



RECOMMENDATIONS FOR THE UK NATIONAL FRAMEWORK FOR CLIMATE SERVICES

Recommendations delivered through the UK Climate Resilience Programme project 'Facilitating the use and delivery of climate services.'

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Decision to be made

Future development of the UK National Framework for Climate Services will likely be most successful with the support of key UK government agencies. Engagement with the UK climate services community has made clear the expectation that government will need to play key a role in the National Framework, for instance by providing a mandate or through conferring legitimacy to the process. The success of the National Framework going forward will also require community support and ownership.

A decision is needed from UK Government on their support for the future development of the UK National Framework for Climate Services and implementation of the recommendations within this paper.

Executive summary

The UK has effective elements of a National Framework for Climate Services (NFCS), however a stronger organisational structure is recommended to better coordinate, facilitate, and strengthen collaboration among the UK climate services community and improve the co-production, tailoring, delivery and use of science-based climate information and services to deliver socioeconomic benefits and make the UK more resilient and prepared for climate-related impacts.

The World Meteorological Organization describes a National Framework for Climate Services (NFCS) as a national mechanism to bridge the gap between the climate information being developed by scientists and service providers on the one hand, and the practical needs of users on the other hand. National Frameworks are recommended by the World Meteorological Organisation (WMO) led Global Framework for Climate Services (GFCS) and there is evidence of benefit provided by NFCS in other nations (Hewitt et al., 2020). The NFCS should aim to coordinate institutions and enable them to work together across the value cycle to co-design, co-produce, communicate, deliver, and use climate services for decision-making in sensitive sectors. The value cycle encompasses the production and delivery of climate services (i.e., from observations, modelling, forecasting, co-design, and service delivery), as well as stakeholder actions and outcomes.

The UK has internationally-respected elements of an NFCS, as exemplified by activities and programmes such as the Met Office Hadley Centre Climate Programme (MOHCCP), the UK Climate Projections (UKCP) and the Climate Change Risk Assessment (CCRA). These are all based on close collaboration with a range of actors across the climate service value chain (including government, academia, public sector and private sector) to co-design and co-develop national capability for climate services, and communicate, deliver and use the climate services for decision-making in sensitive sectors in the UK. These approaches influence and develop the underpinning science and climate information through national and international collaboration.

However, there is lacking a strong organisational structure to fully deliver the benefits from existing

and future climate services. Therefore, there is an opportunity (as identified in the findings of this report) to broaden and enhance the coordination at the national level. Without a strong and well-coordinated NFCS, the UK will likely fail to exploit the full benefit from the activities and legacy of current public and private sector programmes and initiatives (beyond the ones listed above) through a lack of continuity and continued difficulties bringing together multi- and trans-disciplinary approaches to adaptation and building resilience.

The recommendation above is made following an 18-month project which engaged with more than 80 representatives from more than 60 organisations across the UK, as well as key UK government departments to determine the need for and benefits of enhancing what currently exists.

Recommendations for the UK NFCS are grouped into activities under three key domains focused on enhancing the UK climate services ‘COMMUNITY’; promoting knowledge and data ‘EXCHANGE’; and establishing a higher ‘QUALITY’ through standards and ethical practices. These domains reflect key areas highlighted by the UK climate services community and may evolve over time as needs change. A ‘CENTRAL HUB’ acts as a focal point and forum for sharing information in an accessible manner and aims to ensure pull-through of outputs from each of the key domains. A possible NFCS structure based upon consideration of these recommendations is conceptualised in Figure 1.

To ensure the representativeness and sustainability of the NFCS a distributed leadership could be considered, in which the NFCS Central Hub comprises representation from each of the NFCS domains, which in turn are led by those in the community most suited and engaged in individual activities.



Figure 1 Possible structure of the UK NFCS based on three priority domains and a central 'hub'.

The UK's framework for climate services should:

- Provide a driving force and mechanism for the pull-through and implementation of new data, knowledge and practices, aligned with national adaptation and resilience priorities.
- Enable knowledge exchange by building a UK community to link up different actors, promoting common language and understanding.
- Establish and promote good practice, quality standards, and ethical practices within the UK community, as well as engage internationally and offer leadership where appropriate through partnership and collaboration.

Recommendations for the UK NFCS

Provision of a strong organisational structure for the UK National Framework for Climate Services (NFCS) is recommended to help coordinate, facilitate, and strengthen collaboration among the UK climate services community and improve the co-production, tailoring, delivery and use of science-based climate information and services.

Climate services help decision-makers better manage risks and opportunities arising from climate variability and climate change, and could improve the UK's adaptation and mitigation response, building national prosperity. An NFCS is a world-recognised approach building coordination through the Global Framework for Climate Services. A strong organisational structure for the UK NFCS could provide high-level coordination and governance, leading to greater impact of existing initiatives and improved climate resilience.

Crucially, the NFCS is not replicating or providing a delivery mechanism for provision of climate services themselves.

Rather, the NFCS acts to join up UK climate services activity, to promote the exchange of knowledge and information between the climate services community, and to pull through advances and progress into improved national adaptation and resilience action.

Community views on the benefits, challenges, and role of the framework have been gathered over an 18-month period through one-on-one discussions and online workshops, informing the basis of whether future development of the UK NFCS is considered beneficial.

Without a strong and well-coordinated NFCS the UK will likely fail to exploit the full benefit from the activities and legacy of current programmes and initiatives being delivered through both the public and private sectors, through a lack of continuity and continued difficulties bringing together multi and trans disciplinary approaches to adaptation and building resilience.

What is a national framework?

A National Framework for Climate Services (NFCS) is recommended by the World Meteorological Organisation (WMO) for country-level coordination of climate services. A broad range of services are needed to meet the varied needs of decision-makers across multiple sectors, and the growing climate services landscape comprises multiple different groups and activities to meet different priorities. The nature and types of capability required at national level for climate service delivery is described by the WMO through the Global Framework for Climate Services (GFCS) (see Figure 2). The GFCS is a long-term cooperative arrangement through which the international community “links science-based climate predictions and information with the management of climate-related risks and opportunities in support of adaptation to climate variability and change in both developed and developing countries” (WMO, 2009). An NFCS aims to provide coordination of the dynamic and diverse climate services landscape to ensure investment is directed towards priority areas and to connect practitioners and decision-makers.



Figure 2 The implementation of the GFCS has five components: Observations and Monitoring; Climate Services Information System; Research, Modelling and Prediction; User Interface Platform; Capacity Development. The GFCS focuses on developing and delivering services in five priority areas, which address issues basic to the human condition and present the most immediate opportunities for bringing benefits to human safety and wellbeing: Agriculture and Food Security; Disaster Risk Reduction; Energy; Health; Water. Image reproduced from WMO OMM. (2019). GFCS | Global Framework for Climate Services. <https://gfcs.wmo.int/>

Cross UK Government Support for an NFCS

Moving forward with implementing a more structured approach to the UK National Framework for Climate Services will likely be most successful with the support of key UK government agencies. Engagement with the UK climate services community has made clear the expectation that government will need to play key a role in any future National Framework.

The statements below from Defra and BEIS reaffirm the potential value of a National Framework for establishing good practice and shared national adaptation and resilience objectives, as well as the need for working across UK government to support a joined-up approach.

“This UK Climate Resilience Programme (UKCR) project to establish the additional needs for and principles behind a UK National Framework for Climate Services (NFCS) provides UK government with a solid evidence base to support future work in this area. The project recommendations substantiate what we already know, that effective adaptation to climate change requires a committed and transdisciplinary group of actors with easy access to high quality data and a clear set of objectives to work towards. Defra are working across government to develop the forthcoming third National Adaptation Programme (NAP3) and develop a forward look of research and innovation needs to support adaptation, within which the recommendations of this project will be considered. Regardless of outcome, the absence of central coordination in the meantime should not be viewed as a barrier to uptake of NFCS principles.”



Department
for Environment
Food & Rural Affairs

“Climate Services are becoming increasingly important in providing both mitigation and adaptation solutions to a variety of stakeholders, both in the UK and internationally. The UKCR project has scoped a UK National Framework for Climate Services structure that demonstrates the need for a coordinated effort going forward to establish good practice and clear objectives for this growing sector. BEIS works with world-leading scientists across multiple portfolios to tackle climate change and such a framework could support alignment and provide standards for future activities, enabling the UK to maintain its position as an international leader in this sector.”



Department for
Business, Energy
& Industrial Strategy

Recommendations for NFCS Domains

The recommendation to develop the National Framework for Climate Services for the UK is based on evidence gathered during an extensive period of community engagement (see Appendix: Objective summary of NFCS workshops), as well as drawing on the international experience. Engagement with the UK climate services community identified several priority domains as well as the need for a coordinating central focal point which have informed the recommended structure of the NFCS. This structure is conceptualised in Figure 3.

The NFCS domains (Community, Exchange, Quality) are brought together within an NFCS Central Hub. The three key domains are focused on enhancing the UK climate services ‘community’; promoting knowledge and data ‘exchange’; and establishing a higher ‘quality’ through standards and ethical practices. A description of the domains is shown in the infographic below.

These domains may evolve over time as needs change, and ongoing engagement with the UK climate services community is recommended to ensure that the NFCS remains fit for purpose.



CENTRAL HUB

The NFCS is designed to be a multiplier – taking existing programs and initiatives and adding value and enhancing the outputs. The Central Hub acts as a focal point for the pulling together of climate services activity and knowledge, and then disseminating this in accessible formats for the benefit of the community. The Central Hub promotes actions and activities which build trust in climate services and encourages the mainstreaming of climate information into decision making.

COMMUNITY (PEOPLE)

The UK climate services landscape is comprised of people from a diverse range of expertise which would benefit from being brought together. This domain supports the establishment of trans-disciplinary networks, incentivising new partnerships between sectors/industries/disciplines/regions, creating new relationships which strengthen the inclusion of user needs to providers, promoting activities which forge a sense of professional identity within the UK climate services sector.

EXCHANGE (RESOURCES)

The UK climate services community needs more support to incorporate climate data and information into decision making, citing that existing information is difficult to find, access, and understand. This domain is focused on building awareness and exposing access to existing resources (data, guidance, case studies, etc) and training to support the UK climate services community to use climate services.

QUALITY (AND STANDARDS)

Climate service providers and users want to be able to demonstrate quality, and this domain provides a mechanism for the implementation of quality and ethical Standards, as well as a forum to further the discussion around community expectations relating to accreditation.

Figure 3 Conceptual model of a UK National Framework for Climate Services structure, developed from input gathered from the UK climate services community. To the right are descriptions of the objectives of the Central Hub and three key Domains.

Benefits of an NFCS

There are clear near-term and ongoing benefits to developing the UK NFCS. The NFCS is a way to ensure the legacy of past, current, and future investment into climate science and climate services is increased resilience through reduced impacts from climate-related risks as well as improved adaptation and avoidance of maladaptation. The NFCS may also provide a mechanism by which the UK can learn from efforts internationally whilst strengthening UK's position as a world leader for climate action.

Benefits to be realised now

In the near-term the UK can capitalise on its success from hosting COP26 and further its reputation as a world leader by clearly demonstrating a world recognised approach for coordinating national investment and climate service capability. The recommendations for the NFCS are supported by the UK climate services community. There is a clear desire from the UK climate services community for high level coordination and centralised leadership through a focal point to enhance the pull through of climate information into reduced climate-related risks, adaptation planning and action, and increased resilience of the UK to climate impacts.

There is recognition that there is a wealth of climate services activity happening in the UK, including internationally recognised elements of a National Framework, and what is missing is a 'driving force' promoting continuity and longevity and coordinating the UK's rich climate services landscape. Several large programs are coming to an end (e.g., SPF UKCR) and investment in new programs is just beginning (e.g., CS-NOW) which means that the time is right to ensure the value of these investments is realised and maximised, and to secure the legacy of these programs as continuing to provide value to the UK.

Benefits over 2-5 years

A primary benefit of a strong UK NFCS is support for quality assurance of climate service development and delivery. The UK is already benefitting from an active and innovative climate services landscape which produces and delivers climate services to meet a range of needs. The NFCS can uplift the quality of these climate services in the UK through establishing and encouraging best-practice approaches and bringing in the UK climate services community to discussions around codes of ethical practice. There is also the potential for the framework to implement Standards for quality, value, and monitoring of climate services.

One of the challenges for achieving the adaptation solutions agenda is the exchange and translation of climate information and action across scales, including the management of cross-cutting and intersectoral risks. Greater links between multidisciplinary teams and shared access to relevant datasets regarding climate risk were identified as clear benefits of the UK NFCS. The UK NFCS can provide mechanisms for the sharing of information and the coordination of adaptation actions through development of the UK climate services community and building organisational and sector adaptive capacity.

Long-term and ongoing benefits over 5-10 years

Ongoing benefits of an NFCS include maintaining and growing national climate services capacity, stimulating broader and more meaningful collaborations with enhanced sharing between sectors, disciplines, and maturity levels. The recommendations made have the potential to encourage multi- and trans-disciplinary approaches to characterising, quantifying, and managing climate

related risk through enhancing collaboration and knowledge exchange between fields, regions, and organisations, and this work supports the establishment of these activities. Success will be measured over the longer term through establishing a lead and working group for the relevant activities, and through inclusion of broad representation from across disciplines in engagement activities.

NFCS Structure, Governance and Resourcing

Core principles which emerged from the period of UK climate services community engagement and informed the recommendations underpinning the NFCS Central Hub include the need for the NFCS to be representative and inclusive of the community as a whole. The NFCS must be able to evolve and adapt as the UK climate services landscape changes, and the NFCS must be responsive to the adaptation and resilience priorities of the UK over time. In this way the objectives of each domain, currently based on the recommendations derived from engagement with the UK climate services community, may transform according to the changing needs of each domain with time.

NFCS Structure

To ensure the representativeness and sustainability of the NFCS a distributed leadership is proposed, in which the NFCS Central Hub comprises representation from each of the NFCS domains. Leadership of the NFCS domains should take the form of 'domain champions' involved in climate service delivery and with an interest in contributing to the domain objectives. This leadership will change over time to reflect current activities and UK priorities. One proposed structure for the NFCS is shown in Figure 4, which also shows the relationships between the Domains and the Central Hub. It should be noted that the actual structure will need to be determined by the UK climate services community if it is to be accepted.

One strength of taking a distributed approach to NFCS Central Hub and domain leadership is that it is robust to changes in resource and funding environment and is self-sustaining, founded upon community appreciation of the wider benefits of the NFCS.

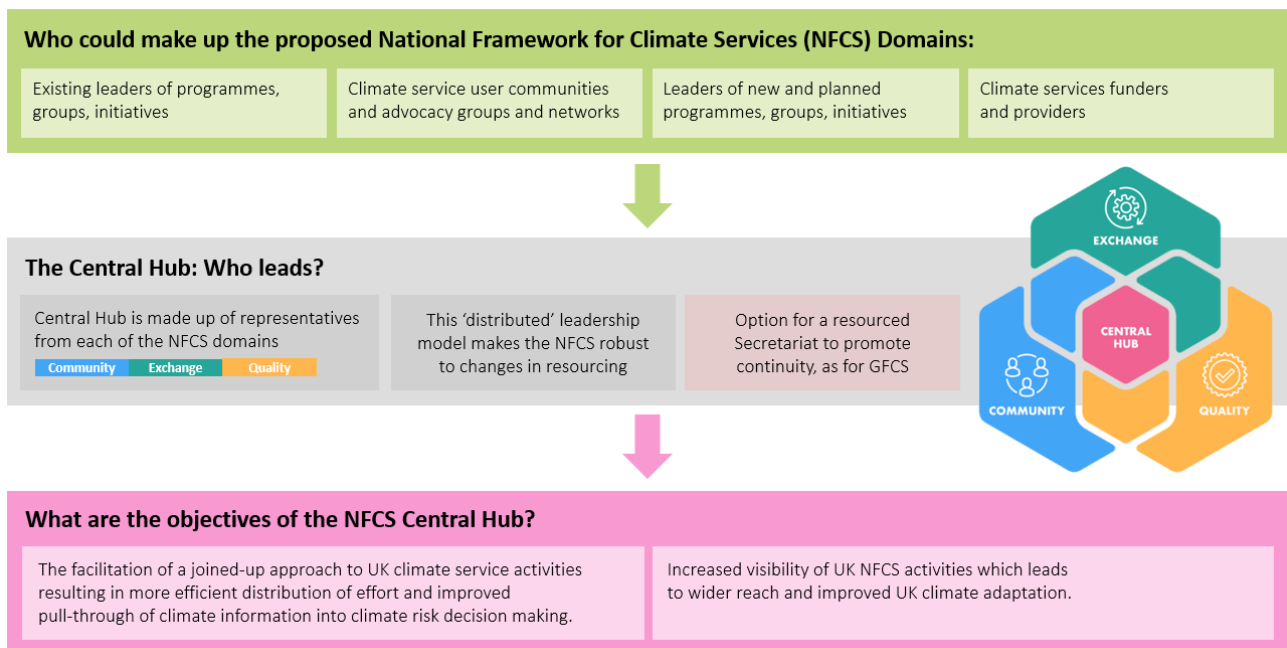


Figure 4 The NFCS for the UK should be flexible in order to respond and adapt to the UKs evolving priorities and resourcing availability. In this schematic the potential composition of NFCS membership is explored using questions, and the relationship between the NFCS Domains and Central Hub is defined. This is one proposed representation of the NFCS structure and alternative structures will have other benefits.

NFCS Governance and Potential Resourcing Requirements

Using the core principles of inclusivity and the need to be responsive and flexible to UK priorities this white paper explores several governance and resourcing options. These options, described in Table 1, have been discussed with key government stakeholders Defra and BEIS, and the purpose is to identify potential pros and cons of taking any one approach. This white paper is not recommending any one of these approaches but rather is putting them forward for consideration.

The options include (1) an 'All voluntary' NFCS structure made up of interested and already engaged individuals. This option allows a more coordinated NFCS to become established without the need for UK government involvement. An NFCS structured in this way would be focused on meeting the objectives of its founding members, with little to no steer from government possible, and is unlikely to align with national policy objectives.

A second option (2) takes a 'Seed funding' approach in which resourcing is provided for a limited period of time in order to establish the NFCS Central Hub with the immediate objective of demonstrating the value of a more structured NFCS. This demonstration of value would then allow the NFCS to secure the required resourcing beyond the seed period and become self-sustaining. This approach would need to consider carefully the metric used to demonstrate value over a short period of an initiative which is supposed to bring longer term benefits.

A third option (3) includes resourcing for a 'core secretariat' and is the most consistent with the approach for an NFCS recommended by the GFC. This option describes a permanent secretariat which can act to perform the administrative role as well as ensure NFCS continuity throughout periods of change in the UK climate services landscape.

Table 1 Exploration of three options for the UK NFCS. Structure and governance for each option is described in the left-hand column. A description of the resourcing required for each option is provided in the central column. The pros and cons of the structure, governance, and resourcing for each option with respect to participation of key players (both government and industry) and in terms of the potential for alignment with national policy priorities is provided in the right-hand column.

Structure & Governance	Resourcing	Pros and cons
<p>1 All voluntary</p> <ul style="list-style-type: none"> Objectives set by individuals who take part Limited opportunity for review and evaluation 	<ul style="list-style-type: none"> No resources from government Voluntary resourcing from interested and motivated organisations 	<ul style="list-style-type: none"> ✓ Lowest administrative burden X Unlikely to promote improved national climate services due to limited membership X Government will have no / limited voice in NFCS objectives, risk not benefitting and unable to align with national policy objectives
<p>2 Initial Seed funding (24+ months)</p> <ul style="list-style-type: none"> Focus on establishing the NFCS Central Hub and on an implementation plan that prioritises securing independent resourcing Intrinsically linked to demonstrating value to secure resourcing (e.g., through successful pilots?) 	<ul style="list-style-type: none"> Resourcing for a few meetings and activities in the first year(s) to establish the Central Hub NFCS governance to become self-resourcing after the first year(s) Seed resources can be government only or mix of government and industry resourcing 	<ul style="list-style-type: none"> ✓ Guarantee the establishment of NFCS Central Hub ✓ Ensures participation of industry ✓ Government representation and benefit assured in short term, limited influence to align with national policy objectives X Risks to continuity from short-term funding cycle ✓ Opportunity to assess if benefits require ongoing resourcing or if self-sustaining model is possible during implementation phase
<p>3 Distributed NFCS with core secretariat (ongoing commitment)</p> <ul style="list-style-type: none"> Establishing the NFCS Central Hub and supporting this hub by resourcing a separate secretariat to perform administrative role Government support essential so will require a long term 'home' 	<ul style="list-style-type: none"> Ongoing government resourcing to support secretariat and desired core NFCS activities Industry resourcing as required (can changed over time) 	<ul style="list-style-type: none"> ✓ Guarantee the establishment and implementation of structured NFCS ✓ Government is assured to benefit from NFCS activities, and can align with desired policy objectives (e.g., Net Zero) X Risk of low industry involvement unless incentivised through demonstration of benefits or mandates (e.g., quality standards and accreditation) ✓ Robust to changes in national climate services landscape, with resourcing contributed by other parties according to activity

Next Steps for the NFCS

This paper provides an evidence base for future development of the UK National Framework for Climate Services, reflecting the wider UK climate service communities' viewpoints on the potential benefits. This information may be used by the UK Government and the UK climate services community to inform discussions on implementing National Framework activities and structure. A decision is needed from UK Government on their support for the future development of the National Framework.

A core principle of the NFCS is to build upon existing programmes, enhancing pull-through and continuity. During the engagement workshops the UK climate services community provided many suggestions for activities to undertake as part of the NFCS.

To capitalise on current momentum and help ensure sustainability of progress these recommendations need to be shared with the UK climate services community. A first step could be to convene a group of engaged and active experts from around the UK which is diverse and representative of the community and which has a clear direction for the development of the NFCS.

To continue building community support it is recommended that targeted communication and some key activities are commenced, as determined by the community themselves (e.g., stocktake activities, regional foci). This includes connecting with international efforts to establish National Frameworks for Climate Services to learn from other approaches and reinforce UK leadership.

Implementation of the NFCS

Recommendations have been made for the UK National Framework for Climate Services (NFCS).

Engagement with the climate services community revealed that support for the NFCS from central government is essential for conferring legitimacy and credibility and to ensure buy-in from the rest of the community. Equally, ownership of the NFCS and engagement in all areas of activity needs to be sought throughout the different parts of the UK climate services community for success and sustainability in its aims. Following on from the white paper recommendations, further support will be needed to support UK government discussions around the desired level of participation and resourcing of the NFCS.

Another key activity during the implementation of the NFCS recommendations is to share communication materials to widen the reach and increase the visibility of the UK NFCS. It will be essential to remain connected with other relevant UKCR projects (e.g., Standards) as well pursue opportunities to ensure that momentum on the NFCS is maintained.

Finally, it would be beneficial to connect with of a core group of international partners who can support and challenge on UK national framework activities.

Appendices

The following collection of appendices provides in more detail the evidence basis for the recommendations for the UK National Framework for Climate Services.

Appendix: UK climate service landscape in context

The UK is a signatory to the Paris Agreement and has an existing policy framework for building climate resilience, including regular assessments of progress on domestic mitigation and adaptation activity. The latest report from the Committee on Climate Change indicates that the UK must further raise the profile and need for adaptation and lift the number and quality of adaptation planning and implementation across sectors (Climate Change Committee, 2021b, 2021a, 2021c; Committee on Climate Change, 2019). This indicates that there is a lack of policy-ready information and services available to government, and that there is more to be done in building the capacity of policy-makers to make use of climate services. In addition to the British Isles, there are many overseas territories and Crown dependencies around the globe which also require access to climate services. Climate services in these territories and dependencies will have needs which may not be currently met by existing services.

Action towards building a climate resilient UK is framed by policy initiatives including legally binding emissions reductions targets of Net Zero by 2050, in accordance with the *Climate Change Act 2008 (2050 Target Amendment) Order 2019* issued by the Minister of State for BEIS in 2019¹. The UK's climate resilience is assessed by the independent Climate Change Committee who provide a report card and recommendations to government on climate readiness and where more effort is needed, and which informs the UK's National Adaptation Programmes (Defra, 2018). The UK's Research and Innovation body (UKRI) coordinates new multi-disciplinary research on priority areas identified by the Climate Change Committee, as well as acting as a conduit to government to feedback additional research needs. Citizens assemblies have been formed in the UK in order to integrate community values into policy responses and adaptation planning. The [UK Climate Assembly](#)², which is comprised of more than 100 members from a cross-section of UK citizens, set out their views and recommendations for meeting the Net Zero targets

in a report released in late 2020, and will be used by policy makers to guide policy (Climate Assembly UK, 2020).

This dynamic and diverse landscape could benefit from national coordination to ensure investment is directed towards priority areas and to connect practitioners and decision-makers. A national framework for climate services is a world-recognised approach building coordination through the Global Framework for Climate Services (WMO-GFCS, 2018). National frameworks enable multi-stakeholder development of climate services at country level and are designed to strengthen coordination among national institutions and preparedness across sectors. NFCs support the Paris Agreement, which aims to strengthen the global response to the threat of climate change, by helping Parties to the Agreement prepare, maintain and communicate their Nationally Determined Contributions (NDCs). By providing climate services that help assess climate vulnerabilities; identify adaptation options and avoid maladaptation; improve the understanding of climate and its impacts; and enhance the adaptation planning and implementing capacity of climate-sensitive sectors, NFCs support the objectives and implementation of National Adaptation Plans (NAPs).

What the UK already has

The UK already has well established infrastructural, technical, human, and institutional capability for producing and providing national climate services. Multi-disciplinary research into the science of climate and human behaviour occurs within universities and research institutes, by dedicated teams within government departments, and at the Met Office³. The UK has world leading climate modelling, and climate prediction capability supported through national computing capability and academic sectors. Core capability as defined by

¹ Climate Change Act 2008 (2050 Target Amendment) Order 2019. <https://www.legislation.gov.uk/uksi/2019/1056/contents/made>

² The UK Climate Assembly. <https://www.climateassembly.uk/>

³ please see Role of the Met Office p17

the GFCS includes observations and monitoring activities and technology through NMHS.

A successful NFCS includes a user interface platform which connects institutions providing climate information to users who need climate information, as well as capacity development which educates and increases the ability of all sectors to use and interpret climate information. This exists to a large extent in the UK already. There is evidence of an actively engaged community working to use climate information for adaptation and resilience decision making. Within the UK exists several vibrant regional forums, such as the Infrastructure Operators Adaptation Forum, and partnerships such as the London Climate Change Partnership. The success of the NFCS relies upon the engagement and support of these existing community activities.

Climate service development in the UK

In 2013 Climate Service UK was launched which aimed to build sustainable growth in a changing climate, building capacity internationally and providing a framework for high value investment in climate science (World Meteorological Organization, 2013). Climate Service UK focussed on the services being provided by the public sector but acknowledged that private companies also provided services to the UK. Included was the UK Climate Projections⁴ analysis toolkit, comprising regional projections datasets and summary information, to support government and business with adaptation planning and which is still in use today. Climate Service UK has struggled to fulfil the dual remit of both developing and delivering climate services for the UK as well as to provide the framework for

quality and building capacity to make use of climate services. Ultimately the success of Climate Service UK has been hindered by inadequate support from government with funding progressively rolled back over time. This highlights a critical component required for the success of the national framework: strong support at high levels sustained over a long period of time.

The UK has a long history of initiatives designed to operate in the boundary between climate science and services for decision-makers. The UK Climate Information Programme, launched in 1997 and now established within the Environmental Change Institute at the University of Oxford, brings academics and other experts in climate adaptation together with a diverse range of stakeholders to seek new responses to the challenges the UK faces. In 2012, DEFRA launched Climate Ready UK to coincide with the publication of the first National Adaptation Plan (Department for Farming and Rural Affairs, 2012b). Part of the Environment Agency, Climate Ready was designed to assist business and other organisations with adaptation, risk management and resilience planning through providing guidance, resources, and tools (Department for Farming and Rural Affairs, 2012a). Climate UK, an NGO which promoted resilience through regional Climate Change Partnerships ran from 2011 until 2018, many of which dissolved after the withdrawal of the Climate Ready program (Salvidge, 2016). Similarly, Climate Local was an initiative supported by the Climate Ready program which assisted councils to increase their resilience, and which also shut down after that programs withdrawal (Local Government Association, 2015). These examples serve to highlight the issue of longevity beyond government support.

⁴ UK Climate Projections (UKCP).

<https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index>

Appendix: International activity around national climate service provision

Support for coordination and collaboration activities at a national scale is aligned with the European Roadmap for Climate Services which aims to develop and grow the climate services market in Europe, as well as uplift the quality and relevance of climate services to better meet the needs of decision-makers (European Commission, 2015). The roadmap builds on the previous work in Europe to establish national climate centres and the Copernicus Climate Change Service (C3S), and seeks to use these to support development of a marketplace which can deliver effective and cost-effective climate adaptation solutions.

More recently, the Climateurope⁵ project released a set of 9 recommendations for building resilience through delivery of effective climate services, several of which are closely aligned with desired outcomes for the UK NFCS: (5) Understanding requirements, decision making context and foresight for climate services; (6) Enhancing diffusion of innovation and information for climate services; (7) Assessing the value of climate services; (8) Standardizing climate services (Döscher et al., 2017) (Climateurope, 2021). These recommendations and the European Roadmap for Climate Services are all working towards the all-important pull-through of the latest science and understanding around risk into effective adaptation action and enhanced resilience.

A recent synthesis of European-centred projects examining the climate services marketplace released a set of priorities and recommendations which can be applied to the UK (Perrels et al., 2019), (1) Increase visibility of providers to support strategic alliances; (2) Showcase success stories and added value; and (3) Pragmatically align with sectoral, cross-sectoral or non-sectoral demand. The EU-MACS and MARCO synthesis took a functional grouping approach to describing the EU climate services marketplace, identifying core capabilities and functions, and aligning activities and stakeholders to being the primary responsibility of the state, business, or networks. Within the State-

centred domain: Standardisation of climate services, Resilience monitoring and forecasting, Policy recommendations. Business-centred domain included: Stimulating the market / matchmaking, Consulting Services, New business models and provision of market intelligence. Network-centred: Awareness Raising, Education/Training, Identifying Framework Conditions, and Helpdesk.

An important driver on the development and uptake of climate services within the financial services community are the TCFD requirements for climate-related financial disclosures, affecting the financing of large projects both within the private and public sectors, as well as the reporting to shareholders of climate-related risks to business. The stated aims of the TCFDs are to provide a ‘market-based solution to climate change ... [pricing] risks associated with climate change and [rewarding] firms that mitigate them’ (Mark Carney & Michael Bloomberg, 2016). The UK has announced its intention to make TCFD-aligned disclosures mandatory across the economy by 2025, with a significant portion of mandatory requirements in place by 2023⁶. The TCFDs mandate reporting on the physical, liability, and transitional risks to businesses associated with climate change. There is a history of provision of physical risk information to government and business, however information needs to support action to manage liability and transitional risks is an emerging area. The nature of ‘foreseen’ events is changing and both *ex ante* and *ex post* litigation is possible meaning that companies and organisations need to carefully manage their liability risk (Barker et al., 2021). Managing interconnected risks requires effective processes for working across sectors as well as clear and effective standards and guidelines for performing risk assessments to support defensible decision-making. To support this reporting and to further the objectives of the European Green Deal the EU has developed an EU Taxonomy for environmentally sustainable activities including both mitigation and adaptation⁷.

⁵ Climateurope. <https://www.climateurope.eu/>

⁶ <https://www.gov.uk/government/publications/uk-joint-regulator-and-government-tcf-taskforce-interim-report-and-roadmap>

⁷ https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

The success of NFCS in other countries

Other countries have also implemented or are in the process of setting up national frameworks. NFCSs are formally established in Africa, South Asia and China and are primarily focused on increasing the local NMHS capacity and capability and the provision of seasonal information. Africa is currently part of a program to establish NFCSs in many countries. In Asia efforts are centred on regional climate forums hosted out of national meteorological and hydrological centres (NMHCs).

The high-level findings from a literature review of national frameworks established or under development in other countries finds that many European countries do not have a formally established framework but do contain many elements required for a NFCS. European coordination typically involves a cross-institutional (and sometimes cross-sectoral as well) board hosted by the country NMHS. Common to the European examples is structuring effort towards climate service development and delivery around sectoral themes. In many European cases there is a stand-alone (virtual) centre for climate change research

and services. European efforts focused around virtual centres of collaboration have found success in directing research priorities and coordinating cross-sectoral projects to better manage climate vulnerabilities and risk.

A summary table of a few European examples of national climate service delivery is given in Table 2, describing the nature of the service and providing an overview of the benefits and costs. These have been selected from countries which have similar existing core capability of the UK and could provide useful exemplars of objectives, governance structures and indicative resourcing. Common to all examples is the role of central government in providing resourcing for coordinating activities and in ensuring that national priorities are integrated into national climate service provision. This occurs in Switzerland through inclusion of all administrative bodies on the Swiss National Centre for Climate Services board of directors, and in other countries through funding which is directed through environmental programmes.

Table 2 Comparison table of national scale climate service delivery in countries with comparable resources and capability to the UK.

Switzerland		
<p>Swiss National Centre for Climate Services: Virtual centre. https://www.nccs.admin.ch</p> <p>A board of directors and secretariat comprised of Swiss institutions which set priority research themes.</p> <p>Additional aims include bundling existing services, aid in comprehension and uptake via provision of training and knowledge brokering.</p>	<p>Established in 2015, comprises 9 member government administrative bodies as well as partner research organisations.</p> <p>Funding: unknown</p>	<p>BENEFITS:</p> <ul style="list-style-type: none"> • Clear governance structure • Inclusion of all administrative bodies means close alignment with national priorities <p>COSTS:</p> <ul style="list-style-type: none"> • Not well connected to private enterprise or industry
Netherlands		
<p>Climate Adaptation Services: Physical centre. https://www.climateadaptationservices.com</p> <p>Born from dedicated government investment from out of the Environment Dep. with an adaptation focus</p> <p>Organisation formed from public research program to service the commercial sector.</p>	<p>Established in 2015 by government as part of the set up as part of the Knowledge for Climate and Climate Changes Spatial Planning programmes (2009 – 2014). Partnership between national met service (KNMI), university research institute Wageningen Environmental Research (WENR) and Deltares independent research institute.</p> <p>Funding: unknown</p>	<p>BENEFITS:</p> <ul style="list-style-type: none"> • Targeted to the private sector • True co-development could ensure success • Public effort reduced over time <p>COSTS:</p> <ul style="list-style-type: none"> • Challenge to create right environment and build trust • Still requires public funding initially
Germany		
<p>Climate Service Centre Germany (GERICS): Project based.</p> <p>https://www.gerics.de/</p> <p>Pilot projects, in partnerships with industry, private sector, universities and government.</p> <p>Recently indicated that these have not fostered as much transfer as hoped.</p> <p>Self-described ‘think tank’ for climate services.</p>	<p>Established 2009 by the federal government as a fundamental part of the German high-tech strategy for climate protection. In 2014 it moved within the Helmholtz-Zentrum Geesthacht (HZG). Governance structure unclear but GERICS employs 70 staff.</p> <p>Financed by programme-oriented funding of the Helmholtz Association and sits as a scientific organizational entity within Helmholtz-Zentrum Geesthacht (HZG).</p>	<p>BENEFITS:</p> <ul style="list-style-type: none"> • Focus on operationalisation through demonstrations • Knowledge sharing as a key element <p>COSTS:</p> <ul style="list-style-type: none"> • Struggle to move beyond pilot phase • Requires robust monitoring and evaluation to measure success
Ireland		
<p>Climate Ireland: Concierge-style / shopfront https://www.climateireland.ie</p> <p>Focus on knowledge translation and integration into decision making: work very closely with regional authorities (internal focus). Development of policy-relevant tools (e.g. Local Authority Adaptation Wizard).</p>	<p>Established in 2017 after a 3-year developmental phase through the EPA funded project ‘A Climate Information Platform for Ireland (ICIP)’ (2011-2013). Employs 6 staff to manage the platform.</p> <p>Recently secured funding for formal establishment of NFCS and funding for a key initial activity to manage national climate data sets via the TRANSLATE project.</p>	<p>BENEFITS:</p> <ul style="list-style-type: none"> • Very targeted to user needs • Likely to have high level of uptake • Potential for upscaling <p>COSTS:</p> <ul style="list-style-type: none"> • Resource intensive to produce (and maintain) tools • Training required • Other sectors don’t benefit?

Appendix: Summary of Bilateral Conversations

During February 2021 bilateral conversations were held with representatives from several government departments to explore the need for developing the UK National Framework for Climate Services (NFCS) and discuss the benefits this would bring. Representatives of DEFRA, BEIS, UKRI/NERC, the CCC, and the FCDO were invited to share their views. After establishing agreement on whether development of the NFCS is needed for the UK, the aim is to develop a collective view of what the framework’s objectives might be, which elements are core to achieving these objectives, and what possible models of governance could be considered. The conversations took place over video conference for one hour, and participants were shown a set of slides to prompt discussion on the need for a framework, the potential benefits and challenges, and some examples of frameworks implemented in other countries. This document summarises the outcomes of these discussions.

Something to bring the [climate services] community together to talk about challenges would be useful as long as [the discussion is] honest and frank: this would be the real use.

DEFRA

Standards and consistent guidance would also be a major benefit with respect to improving the quality of risk assessments.

CCC

Potential Benefits of an NFCS

All participants recognised the need for a national framework for climate services for the UK and outlined several clear benefits to be had from the framework.

Knowledge exchange was a primary benefit expressed by all participants. A framework could support existing and new fora for sharing experiences within and between the public and private sectors and across disciplines, enabling translation of current research and existing services to new contexts (therefore realising additional benefits); as well as enhancing continuity and momentum between players and beyond the lifecycle of projects.

[There is a] disconnect between what government wants and what individual users want, especially internationally, which means people aren’t really getting what they need.

UKRI / NERC

A common theme was the desire for better integration of climate information into decision making and ‘on-

the-ground-action’. This could be manifested in an uplift in the number and quality of risk assessments and adaption plans, including across multiple sectors. It was noted that there is often a gap between what users need and what is being offered, and a framework could help by connecting users and providers, identifying these gaps, and providing guidance.

There was a high degree of support for the development of professional standards – both for quality of services and for practitioners and users – as well as for a code of ethics. It was felt that a framework which contained these as core elements would benefit the UK both domestically and internationally by showing leadership while at the same time improving service offerings.

Public/private enterprise work - how to ensure that both sides are working well together, sticking to guidelines - could a framework assist with this?

FCDO

Keen to avoid something that is admin heavy but doesn’t result in a material change in uptake of climate services [and integration into] decision making.

BEIS

Governance of an NFCS

On the question of governance, all participants expressed the need for a ‘light administrative burden’ but cautioned that this should not be at the expense of the framework being able to effect real action. The need for a high-degree of buy-in from key players must be traded off against the longer-term benefits of starting small and growing over time.

Role of the Met Office

Although the WMO recommends that NFCSs are led by the relevant national met service, a number of stakeholders sought clarification regarding the role of the Met Office as part of this process. Valid concerns were raised on the potential for a conflict of interest in the Met Office as a provider of climate services alongside developing a community-representative view on recommendations for the NFCS. To mitigate this potential for conflict, the Met Office’s interests have been and will be represented by an individual from another part of the organisation at the appropriate time. The project team remain as independent arbiters facilitating the discussion and development of recommendations.

Appendix: Objective summary of NFCS workshops

Framing the framework

Following bilateral conversations with key stakeholders it was determined that a broader stakeholder engagement take place. This broader stakeholder engagement was identified as a key activity to establish community participation and ownership of the process for understanding the potential benefits of any national framework for climate services. To this end a series of identical stakeholder workshops were held throughout June 2021. The aim of the workshops was to undertake a stocktake of climate service capability and identification of current gaps and potential solutions which could be supported by a framework. The framing was around capability: what does the UK currently have and what the UK doesn't have; the intention was to draw out the capability or expertise that is currently missing and understand the role of the NFCS.

The workshops achieved two objectives:

1. What does the UK do/have now? Capture the 'day-job' roles of a broad cross-section of the climate services ecosystem, will assist us to identify what capacity currently sits within which sectors.
2. What would the UK like to have? Collect information on current gaps/barriers stakeholders experience in their 'day-jobs' as well as what is working well.

In total, 82 participants from 64 organisations across the UK (Figure 5) participated in the workshops and contributed their views via interactive Jamboards. The workshops were held in a highly inclusive and participatory manner, and participants were invited to nominate how they would like to be involved going forward using a simple Microsoft Form. Workshops were held on different days of the week to provide many opportunities for people to attend amongst their other calendar commitments. Technology was used to make the workshops as participatory as possible, providing lots of opportunity for participants to provide their input. Participants were provided with a brochure ahead of the workshops describing the project and aims, and during the workshop's participants were shown several examples of national scale climate services from other countries. Participants were also reminded of the other complementary projects occurring as part of WP4.

Schedule of identical workshops and make-up of attendees:

Date	# Attendees
Wednesday 9 June	11
Monday 14 June	12
Friday 18 June (AM)	13
Friday 18 June (PM)	14
Thursday 24 June	12
Tuesday 29 June	20

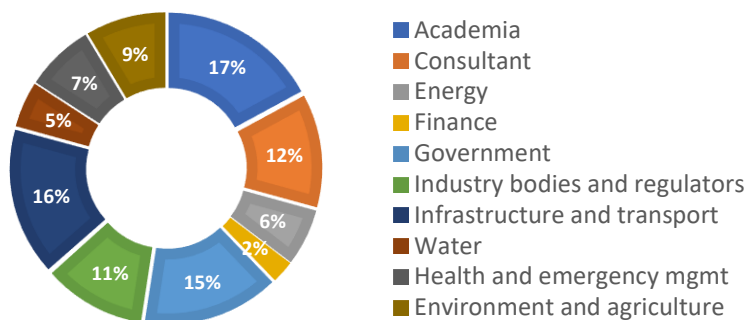


Figure 5 (Left-hand side) Table summarising the workshop dates and number of attendees per workshop, held as an identical series throughout June 2021. (Right-hand side) Visual representation as a pie-chart of the make-up of workshop attendees, by sector.

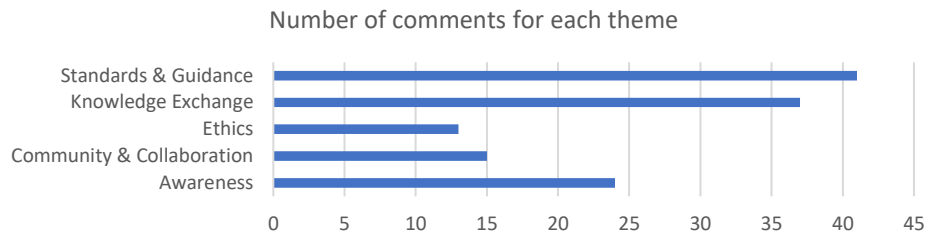


Figure 6 Grouping of workshop attendees input into thematic categories. A total of 162 comments were collected from jamboards on which participants anonymously provided input. The identification of the thematic categories was elicited through conferring with the workshop leads at the conclusion of the series of workshops.

Synthesis of workshop output

Following the workshops, the facilitators qualitatively captured their impressions of common themes (Figure 6). Attendees made many comments relating to the need for initiatives which raise awareness of the current and future climate services landscape, and knowledge exchange featured prominently among discussion on how to enhance the pull-through of climate services into adaptation action. Comments relating to the need for standards and guidance focused on the need for a common language and common understanding. Workshop attendees also raised ethical considerations around the role and remit of a national framework (such as a strong public good focus), and on the ways to strengthen the ability of the community to share information and enhance collaboration.

These impressions were then sense-checked by a more thorough synthesis of the workshop attendees' input, as captured using the sticky notes. The process

for this synthesis comprised of the following steps and visualised in Figure 7:

1. Transferred comments written by attendees on sticky notes to spreadsheets
2. Grouped comments into one of 5 themes and then classified each comment according to topic
3. This allows for comments which are addressing a similar topic across themes to be considered together
4. Look for similarities and contradictions within topics and themes to draw out findings and underpin recommendations

Using this approach recommendations were formulated for each theme according to the evidence gathered in the workshops. These are supported by relevant insights from the literature review / environmental scan of the climate services landscape in the UK and globally.

Grouped workshop input by THEMES and by TOPIC

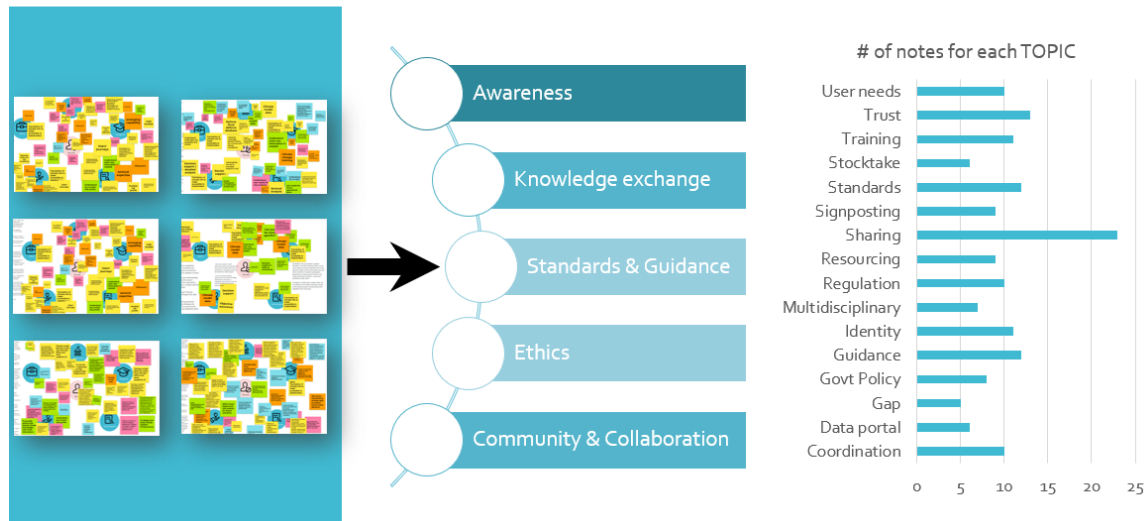


Figure 7 Process for categorising input from workshop attendees to assist with the formulation of recommendations. Within each of the thematic categories each comment was described by a 'topic' which was based upon the content of the comment.

Roles within UK climate services landscape

From the workshops it was also possible to explore the way attendees saw their own roles and the roles of others within the UK climate services landscape. Attendees were asked to use sticky notes to capture the products and services that they would expect from different classes of actors including from government, academia / research institutions, consultants, and sector experts. Attendees were also asked to indicate if there were products and services they currently needed but which were not being provided by anyone ('no-one'). Word clouds were created from the input to examine the key terms used by attendees to describe the roles of climate services actors (Figure 8).

These word clouds visually summarise several key learnings and principles which informed the recommendations for the national framework for climate services in the UK. The first learning underlines the role of government and the research community as data purveyors within the UK climate

services landscape. The community sees that there is an important role for government and the research community as providers of high-quality data and models for building UK climate resilience. The community also defines the role of consultants and sector experts as providing the understanding ('what does this mean') through translation services. This translation of climate science and climate information towards decision ready information and tools to meet the solutions agenda should also include stakeholder expertise from NGOs, who are able to relate climate information to adaptation needs. Within this translation space consultants have a role providing risk information specific to decisions. The community called for more work on 'impacts' (relating climate science to impacts on the ground) as well as more training and resources building capacity for 'how to use' climate services. Throughout the workshops there was voiced a strong desire for policy from government.

Appendix: Recommendations for NFCS activities

One way in which the UK NFCS could be structured and strengthened is described here based on the engagement exercise with the UK climate services community.

Recommendations for NFCS activities have been grouped into themes that could be led by individual entities or groups in common. In this way, the recommendations are modular and can be combined and implemented at different stages as and when funding and capacity become available.

The NFCS recommendations themselves (detailed in Table 3) and their grouping are derived from consultation workshops with the UK Climate Services Community. More than 80 representatives from more than 60 organisations and networks who provide and use climate services, spanning a broad

cross-section of governmental and non-governmental sectors, contributed input on the current state of the UK climate services landscape and recommendations for future investment. These contributions form the evidence base for the need for future development of the UK NFCS and informed the recommendations within the three NFCS domains.

The supporting evidence for these recommendations is tabulated in the Appendices along with examples of how these recommendations might be implemented in practice. These examples have been drawn from the engagement workshops with the UK climate services community as well as from ongoing discussions between government on current and future priority tasks.

Table 3 Description of NFCS Central Hub and Domains, along with activity recommendations derived from extensive user engagement with the UK climate services community.

<p>Central Hub</p>	<p>Acting as a focal point for the pulling together of climate services activity and knowledge, and then disseminating this in accessible formats for the benefit of the community. This is supported by creation of a central location to host / signpost information. In this way the NFCS is designed to be a multiplier – taking existing programs and initiatives and adding value and enhancing the outputs. Central Hub is also a forum where cross-cutting issues can be identified and discussed (e.g., role of the marketplace, data sharing, interconnected risks, etc). The Central Hub promotes actions and activities which build trust in climate services and encourages the mainstreaming of climate information into decision making. An initial activity to be coordinated by the NFCS Central Hub is a ‘stocktake’ activity of UK climate service capability.</p> <p>Activity recommendations for the NFCS Central Hub:</p> <ul style="list-style-type: none"> • Undertake a ‘stocktake’ and information mapping exercise to create a current snapshot of climate service capability in the UK. • Create a central location to host and signpost information and act as a focal point for the climate services community. • Foster better linkages to policy across levels of government and into sectors to align priorities for climate services at national through to local scales. • Encourage funding which stimulates and supports the mainstreaming of climate information into decision making to increase the effectiveness of reducing climate change impacts. • Promote actions and initiatives which promote trust in climate services and providers, which is an essential component of climate service design and uptake. <p>Appendix: NFCS examples table for the Central Hub</p>
<p>Community (PEOPLE)</p>	<p>The UK climate services landscape is comprised of people from a diverse range of expertise which would benefit from being brought together. This domain supports the establishment of trans-disciplinary networks, incentivising new partnerships between sectors/industries/disciplines/regions, creating new relationships which strengthen the</p>

inclusion of user needs to providers, promoting activities which forge a sense of professional identity within the UK climate services sector.

Activity recommendations for the NFCS Community Domain:

- Stimulate closer engagement between providers and users of climate information to promote holistic approaches to mitigation and adaptation and ensure user needs are being met.
- Support the establishment of multidisciplinary regional or other sub-networks where these don't exist to enable knowledge and data exchange between communities and sectors.
- Initiate attractive industry partnerships to incentivise collaboration across the climate services value chain.
- Organise a regular conference and regular communication products to provide a forum for community engagement, create opportunities for relationship building across networks, and keep the community well-informed.

Appendix: NFCS examples table for the Community domain

Exchange (RESOURCES)

The UK climate services community needs more support to incorporate climate data and information into decision making, citing that existing information is difficult to find, access, and understand. This domain is focused on building awareness and exposing access to existing resources (data, guidance, case studies, etc) and training to support the UK climate services community to use climate services.

Activity recommendations for the NFCS Exchange Domain:

- Invest in training and knowledge brokering to upskill users of climate services, empowering users to pull-through climate information into decisions which result in real action to increase the UK's climate resilience.
- Formalise processes and forums for sharing case studies and user journeys to facilitate knowledge and data exchange between sectors for managing climate related risks and opportunities.
- Organise meetings, workshops and communication products promoting knowledge and data exchange to expand the reach of the UK NFCS through high quality, decision oriented engagement.

Appendix: NFCS examples table for the Knowledge & Data Exchange domain

Quality (& Standards)

Climate service providers and users want to be able to demonstrate quality, and this domain provides a mechanism for the implementation of quality and ethical Standards, as well as a forum to further the discussion around community expectations relating to accreditation.

Activity recommendations for the NFCS Quality & Standards Domain:

- Implement standards and quality assurance for climate services to enable service users to access services with confidence and promote a UK climate services landscape which is vibrant and world leading.
- Move towards a requirement for regulation to be carried out by an appropriately capable entity (understands risk, resilience, and adaptation) to protect climate service users and ensure that climate services are fit for purpose.
- Develop sector and Industry-led risk analysis frameworks that are supported by policy and regulation, drawing upon standards and guidance, in response to demand for clear and transparent requirements around climate risk reporting and adaptation planning.
- Work towards agreed practices on use of terminology or defining terminology clearly to improve climate literacy and remove barriers to climate resilience posed by inconsistent understanding of the nature of climate risks and climate information.

Appendix: NFCS examples table for the Standards domain

Appendix: NFCS examples table for the Central Hub

Recommendations: Central Hub	
<ul style="list-style-type: none"> • Undertake a 'stocktake' and information mapping exercise to create a current snapshot of climate service capability in the UK. • Creation of a central location to host and signpost information and act as a focal point for the climate services community. • Better linkages to policy across levels of government and into sectors. • Funding which encourages and supports the mainstreaming of climate information into decision making. • Actions and initiatives which promote trust in climate services and providers. 	
Evidence from workshops (what did people say they wanted)	
<p>Further mapping and information gathering, possibly linking to existing activities that are already underway (e.g., Environment Agency stocktake, ONS data portal scoping) that captures current data products and their locations, decision support tools and services, experts, (other?); could be done at sector level or regional level; roles of actors (e.g., regulators) should also be made clear. This is recommended as a foundation step for a national framework (WMO-GFCS, 2018).</p> <p>Environmental scanning (as distinct from a stocktake or look forward) is seen as an important part of knowing where to go for information and of what info exists / is under development and should include the research/academic and business/industry sectors. Ireland (for example) have recognised this activity as key to effective adaptation and have included it as a core part of their funded framework.</p> <p>A central location that points towards resources and expertise could meet this requirement; could take the form of a hub/interchange/community of practice for better organisation of and access to resources, knowledge, people. Web presence to enable access to signposting, could include ways for community to self-serve and to highlight their presence and activity (dual purpose). Signposting and data portals need to be accompanied by training for users to be effective.</p> <p>Cost of climate information and services is a potential barrier to adaptation: perception that users 'shouldn't have to pay twice for climate data' indicative that the value chain of information production is not transparent or clear enough and community expectations are this information should be free.</p> <p>Improving linkages to identify and tackle 'blind spots' and disconnects between short/medium/long term policy objectives and decision making; introduction of incentives to improve adaptation planning (and mitigation) as for those targeting GHG emissions; incentives for public-private partnership e.g., in funding opportunities.</p> <p>Process for the movement/flow of information into policy and action that is transparent and robust (works both ways) e.g., new science into updated building standards via policy or regulation; how to ensure interdependencies are accounted for (impacts of other people's decisions on you); linked to funding which should encourage continuation and pull-through e.g., CCRA or the NAP; this should start conversations and action not just stopping once a report is published.</p>	
Additional notes:	
<p>One of the recurring challenges for development and provision of climate services is to produce actionable and useful information, in a sustainable way beyond the life of an individual project (Bruno Soares & Buontempo, 2019)</p> <p>Why longevity is important: multiple dimensions, adaptation in a year-on-year thing, need to run services for multiple years to demonstrate benefits, early and later adopters means that benefits grow over time; also nature of services changes over time as users evolve and new users come onboard</p>	
Government / Public Sector	
<p>Key role: Enabling coordination through centralised funding of hub secretariat; reviewing and implementing funding which promotes mainstreaming of climate information (perhaps through mandates or guidelines) as well as continuity beyond the life of projects.</p>	<p>Building on existing services</p> <p>Currently there is no centralised repository of climate services for the UK.</p> <p>EA stocktake and Climate Hub concept: Climate Hub – Providing Credible and Authoritative Climate Evidence.</p> <p>ONS climate change statistics data portal, including the climate element.</p> <p>Examples and ideas</p> <p>Ireland is investing in people to act as this central hub, rather than / in addition to a web-based presence.</p> <p>Online portals such as ClimateAdapt can act as central 'jumping off points' for users, containing information, data, signposting to experts, training, user stories, etc.</p> <p>Literature demonstrating that pull-through occurs when policy (and funding) is aligned from national through to local levels for example (Birchall & Bonnett, 2021).</p> <p>Authentic leadership: Climate Ready Clyde (Scotland); Success in Wales by tying in resilience and making it about well-being of children (Climate Ready Gwent)</p>

Industry	
<p>Key role: Active contributor to stocktake activities; engaging with policy makers to feed in industry perspectives and needs with a focus on innovation.</p>	<p>Building on existing services</p> <p>Taskforce on Climate-related Financial Disclosures (TCFDs) as a driving force for organisational approaches to adaptation and resilience, potential for new markets in response to reporting obligations.</p> <p>EU-MACS looked at the current provision of services in the private sector for Europe (not the UK).</p> <p>Examples and ideas</p> <p>Can use recommendations and lessons learned from the EU-MACS project (Perrels et al., 2019). For example: “The market growth will not only depend on (public) budgeting and economic growth, but also on the intensity and coverage of policy programmes to promote the use of climate services and their integration or connectivity with public and private planning cycles as well as with risk management systems and practices.”</p> <p>Less money for longer periods (this is the approach the Green Climate Fund (GCF) takes) or a tailing off as industry ramps up.</p>
Academia	
<p>Key role: Provide trans and multi-disciplinary input to research proposals and activities; work on ‘blind spots’ and needs to advance the state of the science.</p>	<p>Building on existing services</p> <p>UKCR program: transparently funded, cross-boundary activities and projects at multiple scales; builds relationships between actors within UK.</p> <p>Codes of ethics (RMetSoc).</p> <p>Examples and ideas</p> <p>Cross-sectoral proposals / legislation more likely to get funded (in Ireland) which acts as an incentive.</p> <p>Workshop report from joint Space4Climate and LCCP workshop on ethical data value chains which looked at the strongest (data production) and weakest (funding, user input) links in the chain as well as exploring concepts of inclusivity</p> <p>Project report from South African climate services ethical challenges (with cartoons!)</p>

Appendix: NFCS examples table for the Community domain

Recommendations: Community / Professionalisation	
<ul style="list-style-type: none"> • Closer engagement from providers with decision makers to promote holistic approaches to adaptation and ensure user needs are being met. • Establishment of regional or other sub-networks where these don't exist. • Introduction of incentivised industry partnerships to encourage collaboration across the value chain. • Organisation of a regular meeting / conference and regular communication products. 	
<p>Evidence from workshops (what did people say they wanted)</p> <p>Closer engagement from providers with decision makers when formulating projects and undertaking risk assessments to ensure that user needs are integrated from the start of the conceptualisation process (user-driven, co-developed) and that intersectoral and interdependent risks are accounted for.</p> <p>Inclusion of multi-disciplinary expertise in research proposals.</p> <p>Decision support: moving from understanding available information on risks and impacts to exploring responses; requires multi and inter disciplinary approaches and benefits to be gained from open knowledge exchange.</p> <p>Work to understand user needs including those with less access; appropriate delivery of information to users depends on both the provider (limited picture from consultants, confusion/info overload from academia) and the user (maturity and capacity); flexible and tailored approaches needed to ensure user needs are understood and met. Potential to use existing fora and networks (e.g., climate assembly) and build up.</p> <p>Additional notes:</p> <p>Funding needs to fertilise / catalyse next steps</p>	
Government / Public Sector	
<p>Key role: Creation (through mandates?) of environments that promote closer engagement of providers with decision makers ensure user needs are being met.</p>	<p>Building on existing services</p> <p>Natural Hazards Partnership (NHP) of UK govt agencies: The NHP delivers coordinated assessments, research and advice on natural hazards for governments and resilience communities across the UK.</p> <p>Examples and ideas</p> <p>TalX wholistic adaptation and building the capacity of decision-makers at all levels through working with as many practitioners and voices as possible; currently holding workshops to develop a 'maturity model' framework for increasing capacity for adaptation.</p> <p>Ireland having embedded focal points has been essential for success, e.g. Recently embedded the CARO'S with the GAA (Gaelic Athletic Assoc) and uptake has been better than anticipated, looking very successful; builds trust with local community; can this be implemented in UK?</p>
Industry	
<p>Key role: Bring industry and sector specific perspectives on user needs to providers (both public and private sector); Drive innovation through strengthening of networks within and between sectors.</p>	<p>Building on existing services</p> <p>Within food sector large chains have high data science capability but SMEs and smaller parts of the food chain don't have that capability – networks can enable and promote good practice within a sector.</p> <p>Industry Operators Adaptation Forum(IOAF) is highly successful – can this be rolled out to other sectors?</p> <p>Examples and ideas</p> <p>Recent longitudinal study indicated that funding and access to relevant information was a barrier to building organisational resilience in the UK (Dookie et al., 2021)</p> <p>Real opportunity here for academic and private sector to get involved with market intelligence (combining science-informed policy, with econometrics?), if incentivised.</p> <p>Industry focused partnerships in Germany, Netherlands, Australia (e.g., ESCI) developing new approaches, new tailored datasets</p>
Academia	
<p>Key role: Contribute expertise on holistic approaches to adaptation (trans and multi-disciplinary); Build capacity through being responsive to skills needs.</p>	<p>Building on existing services</p> <p>UKCR Champions acting as focal point.</p> <p>Examples and ideas</p> <p>Role for higher education sector: need skilled graduates across all professions and sectors to have awareness of climate risk; need skilled graduates who can assess climate risk and inform adaptation.</p>

Appendix: NFCS examples table for the Knowledge & Data Exchange domain

Recommendations: Knowledge Exchange	
<ul style="list-style-type: none"> Investment in training and knowledge brokering to upskill users of climate information. Formalisation of processes and forums for sharing case studies and user journeys. Organisation of meetings, workshops and communication products promoting knowledge and data exchange. 	
<p>Evidence from workshops (what did people say they wanted)</p> <p>Matchmaking could link up decision-makers with decision-support (forums, tools, experts); this could be a follow-on activity post-stocktake and be linked to training where users are connected to providers/experts.</p> <p>Networks could be similar to the Regional Climate Forums linking impacts and adaptation; encourage 'healthy competition' as well as exploring interdependencies; relies on clear and linked up policy directives from national to local so that e.g., resourcing can be secured.</p> <p>Collection of user journeys to share within and between sectors to identify expertise that can be applied across the different sectors to optimise and target their evolution; benefits include being more tangible, able to identify interconnected risks, demonstrations of how to combine knowledge that is available now with action.</p> <p>Creation of case studies co-produced by both users and providers to share learning across sectors and industries including 'failures' as a learning tool; could be supported by a 'framework' defining a process for sharing ('knowledge hubs?') and best practice for what to include in case studies to improve comparability; community-led ensures that examples are relevant and of interest (everyone contributes, and everyone gains).</p> <p>Formal transfer of knowledge and expertise from 'mature' sectors to sectors with less experience in using climate information through mandatory reporting (using consistent formats) and / or through knowledge exchange and collaboration hubs and meetings; networks are key to ensure that 'the right people' are involved.</p> <p>Signposting to key glossaries that have been developed would help here, or using IPCC terminology as standard? Awareness is the important thing here rather than agreeing on single terminology, which can then be used as a starting point for knowledge sharing.</p>	
Government / Public Sector	
<p>Key role: Providing leadership and seed funding for establishment of regional networks, linking in at local govt levels to meet local needs.</p>	<p>Building on existing services</p> <p>UKCP: user groups, services and products already servicing some of the needs of the climate services community e.g. looking at user needs and decision support</p> <p>Examples and ideas</p> <p>CCC might oversee something like a network and provide steering / driving force towards a common agreed target, perhaps based on priority areas</p> <p>Ireland: making local councils implement adaptation plans (funded it and supported it with services); making these available means comparisons can be made to 'peer pressure' improvements.</p>
Industry	
<p>Key role: Contribute to and benefit from knowledge exchange; important potential source of resourcing for knowledge exchange if incentivised (policy, regulation, etc); role to play in knowledge brokering and decision support within agreed guidelines and standards.</p>	<p>Building on existing services</p> <p>GOAL13 Impact Platform (led by Deloitte and MO): Open repo for business to share their adaptation journey and actions (global). This could be promoted and expanded.</p> <p>Examples and ideas</p> <p>Met Office training courses targeted at industry could be expanded or act as a model for other service providers; potential for links to standards and quality assurance.</p>
Academia	
<p>Key role: Bring expertise on effective ways of knowledge exchange and provide leadership and guidance.</p>	<p>Building on existing services</p> <p>Examples and ideas</p> <p>Workshop report from Leeds workshop (2021) on codes of ethics for the UK climate services profession which identified strong support for establishment of an ethical code as well as professionalisation of climate services</p>

Appendix: NFCS examples table for the Standards domain

Recommendations: Standards and Quality Assurance	
<ul style="list-style-type: none"> • Implementation of standards and quality assurance for climate services. • Requirement for regulation to be carried out by an appropriately capable entity (understands risk, resilience, and adaptation). • Development of Industry-led risk analysis frameworks that are supported by policy and regulation, drawing upon standards and guidance. • Agreed practices on use of terminology or defining terminology clearly. 	
<p>Evidence from workshops (what did people say they wanted)</p> <p>(Complementary to standards project)</p> <p>The NFCS could have an important role in supporting the delivery of capability required to effectively implement Standards – such as programs/initiatives/incentives to perform QA / monitoring / evaluation of climate services. Not currently happening.</p> <p>Users want assessments against standards/accreditation/regulation applied to tools and datasets to ensure quality.</p> <p>Regulation needs to be both general and consistent across sectors and levels (national, local); also needs to be tied to policy that is specific enough to be actionable (Birchall & Bonnett, 2021). EA has remit for some areas but not all. Could Chartered Institutes fulfil this role? How should a minimum accreditation standard be defined? Can lessons be learned from other areas? Need for support organisations to assist with making sure regulatory requirements are met (e.g., regional CC partnerships, Climate Ready).</p> <p>This could be supported by hazard scenarios and other clear information about what must be planned for. Risk management. frameworks at varying levels of maturity: need help to put climate risk on an appropriately weighted playing field with business risk. Opportunities for more mature sectors to transfer knowledge and approaches.</p> <p>Transparency and salience of guidance and standards key to ensuring trust in information and legitimacy of decisions.</p> <p>Establishment of external review panels for major initiatives including expertise from across the value chain.</p> <p>Additional notes:</p> <p>Important element here to understand and quantify the value of climate services, needed to incentivise uptake and mainstreaming. To do this longevity in funding and capability required. Monitoring and ex-post evaluation is part of this.</p>	
Government / Public Sector	
<p>Key actors: EA, regulators, Defra, BEIS, Chartered Institutes (industry)</p> <p>Key role: Trusted, authoritative owner of standards and QA; bring together community to define and refine best practice in an equitable manner; ongoing monitoring and evaluation as well value and impact</p>	<p>Building on existing services</p> <p>Role for Adaptation Reporting Power (ARP)</p> <p>Assessments of adaptation planning / resilience by the CCRA</p> <p>The Green Book update now includes a framework for incorporating climate risk into policy assessment.</p> <p>Examples and ideas</p> <p>ISO Standards for Climate Change include guidance around environmental management and carbon accounting; adaptation and mitigation; green finance.</p> <p>TCFDs mandatory disclosures of climate risks: Roadmap for the UK (HM Treasury, 2020)</p> <p>EU Taxonomy for Sustainable Activities (for sustainable finance, and related to TCFDs) – fact sheet</p> <p>TaIX assessment of <i>national</i> adaptation policy: if they enable policy (currently in write up stage); used a traffic light system. How are national govts driving/supporting adaptation.</p>
Industry	
<p>Key role: Adopt and benefit from implemented quality standards, being active participants in the evaluation and refinement in practice.</p>	<p>Building on existing services</p> <p>Role for professional bodies and institutes here within their own sectors?</p> <p>Examples and ideas</p> <p>Professions IRS accreditations: looking at what meets the requirements, and could expand this to look at what accreditations would be aligned with climate service profession; also UK Government Science and Engineering Profession.</p> <p>CIWEM (water and env mgmt.): has accreditation process / evidence against criteria</p>
Academia	
<p>Key role: Provide leadership on best practice for value and monitoring of climate services,</p>	<p>Building on existing services</p> <p>Links here possibly with OpenCLIM</p>

as well as the application of standards in partnership with industry and government.

On value of climate services, there are a couple of examples (but not of economic value) of decision making from the [Euporias/LMTool](#) work.

- Examples of farmers using support tools for decisions, with applications in forestry (Falloon et al., 2018).
- Assessing the usability and potential value of seasonal climate forecasts in land management decisions in the southwest UK: challenges and reflections (Soares, 2017)

Examples and ideas

[TalX](#) workshops: language has recurred as a key issue/barrier to communication about climate change and climate change action; recommend not using shorthand even between different disciplines; promote the use of visual info to minimise miscommunication; recommend tailoring comms to intended audience e.g., rewilding has negative connotations to farmers (taking their land).

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