Strengthening climate services in South Asia: **Learning from the ARRCC programme**

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The Asia Regional Resilience to a Changing Climate (ARRCC) programme was funded by the UK Foreign, Commonwealth and Development Office (FCDO) between 2019 and 2022. It aimed to increase the resilience of countries in South Asia to climate change by fostering regional cooperation, supporting improved weather and climate forecasting capability and use of this information in planning and decision-making across climate-sensitive sectors, and promoting innovation in delivering forecasts to users. The programme was delivered by the UK Meteorological Office, the World Bank, and Oxford Policy Management.

Executive summary

Climate services involve 'producers' (primarily national meteorological and hydrological services (NMHSs)) using climate and other data and analyses to develop a climate information 'product' which is then disseminated to various 'users' (including government departments, civil society, and individual citizens), who should integrate this into their decision-making. However, the effectiveness of these services depends on the ecosystem within which they operate, including a range of governance dimensions and political economy drivers.

The UK Foreign, Commonwealth and Development Office- (FCDO-) funded ARRCC programme, delivered between 2019 and 2022 by the World Bank, UK Met Office, and Oxford Policy Management (OPM), aimed to establish new and enhanced climate services in South Asia, by strengthening different parts of the ecosystem for climate services. The delivery partners experimented with a range of approaches, implementing over 30 interventions that focused on both short-range and medium-range forecasts, as well as future climate projections and scenarios.

The programme had clear successes, with 13 new systems and tools for climate services being implemented, 12 government partners reporting enhanced institutional capabilities, and various new partnerships prompting collaboration across countries and between stakeholders that was expected to last beyond the end of the programme.

The purpose of this paper is to document how and why the programme has enabled change, and also where challenges remain.

The learning is organised into the factors that have enabled progress in strengthening climate services, and those that have constrained progress. These are a mix of external factors, such as the growing demand by sectoral line ministries for better information on climate risks, and internal factors, such as the programme's partnership model and innovative approaches to capacity building.

The paper concludes with a series of high-level recommendations, primarily to other programmes and partners that share a similar objective of strengthening climate services: in particular, the United Nations' efforts to ensure every person on Earth is protected by early warning systems by 2027, which will be supported by multilateral and bilateral initiatives, such as FCDO's new 'Climate Action for a Resilient Asia' programme, the United States Agency for International Development's 'President's Emergency Plan for Adaptation and Resilience', and others.

Table of contents

List of abbreviations

ARRCC	Asia Regional Resilience to a Changing Climate
CIMMYT	International Maize and Wheat Improvement Center
DHM	Department for Hydrology and Meteorology, Government of Nepal
FCDO	Foreign, Commonwealth and Development Office, Government of the United Kingdom
IBF	Impact-based forecasting
NMHSs	National meteorological and hydrological services
OPM	Oxford Policy Management
RIMES	Regional Integrated Multi-Hazard Early Warning System
SAHF	South Asia Hydromet Forum
SASCOF	South Asian Seasonal Climate Outlook Forum
ToC	Theory of Change
WMO	World Meteorological Organisation

1. Introduction

This is the final learning paper from the ARRCC programme; it synthesises the learning captured during the course of the four-year programme. The ARRCC programme (2019–22) aimed to increase the resilience of countries in South Asia to climate change through improved forecasting capabilities and the use of better weather and climate information in decision-making. It was delivered by the UK Meteorological Office and the World Bank, with OPM as the monitoring, evaluation, and learning partner. The purpose of this paper is to distil key learnings from the programme as a whole on how to best strengthen climate and hydromet services in South Asia, to inform the work of others, including similar programmes.

The paper starts by setting out in this section a schematic representation of the 'ecosystem' for climate services, capturing global best practice and learning from ARRCC regarding all of the formal and informal elements that need to be put in place for climate services to operate effectively. In Section 2 the key outcomes expected and achieved by the ARRCC programme are mapped against this framework. Section 3 consolidates learning on factors that have enabled and constrained the programme's progress in strengthening climate services. The conclusion ends with a set of tangible and actionable recommendations for others with a similar objective of strengthening climate services.

1.1 Climate services ecosystem

In this section we present a novel framework for the wider ecosystem for climate services, based on learnings from the ARRCC programme and wider literature. This framework situates the producers and users of climate services within the wider enabling environment within which they operate, and includes three elements (see figure and description below):

- The actual system for producing climate services which are used by different actors (the 'operation of climate services');
- The governance dimensions that help support and deliver effective climate services; and
- The wider political economy that influences and determines both of the above.

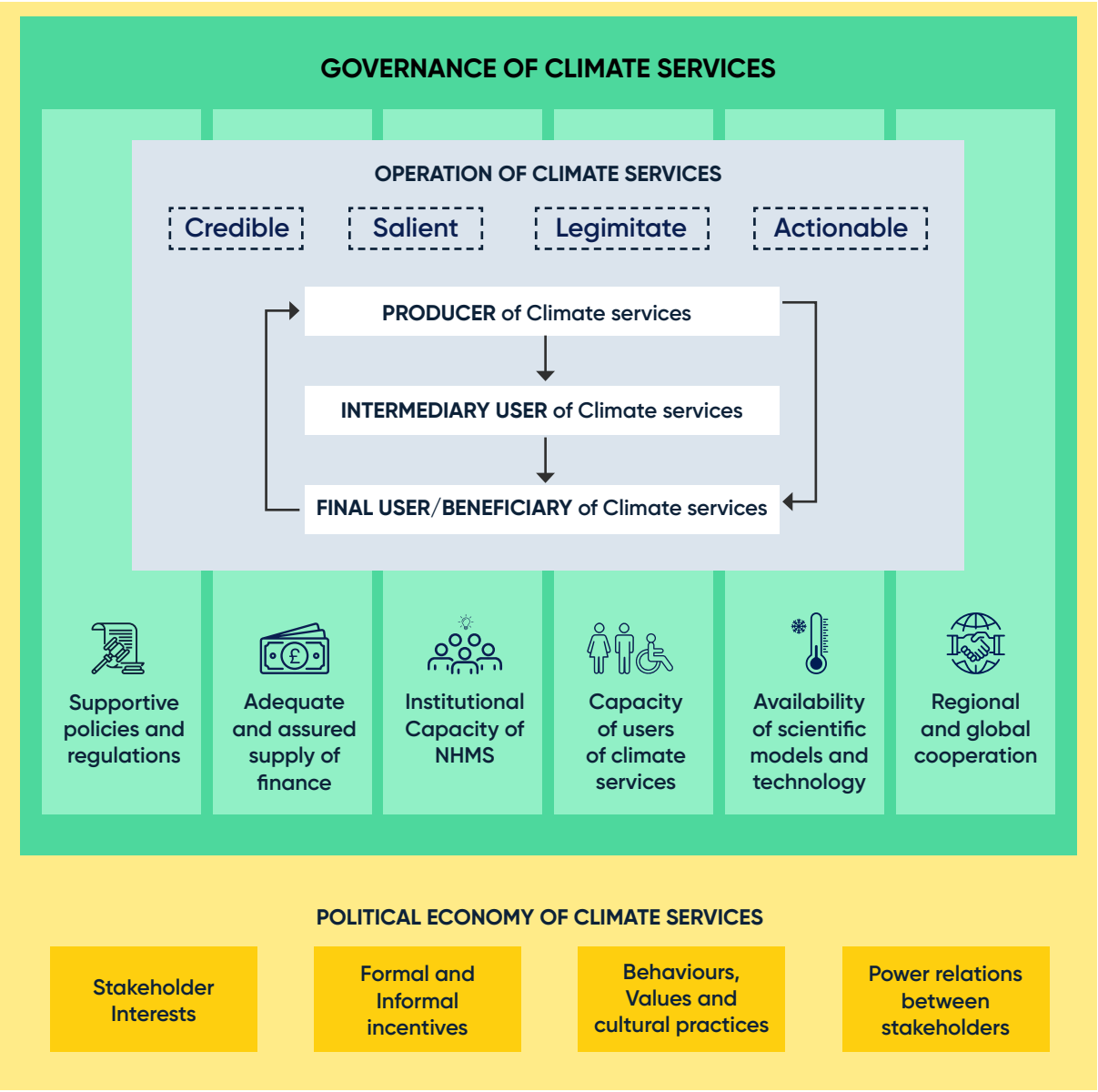


Figure 1 - Summary of the ecosystem for climate services

The operation of climate services

At the core of the ecosystem for climate services is the actual process of producing and using the climate information. This involves 'producers' using climate and other data and analysis to develop a climate information 'product', which is then disseminated to various 'users', who should integrate this into their decision-making. The users include sectoral government agencies, private sector organisations, non-government organisations, and individual citizens.

This is not a simple linear process of supply of and demand for climate information, as in many cases co-production of the climate information between producers and users is required or desirable. In addition, there are important feedback loops whereby users articulate their needs and requirements vis-à-vis climate services, as well as 'intermediaries' who make the climate information more relevant for a specific sector.

Effective climate services must meet the following criteria established by the literature (e.g. Ferdinand et al., 2021; Cash et al., 2006; REAP, 2022; Daly and Dilling, 2019):

- **Credible:** The service must be credible and robust, meaning the information provided is valid and evidence-based. The analysis therefore must be based on accurate data that come from dependable sources, and any uncertainty which exists in the findings should be clearly explained.
- **Salient:** The service must be relevant to the needs of the user, and the information provided must be aligned to the 'problem context'. For example, there is growing recognition that early warnings are essential for managing risks, but the warnings must be locally appropriate and effectively communicated to local communities to be effective (REAP, 2022).
- **Legitimate:** The service must be perceived as fair and ethical, meaning the process is transparent, unbiased, and inclusive of diverse participants and perspectives.
- **Actionable:** The service and the information must be understandable, timely, and actionable. Although the actual effectiveness of the climate service can only be evaluated ex-post, there are characteristics of the process and information that will suggest whether it is likely to be used.

These criteria link the process of developing the climate information, and its actual use and application (Cradock-Henry and Frame, 2021). They also cover all types of climate services, and are agnostic about the 'function' and 'form'.

The governance of climate services

The enabling environment within which climate services operate consists of a set of interconnected governance-related dimensions. These determine how effectively climate information is both produced and used, and the interaction between the stakeholders involved in the process. The following dimensions are therefore required to support and enable effective climate services:

Supportive policies and regulations: Climate services need to be enabled through a clear policy mandate, which provides a high-level political signal of their central role in the national climate strategy, and which authorise the roles and responsibilities of the different government agencies. Detailed policies and laws are also required to govern the production of climate services: for example, rules around the collection, storage, and sharing of data and overall quality standards (Ferdinand et al., 2021). There can also be a legal requirement to use climate information, to build demand for services among users, such as climate risk screening prior to approving any infrastructure budgetary allocation (World Meteorological Organisation (WMO), 2021).

Adequate and assured supply of finance: Long-term investment is essential for enhanced and sustained climate services, with not just the volume of finance being important but also its accessibility and longevity. Vaughan and Dessai (2014) note that relying on donor-funded projects is not ideal as regards maintaining the sustainability of services, and ultimately decreases their effectiveness. However, others argue that national funding streams cannot be expected to solely cover the costs, and supplementary sources will still be required (Kruczkiewicz et al., 2018; Hewitt et al., 2012).

Institutional capacity of NMHSs: Multiple capabilities and functions are required at the individual and organisational level to ensure climate services are effective, many of which are covered by the National Framework for Climate Services (WMO, 2018). These include the following:

- **Coordinating across stakeholders:** The relationship between different government and non-government organisations involved in both the production and use of climate services is at the core of an effective system for climate services (WMO, 2018). Institutional arrangements can facilitate the sharing of data and analysis, the co-production of climate information products, and the dissemination of products to potential users of the information. The National Framework for Climate Services recommends that formal coordination mechanisms be in place, including a user interface platform that brings together users, climate researchers, and climate information providers, who can thereby interact at all levels (WMO, 2018). However, effective climate services also require regular informal communication, and a general culture of working collaboratively and involving all relevant stakeholders (Kruczkiewicz et al., 2018; Hewitt et al., 2012).

- **Ability to continuously improve through monitoring and evaluation of the services:** NMHSs require systems for monitoring and evaluating both the quality of the climate information being produced and also the level of uptake of that information. Officials also need to be able to act on the findings, which includes having sufficient space for reflection and autonomy to adapt.

- **Flexibility to learn, innovate, and adopt the latest practices:** The science and technology involved in climate services is constantly evolving, and global best practice continues to emerge. NMHSs need to monitor these developments and have the flexibility to work with local and international experts to apply and adapt those considered to be relevant to the local context (Kruczkiewicz et al., 2018).

To deliver these functions, NMHSs require certain characteristics and capacities. Firstly, their roles and responsibilities must be clearly defined and accepted by all stakeholders, and codified in the policy framework. Secondly, a sufficient number of skilled personnel are required within the NMHS, which in turn requires a sufficient and sustained supply of finance. The skills required range from being able to develop and use the latest technology and scientific practice to being able to translate and communicate the science in simple, easy-to-understand formats. Thirdly, NMHSs require that the political leadership enables the necessary time and resources to be invested in climate services. Lastly, the informal culture, values, and ideologies of NMHSs also directly affect how they operate.

Capacity of users of climate services: The users of climate services – whether a government department or individual citizen – need sufficient capacity to be able to access, understand, and apply the climate information they provide. Effective dissemination and communication channels between users and producers are needed. Climate services targeting the most vulnerable and at-risk communities need to be particularly sensitive to their needs, resources, and knowledge (Ferdinand et al., 2021). For example, climate services are increasingly digital but producers need to consider the actual digital readiness of the target users.

Availability of scientific models and technology: Climate services require a supporting infrastructure in terms of both hardware (e.g. weather stations, drones) and software (e.g. global and regional models, data sets) (GFAS, 2014). This infrastructure needs to be available and also accessible, given the cost and the technical skills required to use it. For example, transparent or open data are essential for validation, interoperability, and providing free services to those most in need (Ferdinand et al., 2021).

Regional and global cooperation: In regard to transboundary hazards that are driven by regional weather and climate systems it is more efficient and effective to develop regional climate services. For this reason, the WMO is establishing Regional Climate Centres. Regional cooperation can vary in form and function, and in regard to the degree to which data and systems are shared across countries. There is also a need for global cooperation on certain issues, particularly in terms of access to global climate models and the transfer of best practices across regions.

The political economy of climate services

The ecosystem for climate services is informed by a set of political economy drivers that are specific to a given location. The political economy can broadly be defined as 'the processes by which ideas, power and resources are understood, negotiated and implemented by different groups at different scales' (Tanner and Allouche, 2011). The provision of information about climate change is inherently political and is impacted by the wider political economy

environment (Grimes, 2008). For example, highlighting the risk of flooding in tourist areas will likely reduce their investment value, and therefore the publicising of this information could be opposed by tourism operators.

There are four interrelated political economy drivers which affect both NMHSs' and users' ability and willingness to adopt and effectively operate innovative climate services:

- **The different interests of stakeholders involved in producing and using climate services:** This includes whether and how the interests and expectations of producers and users of climate services align, and how well they understand each other.

- **The formal and informal institutional pressures on the production and use of climate services:** NMHSs and different users face a range of day-to-day delivery pressures, and need to meet the formal and informal expectations of others. Public weather forecasts have always been sensitive, given their public nature. The pressure on NMHSs is also increasing, given the number of extreme weather events and the unpredictable nature of the weather, and the need to keep up with the latest technological advances in forecasting (Grimes, 2008).

- **The behaviours, values, or cultural practices related to climate services:** All policymaking processes are affected by a range of informal norms, such as the level of hierarchy and openness to external advice and influence (Gogoi et al., 2017). Decisions around climate services may also face multiple, potentially conflicting, sets of values and ideas about how climate change should be tackled, as well as specific norms around the involvement of the private sector and the transparency of data (Tanner and Allouche, 2011; Grimes, 2008).

  There are different opinions on what constitutes effective climate services. For example, the value given to downscaled climate forecasts depends on whether salience is prioritised over credibility, given that these forecasts are more aligned to the spatial priorities of local stakeholders but pose a risk of interpolation from coarse to fine scale. Cultural practices will determine whether local indigenous knowledge is incorporated into climate services, and what constitutes an 'inclusive' production process (Daly and Dilling, 2019).

- **The power relations within and between different stakeholders involved in climate services:** The co-production of climate services by producers and users has become a popular approach which aims to help ensure the services are usable. However, such initiatives do not always give sufficient attention to the power relations between these two groups (Daly and Dilling, 2019). Decisions about who is included in such participatory processes – given that, in theory, almost anyone can be a potential user of climate services – is fundamentally a political decision. Someone determines whose knowledge 'counts' (Chilvers and Kearnes, 2015). For example, cultural and gender norms can influence decision-making authority and differentiated access to assets, including land, financial credit, and technology (Ferdinand et al., 2021; Gumucio et al. 2020).

2. ARRCC's approach to strengthening climate services in South Asia

This section describes ARRCC's approach to strengthening climate services, and the results that were achieved. It also considers how the partners' own understanding of the problem has evolved, and whether the assumptions made during the design stage were valid. It highlights success stories, but also the factors which proved harder to influence.

2.1 The rationale for ARRCC

The programme's business case in 2018 – setting out the strategic value of FCDO funding for strengthening climate services in the region – focused on the following critical governance-related barriers that ARRCC aimed to address:

Institutional capacity of NMHSs: Forecasting accuracy in all countries in the region was poor at the time, with the exception of India – although even there gaps remained in regard to the effective transmission of forecasts to end users. This was due to poor relationships and coordination with other government ministries, and a lack of staff who were able to produce the data needed – particularly conveying regional information to local levels. There was also a lack of capacity in NMHSs to articulate the value of climate services and to develop value-added services.

Capacity of users of climate services: The business case states that 'current forecasts and other climate information services do not meet user's needs' (FCDO, 2018), and noted the lack of appropriate organisational incentives to encourage NMHSs to be responsive to user needs. User groups also tended to not be aware of the available services and their potential benefits, and lacked the capacity to understand, value, and act on this information. There were limited opportunities for users to articulate their needs to NMHSs, and the most vulnerable and at-risk communities, who have the most to benefit from climate services, often struggled to be heard and to get their needs met.

Lack of an adequate and assured supply of finance: There was insufficient funds for operational expenditure, including equipment and staff. In general, climate services were undervalued in South Asia, and therefore, unlike in Europe and elsewhere, NMHSs were unable to generate sustainable sources of revenue.

Regional and global cooperation: The business case highlighted the lack of regional coordination and cooperation, and that 'regional data sharing is ineffective and low confidence in the quality of forecasts leads to its reduced use' (FCDO, 2018).

2.2 ARRCC's entry points for strengthening climate services

The programme developed a theory of change (ToC) (see Annex II) for how it would address the key barriers to realising the full potential benefits of climate services. The ToC includes a broad set of change pathways related to building the institutional and individual capacity of both producers and users of climate services, strengthening partnerships within and across countries, and developing systems and tools that enhance the dissemination and uptake of climate services. The two delivery partners, the UK Met Office and the World Bank, designed diverse interventions that contributed to achieving the programme's expected outcomes.

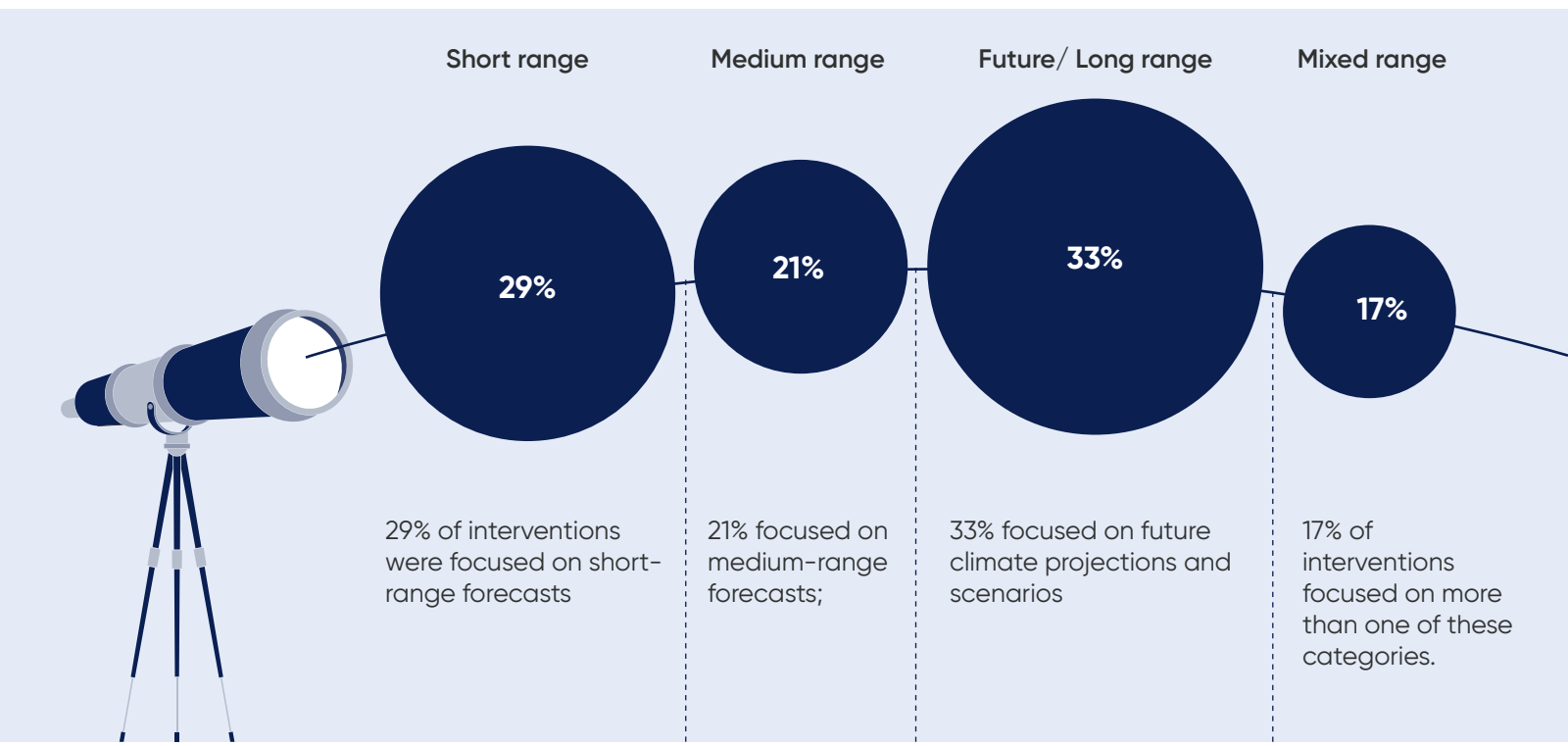
This learning paper does not evaluate whether the programme achieved its expected outcomes, although learning generated from the mid-term review is referenced (OPM, 2021). It instead uses bottom-up learning from the interventions under the programme to understand the challenges in the process of strengthening climate services, and learning about how to overcome them. It first maps the interventions against a series of different factors, and then provides examples of where success was possible.

2.2.1 Mapping of ARRCC interventions

In Annex I the majority of the programme interventions (24) are mapped in terms of their geographic location, the type and timeframe of the climate services which were targeted, and which part of the climate services ecosystem they were focused on. This analysis is based on the number of interventions mapped

against certain criteria, rather than the volume of funds, and as such is not a complete picture of the priorities of the programme[1].

Type of climate services: The programme supported a wide variety of types of climate services, such as macroeconomic forecasting of climate impacts, sea level rise projections, seasonal agricultural advisory products, and daily forecasts of wheat rust outbreaks. The climate services being strengthened were spread across the three timeframes[2], which sets ARRCC apart from most other climate services programmes, which tend to be focused on just one of the three:



Geographies: Most of the interventions took place at the regional level (46%) or in multiple countries (33%), while 21% operated in a single country in the region. The figure below summarises the geographic spread of the programme, and the number of interventions operating in each country[3].

[1] In addition, this analysis has been drawn from the results framework and initial plans of the interventions. In some cases the design of the interventions evolved during the course of the programme, and as such the focus may have changed from these initial expectations.

[2] Short-range forecasts (minutes-days-week) include impact-based forecasts (IBFs) and weather forecasts; medium-range forecasts (fortnight-month-seasons) include seasonal forecasts; and future climate projections and scenarios (decadal and longer) include climate change vulnerability assessments.

[3] The programme had to adapt given security and political considerations in some of these countries; interventions in both Myanmar and Afghanistan were halted during the course of the programme.

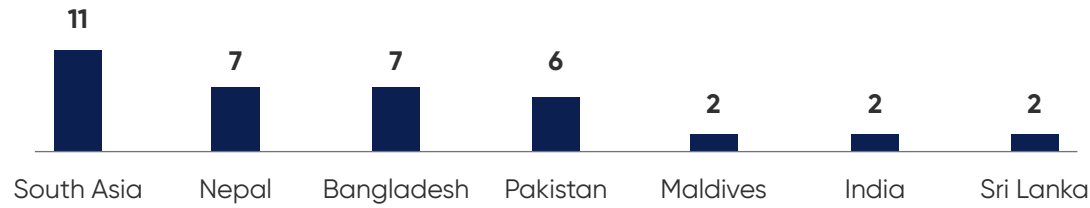


Figure 2 - **Geographic coverage of ARRCC interventions (based on mapping in Annex I)**

Stakeholders: The interventions were aligned with the priorities set out in the business case, with a near equal division between those working with producers and those working with users of climate services: 29% of the interventions worked most closely with producers of climate services, 25% with users, and 46% with both.

Governance: The figure below illustrates which of the governance dimensions the interventions focused on (with each intervention being tagged to up to three dimensions). Half attempted to strengthen the institutional capacity of NMHSs, and more than half sought to make scientific models and technology more available. Only one intervention aimed to strengthen the policy and regulatory framework for climate services as a priority focus, and none were primarily focused on mobilising additional sources of finance for climate services (although others may have been directly or indirectly influencing these dimensions, and the programme leveraged significant amounts of financing).

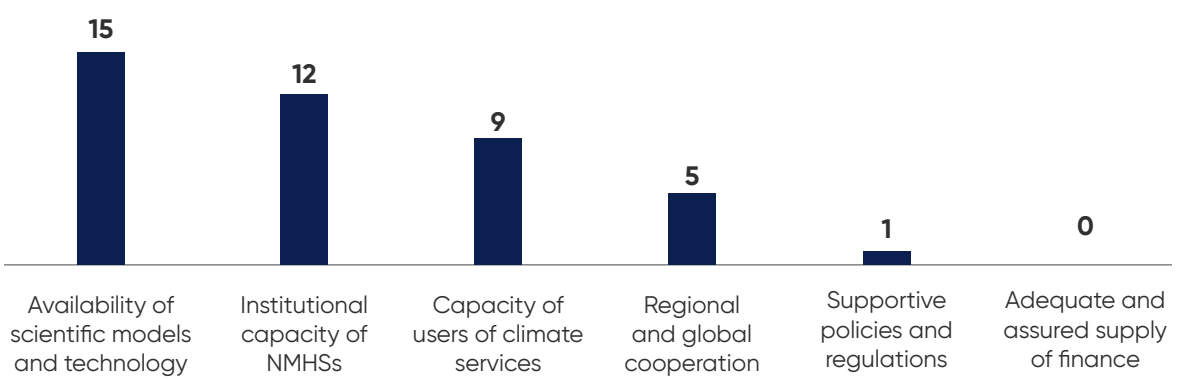


Figure 3 - **The number of interventions focused on different governance dimensions**

Political economy: It is difficult to identify whether and how interventions were focused on influencing the political economy, as this was usually seen as a necessary condition of achieving the intended purpose, rather than a direct focus. Only one intervention appeared to have this as a primary focus, while 44% of all interventions had a secondary focus of influencing a political economy dimension (mostly related to informing stakeholder interests).

In conclusion, ARRCC worked across the 'ecosystem' for climate services, including a relatively equal distribution of attention to producers and users of climate services, and across different types of climate services. This breadth, together with the geographic spread, makes the programme an interesting source of learning. The interventions were focused on a much wider set of governance dimensions than those articulated in the business case, which suggests that the partners' understanding of the problem evolved from the design stage.

2.2.2 Mapping of results

While the focus of the learning paper is not to evaluate the success of the programme, it is useful to reflect on where results occurred, to help frame the learning findings. An accompanying 'stories of change' document also provides some examples of the actual impact of the programme. ARRCC as a whole resulted in 2.3 million people having better access to climate services, with clear evidence that it has kick-started transformational change for certain climate services (FCDO, 2023). Looking across the interventions, there was also progress in addressing each of the three parts of the system for climate services (i.e. governance, operations, and political economy). However, the results tended to relate to a specific type of national-level climate service (for example, a new or enhanced system of seasonal forecasting or an early warning system), as opposed to strengthening capacity or operations across the full spectrum of climate services.

Strengthening the operation of climate services: The programme led to 13 new systems and tools for climate services being implemented, with a further 35 expected to start implementation shortly. These include early warning systems, as well as the piloting and uptake of innovative new technologies. Some examples of results are provided in the table below, organised in terms of the three time horizons.

Strengthening short-range forecasts	Strengthening medium-range forecasts	Strengthening future climate projections
A new early warning system for wheat disease forecasting is providing warnings and advice to 500,000 farmers in Nepal and Bangladesh. The new system is protecting farmers' livelihoods and local food security from fungal diseases such as wheat rust and wheat blast. These diseases are spreading faster and further due to climate change and can destroy entire wheat harvests (in 2016 wheat blast affected over 15,000 hectares in Bangladesh). The new system combines weather information with field surveillance data from mobile phones and disease spread modelling to submit near real-time wheat disease advisories directly to farmers' phones and through radio and other mediums.	Seasonal forecasting in the region has been strengthened through more advanced scientific practices and better access to data. NMHSs are now using more evidence-based and scientific practices for seasonal forecasting as a result of innovations that have been developed and disseminated the South Asian Seasonal Climate Outlook Forum (SASCOF). For example, 73% of a sample of target users reported that a new prototype Seasonal Outlook Consensus Statement that incorporates the latest scientific techniques, to guide national forecasts, is very useful for their work.	In Pakistan, climate scenarios are now based on better data, and are more integrated into decision-making processes. The Pakistan Meteorological Department is now using specially adapted 'Climate Grid' software (first developed in the UK), using data from 100 weather stations to produce grided climate data to help construct and evaluate climate projections. In addition, the Ministry of Finance and Planning is using the findings of two new macro-fiscal models with a climate change module to analyse the economic implications of decarbonising and the budgetary implications of adaptation actions.

Table 1 - **Examples of results in strengthening the operation of climate services**

Box 1

Early warning for landslide risk in Nepal

Landslides are an annual occurrence in mountainous Rasuwa District in Nepal; however, exactly when they will occur has always been difficult to predict. The District Disaster Management Committee previously had no scientific method of forecasting landsides and other impacts from heavy monsoon rainfall. A new IBF service developed and piloted under the ARRCC programme now enables local governments to make decisions on whether to relocate households based on a trusted assessment of the likelihood and potential impacts from monsoon rainfall, including landslides.

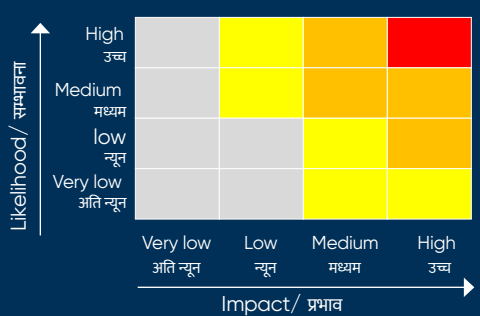
The IBF service was co-developed and operated by the Department for Hydrology and Meteorology (DHM) and National Disaster Risk Reduction and Management Authority following the tragic deaths of 300 people from monsoon landslides in 2020. With technical support and training from the UK Met Office, the pilot IBF service covered 700,000 citizens across four districts.

The IBF service was quickly put to use and shown to be a valuable and potentially life-saving new service for the local community. On 24 June 2022 DHM issued a warning that rainfall that was capable of causing impacts, including landslides, was forecast for Rasuwa District. The warning used an impact matrix system (with the likelihood of impacts plotted against the severity of impacts), supplemented with text to explain the weather forecast and the expected impacts, as well as advice for taking mitigating actions. The text was developed in consultation with local stakeholders on the specific impacts which might typically be experienced as a result of monsoon rainfall, including assessments of local vulnerabilities that could affect the likelihood, and severity, of the impacts.

The warning was sent using emails, Viber group messages, and phone calls to pre-assigned focal persons from government and civil society. This prompted the officials to closely monitor an area considered at particular risk, in Uttergaya Rural Municipality. When a house was swept away by the landslide on 26 June, these plans kicked in, with 21 households being relocated to a safer zone. These households were given tents and/or tin shelters for temporary settlement but many stayed with relatives in other areas (see the photos of this relocation process below).

Over three days, 52.4 mm of rainfall was recorded in the area, of which 30.7 mm happened in a single day, but there was no loss of human or animal life from landslides. This shows the benefits of an IBF warning system over traditional threshold warnings. Previously, this amount of rainfall over three days may not have been enough to warrant a warning but when combined with knowledge of local conditions and historical experience the risk was more accurately assessed.

'We followed up with local officials after issuing the IBF warning. They made the decision to relocate the 21 houses based on our warning as well as their past experience of landslides in that area. Our warning did not take them by surprise, they were already alert to the risks and were considering what action to take. The warning helped speed up their decision-making and give them greater certainty. We expect the new service to continue to save lives and protect livestock.' Mr Samir Shrestha, Senior Divisional Meteorologist, DHM, Nepal.



Strengthening the governance of climate services: Examples of the results of the ARRCC programme in this area are provided in the table below for each of the governance dimensions.

Dimension	Examples of results
 **Supportive policies and regulations**	**The programme did not have a strong focus on strengthening the policy framework for climate services, but it did influence wider policy discussions.** It used a new model and analytical approach to promote a coordinated approach to air quality management across the Indo-Gangetic Plain. In Pakistan the NMHS was influenced by research on sea level rise to create a working group bringing together government departments, the navy, and research institutes to plan how they should respond to this new evidence.
 **Adequate and assured supply of finance**	**The programme leveraged and worked with £1.2 billion of other donor-funded action on climate services.** New analysis on air pollution, using a customised modelling tool, across the Indo-Gangetic Plain, reportedly informed the Government of India's decision to invest over £1 billion in tackling urban air pollution. The World Bank used its trust fund approach to link to and inform £1.2 billion of wider investments in hydromet and disaster risk management services in the region.
 **Institutional capacity of NMHSs**	**Institutional capacity was developed across a range of climate services.** 12 government partners reported that, as a result of targeted training, and also technical assistance and mentoring, they are better equipped as an organisation to produce and use particular climate services. Over 1,200 individuals were trained on a wide variety of new skills and tools, and over 90% of a sample reported that the experience was useful/very useful. For example, the Bangladesh Meteorological Department reported new seasonal forecasting capability, particularly in the agriculture sector, and they convened for the first time a Winter Agromet Forum.
 **Capacity of users of climate services**	**Users were supported to define and co-develop new and enhanced climate services.** Climate Service User Forums were established under SASCOF as a shared platform for sectoral national ministries and other users to express the type and granularity of climate information they require for decision-making and planning, and for NMHSs to understand and communicate the possibilities and limitations of developing such forecasts/advisories. In turn, National Climate Outlook Forums were supported to utilise SASCOF outputs at the national level and for specific sectors.

 **Availability of scientific models and tools**	**Most of the interventions involved providing NMHSs, or user groups, with better information to aid their decision-making.** NMHS are now using a regional data portal provided by WMO Global Production Centres to improve their national forecasts. In Bangladesh a system was developed for incorporating local-level variations in simulation models of sea level rise in the river basin. in Pakistan a new gridded data tool for verifying forecasts was created for the NMHS using software adapted from that used in the UK. Two challenge funds were used to identify and pilot new technologies that could build resilience to climate and extreme weather events. Under the TechEmerge Resilience Challenge, seven innovations addressed both climate-related disaster risks and Covid-19 challenges and were adapted and piloted by private entrepreneurs with State/District Disaster Management Authorities in India. For example, https://www.quantela.com/#!/dashboard."Quantela's COVID-19 Emergency Response Platform (CoVER) is an integrated command and control centre for crisis management which also streamlines the collection of high-quality data; applications allow community members to access critical information and contribute localised data.
 **Regional and global cooperation**	**Regional forums were an effective route to strengthening communication and learning between NMHSs.** The South Asia Hydromet Forum (SAHF) was transformed into a government-led network of both producers and users of climate services in the region that is delivering joint initiatives, such as strengthening observational networks and IBF systems in the region, and managing a new regional training platform.

Table 2 - **Examples of results in strengthening governance of climate services**

Box 2

Building an early warning system for wheat diseases

Wheat diseases are becoming a more common menace for farmers in South Asia as climate change affects weather patterns. They can spread quickly across large distances and destroy an entire crop within less than a week. In 2016, 15,000 hectares were affected in Bangladesh.

Farmers are able to manage the risk of wheat disease by applying fungicide, but this is expensive and is only effective if it is applied at the right time. A new early warning system is now up and running in Nepal and Bangladesh that delivers forecasts about wheat rust disease to farmers' phones. It uses weather information, along with field surveillance data and disease spread modelling, to provide seven-day forecasts on a daily basis, with accompanying weekly advisories.

Setting up the early warning system was a truly global effort. The International Maize and Wheat Improvement Center (CIMMYT) used their existing local partnerships to develop the system, using their experience of developing a similar system in Ethiopia. The UK Met Office and the University of Cambridge provide the weather forecasts and disease spread modelling, respectively. The centre is fully integrated within the existing agro-advisory systems in each country. National government research and agriculture organisations operate both the surveillance network that feeds information into the system and the dissemination of the advisories to farmers. In 2022, a regional model was added to the national systems, making it a truly transboundary early warning system. This allows for faster, regional-level identification of new threats that enables more timely planning and control at national levels.

Well over 500,000 farmers are receiving the advisory information, although this likely underestimates the actual reach of the system as farmer-to-farmer sharing of advisories is widely reported.

"There was no formal forecasting system in place pre-ARRCC. Informal forecasting was done by NARC [Nepal Agriculture Research Council] using our own data. The ARRCC project gave us information on how early to start monitoring, which was a couple of weeks earlier than what we did before. … We also now know that yellow rust strains are coming in from the western part of the region, from Pakistan and India, and so when it appears in neighbouring countries we now know we should start monitoring here."
– Nepal Agriculture Research Council (NARC) official

In terms of the **political economy of climate services,** very few of the interventions under the ARRCC programme had the specific objective of influencing or strengthening the political economy of climate services. As such, it is not possible to identify relevant 'results'. Instead, how the political economy affected, both positively and negatively, the delivery of the programme is discussed in Section 3.

3. Learning from ARRCC on strengthening climate services in South Asia

This section consolidates the key learning findings from the programme about how to strengthen climate services in the region. This includes the enablers that can help facilitate progress and the challenges that need to be managed. The learning findings cut across the three parts of the ecosystem for climate services.

3.1 Factors that enabled progress in strengthening climate services

A broad range of factors enabled the programme's interventions to deliver their intended outcomes. These were mostly internal factors related to specific strategies the delivery partners used to influence decision-making and practice. Some of these featured in the initial design of the interventions, reflecting the prior experience and knowledge of the partners, while others were adopted during the course of delivering the programme in response to challenges that arose. This section highlights those factors which could be relevant and applicable to other programmes that aim to strengthen climate services.

Enabler 1: An increasing interest among both producers and users in improving and diversifying the climate services available

ARRCC benefited from the ongoing trend of greater political and bureaucratic attention being given to climate change and the need for better information about climate risks. Political leaders were keen to project, both domestically and internationally, their commitment and action on climate change. They were generally supportive of the programme and provided important political backing by attending and inaugurating events, including when they were otherwise focused on dealing with the Covid-19 pandemic. For example, several national and sub-national leaders inaugurated the Climate Outlook Forums. This helped the programme gain media attention and made other government stakeholders more willing to participate.

Different user groups have also become more informed about climate risks and are therefore requiring more and better climate information, and are expecting

more from climate service providers. However, there are still different levels of awareness of the benefits of climate services, ranging from agriculture sector stakeholders, who in general are highly aware of the physical risks presented by changes in the natural environment, to transport and health sector stakeholders, who tend to be relative newcomers to issues of climate resilience. In regard to SASCOF, the level of government engagement and interest in the forum has certainly increased: in 2020 SASCOF held four instead of the usual two sessions.

At the same time, over the last two decades there has been a shift in how NMHSs in the region view their role, with greater recognition that the 'service' they provide goes beyond producing climate information and extends to doing everything possible to make sure it gets used. The WMO has also promoted discussions on the future of NMHSs and the need to reaffirm the value of the information they provide by ensuring this information has a clear purpose for individual and organisational decision-making (WMO, 2021). In many cases the NMHSs were therefore eager to partner with the programme to improve the effectiveness of their services.

Enabler 2: Investing time and resources in building communication and coordination between users and producers

Many of the interventions supported a co-development process involving both producers and user groups coming together to design and establish a new or enhanced climate service. The concept of co-development was relatively novel, and institutionalising it was a major focus of the programme. The starting point for building the trust needed between producers and users was to help NMHSs understand the interests and needs of their users. Some NMHSs could not initially answer the delivery partners' question: 'how are your forecasts being used?'. One had a clear idea of who their users were but had not reviewed whether they were meeting users' needs. Partners therefore had to initially invest time and resources, often exceeding what was initially planned, in facilitating communication between these different stakeholders. In one country, the delivery partner facilitated (without realising this in advance) the first ever discussion between the NMHS and a key government department 'user group'.

After trust had been developed between the users and producers, expectations had to be managed and aligned in regard to what climate services can actually deliver. Many government 'users' were able to provide a wish list of

what climate services they would like from NMHSs. However, this was often unrealistic given the capacity and technological constraints. In one country, some local governments were asking the NMHS to provide a forecasting service that would only be feasible if the local government itself was collecting the required data and information, which it was not. Formal and informal 'training' helped to raise awareness among user groups on what forecasting is, and what it is not, and the type of information it requires from user groups.

As the co-development process got underway, it was important to make sure that the responsibility and accountability for the service was 'owned' by all the stakeholders involved. For the IBF pilots, it was crucial at the beginning to make clear that if the accuracy of any forecast is questioned no one single stakeholder will be criticised. This is fair given that the accuracy of the forecasts depends on the information that is fed into it by the different organisations.

Build trust	Facilitate communication to understand needs and interests of different stakeholders
Align expectations	Reach agreement on a feasible scope for the climate service given data and technical constraints
Share responsibilities	Position the climate service, and the associated risks around it, as a shared responsibility

Figure 4 - **Three important features of the co-development process**

Enabler 3: Going beyond being responsive to government partners to putting them in the driving seat

For some of the interventions that had the most notable success, government partners were key decision makers in regard to their design and delivery. Both SASCOF and the SAHF benefited from having NMHSs as decision makers in their governance, therefore ensuring they remained demand driven. There was a noticeable difference between the first SAHF, which had the feel of a World Bank-led initiative, and the ones that followed. After gathering initial interest at the first forum, the participating governments were asked to share their priorities

for the SAHF. These priorities were then incorporated into the agenda of the forum going forwards. A governance mechanism institutionalised the demand-led nature of the SAHF, with an executive council involving seven government representatives and working groups that are defining and delivering technical work.

The interventions used different models to attempt to be truly demand-led. To govern the wheat rust forecasting system, advisory groups were established in both Nepal and Bangladesh comprising national agricultural institutions which provide regular feedback on the content, format, and usefulness of advice. For the challenge funds, the government partners were decision makers in the design process of the funds and the selection of the innovators, resulting in a high level of ownership in the process. For example, the digital Parametric Flood Insurance product was piloted in Nepal with the close collaboration of the government, which resulted in quick approval by the regulatory agency; as a result, 200 applicants, all female, had already been issued insurance by 2022.

Putting government partners in the driving seat of the ARRCC interventions meant that local political considerations took centre stage. Such an approach can have positive effects: for example, a recent disaster can create a political window of opportunity to introduce innovation and reforms in climate services. In Nepal a series of devastating floods and landslides in recent years prompted the reshaping of national institutions and policy frameworks for managing disasters, and the newly created National Disaster Risk Reduction and Management Authority had a specific mandate to work with the DHM to strengthen forecasting services. The political pressure on both organisations meant they were open to new ideas, including establishing an IBF pilot. It was also relatively easy to get buy-in for introducing an enhanced wheat forecasting system because both Nepal and Bangladesh had suffered from severe wheat disease outbreaks in recent years.

However, there were also political considerations that defined the scope and design of the interventions, and, in particular, the extent to which they were willing to collaborate with other governments in the region or make data and information publicly available. It would have been logical to design the wheat rust forecasting system from the start as a regional-level forecasting and advisory service, but geo-political issues meant national-level pilots had to be the starting point, and a regional modelling component was only added at

the final stage. NMHSs also remained cautious about working with the private sector on some issues, and some feared an encroachment into their domain. However, the challenge funds demonstrated how private and public solutions can be mobilised (see box).

Box 3

Harnessing technological innovation to reduce the risk of disasters

Through the power of crowdsourcing, the World Bank found 539 innovators with a technology or innovative practice which they believed could strengthen resilience to the impact of climate-related disasters in South Asia. Two challenge funds – the Climate Innovation Challenge and the TechEmerge Resilience Fund – brought together the public and private sector to co-adapt and 'test' the viability and benefits of 23 of these innovations.

Technological entrepreneurs and government decision makers are not natural partners. They appear to speak a different language, with one speaking about 'consumers' and the other about 'citizens'. Governments are traditionally cynical about the motivations of private companies, given their profit-driven rationale. However, the challenge funds showed that if you put these two groups in a room together they can recognise and respect their respective strengths and work together to find a common approach to fixing a problem. The TechEmerge Resilience Fund for India even described this as 'match-making' between seven tech entrepreneurs and the State Disaster Management Authorities in Uttarakhand and Himachal Pradesh.

The innovations demonstrate the huge variety of ways the private sector and technology can provide communities with accurate and useful information on climate and disaster risks. for example:

- The OWL's Ducklink provides a cost-effective, easy-to-use, and rapidly deployable wireless communications infrastructure that can provide first responders with critical networking capacity.
- The Small Island Geographic Society's Heyli is a mobile application that utilises citizen science and crowdsourcing to gather data on coastal erosion and flooding in the Maldives, which is used to develop maps and statistics to support development planning and further research.

- In Bhutan, Geoneon piloted an innovative approach to automatised land-use segmentation on satellite imagery using deep learning algorithms to help a district administration to understand the extent of hazard-prone areas and the vulnerability of infrastructure to multiple hazards.

These are just a few of the 23 innovations that were piloted through the Climate Innovation Challenge (www.adpc.net/cic/) and TechEmerge Resilience (www.techemerge.org/initiatives/techemerge-resilience-india/)

Enabler 4: Focusing on local and regional 'intermediaries' who can influence the producers and users of climate services

Intermediaries are loosely defined as those organisations which sit between producers and users of climate services, who facilitate the circulation of useful knowledge between them (Webber, 2019). ARRCC worked with a range of different types of intermediaries, which proved to be an effective route to strengthening the overall system of climate services. The important role of intermediaries was not considered in the programme's ToC, and many of the interventions initially considered these organisations simply as implementing partners. However, it emerged that strengthening the capacity and role of these intermediaries was of value in itself, and delivered a wider set of benefits than was initially expected.

Most notably, the Regional Integrated Multi-Hazard Early Warning System (RIMES) has contributed to strengthening both SAHF and SASCOF. As an inter-governmental organisation, RIMES offers a clear and legitimate governance structure, networks, and reach at the national level, but it also has technical capabilities relating to training NMHSs, convening stakeholders, as well as packaging and communicating climate information directly to different users. RIMES reported a significant benefit from its involvement with ARRCC, in particular due to the increased visibility and profile which came from its enhanced involvement with the SAHF and SASCOF. As a result, it has evolved from being an organisation focused on hazard and impact forecasting to now offering a range of integrated services for resilience building.

RIMES' capacity also increased as a result of having stronger relationships with its member governments. For example, it had been struggling for years

to receive localised data from NMHSs to allow it to deliver more downscaled modelling outputs. The programme has strengthened RIMES' relationships with NMHSs and individual officials and it has now finally received these data and is able to provide more useful integration services to them. RIMES' partnership with the UK Met Office for strengthening SASCOF also built its technical capabilities in regard to communicating forecasts and introduced it to more innovative and applied training methods which it has replicated elsewhere.

"The SAHF and SASCOF have helped deepen the relationship between RIMES and the member governments. I get responses to my emails requesting information or participation within a week. Even in the Covid situation, when everything is locked down. In the executive meetings, all the Director Generals actively participate. They are coming to us with new demands. For example, Nepal requested our help with forecasting fog. This was a new area for us, so we reached out to another government in the region to provide the requested assistance." Govindarajalu Srinivasan, PhD, Chief Scientist – Climate Applications, RIMES

Enabler 5: Using learning, both formal and informal, from other innovations and programmes

A number of interventions benefited from their design being based on, or inspired by, similar projects in other geographies, although customised to the local context. For example, the UK Met Office is also implementing a similar programme on climate services in East Africa ('Weather and Climate Information Services for Africa') but it worked closely with RIMES, the Regional Climate Centre Pune, and other local partners to tailor the products, platforms, capacity building, and user offerings it was providing via SASCOF. Foundational elements of the wheat rust forecasting model and the phased approach to its roll-out were derived from a crop disease forecasting project in Ethiopia, with local input data and output formats contributed by Bangladeshi and Nepalese agricultural research and extension agencies.

The use of positive case studies from other countries helped demonstrate to wary government officials that a new approach to climate services could work and that the risks could be mitigated. The most effective examples in this regard were those from other countries in South Asia, which is why the programme strengthened regional forums as a vehicle to showcase these experiences. For example, countries in the region vary in the extent to which they use modern scientific approaches to forecasting, and SASCOF provides a platform for

NMHSs to learn from their neighbours about the detailed technical advances that are possible. However, for many of the climate services being piloted or promoted under the programme, such as IBF, there were no relevant examples from other developing countries. It was much more difficult to convince partners that an example from the UK or another industrialised country was viable for South Asia. Going forward, the delivery partners will use examples developed under ARRCC to spread these good practices to other developing countries.

The programme also leveraged the sense of community that exists among NMHSs around the world. The WMO is held in very high regard, and its backing of some of the solutions being offered by the programme was immediately respected. There is also a strong shared identity among NMHSs around the world, which helped the UK Met Office to connect on an individual level with its counterparts in the region.

Enabler 6: Experimenting with different, tailored approaches to capacity building

The programme used a nuanced approach to capacity building, going beyond formal traditional training sessions. The regional forum convenings allowed NMHSs and others to learn formally and informally from each other: for example, one official reported that they had learnt about the pros and cons of the new version of the Climate Predictability Tool from a counterpart during the informal interactions on the sidelines of SASCOF, which helped them decide whether to invest in the tool or not. Technical delivery was often linked to capacity building: for example, the Institute of Water Modelling in Bangladesh viewed their partnership with the UK Met Office on a sea level rise study as primarily a capacity building exercise for them but one which also delivered useful new analysis to the government. There were also more subtle ways the programme strengthened skills and capacity: for example, by involving NMHSs as co-authors or peer reviewers of technical reports, which meant they were more likely to absorb all the details, as compared to their just reading the final product.

Some interventions were able to overcome the ongoing challenge of investing in building the skills of an official only for them to be transferred to a different department. Under the SAHF, partners engaged both high-level officials, who more regularly get transferred, as well as technical experts, who tend to be more permanent employees of an agency. The technical experts also became comfortable with communicating directly with counterparts in other countries in the region, partly because their seniors in authority had already

committed to working together under the platform. The programme also helped institutionalise capacity development and build upon existing training systems. The Regional Training Programme developed under the SAHF and implemented by RIMES will continue to deliver training sessions requested by NMHSs beyond the lifetime of the programme.

Enabler 7: Adopting a partnership model for the delivery of the programme

All of the interventions relied on multiple partnerships, not just between the delivery partner and the producers and users of climate services, but also with organisations that helped the delivery partner implement the intervention. These implementing partners ranged from international technical partners (e.g. the University of Cambridge, CIMMYT) that provided specialist technical expertise, to regional (e.g. the Asia Disaster Preparedness Centre) and local research organisations (e.g. the Nepal Agriculture Research Council). Implementing partners emerged as one of the most critical determinants of the effectiveness and likely sustainability of an intervention. In some cases, the original idea and design of the intervention originated with them, and often relied on their existing relationships with the expected users and beneficiaries. For example, CIMMYT's past work in Bangladesh and Nepal enabled the wheat rust forecasting system to be up and running relatively quickly. A number implementing partners reported that they themselves had benefited through increased capacity and new partnerships.

The delivery partners – the World Bank and UK Met Office – also leveraged their wider capabilities and resources to support the delivery of the interventions and the wider objectives of the programme. The World Bank intentionally designed its interventions to build upon £1.2 billion of wider investments in hydromet and disaster risk management services in the region. For example, the new integrated modelling tool for climate and macro-fiscal policy, which was developed in Pakistan under the programme, is now being used by the World Bank in 30 other countries to develop Climate Change Diagnostic Reports, which will define future investment strategies. The UK Met Office in turn utilised its reputation as a global technical leader, including within the WMO, to convene and engage NMHSs in the region.

3.2 Factors that constrained progress in strengthening climate services

The interventions faced a number of challenges in delivering their planned activities and achieving the expected outcomes. Many of these took the form of political, bureaucratic, and logistical issues that are common across large development programmes (e.g. regular turnover of government officials, unexpected elections), although the issues presented by the Covid-19 pandemic (see Box 4) could not have been predicted.

Most of the external challenges related to the governance and political economy constraints which the programme itself expected to address. These were often known to partners, but the design of the interventions did not always explicitly and directly focus on addressing them – at least not until it became apparent that the constraints were a barrier to achieving the expected results. The interventions therefore had to 'learn by doing' in terms of finding the best

way to address these barriers. For example, the limited coordination between NMHSs and other government partners was understood in principle, but tackling this was not per se the primary objective of most of the interventions. However, it often became apparent that the limited flow of information between these organisations was a critical barrier to achieving the intended purpose (e.g. establishing an IBF pilot), and, as such, building trust and communication became a more immediate and central objective.

Constraint 1: NMHSs tend to be risk averse

Climate services providers are the first to be criticised if a forecast turns out to be wrong, which has created an institutional culture of being risk averse. This manifests itself in different ways. Firstly, NMHSs tend to be cautious about broadening the scale and type of climate services they provide, as doing so opens themselves up to even more potential criticism. Therefore, under ARRCC they were more immediately interested in opportunities to adopt new techniques that could increase the accuracy of their existing forecasts (e.g. through the SASCOF platform), but needed some convincing to try new and innovative services. It took much longer for the UK Met Office to gain support from government partners in Bangladesh and Nepal to try something completely new and to develop IBF pilots, as compared to the relatively quick process for CIMMYT in regard to obtaining interest in strengthening and expanding an existing wheat forecasting system.

This risk-averse culture also affects the actual operation of climate services. In terms of issuing seasonal forecasts and longer-term projections, NMHSs are wary of being alarmist and are nervous about issuing 'severe' warnings. The science is never black and white and there are often conflicting indicators and inherent uncertainty. This requires NMHSs to use their judgement in interpreting the science and there is a tendency to favour less extreme versions. This is why the programme focused on making the forecasting process more objective and standardised, and establishing the rule that if an official deviates from the standard process, the reasons why need to be clearly documented. For the IBF pilot, NMHS officials preferred to report all potential impacts from the extreme weather forecasted, even those that were experienced regularly, to avoid any risk of criticism. This was managed by institutionalising protocols on what to report, but also by establishing a culture of shared responsibility and accountability across the different organisations involved in the pilot.

Constraint 2: Capacity limits meant relying on a small number of government officials

One overriding capacity constraint remaining across all the NMHSs, and many user government departments, is a limited number of officials. Although the programme was effective in increasing the skills and capabilities of these officials, the fact that their absolute number remained insufficient means the capacity of the overall organisation remained a challenge. This meant that the success of the programme relied on there being incentives for government officials to take on additional work, above and beyond their already full workloads. In some instances individuals recognised the benefits of being involved in the programme for their own career progression and to help get them noticed within their organisation. Forecasters in particular also tend to have considerable pride in their work and contribution to society, which meant they were keen to improve the service they were providing. The government officials also witnessed the personal investment of the partners – for example, being personally involved in developing a forecast and being available at all times to answer questions and offer advice – which in turn motivated them to commit fully to the programme.

However, because the interventions were often reliant on the goodwill of the individuals involved, there were times when it felt like the delivery partner was the one 'pushing' the initiative, rather than being a support function for the organisation's own priorities. For example, the intervention relating to a wheat rust forecasting system recognised that a vital next step is to institutionalise the service within the government, so that they do not just use it but also own it.

Constraint 3: The 'benefits' of the programme had to be distributed fairly

The programme provided a number of perceived or real personal and institutional benefits that might have caused tensions if they were not fairly distributed. In one country government stakeholders were very concerned about the geographic location of the pilot climate service and about making sure that the districts being covered were ruled by different political parties. Thus the 'benefits' of the pilot programme needed to be spread equally across the country, even though it would have been more efficient to have it cover a single geographic region. The partner had to compromise and design the pilot to cover disparate regions, which increased the effort and resources required.

In some countries the opportunity to participate in training sessions also had to be 'shared' across staff. This is a legacy of the time when generous per diems were routinely distributed by donor-funded programmes. Even though FCDO-funded programmes do not allow per diems to be paid, there are other perceived and real benefits from training, including the opportunity to participate in out-station trips and to build up individuals' CVs, which can help boost their personal case for promotion. As such, there continues to be a culture of rotating participation in trainings within a team or organisation. Similarly, in one country, permission to attend or speak at an external event had to be granted at a political level, and it was sometimes the case that the intended person, or even a relevant person, was not nominated to attend. Partners therefore sometimes struggled to target particular groups of individuals for capacity building. This posed a particular challenge for training series that aimed to progressively build up the skills of a particular set of individuals in successive sessions. In some cases partners were able to find solutions, but in general this challenge remains.

Constraint 4: The interventions had to adapt to local cultural practices

Different countries and institutions have particular cultural practices and norms, and these had to be navigated by the programme. Many of these are not specific to the climate services domain. For example, there were often hierarchical ways of working within government organisations which meant, for example, that in a meeting which included someone senior to them, an official would be unwilling to voice an opinion, particularly a dissenting or contradictory opinion, even if they were more knowledgeable than the more senior official.

To different degrees, NMHSs remain quite traditional organisations, and have not modernised their management practices. They are often very bureaucratic; thus a simple decision required multiple levels of approvals and paper to be physically sent across officers for signature. And while they were aware of the need to improve the service they provide, NMHSs struggled to adapt quickly and overcome the legacy of their long history of doing things a certain way, and established practices and mindsets. In one country the programme supported the NMHS to introduce new scientific techniques for seasonal forecasts, but alongside this practice the NMHS continued to also use outdated analogue methods.

Constraint 5: The size and duration of the programme meant governance challenges were not overcome

The duration of the programme was relatively short given the level of ambition, and the resources were also spread across a large number of workstreams. This was intentional, given a second phase of the programme was always envisioned and, as such, this phase used a portfolio approach to experiment with different approaches. However, due to the disruption of the Covid-19 pandemic the timeframe was shortened further, and there were also cuts to the budget. This meant that various interventions had to be narrowed in scope, or completely dropped, As a result, having a second longer phase to the programme, which builds on the most promising and impactful interventions, became even more critical.

Interventions which aimed to establish or strengthen new systems or tools needed more time to embed within national institutions. For example, the wheat rust forecasting system in Nepal and Bangladesh was still considered a pilot at the end of the programme, and while the data collection and dissemination parts of the system were being operated by national partners, it still relied on international partners to carry out the modelling and analysis. A next phase of the programme would allow national partners to be trained on modelling and the analysis of model results, as well as to evaluate the actual effectiveness of the forecasts and advisories when an outbreak occurs. Under SASCOF, countries have established national Climate Services User Forums, an institutional innovation which it is hoped will encourage greater uptake, but additional years of external support are required for them be truly embedded in the national systems and institutions.

Box 4

Case study on the impact of Covid-19

All of the interventions had to adjust their delivery methods as a result of Covid-19, which in some cases amounted to a fundamental shift in approach. Covid-related challenges, including restrictions on travel and in-person meetings, and on the availability of government officials, required some fundamental changes in how the interventions were designed and delivered. The attention of political leaders was also obviously diverted, and many of the interventions involved national disaster management agencies that were also responsible for day-to-day responses to the pandemic. Both government and other partners were therefore distracted and it took extra time to get decisions made and to progress the implementation of work.

Although delivery partners found it challenging and time-consuming, they were able to conduct meetings, deliver trainings, and carry out project planning through online meetings. However, the subtleties or indirect benefits of in-person interactions were starkly missing. The lack of direct engagement with partners took away opportunities for informal side conversations or tapping into each other's knowledge, which can help build valuable interpersonal connections.

Those interventions that were at more advanced stages when the pandemic hit were relatively more able to manage the disruption. For the SAHF, the pandemic came after trust and relationships had been built among governments, particularly on the executive council, which meant that it was not too disruptive to lose the informal and more personal interactions that come with in-person meetings. In addition, some interventions increased the frequency of their meetings with partners and beneficiary organisations to overcome the communication gap that comes from remote working. Furthermore, the scope of the TechEmerge Resilience Challenge Fund was significantly adjusted to respond to the pandemic:[4] a separate new funding track was added to source innovative technology solutions to specifically address disaster response in light of the pandemic.

[4] More details on these and other ARRCC workstreams which adjusted their scope to specifically address the Covid-19 pandemic can be found in the ARRCC Impact Story.

4. Recommendations

This section contains a series of high-level recommendations, primarily directed to other delivery partners who are delivering similar support on climate services, as well as to other funders designing similar programmes. They are based on ARRCC's experience of strengthening climate services in South Asia but are likely to be applicable elsewhere. It is hoped that they are also relevant for, and useful to, the wider community of practice on climate services, including government partners.

Consider the full spectrum of governance dimensions, across the breadth of climate services. A strength of the ARRCC programme was the diversity of interventions focusing on different parts of the system of climate services. Each had a well-considered set of expected results, and had planned the steps needed to achieve these. However, there was not a vision for what these interventions – spread across the two delivery partners – would add up to for a particular country, or at the programme level. There would be value in carrying out a comprehensive assessment of the entire system of climate services for each country, and then prioritising and coordinating where and how the programme and interventions are going to affect change. The National Framework for Climate Services could provide a starting point for this (WMO, 2018).

This is particularly relevant for the objective of capacity building, and ensuring that all the trainings, mentoring, and technical assistance are building towards a shared vision, across delivery partners and governments, of which priority capacity gaps should be addressed. This would also help build a clearer narrative on the role and contribution of the programme to building institutional capacity. It could also help clarify expectations between funders, the government, and the partners on what is realistic in terms of the degree of capacity that can be built within a limited programme timeframe.

Move beyond experimenting to creating systemic, sustainable changes. The ARRCC programme was intentionally experimental, seeking to explore the most viable and impactful opportunities for strengthening climate services. Going forward, further investment is required to further embed and institutionalise the changes that have been started, whether that means further engagement to ensure the new air pollution model gets used, scaling up the challenge fund technological pilots, or fully institutionalising the early warning systems.

Programmes aiming to strengthen climate services require a long duration given that this necessarily involves some amount of governance reform, which is difficult and slow to achieve. Regardless of the duration of the programme, delivery partners should undertake regular sustainability stocktakes, to assess the likelihood that the changes they have supported can be built upon and will not be reversed, and what needs to happen to fully institutionalise and embed them. This will help to identify the priority actions that are needed for the remainder of the project, and those interventions that can potentially be dropped because they look highly unlikely to result in sustainable change.

Focus greater attention on the uptake and use of climate services. Most of the ARRCC interventions were focused at the government level in terms of strengthening systems, putting in place new tools and scientific methods, and building institutional capacity. There was an assumption in the programme ToC that this would directly benefit vulnerable communities, but in reality the causal pathway down to the ground level was mostly undefined. In theory, climate

services should be of most benefit to those that are most at risk from climate change and extreme weather events. However, it remains unclear whether these communities are able to access and use these services sufficiently.

Therefore, at the design stage, a programme should identify the causal pathways by which poor and vulnerable populations, in particular women and marginalised groups, will benefit from the interventions. Critically, this would help to identify assumptions that need to be tested with respect to how poor and vulnerable people are able to benefit, to incorporate the perspectives of these populations in the programme design, to address important gender dynamics, and to select implementing partners that can help target results for poor and vulnerable populations.

This is important in regard to monitoring and evaluating the actual impact of an intervention (see Box 7) but will also ensure the scope and activities are designed to specifically target these populations: for example, by tailoring information and communication processes to their needs, integrating services with rural development efforts that target women, and partnering civil society to address constraining socio-cultural norms (Hansen et al., 2022). It requires specific targeted actions to ensure there is the capacity to use the information being provided. This may require a fundamental change of approach in regard to how interventions are designed and delivered, especially if the target beneficiaries are individuals and households.

Adopt an adaptive programme management approach. The ARRCC programme was flexible and interventions were adapted in response to changes in the local context. Delivery partners were given considerable freedom to test different modalities of delivery, be demand-led, and respond to new opportunities. This is important for any large technical assistance programme (see Arora et al., 2019) but particularly so for one focused on climate services, where interventions may need to respond to extreme weather events. To facilitate the previous recommendations around investing time and resources at the design stage, building a shared overall vision for what the programme hopes to achieve is particularly important. This will provide the broad parameters within which the delivery partners can have the flexibility to adjust and adapt, but will also give the funder confidence that everyone is working towards a common and understood goal.

Box 5

Learning from ARRCC's monitoring, evaluation, and learning

FCDO intentionally invested part of the programme budget in a third-party monitoring, evaluation, and learning partner, OPM. The scope of the monitoring, evaluation, and learning services included synthesising partner reporting to develop regular programme-level monitoring reports, carrying out evaluation activities, such as a mid-term review, and capturing and documenting partners' learning throughout the programme. This in turn produced learning about how to conduct effective monitoring, evaluation, and learning for such programmes. Most of this is not specific to a climate services programme but relates to how to facilitate communication across delivery partners and how to capture learning in as near to 'real time' as possible. However, the following points are specific to the monitoring, evaluation, and learning of a climate services programme:

- A theory-based approach to monitoring and evaluation is recommended given the diversity of types of climate services, and the different ways in which they could be strengthened. The use of categorical indicators to measure progress (e.g. 'Adoption of system enhancement') meant the ARRCC logframe was relevant for all types of interventions. However, very careful definitions of these indicators are required so that the delivery partners can understand how their specific intervention can be incorporated.

- Given the long causal chains between strengthening climate services and impacting communities on the ground, as well as the breadth of possible interventions, it is helpful to develop intervention-specific results chains that can be mapped against the overall programme ToC. This will help the delivery partners to report against the programme-level indicators.

- It is necessary, but difficult, to set the baseline of the situation with regard to climate services in each country. This includes the effectiveness of the operation of climate services, but also the strength of the wider governance system. This is needed to allow for a proper evaluation of the impact of the programme.

Perhaps the most important recommendation is that to fully evaluate the impact of the programme it will be necessary to understand the actual benefits that the enhanced or new climate services are delivering on the ground, particularly in terms of increasing the resilience of vulnerable communities and

helping decision makers to manage climate risks. Empirical evidence on the impact and benefits of climate service is limited and obtaining such evidence presents methodological challenges (Hansen et al., 2022). This needs to be addressed in order to demonstrate the value of programmes like ARRCC, but also to convince governments to invest in climate services in general. Ideally, monitoring, evaluation, and learning would be integrated into the actual climate service itself, so that the NMHS can routinely monitor progress, as well as quantify the benefits – and in essence the return on their investment.

Focus attention on national and regional intermediaries: The ARRCC programme has highlighted the important role research and technical organisations can have in making climate services more relevant and accessible to user groups. These entities also played an important role in implementing activities under the ARRCC interventions, including training and capacity building and developing new tools and methods. One unintended result of the programme was strengthening the capacity of these organisations. In the future this should be an explicit objective as these partnerships have been shown to be critical in delivering results and are equally important in sustaining the impact of the programme, given their mandates, networks, capacities and influence in the region. These organisations should be involved in the design stage of any new intervention, and should feel a sense of ownership over the overall vision of the programme, rather than just the single intervention in which they are involved. Having opportunities for the entire set of partners to come together and discuss progress and challenges can help build this shared sense of purpose.

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Annex I: Mapping of interventions

The table below maps 24 interventions under the ARRCC programme[5]. This includes mapping their location and the type and timeframe of the climate services which were strengthened. The table also maps the focus of the interventions across the three parts of the system of climate services. Firstly, in terms of which stakeholder involved in the operation of climate services was the primary partner of the intervention (user, producer, both). Secondly, in terms of which of the governance dimensions it primarily focused on (maximum of three): policies and regulation; finance; NMHS capacity; user capacity; models and tools; and regional cooperation. Thirdly, in terms of whether it had a particular focus on adjusting the political economy, rated in terms of a primary focus, a secondary focus, or no focus. This was judged in terms of the description of the intended intervention provided during the design stage and early phase of the programme.

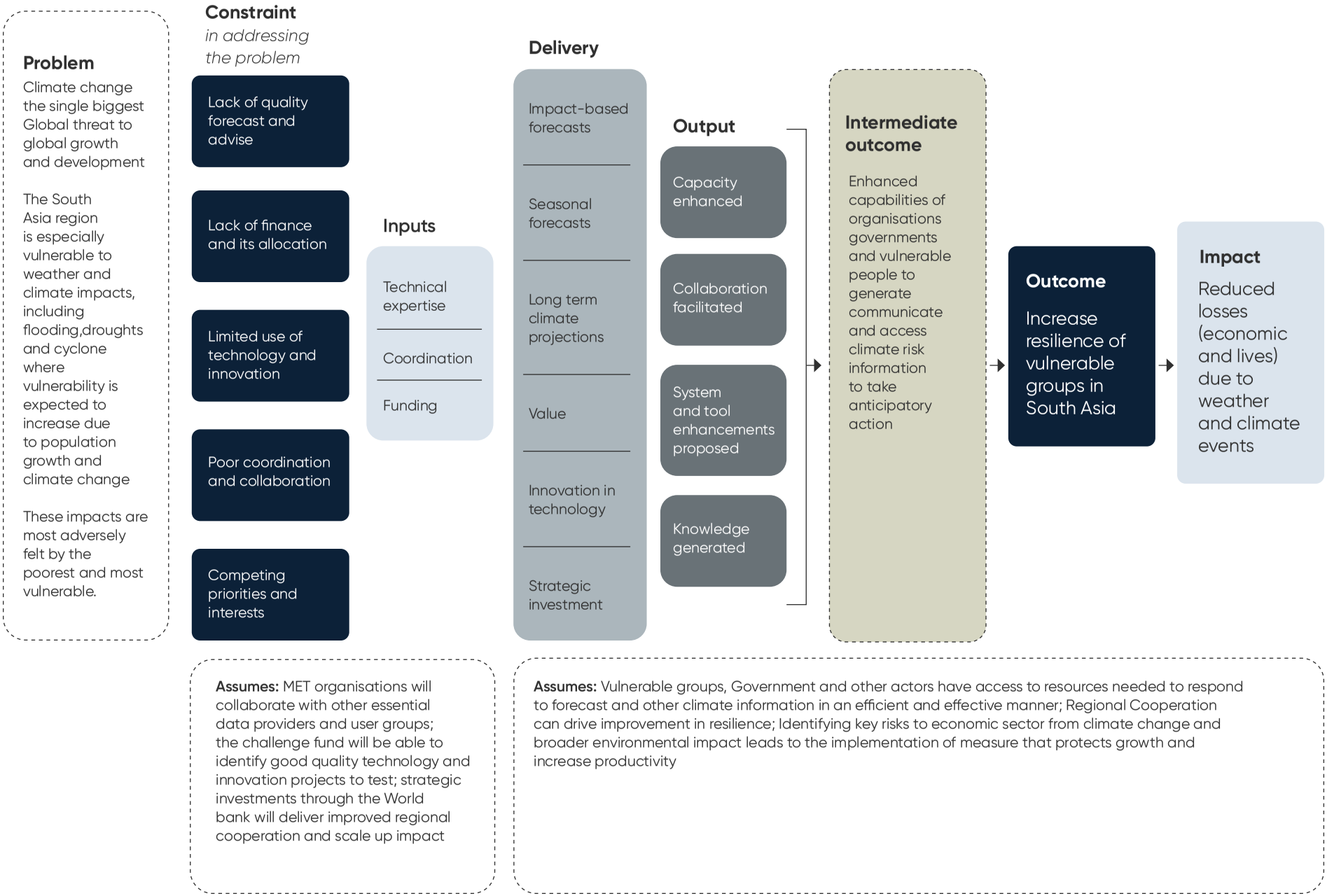
Intervention	Location	Type of climate services	Primary partner	Primary governance dimension	Level of focus on political economy
A Macro-Fiscal Model for Pakistan, with a Climate Change Module	Pakistan	Future projections: Macroeconomic forecasting and analysis models that capture the potential impact of climate change	User	Availability of scientific models and technology	Secondary focus: stakeholder interests
Managing Fiscal Risks Associated with Climate Change	Bangladesh, Maldives, Nepal	Future projections: Analysis of the fiscal risks associated with climate change-related events	User	Availability of scientific models and technology	Secondary focus: stakeholder interests
South Asia Regional Hydromet, Early Warning and Climate Services Programme	South Asia region	Multiple: A range of different types of weather and climate data, products, information, and services	Both	Regional and global cooperation; institutional capacity of NMHSs; capacity of users of climate services	Secondary focus: stakeholder interests
SAR Climate Adaptation and Resilience Partnership	South Asia region	Future projections: Analysis of the impact of climate change and policy mainstreaming options	User	Supportive policies and regulations	Secondary focus: stakeholder interests

[5] This covers most, but not all, of the interventions under ARRCC. There were some interventions that took place in Afghanistan and Myanmar which, due to local political events, were not continued.

SAR Blue Resilience: Strengthening the Resilience of Fishermen	Bangladesh, India, Maldives, Sri Lanka	Short-term: Weather warning	User	Regional and global cooperation; availability of scientific models and technology	Secondary focus: behaviours, values, and cultural practices
Study on Behavioural Insights Around Early Warning Messaging	Sri Lanka	Short-term: Weather warnings	User	Capacity of users of climate services	Primary focus: behaviours, values, and cultural practices
Climate Innovation Challenge	South Asia region	Multiple: Risk management and forecasting	Both	Availability of scientific models and technology	No focus
Tech Emerge Resilience Challenge	India	Multiple: Risk management and forecasting	Both	Availability of scientific models and technology	No focus
Promoting Regional Cooperation in Air Pollution Management	South Asia region	Medium range: Impact assessment	User	Availability of scientific models and technology; regional and global cooperation	Secondary focus: stakeholder interests
IBF	Nepal, Bangladesh, Pakistan	Short-term: Warnings on likely impacts based on weather forecasts	Producer	Availability of scientific models and technology; institutional capacity of NMHSs; capacity of users of climate services	Secondary focus: behaviours, values, and cultural practices
Wheat Disease Early Warning System	Nepal, Bangladesh	Short-term: Daily and weekly forecasts and advisories on wheat rust for farmers	Producer	Availability of scientific models and technology; institutional capacity of NMHSs; capacity of users of climate services	No focus
Severe Weather Forecasting	South Asia region	Short-term: Forecasts and warnings of severe weather	Producer	Institutional capacity of NMHSs	No focus
Regional Cooperation on Floods and Droughts	South Asia region	Short-term: Forecasts of droughts and floods	Producer	Institutional capacity of NMHSs; regional and global cooperation	Secondary focus: stakeholder interests
Operational Agriculture Climate Services	Nepal, Bangladesh	Medium range: Seasonal agricultural advisory services	Both	Institutional capacity of NMHSs; capacity of users of climate services	No focus
Building Regional Capacity for Seasonal Forecasting	South Asia region	Medium range: Seasonal forecasts	Producer	Institutional capacity of NMHSs; availability of scientific models and technology	No focus

National Climate Outlook/ Monsoon Forums	Bangladesh, Nepal, Pakistan	Medium range: Seasonal forecasts	Both	Institutional capacity of NMHSs; capacity of users of climate services; availability of scientific models and technology	Secondary focus: formal and informal incentives
South Asia Seasonal Climate Outlook Forum (SASCOF)	South Asia region	Medium range: Seasonal forecasts	Both	Regional and global cooperation; institutional capacity of NMHSs; capacity of users of climate services	Secondary focus: stakeholder interests
Capacity Building in Regional Climate Projections	South Asia region	Future projections: Regional climate projections	Producers	Institutional capacity of NMHSs	No focus
Development of National Climate Projections	Pakistan	Future projections: Grided observed climate datasets	Producers	Availability of scientific models and technology; institutional capacity of NMHSs	No focus
Sea Level Rise Projections	Bangladesh, Pakistan	Future projections: Sea level rise projections for the Indian Ocean	Both	Availability of scientific models and technology; institutional capacity of NMHSs; capacity of users of climate services	No focus
Regional Climate Projection Data Platforms	South Asia region	Future projections: Regional climate projections	Both	Availability of scientific models and technology	No focus
Development of New Tools/ Services for the Water and Hydropower Sectors	Nepal, Pakistan	Multiple: Extreme rainfall in current and future scenarios	Both	Availability of scientific models and technology	No focus
Climate Services for Food Security	Nepal	Future projections: Climate risks to food security	Both	Availability of scientific models and technology	No focus
Heat Health and Climate Services for Humanitarian Action	South Asia region	Short-term: Managing heat waves	Both	Capacity of users of climate services	No focus

Annex II: ARRCC ToC

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