power system to provide better research conditions for Chinese researchers. This was not part of the APHH China proposal but was China's own initiative. While this certainly reflects the level of political priority China gives to air pollution, it appears that the large level of funding Newton Fund injected in the programme raised its profile to justify the decision to invest.

3.4 Conclusions

Main findings

- **Clear ODA relevance and additionality** - The APHH programme targeted health effects of air pollution in Beijing with the aim of tackling one of China's most serious public health issues. NERC's expertise in air pollution and its pre-existing cooperation on the topic with China was essential in responding quickly to the short funding period of the Newton Fund. The Fund's additionality was to provide much larger sums – also through the matched funding aspect – which allowed upscaling the APHH China programme and its interdisciplinary set-up.
- **A large interdisciplinary programme for maximised collaboration opportunities** – The core of the APHH China programme is about research collaborations as it aims to produce interdisciplinary air pollution research by bringing together five different research projects. On top of that, each of these strands are articulated around the collaboration of several UK and Chinese institutions. New networks and collaborations were built throughout the programme, not just between UK and Chinese institutions, but also among different researchers within China and the UK. Since the project is at a relatively early stage, there was no hard evidence of new projects being developed but respondents expressed an interest in using the networks APHH China created to explore further cooperation opportunities in the future.
- **Impact-oriented activities and a focus on policy relevance** – The APHH China programme aims to tackle China's air pollution issue. Considering the nature of the research process and the fact that data collection is still underway, it is difficult to judge impacts. It is however clear that the programme was tailored from the start to China's needs. By using Chinese datasets and cohorts of Chinese citizens it will produce results on the impact of air pollution in Beijing on the health of its inhabitants. This will form the basis of APHH China's recommendations to policymakers once results are final. This conscious decision to translate scientific results to inform policymakers (and even including channels for communicating results directly to policymakers in the programme's design) is evidence of potential for future impact.
- **Signs of larger impact** – The APHH China programme showed some signs of catalytic effects with researchers from the China project also sharing their methods and lessons with the APHH India project.

This was demonstrated on a larger scale at UK level with DEFRA's involvement in the AIRLESS component of APHH China. There is also evidence of APHH China driving progress as China decided to upgrade facilities for some of the Chinese research institutions as a result of their participation in this project. It is very difficult to say if this would have taken place regardless since air pollution is a top priority within the highest spheres of government, but it seemed that the raised profile of the APHH China programme through the funding by the Newton Fund acted at least as a circumstantial incentive.

Lessons learned

- The level of funding the Newton Fund offered was instrumental in scaling up the programme to its current level. This was essential to expand the scope of the study and to increase the amount of institutional collaboration a well as deepening the interdisciplinary approach.
- Impact on China's development needs was embedded in the programme's design stage by combining disciplines that would provide a comprehensive picture that could be used to inform policymakers. This will be essential in providing scientific data of enough substance on the various aspects of air pollution science that could potentially then be translated into useable material for policy in the future.
- Translation of scientific results for policy use was also formally embedded within the design of the programme through consultation processes and workshops with the relevant Chinese policymakers. This ensured a direct channel of communication not only to disseminate results but also to listen to policymakers' needs.
- Having high profile Chinese institutions and researchers within the APHH China programme will be instrumental in the programme reaching policymakers and for the programme's findings to inform policies in the future. The relationships between Chinese research institutions and policymakers means researchers in these institutions often have direct access to policymakers and can engage them directly with their work. This would otherwise be very difficult to establish for external stakeholders such as UK research institutions.

4 Climate Science for Service Partnership-China (CSSP-China)

4.1 Summary

Action title	Climate Science for Service Partnership-China (CSSP-China) Work Package 3 - East Asian climate variability and extremes Work Package 3.1 - East Asian monsoon and regional water cycle
Short description	CSSP China aims to develop the scientific understanding that will help underpin the development of climate services to support climate-resilient economic development and social welfare.[22]
Objective(s)	CSSP China has three main goals: 1. Develop UK-China partnerships between climate scientists 2. Support collaborative climate science research 3. Use the climate science to collaboratively develop climate services WP 3 investigates the East Asian climate and high impact weather, and modelling the climate at very high spatial resolution[23]. WP 3.1 Aims to identify the present-day large-scale drivers of East Asian hydrological variability across temporal scales, and assess their predictability. The is to enable better prediction of heatwaves and flash floods and the impact of large scale urbanisation and mega cities.
Pillar	Translation
Action value (total budget allocated in country, in GBP)	UK - £18,854,216 China – £18,882,647 Of which WP3 - £4,715,756
Start / end date (Status: ongoing or complete)	2014 - 2020
DP UK and overseas	Met Office Chinese Meteorological Administration (CMA) Institute of Atmospheric Physics (IAP) – Chinese Academy of Sciences (CAS)
Award holders / grantee	**CSSP China** More than 16 UK partners and 30 Chinese partners **Work Package 3** IAP/CAS Met Office Reading University - National Centre for Atmospheric Science Imperial College London University of Leeds/ Reading as a consortium

[22] Met Office website. See https://www.metoffice.gov.uk/research/collaboration/cssp-china
[23] Met Office, Scientific aims of CSSP. See https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/research/wcssp/cssp-china-overview.pdf

4.2 Description of the action

Climate Science for Service Partnership (CSSP) China

As the CSSP China brochure explains, the 2012 extreme rainfall created flash floods and landslides that cost CNY12 billion (Chinese Yuan) in direct economic losses and destroyed 8,000 homes affecting more than 1.6 million people[24].

The Climate Science for Service Partnership (CSSP) China project is a five year scientific research programme that aims to use UK expertise to support the development of Chinese climate services. This should contribute to support climate resilient economic and social welfare in China. 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, South Africa and Southeast Asia. CSSP China is a large programme involving more than 30 Chinese research partners and 80 UK scientists[25]. The Met Office, together with the Chinese Meteorological Administration (CMA) and the Institute for Atmospheric Physics (IAP), aims to deliver its objectives through five work packages (WP).

Considering the large scale of the CSSP China project and to provide deeper understanding of the Newton Fund's impact, this Impact Case Study focused on Work package 3, East Asia Climate Variability and Extremes, and its 3.1 component on the regional water cycle[26]. The Met Office is both a delivery partner and an implementer of the project.

Work package 3.1 seeks to research the causes of variations in East Asian precipitation, particularly the summer monsoon rains that are a critical source of freshwater for the region and its socio-economic development (e.g. hydropower, agriculture). WP 3.1 also evaluates the ability of the Met Office climate model to simulate the East Asian water cycle, to inform the development of climate services that rely upon simulations of future precipitation variability and change.

It combines the complementarity of UK and Chinese scientific expertise, skills and data to support China translating scientific results into climate services. Ultimately, these are aimed at improving the predictability of weather extremes – such as floods and droughts – in the populous and economically thriving north east of China.

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 is shown in Annex 2, Figure 2, and reflects the fact that the project is intended to contribute to both Research and Translation pillars of the Fund.

In terms of **inputs**, research activities are aimed at supporting China's economic and social development by improving the predictability of extreme weather events through enhanced modelling capacities. Taking a populous and prosperous region of China as a case study should make the research directly relevant to inhabitants but also the agricultural and industrial sectors, which are threatened by droughts and floods. Activities are structured around five work packages:

1. Monitoring, attribution and reanalysis
2. Global dynamics of climate variability and change
3. East Asian climate variability and extremes
4. Development of models and climate projection systems
5. Climate services.

[24] Met Office CSSP China website. See https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/research/wcssp/cssp-china-science-summary-%E2%80%93-extreme-weather-english_mandarin.pdf
[25] CSSP infographic, Met Office CSSP China website. See https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/research/wcssp/cssp-china-infographic.pdf
[26] CSSP's Work Package 3 has five components: i) regional water cycle; ii) drought; iii) East Asian Monsoon; iv) Western Pacific tropical cyclones; and v) Convective scale modelling and climate extremes.

Within these, WP 3.1 has the following scientific objectives:

- Evaluation and intercomparison of current climate simulations of the regional water cycle over China;
- Identify key factors controlling regional water cycle over China and assess future risks under global warming;
- Develop an integrated water cycle system for the Yellow River Basin for budget, impact and water resources assessment.[27]

In the case of WP 3 and 3.1, the complementarity of climate modelling expertise between UK and Chinese research institutions is crucial to increasing the relevance of research **outputs**, their international visibility and achieving the fund-level **outcome** of increasing the number of high quality and collaborative results. The collaborations created between British and Chinese institutions aim to increase the capacity of researchers and their institutions to deliver high quality science.

At the same time, CSSP China has directed its effort toward translating the scientific outputs into applicable results. WP 3 aims to test climate models of the East Asian climate system to increase their relevance for China. A specific work package is dedicated to translation by pulling together the science produced under the whole programme and looking at them through the lens of climate services. Regular contact with policymakers indicates CSSP China intends to contribute to an increased number of solutions to China's development challenges.

Ultimately, at **impact**-level, CSSP intends to achieve increased preparedness for climate and extreme weather events by supporting China in developing more evidenced-based decision-making using more accurate climate models. This should help better predict extreme weather events in various areas in China and reduce the negative consequences of floods or droughts on China's population, agriculture and industry. CSSP also wants to establish strategic partnerships between UK and Chinese scientists.

4.3 Answers to the evaluation questions

4.3.1 Relevance

Activity targeting and contribution to ODA

The CSSP China project aims to produce scientific results that will have a practical use in China. Indeed, the translation of climate science into application for climate services is considered quite a new topic in China. CSSP's goal is to collaboratively work with Chinese stakeholders to understand how to support them to perform that transition. It also aligns well with the thematic focus area of Climatic variability and change in the urban and rural environment, which is one of the Newton Fund's focus areas in China.

This commitment to translation of science to services has been embedded in the project's very design, with one of its five work packages (WP5) dedicated to translating the scientific output of the project for climate services. Collaboration under this work package is responsible for channelling the results of all other work packages into practical applications where possible. This commitment is noteworthy in view of the commonly acknowledged gap between research and application in academia.

The scope of the CSSP project was jointly determined by the Met Office and the CMA as part of their long-standing collaboration. WP3 in particular aims to support China's climate services by using the scientifically well-respected model from the Met Office to increase the predictability of extreme weather events. Within WP3, more specific areas to be covered were again determined jointly as part of an annual science workshop in China which aimed to scope out and produce a joint research plan.

The focus of WP 3.1's research was decided with ODA requirements in mind and because of its potential contribution to China's development. This work package is aimed at improving climate models and developing diagnostic tools that could be used by China to improve its own climate models. Northeast China having multi-year drought issues, which affect both agriculture and water supplies, was purposefully chosen as the focus of that research. As such CSSP China supports China's sustainable development by contributing to the reduction of the

[27] Met Office, WP3 Summary Report, July 2017.

impact of extreme weather for its population, its agriculture and its industry. A better understanding of drought systems can also improve local water management that would ensure sufficient water supplies.

4.3.2 Additionality

Relations between the Met Office and the CMA and IAP predate the Newton Fund. They were institutionalised with a Memorandum of Understanding (MoU) signed between the Met Office and CMA in the 1990s and between the Met Office and the IAP in 2013. While this was essential for ensuring high-level support for collaboration once CSSP could be established, the lack of funds available prevented the cooperation from taking off. The Newton Fund's additionality here is twofold: not only did it fill a gap in funding without which the cooperation could not have been realised, but the large amount of funds it offered was also an opportunity to upscale the cooperation to include more fields of interest and to more comprehensively address climate and weather issues using climate models and climate projection systems.

4.3.3 Effectiveness

Research collaborations

Developing and cementing long-term collaborations between the UK and Chinese institutions was an objective of the CSSP. This was encouraged through CSSP's structure of several work and sub-work packages which multiplied collaboration opportunities. Workshops and meetings were organised to help establish and sustain these partnerships. Formal exchanges of researchers between Chinese and UK research institutions took place. Within WP3 for example, both UK researchers and Chinese researchers worked in-country, in their counterparts' institutions and teams for several months or years[28]. The Newton Fund was instrumental in facilitating that, as one researcher stated: "*no way I could be based here without that money. I would not have known people in China to arrange it without the meetings we organised through CSSP. Once here, if it wasn't for broader networks in China related to CSSP, I would not have met the people who are key to advance research*". In particular, the continuity of funding provided by the Newton Fund is understood by the Met Office (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 Newton Fund funding.

These collaborations created value because they brought together complementary expertise in climate modelling to improve climate predictions and to create new knowledge. As evidence of that, CSSP published at least 70 co-authored science papers[29]. Within that, WP 3.1 had resulted in five collaborative publications, of which one published, three submitted and one in preparation as of July 2017[30].

Collaborating with the CMA and IAP allowed the Met Office to access and use Chinese data and the expertise of Chinese scientists to collaboratively work at improving the model. Under WP3 UK and Chinese researchers worked specifically on weather patterns for the Yangtze River as a case study to develop the model. One specific example of successful collaboration is between the China Meteorological Administration (CMA) and the Met Office. Following severe flooding in the Yangtze River Basin, the Met Office and CMA worked together to provide a climate forecast model to the Three Gorges Dam Corporation, which is the entity responsible for flood management. Being

[28] According to CSSP documentation shared with Coffey, two IAP scientists visiting the Met Office for extended periods of time (12 and 18 months), one Met Office scientist is visiting IAP (24months), two IAP scientists visited the University of Reading for 3 months and there were several shorter visits in both directions (IAP, CMA, Met Office). Source: CSSP China WP3 UK-China face-to-face engagement

[29] CSSP China infographic. Met Office CSSP China website. See https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/research/wcssp/cssp-china-infographic.pdf

[30] Guo, L, Klingaman, N. P., Vidale, P. L., Turner, A. G., Demory, M. E., Cobb, A (2017) 'Contribution of tropical cyclones to atmospheric moisture transport and rainfall over East Asia', *Journal of Climate*, 30 (10).
Guo, L, Klingaman, N. P., Demory, M. E., Vidale, P. L., Turner, A.G., Stephan, C. C. (2017) The contributions of moisture fluxes to EA precipitation. *Climate Dynamics*. Submitted.
Stephan, C. C., Klingaman, N. P., Turner, A. G., Vidale, P. L., Demory, M. E., Guo L. (2017) 'A comprehensive study of coherent patterns of rainfall variability in China. Part I: Inter-annual variability', *Climate Dynamics*. Submitted.
Stephan C. C., Klingaman, N. P., Turner, A. G., Vidale, P. L., Demory, M. E., Guo L. (2017) 'A comprehensive study of coherent patterns of rainfall variability in China. Part II: Intraseasonal variability', *Climate Dynamics*. Submitted.
Stephan C. C., Klingaman, N. P., Turner, A. G., Vidale, P. L., Demory, M. E., Guo L. (2017) 'Evaluation of East Asian inter-annual precipitation variability in MetUM GA6/GC2', *Geoscientific Model Development*, in preparation.

able to use the Met Office's model to forecast the summer rainfall more accurately has helped the Corporation plan in advance and be better prepared for potential flooding issues.

On the researchers' side, their feedback confirms research collaborations enabled by the CSSP are very much valued and added value to their work. While some respondents wished for more support from work package leads to identify the right research partners out of a large pool of institutions and people, respondents largely recognised that the collaborations enabled by the Newton Fund through the CSSP project was one of its greatest benefits.

Chinese researchers reported their skills had developed, both scientifically but also in terms of their professional development as researchers such as through improved English language skills. One UK stakeholder from the Met Office stated that: "there is no doubt that the Chinese climate models developed hugely in the last five years and that the project helped with the rapid development of that capability". Some Chinese researchers however 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 own research institution, it was felt to be contradictory to the partnership approach of the Newton Fund.

New international partnerships

While at present there is no clear evidence of new international partnerships developed by project partners beyond the CSSP China project itself, the willingness to ensure the sustainability of existing partnership built with the Newton Fund is evident. This has been expressed by several Met Office and CMA/IAP researchers. For example, one Met Office researcher will be involved in an upcoming CMA project on extreme weather in South China. The lack of sustainable funding sources after the end of the Newton Fund in 2020 is a cause for concern as these relationships hinge on the availability of funding.

Chinese stakeholders such as the IAP have been able to secure funding for further research projects. The Newton Fund and the collaboration with the Met Office has contributed to raising their work's profile and attract funding from the 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 the Ministry of Science and Technology (MoST) and the National Science Foundation of China (NSFC).

Benefits to UK researchers and UK science

The institutional cooperation between the Met Office and the CMA, as well as with the IAP, provided UK researchers with access to a new network of Chinese researchers. These networks often act as an entry point into a much larger local network and are a significant career advantage in academia where networks are essential for building scientific cooperation for future work. This is especially valuable in China as such networks might otherwise be difficult to enter as they are closed to foreigners or people who have not been provided with an entry point. UK researchers have also mentioned having built their capacity through these collaborations and having developed professionally through being exposed to new data and research approaches. One senior scientist said: *"I have been involved in similar size projects in the UK, we were not able to derive as much value as this one, because of the collaboration. Just to discuss research priorities with people in other countries."*

For UK science, the CSSP China project contributed to improving UK climate modelling capability. For example, 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 climate is a global system. As one researcher stated, this not only contributed to improving the Met Office model but it also ensured UK science remains at the forefront of the international research agenda in that field. Some of the models have been showcased to the World Meteorological Organisation.

At the UK institutional level, the project increased the Met Office's visibility in China, with local researchers now more aware of the institution and its scientific output. Participating in the CSSP China experience also prompted the Met Office to improve the translation of climate science into climate services by working at better linking scientific results with climate service user needs. Now the Met Office states it has "a much closer engagement with the user informing the science".

4.3.4 Impact

Link to development improvements

It is difficult to establish whether a science programme aimed at improving climate prediction models has had a visible impact on China's socio-economic development at this stage.

Nevertheless, there are signs WP3 is putting in place adequate measures and channels for this to be achieved at a later stage. In line with CSSP's objective to engage key Chinese actors in the sector of climate services, the project could make use of CMA's contacts and has engaged the priority sectors of energy and water through joint activities.

There is evidence the work of CSSP has been used to increase preparedness for climate challenges. CSSP China scientists 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 and be better prepared for potential flooding. This initial work was well received by stakeholders, and has continued.

4.3.5 Complementarity and coordination

Catalytic effects

CSSP China and Work package 3 in particular was used as best practice in at least two instances:

- An innovative technique (named 'UNSEEN') was developed around extreme temperatures in China. It quantifies the risk of unprecedented extremes (e.g. heat waves, intense rainfall) under the current climate. This technique was used in 2016 by the British government for the UK Cabinet Office/Defra National Flood Resilience Review commissioned following successive winters of very heavy rainfall and severe flooding in England. The aim is to improve contingency planning and decision making in the case of floods. The Met Office anticipates this technique has potential for wider application in the UK, but also Europe and China as well as for its Newton Fund project in Brazil. Scientists working on CSSP Brazil are currently investigating how it may be used to assess risk of extremes in Brazil.
- In China, the format of the IAP's advice on climate extremes is now used as best practice throughout the CMA for its decision-making activities.

Leadership effect

Future best practice opportunities have been identified and include:

- Some of the CSSP China project research on monsoons is relevant for the next IPCC report on monsoons and might be published as part of the next report.
- A water cycle research method developed as part of WP3.1 might be used for the One Belt One Road project relating to transporting water in the region involved in the project.
- A technique developed as part of WP3.1 which aims to determine how much of the precipitation comes from tropical cyclones will be applied outside of the CSSP to a project for the Philippines.

4.4 Conclusions

Main findings

- Efforts embedded in the design and practice throughout the project's five work packages were **aimed at improving China's climate service development** through the provision of predictions for extreme weather events (floods and droughts). This should ultimately benefit China's agricultural and industrial production as well as creating more sustainable water consumption. There has already been evidence of efforts to translate scientific results for application by end-users such as Chinese climate services and policymakers.
- **Additionality was achieved** because the Newton Fund addressed a funding gap between the Met Office and the IAP and CMA without which the cooperation on climate services could be not realised even though

it was identified as having high potential. The large amount of funds offered by the Newton Fund was an opportunity to upscale the cooperation to include more fields of interest.

- The **collaborative approach** to these problems is considered by delivery partners and researchers as one of the **project's greatest areas of added value**. The Newton Fund's financial support cemented long standing institutional relationships and expanded them in depth and scope.
- **Benefits are mutual** – Participation in the CSSP project enabled Chinese institutions to attract new funds in a competitive state-run funding landscape, while UK science saw its climate modelling capacities improved. The capacities of researchers on both sides were developed and a number of scientific results were used as best practice, which attests to some of the project's beneficial results to date.

Lessons learned

- The **volume of funding** offered by the Newton Fund allows delivery partners to **develop more ambitious projects by upscaling them in size and scope**. This presents an opportunity to include more topics as well as more partners and therefore multiply cooperation opportunities. It also raised the profile of the research institutions involved, helping them attract new funding.
- The opportunity to **build long-term collaborations** is one of the projects' main areas of added value. While the relationships built will remain, their sustainability at institutional level, however strong, depend on the Newton Fund's financial contribution and risk being jeopardised once the Fund comes to an end. An exit strategy would be beneficial for delivery partners to plan appropriately and retain the benefits created by the Newton Fund.
- It was felt that the **matched funding aspect of this programme did not provide Chinese researchers with equal opportunities** and that this was contradictory to the partnership approach promoted by the Newton Fund. Chinese researchers, for example, had more limited in-country stays, which was felt prevented the unlocking of some of the benefits of research collaborations (though this issue reflects Chinese requirements rather than any specific problem of the Newton Fund structure or processes).

5 Precision Agriculture for Family-farms in China (PAFiC)

5.1 Summary

Action title	Precision Agriculture for Family-farms in China (PAFiC)
Short description	The principal aim of the PAFiC project is to promote best practice for environmentally and profitably sustainable production on commercial family farms in China through improved resource-use efficiency[31]
Objective(s)	Four interconnected objectives: 1. Agri-Technologies: Advance novel technologies & refine existing agri-technologies to promote the deployment of technologies onto family farms in China. 2. Agri-Methodologies: Develop methodologies for the conversion & integration of agri-technology outputs into agronomic & environmental layers for support decision systems. 3. Social Innovation in Agriculture: Employ Responsible Research Innovation (RRI) & economic analysis to understand socio-economic barriers to agri-technologies & services. 4. Engagement & Dissemination: A clear pathway for engagement & delivery of research outcomes with all actors in Chinese agriculture from farmers to local & national policymakers.
Pillar	Research
Action value (total budget allocated in country, in GBP)	UK - £5,666,459 China – CNY 15,000,000 of which PAFiC £1,288,830
Start / end date (Status: ongoing or complete)	May 2016 – April 2019 as part of the larger joint call between STFC and NSFC
DP UK and overseas	STFC NSFC
Award holders / grantee	UK partners Newcastle University FERA Science Limited RAL Space AgSpace Ltd China partners China National Engineering Research Center for Information Technology in Agriculture (NERCITA) Beihang University

[31] Newton UK-China Agri-Tech – Impact proforma document shared by the research team.

5.2 Description of the action

Precision Agriculture for Family-farms in China

PAFiC is part of a joint STFC-NSFC call together with four other projects under the larger STFC Newton Agri-Tech Programme with China. The other four projects are:

- Regional crop monitoring and assessment with quantitative remote sensing and data assimilation;
- Integrating Advanced Earth Observation and Environmental Information for sustainable management of crop pests and diseases;
- Synthesis of remote sensing and novel ground truth sensors to develop high resolution soil moisture monitoring in China and the UK; and
- Enabling wide area persistent remote sensing for agriculture applications by developing and coordinating multiple heterogeneous platforms.

The Agri-Tech programme is a £12 million initiative developed by the STFC and funded by the Newton Fund to support the use of the UK's expertise in remote sensing and modelling around agricultural technology (agri-tech) to work with and aid the Chinese farming community[32]. The aim of this programme is 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). There are elements of connection between the projects under this programme, for example the Network + is tasked with providing further seed funding and networking between the projects.

China's rapid socioeconomic development has been accompanied by agricultural production efficiency improvements. 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. It aims to promote best practice for environmentally and profitably sustainable production on commercial family farms in China through improved resource-use efficiency[33].

PAFiC involves partners both from the business world and universities – including four UK and two Chinese partners.

Pathway to impact

PAFiC is another example of a project that builds its impact across pillars. PAFiC is a research pillar project with a translation component. This is shown in Annex 2, Figure 3.

The project's research **activities** focus on the development of precision agriculture and fall in line with China's development needs on agriculture, which the government has identified as a policy priority. Precision agriculture has the potential to sustainably intensify agricultural production, benefitting the environment, the food security of Chinese consumers and the welfare of family farmers. PAFiC's work is structured around four work packages that aim to address the main barriers to the use of precision agriculture in commercial farming:

1. Develop precision agriculture technologies
2. Apply the technologies to family farms in China
3. Assess the socioeconomic impact of applying precision agriculture
4. Transfer knowledge gained to farmers and policymakers

The PAFiC project targets six types of **output** for six different kinds of stakeholder:

[32] STFC Newton Agri-Tech Fund website. See https://www.ralspace.stfc.ac.uk/Pages/The-STFC-Newton-Agri-Tech-Fund.aspx
[33] PAFiC presentation shared by the research team

1. By encouraging state of the art research on precision agriculture, activities aim to support both the development of advanced agri-technologies and agri-methodologies but also the development of practical solutions that could be directly applied by farmers for their agricultural production.
2. Agricultural service providers (such as local agronomic service providers and growers who, in China, provide on the ground agricultural services) will be engaged. This aims to increase the acceptance and use of the new services that will be developed.
3. Contacts with government institutions responsible for agriculture will explore the potential uptake of the still relatively expensive technologies and tools produced by the research.
4. PAFiC is also planning to engage UK geospatial service providers to disseminate the technologies created which are expected to have a high commercial and social value for the agricultural sector.
5. The general public will be engaged by disseminating the project's work through radio and television broadcasts, articles and public lectures as well as with web-based materials, blogs and social media.
6. Academically, PAFiC aims to publish articles in high ranking academic journals as well as presenting at international conferences.

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 as well as providing practical solutions that might influence policymakers and prove useful for China's agricultural sector. Indeed, as part of its engagement with government institutions responsible for agriculture, PAFiC plans to include Chinese Ministry of Agriculture officials to improve the delivery of information to policymakers. UK industry representatives will also be included in PAFiC's advisory group to encourage the translation of research outputs into industry-relevant solutions.

At **impact** level, PAFiC targets the development of innovative agricultural technologies that are intended to be useful for Chinese farmers and accessible by them, by engaging not just them but also the range of stakeholders that could facilitate their uptake. Ultimately, the increase in the efficiency of fertiliser and resource use could help the Chinese government reach their goal of capping fertiliser usage in 2020, and improve food security.

5.3 Answers to the evaluation questions

5.3.1 Relevance

Activity targeting and contribution to ODA

Smart agriculture is one of China's policy priorities highlighted in its most recent development blueprint – the 13th Five Year Plan. China is experiencing large-scale use of fertilisers creating environmental issues such as soil and water pollution through contamination. Another characteristic of China's farming landscape is that it has been changing with an increase in small to medium size commercial family farms due to the merging of smaller and non-commercial family plots.

PAFiC is targeting both issues through the development of precision agriculture for commercial family farms as this technology has the potential to significantly reduce fertiliser use and its impact on the environment, as well as helping to maintain rural populations and economies[34]. It does so by rendering the use of nutrients and agrichemicals more efficient, through the use of technology and field, crop and soil data. The sustainable intensification through increases in crop productivity would also in turn increase farming income and the socioeconomic welfare of farmers, helping to keep farming activities profitable. The use of precision agriculture technology would also support their transition to management of larger farming areas. PAFiC researchers are reported to have carried out a series of interviews to assess the social and economic impact of the research on the farming community but these have not been made available to the evaluators for review or analysis.

This project also closely matches Newton Fund priorities in China, one of which is Sustainable food, energy and water.

[34] RCUK website. See http://gtr.rcuk.ac.uk/projects?ref=ST%2FN006801%2F1

5.3.2 Additionality

PAFiC emerged from a rigorous selection procedure as part of STFC's Agri-Tech 'seedcorn' funding mechanism[35]. In an impact-focused approach, this process aimed to de-risk novel concepts by first funding smaller 'pathfinder' projects, which could lead to larger grants for an extended project scope. The idea behind this selection process was to bring together UK science and technology actors who use space-related technologies and data with Chinese researchers and stakeholders in order to provide solutions that are specifically applicable to China's agricultural challenges.

In the first stage of this process, the 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. This study brought the UK PI who was specialised in remote sensing into the field of precision agriculture and who otherwise would probably not have 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 reaching the more than a million-pound PAFiC project it developed into. A networking event organised for that purpose by delivery partners linked both UK and Chinese PI 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 additionality is therefore twofold: the Newton Fund brought the UK PI into a new field of work, and it linked the UK and Chinese partners to jointly develop the PAFiC project.

5.3.3 Effectiveness

Research collaborations

The collaborative nature of the project – in particular between Newcastle University and NERCITA – was actively promoted by the STFC. A so-called 'sandpit event' was organised to bring together potential partner organisations during the project selection phase in order to foster collaborations in the field of precision agriculture. As a respondent involved in the design of this event confirmed: "it was about making sure people can speak together, understand commonalities and put a project together". 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.

A strength of the collaboration is the combination of Newcastle University's remote sensing expertise and NERCITA's precision agriculture expertise. PAFiC's technology-related activities revolve around three main areas of focus: Precise Point Positioning (PPP) which essentially refers to GPS technology, hyperspectral imaging and synthetic aperture radar and soil diagnostics. Examples of successful collaboration outputs include work on PPP, which aims to reduce the current meter-level accuracy positioning to centimetre-level accuracy (as this is the level needed for precision agriculture). The collaboration with Newcastle University used their remote sensing technology and data processing expertise to develop an accurate positioning technology. They calculated that economic benefits of precision seeding increased by 7.9% using laser land levelling and precision seeding. When accompanied by state subsidies, economic benefits increased by 16.6%. Another example is the development of an online Multi-GNSS Precise Point Positioning (MP3), which collects observations on crops and soils, puts them in an online management systems and then combines them with models to predict the yield and prescribe the relevant amount of nutrients. The PAFiC project also published ten papers and has 15 papers under review in high impact scientific journals.[36]

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[35] This concept is presented on the STFC's Newton Agri-Tech Fund website. See https://www.ralspace.stfc.ac.uk/Pages/The-STFC-Newton-Agri-Tech-Fund.aspx

[36] Berra E., Gaulton, R., Barr, S. (2017) 'Commercial Off-the-Shelf Digital Cameras on Unmanned Aerial Vehicles for Multitemporal Monitoring of Vegetation Reflectance and NDVI', *IEEE Transactions on Geoscience and Remote Sensing*.

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Individually, researchers mentioned the collaborations led to professional development. Chinese researchers – both experienced and early career as well as PhD students – felt they have 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.

New international partnerships

The PAFiC project created new partnerships, in particular between Newcastle University and NERCITA. It was the STFC selection procedure that linked the various project partners together and opened the door for Newcastle University to apply their remote sensing expertise to agriculture.

In terms of new partnerships that developed from the PAFiC project, a new project called 'sentinel of wheat' has received funding (around £500,000) from the STFC. It is an 'impact integration activity' the STFC funds to encourage collaboration between the five Agri-Tech projects to make the most of commonalities between the projects and maximise potential impact. NERCITA in particular is very active in the precision agriculture field and already plans new projects, many however are unrelated to the Newton Fund. Nevertheless, taking part in an international collaboration through the Newton Fund played a role in raising NERCITA's profile with Chinese authorities. One respondent stated: "through the implementation of the Newton Fund, the credibility and profile of our institute in the area of smart equipment and precision agriculture was dramatically increased". According to the researchers it was especially the improvement of its management capacity achieved through NERCITA's participation in PAFiC that was determining for NERCITA in leveraging more funds within China's competitive national funding landscape.

Benefits to UK researchers

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, Newcastle University's principal investigator had never delved into that field. Not only did this provide them with a completely new field of expertise but it also prompted the setting-up of a formal collaboration at internal level with the University's agriculture department (with whom they had never cooperated in the past). Newcastle University's agriculture department gained experience in this technological approach to agriculture.

5.3.4 Impact

Demonstrable link to development improvements

The database on soil and crop information created by project partners was made available to Chinese agricultural extension workers who are free to use the data to help them make decisions on water supply, for example. This platform also provides farmers with a digital marketplace connecting them directly with customers, which has the

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potential not only to empower farmers but also increase their profit. It is however unclear to what extent the platform is being used or whether any such impacts are being realised.

PAFiC is an ongoing research project and impacts will only be observed in the long-term. However, the PAFiC project actively works at transferring the knowledge it creates to the end users of the technology – farmers and policymakers. Formal mechanisms of knowledge sharing such as workshops and training courses are organised each year for this purpose. There has also been some contact with local government stakeholders to explore the possibilities of subsidising the cost of the technology for roll-out.

The Hebei Provincial Department of Agriculture has chosen the Gaocheng farm, one of the three PAFiC experimental farms, as the demonstration site in Heibei Province. PAFiC project partners have also been actively engaging the Chinese policymaking community and informing them about PAFiC outputs and results. The project has engaged government and high level officials: in 2017, over ten government officers attended the agri-technology training course at the PAFiC annual meeting and PAFiC was presented to the Vice Prime Minister of China (Yang Wang) at an agriculture conference in Suzhou in 2016 and to the China Secretary of Agriculture (Changbin Han) in 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.

PAFiC's activities also include research around the socioeconomic impact of precision agriculture technologies. Social scientists have been involved in collecting qualitative data and interviewing farmers to improve the relevance of the technology. This creates awareness of the farmers' needs and tailors the research accordingly. This approach however is not just for development purposes but also makes commercial sense as technologies that are not suited to the farmers' needs will ultimately not be adopted in the long run.

5.4 Conclusions

The PAFiC project aims to promote a more productive and sustainable agriculture sector (and small to medium family farms in particular) through precision agriculture. It is a five-year collaboration between four UK and two Chinese partners, which resulted from of a joint STFC-NSFC call.

Main findings

- **ODA and Chinese country priorities are embedded in the project's design and activities** – Food security has been chosen by STFC with the intention of funding projects that contribute to China's sustainable development. Precision agriculture is also targeting at least three of China's policy priorities outlined in its 13th Five Year Plan (2016-2020): food security improvements through productivity gains; modernisation of the agricultures sector; and improving rural income.
- **Additionality** – The PAFiC project has been directly generated by the Newton Fund Agri-Tech programme selection process. This process first introduced the UK PI to a new field of study (agriculture) and then linked the UK and Chinese partners together with a larger study, which then led to the larger PAFiC project.
- **Collaborations** between UK and Chinese institutions were promoted in the selection procedure and led to institutions with complementary expertise and skills coming together to identify and respond to research gaps in the field of precision agriculture. These collaborations contributed to the researchers' professional development and the expansion of their networks.
- **For UK partner institutions, the participation in PAFiC contributed to expanding their area of expertise** by joining up internally with other university departments. This means both departments gained increased professional development and a new set of professional networks thanks to PAFiC.
- PAFiC showed a **commitment to knowledge transfer** to farmers and policymakers. This was underpinned by socioeconomic studies of farmers needs regarding precision agriculture as well as a work package dedicated to promoting knowledge transfer. As this could increase the uptake of the technologies and therefore increase the productivity of crops and land, it can be seen as **evidence of targeting of impact-driven activities**.

Lessons learned

- The level and continuity of funding was crucial in expanding the depth and scope of the research and of the collaborations. It is the greater level of funding received in the third selection phase which enabled the project to be scaled up in size increasing the potential for achieving significant impacts.
- The potential for impact appears to be increased when the users' needs are taken into account and integrated in the research design. Embedding the study of farmers' views into the project would ensure the sustainability of the approach as they are ultimately the end user of the precision agriculture device. Without the farmers' endorsement of the device, it would probably not be used and ultimately not have the impact intended.
- Integrating the scientific impact measurement approach at the call stage as well as within project design was strongly advocated by the STFC in order to be able to understand and evidence project impact. STFC plans to embed project impact measurement much more systematically in the future.

6 Conclusions

Reflecting the country's economic rise over recent decades, China has one of the strongest economic profiles of all Newton Fund partner countries. It ranks highly in almost all science and innovation metrics from the Baseline Report. China has engaged widely with Newton Fund delivery partners, all of whom are involved in projects.

All three projects evaluated aim for fund-level impact and intend to promote, through their science and innovation work, China's socioeconomic development. They all do so in line with China's sustainable development needs; addressing issues of air pollution and health, climate risks and sustainable agricultural intensification.

The case studies highlight:

- **Projects target China's development priorities well.** In the design of their projects researchers/project stakeholders demonstrate a real commitment to developing projects that address both China's priorities and those of the Newton Fund.
- **The Newton Fund facilitated cooperation opportunities previously identified but lacking in funding**. Delivery partners have the expertise and have often already established their interest in cooperating on certain topics and/or with certain partners. However, they lacked the funding that would have allowed such cooperation to happen. The Newton Fund fills a need because it offers levels of funding that could take these opportunities forward and turn potential into reality.
- **The level of Newton Fund support enabled the establishment of larger-scale projects and expanded cooperation opportunities to more participants**. Newton Fund's larger funding and longer, five year, time-frame for projects (compared to that usually received by researchers) allowed the scientific scope of the collaboration to be enhanced by increasing the size and depth of the projects. The complementarity of the UK and Chinese partners is one of the strengths of the collaborations. This is perceived by researchers and project stakeholders to support research and achieve innovative and state of the art results.
- **Most researchers consider the opportunity to cooperate with UK and Chinese counterparts as the area of greatest added value in projects.**

  Some of the **benefits** evidenced on **collaboration** include:

  - **Professional development**

    Researchers from each of the three projects evaluated attest to building their professional capacity due to their participation in Newton Fund supported collaborations. However, none of the projects appeared to have a dedicated capacity-building component. Rather, this was the result of learning through exposure to different research cultures and exchanges. Chinese researchers generally see their projects as a source of professional development which includes a variety of opportunities such as exposure to new research techniques and improving their English language skills.

  - **Increased profile of Chinese projects through exposure to international collaboration**

    In a competitive Chinese funding landscape, the exposure through their Newton Fund participation helped all three projects secure funding for new or follow-on projects. Participating in the Newton Fund gave Chinese partners an edge, but the funding secured is mostly to conduct their own separate research and do not necessarily involve their UK partners or the Newton Fund.

- **Collaborations also encountered challenges:**

  - There is **little evidence of how these collaborations may be continued and funded beyond the lifetime of the Newton Fund**. The sustainability of these collaborations is in many ways dependent on securing new funding for future projects. Although the connections may continue after funding, a lack of clarity on follow-on funding may inhibit further collaboration. The current lack of clarity around an exit strategy for the Newton Fund risks jeopardising the benefits achieved. It seems there is a lack of knowledge regarding alternative funding sources to sustain this kind of cooperation. **Issues include**

access to data and, on the Chinese side, a perceived imbalance in funding – Overall few issues were raised by respondents. One recurring limitation was the occasional restriction in data sharing between UK and Chinese partners (such as models used or datasets). This issue was often creatively solved and did not seem to create major problems. Some Chinese researchers also highlighted issues around match funding, which meant being partner on paper yet subject to disadvantageous Chinese rules (around travel limits for example).

- **A commitment to engaging with policymakers is laying the groundwork for research outputs to inform policy in the future**. Not every project had the same level of success or contacts with Chinese policymakers. Nor can they hope to achieve the same kind of policy impact. This is simply due to the very different nature of their research fields. It is however evident that all three projects made efforts to bring the result of their research to relevant Chinese stakeholders (for example, by embedding dedicated engagement channels in each project structure).
- To achieve engagement with policymakers, **successful projects included well connected Chinese PIs/researchers.** The collaboration with high-profile Chinese researchers and research institutions secured an entry point for projects. This allowed them to disseminate their research outputs to the relevant Chinese policymakers. In China, personal contacts are critical in reaching otherwise inaccessible stakeholders, particularly for non-Chinese people and institutions.
- On the UK side, **the Newton Fund helped the UK to become a partner of choice for China** in R&I cooperation. A wide range of UK respondents – FCO in China and delivery partners – felt large levels of funding from the Newton Fund meant greater visibility for the UK and enhanced cooperation opportunities with Chinese institutions. While this could not be directly confirmed (due to access issues to Chinese funders) there is evidence of cooperation with the UK being increasingly prioritised by the Chinese Ministry of Science and Technology (MoST).
- Several issues prevent full advantage being taken of the Newton Fund's achievements in China. The image and status of the UK as a 'partner of choice' achieved through the Newton Fund is threatened by the lack of a post-2021 strategy (when the Newton Fund is due to end). UK stakeholders are aware that other countries competing for China's attention in S&I could use this to their advantage, taking a more prominent role in scientific co-operation with China in the absence of the Newton Fund. At working level, a lack of metrics to report on **Fund-level impact** was perceived as a missed opportunity. These could have been used to **underpin anecdotal evidence of impact** to showcase achievements and promote Newton Fund branding in China and Fund accountability in the UK.

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Annex 2 – Theories of Change per Action

Figure 1. Theory of Change, Atmospheric Pollution and Human Health in a Chinese megacity (APHH China)

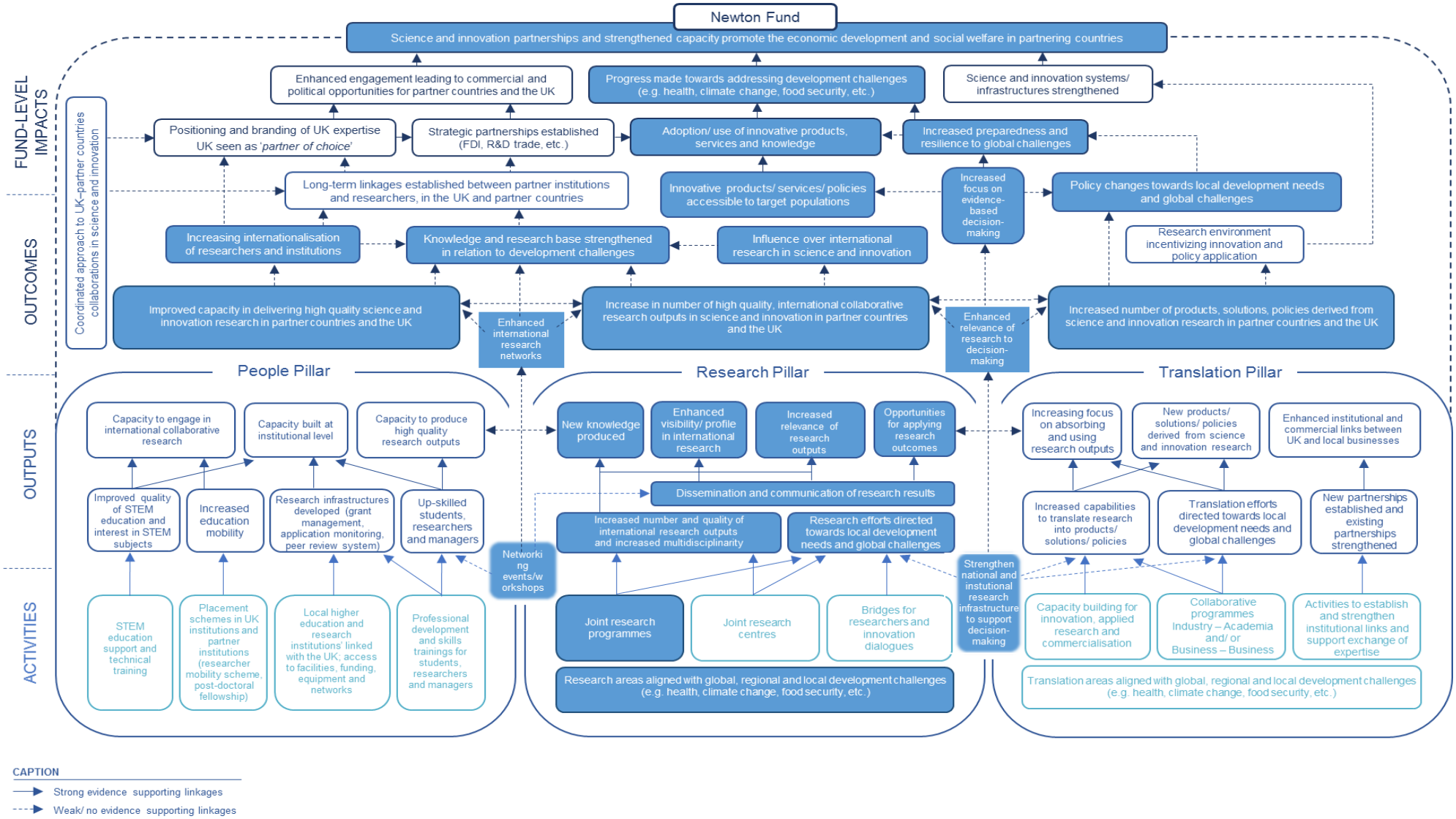


Figure 2. Theory of Change, Climate Science for Service Partnership-China (CSSP-China)

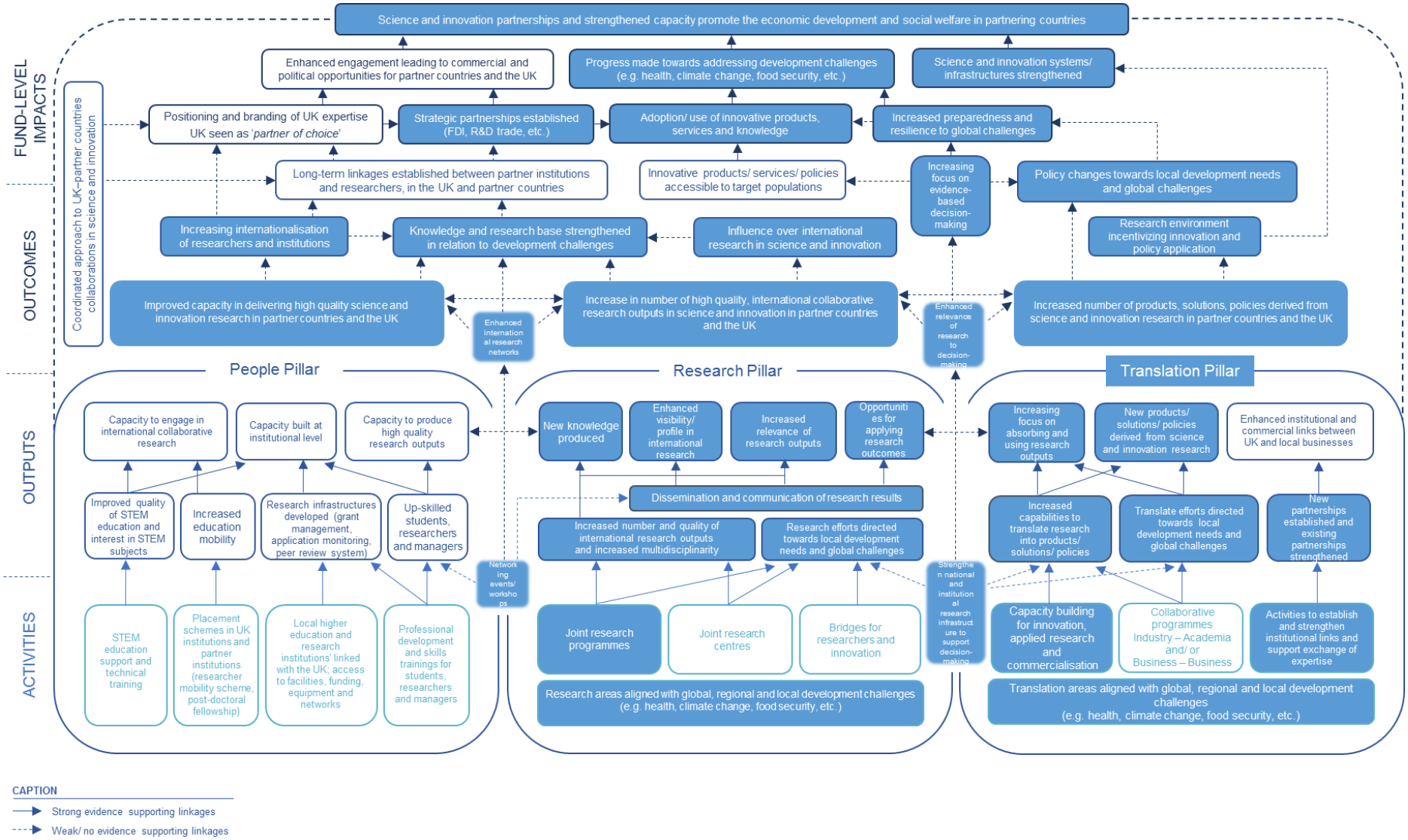
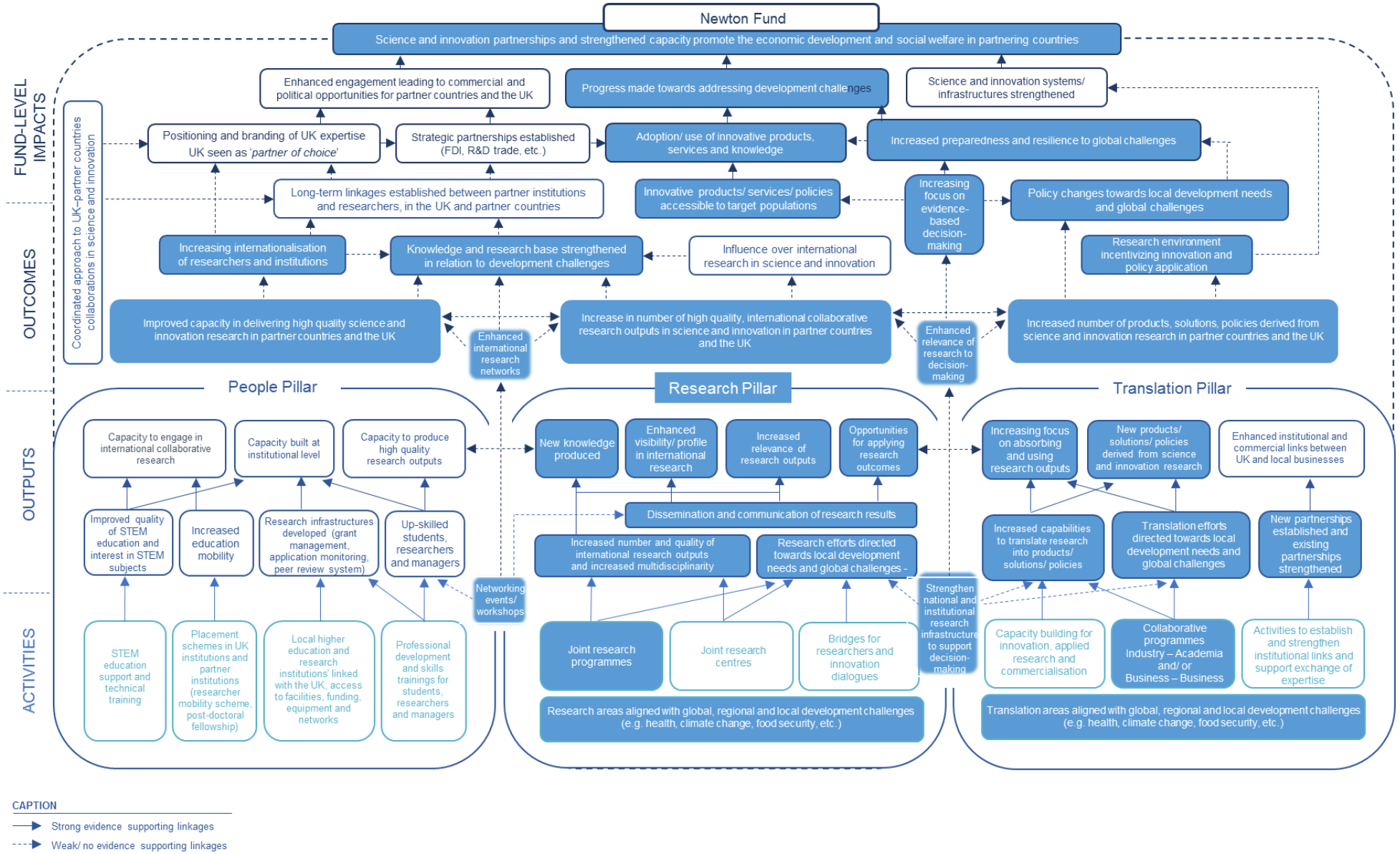


Figure 3. Theory of Change, Precision Agriculture for Family-farms in China (PAFiC)


Newton Fund
Science and innovation partnerships and strengthened capacity promote the economic development and social welfare in partnering countries
FUND-LEVEL IMPACTS
Enhanced engagement leading to commercial and political opportunities for partner countries and the UK
Progress made towards addressing development challenges
Science and innovation systems/ infrastructures strengthened
Positioning and branding of UK expertise UK seen as 'partner of choice'
Strategic partnerships established (FDI, R&D trade, etc.)
Adoption/ use of innovative products, services and knowledge
Increased preparedness and resilience to global challenges
OUTCOMES
Coordinated approach to UK-partner countries collaborations in science and innovation
Long-term linkages established between partner institutions and researchers, in the UK and partner countries
Innovative products/ services/ policies accessible to target populations
Increasing focus on evidence-based decision-making
Policy changes towards local development needs and global challenges
Increasing internationalisation of researchers and institutions
Knowledge and research base strengthened in relation to development challenges
Influence over international research in science and innovation
Research environment incentivizing innovation and policy application
Improved capacity in delivering high quality science and innovation research in partner countries and the UK
Enhanced international research networks
Increase in number of high quality, international collaborative research outputs in science and innovation in partner countries and the UK
Enhanced relevance of research to decision-making
Increased number of products, solutions, policies derived from science and innovation research in partner countries and the UK
People Pillar
Research Pillar
Translation Pillar
OUTPUTS
Capacity to engage in international collaborative research
Capacity built at institutional level
Capacity to produce high quality research outputs
New knowledge produced
Enhanced visibility/ profile in international research
Increased relevance of research outputs
Opportunities for applying research outcomes
Increasing focus on absorbing and using research outputs
New products/ solutions/ policies derived from science and innovation research
Enhanced institutional and commercial links between UK and local businesses
Improved quality of STEM education and interest in STEM subjects
Increased education mobility
Research infrastructures developed (grant management, application monitoring, peer review system)
Up-skilled students, researchers and managers
Dissemination and communication of research results
Increased number and quality of international research outputs and increased multidisciplinarity
Research efforts directed towards local development needs and global challenges
Increased capabilities to translate research into products/ solutions/ policies
Translation efforts directed towards local development needs and global challenges
New partnerships established and existing partnerships strengthened
Networking events/ workshops
Strengthen national and institutional research infrastructure to support decision-making
ACTIVITIES
STEM education support and technical training
Placement schemes in UK institutions and partner institutions (researcher mobility scheme, post-doctoral fellowship)
Local higher education and research institutions' linked with the UK; access to facilities, funding, equipment and networks
Professional development and skills trainings for students, researchers and managers
Joint research programmes
Joint research centres
Bridges for researchers and innovation dialogues
Research areas aligned with global, regional and local development challenges (e.g. health, climate change, food security, etc.)
Capacity building for innovation, applied research and commercialisation
Collaborative programmes Industry – Academia and/ or Business – Business
Activities to establish and strengthen institutional links and support exchange of expertise
Translation areas aligned with global, regional and local development challenges (e.g. health, climate change, food security, etc.)
CAPTION
Strong evidence supporting linkages
Weak/ no evidence supporting linkages