UK CLIMATE RISK

UK Climate Risk
Independent Assessment
(CCRA4)

Technical Report
Chapter 2: Methods

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2.1 Introduction

This chapter sets out the methodology for the Technical Report of the Fourth Independent Assessment of UK Climate Change Risk (CCRA4-IA-TR). The aim of CCRA4-IA-TR is to assess climate risks and opportunities to the UK. To do this, a standard methodology is used to review available peer-reviewed, and other quality-assured, evidence.

A set of 44 climate-induced risks and opportunities for the society, economy and the built and natural environments of the UK have been defined. These are formed around five outcome areas (and corresponding chapters): Infrastructure, Built Environment and Communities, Health and Wellbeing, Land, Nature and Food, and Economy. For each risk and opportunity, a methodology is applied by experts to produce a score indicating the urgency of taking adaptation action. The CCR4-IA-TR methodology addresses an overarching question:

What are the most urgent climate-induced risks and opportunities to the UK?

The methodology applied to answer this question is based on the following concepts:

- **Magnitude:** Refers to the overall impact or severity of the risk or opportunity. Authors gathered evidence and score the magnitude of climate risks in the present day and in the future (for the 2030s, 2050s and 2080s) in quantitative or qualitative terms (see section 2.3.2) using indicators across a range of impact descriptors (e.g. health, economic damages etc).
- **Confidence:** Confidence is assessed to provide an indication of the quality and level of agreement of the evidence used in the magnitude scoring.
- **Adaptation:** Current, planned and announced government and non-government action to either reduce the magnitude of a risk or to realise a potential opportunity, is assessed by the authors. From this, they establish the impact of that action on the level of 'residual' risk/opportunity at different time periods which may require further action.
- **Residual risk/opportunity:** Is the level of risk/opportunity which remains after considering current, planned and announced government action.
- **Urgency:** The urgency score is arrived at using magnitude and confidence scores after adaptation has been considered. There are six possible scores ranging from 'sustain current action' to 'critical action needed'. The scores are intended to aid the Climate Change Committee's (CCC's) recommendations for the prioritisation of government actions.

Additionally, several supporting processes were carried out throughout the assessment (Outlined in Box 2.1).

Box 2.1 Supporting processes for CCRA4

Call for evidence. As well as the authors' own literature searches, two calls for evidence were conducted to gather evidence from the wider academic, policy and practice communities. These were carried out in 2024 (mid-May to early October) and 2025 (late-January to early June). Evidence was requested of how our understanding of risks and opportunities has changed over the last five years. Importantly, this includes updated evidence of how these risks and opportunities are being managed. It also includes whether actions are reducing (or will reduce) the level of risk, or increasing the extent to which opportunities are realised. Material was collected and distributed to the relevant chapter author(s) for evaluation and potential inclusion in the assessment.

Stakeholder engagement. A series of workshops were held with Government stakeholders and Arm's Length Bodies (ALBs) during the course of the assessment. These were held for individual systems such as land, transport, and built environment and communities and included the relevant Government National Adaptation Programme (NAP) risk owners (both for the UK Government and devolved administrations). The workshops occurred at

strategic points of the assessment and focused on i) co-developing the list of risks and opportunities to be assessed in CCRA4, ii) elicitation of evidence to support the assessment, and iii) feedback on interim findings of the assessment. Additionally, chapter authors engaged with relevant stakeholder networks to elicit evidence.

Review process. A structured review process was implemented throughout the project. This involved four groups:

Science Assurance Group: An internal group of four senior academics responsible for ensuring the scientific rigour of the assessment approach and chapter-level output. The Science Assurance Group was involved with the review of draft material throughout the course of the assessment.

Climate Change Committee: The Adaptation Committee and Secretariat of the CCC were similarly involved in the review of the method and draft material throughout the course of the assessment.

Independent Review Group: A panel of external experts was established to review the drafts of all chapters prior to being sent through to a wider community review.

Community Review: An open review was conducted for the draft Technical Report. This review was open to all, with academic, policy and practice communities targeted for feedback.

2.2 Risks and Opportunities

CCRA4-IA-TR has 44 risks and opportunities. These have been reformulated from CCRA3-IA-TR's 63. The process of reformulating the risks and opportunities was co-developed over a series of workshops with risk owners.

The risks and opportunities were defined to be *receptor-based* rather than hazard-based. This means they are focused on where impacts occur, 'the receptor', such as 'Risks to freshwater ecosystems', rather than on specific hazards that might occur – like flooding or extreme heat, for example. Risks were formulated wherever possible to identify a single 'receptor' (i.e. a sector, system, biome etc., that can be negatively affected by climate change, or positively by the climate in the case of opportunities). Receptors were defined with consideration of the governance structures in the UK and devolved administrations (DAs), to improve accountability for managing risks. Wherever possible, risks and opportunities were defined to improve consistency in scale and scope across the assessment. The economy chapter risks did not fit the single receptor principle and therefore represent more aggregated risks in several instances. The scoring of these risks required a macro-level magnitude indicator (see section 2.3.2). International components of the risks and opportunities are considered holistically alongside the national drivers for each risk and opportunity.

2.3 Urgency scoring framework

2.3.1 Assessment framework and process overview

CCRA4-IA-TR maintains a synthesis approach used in CCRA2-IA-TR and CCRA3-IA-TR (the two previous risk assessments), as well as other international approaches. This involves peer-reviewed and other quality-assured

evidence being evaluated by experts using a step-by-step methodology to assess the urgency for action for each of the identified risks and opportunities. The CCRA4-IA-TR uses a three-step process to assess urgency:

1. Review the evidence of the magnitude of risk and opportunities under the assumption of "no additional adaptation" for the present-day and future time periods (under different warming scenarios). For each time period and scenario, assess the level of confidence in the evidence base.
2. Review the evidence of current and planned adaptation action within and outside of government and assesses the residual risk (after adaptation).
3. Assess the urgency of taking additional actions within the next five years, considering the expected magnitude of the risk (assuming current and planned adaptation takes place, under our central climate scenario) and the confidence in the associated evidence base.

For each of CCRA4-IA-TR's four time periods (see Box 2.2), one of six urgency scores is selected, along with an 'overall' urgency score using the urgency scoring matrix (see Section 2.3.4). An overview of the urgency scoring framework is given in Figure 2.1. The detailed description of each of the three steps in the urgency scoring framework is given in Sections 2.3.2-2.3.4.

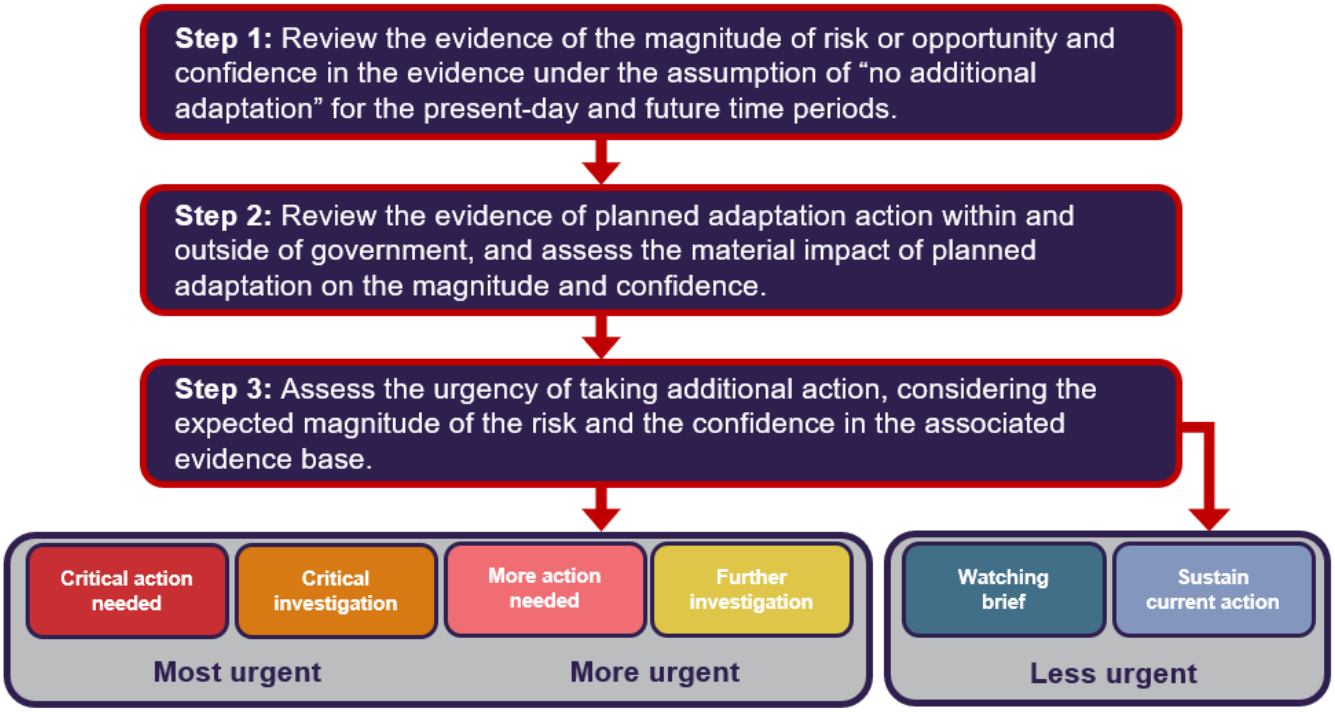

Figure 2.1 CCRA4-IA-TR urgency scoring framework

Box 2.2 Climate framing for CCRA4

CCRA4-IA-TR considers risks and opportunities in the present day and for three future time periods at two or three **Global Warming Level (GWL) climate framings** (depending on the future period in question, see Table 2.1).

Data from model simulations are used from a 20-year period in which the model's global mean surface temperature (GMST) reaches a specified level above the baseline of the pre-industrial GMST for 1850-1900. UK Climate Projections (UKCP) uses a combination of observed warming and estimates from climate model simulations to select the 20-year period whose average temperature most closely matches each GWL (Met Office, 2025).

The GWL approach directly links with global policy goals, including the 2015 Paris Agreement. The GWL approach shifts uncertainty from the timing of *when* climate impacts will happen, to *what* the impacts will be, and how severe. This allows more climate models to be used, including those based on very levels of greenhouse gases that are now considered less realistic. The timing of GWLs can therefore be better aligned with the most up to date assessments of emissions projections, and provide a better basis for risk assessment for planning and adaptation. However, it is less suitable for impacts that strongly depend on the rate of warming, or the cumulative amount of warming over a given period of time – with sea level rise being one example.

The future time periods at which the GWLs are considered to be realised use a 20-year period centred at the mid-point of each decade. These avoid any overlap between time periods. If longer time-periods are used, the decadal mid-point is maintained. To summarise, the four time periods are as follows:

- Present day: risk and opportunities from the range of possible weather and climate conditions possible today.
- 2030s: a near-term reference period centred on 2035, to represent the climate for which the next round of national adaptation programmes will need to fully prepare for.
- 2050s: a mid-century reference period, centred on 2055, consistent with the end of the period of 'largely inevitable' climate change, regardless of the trajectory of global greenhouse gas emissions over the next few decades.
- 2080s: a late-century reference period, centred on 2085, used to consider the implications of further climate change beyond the middle of the century, applicable to long-lived infrastructure or adaptation pathway dependencies.

These time periods allow CCRA4-IA to focus on near-term risks (e.g. 2030s), while also providing alignment with near-term reference periods in the IPPC's Sixth Assessment Report.

In CCRA4-IA-TR a range of global warming scenarios from 1.5 °C (in 2030s) to 3.5 °C (2080s) are considered. The use of global scenarios provides alignment with international climate assessments and with progress on the Paris Agreement's long-term temperature goals. To aid the authors in matching evidence to an appropriate GWL, a tolerance of +/-0.5 °C for 2030s and 2050s is applied, extending to +/-1 °C for the 2080s (Table 2.1). The GWL bands were used to match evidence (magnitude) to the appropriate scenario (Table 2.2).

Authors were asked to report risk magnitude for a central and high scenario for the 2030s and 2050s and a low, central and high scenario for the 2080s. Having a 2080s 'low' allows the authors to explore the possibility that global mitigation efforts are strengthened significantly beyond current policy trajectories (and the associated lower warming outcomes).

Table 2.1 GWL band for literature assessment of GWL based studies. A baseline of 1850-1900 is used. Present day is also considered, creating eight time periods to be assessed. Central values are used for the final urgency scoring.

	2030s (2026-2045)		2050s (2046-2065)		2080s (2076-2095)		
	Central	High	Central	High	Low	Central	High
GWL	1.5 °C	2 °C	2 °C	2.5 °C	1.5 °C	2.5 °C	3.5 °C
GWL band	1.25 °C to 1.75 °C	1.75 °C to 2.25 °C	1.75 °C to 2.25 °C	2.25 °C to 2.75 °C	1 °C to 2 °C	2 °C to 3 °C	3 °C to 4 °C

2.3.2 Step 1 – Assessment of current & future risks and opportunities

Authors were asked to assess **present-day and future climate risk and opportunities with the assumption of 'no additional adaptation'**. 'No additional adaptation' is a representation of maintaining a 'business as usual' approach i.e. existing adaptation assets are maintained up to the end of their planned lifetime, and then replaced like-for-like.

Key to this step is to assess and score the **evidence of the magnitude** of the risks i.e. how the components of hazard, vulnerability and exposure interact to cause actual damages or the risk of damages across a range of **impact descriptors**. Opportunities did not use this risk framing, rather they assessed the extent to which the opportunity will be realised without further adaptation (with the size of the 'residual opportunity' being identified). Impact descriptor evidence was matched to one of the four **magnitude scores** (see Box 2.3). Authors were also asked to provide a **measure for the strength of the evidence** used in the magnitude scoring i.e. a measure confidence based on the quality and level of agreement of the evidence (see Box 2.4).

The risks and opportunities are scored in the present day and in the future across the GWL climate framings (i.e. for 'central' and 'high' GWLs in the 2030s and 2050s, with 'low', 'central' and 'high' in the 2080s), with central scores being taken forward into the urgency framework (section 2.3.4).

Box 2.3 Magnitude scoring

The magnitude scoring aligns with the method used in CCRA3-IA-TR. However, an additional very high magnitude score was co-developed with the CCC for use in CCRA4-IA-TR. Authors scored the risks and opportunities from low to very high using a variety of **quantitative and qualitative monetary and non-monetary indicators across several impact descriptors** (Tables 2.2 and 2.3). These are based on expected annual damage (for risks) and foregone opportunities (for opportunities).

For quantitative evidence of magnitude, the thresholds for indicators generally increase by an order of magnitude between scores. To ensure comparability with previous assessments and internal consistency, thresholds were benchmarked with existing CCRA3-IA-TR thresholds (low-high) and additionally within/across each of the three quantitative magnitude descriptors (economics, health, natural environment). Benchmarking was also carried out through assigning monetary values to non-monetary indicators. For example, one for the natural environment is area of land lost. The value of the very high threshold associated with this indicator (>100,000 hectares of land lost) was monetised, to check comparability with the very high threshold in the economics category (> £ one billion economic damage). Nation-specific indicator thresholds were also developed for the new very high magnitude score using population size and economic data (e.g. gross value added) to account for the relative size of the economy and population between the nations of the UK (Table 2.3).

CCRA4-IA-TR's new Economy chapter contains added risks which represent larger scale macro or systemic threats. **The compounding nature of risk and scale of impacts in the macro-economy** (across multiple sectors) easily passes the threshold for the very high magnitude indicator across all time scales. For a more realistic risk assessment that aligns with national/global economic scales, a **new macro-economic scale indicator was developed** (Table 2.2). At present, this is only used for risks in the Economy chapter. Note: these values align with values used in the European Climate Risk Assessment ((EUCRA) (European Environment Agency, 2024)).

For the qualitative evidence of risk magnitude, authors were asked to present key sources of evidence (peer-reviewed literature, grey-literature, observations, case studies, local knowledge, stakeholder engagement), that suggest the possibility of impacts of the magnitude suggested by the qualitative descriptors (Table 2.2). Wherever possible, quantified evidence was sought.

Table 2.2 CCRA4 magnitude scoring table for England

	Indicator			
Impact descriptor	Very High Magnitude	High Magnitude	Medium Magnitude	Low Magnitude
Qualitative descriptor Annual damage & disruption or foregone opportunities	Critical	Major	Moderate	Minor
Damage and frequency	Very large & frequent	Large and frequent	Substantial	Limited and rate
Extent and pervasiveness	Very high	Large and high	Moderate	Not significant
System functionality	Irreversible loss	Long-term disturbance	Moderate disturbance	Not significant
Economic Annual damages (economic) or foregone opportunities	£ billions or 0.05% GDP	£ hundreds of millions or 0.005%-0.05% GDP	£ tens of millions or 0.001%-0.005% GDP	Less than £10 million or <0.001% GDP
Health impacts Deaths (annual)	Thousands	Hundreds	Tens	A few
Major health impacts (annual)	Tens of thousands	Thousands	Hundreds	Tens
People affected/minor health impacts (annual)	Millions	Hundreds of thousands	Tens of thousands	Thousands
Natural Environment impacts Hectares land lost or severely damaged	Hundreds of thousands	Tens of thousands	Thousands	Hundreds
km of river water or km2 of water bodies affected	Tens of thousands	Thousands	Hundreds	Tens
Impact to valued habitat or landscape types (e.g. BAP habitats and SSSIs)	Critical (~20% or more at national level)	Major (~10% or more at national level)	Intermediate (~5% or more at national level)	Minor (~1% or more at national level)
Culture/Heritage Extent of loss or irreversible damage to nationally iconic heritage assets (e.g. Stonehenge, Giants' Causeway)	Critical	Major	Medium	Low

Table 2.3 CCRA4 adjustment factors for magnitude in the devolved administrations (ATA = as table above)

	England	Northern Ireland	Scotland	Wales
Macroeconomic	ATA	% GDP for each magnitude score used at nation level. Absolute monetary values for each category are reduced by one order of magnitude (i.e. high magnitude will be £ tens of millions, rather than £ hundreds of millions).		
Economic	ATA	Indicators in table above adjusted for gross value added. To give relative importance, values in table are reduced by 1 order of magnitude, and applied equally to Northern Ireland/Scotland/Wales. Damage of foregone opportunities: £ hundreds of millions (very high) £ tens of millions (High), £ millions (Medium) <£ one million (low).		

Health impacts	ATA	Indicators in table above adjusted for population, factoring down levels in table by 1 order of magnitude, and applied equally to all DAs. Very High: Hundreds of deaths, thousands of major health impacts, tens of thousands of people affected / minor health impacts, High: Tens of deaths, hundreds of major health impacts, tens of thousands of people affected / minor health impacts, Medium: A few deaths, tens of major health impacts, thousands of people affected / minor health impacts, Low: No deaths, a few major health impacts, hundreds of people affected / minor health impacts, and/or impacts,		
Natural Environment impacts	ATA	Indicators in table above adjusted for land, factoring down levels in table by 1 order of magnitude. Very high: Tens of thousands of hectares land lost or severely damaged, and/or thousands of km of river water/km^2 of water bodies affected, and/or; High: Thousands of hectares land lost or severely damaged, Med: Hundreds of hectares of land lost or severely damaged; Low: Tens of hectares of land lost or severely damaged.	Given high land area of Scotland (approx. one third of UK) values in table above are used.	Indicators in table above adjusted for land, factoring down levels in table by 1 order of magnitude. Very High: Tens of thousands of hectares land lost or severely damaged, and/or thousands of km of river water/km^2 of water bodies affected, and/or; High: Thousands of hectares land lost or severely damaged, Med: Hundreds of hectares of land lost or severely damaged; Low: Tens of hectares of land lost or severely damaged.
Habitat / Natural Capital	ATA	ATA		

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Box 2.4 Confidence scoring

CCRA4-IA-TR assesses confidence in the evidence for the magnitude of risks and opportunities. A combination of the quality of evidence and the level of agreement between studies is used to score the strength of the evidence used in the assessment. In summary:

- ***High confidence:*** *The evidence is of high quality and there is strong consensus among experts.*
- ***Medium confidence:*** *Evidence is more limited or uncertain, but there is still general agreement on the conclusion.*
- ***Low confidence:*** *The evidence is limited or conflicting, leading to weaker consensus.*

Authors assessed the quality and agreement of evidence using qualitative descriptors from high to low (Table 2.4). For example, evidence from multiple sources that have been peer reviewed would score highly, or where there is limited/no evidence a low score is assigned. Where evidence for a specific period or nation did not exist, authors were allowed to compose justifications for transposing evidence across geographical or temporal scales (where appropriate to do so i.e. the hazard occurs across regions), while acknowledging the evidence gap.

Table 2.41 Confidence descriptors used to score CCRA4-IA-TR evidence, taken and adapted from CCRA3-IA-TR.

High
• Multiple sources of evidence; unified conclusions (agreement of evidence); • Evidence has been peer reviewed in the case of academic literature and/or has been subject to internal review in the case of grey/industry literature; • Based on robust techniques appropriate to the field; • Data used are of a high quality and appropriate to for the aims of the studies; • Use of relevant indigenous and local knowledge (where relevant); • Remains relevant - for instance where evidence published before 2021 is used, ensure that the assumptions and ensuing results are still valid and applicable; • Evidence of validation using different datasets;

• High quality evidence from other countries & description of how the risk framing is related (e.g. hazard, exposure, vulnerabilities).
Medium
• A combination of high and low descriptors: e.g. Some evidence of 'high quality' and some 'low quality evidence'.
Low
• Limited or no evidence e.g. based on only one dataset; • Evidence has not been peer reviewed in the case of academic research; • Based on weak methodologies (e.g. anecdotal evidence); • Poor quality data which may not be appropriate; • Evidence in the existing literature base is no longer relevant (e.g. contains assumptions which are no longer valid); • No use of relevant indigenous & local knowledge (where relevant).

2.3.3 Step 2 – Assessment of current and planned Government and non-Governmental adaptation

Authors were asked to assess whether there was credible evidence of policies and plans, drawing on the CCC's approach to evaluating policy effectiveness set out in its Adaptation Monitoring Framework. Where credible policies and plans were in place, the authors were asked to take those plans into account and assess the level of residual risk for each time period under the different climate scenarios. The authors used the same thresholds as in Step 1. This means that if an adaptation policy will reduce deaths from 300 to 150, magnitude remains high. If an adaptation policy reduces deaths from 300 to 50, magnitude reduces to medium. The authors also assessed the confidence in evidence around residual risk. They therefore produce a full set of magnitude and confidence scores for each time period and climate scenario for the "planned adaptation" scenario.

Residual risk is important, as this is projected future damages caused by climate change that the Government will need to adapt to. For opportunities, the authors were asked to consider whether the plans would fully realise the potential opportunity.

2.3.4 Step 3 - Assessment of overall urgency score

In the final step, authors provided an urgency score for each risk and opportunity using the urgency matrix (Figure 2). The CCRA4-IA-TR assessment of urgency combines the magnitude of residual risk or opportunity, for which the authors considered of the impact of current, planned and announced adaptation policy, and the confidence in the evidence supporting this. Each risk and opportunity is assigned one of six 'urgency scores', ranging from 'watching brief' to 'critical action needed' for each time period (Table 2.5). For each nation, the 'overall' urgency score for each risk/opportunity is based on the highest score from across the time periods using the order of urgency given in Table 2.5 (this is calculated for each nation). CCRA4-IA-TR has two new urgency score categories; 'critical action needed' and 'critical investigation'

CCRA4-IA-TR adopts a similar algorithmic approach to scoring urgency as the EUCRA, which uses a scoring matrix to give a transparent approach to scoring of urgency. As CCRA4-IA-TR prioritises the consideration of near-term climate risk, the urgency matrix (Figure 2.2) has been 'weighted' towards the near-term. Specifically, risks with very high magnitude and medium/high confidence in the evidence in the present day, 2030s and 2050s would be given 'critical action needed', whereas risks in the 2080s would be given 'more action needed'.

Magnitude	Confidence	Present day	2030s (central)	2050s (central)	2080s (central)
Very high	High/med	Critical action needed	Critical action needed	Critical action needed	More action needed
	Low	Critical investigation	Critical investigation	Critical investigation	Further investigation
High	High/med	More action needed	More action needed	More action needed	More action needed
	Low	Critical investigation	Critical investigation	Critical investigation	Further investigation
Medium	High/med	More action needed	More action needed	More action needed	Sustain current action
	Low	Further investigation	Further investigation	Further investigation	Further investigation
Low	High/med	Sustain current action	Sustain current action	Sustain current action	Sustain current action
	Low	Further Investigation	Further Investigation	Watching brief	Watching brief

114 *Figure 2.1 Urgency scoring matrix*

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116 *Table 2.5 Urgency score definitions*

Urgency score	Description
Critical action needed	The combination of very high magnitude risks/foregone opportunities and a strong evidence base calls for critical new, stronger or different Government action, whether policies, implementation activities, capacity building or enabling environment for adaptation – over and above those already planned.
Critical investigation	The combination of very high magnitude risks/foregone opportunities and a poor evidence base calls for Government to prioritise action to fill significant evidence gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action.
More action needed	A combination of high/medium risks/foregone opportunities & high/medium confidence in the evidence base calls for new, stronger or different Government action, whether policies, implementation activities, capacity building or enabling environment for adaptation – over and above those already planned.
Further investigation	A combination of very high/low risks/foregone opportunities and low confidence in the evidence base. On the basis of available information, it is not known if more action is needed or not. More evidence is required to fill significant gaps or reduce the uncertainty in the current level of understanding to assess the need for additional action.
Watching brief	A combination of low risks/foregone opportunities and low confidence in the evidence base. The evidence in these areas should be kept under review, with continuous monitoring of risk levels and adaptation activity (or the potential for opportunities and adaptation) so that further action can be taken if necessary.

Sustain current action	A combination of medium/low risks/foregone opportunities and a high/medium confidence in the evidence base. Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk or opportunity continues to be managed in the future.

2.4 Non-assessed additional considerations

Authors were asked to provide information on several additional elements. Although these do not form part of the scoring framework, they are important for context.

Authors were asked to consider evidence where vulnerable groups are disproportionately affected (although this was treated neutrally in terms of the magnitude scoring). For example, which demographic groups are disproportionately impacted by a climate risk - focusing particularly on those with Public Sector Equality Duty (PSED) characteristics, in recognition that risks are not uniform at the national scale and will affect different groups differently. This added additional context to the discussion of the drivers of risk in the chapters.

Authors were also asked to report on evidence where risks/opportunities interact with other risks/opportunities in the CCRA4-IA-TR assessment. This was achieved through a narrative description of the interactions, as well as diagrammatically.

Specifically, authors were asked to describe interactions for each risk/opportunity. These could be 'upstream' interactions (where another risk/opportunity influences the risk/opportunity in question e.g. coastal erosion can contribute to community flood risk) or downstream (where the risk/opportunities in question influences another CCRA4-IA-TR risk/opportunity e.g. where increased precipitation can increase risks to building fabrics and indoor environmental quality, affecting health and wellbeing). All chapters include written summaries of interactions between intra-chapter, upstream and downstream risks.