



Council of the Isles of Scilly

Isles of Scilly Resilient Islands Strategy



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This work has been undertaken in accordance with the quality management system of RSK.

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LIST OF ABBREVIATIONS

AR5	Intergovernmental Panel on Climate Change 5 th Assessment Report
AR6	Intergovernmental Panel on Climate Change 6 th Assessment Report
AONB	Area of Outstanding Natural Beauty
CAERP	Combined Agency Emergency Response Protocol
IOSRIS	Isles of Scilly Resilient Islands Strategy
CCMA	Coastal Change Management Area
CCRA	Climate Change Risk Assessment
CMIP	Coupled Model Intercomparison Project
CPM	Convection Permitting Model
DEFRA	Department for Environment, Food and Rural Affairs
EMS	European Marine Sites
FCRM	Flood and Coastal Risk Management
GHGs	Greenhouse Gases
INNS	Invasive Non-Native Species
IPCC	Intergovernmental Panel on Climate Change
LFMRS	Local Flood Risk Management Strategies
MET Office	Meteorological Office
MCZ	Marine Conservation Zones
NAP	National Adaptation Programme
NI	National Indicator
RCP	Representative Concentration Pathway
RNLI	Royal National Lifeboat Institution

SAC	Special Areas of Conservation
SAM	Scheduled Ancient Monument
SMP	Shoreline Management Plan Revision
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
UKCP	United Kingdom Climate Projection

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1 INTRODUCTION

1.1 Background

Climate Change Adaptation:

“The process of adjustment to actual or expected climate and its effects”¹.

Climate change is one of the defining issues of our time. Its impacts, which are ‘severe, pervasive, and irreversible’², can be felt throughout every aspect of our lives. In recent years, direct and indirect effects brought about by climate change, such as extreme weather events, rising sea levels, biodiversity loss, compromised food security, and increased health risks, have all made addressing the phenomenon imperative. Immediate actions are urgently required before efforts to adapt to the physical impacts of climate change become extremely difficult and costly.

With coastal flooding and erosion already affecting the community, wildlife, economy and water supply on the islands, the Climate Adaptation Scilly project, funded by the European Regional Development Fund and the Environment Agency, will serve to increase community resilience to the physical impacts of climate change. It is a package of climate change adaptation measures intended to reduce the physical impacts of climate change on one of the most vulnerable parts of the United Kingdom and to develop a strategic plan for ongoing adaptation actions. This project joins a growing list of climate change adaptation projects around the world, such as the Room for the River project

¹ IPCC, 2014: Climate Change 2014: Synthesis Report. Annexes. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland. https://www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf

² Intergovernmental Panel on Climate Change., 2014. Climate Change 2014 Synthesis Report Summary for Policymakers. Intergovernmental Panel on climate Change. Available from: https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf. Last visited: 1st July 2020.

in the Netherlands³, the Africa Disaster Risks Financing Programme⁴, China's Sponge City Programme⁵, and the Great Green Wall Initiative in the Sahel and West Africa⁶.

Through the implementation of various laws and policies, the UK government is committed to meeting the goals set out in the 2015 Paris Agreement. For example, the Climate Change Act 2008 requires the Government to regularly assess the risks associated with climate change to the UK, and to set out adaptation objectives along with proposals and policies to meet those objectives. This is achieved, in large part, and most recently, through the UK Climate Change Risk Assessment (CCRA) 2022 which expanded on the previous CCRA 2017. The CCRA 2022 outlines the projected climate change risks to (1) the viability and diversity of terrestrial and freshwater habitats and species; (2) soil health; (3) natural carbon stores and their sequestration capabilities; (4) crops, livestock, and commercial trees; (5) food, goods, and vital services; (6) people and the economy; (7) human health, wellbeing, and productivity; and (8) the UK due to impacts overseas. These eight priority risk areas will inform appropriate actions that government and non-governmental actors can take through the National Adaptation Programme (NAP).

England's NAP focuses mainly on raising awareness of the need for climate change adaptation, improving the evidence base, and taking timely action to increase resilience to the eight main groups of risks highlighted in the latest CCRA. The NAP highlights the importance of adapting to climate challenges and transitioning to a low-carbon economy. The focus of England's NAP is especially pertinent to the Isles of Scilly, as the islands are exceptionally vulnerable to rising sea levels and extreme weather events due to their exposed location in the Atlantic Ocean.

³ Rijkswaterstaat., Room for the River., Ministry of Infrastructure and Water Management. Available from: <https://www.rijkswaterstaat.nl/en/about-us/gems-of-rijkswaterstaat/room-for-the-river> Last visited: 15th December 2022.

⁴ ACP-EU Natural Disaster Risk Reduction Program., Africa Disaster Risk Financing Initiative: Activity Report 2018-2019., Global Facility for Disaster Reduction and Recovery. Available from: <https://www.gfdr.org/en/publication/africa-disaster-risk-financing-initiative-activity-report-2018-2019> Last visited: 15th December 2022.

⁵ Qi, Y., Chan, F.K.S., O'Donnell, E.C., Feng, M., Sang, Y., Thorne, C.R., Griffiths, J., Liu, L., Liu, S., Zhang, C. and Li, L., 2021. Exploring the Development of the Sponge City Program (SCP): The Case of Gui'an New District, Southwest China. *Frontiers in Water*, p.41. doi: 10.3389/frwa.2021.676965

⁶ United Nations Convention to Combat Desertification., Great Green Wall Initiative., UNCCD. Available from: <https://www.unccd.int/our-work/ggwi> Last visited: 15th December 2022.

1.2 About this Plan

In response to climatic change, and the legal and policy framework which surrounds it in England, the Council of the Isles of Scilly (hereafter referred to as 'the Council') commissioned RSK Group (hereafter referred to as 'RSK'), to undertake a climate change risk assessment of the Isles of Scilly and to develop a Isles of Scilly Resilient Islands Strategy (IOSRIS), including a supplementary Implementation Plan, which delivers a community-led adaptation strategy as part of the Climate Adaptation Scilly project.

The Climate Adaptation Scilly project includes the implementation and improvement of a range of coastal sea defence works (including dunes and rock armour) on St Mary's, St Martin's, Bryher and St Agnes, as well as funding rainwater harvesting for businesses. The Climate Adaptation Scilly project is funded by the European Regional Development Fund and by Grant in Aid from the Environment Agency.

This IOSRIS will support this outcome, through its holistic and stakeholder-centric approach towards the development of a strategy which will integrate into the Climate Change Strategy for the islands, link with any local Farming in Protected Landscapes initiatives, form part of the Local Plan and its Civil Contingency planning, and adhere to, and deliver upon, the UK Government's Community Resilience Development Framework.

Whilst island life has always responded well to adverse and extreme weather conditions, this IOSRIS will support residents, visitors, businesses, and other relevant stakeholders to understand the physical impacts of climate change and to prioritise their response(s) to them, as a means of enhancing the long-term resilience of the thriving island communities and their future generations.

1.3 How to use the Plan

The purpose of this Isles of Scilly Resilient Islands Strategy is to provide evidence to inform local climate change adaptation and to raise awareness among the Isles of Scilly community, businesses and other stakeholders of the potential risks and impacts of climate change. The method and outputs of this action plan have been constructed with these aims in mind.

This report is intended for Council, policy makers, public and private sector partners, the Isles of Scilly community and researchers to support with awareness, understanding and effective decision making at an individual and community level.

For quick reference and links to each section, please refer to:

Section 2 – The Isles of Scilly

- *Content:* Sets the local context including an overview of the Isles of Scilly environment, climate and previous events.

Section 3 – Climate Change Risk Assessment

- *Content:* Presents an overview of the risk assessment methodology, data / model sources, assessment criteria and stakeholder engagement.

Section 4 – Climate Change Impacts

- *Content:* Presents the climate change impact chains for each domain (e.g. infrastructure, health and built environment, natural environment and business). This section also includes a summary of the identified risks and risk rating by domain.

Section 5 – Adaptation Option Development

- *Content:* Presents an overview of the adaptation option development process, prioritisation criteria and an introduction to adaptation pathways.

Section 6 – Isles of Scilly Resilient Islands Strategy

- *Content:* Presents the Isles of Scilly Climate Change Action Plan.

Appendix 1 – Glossary of terms

- *Content:* Presents a list of key terms and their descriptions

Appendix 2 – Sector (Domain) Flow Charts

- *Content:* Presents the flow of information - Hazard > Risk > Adaptation Option(s) > Adaptation Pathway(s) – in one easy to follow diagram.

Appendix 3 – Adaptation Pathways

- *Content:* Presents each of the potential adaptation pathways for each sector (domain) along with their corresponding scorecards.

Appendix 4 – Implementation Plan

- *Content:* Summarises the outputs of this action plan and presents ‘next step’ actions for the Council, individuals, the community, public and private sector partners.

2 THE ISLES OF SCILLY

2.1 The local environment

The Isles of Scilly are an archipelago of over 200 low-lying granite islands which are home to approximately 2,200 people (2011 census), roughly 1,700 of which live on the largest island of St Mary's. The islands have a combined area of 16km² and are situated in the Atlantic Ocean, 28 miles off the south-west coast of Cornwall.

The islands have an oceanic climate which is relatively mild, compared to other parts of the UK. In the summer (June to August), temperatures range from approximate 12°C to 20°C with average rainfall ranging from approximately 50 mm to 77 mm (1991-2020). In the winter (December to February), temperatures range from approximately 6°C to 11°C, with average rainfall ranging from approximately 76 mm to 100 mm (1991-2020). The monthly mean wind speed at 10 m height in winter is on average 15.2 knots and 9.2 knots in summer. Long-term coastal erosion and accretion are relatively stable on the islands, however there are a number of notable exceptions, including, but not limited to Bar Point, Rushy Bay, Porth Cressa, Porth Mellon and Porth Loo. These, and other locations in which erosion and accretion is severe, are areas in which sand and loose head material (locally known as 'ram') are prevalent. For more information relating to flooding and erosion on the islands, please refer to the [Cornwall and Isles of Scilly Shoreline Management Plan 2](#).

There are five inhabited islands; these are (in order of population size); St Mary's, Tresco, St Martin's, St Agnes (with Gugh), and Bryher. The economy of these islands is largely dependent upon tourism, which relies on the tranquil, unspoilt, high-quality environment remaining in a positive state for the islands visitors.

The Isles of Scilly are designated and protected at an international and nation level for a range of features, including:

- Sites of Special Scientific Interest (SSSI)
- Special Areas of Conservation (SAC)
 - Including for Shore Dock and the Atlantic Grey Seal
- Special Protection Area (SPA)
 - As a result of seabird assemblage of international importance including Lesser black-backed gulls and Storm petrels
- Marine Conservation Zones (MCZ)
 - Including six further offshore

- Ramsar sites designated as internationally important wetlands
 - Including habitats such as coastal cliffs, boulder beaches, heathland, and dune grassland.
- European Marine Sites (EMS)
- Area of Outstanding Natural Beauty (AONB)
 - Covering the whole of the islands

In addition to these environmental designations, the coastline is designated as a heritage coast and the islands are home to 129 listed buildings, 280 scheduled ancient monuments (SAMs) and one Grade 1 Registered Park and Gardens. There are also five Protected Wreck Sites in the vicinity of the islands.

To arrive on the islands from the mainland, all passengers and freight must be transported by air (helicopter or light aircraft) or by sea, with inter island travel being restricted largely to the latter.

2.2 Local Context

Most freehold land on the Isles of Scilly is owned by the Duchy of Cornwall. All of the uninhabited islands within the archipelago are leased from the Duchy, by the Isles of Scilly Wildlife Trust who manage them. The island of Tresco is leased to the Dorrien-Smith (Tresco) estate which manages the island as a holiday resort. Thomas Algernon Dorrien-Smith (1891) chaired the first Council of the Isles of Scilly which was granted the power to deal with all aspects of the island's administration. The Council is one of only two sui generis unitary authorities in the United Kingdom, the other being the City of London Corporation. With the Isles of Scilly and the City of London, any application of legislation by the Government needs to be made explicit if it is to be applied to these localities. The Council, together with the Department for Environment, Food and Rural Affairs (Defra), the Tresco Estate and the Duchy of Cornwall are working with South West Water to provide for the sustainable management of water and wastewater services on the islands. Each of these parties, and others, including the community, local businesses and charities, are key stakeholders in the development of this Plan.

2.3 Present Climate

The Isles of Scilly have a unique micro-climate compared to much of the UK. It is a temperate climate with limited seasonal variations. Average maximum temperatures reach around 19.7°C in the hottest

summer month (August) and stay up around 9.91°C in the coldest winter month (January)⁷. Average minimum temperatures drop only as low as 12°C in the coldest summer month (June) and 6.3°C in the coldest winter month (February). During the winter months (December, January, and February) there are on average 0.2 days of air frost and 64.6 hours of sunshine per month. During the summer months (June, July, and August), sunshine hours average 204.2 per month⁸.

There are, on average, approximately 142 rainy days (days when rainfall exceeds 1mm) on the Isles of Scilly, with total average rainfall equating to approximately 879 mm each year (1991 – 2020); the majority of which falls in the winter months when wind speeds are often at their greatest (approximately 15.2 knots at 10m on average)⁹.

The Isles of Scilly has an average annual water (sea surface) temperature on the coast of 13.1°C, with values averaging 10.8°C in winter and spring, 15.9°C in summer, and 14.9°C in autumn. Minimum water temperature in the Isles of Scilly happens in March¹⁰.

2.4 Previous Events

The Isles of Scilly are particularly vulnerable to the impacts of climate change in view of their location and exposure to Atlantic storms and storm surges, as well as their low-lying character, married with the fact that much of the housing stock, critical infrastructure, freshwater resources, and commercial properties are located close to sea level on narrow isthmuses. These factors increase their vulnerability to hazards including, but not limited to sea level rise, coastal flooding, and erosion. This, and their exposure to drought, is highlighted by past weather events as outlined below. Events such as these are projected to increase in frequency and intensity as the climate changes.

⁷ Climate data for the St Mary's Heliport Station (1991-2020). The Met Office. Available at: <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gbgebz4kn> Last visited: 16th December 2022.

⁸ Climate data for the St Mary's Heliport Station (1991-2020). The Met Office. Available at: <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gbgebz4kn> Last visited: 16th December 2022.

⁹ Climate data for the St Mary's Heliport Station (1991-2020). The Met Office. Available at: <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gbgebz4kn> Last visited: 16th December 2022.

¹⁰ Sea temperature data for Isles of Scilly. Sea Temperature. Available at: <https://seatemperature.net/current/united-kingdom/isles-of-scilly-england-united-kingdom-sea-temperature> Last visited: 20th December 2022.

2.4.1 2022 – Storm event

On the 18th of February 2022, storm Eunice brought winds that gusted at over 70Kt (81mph) in exposed coastal locations¹¹, coupled with a storm surge coinciding with high tides associated with the Full Moon. The Isles of Scilly experienced strong winds and significant spray over the sea wall, and some power dips due to power outages on the mainland. The Met Office issued a red weather warning indicating a danger to life with residents urged to make necessary preparations in line with Met Office guidelines. Schools on the Isles of Scilly were closed, and helicopter flights were put on hold. The multi-agency Tactical Command Group for Cornwall, which includes the EA, police, fire and rescue, Met Office and utility companies, monitored the incoming storm. No known significant storm damage was noted on the islands¹².

2.4.2 2021 – Storm event

In July 2021, the Met Office issued an amber, and then a yellow weather warning (winds up to 75 mph), across the southwest of England in response to the storm-force winds and heavy rain caused by Storm Evert. This resulted in local gusts of up to 69mph which required the Royal National Lifeboat Institution (RNLI) to work through the night to support a large number of vessels (no less than 22 people) in difficulty around the islands. This included the need to airlift five people from their vessel by a coastguard helicopter dispatched from Newquay¹³.

2.4.3 2018 – Drought event

In the summer of 2018, the Isles of Scilly experienced a prolonged period of drought with just 23% (11mm) of its average annual rainfall for the month of June and 49% (34mm) for the month of July. This led to the event being classified as the third driest since 1910, as groundwater supplies dropped

¹¹ Met Office (2022), Storms Dudley, Eunice and Franklin, February 2022., The Met Office. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_01_storms_dudley_eunice_franklin_r1.pdf. Last visited 15th Dec. 2022.

¹² Badshah, N., Ambrose, T. and Halliday, J. (2022) 'Storm Eunice: at least four die as winds of up to 122mph batter UK and Ireland – latest updates', *The Guardian*, August 18. Available at: <https://www.theguardian.com/uk-news/live/2022/feb/18/storm-eunice-london-added-to-red-weather-warning-as-met-office-urges-millions-to-stay-indoors-live-news-updates?page=with:block-620f6e768f086f7273b87e89> Last visited: 16th December 2022.

¹³ Dowrick, M., (2021) 'Five people airlifted from boat as Storm Evert hits Cornwall', *Cornwall Live*, July 3. Available at <https://www.cornwalllive.com/news/cornwall-news/five-people-airlifted-boat-storm-5721016> Last visited: 16th December 2022.

to historic lows as water was extracted at unsustainable rates (risking sea water inundation). This posed substantial difficulties for the islands because the local desalination plant only meets approximately one third of demand and was, at the time, operating at its maximum capacity, further risking a potential breakdown of equipment. As a result of this, local residents and visitors to the island were encouraged to take significant steps to reduce their water usage and were banned from lighting fires and/or using barbecues due to the risk of igniting wildfires. The impact of this would have been significant, insofar as drinking water is generally used to extinguish fires on the islands, in the absence of a reservoir, and would therefore have diminished supplies for consumption. In addition to residents and visitors being discouraged from using barbecues, they were also asked not to use hosepipes, sprinklers, and paddling pools to maintain non-essential usage to a minimum¹⁴.

2.4.4 2014 – Storm event

Between January and February 2014, six major storms hit the UK. Of these, the event which took place on the 14th resulted in strong winds (92 mph), significant waves (6 –8 m) and a tidal surge of approximately 0.26 m. During this time, flood defences were exceeded by the February 2014 storm causing flooding with an expected Annual Exceedance Probability of around 1:2 at Porthloo, 1:10 at Old Town and Porth Hellick and 1:25 in Hugh Town on St Mary's; 1:25 at Lower Town and Higher Town on St Martin's; 1:2 at all shorelines on Bryher and 1:2 on St Agnes¹⁵.

2.4.5 2004 – Storm event

In October 2004, a storm event resulted in the sea walls and embankments located at Old Town on St Mary's being overtopped and breached from the Old Town Church to the Old Quay. This event further resulted in sea water inundation into the Lower Moors area. This was a cause for significant concern insofar as this represents one of the principal sources of freshwater on the island¹⁶.

¹⁴ Rossiter, K., (2018) 'People living on the Isles of Scilly face drought and bonfires are now banned', *Cornwall Live*, August 5. Available at: <https://www.cornwalllive.com/news/cornwall-news/people-living-isles-scilly-face-1864904> Last visited: 16th December 2022.

¹⁵ JBA (2019)., Isles of Scilly Coastal Modelling Report. Environment Agency. Devon. England.

¹⁶ Council of the Isles of Scilly. 2017. Isles of Scilly Local Flood Risk Management Strategy

2.4.6 1989/90 – Storm event

On the 16th – 17th December 1989 a major storm hit the Isles of Scilly, which significantly damaged the defences at Porthcressa and overtopped the defences at Old Town and Porthloo on St Mary. This storm reportedly eroded 1,000 tonnes of rock from Popplestone Brow and damaged a stone wall which provided defence against high waters in Green Bay. Extensive flooding and erosion took place at the cliff at Porthloo and threatened to flood six houses and this location. This storm was followed by two subsequent storms in early 1990, the return period of which was determined to be 1:50 years¹⁷. The Proudman Oceanographic Laboratory indicated that the extreme water level for a return period of this significance at St Mary's was approximately 3.55m AOD¹⁸.

2.4.7 Earlier events

According to the Isles of Scilly Local Flood Risk Management Plan (2017)¹⁹, significant storms, resulting in considerable damage and extensive flooding, include ‘the “Great Storm of 1744”, December 1771, March 1962, 1989, Easter 1994, early 1995, October 2004 and the winter of 2013/14 (mentioned above)²⁰. The areas most exposed to these events include Hugh Town on St Mary's, which is situated on a narrow isthmus (a narrow piece of land connecting two larger areas across an expanse of water by which they are otherwise separated) and is highly vulnerable to storms and high tides from the Town Beach and Porthcressa directions. Popplestone/Great Pool on Bryher are also exposed (as noted with reference to the events in 1994 and '95)²¹.

¹⁷ Arup (2011) Isles of Scilly Water Interests Survey: Report of Flood Defences. Defra.

¹⁸ Arup (2011) Isles of Scilly Water Interests Survey: Report of Flood Defences. Defra.

¹⁹ Council of the Isles of Scilly (2017) Isles of Scilly Local Flood Risks Management Strategy. IoS. Available from: <https://www.scilly.gov.uk/sites/default/files/document/planning/Local%20Flood%20Risk%20Management%20Strategy%20FINAL.pdf> Last visited: 16th December 2022.

²⁰ JBA Consulting (2019) Isles of Scilly Coastal Flood Modelling. Environment Agency.

²¹ JBA Consulting (2019) Isles of Scilly Coastal Flood Modelling. Environment Agency.

3 CLIMATE CHANGE RISK ASSESSMENT

3.1 What is climate change?

Climate change is the alteration of long-term climate conditions, as a result of interactions between the Earth's atmosphere and its various physical, chemical and biological processes²². The climate changes naturally; mostly due to variations in solar output (radiation) and the Earth's orbit around the sun²³, however, the present warming trend is, for the first time, the result of human activity²⁴. Many human activities emit greenhouse gases (GHGs) which trap additional heat within the atmosphere, whilst other activities, such as deforestation, limit the capacity of natural systems to remove these gases from the atmosphere. The consequence of this is unprecedented warming leading to the destabilisation of the prevailing climate.

Although reducing greenhouse gas emissions will eventually begin to limit the causes of climate change, some physical climate changes such as sea level rise, droughts and heavy rainfall have already begun. In addition, sea level rise is already 'baked in'. This means people and the environment will have to adapt to the physical impacts of climate change even if emissions can be reduced to pre-industrial levels.

²² International Geosphere-Biosphere Programme., Earth system definitions. International Geosphere-Biosphere Programme. Available from: <http://www.igbp.net/globalchange/earthsystemdefinitions.4.d8b4c3c12bf3be638a80001040.html>. Last visited: 1st July 2020.

²³ Arias, P.A., 2021: Technical Summary. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33–144. doi:10.1017/9781009157896.002.

²⁴ Arias, P.A., 2021: Technical Summary. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33–144. doi:10.1017/9781009157896.002.

The effectiveness of adaptation to the physical impacts of climate change will depend on our ability to work together at an individual, community, regional and global level. We'll have to cope not only with the general warming trend but also with a high degree of climate variability above and below average trends.

Because of this uncertainty about how much climate will change, it is important for climate change adaptation measures to be flexible. For this reason, this Plan provides 1) an understanding of the risks associated with climate change and 2) a description of the adaptation process, options and actions that can be taken to increase community resilience.

To identify potential climate change risks and to develop these adaptation pathways and measures, the following approach was taken.

3.2 Risk assessment methodology

A climate change risk assessment is a process which helps to identify climate hazards and their impacts. Climate hazards represent a possible source of harm such as rising temperatures or heatwaves etc. To achieve this, climate change risk assessments principally consider the results of a vulnerability assessment.

A vulnerability assessment is an assessment of the predisposition of a system (such as a community, business, or the environment) to be adversely affected. Specifically, the assessment comprises an examination of receptor* sensitivity and adaptive capacity:

- sensitivity: 'the degree to which a system or species is affected...by climate variability or change'²⁵.
- adaptive capacity: the capacity to adjust to potential damage or to take advantage of opportunities brought about by climate change.

The vulnerability assessment results are then combined with an understanding of receptor exposure (the presence of the receptor in a place which could be affected by the hazard

²⁵ The International Organisations for Standardisation (2019) ISO 14091: Adaptation to climate change: Guidelines on vulnerability, impacts and risk assessment. ISO Copyright Office. Switzerland

concerned) as well as the likelihood and magnitude of each impact, identified as resulting from a projected climate hazard or combination of hazards; as shown in Figure 1.

* Receptor: part of the system e.g., individuals, assets, or species.

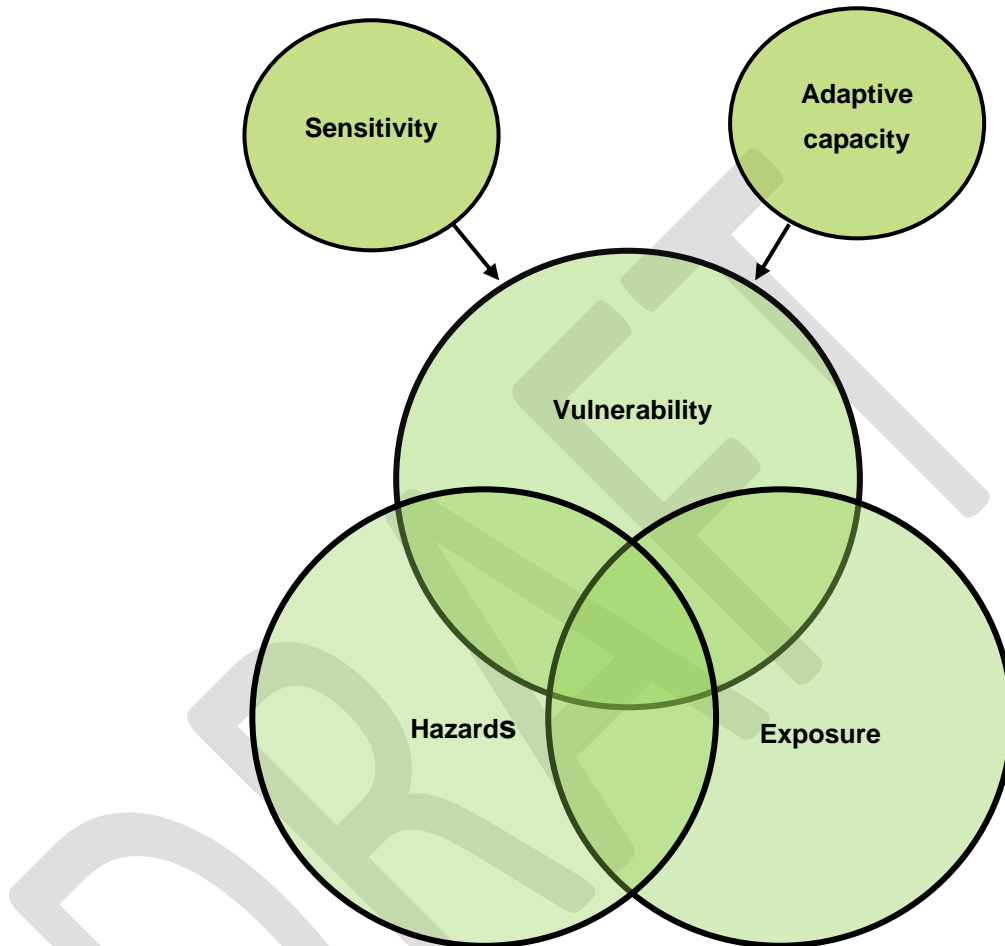


Figure 1: An illustration of the core concepts of risk

The climate change risk assessment for the Isles of Scilly uses ISO 14091 - Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment. To support this, a review of existing risk assessments and relevant adaptation plans and policies was undertaken and summarised as follows.

3.2.1.1 *The UK Climate Change Risk Assessment (CCRA3) 2022*

The Climate Change Act 2008 requires the UK Government to compile its assessment of UK-specific risks and opportunities arising from climate change every five years. The first

CCRA (CCRA1) was published in 2012²⁶, with the second CCRA (CCRA2) published in 2017²⁷. The UK CCRA was updated in 2022²⁸, providing the third five-year assessment of the risks of climate change on the UK (CCRA3). CCRA3 identifies 61 climate risks and opportunities cutting across multiple sectors of the society and highlights eight priority risk areas that require action over the next five years. The eight priority risk areas are:

- Risks to the viability and diversity of terrestrial and freshwater habitats and species.
- Risks to soil health from increase flooding and drought.
- Risks to natural carbon stores and sequestration from multiple hazards, leading to increased emissions.
- Risks to crops, livestock, and commercial trees from multiple climate hazards.
- Risks to supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks.
- Risks to people and the economy from climate-related failure of the power system.
- Risks to human health, wellbeing, and productivity from increased exposure to heat in homes and other buildings.
- Multiple risks to the UK from climate change impacts overseas.

3.2.1.2 *The second National Adaptation Programme (NAP2)*

The Climate Change Act 2008 requires the UK Government to publish a National Adaptation Programme (NAP) every five years, outlining the actions that government and others will take to adapt to the challenges of climate change in the UK, based on the latest

²⁶ Department for Environment, Food & Rural Affairs (2012). UK Climate Change Risk Assessment: Government Report, January 26., GOV.UK. Available at: <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report> Last accessed 16th December 2022.

²⁷ Department for Environment, Food & Rural Affairs (2017). UK Climate Change Risk Assessment 2017, January 18., GOV.UK. Available at: <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2017> Last accessed 16th December 2022.

²⁸ Department for Environment, Food & Rural Affairs (2022). UK Climate Change Risk Assessment 2022, January 17., GOV.UK. Available at: <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022> Last accessed 16th December 2022.

UK CCRA. The second NAP (NAP2²⁹) for England addresses the priority risks identified in CCRA2 and sets out a mix of policies and appropriate actions for government and non-governmental actors to manage and, where possible, mitigate those risks, in the period 2018 to 2023. The third NAP (NAP3) will be published in 2023 and will set out the actions that government and others will take to adapt to the challenges of climate change in the UK, between the period 2023-2028 based on the risks outlined in CCRA3.

3.2.2 Regional plans, policies and assessments

3.2.2.1 National Indicator 188 (NI188) 2008

In 2008, the Isles of Scilly Council signed up to the National Indicator 188, a process-based and self-assessment framework for local authorities to facilitate the management of climate risks and opportunities, which was subsequently discontinued in 2010. Participating within this framework, the Isles of Scilly Council achieved levels 0 (getting started) and 1 (public commitment and impact assessment) in May 2009. This comprised of initial project scoping, collection of environmental data, preliminary research on the impact of extreme weather events and top-level identification of potential risks to the community. Level 2 (comprehensive risk assessment) was further submitted in May 2010 and comprised an assessment of existing and required adaptation responses, supporting a comprehensive risk assessment to identify and quantify the wide-ranging risks of climate change. This risk assessment was conducted by circulating briefing documents and questionnaires to senior Council department heads and members of Local Strategic Partners, with follow-up interviews. This exercise identified risks that required integrating within long-term planning strategies and provided an evaluation of the most effective adaptive responses that could be incorporated within Council strategies, plans, partnerships and operations (e.g., planning, flood and coastal management, economic development, social care, services for children, transport, etc).

²⁹ Department for Environment, Food & Rural Affairs (2018). The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting: Making the country resilient to a changing climate, July 19., GOV.UK. Available at: <https://www.gov.uk/government/publications/climate-change-second-national-adaptation-programme-2018-to-2023> Last accessed 16th December 2022.

3.2.2.2 Climate Change Risk and Adaptation Assessment (CCRAA) 2009/2010

The Isles of Scilly Climate Change Risk and Adaptation Assessment (CCRAA) identified over 50 risks associated with climate change. They were evaluated by a panel of Planning and Economic Development staff considering adaptive procedures already in place and scored low, medium, or high for financial and community impact. The primary risks from the physical impacts of climate change were identified as:

- **Sea level rise and storms:** these pose a risk to administration (e.g., Town Hall and other infrastructure impacts on administration), infrastructure (e.g., roads, sewers and drains, septic tank drainage systems), transport links and both residential and commercial properties, with wide-ranging negative consequences. Adaptation and risk reduction plans and policies associated with these risks include:
 - Climate Change Strategic Plan³⁰
 - Local Plan (2015 – 2030)³¹
 - Shoreline management plan revision 2 (SMP2)³²
 - Isles of Scilly Local Flood Risk Management Strategy (LFRMS)³³

³⁰ Council of the Isles of Scilly (2011). Climate Change Strategic Plan, Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/document/planning/Climate%20Change%20Strategy.pdf> Last accessed 16th December 2022.

³¹ Council of the Isles of Scilly (2021). Isles of Scilly Local Plan, Including Minerals and Waste, 2015-2030, March 25., Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/planning-apps/Adopted%20Local%20Plan%202015-2030%20Website%20Version.pdf> Last accessed 16th December 2022.

³² Cornwall Council (2011). Cornwall and Isles of Scilly Shoreline Management Plan (SMP2), Cornwall Council. Available at: <https://www.cornwall.gov.uk/environment/countryside/flood-risk/shoreline-management-plan-2011-smp2/> Last accessed 16th December 2022.

³³ Council of the Isles of Scilly (2017). Isles of Scilly Local Flood Risk Management Strategy, March 20., Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/document/planning/Local%20Flood%20Risk%20Management%20Strategy%20FINAL.pdf> Last accessed 16th December 2022.

- Combined Agency Emergency Response Protocol (CAERP)³⁴
- Sustainable Transport Strategy³⁵
- **Increased heavy winter rainfall and higher wind speeds:** risks include flooding-induced contamination of mains water supply and an overburdened drainage system, leading to backing up of sewage and contamination of beaches, with associated negative impacts for health, property, business and tourism. Adaptation and risk reduction plans and policies include:
 - Climate Change Strategic Plan³⁶
 - South West Water Business Plan, 2020-2025³⁷
- **Reduced summer rainfall and drought:** these pose a risk to crop growth (including commercial flowers) and can increase the need for greater water volumes for crop-irrigation, leading to negative impact on crop yield and associated financial loss. Adaptation and mitigation plans and policies include:
 - South West Water final Drought Plan 2022³⁸

³⁴ Devon, Cornwall and Isles of Scilly Local Resilience Forum (2018). Combined Agency Emergency Response Protocol (CAERP), Devon, Cornwall and Isles of Scilly Local Resilience Forum. Available at: <https://www.dcisprepared.org.uk/media/2140/caerp-lrfdcios-20160516-v74.docx> Last accessed 16th December 2022.

³⁵ Council of the Isles of Scilly (2011). The Isles of Scilly Strategic Transport Framework, Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/Isles%20of%20Scilly%20Strategic%20Transport%20Framework%20website.pdf> Last accessed 16th December 2022.

³⁶ Council of the Isles of Scilly (2011). Climate Change Strategic Plan, Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/document/planning/Climate%20Change%20Strategy.pdf> Last accessed 16th December 2022.

³⁷ South West Water and Bournemouth Water (n.d.). South West Water Business Plan 2020-2025, South West Water. Available at: <https://www.southwestwater.co.uk/siteassets/document-repository/business-plan-2020-2025/sww-business-plan-2020-25-071118.pdf> Last accessed 16th December 2022.

³⁸ South West Water and Bournemouth Water (2022). Final Drought Plan, South West Water and Bournemouth Water. Available at: <https://www.southwestwater.co.uk/siteassets/document-repository/environment/sww-bw-final-drought-plan-september-2022.pdf> Last accessed 16th December 2022.

- Climate Change Strategic Plan³⁹
- Local Plan (2015 – 2030)⁴⁰

3.2.2.3 Shoreline Management Plan revision 2 (SMP2) 2011⁴¹

First published in 1997, the Isles of Scilly SMP was updated in 2010 to include data on rising sea-level and locations most at risk of inundation between 2010 and 2100 (SMP2). It was further reviewed in 2016 to reassess the most appropriate actions to focus on with regards to coastal management. It identifies and discusses those areas of the shoreline which require protection and prioritises adaptation options which should be considered. The SMP2 Action Plan details ongoing studies needed (e.g., monitoring of sand dunes and sand deposition/erosion patterns) to understand and monitor coastal erosion processes, the preferred adaptive actions to take, and identifies partners and sources of funding to facilitate this.

SMP2 considers objectives, policy setting and management requirements for three future timespans: 0 to 20 years, 20 to 50 years and 50 to 100 years. In terms of management of specific locations, it applies three main policy options of No Active Intervention (a decision not to invest in defences), Hold the Line (maintaining or upgrading current defences) or Managed Realignment (manage coastal processes and vulnerable assets to realign the coastline configuration to create a more sustainable shoreline position).

SMP2 recommends collaboration with AONB, the IOS Wildlife Trust and the Duchy of Cornwall in managing natural defences, as well as a pragmatic approach of facilitating small-scale resilience projects in the local community (e.g., encouragement and support for practical flood defence measures on existing buildings at risk). It specifies that a Flood

³⁹ Council of the Isles of Scilly (2011). Climate Change Strategic Plan, Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/document/planning/Climate%20Change%20Strategy.pdf> Last accessed 16th December 2022.

⁴⁰ Council of the Isles of Scilly (2021). Isles of Scilly Local Plan, Including Minerals and Waste, 2015-2030, March 25., Council of the Isles of Scilly. Available at: <https://www.scilly.gov.uk/sites/default/files/planning-apps/Adopted%20Local%20Plan%202015-2030%20Website%20Version.pdf> Last accessed 16th December 2022.

⁴¹ Cornwall Council (2011). Cornwall and Isles of Scilly Shoreline Management Plan (SMP2), Cornwall Council. Available at: <https://www.cornwall.gov.uk/environment/countryside/flood-risk/shoreline-management-plan-2011-smp2/> Last accessed 16th December 2022.

and Coastal Risk Management (FCRM) strategy should be developed to inform spatial planning and a Coastal Change Management Area (CCMA) should be defined for key areas (e.g., Porthcressa, Porthmellon and Porth Hellick) as a minimum.

3.2.2.4 Climate Change Action Plan 2022

The Climate Change Action Plan was developed by the Council of the Isles of Scilly's Environment Service to recognise what actions the Council, along with local partners and the community, have taken over the last ten years to protect the marine and terrestrial habitats and species. The plan also sets out ten key objectives to address what the Council will do to combat carbon emissions over the coming years, focusing specifically on what can be controlled (through the direct control of sites and services), what can be influenced (working with community and local businesses) and how the council will work with local partners and national stakeholders to move towards net zero carbon by 2030. The Climate Change Action Plan was developed through consultation and engagement with the local community.

3.2.2.5 Climate Change Strategy 2011

In 2011, the Council of the Isles of Scilly developed a long-term Climate Change Strategic Plan, based upon climate projections from the UK's Hadley Climate Research Centre and supported by the NI188 and CCRAA work. This assessed risks and opportunities at a regional and local level, with reference to the Isle of Scilly's unique environment and micro-climate when compared with the UK mainland. Risks identified include those to energy provision, food and agriculture, habitat and species protection, health and animal health, sea level rise/coastal erosion/flooding, tourism, waste management, and water management.

It highlighted the need for resourcing and maintenance of weather and tidal databases and recording of adverse weather events to understand developing climate impacts and risk in the medium to long term. The Climate Change Strategy recommended that the Strategy be reviewed on a timescale of 3 – 5 years, with a major review every 10 years.

3.2.2.6 South West Water – Isles of Scilly Business Plan 2016

South West Water has been responsible for the management of water and sewerage provision on the Isles of Scilly since April 2020. In adopting this responsibility, they undertook extensive due diligence, reviewed proposals for the operation and investment required for the islands and developed their vision to meet regulatory compliance over the

long-term whilst, at the same time, delivering against consumer priorities as per the survey which they also undertook.

3.2.2.7 South West Water Drought Plan 2018

The South West Water Drought Plan was first published in 2018, before the Isles of Scilly joined their supply area. However, its five-yearly revision for 2021/2022 has just been published and includes a plan specific to the Isles of Scilly, and its distinct vulnerability to drought. The Plan sets out how water resources will be managed in response to drought events, whilst balancing the needs of domestic and commercial customers, the economy and the environment. It highlights the remote setting of the Isles of Scilly and the challenges of water availability, resulting in a high drought vulnerability.

3.2.2.8 Local Flood Risk Management Strategies (LFRMS) 2017

The Local Flood Risk Management Strategy was developed in 2017 and is undergoing a 3-year mid-term review for 2021/22, after which it will be updated every six years. This Strategy helps local communities and businesses to better understand and manage flood risk on the islands. It includes an overview of flood risk on the islands and sets out the coordinated approach to managing and reducing these risks.

This Strategy considers the risk of fluvial (from rivers) and pluvial (from stormwater) flooding to be very low, with the main threat from coastal flooding. However, stormwater flooding does occur particularly behind demountable sea defences and at specific low points on the islands.

The main objectives of the Local Flood Risk Management Strategy are:

- ‘Understand areas that flood’ – i.e., flood risk maps.
- ‘Manage the flood risk in the Isles of Scilly’ to ensure no new flood risk is created, existing risk is reduced wherever possible and up to date resilience plans exist.
- ‘Enable people, communities, business and public bodies to work together more effectively’ to ensure there is a common understanding of issues, risks and opportunities and these are used to align priorities, funding and delivery across the islands.
- ‘Help residents both during and after flood events to recover as quickly as possible after incidents’ through continued flood event planning and improving community resilience.

- ‘Seek environmental benefit from flood management interventions’ by working with natural processes wherever possible to manage flood risk.

The Local Food Risk Management Strategy aligns with the Environment Agency’s Flood Risk Management Plans and Flood Plan Explorer data.

3.2.2.9 South West River Basin District Flood Risk Management Plan 2021 to 2027

The South West River Basin District Flood Risk Management Plan identifies measures to reduce the likelihood and consequence of flooding in the south west of England, including the Isles of Scilly. It further highlights opportunities for the improvement of resilience whilst informing the delivery of existing flood programmes. Critically, the Plan highlights the main flood risk issues and changes within the South West River Basin District and emphasises those changes which are likely to come about as a result of climate change.

3.2.2.10 Devon, Cornwall, Isles of Scilly Local Resilience Forum – Combined Agency Emergency Response Protocol (CAERP) 2018

The CAERP provides a framework for the co-ordinated delivery of effective and integrated emergency management arrangements within the Devon, Cornwall and Isles of Scilly Local Resilience Forum area. An emergency is defined as including an event or situation which threatens serious damage to human welfare or the environment at a place in the UK.

Within the Isles of Scilly specifically, the Emergency Planning department co-ordinates the statutory duties of the Council of the Isles of Scilly under the Civil Contingencies Act 2004. The Council of the Isles of Scilly, as the Local Authority, are classified as Category 1 responders.

3.2.2.11 The Environment Agency ‘Isles of Scilly: Our Ambition to 2030’ Strategy 2019

The Environment Agency produced this Strategy in 2019 to help ‘secure a sustainable future for the Isles of Scilly’. It highlighted that the Environment Agency needed appropriate regulatory powers on the Isles of Scilly, particularly with regard to water resources which, due to the geological and geographical nature of the Isles, were highly vulnerable. In addition to this, it highlighted the need for protection against coastal flooding.

3.2.2.12 Local Plan (2015 – 2030)

The Isles of Scilly Local Plan was adopted in March 2021 and is the statutory development plan that forms the basis for decisions on land use planning. It adheres to the National Planning Policy Framework 2019 which requires Local Planning Authorities to adopt

positive strategies towards dealing with climate change. For the Isles of Scilly this is identified as pertaining to sustainable energy and drinking water supplies, improved wastewater treatment, effective waste management and recycling (all mitigation measures) and avoiding areas at risk of flooding (an adaptation measure). Any development that protects against the impacts of coastal flooding or erosion will be encouraged, such as those that improve coastal defences, defend productive agricultural land or protect water resources.

- *Policy SS1 – Principles of Sustainable Development* states that development proposals must consider the “long-term implications of climate change and rising temperatures for flood risk, coastal change, water supply, biodiversity and landscapes”.
- *Policy SS2 – Sustainable Quality Design and Place-Making* states that development proposals must consider sustainable construction, such as “reducing pressure on water resources and increasing re-use by incorporating effective water management measures, including Sustainable Urban Drainage Systems, green roofs and water-saving devices, and rain/grey water collecting and recycling facilities”.
- *Policy SS6 - Water and Wastewater Management* states that development proposals must comply with the “national policy and guidance in relation to flood risk”, “achieve a water consumption standard of no more than 110 litres per person per day” and “all new developments of 500sqm or more achieve the BREEAM107 ‘excellent’ credit required for water consumption”.
- *Policy SS7 – Flood Avoidance and Coastal Erosion* states that development proposals to build below the 5-metre contour, or in other areas deemed at risk of flooding or coastal erosion, will not be permitted unless an appropriate and proportionate Flood Risk Assessment demonstrates how flood risk will be managed. This includes that the development “taking climate change into account, does not create a flood risk over its lifetime to existing or proposed properties and/or surrounding land”.

3.3 Future baseline

3.3.1 Models and projections

Following the development of an understanding of the present climate (see Section 2.3), climate model data was extracted from the UK Climate Projections (UKCP) database. The UKCP provide a current assessment of how the UK climate may change in the future. The projections published in 2009 (UKCP09) were previously used in the development of the Isles of Scilly Climate Change Strategy published in 2010. These projections were updated by the Met Office in 2018 (UKCP18). UKCP18 uses emissions scenarios based upon those used by the Intergovernmental Panel on Climate Change (IPCC) in their fifth assessment report (AR5). These scenarios, referred to as Representative Concentration Pathways (RCPs), specify greenhouse gas concentrations that would result in target amounts of radiative forcing at the top of the atmosphere by 2100, relative to pre-industrial levels. There are four RCPs available through UKCP18, these are: RCP 2.6, RCP4.5, RCP6.0 and RCP8.5 (the numbers denoting radiative forcing levels in W/m^2). Each pathway results in a different range of global mean temperature increases over the 21st century (see Table 1). RCP 2.6 reflects a stringent scenario which sees emissions to decline to net zero by 2075 and become negative after that. RCP 8.5 on the other hand reflects a worst-case scenario which sees emissions steadily rise, doubling by 2050 and more than tripling by the end of the century. The RCPs capture assumptions within the scenarios and make use of the conditions of each scenario to model possible future climate evolutions. The climate change risk assessment prepared in support of this Plan used RCP8.5, which is the high emissions scenario projecting a reasonable worst-case scenario for the future climate.

Table 1: Increase in global mean surface temperature averaged over 2081-2100 compared to the pre-industrial period (average between 1850-1900) for the RCP pathways (best estimate, 5-95% range). From IPCC AR5 WG1 Table 12.3⁴²

RCP scenario	Change in temperature (°C) by 2081-2100
RCP 2.6	1.6 (0.9-2.3)
RCP 4.5	2.4 (1.7-3.2)
RCP 6.0	2.8 (2.0-3.7)
RCP 8.5	4.3 (3.2-5.4)

UKCP18 provides observations, and model projections at a range of spatial scales (global, regional, local, and probabilistic projections). Model data for each of these scales differs slightly; having different strengths and weaknesses and addressing different user requirements in terms of their temporal and spatial resolution, their geographical extent, and the emissions scenarios which they account for as shown in Table 2.

⁴² The Met Office (n.d.). UKCP18 Guidance: Representative Concentration Pathways, The Met Office. Available at: <https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---representative-concentration-pathways.pdf> Last accessed 16th December 2022.

Table 2: Types of datasets for UKCP18 over land projections over land⁴³

	Probabilistic projections	Global (60km) projections	Regional (12km) and local (2.2km) projections
Description	Probabilistic changes in future climate based on assessment of model uncertainties.	A set of 28 climate futures with detailed data on how it may evolve in the 21 st century.	Two sets of 12 climate futures at high resolution.
Period	1961-2100	1900-2100	1981-2080 (12km) 1981-2000, 2021-2040, 2061-2080 (2.2km)
Temporal resolution	Monthly Seasonal Annual	Daily Monthly Seasonal Annual	Subdaily (2.2km) Daily Monthly Seasonal Annual
Spatial resolution	25km	60km	12km 2.2km
Geographical extent	UK and regions	UK and regions Global	UK and regions Europe (12km)
Emissions scenarios	RCP2.6 RCP4.5 RCP6.0 RCP.85	RCP 8.5	RCP 8.5

⁴³ The Met Office (n.d.). UKCP18 Guidance: How to use the UKCP18 land projections, The Met Office. Available at: <https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---how-to-use-the-land-projections.pdf> Last accessed 16th December 2022.

	SRES A1B		
Why should you use it?	<p>Explores emissions scenario uncertainty.</p> <p>Explores uncertainty in key processes in climate models.</p> <p>Helps characterise future extremes in risk assessment.</p>	<p>Long time series.</p> <p>Spatially and temporally coherent.</p> <p>Direct access to 'raw' climate model data.</p> <p>Met Office Hadley Centre global climate model.</p>	<p>Enhanced spatial detail.</p> <p>Spatially and temporally coherent.</p> <p>Improved extremes.</p> <p>Direct access to 'raw' climate model data.</p> <p>CPM* projections use climate model featuring explicitly dynamical representation of large convective storms.</p>

*CPM – convection permitting model

Acknowledging these differences, it was determined that the probabilistic projections should be used for the risk assessment, supplemented by local model data, and coupled with the marine projections, as outlined in further detail below.

Also used in more recent publications such as AR6 are 'Shared Socioeconomic Pathways (SSP)'⁴⁴. SSP5-8.5 represents a 'fossil fuel development' emissions scenario, while SSP1-2.6 is a 'middle of the road' emissions scenario. They are similar to RCP scenarios.⁴⁵

The fossil fuel development scenario SSP5-8.5 suggests global average surface temperatures could rise by a best estimate of 4.4°C by the period 2081 to 2100 relative to the period 1850-1900. Probabilistic projections (25km).

⁴⁴ IPCC Summary for Policymakers AR6, Table SPM.1 in https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

⁴⁵ "The shared socio-economic pathway (SSP) greenhouse gas concentrations and their extensions to 2500", Meinshausen et al. (2020) Geoscientific Model Development, 13, 3571-3605 <https://climateanalytics.org/media/gmd-13-3571-2020.pdf>

3.3.1.1 Probabilistic projections (25km)

Probabilistic projections of climate for a variety of temporal resolutions (monthly, seasonally, annually) are available at a spatial resolution of 25km (Table 3). These projections have been designed as the principal tool for the assessment of model agreement and uncertainty. This is because they show a percentile range which supports an understanding of model agreement (high agreement at 50th percentile and lower agreement at the ‘tails’ of the distribution curve e.g. at the 10th and 90th percentiles) and uncertainty with respect to a given emissions scenario.

For this reason, the probabilistic projections for the South West of England were chosen for the climate change risk assessment. They project the following climatic change* in relation to the climate of the Isles of Scilly, within the immediate future:

Table 3. The 50th, (10th, 90th) Percentile Probabilistic Projections for the South West of England (2020-2039)*

2020-2039				
	Winter	Spring	Summer	Autumn
Mean air temperature (°C)	+0.90 (+0.11, +1.72)	+0.50 (-0.12, +1.17)	+1.17 (+0.21, +2.19)	+1.03 (+0.20, +1.94)
Maximum air temperature (°C)	+0.88 (+0.03, +1.70)	+0.70 (+0.03, +1.49)	+1.51 (+0.26, +2.79)	+1.16 (+0.22, +2.20)
Precipitation depth (%)	+7.15 (-5.01, +19.90)	-0.15 (-12.25, +12.65)	-13.67 (-32.50, +5.75)	+4.20 (-9.75, +18.36)
Sea level pressure (hPa)	+0.07 (-1.97, +2.09)	+0.35 (-0.94, +1.71)	+0.55 (-0.41, +1.65)	+0.26 (-1.43, +1.95)
Humidity (%)	+5.62 (-1.11, +12.71)	+3.28 (-2.00, +9.00)	+4.98 (-0.81, +11.19)	+6.05 (-0.41, +12.82)
Maximum air temperature (°C) (1:100)	+32.49 (+30.46, +34.84)			
One-day total precipitation (mm) (1:100)	+51.01 (+43.41, +60.33)			
Five-day total precipitation (mm) (1:100)	+115.87 (+104.99, +129.39)			

* The values outside of the parenthesis represent the 50th percentile value extracted from the model data whilst the first value within the parenthesis represents the 10th percentile and the latter represents the 90th percentile. Providing this range serves to capture model uncertainty and variable range.

3.3.1.2 Marine Projections

The UKCP18 marine data projects changes in coastal sea levels, with storm surges and surface waves superimposed upon the time-mean sea level data. These drivers of sea level extremes, however, are understood to have a relatively small contribution towards the overall model results and so it is not known whether storm surges will become more severe, less severe, or remain the same – this is an active area of research. However, CMIP5 (Coupled Model Intercomparison Project) data (used by the Inter-Governmental Panel on Climate Change (IPCC) to inform the Fifth Assessment Report (AR5*)) forms the basis of the time-mean sea level projections, including for UKCP18 and are able to capture well horizontal variations in sea level.

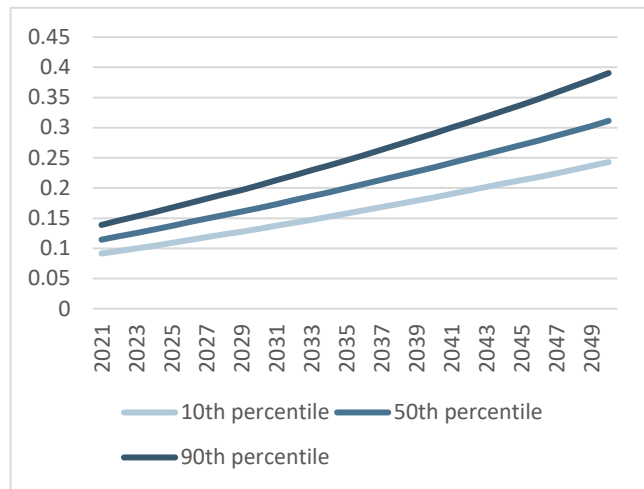


Figure 2. Time-mean sea level anomaly (m) from 2021-2050

Even if greenhouse gas emissions reach net zero by the second half of the 21st century, some climate risks will continue to get worse. For example, global sea level is likely to rise between 0.32 m and 0.62 m by 2100 relative to the period 1995-2014 even if emissions follow the SSP1-2.6 ‘middle of the road’ scenario. This is ‘committed sea level rise’. Under a very high ‘fossil-fuel development’ emissions scenario (SSP5-8.5), global sea level is likely to rise 0.63 to 1.01 m by 2100⁴⁶.

In the short-term by 2040 local sea level is expected to rise by between 20 cm and 30 cm relative to 1990. By 2100 is expected to rise by about 80 cm. These projections are similar to mainland UK, and similar under various emissions scenarios during the period to 2040.

⁴⁶ “IPCC Summary for Policymakers AR6, Table SPM.1 in https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

“Global mean sea level rise above the likely range – approaching 2 m by 2100 and 5 m by 2150 under a very high greenhouse gas emissions scenario (SSP5-8.5) (low confidence) – cannot be ruled out due to deep uncertainty in ice-sheet processes”¹.

3.3.1.3 Local projections

Supplementary to the use of probabilistic projections, local projections (2.2km convective permitting model re-gridded to 5km) were also used (Table 4). These projections better represent effects due to land elevation, coastlines, and surface characteristics, as well as providing improved resolution of dynamical features such as mesoscale circulations and frontal systems. They further provide improved simulations of extremes. For these projections, the 2021–2039 time-horizon has been used for RCP8.5.

Table 4. The 50th, (10th,90th) Percentile Local Projections (2020-2039)*

	2040			
	Winter	Spring	Summer	Autumn
Mean air temperature (°C)	+1.23 (+0.35, +2.28)	+1.35 (+1.11, +1.81)	+1.72 (+1.08, +2.94)	+1.85 (+1.20, +3.06)
Maximum air temperature (°C)	+1.22 (+0.51, +2.18)	+1.36 (+1.14, +2.06)	+1.80 (+1.08, +3.08)	+1.95 (+1.25, +3.02)
Precipitation depth (%)	-1.45 (-33.13, +33.71)	+3.43 (-48.58, +37.55)	-34.74 (-71.89, +12.87)	+3.60 (-22.92, +23.38)
Sea level pressure (hPa)	+0.17 (-5.08, +6.49)	+0.64 (-2.41, +5.39)	+0.68 (-1.33, +2.59)	+0.74 (-0.77, +2.51)
Humidity (%)	+0.04 (-2.71, +1.94)	-1.26 (-3.84, +0.40)	-0.78 (-1.60, +0.53)	+0.35 (-2.70, +2.10)

* The values outside of the parenthesis represent the 50th percentile value extracted from the model data whilst the first value within the parenthesis represents the 10th percentile and the latter represents the 90th percentile. Providing this range serves to capture model uncertainty and variable range.

3.3.2 Limitations and uncertainties

As with all climate modelling, future projected ranges are based upon assumptions (modelling, statistical and dataset) with expert judgement playing a key role in the methodology that is carried out and the data that is chosen.

The probabilistic projections are the main way that the ranges of uncertainties have been considered in UKCP18. However, they may not capture all possible future outcomes. With this in mind, the probabilities provided should be understood as being an indication of how much or how little the evidence from models and the observations support a particular future outcome. For instance, it is more likely that projected outcomes will be near the middle of the distribution (near the 50% cumulative probability level (median)) than in the tails (either below the 10th cumulative probability level or above the 90th cumulative probability level).

3.3.3 Risk register development

Once the model data was extracted from the UKCP18 database, it was analysed and cross-referenced with the literature review findings, supplementary research, and a variety of GIS (geographic information system) data relating to the location of various receptors (e.g., utility assets and heritage assets etc.) to identify the key risks to the islands, with the support of the development of impacts chains (see Section 4.2 for further detail). These risks were included within a risk register which was used to facilitate the scoring of receptor sensitivity (Table 5), adaptive capacity (Table 6) and exposure (Table 7), as well as hazard consequence (Table 8) and likelihood (Table 9); see Section 3.2 for more information and relevant definitions, as per bespoke quantitative and qualitative criteria.

Table 5. Assessment criteria for receptor sensitivity

Score	Rating	Qualitative Definition	Quantitative Definition
5	Significant	Significant and widespread sensitivity of receptors to the hazard	>80% of the receptors are sensitive to the hazard
4	High	High sensitivity of receptors to the hazard	60-80% of the receptors are sensitive to the hazard
3	Moderate	Moderate sensitivity of receptors to the hazard	40-60% of the receptors are sensitive to the hazard
2	Low	Limited sensitivity of receptors to the hazard	20-40% of the receptors are sensitive to the hazard
1	Very Low	Isolated receptors are sensitive to the hazard	<20% of the receptors are sensitive to the hazard

Table 6. Assessment criteria for receptor adaptive capacity

Score	Rating	Definition
5	Very Low	Very low adaptive capacity, with a lack of organisational capability and lack of technical, financial or ecosystem capacity to adapt to barriers effectively.
4	Low	Low adaptive capacity, with some organisational capability but a lack of technical, financial or ecosystem capacity to adapt to barriers effectively.
3	Moderate	Moderate adaptive capacity, with the organisational capability and technical, financial and/or ecosystem capacity to tackle simple barriers for adaptation.
2	High	High adaptive capacity, with the organisational capability and technical, financial and/or ecosystem capacity to adapt to complicated barriers of moderate scale and with some uncertainty.
1	Very High	Very high adaptive capacity, with the organisational capability and technical, financial and/or ecosystem capacity to adapt to complex barriers, both in terms of scale and uncertainty.

Table 7. Assessment criteria for receptor exposure

Score	Rating	Qualitative Definition	Quantitative Definition
5	Significant	Significant and widespread exposure of elements to the hazard	>80% of sector or element is exposed to the hazard
4	High	High exposure of elements to the hazard	60-80% of sector or element is exposed to the hazard
3	Moderate	Moderate exposure of elements to the hazard	40-60% of sector or element is exposed to the hazard
2	Low	Limited exposure of elements to the hazard	20-40% of sector or element is exposed to the hazard
1	Very Low	Isolated elements are exposed to the hazard	<20% of sector or element is exposed to the hazard

Table 8. Assessment criteria for impact consequence

Score	Rating	Qualitative Definition	Quantitative Definition
5	Catastrophic	Substantial change, affecting many of the islands and for a prolonged period of time (more than one month) including irreversible changes	>£5 million
4	Major	Noticeable change, affecting some of the islands and for a relatively long period of time (more than one week but less than one month)	£2M to £5M
3	Moderate	Noticeable change, affecting some of the settlements and for a moderate amount of time (more than three days but less than one week)	£500k to £2M
2	Minor	Noticeable change, affecting a number of properties and for a small amount of time (no more than three days)	£100k to £500k
1	Minimal	Negligible and/or unnoticeable change or no change lasting one day or less.	<£100k

Table 9. Assessment criteria for impact probability

Score	Rating	Qualitative Definition	Quantitative Definition
5	Very Likely	Has historically occurred frequently and/or very likely to occur in the future	90-100% probability
4	Likely	Has historically occurred several times and/or likely to occur in the future	66-100% probability
3	Possible	Has historically occurred from time to time and/or possible to occur in the future	33-66% probability (i.e. about as likely as not)
2	Unlikely	Has historically occurred infrequently and/or unlikely to occur in the future	0-33% probability
1	Very Unlikely	Has historically not occurred and/or very unlikely to occur in the future	0-10% probability

These scores were subsequently combined as per the guidance outlined within ISO 14091: Adaptation for Climate Change – Guidelines on Vulnerability, Impacts and Risk Assessment.

3.3.4 Risk-related stakeholder engagement

To complement and confirm the findings of this process, a series of stakeholder engagement activities took place. Specifically, two virtual workshops were set up with local businesses, utilities providers, charities, academic institutions and Councillors to gather information relating to their knowledge, experience and perceptions of climate change impacts on the islands. This information was used by the Project Team to confirm and further develop and expand upon those risks identified within the risk register. This was also the case with respect to the application of local community knowledge, experience and perceptions of climate change impacts. Specifically, the Project Team, together with the Council, visited each of the five inhabited islands to run stakeholder workshops to this end.

In addition to confirming and informing the risk assessment process, early stakeholder engagement to understand local knowledge, experience and perceptions of climate change impacts on the islands was used to inform the development of adaptation actions and their sequencing, as outlined in detail below (Section 6). Additionally, to build upon the information gathered during the risk-related engagement, further adaptation-focused

engagement also took place with specific reference to the development of adaptation measures.

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4 CLIMATE CHANGE IMPACTS

4.1 Overview

Climate change impacts on the Isles of Scilly were identified as part of the risk assessment process outlined above. Initially, these were identified through the development of impact chains (Section 4.2), and then further refined with the help and support of local stakeholders, including residents and businesses on the islands.

The full list of potential impacts was then categorised with reference to one of four 'domains' and added to a risk register. The domains are:

- Natural environment and agriculture
- Infrastructure
- Health, communities and the built environment
- Business and industry

These broadly correspond with the domains referred to in the UK's most recent CCRA, which further includes a domain which concerns 'international dimensions'.

Once added to the register, receptor sensitivity, adaptive capacity and exposure, as well as hazard consequence and likelihood, were all scored and combined using the below formula to provide an overall risk significance score.

$$\text{Risk score} = \text{Level of Hazard} * \text{Level of Vulnerability and Exposure}$$

Where:

- $\text{Level of Hazard} = \text{Probability} * \text{Consequence}$
Probability: Likelihood of impact occurring
Consequence: Magnitude of impact
- $\text{Level of Vulnerability and Exposure} = \text{Vulnerability} * \text{Exposure}$
*Vulnerability = Sensitivity * Adaptive Capacity*
Sensitivity: is the receptor sensitive to the impact
Adaptative capacity: ability to respond or manage to the impact
Exposure: is the receptor exposed to the impact

A comparison of these significance scores provided for the prioritisation of risks which further informed the development of adaptation options and pathways, as outlined in Section 5. The findings from the risk assessment are summarised in section 4.3.

4.2 Impact chains

An impact chain is an effective tool that helps to better understand, visualise, systemise, and prioritise factors that drive risk in a system. Impact chains serve as an analytical starting point to identify which hazards potentially cause direct and indirect climate change impacts. The impact chains presented below were created in accordance with ISO/DIS 14091 (*Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment*).

Impact chains were developed for each sub-domain (systems within the overall domain e.g., sectors or demographic etc.) to map out the relevant climate change impacts, and their potential interactions, for the Isles of Scilly. Subsequently, impacts chains were developed for the natural environment and agricultural sector (section 4.2.1), infrastructure (section 4.2.2), health and the built environment (section 4.2.3) and business and industry (section 4.2.4). An impact chain was not developed for international risks within this project, given the islands have limited influence over UK level policy.

The impact chains were populated through the application of expert knowledge and were further developed through stakeholder insights, including anecdotal experience, garnered from the first and second rounds of virtual and in-person stakeholder workshops.

The impact chains summarise a high-level overview of the range of indicative changes in the climate and associated hazards (e.g., extreme weather events), along with an indication of the broad systems exposed to the hazards and indicative impacts. The impact chains are not representative of all hazards (e.g., fog and lightning are not detailed as specific hazards) and/or all impacts (e.g., impact of fog on transport; or impacts of oceanic CO₂ levels on fisheries or concrete structures), as this would be overly complex to illustrate. The impact chains do not intend to reflect all direct and indirect cause and effects, and do not suggest whether there will be changes in the magnitude or frequency of events.

4.2.1 Natural environment and Agriculture

Impact chains outlining the key climate hazards, exposure, and impacts (risks and opportunities) for the natural environment and agricultural sector on the Isles of Scilly are shown in Figure 3 and Figure 4 respectively.

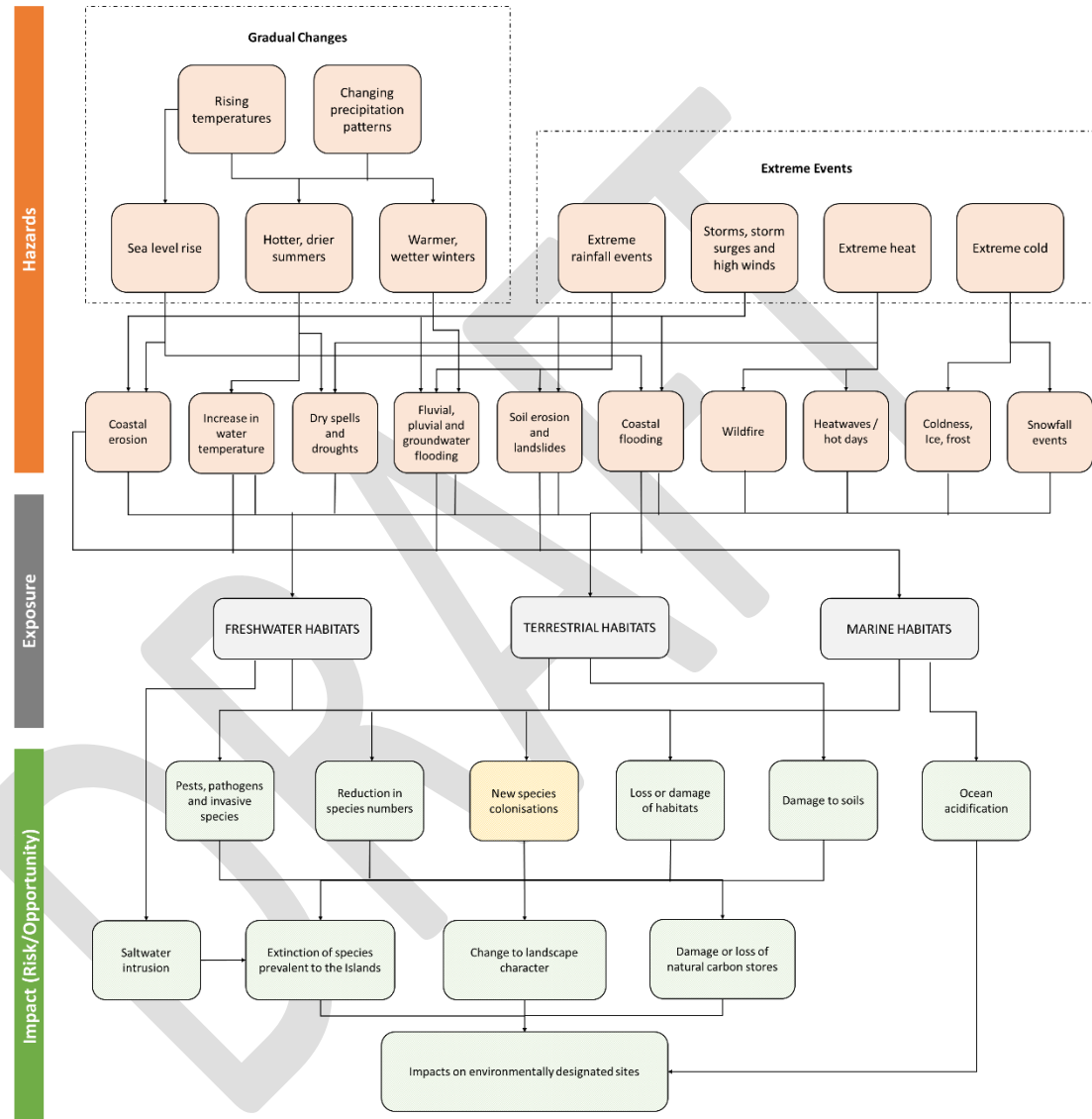


Figure 3. Impact Chain – Natural Environment.

Impact chain outlining the key climate hazards (orange boxes), exposure (grey boxes) and impacts, including both risks (green boxes) and opportunities (yellow boxes) for the natural environment on the Isles of Scilly. Source: designed by RSK.

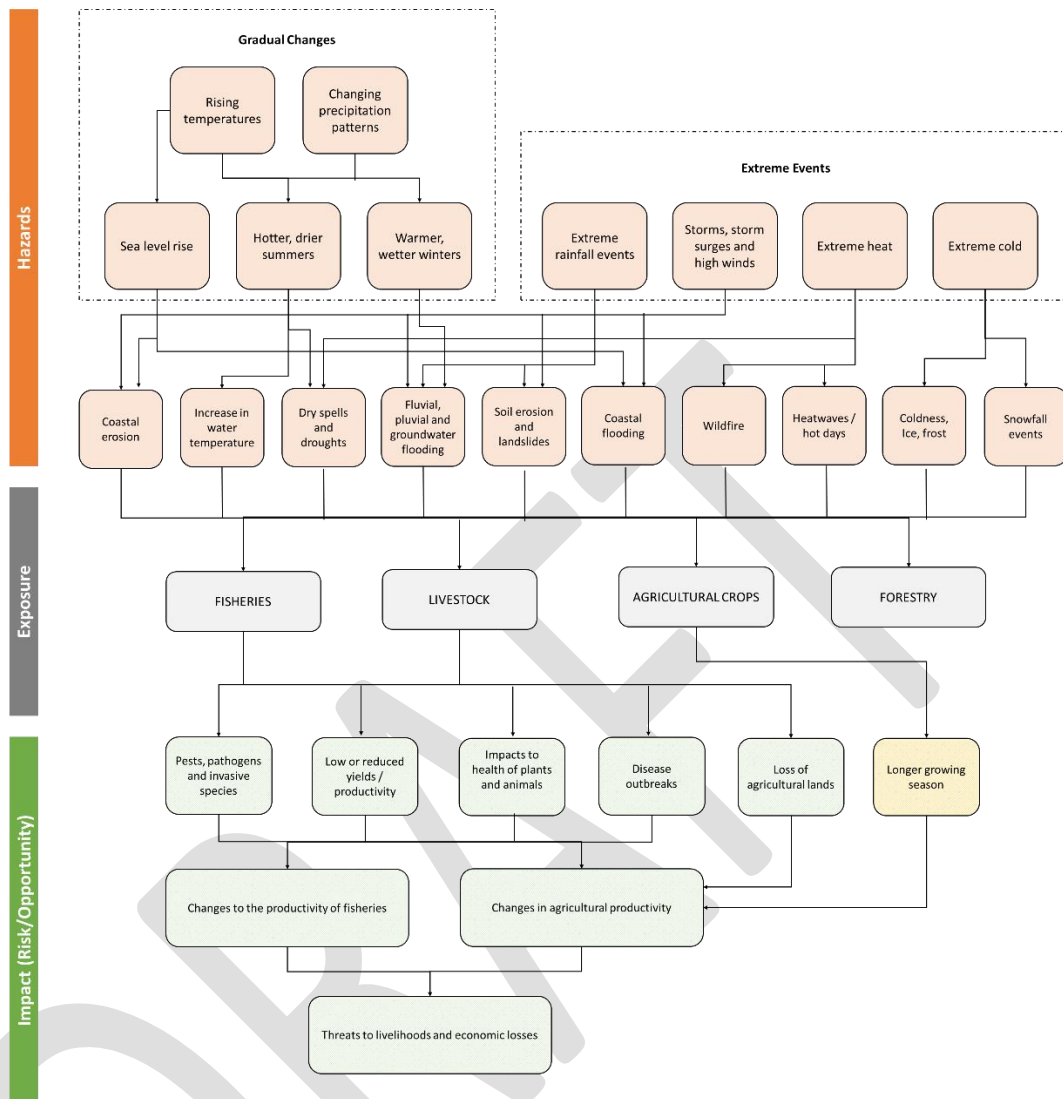


Figure 4. Impact Chain - Agriculture

Impact chain outlining the key climate hazards (orange boxes), exposure (grey boxes) and impacts, including both risks (green boxes) and opportunities (yellow boxes) for the agricultural sector on the Isles of Scilly. Source: designed by RSK.

4.2.2 Infrastructure

An impact chain outlining the key climate hazards, exposure, and impacts (risks and opportunities) for infrastructure on the Isles of Scilly is shown in Figure 5.

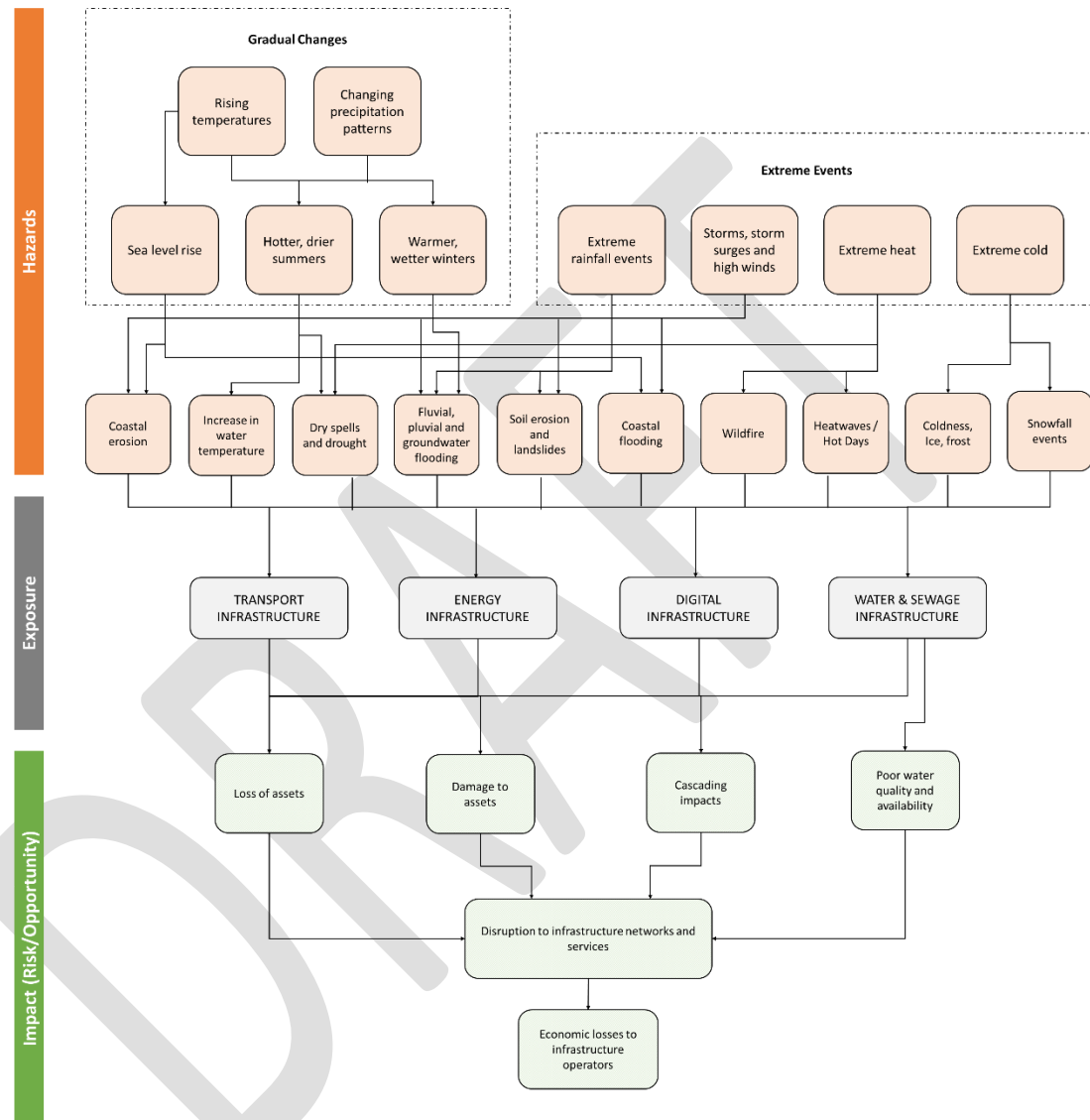


Figure 5. Impact Chain - Infrastructure

Impact chain outlining the key climate hazards (orange boxes), exposure (grey boxes) and impacts, including both risks (green boxes) and opportunities (yellow boxes) for infrastructure on the Isles of Scilly. Source: designed by RSK.

4.2.3 Health, communities, and the built environment

An impact chain outlining the key climate hazards, exposure, and impacts (risks and opportunities) for the health, communities, and the built environment domain on the Isles of Scilly is shown in Figure 6.

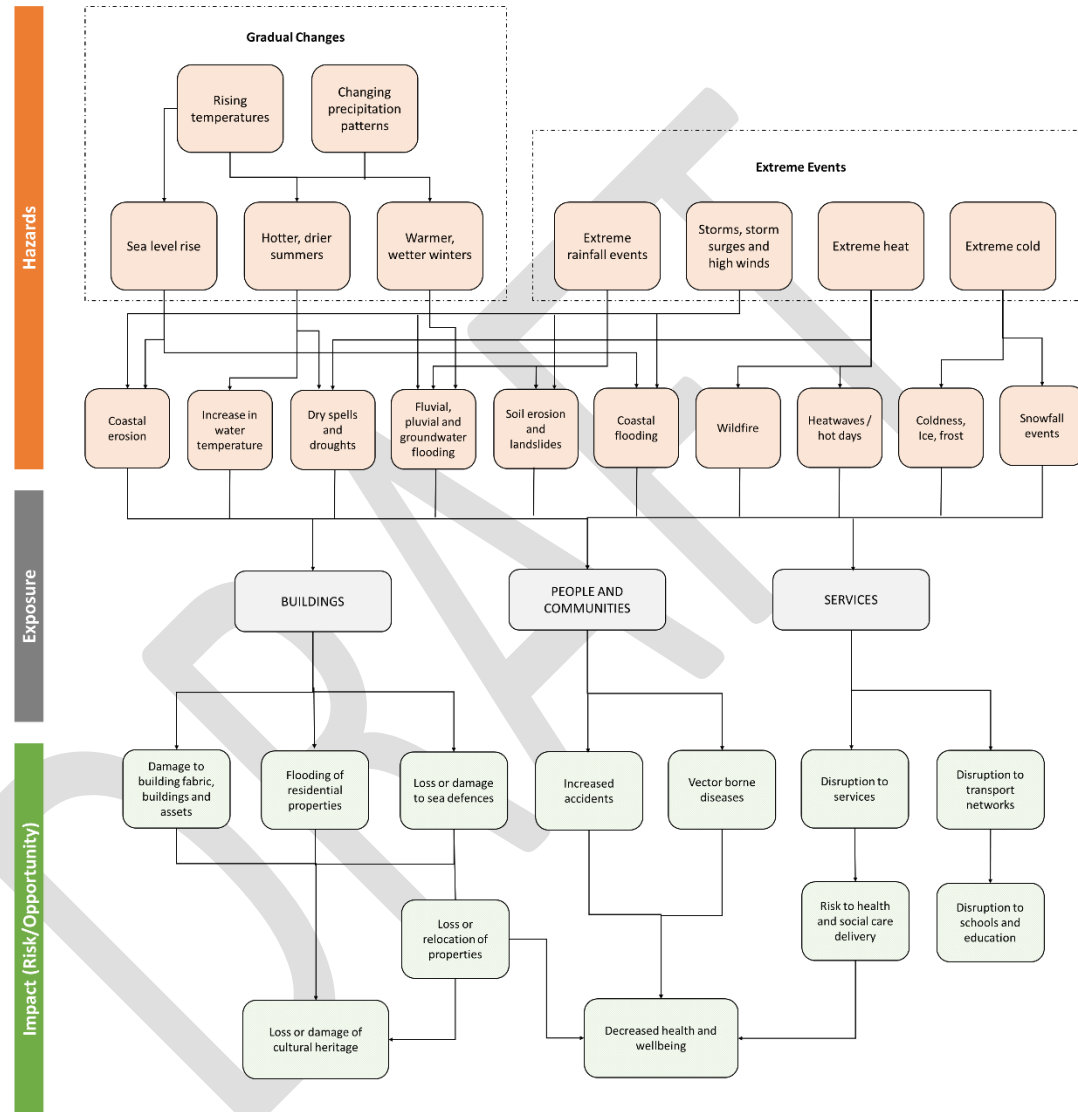


Figure 6. Impact Chain – Health Communities and the Built Environment

Impact chain outlining the key climate hazards (orange boxes), exposure (grey boxes) and impacts, including both risks (green boxes) and opportunities (yellow boxes) for the health, communities, and the built environment domain on the Isles of Scilly. Source: designed by RSK.

4.2.4 Business and industry

An impact chain outlining the key climate hazards, exposure, and impacts (risks and opportunities) for business and industry on the Isles of Scilly is shown in Figure 7.

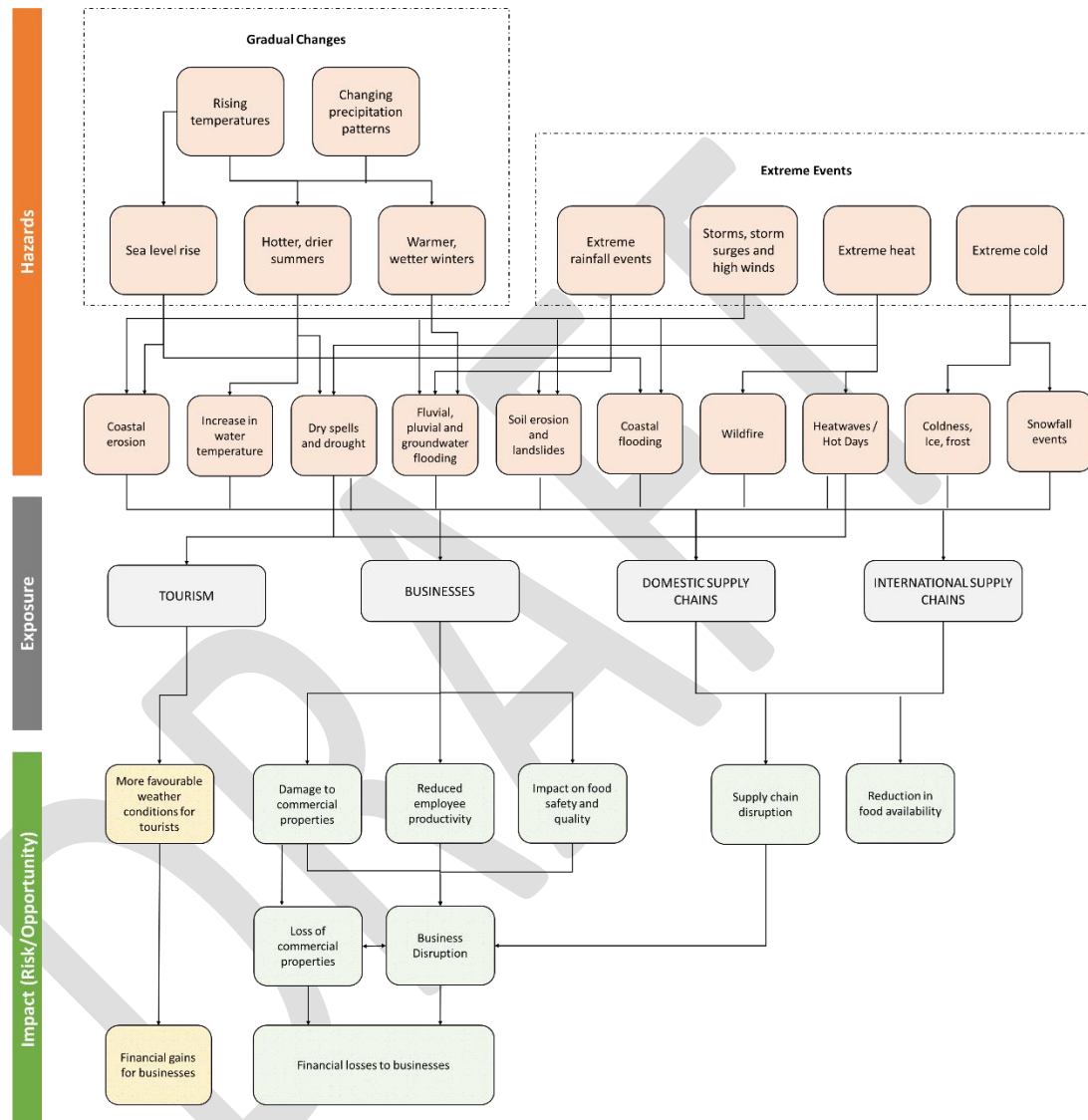


Figure 7. Impact Chain – Business and Industry

Impact chain outlining the key climate hazards (orange boxes), exposure (grey boxes) and impacts, including both risks (green boxes) and opportunities (yellow boxes) for business and industry on the Isles of Scilly. Source: designed by RSK.

4.3 Findings from the risk assessment

In total, 76 potential impacts were identified in the Isles of Scilly risk assessment. The risk description and risk score for each impact is outlined in the following sections, including 22 impacts for the natural environment and agriculture sector (section 4.3.1), 26 impacts for the infrastructure sector (section 4.2.2), 18 impacts for the health and built environment sector (section 4.3.3), and eight impacts for the business and industry sector (section 4.3.4).

4.3.1 Risks to the natural environment and agriculture

Twenty-two risks were identified for the natural environment and agriculture sector, outlined in Table 10. Of these, two were assessed as severe risks, nine as high risk, ten as moderate risk and one as low risk.

Table 10. Risks to the natural environment and agriculture

Risk description	Risk score
Risk of loss or reduction in coastal species or habitats due to sea level rise (coastal squeeze).	5
Risk of saltwater intrusion to freshwater habitats.	5
Risk to agricultural/horticultural productivity due to extreme drought event.	4
Risk of loss or reduction in species or habitats due to extreme drought event.	4
Risk of loss or reduction in coastal species or habitats due to coastal flooding and wave overtopping.	4
Risk of species or habitat loss due to sea level rise.	4
Risks to natural carbon stores and sequestration from changing climatic conditions, including temperature change and water scarcity/abundance.	4
Risks to marine species and habitats due to changing pH levels of the ocean.	4
Risks to marine species and habitats due to rising sea temperatures.	4
Risk of wildfires (damage or loss of crops and livestock) - potentially exacerbated by the presence of peaty surface soils, heath and pine windbreaks.	4

Risk description	Risk score
Risk of wildfires (loss or reduction of species and habitats)- potentially exacerbated by the presence of peaty surface soils, heath and pine windbreaks.	4
Risk to agricultural/horticultural productivity due to changing climatic conditions (temperature rise).	3
Risk of loss or reduction in species or habitats due to changing climatic conditions (temperature rise) .	3
Risk to agricultural/horticultural productivity due to coastal flooding, wave overtopping and saltwater intrusion.	3
Risk of loss of agriculturally/horticulturally productive land due to sea level rise.	3
Risks to agricultural productivity due to pests, pathogens and invasive species.	3
Risks to woodland due to pest, pathogens and INNS.	3
Risk of erosion to soils from changing climatic conditions, including seasonal aridity and wetness.	3
Risks to existing landscape character (including environmentally designated sites) from extreme weather events (including storm surge, wave overtopping and coastal flooding).	3
Risk to fisheries businesses due to species migration.	3
Risks to freshwater species and habitats (including environmentally designated sites) from higher water temperatures and/or water scarcity.	3
Risks to landscape character (including environmentally designated sites) from sea level rise and coastal change.	2

4.3.2 Risks to the infrastructure sector

Twenty-six risks were identified for the infrastructure sector, outlined in Table 11. Of these, four were assessed as severe risks, six as high risk, 12 as moderate risk, one as low risk and three as very low risk.

Table 11. Risks to the infrastructure

Risk description	Risk score
Risks to transport infrastructure and networks due to cascading failure of other infrastructure networks (e.g., energy, water, communications etc.).	5

Risk description	Risk score
Risk of transport service disruption (including supply chain and emergency service disruption) due to coastal flooding, wave overtopping and poor sea state.	5
Risks to water availability and household water supplies due to drought/reduced rainfall/hot days.	5
Risk of erosion to digital infrastructure.	5
Risk to disruption to air transport services due to fog.	5
Risks to transport networks from high winds and lightning.	4
Risks to energy assets and infrastructure services due to coastal flooding and wave overtopping.	4
Risks to digital infrastructure networks from cascading failures (including disruption to transport, energy and water).	4
Risks to water infrastructure networks from cascading failures (including disruption to energy and digital services).	4
Risk of erosion/damage to sea defence infrastructure.	4
Risk of erosion to electricity infrastructure.	4
Risk of loss or damage to inter-island transport infrastructure (e.g. quays and boat landings) due to sea level rise.	3
Risk of loss or damage to land-based transport infrastructure (e.g. roads) due to coastal flooding and wave overtopping.	3
Risks to energy assets and utilities infrastructure services from sea level rise.	3
Risks to energy asset due to high winds and lightning.	3
Risks to energy infrastructure and networks from high temperature extremes and heatwaves.	3
Risks to digital infrastructure from extreme weather events (including storm surge, wave overtopping and coastal flooding and erosion).	3
Risk of surface water flooding to water infrastructure (boreholes/sewers/septic tanks).	3
Risk to water and wastewater infrastructure assets integrity (and household water suppliers) due to coastal flooding, wave overtopping and/or erosion.	3
Risk of water infrastructure failure.	3

Risk description	Risk score
Risk of loss of direct access to Gugh from St Agnes due to sea level rise.	3
Risk of erosion to water infrastructure.	3
Risks to energy infrastructure networks from cascading failures (including from transport, digital and water services).	2
Risks to transport infrastructure (roads, ports and airports) from high temperatures.	1
Risks to digital infrastructure from high winds and lightning.	1
Risks to digital infrastructure from high temperatures.	1

4.3.3 Risks to the health and built environment sector

Eighteen risks were identified for the health and built environment sector, outlined in Table 12. Of these, two were assessed as severe risks, eight as high risk, four as moderate risk, three as low risk and one as very low risk.

Table 12. Risks to the health and built environment sector

Risk description	Risk score
Risks to water quality and household water supplies due to groundwater contamination (sea level rise/coastal flooding).	5
Risks to health and social care delivery due to infrastructure failure as a result of climate change (Reduced or limited capacity to deliver essential care due to lack of electricity/water/communications etc.).	5
Risks to physical and mental human health due to coastal flooding and wave overtopping.	4
Risk of loss or damage of cultural heritage assets from coastal flooding / storm surge / wave overtopping.	4
Loss or damage of cultural heritage assets from sea level rise.	4
Loss or damage of natural (e.g., sand dunes) and physical (e.g. sea walls) sea defences due to coastal flooding / erosion / sea level rise.	4
Risk of wildfires (injury/loss of life) - potentially exacerbated by the presence of peaty surface soils, heath and pine windbreaks.	4
Risk of erosion of public footpaths.	4

Risk description	Risk score
Risk of erosion of cultural heritage assets.	4
Risk of erosion to residential properties.	4
Risks to health from vector-borne disease.	3
Risk to community livelihood due to extreme weather and/or transport disruption restricting access to work.	3
Risks to health (e.g. health care and food supply essentials) due to transport and supply chain disruption associated with extreme weather events.	3
Risk of loss of residential properties and assets due to sea level rise.	3
Risks to health and wellbeing to vulnerable groups from acute high temperatures.	2
Risks to children missing school/education (e.g. due to extreme weather and/or transport disruption).	2
Risk to building fabric due to water ingress (water ingress associated with pluvial flooding but also with rainwater or groundwater penetration through building materials or defects).	2
Risks to health from extreme low temperatures including instances of cold related mortality and fuel poverty due to extreme cold weather.	1

4.3.4 Risks to the business and industry sector

Eight risks were identified for the business and industry sector, outlined in Table 13. Of these, three were assessed as high risk, four as moderate risk one as very low risk.

Table 13. Risks to the business and industry sector

Risk description	Risk score
Risks to commercial properties (including productivity) from coastal flooding / wave overtopping / storm surge).	4
Risk of wildfires (damage and disruption of assets and services) - potentially exacerbated by the presence of peaty surface soils, heath and pine windbreaks.	4
Risk of service and/or supply chain disruption/delay due to transport disruptions as a result of poor sea state.	4

Risk description	Risk score
Risk of service and/or supply chain disruption/delay due to transport disruptions as a result of fog - 900% increase in instances of fog observation since 1958 (7% increase in aviation disruption).	4
Risks to business and livelihood due to changing pH levels of the ocean.	3
Risks of financial loss as a result of reduced business productivity due to infrastructure disruption or failure from extreme weather events (including supply chain disruption) i.e., Disruption to infrastructure resulting in inability to perform tasks critical for business success.	3
Risks to commercial properties from sea level rise.	3
Risk of financial loss to business from reduced employee productivity due to higher temperatures in working environments.	1

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5 ADAPTATION OPTION DEVELOPMENT

Climate change adaptation is the process of adjustment to actual or expected climate and its effects.

Following the completion of the risk register, the development of adaptation options followed three main steps, further outlined below:

1. Adaptation option identification
2. Adaptation option prioritisation
3. Adaptation action planning

5.1.1 Adaptation option identification

When developing a process of adjustment to actual or existing models of climate change it is not always possible, or necessary, to deal with every identified risk. As such, in the development of the adaptation options for the Isles of Scilly, only those risks identified as having a severe or high impact upon the community were considered (see Section 4.3 for further detail).

Actions to adapt to specific risks were identified through collation of existing measures, relevant case studies, research papers and grey literature to identify those which may be feasible for the islands to undertake.

5.1.1.1 *Engagement on adaptation options*

All identified options were summarised alongside an indicative ranking of cost, target effect and co-benefits. These were discussed and workshopped at three community events organised in conjunction with the Council of the Isles of Scilly. Drop-in workshops were held on:

- Tuesday 28th June 2022 at the Council Chambers, St Mary's.
- Wednesday 29th June at the Council Chambers.
- Wednesday 29th June at the St Mary's and Scilly Farmers and Growers Market.

Indicative feedback was collected for each of the identified options to understand where measures were seen favourably, by the wider community, in terms of feasibility, or unfavourably, due to other criteria such as cost or target effect.

Consultation was also undertaken during the initial risk review workshops with stakeholders from utilities, landowner representatives and key nature and environment stakeholders,

including academia. Input was sought on the existing actions, plans and timescales for programmes to deal with current impacts from climate change.

The key aim, in both the community and stakeholder workshops, was to identify and understand the value of the adaptation options to local residents, businesses and visitors to the islands.

5.1.2 Adaptation sectors and pathways

Further development of the options list required setting indicative pathway aims for each sector, ensuring that a clear pathway was developed to reduce the potential impact of identified hazards.

Within each sector a series of high-level pathways have been created; these detailed the:

- **Hazard** (e.g., coastal flooding and wave overtopping).
- **Risk** (e.g., species or habitat loss due to sea level rise).
- **Adaptation option(s)** (e.g., dune / embankment strengthening).
- **Pathway aim** (e.g., to retain land area, providing ecosystem services, with aim to keep species diversity at baseline levels as a minimum).

Adaptation pathway flowcharts are included within Appendix 2.

5.1.1 Adaptation option prioritisation

In order to prioritise the adaptation options within each pathway, a multi-criteria scoring system was used for systematic assessment of both qualitative (observation) and quantitative (measured) data. Often multi-criteria assessments (MCAs) use cost-benefit analysis as one of the key criteria. However, for this study, and in almost all cases, the data on cost and benefits of existing adaptation measures on the Isles of Scilly was not available, and so was not included explicitly in the set of criteria. Instead, relative cost was used as an alternative criterion.

The criteria used within this analysis are outlined in Table 14, below:

Table 14 multi-criteria assessment – criteria, description, and weighting

#	Criteria	Description	Criteria weighting
1	Importance (Target Effect)	Damage avoidance effectiveness. 1 - Poor 2 - Fair 3 - Good 4 - Very good 5 - Excellent	35%
2	Relative Cost	Indicative cost of the option and maintenance compared to other applicable options. 1 - Very high cost 2 - High cost 3 - Medium 4 - Low cost 5 - Nominal cost	25%
3	No regret Characteristics	Option is worthwhile (e.g., yields economic and environmental benefits which exceed its cost), and will continue to be worthwhile, irrespective of any benefits of avoided climate damages.	5%
4	Co-Benefits	Positive impact on Isles of Scilly stakeholder aims / objectives unrelated to climate change. 1 - Highly negative 2 - Negative 3 - Neutral 4 - Positive 5 - Highly positive Likert scale values ranging from 1 to 5, with 3 as neutral response.	20%
5	Mitigation Effect	Degree to which the adaptation option will also induce a reduction of greenhouse gas emissions. Scale - 1 to 5 with 3 as neutral response.	10%
6	Stakeholder / Community	Weighted score of option preference from stakeholders / community (grouped in ranges 1 to 5).	5%

The adaptation action scoring criteria were based upon works undertaken by D Bruin et al., 2009, and adapted for the local (Isles of Scilly) context, including the addition of a stakeholder/community criteria. The criteria were applied on a sector-by-sector basis and used to validate all identified options.

5.1.2 Adaptation scorecards and pathways

Developing actions to cope better with a changing climate will be an ongoing and iterative process. For this CCRA, climate change projections through to 2040 were used, though adaptation measures were considered beyond this, up to the end of the century.

Consequently, this will need key stakeholders, including the community, to make critical decisions relating to adaptive action pathways, with potentially very long-term horizons, based on incomplete knowledge or uncertain information about future changes (beyond 2040).

To assist stakeholders in implementing these actions, Figure 8 below summarises the multi-criteria scoring applied to adaptation pathway scorecards. This indicates which of the available options should be prioritised and also highlights the next step actions which may be required as climate change impacts on the Isles of Scilly increase in magnitude.

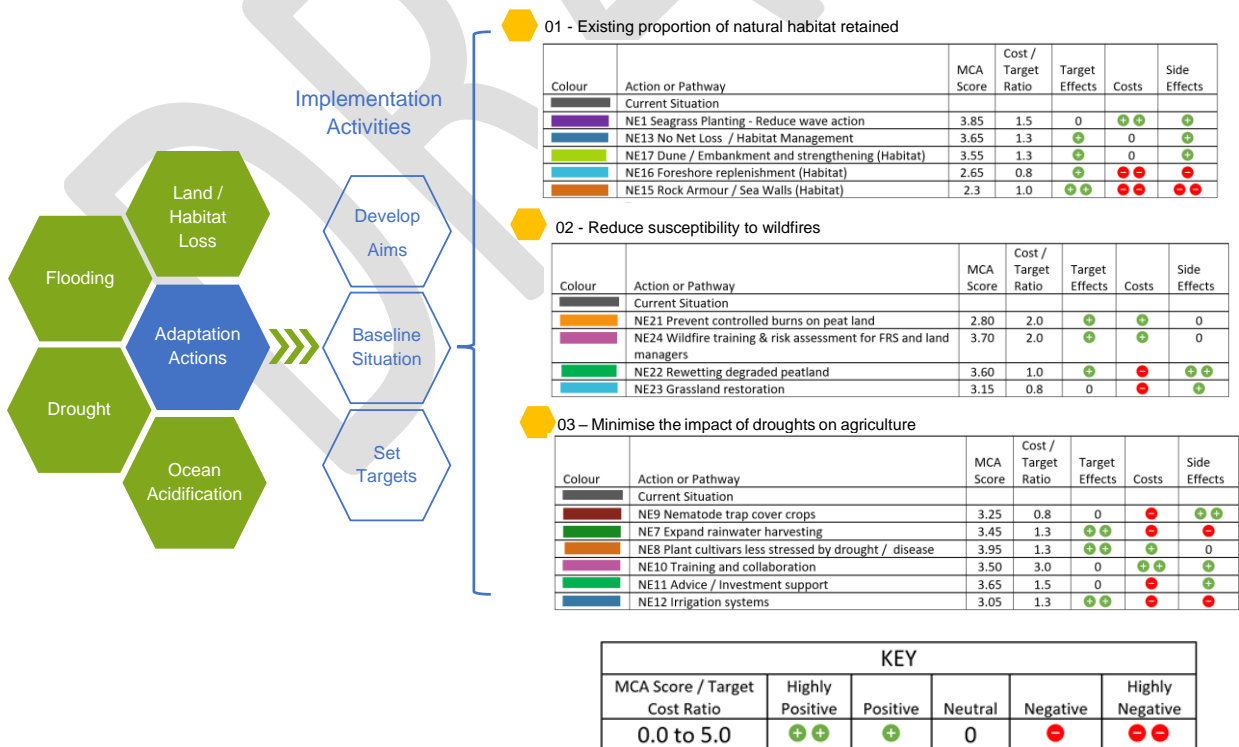


Figure 8. Adaptation Scorecards (example)

To assist in appraising and sequencing these actions, indicative adaptation pathway diagrams have been created. There are 16 adaptation pathways in total for the Isles of Scilly. These are available alongside their corresponding scorecards in Appendix 3. The pathways illustrate a range of adaptation options and show how these may be sequenced over time by highlighting which options should be acted upon immediately and which may be considered in the future.

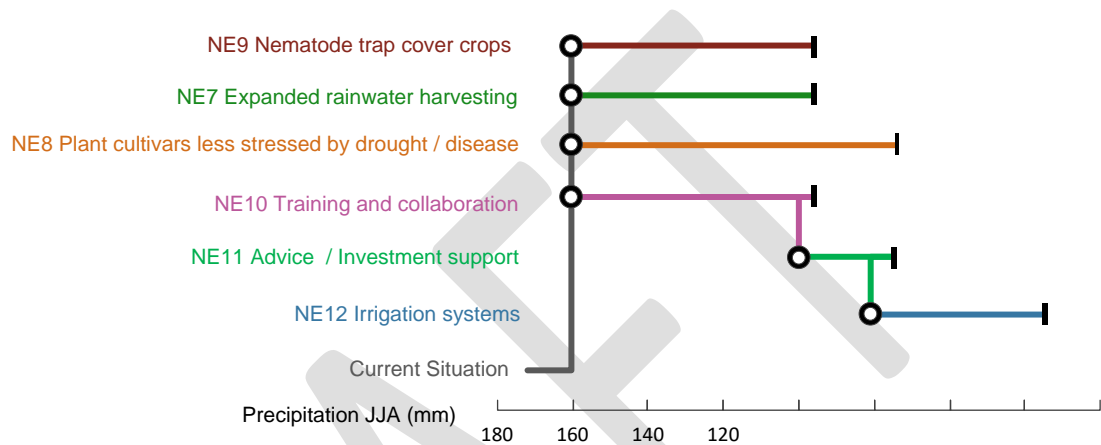


Figure 9. Adaptation Pathway (example)

Adaptation pathways are informed by tipping points and trigger points. Whereas a tipping point relates to the biophysical threshold(s) at which the magnitude of change means the current management strategy will no longer be able to meet the objectives (e.g., moving from a hold the line strategy to a managed realignment strategy for shorelines), a trigger point is a moment in time at which a threshold (e.g., sea level) has been crossed, initiating the transition into an alternative adaptation option. For example, in the example pathway above, which relates to drought conditions, trigger points are reached after the socio-economic adaptation actions (NE10 and NE11), initiating the introduction of potentially expensive and environmentally damaging irrigation systems. The trigger point, as identified through the monitoring and analysis of data, ensures that the sector has time to assess the risks and implement an appropriate adaptation solution.

6 ADAPTATION OPTIONS

6.1.1 Isles of Scilly Resilient Islands Strategy

Table 15 presents the Isles of Scilly Isles of Scilly Resilient Islands Strategy up to and beyond 2040. This plan is a first step in preparing the Isles of Scilly for the likely impacts of climate change. The plan is a live document. The review and update of this plan will be an ongoing and iterative process to ensure that advances in data, modelling practices, research and technology are captured and woven into future plans.

Table 15. The Isles of Scilly Isles of Scilly Resilient Islands Strategy

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
Natural Environment Pathway 1	Retain land area proportion providing ecosystem services with aim to keep	Coastal flooding and wave overtopping	Risk from saltwater intrusion, habitat / species loss due to	<ul style="list-style-type: none"> ➤ NE1: Seagrass planting ➤ NE13: No net loss / habitat management ➤ NE17: Dune/embankment strengthening ➤ NE16: Foreshore replenishment ➤ NE15: Rock armour / sea walls 	<ul style="list-style-type: none"> ➤ AONB Exec Team (facilitated by The Council of the Isles of Scilly) ➤ Council of the Isles of Scilly ➤ Isles of Scilly Wildlife Trust ➤ The Isles of Scilly Inshore Fisheries & Conservation Authority

⁴⁷ NE = Natural Environment. HBE = Health and Built Environment. EX = Existing (actions). INF = Infrastructure. BUS = Business

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
	species / habitat diversity at baseline levels		coastal flooding		<ul style="list-style-type: none"> ➤ The Royal Society for the Protection of Birds ➤ Isles of Scilly Community Archaeology Group ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG) ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ Natural England ➤ Environment Agency
Natural Environment Pathway 2	Reduce susceptibility to wildfires to protect natural habitats	Drought / Temperature rises	Loss of species and habitats	<ul style="list-style-type: none"> ➤ NE21: Prevent controlled burns on peatland ➤ NE24: Wildfire training and risk assessment for FRS and land managers ➤ NE22: Rewetting degraded peatland ➤ NE23: Grassland restoration 	<ul style="list-style-type: none"> ➤ Emergency Services (Fire) ➤ AONB Exec Team (facilitated by The Council of the Isles of Scilly) ➤ Tresco Estate ➤ The Duchy of Cornwall ➤ Isles of Scilly Wildlife Trust ➤ Tenant Farmers / Land Administrators ➤ Natural England
Natural Environment Pathway 3	Minimise impacts of drought events on habitat / species diversity	Extreme drought events	Loss / reduction of species and habitats	<ul style="list-style-type: none"> ➤ EX10: Proactive monitoring / practical management ➤ EX11: Hydrological study and re-wetting areas ➤ NE13: No net-loss / habitat management ➤ NE10: Awareness and collaboration 	<ul style="list-style-type: none"> ➤ Isles of Scilly Wildlife Trust ➤ The Royal Society for the Protection of Birds ➤ IOS Residents ➤ Natural England

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
Natural Environment Pathway 4	Maintain resilience in agriculture to extreme drought events at baseline levels	Extreme drought events	Lost productivity	<ul style="list-style-type: none"> ➤ NE9: Nematode trap cover crops ➤ NE7: Expand rainwater harvesting ➤ NE8: Plant cultivars less stressed to drought / disease ➤ NE10: Awareness and collaboration ➤ NE11: Advice / investment support ➤ NE12: Irrigation systems 	<ul style="list-style-type: none"> ➤ AONB Exec Team (Farming in protected landscapes) ➤ The Duchy of Cornwall (Future Farming) ➤ Tenant Farmers / Land Administrators ➤ Defra
Natural Environment Pathway 5	Maintain carbon sequestration ecosystem service at baseline levels	Drought / Temperature rise impacting natural carbon storage	Reduced areas / resources available for sequestration	<ul style="list-style-type: none"> ➤ NE19: Peat land restoration / adding mosses ➤ NE20: 'Tiny Forest' planting ➤ NE23: Seagrass planting ➤ NE26: No net loss / Habitat management 	<ul style="list-style-type: none"> ➤ The Isles of Scilly Inshore Fisheries & Conservation Authority ➤ AONB Exec Team ➤ Tenant Farmers / Land Administrators ➤ The Duchy of Cornwall (Future Farming) ➤ Defra
Natural Environment Pathway 6	Retain marine ecosystem services with aim to improve baseline levels of habitat diversity	Temperature rises / acidification	Species and habitat loss	<ul style="list-style-type: none"> ➤ NE1: Seagrass planting ➤ NE27: Expand MPA protection to reduce pressure on marine species ➤ NE2: Develop markets for alternative species ➤ NE3: Diversification into warm water species 	<ul style="list-style-type: none"> ➤ The Isles of Scilly Inshore Fisheries & Conservation Authority ➤ Marine Management Organisation
Health and Built Environment Pathway 1	Protect essential health services, community	Coastal flooding and wave overtopping	Risk to physical / mental health, healthcare	<ul style="list-style-type: none"> ➤ HBE2: Property level flood resistance and resilience ➤ HBE8: Education / Awareness ➤ HBE19: Dune / embankment strengthening 	<ul style="list-style-type: none"> ➤ Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
	and landscape character with aim to retain resilience during events and speed recovery		services and healthcare infrastructure	<ul style="list-style-type: none"> ➤ HBE18: Foreshore replenishment ➤ HBE17: Rock armour / sea walls ➤ HBE16: Managed retreat 	<ul style="list-style-type: none"> ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ Cornwall Partnership NHS Foundation Trust ➤ St Mary's Community Hospital ➤ St Mary's Health Centre ➤ St Mary's Patient representation group ➤ Council of the Isles of Scilly
Health and Built Environment Pathway 2	Preserve cultural heritage assets	Permanent loss of land / coastal erosion	Loss of cultural heritage assets due to erosion / sea level rise	<ul style="list-style-type: none"> ➤ HBE6: Managed decline to adaptive release⁴⁸ ➤ HBE15: Dune / embankment strengthening ➤ HBE14: Foreshore replenishment ➤ HBE13: Rock armour / sea walls 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estate ➤ Historic England ➤ Isles of Scilly Community Archaeology Group ➤ Exeter University ➤ Isles of Scilly Museum
Health and Built Environment Pathway 3	preserve amenity, nature trails, paths at baseline level	Permanent loss of land / Coastal Erosion	Erosion of footpaths	<ul style="list-style-type: none"> ➤ HBE12: Managed retreat (new assets / realignment) ➤ HBE15: Dune / embankment strengthening ➤ HBE14: Foreshore replenishment 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estate ➤ Isles of Scilly Wildlife Trust ➤ Tenants / Landowners ➤ Council of the Isles of Scilly

⁴⁸ <https://ore.exeter.ac.uk/repository/handle/10871/127259>

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
				➤ HBE13: Rock armour / sea walls	
Health and Built Environment Pathway 4	Protect Property in line with Shoreline Management Plan	Permanent loss of land / coastal erosion	Erosion impacting residential properties	<ul style="list-style-type: none"> ➤ EX15: Land use & building regulations ➤ HBE3: Increased hard protection (rock armour / sea walls) ➤ HBE4: Foreshore replenishment ➤ HBE5: Dune construction and strengthening ➤ HBE7: Managed retreat ➤ HBE2: Property level flood resistance and resilience 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estates ➤ Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG) ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ Cornwall Rural Housing Association ➤ Anchor (Hanover Court)
Infrastructure Pathway 1A	Ensure transport infrastructure remains serviceable and resilient	Coastal flooding, wave overtopping, high winds and lightning	Erosion, flooding and overtopping affecting harbor / quay infrastructure	<ul style="list-style-type: none"> ➤ EX2: Rock armour (Church Quay protection, Bryther) ➤ EX3: Rock armour (Porthloo beach slipway, St Marys) ➤ EX4: Isles of Scilly integrated Shoreline Management Plan ➤ EX7: Rock armour (Church Quay protection, Bryther) ➤ EX8: Rock armour (Porthloo beach slipway, St Marys) ➤ INF1: Rock armour / sea walls ➤ INF2: Foreshore replenishment ➤ INF3: Dune construction and strengthening ➤ INF4: Proactive asset resilience / maintenance ➤ INF5: Managed retreat 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estate ➤ Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG) ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ Isles of Scilly Steamship Company ➤ IoS business owners

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
Infrastructure Pathway 1B	ensure transport infrastructure remains serviceable and resilient	Coastal flooding, wave overtopping, High winds and lightning	Erosion, flooding and overtopping affecting roads / supply chain	<ul style="list-style-type: none"> ➤ INF11: Rock armour / sea walls ➤ INF12: Foreshore replenishment ➤ INF13: Dune construction and strengthening ➤ INF19: Proactive asset resilience / maintenance ➤ INF14: Managed retreat ➤ INF16: Update Isles of Scilly flood plan to include supply chain ➤ INF15: Supply interruption (increase on-island production and stores / storage capacity) 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estate ➤ The Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG) ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ Isles of Scilly Steamship Company ➤ IoS business owners
Infrastructure Pathway 2	Minimise disruption to mail / passenger transport due to fog	Fog	Disruption to air transport	<ul style="list-style-type: none"> ➤ INF7: Drones ➤ INF8: Satellite-based approach and landing aids (Localiser Performance with Vertical Guidance (LPV) capable GPS). 	<ul style="list-style-type: none"> ➤ The Council of the Isles of Scilly ➤ Royal Mail ➤ Penzance Helicopters ➤ Isles of Scilly Steamship Company ➤ Couriers ➤ Cornwall Partnership NHS Foundation Trust
Infrastructure Pathway 3	Ensure utilities infrastructure service levels retained at baseline levels	Flooding / erosion	Cascading failures / erosion / flooding	<ul style="list-style-type: none"> ➤ EX13: Bryher / St Agnus source protection. Raised embankments to reduce overtopping ➤ INF31: Mains sewerage and pump station flood resilience ➤ INF32: Improve resilience (through use of solar plus battery storage) ➤ INF33: Relocate critical infrastructure (switchgear and control cubicles) 	<ul style="list-style-type: none"> ➤ South West Water ➤ Private water suppliers ➤ Openreach ➤ Western Power ➤ Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG)

Sector / Pathway	Aim	Hazard(s)	Risk(s)	Adaptation Action ⁴⁷	Stakeholders
				<ul style="list-style-type: none"> ➤ INF34: Protect / relocate vulnerable cables and interconnector assets ➤ INF30: Resilient borehole headworks 	<ul style="list-style-type: none"> ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum
Infrastructure Pathway 4	Minimise drought effect on service / supply	Drought	Supply failures / restrictions	<ul style="list-style-type: none"> ➤ EX14: South West Water – Isles of Scilly Drought Plan 2021 (update / delivery) ➤ INF26: Rainwater / greywater incentives for households ➤ INF27: Increase raw water storage ➤ INF28: Increase treated water storage ➤ INF29: Increased desalination / abstraction ➤ INF36: Import bottled water ➤ INF37: Drought restrictions. 	<ul style="list-style-type: none"> ➤ South West Water ➤ Council of the Isles of Scilly ➤ AONB Exec Team
Business Pathway 1	Minimise impacts of rising sea level and storm surge on business operations	Sea level rise and storm surge	Risks to commercial properties (including productivity) from coastal flooding / wave overtopping / storm surge)	<ul style="list-style-type: none"> ➤ BUS1: Property level flood resistance and resilience measures ➤ BUS2: Increased Hard Protection - Rock Armour / Sea Walls (Commercial Property) ➤ BUS3: Increased Soft Protection - Foreshore replenishment ➤ BUS4: Increased Soft Protection - Dune construction and strengthening ➤ BUS6: Managed Retreat - New Assets / Realignment (Commercial Property) 	<ul style="list-style-type: none"> ➤ The Duchy of Cornwall ➤ Tresco Estate ➤ Council of the Isles of Scilly ➤ SW Regional Flood and Coastal Committee ➤ Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG) ➤ Devon, Cornwall and Isles of Scilly Local Flood Resilience Forum ➤ IoS business owners ➤ Island Futures Board

6.1.2 Implementation plan

Following on from the identification, assessment and sequencing of adaptation options, an Adaptation Action Implementation Plan was developed. The purpose of the Implementation Plan is two-fold:

1. To consolidate and document details relating to the key steps required to successfully deliver adaptation activities.
2. To provide an accessible, non-technical summary of the Council of the Isles of Scilly's intentions to encourage stakeholders to be part of, and engage with, the islands' adaptation journey.

Building on the CCRA, the development of the Adaptation Action Plan and stakeholder workshops, the draft Implementation Plan was developed. A virtual stakeholder workshop was then held in November 2022 to present the draft Implementation Plan and raise awareness of the contents. This was an opportunity to receive feedback on the Plan and to engage stakeholders so that they would buy-in to, and support, its delivery.

Key stakeholder groups that are, or are likely to be, involved in planning or delivering adaptations measures on the islands are listed in Table 15.

The implementation plan will be made available on the Council website.

APPENDIX I: GLOSSARY OF TERMS

Adaptive Capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences ⁴⁹ .
Adaptation Pathway	A series of adaptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation ⁵⁰ .
Climate	The statistical description of weather in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years ⁷ .
Climate Change	The change in climate that persists for an extended period, typically decades or longer. Climate change might be due to natural processes, internal to the climate system, or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use ⁷ .
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services, resources,

⁴⁹ International Organisation for Standardisation (2019). *Adaptation to Climate Change – Principles, Requirements and Guidelines* (BS EN ISO Standard No. 14090:2019(E)).

⁵⁰ IPCC. (2018). Annex I: Glossary. In *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 541-562. <https://doi.org/10.1017/9781009157940.008>.

infrastructure, or economic, social, or cultural assets in places and settings that could be affected. Exposure can change over time, for example, because of land use change⁷.

Hazard

The potential source of harm, in terms of loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. Hazard comprises slow-onset developments as well as rapidly developing climatic extremes or increased variability⁷.

Likelihood

The chance of a specific outcome occurring, where this might be estimated probabilistically⁸.

Magnitude

The large size or importance of something. Magnitude considers factors such as severity, size, or extent of an impact. The magnitude of a potential climate change impact is not the same as its significance. If thresholds are defined, the magnitude of a change can indicate its significance⁵¹.

Paris Agreement

The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is 'Holding the increase in the global average temperature to well below

⁵¹ International Organisation for Standardisation (2019). *Adaptation to Climate Change – Guidelines on Vulnerability, Impacts and Risk Assessment* (ISO/DIS Standard No. 14091:2019(E)).

2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change⁸.

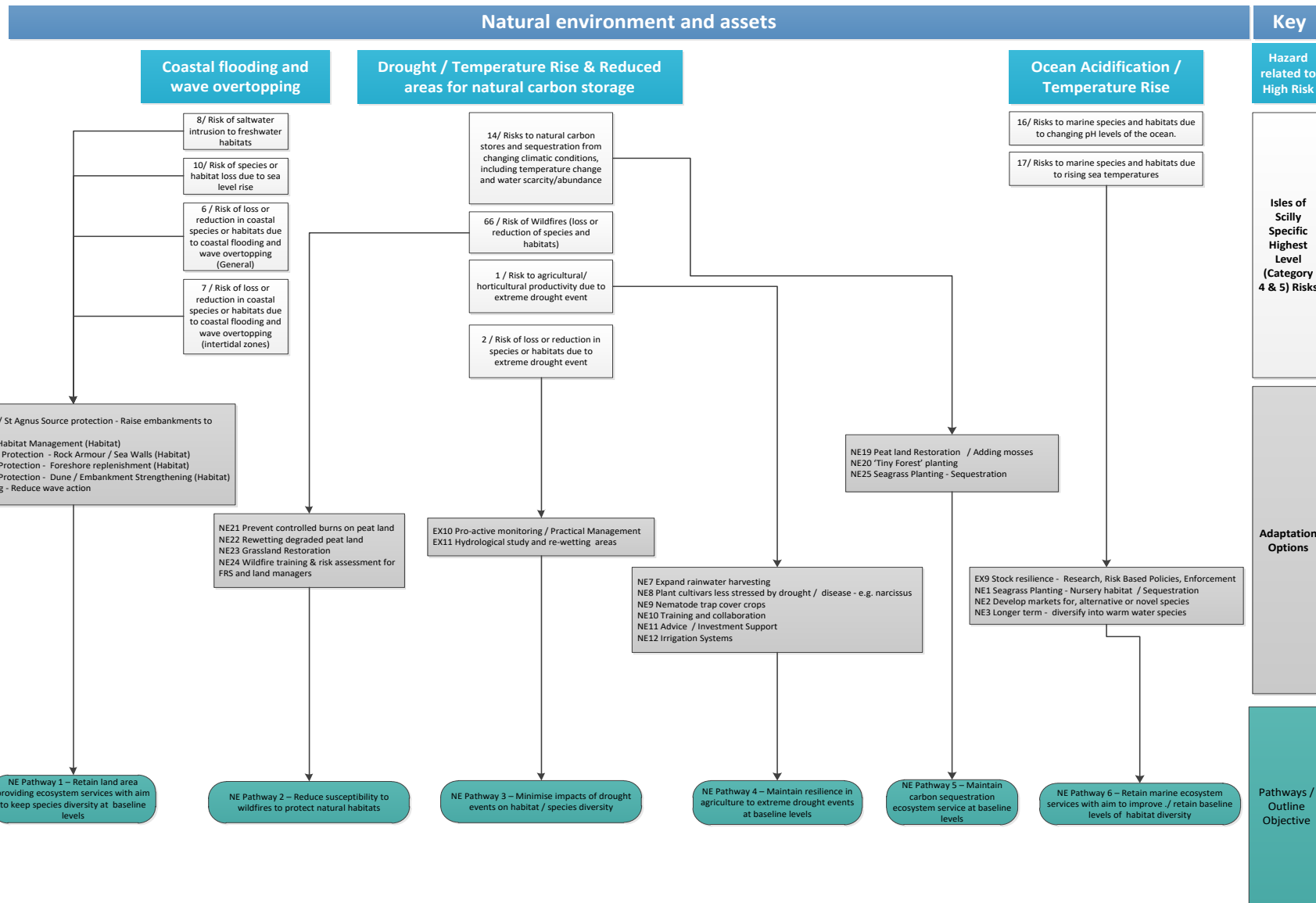
Receptor	The people, livelihoods, species or ecosystems in places and settings that may be affected by climate change ⁵² .
Representative Concentration Pathways	Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels but also the trajectory taken over time to reach that outcome are of interest ⁹ .
Risk	The effect of uncertainty. An effect is a deviation from the expected. It can be positive, negative or both, and can arise as a result a response, or failure to respond, to an opportunity or to a threat related to objectives. Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood ⁷ .
Sensitivity	The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct or indirect ⁹ .

⁵² Canadian Council of Ministers of the Environment. (2021). *Guidance on Good Practices in Climate Change Risk Assessment*. Retrieved from <https://ccme.ca/en/res/riskassessmentguidancesecured.pdf>

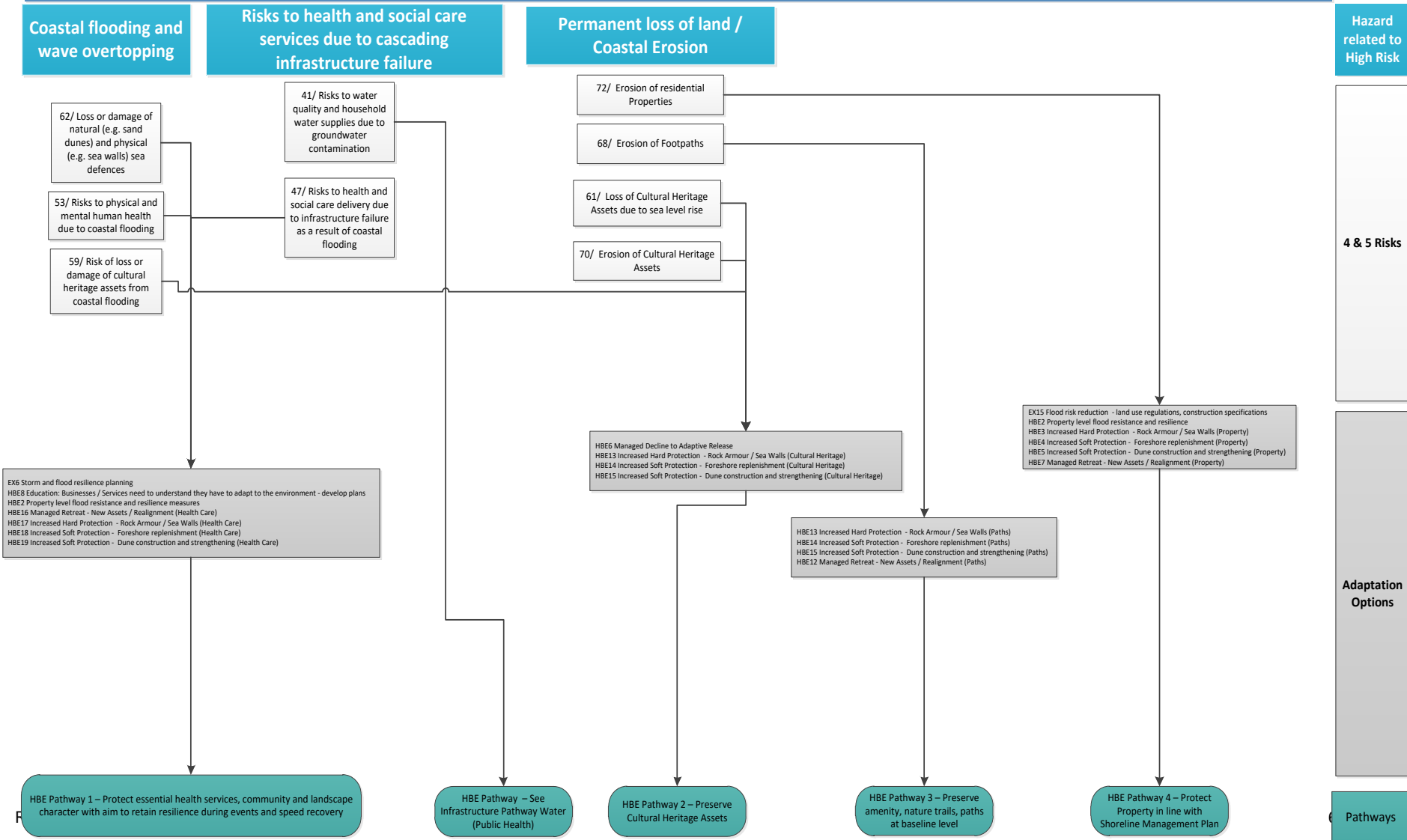
Tipping Point	These are biophysical thresholds where the magnitude of change means the current management strategy (e.g. 'hold the line' or 'managed retreat' will no longer be able to meet the objectives.
Trigger Point	Trigger points mark the necessary lead time for action before reaching a turning point.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt ⁷ .

APPENDIX 2: SECTOR FLOWCHARTS

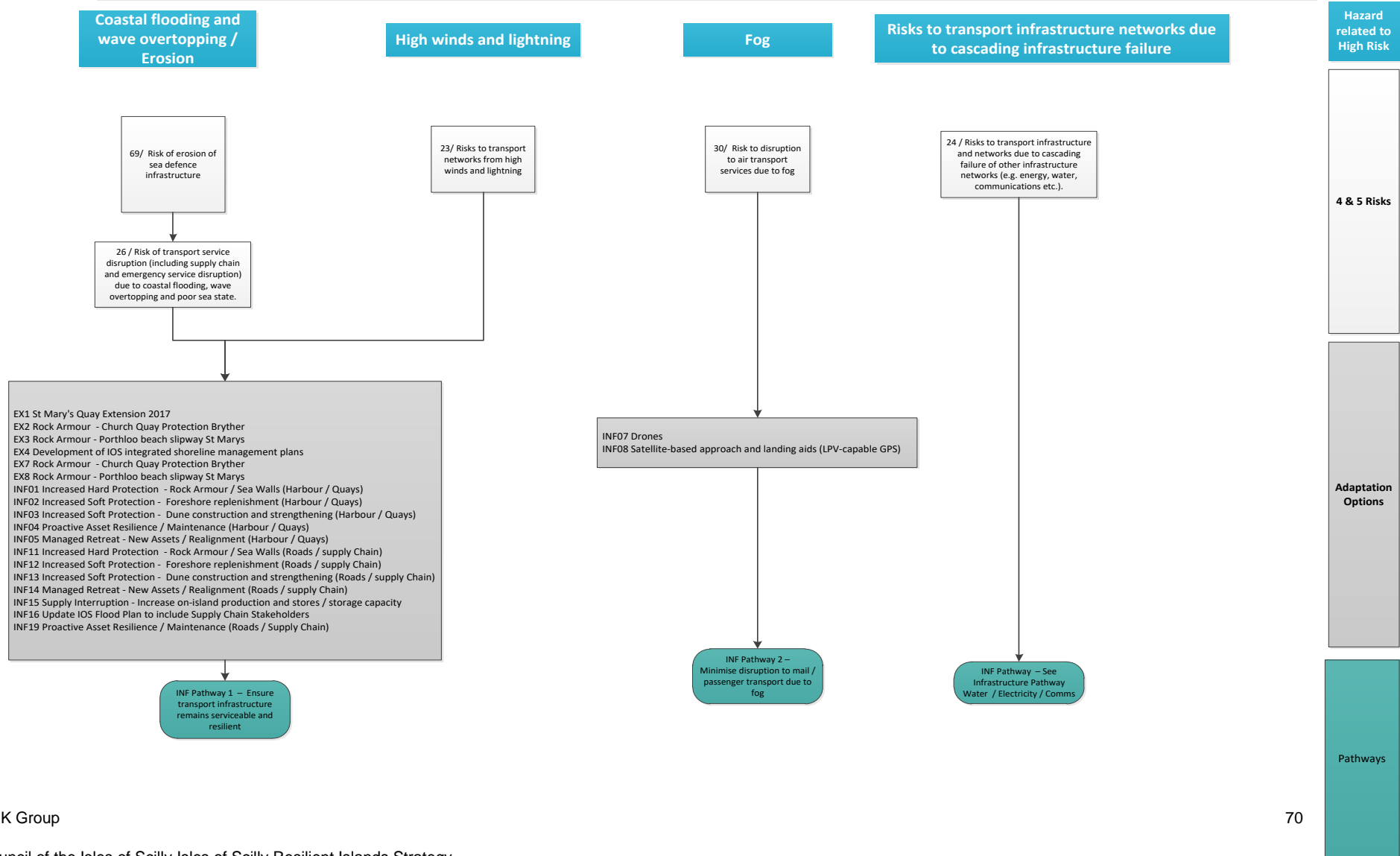
This section presents sector flowcharts which detail the sector, the hazards and associated risks to that sector, the potential adaptation options and the pathway reference to which the options relate.



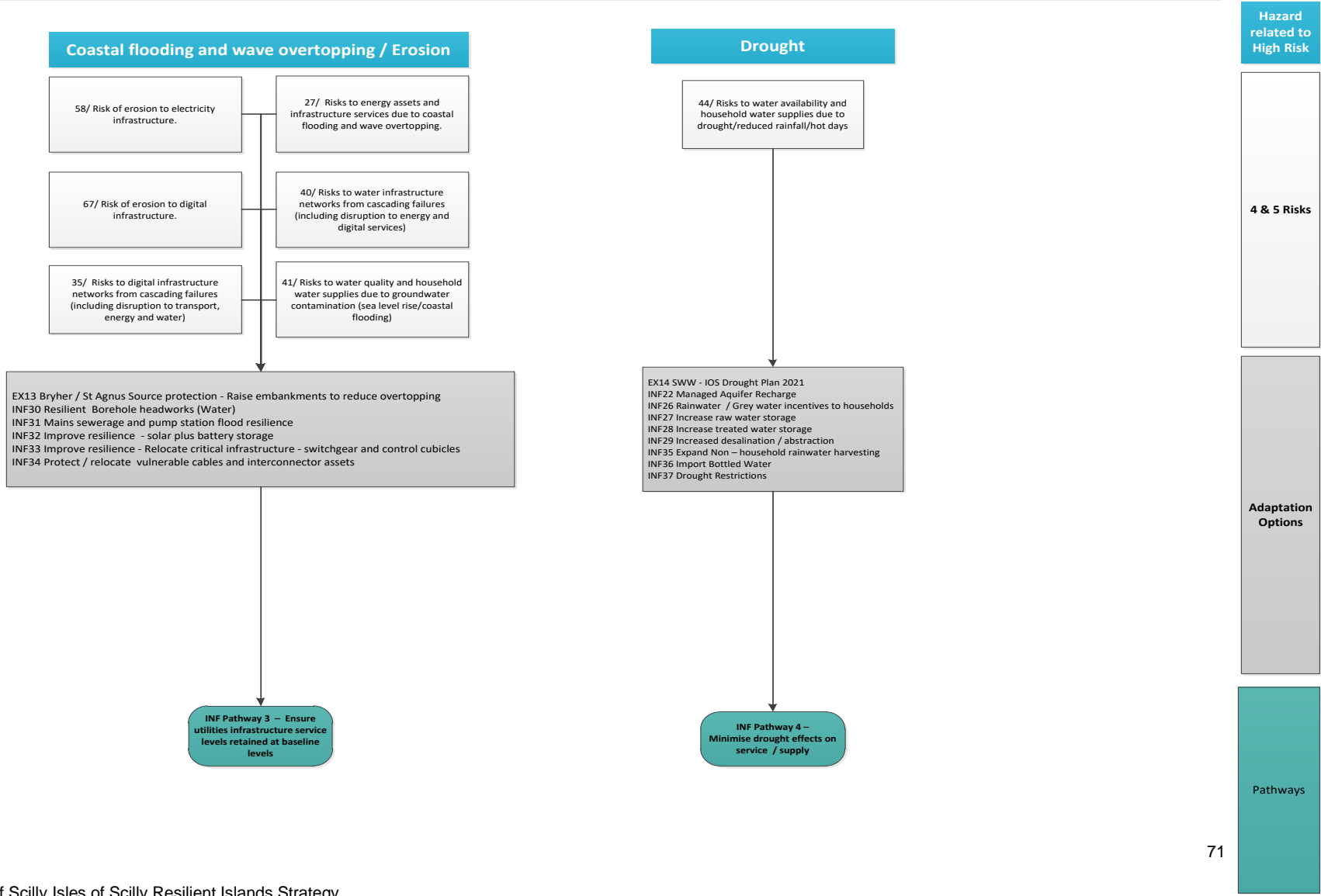
Health, communities and the built environment



Infrastructure – Transport



Infrastructure – Water, Electricity, Comms



Business and Industry

Sea level rise and storm surge

56/ Risks to commercial properties (including productivity) from coastal flooding / wave overtopping / storm surge)

- B1 Property level flood resistance and resilience measures
- B2 Increased Hard Protection - Rock Armour / Sea Walls
- B3 Increased Soft Protection - Foreshore replenishment
- B4 Increased Soft Protection - Dune construction and strengthening
- B5 Awareness: Businesses / Services need to understand they have to adapt to the environment - develop plans
- B6 Managed retreat / New assets

BUS Pathway 1 – Provide sea defences / quays That remain serviceable and provide required risk reduction

Hazard related to High Risk

4 & 5 Risks

Adaptation Options

Pathways

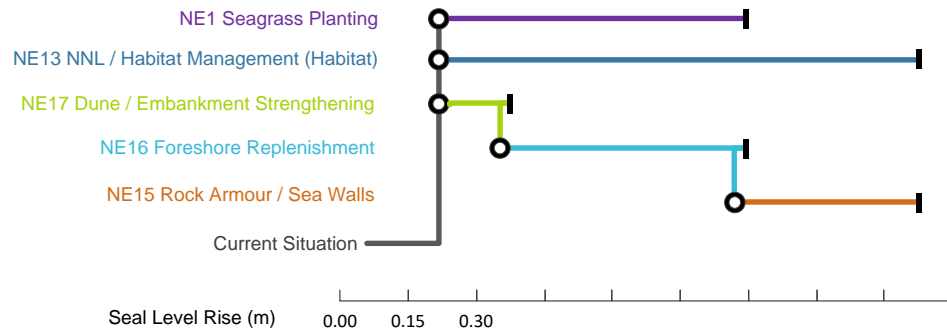
APPENDIX 3: ADAPTATION PATHWAYS

This sections presents adaptation scorecards and indicative pathways for each sector – Natural Environment (6 pathways), Health and Built Environment (4 pathways), Infrastructure (5 pathways) and Business (1 pathway)

NATURAL ENVIRONMENT SCORECARD AND PATHWAY

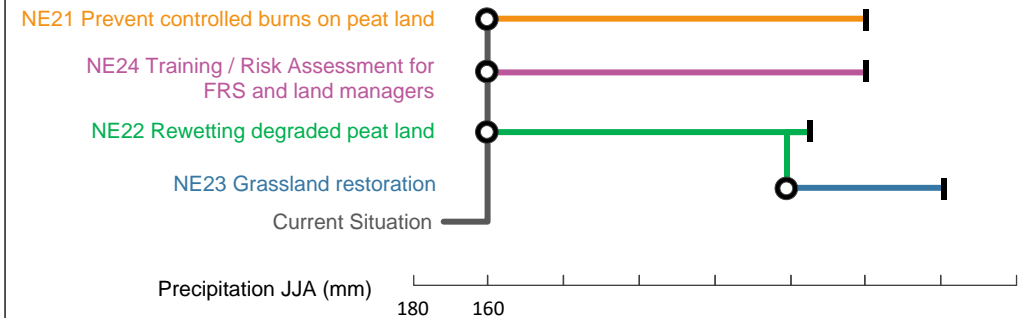
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Natural Environment Pathway 01



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation					
Purple	NE1 Seagrass Planting - Reduce wave action	3.85	1.5	0	++	+
Blue	NE13 No Net Loss / Habitat Management	3.65	1.3	+	0	+
Green	NE17 Dune / Embankment and strengthening (Habitat)	3.55	1.3	+	0	+
Light Blue	NE16 Foreshore replenishment (Habitat)	2.65	0.8	+	--	--
Orange	NE15 Rock Armour / Sea Walls (Habitat)	2.3	1.0	++	--	--

Natural Environment Pathway 02

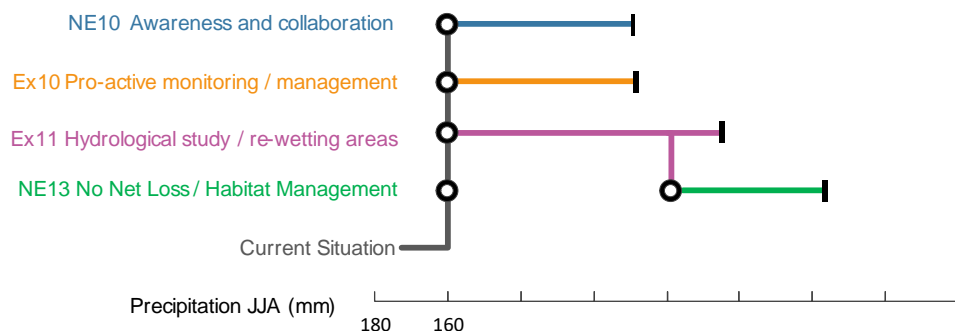


Colour	Action	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	NA	NA	NA	NA	NA
Orange	NE21 Prevent controlled burns on peat land	2.80	2.0	+	+	0
Purple	NE24 Wildfire training & risk assessment for FRS and land managers	3.70	2.0	+	+	0
Green	NE22 Rewetting degraded peatland	3.60	1.0	+	-	++
Blue	NE23 Grassland restoration	3.15	0.8	0	-	+

NATURAL ENVIRONMENT SCORECARD AND PATHWAY

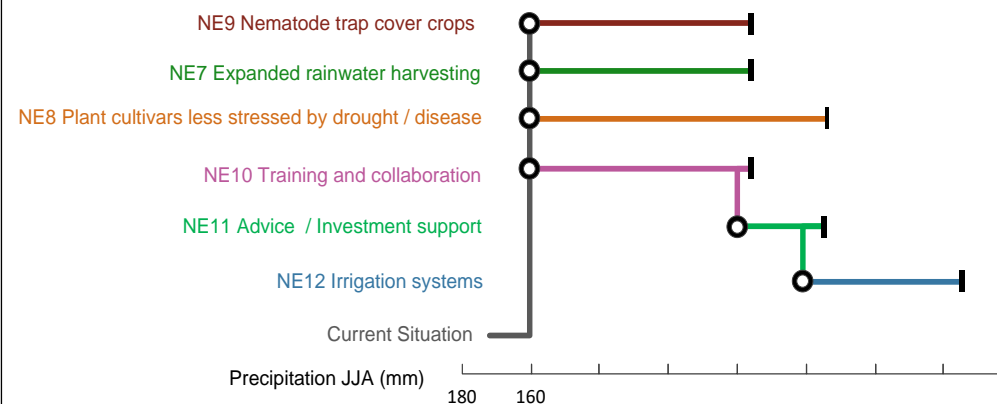
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Natural Environment Pathway 03



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation					
Orange	EX10 Pro-active monitoring / Practical Management	N/A	N/A	N/A	N/A	N/A
Purple	EX11 Hydrological study and re-wetting areas	N/A	N/A	N/A	N/A	N/A
Green	NE13 No Net Loss / Habitat Management	3.65	1.3	+	0	+
Blue	NE10 Awareness and collaboration	3.50	3.0	0	++	+

Natural Environment Pathway 04

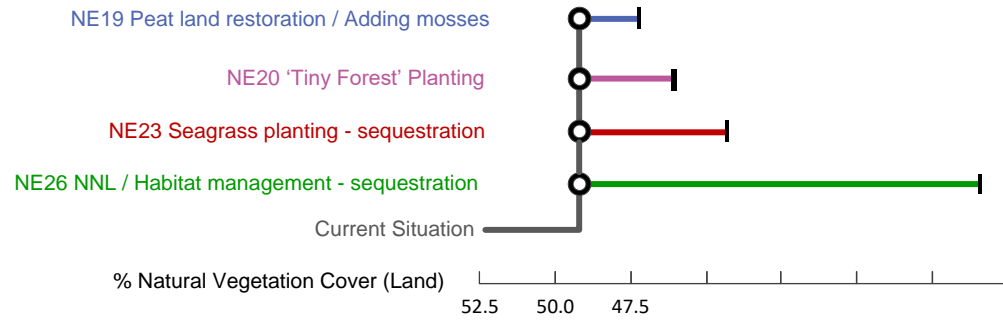


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Red	NE9 Nematode trap cover crops	3.25	0.8	0	-	++
Green	NE7 Expand rainwater harvesting	3.45	1.3	++	-	-
Orange	NE8 Plant cultivars less stressed by drought / disease	3.95	1.3	++	+	0
Purple	NE10 Awareness and collaboration	3.50	3.0	0	++	+
Green	NE11 Advice / Investment support	3.65	1.5	0	-	+
Blue	NE12 Irrigation systems	3.05	1.3	++	-	-

NATURAL ENVIRONMENT SCORECARD AND PATHWAY

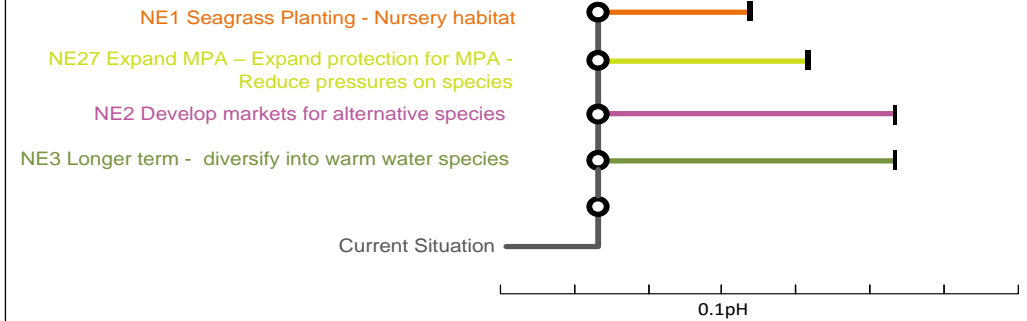
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Natural Environment Pathway 05



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation					
Blue	NE19 Peat land restoration / Adding mosses	4.30	2.0	+	+	++
Purple	NE20 'Tiny Forest' planting	3.40	1.0	+	-	++
Red	NE23 Seagrass planting - sequestration	3.70	1.0	+	-	++
Green	NE26 NNL / Habitat Management (Sequestration)	3.5	0.8	++	--	+

Natural Environment Pathway 06

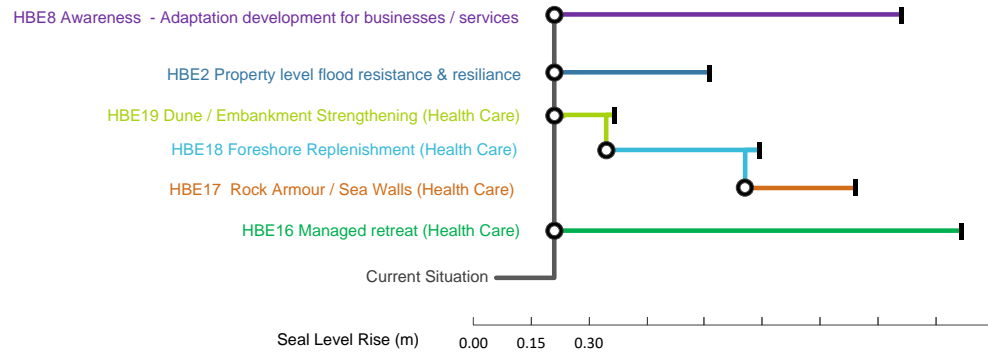


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Orange	NE1 Seagrass planting - Nursery habitat	3.35	0.8	0	-	+
Yellow	NE27 Expand MPA - Reduce pressures on species	3.35	0.8	+	++	++
Purple	NE2 Develop markets for alternative species	3.25	1.5	0	+	+
Green	NE3 Diversification into warm water species	3.15	1.5	0	+	+

HEALTH AND BUILT ENVIRONMENT SCORECARD AND PATHWAY

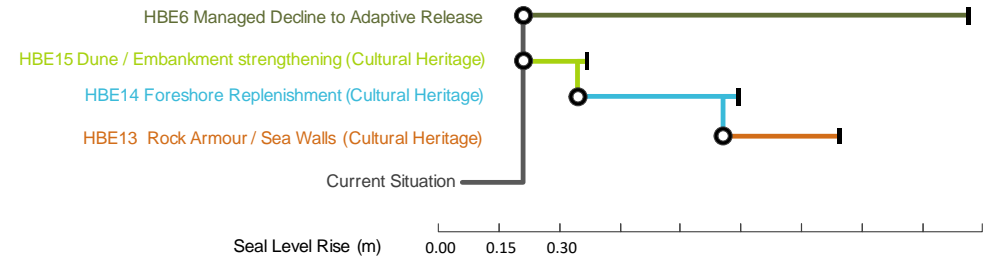
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Health and Built Environment 01



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Blue	HBE2 Property level flood resistance and resilience	3.30	2.0	+	-	-
Purple	HBE8 Education - Adaptation for businesses / services	3.85	0.8	+	+	0
Yellow-green	HBE19 Dune / Embankment strengthening (Health Care)	3.55	1.3	+	0	0
Light blue	HBE18 Foreshore Replenishment (Health Care)	2.70	1.0	+	-	--
Orange	HBE17 Rock Armour / Sea Walls (Health Care)	2.95	1.3	++	-	--
Green	HBE16 Managed retreat (Health Care)	2.5	1.0	++	--	--

Health and Built Environment 02

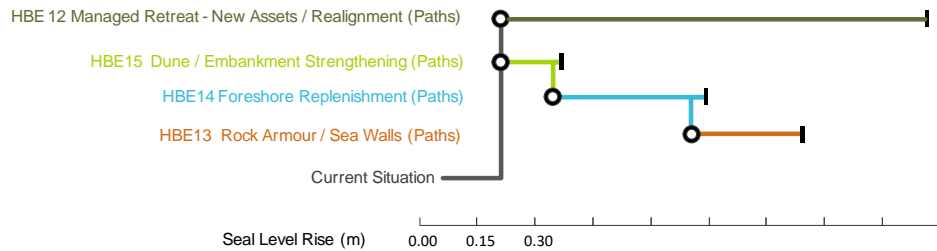


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Dark green	HBE6 Managed Decline to Adaptive Release	2.95	1.5	+	+	-
Yellow-green	HBE15 Dune / Embankment strengthening (Cultural Heritage)	3.3	1.0	+	0	0
Light blue	HBE14 Foreshore Replenishment (Cultural Heritage)	2.7	1.0	+	-	--
Orange	HBE13 Rock Armour / Sea Walls (Cultural Heritage)	2.7	1.0	+	-	--

HEALTH AND BUILT ENVIRONMENT SCORECARD AND PATHWAY

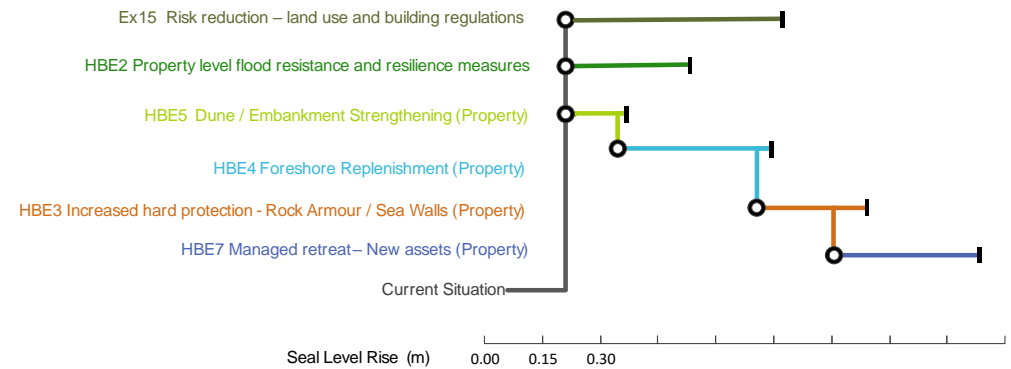
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Health and Built Environment 03



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Dark Green	HBE12 Managed retreat – new assets / realignment	2.95	1.5	+	+	-
Light Green	HBE15 Dune / Embankment strengthening (Pathways)	3.3	1.0	+	0	0
Blue	HBE14 Foreshore Replenishment (Pathways)	2.7	1.0	+	-	--
Orange	HBE13 Rock Armour / Sea Walls (Pathways)	2.7	1.0	+	--	--

Health and Built Environment 04

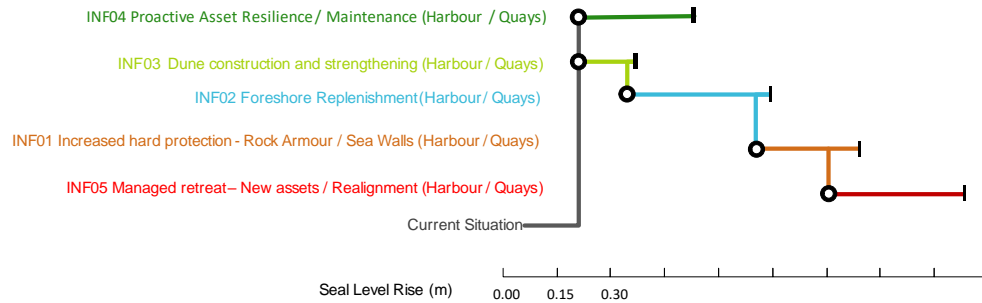


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Dark Green	EX15 Risk reduction - land use regulations, building regulations	N/A	N/A	N/A	N/A	N/A
Orange	HBE3 Increased Hard Protection - Rock Armour / Sea Walls (Property)	2.95	1.3	++	-	-
Blue	HBE4 Foreshore replenishment (Property)	2.70	1.0	+	-	-
Light Green	HBE5 Dune construction and strengthening (Property)	3.55	1.3	+	0	0
Dark Blue	HBE7 Managed Retreat - New Assets (Property)	2.50	1.0	++	--	--
Green	HBE2 Property level flood resistance and resilience measures	3.30	2.0	+	-	-

INFRASTRUCTURE SCORECARD AND PATHWAY

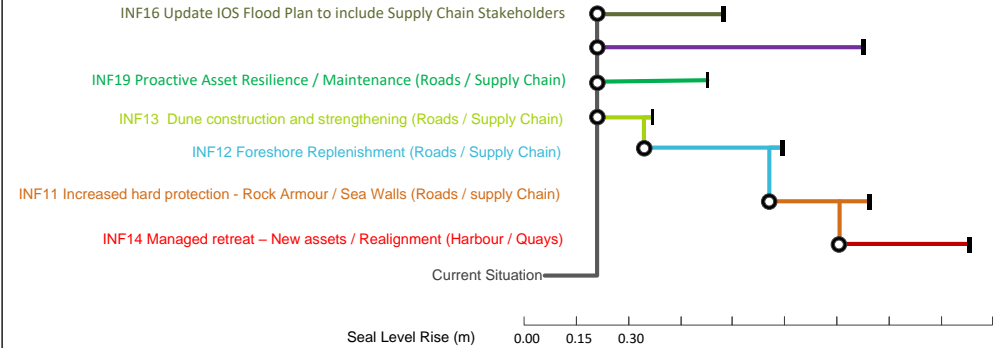
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Infrastructure Pathway 1A



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
N/A	EX2 Rock Armour - Church Quay Protection Bryther EX3 Rock Armour - Porthloo beach slipway St Marys EX4 Development of IOS integrated shoreline management plans EX7 Rock Armour - Church Quay Protection Bryther EX8 Rock Armour - Porthloo beach slipway St Marys	N/A	N/A	N/A	N/A	N/A
Orange	INF01 Rock Armour / Sea Walls (Harbour / Quays)	2.75	1.3	+	-	--
Blue	INF02 Foreshore replenishment (Harbour / Quays)	2.70	1.0	+	-	--
Yellow-green	INF03 Dune construction and strengthening (Harbour / Quays)	3.25	1.3	0	0	0
Green	INF04 Proactive Asset Resilience / Maintenance (Harbour / Quays)	2.65	0.8	0	-	-
Red	INF05 Managed Retreat - New Assets / Realignment (Harbour / Quays)	2.50	1.0	++	--	--

Infrastructure Pathway 1B

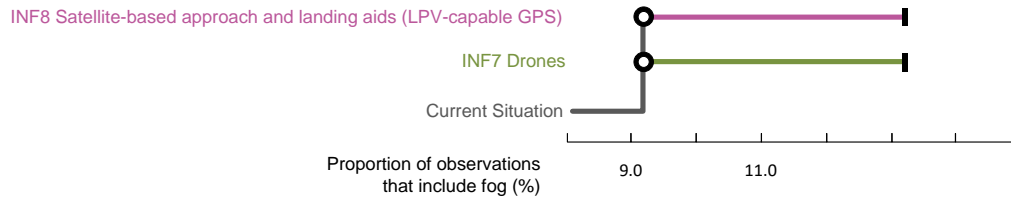


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Orange	INF 11 Rock Armour / Sea Walls (Roads / supply Chain)	2.75	1.3	+	-	--
Blue	INF12 Foreshore replenishment (Roads / Supply Chain)	2.7	1.0	+	-	--
Yellow-green	INF13 Dune construction and strengthening (Roads / Supply Chain)	3.25	1.3	0	0	0
Green	INF19 Proactive Asset Resilience / Maintenance (Roads / Supply Chain)	2.95	1.3	0	0	-
Red	INF14 Managed Retreat - New Assets / Realignment (Roads / Supply Chain)	2.50	1.0	++	--	--
Purple	INF16 Update IOS Flood Plan to include Supply Chain Stakeholders	3.70	3.0	0	+	0
Dark Purple	INF15 Supply Interruption - Increase on-island production and stores / storage capacity	2.70	1.0	0	+	0

INFRASTRUCTURE SCORECARD AND PATHWAY

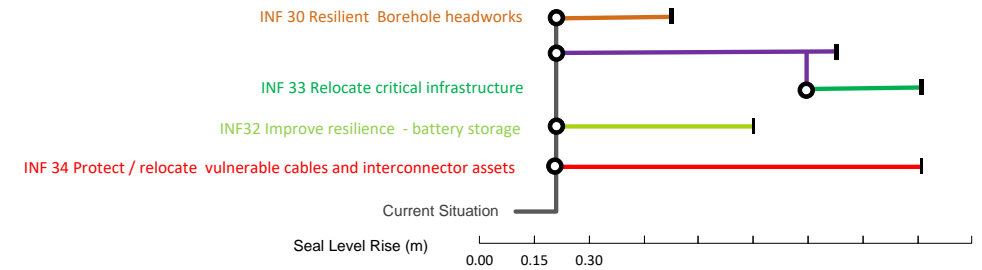
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Infrastructure Pathway 02



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Green	INF07 Drones	3.15	1.3	+	0	+
Purple	INF08 Satellite-based approach and landing aids (LPV-capable GPS)	2.6	1.0	0	0	+

Infrastructure Pathway 03

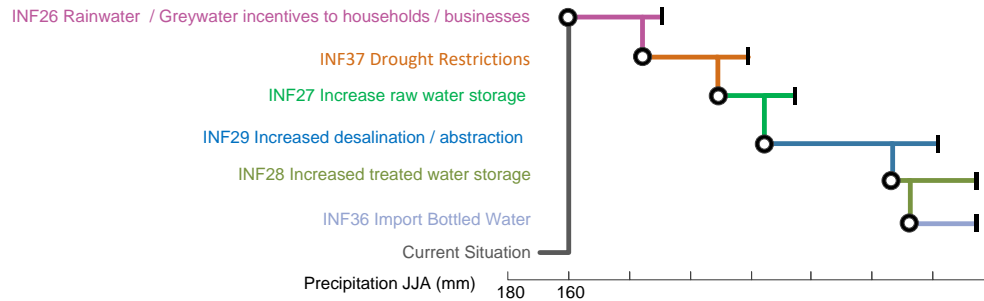


Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
N/A	Ex13 Bryher / St Agnus Source protection - Raise embankments to reduce overtopping	N/A	N/A	N/A	N/A	N/A
Purple	INF31 Mains sewerage and pump station flood resilience	2.90	1.0	+	-	-
Green	INF32 Improve resilience - battery storage	3.55	1.3	++	-	-
Light Green	INF 33 Relocate critical infrastructure	3.25	1.3	++	-	--
Red	INF 34 Protect / relocate vulnerable cables and interconnector assets	3.15	1.3	++	-	--
Orange	INF 30 Resilient Borehole headworks	3.50	2.0	+	+	-

INFRASTRUCTURE AND BUSINESS SCORECARD AND PATHWAY

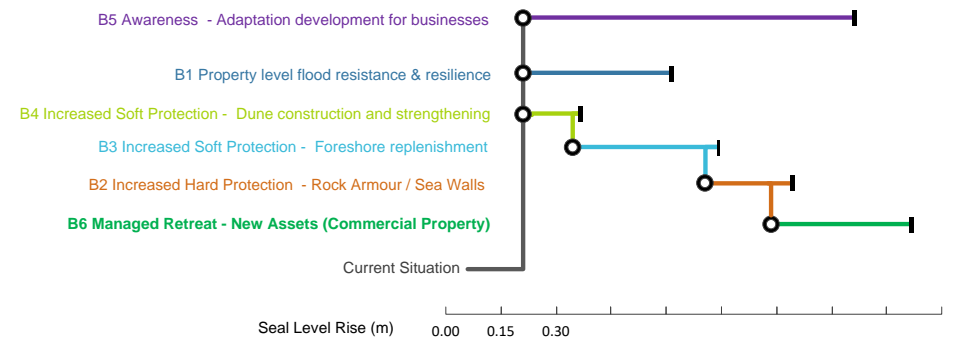
KEY					
MCA Score / Target Cost Ratio	Highly Positive	Positive	Neutral	Negative	Highly Negative
0.0 to 5.0	++	+	0	-	--

Infrastructure Pathway 04



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
N/A	Ex14 SWW - IOS Drought Plan 2021	N/A	N/A	N/A	N/A	N/A
Pink	INF26 Rainwater / Greywater incentives to households / businesses	3.30	1.0	+	-	0
Green	INF 27 Increase raw water storage	3.05	1.3	++	-	-
Light Green	INF28 Increase treated water storage	2.35	0.8	+	--	-
Blue	INF29 Increased desalination / abstraction	2.95	1.3	++	--	--
Light Blue	INF36 Import Bottled Water	2.60	1.0	+	-	--
Orange	INF37 Drought Restrictions	3.55	2.5	++	+	0

Business 01



Colour	Action or Pathway	MCA Score	Cost / Target Ratio	Target Effects	Costs	Side Effects
Grey	Current Situation	N/A	N/A	N/A	N/A	N/A
Pink	B5 Awareness and adaptation development for businesses	3.60	3.0	0	++	+
Blue	B1 Property level flood resistance and resilience measures	3.45	2.0	+	-	-
Green	B2 Increased Hard Protection - Rock Armour / Sea Walls	2.95	1.3	++	--	--
Light Blue	B3 Increased Soft Protection - Foreshore replenishment	2.70	1.0	+	-	-
Light Green	B4 Increased Soft Protection - Dune construction and strengthening	3.45	1.3	++	0	0
Dark Green	B6 Managed Retreat - New Assets / Realignment (Commercial Property)	2.50	1.0	++	--	--

APPENDIX 4: IMPLEMENTATION PLAN

The Implementation Plan can be found on the Council's website