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Foreign, Commonwealth & Development Office

CLARE consultation: Final report

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EXPERT ADVISORY CALL DOWN SERVICE – LOT B

STRENGTHENING RESILIENCE AND RESPONSE TO CRISES

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We offer support for risk informed design for development interventions across all sectors; risk and contingency financing; understanding changing systems; and strategic integration of humanitarian action and development.

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- Consistent end-to-end quality assurance
- A user friendly, customer-oriented outlook
- A pro-active approach to knowledge sharing and communication
- A focus on due diligence, efficiency and cost effectiveness.

ACKNOWLEDGEMENTS AND DISCLAIMER

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Prioritised research gaps:

This consultation identified a substantial list of research gaps that can be seen as a list of priorities. The survey stage of this consultation drew attention to the following research gaps, which were more frequently selected as prioritises:

- **Fresh water security:** 'Understanding the impact of climate change on fresh water security' was selected as an overall priority and also ranked highly in relation to likelihood of action arising from this research and the level of its impact.
- Gaps in a theme: **'Climate and weather dynamics and projections**' were likely to be prioritised across criteria (especially research aiming to improve the understanding of the hydrological cycle). This is perhaps reflecting that climate science underpins a range of research projects relevant to climate change, as well as a large proportion of respondents being involved in climate science.
- **Synergies between mitigation and adaptation:** 'Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development' was the only gap from theme 5 (adaptation responses) prioritised highly across all criteria. It was also selected as top in regards to its potential for developing and utilising interdisciplinary and transdisciplinary approaches.
- **Integrated research and capacity building:** 'Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production' came first in relation to research timescales and legacy considerations. This research gap ranked highly across all prioritisation criteria.
- **Climate change and food systems:** 'Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies' was ranked as top priority in terms of its level of impact.
- **Impact-based forecasting:** 'Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries' emerged as top priority in relation to likelihood of action arising from research.

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Executive summary

Perceptions of priorities and approaches to prioritisation

Qualitative stages of this consultation explored different approaches to prioritising research projects and the challenge of having to compare and choose between projects of radically different natures, scopes and impacts. The findings should be read with the understanding that there isn't a single way of prioritising funding allocation, while the sentiments of the expert community varied too – some preferring a cost-benefit approach, where others, for example, prioritised addressing the urgency of need.

For a quick overview, please explore the following pages outlining different prioritisation lists:

- Page 37: Gaps prioritised as being most critical to advancing knowledge of climate and climate change
- Page 61: Prioritising research funding against specific criteria
- Page 68: Overall prioritisation across the above criteria

A wider list of research themes, clusters and gaps

For a more in-depth look at the organisation of the gaps and research areas identified throughout the consultation, explore the following pages:

- Page 16: Overarching research themes
- Page 17: More granular thematic clusters
- Pages 20-31: Structured list of primary research gaps
- Pages: 73-104: Appendix A with a full list of additional research gaps and themes identified in the survey

Executive summary

Relationships between priority areas

We also hoped to understand how addressing one knowledge gap or research problem might affect other research areas and priorities. Mapping those relationships has proved difficult in this consultation, but some areas stand out as underpinning many research gaps:

- Reliability of science, confidence in data, skill of modelling.
- Assessment and evaluation of evidence, actions and approaches to know what works.
- Conducting science across scales and contexts and evidence synthesis.

Gap 1. 'Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries' and gap 4. 'Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change' were seen as most linked to other research problems.

Alongside connections between research gaps, cross-cutting themes were identified. We refer to these as research amplifiers, as they have the potential to amplify the implementation and impact of multiple individual research projects. Systems thinking and systems approach to climate change, mitigation and adaptation research was also identified as a gap in itself.

Challenges and barriers to addressing the gaps

In both the qualitative and quantitative stage, respondents were asked to choose potential obstacles that prevent the exploration of important research gaps. Most frequently identified challenges were of very different kinds:

- Economic – insufficient funding.
- Scientific – insufficient observations being collected / unreliable data.
- Perceptual – lack of understanding of research value / potential.
- Logistical – lack of access to knowledge / research / data.

Respondents were also asked to identify which disciplines and areas of expertise had a role to play in addressing the knowledge gaps. In qualitative stages, the importance of interdisciplinary and transdisciplinary working was often highlighted. These themes were also mentioned as gaps. Quantitative findings do not reflect that clearly, as the top areas of expertise listed as having a role to play were climate science, adaptation, environmental science, economics and social economics, and computer modelling. This might be due to question design.

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BACKGROUND, RESEARCH OBJECTIVES AND METHODOLOGY

About these findings

Overall, more than 200 individual research and knowledge gaps or priority areas of various sizes and types were identified by the research community across the consultation phases. These were simplified into a list of primary gaps. Throughout the consultation, participants were also asked to think about the prioritisation of gaps and links between them.

These research gaps were grouped into 27 thematic clusters, which were then gradually re-structured into overarching research themes that have the most potential to address the challenges around building resilience and adaptation in developing countries.

9 overarching themes were identified, covering research areas from pure science to the implementation and assessment of adaptation responses, and from topic-specific research projects to methodological and ontological approaches. Additionally, a list of cross-thematic research amplifiers was identified.

RESEARCH GAPS

We often merged very similar knowledge/research gaps to reduce overlap and some detail was omitted to make them more comprehensive. However, areas of overlap still exist between them, as some are more specific, others more general.

RESEARCH THEMES

We acknowledge that grouping gaps into themes could be approached in multiple ways and the current hierarchical list is not perfect, especially in relation to highlighting boundary-spanning research.

RESEARCH AMPLIFIERS

Some topics identified by respondents as important were not strictly research gaps but factors or principles that could aid the implementation of research projects and climate actions.

Background and research objectives

Background and methodology

This report presents findings from the three-phase consultation project designed to provide evidence to inform the design and development of a new climate and resilience research framework (CLARE), which is jointly managed between the Foreign, Commonwealth and Development Office (FCDO) and the International Development Research Centre (IDRC) Canada.

The consultation also sought to inform the FCDO's wider understanding of the opportunities and challenges facing climate research.

Shift Insight were commissioned to provide technical and logistical support in collecting insights from academic audiences involved in fields related to climate, and in analysing the data and reporting on the findings.

The research was conducted in three phases, including a two-round Delphi approach with an expert panel of 30 researchers, followed by a final survey to the wider research community (ca. 780 researchers were invited), which received 164 usable responses.

Key question areas explored in this research were as follows:

- Where do climate research community members perceive the priority knowledge gaps in their fields to lie?
- Which are the priority challenges relating to resilience and adaptation in developing countries?
- What research themes would have the most potential to address these challenges?
- What are the potential barriers to conducting research in these priority areas, and how could these be overcome?
- How are priority areas interrelated from a systems perspective, and how could this impact on their ranking as priority areas?

Methodology

The research was conducted in three phases, including a two-round Delphi approach with an expert panel of 30 researchers, followed by a final survey to the wider research community.

Phase 1: Qualitative interviews

45-minute interviews with experts in the fields of climate science, climate change, international development and developing countries.

Phase 2: Expert panel survey

Participants from phase 1 were asked to review collated outcomes of interviews anonymously and identify any additional gaps.

Phase 3: Survey to wider research community

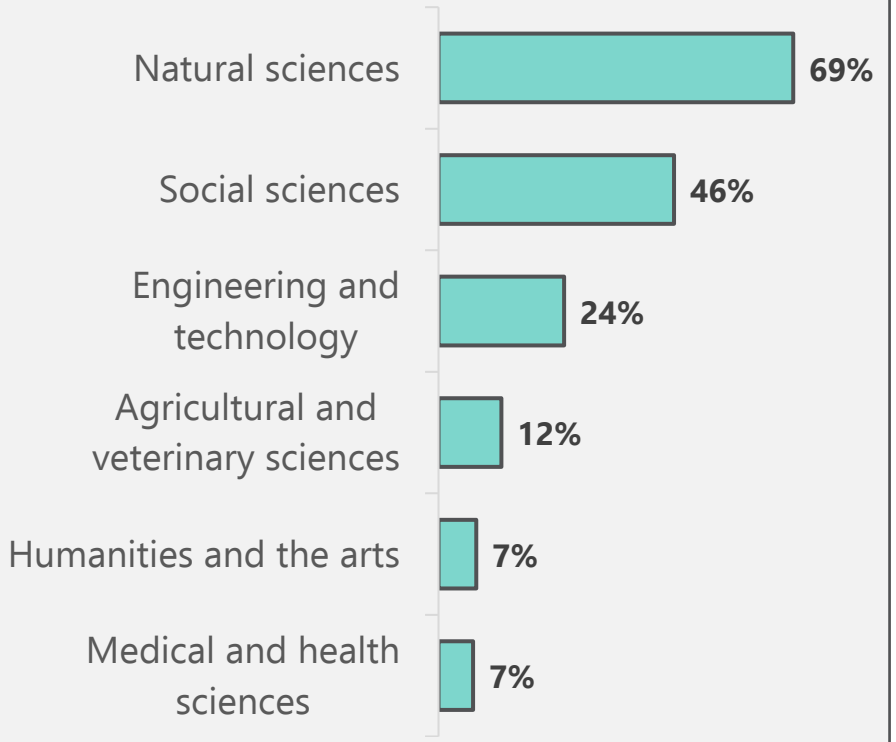
Findings from the phase 1 & 2 Delphi analysis informed the development of a survey with the wider research community – aiming to establish a finalised framework for prioritising future climate science research.

PROFILE OF RESPONDENTS

Profile of respondents

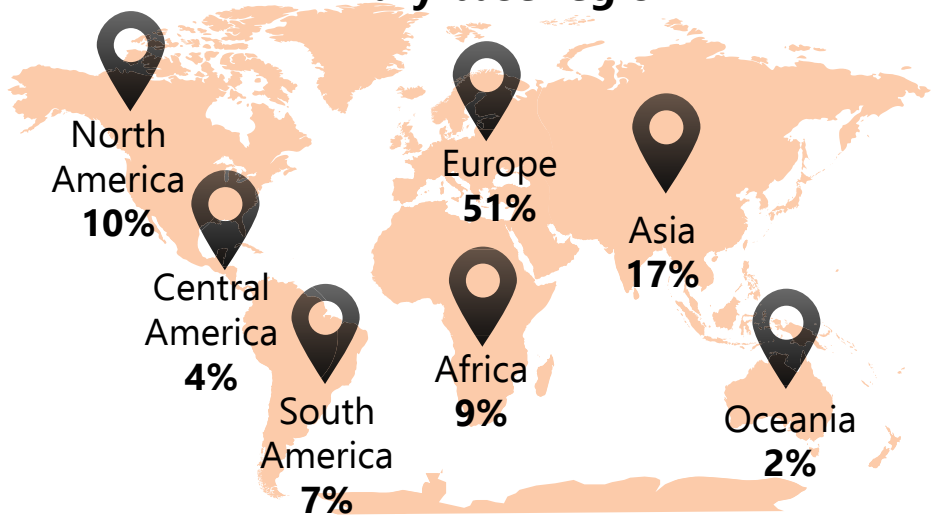
After careful data cleaning and processing, 111 complete and 53 partial survey responses were included in the analysis, giving a total of 164 useable responses. These survey responses came from researchers working in a diverse range of fields, job roles, sectors and global regions.

Field of research

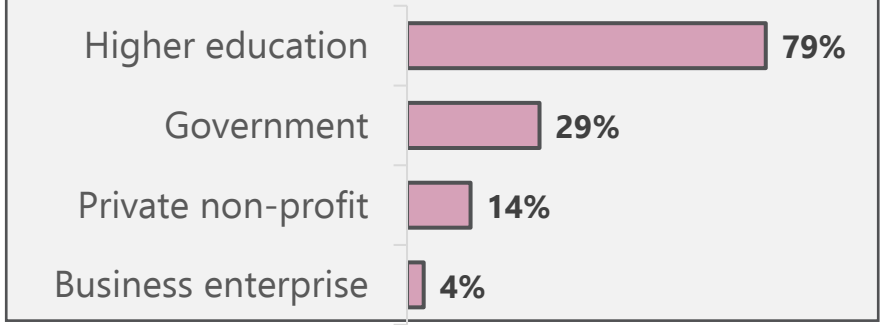


Job role	
59%	Senior researcher
33%	Senior leadership role
16%	Researcher
16%	Management role.
5%	Early-career researcher
1%	PhD student

Primary base region



Sector



Note: some respondents worked across multiple fields, roles or sectors.

Base n=164

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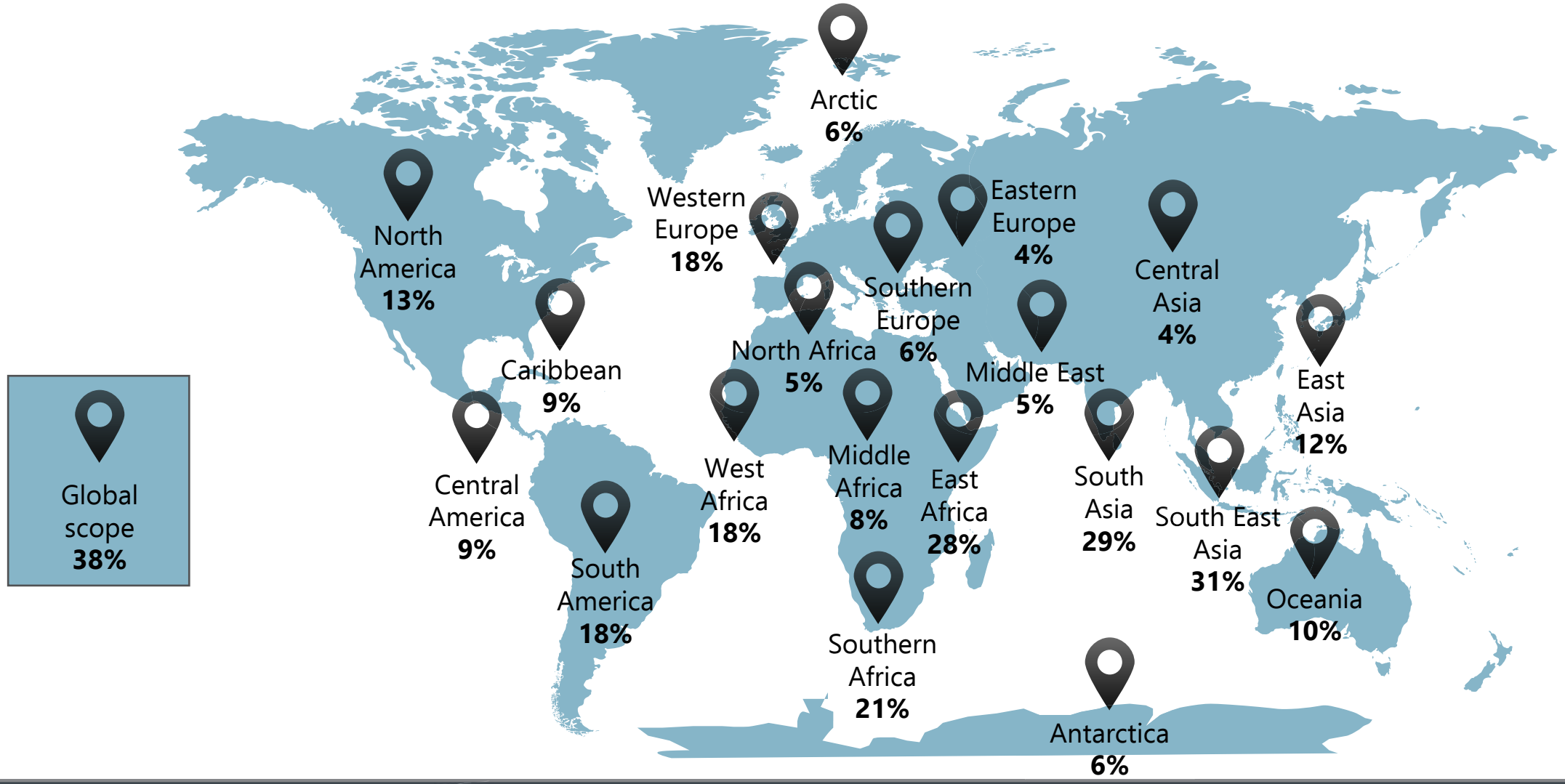
Profile of respondents

Ares of research							
65%	Climate adaptation	**20%**	Policy	**10%**	Civil engineering	**4%**	History
51%	Environmental science	**20%**	Weather science / Meteorology	**10%**	Economics and social economics	**4%**	Psychology
47%	Climate science	**18%**	Observations and remote sensing	**10%**	Political economy	**4%**	Soil science
32%	Geography (human and physical)	**16%**	Data science, machine learning or statistics	**9%**	Sociology	**3%**	Finance
31%	Hydrology	**16%**	Oceanography / Marine science	**7%**	Geology / geoscience	**2%**	Demography
28%	International development	**15%**	Ecology	**5%**	Health / Public health	**2%**	Arts
27%	Climate / weather services	**15%**	Urban planning	**5%**	Anthropology	**2%**	Epidemiology
26%	Risk management	**13%**	Education	**4%**	Biology	**2%**	Technology
25%	Climate mitigation	**12%**	Agricultural and crop science	**4%**	Humanitarian relief	**1%**	Cognitive science
22%	Computer modelling	**11%**	Loss and damage	**4%**	Humanities		

Base n=164

Profile of respondents

The geographical focus of the research that respondents were involved in spanned many regions across the globe.



Base n=164. Note that respondents were involved in research that spanned multiple regions.

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THE RESEARCH LANDSCAPE – BREADTH OF KNOWLEDGE GAPS

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Research themes

Overarching research themes

Theme 1: Climate and weather dynamics and projections

Theme 2: Weather forecasting and seasonal prediction

Theme 3: Climate – environment – human dynamics: understanding structures of hazard, exposure and vulnerability

Theme 4: Useful and usable science and pluralism in knowledge production

Theme 5: Effective and adequate adaptation responses

Theme 6: Climate change governance*

Theme 7: Climate change and environmental degradation*

Theme 8: Systems approaches to understanding climate change*

Theme 9: Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development*

Research amplifiers

Understanding and building capacity

Effective communication of climate science*

Intersectionality

Public engagement and awareness*

Interdisciplinary and transdisciplinary working

Useful climate services*

Please note that respondents had different approaches to transdisciplinary work: for some it was limited to scientific / academic knowledge, for others it included non-traditional knowledge sources (e.g. indigenous knowledge).

**Additional themes identified in consultation phase 3*

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New thematic clusters from consultation phase 3*

Respondents were asked to identify themes and research gaps missing from the list presented to them. Their responses can be grouped into the following thematic clusters. Many of these clusters were already covered by themes and gaps identified in previous stages of the consultation. There are a few additional ones that are new however (highlighted in yellow).

Thus, the grid below doesn't necessarily point to what was missing from the initial list, but illustrates which thematic clusters respondents saw as important enough to be listed and described separately.

Adaptation assessment	Adaptation responses	Attribution	Capacity	Climate – environment – human dynamics	Climate and weather dynamics and projections	Climate finance
Climate justice	Climate services and communication	Energy	Environmental degradation	Evidence synthesis	Extreme events	Food security
Climate governance	Human health	Indigenous knowledge	Interdisciplinary working	Intersectionality	Knowledge co-production	Climate observations and monitoring
Nature-based solutions	Public engagement	Synergies between Mitigation, Adaptation, DRR and SD	Systems approach	Understanding risk and vulnerability	Water security	

Please see Appendix A attached to this report for a comprehensive overview of all newly identified research gaps in themes in the survey part of the consultation

How to analyse the new research gaps and themes

This survey aimed to identify as many additional knowledge gaps and research problems as possible to account for any blind spots from the small scope of the initial qualitative consultation phase. We received around 240 descriptions of different themes and gaps. This report tries to synthesise those as much as possible into more comprehensive research gaps. However, this synthesis is unavoidably imperfect, as the amount and detail of the descriptions differed, so interpretative decisions were made to merge some and exclude others if they felt out of scope. A full list of lightly edited entries from the research community is included in the appendix.

Analytical limitations

- Listed knowledge / research gaps were of various scales and sizes – some overarching, others very localised and specific. For brevity, some of this detail was omitted in the overview list presented in this section.
- Some responses included minimal detail and their objective had to be interpreted based on limited data.
- Respondents had a chance to include their own gaps in the list of priorities, but they couldn't see additional gaps identified by other respondents and vote for them, so the omission of new thematic clusters from the ranking of priorities should not be read as a sign of their lesser significance.
- Not all responses were knowledge gaps or research problems – some were guiding principles or areas in which *action* rather than research was needed.
- It wasn't always possible to differentiate whether the gaps related to addressing current levels of understanding or current actions, implementation and capacities.

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How to analyse the new research gaps and themes

The following thematic clusters were decided to encompass enough to be treated as overarching research themes or research amplifiers.

The tables in this section present a list of primary research and knowledge gaps organised into overarching themes.

These gaps were identified in different consultation phases (qualitative or quantitative), so the level of collected detail and specificity of description varies.

Climate change governance

This thematic cluster, and the individual knowledge gaps and research questions covered by it, wasn't included in the pre-existing list and constitutes the biggest new overarching theme identified in the survey stage.

Environmental degradation

The pre-existing list didn't include this as a standalone theme. However, some aspects of individual research gaps within it were identified in the previous stages. Following this stage of consultation, it became an overarching theme.

Systems approach

This was upgraded from an individual gap to a standalone theme.

Research amplifiers

Some thematic clusters around capacity building, ways of working and ways of understanding the problems and implementing the results of research were treated as research amplifiers. It's because of their potential to make research more effective or impactful rather than being research problems themselves.

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Gap number, consecutive across themes. Gaps 1-40 were identified in phases 1 and 2, gaps 41-107 in phase 3.

Structured list of research gaps

Consultation phase in which the gap was identified

Theme number (1-9)

Theme 1: Climate and weather dynamics and projections	1:1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.	Phase 1
	1:2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.	Phase 1
	1:4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change (e.g. in response to El Nino, ENSO, and sea surface temperature changes).	Phase 1 and 3
	1:5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle.	Phase 1
	1:6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development.	Phase 1
	1:7. Minimising uncertainty in shorter-term climate projections (5-10 years).	Phase 1
	1:41. Attributing extreme climate and weather events to causes, to help inform adaptation as well as test observational data and model simulations.	Phase 3
	1:42. Delineating predictable versus impactful aspects of climate change – outlining what is known well about climate change versus what should be known.	Phase 3
	1:43. Considering all drivers of change together with climate change through long-term monitoring, collecting quantitative data, increasing observations, and transboundary data sharing to establish monitoring systems to track climate and its impacts.	Phase 3
	1:44. Addressing the lack of observations of the climate system in hotspots of projected change.	Phase 3

*Consultation phase in which this research gap was identified.

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Structured list of research gaps

Theme 2: Weather forecasting and seasonal prediction	2:14. Developing new science to inform predictions across time-scales (nowcasting, forecasts based on numerical weather prediction, sub-seasonal, seasonal, and synoptic) and applying existing science and tools on those time-scales.	Phase 2
	2:3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries.	Phase 1
	2:45. Improving monsoon prediction at seasonal and decadal level and monsoon future projections (through better observation data and understanding of processes).	Phase 3
	2:46. Determining the precipitation threshold that potentially triggers landslide in a defined landscape.	Phase 3
	2:47. Strengthening sustainable Monitoring, evaluation and learning (MEL) capacities within National Meteorological and Hydrological Services (NMHS) and climate research institutions beyond project-based approaches to demonstrate value of national investment in climate services.	Phase 3

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Structured list of research gaps

Theme 3: Climate – environment – human dynamics: understanding structures of hazard, exposure and vulnerability	3:36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).	Phase 2
	3:37. Understanding the impact of climate and weather changes on energy security.	Phase 2
	3:8. Mapping coastal erosion and understanding the relationship between sea conditions and coastal erosion and the impacts of human interventions that exacerbate or counter coastal erosion.	Phase 1
	3:11. Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies.	Phase 1
	3:12. Making infrastructure systems resilient to climate change so that they support resilience, development and economic growth.	Phase 1
	3:16. Understanding the interaction between multiple stressors, including climate change, and their combined impact on oceans and marine life.	Phase 1
	3:25. Understanding the impacts of extreme heat on human health, livelihoods and productivity in warmer climate zones and developing countries and the impact of warming trends on human health and productivity in moderate climate.	Phase 1
	3:27. Analysing the benefits and limitation of ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature.	Phase 2
	3:33. Understanding the primary and secondary impacts of climate change on the spread of infectious diseases.	Phase 1
	3:34. Understanding the sensitivity of agricultural ecosystems and biodiversity to climate change as well as to responses to climate change.	Phase 2
	3:48. Studying the social justice implications of climate change, especially its exacerbation of conflict, inequity and forced migration.	Phase 3
	3:49. Developing socio-cultural and ethical perspectives on climate actions, e.g. a rights-based approach to climate change adaptation and mitigation.	Phase 3

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Structured list of research gaps

Theme 3: Climate – environment – human dynamics: understanding structures of hazard, exposure and vulnerability (continued)	3:50. Understanding the complex governance of the water-energy-food nexus in the context of climate change.	Phase 3
	3:51. Researching the relationship between food security, population growth and climate change in the poorest nations.	Phase 3
	3:52. Understanding the impact of glacier retreat on food, water and energy security.	Phase 3
	3:53. Developing an inventory of climate impacts and their causes – using attribution and detection language, providing information relevant to adaptation planning and quantification of loss and damage.	Phase 3
	3:54. Developing a method to distinguish between forced climate changes and those arising from internal variability.	Phase 3
	3:55. Understanding the health impacts of air pollution.	Phase 3
	3:56. Researching gender equality in relation to the impact of climate change on health.	Phase 3
	3:57. Understanding how climate and health risks are traded off against one another.	Phase 3
	3:58. Studying the impacts of climate change (including extreme events and sea level rise) on coastal populations, infrastructure, livelihoods and food security.	Phase 3
	3:59. Understanding the benefits of, and cautions around, Marine Protected Areas to support climate adaptation.	Phase 3
	3:60. Researching rainfall to run-off system in urban settlement versus agricultural landscapes and forest-covered areas.	Phase 3
	3:61. Evidencing the connections between historical and international causes of local risk.	Phase 3

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Structured list of research gaps

Theme 3: Climate – environment – human dynamics: understanding structures of hazard, exposure and vulnerability (continued)	3:62. Modelling compound hazards to predict wave-surge-tide-rainfall with climate change effect.	Phase 3
	3:63. Assessing and managing cascading and transboundary climate risks.	Phase 3
	3:64. Identifying specific regions and local communities that are highly vulnerable to climate (e.g. vulnerability assessment of coastal communities).	Phase 3
	3:65. Researching the response of non-glacial ice masses to climate warming in high mountains, including the impact of rock glaciers on water supplies.	Phase 3
	3:66. Assessing the impact of the lack of effective large-scale waste water treatment on water quality.	Phase 3
	3:67. Researching how colonial histories and racism have shaped different vulnerabilities.	Phase 3

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Structured list of research gaps

Theme 4: Useful and usable science and pluralism in knowledge production	4:39. Increasing the societal demand for, understanding of, and trust in, climate change science to maximise its impact.	Phase 2
	4:9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.	Phase 1
	4:17. Creating a more heterogeneous and inclusive climate change knowledge through interdisciplinary and transdisciplinary working.	Phase 1
	4:18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production.	Phase 1
	4:19. Conceptualising and operationalising climate change impact and adaptation in a way that acknowledges diverse knowledge sources and both qualitative and quantitative evidence.	Phase 1
	4:31. Synthesising and scaling up existing research on vulnerabilities, resilience and adaptation to enable spatial mapping of knowledge and maximise the use of knowledge across research, policy and practice.	Phase 1
	4:68. Developing risk communication training for meteorologists and climate scientists, and methodologies for effectively communicating the confidence and certainty in weather and climate information.	Phase 3
	4:69. Researching the endemic understanding of environment, climate science and adaptation among indigenous communities.	Phase 3
	4:70. Exploring the local and traditional knowledge of resource management and the role of cultural heritage in supporting local innovations.	Phase 3
	4:71. Utilising the contribution of arts & creative practices to connect with communities to improve climate change understanding, imagine changes and envisage the future.	Phase 3
	4:72. Utilising archaeological and historical records to connect climatic and social variability and learn from the past.	Phase 3
	4:73. Using oral histories and an intergenerational knowledge base as key for context and understanding of current climate change trajectories.	Phase 3

Structured list of research gaps

Theme 4: Useful and usable science and pluralism in knowledge production	4:74. Recognising the role of interactive and participatory research approaches and methods (e.g. citizen science).	Phase 3
	4:75. Understanding the role of values in the scientific and broader communities and how they guide research, communication and uptake.	Phase 3

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Structured list of research gaps

Theme 5: Effective and adequate adaptation responses	5:40. Understanding the role of social and technological innovation in driving adaptation responses and their uptake.	Phase 2
	5:15. Understanding the soft and hard limits to adaptation that make communities vulnerable to climate change loss and damage.	Phase 1
	5:20. Simulating the potential effectiveness of adaptation strategies under different future climate changes.	Phase 1
	5:21. Understanding the impact of adaptation strategies and their potential unintended consequences.	Phase 1
	5:22. Understanding adaptation strategies within the context of structural drivers of vulnerability and social challenges to ensure just transitions.	Phase 1
	5:23. Understanding the on-the-ground capacities for implementing climate adaptation measures, what communities are currently doing and what level of capacity local governments have to implement adaptive changes.	Phase 1
	5:24. Developing methodological approaches to assess the effectiveness and adequacy of adaptation programs.	Phase 1
	5:26. Evidencing innovative, transparent and effective financing for climate adaptation.	Phase 1
	5:28. Defining adequate adaptation strategies and identifying when to implement them and to what purpose.	Phase 1
	5:29. Understanding the decision-making, coping strategies and power relations of vulnerable households to inform adaptation uptake.	Phase 1
	5:32. Providing evidence-based insight for avoiding and managing climate change losses and damages, including the systematic assessment of lived experiences of losses and damages across different countries for a global synthesis of risk.	Phase 2

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Structured list of research gaps

Theme 5: Effective and adequate adaptation responses (continued)	5:76. Understanding effective adaptation responses for different settings (informal settlements, urban resilience, rapid urbanisation, rural-urban linkages).	Phase 3
	5:77. Understanding and mobilising effective engagement of voluntary labour for climate action.	Phase 3
	5:78. Understanding the role of children and youth in household-level awareness of climate change.	Phase 3
	5:79. Understanding intergenerational perceptions and actions on climate change. Developing cross-generational methodologies for inclusive adaptation and mitigation.	Phase 3
	5:80. Understanding what adaptation measures work best in already water-stressed extreme environments.	Phase 3
	5:81. Understanding how adaptive capacities and responses to climate change differ by gender, ability and other demographic and relational factors.	Phase 3
	5:82. Defining climate-resilient development pathways across spatial and temporal dimensions.	Phase 3
	5:83. Assessing climate-resilient development pathway suitability and options in relation to socio-economic development objectives.	Phase 3
	5:84. Researching social safety nets for climate adaptation, from informal social and financial support to microinsurance and private finance.	Phase 3
	5:85. Studying behavioural change in relation to adaptation to understand what tools incentivise adaptation behaviour, especially anticipatory adaptation.	Phase 3

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Structured list of research gaps

Theme 6: Climate governance	6:86. Understanding the processes of governance of climate responses at multiple scales (decision-making, actors and institutions, policy mobilisation and implementation, political will and leadership).	Phase 3
	6:87. Researching the legal, institutional and administrative contexts of responses to climate change.	Phase 3
	6:88. Working with policy-makers and politicians to change relevant policies.	Phase 3
	6:89. Understanding the political economy of climate actions across scales.	Phase 3
	6:90. Understanding the resilience, vulnerabilities, pressures and risks of current governance, management and regulatory systems.	Phase 3
	6:13. Gathering evidence to inform climate risk governance and management, especially on dealing with multidimensional, consecutive and compounding risks.	Phase 1

Theme 7: Climate change and environmental degradation	7:38. Understanding the impact of climate change, urbanisation and industrialisation on water quality and pollution.	Phase 2
	7:91. Researching the impact of climate change on the risk of wildfires.	Phase 3
	7:92. Researching the impact of climate change on tropical peat forests, and their role as carbon storage or source.	Phase 3
	7:93. Researching the impact of climate change on high mountain hazards, such as rock avalanches.	Phase 3
	7:94. Researching the impact of land use change and eutrophication on carbon emissions from freshwater systems.	Phase 3
	7:95. Researching the agroecological degradation (forest, soil, water, agriculture) in mountain regions caused by climate change.	Phase 3

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Structured list of research gaps

Theme 8: Systems approach	8:10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impacts.	Phase 1
	8:96. Recognising the need to adapt systems models as the situation changes – for example, as circular economy alters impact.	Phase 3
	8:97. Linking socio-technical transitions with socio-ecological resilience.	Phase 3
	8:98. Considering all drivers of change together with climate change using long-term monitoring.	Phase 3
	8:99. Recognising the cognitive vulnerability and the limits to understanding the systemic nature of climate.	Phase 3
	8:100. Understanding the required institutional transformative change to address SDGs while responding to climate change.	Phase 3
	8:101. Understanding the relationship between climate change, food and water security within the social, cultural and ecological context.	Phase 3

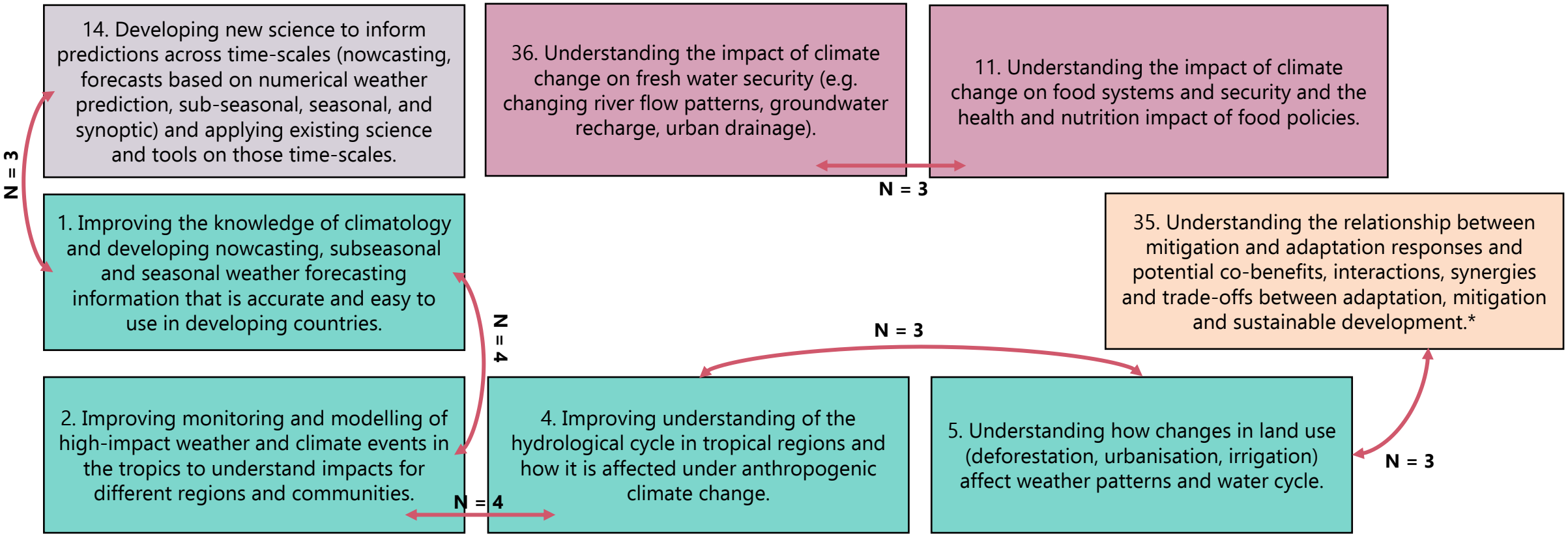
Structured list of research gaps

Theme 9: Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development	9:35. Understanding the potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development.	Phase 2
	9:30. Evidencing, monitoring and evaluating adaptation options to understand what works and what to prioritise, especially in the context of climate-resilient development pathways.	Phase 1
	9:102. Identifying the direct benefits and co-benefits of peatland restoration as a Nature-based Solution.	Phase 3
	9:103. Researching how developing nations can achieve just energy transitions and leapfrog fossil fuels to renewables.	Phase 3
	9:104. Understanding how climate-induced disasters are impacting vulnerable groups and adaptation measures.	Phase 3
	9:105. Understanding synergies between adaptation and disaster risk reduction in the context of transboundary governance.	Phase 3
	9:106. Understanding how various approaches to mitigation and adaptation will affect different marine ecosystem services leading to trade-offs.	Phase 3
	9:107. Bridging international frameworks on climate change mitigation and disaster risk reduction.	Phase 3

Relationships between gaps – overview

We hope to understand how addressing one knowledge gap or research problem may affect other research areas and priorities. Respondents were therefore asked to indicate if they recognised any relationships between the gaps explored in the research. The most commonly identified relationships are outlined below, in addition to the number of times these connections were identified.

Q: Please choose 2 gaps from the below list and indicate how they interact with one another.



Gaps are colour-coded to show distribution by theme.

**Originally this gap was in theme 5, but it was moved to theme 9 after the survey.*

SHIFT INSIGHT

Relationships between gaps – exploration

1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.

+

2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.

- A relationship between gaps 1 & 2 was identified by 4 respondents – working across natural sciences, engineering and technology, and social sciences.
- Minimal explanation was provided as to what connected these gaps, but it was suggested that modelling would be more effective if knowledge was reliable.

2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.

+

4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change.

- A relationship between gaps 2 & 4 was identified by 4 respondents – working across natural sciences, engineering and technology, agriculture and veterinary science, and social sciences.
- One respondent believed gap number 4 would advance gap number 2. Others suggested monitored data was required to inform hydrological understanding and assessment.

14. Developing new science to inform predictions across time-scales (nowcasting, forecasts based on numerical weather prediction, sub-seasonal, seasonal, and synoptic) and applying existing science and tools on those time-scales.

+

1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.

- A relationship between gaps 14 & 1 was identified by 3 respondents – all working in natural sciences.
- One respondent believed these gaps were ‘virtually the same’, while another mentioned science across scales.
- This suggests a potential overlap (rather than a relationship between these gaps). For that reason, gap 14 is included in the top 10 prioritised gaps (it came 11th).

Gaps are colour-coded to show distribution by theme.

Relationships between gaps – exploration

4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change.

5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle.

- A relationship between gaps 4 & 5 was identified by 3 respondents – working across natural sciences and engineering and technology.
- Both gaps were thought to interact in local environment and affect the local water cycle. Both gaps also impact living things and livelihoods in developing countries.

35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development.

5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle.

- A relationship between gaps 35 & 5 was identified by 3 respondents – working across natural sciences, engineering and technology, agriculture and veterinary science, and social sciences.
- Minimal feedback was given on the relationship, but one respondent believed land use changes determined the capacity of the ecosystem and people to respond, adapt and mitigate climate change.

36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).

11. Understanding the impact of climate change on food systems and security and the health and nutrition impact of food policies.

- A relationship between gaps 36 & 11 was identified by 3 respondents – working across natural sciences, engineering and technology, and social sciences.
- Respondents acknowledged the relationship between water and food. One respondent provided an example of the droughts in the Mekong Delta, which led to harvest, job and income loss.

Gaps are colour-coded to show distribution by theme.

SHIFT INSIGHT

Observed interdependencies

Some gaps were likely to be selected as having a relationship with others. This included gaps 1, 4, 36, 2 and 10, which sat under theme 1 (climate and weather dynamics and projections) and theme 3 (climate – environment – human dynamics). Below are the top 2 gaps most commonly chosen in this regard (gap 1 selected 18 times, gap 4 selected 14 times), along with the gaps they were thought to be linked to.

Gap 1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.	**n**
2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.	4
14. Developing new science to inform predictions across time-scales (nowcasting, forecasts based on numerical weather prediction, sub-seasonal, seasonal, and synoptic) and applying existing science and tools on those time-scales.	3
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries.	2
10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact.	2
36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).	1
11. Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies.	1
27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy).	1
9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.	1
13. Gathering evidence to inform climate risk governance and management, especially on dealing with multidimensional, consecutive and compounding risks.	1
26. Evidencing innovative, transparent and effective financing for climate adaptation.	1
29. Understanding the decision-making and coping strategies of vulnerable households to inform adaptation uptake.	1

Gap 4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change.	**n**
2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.	4
5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle.	3
6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development.	2
36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).	2
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries.	1
10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact.	1
9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.	1

Gaps are colour-coded to show distribution by theme.

SHIFT INSIGHT

SHIFT SUSTAINABILITY

OVERALL PRIORITISATION

SHIFT INSIGHT

Which three gaps would you choose to prioritise as being most critical to advancing knowledge of climate and climate change? (Top 11)

FREQUENCY OF RESPONSES

Knowledge / research gap	Times selected
No.36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).	29
No.1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.	27
No.4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change.	25
No.6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development.	22
No.27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy).	22
No.2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.	20
No.9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.	19
No.35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development.	19
No.10. Recognising climate change as one risk among many and taking a more systems-centered approach to understanding climate change impact.	18
No.18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production.	17
No.14. Developing new science to inform predictions across time-scales (nowcasting, forecasts based on numerical weather prediction, sub-seasonal, seasonal, and synoptic) and applying existing science and tools on those time-scales.	15

SHIFT INSIGHT

Overall prioritisation – explored by geographical focus

Outlined below are the most common gaps prioritised as being most critical to advancing knowledge of climate and climate change, based on respondents' geographical area of focus. Note that geographical areas have been grouped into continent.

	Global scope	Africa	Asia	South America
#1	1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (n=10)	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=15)	1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (n=17)	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=8)
#2	6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development. (n=10)	1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (n=13)	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=15)	18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (n=6)
#3	2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities. (n=9)	4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (n=11)	35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (n=13)	9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design. (n=5)

*N = times it was selected as Option 1, Option 2 or Option 3
Gaps are colour-coded to show distribution by theme.

SHIFT INSIGHT

Overall prioritisation – explored by discipline

Outlined below are the most common gaps prioritised as being most critical to advancing knowledge of climate and climate change, based on the discipline of respondents.

	Natural sciences	Engineering and technology	Social sciences	Agriculture & veterinary
#1	1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (n=25)	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=17)	35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (n=16)	27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (n=5)
#2	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=24)	1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (n=10)	27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (n=13)	10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (n=4)
#3	4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (n=24)	10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (n=6)	36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (n=12)	35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (n=3)

*N = times it was selected as Option 1, Option 2 or Option 3
Gaps are colour-coded to show distribution by theme.

SHIFT INSIGHT

1st most frequently prioritised research gap

Gap 36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage).

The reasons for its importance centred on:

- Being critical to climate-resilient development.
- Impacting sustainable development, livelihoods and all economic and social activities.
- Addressing urgency of need where systems might already be pushed to tipping points and water resources are already overexploited.
- Having relevance for addressing flooding.
- Affecting food security.
- Being a component of the land use systems transition and impacting other systems transitions (energy, urban, industrial, societal).
- Affecting coastal areas.

Areas of expertise that have a role to play	
Hydrology	15
Computer modelling and simulation	11
Climate science	10
Climate adaptation	9
Climate / weather services	9
Environmental science	9
Weather science / Meteorology	9
Agricultural and crop science	8
Data science, machine learning or statistics	8
Observations and remote sensing	7
Risk management	7

Main barriers or challenges	
Insufficient observations being collected / unreliable data	18
Lack of funding	12
Lack of understanding of its value / potential	10
Lack of local capacity or expertise	10
Long timescales needed to conduct this research	8
Lack of interest from policy-makers	7
Lack of access to knowledge / research / data	7

Locations research should focus on

Global scope (11)	Southern Asia (6)	South-eastern Asia (5)	Southern Africa (5)
Eastern Africa (9)	South America (5)	Western Africa (5)	

SHIFT INSIGHT

2nd most frequently prioritised research gap

Gap 1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries.

The reasons for its importance centred on:

- Addressing the lack of local capacity to develop accurate forecasts.
- Building the resilience and preparedness of developing countries.
- Addressing urgency, as such short-timeline information is needed now.
- Decreasing the vulnerability of communities to weather and climate risks.
- Increasing confidence and trust in science.
- Having relevance to many sectors and being fundamental for agriculture.
- Informing planning decisions.
- Having relevance to micro-climatic environments.

Areas of expertise that have a role to play	
Climate / weather services (e.g. forecasting products)	22
Climate science	21
Weather science / Meteorology	18
Climate adaptation	14
Computer modelling and simulation	14
Hydrology	14
Data science, machine learning or statistics	13
Observations and remote sensing	12
Oceanography / Marine science	12
Agricultural and crop science	10
Risk management	10

Main barriers or challenges	
Lack of understanding of its value / potential	13
Lack of local capacity or expertise	13
Insufficient observations being collected / unreliable data	12
Lack of funding	10
Lack of access to knowledge / research / data	10
Lack of interest from policy makers	8
Technological limitations	8

Locations research should focus on

Western Africa (12)	Southern Asia (11)	South-eastern Asia (10)	Northern Africa (8)
Eastern Africa (12)	Southern Africa (11)	Middle Africa (9)	

SHIFT INSIGHT

3rd most frequently prioritised research gap

Gap 4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change.

The reasons for its importance centred on:

- Tropical hydrological cycle already being affected by human activities and changes in land use, with land use being a neglected driver of climate.
- Affecting a large proportion of the world's population.
- The critical role of water for both humans and natural environments.
- Increasing regional-level resilience and reliability of projections.

Areas of expertise that have a role to play	
Climate science	16
Hydrology	10
Weather science / Meteorology	10
Agricultural and crop science	8
Climate adaptation	8
Ecology	8
Observations and remote sensing	8
Computer modelling and simulation	7
Environmental science	7
Climate / weather services (e.g. forecasting products)	6

Main barriers or challenges	
Insufficient observations being collected / unreliable data	14
Lack of funding	8
Lack of local capacity or expertise	8
Lack of access to knowledge / research / data	7
Long timescales needed to conduct this research	6
Geopolitical agendas	5
Technological limitations	5
Lack of interest from policy makers	4
Lack of understanding of its value / potential	4

Locations research should focus on

Global scope (9)	Southern Asia (7)	Middle Africa (6)	South America (5)
South-eastern Asia (8)	Western Africa (6)	Eastern Africa (6)	Southern Africa (5)

SHIFT INSIGHT

4th most frequently prioritised research gap

Gap 6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development.

The reasons for its importance centred on:

- Informing policy-makers and impacting scientists' and other stakeholders' decisions.
- Being achievable through regional physically-based approaches.
- Being fundamental to increasing confidence in climate projections.
- Addressing the urgent need to understand and acknowledge model uncertainty and errors.
- Being critical for medium to long-term national development plans.

Areas of expertise that have a role to play	
Climate science	15
Computer modelling and simulation	9
Data science, machine learning or statistics	9
Climate adaptation	5
Oceanography / Marine science	5
Weather science / Meteorology	5
Hydrology	4
Climate mitigation	3
Climate / weather services (e.g. forecasting products)	3
Environmental science	3
Observations and remote sensing	3
Risk management	3

Main barriers or challenges	
Lack of funding	10
Insufficient observations being collected / unreliable data	6
Long timescales needed to conduct this research	6
Technological limitations	5
Lack of access to knowledge / research / data	4
Lack of understanding of its value / potential	3
Lack of local capacity or expertise	3

Locations research should focus on

Global scope (10)	Western Africa (4)	Southern Africa (4)
Middle Africa (5)	Eastern Africa (4)	Southern Asia (3)

SHIFT INSIGHT

5th most frequently prioritised research gap

Gap 27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy).

The reasons for its importance centred on:

- Having the potential to mitigate suffering of marginalised communities and promote sustainability.
- Having the potential to achieve multiple benefits – for instance, in gender equality and human health.
- Having relevance for restoration and improvement of adaptive capacities of marine ecosystems (esp. coral reefs, mangroves and seagrasses) and livelihoods of coastal communities.
- Contributing to mitigation (CO2 emissions reduction and carbon removal).
- Being fundamental to developing a socio-ecological framework for climate justice.

Areas of expertise that have a role to play	
Ecology	16
Climate adaptation	13
Economics and social economics	12
Environmental science	12
Agricultural and crop science	11
Geography (human and physical)	11
Climate science	10
Data science, machine learning or statistics	9
Biology	8
Hydrology	8
Risk management	8

Main barriers or challenges	
Lack of funding	12
Geopolitical agendas	12
Lack of local capacity or expertise	11
Insufficient observations being collected / unreliable data	10
Lack of interest from policy makers	8
Lack of understanding of its value / potential	8
Lack of access to knowledge / research / data	8
Technological limitations	6

Locations research should focus on

Global scope (11)	Southern Asia (6)	Eastern Africa (6)	South-eastern Asia (5)
South America (6)	Western Africa (6)	Caribbean (5)	

6th most frequently prioritised research gap

Gap 2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.

The reasons for its importance centred on:

- Impacting most of the world's population.
- Recognising that such events are causing high death tolls and large economic damage, mostly in Low-to-Middle-Income Countries (LMICs).
- Increasing need to address such events, as they are becoming more frequent.
- Addressing limited capability to monitor and model such events in many LMICs.
- Extreme events causing compound and cascading events.
- Contributing to the generation of effective and long-lasting solutions for populations dependent on nature-based resources for their livelihoods.
- Contributing to impact studies.
- Addressing considerable uncertainty in changes in tropical cyclones.
- Being achievable through better physically-based approaches (such as those used in CP4-Africa).
- Informing impact warnings on seasonal, interannual and decadal timescales.

SHIFT INSIGHT

6th most frequently prioritised research gap

No.2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities.

Areas of expertise that have a role to play	
Climate science	12
Computer modelling and simulation	11
Climate / weather services (e.g. forecasting products)	10
Weather science / Meteorology	10
Data science, machine learning or statistics	8
Environmental science	8
Hydrology	8
Risk management	8
Climate adaptation	6
Observations and remote sensing	6
Urban planning	6

Main barriers or challenges	
Insufficient observations being collected / unreliable data	9
Lack of funding	7
Lack of access to knowledge / research / data	6
Technological limitations	6
Lack of local capacity or expertise	6
Long timescales needed to conduct this research	6
Lack of understanding of its value / potential	4
Difficulties working with other disciplines / siloed working	3

Locations research should focus on			
Southern Asia (9)	Middle Africa (9)	Western Africa (8)	Southern Africa (7)
South-eastern Asia (9)	Eastern Africa (9)	Central America (7)	

SHIFT INSIGHT

7th most frequently prioritised research gap

Gap 9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.

The reasons for its importance centred on:

- Ensuring the development of usable science and products.
- Aiding implementation, uptake and legacy of technology and scientific products at all levels.
- Addressing the disconnect between climate researchers and knowledge users.
- Increasing the trust in science and scientific information needed for mitigation, adaptation and resilience solutions.
- Having the potential to address other knowledge gaps by deepening understanding of what works where for whom.
- Improving the legacy of research projects and the impact of findings.
- Contributing to building capacity for climate research in developing countries.
- Having the potential to minimise maladaptation by utilising local expertise.
- Ensuring frontier science is aligned with the specific needs of particular contexts and communities at risk.

7th most frequently prioritised research gap

Gap 9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design.

Areas of expertise that have a role to play	
Climate adaptation	12
Climate science	10
International development	9
Agricultural and crop science	8
Environmental science	8
Urban planning	8
Anthropology	7
Climate mitigation	7
Geography (human and physical)	7
Climate / weather services (e.g. forecasting products)	6
Education	6
Hydrology	6
Policy	6
Sociology	6

Main barriers or challenges	
Lack of funding	11
Lack of understanding of its value / potential	9
Difficulties working with other disciplines / siloed working	7
Lack of local capacity or expertise	6
lack of interest from research community	5
Other resource constraints	5
Long timescales needed to conduct this research	5
Lack of interest from policy makers	4

Locations research should focus on		
Global scope (11)	Eastern Africa (4)	Western Africa (3)
Southern Asia (5)	South America (3)	Middle Africa (3)

8th most frequently prioritised research gap

Gap 35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development.

The reasons for its importance centred on:

- Encompassing many of the important and complex issues relevant for addressing climate change.
- Being fundamental to sustainable and climate-resilient development planning.
- Informing a framework for transparent prioritisation of adaptation, mitigation and sustainable development agendas.
- Addressing the increasing need to approach mitigation and adaptation in a joined-up, systemic way, highlighting cost-benefit trade-offs.
- Being valuable for avoiding 'trial and error' approaches to managing the risks across different communities in the long term.
- Helping communities avoid trade-offs between adaptation, livelihoods and sustainable development.
- Building a common understanding between researchers and policy-makers.
- Recognising that human and natural systems are affected by and require adaptation, mitigation and sustainable development simultaneously.
- Addressing the fragmentation of the knowledge base.

SHIFT INSIGHT

8th most frequently prioritised research gap

Gap 35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development.

Areas of expertise that have a role to play	
Economics and social economics	14
Climate mitigation	13
Climate adaptation	13
Risk management	12
Agricultural and crop science	11
Environmental science	11
Policy	11
Computer modelling and simulation	10
Geography (human and physical)	10
Political economy	10
Urban planning	10

Main barriers or challenges	
Lack of funding	12
Insufficient observations being collected / unreliable data	9
Lack of understanding of its value / potential	8
Difficulties working with other disciplines / siloed working	8
Lack of access to knowledge / research / data	7
Lack of local capacity or expertise	7
Lack of interest from policy makers	6
Geopolitical agendas	5
Long timescales needed to conduct this research	5

Locations research should focus on			
Global scope (15)	South-eastern Asia (6)	Oceania (4)	Eastern Africa (4)
Southern Asia (6)	Caribbean (4)	Western Africa (4)	
Southern Africa (5)	South America (4)	Middle Africa (4)	

SHIFT INSIGHT

9th most frequently prioritised research gap

Gap 10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact.

The reasons for its importance centred on:

- Addressing the need for more systemic approaches to planetary health.
- Aligning responses to climate risks across sectors and regions to avoid inadvertent impacts.
- Recognising the impact and threat of other anthropogenic pressures.
- Avoiding wrong solutions and maladaptation.
- Recognising the systemic nature of climate change, which compounds other ongoing pressures.
- Systemic thinking helping to make immense complexity manageable.
- Systems approach helping to be proactive rather than reactive to climate change risks.
- Helping make responses to climate change a part of the wider goal to achieve a sustainable and inclusive society.
- Contributing to understanding the cascading impacts that occur through systems.

9th most frequently prioritised research gap

Gap 10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact.

Areas of expertise that have a role to play	
Computer modelling and simulation	11
Environmental science	11
Climate adaptation	10
Risk management	10
Data science, machine learning or statistics	9
Climate science	8
Climate mitigation	8
Economics and social economics	8
Geography (human and physical)	8
International development	8
Political economy	8

Main barriers or challenges	
Lack of funding	11
Insufficient observations being collected / unreliable data	5
Lack of access to knowledge / research / data	5
Lack of local capacity or expertise	5
Long timescales needed to conduct this research	5
Lack of understanding of its value / potential	4
Lack of interest from policy makers	3
lack of interest from research community	3
Difficulties working with other disciplines / siloed working	3
Geopolitical agendas	3

Locations research should focus on		
Global scope (11)	Southern Asia (2)	Western Africa (2)
South America (2)	South-eastern Asia (2)	

10th most frequently prioritised research gap

Gap 18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production.

The reasons for its importance centred on:

- Being essential to building resilience and development at national and local level.
- Avoiding side-lining local communities' needs in programmes designed by external experts.
- Enabling local researchers and stakeholders to access knowledge and collect data.
- Designing research projects informed by a realistic assessment of local capability.
- Being key for preventing top-down interventions that result in maladaptation.
- Helping knowledge / science / research reach transformative potential.
- Helping to increase acceptance, take-up and legacy of climate actions.
- Aiding collaboration between the Global South and Global North.
- Recognising that adaptability is situated and context-specific.

10th most frequently prioritised research gap

Gap 18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production.

Areas of expertise that have a role to play	
Education	11
Environmental science	11
Geography (human and physical)	11
Policy	11
Economics and social economics	10
Climate science	9
Climate adaptation	9
Agricultural and crop science	8
Hydrology	8
International development	8
Risk management	8

Main barriers or challenges	
Lack of funding	13
Lack of understanding of its value / potential	8
Difficulties working with other disciplines / siloed working	8
Lack of local capacity or expertise	7
lack of interest from research community	6
Lack of access to knowledge / research / data	6
Lack of interest from policy makers	5
Geopolitical agendas	5
Long timescales needed to conduct this research	5

Locations research should focus on			
Global scope (11)	Middle Africa (7)	Southern Africa (6)	South America (5)
Western Africa (8)	Eastern Africa (7)	Caribbean (5)	Northern Africa (5)

SHIFT SUSTAINABILITY

HOW TO APPROACH PRIORITISATION (CONSULTATION PHASE 1 AND 2)

Consultation phase 2: Revised criteria for prioritisation

Experts suggested the following should be considered as criteria for prioritising research gaps.

Category 1: Considerations around the likelihood of action arising from the research.

- The extent to which the research outputs will speak to power – informing policy and driving action.
- The extent to which the research reflects national priorities and objectives.
- The extent to which the research informs and empowers vulnerable communities to take action.
- The extent to which the research helps to build relationships and capacity on the ground, involving multiple stakeholders.
- The extent to which the research contributes to Sustainable Development Goals.

Category 2: Considerations around levels of impact.

- The level of impact resulting from not conducting the research / taking the action.
- The greatest impact on the highest number of people and the ecological resource base, in the highest number of countries.
- The greatest impact on the most world's most vulnerable people, addressing the greatest need.
- The greatest impact on the most areas (e.g. biodiversity, people) or types of strategies (mitigation, resilience, adaptation).
- The greatest impact in relation to informing or assisting with other global issues (pandemics, conflicts).
- The greatest cost-benefit of the project.

Consultation phase 2: Revised criteria for prioritisation

Category 3: Considerations around the legacy of research projects.

- The longevity of the project – providing a positive legacy after the project ends / researchers leave.
- The extent to which the research project could complement, enable or leverage and build on other projects and actions.
- The right balance of projects that require longer and shorter durations and have short-term and long-term outcomes.

Category 4: Considerations around interdisciplinary and transdisciplinary approaches.

- The extent to which the research area interacts with other research areas – how together they can have more impact.
- The extent to which the research approaches the knowledge gap in a holistic or integrated way that breaks down disciplinary, siloed working.
- The extent to which the research is inclusive of diverse knowledge sources and agendas, involving a range of stakeholders and partners – community, local government, national government, NGOs, local researchers, citizen researchers, as well as academics across disciplines.

Consultation phase 2: Experts' comments on prioritisation criteria

General considerations around prioritisation:

- Some of the criteria appear to be measures to assess individual projects, while others may assess the full spending for CLARE across all the projects. These should be treated separately.
- There is a need for balance between short-term and long-term projects.
- Inter-and transdisciplinary approaches should be a prerequisite rather than a criterion. *"Interdisciplinarity is the sine qua non of all research and policy in this space. As such, I don't think it should shape prioritisation – it should be a core requirement."*
- Some of these categories have a policy orientation, others are focused on impact, and some are focused on approaches. All these criteria should guide which projects are supported.
- A criterion assessing costs and benefits of the work is needed as *"without that, rational prioritisation is not possible."*

Suggestions for caution:

- Focusing on reflecting national objectives *"will inevitably bias towards quantitative research that does large-scale modelling or analysis of large areas, and bias against rich place-based qualitative research that may have important implications beyond that study."*
- Not all research needs to be interdisciplinary: *"there are many well-known challenges, grand challenges even, that we know are bottlenecks, and are largely disciplinary, though solving them will benefit multiple disciplines and application sectors."*
- Criteria that isolate people from their natural resource base should be avoided.
- Legacy of projects *"is political and depends on FCDO budgets and timelines … it's not something that should shape prioritisation."*

Consultation phase 2: Experts' comments on prioritisation criteria

Experts' prioritisation preferences:

"Those criteria that resonate the most are centred around driving action in an interdisciplinary manner, to address the urgency of the climate crisis."

- **Research or action:** The scope of this programme could be clarified; whether it's purely research or also action-oriented. *"If this is aid funding then the first category is the only important one. However, if this is research funding then the other three categories are equally important."*
- **Interdisciplinarity**: Approaches supporting pluralist knowledge production are crucial. *"Normally ensuring interdisciplinarity is the first step towards ensuring diversity of participants and knowledge holders."*
- **Implementation:** *"Implementation should be the focus and learning from implementation experience should be the key, which means we should focus on longer duration projects."*
- **Urgency and action:** *"Adaptation and resilience need to be developed with some urgency, and in many cases … we know enough to act now, and the major gaps in policy-relevant research are not in the area of climate dynamics. While this is certainly an area of potential research development, it is not a critical area that is fundamentally constraining policy, action, and resilience now."*
- **Urgency and integration:** *"The most urgent research is that which engages directly with those who can take decisions that improve resilience on an ongoing basis."*

Consultation phase 2: Experts' comments on prioritisation criteria

- **Solution-orientation:** *"Reflect on the scope of the funding. It is called 'resilience and adaptation', but some of these themes are quite separate from resilience or adaptation. … The major gaps in some cases are in the areas that people don't recommend, or that only a few people recommend. And other areas are identified that are not gaps or relevant, and … risk crowding out the solutions-oriented focus implied in the CLARE title."*
- **Impact:** Some experts felt impact was the most important criterion. *"Some of the issues listed will potentially shape the future of people and the planet and these must surely be prioritised (however thorny) to tackle the climate crisis."*
- **Greatest need:** *"There is evidence that addressing the needs of the most vulnerable is a means to ensure everyone is safe."*
- **Co-production, interdisciplinarity and integration:** *"These criteria will enable prioritisation of research that considers co-production, interdisciplinarity and integration. Research to develop the science in isolation won't necessarily be prioritised through these criteria, but if it is embedded in capacity building and research that links the science to society and the environment in various ways, then it should be prioritised. It'll be interesting to see how much the research community will still focus on fundamental rather than applied work."*
- **Climate footprint:** Prioritisation could consider *"the extent to which the project minimises the climate footprint of the research project itself."*

SHIFT SUSTAINABILITY

PRIORITISING RESEARCH FUNDING AGAINST SPECIFIC CRITERIA (CONSULTATION PHASE 3)

SHIFT INSIGHT

Prioritisation based on 'likelihood of action'

The panel consultation suggested a range of criteria to use to prioritise research gaps. These criteria were then used to define ranking questions in the wider survey. The table shows gaps selected by 10 or more respondents against the criteria 'likelihood of action'.

Which 3 gaps would you prioritise due to the likelihood of action arising from the research?	**%**	**n**
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries. (Theme 2)	16%	19
18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (4)	15%	18
35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)	14%	16
12. Making infrastructure systems resilient to climate change so that they support resilience, development and economic growth. (3)	13%	15
4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (1)	10%	12
36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (3)	10%	12
5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle. (1)	9%	11
7. Minimising uncertainty in shorter-term climate projections (5-10 years). (1)	9%	11
10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (3)	9%	11
23. Understanding the on-the-ground capacities for implementing climate adaptation measures, what communities are currently doing and what level of capacity local governments have to implement adaptive changes. (5)	9%	10

Gaps are colour-coded to show distribution by theme.
The theme number is recorded in brackets after each gap description.

SHIFT INSIGHT

Prioritisation based on 'level of impact'

Which 3 gaps would you prioritise based on their level of impact?	%	n
11. Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies. (3)	18%	21
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries. (2)	16%	18
27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (3)	13%	15
39. Increasing the societal demand for, understanding of, and trust in, climate change science to maximise its impact. (4)	13%	15
35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)	12%	14
18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (4)	10%	12
12. Making infrastructure systems resilient to climate change so that they support resilience, development and economic growth. (3)	9%	11
31. Synthesising and scaling up existing research on vulnerabilities, resilience and adaptation to enable spatial mapping of knowledge and maximise the use of knowledge across research, policy and practice. (4)	9%	11
4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (1)	9%	10
5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle. (1)	9%	10
36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (3)	9%	10

Gaps are colour-coded to show distribution by theme.
The theme number is recorded in brackets after each gap description.

SHIFT INSIGHT

Prioritisation based on 'timescales and legacy considerations'

Which 3 gaps would you prioritise based on their timescales and legacy considerations?	%	n
18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (4)	17%	19
27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (3)	17%	19
23. Understanding the on-the-ground capacities for implementing climate adaptation measures, what communities are currently doing and what level of capacity local governments have to implement adaptive changes. (5)	12%	14
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries. (2)	12%	13
11. Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies. (3)	11%	12
6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development. (1)	10%	11
4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (1)	9%	10
12. Making infrastructure systems resilient to climate change so that they support resilience, development and economic growth. (3)	9%	10
17. Creating a more heterogenous and inclusive climate change knowledge through interdisciplinary and transdisciplinary working. (4)	9%	10
31. Synthesising and scaling up existing research on vulnerabilities, resilience and adaptation to enable spatial mapping of knowledge and maximise the use of knowledge across research, policy and practice. (4)	9%	10
35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)	9%	10

Gaps are colour-coded to show distribution by theme.
The theme number is recorded in brackets after each gap description.

SHIFT INSIGHT

Prioritisation based on 'potential for developing and utilising interdisciplinary and transdisciplinary approaches'

Which 3 gaps would you prioritise due to their potential for developing and utilising interdisciplinary and transdisciplinary approaches?	**%**	**n**
35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)	19%	22
17. Creating a more heterogenous and inclusive climate change knowledge through interdisciplinary and transdisciplinary working. (4)	18%	20
10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (3)	16%	18
18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (4)	12%	14
27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (3)	12%	13
3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries. (2)	11%	12
13. Gathering evidence to inform climate risk governance and management, especially on dealing with multidimensional, consecutive and compounding risks. (5)	11%	12
31. Synthesising and scaling up existing research on vulnerabilities, resilience and adaptation to enable spatial mapping of knowledge and maximise the use of knowledge across research, policy and practice. (4)	11%	12
19. Conceptualising and operationalising climate change impact and adaptation in a way that acknowledges diverse knowledge sources and both qualitative and quantitative evidence. (4)	10%	11
39. Increasing the societal demand for, understanding of, and trust in, climate change science to maximise its impact. (4)	10%	11

Gaps are colour-coded to show distribution by theme.
The theme number is recorded in brackets after each gap description.

Gaps chosen by 10 or more respondents across 2 or more prioritisation areas

Across all 4 prioritisation areas

- 3. Developing well-evaluated impact-based forecasting to inform humanitarian action and enable early-warning systems in developing countries. (Theme 2)
- 18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (2)
- 35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)

Across 3 prioritisation areas

- 12. Making infrastructure systems resilient to climate change so that they support resilience, development and economic growth. (3)
- 4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (1)
- 27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (3)

Across 2 prioritisation areas

- 36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (3)
- 5. Understanding how changes in land use (deforestation, urbanisation, irrigation) affect weather patterns and water cycle. (1)
- 10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (3)
- 23. Understanding the on-the-ground capacities for implementing climate adaptation measures, what communities are currently doing and what level of capacity local governments have to implement adaptive changes. (5)
- 11. Understanding the impact of climate change on food systems and security and health and nutrition impact of food policies. (3)
- 17. Creating a more heterogenous and inclusive climate change knowledge through interdisciplinary and transdisciplinary working. (4)
- 31. Synthesising and scaling up existing research on vulnerabilities, resilience and adaptation to enable spatial mapping of knowledge and maximise the use of knowledge across research, policy and practice. (4)

SHIFT INSIGHT

SHIFT SUSTAINABILITY

CONCLUSIONS

Overall prioritisation – Top 10

Respondents were asked to provide their overall top 3 research priorities, with no specific prioritisation criteria in mind. The following gaps were selected by 10 or more respondents as their top 3. The chart also shows where these overall prioritisation selections overlap with the most frequently selected gaps for the range of specific criteria.

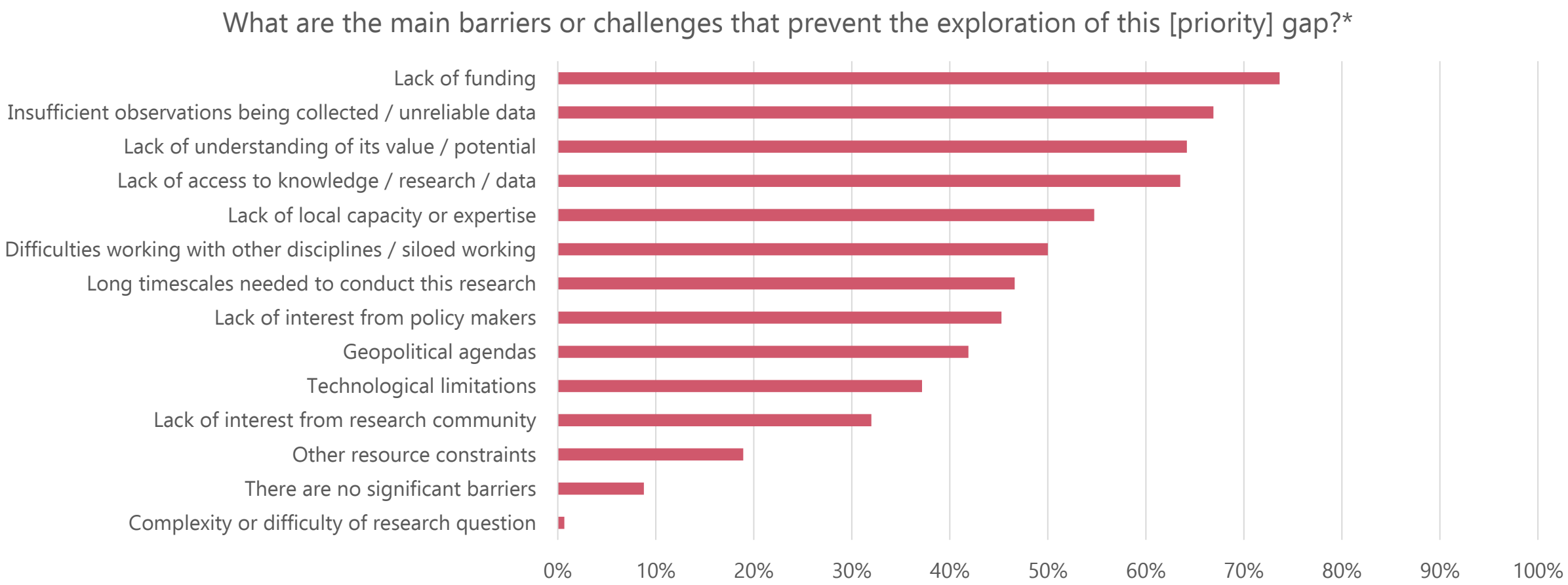
Four gaps, each from a different theme, occur in at least four prioritisation approaches – gap 4, 35, 18, 27. Some gaps appear highly ranked in the overall prioritisation but not in specific prioritisation criteria.

Top 3 priorities	Overall prioritisation *	'likelihood of action'	'level of impact'	'timescales and legacy considerations'	'potential for developing and utilising interdisciplinary and transdisciplinary approaches'
36. Understanding the impact of climate change on fresh water security (e.g. changing river flow patterns, groundwater recharge, urban drainage). (Theme 3)	29	12	10	-	-
1. Improving the knowledge of climatology and developing nowcasting, subseasonal and seasonal weather forecasting information that is accurate and easy to use in developing countries. (1)	27	-	-	-	-
4. Improving understanding of the hydrological cycle in tropical regions and how it is affected under anthropogenic climate change. (1)	25	12	10	10	-
6. Minimising the uncertainty and errors in multi-decadal climate change projections by improving the understanding of climate drivers and physical climate processes, and investing in model development. (1)	22	-	-	11	-
27. Researching ecosystem-based adaptation and nature-based solutions to ensure climate justice for people and nature (e.g. resilient cities, food and water security, circular economy). (3)	22	-	18	13	12
2. Improving monitoring and modelling of high-impact weather and climate events in the tropics to understand impacts for different regions and communities. (1)	20	-	-	-	-
9. Designing climate science projects with co-production in mind where frontier science learns from users and incorporates users' knowledge into scientific design. (4)	19	-	-	-	-
35. Understanding the relationship between mitigation and adaptation responses and potential co-benefits, interactions, synergies and trade-offs between adaptation, mitigation and sustainable development. (5)	19	16	14	10	22
10. Recognising climate change as one risk among many and taking a more systems-centred approach to understanding climate change impact. (3)	18	11	-	-	18
18. Developing an integrated approach to research that builds sustained, local capacity for action and knowledge production. (4)	17	18	12	19	14

**Times it was selected as Option 1, Option 2 or Option 3*
Gaps are colour-coded to show distribution by theme. The theme number is recorded in brackets after each gap description.

Overall challenges and barriers

After selecting their three priority gaps, respondents were asked to choose from a list of potential obstacles that might prevent each priority gap's exploration. Combined responses show that lack of funding was listed as the main barrier to addressing priority knowledge gaps. While we don't question it is a legitimate concern, it's worth noting that the survey was conducted on behalf of a major funding body, hence respondents might have taken the opportunity to flag this issue above other constraints.



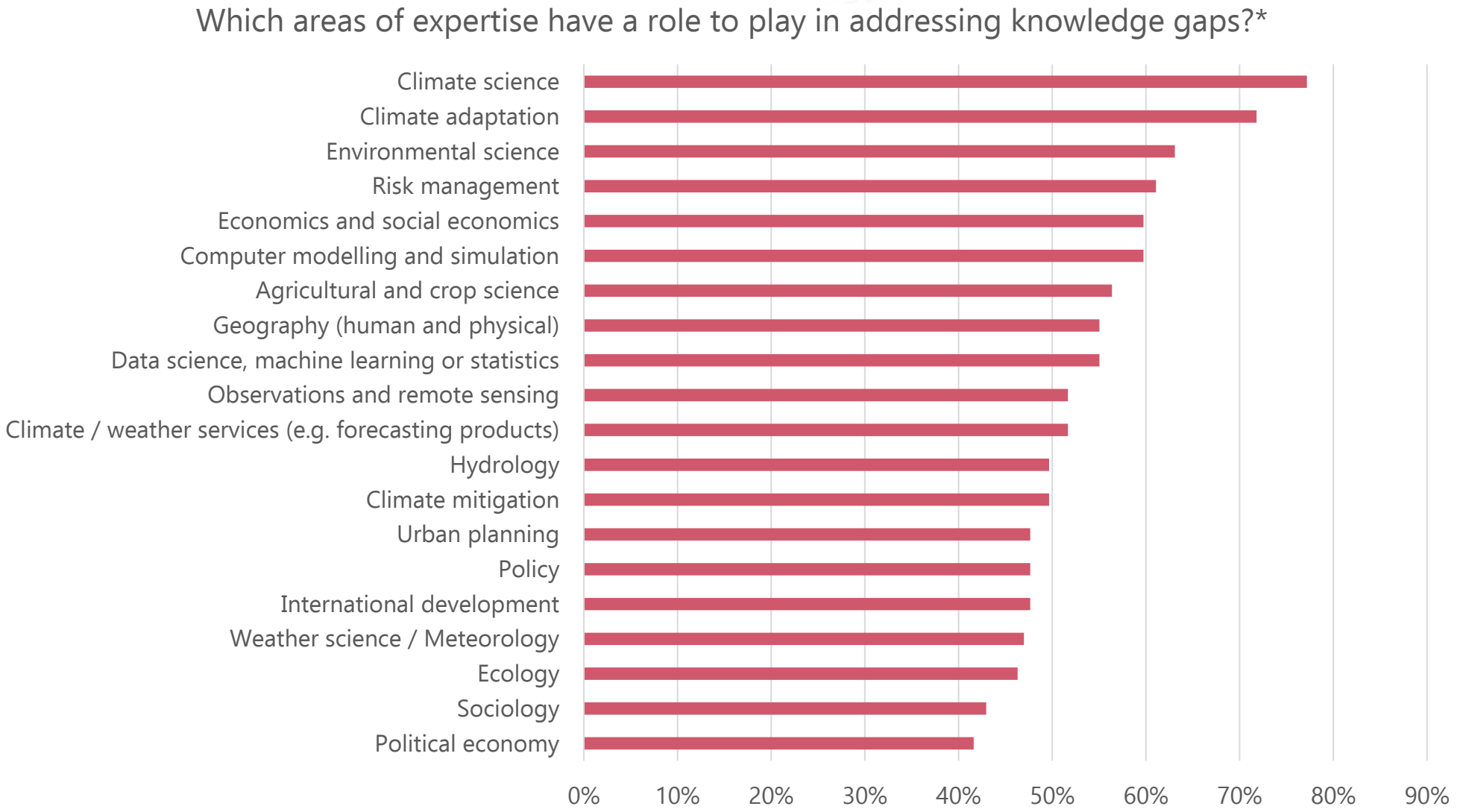
Base n = 133 to 144

Required areas of expertise

After selecting their three priority gaps, respondents were asked to also select from a list of areas of expertise that had a role to play in addressing the gaps they prioritised.

Unsurprisingly, climate science was top, but the top 20 areas of expertise include a range of disciplines – including social sciences.

Interdisciplinary expertise was selected only by a handful of respondents, but this might be misleading as this was a multiple-choice question, hence respondents could select a range of expertise areas required to work together.



Top 20 most frequently selected responses. Base n = 149

SHIFT INSIGHT

Final thoughts to inform funding programmes

A final question in the survey asked respondents to share any other thoughts to help inform the CLARE programming. The following themes emerged from those open responses.

A need for more locally led exploration of climate research gaps

"Please provide support to developing countries based on rationalization … they would be better conducting the research at local level as they can understand better the local resource mix and the culture and ecology too."

A need to shift the focus of climate research

"Climate change research has traditionally been viewed as a physical science research topic although its impact is on society and actions to manage the issue is political. More support is needed to understand impact on society and the societal drivers in order to facilitate the enabling environment for just climate action."

Specific regional differences and climate issues

"The issues and challenges vary by geographical regions so region-specific research program would be more appropriate."

A need for developing improved measures to inform decision-making

"Success metrics need to go beyond the tick marks at project completion, and longitudinal monitoring needs to be systematically considered and resourced."

A need for collaboration across disciplines

"It is important to keep the unusual voices in the room – i.e. from disciplines outside the usual suspects – to ensure local ownership and the linking of high quality science to everyday struggles to adapt and mitigate impacts."

Criticisms of the survey

Some criticisms of the survey were also stated in responses to the final open question.

Criticisms of the survey design

- There were several comments given about the length and complexity of the survey. It was felt by some that there were too many options to evaluate effectively, and that the responses may be unreliable due to bias towards options closer to the top of the list.
- Some commented on finding the survey too demanding and time-consuming.
- It was also felt, by some, that this survey was an over-simplistic approach to evaluating gaps and priorities in climate research.

Recent programme funding cuts

A couple of respondents made references to recent cuts on FCDO-funded projects. Some criticised this survey as being inappropriately timed, too soon after these cuts.

"Honestly this form is far too complicated and confusing to get reliable answers from. You will have a bias towards answers towards the top for most questions because there is no way for someone to take in all of the options and make well founded suggestions."

"The research community involved in social science is very large compared with the community involved in climate science. How can this survey compensate for the differences in numbers in these communities? A straight tally on priorities will simply show which constituency is the larger, not which is really more important."

"The UK needs to re-build trust with partners following recent cuts to funding and programmes. This was hugely irresponsible and poorly executed. This 'new' programme would benefit from some guarantees that the same thing won't happen again."

SHIFT SUSTAINABILITY

APPENDIX A: A FULL LIST OF ADDITIONAL RESEARCH GAPS AND THEMES IDENTIFIED IN THE SURVEY

SHIFT INSIGHT

Climate change governance

Climate Change Governance		
Knowledge gaps*	**Details**	**Covered by existing gap?**
Governance of climate responses at multiple scales	Politics and political economy of choosing adaptation options, including voices of vulnerable people	New
Governance of climate resilience	Actors, institutions and policies driving responses to climate change and their differential outcomes	New
Government engagement	The government still has a lot to do in this aspects. Expenditure and funding research must increase.	New
Drivers of decision making	Understanding the political and economic drivers of decision making	New
Management and regulatory systems	Understanding the resilience and vulnerabilities of current management and regulatory systems. Natural resources regulations, for example in fisheries, can provide outputs from maladaptation.	New
Decision making for risk management	Integrating decision-making and risk-management systems for climate resilience. Context-sensitive systems for deciding on timely actions to keep risks at/below acceptable levels.	New
International frameworks	Bridging international frameworks on climate change & related topics to bring adequate and effective evidence bridging disaster risk reduction and CCA.	New
Policy mobilisation	Understanding how to move ideas into actions on the ground.	New

*Some research gaps are listed under more than one thematic cluster to show their relevance in different contexts.

SHIFT INSIGHT

Climate change governance

Climate Change Governance (continued)		
Decision making under uncertainty	Taking into account changes in climate and development over time	New
Synergy of climate change adaptation and disaster risk reduction	Implementing policy from national to local level.	New
Business and industrial engagement	Business and industries must also contribute more	New
Economics of climate actions across scales	Macro-development at national and local-scale business perspectives and interactions	New
Climate law	What are the implications in the Global South of growing litigations on climate change?	New
Decision-making for risk management	Enabling and catalyzing conditions in climate change decision making for managing risk.	New
Policy context	Understanding the policy/governance context of climate change adaptation.	New
Multiscale adaptation policies	The interaction of policy initiatives at local, regional, national and, if relevant, global scales.	New
Administrative contexts	The social/political/administrative context of mitigation and adaptation strategies.	New

SHIFT INSIGHT

Climate change governance

Climate Change Governance (continued)		
Climate change policies	Addressing the lack of adequate and updated climate change policies at national and provincial levels.	New
Legal Framework	Research based legal, regulatory & MRV framework for climate governance	New
Engagement with policy-makers	Working with policy-makers and politicians to change relevant policies through policy analysis and engagement research with policy-makers, politicians and other stakeholders.	New
Transparency and political will from developing countries leadership	Addressing low transmision of climate knowledge to grassroots by using transparency	New
Threats and vulnerability of climate change governance	What are the growing risks to effectively governing the climate - misinformation, climate litigation?	New
Institutional framework for climate change	Minimum set up of institutions, HR & skill set required for climate governance with defined roles	New
Leadership and climate change	Role of leaders, activists, champions at all scales in mobilising climate action	New
Role of non-state actors in adaptation and mitigation	In the context of reduced Aid budgets, pressures from Covid- how will that impact action on cc.	New
Declaring climate emergencies	The urgent need to declare national climate emergencies for climate planning and plans.	New

Environmental degradation

Environmental degradation		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Agroecological degradation in mountain regions	Mountain farmers' dependence on degrading forests, soil, agriculture and water due to climate change.	New gap
Water pollution	The impact of economic drivers linked to industrialisation and urbanisation on deteriorating water quality.	Gap 38
Impacts of climate change on tropical peat forest	Tropical peat forest is an important Carbon storage, and tropical peatlands have become a carbon source.	New gap
Wildfires	Climate change and risk of wildfires.	New gap
Mountain hazards	There is much work on glacial lake outburst floods (GLOFs) but less on high mountain hazards such as rock avalanches.	New gap
Freshwater systems	Impact of land use change and eutrophication on carbon emissions from freshwater systems.	New gap
Water quality	Accounting for changes in natural contamination of water.	Gap 38

Adaptation assessment

Adaptation assessment		
New knowledge gaps	**Details**	**Covered by existing gaps?**
Agreed metrics for assessing benefits of investments in climate resilience building	Sharing learning/ methodologies for tracking both socio-economic and scientific developments	Gap 30
Quantifying the effectiveness of different climate adaptation options	Lack of coordinated evidence on which methods are most effective/cost effective in practice	Gap 30
Unintended consequences	Unintended costs / risks from climate adaptation	Gap 21
Indicators	Indexes for adequacy and effectiveness of adaptation strategies and options	Gap 30
Defining adequacy	Understanding and defining adequacy of adaptation measures and climate justice, including socio-cultural and ethical considerations in perceptions and expectations of adequacy.	Gap 24
Socio-economic benefit assessment	Developing rigorous methodology that is non-resource intensive that can be integrated within existing systems.	Gap 24
Economic evaluation	Economic evaluation of adaptation.	Gap 30
Transformative adaptation	Understanding the limits of existing adaptation capacity/vision/politics and the costs and benefits of transformation.	Gap 21, 23, 30, 15

Adaptation responses

Adaptation responses		
New knowledge gaps	**Details**	**Covered by existing gap?**
Adaptation scales	Understanding at which spatial and temporal scales adaptation needs to take place	Gap 28
Transformational responses to climate change	Livelihood diversification and transformation strategies to respond to climate change	Gap 30
Rural – urban context	Climate change adaptation and rural-urban linkages	New gap
Informal settlements	The Global South's population living in informal settlements cannot benefit from standard adaptation	New gap
Technology transfer	Adaptation technology transfer from developed countries.	Gap 40
Urban adaptation	More research needed on urban adaptation and resilience action in SIDS	New gap
Social mobilisation	Studying social mobilisation as a response to climate change.	New gap
Urbanisation	Adaptation in the context of rapid urbanisation and informality	New gap
Livelihoods transformation	The set of responses, barriers and adaptive capacities that allow for a transformative response	Gap 15, 23, 29

SHIFT INSIGHT

Adaptation responses

Adaptation responses (continued)		
Social safety nets for climate adaptation	Including informal social and financial support to microinsurance and private finance	New gap
Behavioural change and adaptation	What tools incentivise adaptation behaviour, especially anticipatory adaptation?	New gap
Cross-country adaptation strategies	Implementation of adaptation strategies already practised in other countries	Action focus
Climate-environment-human dynamics	Understanding what adaptation measures work best in already water stressed extreme environments.	New gap
Community capacity assessment	Assessing the adaptive capacity of communities at micro scale. This helps adaptive actions at local, regional and national scale for adaptation/mitigation planning.	Gap 23, 29
Community based adaptation and climate finance	Recognising local knowledge on adaptation, and the value added by the local knowledge, tailored risk information, Community Based Early Warning System.	Gap 23

SHIFT INSIGHT

Evidence synthesis

Evidence synthesis

Knowledge gaps	Details	Covered by existing gaps?
Gaps in literature	Addressing regional gaps in the literature (for example in Central America).	Gap 31
Transboundary knowledge sharing	Knowledge sharing among the developing countries	Gap 31
Transboundary knowledge sharing	Transboundary sharing of data and information [for] political commitments. E.g. data sharing during flood period, basin-wide river managements and treaties can help to reduce vulnerability.	Gap 31
Data collection	Collecting quantitative data and establishing monitoring systems to track climate and its impacts for mitigation and adaptation purposes.	Gap 31
Scaling up research	Scaling up research and mitigation processes to ocean-basin scale. Due to the connectivity of ocean ecosystems, we need to scale-up our research to ocean-basin scale.	Gap 31, 16

SHIFT INSIGHT

Climate justice

Climate justice		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Ethics of climate actions	Socio-cultural, ethical perspectives and interactions with climate actions	New gap
Social equity	Starting with the people, especially those most disenfranchised, to work towards equity	New gap
Social consequences of climate change	Looking at things like increased conflict, increased inequity, forced migration	New gap
Climate change and conflict	Aggravation of conflicts in response to climatic pressures (in particular water security).	New gap
Human rights-based approaches	Understanding the nexus between ocean, climate, biodiversity and human rights; taking a rights-based approach to climate change adaptation and mitigation.	New gap
Energy Justice	Researching how developing nations must leapfrog fossil fuels to renewables.	New gap
Climate change and conflict	The Arab Spring and the Syrian war are likely related to drought and food insecurity.	New gap
Climate change and migration	[Providing?] renewable energy and sustainable systems for displaced communities	Action focus
Climate change and migration	Researching how livelihood choices and migration behaviour are changing due to climatic risks.	New gap

Climate services and communication

Climate services and communication		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Early warning systems for landslides	Addressing the lack of knowledge on determining the precipitation threshold that potentially triggers landslide in a defined landscape.	New gap
Forecast information for farmers	Delivering forecast information to small farmers and improving their response capacity to the forecast. The challenge is to deliver the information to end users, and provide them with tools to respond.	Action focus, Gap 14
Sustainable management of climate services	Building programme, project and knowledge management on country and regional levels	Action focus
Risk communication	Developing risk communication training for meteorologists and climate scientists and methodologies for effectively communicating the confidence and certainty in weather and climate information.	New gap
Community access to information	The challenge is for vulnerable communities to have access to information.	Gap 9, 18
Using information to support decision making	Presenting climate (change) information in a way that supports actual decision making	Gap 31, 9

Energy | Food security

Energy

Knowledge gaps	Details	Covered by existing gaps?
Just transitions in energy production	Researching how developing nations must leapfrog fossil fuels to renewables.	New gap
Water-energy-food nexus	Understanding the complex governance of the water-energy-food nexus in the context of climate change.	New gap

Food security

Knowledge gaps	Details	Covered by existing gaps?
Food security, population growth and climate change.	Researching the relationship between food security, population growth and climate change in the poorest nations. E.g. the Sahel, where population growth is high, and food is scarce. Climate change will worsen this.	New gap
Glacier retreat and food security	Understanding the impact of glacier retreat on food, water and energy security.	New gap
Water and food security	Researching climate impacts on water and food security and adaptation options for water and food security (e.g. in relation to irrigation and agriculture).	Gap 11, 36

Extreme events | Nature-based Solutions

Extreme events

Knowledge gaps	Details	Covered by existing gaps?
Extreme event attribution	Attributing extreme climate and weather events to causes, to help inform adaptation. Extreme event attribution is an important emerging area.	New gap
Extreme event impact	Understanding changes in extremes and their impacts and how risk might change.	Gap 2
Disaster risk reduction	Focusing on disaster risk reduction due to weather and climate related extremes	Action-focus
High-impact weather and climate variability	Improving understanding of how high-impact weather in the tropics responds to climate variability and change.	Gap 2
Extreme event attribution	Attributing observed extremes to test observational data and model simulations	New gap

Nature-based Solutions

Knowledge gaps	Details	Covered by existing gaps?
Role of natural habitats	Understanding how natural habitats can aid climate change adaptation and mitigation (ecosystem services)	Gap 27
The advantages and limitations of Nature-based Solutions	Systematic analysis of the advantages and limitations of Nature-based Solutions. More needs to be understood in order to optimise adaptation actions in addition to social justice.	Gap 27
Restoring degraded tropical peatland	Analysis of direct and co-benefits of peatland restoration as NbS.	New gap

Attribution

Attribution		
New knowledge gaps	**Details**	**Covered by existing gaps?**
Correlation and causation in observed change	Importance of attribution and detection language that's critical in social science aspects of Anthropogenic, or human-caused, Global Warming.	New gap
The attribution of climate impacts	Understanding how hazard/exposure/vulnerability drivers of impacts inform adaptation/loss and damage.	New gap
Attribution science in Africa's development	In light of Africa 2063 Agenda what is or can be the role of event attribution science?	New gap
Inventory of climate impacts and their causes	Developing an inventory of climate impacts and their causes; providing information relevant to adaptation planning and quantification of loss and damage.	New gap
Land uses and water governance	Understanding the interaction between climate and land use changes in altering local water availability.	Gap 5
Trade-offs between unforced climate variability and forced changes	How do we distinguish between forced climate changes and those arising from internal variability?	New gap

SHIFT INSIGHT

Capacity

Capacity		
New knowledge gaps	**Details**	**Covered by existing gaps?**
Institutional capacities of governments	[Improving?] institutional capacities of governments in developing countries. More vulnerable countries show lower institutional capacity to access international funding.	Action focus, Gap 23
Resilience and adaptive capacity	Understanding how ecosystems adapt and communities develop their resilience capacities.	Gap 27, 23, 34
Capacity of researchers, communities, and authorities	Understanding essential role of capacity building, diverse knowledge and technology transfer. It is very important to invest in developing capacity of researchers, communities, and authorities	Gap 19, 18, 40
Assessing the adaptive capacity of communities at micro scale	This helps adaptive actions at local, regional and national scale for adaptation/mitigation planning.	Gap 23
Monitoring, evaluation and learning (MEL) capacities	Strengthening sustainable MEL capacities within National Meteorological and Hydrological Services (NMHS) and climate research institutions, beyond project-based approaches to demonstrate value of national investment in climate services.	New gap
Community based DRRM and DRR finance	Building capacity of local institutions and increase investment in resilience.	Action focus, gap 18
Livelihoods transformation	Understanding the set of responses, barriers and adaptive capacities that allow for a transformative response.	Gap 29, 23
Adaptation capacity limits	Understanding the limits of existing adaptation capacity/vision/politics and the costs and benefits of transformation	Gap 15, 23, 21, 30.

SHIFT INSIGHT

Climate - environment - human dynamics

Climate - environment - human dynamics

Knowledge gaps	Details	Covered by existing gaps?
Forests	The role of land use, water quality and quantity, natural carbon stores in natural forests.	Unclear focus, gap 27
Coastal communities	Understanding the impact of regional sea level rise on coastal populations.	New gap
Groundwater	Understanding the response of groundwater systems, and technologies tapping it, to climate change.	Gap 36
Ecosystems and livelihoods	The interlinkage between changing climate, ecosystem services and livelihood.	Theme 3
Coastal communities	Impacts of climate change (including extreme events) on coastal infrastructure, livelihoods, food security etc.	New gap
Marine ecosystem	Climate change impact on marine ecosystem services that underpin society's health and wellbeing.	New gap, gap 16
Marine protected areas	Understanding benefits of, and cautions around, Marine Protected Areas to support climate adaptation. The creation of new marine protected areas around the world must respect human rights.	New gap
Rainfall run-off in urban environments	Researching rainfall to run-off system in urban settlement vs. agricultural landscapes and forest-covered areas. Single threshold for dense populated area to that of open area does not reflect potential risk.	New gap

SHIFT INSIGHT

Climate and weather dynamics and projections

Climate and weather dynamics and projections

Knowledge gaps	Details	Covered by existing gaps?
Robustness of projections	Improving robustness of local and regional climate change projections - Having a clearer focus on the key issue of robustness.	Aspect of theme 2
Predictable vs. impactful aspects of climate change	Delineating what we know well about climate change vs. what we want to know?	New gap
Hydrological cycle	Improving understanding of the hydrological cycle in extratropical regions and its changes	Gap 4
Decadal prediction	Developing initialised prediction of climate 1-10 years ahead.	Gap 7, 14, 3
Monsoon prediction	Improving monsoon prediction at seasonal and decadal level and monsoon future projections. Not enough observation data and understanding of processes.	New gap
Hydrological cycle	Understanding hydrological cycle in tropical regions in response to El Nino, ENSO, SST changes.	Gap 4, but more detail
Increasing confidence in projections	Establishing the level of confidence in projected local/regional climate changes and generating information which can be used with confidence.	Gap 6, 7
Limits of modelling	Understanding the limits of modelling and the political gaming of indicators.	Gap 6, 7
Understanding fundamental climate processes	Addressing the fact that many African physical land-water-air processes are still poorly understood, or yet to be described.	Gap 6

Climate observations and monitoring

Climate observations and monitoring		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Observations of climatic hotspots	Addressing the lack of observations of the climate system in hotspots of projected change.	New gap
Systems approach to monitoring	Considering all drivers of change together with climate change using long-term monitoring.	New gap
Data and information systems	Collecting quantitative data and establishing monitoring systems to track climate and its impacts.	New gap
Monitoring ongoing climate change	Observing and interpreting ongoing climate change.	Aspect of other gaps
Transboundary data sharing	Addressing the lack of good quality observations and transboundary data sharing.	New gap

SHIFT INSIGHT

Climate finance

Climate finance		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Loss & Damage and Finance	Exploring how L&D can lead to social protection finance.	Gap 32
Finance / economic models	Addressing the issues with economic models, which are not comprehensive, use old data, don't account for cost of negative impact, artificially reducing ROI.	Gap 26
Community-based Disaster Risk Reduction and Management and DRR finance	Building capacity of local institutions and increase investment in resilience.	Action focus
Forecast-based finance	Developing forecast-based finance for more effective humanitarian responses. Using (impact-based) forecasting to inform financial interventions (humanitarian/insurance etc).	Gap 26, action focus
Risk spreading measures/instruments	[Utilising?] social and financial risk spreading measures such as insurance, co-operatives etc.	Gap 26, action focus

SHIFT INSIGHT

Human health

Human health		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Impacts of climate change on human health and wellbeing	Direct impacts of climate change on physical and mental health e.g. through vector-borne diseases, water-borne diseases.	Gap 35
Climate health and gender	Gender equality and health in climate change impacts	New gap
Climate, health and risk	Understanding how climate and health risks are traded-off against one another	New gap
Health systems	Building climate resilient health systems	Action focus
Temperature, humidity and diseases	Impact of climate change on diseases, especially the Covid19 pandemic. Researching the impact of increasing global temperature and humidity on diseases spreading.	Gap 25
Air pollution	Health impacts of air pollution	New gap

Indigenous and local knowledge

Indigenous and local knowledge		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Indigenous and local knowledge and traditional decision making	Researching the endemic understanding by communities of climate science and adaptation.	New gap
Community knowledge and action	Acknowledging informal and historic responses that may not fit established climate thinking.	New gap, gap 23
Traditional knowledge of resource management	Exploring the local/traditional knowledge of resource management. Many societies have rich Indigenous Knowledge (IK) of resource management which are gradually vanishing.	New gap
Cultural heritage	Acknowledging that cultural sites and rituals contain important generational information to support local innovations.	New gap
Community knowledge and action	Acknowledging the value of local knowledge on adaptation, tailored risk information, Community-based Early Warning System.	Gap 23
Local values	Acknowledging that the ways in which environment is known and valued shapes responses and actions.	New gap
Recognising indigenous voices	It would make one of the most vulnerable groups visible.	New gap
Natural and cultural heritage	Recognising that strategies to respond/adapt to climate change are not sustainable in the absence of cultural knowledge.	New gap

Indigenous and local knowledge

	Indigenous and local knowledge (continued)	
Indigenous knowledge and adaptation	Preserving indigenous knowledge for adaptation among communities in poverty.	Gap 23
Oceans as intangible heritage	Understanding the role of intangible heritage of ocean in climate change adaptation. How people relate to oceans culturally and spiritually will be essential to climate adaptation.	New gap
Indigenous knowledge in equal dialogue with science	Equal partnerships are key and research themes should emphasise co-production.	Gap 9
Indigenous knowledge and adaptation	The roles of indigenous youths and indigenous knowledge in adapting to climate change.	New gap

SHIFT INSIGHT

Interdisciplinary working

Interdisciplinary working		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Arts contribution	The contribution of Arts & Creative practices to engage and connect with communities in relation to climate change knowledge/understanding	New gap
Humanities contribution	Utilising archaeological and historical records to connect climatic and social variability; learning from the past, where we can.	New gap
Behavioural science contribution	Using behavioural research to examine attitudes/actions and how these may be used to drive behavioural change.	New gap
Art and culture contribution	Recognising that data-driven predictions are often unpalatable thus ignored, and creatives and story tellers can help imagine change.	New gap
Humanities contribution	Learning from the past: evolutionary perspective in climate change adaptation.	New gap
Arts contribution	Developing visioning tools (e.g. Future 'scapes') to work collaboratively in climate change research.	New gap
Behavioural science contribution	Understanding what tools incentivise adaptation behaviour, especially anticipatory adaptation.	New gap
Humanities contribution	Using oral histories and intergenerational knowledge base as key for context and understanding of current climate change trajectories.	New gap

SHIFT INSIGHT

Intersectionality

Intersectionality		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Climate change, health and gender	Gender equality and health in climate change impacts	New gap
Intra-household inequalities	Understanding differences in power between family members (to identify who is more vulnerable)	Gap 29
Racism and vulnerability	Researching how colonial histories and racist exclusion have shaped different vulnerabilities.	New gap
Gendered dimensions of climate resilience	Focusing on gendered impacts and responses to climate change. The gender issue is still aspirational in government programs, institutions, and in research.	Gap 22
Intersectionality and adaptation	Understanding how adaptive capacities differ by gender and other demographic, relational factors	New gap, also gap 22
Gender, social inclusion and differently-abled groups	impacts of climate change, disasters in these above vulnerable group to be explored/researched	New gap
Invisible vulnerabilities, invisible capacities	Drivers of vulnerability understood alongside the capacities of people, specially those excluded	Gap 22
Adaptation challenges for sex and gender diverse people	Understanding how sex and gender diverse people deal with adaptation challenges.	New gap
Gendered ownership	Acknowledging the importance of socio-ecological systems and gendered ownerships.	New gap

Knowledge co-production

Knowledge co-production		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Gender in climate change project design	Addressing the fact that projects in small island developing states (SIDS) are dominated by men with limited female input in design.	Gap 19
Co-creation of climate change responses	Investing in collaborative and co-production working, including citizen science for climate change adaptation.	Gap 18, 9
Informal sector and settlements	Recognising cosmopolitan populations could be great source of knowledge innovation.	New gap
Scientific values	Understanding values in climate analysis and its socioecological implication.	Gap 9, 17, 19
Participatory and collaborative research	Recognising the role of interactive and participatory research approaches/methods.	New gap
Alignment of on the ground knowledge with model outputs	N/A	Gap 9
The role of values in the scientific and broader communities	Values that guide research, communication, community uptake, governmental climate communication effectiveness.	New gap
Working with unusual stakeholders	Identifying potential adaptation and resilience strategies from unexpected stakeholders like kids.	New gap
Utilising experiential knowledge	Considering voices on the ground in the planning approach.	Gap 9

SHIFT INSIGHT

Public engagement and awareness

Public engagement and awareness		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Awareness of rural communities	[Increasing?] long-term climate change awareness of rural communities.	Action focus
Public activism	[Increasing?] public engagement in climate change communication, activism and governance.	Action focus
Awareness of children and youth	[Understanding the role of?] children and youth in household-level awareness of climate change.	New gap
Inter-generational perceptions	Understanding inter-generational perceptions and actions on climate change. Developing cross-generational methodologies for inclusive adaptation and mitigation.	New gap
Climate science education	Making climate science an educational priority. Educating general public through climate awareness programmes.	Action focus
Voluntary labour for climate action	Understanding and mobilising effective engagement of voluntary labour for climate action.	New gap
Awareness in developing countries	Raising climate change awareness in societies, especially in developing countries.	Action focus
Youth dimension of climate reslience	Recognising young people as an important axis of social difference.	New gap

SHIFT INSIGHT

Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development

Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Climate resilient development	Understanding what climate resilient development is and how it looks like.	Gap 30
Synergies between mitigation and adaptation	Addressing the fact that these are not initial objectives nor are they monitored and evaluated in climate change studies and policies.	Gap 35
Climate-induced disasters and adaptation	Understanding how these disasters are impacting vulnerable groups and adaptation measures.	New gap
Synergies between adaptation and disaster risk reduction	Understanding synergies between adaptation and disaster risk reduction in the context of transboundary governance of urban and rural areas.	New gap
Synergies between adaptation, resilience and sustainability.	Researching the relationships and trade-off among and between adaptation, resilience and sustainability.	Gap 35
Trade-offs between different adaptation and mitigation approaches	Different approaches will affect different marine ecosystem services leading to trade-offs.	New gap
Climate resilient development	Defining climate-resilient development pathways across spatial and temporal dimensions.	New gap
Synergies between disaster risk reduction and development	Making disaster management plans integral part of the development plan.	New gap

Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development

Synergies between Mitigation, Adaptation, Disaster Risk Reduction and Sustainable Development (continued)

Knowledge gaps	Details	Covered by existing gaps?
Climate resilient development pathways (CDRP)	Assessment of CRDP suitability in relation to development status and objectives. Interactions between socio-economic development objectives and the CDPR options and effect of choice.	New gap
Synergies between mitigation and disaster risk reduction	Aligning international frameworks on climate change & related topics to bring adequate and effective evidence bridging disaster risk reduction and Climate Change Agreements.	New gap
Integration across mitigation and adaptation	Acknowledging the role land use, water quality and quantity, natural carbon stores in natural forests to inform mitigation and adaptation.	Gap 27, 35
Synergies between adaptation and disaster risk reduction	Implementing policy from national to local level.	Action focus

Systems approach

Systems approach		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Dynamic systems approaches to climate change	Recognising the need to adapt systems models as the situation changes, for example as circular economy alters impact.	New gap
Systems transitions	Linking socio-technical transitions with socio-ecological resilience.	New gap
Systems approach to change	Considering all drivers of change together with climate change using long-term monitoring.	New gap
Cognitive vulnerability	Recognising the limits to understanding of the systemic nature of climate.	New gap
Institutional transformation	Understanding the required institutional transformative change to address SDGs while responding [to climate change?].	New gap

Understanding risk and vulnerability

Understanding risk and vulnerability

Knowledge gaps	Details	Covered by existing gaps?
Causes of local risk	Evidencing the connections between historical and international causes of local risk.	New gap
Climate change risk and resilience assessment	Using the IPCC risk framework (i.e. risk = hazard * exposure * vulnerability).	Action focus
Compound hazards modelling	Predicting wave-surge-tide-rainfall with climate change effect.	New gap, also gap 13
Non-climate risk drivers	Understanding the multiple drivers of societal exposure and vulnerability, and therefore of risk. Besides physical impacts driven by climate change, we need to understand non-climate risk drivers.	Gap 10, 22
Cascading and compounding risks	Managing cascading and compounding risks	Gap 13
Cascading and transboundary risks	Assessing and managing cascading and transboundary climate risks	New gap
Coupling of mitigation, climate change and vulnerability	Mitigation options can reduce climate change, but might also increase vulnerability	Gap 35
Systemic vulnerability	Enhancing programming to reduce systemic vulnerability relevant to all hazards	Action focus
Climate change vulnerability	Identifying specific regions and local communities that are highly vulnerable to climate (e.g. vulnerability assessment of coastal communities).	New gap
Invisible vulnerabilities, invisible capacities	Understanding drivers of vulnerability alongside the capacities of people, specially those excluded.	Gap 22

SHIFT INSIGHT

Water security

Water security

Knowledge gaps	Details	Covered by existing gaps?
Adaptation in water-stressed environments	Understanding what adaptation measures work best in already water stressed extreme environments.	New gap
Water supply in high mountains	Researching the response of non-glacial ice masses to climate warming in high mountains, including the impact of rock glaciers on water supplies in high mountains.	New gap
Water and food security	Researching climate impacts on water and food security and adaptation options for water and food security (e.g. irrigation and agriculture).	Gap 36, 11
Waste water treatment	Assessing the impact of lack of effective large scale waste water treatment on water quality.	New gap
Water-energy-food nexus	Understanding of complex governance of the water-energy-food nexus in the context of climate change.	New gap
Water and food security	Understanding the relationship between climate change, food and water security within the social, cultural and ecological context.	New gap
Water governance and management	Recognising that 90% of climate change adaptation relates to water.	Gap 36, 4
Water security and conflict	Addressing the aggravation of conflicts in response to climatic pressures (in particular water security).	New gap
Land uses and water governance	Researching land uses and water governance.	Gap 36, 5
Glacier retreat	Researching the impact of glacier retreat on food, water and energy security.	New gap

Miscellaneous research gaps

Miscellaneous research gaps		
Knowledge gaps	**Details**	**Covered by existing gaps?**
Digitalisation and climate change impacts	Understanding the interaction between climate change and digital transformations.	New gap
Hotspots of climate change	Researching hotspots of climate change.	New gap
Downscaling resiliency	Knowing how to express to stakeholders that as we regionalise climate impacts, skill typically degrades.	Unclear
Distribution of climate change impacts	Understanding the distribution of climate change impacts within and across societal levels and the implications for security.	New gap
Higher education and business	Convergence between higher education and business.	Unclear
Higher education and general public	Closing the gap between higher education and general public	Unclear
Reaching net-zero emissions	Innovating in energy and production processes to reach zero carbon emissions.	Out of scope
Unintended consequences of mitigation	Understanding unintended costs / risks from climate mitigation	Out of scope

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