Climate Change Risk and Impact Assessment for Kent and Medway

Part 1:

Methodology and Summary of Findings

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Contract

This report describes work commissioned by Kent County Council. Kent County Council's representative for the contract was Christine Wissink. Rachel Brisley, Rachelle Ngai, Hannah Bishop, Ben Sullivan and Katie Chorlton of JBA Consulting carried out this work.

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Executive summary

Climate change is already affecting Kent and Medway. Therefore, understanding the potential future impacts of warmer, wetter winters and hotter, drier summers is crucial for future prosperity, environmental quality, and health and well-being of communities. The impacts of climate change are likely to be felt acutely in Kent with its long, strategically important coastline, large number of properties at risk of flooding and warm summers compared with the rest of the United Kingdom. It is imperative that the impacts of climate change are considered alongside other drivers of change including economic fluctuations, population growth and demographic shifts.

The Climate Change Risk and Impact Assessment for Kent and Medway (CCRIA) is intended to inform policy and decision-makers of the key climate risks that will have the greatest impact on Kent's society, economy and environment, within the context of other future socio-economic drivers, providing the evidence for future planning.

The CCRIA has been developed as a county-level version of the UK Climate Change Risk Assessment (UK CCRA) published in 2017. The study is pioneering as very few local authorities have conducted climate change risk assessments at this scale. Therefore, the findings in this report are likely to be of national, as well as local, interest. The approach is based on the UK CCRA methodology where current climate risks, opportunities and adaptation are assessed and assigned urgency scores with recommendations reflecting the type of action that will be required in the short-term.

For the CCRIA, the methodology was tailored to focus on risks and impacts as adaptation planning will be addressed in separately. The urgency scoring approach is centred on the magnitude of the future risk (taking into account probability and impact), the adaptation shortfall (the gap between current actions and adaptation required) and interdependencies (the degree to which risks influence or are influenced by risks in other sectors and at national/international scales). Research undertaken to complete the CCRIA comprised: a SWOT review of the socio-economic characteristics of key sectors, an initial analysis of the most recent local climate change projections (UKCP18), stakeholder consultation, and development of a comprehensive impact and prioritisation scoring matrix.

The CCRIA findings are presented in three outputs. Part 1 provides the methodology and summarises the overall findings. Part 2 presents specific assessments for each of Kent's key sectors: Agriculture, Industry, Natural Environment, People and the Built Environment, Transport, and Utilities. These are intended to be read and used either on a stand-alone basis or as part of the full report. Part 3 gives snapshots of the sector summaries through fact sheet infographics.

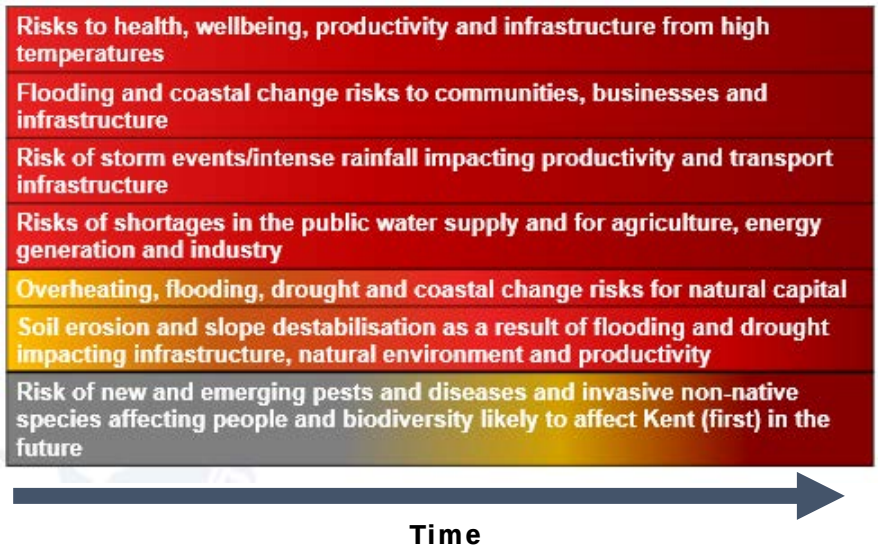
Analysis of UKCP18 projections identified the following climate changes for Kent:

- Hotter summers with an increase in average summer temperature of 2 – 3°C by 2040 and 5 – 6°C by 2080.
- Warmer winters with an increase in average winter temperature of 1 – 2°C by 2040 and 3 – 4°C by 2080.
- Drier summers with a reduction in average precipitation of 20 – 30% by 2040 and 30 – 50% by 2080.
- Wetter winters with an increase in average precipitation of 10 – 20% by 2040 and 20 – 30% by 2080.

- Increases in sea-level rise by up to 0.3m by 2040 and 0.8m by 2080.

The highest priority risks for Kent are comparable to those for the UK and are set out in Figure 1. Risks shaded red are high priority now and in the future. Those shaded in orange are less of a priority now but are likely to become high priority in the future.

Figure 1: Priority risks for Kent and Medway



Recent modelling suggests that the impacts of climate change will likely become increasingly severe over the next 30-80 years without significant, rapid action. Decisions made today will have lasting effects on local populations, services, the natural environment, infrastructure and finances over the coming decades. Key recommendations are:

- Undertake more in-depth research into localised and specific climate risks and impacts to build the evidence base, awareness and capacity to take action.
- Ensure projects, plans and processes have taken into account climate change and are resilient to climate risk in the long-term.
- Take action to reduce future financial costs – many studies show that adaptation is generally cheaper and more effective over time than the costs incurred responding to the impacts.
- Invest in cross-sector co-benefits – actions can deliver multiple wider benefits such as improving health and wellbeing, property values, skills and employment, reducing emissions and supporting biodiversity.

Proactive measures must be implemented to reduce the risks Kent and Medway face. There is a need for better research, strategic planning and co-ordination of adaptation across Kent and Medway to ensure measures are appropriate, robust and support pooling of resources to respond to climate risks. Failure to adapt will undermine the long-term viability and quality of life in the county. As a result of the CCRIA, Kent County Council will be leading on a Kent-wide adaptation programme to build the county's resilience to climate change over the next few years.

Contents

1 Introduction

Kent is one of the most diverse counties in the UK with many unique features formed by its varied geology, 350-mile coastline, landscape history, southerly location and proximity to the continent. Its high-quality environment, varied towns and rural landscapes, resources and assets are valued by residents, business and visitors alike providing significant benefits to the county's economy and the health and wellbeing of its residents.

Kent is of critical importance to national prosperity with its strategic location as the main international gateway from Europe into the UK and key infrastructure, transport and economic links to London, and the rest of the country. Large numbers of houses have been built in recent years, and the Kent and Medway Growth and Infrastructure Framework (GIF)[1], and Local Plans set out an ambitious growth agenda. Delivering this growth will be challenging; housing need still outstrips supply and there are already high levels of congestion and substantial pressure on public services across Kent and Medway. The impacts of climate change are likely to add to these challenges, and to be felt acutely in Kent, with its long coastline, large number of properties at risk of flooding and relatively warm and dry temperatures compared with the rest of the UK. This study will ensure that policy and decision-makers are informed about the climate risks that will have the greatest impact on Kent's society, economy and environment, enabling creation of evidence-based, future-proof plans.

The Climate Change Risk and Impact Assessment for Kent and Medway (CCRIA) provides a detailed assessment of the county's current and future risks, opportunities, and impacts of climate change and prioritises these to identify the risks of most importance. It also provides recommendations for further action. The CCRIA is being undertaken as part of the EU funded Flood Resilient Areas by Multi-LayEred Safety (FRAMES) project[2]. This project aims to assess the impact of, and build resilience to, flooding and climate change, particularly through the concept of multi-layer safety where risk is minimised through improving built infrastructure, developing spatial planning measures, building emergency preparedness and response capability, and reducing future risk through resilient recovery. The FRAMES project is co-financed by the European Regional Development Fund – Interreg VB North Sea Region Programme 2014 -2020.

The CCRIA is focused on Kent's key sectors – agriculture, infrastructure, natural environment, people and the built environment, transport, and utilities. The overall approach is based on the UK Climate Change Risk Assessment (UK CCRA) 2017[3] and the findings complement the Kent and Medway GIF and the Kent Environment Strategy[4]. The project, while focussing on identifying and prioritising risks, does not recommend specific adaptation priorities, however, it does consider current work being undertaken to manage present day climate risks.

[1] Kent County Council. 2018. Kent and Medway Growth and Infrastructure Framework - https://www.kent.gov.uk/about-the-council/strategies-and-policies/environment-waste-and-planning-policies/growth-and-infrastructure-framework-gif

[2] Kent County Council. 2019. Flood Resilient Areas by Multi-LayEred Safety (FRAMES) project - https://www.kent.gov.uk/business/business-loans-and-funding/eu-funding/frames

[3] Committee on Climate Change. 2017. UK Climate Change Risk Assessment, 2017 - https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/

[4] Kent County Council. 2016. Kent Environment Strategy - https://www.kent.gov.uk/about-the-council/information-and-data/Facts-and-figures-about-Kent/environmental-policies/kent-environment-strategy

1.1 Using this report

The purpose of the CCRIA is to provide evidence to inform local climate change adaptation and to raise awareness among Kent's local authorities, businesses, and communities of the potential risks and impacts of climate change. The method and outputs of the CCRIA have been constructed with these two aims in mind. The approach taken involves urgency scoring to prioritise the climate risks.

The CCRIA findings are presented in three outputs:

- Part 1 provides the context and methodology for the study and summarises the overall findings.
- Part 2 presents specific assessments for each of Kent's key sectors: Agriculture, Industry, Natural Environment, People and the Built Environment, Transport, and Utilities. These are intended to be read and used either on a stand-alone basis or as part of the full report.
- Part 3 gives snapshots of the sector summaries through fact sheet infographics.

1.2 Target audience

The assessment's findings are intended for Kent County Council (KCC), local authorities, and a range of public, private and third-sector partners and stakeholders across Kent. The study's findings are also likely to be of interest on a national basis as few studies have been conducted at a local scale using the UK CCRA methodology, and because of the importance of Kent to the national economy. National stakeholders that are likely to be interested in this study include Defra, the Adaptation Sub-Committee to the Committee on Climate Change, the Environment Agency, Network Rail, Highways Agency, Homes England, Public Health England, Natural England, the Infrastructure Operators Adaptation Forum, National Farmers Union, the Rivers Trust and the National Trust.

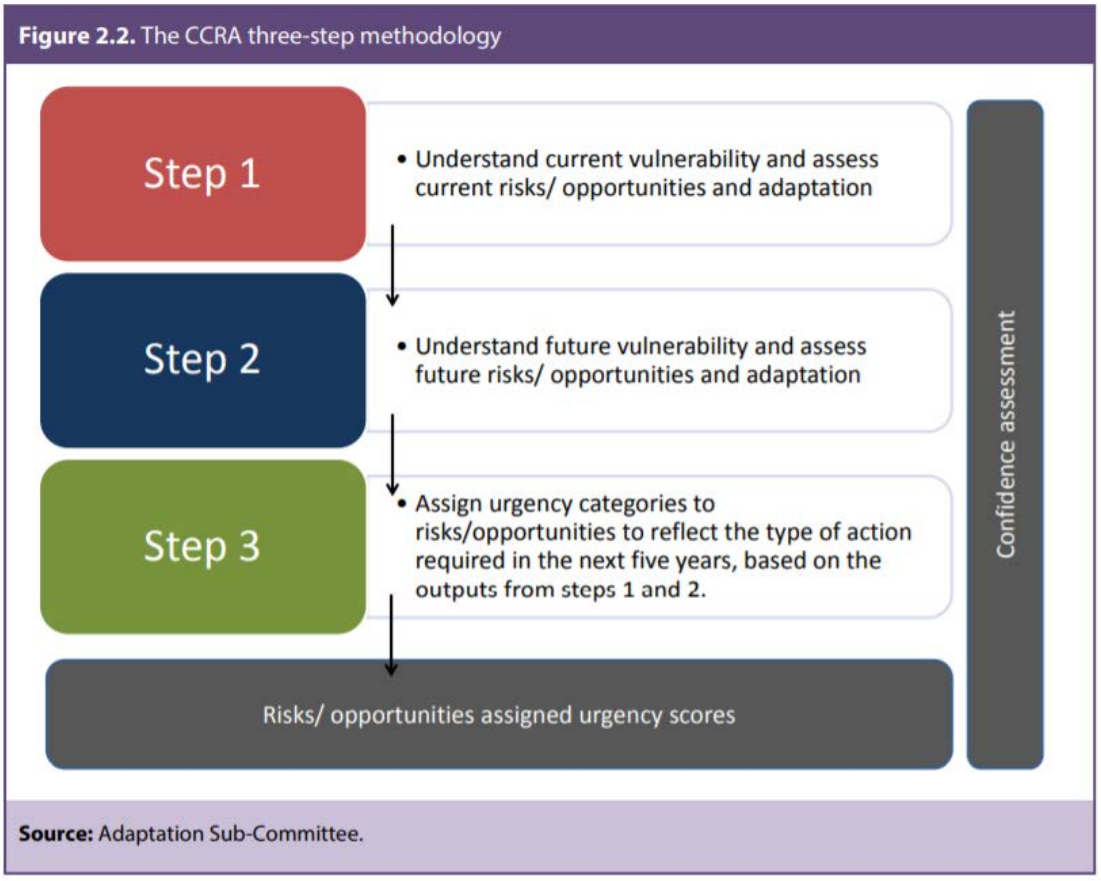
2 Approach

This section sets out the overall approach and more detailed methodology deployed to conduct the CCRIA.

2.1 Overall approach

The overall approach is substantially based on the methodology used in the latest UK CCRA (2017) and focuses on analysing existing knowledge, supplemented by stakeholder consultation.

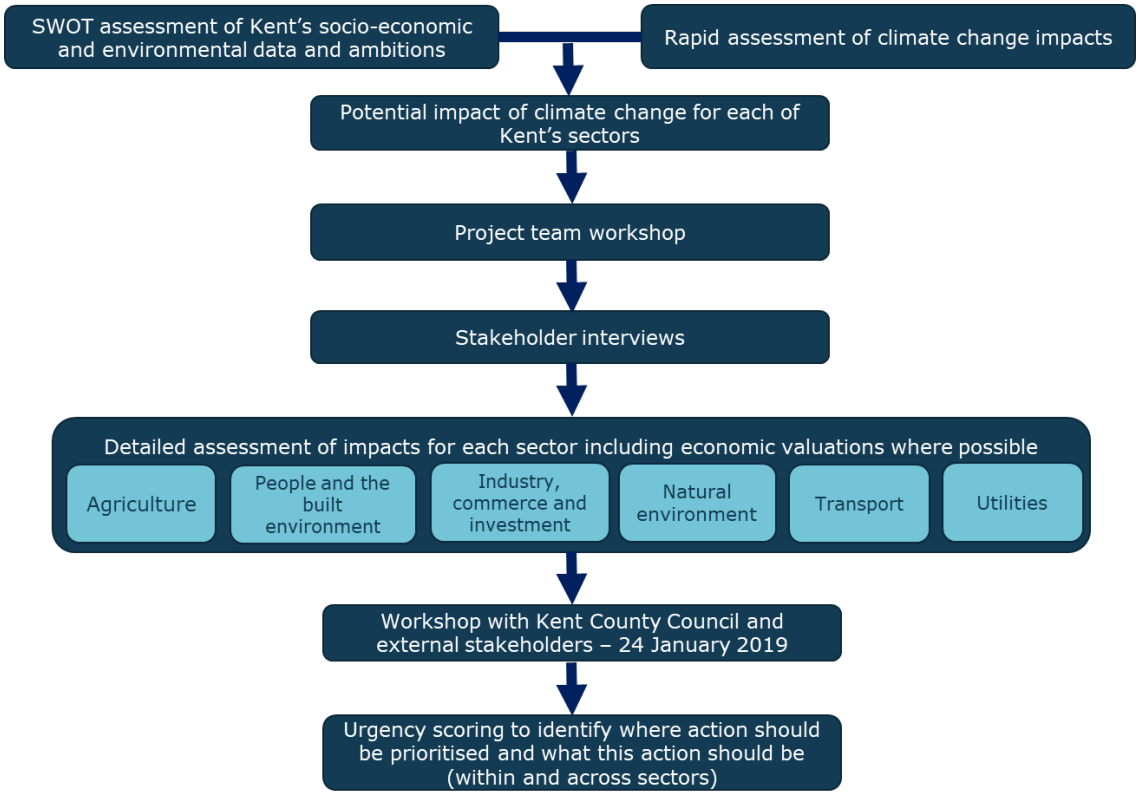
Figure 2-1: UK CCRA three-step methodology



The approach builds on the wealth of previous research and develops existing knowledge and awareness of current and future climate impacts in Kent. The most recent climate projections (UKCP18), published in November 2018, have been used to help identify the magnitude of climate change for Kent. However, the main body of the analysis (specifically the sector summaries in Part 2) are based on the previous UKCP09 projections. This was because many of the impacts of climate change (e.g. flooding) have not yet been analysed in relation to recent UKCP18 data. Differences between UKCP09 and UKCP18 are generally not considered to be of such significance that they affect the robustness of results for this assessment, with the exception of sea level rise projections. UKCP18 data suggests that sea level rise could be substantially higher than was previously anticipated for Kent.

The methodology adopted for the CCRIA is illustrated in Figure 2-2:

Figure 2-2: Kent's CCRIA approach



2.1.1 Kent's key sectors

Key sectors for the CCRIA were determined by and based on sector chapters in the UK CCRA and the GIF: agriculture, industry, natural environment, people and the built environment, transport, and utilities. Table 2-1 shows how these relate to the sectors set out in the UK CCRA and the GIF. International aspects were identified as a cross-cutting theme that would be highlighted within the agriculture, industry, people and transport sectors, particularly in relation to the importance of international links to the Kent economy.

Table 2-1: UK CCRA, Kent CCRIA, and GIF key sectors

UK CCRA	Kent CCRIA	GIF
Business and industry	Agriculture	
	Industry	
Natural environment and assets	Natural environment and assets	Natural environment
People and the built environment	People and the built environment	Community and culture
		Education
		Health and social care
Infrastructure	Transport	Transport
	Utilities	Utilities
International aspects	Considered within sectors	

Part 2 of the CCRIA Report provides summaries for each of Kent's key sectors. These are intended to be read either as standalone documents or as part of the full outputs from this study. The sector summaries provide policy and decision makers with the following evidence:

- Overview of the socio-economic characteristics of the sector.
- Summary of how climate hazards have previously affected the sector in Kent and Medway.
- Assessment of potential future impacts resulting from climate change specifically in relation to increased temperatures and heatwaves, drought, increased rainfall, flooding, and sea-level rise.
- High level review of the actions currently being undertaken to address the identified risks now and to build resilience into the future.
- Urgency scoring where the risks are scored in relation to magnitude, adaptation shortfall and interdependencies and recommendations provided that fall into the categories of more action needed, sustain current action, watching brief, and research priority.

2.2 Assessment of current and future climate impacts for Kent

The study commenced with a literature review and SWOT (strengths, weakness, opportunities and threats) assessment of the identified sectors in Kent and Medway. The purpose was to develop an insight into sector specific socio-economic characteristics and the long-term drivers that will affect the local economy, environment and society to 2050 and beyond.

In parallel, an initial assessment of climate change impacts was undertaken. This allowed identification of current and future climate hazards, based on a review of relevant UKCP18 projections and sector relevant headline impacts pertinent to Kent from the UK CCRA 2017. The following climate hazards were identified as the key climate risks with the greatest potential impact on Kent:

- Increase in average temperature
- Heatwaves
- Drought
- Sea-level rise
- Heavy rainfall
- Flooding
- Soil destabilisation and landslides

Nine stakeholder interviews were conducted with representatives from key sectors to test the preliminary findings derived from the SWOT analysis and climate change impact assessment. The interviews provided an opportunity for stakeholders to identify the risks they considered of greatest importance and to suggest the actions they felt were necessary to build Kent's resilience to climate change. In addition to the interviews, an e-survey was conducted to gather additional stakeholder input. This was sent to 60 stakeholders and nine responses were received.

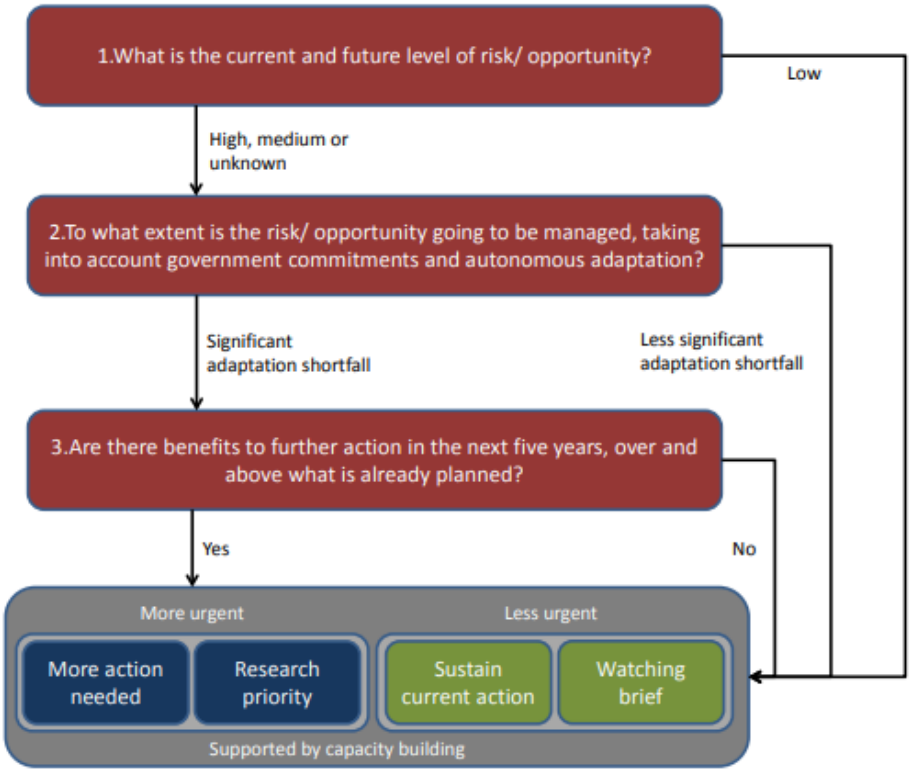
Findings from the interviews and survey responses were analysed in a comprehensive Impact Assessment and Prioritisation exercise. The Prioritisation exercise involved urgency scoring (see section 2.3). Recommendations for next steps concluded this piece of work.

The draft analysis was presented at a stakeholder workshop held in Kent in January 2019. The workshop's purpose was to raise awareness of the CCRIA, gather further information to inform sector analysis and test the findings to date. The aims of the workshop were to better understand stakeholder views on the risks to Kent, and to gather additional data and knowledge on the interdependencies between sectors and locations across the UK and Europe. The workshop was attended by 30 stakeholders, representing a range of teams from Kent County Council and other organisations including District and Borough Councils, the Environment Agency, Port of Dover and local water companies, among others. It provided considerable additional information for the CCRIA as well as recommendations for future action.

2.3 Urgency scoring and recommendations

The urgency scoring approach adopted for the CCRIA was based on the approach taken in the UK CCRA (Figure 2-3) and was customised for the Kent context. For the CCRIA, the third question was not fully considered as the focus of the study was on risks and impact assessment. Adaptation planning will be analysed and progressed by Kent County Council and its partners following the CCRIA.

Figure 2-3: Overview of approach for urgency scoring in UKCCRA 2017[5]



5 Committee on Climate Change. 2017. UK CCRA: Chapter 2. https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Chapter-2-Approach-and-context.pdf

As an alternative criterion, interdependencies were considered. It was considered that interactions between risks within and between sectors across Kent, London, the rest of the UK and internationally, should carry weight in determining urgency of action. Interdependencies refer to the interactions between risks in different sectors. For example, disruption to transport as a result of extreme events has impacts for the economy in terms of staff access to the workplace; the supply and distribution of goods and impacts on air quality. It can also affect access to healthcare and education services. Consideration of the cross-cutting nature of risk and management of these risks is important to define the true nature of the risk. Thinking about risks in each sector independently can create a false impression of the magnitude of the risk and lead to maladaptive solutions. Each sector summary includes an analysis of interdependent risks with other sectors.

The three aspects of the CCRIA urgency scoring comprise: risk magnitude, adaptation shortfall and interdependencies.

1. Risk magnitude – the current and future level of risk/opportunity. The level of risk was assessed as the probability of the risk occurring and the consequences if it did (Table 2-2).

2. Adaptation shortfall - the extent to which the risk or opportunity is being managed. The extent to which the risk is going to be managed was interpreted as evidence of ongoing adaptation and whether this is enough to manage the risk now and will be in the future to 2050 and beyond (Table 2-3).

3. Interdependencies - the degree to which the risk is affected by, and affects, other sectors and geographic areas, including beyond Kent (Table 2-4).

Table 2-2: Urgency scoring - risk magnitude scoring approach

	High Magnitude	Medium Magnitude	Low Magnitude
Quantitative Evidence	Major annual damage and disruption or foregone opportunities.	Moderate annual damage and disruption or foregone opportunities.	Minor damage and disruption or foregone opportunities.
	Greater than £10 million damage or foregone opportunities.	Between £1m and £10m damages or foregone opportunities.	Less than £1m damages or foregone opportunities.
	Hundreds of hectares/km of land lost or irreversible damaged.	Tens of hectares/km of land lost or irreversibly damaged.	Few hectares/km of land lost or irreversibly damaged.
	Thousands affected, tens of deaths, or people irreversibly harmed.	Hundreds affected, a few deaths, or a few people irreversibly harmed.	Tens affected and no people irreversibly harmed.
	Changes to majority of Kent's natural assets and their associated goods and services.	Changes to around half of Kent's natural assets and their associated goods and services.	Changes to a minority of Kent's natural assets and their associated goods and services.

	High Magnitude	Medium Magnitude	Low Magnitude
Qualitative Evidence	Expert judgement and widespread agreement across number of peer reviewed and grey literature which suggests there is a possibility of the impacts of the magnitude suggested above.	Expert judgement and widespread agreement across number of peer reviewed and grey literature which suggests there is a possibility of the impacts of the magnitude suggested above.	Expert judgement and widespread agreement across number of peer reviewed and grey literature which suggests there is a possibility of the impacts of the magnitude suggested above.

Table 2-3: Urgency scoring - adaptation shortfall scoring approach

Score	Explanation
High	Evidence suggests risk of medium or high magnitude and cannot be reduced to low with current adaptation and key drivers cannot easily be managed.
Medium	Evidence is not clear - unlikely to meet the high-risk criterion but not so clear cut that it meets the low criterion.
Low	Risk is low magnitude, risk magnitude could be reduced to low with current adaptation, key drivers could be managed over time to keep risks to a minimum (e.g. with flooding this could relate to planning and managing the impact of population growth to ensure there is no increase in impermeable surface).

Table 2-4:Urgency scoring - interdependency scoring approach

Score	Explanation
High	Clear climate impact interdependences with two or more sectors (includes interdependencies within the same sector but outside Kent and Medway, e.g. London or international as a separate sector).
Medium	Clear climate impact interdependencies with one other sector.
Low	No interdependencies with other sectors.

Following this analysis, recommendations were made for each sector in the categories of ‘more action needed’, ‘research priority’, ‘sustain current action’ and ‘watching brief’. However, as this study was not considering adaptation actions in detail, categorisation into ‘more urgent’ and ‘less urgent’ action was not undertaken.

2.4 Benefits and limitations of the approach

In applying this method, several benefits and limitations were identified and are summarised below.

2.4.1 Benefits of the approach

- Using a similar approach to the UK’s CCRA provides a consistent and robust approach to assessing climate change risks.

- Undertaking a SWOT assessment of key sectors expanded the available socio-economic trends and evidence available to provide a more local assessment of climate change impacts.
- Focussing on the risk magnitude, adaptation shortfall and interdependencies in the urgency scoring provides a structured and transparent approach that justifies the prioritisation of key risks.

2.4.2 Limitations of the approach

- Engaging stakeholders – the initial response from stakeholders invited to interview was very positive; however, three of the 12 invited to participate either declined or did not respond. Those interviewed covered all sectors within the scope of the study, but a majority of those interviewed worked for Kent County Council. The workshop was well attended, but again most attendees were from Kent County Council. Additional interviews recommended by stakeholder consultees and an e-survey were undertaken to obtain broader insights from a range of interests.
- Urgency scoring – this was based on the expert judgement of consultants and stakeholders, informed by research presented in each of the sector summaries. There is a risk that expert judgement can hide value judgements or biases. This was minimised through consultation with a wide range of cross-sector stakeholders.
- Quantitative evidence - a key requirement of the study was to identify economic valuations of climate risks with a reliance on secondary data and stakeholder engagement to inform the valuations. However, the amount of quantified, let alone monetised data, is limited. Consequently, there is limited quantifiable evidence to allow for direct comparisons of magnitude between risks.
- The approach does not include an options appraisal exercise for future climate risks and impacts. This is because it provides a high-level assessment of risks with adaptation options likely to be investigated in more detail through the upcoming Kent Adaptation Programme.

3 Future climate change projections for Kent

This section sets out how climate projections have been used in the study and summarises the key likely climate changes for Kent.

3.1 Climate projections

The CCRIA has been informed by the most recent climate change projections for the UK. Climate projections are informed predictions of the future climate based on climate models. Climate models simulate the fundamental processes driving weather and climate. UKCP18, published in November 2018 by the MET Office Hadley Centre, is the latest in a series of climate change projections for the UK that stretches back more than 25 years. It is the first major update of UK climate projections for almost 10 years, taking advantage of the latest observed data and the most recent generation of international and MET Office global and regional climate models. UKCP18 contains a set of tools for assessing how the UK climate is likely to change on land and in surrounding waters. The projections cover temperature and rainfall changes – for averages and extremes – as well as more specialist variables, such as specific humidity, air pressure and cloud cover. These are available for each month and season of the year, different emissions scenarios and future time periods.

UKCP18 includes four different types of projections: probabilistic, global, regional and derived. Each of these projections has different temporal and spatial resolutions and geographical extents and are available for different emissions scenarios. The projections are presented in a variety of ways including maps and data for administrative regions, catchments, marine regions, and 2.2-25km^2 grids.

These UKCP18 datasets are based on probabilistic changes in future climate and an assessment of modelled uncertainties and give estimates of different future climate outcomes and their relative probabilities across all representative concentration pathways (RCPs). RCPs are future scenarios including potential changes in population, economic development, and types of mitigation of greenhouse gases.

This study has used the probabilistic projections at regional level under the 8.5 RCP as these are recommended to help characterise the future climate extremes. These projections are also closely aligned to those UKCP09, which informed a lot of the pre-existing local research used to develop this CCRIA.

3.2 Key climate change projections for Kent and Medway

The tables below show the probabilistic projections for UKCP18 for the highest emission scenario (RCP 8.5) for the South East. This RCP was used for the study to understand the worst-case scenario and potential extreme events. Projections for the South East have been used as this is the closest geographical unit to Kent for which projections are available without additional extrapolation and analysis. The projections are provided at a 25km^2 grid square scale. The sea level rise projections for London are used in the study as these provided the closest fit to Kent and Medway.

Projections have been selected for the 2040s and 2080s which were agreed as fitting the brief to consider climate change impacts for Kent for 2050 and beyond.

Projections for mean temperature, rainfall and sea level rise are shown below. Temperature and rainfall projections are shown for the 50th percentile – this is the central estimate across the models. Sea-level rise projections are reported for the 5th

and 95th percentiles that relate to the lowest 5% and highest 5% of the model results. The key changes for Kent are:

- **Hotter summers** with an increase in average summer temperature of 2 – 3°C by 2040 and 5 – 6°C by 2080.
- **Warmer winters** with an increase in average winter temperature of 1 – 2°C by 2040 and 3 – 4°C by 2080.
- **Drier summers** with a reduction in average precipitation of 20 – 30% by 2040 and 30 – 50% by 2080.
- **Wetter winters** with an increase in average precipitation of 10 – 20% by 2040 and 20 – 30% by 2080.
- **Increases in sea-level rise** by up to 0.3m by 2040 and 0.8m by 2080.

Table 3-1: UKCP18 Probabilistic projections of mean temperature and rainfall at 50th percentile for RCP8.5 for South East England

Year	Change in mean temperature			Change in rainfall		
	Annual	Summer	Winter	Annual	Summer	Winter
2040	+1°C to 2°C	+2°C to +3°C	+1°C to +2°C	-10% to +10%	-20% to -30%	+10% to +20%
2080	+4°C to 5°C	+5°C to +6°C	+3°C to +4°C	-10% to +10%	-30% to -50%	+20% to +30%

Table 3-2: UKCP18 Probabilistic projections of mean daily minimum and maximum temperature at 50th percentile for RCP8.5 for South East England

Year	Change in mean daily minimum temperature		Change in mean daily maximum temperature	
	Summer	Winter	Summer	Winter
2040	+2°C to +3°C	+1°C to +2°C	+2°C to +3°C	+1°C to +2°C
2080	+4°C to +6°C	+3°C to +4°C	+5°C to +7°C	+3°C to +4°C

Table 3-3: UKCP18 Projected range (for 5th and 95th percentiles) of sea level rise in London (in m) under RCP8.5 relative to baseline period of 1981-2000

Year	Projected sea level rise in London
2040	0.16-0.29m
2080	0.39-0.80m

Further information on the UKCP18 projections can be obtained from: https://www.metoffice.gov.uk/research/collaboration/ukcp.

3.3 Previous climate projections and the CCRIA

The science and data underpinning climate change impacts are changing constantly. Impacts arising from loss of sea ice, glaciers and seasonal snow cover and the 'feedback loop' exacerbation of global trends are increasingly better understood. Newer evidence and modelling data points to more rapid climate change and increased severe weather and sea-level rise impacts.

The CCRIA is based on an initial assessment of the most recent large-scale, UK wide climate projections (UKCP18). UKCP18 projections were published in November 2018 and as such, detailed analysis has not yet been completed to understand the full implications of the new projections.

In addition, much of the detailed analysis undertaken for the accompanying sector summaries is based on research that used the previous UKCP09 projections. According to Met Office analysis, there is not significant change between the projections published for UKCP09 and UKCP18 for regional scale assessments.

A key difference between UKCP09 and UKCP18 is that all projections are slightly higher in UKCP18 and therefore impacts could be of greater significance. This is particularly pertinent for sea-level rise; UKCP18 projections show a greater increase compared with UKCP09 due to different treatment of land ice contributions to sea-level rise. This was expected and has been considered in local and national adaptation planning.

With regards to implications for this study, the use of research based on the UKCP09 projections is considered a robust approach, but the potential for impacts to be greater than previously anticipated is incorporated into the analysis set out in the sector summaries in the accompanying report.

4 CCRIA findings

This section combines the key findings to determine and describe the seven priority climate change risks that are likely to have the most significant impacts for Kent's economy, society and environment.

The highest priority risks for Kent (Figure 4-1) are comparable to those for the UK (Figure 4-2). The risks shaded red are high priority now, and in the future, while those shaded orange are less of a priority today, but likely to become high priority in the future. The risks in grey show were not enough information is available at present to fully assess the impacts but are likely to have a great affect in the future.

Figure 4-1: Priority climate risks for Kent and Medway

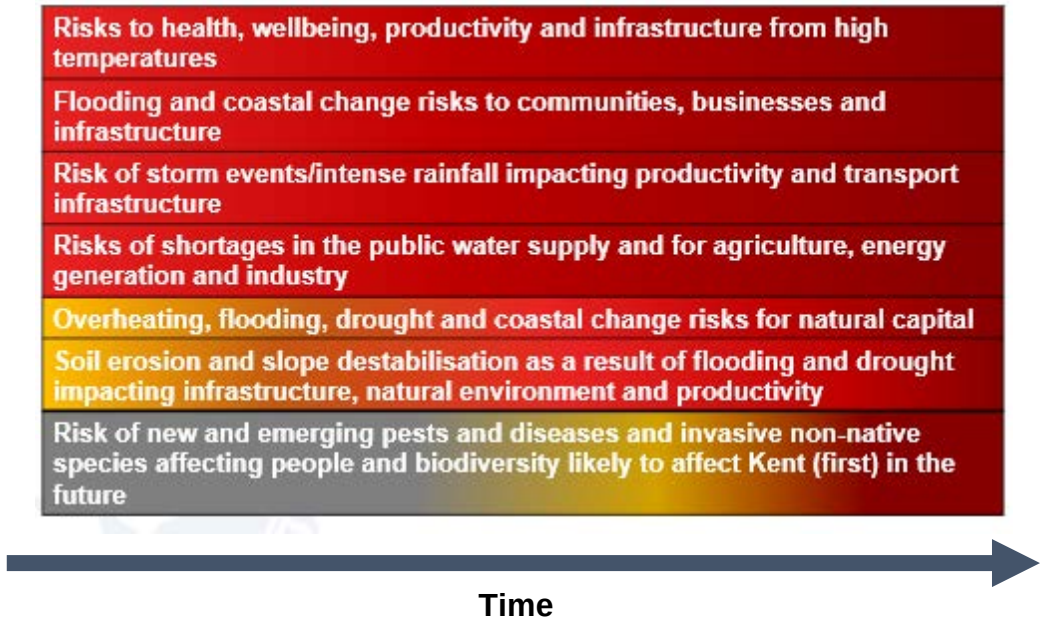


Figure 4-2: Top six inter-related climate risks for the UK

Source: ASC synthesis of the main areas of risk and opportunity within the chapters of the Evidence Report.
Notes: Future magnitude is based on a combination of climate change and other drivers of risk (e.g. demographic change), taking account of how current adaptation policies and plans across the UK are likely to reduce risks.

Several stakeholders noted in their feedback that these risks are unlikely to occur in isolation and that the cumulative effects of multiple risks may be more significant than has been assessed here.

4.1 Risks to health, wellbeing, productivity and infrastructure from high temperatures

High temperatures are a national risk from climate change that will be more significant in Kent and Medway than elsewhere due to a warmer local base climate. This will have impacts for the economy as well as for society. Kent is the warmest part of the UK and the second highest temperature ever recorded in the UK was in Faversham, Kent in August 2003 at 38.5°C. Higher average temperatures, heatwaves and extreme temperatures are likely to cause health impacts for the population. Overheating in private homes, public buildings, hospitals, care homes, prisons and workplaces is likely to increase; affecting health and productivity and requiring increased energy for cooling. However, increased temperatures are also likely to provide a boost for tourism from both domestic and international visitors due to Kent's location as a gateway to the UK.

Poor air quality is already an issue in Kent and projected increases in population could worsen current traffic congestion challenges. Increased traffic congestion and longer periods of very warm weather could worsen air quality leading to health impacts, particularly for older people and those with existing respiratory illnesses. Increasing population and a growing older population, combined with the projected health impacts from higher temperatures will place extra pressure on a health and social care system that is already under strain. Air quality is an acknowledged issue for Kent and Medway, and actions are already being taken to improve air quality across the county.

Kent's reputation as 'the Garden of England' could be affected as horticulture is impacted by higher temperatures, leading to changes in the ability to grow certain crops. Higher temperatures are likely to lead to a longer growing season and higher yields for some crops, such as potatoes, but adversely affect the productivity of other crops including hops, tomatoes and lettuces. Higher average temperatures may also increase the potential to diversify into other areas such as viticulture, already an area of growth in Kent. Changes in rainfall patterns and intensity will also impact on fruit farming in Kent, particularly for soft fruit growers.

High temperatures have already affected transport infrastructure, and this is likely to be an increased risk in future with heat related impacts on road and rail networks leading to delays and disruption that, in turn, will have implications for people, the environment and the economy. The key interdependencies related to higher temperatures are impacts on industry from workers being absent due to heat related illness and the potential for people's welfare to be adversely affected by heat related transport disruption.

While Kent County Council, the NHS, transport operators and other stakeholders are aware of these future risks, impacts are already being felt and more action is needed to build Kent's resilience to higher temperatures.

4.2 Flooding and coastal change risks to communities, businesses and infrastructure

Kent is currently at risk of flooding from sea, river, surface water and groundwater sources. There are currently 88,000 properties in Kent at risk of flooding and the risk is projected to worsen with increased winter rainfall and increased frequency and severity of intense rainfall events throughout the year. Previous flood events have affected residential, commercial and agricultural property, as well as transport and

utilities infrastructure, with a significant cost to individuals, communities and the local economy.

The most recent climate projections and research suggest the risk and impact of sea level rise is likely to be higher than previously thought. This could have negative impacts for Kent's coastal communities; many of which are in vulnerable areas associated with high deprivation. Significant sections of the coastline are defended, but sea level rise could lead to the loss of intertidal areas through coastal squeeze. There are extensive defences in coastal areas, and additional measures to protect major infrastructure such as regular beach replenishment at Dungeness B Power Station and frequent berth height increases at the Port of Dover are helping to manage risks. Sea level rise could lead to damage to, or loss of, valuable agricultural land and coastal habitat, as well as affecting infrastructure and industry based in coastal locations. Large amounts of agricultural land could be at risk in the next 50 years on the Isle of Grain, Isle of Sheppey, the Medway Banks and Romney Marsh. The railway line between Folkestone and Dover could be affected by storm surges leading to damage, disruption and delay.

Surface water flooding remains a significant challenge, especially as future surface and groundwater flood risk is not as well understood as flooding from rivers and the sea. Kent's Local Flood Risk Management Strategy identifies the key areas at risk and actions to manage them.

4.3 Risk of storm events/intense rainfall and sea level rise impacting productivity and transport infrastructure

Storm events are not identified as a specific risk within the UK CCRA and were not identified at the outset of the study but were highlighted by stakeholders as a key current and future risk to Kent, and therefore, were included in the final list of priority risks.

Kent's industry and economy are likely to be affected by storm events more than the rest of the UK due to dependence on transport infrastructure, particularly ports. Disruption at ports impacts the Kent and UK economy due to delays in shipping and resulting impacts on haulage. When crossings are prevented by severe weather, this can cause serious congestion resulting in the implementation of Operation Stack, isolating local communities and businesses. Storms and intense rainfall events can also impact road and rail transport infrastructure away from ports – for example, closing the QEII bridge and Sheppey Crossing during severe weather events, leads to delays and disruption to travel.

Climate change is projected to lead to periods of more frequent and intense storm events and rainfall that could affect agricultural and horticultural yields. This could result in an increasing need for crop protection measures, such as polytunnels, that can affect the landscape character. An increase in the number and intensity of storm events can cause damage to crops, agricultural buildings, residential and commercial properties and infrastructure.

Water and sewerage infrastructure and the electricity and gas networks (particularly overhead cables) are vulnerable to tree and debris-related damages as a result of storms and could also be affected by lightning strikes that are projected to increase as a result of climate change. Utility companies are building resilience into their

infrastructure but there is still the potential that future storms could have a serious impact.

Network Rail is developing a Weather Resilience and Climate Change Adaptation Plan for the South East route and is investing in earthworks and drainage improvements along this route.

4.4 Risks of shortages in the public water supply and for agriculture, energy generation and industry

Kent is an area of water stress and has experienced numerous drought events since the 1970s. Projected climate change and population growth may increase water demand while decreasing water available for supply. Significant investment will be needed to balance future supply and demand in Kent – depending on the climate path, level of population growth and the mitigation action taken, projections suggest an additional 1.5 – 2.6 billion litres per day will be needed by 2080 in the South East. This will have significant impacts on the public water supply and high-water consumption sectors such as agriculture, manufacturing industries and energy producers. Unless more is done to balance water supply and demand, droughts are likely to pose an increasing threat for soft and top fruit and salad production (Kent's main irrigated crops) in summer months, particularly where they rely on high levels of irrigation from river abstraction, reservoirs and groundwater sources.

The South East regional water resources group has developed a long-term strategy for the area and the water companies that operate in Kent are looking at both demand minimisation and supply maximisation measures to maintain a sustainable water supply for the county. Farmers are investigating diversification into more drought tolerant crops and the National Institute of Agricultural Botany East Malling Research (NIAB EMR) continues to support advances in horticulture including irrigation technology. However, water scarcity remains a very real and increasing risk for the future.

4.5 Overheating, flooding, drought and coastal change risks for natural capital

Increased temperatures and water scarcity create the potential for changes to biodiversity. Climate change can also cause a change in habitat preference or mismatch with other dependent species.

Currently, many of Kent's rivers are classed as poor under the Water Framework Directive, and with higher temperatures, possible droughts and low flows, pollution and runoff concentrations are likely to increase which will limit the potential to improve the status of these water bodies without substantial action.

Wetter winters are likely to increase fluvial flood risk, as well as threaten large areas of nationally and internationally important habitat. Coastal habitats are potentially vulnerable to changes in erosion rates as a result of increased rainfall and inundation from sea level rise. This could impact the Sheppey Cliffs SSSI, an area of geological and botanical interest due the presence of fossils and the rare cliff vegetation *Tetragonolobus maritimus* (Dragon's Teeth).

Projected rises in sea level can accelerate the natural erosion of coastal and intertidal habitats and alter the pace of natural geomorphological processes in coastal regions. These changes may have a significant impact on Kent's soft chalk cliffs and the

vegetation communities that grow on them. Coastal grazing marshes, raised bogs, and saline lagoons are all threatened by the increases in salinity that can result from increased percolation and inundation of sea water during storm tides and flooding.

Kent County Council, the Kent Nature Partnership and district authorities are working to improve the management of habitats and minimise habitat fragmentation. This action needs to continue to minimise climate impacts on biodiversity. Water scarcity has the potential to have a significant impact on Kent's environment with its habitats and wetlands sensitive to changes in water levels and river flows. There is a clear interdependency with the management actions of the main water consuming and management sectors – agriculture, industry and utilities.

4.6 Soil erosion and slope destabilisation as a result of flooding and drought impacting infrastructure, natural environment and productivity

Flooding and drought both have the potential to lead to soil erosion and slope destabilisation that, in extreme cases, can lead to landslides. The quality of agricultural land is likely to be affected by soil erosion as valuable nutrient-rich soil is lost, exacerbating pollution problems in rivers and other water courses through leaching of phosphates as soil is lost to erosion as a result of rainfall. Changing precipitation patterns may also increase groundwater pollution issues in Nitrate Vulnerable Zones (areas designated as being at risk from agricultural nitrate pollution) as rainwater percolates through soil into groundwater systems.

Pipe leaks and bursts can also result from frost heave in clayey soils arising from changes in soil moisture content. Prolonged periods of high temperatures can impact soil moisture content, also affect the stability of rail embankments, destabilising tracks and causing travel disruption.

Network Rail is investing in earthworks maintenance in its current Control Period and farmers are planting cover crops to help stabilise soils and banks to minimise erosion. Flood defences are also helping to reduce the current challenges by stabilising banks, although more may need to be done to address potential increased soil erosion and slope destabilisation in the future.

4.7 Risk of new and emerging pests and diseases and invasive non-native species affecting people and biodiversity

Increased temperatures are likely to lead to shifts in habitats and biodiversity that can result in the spread of pests and diseases, including those previously not seen in the UK. Kent's location at the South East corner of the UK, its busy ports, regular passenger and freight crossings to mainland Europe and other destinations worldwide mean that Kent has the potential to be affected first by invasive non-native species (INNS).

Milder winters can increase the ability for some pathogens to overwinter in the UK, while earlier springs will favour the growth of other species. Discussions with stakeholders revealed that there has been some evidence of pests, including the Asian tiger mosquito and Killer Shrimp in recent years. Forest pests and pathogens are also likely to increase in Kent, either through direct impact of climate on the abundance or distribution of species, or through the indirect effect of increased water stress.

There is limited information on the species and impacts of the INNS likely to colonise in Kent due to increasing temperatures as there are other factors involved in their propagation. However, previous examples of INNS colonisations indicate there will be an impact on native populations, other species and surrounding ecosystems.

As with the rest of the UK, more research is needed to understand the degree to which pests, diseases and INNS are likely to appear in the UK, the types of species and the necessary measures required to limit their impact.

5 Conclusions and Recommendations

Kent and Medway are already experiencing the effects of climate change, and hotter, drier summers, warmer, wetter winters and more frequent and severe extreme weather are more likely into the future. Development pressure, population growth, demographic change and economic drivers, coupled with geographical location and underlying geology mean that Kent is particularly vulnerable to current and future impacts of climate change.

Decisions made today will have lasting impacts on local populations, services, the natural environment, infrastructure and finances over the coming decades. Recent modelling suggests that the impacts of climate change will likely become increasingly severe over the next 30-80 years without significant, rapid action from all sectors and at a range of scales across the county. Key recommendations are:

- Undertake more in-depth research into localised and specific climate risks and impacts to build the evidence base, awareness and capacity to take action.
- Ensure projects, plans and processes have taken into account climate change and are resilient to climate risk in the long-term.
- Take action to reduce future financial costs – many studies show that adaptation is generally cheaper and more effective over time than the costs incurred responding to the impacts.
- Invest in cross-sector co-benefits – actions can deliver multiple wider benefits such as improving health and wellbeing, property values, skills and employment, reducing emissions and supporting biodiversity.

Proactive measures must be implemented to reduce the risks Kent and Medway face. These actions will need to include changes to economic, social and land management practices, in addition to transport, infrastructure and utilities provision. Local and regional strategies, policies and plans must reflect climate risks and the urgency of implementing appropriate measures to build resilience.

A cross-sector, holistic approach to adaptation that assesses, monitors and builds capacity to address climate risks will be needed. Key areas of focus for adaptation are:

- Corporate plans, policies and performance
- Economic development
- Natural capital
- Infrastructure
- Spatial planning
- Health and social care

There is a need for better research, strategic planning and co-ordination of adaptation across Kent and Medway to ensure measures are appropriate, robust and support pooling of resources to respond to climate risks. Failure to adapt will undermine the long-term viability and quality of life in the county. As a result of the CCRIA, Kent County Council will be leading on a Kent-wide adaptation programme to build the county's resilience to climate change over the next few years.

6 Appendices

A Abbreviations

AEP	Annual Exceedance Probability
ALC	Agricultural Land Classification
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
CCC	Committee on Climate Change
CCRA	Climate Change Risk Assessment
CCRIA	Climate Change Risk and Impact Assessment
CP	Control Period
CSF	Catchment Sensitive Farming
DfT	Department for Transport
DEFRA	Department for Environment, Food, and Rural Affairs
FDI	Foreign Direct Investment
FRAMES	Flood Resilient Areas by Multi-Layered Safety
GIF	Kent's Growth and Infrastructure Framework
HS1	High Speed 1 Rail Network
ICT	Information and Communications Technology
KES	Kent Environment Strategy
KCC	Kent County Council
KCC H&T	Kent County Council Highways and Transportation
KCHT	Kent Community Health NHS Foundation Trust
LCLIP	Local Climate Impacts Profile
LEP	Local Enterprise Partnerships
MENE	Natural England Monitoring Engagement with the Natural Environment
MFP	Medway Flood Partnership
NFM	Natural Flood Management
NE	Natural England
NIAB EMR	National Institute of Agricultural Botany East Malling Research
PFR	Property Flood Resilience
PHE	Public Health England
PRoW	Public Rights of Way
PTSD	Post-traumatic stress disorder
RCP	Representative Concentration Pathways
SAC	Special Area of Conservation
SME	Small and Medium Enterprises
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSSI	Site of Specific Scientific Interest
SWIMS	Severe Weather Impacts Monitoring System
SWOT	Strengths, Weaknesses, Opportunities and Threats
UKCCRA	UK Climate Change Risk Assessment
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
WATERR	Water Advisory Team for Efficient Resource Recovery
WRSE	Water Resources in the South East

B Definitions

Adaptation[6]
Involves changing the way we do things to prepare for the potential effects of climate change.

Annual exceedance probability (AEP)[7]
The probability of exceeding a specified flow or level in any year (inverse of the return period for an annual maximum series).

Catchment area[8]
The area drained by a river of body of water.

Climate Change[9]
Climate Change refers to a large-scale, long-term shift in the planet's weather patterns or average temperatures. See the UK Met Office's climate guide (http://www.metoffice.gov.uk/climate-guide) for further information.

Coastal change[10]
Can be defined as the physical change to the shoreline through erosion, coastal landslip, permanent inundation, or addition of shoreline.

Coastal erosion[11]
The removal of material from the coast by wave action, tidal currents and/or the activities of man, typically causing a landward retreat of the coastline.

Coastal/tidal flooding[12]
Occurs when coastal defences are unable to contain predicted high tides. Usually occurs when a high tide combines with a storm surge (created by high winds or very low atmospheric pressure).

Discharge (flow)[13]
The volume of water that passes through a channel cross section in a unit of time, normally expressed at cubic metres per second (m^3/s) in river design (often more simply referred to as 'flow').

Embankment[14]
An artificial, usually earthen, structure, constructed to prevent or control flooding, or for various other purposes including carrying roads and railways.

Estuary[15]
Bodies of water where rivers meet the sea.

Flash Flooding[16]
A type of river or surface water defined by rapid flooding of a low-lying area as a result of an intense heavy rainfall event typically lasting not more than a few hours.

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[6] Defra, 2016. 2010 to 2015 government policy: climate change adaptation. Available from: https://www.gov.uk/government/publications/2010-to-2015-government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation
[7] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[8] Kent County Council. 2016. Kent Environment Strategy: A Strategy for Environment, Health, and Economy. https://www.kent.gov.uk/__data/assets/pdf_file/0020/10676/KES_Final.pdf
[9] Ibid
[10] HM Government. 2011. UK Marine Policy statement. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf
[11] British Geological Survey. 2012. UK Geohazard Note: Coastal Erosion. https://www.bgs.ac.uk/downloads/start.cfm?id=2495
[12] Defra. 2011. Understanding the risks, empowering communities, building resilience: The national flood and coastal erosion risk management strategy for England. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf
[13] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[14] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[15] NOAA. 2018. What is an Estuary. https://oceanservice.noaa.gov/facts/estuary.html
[16] Archer, D.R. and Fowler, H.J. 2018. Characterising flash flood response to intense rainfall and impacts using historical information and gauged data in Britain. Journal of Flood Risk Management. 11(S1), pp.S121–S133.

Floodplain[17]
Area of land bordering a river which is partly or wholly covered with water during floods.

Flood Frequency[18]
The probability (as a percentage), that a flood of a given size will occur within a year (see AEP).

Flood risk[19]
A combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall, rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

Flood Storage Areas[20]
Areas that act as a balancing reservoir, storage basin or balancing pond. Their purpose is to attenuate an incoming flood peak to a flow level that can be accepted by a downstream channel.

Grey Literature[21]
Information that is not produced by commercial publishers. It includes research reports, working papers, conference proceedings, theses, preprints, white papers, and reports produced by government departments, academics, business and industry.

Groundwater Flooding[22]
Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable strata are particularly susceptible.

Hard Engineering[23]
A collective term for man-made structures – typically involving steel, masonry and concrete – that control or disrupt natural processes (see also 'soft engineering').

Interdependencies[24]
A situation where two or more people or things are dependent upon one another.

Invasive species[25]
An invasive species can be any kind of living organism that is not native to an ecosystem and causes harm. They can harm the environment, the economy, or even human health.

Lead Local Flood Authority (LLFA)[26]
Responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets (unitary authorities or county councils).

Local Enterprise Partnerships (LEPs)[27]
Business led partnerships between local authorities and local private sector businesses who play a role in determining local economic priorities and driving economic growth.

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[17] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[18] Environment Agency. 2018. Working with Natural Processes- Evidence directory. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
[19] HM Government. 2018. Planning Practice Guidance. https://www.gov.uk/government/collections/planning-practice-guidance
[20] Data.gov.uk. 2019. Flood Map for Planning (rivers and sea)- flood storage areas. https://data.gov.uk/dataset/cae4e24c-0342-48aa-8a93-d727ce582b3c/flood-map-for-planning-rivers-and-sea-flood-storage-areas
[21] University of Leeds. No date. Resource Guides, Grey Literature. https://library.leeds.ac.uk/info/1110/resource_guides/7/grey_literature
[22] Defra. 2011. Understanding the risks, empowering communities, building resilience: The national flood and coastal erosion risk management strategy for England. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf
[23] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[24] Oxford English Dictionary. https://en.oxforddictionaries.com/definition/interdependent
[25] The National Wildlife Federation. No date. Invasive Species. https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species
[26] https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities
[27] LEP Network. 2018. https://www.lepnetwork.net/about-leps/location-map/

Natural Flood Management (NFM)[28]
Involves techniques that aim to work with natural hydrological and morphological processes, features and characteristics to manage the sources and pathways of flood waters.

Ordinary watercourse
All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewers) and passages through which water flows and which does not form part of a main river.

Overtopping[29]
The passage of water over a defence such as a dyke or seawall due to high water levels or wave action.

Permeable[30]
A material or surface that allows liquids or gases to pass through it.

Property Flood Resilience (PFR)[31]
Property Flood Resilience measures are designed to make people and their property more resilient to the physical impacts of flooding.

Residual Risk[32]
The risk that remains after risk management and mitigation.

Resilience[33]
This is defined as the capacity to recover quickly from difficulties.

Return periods[34]
Average interval of time between events that equal or exceed a given magnitude. The use of the term 'return period' to express the probability of a flood is now often discouraged, as it can lead to confusion in the minds of the public. 'Annual exceedance probability' (AEP) is now the generally preferred means of expressing probability, 1% AEP being equivalent to a return period of 100 years.

Risk[35]
Measures the significance of a potential event in terms of likelihood and impact. In the context of the Civil Contingencies Act 2004, the events in question are emergencies.

River flooding[36]
A result of a river or stream overflowing its embankment as it cannot cope with the water draining into it from surrounding land and often increased levels of rainfall.

Runoff[37]
Overland flow produced by rainfall.

Saltwater Intrusion[38]

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[28] SEPA. 2016. Natural Flood Management handbook. https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
[29] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
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[32] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[33] Kent County Council. 2016. Kent Environment Strategy: A Strategy for Environment, Health, and Economy. https://www.kent.gov.uk/__data/assets/pdf_file/0020/10676/KES_Final.pdf
[34] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[35] Defra. 2011. Understanding the risks, empowering communities, building resilience: The national flood and coastal erosion risk management strategy for England. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf
[36] Centre for Flood Risk and Resilience, Brunel University London
[37] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[38] European Environment Agency. 2019. Saltwater Intrusion. https://www.eea.europa.eu/help/glossary/eea-glossary/saltwater-intrusion

Process by which an aquifer is over pumped creating a flow imbalance within an area that results in saltwater encroaching into fresh-water supply.

Sea Wall[39]
A wall or embankment erected to prevent the sea from encroaching on or eroding an area of land.

Sewer Flooding[40]
Flooding caused by a blockage or overflowing in a sewer or urban drainage system.

Shoreline Management Plan (SMP)[41]
A large-scale report, assessing the risks associated with coastal processes. It aims to reduce these risks to people, property and the historic and natural environment.

Soft Engineering[42]
The use of ecological and geomorphological principles and practices (for example to reduce erosion and stabilise channel banks), while enhancing habitat, improving aesthetics and reducing capital costs.

Subsidence[43]
The gradual caving in or sinking of an area of land.

Surface Water Flooding[44]
Surface water flooding occurs when heavy rainfall exceeds the capacity of the ground and local drainage networks. This can lead to water flowing across the ground and ponding in low-lying areas, which may be downstream, and it may not be obvious that one area is contributing to flooding elsewhere. This sort of flooding is typically caused by short, intense rainfall.

Sustainable Development[45]
The National Planning Policy Framework definition of sustainable development is: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is central to the economic, environmental and social success of the country and is the core principle underpinning planning.

Sustainable Urban Drainage Systems (SuDS)[46]
Sustainable urban drainage systems (SuDS) are a material consideration requirement in planning decisions as documented in the NPPF. SuDS aim to manage rainwater runoff in a natural way by replicating natural processes. Examples include green roofs; soakaways; ponds; wetlands; shallow ditches or swales, permeable pavement and underground storage areas.

Tidal/Storm Surge[47]
Abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide.

Topography[48]
The representation of a portion of the earth's surface showing natural and artificial features of a given locality such as rivers, streams, ditches, lakes, roads, buildings and variations in ground elevations.

Urbanisation[49]

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[39] Oxford English dictionary. 2019. Sea Wall. https://en.oxforddictionaries.com/definition/us/sea_wall
[40] Kent County Council. 2015. Ramsgate Surface Water Management plan- Glossary. https://www.kent.gov.uk/__data/assets/pdf_file/0005/49604/Ramsgate-SWMP-appendix-A-glossary-and-abbreviations.pdf
[41] HM Government. 2019. Shoreline Management plan. https://data.gov.uk/dataset/2f843faa-5296-484c-b580-38a8a3897c7b/shoreline-management-plan-smp-2
[42] Environment Agency. 2018. The Fluvial Design Guide- Glossary. http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Glossary.sflb.ashx
[43] NOAA. 2019. What is Subsidence? https://oceanservice.noaa.gov/facts/subsidence.html
[44] Kent County Council. 2016. Kent Environment Strategy: A Strategy for Environment, Health, and Economy. https://www.kent.gov.uk/__data/assets/pdf_file/0020/10676/KES_Final.pdf
[45] Ibid
[46] Ibid
[47] NOAA. Defining storm surge, Storm Tide, and Inundation. https://ocean.weather.gov/defining_storm_surge.pdf
[48] European Environment Agency. 2019. Topography. https://www.eea.europa.eu/archived/archived-content-water-topic/wise-help-centre/glossary-definitions/topography
[49] OECD. 2003. Glossary of Statistical terms. https://stats.oecd.org/glossary/detail.asp?ID=2819

An increase in the proportion of a population living in urban areas and the process by which many people become permanently concentrated in relatively small areas.

Vulnerability[50]
The capacity of an individual or group to anticipate, cope with, and recover from the impact of a hazard.

[50] IFRC. 2019. What is Vulnerability. https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/what-is-a-disaster/what-is-vulnerability/

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