Heathrow

CLIMATE ADAPTATION REPORT

FOURTH ROUND
DECEMBER 2024

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EXECUTIVE SUMMARY

The impacts of climate change are increasingly being felt across the UK, leading to more pronounced and severe weather events. Since the third round of Adaptation Reporting (ARP3), we have experienced several severe weather events which have highlighted the risks from a changing climate.

For example, the heatwave and high winds of 2022 and the flooding experienced in 2023. These events have tested the resilience of our own operations and show that climate change is happening now, and that adaptation is a necessity. As a key global transport hub, we play a vital role in global mobility, enabling connectivity and trade to deliver wider societal benefits as well as economic growth. Physical climate risks impact directly on the resilience of our assets, operations and network and require us to adapt so that we can continue to operate in a more extreme climate.

We are proactively responding to the risks associated with climate change through capturing and managing risks within our overall risk management framework and embedding adaptation into how we run our business. This is an iterative process, whereby risks are understood through carbon quantification and a physical climate change risk assessment (CCRA) before strategies are developed to take action and respond.

We have provided an update to our CCRA in the fourth round of adaptation reporting (ARP4) through reviewing wider literature, work undertaken since 2021, and consulting our internal teams.

We have also undertaken a participatory system mapping approach to inform our interdependency risk assessment, pooling knowledge from internal and external stakeholders across multiple teams (Surface access, Airspace, IT, Water, Supply chain operations and Engineering teams) to inform this update.

In alignment with our Climate Financial Disclosure (TCFD or CFD) reporting and UK Climate Change Committee (CCC) guidance, our CCRA assesses physical risks under three emissions scenarios (Representative Concentration Pathway (RCP) 2.6, RCP 4.5 and RCP 8.5) and for three-time horizons (present-day, 2050s and 2090s).

At ARP3 we identified three priority risks:

1

High levels of precipitation leading to both groundwater flooding and surface water flooding.

2

High temperatures leading to infrastructure damage affecting the structural integrity of airfield structures such as runway and apron tarmac.

3

Low temperatures leading to increased de-icing requirements and challenging winter contingency plans.

EXECUTIVE SUMMARY (CONTINUED)

The updated CCRA suggests that **groundwater** and **surface water flooding** remain a priority risk and are driven by both intense rainfall events and higher rainfall over extended durations across the catchment leading to elevated groundwater levels. High temperatures also continue to be a priority risk although some scores have decreased since ARP3, as we have improved our understanding of heat impacts. However, low temperatures are no longer considered to be a priority risk. Instead, **compound storm events** are now considered to be our other priority risk.

In comparison to ARP3, the ARP4 CCRA has highlighted the following key updates:

An increase in scores associated with groundwater and surface water flooding, due to impacts experienced in a June 2023 rainfall event and findings from our asset risk assessment.

An increase in scores associated with winds and particularly strong gusts, due to multiple events and impacts since 2021 and findings from our asset risk assessment.

A relative decrease in scores associated with heat, due to limited impacts from the 2022 heatwave. The asset risk assessment undertaken at a higher threshold of 40°C, also did not show increased impacts compared to the 32°C threshold used at ARP3.

A decrease in scores associated with cold weather and snowfall, due to:

- Projections suggesting a lower likelihood of events occurring as seasonal average temperature increases.
- The winter hazard mitigation plans which were put in place following snow events at Heathrow in 2010 which have been maintained.

New direct risks were also identified including the following:

Risks to power supplies from extreme heat, with the potential to cascade to other critical operations such as IT systems.

Risks to storage and transport of cargo from high temperatures.

Risks of on-airport fires due to heat and extended drought conditions.

The interdependency analysis also highlighted several key risks and interfaces with other organisations, where we have less control in managing, mitigating and responding to climate hazards. This leaves us vulnerable to cascading risk or in-combination impacts which may exacerbate direct risks from hazards such as rainfall and heat. Our priority interdependencies are the impact of **catchment management on flood risk** and **substation assets on the resilience of our electricity supply.**

We are committed to setting a clear direction and approach to delivering climate adaptation at Heathrow through an Adaptation Strategy. Our Strategy, currently in development, will be completed in 2025. This will provide an overarching framework for adaptation, from risk assessment through to investment in adaptation actions.

Priority actions to mitigate the risks identified from the CCRA include continued assessment and related improvements to our asset standards and performance, to account for increasing climate risks and respond to analysis from our updated flood and wind models. We will also continue engaging with catchment stakeholders and suppliers of critical infrastructure to manage our interdependency risks and we are committed to supporting any collaborative frameworks initiated at government level.

1.0 INTRODUCTION

1.1 CLIMATE CHANGE ADAPTATION AND HEATHROW

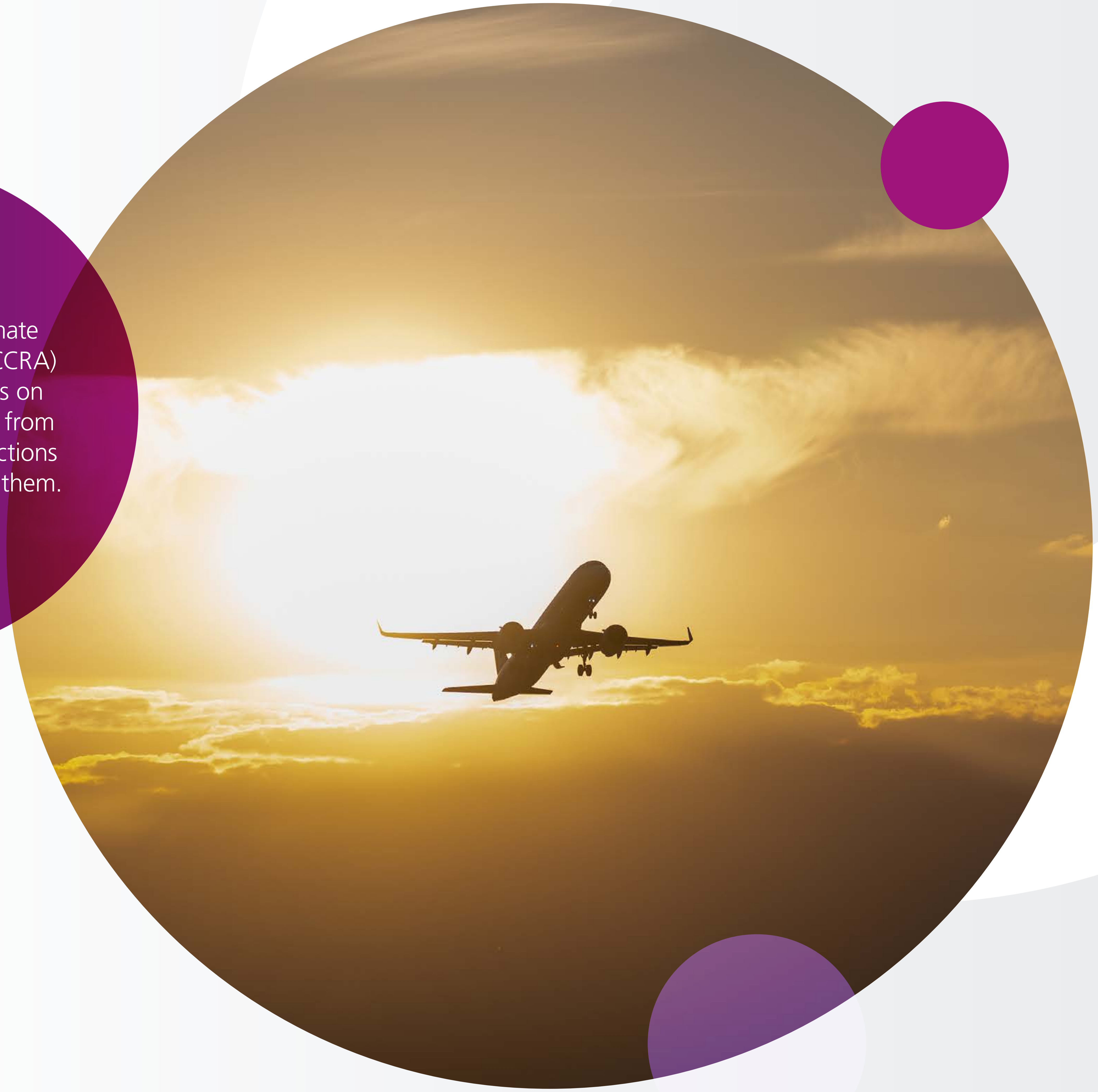
As a key global transport hub, we play a vital role in global mobility, enabling connectivity and trade to deliver wider societal benefits as well as economic growth.

Heathrow is expected to contribute approximately £4.7bn to the UK economy by 2025 and we connect over 200,000 passengers daily to onward journeys in 239 destinations in 89 countries. We also play a significant role in the local community, supporting 114,000 local jobs and functioning as the largest single-site employer in the UK through employing more than 76,000 people directly. The scale of Heathrow's services means that millions of people in the UK are dependent on the resilience of our infrastructure and operational activities to climate change.

Climate change creates a variety of risks for aviation and our activities, including physical and transition risks. Whilst tackling climate change by reaching net zero remains our priority, adaptation to physical risks is also a necessity.

Physical climate risks impact directly on the resilience of our assets, operations and network and require us to adapt so that we can continue to operate in a more extreme climate. Physical risks are increasingly being realised, as climate change leads to more pronounced and severe weather events. For example, the record-breaking heatwave of 2022 and the intense rainfall and flooding events in summer 2023 caused disruption to infrastructure owners and operators across the country. These events have tested the resilience of our own operations. Meanwhile, climate projections and high-profile global incidents such as the flooding of Dubai airport in April 2024 point to a future where extreme weather will continue to test our resilience.

This report, and the climate change risk assessment (CCRA) that underpins it, focuses on the physical risks we face from climate change and the actions we are taking to adapt to them.

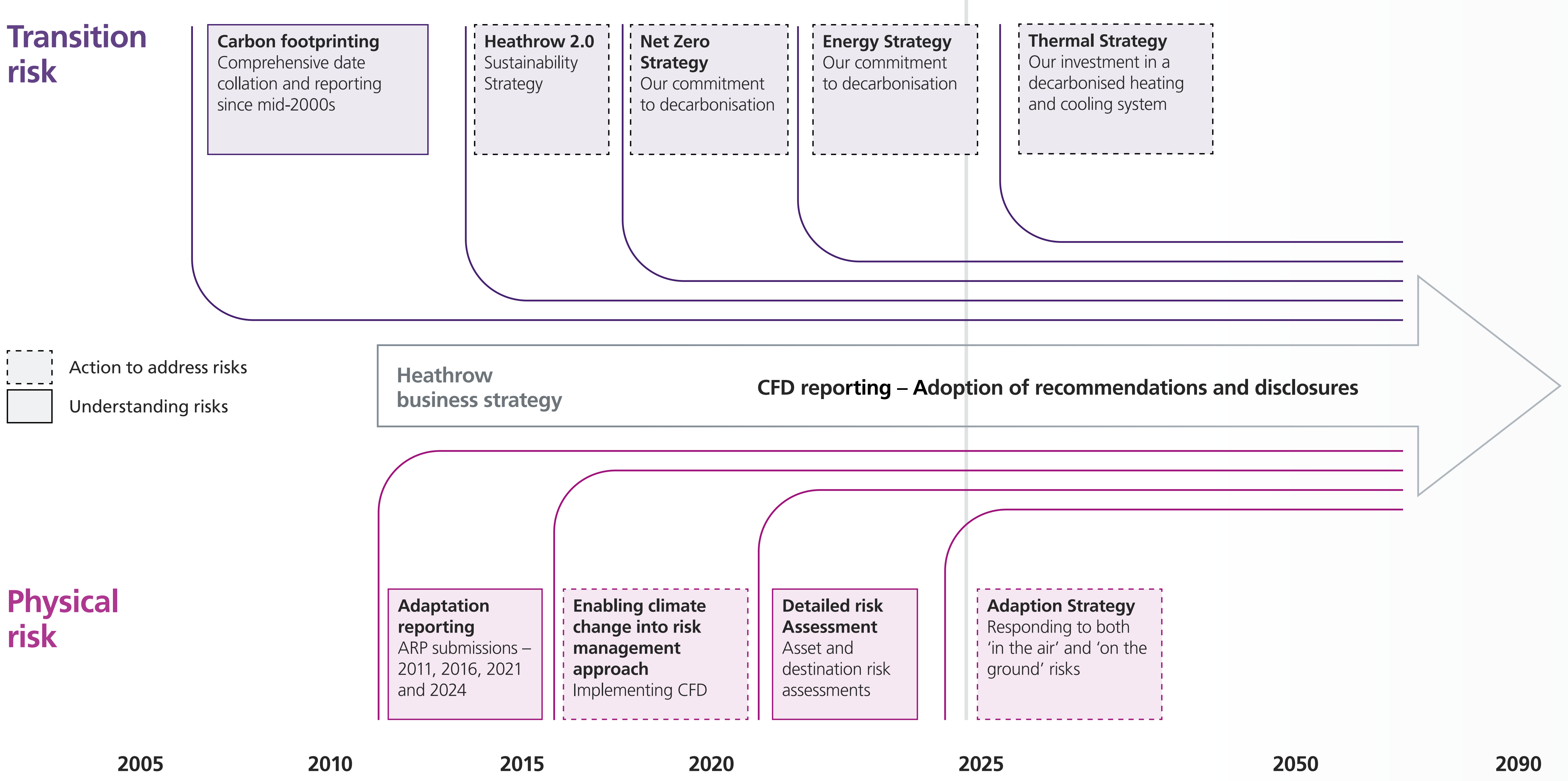


1.0 INTRODUCTION (CONTINUED)

1.2 EMBEDDING CLIMATE RISK MANAGEMENT IN OUR BUSINESS

We are proactively responding to the risks associated with climate change through capturing and managing risks within our overall risk management framework and embedding adaptation into how we run our business (Figure 1).

Figure 1: Embedding climate risk management in our business



This is an iterative process, whereby risks are understood through carbon quantification and physical CCRA before strategies are developed to take action and respond.

Our approach to embedding climate risk within our business aligns with the recommendations of the Taskforce for Climate Financial Disclosure (TCFD or CFD) and we disclose these risks in our Annual Report. Following the recommendations, we use scenario analysis to understand how climate change impacts our business through both transition and physical risks. We are beginning to bring together transition and physical risk in our scenarios for CFD, recognising that risks are materialising within the same timescales and that opportunities exist to develop more cost-effective mitigation. The ARP4 process, and especially the update to our CCRA, is an important aspect of scenario analysis.

By updating the physical risk assessment we undertook at ARP3, we have developed our understanding of physical risks to our infrastructure and operations under a range of scenarios (both emissions scenarios and time horizons). The scenarios used in the ARP4 CCRA are consistent with the scenarios used in our wider CFD assessments. In line with CFD, we assess the material financial impacts that arise from the different scenarios and disclose them in our Annual Report.

Our approach to understanding and embedding physical climate risks is aligned with that of the wider transport sector and the Department for Transport's (DfT) Adaptation Strategy. We also recognise the interdependent nature of climate risk and the need to collaborate with other stakeholders to develop effective adaptation actions.

1.3 CONTENT OF THIS REPORT

As an owner and operator of infrastructure critical to the UK economy, we have voluntarily responded to the request from Defra to submit a response at ARP4. In line with Defra guidance for organisations who reported at ARP3, we have provided an update to our physical risk assessment. This accounts for any changes to scoring for our direct risks (climate hazards impacting our assets or operations) as well as a particular focus on interdependency risks (processes or organisations which if impacted by climate hazards will impact on Heathrow). We also present our progress against the adaptation actions identified at ARP3, as well as information on our future planned adaptation informed by the updated CCRA.

2.0 METHOD

2.1 APPROACH TO UPDATING OUR CCRA

Our approach to the CCRA for ARP4 consisted of the following steps:

Deciding on scenarios and time horizons to use within the CCRA to align with CFD reporting and available climate projection data from the United Kingdom Climate Projections 2018 (UKCP18).

A review of the ARP3 CCRA to determine which risks were still relevant and where scores needed updating.

Review of work we have undertaken since 2021 to develop the evidence base for our understanding of physical risks (including reports, risk assessments, and supporting analysis), leading to updates to risk scores.

Review of wider literature, for example climate risks to the aviation sector (e.g. EUROCONTROL climate risk review) and ARP3 reports produced by other infrastructure owners to collate potential interdependencies and inform risk scoring.

Consultation with our Strategy, Solutions and Operations teams to gather evidence of impacts from direct risks and interdependencies.

Reviewing the documents above and consultation also helped us to consider control measures – or mitigation actions in place which may modify risk scores.

Evidence was also gathered for future planned adaptation actions although these did not inform risk scores.

Primary updates to the method used at ARP3 included the following:

Updated climate projection data was sourced from UKCP18 to enable us to assess risks under the emission scenarios and time periods selected. Further detail on the climate projection data used can be found in Appendix A.

Use of three emissions scenarios (Representative Concentration Pathway (RCP) 2.6, RCP 4.5 and RCP 8.5) and three-time horizons (present-day, 2050s, 2090s).

The choice of scenarios for the CCRA aligns with our approach to scenario analysis, following CFD recommendations and the UK Climate Change Committee's (CCC) guidance which recommends planning for 2°C of warming but preparing for 4°C of warming.[1] For ARP4, RCP4.5 and RCP8.5 were only applied to the medium and longer-term horizons in alignment with CFD guidance.[2, 3] The scenarios used are summarised in Table 1:

Table 1: Summary of emissions scenarios used in CCRA

Time period	Emissions scenario
Present day/near term to 2030	1.5°C (RCP2.6)
Medium term – 2050	1.5°C (RCP2.6), 2°C (RCP4.5), 4°C (RCP8.5)
Long term – 2090	1.5°C (RCP2.6), 2°C (RCP4.5), 4°C (RCP8.5)

[1] *CCC (2021) CCC Insights Briefing 6: Undertaking a climate change risk assessment. Available at: CCC-Insights-Briefing-6-Undertaking-a-climate-change-risk-assessment.pdf (theccc.org.uk) [accessed 29/07/24]*
[2] *TCFD (2017) Technical Supplement: The use of scenario analysis in disclosure of climate-related risks and opportunities. Available at: FINAL-TCFD-Technical-Supplement-062917.pdf (bbhub.io) [last accessed 29/07/24]*
[3] *Heathrow Airport Holdings Lt (2023). Annual Report 2023. Available at: https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/investor/reports-and-presentations/annual-accounts/airport-holdings/2023_FY_HAHL_ARA_Final.pdf*

2.0 METHOD (CONTINUED)

The CCRA scoring was conducted using the same 5x5 risk matrix used in ARP3. This follows our Enterprise Risk Management framework, combining the likelihood and consequence of a risk occurring to derive a risk score (see Table 2). For each risk, a narrative describing the factors considered in determining likelihood and consequence was provided. Risk scores take into account current control measures, i.e. activities already in place and funded which mitigate the risk.

The ARP3 risk narrative was updated based on evidence of the risk materialising since 2021 and information gathered from stakeholders. Consultation also informed an update of current control measures. The updated evidence base was used to informed the likelihood and consequence scores under each scenario.

Table 2: Risk assessment matrix

		Consequence				
		1 Minimal	**2** Minor	**3** Moderate	**4** Major	**5** Catastrophic
Likelihood	**5** Highly probable	10	10	15	20	25
	4 More than likely	4	8	12	16	20
	3 Less than likely	3	6	9	12	15
	2 Unlikely	2	4	6	8	10
	1 Improbable	1	2	3	4	5

2.1.1 Interdependency analysis method

We have also undertaken a participatory system mapping approach to inform our interdependency risk assessment, pooling knowledge from internal stakeholders across multiple teams to inform this update. The interdependency risk assessment was also informed by external stakeholder engagement undertaken since 2021. This allowed us to create an integrated system map of Heathrow and identify our interdependency risks. As part of the internal engagement process, the longlist was then reviewed and a prioritisation exercise determined a list of interdependencies to take forward to the CCRA. These are shown within a summary risk map (see Appendix B). The longlist has been retained within the integrated system map as an audit trail of all interdependencies assessed.

Within the CCRA, climate hazards were grouped for each interdependency, with the narrative highlighting any material differences e.g. scores for the electrical substation asset interdependency consider impacts from multiple hazards (e.g. extreme heat, flooding). Control measures were also considered for both Heathrow and the relevant organisations to inform both likelihood and consequence scoring.

3.0 CLIMATE CHANGE AND HEATHROW

3.1 WHAT IS THE CLIMATE AT HEATHROW AND HOW IS IT CHANGING?

3.1.1 Summary of current climate

Heathrow currently experiences a temperate climate, with cold, wet winters and warm, dry summers, as well as changeable weather that can bring storms and heavy rainfall in summer and winter.

Since ARP3, we have experienced several severe weather events which have highlighted our vulnerability to climate change. For example, the heatwave and high winds of 2022 and the flooding experienced in 2023. These events have also informed the updates to our physical risk assessment in ARP4.

CASE STUDY 1: EXTREME HEAT

WHAT HAPPENED?

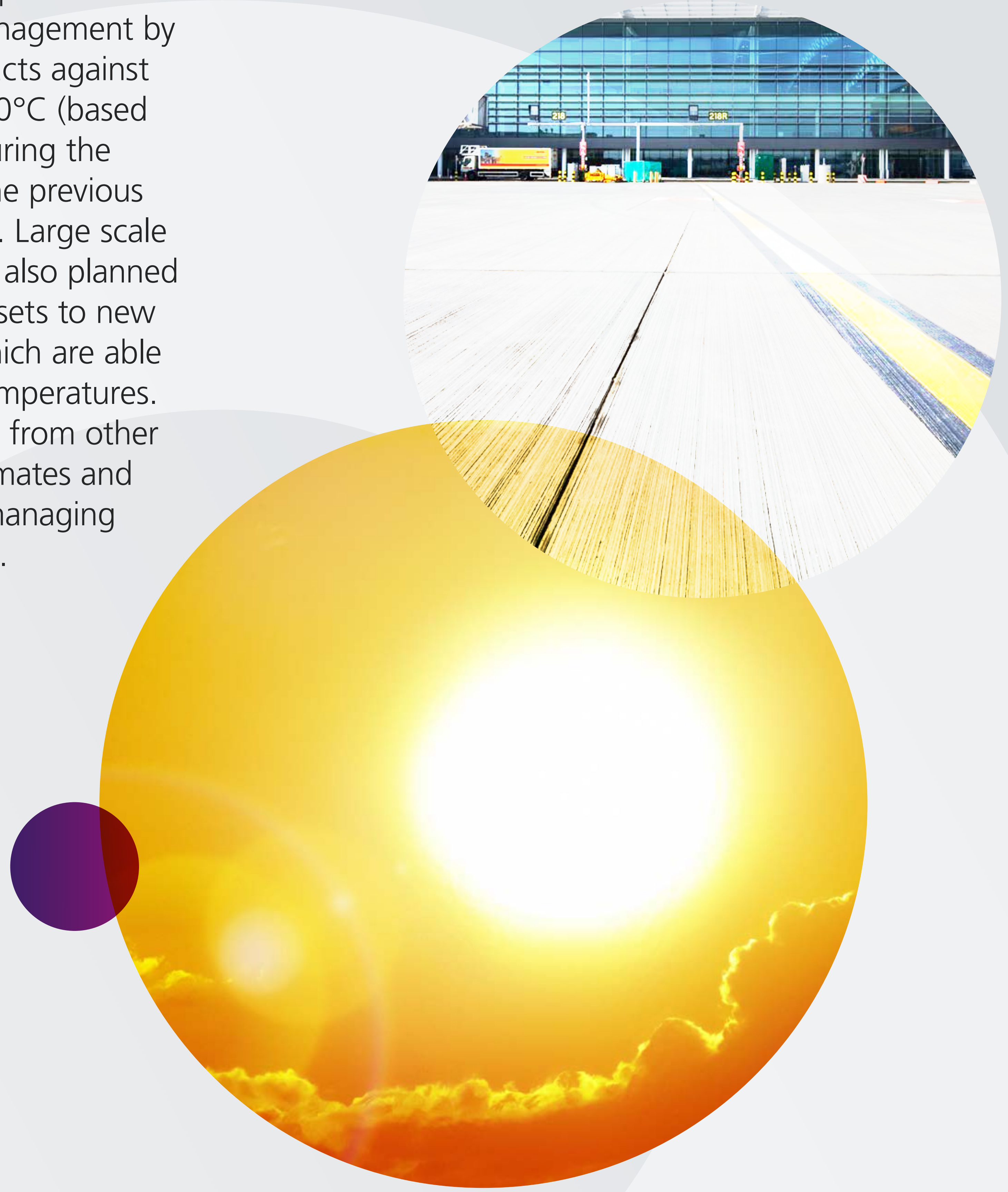
On 19 July 2022, the UK recorded temperatures above 40°C for the first time as part of an unprecedented heatwave event, with Heathrow Airport the first place in the UK to break the 40°C mark, reaching 40.2°C at 12:50 BST. Although Heathrow's infrastructure did not experience severe impacts in comparison to some other UK airports, asset deterioration was still noted across the airport.

WHAT DID WE LEARN?

A review of heat impacts post-event highlighted how successive hot nights followed by hot days are a key factor in determining heat risks. These conditions were amplified by the urban heat island effect, a phenomenon whereby dark-coloured infrastructure and materials such as concrete absorb and retain heat, with hard surfaces also reducing green spaces where cooling impacts of evapotranspiration can take place. This points towards potential synergies between climate adaptation and broader environmental strategies to reduce carbon emissions and improve air quality.

HOW DID WE RESPOND?

We have adopted a proactive approach to risk management by modelling heat impacts against a risk threshold of 40°C (based on data gathered during the event) rather than the previous 32 degree threshold. Large scale asset replacement is also planned by 2050 to adapt assets to new design standards which are able to tolerate higher temperatures. We are also learning from other airports in hotter climates and their strategies for managing during extreme heat.



3.0 CLIMATE CHANGE AND HEATHROW (CONTINUED)

CASE STUDY 2: HIGH WINDS

WHAT HAPPENED?

On 31 January 2022 the recorded mean wind speed at Heathrow was 22.8 m/s with peak gusts of 67 m/s. Assets impacted included air bridges, cladding on buildings and impacts to inflatable roofs and forecourt design features. This occurred during the post-Covid recovery and as a result there were limited impacts to operations. A similar event in August 2023 led to 759 delayed flights and 49 cancellations.

WHAT DID WE LEARN?

This incident highlighted a knowledge gap in our understanding of wind impacts, with the interaction between built up areas and very high winds being poorly understood. This also highlighted the impact of gusting winds on specific assets and showed the importance of reflecting changes in wind conditions in our asset standards and evolving these as our understanding of climate change improves.

HOW DID WE RESPOND?

We have developed a wind model to better understand the nature of wind risks and potential impacts. The model will be updated in future using 1 in 50, 1 in 100 and 1 in 200 return periods. We will also ensure the modelling outputs inform the design and retrofit of new infrastructure to mitigate localised impacts to other assets.

CASE STUDY 3: EXTREME RAINFALL EVENT

WHAT HAPPENED?

On 12th June 2023, Heathrow Airport experienced a significant rainfall event, with 25mm of rain falling over a period of two hours. This intense rainfall led to surface water accumulation across the airport. This was exacerbated by high groundwater levels as a result of rainfall across the catchment. This led to reduced headroom within the drainage network.

WHAT DID WE LEARN?

This highlighted a need to further understand the geographical extent of surface water flood risk and the impacts to the drainage network. We also recognised the current limitations of climate models for assessing flood risk at Heathrow, with limitations in their temporal resolution, typically not providing outputs for periods shorter than 24 hours. This presents significant challenges in predicting and preparing for short-duration, high-intensity rainfall events. There was also the need to understand groundwater and surface water interactions, as elevated groundwater levels caused by rainfall in the upper catchment (e.g. the Chiltern Hills) with a lead time of 12 months can amplify the effects of localised rainfall at Heathrow itself.

HOW DID WE RESPOND?

We have undertaken comprehensive modelling of the on-airport drainage system and the broader catchment area. This includes an in-depth analysis of rainfall distribution and its impact on existing infrastructure, as well as wind and groundwater models to address the compound nature of storm events. We also responded to consultations on the future of UK climate projection data based on our experiences, proposing the inclusion of hourly weather data, including rainfall data.

We have also engaged externally with external stakeholders to better understand risks associated with catchment drainage systems and flooding. We collaborate with a local school to allow them to pump water on to our land when their storage pond is full to prevent surface water flooding in the community. We are also including flooding within our interdependency risk assessment as part of this ARP4 update to better understand our reliance on other asset owners within the catchment.

3.1.2 Summary of projected climate change

Climate projections for Heathrow are presented below and indicate the following changes against the climate baseline (1981-2010) for the 2030s, 2050s, and 2090s under a worst-case (RCP8.5) emissions scenario:

An increase in average and extreme temperatures (Figure 2).

A decrease in average summer precipitation but an increase in extreme summer rainfall events (Figure 3).

An increase in both average winter precipitation and extreme winter rainfall events (Figure 4).

Additional emissions scenarios (RCP2.6 and RCP4.5) are presented in Appendix C.

Figure 2: Projected changes to baseline temperatures

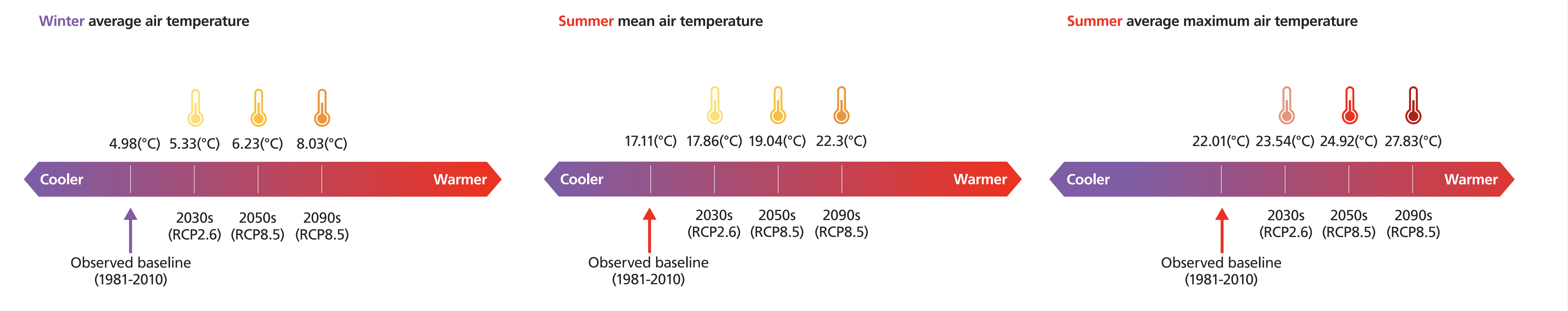
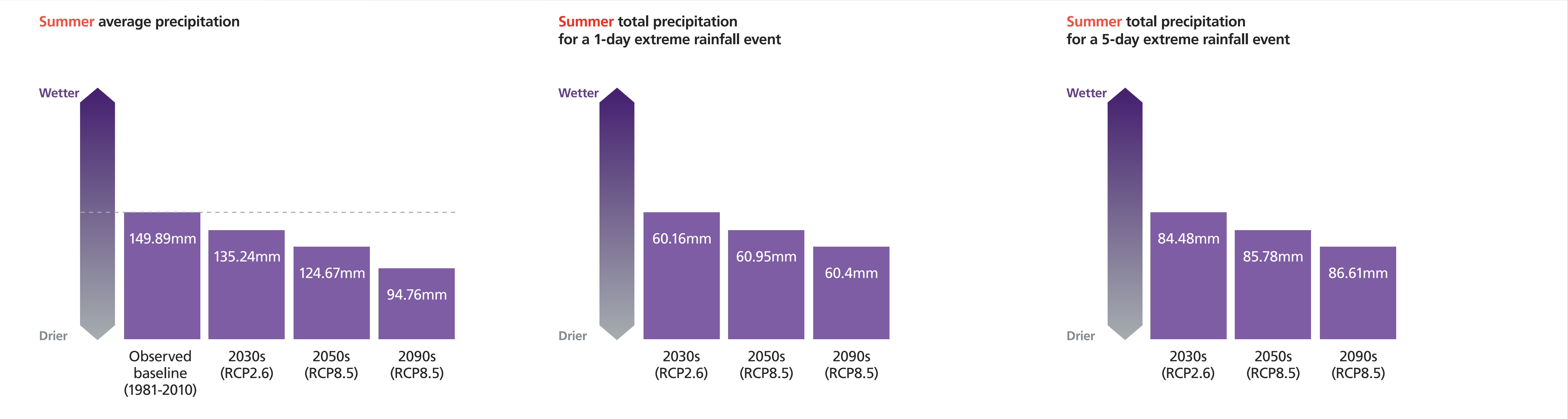
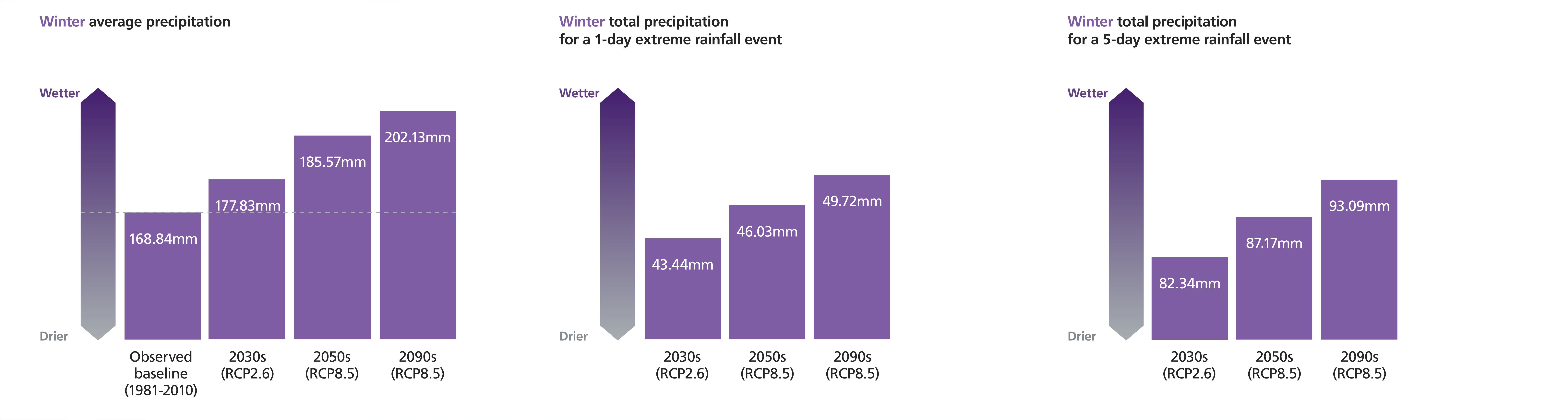


Figure 3: Projected changes to baseline summer precipitation and extreme events



3.0 CLIMATE CHANGE AND HEATHROW (CONTINUED)

Figure 4: Projected changes to baseline winter precipitation and extreme events



Airports in other countries are already experiencing significant operational impacts relating to extreme weather events (see examples). Aviation is being increasingly challenged by extreme weather which is projected to become more frequent and extreme in a changing climate, emphasising the need for adaptation.

Dubai International Airport, UAE

In April 2024, an extreme rainfall event led to flash flooding in Dubai. Areas of the airport were flooded, including the apron, causing the immediate cancellation of ~300 flights. Passengers within the airport were subject to extreme delays and experienced difficulty leaving the airport due to road conditions in the surrounding area.

Salgado Filho International Airport, Brazil

In May 2024, Southern Brazil was subject to extreme flooding from the Guaíba River. Flood waters entered the main terminal and fully submerged the runways and roads. The airport plans to re-open in October 2024 after being closed for 5 months due to impacts from flooding.

4.0 OUR PHYSICAL RISKS

4.1 CCRA UPDATE

4.1.1 Primary updates to ARP3 CCRA

In comparison to ARP3, the ARP4 CCRA highlighted the following key updates:

An increase in scores associated with groundwater and surface water flooding, due to impacts experienced in the June 2023 rainfall event and findings from our asset risk assessment.

An increase in scores associated with winds and particularly strong gusts, due to multiple events and impacts since 2021 and findings from our asset risk assessment.

A relative decrease in scores associated with heat, due to limited impacts from the 2022 heatwave. The asset risk assessment undertaken at a higher threshold of 40°C, also did not show increased impacts compared to the 32°C threshold used at ARP3.

A decrease in scores associated with cold weather and snowfall, due to:

– Projections suggesting a lower likelihood of events occurring as seasonal average temperature increases.

– The winter hazard mitigation plans which were put in place and have been maintained following the 2010 snow incident at Heathrow.

Two risks from ARP3 were classed as no longer significant and have been removed from the ARP4 risk assessment. These were:

R3: High temperatures impacting aircraft take-off weights - our update suggests that consequences are primarily for airlines as cargo shedding to lighten loads will have a limited impact on Heathrow directly.

R13: Extreme low temperatures and airfield de-icing (extreme) - low temperature impacts are still considered within the CCRA but at a single threshold rather than multiple risk thresholds of 0 °C and -7 °C. Therefore, risks R12 (Low temperatures) and R13 (Extreme low temperatures) from the ARP3 CCRA have been combined in this assessment.

New direct risks were also identified including the following:

Risks to power supplies from extreme heat, with the potential to cascade to other critical operations such as IT systems.

Risks to storage and transport of cargo from high temperatures.

Risks of on-airport fires due to heat and extended drought conditions.

Interdependency assessment

The ARP4 CCRA also includes additional interdependency risks which were prioritised as a result of the system mapping and stakeholder consultation (Table 3). As we mature our approach to risk assessment, we have assessed these interdependencies in greater detail than at ARP3, where these were considered at a higher level e.g. power sector or supply chains as a whole. Interdependencies were de-prioritised where impacts were not considered to be material to Heathrow's operations. For example, where a high level of mitigation was in place or consequences were considered to be limited (e.g. dependency on the gas network which will be phased out as part of the Net Zero transition). The longlist of 33 interdependencies has been retained and listed within an integrated system map as an audit trail of all interdependencies considered.

Table 3: Summary of interdependencies assessed

Sector	Summary of interdependencies assessed
Surface access	Rail networks, Road networks
Aviation	Cascading route impacts, Air traffic control systems, Demand at Heathrow
Supply chains	Logistics and supply chains, IT and telecoms assets, External staff and contractors
Power and energy	Distribution network capacity, Transmissions network capacity, Substation assets, Linear infrastucture
Land use and ecoservices	Catchment management, Flood defences
Water and wastewater	Water quality, Water supply, Sewer flooding, Combined Sewer Overflows (CSOs)

4.2 CCRA FINDINGS

4.2.1 Priority risks

From the CCRA, the following priorities were identified and are presented below:

Flooding

Analysis of flood risk since ARP3 has highlighted the complexity of surface water and groundwater flooding events at Heathrow. These are caused by a number of different pathways which can occur in combination or individually. The assessment also highlighted interdependencies with catchment management in the groundwater fed Colne catchment and also the Crane, as well as with the combined sewer network and storm overflow system. Flooding can impact on assets such as buildings, subsurface infrastructure (e.g. data centres, cabling) and also on airfield operations.

Flooding pathways and risks associated with flood hazard include:

Intense rainfall events leading to high levels of runoff at Heathrow itself, overwhelming the drainage network and leading to surface water flooding.

Intense and longer duration rainfall events leading to high levels of runoff and river levels. This can cause flooding directly in exceptional circumstances, but the primary impact of higher river levels is to reduce our ability to discharge surface water runoff from our lagoons.

Intense and longer duration rainfall events leading to high levels of runoff and overwhelming of the combined sewer network. This can lead to storm overflows discharging and reduce our capacity to discharge, limiting the effectiveness of our balancing reservoirs and pumping regimes.

High rainfall events in the upper catchment of the Colne can lead to elevated groundwater levels at Heathrow and infiltration into the drainage network, contributing to both groundwater flooding and surface water flooding.

We have taken action to understand our flood risks through modelling and investments in our drainage network. However, climate projections and the potential for in-combination impacts from multiple interdependencies justifies an increasing risk trend and high scores for both surface water and groundwater flood risks.

Compound storm events

Compound storm events occur when lightning, wind and intense rainfall coincide, for example during the June 2023 events, when flooding coincided with high winds, leading to 730 delayed flights and 78 cancellations. This is a high risk due to the consequences of potential disruption to operations and safety risks to operational staff, e.g. from foreign object debris (FOD). The likelihood of summer thunderstorms and compound events is also expected to increase.

Increased maximum and average summer temperatures

Sustained heatwaves increase fire risk, and can negatively affect passenger experience, airfield structures and surface access routes. Risk scores reflect impacts to operations and health and safety of staff and passengers. Projections for maximum temperature suggest that the 40°C threshold used within the CCRA will be exceeded more frequently. Assets at risk include power and electrical systems for critical infrastructure such as data centres and cold storage, with the potential for cooling supplies to be impacted. Sustained high temperatures (especially overnight), can lead to high temperatures being maintained for assets and materials. These high temperatures are also exacerbated by the urban heat island effect.

Extreme winds

Extreme winds and gusts can impact on airfield operations and structures (e.g. cladding, masts). Higher risk scores reflect impacts to operations through flow rate restrictions and reduced throughput, in addition to safety risk from FOD. There is also high uncertainty associated with wind projections and how peak gusts will affect structures.

4.2.2 Summary of interdependencies

A summary of our interdependency analysis is provided below, grouped by sector:

Power and energy

Power sector assets can be susceptible to impacts from climate hazards such as heat, winds, lightning and flooding. Flood risks to electrical substation assets are a particular concern, with the potential for larger scale disruption, whereas temperature or wind and debris related impacts are limited to individual assets e.g. transformers or switchgear. Disruption can also last for longer during storm events due to safety risks to operatives from lightning or debris. In the longer term, higher temperatures will also place greater strain on capacity within both distribution and transmission networks.

Land use and eco-services

Intense and longer duration rainfall events can increase groundwater levels and runoff in upstream catchments. This means we are reliant on catchment management upstream by other landowners to mitigate much of our flood risk. For example, through the implementation of nature-based solutions and sustainable urban drainage systems (SuDS) to improve infiltration and 'slow the flow' from higher rainfall, reducing the potential for groundwater, surface water and fluvial flooding. Flood defences also protect our assets from fluvial flooding in the upper tributaries of the Thames.

Water and wastewater

Climate hazards such as heat and intense rainfall can test the resilience of both wastewater and clean water networks which we depend on. The overwhelming of the combined sewer network can impact on our ability to discharge effluent as well as manage surface water. If we are unable to discharge, then this could lead to sewer flooding with negative reputational and health and safety impacts. Combined sewer overflows also limit discharges from our lagoons. This presents a particular challenge during winter periods, as heavy rainfall following periods of extreme cold can lead to high volumes of de-icer effluent in storage.

Our water supply can also be impacted by high temperatures increasing the risk of Legionella or other bacterial growth in our water supply network. Extended droughts can also lead to water use restrictions being imposed.

Aviation

Climate hazards such as storms and high winds can lead to cascading route impacts or flow rate restrictions being imposed, which reduce aircraft throughput. This impacts on airspace and airfield operations, with communities also impacted by scheduling disruption and increased night flights. Projections suggest there is increased potential for greater regional impacts on multiple airlines as tropical storms and summer storms intensify, while alterations to the jet stream can also lead to planes arriving earlier or later than scheduled.

Air traffic control systems and assets (e.g. radar, control towers) are also vulnerable to winds, storms and extreme low temperatures, although impacts to airspace and Heathrow's operations are likely to be limited geographically. In the longer term, demand at Heathrow may be impacted by climatic changes affecting the commercial viability of certain routes and destinations.

Supply chains

Supplier assets such as data centres and cable networks will be increasingly at risk from flooding and extreme heat, which could cascade through to our IT and communications systems. The consequences of IT system failures will also be impacted by increased demand for data and monitoring. Our logistics network is also critical to ensuring materials (including scarce just-in time components) and services can be provided for both operation and asset maintenance. Disruption to port and road networks can affect this wider logistics chain. Our cargo operations are also sensitive to supply chain disruption due to the specific transportation requirements involved (e.g. cold chains or fast transfer to avoid spoiling). The majority of Heathrow's ground handlers and construction workers work for our contractors and can be exposed to climate hazards such as heat and wind. Bad weather can compress delivery schedules due to lost working days, with time and cost impacts.

Surface access

Impacts to the road and rail networks from hazards such as flooding, wind, lightning and heat can cause delays to passenger journeys as well as creating congestion in the wider community, impacting on Heathrow's reputation and delaying passengers. Closures to rail lines can also increase vehicle traffic, with forecourt congestion impacting on air quality.

4.0 OUR PHYSICAL RISKS (CONTINUED)

4.2.3 Overall summary of ARP4 CCRA

At ARP3 we identified three priority risks:

High levels of precipitation leading to both groundwater flooding and surface water flooding.

High temperatures leading to infrastructure damage affecting the structural integrity of airfield structures such as runway and apron tarmac.

Low temperatures leading to increased de-icing requirements and challenging winter contingency plans.

The updated CCRA suggests that **groundwater** and surface **water flooding** remain a priority risk and are driven by both intense rainfall events and higher rainfall over extended durations across the catchment leading to elevated groundwater levels. High temperatures remain a priority risk although some scores have decreased since ARP3, as we have improved our understanding of heat impacts.

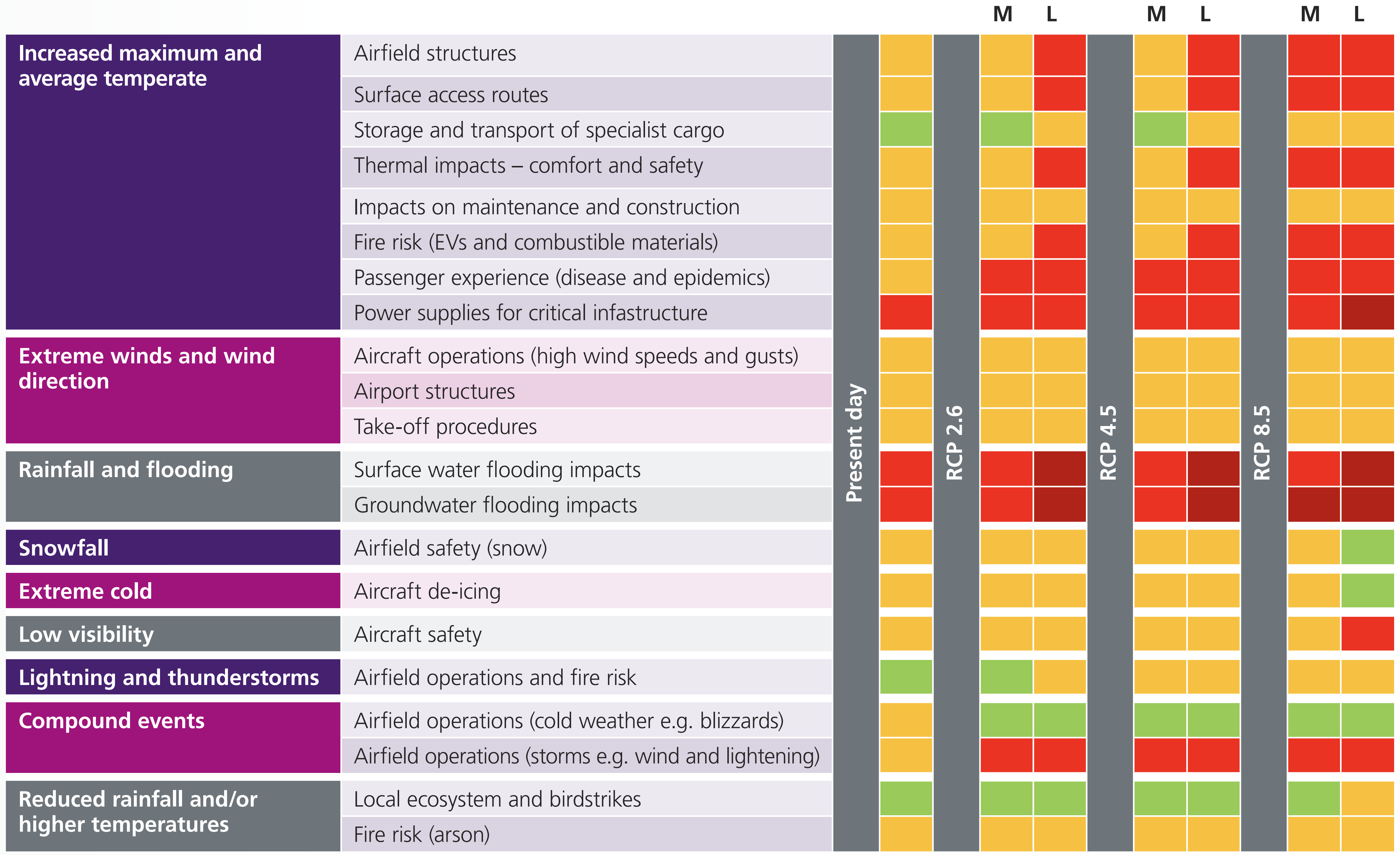
However, low temperatures are no longer considered to be a priority risk. Instead, **compound storm events** are now considered to be our other priority risk.

The interdependency analysis also highlighted a number of key risks and interfaces with other organisations, where we have less control in managing, mitigating and responding to climate hazards. This leaves us vulnerable to cascading risk or in-combination impacts which may exacerbate direct risks from hazards such as rainfall and heat. Our priority interdependencies are the impact of **catchment management on flood risk** and **substation assets on the resilience of our electricity supply.**

4.2.4 Summary of climate and interdependency risks

Figure 5 provides a summary of the CCRA findings for our direct risks, showing the different risk trends across medium-term and long-term horizons for all 3 scenarios (RCP 2.6, 4.5 and 8.5).

Figure 5: Summary of climate risk scores



Representative concentration pathway (RCP):

- **RCP 2.6** radiative forcing of 2.6W/m² by 2100, global warming below 2°C
- **RCP 4.5** radiative forcing of 4.5W/m² by 2100, global warming of around 2.4°C
- **RCP 8.5** radiative forcing of 8.5W/m² by 2100, global warming of around 4.3°C

Timelines:
M (medium-term 2025)
L (long-term 2090)

Climate risk score:

- 0 < 3
- 4 < 9
- 10 < 19
- 20 < 25

See p.8 for more details in the 'risk assesment matrix'

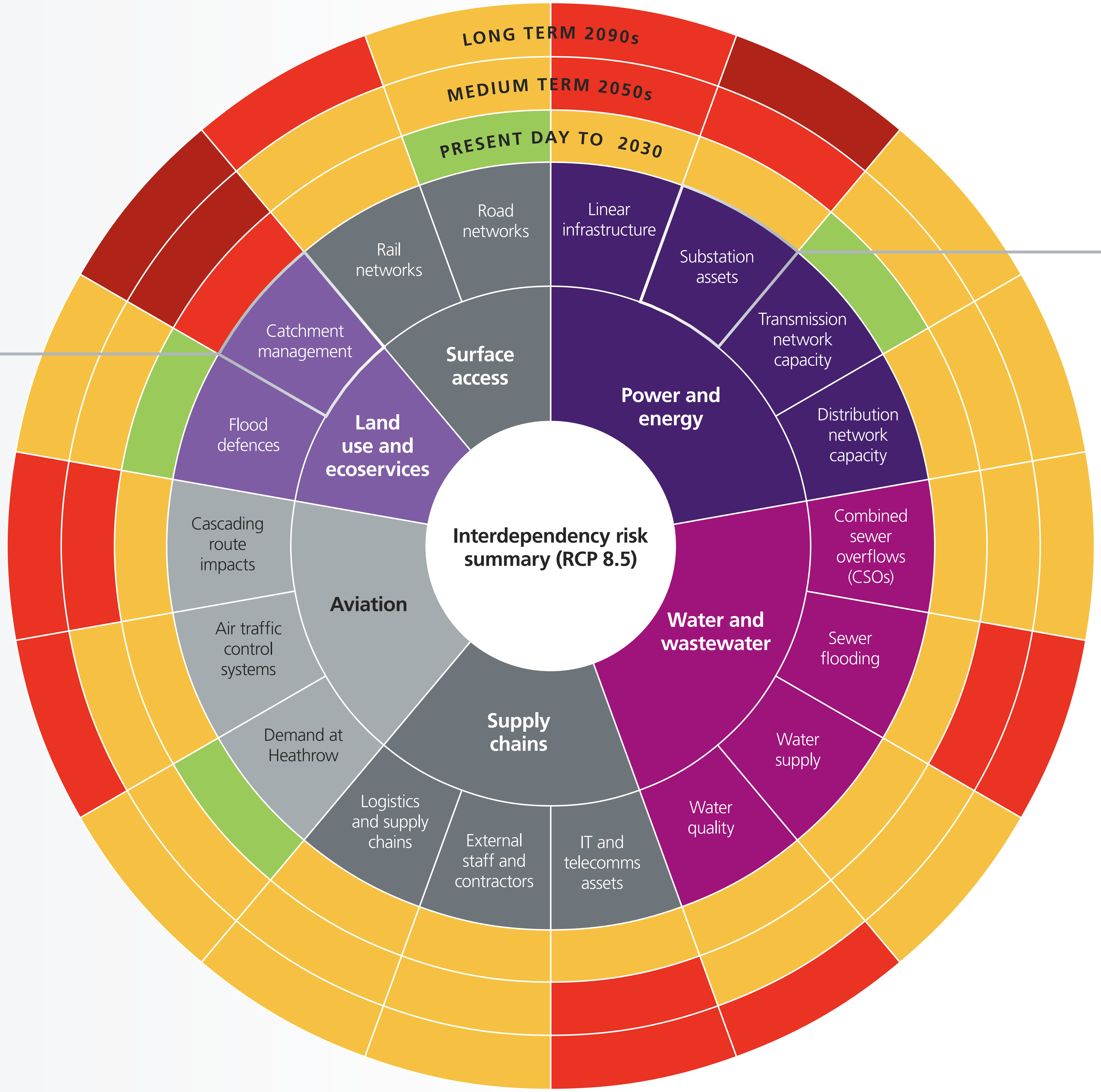
Figure 6 provides a summary of our interdependency risks, highlighting our key risks and showing each of the key sectors we are dependent on and how these risks change over the three-time horizons. Risk scores are shown for the worst-case RCP8.5 scenario only.

Figure 6: Summary of interdependency risk scores

Climate risk score:

- 0 < 3
- 4 < 9
- 10 < 19
- 20 < 25

See p.8 for more details in the 'risk assesment matrix'



Flood risk management

- Flooding at Heathrow is influenced by rainfall in the Chilterns with a lag time of several months.
- Holistic catchment management is required to address surface water and groundwater flood risks.
- Interdependencies with catchment management and the combined network (e.g. CSOs) highlight the multi-sectoral challenges associated with managing flooding.

Electricity supply

- We are dependent on the resilience of key assets such as power substations within the wider grid.
- Power supplies are critical for airport operations and disruption can cause impacts to flight schedules and passenger experience with financial and reputational consequence.
- The resilience of our electricity supply will be increasingly critical as we move towards a decarbonised future.

5.0 ADAPTATION PROGRESS UPDATE

5.1 OUR APPROACH TO CLIMATE ADAPTATION

We are committed to setting a clear direction and approach to delivering climate adaptation at Heathrow through an Adaptation Strategy. Our Strategy is currently in development and will be completed in 2025, encompassing the objectives, goals, strategies, targets and metrics required for Heathrow to be a well-adapting airport. This will provide an overarching framework for adaptation, from risk assessment through to investment in adaptation actions. Our aim is for adaptation planning to be incorporated as part of business-as-usual operations and investment planning.

At ARP3 we identified adaptation actions in the following focus areas:

Risk framework:
Embedding and managing climate risk

Risk assessment:
Further understanding of climate risk and mitigation

Planning and delivery:
Investment case, Evolving standards, Operational improvements

Table 4 provides a summary of the progress that we have taken to address these actions, under five new categories:

Embedding and manage climate risk within the business

Improving the resilience and adaptation of our asset base

Developing our people and processes to respond to climate change

Understanding system risks and interdependencies

Assessing risks to our networks and destinations

Table 4: Progress against ARP3 actions

Action category	Summary of progress	
Embedding and managing climate risk within the business	• We have continued to refine our approach to embedding and managing climate risk within the business through implementation of CFD principles. • We are aligning our functional risk registers with overall principal risks to embed and manage risk at a departmental level.	• We have included adaptation requirements within our Thermal Strategy and factored increased energy demand for cooling into our Energy Strategy.
Improving the resilience and adaptation of our asset base	• We reviewed and updated our physical risk assessment as part of our preparation of ARP4. This was supported by a detailed asset systems risk assessment undertaken in 2023. • We have also taken action to develop the resilience of our asset base itself through: – Two rounds of surface water drainage modelling, groundwater modelling and wind modelling, and calibration of drainage and wind models – Simulating the impact of future extreme weather events with different return periods to test preparedness – Increasing drainage/storage capacity in the Eastern Balancing Reservoir and new sheet piling and tilting weirs to control flow	– The introduction of 'no net gain' in hardstanding to reduce adverse impacts to runoff and drainage. – Ongoing landscaping work including the diversification of the airside grass mix for increased resilience to drought and increased infiltration to mitigate surface runoff and flood risk – Ongoing monitoring of critical infrastructure (e.g. degrees of movement during storm and high wind events) – Routine sampling and monitoring of critical assets (e.g. to mitigate Legionella risk during hot weather)
Developing our people and processes to respond to climate change	• We have maintained our processes established over the last decade to manage winter hazards, continuously improving refining and improving these where possible - such as through communication with the community.	• We have undertaken internal engagement on climate adaptation as part of our assessment of climate risks, interdependencies and the development of our adaptation strategy.
Understanding system risks and interdependencies	• We have undertaken an interdependency risk assessment and identified potential actions and areas to target engagement moving forwards.	• We have improved our understanding of system risks across infrastructure through collaboration with best practice forums across industry (e.g. CIRIA, DfT) and engagement with catchment stakeholders (e.g. Royal Parks, Thames Water Strategic Group, local communities). We have also collaborated with government (e.g. DfT, Defra, London Climate resilience review) in responding to consultations on climate risk.
Assessing risks to networks and destinations	• We have started considering climate risks within our network and the destinations we serve and have included a 2 and 4 degree scenario analysis in our passenger forecasting process.	

5.2 PLANNED ACTIONS TO ADDRESS ARP4 PRIORITY RISKS

The CCRA has highlighted priorities for further action. Our planned adaptation actions, their categorisation and the risks they address are presented in Table 5. We will also explore how adaptation planning can deliver co-benefits for climate mitigation and biodiversity (e.g. through Nature-based Solutions).

Table 5: Planned actions to address ARP4 priority risks

Hazard	Summary of planned adaptation action
Flooding	• Setting out the investment case to adapt to more extreme weather to our airline customers and the CAA in our business plan for our next five-year regulatory settlement period 2027 – 2031 (by June 25). • Testing preparedness, the effectiveness of existing flood risk mitigations and business resilience. • Completion of the Eastern Balancing reservoir to provide additional storage. • Exploring opportunities to deliver green infrastructure on-site to align with our Nature Plan and maximise flooding and biodiversity benefits. • Further engagement with catchment stakeholders to improve infiltration and habitat restoration in upstream catchments.
Heat	• Reflecting future climate scenarios (2 and 4°C) and temperature increases as part of asset strategies and plans. • Continuing to review our operating procedures for terminal buildings with relation to future temperatures. • Continuing to build adaptation into proposed Net Zero transition projects to ensure that new cooling and energy infrastructure is resilient to climate risks.
Compound storm events (including high winds)	• Using our updated wind model (with different future return periods) to assess impacts on infrastructure and understand which structures are at risk. • Assessing the potential to replace cladding, advertising, structures and airbridges in high-risk areas based risk assessment.

5.3 JOINT ACTIONS TO ADDRESS INTERDEPENDENCY RISKS

As part of our adaptation planning, we will continue to work collaboratively with a wide range of stakeholders to further our understanding of interdependency risks and develop joint actions to mitigate these. We will prioritise supporting government-led initiatives and frameworks to co-ordinate multi-sector assessment of cascading risk and adaptation planning.

To provide a more detailed understanding of our risk position, we will also prioritise engagement in the following areas:

Catchment management – through further engagement with catchment stakeholders to work towards collaborative management. We will also continue discussions with relevant organisations to improve the granularity of rainfall data and inform our monitoring of flood risk.

Suppliers of critical infrastructure (e.g. water, power and energy, IT systems) – targeted engagement with suppliers and organisations identified through our interdependency risk assessment to understand the vulnerability of key assets.

Aviation – continued engagement with the aviation sector (e.g. NATS, EUROCONTROL, European Aviation Climate Change Adaptation Working Group) to understand climate risks to our destinations and the wider aviation network.

APPENDIX A

CLIMATE PROJECTION DATA

Table 6: Climate projection data obtained to inform the ARP4 CCRA update

Climate variable	Unit	Emissions scenario	Temporal resolution	Time horizon	Return period	Spatial resolution	Spatial grid	Data source
Maximum air temperature anomaly	°C	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
Minimum air temperature anomaly	°C	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
Maximum air temperature (Extreme)	°C	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes
Precipitation change (%)	mm	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	N/A	25km	512500, 187500	UKCP18 Probabilistic Projections
1-day total precipitation	mm	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes
5-day total precipitation	mm	RCP2.6	Seasonal	2020-2049 2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes
		RCP4.5 & RCP8.5	Seasonal	2040-2069 2070-2099	100-year	25km	512500, 187500	UKCP18 Probabilistic Projections for Climate Extremes

APPENDIX A (CONTINUED)

Table 6: Climate projection data obtained to inform the ARP4 CCRA update (Continued)

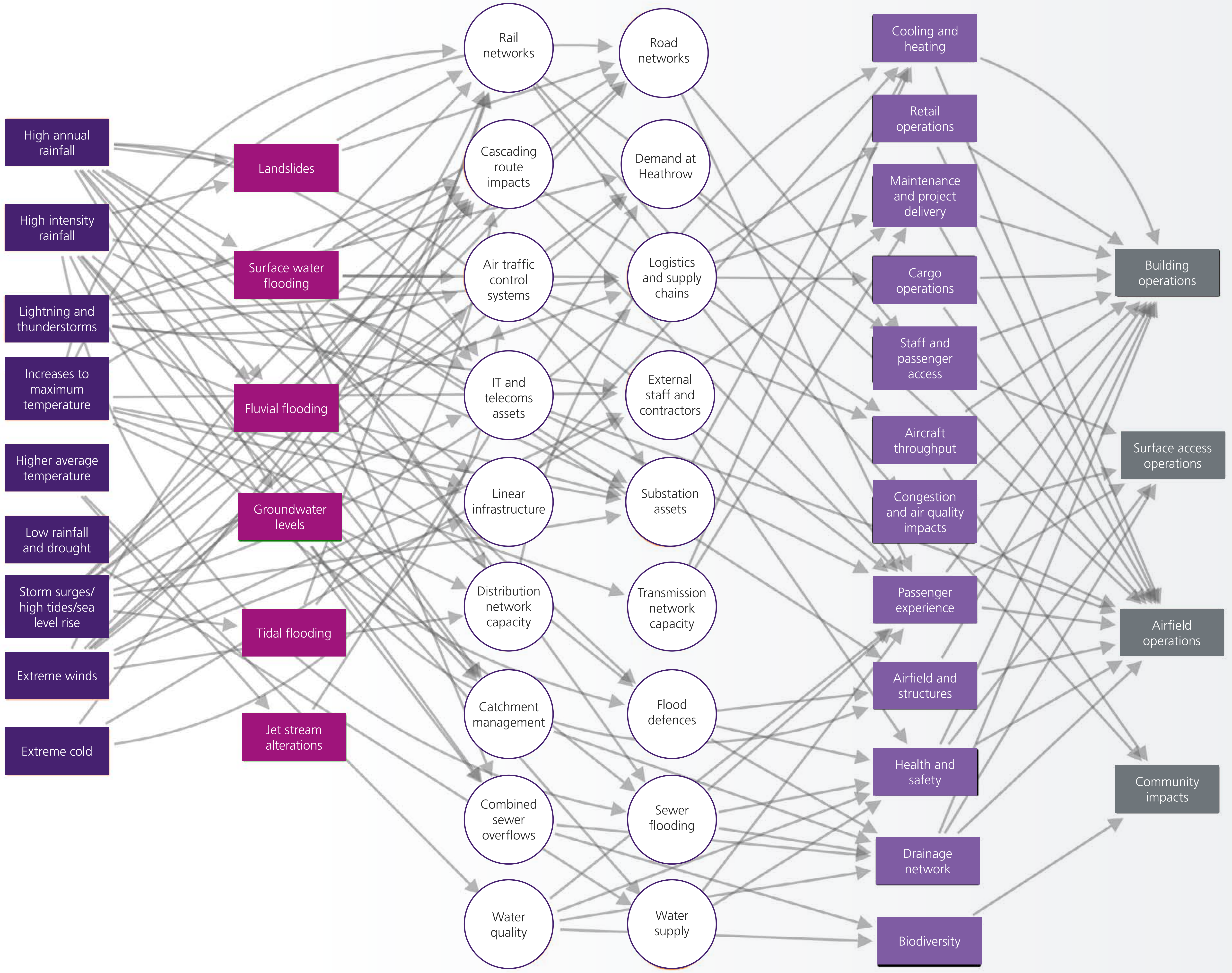
Climate variable	Unit	Emissions scenario	Temporal resolution	Time horizon	Return period	Spatial resolution	Spatial grid	Data source
Mean wind speed	M s-1	RCP8.5	Seasonal	2021-2040 2061-2080	N/A	12km	510000, 174000	UKCP18 Regional Projections
Wind speed gust maximum	M s-1	RCP8.5	Seasonal	2021-2040 2061-2080	N/A	2.2km (regridded to 5km)	(502500, 177500), (502500, 172500), (507500, 177500), (507500, 172500), (512500, 17750), (512500, 172500)	UKCP18 Local Projections
Eastward wind	M s-1	RCP8.5	Seasonal	2021-2040 2061-2080	N/A	2.2km (regridded to 5km)	(502500, 177500), (502500, 172500), (507500, 177500), (507500, 172500), (512500, 17750), (512500, 172500)	UKCP18 Local Projections
Northward wind	M s-1	RCP8.5	Seasonal	2021-2040 2061-2080	N/A	2.2km (regridded to 5km)	(502500, 177500), (502500, 172500), (507500, 177500), (507500, 172500), (512500, 17750), (512500, 172500)	UKCP18 Local Projections
Surface snow amount	mm	RCP8.5	Seasonal	2021-2040 2040-2069 2061-2080	N/A	12km	51000, 174000	UKCP18 Regional Projections
Total cloud cover	%	RCP8.5	Seasonal	2021-2040 2040-2069 2061-2080	N/A	12km	51000, 174000	UKCP18 Regional Projections

APPENDIX B

INTERDEPENDENCY RISK MAP

Figure 7: Our interdependency summary risk map which can be filtered by each interdependency or climate hazard to look at risks in isolation or in combination.

- Climate hazard
- Environmental pathway
- Interdependency
- Operations and activities
- Impacts
- Dependency relationship



APPENDIX C

CLIMATE SCENARIOS RCP 2.6

Figure 8: Projected changes to baseline temperatures

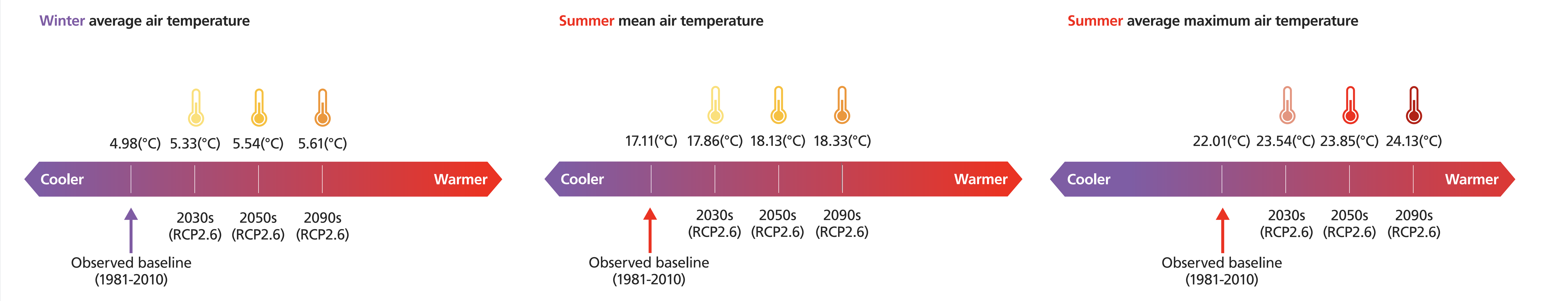
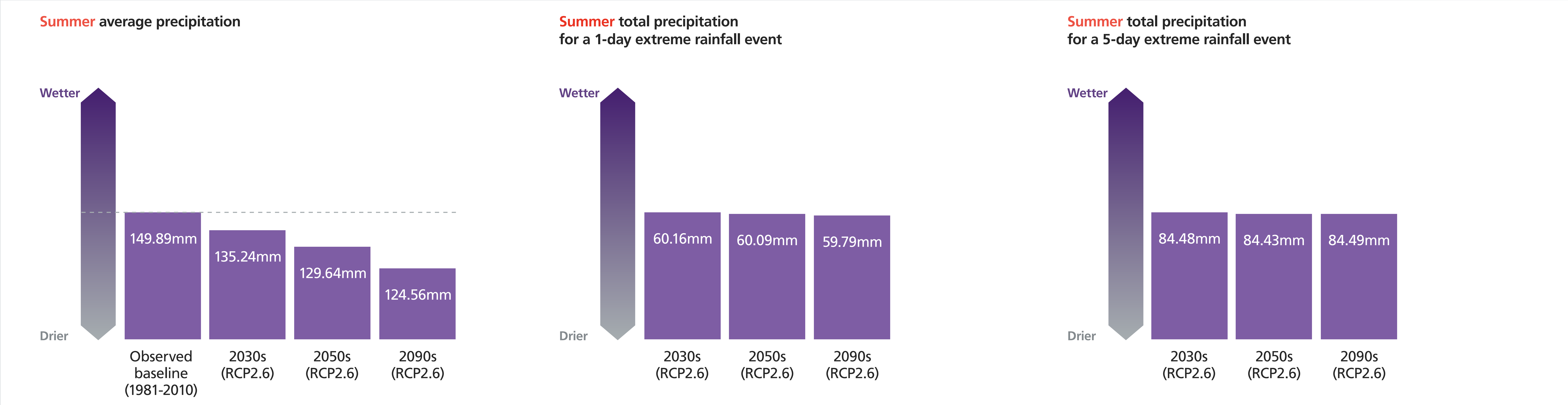


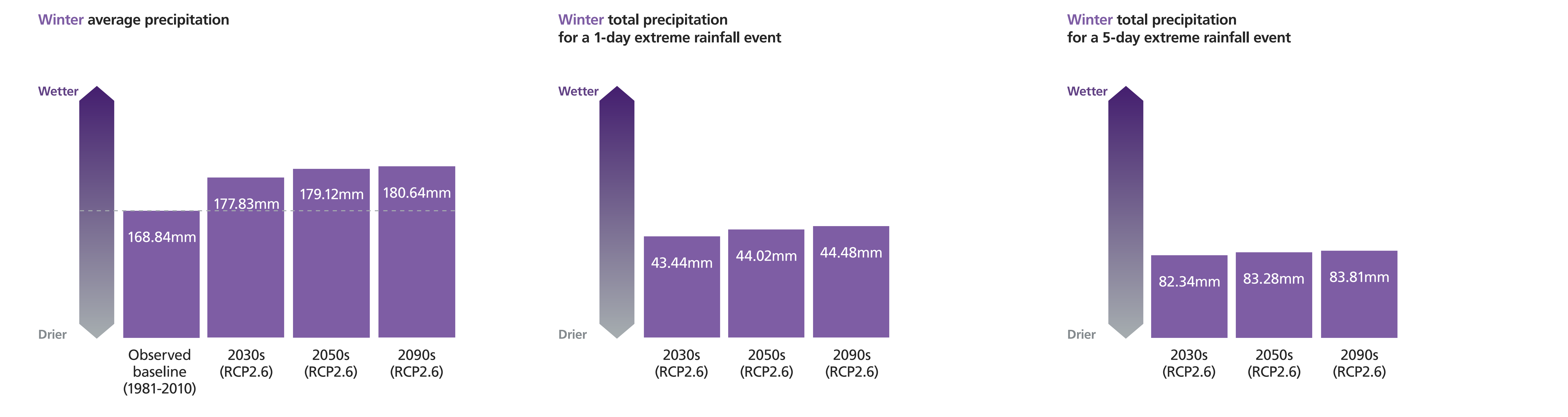
Figure 9: Projected changes to baseline summer precipitation and extreme events



APPENDIX C (CONTINUED)

CLIMATE SCENARIOS RCP 2.6 (CONTINUED)

Figure 10: Projected changes to baseline winter precipitation and extreme events



APPENDIX C (CONTINUED)

CLIMATE SCENARIOS RCP 4.5

Figure 11: Projected changes to baseline temperatures

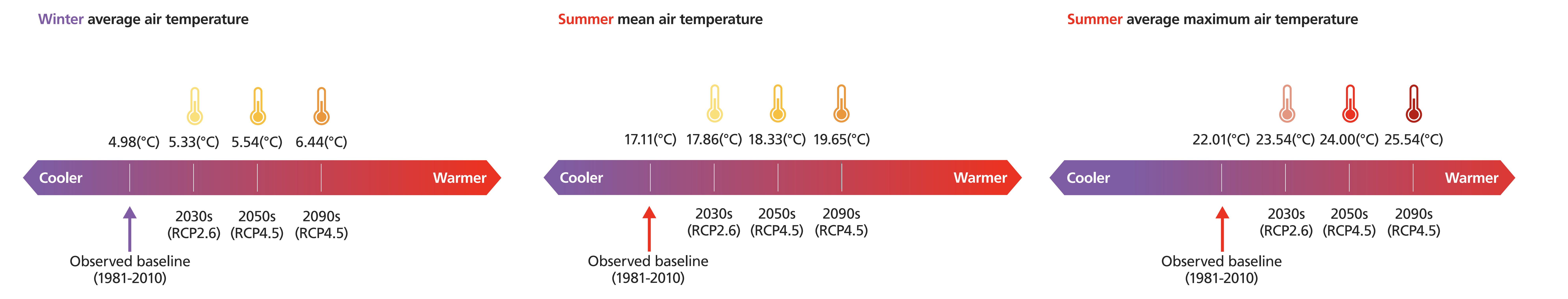
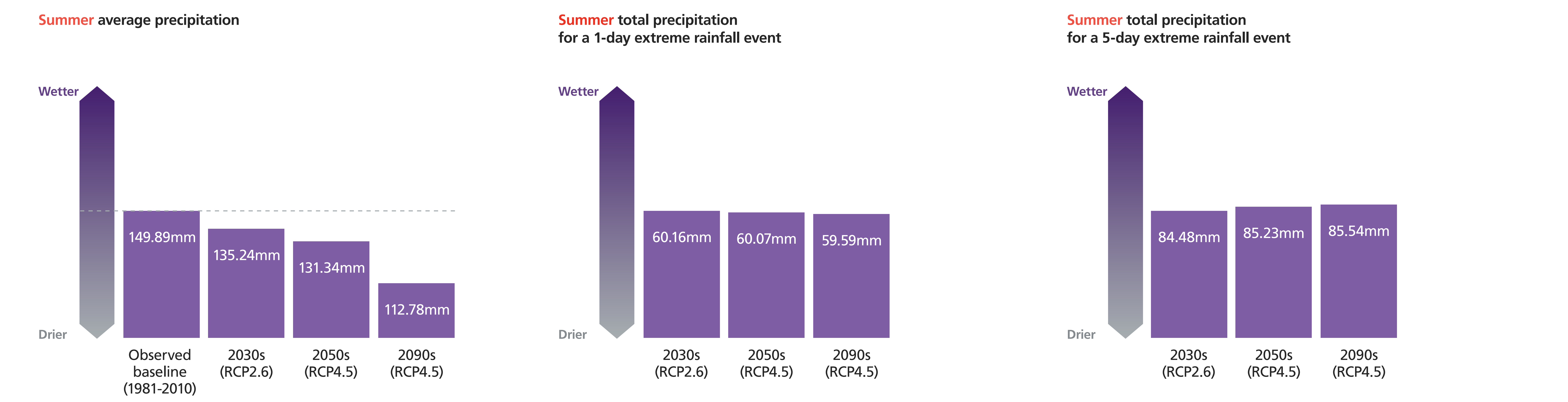


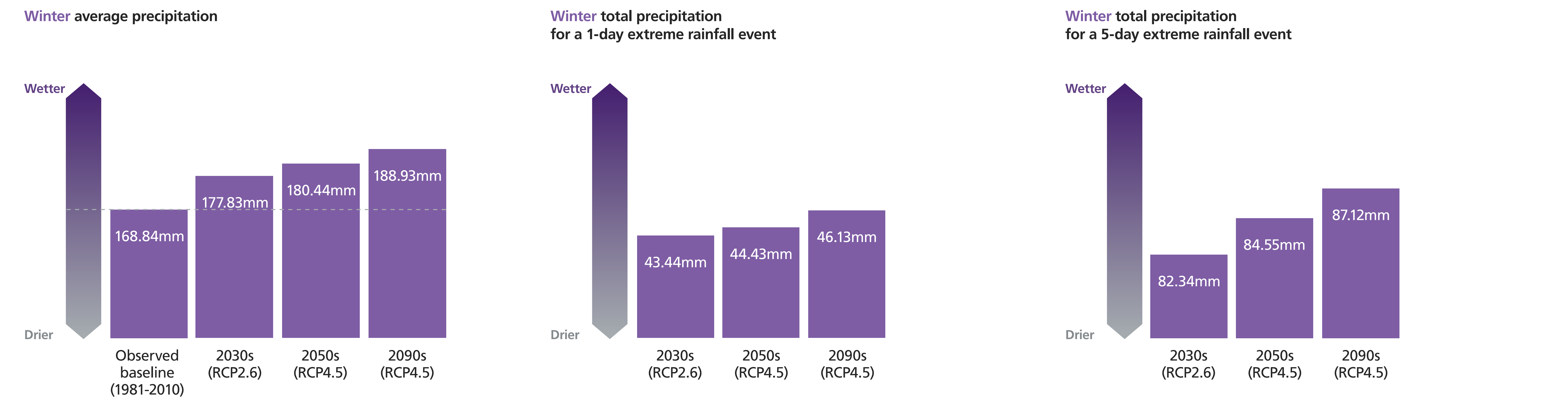
Figure 12: Projected changes to baseline summer precipitation and extreme events



APPENDIX C (CONTINUED)

CLIMATE SCENARIOS RCP 4.5 (CONTINUED)

Figure 13: Projected changes to baseline winter precipitation and extreme events



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