Brighton & Hove City Council

ARUP

Brighton & Hove City Council

Climate Risk & Vulnerability Assessment & Adaptation Action Plan

Summary Report

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1 Background

Brighton & Hove City Council (BHCC) is committed to climate action for a cleaner, healthier, and fair future.

In 2018, BHCC declared a climate and biodiversity emergency and pledged to be carbon neutral by 2030. Since this commitment, BHCC has commenced a programme of works to reduce emissions. However, work to understand and manage the risks posed by the physical impacts of climate change is less advanced. This report addresses this gap and represents the first comprehensive piece of work on climate adaptation by the council since 2011.

Average global temperatures have increased by 1.1°C since the pre-industrial era, driven by increasing concentrations of greenhouse gases[1] and we are confident that the climate will continue to change over the course of the 21st century. Warmer, wetter winters and hotter, drier summers are expected, alongside increasingly extreme weather events like heatwaves and storms. These changes have the potential to catastrophically affect the people, economy, and natural environment of Brighton & Hove, as well as adversely affecting the assets and operations of the council. Therefore, it is vital that action is taken readily to understand and address the impacts of the changing climate by implementing adaptation measures.

This report summarises the council's latest work on climate adaptation. It first presents a thorough literature review, setting out the latest observations and climate projections, and the policy and legislative framework. It then goes on to present the approach to and results of the Climate Risk and Vulnerability Assessment (CRVA). This is brought together to inform a list of recommended adaptation actions for BHCC to implement, known as the Adaptation Action Plan. Finally, next steps and recommendations are set out.

This report has been informed by many stakeholders across Brighton & Hove. To be successful, adaptation requires multiple actors, and if implemented, the action plan will require actions from a range of different sectors and institutions from planning and policy to investment and research. We hope that this report will enable future planning, policy, and projects to consider the changing climate, inform service-level investment and response across sectors, and help drive action to mitigate damage costs.

Figure 1 - Flooding in Brighton (Source: Brighton & Hove City Council, n.d. (online). Available at: brighton-hove.gov.uk).

[1] NASA (n.d.): World of Change: Global Temperatures. [Available online].

2 Climate change in the UK

2.1 Observations & projections

Global average temperatures, including those in the UK, have increased at an unprecedented rate since the pre-industrial era, driven by a rise in greenhouse gas emissions.

The rate of temperature increase has continued to grow; the most recent *State of the UK Climate 2022* report[2] shows how UK temperature extremes are changing much faster than average (based on 1960 to 2022 UK daily average maximum and minimum temperatures), with 2022 being the warmest year on record for the UK. Figure 2 shows the mean temperature increase above the 1961 – 1990 (left) and 1991 – 2020 (right) baseline long-term averages for year 2022. The highest anomalies relative to 1961 – 1990 were across England (1.9°C) and the highest anomalies relative to 1991 – 2020 were across central and eastern England (+1.0°C)[2].

As for the future, hot summers are expected to become more common, with temperatures projected to continue to increase. The UK Climate Projections 18 (UKCP18)[3] show an increased chance of milder, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes. Moreover, the chance of seeing a summer as hot as 2018 - when daytime temperatures in parts of the country consistently topped 30°C and a record-breaking[4] temperature of 38.7°C was recorded by the Met Office in Cambridge[5] - has increased from less than 10%, to between 10-20% currently and is expected to rise to 50% by mid-century.

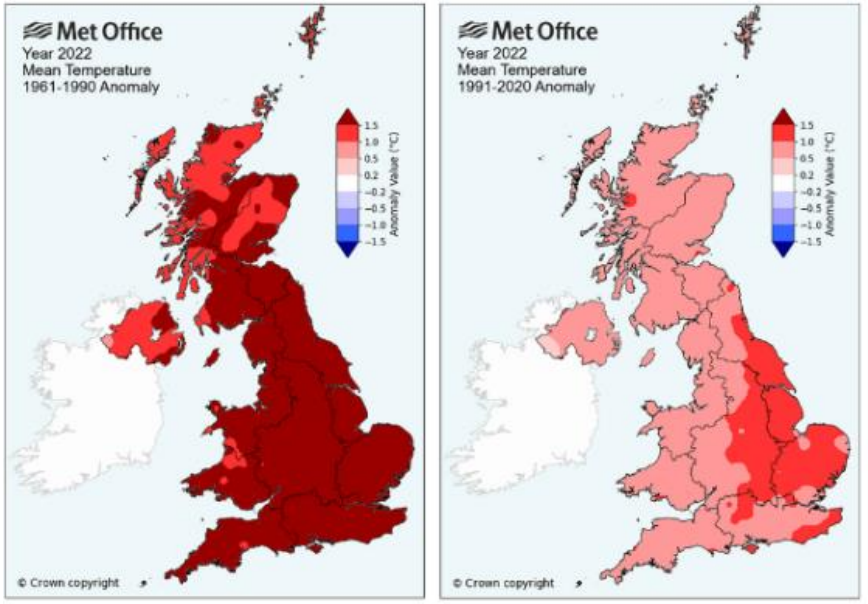

Figure 2 - Mean temperature anomalies relative to 1961–1990 (left) and 1991-2020 (right) for year 2022 (Source: Met Office, 2023).

The UK has recently experienced several very serious flooding events, driven by heavy and intense rainfall, as well as rivers bursting their banks. Relevant examples for Brighton are outlined in Section 3.1.

Future climate projections estimate that UK winter precipitation will increase significantly, and summer precipitation will decrease significantly. However, the variability in rainfall is also expected to increase, meaning that we can expect to see more intense storms in summer months, driving 'flash' flooding[3]. Unlike the observed and anticipated trend in increasingly intense storm-driven rainfall, there is no observed trend in increasing high winds (maximum gust speeds) since records began in 1969. Winter wind speeds are anticipated to increase between 2050 and 2100, accompanied by an increase

[2] Met Office (2023): State of the UK Climate. [Available online].

[3] Met Office (2018): UKCP18 National Climate Projections. [Available online].

[4] The record-breaking temperature of 2018 has since been broken in summer 2022, when a temperature of 40.3°C has been recorded in Coningsby, Lincolnshire. (Source: Carbon Brief).

[5] Met Office (2019a): Study examines drivers of 2018 UK summer heatwave. [Available online].

in the frequency of winter storms. However, the overall projected increases in wind speeds are small compared to the inter-annual variability observed in recent years[6], and so the future risk is considered similar to present-day.

Meanwhile, water companies have been struggling to meet customer demand for water, due to a range of short to long-term deficits in total rainfall. This has led to water restrictions in many parts of the country in recent years, including across the Thames Valley, Hampshire, Kent, and parts of Sussex in 2022[7]. Currently, the Environment Agency categorises most of England as seriously water stressed, including south-east, east, and central England. With hotter, drier summers and less predictable rainfall, this will also worsen existing drought and water scarcity risk.

Climate change is also driving an increase in sea levels, both historically and in future projections[8]. This, alongside more extreme storm events, is expected to increase the risk of coastal flooding, coastal erosion, and saline intrusion of groundwater aquifers.

Since the 1900s, the UK sea level has risen by 18.5cm. However, this increase is not linear, and there is observational evidence that the rate of sea level rise is increasing, with over 60% (11.4cm) of the total rise having occurred in the past 30 years. Sea level rise is also not uniform around the coastline of the UK, with the South of the country being at risk of higher rises than the North[3].

Beyond 2100, sea level rise is projected to increase at all locations around the UK under all climate change scenarios. However, the rate of increase will vary depending on the rate of success in reducing global greenhouse gas emissions in the future[3]. A study published in 2022[9] found that up to 200,000 homes and businesses in England could be completely submerged by 2050, as the mean sea levels around England could be up to 30-35cm higher by mid-century. Figure 3 shows the locations of properties at risk from flooding from sea level rise by 2050, with the scenario assuming a global temperature rise of 2°C by 2100[10].

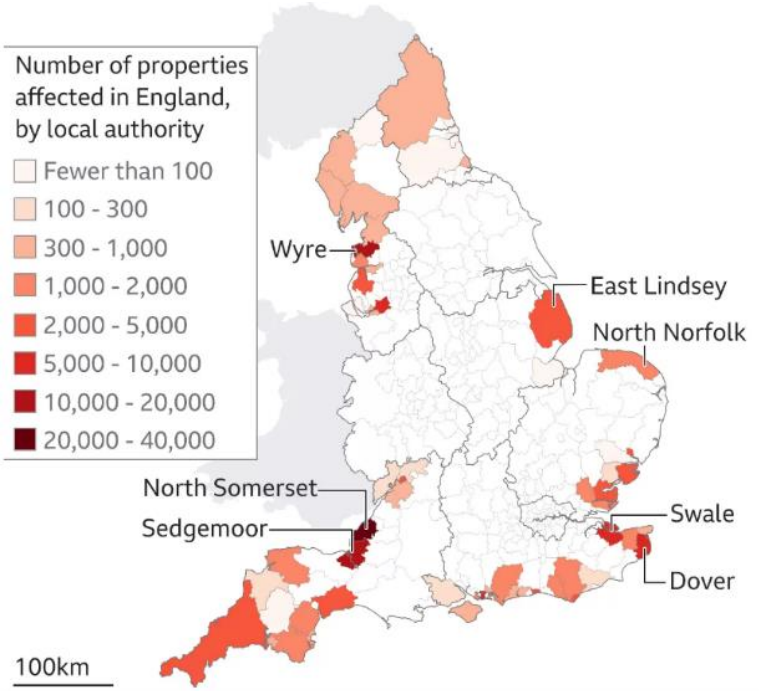

Figure 3 - Properties at risk from flooding from sea level rise by 2050 (Source: Sayers et al/UEA via BBC 2022 (online). Available at: https://www.bbc.co.uk/news/science-environment-61795783).

[6] Met Office (2021) Recent trends and future projections of UK storm activity. [Available online].

[7] ITV News (2022): Is there a hosepipe ban in my area and which regions could be next? [Available online].

[8] Met Office (2019b): UK sea level projections to 2300. [Available online].

[9] Tyndall Centre for Climate Change Research (2022): 150,000 – 200,000 homes and businesses in England at risk of sea level rise from the 2050s. [Available online].

[10] BBC (2022): Climate change: Rising sea levels threaten 200,000 England properties. [Available online].

2.2 Policy and legislative framework for action

Climate risk and adaptation has been incorporated into UK policy and legislation, alongside ambitions to reduce greenhouse gas emissions to reduce future climate change. The **Climate Change Act (2008)** committed the UK government to set legally binding targets to reach net zero by 2050, implemented several requirements for climate adaptation and set up the Committee on Climate Change. Through the Act, the UK Government is required to conduct a Climate Change Risk Assessment every five years to identify climate risks, followed by a National Adaptation Programme to address those risks. In 2022, it published the third and latest Climate Change Risk Assessment (CCRA3), which identified 61 climate risks and opportunities to the country associated with climate change, organised under five categories:

1. Natural Environment & Assets
2. Infrastructure
3. Health, Communities & the Built Environment
4. Business & Industry
5. International Dimensions

The Department for the Environment, Food and Rural Affairs (Defra) releases a **National Adaptation Programme** (NAP) every five years. The NAP, published in 2023, sets out the actions the UK Government and others will take to adapt to climate change between 2023 and 2028. This third NAP recognises the vital role that local government plays in climate adaptation. Local authorities are said to be responsible for ensuring that local service delivery is resilient to the impacts of the changing climate. The NAP also states that local authorities have an important role in raising awareness and involving local communities by sharing information to explain local climate changes, how they can be managed and what households and businesses can do to help.

The Climate Change Act has also put in place an Adaptation Reporting Power which asks authorities to outline how they are preparing and adapting to the current and predicted climate risks. These organisations include the Environment Agency, Natural England, Network Rail and Southern Water, who report on what they are doing to adapt to climate change. These documents provide validation and justification of climate risks and impacts and outline what assessments and actions key stakeholders are implementing to adapt to climate change.

The documents described above have provided guidance for this report. They have highlighted relevant climate risks and impacts, set out potential adaptation actions and strategies that have been used successfully elsewhere, and outlined Central Government's and Statutory Authorities' responsibilities for climate change adaptation.

3 Climate change in Brighton & Hove

3.1 Observations & projections

Brighton & Hove currently experiences mild winters and hot, humid summers. Its proximity to the coast and exposure to sea breezes lead to lower maximum summer temperatures and milder winter temperatures compared to inland areas.

Climate projections for the area broadly align with UK-wide projections. Winters are expected to become milder and wetter, whilst summers are projected to get hotter, and drier. Figure 4 shows the increase in average temperature to year 2080 under both a high emissions scenario, where global emissions grow unmitigated (Representative Concentration Pathway, RCP 8.5) and a low emissions scenario, where global emissions are strongly mitigated and reduced (RCP 2.6). RCP 8.5 projects a temperature increase of approximately 4°C by 2080, whilst RCP 2.6 projects a temperature increase of approximately 1.7°C by 2080. More detail on temperature variations across the city is provided in Section 3.1.1.

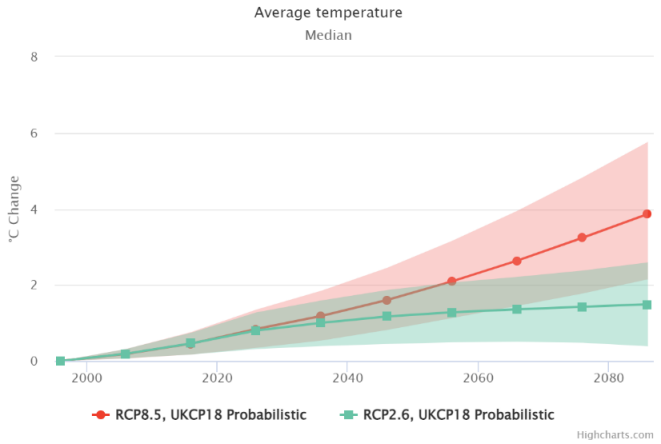

Figure 4 - Annual average temperature projections for Brighton & Hove (Source: UK CRI n.d., (online). Available at: https://uk-cri.org/).

Figure 5 shows the projected average rainfall for Brighton & Hove in summer and winter. Summer average rainfall is expected to decrease by over 20% under RCP 2.6, or ~40% under RCP 8.5. However, winter rainfall is projected to increase by ~15% under RCP 2.6 or ~35% under RCP 8.5.

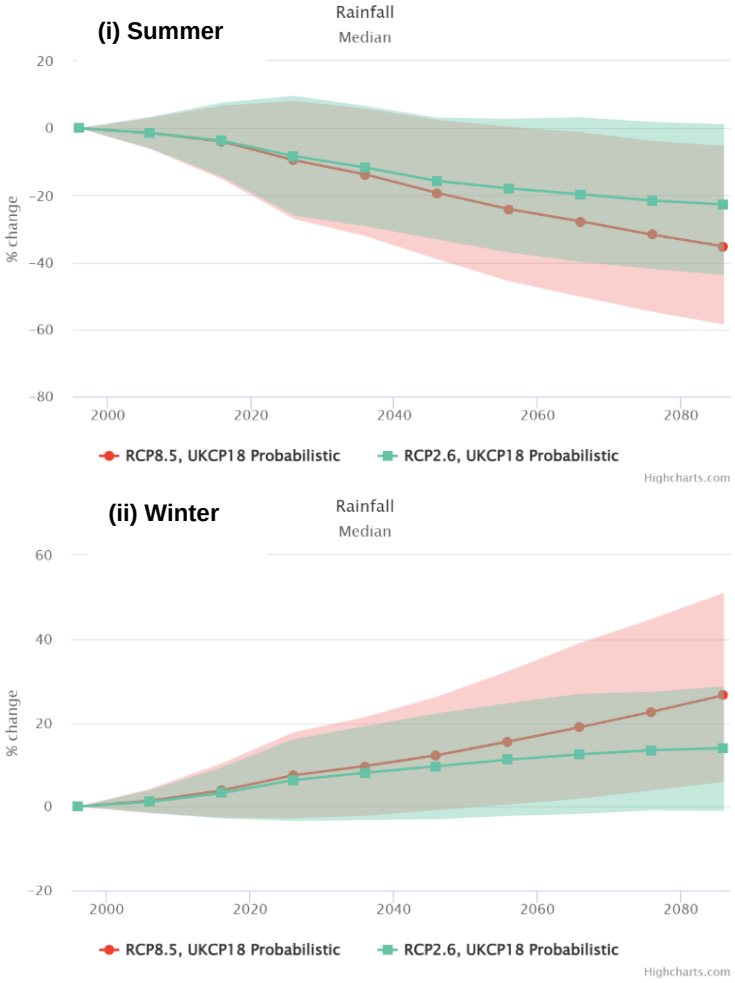

Figure 5 - Annual average (i) summer and (ii) rainfall projections for Brighton & Hove (Source: UK CRI n.d., (online). Available at: https://uk-cri.org/).

Flood risk in Brighton & Hove is significant, with the city ranked 8th out of the top ten Flood Risk Areas in England, with over 30,000 properties in the city at risk of flooding[11]. Surface water run-off from heavy rainfall poses the biggest problem, causing 'flash' flooding across the steep urban city centre. On 20th June 2023, many homes and businesses were flooded in Brighton, with East Sussex Fire and Rescue called out to 18 flood-related incidents[12]. The risk of surface water flooding in the city is projected to worsen, in line with increasingly intense rainfall events[13]. Furthermore, flooding elsewhere is known to have knock-on impacts to city infrastructure services. For example, on 15th November 2022, train services between Brighton and Three Bridges were disrupted as a tunnel became flooded[14]. This was not a one-off incident, with flooding having disrupted trains before in Brighton and Hove in June[15] and December[16] 2019, December 2022[17], and, more recently, in June 2023[18]. The Environment Agency's South East River Basin District Flood Risk Management Plan 2021-2027 highlights that 8km of railway is at risk from surface water flooding in the City of Brighton and Hove[19].

Coastal erosion is an ongoing challenge along Brighton & Hove's coastline. However, the Environment Agency's Shoreline Management Plan strategy is to 'hold the line' along the coast to prevent any erosion and protect existing infrastructure assets. While plans are in place to avoid erosion, this is expected to become an increasing challenge with the impacts of future sea level rise, more frequent and severe floods, and storm surges[20].

[11] BHCC (2022) World Water Day and how we're reducing flood risk. [Available online].

[12] Brighton and Hove News (2023) Homes and businesses flooded after thunderstorm hits Brighton and Hove [Available online].

[13] Met Office (2022) Reading Climate Pack. [Available online].

[14] The Argus (2022) Trains between Brighton and Three Bridges due to tunnel flood. [Available online].

[15] Brighton and Hove News (2019): Wrong type of water – or too much of it – leaves no trains on the line. [Available online].

[16] Network Rail (2019): DO NOT TRAVEL- Severe flooding on Brighton Main Line affecting Southern, Thameslink and Gatwick Express services. [Available online].

3.1.1 Urban heat island in Brighton & Hove

Brighton & Hove's urban heat island has been analysed using Arup's UHeat service. The aim of this analysis was to provide an understanding of the variation in exposure to heat across the city, and an indication of 'hotspots' where the likelihood of overheating during heatwave events is particularly pronounced.

The UHeat digital tool combines the input of satellite imagery and open-source climate data from summer 2022, with a model developed by the University of Reading (UK) to estimate the impact of city characteristics on the urban climate. It accounts for factors including building heights, surface albedo (reflectiveness), the amount of green and blue infrastructure, impervious surfaces, population density and the urban climate.

Results indicate Brighton & Hove has a weak urban heat island effect compared with other global cities[21]. This is due to its geographic location on the coast, with cooling sea breezes, as well as the significant presence of greenspace in the outskirts of the city. The urban centre is also relatively small compared with other cities; the built-up area causes the overall UHI effect on air temperatures to be smaller.

However, there is a clear trend in warmer temperatures in the urban city centre. As shown in Figure 6, the average summer surface temperature uplift; or surface urban heat island intensity, is +7.7°C in the worst-impacted area. This follows the expected patterns of urban heat where the city centre, which has a higher proportion of dark paved/building surfaces, gets much hotter

[17] Brighton and Hove News (2022): Train passengers face delays today and tomorrow because of heavy rain. [Available online].

[18] Sussex World (2023): Heavy rain flooding parts of railway causing disruption across Southern, Thameslink and Gatwick Express networks. [Available online].

[19] Environment Agency (2022): South East River Basin District Flood Risk Management Plan 2021 to 2027. [Available online].

[20] Environment Agency (2023) Flood and coastal erosion risk management report: 1 April 2021 to 31 March 2022. [Available online].

[21] Arup (2023) Urban Heat Snapshot [Available online].

than rural areas where greenery and lighter surfaces reflect more solar radiation and maintain lower temperatures.

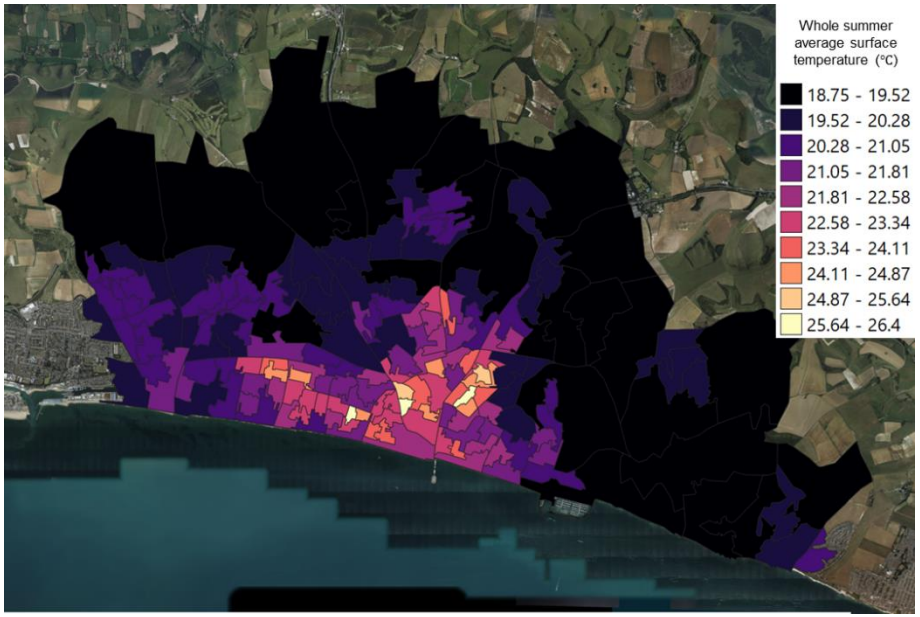

Figure 6 - Surface temperatures across Brighton aggregated over summer 2022 period presented at Lower Layer Super Output Area (LSOA).

More detail, including assumptions and limitations of this analysis, is provided in Appendix C.

3.2 Local assessment & action planning

Cities and towns across the UK, including Brighton & Hove, are already experiencing the impacts of climate change. Some of the negative impacts felt by people are related to heat, drought, and heavy rainfall, as well as health impacts, particularly from heat stress[22]. Brighton & Hove City Council have several key stakeholders who have recorded and prioritised key climate risks that are relevant to both the national and local context.

The key stakeholder organisations are:

- **Natural Environment and Assets:** Environment Agency; Natural England; Marine Management Organisation; Wildlife Trusts; South Downs National Park.
- **Infrastructure:** Network Rail; Southern Water; National Highways; National Grid; UK Power Networks.
- **Health, Communities & the Built Environment:** NHS Sussex Integrated Care Systems; Fire and Rescue Services; East Sussex County Council; English Heritage.

These stakeholders have identified the following risk categories that are applicable to the Brighton & Hove area, but also more widely:

- Changed rainfall patterns leading to water scarcity, drought, flooding, sea level rise and coastal erosion;
- Changes in temperature, leading to heatwaves, wildfire, and cold snaps;
- Extreme weather events such as storms and high winds; and
- Loss of and impact to terrestrial, freshwater[23] and marine ecosystems.

[22] Met Office (2022): Reading Climate Pack. [Available online].

[23] While Brighton & Hove has minimal freshwater ecosystems it is still an important impact area to consider. Aquifers are considered as part of 'freshwater ecosystems' as specified in the UN Water definition.

4 Climate Risk and Vulnerability Assessment

This section presents the approach and findings from our first city-wide and city-scale climate risk and vulnerability assessment.

4.1 Approach

The Climate Risk and Vulnerability Assessment (CRVA) follows a five-stage approach (see Figure 7). This approach makes use of the risks identified in the UK Government's Third Climate Change Risk Assessment (CCRA3), and incorporates specific milestones for stakeholder engagement, although engagement was embedded throughout the full project process.

Figure 7 - Approach to CRVA.

4.1.1 Risk screening

As outlined in Section 2.2, the UK CCRA3 identified 61 risks and opportunities. The first stage of the CRVA was to undertake a materiality assessment of these risks, to focus the assessment on risks that are relevant to the BHCC context only, considering the local geography. Risks that were shortlisted from the materiality assessment were reviewed by a range of stakeholders from across the Council, during a 'check and challenge' session.

From the original 61 risks and opportunities, a total of 31 risks were taken forward for inclusion in the CRVA. Due to the scope of this study, all risks in the International Dimensions category were screened out. The risks screened in, where relevant, have been broken out to differentiate the risks posed by individual climate hazards.

4.1.2 The Climate Risk and Vulnerability Assessment

While this may be the first CRVA that BHCC has undertaken, the Council has a wider corporate risk management framework that we use to assess a range of risks to the organisation and the local area. To ensure this CRVA aligns with our wider work, all risks have been assessed using the Council's risk matrix, considering the scale of the risk as a function of its likelihood and impact (see Table 1). The full definitions of likelihood and impact are presented in Appendix B.

The risk scores and assigned colours are based on risk ratings, that also align with the Council's corporate risk management framework (see Table 2).

Table 1 - Risk matrix used for CRVA.

Likelihood	Impact				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost impossible (1)	1	2	3	4	5
Unlikely (2)	2	4	6	8	10
Possible (3)	3	6	9	12	15
Likely (4)	4	8	12	15	20
Almost certain (5)	5	10	15	20	25

Table 2 - Risk grading used for CRVA.

Risk Score	Risk Rating	Recommended action
1-3	Low	Monitor periodically
4-6	Moderate	Monitor if the risk levels increase
8-12	Significant	Review & ensure effective controls
15-25	High	Immediate action required & need to escalate to the management level above

There is varying availability of data and information across the 31 risks identified as relevant to Brighton & Hove and the Council. This led to three different approaches to assessing the likelihood and impact of the risks.

- **Spatial approach**: where geospatial data was available, geospatial analysis has been undertaken to identify vulnerable or exposed locations or assets within Brighton & Hove. Examples of this analysis included the percentage of road networks or important buildings that are at-risk from different types of flooding.
- **Quantitative approach**: Climate projection data was extracted from the Climate Risk Indicator portal, UK-CRI[24], to identify trends in climate indicators at the Brighton & Hove scale. Examples of these include Amber heat-health alert and the Met Office Fire Severity Index.
- **Qualitative approach**: where data gaps existed from the spatial and quantitative assessments, existing resources were used to infill these gaps. They also helped to provide wider context in cases where spatial and quantitative data was used. Examples of the resources referred to include the Sussex NHS Climate Change Impact Assessment[25], the South Downs National Park Climate Change Adaptation Plan[26] and several of the UK Climate Risk Sector Briefings[27].

The CRVA considers both the present-day and future climate impacts, considering two future scenarios – a moderate climate scenario and a more extreme, high-end scenario. Depending on data availability, the risk ratings for these two scenarios were informed by different future time periods (e.g. 2050s and 2080s), or different emissions scenarios (e.g. RCP4.5 and RCP8.5, or 2°C and 4°C warming).

4.1.3 Stakeholder engagement

Following the development of the draft CRVA, a stakeholder engagement workshop was held, with representatives from across different Council departments and key external stakeholders. The aim of the workshop was to review the key climate risks and gather feedback to be used to inform the final version of the CRVA.

Brighton & Hove's key climate risks are presented in Section 4.2, 4.3, 4.4 and 4.5.

[24] UK-CRI (n.d.) Climate Risk Indicators. [Available online].

[25] Greengage (n.d.). Sussex ICS Climate Change Impact Assessment. [Access provided via SharePoint].

[26] South Downs National Park Authority (2016). Climate Change Adaptation Plan. [Available online].

[27] Sustainability West Midlands et al. (2021). UK Climate Risk Sector Briefings. [Available online].

4.2 Natural Environment & Assets

Table 3 presents the significant and high risks for Brighton & Hove's natural environment. Three of the 10 risks identified as relevant to Brighton & Hove are rated in the highest risk category for present day. This increases to seven high risks by the 2080s, driven by the emerging risk of sea level rise and increasingly likely and extreme high temperatures.

At present, hotter, and drier summers are already considered a high risk to terrestrial species and agricultural productivity[28]. Reductions in water availability and aquifer storage or recharge can cause calcareous habitats to struggle. Increased periods of drought and higher summer temperatures impact agriculture crops and livestock farming across the South Downs. There are some agricultural opportunities arising from warming temperatures; for example, some new crops like grape vines are becoming more suitable.

As the climate continues to warm, it is projected that we will experience more frequent and intense hot weather, to which many temperate species are not adjusted. This has and will trigger declines in species populations, local extinctions, and changes in species range, and/or shift migratory patterns. The impacts are not only felt during summer months – less winter frost and warmer damp conditions also have the potential to increase the prevalence of pests, pathogens, and invasive species such as ticks that carry Lyme's disease, with cases recorded to be on the rise[29,30].

Sea level rise is also a notable emerging risk for Brighton's natural environment. It could lead to saltwater intrusion of Brighton's chalk aquifer, due to hydrological connectivity with the sea. This can have cascading impacts for the natural environment which is reliant on the freshwater provided by the aquifer. In addition, rising sea levels could result in the loss of rare coastal habitats such as the city's iconic shingle coastline. While saltwater intrusion is currently managed by preferential pumping of groundwater boreholes, this may no longer be sufficient in future.

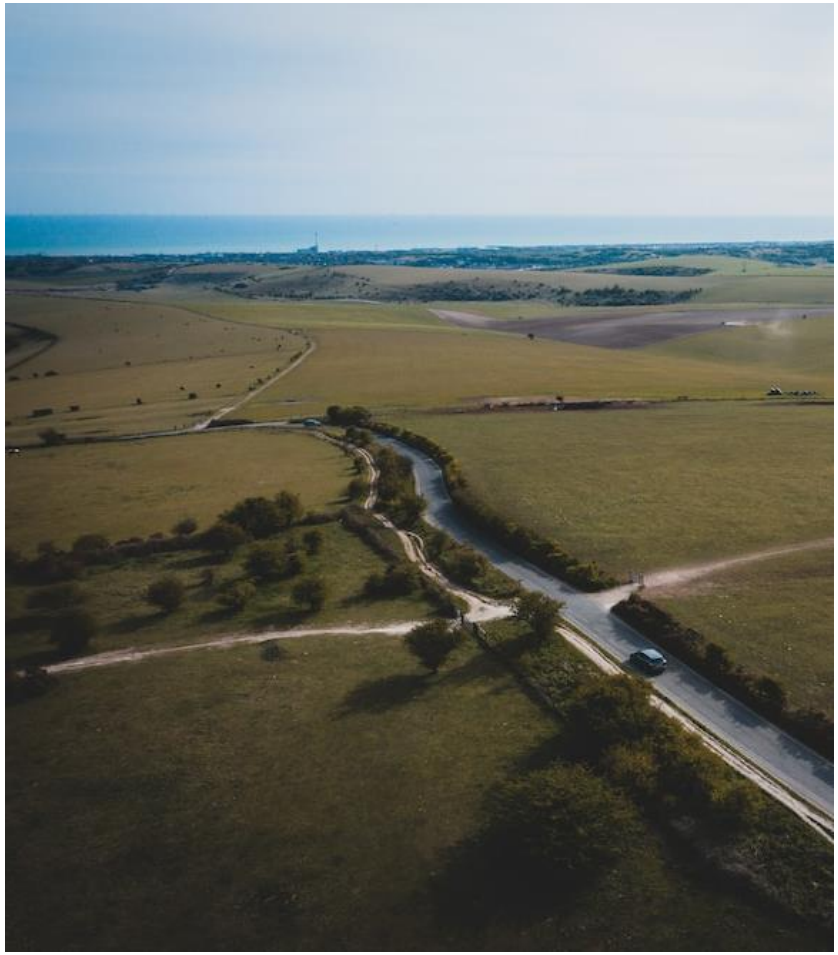

Figure 8 – Devil's Dyke, Brighton, UK. (Source: Unsplash https://unsplash.com/photos/JJiTQJ910eg)

[28] The risk posed to soils in Brighton from changing climatic conditions was perceived to be an important risk for stakeholders. It is identified as a high risk at a national scale in the UK Climate Risk sector briefing, which – due to a lack of more detailed local information – directly informed the rating presented in this work.

[29] University of Brighton (2016): A hot spot for Lyme disease. [Available online].

[30] UK Health Security Agency (2022): Tick-borne disease in the UK: stay safe this spring and summer. [Available online].

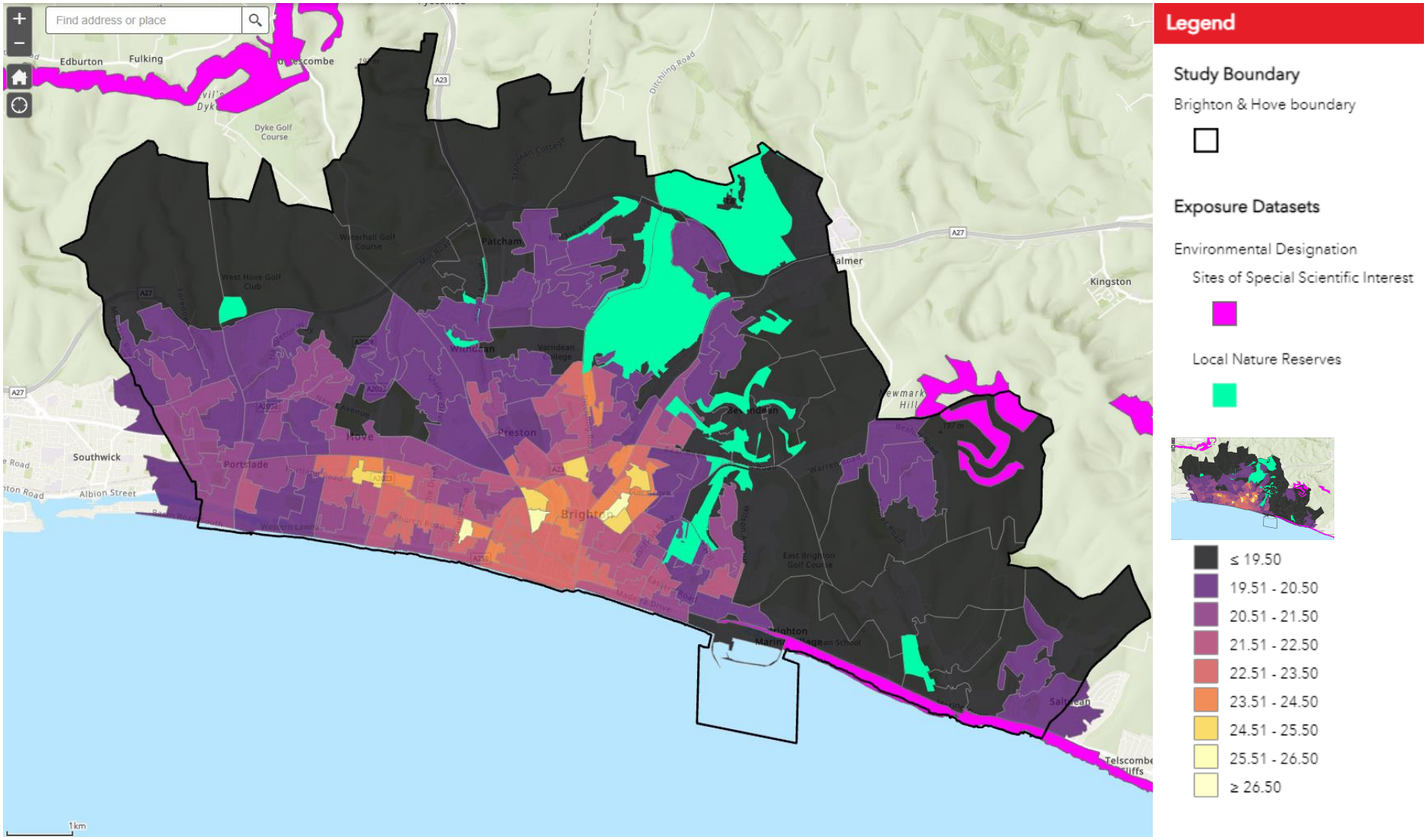

Figure 9 – Map demonstrating the limited intersection between hotter areas of Brighton & Hove, with nationally protected environmental designations.

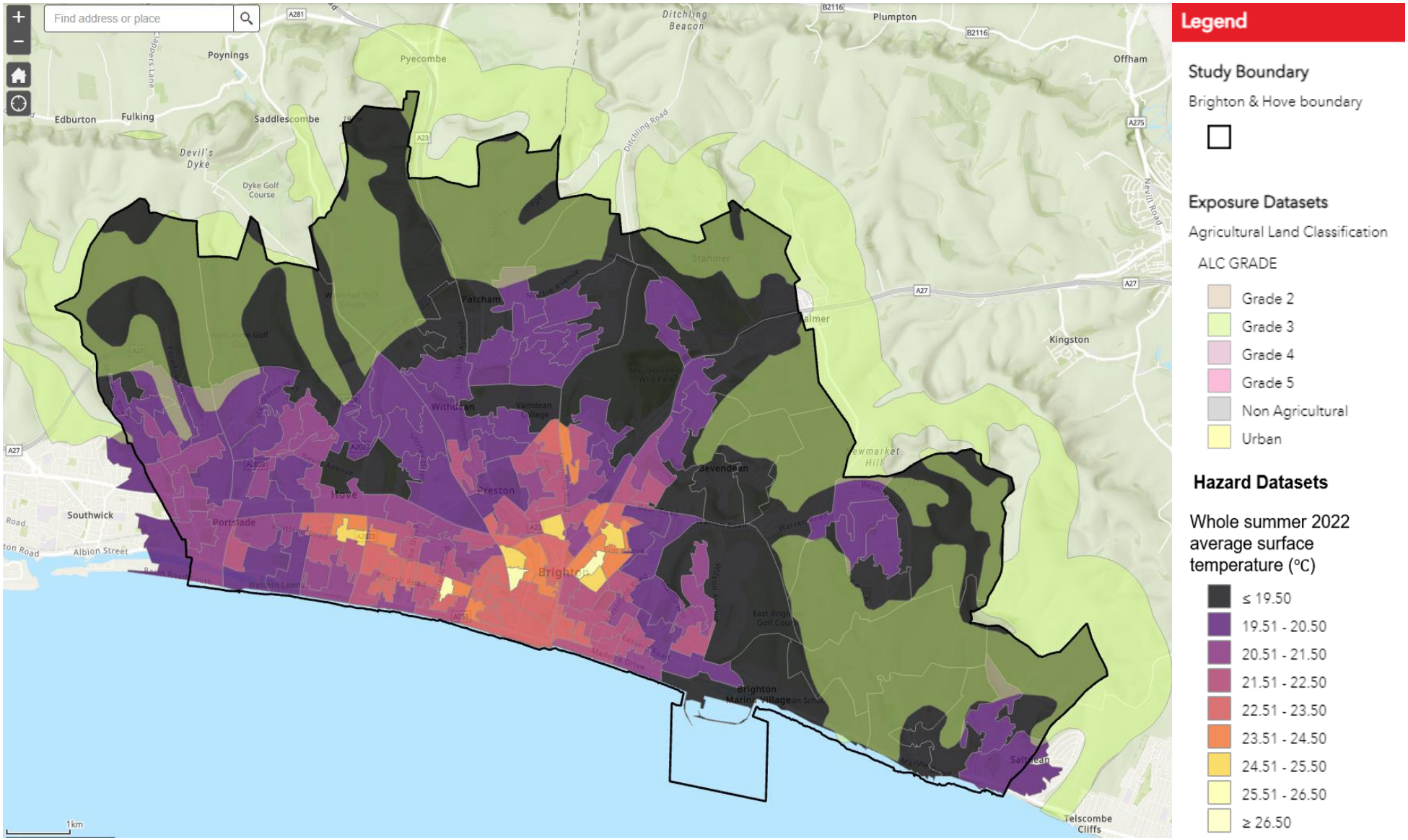

Figure 10 – Map demonstrating the limited intersection between hotter areas of Brighton & Hove, with high-grade agricultural land.

Table 3 – High and significant risks to Brighton & Hove's natural environment and assets by the 2080s (if not before) and ranked from highest to lower risk ratings.

UK Climate Risk (2021) risk reference and risk description	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
N1 – Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding, and saline intrusion).	High temperatures	High	High	High	Warmer summers and more frequent hot days are expected to have a short-term impact to habitats, becoming more long-term as high temperatures becoming increasingly sustained. However, risks to terrestrial species and habitats in protected environmental designated areas of Brighton & Hove are unlikely to be exacerbated by the forcing urban heat island effect, as they stay cooler during hottest periods of the year than the urban city centre, as shown in Figure 9.
N4 – Risk to soils from changing climatic conditions, including seasonal aridity and wetness.	Seasonal aridity	High	High	High	Considered a high risk at the national level.
	Wetness	High	High	High	There is a risk to soil erosion from heavy rain events causing major erosion events, especially during the summer when a heavy rain event/storm happens after a period of dry weather. This could lead to the loss of more fertile top soil. Considered a high risk at the national level.
N6 – Risks to and opportunities for agricultural productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind, and saline intrusion).	High temperatures	High	High	High	Increased summer temperatures are expected to result in heat stress to livestock and crop failure and/or reduced crop yields. However, average summer temperatures in areas of high-grade agricultural land in Brighton & Hove typically do not reach the peaks seen in other parts of the city (see Figure 10).
	Water scarcity	High	High	High	Increased periods of drought impact agricultural crops and livestock farming.
N1 – Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding, and saline intrusion).	Water scarcity	Significant	High	High	Reductions in water availability and aquifer storage/recharge can cause calcareous and woodland habitats etc to struggle. The Southern Water Drought Plan 2019 states that Drought Permits/Orders, which can have the potential to detrimentally impact species and habitats,

UK Climate Risk (2021) risk reference and risk description	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
					are expected to be required by Southern Water at a return period of 1 in 20 years.
N16 – Risks to marine species and habitats from pests, pathogens, and invasive species.	High temperatures	Significant	High	High	Warming of UK shelf seas is projected to continue to 2100 and beyond with most projections indicating increases of between 0.2°C and 0.4°C per decade, but with regional differences and the greatest warming in the Channel and southern North Sea. In addition, other stressors, including pollution incidents such as sewage spills, ocean acidification and changes in salinity levels due to stratification and modification of currents, are likely to continue, increasing the vulnerability of marine organisms to INNS or pathogens.
N17 – Risks to coastal species and habitats due to coastal flooding, erosion, and climate factors.	High temperatures	Significant	High	High	Coastal species may not survive at the really high temperatures expected. Warming sea waters could also negatively impact coastal species. As identified in the urban heat island modelling, high temperatures are less extreme in coastal regions due to the cooling effects of coastal sea breezes.
N14 – Risks to marine species, habitats, and fisheries from changing climatic conditions, including ocean acidification and higher water temperatures.	High temperatures	Significant	Significant	High	High temperatures can drive ocean acidification, which can negatively affect maritime species and habitats by dissolving shells and skeletons made from calcium carbonate (affecting sea snails and oysters). Increasing water temperatures are already globally affecting maritime species and habitats, causing loss of breeding grounds.
N2 – Risks to terrestrial species and habitats from pests, pathogens, and invasive species	High temperatures	Moderate	Significant	High	Less frost and warmer damp conditions will increase the prevalence of pests, pathogens, and invasive species.
N10 – Risks to aquifers from sea level rise, saltwater intrusion	Sea level rise	Moderate	Significant	High	Impacts to aquifers are possible due to hydrological connectivity.
N17 – Risks to coastal species and habitats due to coastal flooding, erosion, and climate factors.	Sea level rise	Moderate	Significant	High	Sea level rise can diminish coastal habitats through ‘coastal squeeze’.

UK Climate Risk (2021) risk reference and risk description	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
N1 – Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding, and saline intrusion).	Wildfire	Significant	Significant	Significant	Severe and long-term damage expected if a wildfire occurred. However, the likelihood is low due to the dominance of resilient broadleaf tree species in Brighton. Please note that if the sensitivity of the broadleaf tree species were to be higher than expected, then the risk could increase.
	High winds	Significant	Significant	Significant	Several impacts are recognised in the South Downs National Park Climate Change Adaptation Plan. This includes loss and damage to mature trees and hedgerows by wind damage.
	Saline intrusion	Significant	Significant	Significant	Saline intrusion could mean terrestrial habitats and species that rely on freshwater could become degraded or lost.
N6 – Risks to and opportunities for agricultural productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind, and saline intrusion).	Wildfire	Significant	Significant	Significant	If they were to occur, wildfires would have major impacts on agriculture. There have been cropland fires in Sussex over the last 5 years, making the risk significant.
	Surface water flooding	Significant	Significant	Significant	Surface water flooding would increase damage and loss of crops. However, from mapping the chance of agriculture lands being affected by surface water flooding is 1%.
	Saline intrusion	Significant	Significant	Significant	If it were to occur, it could have major impact. However, likelihood is low.
N10 – Risks to aquifers from sea level rise, saltwater intrusion	Saline intrusion	Significant	Significant	Significant	Impacts to aquifers is possible due to hydrological connectivity. Saline intrusion of the aquifer could mean the habitat that relies on the freshwater in the aquifer becomes more degraded.
N17 – Risks to coastal species and habitats due to coastal flooding, erosion, and climate factors.	Coastal flooding	Significant	Significant	Significant	Risks to locally important habitats such as shingles and saltmarshes, diminishing or damaging coastal habitats by eroding substrates that habitats are based on.
	Coastal erosion	Significant	Significant	Significant	

UK Climate Risk (2021) risk reference and risk description	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
	Extreme weather events (storms, heavy rainfall)	Significant	Significant	Significant	Extreme rainfall events cause sewer overflows along the Brighton & Hove seafront. Storms also cause weather-related erosion.
N18 – Risks from climate change to landscape character	Water scarcity	Significant	Significant	Significant	Increased drought conditions may result in a reduction of extensive grazing or arable cropping alongside changes to The Living Coast UNESCO Biosphere designation characteristics and wider SDNP landscape character.
	Wildfire	Significant	Significant	Significant	Wildfires can have a major impact on landscape character. Likelihood is low in the areas with broadleaf tree species. However, the risk increases in cropland areas where several fires have occurred in the last 5 years.
	Saline intrusion	Significant	Significant	Significant	Indirect impacts of saline intrusion of the Brighton chalk aquifer could mean the downland landscape that relies on the freshwater in the aquifer becomes more degraded.
N7 – Risks to agriculture from pests, pathogens, and invasive species	High temperatures	Moderate	Significant	Significant	Less frost and warmer damp conditions would increase the prevalence of pests, pathogens, and invasive species.
N18 – Risks from climate change to landscape character	High temperatures	Moderate	Significant	Significant	Continuing declines and damage to habitats and species with new or novel species/crops that are more adaptable to increased summer temperatures would change the visual character of the landscape.
	Coastal flooding	Moderate	Significant	Significant	Flooding would impact the landscape character by damaging habitats and species which cannot survive in these conditions.

4.3 Infrastructure

Table 4 presents the significant and high risks for Brighton & Hove's infrastructure. Eight of the 13 UK CCRA3 infrastructure risks were screened-in due to their relevance for Brighton & Hove, and all are considered either significant or high risk at present-day. The risk profile increases, with seven risks within the very highest category by the 2080s.

Flooding is the key climate risk that currently affects infrastructure assets and service delivery in Brighton & Hove. Surface water flooding is considered the most risky and widespread type of flooding for Brighton & Hove, as shown in Figure 11. This risk is exceptionally large in Brighton & Hove, due to the significant presence of hard, impermeable surfaces across the city, as well as the steep topography and lack of rivers. Rain falls and is typically funnelled down the city's often steep roads – where the concentration and intensity of rainfall and runoff is too high, the drainage system is unable to cope and causes surface water flooding. It is therefore unsurprising that 23% of the most-used strategic parts of the road network, are exposed for the present-day 1 in 100-year scenario. These events will become more likely with climate change, due to the increasingly intense 'flash' rainfall events. This poses a notable risk to infrastructure services. The surface water flooding impacts to people, communities and businesses are discussed in the following sections.

In contrast, coastal flooding is a more localised risk for Brighton & Hove's infrastructure. Using the Environment Agency's 1 in 100 and 1 in 1000 year 'Risk of Flooding from Rivers and Sea' flood extents, both show that less than 1% of the city's roads and streets are exposed to coastal flooding. Meanwhile, the risk of coastal erosion is not expected to change throughout the 21st century. This is due to the Environment Agency's stance on erosion along Brighton & Hove's shoreline, with plans in place to 'hold the line' along the coast to prevent any erosion and protect existing infrastructure assets. It is important to note that mitigation measures are required to ensure that approach is adopted and that the risk does not become realised. Coastal recession is ongoing at Brighton Marina at an average rate of 2.6cm per year.

High temperatures are an emerging risk for Brighton & Hove's infrastructure, with the risk rating increasing from significant to high through the 21st century. High temperatures during summer months can have a wide range of impacts to transport infrastructure and service delivery to public transport passengers, including the buckling of rail lines, line sag and rail speed restrictions, damage to bridges, pavements and road surfaces.

The impacts of stormy weather can be very damaging to Infrastructure In the region. High winds and resultant debris can cause damage to power lines and lightning can lead to power cuts. Future trends in extreme wind and lightning are not clear, with low confidence in any existing future projections.

Finally, the cascading impacts from one infrastructure type to another are often significantly underestimated as identified in the UK CCRA3. For example, cascading risks from the disruption of communications and IT services can also lead to transport delays.

Water scarcity is primarily identified as a risk to public water supplies, from reduced water availability. Brighton & Hove's water supply is solely sourced from local groundwater, which is found to be resilient to climate change impacts due to wetter winters that help to mute impacts of drier summers[31].

[31] Southern Water (2019) Water Resources Management Plan 2019 Annex 3: Supply Forecast. [Accessed online]

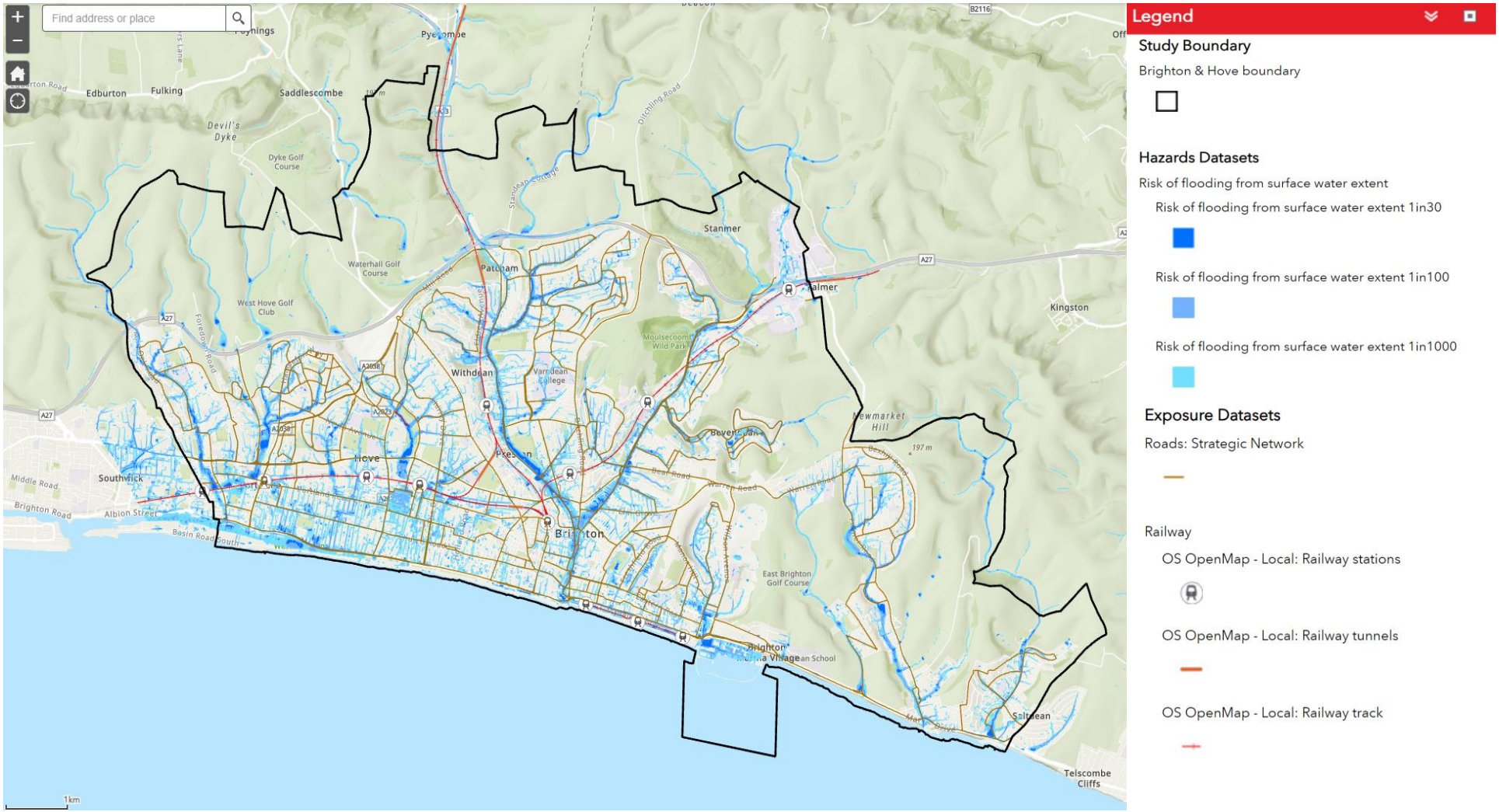

Figure 11 – Risk to road and rail infrastructure from present-day surface water flooding [32], the key form of flood risk to the city which significantly affects Brighton's roads.

[32] Environment Agency (2020) Risk of Flooding from Surface Water. [Accessed online].

Table 4 – High and significant risks to Brighton & Hove's infrastructure by the 2080s (if not before) and ranked from highest to lower risk ratings.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
I1 – Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures	Several	High	High	High	Vulnerabilities on one infrastructure network can cause problems on others, and energy infrastructure represents a significant part of this system. Recent research conducted to support the UK CCRA has indicated that the vulnerability of interconnected systems may be significantly underestimated. The risk of network failures is already high, potentially affecting hundreds of thousands of people per year, in urban areas.
I2 – Risks to infrastructure services from surface water and groundwater flooding	Surface water flooding	High	High	High	9% of railway stations in the Brighton & Hove area lie within the 1 in 100-year surface water flood extent (not considering any on-the-ground mitigation measures, or site raising). This increases to 18% when the 1 in 100-year flood event is increased by 30 or 40% as a proxy climate change allowance, as modelled for BHCC. This poses a notable risk to infrastructure services. 8% of the total lengths of transport streets within Brighton & Hove are exposed to a 1 in 100-year surface water flood, increasing to 9% under the 40% climate change scenario. However, 23% of the strategic network, comprised of the roads most used in Brighton & Hove, are exposed for the present-day 1 in 100-year scenario. This poses a notable risk to infrastructure services. No electricity substations in Brighton & Hove are exposed to surface water flooding. Greater risk of flooding due to increased occurrence and severity of weather events.
	Groundwater flooding	High	High	High	Modelling results suggest 30% of the strategic road network and transport streets are exposed to either a high (5% - where water levels are between 0.025 and 0.5m below ground level) or medium risk of groundwater flooding (25% - where water levels are between 0.5 and 5m below ground level). Groundwater flood events have the potential to close roads, and typically have a longer event length than other types of flooding due to the difficulty in removing the water. Crude modelling suggests that 65% of railway track is at medium risk, and an extra 7% is at high risk of groundwater flooding. Note this does not consider track elevation. 1% of substations in Brighton & Hove lie within areas at medium or high risk of groundwater flooding. Greater risk of flooding due to increased occurrence and severity of weather events.
I3 – Risks to infrastructure services from coastal flooding and erosion	Coastal erosion	High	High	High	The Environment Agency's NCERM approach along the Brighton & Hove coast is to 'hold the line' to avoid any coastal erosion. However, the Brighton Marina to Newhaven Western Harbour Arm Plan suggests there are sections along the coastline which are uneconomic to actively defend, leaving properties at-

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
					risk (Lewes District Council and Brighton & Hove Council (2016)). The economic case is significantly driven by the presence or absence of the A259. Brighton Marina cliff top recession reports indicate the cliff has receded at an average annual rate of 0.026 metres per year, or 2.6cm per year. Increased erosion of chalk cliffs will result from increases in storm and wave impact.
I12 – Risks to transport from high and low temperatures, high winds, lightning	High temperatures	High	High	High	High temperatures lead to buckling of rail lines, line sag and rail speed restrictions, damage to bridges and pavements, deterioration of road surfaces and disruption of communications and IT services leading to transport delays. Urban heat island (UHI) modelling results show the 'hot spots' in the city most vulnerable to road/pavement deterioration, including Hanover, Lansdowne Place, and the area to the south-west of Brighton Station towards Dyke Road. These areas are particularly vulnerable due to the high impervious surface cover and albedo
I5 – Risks to transport networks from slope and embankment failure	Extreme weather events (storms, heavy rainfall)	Significant	High	High	Deterioration and failure of these assets have significant negative impacts on transport networks through damage, travel delays and accidents.
I8 – Risks to public water supplies from reduced water availability	Water scarcity	Significant	High	High	Increased periods of drought could impact availability of water supplies to households. As per Southern Water's Water Resources Management Plan, impacts are expected to be less pronounced than other regions of the UK due to the use of groundwater sources that are less vulnerable to short-term summer deficits in rainfall, compared with regions reliant on surface water sources. However, future increased development and population growth puts pressure on infrastructure, including water availability, which could make the risk more significant.
I10 – Risks to energy from high and low temperatures, high winds, lightning	High temperatures	Significant	High	High	High temperatures can affect the amount of energy generated from thermal generators and solar panels. Some communications equipment supporting the national gas grid have been found to have a maximum operating temperature of 40°C (where external temperature and the load on the asset are contributing factors). Summer operation of some facilities is already being affected and this will be exacerbated by projected increases in summer temperatures. Energy assets near the urban city centre of Brighton are most at-risk during summer months, due to the urban heat island effect.
I13 – Risks to digital from high and low temperatures, high winds, lightning	High temperatures	Significant	High	High	Heatwaves and droughts can affect information and communications technology (ICT) infrastructure through ground shrinkage that damages underground electrical, gas, and water infrastructure and thus co-sited ICT, and through demands for cooling putting pressure on energy networks, causing energy failures and 'brown outs'. Digital assets near the urban city centre of Brighton are most at-risk during summer months, due to the urban heat island effect. Heat and humidity pose a challenge for data centres, which need to be kept cool to operate.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
I3 – Risks to infrastructure services from coastal flooding and erosion	Coastal flooding	Significant	Significant	Significant	Using the Environment Agency's 1 in 100 and 1 in 1000 year 'Risk of Flooding from Rivers and Sea' extents, less than 1% of roads and streets in Brighton are exposed to coastal flooding under the 1 in 100-year scenario. Rail and energy assets are not exposed. Note this is a defended scenario. Coastal flooding incidents can significantly impact infrastructure, but impacts are tempered by improvements in flood defences and advances in flood forecasting, warning, and emergency response.
I10 – Risks to energy from high and low temperatures, high winds, lightning	High winds	Significant	Significant	Significant	There is no compelling trend in changes to maximum wind gust speeds. There is significant uncertainty around future projections on how high wind events may evolve throughout the 21st century.
	Lightning	Significant	Significant	Significant	Anticipated that buildings and assets are protected against lightning, however if an increase in lightning strikes increased power failures, more standby generators may be needed. There remains uncertainty to the understanding of how climate change will affect lightning hazard.
I12 – Risks to transport from high and low temperatures, high winds, lightning	High winds	Significant	Significant	Significant	High winds leading to disruption of rail operations due to debris on lines, damage to road infrastructure, closure of bridges, and suspension of port and vessel operations.
	Lightning	Significant	Significant	Significant	Lightning strikes on railways damaging electronic equipment, line-side trees, and buildings, and causing line-side fires.
I13 – Risks to digital from high and low temperatures, high winds, lightning	High winds	Significant	Significant	Significant	Significant ICT infrastructure is located underground. Potential impacts to overhead lines and masts – which can have moderate impact across Brighton & Hove to residents and businesses.
	Lightning	Significant	Significant	Significant	Significant ICT infrastructure is located underground. Potential impacts to overhead lines and masts. There remains uncertainty to the understanding of how climate change will affect lightning hazard.

4.4 Health, Communities & the Built Environment

Table 5 presents the significant and high risks for Brighton & Hove's communities, their health, and the built environment. Eight of the nine risks identified as relevant to Brighton & Hove are rated either significant or high for present-day. The key climate risks are surface water and groundwater flooding, as well as high temperatures.

Surface water flooding is a key risk to residents, communities, and buildings, including key cultural sites that are important for the city's tourism industry. The map in Figure 13 shows how surface water flood risk intersects with health and disability deprivation data from Census 2021, demonstrating a potential opportunity to focus adaptation efforts in the areas of highest deprivation. The risk of surface water flooding to schools, universities and medical facilities is projected to increase over time associated with the increase in the intensity of heavy rainfall events. More detail on how these events arise is provided in Section 4.3. Groundwater flooding is another important risk in certain areas of Brighton. Figure 14 shows significant risk in Aldrington, Patcham and Falmer. Properties with basement flats – as many do in central areas of Brighton & Hove – are particularly vulnerable to groundwater flooding.

Hot summer weather poses a significant challenge for Brighton & Hove, as many buildings and housing stock across the city are vulnerable to overheating. Higher temperatures can also worsen local air quality, which can exacerbate existing health (respiratory) issues, particularly in areas with significant car traffic.

As discussed in the previous section, coastal erosion is a stable risk in Brighton & Hove, as the Environment Agency's 'hold the line' approach means there should be no loss of communities or assets to coastal erosion throughout the 21st century.

The warming winters associated with climate change do present a potential opportunity for fewer cold weather-related hospital admissions, as well as a fall in energy consumption and costs for heating homes, which is known to be a challenge for the city's most vulnerable communities during winter months.

Figure 12 – Brighton Promenade (Source: Unsplash https://unsplash.com/photos/DusxsFh_EpM).

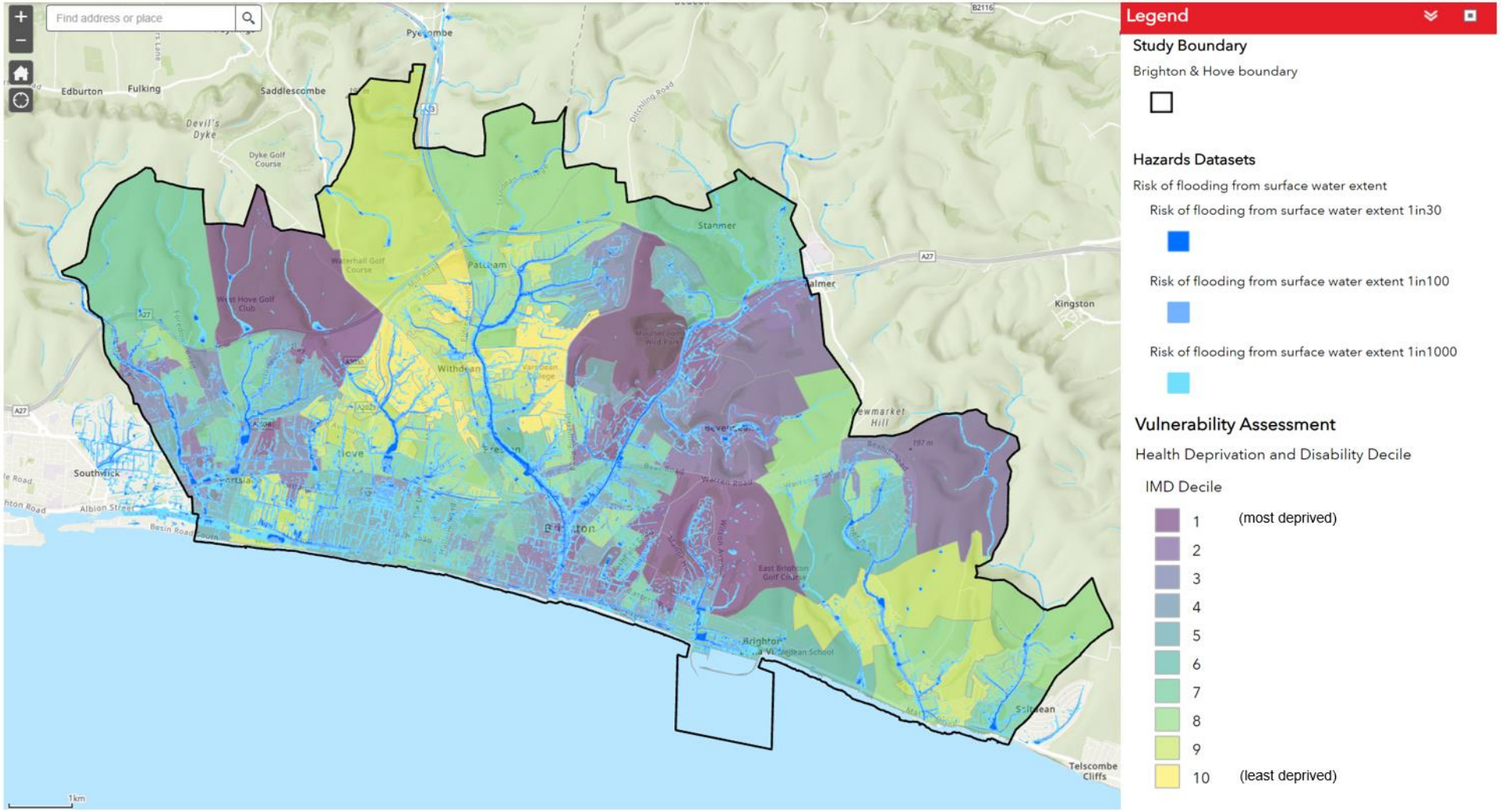

Figure 13 – The intersection of health and disability vulnerability[33] and present-day surface water flood risk[34], which is greatest in Brighton city centre, the University of Brighton campus, Bevendean and Portslade.

[33] Department for Levelling Up, Housing and Communities (2019). Indices of Deprivation 2019: Health Deprivation and Disability [Accessed online].

[34] Environment Agency (2020) Risk of Flooding from Surface Water. [Accessed online].

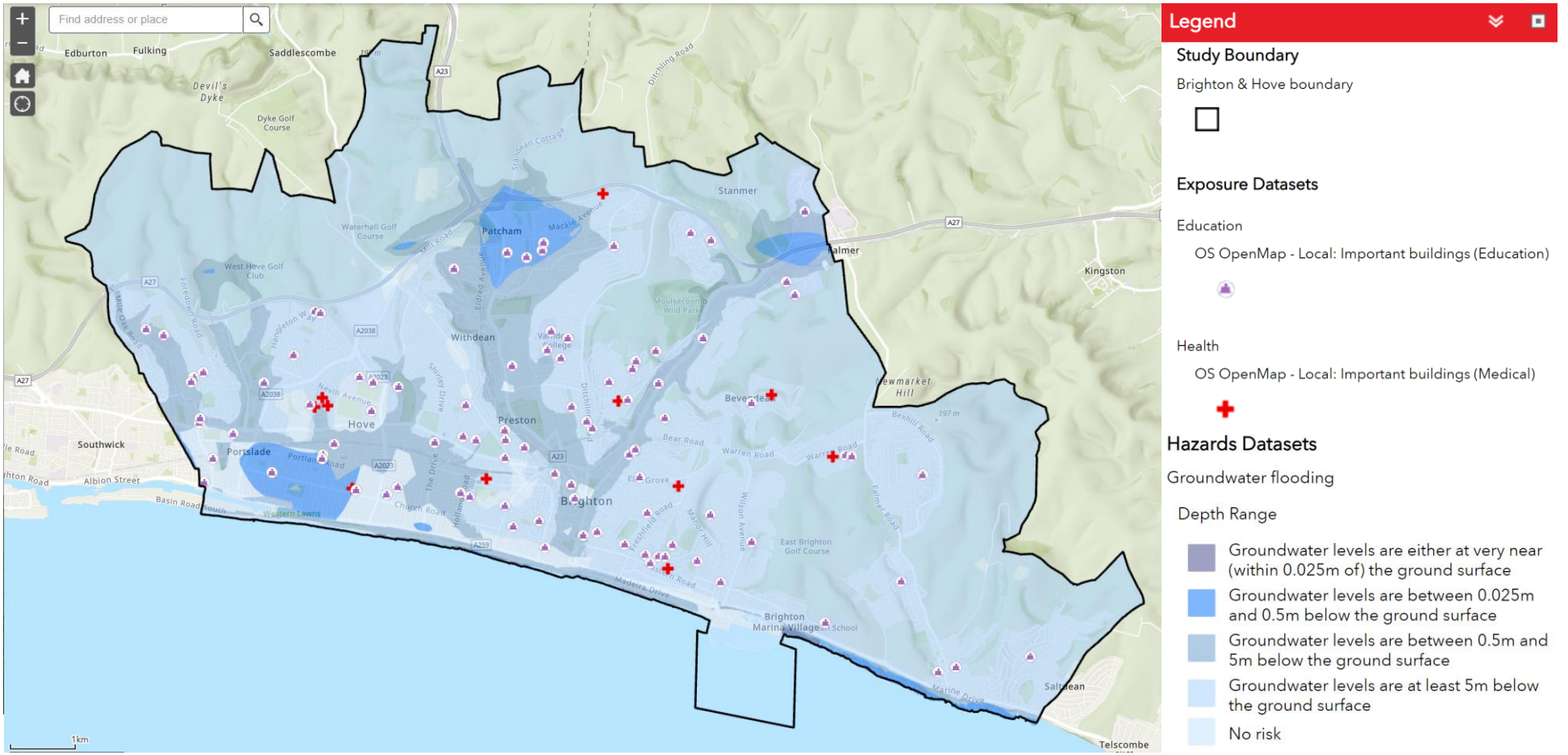

Figure 14 – Risk to education and medical facilities from groundwater flooding, which is greatest to facilities in Patcham and New Church Road in Aldrington.

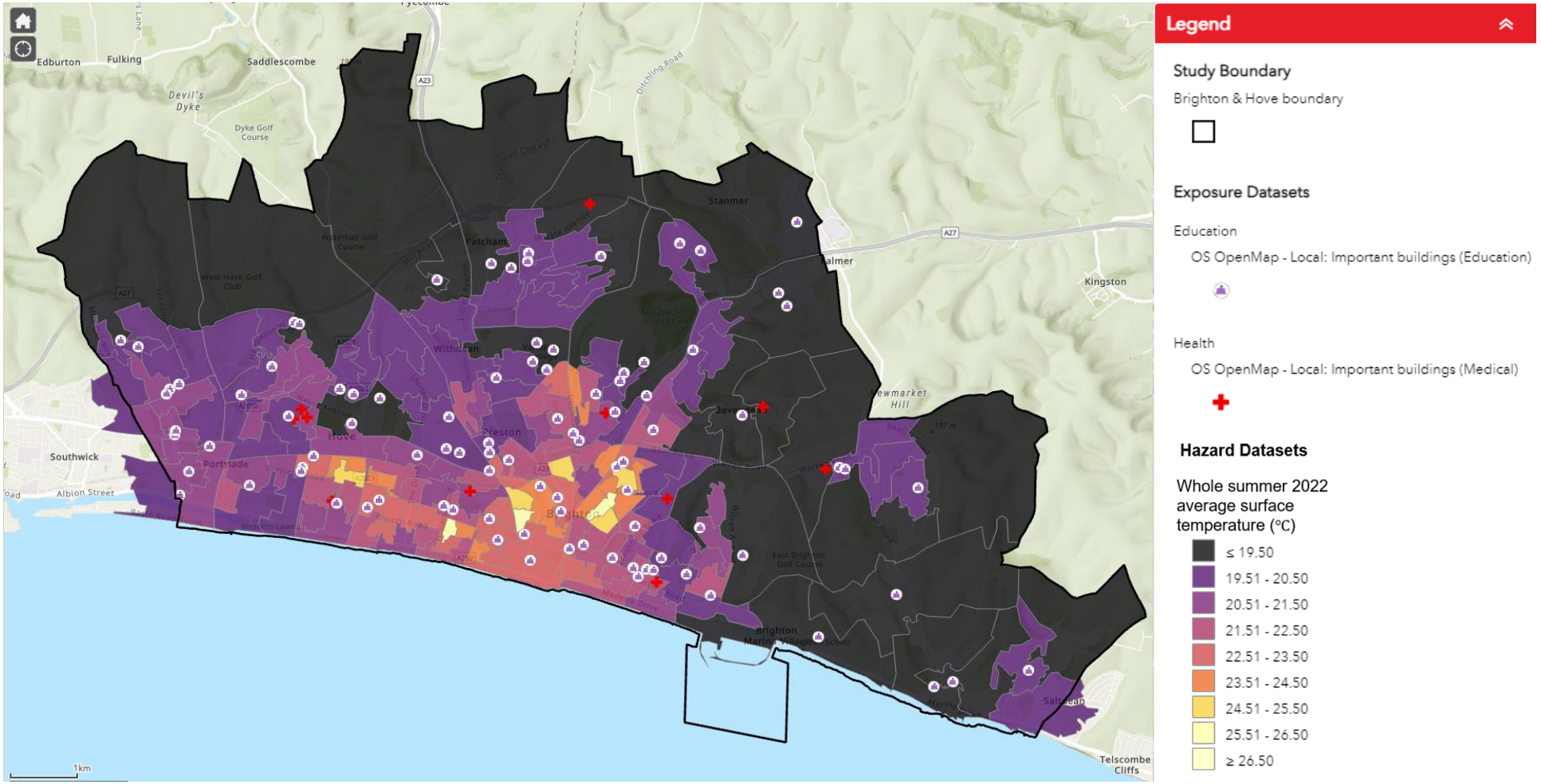

Figure 15 – Risk to education and medical facilities from high temperatures in summer months, which is greatest to facilities in Brighton city centre.

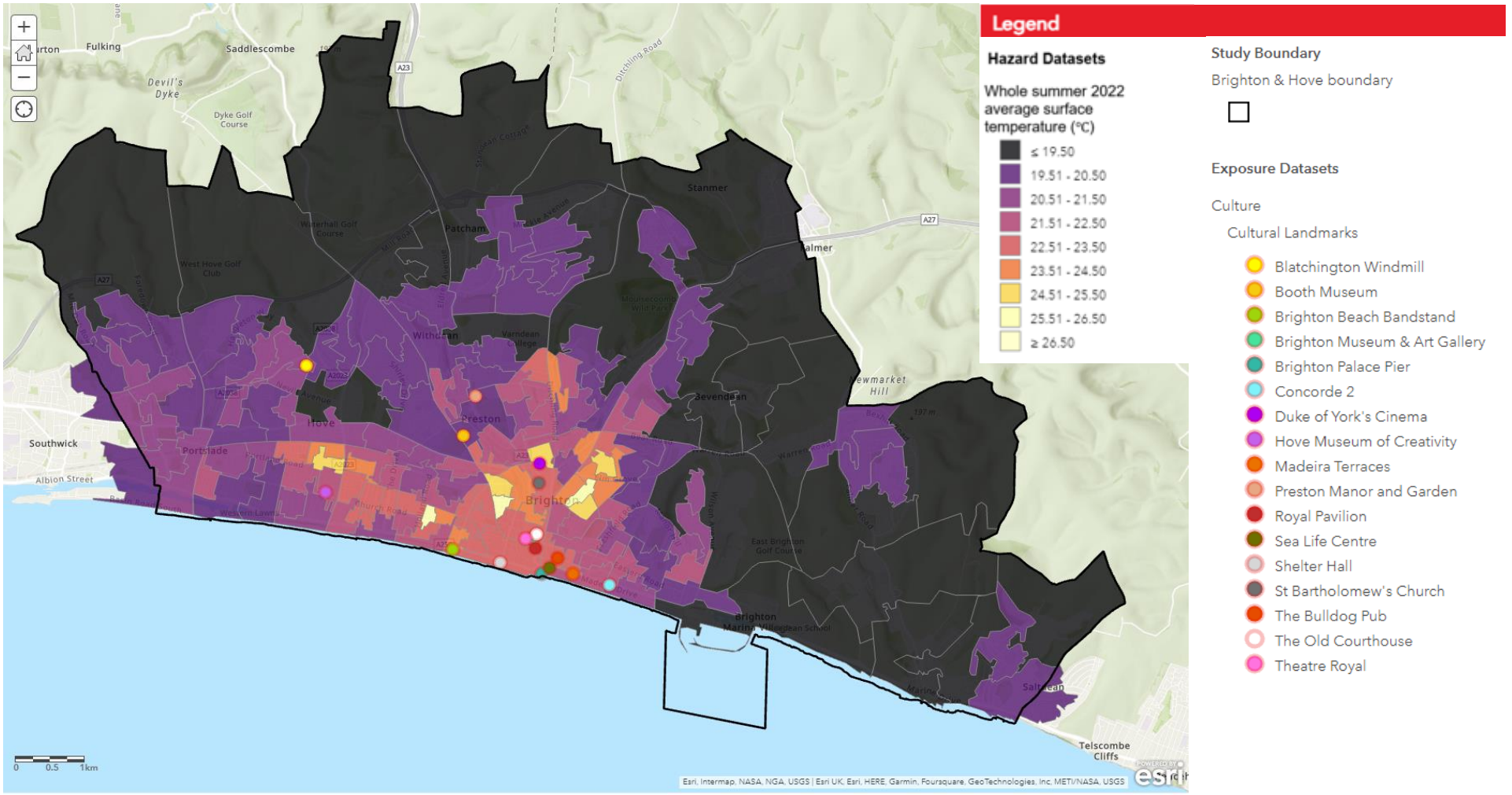

Figure 16 – Risk to cultural landmarks across Brighton & Hove from high temperatures in summer months, which is most acute for those buildings in the city centre including Duke of York's Cinema.

Table 5 – High and significant risks to Brighton & Hove's communities and built environment by the 2080s (if not before) and ranked from highest to lower risk ratings.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
H1 – Risks to health and wellbeing from high temperatures	High temperatures	High	High	High	The UK CCRA3 sector briefing for health and social care states that recent events have been extreme – during the summer of 2020 for example, an additional ~2,500 deaths were recorded during the heatwave across England, which could not be explained by other factors. Currently, the risk of a '2018 type' summer has already increased to around a 10-20% probability in any one year, and this will almost certainly increase to 50% by 2050, as stated in the UK CCRA3 sector briefing. There is also an increased frequency / likelihood of Met Office amber heat-health events in future – 0.033 events per year, increasing to 0.8 events per year (4°C warming, 50th percentile) or 2.667 for 90th percentile. The impacts of heatwave events are anticipated to be particularly acute in the city's 'hot spots', identified in the urban heat island modelling detailed in Section 3.1.1. These are Hanover, the streets around Lansdowne Place, and the streets between Dyke Road and Brighton Station, as well as more broadly Brighton's city centre. The Sussex NHS Climate Change Impact Assessment also states there is also a projected increased risk of vector-borne diseases, related to the preferred warmer climates for breeding.
H3 – Risks to people, communities, and buildings from flooding	Surface water flooding	High	High	High	Surface water flood risk maps show extents are widespread across Brighton & Hove. Surface water flow pathways are concentrated along key roads including the A23 (Preston Road) and A270 (Lewes Road), as shown in Figure 11. As the risk is widespread across the whole of Brighton & Hove, it is important for the areas of high vulnerability to be prioritised. The areas where most people live in social housing are near Brighton College and Sallis Benney Theatre, Whitehawk, Woodingdean, Moulsecoomb (especially North), near Mile Oak Primary School and Portland Business Park, amongst others.
	Groundwater flooding	High	High	High	Groundwater flooding hotspots include Aldrington, Patcham and around Falmer, including university buildings, the A27, railway lines and the Brighton & Hove Albion Football Stadium. There are pockets of areas where houses have basements within Brighton's city centre. These are particularly vulnerable to the impacts of groundwater flooding. The impact of climate change on groundwater flooding is poorly understood. The vulnerability assessment shows that there are a few areas with particularly deprived households in at least one dimension and at risk of groundwater flooding, especially south of Stanmer, near the University of Brighton, in Patcham, Portslade and Aldrington.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
H11 – Risks to cultural heritage	Surface water flooding	High	High	High	Of the 17 key cultural sites identified by BHCC, 29% are exposed to present-day 1 in 100-year flood events. This increases to 41% when the flood event magnitude is increased by either 30% or 40%, as a proxy for the projected increased intensity of heavy rainfall events under climate change. Potential economic impacts from damage to key cultural assets.
	Groundwater flooding	High	High	High	Of the 17 key cultural sites identified by BHCC, 71% lie in areas at medium risk of groundwater flooding (where the water table is between 0.5 and 5m below ground levels). None are within the high-risk zone. Potential economic impacts from damage to key cultural assets.
H5 – Risks to building fabric	High temperatures	Significant	High	High	The Sussex NHS Climate Change Impact Assessment states that buildings constructed during the 1960s and 1970s used more lightweight methods that have been found to be at greater risk of overheating. However, well-insulated more modern buildings that improve winter energy efficiency can also be challenging to keep cool. Buildings in the city's 'hot spots' are particularly vulnerable. These are Hanover, the streets around Lansdowne Place, and the streets between Dyke Road and Brighton Station, as well as more broadly Brighton's city centre.
H12 – Risks to health and social care delivery	High temperatures	Significant	High	High	The UK Climate Risk sector briefing estimated that up to 90% of hospital wards could be at risk from overheating due to their design. The high density of equipment which produces a lot of waste heat energy make hospitals a particularly hot building typology. Those constructed in the 1960s and 1970s are at particular risk. Positively, the map in Figure 15 shows that medical facilities in the city broadly avoid the hottest areas of the city, as identified from UHI modelling. The demographics of many hospital residents are particularly vulnerable to overheating – those aged 65+, with chronic and severe illness, and infants.
	Surface water flooding	Significant	High	High	24% of all medical facilities within Brighton & Hove are exposed to present-day 1 in 100-year flood events. This increases to 32% when the flood event magnitude is increased by 30%, and 34% when increased by 40%, as a proxy for the projected increased intensity of heavy rainfall events under climate change.
H7 – Risks to health and wellbeing from changes in air quality	High temperatures	Significant	Significant	High	Hotter temperatures and impacts to air quality can exacerbate respiratory health issues. There appears to be correlations between the 'hot spot' areas identified in this modelling and the areas in the city centre identified at high risk of poor air quality (the city's Air Quality Management Area 1). As higher temperatures can exacerbate air pollution issues, this provides additional reason to address air quality in these areas now and into the future.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
					The UK Climate Risk sector briefing states that outdoor air pollution is associated with tens of thousands of deaths per year in the UK. A Kings College London study from 9 English cities found that on high pollution days there are 673 additional out-of-hospital cardiac arrests and hospital admissions for stroke and asthma, with spikes in ambulance 999 callouts. $PM_{2.5}$ concentrations are particularly bad in Brighton city centre near the train station, as considered in the Sussex NHS Climate Change Impact Assessment. Given the upwards trend in amber heat-health events and heatwave events as seen in UK-CRI data, it is expected to also see an increase in related health issues with impacts to local health services. From a vulnerability point of view, Brighton & Hove has a large proportion of population with health deprivation and disabilities. The most vulnerable areas from a health and disability perspective are in central Brighton, the area around Moulsecoomb, especially North Moulsecoomb, but also the area around Pavilion Retail Park, Whitehawk, Woodingdean, and west around Portslade Village and Southern Cross.
H13 – Risks to education	High temperatures	Significant	Significant	High	The age, design, and fabric of school buildings present particular risk factors during hot weather conditions. A recent study conducted by Arup for the Greater London Authority found 78% of 60 identified schools across London have already experienced overheating issued during summer term, with impacts to learning and wellbeing. As shown in Figure 15, educational facilities in the city are broadly located outside the very hottest parts of the city, however some schools are in relatively hot areas, such as Elm Grove Primary School and Bellerbys College.
H3 – Risks to people, communities, and buildings from flooding	Coastal flooding	Significant	Significant	Significant	The EA maps indicate that only a constrained area along the Brighton & Hove coastline is at risk from coastal flooding. The areas of greatest extents are shown to be around Brighton Marina and Shoreham Ports/Western Lawns, as well as impacts to the unique undercliff walk. Note these maps were produced using a defended scenario. It is important to recognise both the social and economic benefits of the beachfront. Most people who live near the coast live in higher density accommodation types (flats, converted buildings etc). Therefore, more people would be affected if coastal floods were to happen.
H5 – Risks to building fabric	Surface water flooding	Significant	Significant	Significant	Buildings are at risk from increased damp due to flooding and intense rain. This can result in health (respiratory) and financial impacts. The presence of Bungaroosh building materials is also a particular issue where underlying geology includes clay superficial deposits. The SDNP CAP (2016) stated that there is a medium risk of damage and deterioration of the protective building envelope caused by more severe weather conditions.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
	Groundwater flooding	Significant	Significant	Significant	There are pockets of areas where houses have basements within Brighton's city centre. These are particularly vulnerable to the impacts of groundwater flooding. The presence of Bungaroosh building materials is also a particular issue where underlying geology includes clay superficial deposits. Impacts of climate change to groundwater flooding is not well understood.
H10 – Risks to water quality and household water supplies	Water scarcity	Significant	Significant	Significant	Drought reduces the volumes of water within the chalk aquifer; when rainfall events do occur, these can carry high concentrations of pollutants like nitrates from roads and farms. Potential for water restrictions to be implemented by Southern Water. The company's Drought Plan 2019 states these are expected to occur at a return period of 1 in 10 and 1 in 20 years. An Emergency Drought Order to restrict water use would only occur in a civil emergency (>1 in 500 years). Southern Water's Water Resources Management Plan develops a plan to ensure the impacts of climate change and increasingly extreme droughts are appropriately managed while maintaining the same of improved return periods.
	Saline intrusion	Significant	Significant	Significant	The SDNP CAP (2016), using data from the British Geological Survey, states a medium risk of saltwater intrusion causing increased salinity of both surface and groundwater in coastal areas, impacting the quality and availability of drinking water supplies in coastal areas. This is currently managed by preferential pumping of coastal boreholes.
H11 – Risks to cultural heritage	Coastal flooding	Significant	Significant	Significant	Of the 17 key cultural sites identified by BHCC, only 1 (Brighton Palace Pier) is identified as vulnerable to coastal flooding, using the EA maps. Note these maps were produced using a defended scenario.
	High temperatures	Significant	Significant	Significant	Higher temperatures can cause overheating of buildings and places. Older or less well-maintained properties may be more vulnerable to heat damage. Increasing temperatures can also affect visitor numbers, frequency, and behaviours. As shown in Figure 16, the risk of overheating is most acute for those buildings in the city centre including Duke of York's Cinema.
H12 – Risks to health and social care delivery	Groundwater flooding	Significant	Significant	Significant	4% of all medical facilities in Brighton & Hove lie within the medium risk groundwater extent. 2% lie within the high-risk area.

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
H13 – Risks to education	Surface water flooding	Significant	Significant	Significant	15% of all education facilities within Brighton & Hove are exposed to present-day 1 in 100-year flood events. This increases to 21% when the flood event magnitude is increased by 30%, and 23% when increased by 40%, as a proxy for the projected increased intensity of heavy rainfall events under climate change.
	Groundwater flooding	Significant	Significant	Significant	From the mapping analysis, 29% of education buildings are within areas of medium (23%) or high (6%) risk of groundwater flooding. It is not known whether these buildings have basements, which is a critical component of building vulnerability to groundwater flooding. Basements are commonly used for storing key electrical and heating assets in school buildings.
H6 – Risks from summer and winter household energy demand	High temperatures	Moderate	Significant	Significant	UK-CRI data suggests cooling degree days will become much greater, from 90 to 198 by 2050s (4°C, 50th percentile) or 380 by 2080s (4°C, 50th percentile). This has the potential to significantly increase energy demand in the hottest periods, assuming active cooling solutions are used. From a vulnerability point of view this is particularly concerning as a large area of Brighton & Hove has households that are deprived in at least one dimension. The worst affected areas are central Brighton, near the College, the whole area from Stanmer to Bevendean and down to Whitehawk, Woodingdean and the area south of Brighton & Hove Golf Course around West Blatchington.

4.5 Business & Industry

Table 6 presents the significant and high risks for Brighton & Hove's businesses and industries. Four of the seven UK CCRA3 risks are screened-in for Brighton & Hove. Of these four, three are rated either significant or high, both for the present-day and across the future time-slices.
Many of the city's industrial centres are at risk from surface water and groundwater flooding, while Shoreham Port is exposed to coastal flooding. Changes to the coast pose a potential risk to the local tourism and event economies, which are reliant on the draw of the city's coastline. However, this is being managed by the Environment Agency's 'hold the line' approach.

The secondary impacts to businesses from reduced employee productivity from high temperatures as well as infrastructure disruption driven by storms or heavy rainfall, are considered a growing risk throughout the 21st century. This is due to climate projections indicating more frequent very hot days and hot nights that reduce productivity, as well as increasingly extreme heavy rainfall events that can affect infrastructure, as discussed in Section 4.3.

The risks to the area's agricultural sector are covered in Section 4.2. As such, the risk of water scarcity, driven by long-term reductions in rainfall volumes that fill the local aquifer, is rated as a low/medium risk to businesses in this section. This is due to the expectation that non-household business customers would not experience water restrictions during drought events. While risk is low, it is important that everyone – residents, visitors, and businesses - plays their part in championing water efficiency to reduce the pressure on water supplies to help protect the natural environment.

Figure 17 - Shoreham Harbour, UK. (Source: Unsplash, https://unsplash.com/photos/g6At623P8EA)

Table 6 - High and significant risks to Brighton & Hove's businesses and industries by the 2080s (if not before) and ranked from highest to lower risk ratings

Risk	Climate variable	Current risk score	Risk score (2050s)	Risk score (2080s)	Narrative
B1 - Risks to businesses from flooding	Surface water flooding	High	High	High	Flooding of access routes into Fairway Business Park, Conway Street Industrial Estate, Goldstone Retail Park as well as some key retail streets in Brighton City Centre.
	Groundwater flooding	High	High	High	Portland Road trading Estate and Portland Business Park both within the 'high risk' groundwater flood extent. Other groundwater flood hotspots around Falmer and Patcham can also have impacts to businesses, especially as they intersect the A27.
B5 - Risks to business from reduced employee productivity due to infrastructure disruption and higher temperatures in working environments	High temperatures	Significant	High	High	The impacts of extreme heat are likely to vary widely across business sectors or geographies, depending on factors such as the type of work, whether work is indoors or outdoors, and the local built environment and infrastructure. Given the dominance of summer tourism and event income to Brighton & Hove, impact is considered major. Air temperatures in the city centre and along the seafront are moderated by coastal sea breezes, although surface temperatures remain higher due to the urban heat island effect.
	Extreme weather events (storms, heavy rainfall)	Significant	High	High	The impacts of extreme weather events on employee productivity due to infrastructure disruptions are likely to vary widely across business sectors or geographies, depending on factors such as the type of work, whether work is indoors or outdoors, if the employees can work from home and the local built environment and infrastructure. Therefore, making it hard to quantify.
B2 - Risks to businesses and infrastructure from coastal change from erosion, flooding, and extreme weather events	Extreme weather events (storms, heavy rainfall)	Significant	Significant	High	Potential coastal storm impacts to Shoreham Port and tourism along seafront, as identified from using EA maps.
	Coastal flooding	Significant	Significant	Significant	Potential impacts to Shoreham Port, as identified from using EA maps.

5 Climate Adaptation Action Plan

In response to the risks identified in this assessment, the Climate Adaptation Action Plan sets out:

- Completed and/or ongoing actions, related to climate adaptation, which have been identified from other BHCC strategies and action plans, including three detailed case studies;
- Recommended actions identified to adapt the BHCC natural environment, infrastructure, people, and businesses to a changing climate (see Table 7);
- Organisation(s) that may be able to lead on the implementation of the action(s);
- An indicative timescale for delivery of the action(s) (short-term, medium-term, or long-term); and
- An indicative cost for delivery of the action(s) (high, medium, or low).

Adaptation actions in Table 7 have been identified for the impacts that were assessed as **high risk** in the CRVA, to help minimise these high risks and associated projected impacts of climate change in Brighton & Hove. These recommended actions are based on the evidence and stakeholder feedback. We recognise that some actions may be scoped out and/or implemented by organisations that we were unable to consult with during the evidence-gathering stage. Engagement will be critical during the implementation phase to ensure actions are progressed collaboratively.

5.1 Progress to date and ongoing climate adaptation actions

Brighton & Hove City Council has several existing strategies and action plans that relate to climate adaptation – such as the Air Quality Action Plan (2022-2027)[35], Carbon Neutral Programme 2030[36] and the Southdowns Shoreline Management Plan[37]. Here, we summarise some of the key relevant actions set out within these plans and strategies, which we consider to be completed or planned actions. These actions have also helped shape the comprehensive climate adaptation action plan presented in Table 77.

1. We are undertaking adaptation measures for the coastline, including the implementation of a Coastal Defence Strategy, a Shoreline Management Plan, Shingle Beach Replenishment and Groynes, and the Marina to Adur Coastal Protection Scheme.
2. We are implementing the City Downland Estate Plan published in 2023, which is a 100-year plan to improve biodiversity, carbon sequestration, health and wellbeing, and local food supply.
3. We are rolling out rewilding projects, such as Changing Chalk, Waterhall and Carden Hill, which will improve biodiversity, and help with local cooling and stormwater management.
4. We are supporting the Wild Flower Conservation Society to plant local wildflowers across the city.
5. We are increasing biodiversity in green and blue spaces and networks through tree planting, green corridors (verges) and restoration of existing features such as hedges and ponds, which will contribute to local cooling and stormwater management.
6. We are continuing to manage air quality in the city, including developing and implementing the Air Quality Action Plan (2022-2027).
7. We are providing guidance to the public during extreme weather events including heatwaves and floods.
8. We are running environmental education campaigns, which will include climate risk and adaptation information.

[35] BHCC (2022) Air Quality Action Plan. [Available online].

[36] BHCC (2021) Carbon Neutral Programme 2030. [Available online].

[37] BHCC (2006) Southdowns Shoreline Management Plan. [Available online].

5.2 Case studies of past and ongoing climate adaptation action

There are several examples of projects happening in Brighton & Hove that contribute to climate adaptation objectives. Here we provide three examples of resilience and adaptation measures that have been implemented to reduce the risk from climate and weather hazards:

- Case Study 1: Wild Park Rainscapes;
- Case Study 2: Sussex Local Nature Partnership; and
- Case Study 3: Risk-based approach to maintaining our drainage network.

Case Study 1: The Wild Park Rainscape

The challenge: Currently, polluted run-off water from a junction on the A27 is held in a balancing pond before being piped to soakaways next to Wild Park, which is a pollution risk to the aquifer. This also causes localised flooding within the park entrance, which will only increase as climate change is expected to cause more intense rainfall.

The action: The Wild Park Rainscape is a nature-based approach to managing local flood risk and water pollution. The balancing pond will be upgraded to improve treatment and flow, connected to a new swale which will divert water to a wetland area designed around several shallow planted basins. These vegetated swales and basins provide further treatment, so when the water infiltrates the chalk it will be cleaner. The system is designed to accommodate the heaviest rainfall.

The outcome: This project is designed to address several flood and pollution related risks identified in the climate risk and vulnerability assessment, including:

- I2 - Risks to infrastructure services from surface water flooding
- H3 - Risks to people, communities, and buildings from flooding
- N10 - Risks to aquifers from sea level rise, saltwater intrusion

Partners: The Aquifer Partnership brings together the South Downs National Park Authority, the Environment Agency, Southern Water, Brighton & Hove council, and the Brighton and Lewes Downs Biosphere (The Living Coast). The project is funded by National Highways from its Environment and Wellbeing Fund.

Figure 18 - Mock-up design of the Wild Park Rainscape [Available online].

Case Study 2: Assessing the natural capital of the local environment

The challenge: The Sussex Local Nature Partnership has recognised that nature is in crisis. As shown in the climate risk and vulnerability assessment, there is a wide range of climate-related risks to nature, which are projected to worsen over time. However, the value of natural environment is often not considered in financially driven decision-making, as capital value is difficult to quantify. This can often lead to a lack of consideration of the natural environment, and a lack of understanding of what habitats or environments should be prioritised for protection or improvement.

The action: A Natural Capital Assessment is a mechanism to assign habitats a monetary value, based on the services the environment provides to people. These benefits include food, fuel, and clean air, as well as carbon storage, natural flood defences and crop pollination. Some examples of the work that has been done include compiling a register of the Natural Capital assets found in Sussex, such as rivers, streams, lakes, reservoirs, heathland, grassland, woodland, agricultural land, hedgerows, sand dunes, cliffs, and seabed habitats. This then led to identifying the 'at risk' Sussex Natural Capital Assets.

The outcome: This has enhanced the collective understanding of where these natural assets are, what condition they are in, and their benefits to local Brighton communities and nature. It has allowed technical experts to highlight where the investment priorities (both geographically and conceptually) are to invest in Natural Capital. This means that that they can protect and enhance services and benefits that are vulnerable in a way that benefits the population of Sussex most. This can help the council and stakeholders take a value-based approach to protecting Brighton & Hove's natural environment, in line with the adaptation actions identified in this Action Plan.

Figure 19 - South Downs National Park [Available online].

Case Study 3: Risk-based approach to maintaining our drainage network

The challenge: Brighton & Hove is ranked 8th of the top 10 Flood Risk Areas in England – over 30,000 properties in the city are at risk of flooding. Surface water run-off from heavy rainfall poses major problems. This is in part driven by the region's geographical and geological characteristics; the steep topography and lack of natural rivers leads to a prevalence of runoff along impermeable surfaces that quickly channel water into the drainage system. This is exacerbated by the dominance of impermeable surfaces, like concrete and tarmac, which covers the city including on private land like driveways – which increases the volumes of water received by the Victorian drainage system. The council's drainage maintenance budgets are limited, which has led to a reduction in the frequency of gulley cleansing across the city. As climate change escalates the frequency and intensity of rainfall, flooding and associated negative impacts are also expected to rise.

The action: A proactive strategy rooted in surface water flood risk assessment guides drainage maintenance efforts. Priority gullies necessitating more frequent attention are identified using flood risk zones and maps. Collaboration among local authorities in southeastern England facilitates coordinated maintenance initiatives, with maintenance activities then recorded through MAP16 to establish a historical dataset. Additionally, the strategic placement of sensors within clean gullies provides valuable insights into sediment buildup during storm events.

The outcome: The result has been a more pragmatic, risk-based approach to drain maintenance to make best use of the council's available budget.

Figure 20 - Gullies and Slot drains on Warmdene Road [Available online].

Case Study 4: Wilder Verges

The challenge: Biodiversity is the planet's life support system and restoring nature underpins the health and wellbeing of people and wildlife in a time of climate change. The Wilder Verges project follows the UK's National Pollinator Strategy guidance which responds to UK insect declines and extinctions.

The action: Brighton & Hove's Wilder Verges project is a trial to find out how managing verges in a different way can improve their wildlife and biodiversity. Funded by Natural England, the council worked with Brighton & Hove's Wildlife Forum and volunteers from across the city to trial the Wilder Verges project to find out if managing verges better can improve the area's wildlife and biodiversity.

To improve how the council manages the verges on over 20 verge sites, it didn't mow them from March/April to August/September which is the main botanical flowering season and allowed the plants to grow to maturity and flower.

The outcome: The pilot helped biodiversity by allowing plants to flower, complete their lifecycle, set-seed and provide connectivity, food and shelter for insects and wildlife including insect-eating birds such as starlings. It is important to highlight that a year is a very short amount of time in natural systems and their recovery, and this pilot represents a tiny snapshot. Monitoring and using the information to tailor management prescriptions is important in the longer term with further analysis of results, for example, the effect on soil nutrient levels from the roads – such as salt and pollution.

Figure 21 – Example of Wilder Verges [Available online].

5.3 Future priorities for recommended action on climate adaptation

Table 7 presents 24 priority actions for Brighton & Hove council, often in collaboration with partners and stakeholders, to help address the key risks facing the city, both now and over the coming decades. Given the all-encompassing nature of climate impacts, these actions call for the council to take an integrated approach to adaptation, spanning many teams and services.

The table starts with actions related to climate adaptation in the round, which is spearheaded by the development of a council-led programme for climate adaptation that includes building capacity and knowledge within BHCC. The following four sections then identify actions that directly address risks associated with the four key CCRA3 themes, although many also help to manage the city's key risks across other themes too.

Table 7 – Brighton & Hove City Council's Climate Adaptation Action Plan. For each action, an owner, timescale for delivery and indicative cost has been set out. Indicative cost ranges have been assessed as follows: Low = <£25,000, Medium = £25,000-80,000 and High = >£80,000. Further definition of actions will be required to reach a robust cost estimate for each action.

	Risk	Action	Action Owner and other stakeholders	Timescale for delivery	Indicative cost (H / M / L)
	Governance, reporting and monitoring				
1	N/A	**PRIORITY ACTION** Develop a **council-led programme for climate adaptation**, with clear leadership, accountability, and dedicated resources to work alongside all relevant departments/services. This programme should be led by a named responsible individual(s) who is tasked to identify funding opportunities and advise senior management on (amongst other things): • Existing departmental budgets, Section 106, Community Infrastructure Levy, the Estate Development Budget, and other council funds, to ensure that spending is aligned with adaptation priorities. • Collaboration with other government bodies and non-governmental organisations to create opportunities to co-develop funding applications and/or projects and enhance sharing of resources. This should include engagement with NHS Trusts, the South Downs National Park Authority, and The Aquifer Partnership, among others.	BHCC	Short term: within 2 years	M
2	N/A	Continue to build **collaboration with other local, regional, and national stakeholders** on climate adaptation: • Chair a working group with key local stakeholders on climate adaptation, using the momentum built through this climate risk and vulnerability assessment. • Identify, communicate, and incentivise non-government actors to share responsibility for adapting to climate change (e.g. through voluntary initiatives with businesses, council support to community groups, etc.). • Share lessons learned by engaging with the Local Adaptation Advisory Panel that is coordinated by Defra and the Local Government Association and other cities and organisations working on adaptation.	BHCC External stakeholders	Short term: within 2 years	L
3	N/A	**Mainstream climate adaptation in decision-making and other strategy development**, such as: • Build additional climate adaptation capacity and capabilities within the council's Sustainability Team and embed expertise in other departments (e.g. Parks, Highways, Public Health, Schools, Flooding and SuDS). • Align existing and future council plans and strategies with adaptation priorities, including the Carbon Neutral 2030 Action Plan, Local Nature Recovery Strategy, Economic Development Strategy, Outdoor Events Strategy and Tree Strategy, amongst others.	BHCC	Medium term: 2-5 years	M
4	N/A	Roll out **educational campaigns** to raise awareness of climate impacts and solutions: • Promote awareness and engagement within the wider Brighton & Hove community (including residents and businesses) on climate change adaptation to improve risk awareness, build inclusivity, and promote a sense of shared responsibility. • Identify ways to help people adapt their behaviours in response to extreme weather events, both through improved promotion and use of existing tools, and the design and development of new initiatives. For example,	BHCC	Short term: within 2 years	L

	Risk	Action	Action Owner and other stakeholders	Timescale for delivery	Indicative cost (H / M / L)
		the Sussex Air Quality Alert supports individuals with underlying health conditions to manage their breathing and wellbeing when air pollution levels are high. Learnings can be taken from this to inform tools for climate adaptation. • Roll out climate response and resilience training for city staff, schools, and community groups.			
5	N/A	Put in place an **early warning system** and **emergency response plan** for extreme climate events, linking with the National Heatwave, Cold Weather Plan and Flood Risk Management Strategy.	BHCC	Short term: within 2 years	M
6	N/A	Review all council services and activities to identify adjustments that will ensure the **safety and wellbeing of staff and communities** under changing weather conditions. For example, ensuring that waste collection operatives and landscape management teams do not work outside during the hottest times of the day; providing guidance to schools about adjustments to school routines under severe weather conditions; allowing flexibility in staff uniforms to avoid overheating, etc.	BHCC	Short term: within 2 years	L
7	N/A	**PRIORITY ACTION** Create a role for a dedicated specialist to oversee creation and implementation of a **communications & engagement** plan. This will help to ensure that there is better coordination for messaging on climate risk, particularly around sensitive or urgent issues.	BHCC	Short term: within 2 years	L
	Natural Environment & Assets				
8	N1 H1 H3 H7 I2	**PRIORITY ACTION** Develop and implement a **green-blue infrastructure plan** that embeds climate adaptation and covers: • Surface water flooding: establish an effective strategy for SuDS implementation that addresses flood risk and groundwater quality, targeting optimum sites for maximum benefit. • Implementation of green infrastructure to mitigate overheating and improve water and air quality (initially in key sites such as acute and regional hospitals and children's services). • Street trees for shading and stormwater management (climate-resilient species prioritised in heat risk areas). • Development of parks and urban forests. • Preventive forestry management to support ecosystem health and resilience to climate changes. • A supporting investment plan to ensure the plan is financially viable.	BHCC	Short term: within 2 years	M
9	N1 N2 N4 N6	**Restore and enhance biodiversity** in green and blue spaces and networks, including through the following practices: • Support a Local Nature Recovery Strategy.	BHCC South Downs National Park	Medium term: 2-5 years	M

	Risk	Action	Action Owner and other stakeholders	Timescale for delivery	Indicative cost (H / M / L)
		• Support nature conservation management and restoration of damaged habitats, including designated nature sites. • Support evidence-based rewilding projects and the creation of new habitats and connectivity. • Support catchment management schemes to reduce nitrate pollution. • Support regenerative agriculture methods. • Support invasive species management.	Sussex Local Nature Partnership Local farmers Southern Water		
10	N10 N14 N16 N17 H3 I3 B2	Continue adopting **coastal management measures** that 'hold the line' along the city's coastline in a strategic, holistic, and sustainable approach, including maintaining and improving the quality of beaches and leading marine conservation, and preparing for sea level rise and coastal storms with nature-based and artificial barriers.	BHCC Environment Agency Defra	Long term: 5+ years	M
	Infrastructure				
11	I1 I2 I3 I5 I8 I10 I12 I13 N10	Use the council's **convening powers** and **knowledge** of future development requirements to: • Influence water and wastewater management in the region. • Support the regional transport sector to adapt to climate change. • Influence the regional energy sector to adapt to climate change. • Influence the regional digital sector to adapt to climate change.	BHCC Southern Water National Highways Bus operators Train companies Network Rail Energy companies Telecommunications and ICT providers	Short term: within 2 years	L
12	I2 I3 H3 H11 H12 H13 B1	Undertake and **implement Flood Risk and Drainage Assessments** with up-to-date climate projections and develop a strategy to implement and drive the business case for solutions.	BHCC	Medium term: 2-5 years	L

	Risk	Action	Action Owner and other stakeholders	Timescale for delivery	Indicative cost (H / M / L)
13	NA	Update all **infrastructure design and maintenance** plans for council assets to include climate risk and adaptation considerations.	BHCC	Medium term: 2-5 years	L
	Health, Communities & the Built Environment				
14	H5 H1 H3 I8	Embed climate adaptation into **planning regulations and planning policy** via existing and new Supplementary Planning Documents (e.g. SuDS, water efficiency, flood-proofing and SuDS, heat management), review of City Plan part 1, and other key strategic planning documents. masterplans, tools, projects, and programmes.	BHCC	Medium term: 2-5 years	M
15	H1 H5 H12 H13	Consider refurbishing and **retrofitting council-owned or managed built assets to reduce overheating,** as part of long-term climate adaptation programme (including social housing and schools).	BHCC	Long term: 5+ years	H
16	H1	Promote **public drinking water facilities**, and **warm and cool spaces**, all year round. Prepare a "cool spaces map" to communicate locations where people can go during extreme heat events to access cool conditions.	BHCC	Short term: within 2 years	M
17	H1 H7	Coordinate with ongoing council efforts to **address air quality**, acknowledging the likely impact of increased heat on local air pollution, and overlapping risk areas identified from the Urban Heat Island (UHI) modelling and Air Quality Management Areas. This includes the actions set out in the BHCC Air Quality Action Plan (2022-2027).	BHCC	Short term: within 2 years	L
	Business & Industry				
18	B1 B2 B5	**PRIORITY ACTION** **Co-develop a climate adaptation toolkit** to help local businesses manage their climate risks. This could include: • Resources for a specific sector e.g. climate change risk assessment for the visitor/tourism sector and guidance on the implications, risks, and actions required by the sector to maintain visitor flows into Brighton & Hove. • Resources for event organisers to better understand their climate risks and impacts and contribute to policies and solutions that will enable locally important events to continue safely under changing weather conditions. • A targeted plan to secure long-term viability of historic sites in collaboration with Historic England.	BHCC Local businesses Local authorities / Local authority networks	Medium term: 2-5 years	H

6 Next Steps

This Action Plan, informed by stakeholder engagement, is the first step in ensuring that Brighton & Hove's people, places, and businesses can adapt and become resilient to climate change and its impacts. It is extremely important that authorities and organisations start to act by allocating the necessary resources, working collaboratively and sourcing or re-directing funding.

As such, the next steps towards successful implementation of actions are as follows:

- Engage with key decision makers, such as Councillors, senior leaders, and the Brighton & Hove Mayor to communicate the urgency of adaptation, to establish buy-in and ensure that adaptation can be reflected in decision-making at the highest levels;
- Establish the governance and delivery model for adaptation within BHCC, including ensuring sufficient resourcing and budget;
- Engage with partners to undertake research in critical or poorly understood risk areas, such as climate risks to Brighton & Hove's food supply chain; climate change impacts on goods and services flows into Brighton & Hove; and the vulnerability of the housing mix in Brighton & Hove to climate impacts;
- Develop placed-based demonstrators of actions in this plan to prove the concept and build buy-in for future scaling and city-wide roll-out;
- Identify new and ongoing council projects/programmes where adaptation priorities could be easily embedded, including the Carbon Neutral 2030 programme;
- Identify and implement the quick wins included in this Action Plan, where resources are already available;
- Prioritise and shape other actions depending on urgency (related to specific locations), quantifiable co-benefits across social, economic, and environmental indicators, resource availability, council powers (control/influence), and the scale of stakeholder coordination required;
- Establish a cross-sector Adaptation Working Group to drive implementation and integration of actions, as working in collaboration is crucial to successful implementation;
- Develop a robust monitoring and evaluation process to ensure that actions are having the planned impact;
- Map funding opportunities available to support implementation of these actions and consider strategic use of public sector funds to lever in appropriate private sector investment.

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Appendix A: Summary of risk screening exercise for this CRVA

Table 8 sets out the full list of risks reviewed and whether they were scoped in or out of this CRVA.

Table 8 - Full list of risks reviewed for the CCRA.

UK Climate Risk (2021) risk reference	Description	Scoped in/out of CRVA
Natural Environment and Assets		
N1	Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding, and saline intrusion).	In
N2	Risks to terrestrial species and habitats from pests, pathogens, and invasive species	In
N3	Opportunities from new species colonisations in terrestrial habitats	Out
N4	Risk to soils from changing climatic conditions, including seasonal aridity and wetness.	In
N5	Risks and opportunities for natural carbon stores, carbon sequestration from changing climatic conditions, including temperature change and water scarcity	Out
N6	Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind, and saline intrusion).	In
N7	Risks to agriculture from pests, pathogens, and invasive species	In
N8	Risks to forestry from pests, pathogens, and invasive species	Out
N9	Opportunities for agricultural and forestry productivity from new/alternative species becoming suitable.	Out
N10	Risks to aquifers and agricultural land from sea level rise, saltwater intrusion	In
N11	Risks to freshwater species and habitats from changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts.	Out
N12	Risks to freshwater species and habitats from pests, pathogens, and invasive species	Out
N13	Opportunities to freshwater species and habitats from new species colonisations	Out
N14	Risks to marine species, habitats, and fisheries from changing climatic conditions, including ocean acidification and higher water temperatures	In
N15	Opportunities to marine species, habitats, and fisheries from changing climatic conditions	Out
N16	Risks to marine species and habitats from pests, pathogens, and invasive species	In
N17	Risks and opportunities to coastal species and habitats due to coastal flooding, erosion, and climate factors	In
N18	Risks and opportunities from climate change to landscape character	In
Infrastructure		
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures	In
I2	Risks to infrastructure services from river, surface water and groundwater flooding	In
I3	Risks to infrastructure services from coastal flooding and erosion	In
I4	Risks to bridges and pipelines from flooding and erosion	Out
I5	Risks to transport networks from slope and embankment failure	In
I6	Risks to hydroelectric generation from low or high river flows	Out
I7	Risks to subterranean and surface infrastructure from subsidence	Out

UK Climate Risk (2021) risk reference	Description	Scoped in/out of CRVA
I8	Risks to public water supplies from reduced water availability	In
I9	Risks to energy generation from reduced water availability	Out
I10	Risks to energy from high and low temperatures, high winds, lightning	In
I11	Risks to offshore infrastructure from storms and high waves	Out
I12	Risks to transport from high and low temperatures, high winds, lightning	In
I13	Risks to digital from high and low temperatures, high winds, lightning	In
Health, Communities, and the Built Environment		
H1	Risks to health and wellbeing from high temperatures	In
H2	Opportunities for health and wellbeing from higher temperatures	Out
H3	Risks to people, communities, and buildings from flooding	In
H4	Risks to the viability of coastal communities from sea level rise	Out
H5	Risks to building fabric	In
H6	Risks and opportunities from summer and winter household energy demand	In
H7	Risks to health and wellbeing from changes in air quality	In
H8	Risks to health from vector-borne disease	Out
H9	Risks to food safety and food security	Out
H10	Risks to water quality and household water supplies	In
H11	Risks to cultural heritage	In
H12	Risks to health and social care delivery	In
H13	Risks to education and prison services	In
Business and Industry		
B1	Risks to businesses from flooding	In
B2	Risks to businesses and infrastructure from coastal change from erosion, flooding, and extreme weather events	In
B3	Risks to business from water scarcity	In
B4	Risks to finance, investment and insurance including access to capital for businesses	Out
B5	Risks to business from reduced employee productivity due to infrastructure disruption and higher temperatures in working environments	In
B6	Risks to business from disruption to supply chains and distribution networks	Out
B7	Opportunities for business from changes in demand for goods and services	Out
International Dimensions		
ID1	Risks to UK food availability, safety, and quality from climate change overseas	Out
ID2	Opportunities for UK food availability and exports from climate impacts overseas	Out
ID3	Risks and opportunities to the UK from climate-related international human mobility	Out
ID4	Risks to the UK from international violent conflict resulting from climate change overseas	Out
ID5	Risks to international law and governance from climate change that will impact the UK	Out
ID6	Opportunities from climate change (including Arctic ice melt) on international trade routes	Out

UK Climate Risk (2021) risk reference	Description	Scoped in/out of CRVA
ID7	Risks associated with international trade routes	Out
ID8	Risk to the UK finance sector from climate change overseas	Out
ID9	Risk to UK public health from climate change overseas	Out
ID10	Systemic risk arising from the amplification of named risks cascading across sectors and borders	Out

Appendix B: Risk matrices – definitions of likelihood and impact

Table 9 - Likelihood definitions used in CRVA.

Level of Likelihood	Definition of Likelihood
Almost impossible (1)	Difficult to see how this could occur. Has happened very rarely before or never. Is a highly unlikely climate scenario, even at the extremes of climate projections.
Unlikely (2)	Do not expect occurrence but it is possible. Less than 10% chance of occurrence May have happened in the past; unlikely to happen in the next three years
Possible (3)	May occur occasionally. Only likely to happen once in 3 or more years Has happened in the past; reasonable possibility it will happen as part of climate change scenarios
Likely (4)	Will occur persistently but is not an everyday occurrence. Likely to happen at some point within the next 1-2 years Circumstances occasionally encountered within likely climate change scenarios
Almost certain (5)	High probability of situation occurring Regular occurrence, Circumstances frequently encountered, daily/weekly/monthly/seasonally

Table 10 - Impact definitions used in CRVA.

Impact Rating	Health	Impact on city life	Service delivery	Economic	Environment	Reputation
Insignificant (1)	minor injury, basic first aid required, one person affected, no days of absence, no delay	insignificant disruption to community services, including transport services and infrastructure	no service disruption, unlikely to cause complaint or instigate litigation	none/minimal financial burden (less than £100, can be resolved at local service / department level), minor interruption to income generation, no permanent loss	insignificant impact on environment	organisation(s) reputation remains intact
Minor (2)	non-permanent harm, short-term injury, resulting in absence of up to 3 days. 1 – 2 persons affected	minor localised disruption to community services or infrastructure less than 24 hours	minor service disruption, complaint possible, litigation unlikely	minimal financial burden or disruption to income generation (less than £1,000 but greater than £100). Can be resolved at line manager/ service manager level through usual budgetary measures	minor impact on environment with no lasting effects	minimal impact on organisation(s) reputation
Moderate (3)	causing semi-permanent disability, injury, disease, or harm which could interrupt attendance at work for 3-28 days AND/OR affects 3 - 50 people	damage that is confined to a specific location, or to a number of locations, but requires additional resources. Localised disruption to infrastructure and community services	moderate service disruption. High potential for complaints, litigation possible, but not certain	moderate financial burden (less than £10,000 but greater than £1,000). Interruption to income generation lasting less than 14 days, majority of income recoverable but at additional cost	limited impact on environment with short-term or long-term effects	moderate impact on organisation(s) reputation
Major (4)	causing death, permanent disability, serious injury or harm, e.g. loss of function or body part(s), serious disability, single death of any person. 51-200 people affected. Long term absence from work (28-84 days), extended medical attention required, e.g. up to a month in hospital	significant damage that impacts on and possible breakdown of some local community services. Requires support for local responders with external resources	service closure for 1-7 days, complaints expected, litigation expected	major financial burden (less than £100,000 but greater than £10,000). Can include significant extra clean up and recovery costs.	significant impact on environment with medium to long term effects	major impact on organisation (s) reputation / National adverse publicity
Catastrophic (5)	multiple deaths involving any persons, greater than 200 people affected, more than 84 days absence, more than 30 days extended	extensive damage to properties and built environment in affected areas. General & widespread displacement of more than 500 people for prolonged duration. Community unable to function without significant support	service closure for more than 7 days or closure of multiple services, complaints certain, litigation certain	catastrophic financial burden (greater than £100,000). Extensive clean up and recovery costs	serious long-term impact on environment and/or permanent change.	catastrophic impact on organisation(s) reputation. International adverse publicity

Appendix C: Urban Heat Island modelling – assumptions and limitations

This Appendix describes the assumptions and limitations associated with the Urban Heat Island (UHI) modelling work referred to in Section 3.1.1, which presents modelled surface temperatures. The full outputs and analysis have been provided to BHCC in a separate file.

The limitations of the modelling primarily arise due to the assumptions and data sources used:

- The accuracy of the model is dependent on the accuracy and resolution of the input data on variables such as land surface classification, land surface cover etc. There may be small features and updates that may not be captured in the model.
- Data on anthropogenic heat emissions, i.e. heat from buildings, transport, and people, was not readily available. Population density was used in the model to make predictions for these variables.
- The 'Surface Urban Energy and Water Balance Scheme' (SUEWS) model used in this study is a surface model and limited to the resolution of the data available. It does not account for detailed 3D features.
- SUEWS is not a computational fluid dynamics model and does not account for advection across the city. This would have an impact on the urban heat island but would require more complex modelling to be undertaken which is outside the scope of this work.
- Other climate variables such as solar radiation and humidity will have an impact on thermal comfort and heat stress. These are not accounted for in the temperature maps. These are microclimate features and should be considered when surveying areas in more detail.