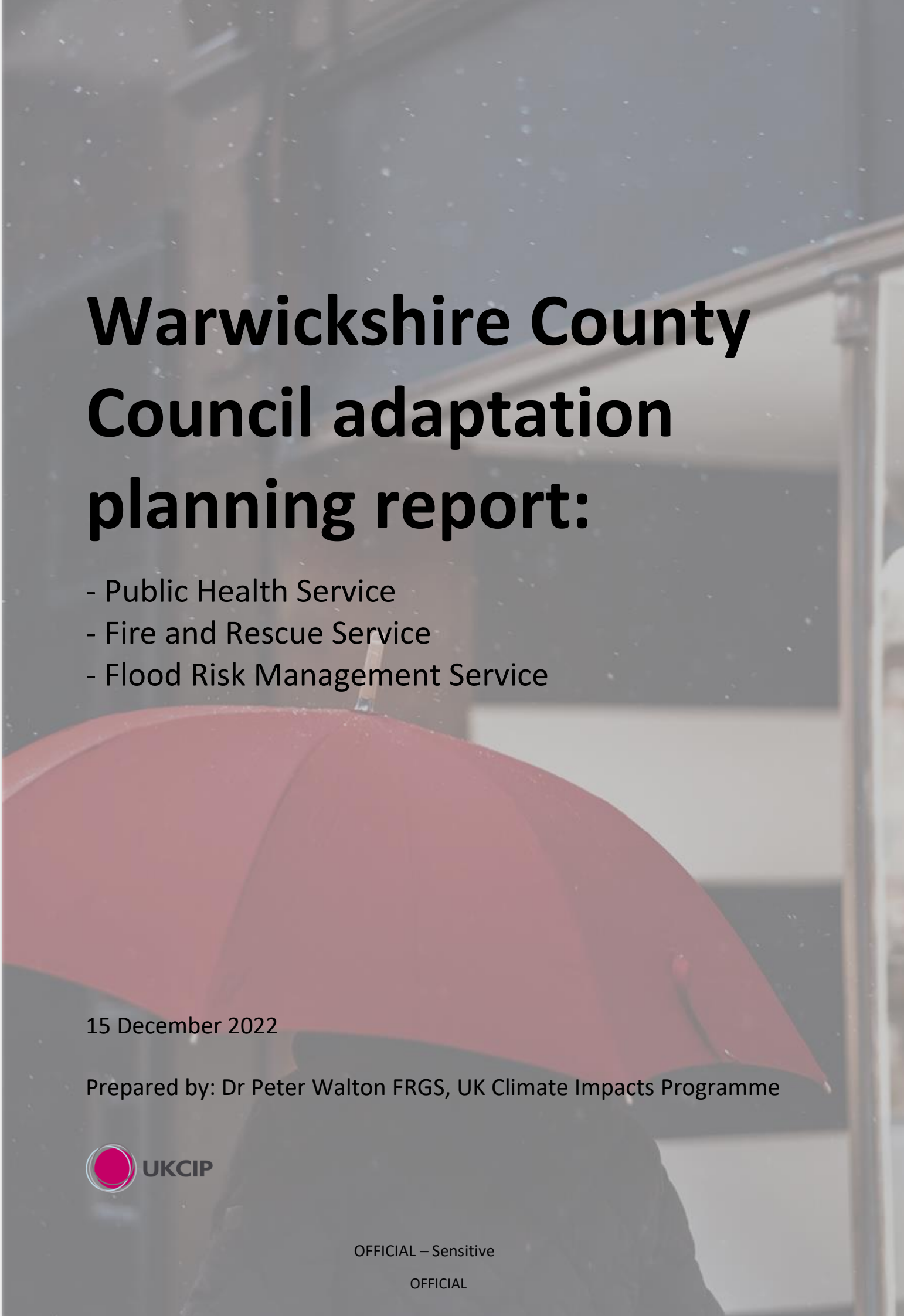


Warwickshire County Council adaptation planning report:

- Public Health Service
- Fire and Rescue Service
- Flood Risk Management Service

15 December 2022

Prepared by: Dr Peter Walton FRGS, UK Climate Impacts Programme

UKCIP

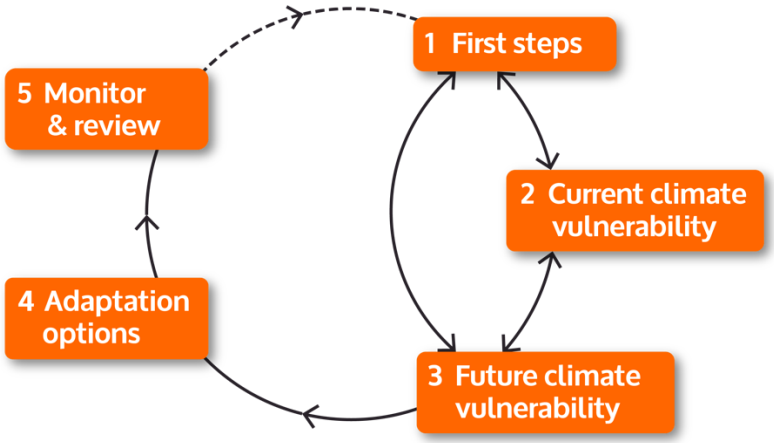
Introduction

As highlighted in the 2021 UK Climate Change Committee's Third Climate Change Risk Assessment, the UK is already experiencing the impacts of climate change, but we are ill-prepared to deal with them. Whilst the race to achieve net-zero is well-advanced, largely through the reduction in greenhouse gases such as carbon dioxide, our resilience to effects of climate change isn't. Regardless of how much mitigation takes place we will continue to experience these effects throughout this century. There is a pressing need to build resilience that is cost-effective, sustainable, and just. It is often the most vulnerable who are least able to cope with the impacts of climate change but are often the ones most affected by it.

Following an initial scoping study by the Local Partnerships and UK Climate Impacts Programme, three key council services were identified to have a further assessment: Public Health Service, Fire and Rescue Service, Flood Risk Management. To support the assessment process, a decision-making framework called the Adaptation Toolkit that has been developed for local authorities was used. The Adaptation Toolkit is a risk-based approach to adaptation planning that follows a 5-stage process as shown in the figure below.

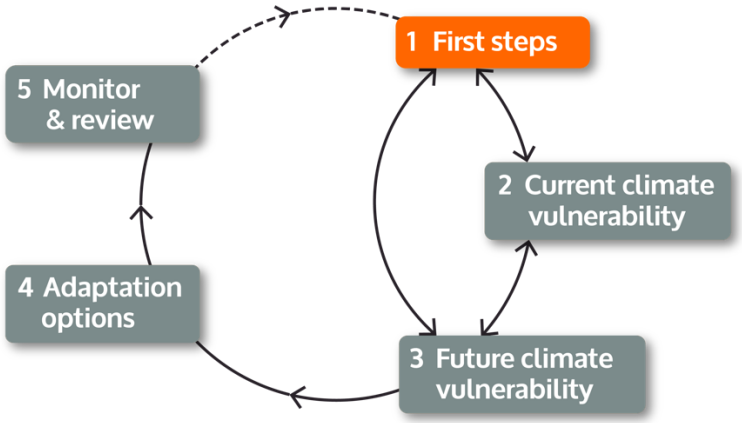
From establishing the parameters of the assessment, (including budget, scope, staff, timeframes) the process explores the service's current vulnerability to weather impacts before considering how this vulnerability might be affected by climate change. Options to adapt to these changing impacts are then explored with a view to identifying priority areas. Once the plan has been written it is important to monitor and review the information at each of the stages to ensure the information, data, processes, options etc.

This report details the findings for each stage of the toolkit for the 3 service areas.



Adaptation Toolkit (www.localpartnerships.org.uk/climate-adaptation/)

Stage 1: Getting Started



Stage 1 of the adaptation toolkit process sets in place the building blocks for the rest of the stages. These include considering

- Key organisational staff
- Important documentation
- Internal and external stakeholders
- Areas of responsibilities
- Organisational opportunities, barriers and constraints
- Services being impacted by climate change
- Service area priorities for the adaptation process

Aims and objectives
It is important that the aims and objectives of the adaptation planning process is agreed in order to define the scope, for example which service areas will be included, how the adaptation report relates to other corporate responsibilities. For this report, the aim of the process is to identify how climate change adaptation and mitigation can be embedded within all council service areas, both currently and in the future.

Stakeholders
A number of stakeholders were identified as being important to the delivery of the service provision that would be necessary to consider as part of any adaptation planning. The list is not meant to be exhaustive and, as such, it will be important to revise this list as an ongoing process to ensure that as many parties are engaged to ensure the services can deliver its operational functions. The public should also be seen as a key stakeholder group though engagement with them is largely through other council service areas or external agencies.

Documents
There will be key documents that inform the services remit and operational functions. These documents will be from internal council sources such as procurement processes, but also from external sources such as central government departments or agencies such as the UK Health Security Agency and the Environment Agency.

Climate literacy
When considering climate change adaptation it is important that all parties fully understand the terminology being used to avoid any confusion. A glossary of commonly used key terms and

concepts has been provided at the end of the report to help develop a coherent set of definitions that people following the Adaptation Toolkit can use.

Barriers and opportunities
Understanding any challenges and opportunities that could impact the planning process is important to guide the planning process. These will change over the period of the adaptation plan and will need monitoring as part of the stage 5 of the adaptation toolkit.

From initial workshops with the key service areas, staff from each of the service areas identified the following information that is relevant to the adaptation process for Warwickshire County Council.

1.1 Public Health Service

Stakeholders that were identified in the initial scoping workshop included:

- Commissioning colleagues
- Contract influencing
- Community hubs - VCS
- Building control
- Education and schools
- Warwickshire Fire and Rescue Service
- CQC - Quality assurance
- Procurement across all services
- Business intelligence for health impacts
- District Borough planning
- Environmental health
- Health and safety
- Housing
- Social care estate

Relevant documents:

- UK Health Security Agency strategies
- Faculty of Public Health strategies
- The Office for Health Improvement and Disparities
- NHS Integrated care systems sustainability strategy
- NHS Integrated care boards
- West Midlands Ambulance Service

Constraints:

- Staff turnover will affect continuity of service provision and impact institutional learning that can be important in implementing an adaptation plan. This will be the case for the Public Health Service with 2 key staff leaving, or having left, the service at time of writing.

Opportunities from the adaptation planning process:

- Articulating health impacts of climate change and communities most at risk to help prioritise adaptation projects - health inequalities.
- Work with regional and national UKHSA/FPH on understanding and implementing evidence based public health action including communicable diseases.
- Working commissioning colleagues on how we articulate risks to service teams and influence contracts in terms of adaptation expectations. NHS/LA estates but not just people services.

Consider other agencies who have information on building design in relation to human health such as RIBA
- Heatwave and cold weather alerts - can we strengthen this?
- Stakeholder and public communications.
- Influence and advocate among partners
- Take appropriate public action related to communicable disease control linked to changing climate.
- Air quality and fuel poverty can be both mitigation and adaptation.
- Share good practice with other local authority areas

1.2 Warwickshire Fire and Rescue Service

Stakeholders that were identified in the initial scoping workshop included:

- Portfolio Management Office
- Procurement and contracts dept.
- Senior Council Officers
- Public Health Dept.
- Local community, in particular those considered vulnerable (it will be helpful to understand who the vulnerable groups in the community are and where they are in the county)
- Environmental Agency
- Local Resilience Forum [LRF]
- Health and Safety committee meetings with representative bodies
- UK Building Standards Agency
- National Volunteers Council
- Land owners in particular famers
- National Fire Chiefs Council [Ben Brook]

Relevant documents:

- Risk register is seen as the most fundamental document in this process.
- Climate is already identified as one of the hazard groups

(It will be useful to know which climate hazards are already included)

- They want to include flooding into this group
- They hope that this project can help them expand that hazard group
- They have a responsibility for developing and maintaining the community risk management plan.
- Recently launched their strategy for the next five to six years, which will go out for a forthcoming consultation to the public.
- States that we embed environmental and climate change considerations into everything they do.
- This will get used for service review purposes by senior managers.
- it is being applied already as part of their assurance framework.

Challenges:

- There is a lack of wider infrastructure to be able to fully implement potential adaptation and mitigation strategies. For example, the fleet replacement strategy doesn't have access to charging points if they want to convert to electric vehicles.
- They have a good idea awareness of the general issues, but without knowing how they're playing out within more detailed areas.
- Water availability is a critical factor when it comes to putting out fires. There is also the problem of reducing the amount of hydrants within the local area and dramatically reducing the flow to those hydrants.

- Reducing the size of water capacity on new fire appliances to reduce weight and save co2 emissions.
- National policy informs what is happening on the regional level, and often they have to wait for national policy before they can implement their own.

Opportunities:

- Working with the National Volunteers Council they can make some rapid changes with the messages they deliver that can be the first step in the overarching strategies. And there are some very, very quick wins to start changing our practices immediately.
- Chance to inform local communities through simple messaging about fire prevention. This can be facilitated through community events by 'planting a seed in people's minds to change their attitude towards things'.
- Expanding the hazard group for climate within our risk analysis.
- This acts as a key driver for risk analysis that in turn drives the allocation arrangement of resources.
- There is an opportunity to help people make connections between their actions and the impacts.
- The climate change impact of an event could be captured as part of the debrief session after an incident.
- R.E.P.S. (risk, ethics, people and sustainability) is a big cultural shift for fire. And it is a very different way of thinking. And even if it's not in line, I think it has some value just because it's, it's that tool to make us think and work differently. And there will be advantages from that.
- I think we'll be linking in with the LRF a lot more as well to identify kind of what the risks are for different partners as well.
- Opportunity to leverage specific funds to help overcome climate hazards
- Develop more of a partner agency approach.

Further information:

- Approach has 3 levels: prevention, protect response
- R.E.P.S. help sustainable development and planning
- Climate change already forms part of their risk analysis
- Contingency plan on developing stations and departments across the service.
- Currently working on a project to enhance our power resilience. What the impact would be if the power went out, and how would they manage to operate the appliances and charging equipment?
- Prevention services have a lot of issues with hoarders, which has a wider environmental risk to the local community. For example, members of the public who hoard old newspapers in their homes rather than disposing of them creates a health and fire risk.
- Closely linked to mental health and, therefore, the public health service. Mental health population seen as high-risk groups
- Prevention is seen as the primary goal in the risk hierarchy that adopts a person-centred concept.
- As part of the Local Resilience Forum there is an opportunity to draw on their risk register and work with the other first responders to develop a cohesive adaptation plan.
- The service hasn't currently been asked to address climate change mitigation and emissions reduction.
- On occasions the fire crews would choose to let a fire burn, because if they attack the fire, it has a significant impact on the environment because of water runoff.

1.3 Flood Risk Management Service (and Highways)

Stakeholders:
Stakeholders that were identified in the initial scoping workshop included:

- Warwickshire County Council Design services
- County Highways
- Coventry, Solihull, Warwickshire resilience team
- Warwickshire Fire and Rescue Service
- Warwickshire County Council Ecology, Historic Environment & Landscape
- Environment Agency
- Local riparian landowners
- Severn Trent Water
- Central Government for legislation (see 'relevant documents' below)
- 6 Local planning authorities (our D&B's + County planning)

Relevant Documents:

- Flood and Water Management Act 2010 (Schedule 3)
- Highways Act 1980 (Section 38 & Section 278)
- Local flood risk management strategy [under review]
- Surface water management plan [under review]
- Highway design guide
- Strategic flood risk assessment [under review]
- EA FCERM strategy [national consultation]
- The Flood Risk Management Overview and Scrutiny Committee (England) Regulations [draft in process]

Constraints:

- Service doesn't hold any assets or own any assets or have responsibility for any assets.
- They have powers to 'encourage' land owners to take some action, but a lot of it comes down to the relationship with the stakeholders.
- The procurement process is a fundamental part of their supply chain. Whilst this can be seen as a constraint it can also be seen as an opportunity to influence contracts to include adaptation to identified climate risks.

Opportunities:

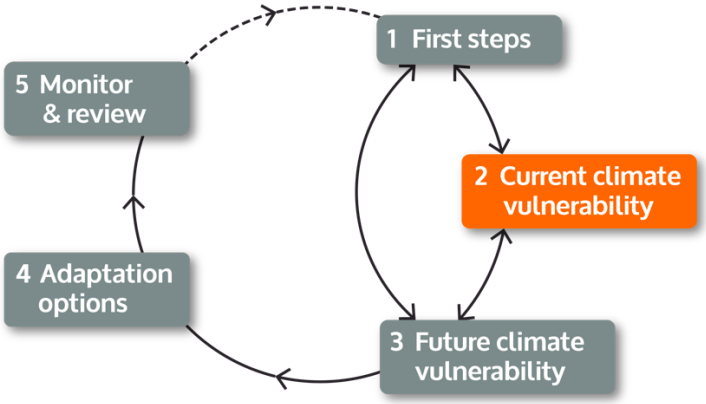
- There is an opportunity to develop and build on already positive relationships with the council's ecology team.
- This could be in terms supporting biodiversity net gain and helping inform and influence new developments in relation to biodiversity as well as surface water.

Further information:

- Principle responsibilities are in managing flooding and surface water
- Current planning tends to be more reactive than looking to future resilience though this is hoping to change with new strategy.
- They have a small capital programme to support vulnerable communities
- There is an interest to do more engagement with land management groups
- Not much work is currently done with farmers regarding surface water run off but there are other partners that do.

- Working with active self-organised volunteer groups such as SAFAG (Shipston Area Flood Action Group)
- Hayley Deighton from Shropshire County Council is the Programme Manager for the River Severn Partnership (RSP), WCC FRM are one of the partners.
- Stephen Lawrence from the Environment Agency is Programme Manager on one of the Adaptive Planning Pilot projects that include The Thames, The Humber, South Yorkshire, Shropshire. WCC FRM feed into this.
- Often decision-making is siloed which the RSP is looking to address. They are also looking at new funding models to support greater collaborations between actors and agencies.
- Birmingham City University are looking to develop a 'benefits tool' that will be useful in evaluating future adaptation projects. This is still in the feasibility stage so will not be available anytime soon.

Stage 2: Assessing current vulnerabilities



The purpose of stage 2 of the Adaptation Toolkit is to understand the service area's current vulnerability to weather events. By identifying where the current vulnerabilities exist it is possible to understand how the risk could be affected by climate change as part of stage 3 of the adaptation process. Where possible, service responses to weather events have been included in the report. However, there are a number of gaps in the data collected and provided that can be considered important in assessing adaptation options. These data gaps can be addressed in stage 5 of the toolkit, when considering the monitoring and evaluation process. The response to major flooding incidences are recorded in S19 reports providing an excellent source of information. Warwickshire Fire and Rescue Service have a post-incident review process that could be used to identify how well the service responded to those incidences directly related to a weather event.

2.1 Public Health Service

In relation to climate change, heatwaves can be considered the biggest threat to human health in Warwickshire. Often described as a silent killer, it can also lead to other impacts such as breathing difficulties, heat stress, lack of sleep, and severe dehydration. A fundamental challenge in addressing heatwaves is that there are many ways to define them. The UK Heath Security Agency (UKHSA) in their Heatwave Action Plan uses a trigger of daily maximum temperature exceeding 30°C, whilst the UK Met Office the definition of, 'threshold is met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold'. The temperature threshold varies according to the county, for Warwickshire this is 27°C.

When linking excess deaths due to exposure to heatwaves, the UKHSA uses different definitions stating that, 'a heatwave period for the purpose of excess death estimation was previously defined as:

- days on which there was a Met Office defined Level-3 heatwave alert
- days with a mean Central England Temperature greater than 20°C

There are also difficulties in associating health conditions with extreme heat as often there are multiple factors such as housing, education, diet etc.

The Warwickshire Public Health Service operates under the UK Health Security Agency (UKHSA) guidelines that publish its guidance in the Heatwave Plan for England report, updated in July 2022. The heat health alert system operates a 4 level structure with levels 1 and 2 providing guidance on being prepared for high temperatures in each region. Level 3 (Amber) triggers an alert that a heatwave is forecast and that action needs to be taken. This stage requires social and healthcare services to target specific actions at high-risk groups. Level 4 (Red) triggers an alert that the advent of a heatwave can be seen as a national emergency where, 'Reached when a heatwave is so severe and/or prolonged that its effects extend outside the health and social care system. At this level, illness and death may occur among the fit and healthy, and not just in high-risk groups.' A level 4 national emergency for heatwaves was issued for the first time in 2022.

For the West Midlands region, the UKHSA identify a threshold of a maximum daytime temperature of 30°C and a minimum night time temperature of 15°C for 2 consecutive days.

One of the challenges in looking at weather impacts on the Public Health Service is access to data. The majority of the work that the service does is commissioned to outside agencies, or is in collaboration with other health care providers in the region such as GP surgeries, Hospitals, and social care.

For the purposes of this assessment the UKHSA's annual 'Heatwave mortality monitoring reports' were used to identify excess deaths. The data is provided on a regional scale rather than a county level that would be more appropriate to understand impacts of extreme heat on the service. The data can be used though to show links in the region between extreme heat and excess deaths and the trend of recent years.

Observed weather data (daily maximum temperature) was accessed using the Climate Explorer portal which is managed by the Dutch Met Office as part of the World Meteorological Organization's open access to weather station data. Temperature, unlike precipitation, does not vary across a region as much as rain fall does and so it is possible to use the weather station at Wellesbourne to understand the temperature across the county. Urban Heat Island effect will be a factor in larger settlements often increasing temperatures by several degrees compared to the surrounding area. Station data from these sorts of locations have not been accessed. A number of factors will cause the urban heat island effect such as size of settlement, density of the building, types of surfaces, waterways, and parklands. These factors can either cause heat to be produced or trapped causing heating or reduce heating effects by cooling the air. For example, poorly insulated buildings that are densely built will lead to a heat leaking out of the buildings and being trapped in the narrower streets. However, settlements with wide streets, even if the buildings lose heat, will have air flow that can disperse the heat reducing the likelihood of build-up of heat. The heating effect will not be uniform across a whole settlement making it necessary to look in more detail at affected areas in relation to vulnerable populations and infrastructure. It has been noted that settlements with as few as 1000 people can exhibit the effects of urban heat island depending on the combination of the

factors noted earlier. In Warwickshire, therefore, it is likely that settlements such as Nuneaton, Rugby and Warwick (amongst others) will be warmer.

One of the trade-offs with urban heat islands, is that whilst it can cause difficulties during summer months, it can have a benefit during winter months where the settlement could be warmer than surrounding areas. This aspect, however, should be considered with caution. The following table shows the number of heat waves in Warwickshire since 2017.

Dates	**Max Temperature range °C**	**Min Temperature °C range**	**Impact across West Midlands (Excess deaths)**
17- 22 July 2021	27.8 - 31.3	14 – 18.9	312
30-31 July 2020 7-11 August 2020	28.2 - 35.1	13.5 – 17.9	280
29 June 2019 22-25 July 2019	33 28-36.5	12.5 15 – 18.6	See below
25 June-9 July 2018 14-16 July 2018 22- 27 July 2018 2-7 August 2018	26.5-30.7 27.9 – 28.3 28.5-32.4 27.8 – 30.2	10.8-17.7 14 – 14.9 15.3 – 18.5 14.2 – 16.4	53 48 See below
17-21 June 2017 5-9 July 2017	29.3-32.5 26.2-32.2	13.2-17.8 12.1-17.8	134 43

2019

Whilst the UK officially recorded 3 heatwaves in 2019 (28 June to 30 June 2019), (21 July to 28 July 2019), (23 August to 29 August 2019), Warwickshire only experienced heat over 30°C that would trigger an Amber alert for 2 of those periods.

Impacts: The regional data for excess deaths in the West Midlands has a large amount of uncertainty associated with it. This is due to the statistical process the UKHSA uses to quantify excess deaths due to heatwaves. It may be possible to work directly with regional health care providers to capture the data locally rather than using a central health agency.

2018

England observed 4 heatwave periods in 2018 with significant excess mortality impact in the 65+ year olds observed at a national level during the first 3 heatwaves only and at a regional level during all 4 heatwaves with significant excess observed in the West Midlands during heatwave 1. In the West Midlands the excess deaths for heatwaves 3 and 4 are statistically ambiguous.

Impacts on the Public Health Service

In addition to the population being affected by heatwaves through increased mortality and health issues, the county's Public Health Service is also impacted through the increase in administration in alerting health care providers of the change in risk. The process involves both dissemination of information and dealing with enquiries from other council service areas and externally such as care home providers and schools. For example, in the heatwave of 2022, the Public Health Service was approached by the county's Waste Management Team to ask how they could keep their workers safe when outdoors collecting waste, whilst Warwickshire had 2 official school closures and 10 unofficial school closures, as well as a fire close to another school.

In addition to directly responding to amber alerts for heatwaves, the service also works proactively on health campaigns prior to the warnings being issued. In 2022, this involved developing 4 videos to cover key topics that would be used on Instagram and Snapchat; A range of social media messages with still images; and a press release and internal articles about the campaign. The wellness page was also updated under the 'you may be interested in' list to also link in with the other campaigns and webpages. These were produced in conjunction with the county's Resource Directorate.

2.2 Warwickshire Fire and Rescue Service

The assessment of the service's current vulnerability to weather events is drawn from reports from the control centre detailing call outs for a range of incidences between the period 2017 to 2021:

- Flooding
- Water Rescues
- Water Incidences (Not rescues or flooding)
- Small fires
- Road Traffic Collisions (RTC)

To help understand the relationship between call outs and weather events a range of meteorological data sources were used that provide information on a range of scales. The sources include:

- Met Office climate summaries provide an annual, seasonal and monthly report on weather patterns across the UK. These can provide a useful overview of weather patterns particularly those major events such as impactful storms and extreme weather. The summaries highlight notable events at the regional level with some information on specific locations where records might have been broken or extreme anomalies exceeded. However, in relation to flooding events understanding where the rain falls, over what period and what the antecedent conditions were like these can only be used as a guide.
- Precipitation levels from the Wellesbourne weather station data was used to identify high impact events. Whilst these are more specific to Warwickshire, as with the Met Office climate summaries, they can still only be used as a guide. Observational data was accessed through Climate Explorer, an online portal managed by the Dutch Met Office as part of the World Meteorological Organization's programme on providing observational weather data.

These can be associated with likely weather events including heavy rainfall leading to localised surface water flooding, more extensive flooding due to water courses over topping, extended periods of low rainfall leading to drought conditions, higher temperatures associated with heat waves, high winds and snow/ice events.

These conditions can lead to impacts such as vehicles trapped by flood waters, water ingress in buildings, small fires, road traffic collisions, swimming incidences, damage to buildings.

The following table highlights the significant incidences regarding the impact of weather events on call outs for WFRS during the period 2017 – 2021. An estimated cost has been provided for these events based on the working figure of £400 for a 'unit' (Fire engine and crew) to attend. The working assumption is for 1 unit to attend each incident when, in reality, multiple units may have been in attendance. The costs do not extend beyond the unit being in attendance, however, other costs including service and council reputation, days lost through stress or ill-health, support staff etc. would mean the actual figure per call out is much higher. There would also have been a requirement to call on neighbouring Fire and Rescue Services to support attendance at incidences if WFRS were

unable to meet demand. The call out figures do not include incidences where WFRS crews were called out to support areas outside of the County.

Date(s)	Extreme Event	Impact(s)	Event Cost (£400/unit)	Av. Call outs/year (Baseline)*	Av. Cost for same period (baseline) (£400/unit)**
1-20 Mar 2018	Heavy snow and winds ('Beast from the East')	21 call outs for Road Traffic Collisions	8,400	10	4,000
1-6 Mar 2018	Heavy rain	29 call outs for building flooding	11,600	<1	<400
27 May 2018	Thunderstorms leading to Heavy rainfall	13 call outs for building floods	5,200	0	0
1 June – 27 July 2018	<1mm of rainfall recorded at Wellesbourne leading to drought conditions coupled with the second warmest July since 1910	241 call outs for small fires	96,400	84	33,600
25-26 Oct 2019	Heavy rain falling on already saturated land	10 call outs for building floods	4,000	<1	<400
14-15 Nov 2019	Heavy rain falling on already saturated land	13 call outs for building floods 24 call outs for vehicle rescues from the floods	14,800	<1 building floods 0 call outs for vehicle rescues	<400
7 – 12 Feb 2020	Storm Ciara – High winds and rain	8 call outs for RTC	3,200	~5	2,000
15-23 Feb 2020	Storm Dennis – High Winds and rain	13 call outs for RTC	5,200	~4	1,600

*This column shows the average number of call outs for the same period between 2017-2021, excluding the year in question.
** This column shows the average cost of call outs for the same period between 2017 – 2021 excluding the year in question. The assumed call out rate is £400 per unit with one unit attending each incident.

Flooding:
Flooding events can be seen to have a direct correlation with weather in that they are as a direct result of heavy rainfall. Whilst it can be seen that flood impacts are precipitated by a particular weather event, there are other factors that can cause an impact to occur beyond just a certain volume of rainfall. Such factors can include:

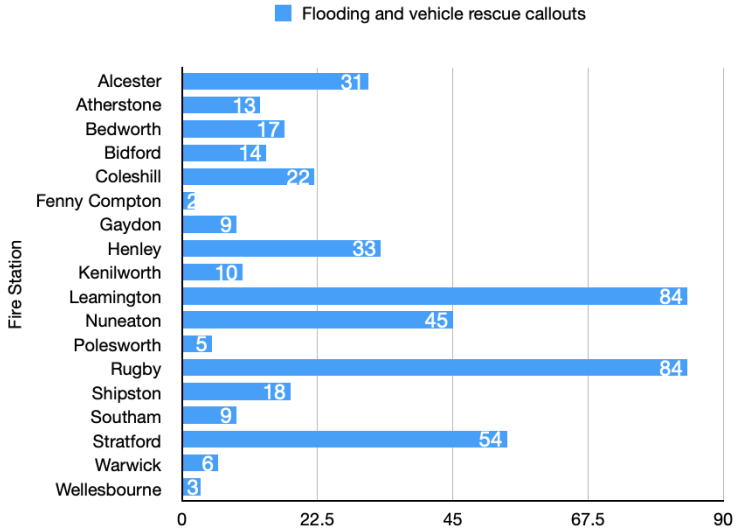
- Topography
- Surface type
- Intensity and duration of rainfall
- Antecedent conditions
- Environmental factors such as landuse
- Existing water management practices and their maintenance.

In the period 2017 – 2021:

- 351 total number of call outs to flooding events.
- 76 total number of water rescues of vehicles

At an estimated cost of £400 per unit for each call out, flooding events would have cost Warwickshire County Council's fire and rescue service £170,800.

The service was not equally impacted across the county as seen in the table below. The Leamington and Rugby stations received the majority of call outs in this period for flood-related events, with 84 call outs each. Stratford and Nuneaton also received higher levels of call outs than other stations, whilst Fenny Compton, Polesworth and Wellesbourne were impacted the least by flooding events requiring Fire and Rescue attendance. The following table shows the impact of the flooding and vehicle rescue callouts for each station across the county. As can be seen, stations at Leamington and Rugby have been most affected, with Stratford and Nuneaton also impacted but not quite as severely.



Road Traffic Collisions:
The data for the road traffic collision call outs do not identify if the cause of the collision was weather-related and so proxy indicators as to their cause need to be considered. Access to observed weather data for Warwickshire is not possible for snow, ice or fog that could directly impact traffic collisions. Met Office weather warnings and monthly weather summaries can provide indicators of weather patterns though these are not always specific to Warwickshire. High winds bringing down

trees, or tree debris such as branches could also contribute to road accidents requiring assistance, though again it is not possible to directly attribute these impacts from the call out records.

Small fires:
As with other call out records the impact of weather events is not noted and so conclusions need to be drawn from other information. There appears to be no correlation between high temperatures and small fire call outs which can be considered surprising. What appears to be more significant is the extent to which drought conditions prevail causing vegetation to die back. Extreme heat will be a factor in causing drought conditions though it is the level of rainfall that appears to be the biggest influence.

It could be that extreme temperatures caused building fires through the combustion of materials such as paper or chemicals, however, the causes of the building fires do not appear to be captured and so this assumption cannot be confirmed.

Lightning strikes:
It would be interesting to identify if lightning strikes currently have an impact in starting fires in the county, particularly in the summer during periods of drought and thunderstorms triggered by convection storms. Whilst call out logs show if the small fires were deliberate or otherwise, they do not distinguish what 'natural' causes might have started the fire.

Of interest:
In addition to the observations above, there are a number of other points of interest that can be drawn from the data. These include:

- 22-25 July 2019 was a period of high temperatures in the UK though there were few small fire call outs suggesting a stronger impact of drought conditions on fires rather than high temperatures on their own. Call out records show relatively few small fire incidences compared to other years.
- Storm Ciara (8-12 February 2020) caused widespread damage in England but there was no significant increase in call outs for flood events in this period.
- Storm Dennis (15-23 February 2020) also caused similar damage but again there was no increase in call outs for flooding in this period. Given the saturated soil and swollen rivers from a wet start to the year this is more surprising.
- In 2021 the Met Office recorded snow in January and February, high temperatures in July and heavy rain in October, however, these did not result in any significant increase in call outs.
-

2.3 Flood Risk Management Service

Whilst it can be seen that flood impacts are precipitated by a particular weather event, there are other factors that can cause an impact to occur beyond just a certain volume of rainfall. Such factors can include:

- Topography
- Surface type
- Intensity and duration of rainfall
- Antecedent conditions
- Environmental factors such as landuse
- Existing water management practices and their maintenance.

The Flood Risk Management team collated the total number of reports of flooding events in the period 2016 to 2021. Data was largely 'anonymised' so that specific locations could not be identified

though postcodes and council regions were provided to give some indication of where events were happening. It should be acknowledged that the records may not be entirely accurate or complete as it is a record of information provided to the team by others regarding flooding. Data is available outside of the period 2016 to 2021, however, 2016 was chosen to reflect the time in which WCC began recording flood information itself in a more comprehensive way.

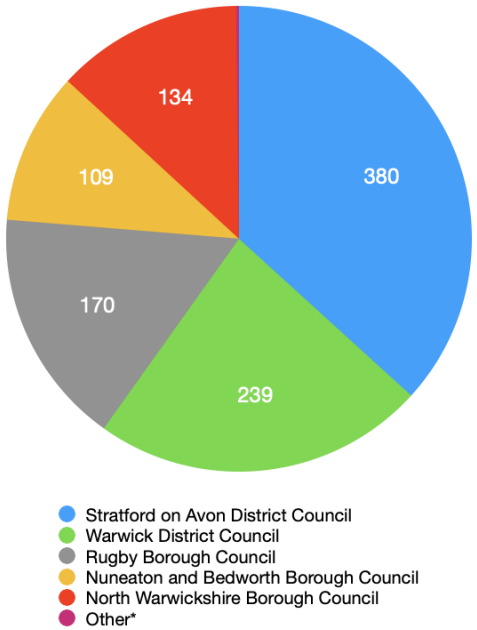
Weather data:

- Met Office climate summaries provide an annual, seasonal and monthly report on weather patterns across the UK. These can provide a useful overview of weather patterns particularly those major events such as impactful storms and extreme weather. The summaries highlight notable events at the regional level with some information on specific locations where records might have been broken or extreme anomalies exceeded. However, given the importance of where the rain falls and for how long these can only be used as a guide.
- Precipitation levels from the Wellesbourne weather station data was used to identify high impact events. Whilst these are more specific to Warwickshire, as with the Met Office climate summaries, they can still only be used as a guide.
- Satellite Radar data provides more geographically specific information.

Total reports for flooding incidences

From 2016 to 2021 there were 1034 reports of flooding, where a report is a single call, email or media coverage of flooding that is then logged in FRM records. This can be from the public or partners (internal and external.

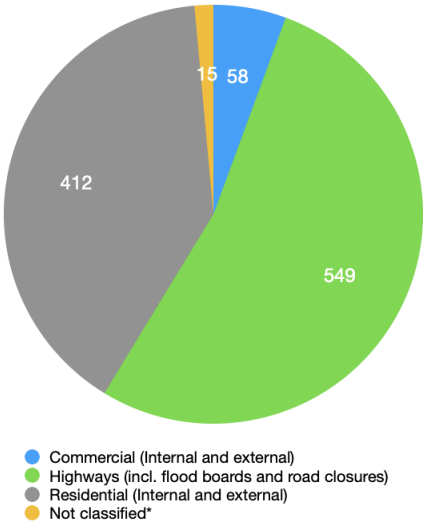
From the data of incident reports, it is only possible to identify flooding in relation to District and Borough Council levels. There are also a number of incidences that have been reported that have locations identified by street but without indicating where they were in the county. The following graph shows the total number of reports by council districts during the period 2016 - 2021:



*No location was recorded (n=2)

Impacts

The impacts from flooding events in the county can be broken down into the following areas:



* The extent of the flooding was not recorded

NB: Commercial/Residential internal and external flooding refers to whether the flooding was reported inside of the building or if it flooded the outside of the property. Flood boards are put out on highways to warn where flooding has occurred on a highway.

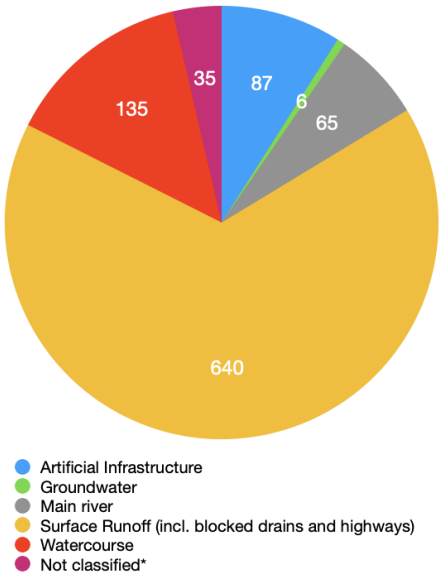
Impacts on critical infrastructure
The following table highlights significant flooding events that correlate periods of high rainfall.

Date	**Number of reports***	**Critical infrastructure Impact**	**Location of Critical impacts (rainfall per location where identified)**
8 Feb 2016	31 reports	Business closed for 2 weeks	CV11
9 March 2016	122 reports 63 surface water run off 59 water course	Primary and secondary schools closed STW Foul pumping station failed	B49 (19.2mm) and B95 (17.6mm), CV35(17.8mm), CV36 (32mm), CV37 (21mm), CV47 (15.9mm)
26 October 2019	25 Reports 7 River flooding 18 Surface run off	Road and rail impacted	Rugby Borough Council (No specific locations identified)
14 November 2019	253 incidences of flooding from surface run off 48 water courses	3 schools closed	>30mm
16-18 August 2020	77 total reports 42 surface water runoff	Electrical Sub Station	A429 Wellesbourne
3-8 July 2021	Total 58 reports Flooding caused through intense thunderstorm rainfall.	Police station	Rother Street, Stratford (24.8mm)

* A report is a single call, email or media coverage of flooding that is then logged in FRM records. This can be from the public or partners (internal and external).

Whilst in February 2020 Storm Ciara and Storm Dennis had significant impact across the UK there were no significant events of surface run off or water course flooding for Storm Ciara and 30 reports for Storm Dennis. It should be noted that neither of these storms have been studied to understand if they were made more likely or more intense as a result of climate change. However, we can anticipate that with climate change we can expect storms like these to increase in intensity though not necessarily in frequency.

Source of flooding
The sources of flooding incidences were reported to be from the following areas:



*Source of flooding was not recorded

NB: Main Rivers are watercourses marked as such on a main river map. Generally main rivers are larger streams or rivers, but can be smaller watercourses. Main Rivers are determined by Defra in England, and the Environment Agency has legal responsibility for them. An ordinary watercourse is any river, stream, ditch, cut, sluice, dyke or non-public sewer which is not a Main River. The local authority or Internal Drainage Board has powers for such watercourses.

14 November 2019
Further details can be found on this incident in the Section 19 Flood Investigation
Flooding 14/15 November 2019 (currently in draft)

Costs
*Direct costs to the service have been calculated as being:

- **An average of 1.2 FTE per year of FRM time to manage the reporting of floods events.
- In addition, approximately £40,000 p.a. (average) spend on survey work, minor civils works, culvert jetting, remediation etc. is needed.
- These costs only reflect those for the FRM service and do not include costs associated with other service areas.

*Data used to determine these values was taken from a period of time where Warwickshire was not widely affected by flooding as in some other areas of the country. And therefore, costs could be significantly underestimated.

** It should be noted that the average does not reflect the 'peaks and troughs' that resourcing flood events demands from the team, with typically 5 to 10 FRM staff pulled to these activities in significant flood events.
NB: These calculations, when applied to more frequent or widespread events, will increase the cost and resource requirements significantly.

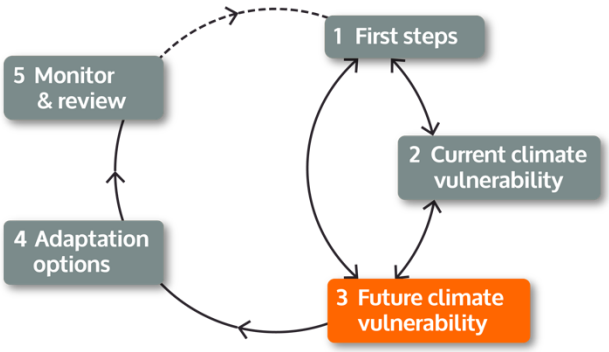
Additional impacts:
Whilst not all impacts can be directly measured in terms of costs, impacts on the service can manifest themselves in other ways. These have included:

- Additional stress and fatigue
- Needing to balance "business-as-usual" workload with flood response
- Responding to angry/distraught/upset flooded residents
- We do not have a duty role, but support/respond on a best endeavours basis.
- Can involve working outside of your normal working pattern

Section 19 incidences:
As required by Section 19 of the Flood & Water Management Act 2010, Warwickshire County Council (WCC) as Lead Local Flood Authority (LLFA) has a duty to investigate flooding where the appropriate thresholds have been met:

1. Flooding that poses a threat to the safety of the public or may directly result in serious injury or death.
2. Five or more residential properties internally flooded.
3. Two or more commercial properties internally flooded.
4. One or more piece of critical infrastructure affected that impact on the wider area.
5. Flooding that place vulnerable individuals or vulnerable communities at risk e.g. hospitals, care and nursing homes, schools, secure units, etc.
6. Additionally, where one or more residential property has flooded internally from the same source on five or more occasions within the last five years.

Stage 3 Understanding future vulnerability to climate change impacts



Stage 3 of the adaptation toolkit explores the changing risk of these events happening, particularly in the near-future when most planning decisions are based on. In addition, the UK's 3rd Climate Change Risk Assessment (CCRA3) identified a range of hazards and their risk that need consideration for future adaptation planning. The report is high level and does not distinguish sub-national impacts, nor the time period that they can be expected to occur. However, they can be used as a useful indicator for planning in Warwickshire. In particular, the CCRA3 report stated that: "The risk of flooding to people, communities and buildings is one of the most severe climate hazards for the population, both now and in the future. Most of the present and future flood risk is in England, given

its larger population. Risk of flooding from rivers is the dominant source, but surface water flood risk accounts for a greater number of properties at risk."

The 2018 UK Climate Projections show that we can expect to experience warmer, wetter winters and hotter, drier summers with increased frequency and intensity of extreme weather events such as heatwaves, droughts and heavy rainfall.

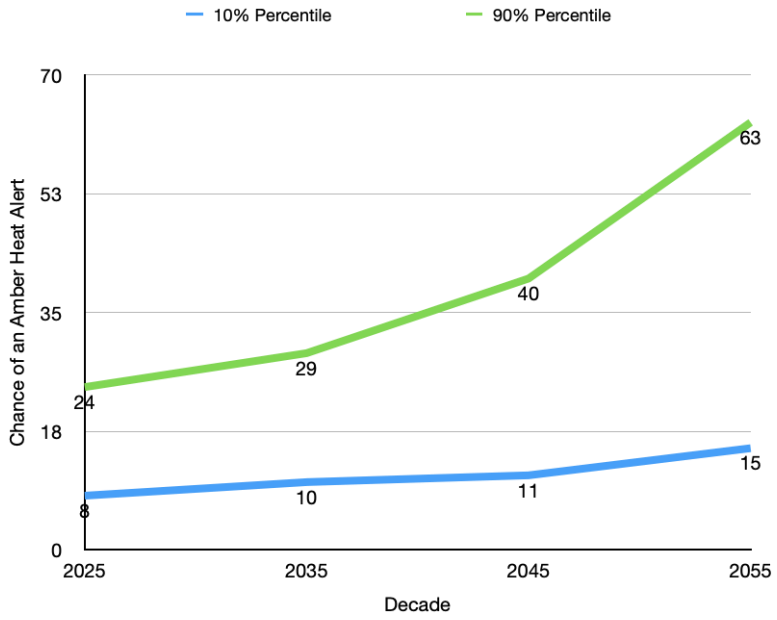
Detailed below are the changing risks of key events that are seen to already affect the three service areas. Data is drawn from the UK Climate Projections 2018 and from the recently developed UK Climate Risk indicators.

Data are based on using the RCP 6.0 which is considered a higher emission scenario but one that is most closely representative of the global emissions pathway we are on. However, when considering decision-making (between now and the middle of the century) the emission pathways are closely aligned and so the values would not change significantly of a different emission pathway was chosen.

The graphs show the full range of likely values (10th to 90th percentile) with the darker line showing the 50th percentile (median value). The likely values can be understood to mean that it is likely to be above the 10th percentile number and lower than the 90th percentile. For the median 50th percentile it is as likely to be above as below that number.

3.1 Public Health Service

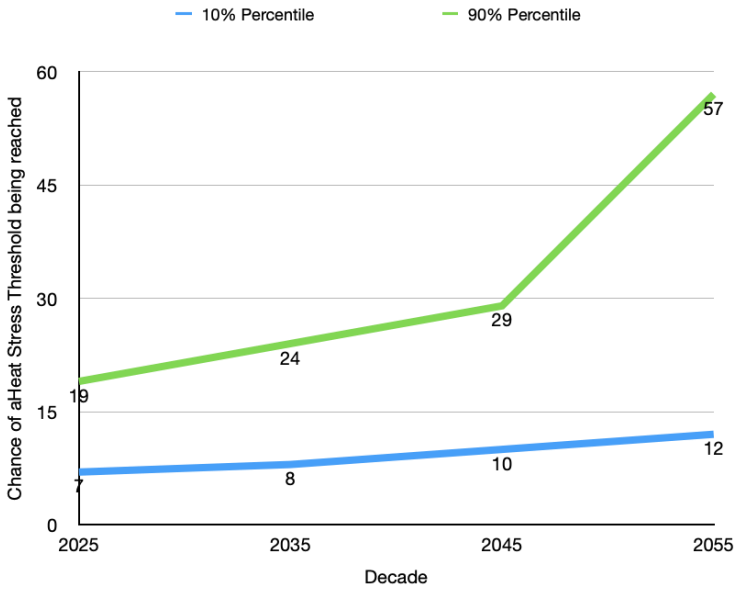
The Public Health Service currently manages its response to extreme temperatures from the Amber Heat Health alerts issued by the Met Office. The definitions of which vary according to regions in the UK, with the threshold in Warwickshire being 30°C. The risk of these alerts being issued continues to increase as we expect heatwaves to become more intense and more frequent with climate change. The change in risk of an amber heat-health alert for any one day being issued between now and 2050's is shown in the figure below with the 2 lines showing the likely range.



Heat stress

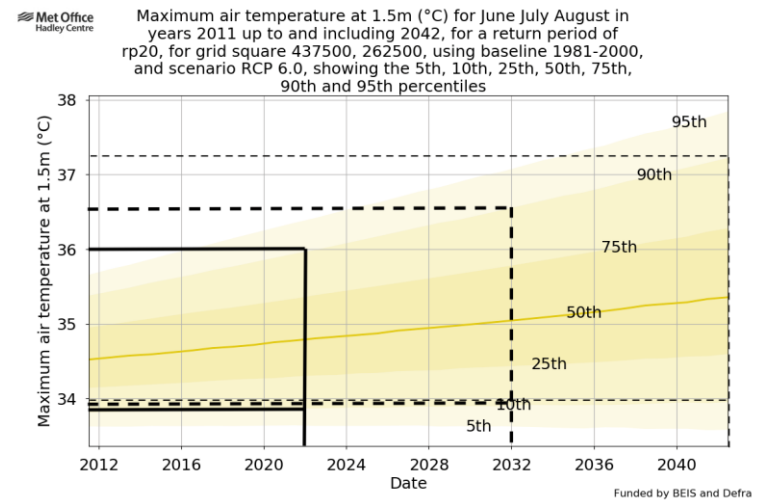
Heat stress is the relationship between temperature and humidity and is often seen as having the biggest effects on health than just temperature itself. In buildings that are not well ventilated this can be a particular problem and is not identified in Amber alerts issued by the Met Office. The figure

below shows the change in likelihood of heat stress levels being reached on any one day with the 2 lines showing the likely range.

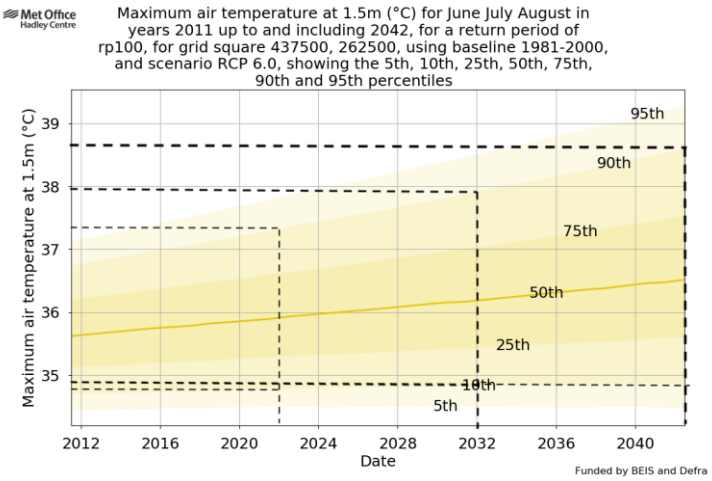


Potential extreme temperatures

As well as considering the change in risk of the number of heat-related warnings, it is also possible to identify the change in temperatures associated with extreme weather events. The 2 graphs below show the likely temperature for 2 different extreme events: a 1 in 20-year event and a 1 in 100-year event. The graphs are for the 25 km grid square covering Warwick though it can be representative of the whole county.



Year	Likely range of max air temperature °C (1:20 year event)
2012	33.8 - 35.4
2022	33.9 - 36.0
2032	33.9 - 36.6
2042	34.0 - 37.2



Year	Likely range of max air temperature °C (1:100 year event)
2012	34.7 - 36.8
2022	34.8 - 37.4
2032	34.8 - 37.9
2042	34.9 - 38.6

From the 2 graphs it is likely that what we understand as a rare extreme heat event (1:100-years) in 2022 will no longer be such a rare event. And that when a rare event does occur it will likely be a lot more intense as a result of climate change.

Cold weather

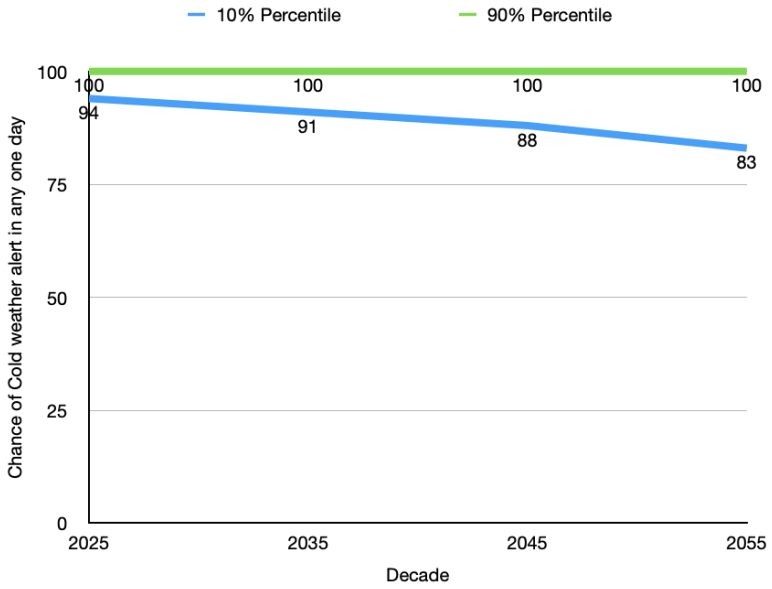
Whilst it is known that we can expect warmer winters with climate change there is still a strong likelihood of cold weather alerts being issued by the Met Office during the coming decades. The Cold weather health watch comprises five levels of response based on cold weather thresholds. The thresholds have been developed to trigger an alert when severe cold weather is likely to significantly affect people's health. The alerts take account of temperature along with other winter weather threats such as ice and snow.

The cold weather alert system, as with heatwave alerts, operates at a number of levels as described below:

- Level 0:
  - All year-round preparedness and long-term planning
- Level 1:
  - Winter preparedness and action during the period 1 November to 31 March
  - This is the minimum state of caution during winter months.
- Level 2 (Yellow):
  - Severe winter weather is forecast - Alert and readiness
  - Mean temperature of 2 °C and/or widespread ice and heavy snow is predicted within 48 hours, with 60% confidence.
- Level 3 (Amber)
  - Response to severe winter weather - Severe weather action
  - Mean temperature of 2 °C or less and/or widespread ice and heavy snow

- Level 4 (Red)
  - Major incident - Emergency response
  - Central Government will declare a Level 4 alert in the event of severe or prolonged cold weather

The figure below shows the likelihood of a cold weather alert being issued in Warwickshire up until the middle of the century.



Additional future change in hazard and risks

The UK's 3rd Climate Change Risk Assessment (CCRA3) identified a range of hazards and their risk that need consideration for future adaptation planning. The report is high level and does not distinguish sub-national impacts, nor the time period that they can be expected to occur.

For the Public Health Service the following health-related hazards have been identified in the CCRA3:

- Some diseases transmitted by insects and ticks (vectors) are likely to change in prevalence in the future due to warmer temperatures changing the distribution of the vector in the UK as well as diseases acquired by people overseas and being brought back into the UK. The key factors associated with the former include the following:
  - Lyme disease cases may increase with climate change due to an extended transmission season and increases in person-tick contact. This is a considered a medium risk.
  - Culex is a species of mosquito. The risk of Culex-transmitted diseases may increase in England. West Nile Virus was found established in two marshland sites of the Thames Estuary and has since been found at other sites in south-east England.
  - The risk of mosquito-transmitted diseases (such as Chikungunya and Dengue fever) is likely to increase in England and climate modelling indicates that southern England could become warm enough for establishment of the mosquito (*Aedes albopictus)* which carries these diseases. The risk that malaria may become established remains low.
- Higher temperatures may improve or reduce indoor air quality; if temperatures are higher then people may open windows more which could provide increased air circulation. However, in instances of poor outdoor air quality this could reduce the quality of indoor air. Overall, however, there is very little evidence on the impact of climate change on indoor air quality.

- Weather patterns can affect the formation and dispersion of air pollutants. Climate change may also change emissions of some pollutants or precursors of health-relevant pollutants. The incremental change in risk from climate change only, compared to non-climate causes, is uncertain.
- With the increase in higher temperatures there is the potential for an increase in people enjoying swimming in open water. This could lead to an increase in water-borne infections such as Weil's disease, or incidences of drowning.
- An increase in the number of heat alerts will lead to more warnings being issued, and greater workload in coordinating education and responses to other county services such as care and education settings. This increased workload could have an impact on staff's mental health.
- Heatwaves causing workplaces to become hotter leading to an unsafe working environment. Given the extent of home working the workplace should be extended to include other spaces than just in the council offices.
- Higher temperatures impact ICT equipment causing computing servers and laptops to overheat and stop working.
- Increased periods of heatwaves and drought conditions can lead to an increased number of convective storms. These, in turn, can lead to an increase in likelihood of lightning strikes and incidences of intense rainfall. Both can impact IT networks (broadband) making it difficult to send email alerts and handle enquiries.

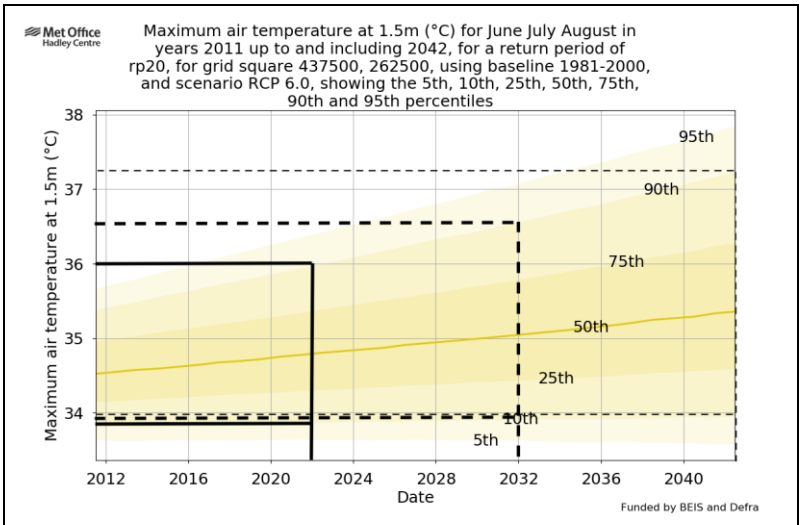
3.2 Warwickshire Fire and Rescue Service

Stage 2 of the adaptation toolkit explored how the Council's Fire and Rescue Service is currently being impacted by weather events. High intensity rainfall has led to flooding in the county causing the service to support residents and owners of flooded properties, and rescue people trapped in their vehicles. Periods of low rainfall and high temperatures led to call outs to small fire incidences, whilst intense winter storms caused a number of road traffic collisions.

Small fire incidences

Changes in extreme summer temperatures have been explored for the Public Health service, however, they are also relevant to the Fire and Rescue Service. This report features the same data for each service area to keep each service self-contained.

As well as considering the change in risk of the number of heat-related warnings, it is also possible to identify the change in temperatures associated with extreme weather events. The 2 graphs below show the likely temperature for 2 different extreme events: a 1 in 20-year event and a 1 in 100-year event. The graphs are for the 25 km grid square covering Warwick though it can be representative of the whole county.



Year	Likely range of max air temperature °C (1:20 year event)
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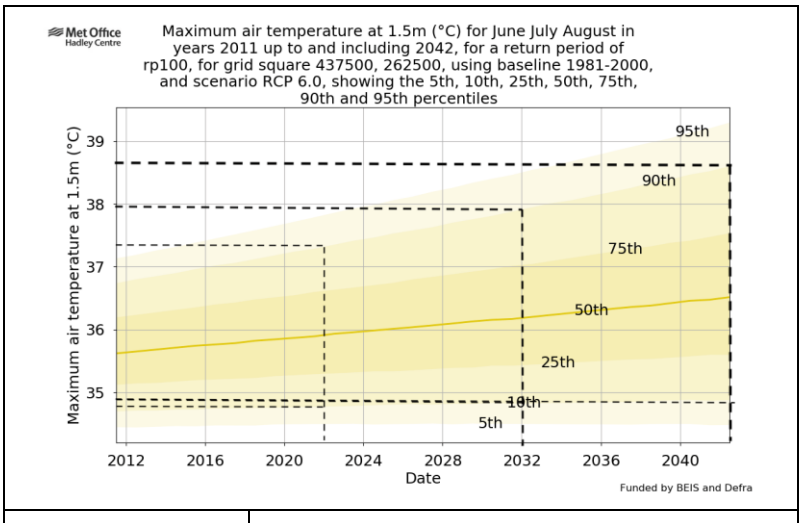
2022	33.9 - 36.0
2032	33.9 - 36.6
2042	34.0 - 37.2



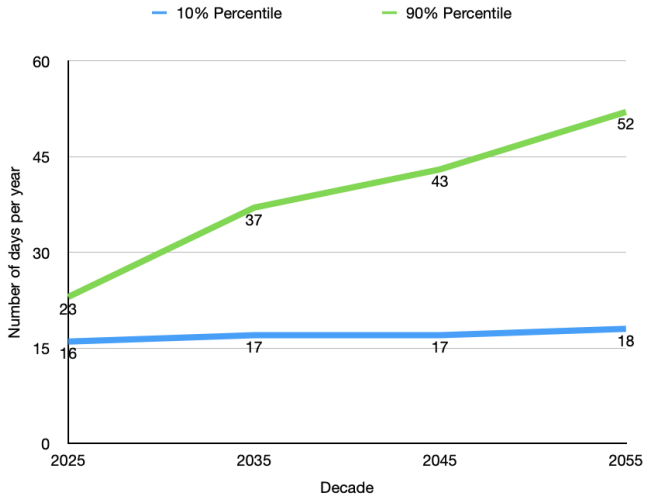
Year	Likely range of max air temperature °C (1:100 year event)
2012	34.7 - 36.8
2022	34.8 - 37.4
2032	34.8 - 37.9
2042	34.9 - 38.6

Change in rainfall:
It was seen that dry conditions led to an increase in fires primarily in the summer months, though not exclusively. Climate projections do not represent change in rainfall due to the complexity of the

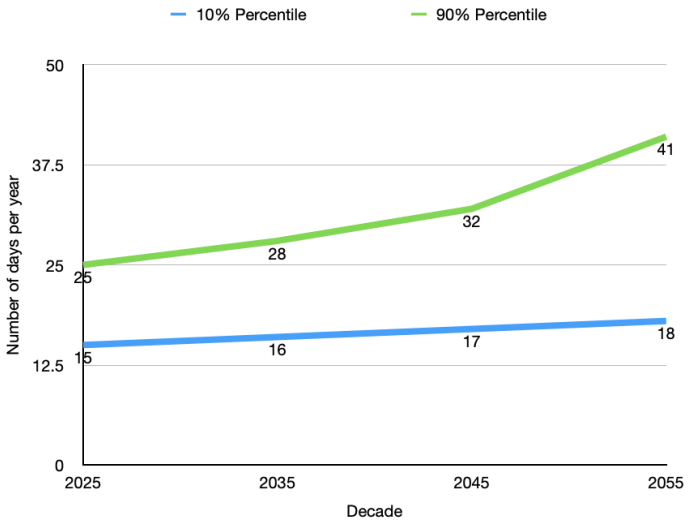
climate physics in relation to precipitation. As such, projections show a wide range of possible scenarios both increasing and decreasing. The table below shows the change in summer precipitation (rainfall) that could lead to further drying and, therefore, a likely change in fires.

Decade	Likely change in rainfall
2020's	-16% and +20.5%
2030's	-21.6 and +20.3%
2040's	-26.6% and +17.5%

The number of days that could be affected by dry conditions and wind enough to lead to fires in Warwickshire could increase in the next 30 years. As seen in the figure below the likely range of number of days could rise to as many as 44 days.



It has been seen that extreme temperatures experienced in the UK have caused damage to infrastructure such as roads causing them to melt. This has the potential to cause disruption to the road network making it difficult for fire and rescue crews to get to incidences. The likely range of the number of days that this might occur can be seen in the following graph. The threshold is days with a maximum temperature greater than 25°C. This threshold is taken from the UK Climate Risk Indicators.



Higher and prolonged summer temperatures will lead to convective storms increasing the likelihood of thunderstorms leading to increase in lightning strikes and increased flash flooding from high intensity rain fall. Lightning strikes can lead to failures in communication infrastructure and sparking wildfires.

Higher temperatures will impact the fire crews attending incidences by exposing them to prolonged periods of heat. This will be increased when having to wear protective equipment.

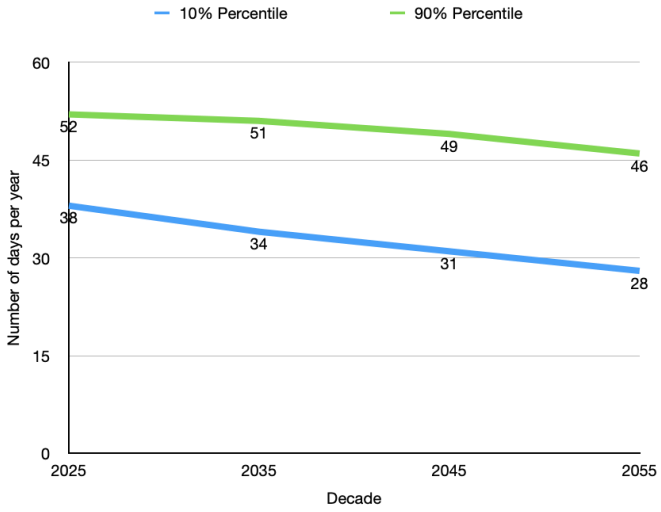
Warmer, drier weather could lead to an increase in social activities that could lead to an increase in call outs. These could include people getting into difficulty requiring assistance in open water; and an increase in fires from people spending more time outdoors having picnics.

As was seen in the summer of 2022, heatwaves cause workplaces to become hotter leading to an unsafe working environment. Given the extent of home working the workplace should be extended to include other spaces than just in the council spaces. In addition, higher temperatures will put greater impact on ICT equipment causing computing servers and laptops to overheat and stop working.

An increase in the likelihood of summer droughts could lead to causing problems of access to water for fire incidences.

Road Traffic Collisions

The risk of road traffic collisions caused through freezing conditions (min. temperatures less than 0°C) can be seen as a reducing though they will still occur despite a warming winter. This is reflected in the figure below.



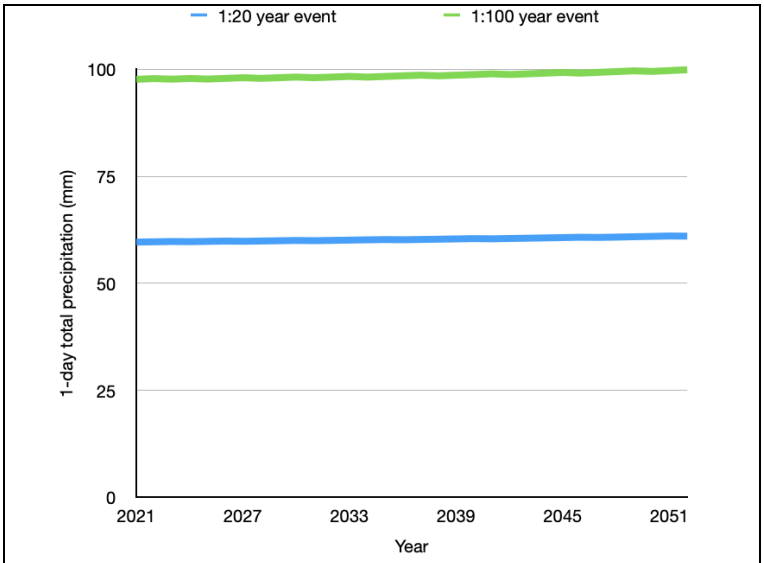
NOTE: Whilst not limited to road traffic collisions it should be noted that there will likely be an impact on the mental health of fire and rescue crews attending more events, as well as the support and administration staff handling an increase of calls.

3.3 Flood Risk Management

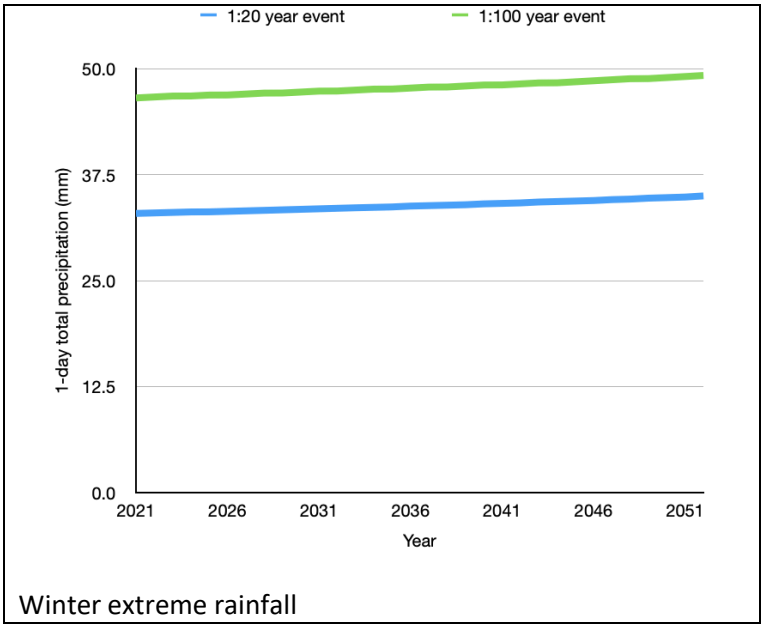
As seen in stage 2, understanding the change in flood risk is determined by a number of social, economic and political factors as well as the physical climate systems. Projections suggest that the total annual rainfall won't change significantly but what will change is when it will fall and in what form, e.g. change in extreme weather events. It is these events that will likely cause the greatest amounts of flooding and as such form the focus of this section.

Below are projections for two extreme events a 1:20-year and a 1:100-year event over the next 30 years. There are number of ways to express extreme weather events in addition to return periods as used here, for example Annual Exceedance Probability. Unfortunately, the UK Climate Projections only allow for extreme weather events to be communicated as return periods.

Each plot shows the highest rate of likely amounts of daily rainfall for the 2 extreme weather events.



Summer extreme rainfall events



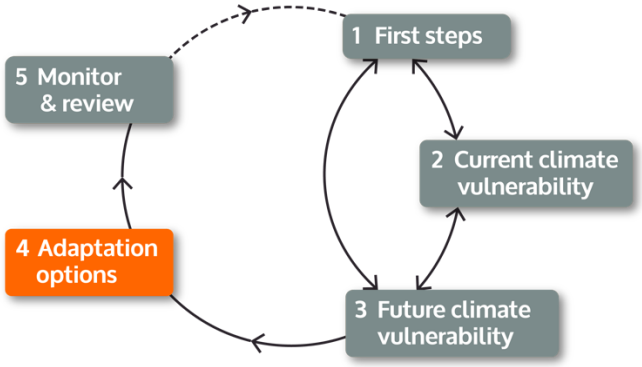
Winter extreme rainfall

During the storm in 2019, which led to widespread flooding of commercial and residential properties as well as impacting critical infrastructure in the county, over 30mm of rain was recorded in 2 days (14/15 November). Projections show that the likely range of a 1:20-year event in the same period (November) is ~35mm in 1 day, suggesting that similar episodes of rain could be expected more regularly in the near-future. When looking at extreme rainfall in the summer it can be seen that a 1:20-year event could see up to 61mm in one day by the middle of the century and by ~100mm in one day for a 1:100-year event.

It is expected that there will be heavier periods of daily rainfall in the summer months as seen in the 2 graphs above. However, winters are likely to become wetter with rain falling over longer periods on saturated ground that will potentially lead to increased surface run off.

The change in intensity and likelihood of extreme rainfall caused by climate change will likely lead to more flooding events in the county, directly leading to an increase in impacts on residential and commercial properties and a large increase in the workload of the service. would lead to an increase in the impacts already being experienced and identified in the risk matrix.

Stage 4: Identifying adaptation options



Stages 2 and 3 of the adaptation toolkit explore the ways that the particular service area is being impacted by weather events, and then how these impacts could be affected by climate change. That is, the weather events made more intense and/or more frequent. The projected changes in weather events have a degree of uncertainty associated with them, in so far as, it is known that change could occur, but the extent of that change could be within a range of plausible values. Understanding the services' planning decisions in consideration of the uncertainty of climate projections requires an acknowledgement as to the accepted level of risk. The risk 'score' identified in this section assumes a risk averse position for each service area, that assumes a 'worst case scenario' and plans for such. When reviewing this document, this attitude to risk should be considered to ensure it is correct.

Stage 4 of the Adaptation Toolkit considers possible adaptation options and how to prioritise them. A risk matrix can help to prioritise decision-making for future risk though it is by no means a quantifiable method. The matrix plots the likelihood of an event with the possible impact of it happening. For example, stubbing a toe is quite likely but the consequences are not that severe, however, a bridge collapsing is unlikely but if it did it would have severe consequences. The matrix below is one used by the Met Office and employed by the Flood Risk Management Team, as such is used for the purposes of this report to aid continuity.

Likelihood					
	High	4	8	12	16
	Medium	3	6	9	12
	Low	2	4	6	8
	Very low	1	2	3	4
		Minimal	Minor	Significant	Severe
			Impact		

Having established the priority risk areas, it is necessary to consider the adaptation options to mitigate the potential impacts and potential increased levels of risks brought about by climate change. The tables of adaptation options in this section focus on those events that were identified as being of high risk in the next 5-10 years. The other impacts noted in stage 3 should be reviewed as part of the monitoring and evaluation process detailed in stage 5 of the adaptation toolkit. The options identified in the table also focus on empowering, and working with, other people and agencies outside of the service to alleviate some of the work pressures and financial responsibilities associated with adaptation. This will increase the adaptive capacity of the council services which is important to increase resilience and reduce vulnerability. The lead for some of the actions may well lie outside of the particular service area, which may make its implementation difficult. This in turn has implications regarding financial and staffing resources and who pays for what. Clear coordination across the service areas is, therefore, an imperative. It should be noted that the suggested adaptation options are not meant to be exhaustive, and it will be necessary to review them editing them accordingly.

4.1 Cross-Council risks and adaptation options

There are a number of impacts that affect all service areas. These have been separated out from the sections for each service and presented here. In addition to these risks, it is important to note to risk to staff, budgets and resource allocation for the service areas in response to increased demand caused by climate change. This could include increased number of call outs to small fires or flood events, handling an increased number of calls, spending more time working with external agencies and other council services to implement adaptation options. Without adequate support there is a risk of the service areas not being able to fulfil their statutory duties.

Risk description	Likelihood	Impact	Risk score
Increase in work-related stress	4	4	16
Overheating in the workplace	4	3	12
Overheating IT equipment	3	4	12
Damage to broadband network from water and lightning strikes	3	4	12

Suggested adaptation options to these impacts.

Risk description	Adaptation Option(s)
Increase in work related stress	• Work with senior managers and HR to identify procedures to reduce or eliminate increased workload that could lead to increase in work related stress.

Overheating in the workplace	• Follow UKHSA heatwave plans including:
	  ○ Provide ventilation and shading
	  ○ Consider changing work hours to take advantage of the cooler times of day.
	  ○ Wear lighter, cooling clothing rather than uniforms in an office environment
	  ○ Use fans/air conditioning sparingly on extreme hot days
	  ○ Stay hydrated by drinking plenty of water

Overheating IT equipment	• Liaise with the IT council services to consider options to keep IT and communication systems cool in extreme heat. Simple solutions include: • Keep personal IT equipment out of direct sun • Provide adequate shade to windows: curtains, blinds or planting trees for longer term solution • Ensure plenty of air circulation around laptops

4.2 Public Health Service risks and adaptation options

Risk description	Likelihood	Impact	Risk
Increase in heat waves	4	4	16
Increase in heat stress	4	4	16
Cold weather alerts	3	4	12
Introduction of vector-borne disease	2	3	6
Change in outdoor air quality	3	2	6
Change in Indoor air quality	2	2	4
Increase in outdoor swimming	2	2	4

Suggested adaptation options to these impacts.

Risk description	**Adaptation options**
Increase in heat waves and extreme temperatures.	• Maintain access to the Met Office Heat Wave Alerts. • Maintain process of cascading heat health alerts to other council services and relevant agencies. • Develop safety advice for council employees. This should include those working in offices as well as outdoors. • Consider implementing climate change adaptation specifications into service procurement contracts. • Work with care home providers to help them develop appropriate thermal comfort for residents. Research projects such as ClimaCare can be a helpful source of knowledge. https://www.cibse.org/knowledge-research/knowledge-portal/research-insight-04-climacare-climate-resilience-in-care-settings-2020-pdf • Continue to maintain working relationships with neighbouring authorities and regional partners including Sustainable West Midlands who are examining issues to do with health in care homes. • Work with other council service providers such as Fire and Rescue who provide home visits to help monitor vulnerable people in their homes. • Work with urban planners to identify ways of improving local neighbourhoods to include more blue and green spaces that have the benefit of reducing heat as well as improving mental health. • Develop targeted education programmes on keeping safe in extreme temperatures. • Work with education providers on developing strategies for keeping children safe in schools and other childcare settings.
Increase in levels of heat stress	• Heat stress can be considered a factor of heatwaves with the addition of increased humidity. As such, the same adaptation options for extreme temperatures can be implemented. • Ensure adequate ventilation is provided for care homes managed by the council (e.g. 32 Station Road) to improve thermal comfort

4.2 Warwickshire Fire and Rescue Service risks and adaptation options

Risk description	Likelihood	Impact	Risk
Flooding of properties	4	4	16
Flooding of properties	4	4	16
Vehicle rescue in floods	4	4	16
Road traffic collision: storms	4	4	16
Small fires through drought and heat waves	4	4	16
Physical health of fire crews through heat exhaustion	4	4	16
Wildfires	4	4	16
Drought affecting water availability at fire sites	4	4	16
Road melt through extreme heat	3	4	12
Road traffic collision: snow/ice	3	4	12
Open water incidences	3	2	6

Suggested adaptation options to these impacts.

Risk description	Adaptation Options
Open water incidences	• Develop education campaign to warn people of the risks associated with open swimming and what to do in case of emergencies. • Liaise with organisations responsible for open water swimming locations such as the Environment Agency, and Severn Trent Water to develop safety measures.
Flooding of properties	• Identify sources of flooding for example river floods or surface run off. • Liaise with the flood risk management service to identify areas at risk, and how this risk could change • Liaise with the Environment Agency and other water authorities to identify the change in flood risk of water courses in Warwickshire. • Liaise with the local resilience forum to identify strategies for flood mitigation. • Identifying areas of vulnerable people
Vehicle rescue in floods	• As per flooding of properties.
Road traffic collision: storms	• Maintain access to the Met Office storm alerts • Work with highways and wildlife services to maintain trees close to road to prevent dead branches falling on to road.
Road traffic collision: snow/ice	• Maintain access to the Met Office cold weather alerts • Identify if accident black spots exists such as frost hollows • Work with Highways services to plan gritting regime for key areas
Small fires through drought and heat waves	• Monitor the UK Fire Severity index: https://www.metoffice.gov.uk/public/weather/fire-severity-index/#?tab=map&fcTime=1668340800&zoom=5&lon=-4.00&lat=55.74.
Wildfires	• Monitor the UK Fire Severity index: https://www.metoffice.gov.uk/public/weather/fire-severity-index/#?tab=map&fcTime=1668340800&zoom=5&lon=-4.00&lat=55.74. • Liaise with the wildlife service to identify areas prone to drying leading to potential wildfires.
Drought affecting water availability at fire sites	• Liaise with local landowners about maintaining water reservoirs to store water. • Invest in technology such as fire trucks with larger water capacity tanks • Invest in technology and specialist equipment such as drones and water bowser fire appliances. • Accelerate trend towards smaller fire engines to facilitate off road capability and enable access to difficult terrain.
Road melt through extreme heat preventing access to incidences	• Liaise with highways services to set up measures to identify where roads were being repaired to be able to anticipate access routes to incidences.
Physical and mental health of fire crews through heat exhaustion	• Continue to work with occupational health about supporting staff welfare recognising that there could be a likelihood of increased number of incidences.

4.3 Flood Risk Management risks and adaptation options

Categories of overall flood risk in relation to the risk matrix shown earlier:

Very low	Low	Medium	High

Summary of potential impacts:

- Minimal:
    - Isolated and minor flooding of low-lying land and roads
    - Isolated spray/wave on coastal promenades
    - Little or no disruption to travel, but wet road surfaces

- Minor:
    - Localised flooding of land and roads
    - Flooding affecting individual properties
    - Disruption to travel and key sites in flood plans

- Significant:
    - Flooding affecting parts of communities
    - Possible danger to life and damage to buildings/structures
    - Disruption to travel and key sites in flood plans
- Severe:
    - Danger to life, severe disruption to travel
    - Widespread flooding affecting whole communities
    - Widespread disruption or loss of infrastructure
    - Large scale evacuation of properties possible

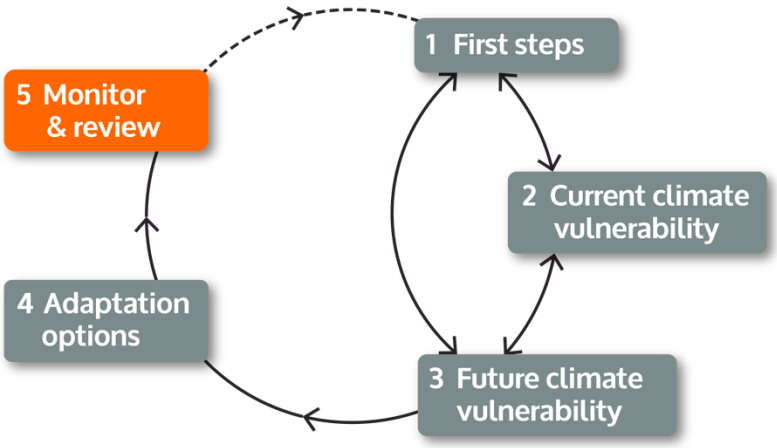
Risk description	**Likelihood**	**Impact**	**Risk**
Flooding of residential properties	4	4	16
Flooding of commercial properties	4	4	16
Damage to critical infrastructure	4	4	16
Road closures	4	3	12

Suggested adaptation options to these impacts.

Risk description	**Adaptation options**

Flooding of residential and commercial properties
 	
Damage to critical infrastructure.
 	
Road closures
	• Continue to liaise with the Environment Agency to receive flood and storm alerts.
	• Continue to work with Highways Service to develop road and drainage maintenance schemes, and explore the use of retrofit SuDS schemes to better manage highway runoff quantity and quality.
	• Continue to take a strategic approach to appraising and developing capital schemes for flood risk reduction to at-risk communities, in collaboration with those communities and partner agencies.
	• Work with other services such as CSW Resilience team and Fire and Rescue Service who carry out home visits to identify vulnerable people and put plans in place to support them in flooding situations.
	• Establish early warning systems within communities that are already flood prone.
	• Consider ways to extend existing flood management options beyond sandbags and flood walls (sandbags, in particular have been seen to be an ineffective flood management solution). These are costly and require time to establish and ideally should not be considered the immediate adaptation response.
	• Identify ways to reduce surface runoff. Where suggested options are already happening, these should continue to be employed:
	  ○ Work with local landowners to identify ways to maintain soil moisture and reduce surface runoff including tree planting, mowing regimes, natural ponds, maintenance drainage ditches.
	  ○ Continue to work with local planners to identify new developments and their risk of flooding.
	  ○ Work with managers of critical infrastructure including essential services to identify their flood risk and ways they can mitigate the impacts.
	  ○ Work with local communities to identify opportunities for retrofit SuDS schemes /micro-SuDS / rainwater harvesting.
	  ○ Develop 'education' initiatives to support people's awareness of flood risk and their responsibilities in reducing it through personal property management.
	  ○ Strengthen and widen our influence in advocating the use of well-designed, multi-functional, above ground SuDS as per LGA guidance.https://www.local.gov.uk/topics/severe-weather/flooding/sustainable-drainage-systems.
	  ○ Work with urban planners to develop further nature-based solutions in urban areas to capture and store water, maintain soil moisture, create permeable surfaces in line with SuDS principles.
	  ○ Consider exploring further modelling tools to understand changing risks of flooding such as FUTURE-DRAINAGE (https://artefacts.ceda.ac.uk/badc_datadocs/future-drainage/FUTURE_DRAINAGE_Guidance_for_applying_rainfall_uplifts.pdf).

Stage 5: Monitor and Review



Stage 5 of the adaptation toolkit considers how best to monitor and review the adaptation plan. including all stages of the process. Periodically reviewing the plans will maintain relevance to the service and accuracy in relation to the impacts being faced and the adaptation options implemented. To support the review, an ongoing process of data gathering could be implemented. Where possible the review and data gathering should be part of existing monitoring processes used by the service. Where this is not already in place, systems should be put in place that do not increase the workload of the service teams. The monitoring process also needs to take account of other County Council initiatives such as achieving net-zero targets and any changing statutory requirements or guidance.

Opportunities to embed monitoring and review processes need to be identified for each service area, however, council-wide processes such as maintaining the corporate risk register could be used as the steer for when and how adaptation planning is reviewed.

Next steps

The impacts of climate change can no longer be seen as something that is happening to other people, or that is something to worry about in the future, but as a risk that is already impacting the council's ability to fulfil its duties. With the increase in frequency and intensity of weather events, the service areas are going to be under increasing pressure. Whilst this report has focussed on 3 key service areas, the hazards will affect all areas of the council services. This report has highlighted a number of areas where council service provision is being impacted by weather events, and that these events will continue to impact services in the immediate future necessitating action to be taken. It is recommended that the following should be considered next steps in building resilience to climate change impacts within Warwickshire County Council:

- Conduct a full review of all council service areas using the same methodology used in this report. Using the methods presented in the Adaptation Toolkit provides a consistent approach to adaptation planning that is important in ensuring a cohesive strategy.
- Embed adaptation planning policy within existing policies rather than 'bolted-on'. As another business continuity risk, embedding new approaches will more likely ensure they are adopted rather than considered a 'luxury'.
- The report has highlighted internal stakeholders that are impacted by, and impact other service areas. These should be considered as the next priority service areas to be reviewed. For

example, the importance of the Highways Department and the Ecology, Historic Environment & Landscape were identified for both FRM and WFRS.

- Adaptation planning should be considered within each service area, however it is important to have a person(s) providing oversight. The importance of a 'champion' within an organisation has been identified within other local authorities and businesses in maintaining the development of adaptation planning, particularly at senior levels.

Glossary

• **Adaptation** – is the term used to describe responses to the effects of climate change. The IPCC defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."
In this guidance the term is used in the narrower sense of planned responses aimed at minimising the threats and maximising the opportunities of a changing climate. Adaptation can also be thought of as the ongoing process of managing changing climate risks.

• **Adaptive capacity** – is defined by IPCC as "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."

• **Capacity building** – in the context of climate change, capacity building is developing the technical skills and institutional capabilities to adapt to a changing climate. (Modified from IPCC.)

• **Climate** - is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time. These quantities are most often surface variables such as temperature, precipitation, and wind. The conventional period of time over which weather is averaged to calculate climate is 30 years, as defined by the World Meteorological Organization (WMO). (Modified from IPCC.)

• **Climate change** – the IPCC defines this generally as "...any change in climate over time, whether due to natural variability or as a result of human activity." This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines 'climate change' specifically in relation to human influence as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.

• **Climate model** – is a numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties. (Modified from IPCC.) Modelling for the UK climate projection is undertaken by the Met Office Hadley Centre (MOHC).

• **Climate projections** – are the calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, usually based on simulations by climate models. Climate projections critically depend on the emissions/ concentration/radiative forcing scenario used, and therefore on assumptions of future socio-economic and technological development that are highly uncertain. (Modified from IPCC.) Climate (change) projection is a plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships and assumptions of radiative forcing, typically based on emission scenarios. A 'climate change projection' is the difference between a climate scenario and the current climate. (Modified from IPCC.)

• **Consequence** – the result or effect caused by a situation or event. In order to undertake a risk assessment, it is necessary to make a quantitative, or qualitative, estimate of the magnitude of the consequence(s) of an event. Note that there will typically be a range of consequences for different receptors affected by a weather event or the impact of a climate change.

• **Emission scenarios** – are assumed future emissions of greenhouse gases used as inputs to climate models in order to estimate future climate changes. The IPCC formally defines an emission scenario

as “a plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships.” The current set of scenarios used by the IPCC and for the UK climate projections are known as RCPs (see below).

• **Exposure** – is a term used in risk management to describe the extent to which a system is exposed to a particular stimulus (usually hazardous). In the context of adaptation, it is used to refer to the extent to which a particular climate risk is received by a system of interest. See also exposure unit below.

• **Hazard** – a term used in risk management for a situation or event with the potential to cause harm.

• **Heat Island** – is an urban area characterised by temperatures higher than those of the surrounding non-urban area. As urban areas develop, buildings, roads, and other infrastructure replace open land and vegetation. These surfaces absorb more solar energy, which can create higher temperatures in urban areas

• **Impact** – a beneficial or (more usually) detrimental consequence (of a situation or event). The IPCC describes climate change impacts as the “effects of climate change on natural and human systems”. When considering adaptation it can be useful to distinguish between:

- potential impacts – all the impacts that may occur given a projected climate change, without considering adaptation; and
- residual impacts – the impacts of a climate change that may occur after the implementation of any adaptation measures.

• **IPCC** – Intergovernmental Panel on Climate Change was set up jointly by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to provide an authoritative international statement of scientific understanding of climate change. Most recently they published their Sixth Assessment Report(s) in 2021.

• **Likelihood** – a general concept relating to the chance of an event (or impact) occurring. Generally expressed as a probability or frequency. In order to undertake a risk assessment, it is necessary to make a quantitative, or qualitative, estimate of the likelihood of a particular (hazardous) event or impact occurring.

• **Mitigation** – is a human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

• **RCPs** - A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were used for climate modeling and research for the IPCC fifth Assessment Report (AR5) in 2014. The pathways describe different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come. The RCPs – originally RCP2.6, RCP4.5, RCP6, and RCP8.5 – are labelled after a possible range of radiative forcing values in the year 2100.

• **Resilience** – is defined formally by IPCC as “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.” This definition has its origins in

ecology and, in practice, improving the resilience of human systems may involve some changes to structure and function. A much simpler description is the ability of a system to recover from the effect of stress. One way of thinking about adaptation is as the process of improving resilience to projected climate changes. See also the term robustness below.

• **Return Period -** A return period, also known as a recurrence interval or repeat interval, is an average time or an estimated average time between events such as floods or heat waves to occur. For example, the term "100-year flood" is used to describe the recurrence interval of floods. The 100-year recurrence interval means that a flood of that magnitude has a one percent chance of occurring in any given year. In other words, the chances that a river will flow as high as the 100-year flood stage this year is 1 in 100.

• **Risk** – the combination of the likelihood, or probability, of an event occurring, and the magnitude of the impact(s), or consequence(s), associated with that event.

• **Robustness** – is the ability of a system to continue to perform satisfactory under stress. The concept of robustness is very similar to that of resilience, but tends to emphasise continuity of performance whist under stress rather than the capacity to recover from the effects of stress.

• **Sensitivity** – the degree to which a system would be affected by a stimulus.

• **Threshold** – the IPCC defines threshold as “the level of magnitude of a system process at which sudden or rapid change occurs”. In terms of adaptation, the term threshold is often used to describe a level at which the magnitude of a consequence is considered unacceptable, for instance, an internal temperature above which there are significant health risks to vulnerable people.

• **Vulnerability** – the magnitude of harm that would result from a particular hazardous event. The IPCC describes vulnerability as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change.” Note that different types of receptors may differ in their vulnerability to a particular level of hazard.