ADURA

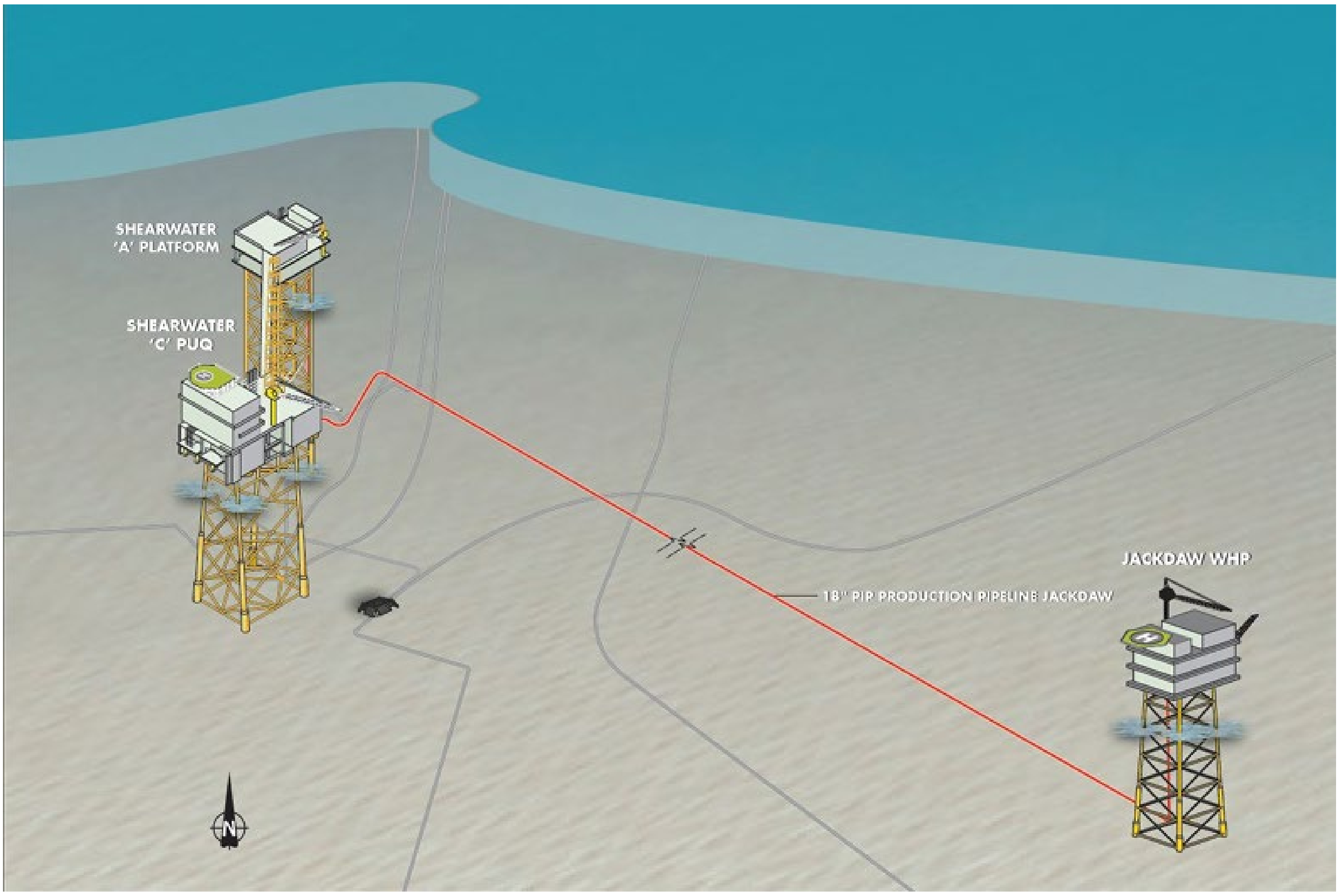
JACKDAW FIELD DEVELOPMENT

RESPONSES TO REGULATION 12(1) NOTICE (27TH MARCH 2026)

19th June 2026

ES Ref: D/4260/2021 (February 2022).

Further information required under DESNZ Regulation 12(1) Notice dated 27th March 2026.



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Notes on Text

The Supplementary Guidance for Assessing the Effects of Downstream Scope 3 Emissions on Climate from Offshore Oil and Gas Projects (OPRED, 2025) sets out guidance on the assessment of the effects of downstream GHG emissions on climate from an offshore oil & gas project. It is not prescriptive in the approach to be taken and invites developers to make an assessment which is appropriate for the particular project that is being assessed. It confirms that OPRED accepts that alternative approaches may be possible or even preferable. Consequently, consideration should be given to the appropriate approach for a particular project on a 'case by case' basis. Adura does this for each of its projects and this may result in different, though equally valid, approaches being adopted.

Relevant scientific publications are regularly modified and updated. Adura has referenced publications up to date as of 22nd May 2026. Adura is not aware of any relevant publications issued subsequent to this date that would materially alter the conclusions of this response.

CONTENTS

ABBREVIATIONS

Abbreviation	Definition
%	Percent
°C	Degrees Celsius
APS	Announced Pledges Scenario
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
bbl	Barrel of Oil
BCC	British Chambers of Commerce
BEIS	Department for Business, Energy, and Industrial Strategy
BNZP	Balanced Net Zero Pathway
CAGR	Compound Annual Growth Rate
CCAC	Climate and Clean Air Coalition
CCC	Climate Change Committee
CDD	Consecutive Dry Days
CCUS	Carbon Capture, Usage and Storage
CDR	Carbon Dioxide Removal
CH_4	Methane
cm	Centimetres
CO	Carbon Monoxide
CO_2	Carbon Dioxide
$CO_2e(q)$	Carbon Dioxide Equivalent
CO_2e/bbl	Carbon Dioxide Equivalent per Barrel (of Oil)
CO_2e/boe	Carbon Dioxide Equivalent per Barrel of Oil Equivalent
CO_3^{2-}	Carbonate
CPS	Current Policies Scenario
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CurPol	Current Policies
DESNZ	Department for Energy Security and Net Zero
EDGAR	Emissions Database for Global Atmospheric Research
EF	Emission Factor
EIA	Environmental Impact Assessment
EPL	Energy Profits Levy
EPO	Environmental Protection Objectives
ERAP	Emissions Reduction Action Plan
ERRV	Emergency Response and Rescue Vessel

ERSSTv5	Extended Reconstructed Sea Surface Temperature, Version 5
ES	Environmental Statement
ESG	Environmental, Social and Governance
EU MER	European Union Methane Emissions Regulation
EV	Electric Vehicle
GEC	Global Energy and Climate Change
GHG	Greenhouse Gas
GSAT	Global Surface Air Temperature
Gt	Gigatonnes
Gt/yr	Gigatonnes per Year
$GtCO_2/yr$	Gigatonnes of Carbon Dioxide per Year
$GtCO_2e$	Gigatonnes of Carbon Dioxide Equivalent
$GtCO_2e/yr$	Gigatonnes of Carbon Dioxide per Year
GVA	Gross Value Added
H^+	Hydrogen ion
HadSST4	Hadley Centre's sea surface temperature dataset, Version 4
HCO_3^-	Bicarbonate
HDJU	Heavy Duty Jack-Up
IAM	Integrated Assessment Modelling
IEA	International Energy Agency
IMP	Illustrative Mitigation Pathway
IPCC	Intergovernmental Panel on Climate Change
ISEP (formerly IEMA)	Institute of Sustainability end Environmental Practitioners (formerly Institute of Environmental Management and Assessment)
JAXA	Japan Aerospace Exploration Agency
kboe/d	Thousands of Barrels of Oil Equivalent per Day
kg CO_2e/boe	Kilograms of Carbon Dioxide Equivalent per Barrel of Oil Equivalent
km^2	Square Kilometres
LoF	Life of Field
m	Metre
mm	Millimetre
mm/yr	Millimetres per Year
ModAct	Moderate Action
Mt	Million Tonnes
$MtCH_4/yr$	Million Tonnes of Methane per Year
$MtCO_2e$	Million tonnes of Carbon Dioxide Equivalent
MtN_2O/yr	Million Tonnes of Nitrous Oxide per Year

$MtSO_2$/yr	Million Tonnes of Sulphur Oxide per Year
NDC	Nationally Determined Contributions
NGL	Natural Gas Liquid
N_2O	Nitrous Oxide
NOAA	National Oceanic and Atmospheric Administration
NOIA	National Ocean Industries Association
NSFP	North Sea Future Plan
NSIDC	National Snow and Ice Data Centre
NSTA	North Sea Transition Authority
NSTD	North Sea Transition Deal
NZE	Net Zero Emissions
OECD	Organisation for Economic Co-operation and Development
OGA	Oil and Gas Authority
OGCI	Oil and Gas Climate Initiative
OGMP	Oil & Gas Methane Partnership
OGPM	Oil and Gas Price Mechanism
ONS	Office of National Statistics
OPEC	Organisation of Petroleum Exporting Countries
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSI SAF	Ocean and Sea Ice Satellite Application Facility
PINS	Planning Inspectorate
ppb	Parts Per Billion
ppm	Parts Per Million
RCPs	Representative Concentration Pathways
SECE	Safety and Environmental Critical Elements
SO_2	Sulphur Dioxide
SPEI	Standardised Precipitation-Evapotranspiration Index
SPI	Standardised Precipitation Index
SSP	Shared Socioeconomic Pathways
STEM	Science, Technology, Engineering, Mathematics
STEPS	Stated Policies Scenario
tCO_2/t	Tonnes of Carbon Dioxide per Tonne
tCO_2e	Tonnes of Carbon Dioxide Equivalent
TEC	Transitional Energy Certificates
TFP	Total Factor Productivity
toe	Tonnes of Oil Equivalent

uHPHT	ultra-High Pressure and High Temperature
UKCS	United Kingdom Continental Shelf
UNEP	United Nations Environment Programme
WDCGG	World Data Centre for Greenhouse Gases
WGI	Working Group I
WGII	Working Group II
WHP	Well Head Platform
WMO	World Meteorological Organisation
WSI	Water Scarcity Index
WTT	Well To Tank
ZJ	Zettajoules

INTRODUCTION

This document provides the response to the request for further information in respect of the Jackdaw Field Development under The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (the "Regulations"), Regulation 12(1) Notice received by Adura on the 27th March 2026 (the "March 2026 Regulation 12(1) Notice").

For each OPRED comment received, Adura has considered the comment, presents a response to address the comment and (where relevant) states whether the further information provided affects the conclusions of the original downstream scope 3 emissions presented in Shell (2025).

PART 1: SCOPE 3 EMISSIONS ASSESSMENT DOCUMENT

1 ITEM 1

> 1. Page 7 – Section 3.1.1 – Current State of the Environment –The Supplementary guidance for assessing the effects of downstream scope 3 emissions on climate from offshore oil and gas projects ("the Supplementary Guidance"), states (emphasis added) '*a realistic and reasonable description of the* ***current state of the environment (baseline scenario)*** *should be presented' and that '[the]* ***baseline scenario has to be based on available up to date environmental information and scientific knowledge on global GHGs and climate****, which is well documented (IPCC, 2023; Lan, 2025; Lindsey, 2025; Jacobson, 2023; Met Office, 2025)''* The global baseline scenario presented should consider all relevant environmental information and scientific knowledge in relation to climate and the effects of climate when evaluating the project over the lifetime of the project.
>
> In the further information, Adura have only described the correlation between increasing global atmospheric CO_2 levels and rising global temperatures. The baseline scenario does not consider other environmental indicators. Please describe the current state of the climate and the environment. The Supplementary Guidance indicates several sources where information on the environment can be obtained.
>
> In addition, the Supplementary Guidance states (emphasis added):
>
> *'…the scope 3 emissions estimated to be produced by the project, as outlined in "Estimating scope 3 emissions" section below, should be evaluated in the context of a global baseline scenario of GHGs.'*
>
> In your response you should present information on the global baseline of GHGs.

To enable the assessment of the effects of the Jackdaw Project on the environment, additional information for Section 3.1.1 – Current State of the Environment of Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) is provided to better reflect the global baseline scenario, considering all relevant environmental information and scientific knowledge, in relation to climate and the effects of climate over the lifetime of the project.

In order to "*identify a reasonable future estimate of global GHG emissions affecting the climate over the lifetime of the project, reflecting the expected trajectory of climate conditions and the environment*" (OPRED, 2025), please refer to the response to Item 2.

1.1 CURRENT STATE OF THE ENVIRONMENT

1.1.1 GREENHOUSE GAS CONCENTRATIONS

This section, in accordance with the Supplementary Guidance for Assessing the Effects of Downstream Scope 3 Emissions on Climate from Offshore Oil and Gas Projects (OPRED, 2025) (the "Supplementary Guidance") and Schedule 6(3) of the Regulations, describes the current state of the environment as referred to in the sources listed by OPRED in Item 1.

The IPCC is the international body for assessing the science related to climate change. The IPCC was set up to "*provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation"* (IPCC mandate).

IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies. The assessments present projections of future climate change based on different scenarios and the risks that climate change poses.

The IPCC Annual Report 6 (AR6) (IPCC, 2023) Working Group I states that it is *"unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."*

Human activities have contributed to significant changes in the environment over the past century. One of the most notable indicators is the rising concentration of GHG emissions, particularly carbon dioxide (CO_2), in the atmosphere. Global monitoring stations, such as the Mauna Loa Observatory in Hawaii and those operated by National Oceanic and Atmospheric Administration (NOAA), continuously track CO_2, methane (CH_4) and nitrous oxide (N_2O) concentrations to assess trends and guide efforts to reduce GHG emissions. The World Data Centre for GHG emissions compiles data from various sources to estimate global GHG levels (Met Office, 2026a).

Since 1750 (representative of the pre-industrial period), global concentrations of CO_2, CH_4 and N_2O have increased by approximately 47%, 156% and 23%, respectively (IPCC, 2023).

1.1.1.1 CARBON DIOXIDE (CO_2) CONCENTRATIONS

Recent measurements indicate that atmospheric CO_2 has surpassed 420 parts per million (ppm) (Lan *et al.*, 2026). This represents approximately a 47-50% increase since pre-industrial times, primarily driven by fossil fuel combustion, deforestation, and industrial processes (IPCC, 2023; Lindsey, 2025). Emissions from fossil fuel combustion are largely attributable to economically developed, densely populated regions, with around 82% of these emissions attributed to the industrialised northern extratropics (Jacobsen *et al.*, 2023).

Seasonal variations are also observed: CO_2 levels tend to rise during winter and spring in the Northern Hemisphere and decrease in summer and early autumn due to increased plant photosynthesis. Despite these seasonal fluctuations, the overall trend is a consistent increase in atmospheric CO_2 over time (Met Office, 2026a). Figure 1 presents monthly atmospheric CO_2 concentrations from four datasets: Mauna Loa, NOAA marine global, Kennaook/Cape Grim (Commonwealth Scientific and Industrial Research Organisation (CSIRO 2025), and (World Data Centre for Greenhouse Gases (WDCGG)), and shows an upward trend in concentration since the 1950s (Met Office, 2026a).

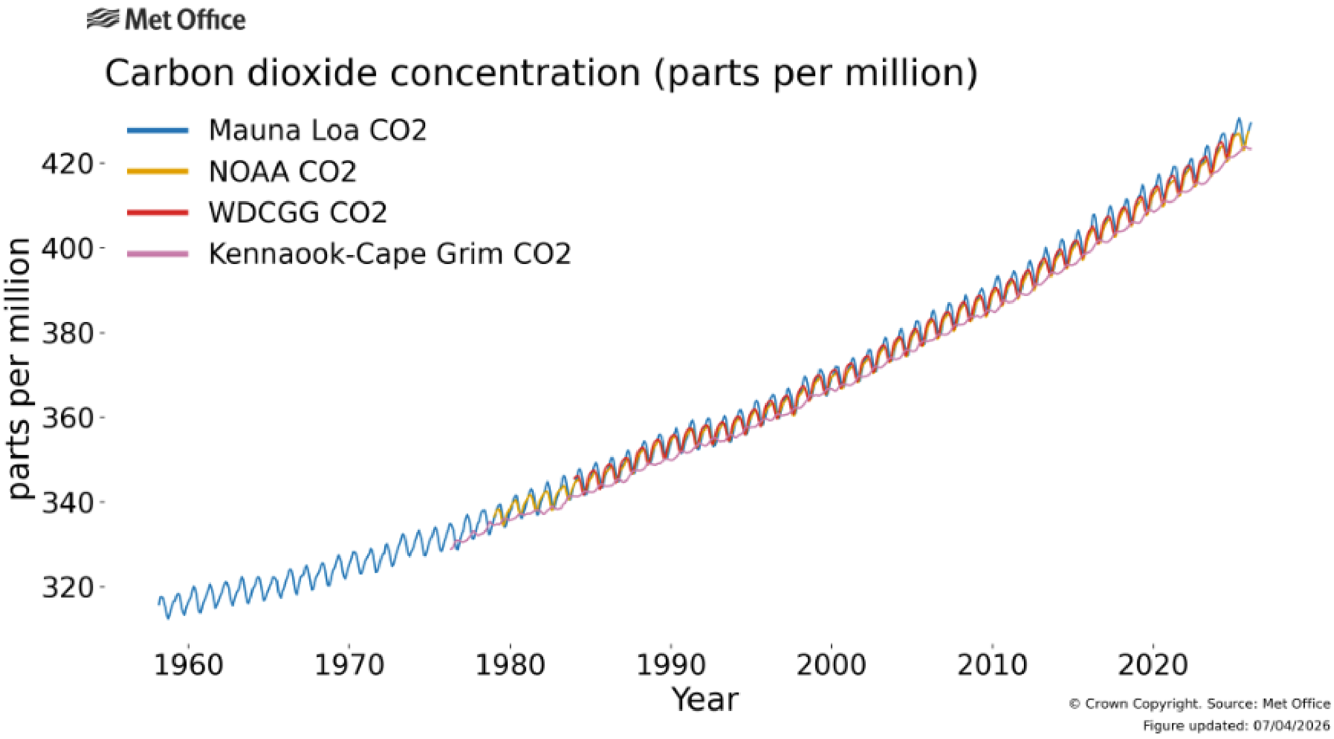


Figure 1: Monthly carbon dioxide concentration in the atmosphere. Four data sets are shown: Mauna Loa, NOAA marine global, Kennaook/Cape Grim (CSIRO), and WDCGG (Met Office, 2026a).

During the 1960s, atmospheric CO_2 increased at an average rate of approximately 0.8 ppm per year. This rate rose to about 1.6 ppm per year in the 1980s and remained elevated at around 1.5 ppm per year through the 1990s. In the most recent decade (2015-2024), the annual increase has further accelerated to approximately 2.6 ppm per year. Consequently, the annual rate of increase in atmospheric CO_2 over the last 60 years is estimated to be 100-200 times faster than the natural increases observed at the end of the last ice age, between 11,000 and 17,000 years ago (Lindsey, 2025).

1.1.1.2 *METHANE (CH_4) CONCENTRATIONS*

Although CH_4 has a shorter atmospheric lifetime than CO_2 (and eventually oxidises to form CO_2), it is a considerably more powerful GHG due to its higher radiative efficiency, resulting in a greater warming effect per unit mass (IPCC, 2021).

The Global Monitoring Division of NOAA's Earth System Research Laboratory has monitored atmospheric CH_4 concentrations since 1983. Recent observations indicate a continuing increase in CH_4 concentration, which reached approximately 1,946 parts per billion (ppb) in November 2025, up from around 1,940 ppb in November 2024 (Lan *et al.*, 2026).

Recent increases in atmospheric CH_4 concentrations have accelerated since 2006, increasing by an average of about 7.6 ppb per year between 2010 and 2019, with a faster rise of roughly 9.3 ppb per year from 2014 to 2019 (IPCC, 2021). Figure 2 presents monthly global atmospheric CH_4 concentrations from three datasets: NOAA, CSIRO, and WDCGG, all of which show a consistent overall trend, with a more rapid increase evident from around 2006 onward (Met Office, 2026a).

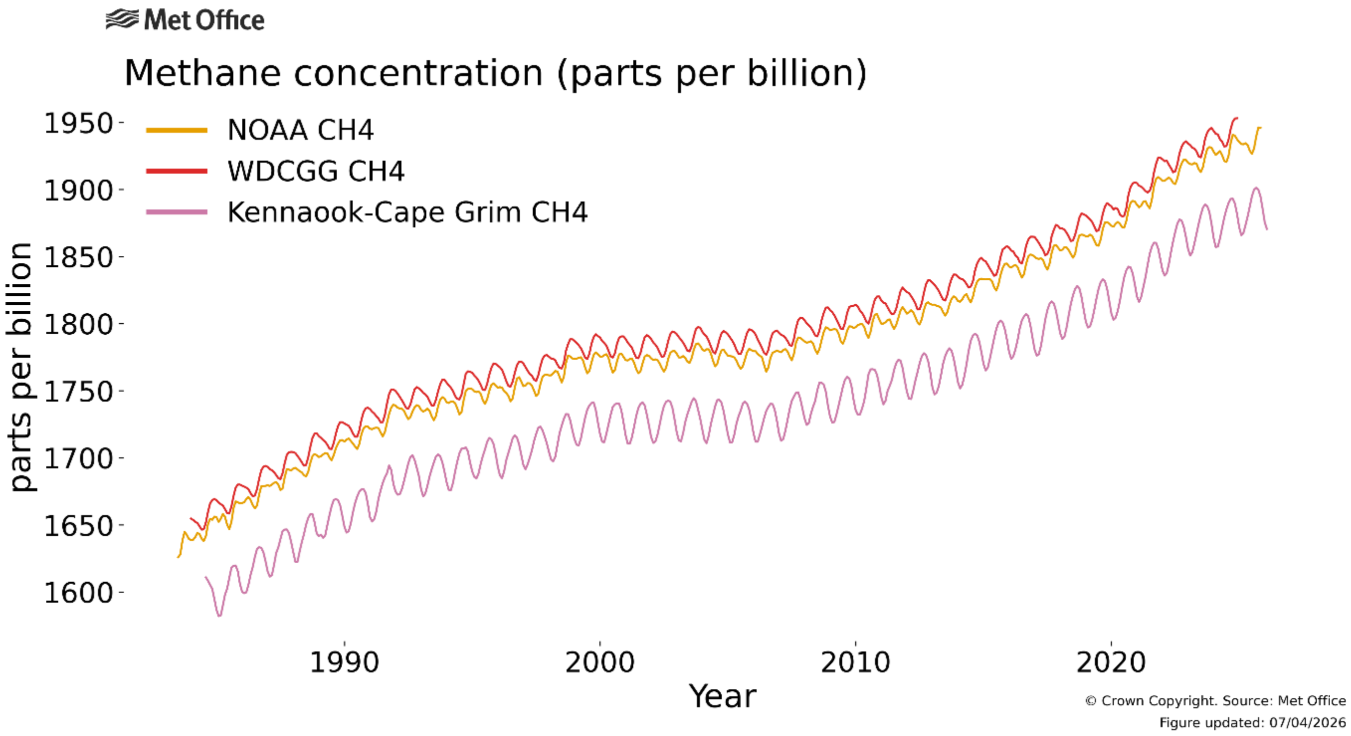


Figure 2: Monthly global methane concentration in the atmosphere. Three data sets are shown: NOAA, Kennaook/Cape Grim (CSIRO) and WDCGG (Met Office, 2026a).

Large uncertainties in CH_4 emission sources and sinks have made it difficult to accurately quantify global CH_4 concentrations and determine the main drivers of CH_4 increases since the 1980s. Despite these uncertainties, assessments indicate that "*the multi-decadal growth trend in atmospheric CH_4 is dominated by anthropogenic activities, and the growth since 2007 is largely driven by emissions from both fossil fuels and agriculture (dominated by livestock)*" (IPCC, 2021). However, other studies suggest "*that increased emissions from microbial sources are the strongest driver, with a relatively smaller contribution from other processes, e.g. fossil fuel exploitation*" (Lan *et al.*, 2021).

1.1.1.3 NITROUS OXIDE (N_2O) CONCENTRATIONS

The NOAA Global Monitoring Laboratory has monitored N_2O concentrations since 1997 and available data shows concentrations are steadily increasing. A global average atmospheric N_2O concentration of 339.46 ppb was observed in November 2025 (an increase from 338.08 ppb in November 2024) (Lan *et al.*, 2026).

Between 1995 and 2019, N_2O concentrations increased by an average of about 0.85 ppb per year, rising further to around 0.95 parts per billion (ppb) per year during 2010 – 2019 (IPCC, 2021). As noted by the IPCC, *"This increase is dominated by anthropogenic emissions, which have increased by 30% between the 1980s and the most recent observational decade (2007-2016). Increased use of nitrogen fertilizer and manure contributed to about two-thirds of the increase during the 1980–2016 period, with the fossil fuels/industry, biomass burning, and wastewater accounting for much of the rest.*" (IPCC, 2021).

Figure 3 presents the monthly N_2O concentration in the atmosphere from the Kennaook/Cape Grim (CSIRO 2025) and WDCGG, highlighting a long-term increase in N_2O levels (Met Office, 2026a).

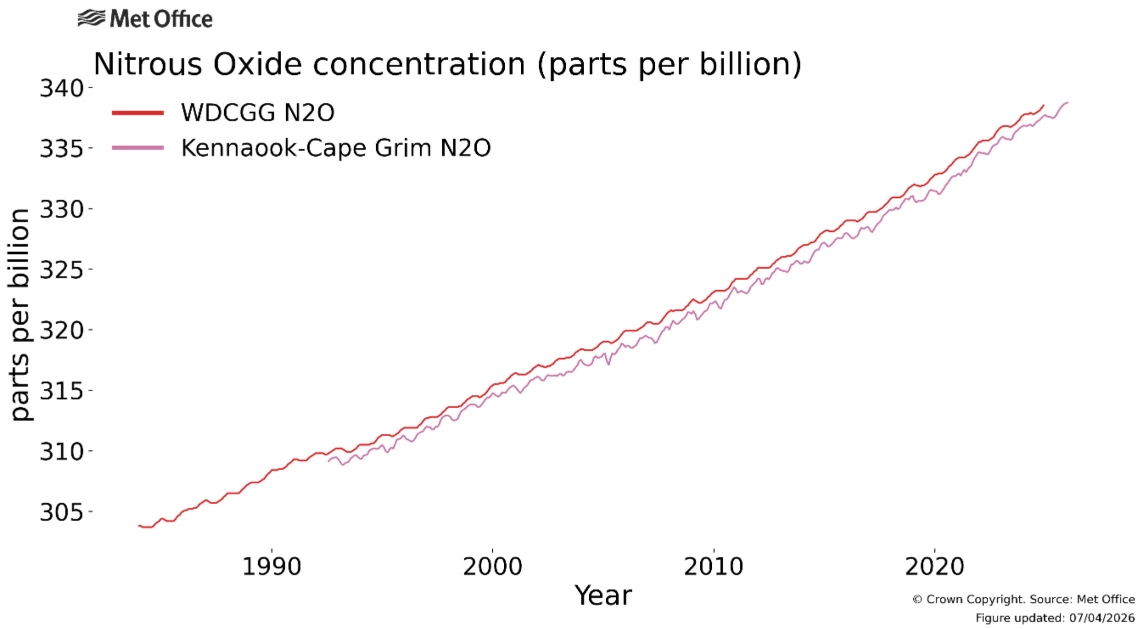


Figure 3: Monthly nitrous oxide concentration in the atmosphere as calculated by Kennaook/Cape Grim (CSIRO) and WDCGG (Met Office, 2026a).

1.1.2 CURRENT STATE OF THE ENVIRONMENT – ENVIRONMENTAL INDICATORS

The IPCC AR6 (IPCC, 2023) Working Group I states that it is *"unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."*

"Tipping points refer to critical thresholds in a system that, when exceeded, can lead to a significant change in the state of the system, often with an understanding that the change is irreversible. An understanding of the sensitivities of tipping points in the physical climate system, as well as in ecosystems and human systems, is essential for understanding the risks associated with different degrees of global warming." (IPPC, 2018).

Table 1 provides a high-level summary of relevant scientific literature relating to the current state of the environment based on the environmental observations described in APPENDIX 1 and focusing on key indicators linked to potential climate tipping points. These indicators span the cryosphere, biosphere, ocean, and atmosphere, highlighting recent changes and emerging signals of heightened climate risk. Table 1 and APPENDIX 1 have been prepared by Adura by drawing on a range of respected, publicly available scientific sources. Table 1 and APPENDIX 1 summarise and paraphrase information from those sources and do not express the views or opinions of Adura. While efforts have been made to reflect the content of the underlying sources accurately, the summaries necessarily involve simplification and are not intended to constitute an exhaustive description of every aspect of that source. Readers should refer to the original sources for the full analysis.

Table 1: Summary of environmental baseline indicators with reference to 2020 Regulations Schedules 6(3) & 6(5): current global observations.

Environmental Indicator (EIA Regulation Schedule 6(5)(a))	Current Global Observations	Appendix 1 Sub-Sections
Surface Temperature *(Schedule 6(5)(a)(iii))*	- Global average temperature has increased by around 1.1°C compared with pre-industrial levels (1850-1900 baseline). - Recent years have been among the warmest on record; notably, 2024 was the warmest year on record at around 1.55°C above the 1850–1900 baseline.	Global Surface Temperature
Extreme Weather and Climate Events *(Schedule 6(5)(a)(iii))*	- Extreme weather events are rare events at a specific place and time, while extreme climate events persist for some time, such as a season. - Recent decades show an increased frequency and intensity (compared to 1850-1900 baseline) in heatwaves, heavy rainfall, droughts, and tropical cyclones globally. - **Temperature extremes:** Since the 1950s, hot extremes and heatwaves have become more frequent, intense, and longer-lasting worldwide, while cold extremes have declined. Land minimum temperatures have increased around three times more than global surface temperatures since the 1960's, particularly in the Arctic. - **Heavy precipitation:** The frequency and intensity of heavy rainfall events have increased across most land regions, particularly in North America, Europe, and Asia, though confidence is lower for very short-duration events due to limited data. - **Drought trends:** Agricultural and ecological droughts have increased globally since the 1950s, becoming more widespread, intense, and long-lasting, with particularly strong effects in mid-latitude and subtropical regions.	Extreme Weather and Climate Events
Sea Level Rise *(Schedule 6(5)(a)(iii))*	- Global mean sea level rose by approximately 0.16 m between 1902–2015. - The rate of sea level rise has increased significantly in recent decades, with the rate accelerating from around 1.4 mm/yr (1901–1990) to around 3.6 mm/yr (2006–2015) and around 4.75 mm/yr during 2015–2025. - In recent years, satellite data has shown rapid sea level rise of approximately 5 mm in 2023–2024 influenced by El Niño. - By 2025, global mean sea level was around 11 cm higher than in 1993.	Global Mean Sea Level

Environmental Indicator (EIA Regulation Schedule 6(5)(a))	Current Global Observations	Appendix 1 Sub-Sections
Cryosphere Changes *(Schedule 6(5)(a)(iii))*	- **Ice mass loss:** During 2006-2015, the Greenland Ice Sheet lost approximately 278 Gt/yr (equivalent to 0.77 mm/yr sea-level rise) and the Antarctica Ice Sheet lost around 155 Gt/yr (equivalent to 0.43 mm/yr), reflecting rapid cryosphere ice loss. - **Permafrost thaw:** Permafrost temperatures have risen by around 0.29°C (±0.12°C) since the 1980s across polar and high-mountain regions, increasing ground instability and potentially affecting approximately 1460–1600 Gt of carbon stored in frozen soils. - **Sea-ice decline:** Arctic sea ice has decreased across all months throughout the year since 1979, with September extent declining by around 12.8% per decade. In 2025, Arctic sea ice averaged around 10.10 million km² (approximately 0.9 million km² below normal) and Antarctic sea ice around 10.81 million km², the third lowest on record.	Cryosphere Changes
Oceanic Changes *(Schedule 6(5)(a)(iii))*	- **Rising sea surface temperatures:** Global ocean surface temperatures have increased by around 0.88°C since pre-industrial times, with most warming occurring since 1980, indicating an acceleration of ocean warming in recent decades. - **Increasing ocean heat content:** Ocean heat content has risen steadily since the 1970s, reaching record levels in 2025; the rate of warming in the upper 2,000 m has more than doubled since the mid-20th century. - **Marine heatwaves and stratification:** Marine heatwaves are becoming more frequent, longer-lasting, and more intense, while surface warming and freshening have increased upper-ocean stratification, reducing vertical mixing and affecting circulation and ecosystems. - **Ocean acidification:** The ocean has absorbed approximately 20–30% of anthropogenic CO_2 since the 1980s, causing surface ocean pH to decline by around 0.017–0.027 pH units per decade. Ocean acidification is widespread, exceeds natural variability, and is strongest in parts of the Indian, Southern, Pacific, and Atlantic Oceans.	Oceanic Changes
Biodiversity *(Schedule 6(5)(a)(ii))*	- **Ecosystem disruption:** Widespread changes have been observed across terrestrial, freshwater, and marine ecosystems, including shifts in species ranges, altered seasonal timing, and ecosystem reorganisation.	Biodiversity

Environmental Indicator (EIA Regulation Schedule 6(5)(a))	Current Global Observations	Appendix 1 Sub-Sections
	- **Biodiversity decline:** Global wildlife populations show high declines, with average vertebrate abundance falling by around 73% since 1970, indicating widespread ecosystem stress and reduced resilience. - **Coral reef loss:** Coral reefs are experiencing rapid degradation, with the ongoing global bleaching event (since 2023) affecting around 84% of reefs, threatening biodiversity and ecosystem functioning.	
Population and Human Health *(Schedule 6(5)(a)(i))*	- **Rising health risks:** Physical health, mental well-being, nutrition, and longevity are all impacted with growing pressure on healthcare systems. - **Climate-sensitive diseases:** Observed changes in temperature, rainfall, and extreme events are linked to the spread of vector- and water-borne diseases (e.g. dengue, malaria at higher altitudes, diarrhoeal diseases), and increased respiratory and mental health impacts following floods, storms, and wildfires. - **Heat-related impacts:** More frequent and intense heat extremes are increasing heat-related illness, reducing safe working capacity, and negatively affecting mental health, cognitive performance, and well-being. - **Food and nutrition insecurity:** Climate variability and extremes are associated with increased food insecurity and multiple forms of malnutrition, particularly in low- and middle-income regions affected by droughts, floods, and storms.	Population and Human Health
Material Assets *(Schedule 6(5)(a)(iv))*	- There are increasing risks to buildings, infrastructure, and physical assets due to more frequent and intense flooding, heatwaves, storms, erosion, and wildfires. - Many assets were designed for historic climate conditions and are increasingly vulnerable to accelerated degradation, reduced performance, and shorter lifespans. - **Energy and Industrial Water Use:** Water scarcity and rising temperatures are reducing the performance and utilisation of energy infrastructure, particularly hydropower and thermoelectric power plants, with increased operational disruptions and economic losses. - **Extreme events and costs:** Growing frequency and intensity of extreme weather events are driving rising economic losses through infrastructure damage, supply-chain	Material Assets, Cultural Heritage and the Landscape

Environmental Indicator (EIA Regulation Schedule 6(5)(a))	Current Global Observations	Appendix 1 Sub-Sections
	disruption, and recovery costs, placing pressure on public finances, insurance systems, and development pathways. - **Food and resource systems under stress:** Reduced crop yields, fishery productivity, and forest outputs in multiple regions have been observed, with extreme events increasingly causing large-scale food production losses and threatening food security and livelihoods.	
Cultural Heritage ***(Schedule 6(5) (iv))***	- Cultural heritage assets, including historic buildings, archaeological sites, cultural landscapes, and traditional practices, are increasingly exposed to climate-related pressures such as erosion, flooding, wildfires, sea-level rise, and changing soil moisture. - Traditional land-use and farming practices are being eroded, particularly Indigenous and small-scale systems, leading to loss of cultural knowledge and reduced resilience of cultural landscapes.	Material Assets, Cultural Heritage and the Landscape
The Landscape ***(Schedule 6(5) (iv))***	- Widespread change has been observed across terrestrial, freshwater, coastal, and marine landscapes through rising temperatures, altered rainfall patterns, sea-level rise, and more frequent extreme events. - **River Landscapes and Connectivity:** River landscapes are being altered by changing flow regimes, with increased drying, reduced connectivity, and shifts from permanent to intermittent watercourses in many regions. - **Lake Landscapes:** Lake landscapes are changing unevenly, with lake levels rising, falling, or stabilising depending on location, and growing evidence of loss of small temporary ponds, resulting in simplified freshwater landscapes. Mountain and high-altitude landscapes are being reshaped by glacier retreat, permafrost thaw, and altered runoff, leading to new lake formation, changed drainage patterns, and increased landscape instability.	Material Assets, Cultural Heritage and the Landscape
Note: The following references were used to develop the content in 1: (Burton *et al.*, 2024; EDGAR, 2025; European Parliamentary Research Service, 2024; Forster *et al.*, 2025; Historic England, 2026; IPCC, 2019; IPCC, 2021; IPCC, 2022; IPCC, 2023; Jacobson *et al.*, 2023; Lan *et al.*, 2021; Lan *et al.*, 2026; Lindsey, 2025; Met Office, 2026a; Met Office, 2026b; Munich Re, 2026; National Geographic, 2019; NOAA, 2025; OECD, 2025; Ortiz-Bobea *et al.*, 2021; Rodell and Li, 2023; Vicente-Serrano *et al.*, 2022; UNESCO World Heritage Centre, n.d.; WMO, 2025; WMO, 2026; WWF, 2024).		

1.2 FUTURE ESTIMATE OF GHGS AFFECTING CLIMATE OVER THE LIFETIME OF THE JACKDAW PROJECT

1.2.1 GREENHOUSE GAS CONCENTRATIONS

The IPCC Shared Socioeconomic Pathways (SSPs) are a set of alternative socioeconomic future projections designed to support climate change analysis. Their purpose is to provide a consistent framework for exploring how different patterns of societal development influence future GHG emissions and are used in scenario-based projections to compare how different development pathways lead to different climate outcomes and risks (IPCC, 2022).

The projected CO_2 emissions from 2015 to 2100 under five IPCC Shared Socioeconomic Pathways (SSPs) are presented in Figure 4. The projected atmospheric CO_2 concentrations under the different SSP futures are also shown in Figure 4.

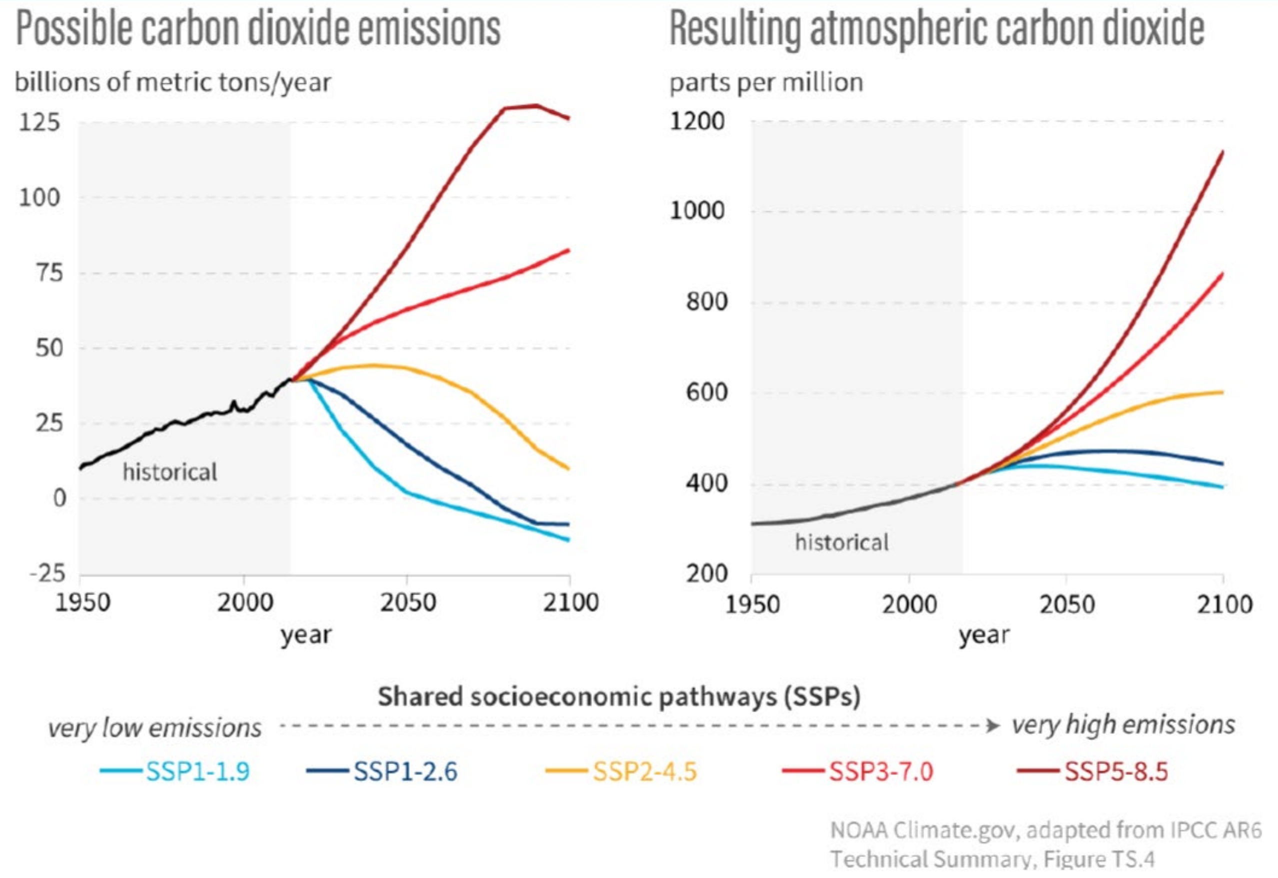


Figure 4: Potential future pathways for annual global CO_2 emissions (left) and the resulting atmospheric CO_2 concentrations through the end of the century (right) (Lindsey, R. 2025).

For the five different SSPs, Figure 4 shows:

- **SSP1-1.9 and SSP1-2.6:** Rapid CO_2 emissions cuts with net zero reached by mid-century. The CO_2 concentrations peak and then stabilise, with a slight decline by 2100. These pathways align with 1.5–2°C long-term warming limits.
- **SSP2-4.5:** CO_2 emissions decline at a slower rate compared to SSP1-1.9 and SSP1-2.6. CO_2 concentrations continue to accumulate in the atmosphere, locking in higher long-term warming.
- **SSP3-7.0 and SSP5-8.5:** CO_2 emissions continue rising with the resulting CO_2 concentrations accelerating upwards. This leads to very high warming which is largely irreversible over century-scale time horizons.

Figure 5 panel (a) presents the projected emissions trajectories for CO_2 and additionally presents the emission pathways from 2015 to 2100 for three key non-CO_2 drivers included in the SSPs: methane (CH_4), nitrous oxide (N_2O) and sulphur dioxide (SO_2). SO_2 is a contributor to cooling aerosols but is not considered further in this assessment. The lower-emissions pathways (SSP1-1.9, SSP1-2.6) project declining emissions of most non-CO_2 gases while the higher-emissions pathways (SP3-7.0, SSP5-8.5) project sustained or increasing emissions for CH_4 and N_2O. SO_2 emissions decline across all scenarios, reflecting improved air-quality controls.

Panel (b) in Figure 5 illustrates the projected contributions to global surface temperature increase from CO_2 and non-CO_2 GHG emissions for the five SSPs in 2081-2100 (relative to the 1850-1900 baseline). In all scenarios, CO_2 is shown as the largest contributor to total warming, with non-CO_2 GHG emissions contributing to additional warming. Net cooling contributions are also presented across all scenarios from other anthropogenic drivers, primarily aerosols and land-use changes, which partially offset GHG-related warming.

1.2.2 ENVIRONMENTAL RECEPTORS

Future predictions of how environmental receptors (such as human health, biodiversity, oceans, the cryosphere etc.) will respond in a warming world are inherently difficult to define with precision. The climate system is complex and influenced by numerous interacting physical, biological, and socio-economic processes operating across different spatial and temporal scales. While the direction of change is often well understood (for example, increasing temperatures, sea-level rise, and changes in precipitation patterns), the magnitude, timing, and regional expression of these changes remain uncertain. These uncertainties arise from limitations in observational records, natural climate variability, differences between climate models, and uncertainty around future human activities and emissions trajectories.

The IPCC has addressed these challenges through a structured and evidence-based assessment process. **Working Group I (WGI)** focuses on the physical science basis of climate change, using observations, paleoclimate records and climate model simulations to project future changes in temperature, precipitation, sea level, cryosphere extent and extreme weather events. These IPCC WG1 projections are not exact predictions of what will happen. Instead, they describe a range of possible future outcomes and include confidence ratings that assess how strong and consistent scientific evidence is.

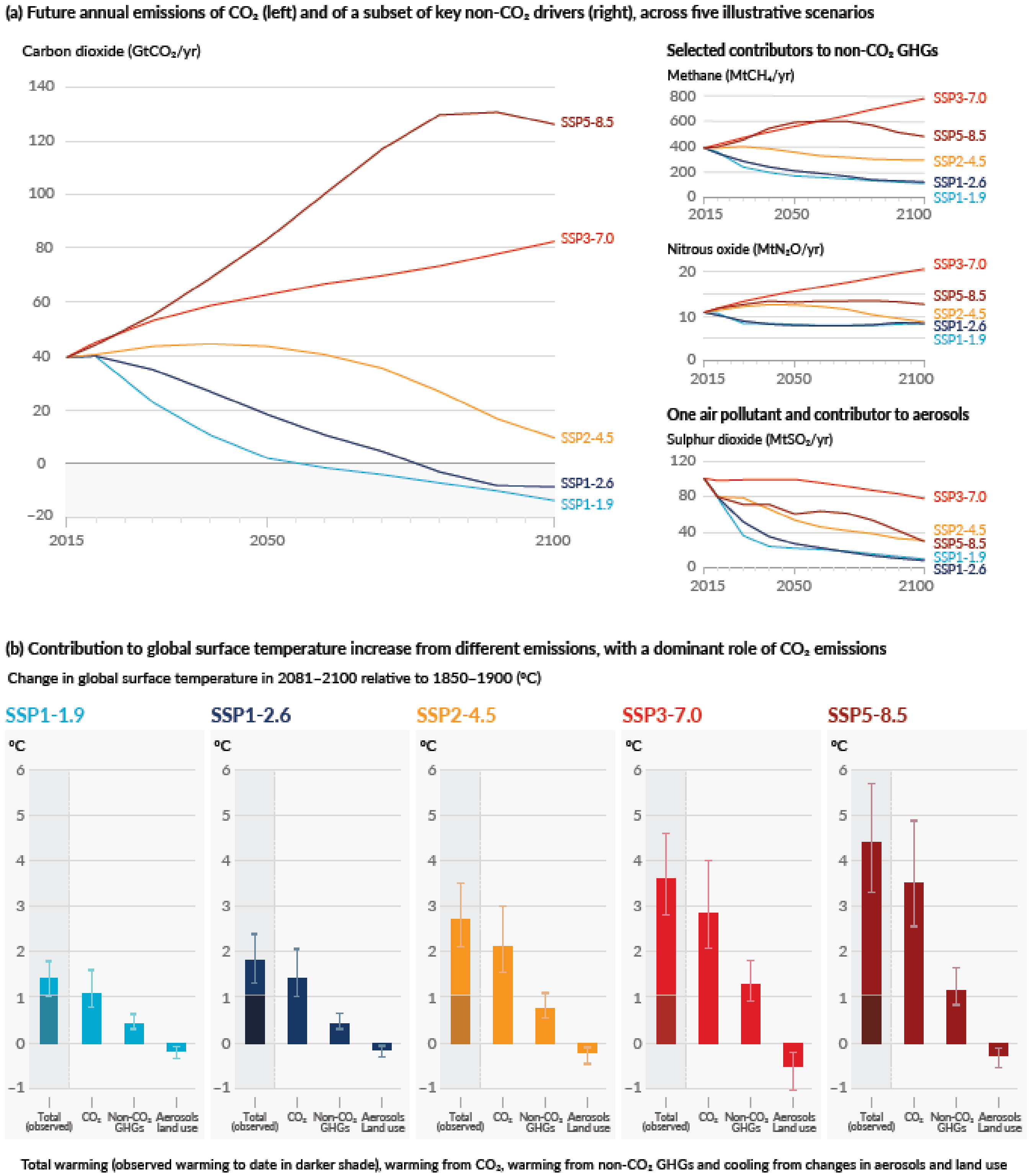


Figure 5: Projected emissions trajectories in panel (a) for CO_2 from all sectors, expressed in gigatonnes of CO_2 per year ($GtCO_2/yr$), shown in the left panel. The right-hand panels show emissions pathways for a subset of three key non-CO_2 climate drivers included in the scenarios: CH_4, in $MtCH_4/yr$, top-right), N_2O, in MtN_2O/yr, middle-right, and SO_2, in $MtSO_2/yr$, bottom-right. The contribution to global surface temperature in 2081-2100 shown in panel (b) across all scenarios (IPCC, 2021).

The IPCC Working Group II (WGII) builds on the WGI climate projections to examine how climate change may affect ecosystems, biodiversity and human communities. It considers how environmental receptors may change at different levels of global warming, recognising that impacts do not increase linearly with temperature and can vary widely depending on local conditions. WGII also highlights that uncertainty increases when moving from climate changes to real-world impacts, because impacts depend not only on the climate itself but also on how exposed and sensitive systems are, how well they can adapt, and how societies develop in the future. For this reason, WGII presents its findings as ranges of risk and confidence, rather than exact predictions.

In combination, the assessments from IPCC Working Groups I and II provide a robust scientific framework for understanding likely future changes while clearly acknowledging uncertainty. This is summarised at a high-level in Table 2, which shows the projected state of the environment under lower-, intermediate- and higher-warming futures across key environmental receptors. Further detail, including underlying assumptions, confidence levels, and region-specific scientific assessments, is available from the IPCC, particularly through the assessments of Working Groups I and II.

1.2.2.1 IPCC SCENARIOS

The projections shown in Table 2 are mainly based on the IPCC's SSPs from the Sixth Assessment Report (AR6). However, where appropriate, projections derived from the IPCC's Representative Concentration Pathways (RCPs), which formed the basis of climate projections in the Fifth Assessment Report (AR5), have been used where SSP-based data for certain key environmental receptors is not available.

RCPs describe trajectories of GHG concentrations and radiative forcing, while SSPs combine socio-economic development pathways with different levels of radiative forcing to explore a broader range of possible future climate outcomes.

Table 2 provides a high-level summary of relevant scientific literature relating to the projected state of the environment under lower-, intermediate- and higher-warming futures across key environmental receptors. More detailed information is provided in APPENDIX 2. Table 2 and APPENDIX 2 have been prepared by Adura by drawing on a range of respected, publicly available scientific sources. Table 2 and APPENDIX 2 summarise and paraphrase information from those sources and do not express the views or opinions of Adura. While efforts have been made to reflect the content of the underlying sources accurately, the summaries necessarily involve simplification and are not intended to constitute an exhaustive description of every aspect of that source. Readers should refer to the original sources for the full analysis.

Table 2: Summary of the projected baseline state of the environment under lower-, intermediate- and higher-warming futures across key environmental receptors and by reference to 2020 EIA Regulations Schedules 6(3) and 6(5).

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
Mean Global Surface Temperature *(Schedule 6(5)(a)(iii))*	- Increase by between 1.0°C to 1.8°C (relative to 1850-1900 baseline) by 2100.	- Increase by between 2.1°C to 3.5°C (relative to 1850-1900 baseline) by 2100.	- Increase by between 3.3°C to 5.7°C (relative to 1850-1900 baseline) by 2100.
Extreme Weather and Climate Events *(Schedule 6(5)(a)(iii))*	- **Hot temperature extremes** are projected to become more frequent, intense, and longer-lasting across most inhabited regions, while cold extremes are projected to become less frequent, even if warming is limited to 1.5°C, with much larger changes at higher warming levels. - **Heavy precipitation:** Under SSP1, increases in the frequency and intensity of heavy precipitation are projected to occur, but these changes are relatively moderate, with present-day one-in-10-year events becoming more frequent (around 1.3–1.5 times) at lower levels of global warming. The frequency of present day one-in-10-year events is projected to increase by around 1.5 times at lower global warming levels.	- **Hot temperature extremes** are projected to at least double in intensity at 2°C, alongside increases in hot days, warm nights, and heatwave duration across most land areas. - **Heavy precipitation:** Increases in the frequency and intensity of heavy precipitation are projected to be more pronounced. The frequency of present-day one-in-10-year events becoming significantly more frequent (around 1.5–1.7 times) as global warming approaches ~2°C. - **Droughts:** Frequency of present day one-in-10-year agricultural and ecological drought events is projected to increase by around 2.4 times.	- **Hot temperature extremes** are projected to quadruple in intensity at 3°C, with widespread increases in hot days, warm nights, and heatwave duration. - **Heavy precipitation:** Heavy precipitation events become more frequent and more intense globally, particularly for rarer events. One-in-10-year and one-in-50-year events are projected to approximately double and triple in frequency, respectively. - **Droughts:** Frequency of present day one-in-10-year agricultural and ecological drought events is projected to increase by around 4.1 times.

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
	- **Droughts:** Frequency of present day one-in-10-year agricultural and ecological drought events is projected to double.		
Sea Level Rise *(Schedule 6(5)(a)(iii))*	- Global mean sea level rise is projected at approximately 2–3 m if warming is limited to 1.5°C over the next 2000 years.	- 2–6 m of sea level rise over the next 2000 years is projected if warming is limited to 2°C.	- Global mean sea level rise is projected to exceed the likely range, reaching nearly 2 metres by 2100 and over 15 m by 2300.
Cryosphere Changes *(Schedule 6(5)(a)(iii))*	- **Ice sheets:** Projected contribution to global mean sea level rise by 2100 will be 0.01–0.10 m (from the Greenland Ice Sheet) and 0.03–0.27 m (from the Antarctic Ice Sheet). - **Glaciers:** Evidence is limited and confidence is low, but projections indicate that with sustained warming of 1.5–2°C, around 50-60% of glacier mass could remain, mostly in the polar regions. - **Permafrost:** For every 1°C increase in Global Average Surface Temperature, the volume of permafrost in the top 3 metres of soil is reduced by about 25% (±5% uncertainty). - **Permafrost:** By 2100, near-surface permafrost area (within 3–4 m depth)	- At sustained warming of 2–3°C, the Greenland and West Antarctic ice sheets are projected to be lost almost completely and irreversibly over multiple millennia. - **Ice sheets:** Projected contribution to global mean sea level rise by 2100 is 0.04–0.13 m (from the Greenland Ice Sheet) and 0.03–0.29 m (from the Antarctic Ice Sheet). - **Glaciers** are projected to lose around 29,000 Gt (9,000-49,000 Gt) which represents around 18% (range of 5-31%) of their early 21st century mass. - **Glaciers:** Around 50–60% of glacier mass outside Antarctica is projected to be lost.	- **Ice sheets:** Projected contribution to global mean sea level rise by is 0.09–0.18 m (from the Greenland Ice Sheet) and 0.03–0.34 m (from the Antarctic Ice Sheet). - **Glaciers** are projected to lose around 58,000 Gt (28,000-88,000 Gt) which represents around 36% (range of 16-56%) of their early 21st century mass. - **Glaciers:** An estimated 60–75% of glacier mass outside Antarctica is projected to disappear. At this level of warming, there is medium confidence that nearly all glacier mass in low latitudes, Central Europe, the Caucasus, western Canada and the United States of America (USA),

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
	is projected to decrease by 24 ± 16%. Lower emissions substantially dampen permafrost-carbon release relative to higher-warming scenarios.	- **Permafrost:** By 2100, near surface permafrost is projected to decline by 15-87%.	North Asia, Scandinavia, and New Zealand will be lost. - **Permafrost:** By 2100, near-surface permafrost area is projected to decline by 69 ± 20%. Thawing permafrost is projected to result in the cumulative release of tens to hundreds of gigatonnes of carbon as CO_2 and methane to the atmosphere by 2100, with the potential to further amplify climate change.
Oceanic Changes *(Schedule 6(5)(a)(iii))*	- **Ocean surface temperature** is projected to increase by around 0.86°C (likely range: 0.43–1.47°C) between 2081–2100. - **Ocean heat content** is projected to increase by around 2–4 times by 2100 (compared to 1971–2018 baseline). - **Marine heatwaves** are projected to become around 4 times more frequent (likely range: 2–9) in 2081–2100 (compared to 1995–2014 baseline). - **Ocean acidification:** It is virtually certain that surface ocean pH will decline by 0.036 to 0.042 pH units by	Specific changes under intermediate-warming futures are not directly detailed within the AR6 report as it is an intermediate scenario. However, the following information can be derived from the IPCC Regional Fact Sheet (IPCC, 2021): - **Ocean surface temperature** is projected to increase further with a likely range of 1.5 to 2.5°C. - **Ocean heat content** is projected to continue to increase throughout the 21st Century.	- **Ocean surface temperature** is projected to increase by around 2.89°C (likely range: 2.01–4.07°C) between 2081–2100. - **Ocean heat content** is projected to increase by around 4–8 times by 2100 (compared to 1971–2018 baseline). - **Marine heatwaves** are projected to become around 8 times more frequent (likely range: 3–15) in 2081–2100 (compared to 1995–2014 baseline). - **Ocean acidification:** It is virtually certain that surface ocean pH will decline by 0.287 to 0.29 pH units by

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
	2081-2100 (relative to 2006-2015 baseline).	- **Marine heatwaves** become more frequent and intense. - **Ocean acidification** continues steadily.	2081-2100 (relative to 2006-2015 baseline). There are elevated risks for aragonite (carbonate mineral) shell-forming species as aragonite-corrosive conditions is likely over about 16–20% of the surface ocean by 2081–2100, mainly affecting the Arctic and Southern Oceans and parts of the northern Pacific and northwestern Atlantic.
Biodiversity ***(Schedule 6(5)(a)(ii))***	- **Terrestrial ecosystems:** An estimated 3–14% of assessed species are projected to face a very high risk of extinction. - **Ocean and coastal ecosystems:** Risks of biodiversity loss range from moderate to very high. - **Biodiversity hotspots:** Very high extinction risk for endemic species is estimated at around 2%.	- **Terrestrial ecosystems:** The proportion of species at very high extinction risk increases to 3–18%. - **Ocean and coastal ecosystems:** Risks of biodiversity loss remain moderate to very high, with more ecosystems at high and very high risk. - **Biodiversity hotspots:** Very high extinction risk for endemic species doubling to at least 4% (relative to 1.5°C).	- A very high extinction risk for endemic species (i.e. species exclusively confined to a single, specific geographic region) in biodiversity hotspots. - Extinction risk is projected to increase at least tenfold as warming rises from 1.5°C to 3°C. - **Terrestrial ecosystems:** The proportion of species at very high extinction risk increases to 3–18%. - **Ocean and coastal ecosystems:** Risks of biodiversity loss increases to high to very high.

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C) Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C) Aligns with: SSP2-4.5 and RCP4.5	Higher-Warming Futures (continued high emissions; >3°C Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
			- **Biodiversity hotspots:** Very high extinction risk for endemic species is 10 times higher than at 1.5°C.
Population and Human Health *(Schedule 6(5)(a)(i))*	- **Climate-sensitive diseases:** - Malaria: Increased distributional range and vectorial capacity of malaria in parts of sub-Saharan Africa, Asia and South America. - Aedes-borne diseases (dengue, Zika, chikungunya, yellow fever): Projected increased global abundance of Aedes mosquito by around 20% by the end of the century. Europe largely avoids widespread exposure increases. - **Food and nutrition insecurity:** Increased frequency, intensity and severity of droughts, floods and heatwaves, together with continued sea-level rise, are projected to increase risks to food security. In vulnerable regions, food security risks increase from moderate to high,	- **Climate-sensitive diseases:** - Malaria: Clear increases in malaria transmission risk in many endemic regions. - Aedes-borne diseases: Around half of global population exposed to transmission risk by 2050, with most of Europe experiencing significant increases in exposure compared to pre-industrial conditions. - **Food and nutrition insecurity:** Food security risks become more severe. Impacts include increased malnutrition and micronutrient deficiencies. Risks are concentrated in Sub-Saharan Africa, South Asia Central and South America, and Small Island states.	- **Climate-sensitive diseases:** - Malaria: Severe and widespread increases in transmission risk. - Aedes-borne diseases: Overall exposure to mosquito-borne disease transmission continues to increase, with *Aedes aegypti* (yellow fever mosquito) abundance projected to increase by around 30% by the end of the century. - **Food and nutrition insecurity:** Compared with warming of 2°C or less, climate-related hazards are projected to affect much larger areas, intensifying regional inequalities in food security and disproportionately impacting vulnerable regions.

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
	assuming no or low levels of adaptation.		
Material Assets *(Schedule 6(5)(a)(iv))*	- **Impacts on energy and industrial water use:** Hydropower and thermoelectric power plants adaptations are projected to be most effective at lower levels of warming. - **Increasing Adaptation Limits:** Beyond 1.5°C of global warming, limited freshwater availability may create hard limits for Small Islands and regions that rely on glacier and snowmelt. - **Productivity loss:** Estimated global GDP reduction of around 0.5% due to climate-related productivity losses. - **Food production loss:** By 2100, less than 8% of current global agricultural areas are projected to become climatically unsuitable.	- **Impacts on energy and industrial water use:** The effectiveness of adaptation measures for hydropower and thermoelectric plants decreases at higher levels of warming. This may be due to reduced water availability for hydropower, lower cooling efficiency from higher river temperatures, and greater disruption from droughts and floods. - **Increasing Adaptation Limits:** Soft adaptation limits are expected to affect major crops in many areas, particularly in tropical regions. - **Flood-related damages** are projected to rise substantially without adaptation, at around 1.4 to 2 times higher at 2°C warming compared to 1.5°C.	- **Increasing Adaptation Limits:** Some water management measures are projected to become less effective across many regions, with certain areas of Europe reaching hard limits to adaptation. - **Flood-related damages** are projected to rise substantially without adaptation, at around 2.5 to 3.9 times higher at 3°C warming compared to 1.5°C. - **Productivity loss:** Estimated global GDP reduction of around 2.4%, relating to greater heat exposure and productivity losses. - **Food production loss:** A substantial share of current crop and livestock areas is projected to become climatically unsuitable. Approximately 10% of current global agricultural areas become unsuitable by 2050 and more than 30% become unsuitable by 2100.

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
Cultural Heritage *(Schedule 6(5)(a)(iv))*	Predicting impacts on cultural heritage is inherently challenging, as heritage assets are highly location-specific, and there is limited consistent data available on their condition and vulnerability. However, key projected risks include: - **Coastal risks:** Sea-level rise and storm-driven coastal erosion threatening archaeological and heritage sites worldwide. Rising sea levels are projected to increase the risk of flooding and erosion, threatening World Heritage sites across regions such as Africa, the Arctic and the Mediterranean. - **Physical damage and loss:** Direct damage to cultural and natural heritage sites from flooding, erosion, and other climate hazards. - **Loss of intangible heritage:** Disruption or loss of traditional cultures, ways of life, and community identities. This may include the loss traditional knowledge systems. - **Arctic impacts:** Increasing permafrost thaw and flooding affecting heritage sites and altering tourism patterns linked to cultural heritage in Arctic regions.		
The Landscape *(Schedule 6(5)(a)(iv))*	- More frequent and severe droughts could transform perennial rivers into intermittent ones and lead to the complete loss of already intermittent rivers (medium evidence, medium agreement). This would put freshwater fish at greater risk in environments that are already prone to heat and drought. - **Loss of scenic value:** Higher temperatures, lower rainfall, and more frequent fires are expected to reduce the scenic quality. Scenario analysis estimates a projected	- **Changes in freshwater ice:** River ice duration is projected to decrease by around 7.3 days between 2009-2029 and 2080-2100.	- **Impacts on water quality and availability:** Wildfire frequency is expected to rise by around 30%. More frequent fires, together with soil erosion linked to deforestation could negatively impact water quality and availability. - **Increased areas of drier landscapes:** In ecosystems that historically experience few fires, a 4°C increase in global temperatures significantly elevates fire risk, potentially leading to greater tree mortality and the transformation of

Receptor (EIA Regulation Schedule 6(5) Topic)	Lower-Warming Futures (rapid emissions reductions; ~1.5–2°C)	Intermediate-Warming Futures (Intermediate Emissions and Warming Pathway; ~2-3°C)	Higher-Warming Futures (continued high emissions; >3°C
	Aligns with: SSP1-1.9 and SSP1-2.6 and RCP2.6	Aligns with: SSP2-4.5 and RCP4.5	Aligns with: SSP3-7.0 and SSP5-8.5 and RCP8.5
	reduction in aesthetic visual experience by 18–28% by 2050.		large areas of the Amazon rainforest into drier landscapes with lower biomass. - **Changes in freshwater ice:** Around 4.6% of ice-covered lakes in the Northern Hemisphere could shift to having only intermittent winter ice. Warmer lakes with less ice lose more water through evaporation. By 2100, annual global lake evaporation is expected to increase by about 16% (compared to a 2006–2015 baseline). As ice melts, more energy goes into evaporation rather than heating the air, further increasing water loss. River ice duration is also projected to decrease, by nearly 17 days between 2009-2029 and 2080-2100.
Note: The following references were used to develop the content in Table 2: IPCC (2019a), IPCC (2019b), IPCC (2021a), IPCC (2021b), IPCC (2022a), IPCC (2022b) and IPCC (2023).			

2 ITEM 2

2. Page 11 – Section 3.1.3 – Future Estimates of Carbon Emissions – This section states 'International organisations have developed scenarios depicting how the climate might evolve in the future. This section describes a range of future climate scenarios (future baseline) which outline the climate's likely evolution without implementation of the Jackdaw project (e.g. the 'do nothing' scenario).' The Intergovernmental Panel on Climate Change (IPCC) modelled scenarios aligned with the Paris agreement i.e. limit warming to 1.5°C, (C1 and C2). Other IPCC scenarios, not aligned with the Paris agreement, are briefly described. The International Energy Agency (IEA) Announced Pledges Scenario (APS) and Net Zero Emissions (NZE) are also described as aligning with the Paris agreement and aligning with the IPCC C1 and C2 scenarios, so have been assumed to be reasonable future estimates of global greenhouse gases (GHGs) affecting climate over the lifetime of the Jackdaw project.

However, use of the IPCC C1 and C2 scenarios in isolation excludes the possibility that the 1.5°C warming target will not be met. In the case of the IEA APS, the model is based on the expected outcome of announced pledges and the assumption that all pledges will be met in full and on time which may or may not happen. This scenario is also predicted to result in warming of 1.7°C which is not aligned with the more ambitious goals of the Paris agreement. In the case of the NZE scenario this is based on a desired outcome i.e. net zero by 2050 and identifies a pathway to meet that scenario.

None of the selected scenarios are predictors of future emissions and therefore it is important to fully consider the assumptions, limitations and uncertainties of any model before considering it as the baseline scenario.

The baseline scenario needs to consider that the baseline will not be static over the lifetime of the project. In line with the Supplementary Guidance and Schedule 6(3), the baseline scenario should include a reasonable future estimate of global GHG emissions affecting the climate over the lifetime of the project, reflecting the expected trajectory of climate conditions and the environment. Your response should consider the baseline scenario for climate and the environment over the lifetime of the project before putting it into the context of the selected pathways e.g. IPCC AR6[1] and the Global Carbon Budget[2].

[1] Intergovernmental Panel on Climate Change (2023) Sixth Assessment report. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf

[2] Global Carbon Budget (2025) https://globalcarbonbudget.org/

Section 3.1.3 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) adopted a precautionary approach by placing Jackdaw's estimated Scope 3 emissions in the context of ambitious trajectories, i.e. aligned with the Paris Agreement. Whilst the International Energy Agency (IEA) Announced Pledges Scenario (APS) is predicted to result in a warming of 1.7°C, its use, along with the IEA Net Zero Emissions (NZE) scenario, spans all the IPCC scenarios limiting warming to 1.5°C in their C1 and C2 categories. This is considered as being consistent with EIA principles as it presents the magnitude of the emissions in the most conservative way because Net Zero pathways have the lowest carbon budget.

However, as stated by OPRED above, the use of the IPCC C1 and C2 scenarios in isolation excludes the possibility that the 1.5°C warming target will not be met. The following text therefore adds to the narrative from Section 3.1.3 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) to identify "*a reasonable future estimate of global GHG emissions affecting the climate over the lifetime of the project, reflecting the expected trajectory of climate conditions and the environment*," (OPRED, 2025).

2.1 IPPC SHARED SOCIOECONOMIC PATHWAYS (SSPS)

The IPCC is an organisation of governments that are members of the United Nations or World Meteorological Organisation (WMO). Its primary objective is to provide governments with climate change related scientific information to develop climate policies. One of the ways it meets this objective is publishing Shared Socioeconomic Pathways (SSPs) which are a set of alternative socioeconomic future projections designed to support climate change analysis. Their purpose is to provide a consistent framework for exploring how different patterns of societal development influence future GHG emissions and are used in scenario-based projections to compare how different development pathways lead to different climate outcomes and risks (IPCC, 2022). The SSPs are a set of five baseline narrative scenarios describing how society might evolve (economics, population, technology, governance), and how this influences emissions, as described below:

- **SSP1-1.9 and SSP1-2.6:** Rapid CO_2 emissions cuts with Net Zero reached by mid-century. The CO_2 concentrations peak and then stabilise, with a slight decline by 2100. These pathways align with 1.5–2°C long-term warming limits.
- **SSP2-4.5:** CO_2 emissions decline at a slower rate compared to SSP1-1.9 and SSP1-2.6. CO_2 concentrations continue to accumulate in the atmosphere, locking in higher long-term warming.
- **SSP3-7.0 and SSP5-8.5:** CO_2 emissions continue rising with the resulting CO_2 concentrations accelerating upwards. This leads to very high warming which is largely irreversible over century-scale time horizons.

In comparison, the IPCC scenario categories (C1–C8) are outcome-based classifications driven by temperature outcomes and mitigation characteristics and are not based on narratives. These two frameworks are explicitly linked because the SSP scenarios (e.g., SSP1-1.9, SSP3-7.0) produce emissions trajectories, and these trajectories result in temperature outcomes which are then classified into categories C1–C8.

Across every SSP assessed, global average surface temperatures are projected to keep rising until at least the middle of this century. Projected global surface temperatures for three periods (2021-2040, 2041-2060 and 2081-2100) are shown in Table 3 along with illustrative mapping of how the SSPs broadly relate to the C1 to C8 categories. However, multiple SSPs can fall into the same category, i.e. have the same temperature outcome, and the C1 to C8 categories include scenarios not covered by the SSP narratives.

The IPCC also has a Current Policies (CurPol) scenario and a Moderate Action (ModAct) scenario which are used to benchmark against the SSPs (IPCC, 2022a). The CurPol scenario represents GHG emissions based on global policies implemented by circa 2020 with no additional strengthening of climate policy and shows GHG emissions continuing to rise or plateau at high levels. The ModAct scenario represents moderate strengthening of global policies, e.g. implementation of NDCs (Paris pledges) and gradual additional action resulting in GHG emissions slowly stabilising but not declining rapidly (IPCC, 2022). CurPol and ModAct are grounded in real-world policy decisions and commitments, rather than being outcome driven. They are included in this assessment because they can be considered as indicative of future warming outcomes if governments take no other action than what is already enacted (CurPol) or broadly follow through on stated intentions (ModAct). In IPCC AR6, emissions pathways from SSPs and the CurPol and ModAct pathways are harmonised to a common 2015 base year to ensure consistency across scenarios (IPCC, 2022).

Table 3: Projected changes in global surface temperature (relative to the 1850-1900 baseline) for selected 20-year periods across the five illustrative emissions scenarios (IPCC, 2021).

IPCC Scenario	Likely Category	Near Term (2021-2040)		Mid Term (2041-2060)		Long Term (2081-2100)	
		Best Estimate (°C)	Very Likely Range (°C)	Best Estimate (°C)	Very Likely Range (°C)	Best Estimate (°C)	Very Likely Range (°C)
SSP1-1.9	C1a	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	C3a	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	C6	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	C7	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	C8	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

The IEA is an intergovernmental organisation that researches and reports on global energy markets, trends, policy recommendations and technologies to help countries meet their energy needs reliably, affordably and sustainably. Although not perfectly aligned due to differing primary objectives, the scenarios outlined by the IEA in the World Energy Outlook (IEA, 2025; IEA, 2024) can be nominally mapped onto specific IPCC SSPs as follows, but recognising that the IEA scenarios are single pathways:

- The Net Zero Emissions (NZE) scenario is a highly ambitious normative scenario, assumes a pathway to Net Zero CO_2 emissions for the global energy system by 2050 and aligns with limiting long-term global warming to approximately 1.5°C above pre-industrial levels, closely corresponding to the SSP1-1.9 scenario.
- The Announced Pledges Scenario (APS) assumes that governments will meet their GHG and Net Zero targets on time and in full but that there will still be residual GHG emissions in 2050 and is associated with around 1.7°C of warming, positioning it between SSP1-1.9 and SSP1-2.6. As part of the Paris Agreement's five-year update cycle, countries were formally required to submit their next round of Nationally Determined Contributions (NDCs) in 2025. However, at the time of publishing the 2025 edition of the World Energy Outlook not all NDCs had been submitted. Since the IEA's APS depends on a complete and current set of national pledges, the IEA excluded the APS from the 2025 edition of its World Energy Outlook.
- Stated Policies Scenario (STEPS) is a policy-driven scenario that includes both enacted and announced measures, showing a world where GHG emissions peak and decline modestly, fossil fuel use stabilises, and warming reaches around 2.5°C. It indicates progress but still falls well short of climate goals and is most comparable with SSP2-4.5.
- Current Policies Scenario (CPS) is a baseline energy pathway that assumes no further policy action beyond what is already implemented. It is a policy-constrained pathway that corresponds to the high-emissions, weak-policy end of the IPCC scenario space, broadly aligning with SSP2 and SSP3 groups of pathways without strong mitigation.

The projection of CO_2 emissions SSPs are presented in Figure 6 along with historical emissions, with the lifetime of the Jackdaw Project shown for context. The IEA projected CO_2 emissions scenarios are also presented in Figure 6 to show that their respective emissions trajectories are between SSP1-1.9 and SSP2-4.5. The IPCC Illustrative Mitigation Pathways (IMPs) CurPol and ModAct are also included in Figure 6 and show that, over the lifetime of the Jackdaw Project, both scenarios are broadly aligned with SSP2-4.5. All of these scenarios are projections which have limitations, assumptions and uncertainties associated with them which have been summarised in APPENDIX 3.

2.2 IDENTIFYING LIKELY FUTURE SSPS

It is appropriate to identify which of the SSPs could be used as a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project. The United Nations Environment Programme (UNEP) is the main environmental body of the United Nations. It plays a central role in global environmental governance by providing science, coordinating international action, and helping countries address environmental challenges. Since 2010, it has provided an annual science-based assessment of the gap between estimated future GHG emissions if countries implement their climate mitigation pledges, and where they should be to avoid the worst impacts of climate change.

In its most recent Emissions Gap Report 2025 (UNEP, 2025), UNEP concludes that global climate action is off-track, with current pledges leading to around 2.3–2.8°C warming and an increasing GHG emissions gap relative to Paris targets. UNEP analysis indicates that limiting warming to 1.5°C by 2100 remains technically possible but that a temporary exceedance of 1.5°C is now highly likely, and avoiding dangerous levels of warming requires large reductions in global GHG emissions of 35–55% by 2035.

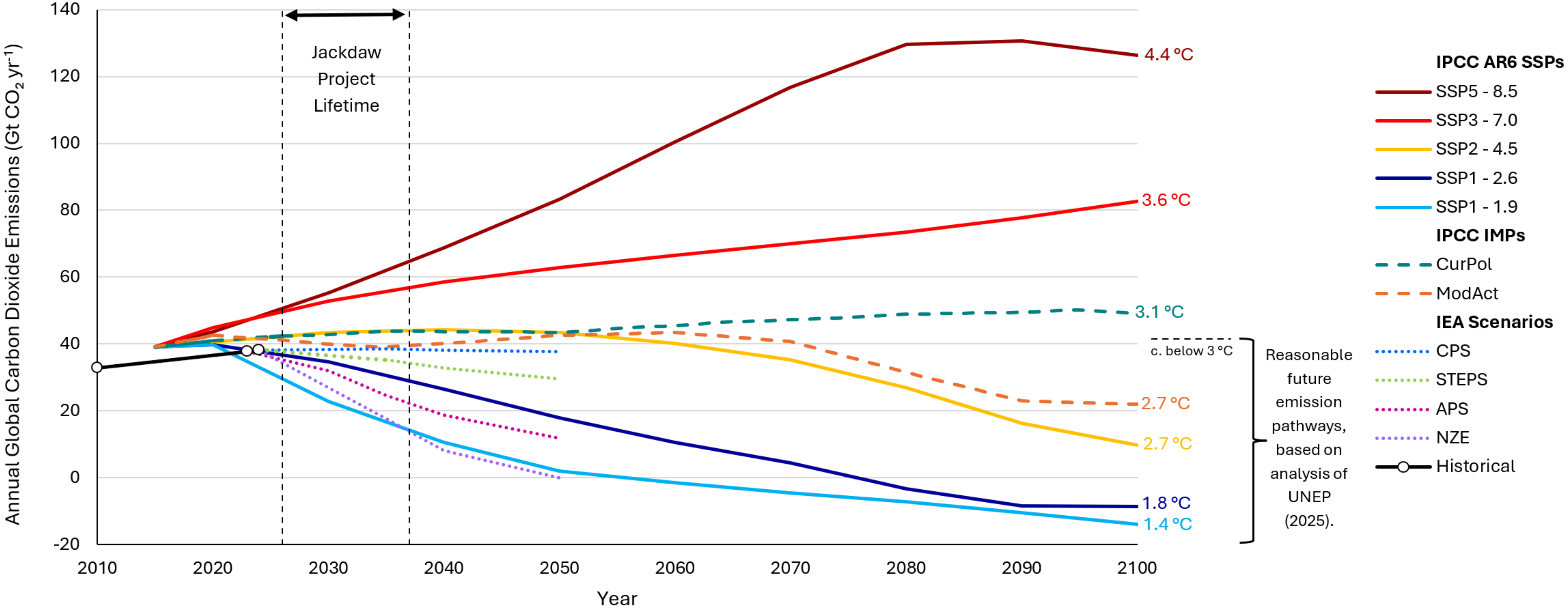


Figure 6: Carbon dioxide emissions of IPCC Pathways and IEA Scenarios, with selected reasonable future emission pathways highlighted (IEA, 2024; IEA, 2025a; IEA, 2025b; Rogelj *et al.*, 2021; IIASA, 2026; UNEP, 2025).

The assessment by UNEP is based on four types of scenarios, as described in Table 4. (UNEP, 2025), that provided the foundation for estimating the emissions gap and the global temperature implications of the emissions gap. It's clear from the UNEP assessment that warming outcomes are dependent on collective actions of the international community and governments. In the Current Policies continuing scenario there is an 80% chance of keeping warming below 3°C over this century. This likelihood increases if unconditional NDCs are fully implemented by 2035 and similar efforts continue. The UNEP Report finds that global warming projections over this century, based on full implementation of NDCs, are now 2.3-2.5°C, while those based on current policies are very likely not to exceed 3°C. It is still technically possible under a Conditional NDCs plus all net-zero pledges scenario that warming would be kept below 1.5°C by the end of the century.

Table 4: Summary of scenarios for emissions gap assessment and global warming projections (UNEP, 2025).

UNEP Scenario	Scenario Description
Current Policies Continuing	This scenario projects global GHG emissions based only on policies adopted and implemented as of November 2024, as well as policy rollbacks in the United States of America as of September 2025.
Unconditional NDCs Continuing	This scenario projects GHG emissions assuming full implementation of the most recent NDCs and announced 2035 pledges that do not depend on explicit external support (cut-off date: 30 September 2025). For the G20 economies and major emitting countries that do not yet have a new NDC or announced pledge, it assumes a current policies scenario. For others, it assumes a continuation of efforts at a similar level of ambition to their 2030 pledge. Default projections include the NDC of the United States of America.
Conditional NDCs continuing	In addition to the unconditional NDCs and announced 2035 pledges, this scenario encompasses the most recent NDC targets for which implementation is contingent on receiving international support, such as finance, technology transfer and/or capacity-building (cut-off date: 30 September 2025). For the G20 economies and major emitting countries that do not have a new NDC or announced pledge, it assumes a current policies scenario, based on policies already adopted and/or implemented. For others, it assumes a continuation of efforts at a similar level of ambition to their 2030 pledge. Default projections include the United States of America's NDC.
Conditional NDCs plus all net-zero pledges	This is the most optimistic scenario included. It assumes the achievement of the Conditional NDC scenario until 2035 and all net-zero or other long-term low emissions development strategies (LT-LEDS) pledges (cut-off date: 30 September 2025) thereafter. The United States of America's former net-zero target is excluded.

Based on the analysis of the UNEP Emissions Gap Report (UNEP, 2025), it is reasonable to conclude that a future estimate of global GHG emissions will be bounded by SSPs that are aligned with keeping temperatures below 3°C. This aligns with IPCC Working Group I conclusions, "*which stated that the most fossil fuel intensive scenario (SSP5-8.5) is unlikely, that SSP5-8.5 and SSP3-7.0 should be considered counter-factual scenarios, and that current policies would lead to approximately stable GHG emissions similar to those in SSP2-4.5*", i.e. temperatures below 3°C (Gillet, 2024). Additionally, the IEA World Energy Outlook (WEO) in 2025 highlight "*that, far from limiting global warming to 1.5°C or well below 2°C, we are* *currently heading towards outcomes in the range of 2.5-3°C"* but confirmed "*there are still pathways that mitigate these risks significantly, while the options to reduce emissions substantially are well understood and, in many cases, cost effective*". Therefore, the SSPs considered to bound a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project are SSP1-1.9 to SSP2-4.5.

SSP1-1.9 to SSP2-4.5 are shown in Figure 7 along with the IEA scenarios and IPCC IMP scenarios CurPol and ModAct. CurPol is included because, over the Jackdaw Project lifetime, it is bounded by SSP2-4.5, which is aligned with keeping temperatures below 3°C. Post 2050 CurPol and SSP2-4.5 deviate, as shown in Figure 6. The likely evolution of climate conditions and the projected state of the environment associated with SSP1-1.9 to SSP2-4.5 i.e. lower- to intermediate-warming futures, are described in Table 2 in the response to Item 1.

Therefore, the likely evolution of climate conditions and hence the projected state of the environment will depend on the actions of the international community as a whole and will likely continue on a similar trajectory with or without the Jackdaw Project. Currently producing facilities and future development projects will meet whatever demand for oil and gas is generated by the framework of policy measures enacted by national governments in relation to emissions control. If these collectively do not lead to emissions reductions in line with scenarios that limit global warming to 1.5°C, for example along the lines of the IEA's CPS scenario, then the evolution of climate conditions will lead to impacts of an intermediate-warming future, e.g. SSP2-4.5. Conversely, if further action is taken globally, for example along the lines of the IEA's NZE scenario, which enables an emissions trajectory that achieves limiting global warming to 1.5°C, then the evolution of climate conditions will lead to impacts of a lower-warming future, e.g. SSP1-1.9.

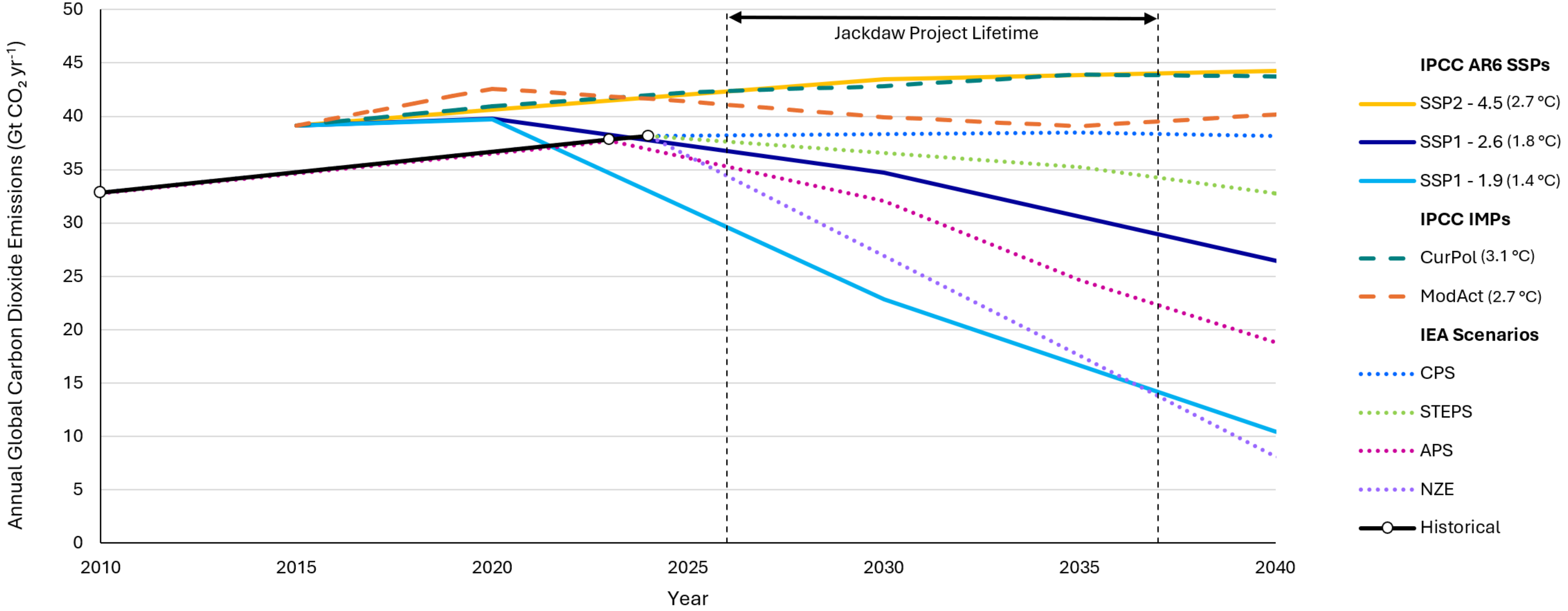


Figure 7: Reasonable future emissions pathways over the project lifetime, with Global Surface Air Temperature (GSAT) in 2100 of IPCC pathways given in the legend (IEA, 2024; IEA, 2025a; IEA, 2025b; Rogelj *et al.*, 2021; IIASA, 2026).

3 ITEM 3

3. Page 13 – Section 3.1.4 – Cumulative Effects – Reference has been made to the IEA Global Energy and Climate Change (GEC) model, and it is stated:

'The GEC projects the level of oil and gas supply and demand for the next two and a half decades which relies on:

- *Standard production profiles and estimates of decline rates at field and country levels derived from IEA detailed field-by-field analysis.*
- *An extensive survey of upstream projects sanctioned, planned and announced over the short term in both Organization of the Petroleum Exporting Countries (OPEC) and non-OPEC countries, including conventional and non-conventional reserves, as performed by the IEA Oil Market Report team; this is used to derive production over the projection period to 2030.'*

However, section 1.1 of the GEC Documentation 2025 states:

'The GEC Model is used to explore multiple scenarios, each of which is built on a different set of underlying assumptions about how the energy system might evolve over time. By comparing them, readers can assess what drives the various outcomes, and the opportunities and pitfalls that lie along the way. These scenarios are not forecasts, and do not contain a single view about what the long-term future might hold. Instead, the scenarios seek to enable readers to compare different possible versions of the future, and the levers and actions that produce them, and to gain insights into the future of global energy.'

Please update your assessment to consider the assumptions and limitations of the selected model to help contextualise and assess the significance of scope 3 emissions from the project.

There is no single dataset that can be used to predict future global GHG emissions associated with existing and planned projects, therefore modelled scenarios and pathways are used to explore future emission projections in assessing the impact of Jackdaw Scope 3 emissions. APPENDIX 3 provides a description of the assumptions and limitations associated with the Intergovernmental Panel on Climate Change (IPCC) Shared Socioeconomic Pathways (SSPs), Current Policies (CurPol) and Moderate Action (ModAct) model scenarios as well as the IEA Global Energy and Climate Change (GEC) model used to derive Current Policies Scenario (CPS), Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and Net Zero Emissions (NZE) model scenarios used in this assessment.

Across all emission pathways considered in the assessment, there are key limitations:

- The pathways represent alternative futures, rather than predictions. Emissions projections are typically based on Integrated Assessment Models (IAMs), which are simplified representations of complex systems;
- IMPs and other similar pathways (e.g. NZE scenario from IEA (2023, 2024) and updated by IEA (2025a)) are normative (i.e. designed to achieve a specified outcome) and/or illustrative rather than predictive. These pathways are designed to demonstrate how temperature or emissions targets can be achieved under defined assumptions, and therefore represent ambitious (yet pragmatic), policy-driven futures;
- The pathways are based on assumptions regarding policy, technology deployment, behaviour change, and economic conditions;
- No specific likelihoods are assigned to individual pathways;

- Emission pathways are not representative of up to date global oil and gas production (historic and forecast); and
- The outcomes vary significantly depending on the extent and timing of global mitigation action.

To address the assumptions and limitations, a range of plausible scenarios is considered, including high-ambition mitigation scenarios (e.g. NZE/IMPs) and less stringent policy environments (e.g. STEPS/CurPol). In Paris-aligned scenarios and pathways, fossil fuel use is more constrained, which provides a more stringent benchmark against which Jackdaw Scope 3 Emissions were assessed. On the other hand, pathways consistent with current policies (e.g. STEPS) are consistent with higher levels of fossil fuel demand and use, but are increasingly misaligned with the goals of the Paris Agreement. The evolution of the baseline takes into account uncertainty across the spectrum of pathways considered, rather than assuming that any one pathway will be realised. While uncertainties remain, the consideration of multiple pathways ensures that the assessment is not dependent on any single set of assumptions and provides a transparent and robust basis for assessing the impact of Jackdaw Scope 3 emissions.

4 ITEM 4

4. Page 14 – Section 4 – Estimating Scope 3 Emissions The methodology used for calculating the scope 3 emissions uses the Emission Factor (EF) for petrol as opposed to diesel which has a higher EF. Please explain why the petrol EF was considered to be the most appropriate.

Method 2 'Life Cycle (Well-To-Tank (WTT + End Use)' assumed that the Jackdaw Project's life cycle Scope 3 emissions arising from natural gas liquids (NGLs) and condensate products would be refined into petrol (100% mineral blend) and subsequently combusted in vehicles. We note the observation that diesel carries a higher end-use emission factor (EF) than petrol on a per-tonne-of-fuel basis. However, when the well-to-tank (WTT) emissions are considered (i.e. the emissions attributed to getting a product to its end users), petrol has a marginally higher overall EF. The petrol EF was therefore deemed more conservative than the diesel EF, as indicated in Table 5, based on 100% mineral blend fuels (DESNZ, 2025).

Table 5: UK GHG Reporting Fuel EFs (100% Mineral Blend) (DESNZ, 2025)

Emissions Factor Component	Petrol (tCO_2e/t)	Diesel (tCO_2e/t)
End Use	3.154082	3.203911
Well-To-Tank	0.815935	0.752028
TOTAL	**3.970017**	**3.955939**

By way of demonstrating that NGLs and condensate refined into petrol is a more conservative assumption than being refined into diesel, the Method 2 calculation has been repeated using the EFs for petrol and diesel. The results are shown in Table 6. Scope 1 emissions have been deducted from the totals to be consistent with how the emissions are presented in the Part 1 Jackdaw Scope 3 Emissions Assessment November 2025 (Shell, 2025). Table 6 shows that the total Scope 3 emissions from assuming NGLs and condensate are refined to petrol is marginally higher than assuming the NGLs and condensate are refined into diesel.

Table 6: Jackdaw Scope 3 Sensitivity for Use of Sold Products

Jackdaw Production (LoF toe)	NGL + Condensate	
	3,856,163	
Scenario	Option 1: Petrol	Option 2: Diesel
End Use Emissions (tCO_2e)	12,162,655	12,354,805
Well-To-Tank Emissions (tCO_2e)	3,146,379	2,899,941
Total (WTT + End Use) (tCO_2e)	**15,309,034**	**15,254,746**

5 ITEM 5

> 5. Pages 19 to 29 – Section 5 – Evaluating Significance of the Likely Effects – While it is acknowledged that the Supplementary Guidance requires an assessment of the significance of the likely effects of scope 3 emissions, the assessment presented in this section does not expressly address all the matters laid down in Schedule 6(4)(f) and 6(5) of the EIA Regulations:
>
> "4. An assessment of the likely significant effects of the project on the environment, including those resulting from—
>
> …
>
> *(f) the impact of the project on climate …"*
>
> *"5. The assessment under paragraph 4 must—*
>
> *(a) cover the likely significant effects on—*
>
> *(i) population and human health;*
>
> *(ii) biodiversity, with particular attention to species and habitats protected under any law of any part of the United Kingdom that implemented Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC on the conservation of wild birds;*
>
> *(iii) land, soil, water, air and climate;*
>
> *(iv) material assets, cultural heritage and the landscape;*
>
> *(v) the interaction between the factors referred to in paragraphs (i) to (iv);*
>
> *(b) cover the direct effects and any indirect, secondary, cumulative, short term, medium-term and long-term, permanent and temporary, positive and negative effects of the project, including any effects on the environment in other countries;…."*
>
> The effects of climate change are well documented (e.g. IPCC, 2023, WMO, 2024)[3]. Your response should ensure that the assessment of likely significant effects is in line with the requirements of the EIA Regulations as relevant. This assessment should be undertaken against the baseline scenario for the environment and climate and its likely evolution over the lifetime of the project.
>
> [3] World Meteorological Organization (2024) State of the Global Climate 2024. https://wmo.int/publication series/state-of-global-climate-2024

Please refer to the response to Item 2 for an assessment of the baseline scenario for the environment and climate and its likely evolution over the lifetime of the Jackdaw Project. The response to Item 2 concludes that the SSPs that are considered to be a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project are SSP1-1.9 to SSP2-4.5. The expected trajectory of climate conditions and the projected state of the environment associated with SSP1-1.9 to SSP2-4.5 are described in Table 2 in the response to Item 1. Further information on the likely significant effects is detailed in the response to Item 10.

6 ITEM 6

> 6. Page 19 – Section 5.3.1.1 – [Evaluation of Magnitude] Global Future Estimates of Carbon Emissions – This section presents the IEA APS and NZE scenarios as reasonable estimates of future global GHG emissions and states that the project scope 3 emissions represent a very small proportion of the projected global emissions in 2030 and 2035 and concludes that Jackdaw scope 3 emissions are not considered to have a likely significant effect on the ability to meet global Paris Agreement-aligned emissions pathways that limit warming to 1.5°C.
>
> i. As per point 2 in this letter, the IPCC C1 and C2 scenarios in isolation and the IEA scenarios do not have a likelihood attached but the assessment of significance relies on these pathways as reasonable future estimates of global GHGs affecting climate over the lifetime of the project.
>
> ii. Characterising the emissions from the project solely in numeric terms against global GHG emissions does not provide a meaningful expression of the global effect of those scope 3 emissions because of the obvious difference in scale between the project and global emissions levels. Adura has noted this within section 5.3.2 which states 'The UK's share of global CO_2 emissions has fallen from 2.3% since 1990 and now accounts for 1%. Therefore, comparing any UK project in isolation to global CO_2 emissions will always result in the individual project being a small proportion of those emissions.'
>
> As set out in the Supplementary Guidance, an assessment of scope 3 emissions in relation to the current state of climate and global emissions reduction pathways (IPCC, 2023) is more likely to support a reasoned conclusion on significance. Please update your assessment, as appropriate, in line with the Supplementary Guidance.

Section 5.1 of Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025), defines how "likelihood" is used in the evaluation of significance, i.e. the impact on the climate is considered "likely" as GHG emissions from any project will contribute to climate change. IPCC Categories, SSPs, and IMPs and the IEA Scenarios do not have a likelihood attached to them. Furthermore, no probabilities are assigned to pathways because they are scenario-based and exploratory (not predictive) and Net Zero policies and Paris-aligned pathways are policy-relevant benchmarks to test consistency with internationally agreed climate objectives (and are not a prediction of future outcomes). Given the range of uncertainties associated with any single pathway (see response to Item 3), the assessment considers a range of plausible futures to contextualise the Scope 3 emissions from the Jackdaw Project.

Section 5.3.1 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) adopted a precautionary approach by placing Jackdaw's estimated Scope 3 emissions in the context of ambitious trajectories, i.e. aligned with the Paris Agreement. Whilst the IEA APS is projected to result in warming of 1.7°C, its use, along with the IEA NZE scenario, spans the IPCC scenarios limiting warming to 1.5°C in their C1 and C2 categories. This is considered as being consistent with EIA principles as it presents the magnitude of the emissions in the most conservative way because Net Zero pathways have the lowest carbon budget.

Section 3.1.4 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) describes the approach to cumulative effects, where Jackdaw Scope 3 emissions were assessed as a proportion of the production emissions included in the IEA NZE and APS scenarios.

However, as stated by OPRED above, the use of the IPCC C1 and C2 scenarios in isolation excludes the possibility that the 1.5°C warming target will not be met. The response to Item 2 expands the narrative from Section 3.1.1 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) to place Jackdaw emissions in the context of the current state of climate and global GHG emissions reduction pathways.

This expanded narrative concludes that SSP1-1.9 to SSP2-4.5 are considered to be a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project. As shown in Figure 7, the IEA scenarios and IPCC CurPol and ModAct scenarios fall within the SSP1-1.9 to SSP2-4.5 range during the Jackdaw Project lifetime. CurPol and ModAct are grounded in real-world policy decisions and commitments, rather than being outcome driven. They are included in this assessment because they can be considered as indicative of future warming outcomes if governments take no other action than what is already enacted (CurPol) or broadly follow through on stated intentions (ModAct).

The following text therefore provides additional narrative to Section 3.1.4 and 5.3.1 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) and places Jackdaw emissions in the context of a cumulative assessment of Scope 3 emissions in relation to the current state of climate and global emissions-reduction pathways. Significance is addressed in the response to Item 10.

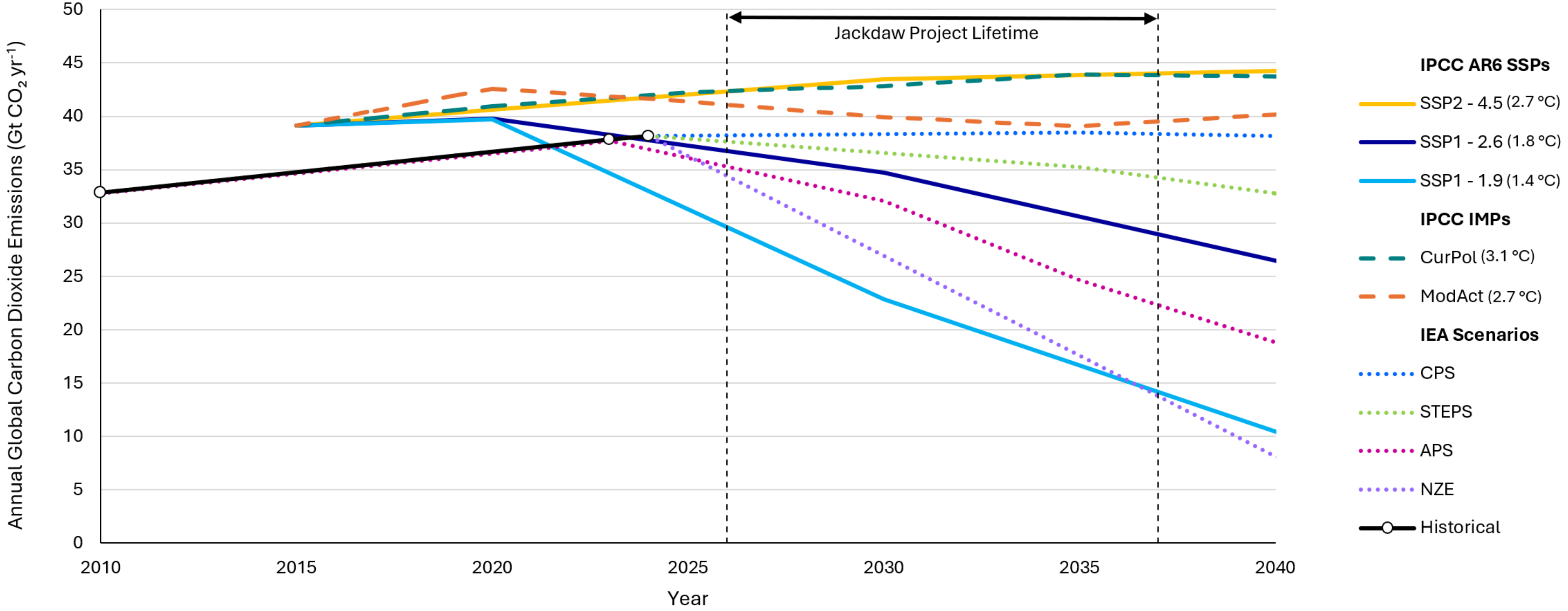


Figure 7: Reasonable future emissions pathways over the project lifetime, with Global Surface Air Temperature (GSAT) in 2100 of IPCC pathways given in the legend (IEA, 2024; IEA, 2025a; IEA, 2025b; Rogelj *et al.*, 2021; IIASA, 2026).

6.1 ADDITIONAL INFORMATION FOR SECTION 3.1.4 AND 5.3.1

Schedule 6(5) of the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (the “Regulations”) requires that an ES consider the cumulative effects of the proposed project and other existing or approved projects. Although the Regulations set the legal requirement to consider cumulative effects, they do not specify the approach that should be undertaken.

There is no single standardised approach for cumulative effects assessments and there are a number of ways such an assessment could acceptably be undertaken. The Planning Inspectorate (PINS) (2025) advice on cumulative effects assessment is generally regarded as the best available guidance for undertaking a systematic and repeatable assessment (as identified in IEMA, 2020).

There is no correlation between where GHG emissions occur and where the effect of rising concentration of atmospheric emissions occurs, i.e. the area that is impacted by the release of Scope 3 emissions is not restricted to the Jackdaw Project location and immediate surrounding area. GHG emissions occupy a unique space for assessing cumulative effects. There is no meaningful “Zone of Influence” or spatial boundary for the identification of existing and/or approved projects and no defensible basis for selecting specific projects as every activity that results in GHGs is relevant. This is reflected in ISEP guidance (ISEP, 2026) which states:

- *“The atmospheric concentration of GHGs and resulting effect on climate change is affected by all sources and sinks globally, anthropogenic and otherwise. As GHG emission impacts and resulting effects are global rather than affecting one localised area, the approach to cumulative effects assessment for GHGs differs from that for many EIA topics where only projects within a geographically bounded study area of, for example, 10 km would be included.”*
- *“All global cumulative GHG sources are relevant to the effect on climate change, and this should be taken into account in defining the receptor (the atmospheric concentration of GHGs) as being of ‘high’ sensitivity to further emissions.”*
- *“Effects of GHG emissions from specific cumulative projects therefore in general should not be individually assessed, as there is no basis for selecting any particular (or more than one) cumulative project that has GHG emissions for assessment over any other.”*

There is no scientifically robust or non-arbitrary basis for selecting a discrete subset of individual projects for separate cumulative assessment with respect to GHGs, so contextualisation using emissions reduction pathways represents an appropriate and inherently cumulative assessment approach. Pathways, such as SSP1-1.9, SSP 1-2.6, etc., incorporate assumptions relating to existing, approved and future emissions sources, thereby providing a scientifically grounded means of assessing cumulative impact without requiring an exhaustive or selective project list.

The Supplementary Guidance further states that “*an assessment of scope 3 emissions in relation to the current state of climate and global emission-reduction pathways is more likely to support a reasoned conclusion on significance*” and that if “*global reduction pathways are used to contextualise magnitude of emissions as above, this approach should be inherently cumulative as these pathways take into account a wide range of existing and planned projects and other activities*”.

The SSPs consider a wide range of GHG sources from both natural and anthropogenic activities. They also consider the net impact of atmospheric emissions attributed to sources and sinks and hence are inherently cumulative. Therefore, the cumulative effects of the Scope 3 emissions from the Jackdaw Project have been considered within the context of the SSPs.

To address the assumptions and limitations that are inherent in pathways and scenarios, a range of plausible scenarios is considered, including high-ambition mitigation scenarios (e.g. NZE/IMPs) and less stringent policy environments (e.g. STEPS/CurPol). Assumptions and limitations are described in APPENDIX 3.

In Paris-aligned scenarios and pathways, fossil fuel use is more constrained, which provides a more stringent benchmark against which Jackdaw Scope 3 Emissions were assessed. On the other hand, pathways consistent with current policies (e.g. STEPS) are consistent with higher levels of fossil fuel demand and use, but are increasingly misaligned with the goals of the Paris Agreement. The evolution of the baseline takes into account uncertainty across the spectrum of pathways considered, rather than assuming that any one pathway will be realised. While uncertainties remain, the consideration of multiple pathways ensures that the assessment is not dependent on any single set of assumptions and provides a transparent and robust basis for assessing the impact of Jackdaw Scope 3 emissions.

SSP1-1.9 to SSP2-4.5 are considered to be a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project. As shown in Figure 7, the IEA scenarios and IPCC Illustrative Migration Pathways (IMPs) Current Policies (CurPol) and Moderate Action (ModAct) fall within the SSP1-1.9 to SSP2-4.5 during the Jackdaw Project lifetime. CurPol and ModAct follow a trajectory similar to SSP2-4.5 over the lifetime of the Jackdaw Project. Post-2050, however, the IMPs start to deviate from the SSP2-4.5 trajectory, with CurPol projected to exceed 3°C of warming by 2100. All these pathways and scenarios are projections which have limitations, assumptions and uncertainties associated with them. These have been summarised in APPENDIX 3. Table 7 presents the estimated Jackdaw Scope 3 emissions against those pathways and scenarios that are considered to be a reasonable future estimate of global GHG emissions.

Table 7: Jackdaw in the context of Future Global IPCC Shared Socioeconomic Pathways and IEA Scenarios [A1.1] (IPCC, 2022; IEA, 2024; IEA, 2025).

Temperature Increase by 2100	Emissions Pathway	Parameter	Reference Year				Key Assumptions	
			2030	2035	2040	2050	Energy and Emissions	Socioeconomic and Policy
Limit warming to 1.5°C **Likelihood >50%**	IPCC SSP1-1.9	Median Global GHG Emissions ($GtCO_2e/yr$)	33	No data	18	8	Very low emissions and high mitigation efforts including high levels of electrification and rapid shifts to using renewable energies. Energy demand stabilises and net zero reached circa 2050.	Low population growth, high income, and reduced inequalities, food produced in low GHG emission systems, effective land use regulation and high adaptive capacity.
		Jackdaw Projected Proportion	0.0149%	-	N/A	N/A		
Warming consistent with 1.5°C	IEA Net Zero Emissions Scenario (NZE)*	Annual Global Emissions ($GtCO_2/yr$)	25.1	17.6	8.137	No data	Net zero reached by 2050. Rapid decarbonisation but uneven trajectory of policy and technology deployment. Overshoot scenario where warming peaks above 1.6°C and exceeds 1.5°C for several decades before returning below 1.5°C by 2100.	
		Jackdaw Projected Proportion	0.0196%	0.0075%	N/A	N/A		
Warming consistent with 1.7°C	IEA Announced Pledges Scenario (APS)**	Annual Global Emissions ($GtCO_2/yr$)	32.1	24.7	18.82	11.711	All climate commitments made by governments and industries around the world as of the end of August 2024, including NDCs and longer-term net zero targets, as well as targets for access to electricity and clean cooking, will be met in full and on time.	
		Jackdaw Projected Proportion	0.0154%	0.0054%	N/A	N/A		
	IPCC	Median Global GHG	40	No data	29	20		

Temperature Increase by 2100	Emissions Pathway	Parameter	Reference Year				Key Assumptions	
			2030	2035	2040	2050	Energy and Emissions	Socioeconomic and Policy
Limit warming to 2°C **Likelihood >67%**	SSP1-2.6	Emissions ($GtCO_2e$/yr)					Low emissions and high mitigation efforts. Energy demand stabilises and net zero reached circa 2070.	Low population growth, high income, and reduced inequalities, food produced in low GHG emission systems, effective land use regulation and high adaptive capacity.
		Jackdaw Projected Proportion	0.0123%	-	N/A	N/A		
Warming consistent with 2.5°C	IEA Stated Policies Scenario (STEPS)***	Annual Global Emissions ($GtCO_2$/yr)	36.2	35.2	32.764	29.629	Current policies and regulations remain in place and formally tabled policies are implemented. Existing policies extend into future but not all targets are met. Slightly more rapid introduction of decarbonisation technologies than CPS. Prediction of which ambitious targets are met based on analysis of markets / finances / infrastructure.	
		Jackdaw Projected Proportion	0.0136%	0.0038%	N/A	N/A		
Warming consistent with 2.9°C	IEA Current Policies Scenario (CPS)	Annual Global Emissions ($GtCO_2$/yr)	No data	38.5	38.126	37.779	Current policies and regulations remain in place, with cautious assumptions on implementation of decarbonisation technologies. Aspirational goals e.g. NDCs, are not assumed to be achieved.	
		Jackdaw Projected Proportion	-	0.0034%	N/A	N/A		
	IPCC	Median Global GHG	54.0	No data	53	52		

Temperature Increase by 2100	Emissions Pathway	Parameter	Reference Year				Key Assumptions	
			2030	2035	2040	2050	Energy and Emissions	Socioeconomic and Policy
Limit warming to 3°C **Likelihood >50%**	SSP 2-4.5 (Moderate Action)****	Emissions ($GtCO_2e/yr$)					Intermediate emissions with moderate mitigation efforts and rapid growth of energy demand. Rapid growth of consumption-based emissions rise up to 2050. No net-zero, temperature doesn't peak by 2100.	Continued GDP and world population growth. Increase in land-use for agriculture.
		Jackdaw Projected Proportion	0.0091%	-	N/A	N/A		
Limit warming to **4°C**	IPCC 3-7.0 (CurPol) ****	Median Global GHG Emissions ($GtCO_2e/yr$)	62.0	No data	67	70	Low mitigation efforts and high emissions, particularly of short-lived climate forcers. No net-zero, temperature doesn't peak by 2100.	Continued GDP and world population growth. Increase in land-use for agriculture.
		Jackdaw Projected Proportion	0.0079%	-	N/A	N/A		

Note: *** 2030 values taken from IEA, 2024 and other years taken from IEA,2025.
*** All values from IEA, 2024.*
**** All values taken from IEA,2025 except 2030 which is taken from IEA, 2024.*
***** IPCC links WGIII Illustrative Pathways Moderate Action and Curpol to WGI SSPs SSP2 -4.5 and SSP3-7.0 respectively. Moderate Action and Current Policies pathways are also linked to the climate categories C6 and C7. However, both ModAct and CurPol are defined as potential overshoot scenarios, meaning that temperature stabilisation may not be achieved.*
"no data" represents entries for which data has not been published. The IPCC has not published data for the Median Global GHG Emissions ($GtCO_2e/yr$) of SSPs in 2035. Similarly, the IEA has not published data for the Annual Global Emissions ($GtCO_2/yr$) of the NZE scenario in 2050.
"N/A" represents data entries for which the reference year is beyond the Jackdaw anticipated cessation of production in 2037.

7 ITEM 7

7. Page 20 – Section 5.3.1.2 – Global Cumulative Assessment – Similar to section 5.3.1.1, this section sets the project emissions against IEA APS and NZE for world oil and gas scenarios and states that the project scope 3 emissions represent a very small proportion of the projected oil and gas combustion global emissions in 2030 and 2035. Adura has concluded from this that Jackdaw scope 3 emissions are not considered to have a likely significant effect on the ability to meet global Paris Agreement-aligned emissions pathways that limit warming to 1.5°C. i. As per point 5 in this letter, the IEA scenarios do not have a likelihood attached but the assessment of significance relies on these pathways as reasonable future estimates of global GHGs affecting climate over the lifetime of the project. ii. Characterising the project emissions from the project solely in numeric terms against global GHG emissions does not provide a meaningful expression of the global effect of those scope 3 emissions because of the obvious difference in scale between the project and global emissions levels. iii. It is unclear how Jackdaw emissions are considered to be cumulative and in the context of the scenarios presented. In Section 3.1.3 it is stated that Jackdaw emissions are not included in these scenarios i.e. a ‘do nothing’ (no project) scenario. As set out in the Supplementary Guidance, a cumulative assessment of scope 3 emissions in relation to the current state of climate and global emissions-reduction pathways (IPCC, 2023) is more likely to support a reasoned conclusion on significance. The cumulative assessment should consider the emissions from existing and approved projects over the life of the field.

Section 5.1 of Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025), defines how “likelihood” is used in the evaluation of significance, i.e. the impact on the climate is considered “likely” as GHG emissions from any project will contribute to climate change. IPCC Categories, SSPs, and IMPs and the IEA Scenarios do not have a likelihood attached to them. Furthermore, no probabilities are assigned to pathways because they are scenario-based and exploratory (not predictive) and Net Zero policies and Paris-aligned pathways are policy-relevant benchmarks to test consistency with internationally agreed climate objectives (and are not a prediction of future outcomes). Given the range of uncertainties associated with any single pathway (see response to Item 3), the assessment considers a range of plausible futures to contextualise the Scope 3 emissions from the Jackdaw Project.

Please refer to the response to Item 6 for additional information on the cumulative assessment of the Jackdaw Project’s Scope 3 emissions considering emissions from existing and approved projects over the life of the field. Significance is addressed in the response to Item 10.

8 ITEM 8

8. Pages 21 to 23 – Section 5.3.2.1 - National Future Estimates of Carbon Emissions –Table 5-3 presents the project emissions against UK Nationally Determined Contributions (NDCs) for 2030 and 2035 as well as the fourth, fifth and sixth carbon budget periods. Adura has concluded that Jackdaw scope 3 emissions represent a very small proportion of UK carbon budget emissions and are not considered to have a likely significant effect on the UK's ability to meet its NDCs and carbon budgets or global Paris Agreement-aligned emissions pathways that limit warming to 1.5°C. However, presenting the emissions from a single project against UK national targets does not provide a meaningful insight into cumulative effects of other projects. Your response should consider the assessment of project emissions against current and projected global emissions.

Please refer to the response to Item 6 for additional information to address the assessment of the Jackdaw Project's Scope 3 emissions against current and projected global emissions.

Please refer to the response to Item 10 for additional information on why assessing the Jackdaw Project's Scope 3 emissions against UK carbon budgets is considered relevant.

9 ITEM 9

9. Pages 24 to 26 – Section 5.4.1 – [Evaluation of Significance] Methodology – The further information cites the Institute of Environmental Management (IEMA), now The Institute of Sustainability and Environmental Professionals (ISEP), 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' guidance.

It is stated that the IEMA approach, combined with the project's (assumed to be receptors) sensitivity [high] and magnitude assessment have been used in a significance matrix (Table 5-6) to assess the likely significant effect of the Jackdaw scope 3 emissions.

Section 4 of the 2022 Jackdaw ES included an impact assessment methodology with matrices, and this methodology was used to assess the likely significant effects of the project scope 1 emissions on climate change. The rationale for developing a new methodology for assessing the likely significant effects of scope 3 emissions has not been explained. Please clarify.

The Environmental Impact Assessment (EIA) methodology and matrices described in Section 4 of the 2022 Jackdaw Environmental Statement (ES) (Shell, 2022) followed industry best practice at the time of submission. This methodology assessed Scope 1 emissions by comparing them with UK metrics.

The Supplementary Guidance (OPRED, 2025) states "*OPRED expects that ESs will consider how the GHG emissions associated with a proposed project impact climate at a global level and a national level.*" and *"[a] key goal of EIA is to inform the decision maker about the relative severity of environmental effects such that they can be weighed in a planning balance. Therefore, it is essential to provide context for the magnitude of GHG emissions reported in the EIA in a way that aids evaluation of these effects by the decision maker."* (IEMA, 2022).

This guidance led to a re-evaluation of the impact assessment methodology and matrices for Jackdaw to incorporate indirect global effects of Scope 3 emissions. The ISEP (formerly IEMA) guide to Assessing Greenhouse Gas Emissions and Evaluating Their Significance (ISEP, 2026) were cited by the Supplementary Guidance as providing six step assessment principles that a developer may wish to follow when assessing emissions. The ISEP guide also provides contextual information and significance definitions for assessing the significance of GHGs. These definitions were considered to provide robust significance criteria whilst also providing context for the magnitude of Scope 3 emissions to aid evaluation by decision makers.

These ISEP definitions do not readily align with the impact assessment methodology described in Section 4 of the 2022 ES. Following the re-evaluation, a new methodology was developed to align with the Supplementary Guidance to assess the likely significant effects of Scope 3 emissions. Further information on the significance assessment methodology is detailed in Item 10.

10 ITEM 10

> 10. Pages 26 and 27 – Section 5.4.2.1 – [Significance Assessment of Jackdaw emissions] Global Future Estimates of Carbon Emissions – The assessment against global future estimates of carbon emissions refers back to the IEA APS and NZE scenarios and states that the project emissions are very small proportions of these scenarios and the emissions are not considered to have a likely significant effect on the ability of states to meet global Paris-aligned emission pathways that limit warming to 1.5°C. The effects of the project scope 3 emissions have therefore been concluded to be 'Minor adverse' and therefore not significant in line with the matrix set out at Table 5-6. 'Minor adverse' is described as 'GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve a trajectory towards net zero.'. As previously stated, the IEA scenarios do not have a likelihood attached but the assessment of significance relies on these pathways as reasonable future estimates of global GHGs affecting climate over the lifetime of the project (and the APS scenario is not aligned with a 1.5°C pathway). Furthermore, characterising the emissions from the project solely in numeric terms against global GHG emissions does not provide a meaningful expression of the global effect of those scope 3 emissions.
>
> It is unclear how the project is considered to be fully in line with measures necessary to achieve a trajectory towards net zero and therefore how the project scope 3 emissions are aligned with the 'Minor adverse' significance criteria. Please clarify.

Section 5.1 of Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025), defines how "likelihood" is used in the evaluation of significance, i.e. the impact on the climate is considered "likely" as GHG emissions from any project will contribute to climate change. IPCC Categories, SSPs, IMPs and the IEA Scenarios do not have a likelihood attached to them. Furthermore, no probabilities are assigned to pathways because they are scenario-based and exploratory (not predictive) and Net Zero policies and Paris-aligned pathways are policy-relevant benchmarks to test consistency with internationally agreed climate objectives (and are not a prediction of future outcomes). Given the range of uncertainties associated with any single pathway (see response to Item 3), this assessment considers a range of plausible futures to contextualise the Scope 3 emissions from the Jackdaw Project.

The context in which a project's GHG emissions is assessed determines whether it supports or undermines a trajectory towards Net Zero. In Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) the context was presented in terms of National Carbon Budgets (Section 5.3.2), Environmental Protection Objectives (EPOs) (Section 3.1.2), and comparison against industry benchmarks, i.e. GHG intensity (Section 5.4.2.3). The conclusion that the effects of the project would be minor adverse was reached because oil and gas production in the UK is a well-regulated industry, with targets and commitments that are aligned with the expectations of the Paris Agreement. Further, the UK has published binding reduction commitments that are Paris-aligned and include, as part of its reduction commitments, the demand for hydrocarbon products out to 2050. The following text adds to the narrative from Section 5.4.2.1 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) to demonstrate that the estimated Jackdaw Scope 3 emissions are consistent with applicable existing and emerging policy requirements and good practice for projects of this type, and hence support the conclusion that the effects of the project are 'Minor adverse'.

10.1 ADDITIONAL INFORMATION FOR SECTION 5.4.2.1

"*Every fraction of a degree of global warming matters. Each additional 0.1°C of global warming is associated with an escalation of damage, losses and adverse health impacts that are already being experienced at current levels of global warming"* (UNEP, 2025). The significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or negligible (ISEP, 2026).

The crux of significance is whether a project contributes to reducing GHG emissions relative to a baseline consistent with a trajectory towards Net Zero by 2050. An EIA must therefore give proportionate consideration to whether and how a project will contribute to or undermine the achievement of Paris-aligned targets (ISEP, 2026).

ISEP provides examples of the types of contextual information against which a project can be evaluated to determine if the project is contributing to or undermining achieving Paris-aligned targets. Those that are applicable to the Jackdaw Project are shown in Table 8.

Table 8: Contextual information used to determine significance.

Context from ISEP (ISEP, 2026)	Applicability to Jackdaw	Outcome
National or devolved administration carbon budget and NDCs	**YES**: As most of the Jackdaw products are likely to be consumed in the UK, e.g. gas in power stations generating electricity or providing heat to homes or fuel consumed whilst driving cars, the emissions are directly related to the UK carbon budget and NDCs.	The UK has a carbon budget that is aligned to the Paris Agreement and is legally binding. Hydrocarbon use is included in the carbon budget out to 2050. Projected production and emissions from Jackdaw are not a material proportion of the budget.
Local or regional carbon budgets developed by local authorities and researchers	**NO**: There are no local or regional budgets that have been identified as being relevant.	Not Applicable.
Sectoral budgets or reduction strategies	**YES**: The UK offshore industry is subject to the North Sea Transition Deal. The OGA expects the upstream Oil and Gas industry to reduce GHG emissions from all aspects of their upstream operations.	The OGA strategy requires industry to take steps to reduce as far as reasonable in the circumstances greenhouse gas emissions. The UK offshore Oil and Gas industry is taking action in line with the North Sea Transition Deal. Adura complies with the requirements of its permits and consents, providing status on Net Zero related activities to regulators as required.
Current and future GHG emissions intensity of an activity	**YES**: GHG emissions intensity data is available and can be used to benchmark the Jackdaw Project's emissions.	The NSTA average GHG emissions intensity of producing and processing UK domestic gas in 2024 was 28 kgCO_2e/boe which was comprised of an emissions intensity of 18 kgCO_2e/boe for upstream operations and 10 kgCO_2e/boe for transport and processing. Jackdaw's estimated upstream operations GHG emissions intensity is 8.5 kg CO_2e/boe which compares favourably with the UK average of 18 kgCO_2e/boe. Assuming the average 10 kgCO_2e/boe for transport and processing is added to the Jackdaw upstream operations GHG emissions intensity of 8.5 kgCO_2e/boe, the Jackdaw Project's estimated overall GHG emissions intensity would be 18.5 kgCO_2e/boe, which is below the UK average intensity of 28 kgCO_2e/boe. UK imported LNG has an average GHG emissions intensity of 85 kg CO_2e/boe which includes production, processing, liquefaction, shipping and regasification.

Context from ISEP (ISEP, 2026)	Applicability to Jackdaw	Outcome
		According to the NSTA, in 2024 imported LNG accounted for only 15% of total UK gas supply but contributed the largest share of associated GHG emissions at 46% (NSTA, 2025). Based on import data (NSTA, 2025), replacing the expected production of gas from Jackdaw with US LNG (as Norwegian pipeline gas is at capacity) could result in approximately 4 $MtCO_2e$ of additional emissions. Hence, importing LNG could result in around 20% more CO_2e emissions than producing the same gas domestically.
Existing and emerging national and local policy or regulation	**YES**: The UK is a signatory to the Global Methane Pledge and must align with the EU Methane Emissions Regulation (EU MER) which, by 2030, will need to demonstrate that methane intensity is below EU-established thresholds.	The UK oil and gas industry is also aligned to the OGCI 2025 methane intensity commitment (also reflected in the NSTD Supply Decarbonisation commitments) which stipulates a methane intensity target for the sector of "well below" 0.2% by 2025. Methane intensity is calculated by dividing the total methane emissions for each year as reported by natural gas production to give a percentage of methane emitted per cubic meter. UK oil and gas methane intensity in 2023 was circa 0.13% and was on target for 0.12% in 2024 (NSTA, 2025a) which is below the OGCI commitment. Alternatively, methane intensity can be reported on a production basis. The latest data for 2024, compiled by the NSTA indicates the UK's methane emissions intensity is 1.5 $kgCO_2e$/boe, compared to a global methane intensity average of 15 $kgCO_2e$/boe. The UK's relatively favourable methane emissions intensity performance is supported by its progress in reducing absolute methane emissions by more than 50% since 2018 according to NSTA data (NSTA, 2025a). The estimated Shearwater (host installation) and Jackdaw combined methane intensity is 0.44 $kgCO_2e$/boe which is below the UK average of 1.5 $kgCO_2e$/boe. This supports the case that domestic production can reduce overall supply-chain emissions when meeting UK demand.

Context from ISEP (ISEP, 2026)	Applicability to Jackdaw	Outcome
		Additionally, the Oil and Gas Methane Partnership (OGMP) 2.0 is a comprehensive reporting framework developed by the United Nations Environment Programme (UNEP) and the Climate and Clean Air Coalition (CCAC). Adura is a signatory to OGMP 2.0 and is currently reviewing the status of each of its assets against the OGMP 2.0 framework.
Expert advice of guidance bodies	**YES:** UNEP indicates that reducing losses in the value chain can reduce impact of fuel use on climate. IPCC and WMO supports prioritising methane reductions as a pragmatic near-term complement to the essential long-term task of reaching net-zero CO_2.	Importing gas as LNG is not an efficient use of global reserves when lower intensity domestic reserves are available because of the "losses" along the value chain from fuel gas use, flaring, venting, liquefaction, regasification etc. Domestic UK production also has losses but these are approximately 8% compared with approximately 25% for LNG imports. Reducing losses in the fuel value chain can reduce impact of fuel use on climate, which is consistent with analysis from UNEP.
Company-specific TCFD reporting, transition risk assessments or Science Based Targets	**NO**: Adura has yet to make any financial disclosures.	Not Applicable.

Table 8 demonstrates that the GHG emissions from the Jackdaw Project are consistent with applicable existing and emerging policy requirements and good practice. Supporting information is provided in APPENDIX 4. To summarise:

- The UK has a carbon budget which is Paris-aligned and hydrocarbon use is included in the budget.
- Industry is aligned with the UK commitments and data demonstrates that UK performance is better than the global average for GHG and methane intensity. Adura is a signatory to OGMP 2.0.
- Adura operates in line with established industry practices, for example, each asset operated by Adura has an Emissions Reduction Action Plan (ERAP) which is designed to drive reduction of GHG emissions and identify emissions abatement opportunities that are under evaluation or under development.
- Producing gas via the Jackdaw field as a tie-back to existing infrastructure (Shearwater host installation) is likely to result in less emissions than the do-nothing case of importing LNG. This indicates that there is likely a beneficial net effect from domestic UK production.

The global carbon budget is an estimate of the total cumulative net amount of CO_2 that can be released to limit global warming to a specified temperature above pre-industrial levels, with a given probability. Estimates of the global carbon budget are not aligned to temperature outcomes of SSPs which means it is not possible to precisely align with SSP2-4.5 which is the upper bound of the likely evolution of climate conditions (Item 2). However, the estimated remaining global carbon budget from the beginning of 2025 that give a 50% chance of limiting warming to 2°C is circa 1050 Gt CO_2 (Forster, 2025; Friedlingstein *et al.* 2026). These figures are considerably higher than the estimated 0.0358 GT CO_2e Jackdaw Scope 3 emissions (Shell, 2025), demonstrating that the project alone will not materially influence global carbon budgets. How quickly remaining global budgets will be spent will depend on the actions of the international community as a whole and will likely continue on a similar trajectory with or without the Jackdaw Project.

According to ISEP, effects of GHG emissions from specific cumulative projects should not be individually assessed, as there is no basis for selecting any particular cumulative project(s) GHG emissions for assessment over any other (ISEP, 2026). However, the estimated Scope 3 emissions from the Jackdaw Project can be placed in context of global GHG emissions that are attributed to hydrocarbon production during the lifetime of the project.

Wood Mackenzie is a global leader in analytics, insights and proprietary data across the entire energy and natural resources landscape. Its data on commercially feasible (onstream, under development or probable development) hydrocarbon production, which includes Jackdaw, indicates that circa 1/3 of the remaining global carbon budget to limit warming to 2°C could be attributed to those hydrocarbons combusted in end use during the lifetime of the Jackdaw Project. Jackdaw production contributes to circa 0.01% of those emissions. Table 5-2 in the Part 1 Jackdaw Scope 3 Assessment (Shell, 2025) presented Jackdaw emissions as a proportion of the emissions attributed to global production emissions included in the IEA NZE and APS scenarios. This also shows that Jackdaw's contribution to global hydrocarbon production emissions in those scenarios is of a similar proportion, demonstrating that the Jackdaw Project alone will not materially influence global pathways.

10.2 ADDITIONAL INFORMATION FOR SECTION 6 – CONCLUSION

This section provides additional information to Section 6 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) to summarise the original responses and include further information.

The SSPs considered to bound a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project are SSP1-1.9 to SSP2-4.5, as described in the response to Item 2. The projected state of the environment associated with SSP1-1.9 to SSP2-4.5 i.e. lower- to intermediate-warming futures, are described in Table 2 in the response to Item 1.

SSP1-1.9 to SSP2-4.5 consider a wide range of GHG sources from both natural and anthropogenic activities. They also consider the net impact of atmospheric emissions attributed to sources and sinks and hence are inherently cumulative. Therefore, the cumulative effects of the Scope 3 emissions from the Jackdaw Project have been considered within the context of SSP1-1.9 to SSP2-4.5.

Whilst the Jackdaw Project emissions draw from the global carbon budget, the cumulative effect on the global carbon budget depends on the complex interactions between the sources and sinks, both natural and anthropogenic, that will be the result of actions of the international community.

The projected Jackdaw proportion of global GHG emissions is anticipated to be less than 0.02% in any reference year during the lifetime of the Jackdaw Project for the emissions pathways and scenarios bound by SSP1-1.9 to SSP2-4.5. This indicates that the project alone will not materially influence the evolution of future global GHG levels or the impacts attributed to those future GHG levels.

Determination of significance is based on how much a project contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050. The assessment demonstrates that the Jackdaw Project will be operating in a highly regulated sector that has initiatives and commitments that are aligned to the UK Net Zero targets, which are enshrined in UK law. Benchmarking against global oil and gas production demonstrates that hydrocarbons are produced in the UK sector with lower GHG intensities than the global average. This shows that meeting the hydrocarbon demand in the UK's Net Zero pathway using domestic production results in lower GHG emissions globally than meeting that demand with imported LNG. Adura complies with sector initiatives and commitments and anticipates that the GHG intensity of the gas produced from the Jackdaw Project will be better than the sector average.

In conclusion, the Jackdaw Project is considered to be fully in line with measures necessary to achieve a trajectory towards net zero and hence Jackdaw Scope 3 emissions are assessed as being aligned with the 'Minor adverse' significance criteria. On this basis, the significance conclusions presented are considered to be reasonable, evidence-based, and aligned with the expectations of the Regulations.

11 ITEM 11

11. Page 27 – Section 5.4.2.2 – [Significance Assessment of Jackdaw emissions] Global Cumulative Assessment – It is stated that the IEA APS and NZE scenarios demonstrate that there is continued global oil and gas combustion for the duration of the project high production case period and that the project emissions are a very small proportion of the future global oil and gas emissions. It is concluded that the emissions are not considered to have a likely significant effect on the UK's ability to meet its carbon budget targets or global Paris-aligned emission pathways that limit warming to 1.5°C. As set out in the Supplementary Guidance, a cumulative assessment of scope 3 emissions in relation to the current state of climate and global emissions-reduction pathways (IPCC, 2023) is more likely to support a reasoned conclusion on significance. The cumulative assessment should consider and explain the emissions from existing and approved projects over the life of the field and fully consider the assumptions, limitations and uncertainties of any model used. Please reconsider and update your assessment in line with the Supplementary Guidance.

Please refer to the response to Item 2 for an assessment of the baseline scenario for the environment and climate and its likely evolution over the lifetime of the Jackdaw Project. The response to Item 2 concludes that the SSPs which are considered to be a reasonable future estimate of global GHG emissions over the lifetime of the Jackdaw Project are SSP1-1.9 to SSP2-4.5. The expected trajectory of climate conditions and the projected state of the environment associated with SSP1-1.9 to SSP2-4.5 are described in Table 2 in the response to Item 1.

Please also refer to the response to Item 6 for additional information addressing the assessment of estimated Jackdaw Project Scope 3 emissions against current and projected global emissions.

Additionally, there is no single dataset that can be used to predict future global GHG emissions associated with existing and planned projects, therefore modelled scenarios and pathways are used to explore future emission projections in assessing the impact of Jackdaw Scope 3 emissions. For a description of the assumptions and limitations associated with the Intergovernmental Panel on Climate Change (IPCC) Shared Socioeconomic Pathways (SSPs), Current Policies (CurPol) and Moderate Action (ModAct) model scenarios, as well as the IEA Global Energy and Climate Change (GEC) model used to derive Current Policies Scenario (CPS), Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and Net Zero Emissions (NZE) model scenarios used in this assessment, please refer to APPENDIX 3.

To address the assumptions and limitations that are inherent in pathways and scenarios, a range of plausible scenarios is considered, including high-ambition mitigation scenarios (e.g. NZE/IMPs) and less stringent policy environments (e.g. STEPS/CurPol). In Paris-aligned scenarios and pathways, fossil fuel use is more constrained, which provides a more stringent benchmark against which Jackdaw Scope 3 emissions were assessed. On the other hand, pathways consistent with current policies (e.g. STEPS) are consistent with higher levels of fossil fuel demand and use, but are increasingly misaligned with the goals of the Paris Agreement. The evolution of the baseline takes into account uncertainty across the spectrum of pathways considered, rather than assuming that any one pathway will be realised. While uncertainties remain, the consideration of multiple pathways ensures that the assessment is not dependent on any single set of assumptions and provides a transparent and robust basis for assessing the impact of Jackdaw Scope 3 emissions.

12 ITEM 12

12. Page 27 – Section 5.4.2.2 – [Significance Assessment of Jackdaw emissions] Global Cumulative Assessment – The emission intensity of the Jackdaw project upstream operations (8.5 kgCO_2e/boe) is presented, and comparison has been drawn to the average emissions intensity of global upstream gas extraction and processing (43 kgCO_2e/boe) and the average emissions intensity of production and processing UK domestic gas (28 kgCO_2e/boe). No indication of the transport and processing emissions intensity for Jackdaw is provided. It is noted that the 2022 ES (section 7.4.2.1) states that the combined Shearwater and Jackdaw emissions intensity is 31 kgCO_2e/boe.

It is unclear how the comparison of scope 1 emissions is related to a global cumulative assessment of scope 3 emissions. However, when the Shearwater host installation is considered, which is intrinsically linked to the production of Jackdaw hydrocarbons, the emissions intensity appears higher than the UKCS average. Please clarify.

For an explanation of how a comparison of scope 1 GHG emissions is relevant to a global cumulative assessment, please refer to the response to Item 10. The scope 1 GHG emissions intensity provided within Section 5.4.2.2 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) was provided to complete the carbon intensity narrative. For additional information on intensities, including transport and processing emissions intensity, please refer to the response to Item 10.

With respect to the Shearwater host installation, including the proposed integration of Jackdaw production, the GHG intensity value of 31 kgCO_2e/boe presented in the 2022 ES (Shell, 2022) was derived from forecast emissions and production profiles and represented a conservative (maximum case) assessment. This approach was consistent with OPRED guidance at the time of submission which recommended adopting precautionary assumptions where uncertainty existed.

Since the ES was submitted, updated GHG intensity projections have been developed using the latest P50 (most probable outcome from reservoir modelling mid-case) production forecasts for the Shearwater host installation, including the estimated P50 production profile for Jackdaw. The application of the P50 case is considered appropriate at this stage of project maturity and presents a realistic and unbiased estimate of estimated operational performance. These projections are provided in Table 9.

Table 9 demonstrates that the forecast GHG intensity of the Shearwater host installation (including Jackdaw) remains below the 2024 UK Continental Shelf (UKCS) average of 24.8 kgCO_2e/boe (NSTA, 2025 [GHG emissions of Offshore fields excluding Terminals]) for the majority of the assessment period. The increase observed in 2031 reflects declining production during late-life operations, a recognised characteristic of mature offshore assets, and does not indicate a degradation in operational efficiency.

Over the assessment period (2026-2031), the average GHG intensity for the Shearwater host installation (including Jackdaw) of 16.6 kgCO_2e/boe remains below both the 2024 UKCS average and the Central North Sea regional average [2024] of 25.5 kgCO_2e/boe (NSTA, 2025). This demonstrates that the Shearwater host installation is expected to deliver production with comparatively lower GHG intensity than basin benchmarks, consistent with NSTA expectations to minimise GHG emissions and support the transition to a lower-carbon UKCS (NSTA, 2024).

Table 9: Annual Carbon Intensities of the Shearwater Host Installation (2026 – 2031), including production estimated from Jackdaw.

Year[(1)]	Total CO_2e Emissions (tonnes)	Production (kboe/d)	Emissions Intensity ($kgCO_2e$/boe)
2026	281,554	47	16.5
2027	383,640	76	13.8
2028	332,078	61	14.9
2029	261,936	45	16.1
2030	246,312	34	19.9
2031	203,896	20	28.2
Average Carbon Intensity (2026-2031)			**16.6**

Note [(1)] [redacted]

An Emission Reduction Action Plan (ERAP) is in place for the Shearwater installation. This plan will be used to continuously improve the emissions intensity of the Shearwater installation, including the Jackdaw Project, throughout its operational lifetime. In doing so, the aim is to keep the emissions intensity as low as reasonably practicable. The carbon intensity projections presented assume [redacted] a P50 (most probable outcome from reservoir modelling mid-case) production profile has been adopted to provide a balanced estimate of future emissions intensity.

As per the Supplementary Guidance, the Jackdaw Scope 3 assessment (Shell, 2025) "*reflects the highest anticipated hydrocarbon production (the 'P10' data) specified in the application for development and production consent submitted to the NSTA*". [redacted]

PART 2: UPDATED ASSESSMENT OF THE PROJECT

13 ITEM 13

13. Page 17 – Section 5.5 – Atmospheric Emissions – Drilling Operations – The drilling rig fuel use figure referred to in the ES (12,825 tonnes) is reflected in table 2-12 of the ES, but this represents the drilling rig fuel use only. There is no consideration in this section of the associated atmospheric emissions from Emergency Response and Rescue Vessel (ERRV), supply vessels or helicopters which are all required to support drilling. The total for such emissions detailed within Table 2-12 of the ES is 20,740 tonnes. Please reconsider the drilling operations atmospheric emissions to account for the support emissions described above.

The fuel consumption associated with the Jackdaw drilling and installation activities to 31st March 2026 is summarised in Table 10. This shows that the overall fuel use for the drilling and installation activities, and therefore associated emissions to atmosphere, is below the overall figure presented in the 2022 ES (Shell, 2022).

Table 10: Drilling and installation activities fuel use comparison between Environmental Statement and actual and predicted project use.

Operation	Estimated Fuel Consumption as per Environmental Statement [February 2022] (Tonnes)	Fuel Consumption to 31/03/26 (Tonnes)	Projected Fuel Consumptions to complete Drilling & Installation Activities (Tonnes)	Total Fuel Use [Actual plus Projected] (Tonnes)
WHP Jacket Installation	4,600	1,437	0	1,437
Drilling activities				
Drilling Rig (HDJU)	12,825	11,219	1,431	12,650
AHV (Rig Positioning)	3,000	156	468	624
ERRV	487	2,055	340	2,395
Supply Vessel	4,044	3,212	1,431	4,643
Helicopters	385	745	314	1,059
Drilling Activities Sub-Total	20,740	17,387	3,984	21,371
Topsides Installation	2,648	1,745	0	1,745
Pipeline Installation	3,756	3,554	0	3,554
Totals Tonnes Fuel	**31,745**	**24,123**	**3,984**	**28,107**

Based on actual and forecast data, total fuel use is expected to be approximately 11% lower than the estimate presented in the 2022 ES for Jackdaw drilling and installation activities. While the duration of the drilling activities exceeded the original schedule resulting in higher-than-estimated fuel use for certain support activities, this was offset by reduced consumption in other areas. In particular, the selection of a modern heavy-duty jack-up (HDJU) drilling rig resulted in daily fuel consumption that was nearly half of the figure estimated in the ES. Fuel use associated with jacket and topsides installation was also lower than originally estimated.

During the drilling activities it was found that the 4 Ultra High Pressure and High Temperature (uHPHT) wells required the development and qualification of new Wellhead equipment, drilling fluids, cement designs and operated drilling tools. This meant that the wells took longer to drill, with additional engineering updates required to perfect the new designs and systems. This included the side-tracking and re-drilling of one well and the workover/re-completion of another well. The installation of the topsides, whilst the drilling rig was on location, was a further factor. Additional time was required to suspend the wells during installation of the topsides and thereafter to support implementation of the Safety and Environmental Critical Elements (SECE) prior to the recommencement of well operations.

Fuel consumption for safety and service activities exceeded initial estimates, primarily due to the extended duration of drilling activities outlined above. As a result, the Emergency Response and Rescue Vessel (ERRV) remained on station for a longer period, leading to increased fuel use. Additional fuel consumption was also associated with increased supply vessel activities, and a higher number of helicopter crew change flights. This has resulted in the estimated total fuel consumption for the drilling activities being 3% higher (21,371 tonnes) than the estimate included in the ES (20,740 tonnes). The potential flaring associated with the well perforation operations, as discussed in Section 5.5 of the Part 2 Updated Assessment of the Project, (Shell, 2025) was not required and has therefore not been included in Table 10.

The total fuel use associated with the drilling and installation activities is not expected to exceed the quantities assessed within the ES. As mentioned above, total fuel use for the Jackdaw drilling and installation activities is expected to be approximately 11% lower than the figures presented in the ES (Shell, 2022).

14 ITEM 14

14. Page 20 – Section 5.5 – Atmospheric Emissions – Production Operations at Shearwater Host Installation – It is stated '…an assessment of the emissions associated with the Shearwater Native emission has also been undertaken which has demonstrated that the Shearwater Native Emissions are below those reported in the ES.'. It is unclear what assessment is being referred to here. Please clarify.

The assessment we are referring to here formed part of the revised and updated assessment of the likely significant effects of the project on the environment to provide, where relevant, updated information on the Environmental Statement (Shell, 2022). For production operations at the Shearwater host installation, we assessed the latest estimated future production and associated atmospheric emissions profile for the Shearwater host installation and compared this with the relevant information presented in the original ES. Included within this assessment were the estimated emissions from the Shearwater host installation, i.e. well stream fluids from Shearwater, existing tiebacks and the Jackdaw WHP. The Part 2 Updated Assessment of the Project, (Shell, 2025a) demonstrated that Shearwater host installation emissions were below those reported in the ES.

PART 3: RELEVANT INFORMATION TO THE PROJECT

Parts 1 and 2 of this response document address items relating to the environmental impact of the Jackdaw Project. In addition to answering the specific questions in Part 3 of the March 2026 Regulation 12(1) Notice, which are addressed later in this section, Adura is taking the opportunity to outline a number of additional matters to reflect developments since the Jackdaw Project (November 2025) submission, including the formation of Adura and the publication of the North Sea Future Plan by the UK Government.

3.0 INTRODUCTION TO ADURA

Since the Jackdaw submission of November 2025, Shell and Equinor combined the majority of their UK offshore oil and gas operations to form Adura on 1st December 2025.

Headquartered in Aberdeen and owned by Shell U.K. Limited (50%) and Equinor UK Limited (50%), Adura brings together two strong portfolios and combined expertise.

Adura employs approximately 1,100 employees and has interests in ten North Sea producing oil and gas assets: Buzzard, Clair, Gannet, Mariner, Nelson, Penguins, Pierce, Schiehallion, Shearwater, and Victory, and two projects in execution: Jackdaw and Rosebank.

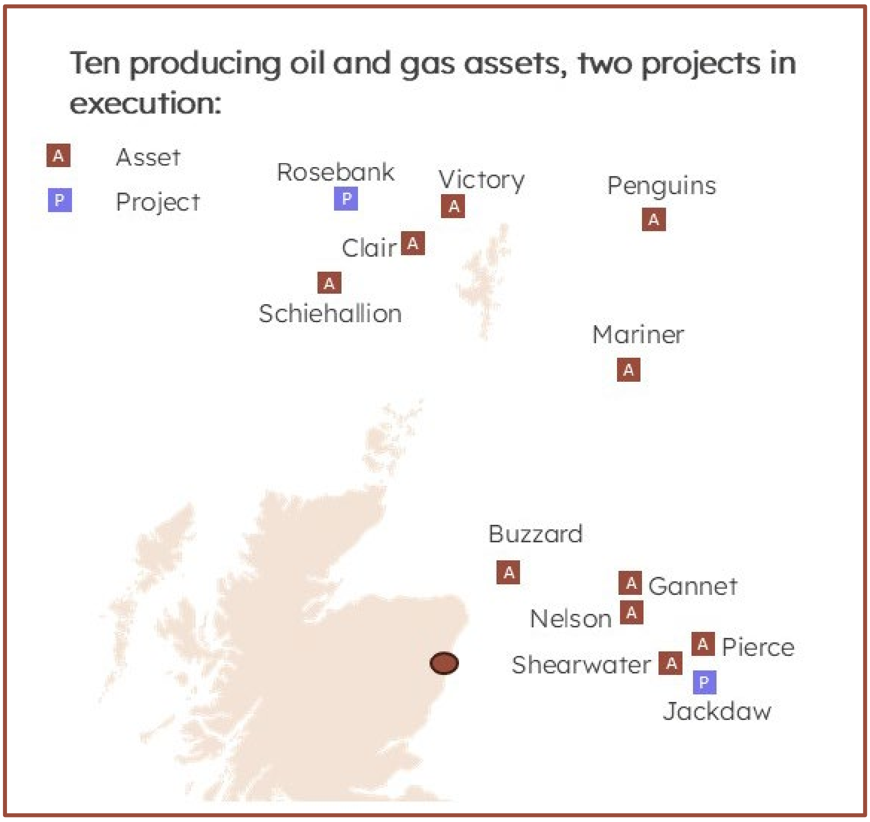


Figure 8: Adura portfolio assets and projects.

3.1 BALANCE OF ADVANTAGE

Parts 1 and 2 of this response document address items relating to the environmental impact of the Jackdaw Project. The purpose of this Part 3 is to support the Secretary of State in taking a decision by presenting information relevant to the 'balance of advantage', in accordance with the Supplementary

Guidance. This section provides additional information to Part 3 Relevant Information to the Project (Shell, 2025). The Supplementary Guidance states:

"When reaching a decision as to whether agreement should be given to the grant of consent the Secretary of State will consider the environmental effects of the project (as required by the Offshore EIA Regulations) and will form a view of the overall balance of advantage between any potential significant effects on the environment and wider benefits to the interests of the nation and any other relevant factors in proceeding with the project."

The Supplementary Guidance indicates factors which may be considered as part of the "balance of advantage" test. In accordance with the guidance this Part 3 provides further information on the UK Government's energy and environmental objectives and the socio-economic and other advantages of the Jackdaw Project proceeding.

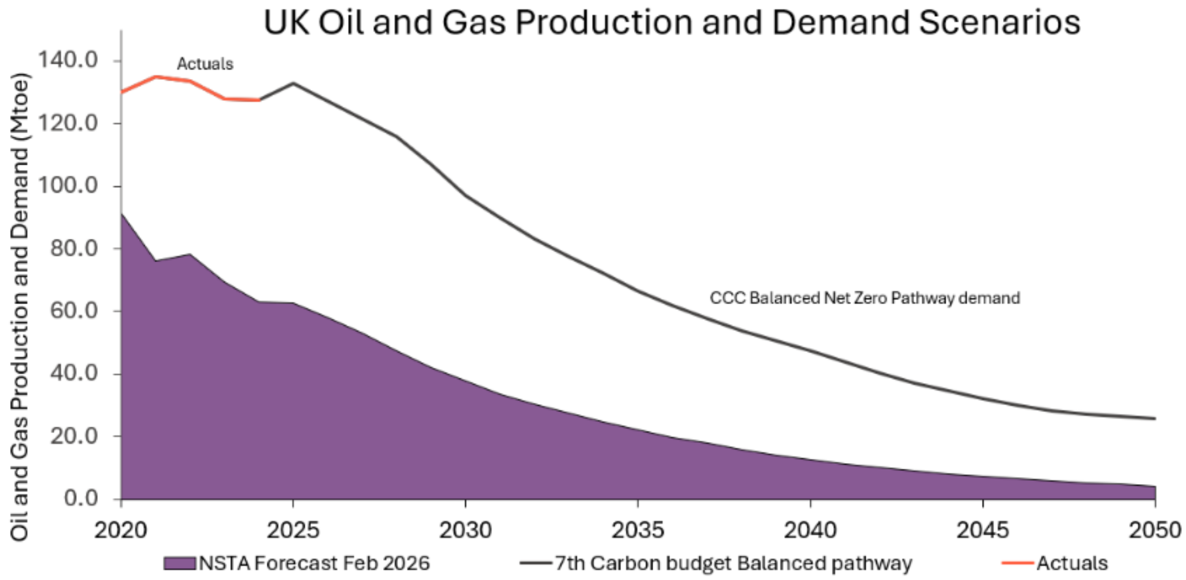
3.1.1 ALIGNMENT WITH UK POLICY OBJECTIVES

The Supplementary Guidance makes reference to an "*assessment of the extent to which the project aligns with the Government's stated objectives for the future of the North Sea"* (OPRED, 2025). Throughout the development phase of the Jackdaw Project, Shell, and now Adura, have acted as responsible operators, ensuring consistency with UK Government policy.

Shortly after the publication of the Supplementary Guidance and the subsequent submission in November 2025, UK Government policy evolved, most notably with the publication of the North Sea Future Plan (DESNZ, 2025a) (the "NSFP"). The NSFP sets out clear objectives:

- "**Overarching objective:** to foster an internationally-leading offshore clean energy industry, which ensures good, long-term jobs, growth and investment in communities across the North Sea, in tandem with a sustainable transition in oil and gas – boosting the country's economy and energy security, in line with our climate obligations.
- **Supporting objective 1:** to ensure our oil and gas workers and supply chain can take advantage of the opportunities of our clean energy transition, creating a global blueprint for a transition which supports prosperity, jobs, growth, communities and energy security.
- **Supporting objective 2**: to take a globally standard-setting, 1.5°C and climate science aligned approach to future oil and gas production."

It is clear from these objectives that the UK Government's focus is to deliver an orderly and fair transition, whilst recognising the need to support employment, growth and investment in the North Sea. The UK Government, and independent bodies such as the Climate Change Committee (CCC) in their 7th Carbon Budget, have also acknowledged the demand for oil and gas up to and beyond 2050 (CCC, 2025).



Source: Adura (NSTA, 2025 and CCC, 2025)

Figure 9: UK Oil and Gas Production and Demand Scenarios.

Figure 9 provides a visual representation of the 7th CCC Carbon Budget's Balanced Net Zero Pathway demand alongside the NSTA's forecast for UK oil and gas production. The UK has been a net importer of oil and gas since 2004, so the supply deficit between 2020 and 2025 ('actuals') is in line with the longer-term historical trend (UK Parliament, 2018). However, as explored throughout this section, closing the demand gap with domestic production is the least GHG emissions intensive and most economically beneficial option for the UK. The NSFP indicates that the UK Government intends to utilise existing fields in the UKCS to help meet this demand, alongside international suppliers, and support the transition. The NSFP states:

"Continued oil and gas production from existing fields will support a smoother transition and retain the skilled workforce we need in the UK as we ramp up cleaner technologies."

The Jackdaw Project is designed to operate as a tieback to the Shearwater host installation which appears to be consistent with the intent of the proposed Transitional Energy Certificates (TECs) (DESNZ, 2025a), whilst both Jackdaw and Rosebank Projects are recognised as existing fields in the UKCS Offshore Activity portal (NSTA, website). Therefore, it would appear that both Projects sit within the existing and future policy framework. With an initial expected lifespan of less than 10 years, the Jackdaw Project could provide domestic supply to meet residual demand and form part of the critical pathway for a managed decline of the UKCS.

Further to the energy policy objectives set out in the NSFP, the UK Government's Autumn 2024 Budget set fiscal policy relevant to North Sea developments. In the Autumn 2024 Budget the UK Government increased the Energy Profits Levy (EPL) from 35% to 38%, bringing the headline tax rate up to 78%. The Chancellor of the Exchequer also extended the EPL sunset clause to 31 March 2030 and removed the 29% investment allowance. However, by maintaining the first year 100% allowance and the decarbonisation allowance (reduced to 66%), this provided an indication to the market that further investment was desirable.

In confirming the changes during the Autumn 2024 Budget speech, the Chancellor of the Exchequer stated "*The levy will now expire in March 2030, and we will remove the 29% investment allowance. To ensure that* *the oil and gas industry can protect jobs and support our energy security, we will maintain the 100% first-year allowances, and the decarbonisation allowances, too.*" (UK Parliament, 2024).

The Jackdaw Project would contribute to meeting this policy objective to attract investment, jobs and energy security, delivering lower GHG emissions than the UK production average (see following section) and subsequently returning significant revenue to the UK Government under the current fiscal regime and subsequent Oil and Gas Price Mechanism (OGPM).

3.1.2 SIGNIFICANCE OF DOMESTIC PRODUCTION

The Supplementary Guidance states that the Secretary of State may consider "*the severity, extent, understanding and duration of the significant effects [of the project]*" and *"the Government's overall energy and environmental objectives"*. Parts 1 and 2 of this document have provided a detailed response to the items relating to the environmental impact of the Jackdaw Project.

With demand expected to continue through to the 2050s under the CCC's Net Zero Balanced Pathway, as highlighted in Figure 9 and the NSFP, the question is not whether the UK will need fossil fuels to meet its energy needs, but where those fossil fuels will come from. While GHG emissions from gas combustion are broadly consistent, at around 350 kgCO_2e/boe, production and processing emissions can vary significantly depending on the source.

The UK is a net importer of gas with imports accounting for 61% of the UK's total gas supply in 2024 (NSTA, 2025a) in order to meet UK demand. Of that 61%, 46% was imported from Norway (via pipeline) at relatively low intensity, 8 kgCO_2e/boe. The remainder was met by LNG imports at significantly higher intensities, at an average of 85 kg CO_2e/boe (including production, processing, liquefaction, shipping and regasification), as shown in Figure 10. With the Norwegian pipeline operating at capacity, the demand deficit needs to be met from other sources.

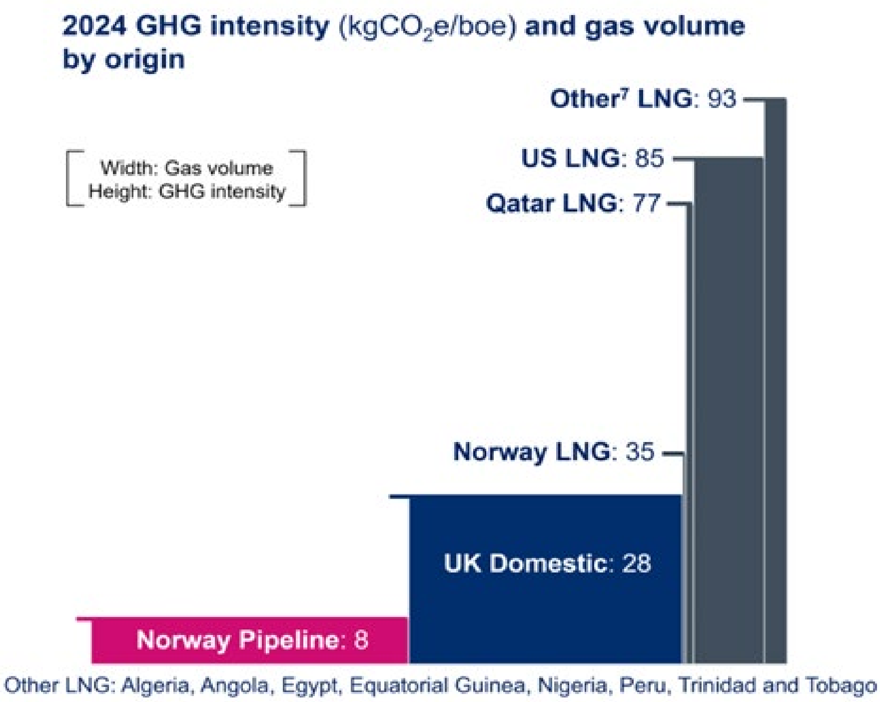
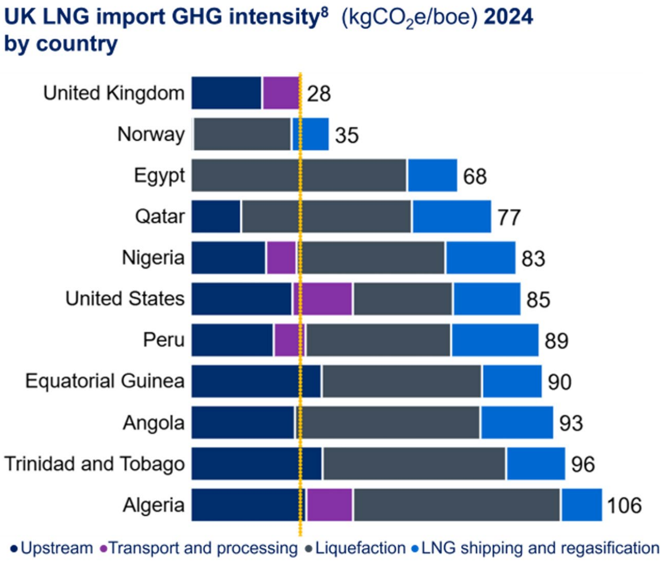
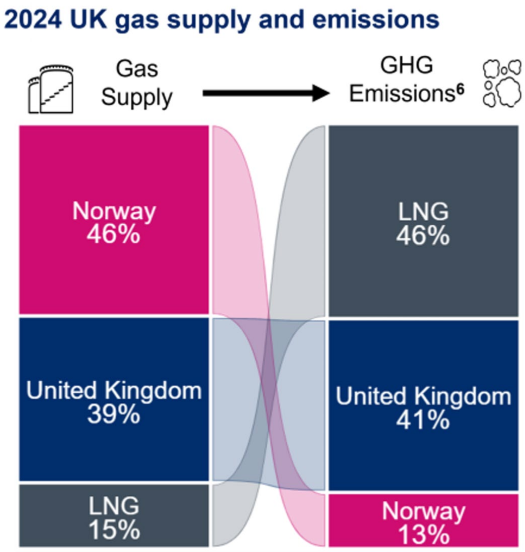


Figure 10: GHG intensity and gas volume by origin (NSTA, 2025a).





[8] The LNG value chain stages include: Upstream, Transport and processing, Liquefaction, LNG shipping and Regasification.

[6] Excludes emissions for 0.5 MMboe of the UK's 2024 natural gas supply (0.5% of gross supply) from Belgium and the Netherlands, which do not have associated value chain intensity values.

Figure 11: UK LNG import GHG Intensity (NSTA, 2025a).

Figure 12: 2024 UK gas supply and associated emissions (NSTA, 2025a).

The NSTA average GHG emissions intensity of producing and processing UK domestic gas in 2024 was 28 kgCO_2e/boe, as shown in Figure 11. This comprises GHG emissions intensity of 18 kgCO_2e/boe for upstream operations and GHG emissions intensity of 10 kgCO_2e/boe for transport and processing. The Jackdaw Project's estimated upstream operations GHG intensity is 8.5 kgCO_2e/boe. When combined with UK average transport and processing emissions intensity, the Jackdaw Project's estimated emissions intensity is 18.5 kgCO_2e/boe which compares favourably with the UK produced and import averages.

In 2024 imported LNG accounted for only 15% of total UK gas supply but contributed the largest share of associated GHG emissions at 46% (NSTA, 2025a), as shown in Figure 12. Therefore, on the basis of the NSTA data available, the Jackdaw Project offers a significantly reduced footprint when compared to the alternative, imported LNG.

Further detail can be found in APPENDIX 4.

3.1.3 JACKDAW AND ADURA'S SOCIO-ECONOMIC CONTRIBUTION

Jackdaw's Economic Contribution

As explored further in the responses to items 15, 16, 18, and 19, the Jackdaw Project has the potential to provide a significant economic contribution to the UK. This is consistent with the Supplementary Guidance which states that, "*the potential economic and other advantages of the project proceeding*" will be considered by the Secretary of State.

Important for the UK, this economic contribution is not confined to Aberdeen. The economic effects of the Jackdaw Project can be felt across the UK through direct, indirect and induced expenditure shown in the response to item 16(a)(i). To summarise, the Jackdaw Project:

- In addition to its direct UK tax contribution, could deliver a peak annual Gross Value Added (GVA) of over £825 million, and over £4.4 billion GVA through its lifetime.
- Has contributed over 1,000 direct and indirect jobs on- and offshore to date. The Jackdaw project would continue to provide high quality jobs through to decommissioning.
- Utilises 117 UK based supply chain companies, covering Scotland, England, Wales, and the Isle of Man. A further 19 supply chain companies are based internationally.
- Could contribute ~6.5% of UKCS gas supply at peak production, equivalent to around 1.4 million homes' use.
- Jackdaw gas would physically enter the National Gas grid (via St Fergus) and could sustain critically important national energy infrastructure[1] in lockstep with UK Government's policy commitment.

Adura Portfolio Socio-Economic Contribution

The Jackdaw Project sits within a wider portfolio (see '3.0 Introduction to Adura'). Alongside the Rosebank Project, the Jackdaw Project could form a significant part of Adura's community offer which has seen direct investment in skills and communities across Scotland. Together, the Jackdaw and Rosebank Projects would provide a combined contribution of ~10% of UK gas supply and £28.7 billion GVA to the UK at peak production, in addition to tax contributions.

Adura is committed to investment within the communities that support its activities. We work closely with community leaders to consider the social, economic, and environmental impact of existing and planned activities, as well as the most beneficial social investments. The scale of Adura's subsequent contribution is a product of the cumulative success of the portfolio rather than any individual asset. Therefore, the commencement of operations at Jackdaw, as well as Rosebank, would provide the means to sustain this contribution for a longer duration. To date, these social investments include:

- Sponsorship of the Aberdeen Science Centre to make science accessible to everyone, nurturing the next generation of innovators.
- Sponsorship of the River Dee Trust to deliver the educational fund and transport & lunch fund which provide support to schools, organisations, and individuals, as well as funding physical restoration of the Culter catchment area, the second largest sub-catchment of the River Dee.
- Involvement in the Highlands and Islands Enterprise Science Skills Academy, specifically through sponsorship of the Newton Room in Shetland, a STEM classroom intended to make learning accessible in remote areas.
- Collaborating with local partners to deliver activities and projects tailored to local priorities – such as sponsorship of Our Union Street[2].

Adura's skills and development programs

The pipeline of work which the Jackdaw Project is providing, and will continue to provide, will help the UKCS remain a competitive draw for our skilled workforce and creates additional incentive for the next generation, whilst an employment market for new technologies matures.

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[1] Further_Information_Part_3_-_Relevant_Information_to_the_Project.pdf – Page 6
[2] About - Our Union Street

Adura actively supports the development of the workforce at all stages of their careers. Adura is also engaged in the development of apprentices and the diversification of the workforce through:

- Sponsorship of the APTUS Apprenticeship Scheme, managed by OPITO, providing for unique onshore and offshore work experiences for apprentices by combining classroom learning with hands-on training. Adura has 21 apprentices in the active pipeline. The next opportunity to pledge will be in Q3 2026.
- Support for STEM initiatives near the Adura offices and activities, in partnership with leading education and skills organisations.

In 2026, Adura became the lead industry partner of the Aberdeen Energy Transition Skills Hub, the largest skills hub in Scotland. Shell UK initially committed £1.8 million to support the establishment and initial operation of the hub, with Adura now building on this strong foundation and taking forward the remaining £1.1 million of Shell UK's original sponsorship (Adura, 2026) (Shell, 2023).

The hub is the anchor project of the city's Energy Transition Zone. It brings together state of the art facilities including:

- A welding academy, already trebling North East Scotland College's (NESCoL) previous training capacity
- An advanced manufacturing zone
- Future technology digital training suites used for innovation, renewables and modern engineering skills

The hub aims to support 1,000 people into jobs in its first five years. As of March 2026, it has already provided 150 training places in welding, trebling NESCol's previous training capacity. With further expansion planned for 2026/27, this could rise to four times the pre-hub capacity (Adura, 2026) (Adura, 2026a).

Adura also supports the Girls in Energy programme which encourages this under-represented group to consider careers in energy, including in renewables. Over 1,800 young women have completed the Girls in Energy programme since 2010.

In 2026 the Aberdeen Energy Transition Skills Hub and the Girls in Energy programme has provided:

- 150 welding training places (with a plan to quadruple capacity from 2027)
- >130 students regularly using the advanced manufacturing, innovation, renewables and flexible workshop spaces
- 284 participants in the Girls in Energy programme
- 25 competitors in the Ocean Winds Virtual Welding Challenge

Further detail on this has been provided in the response to item 17.

3.3 CONCLUSION

In summary the purpose of this section is to support the Secretary of State in taking a decision by presenting information relevant to the balance of advantage, in accordance with the Supplementary Guidance.

Adura's response to Part 1 explains that Jackdaw gas would not only be significantly less GHG intensive than LNG imports, but is also forecast to be less GHG intensive than the UK average. Adura's view is that it is logical and consistent with current UK Government policy to prioritise domestic production alongside

Norwegian pipeline gas whilst residual demand exists up to and beyond 2050, as per the 7th Carbon Budget.

In this Part 3, Adura explores the potential economic contribution of the Jackdaw Project as an individual asset, but also as it relates to a wider, established portfolio.

The Jackdaw Project directly contributes economic benefits through the provision of over 1,000 jobs, UK supply chain utilisation and could support £4.4 billion in GVA over the life of the field. In addition, as part of Adura's portfolio, Jackdaw will enable Adura to continue to provide substantial community benefits.

Jackdaw gas is transported through the Fulmar gas line where it is processed onshore at the St Fergus gas plant and then physically enters the National Gas Transmission Network. At the St Fergus gas plant Jackdaw gas is sold into the UK market on a daily basis under UK National Balancing Point contracts. This means that Jackdaw gas will be used mainly to heat UK homes and business, provide energy for industries, and generate electricity. The Jackdaw Project also remains consistent with UK Government policy – first with the North Sea Transition Deal and now the North Sea Future Plan and the UK government's current fiscal framework which supports investment in the North Sea.

To conclude, the information presented demonstrates that the Jackdaw Project supports the UK Government's objectives of driving growth and economic resilience, strengthening our energy security, and producing gas at lower intensities than the available alternatives.

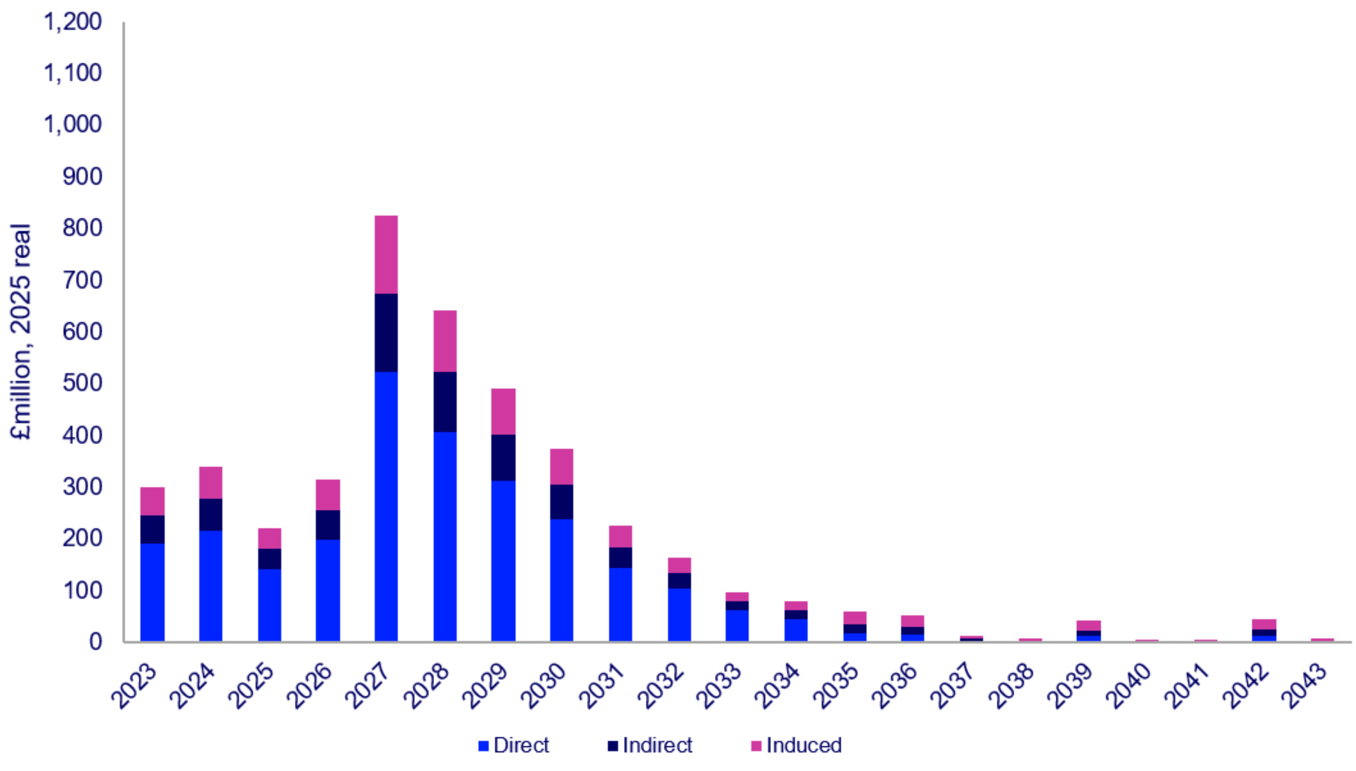
15 ITEM 15

15. In relation to the sections titled 'Jackdaw's Economic and Social Contribution to the UK' (pages 5 & 6), please provide:

a. An annual profile across the Jackdaw **project's lifespan** of the Gross Value Added (GVA) generated - broken down by direct, indirect and induced GVA, including detail of the methodology and assumptions.
b. Any uncertainty analysis of GVA generated (i.e. high / low sensitivities).
c. An annual profile across the Jackdaw **project's lifespan** of the investment and cost figures - for example, capital expenditure; operating expenses and decommissioning, with a breakdown of investment / costs.

15.1 ITEM 15A

As shown in Figure 13 below, the Jackdaw Project is anticipated to provide a peak GVA of £825 million. Through development and peak production the project maintains a significant GVA contribution.



Source: Adura, Wood Mackenzie, Office for National Statistics GVA multipliers

Figure 13: Jackdaw GVA profile by category.

GVA Methodology

- The field cash flow model was adapted from Wood Mackenzie's Upstream Research model with cost, reserve, and production data provided by Adura.

- CAPEX and OPEX were provided by Adura on a year-by-year basis; Wood Mackenzie classified the spend by industry group and determined the split of domestic (UK) versus non-UK spend for OPEX while the CAPEX split was provided by Adura.
- An input-output model was developed to quantify the GVA resulting from the Jackdaw Project. Direct GVA was calculated by summing UK CAPEX and field revenues net of OPEX. Type I industry-specific GVA multipliers were then applied to obtain the combined direct and indirect GVA. The same process was followed using Type II GVA multipliers to obtain the combined direct, indirect, and induced GVA.
- Oil and gas prices used were as per Wood Mackenzie's base price deck, based on forward curve for three years then flat real price of US$65/bbl.
- The GVA multipliers were sourced from the Office for National Statistics (ONS) Analytical Tables.
- In terms of ONS multiplier classifications, drilling and completions activities are covered by "Oil and Gas Extraction" and oilfield services are covered by "Mining Support".

15.2 ITEM 15B

High/low sensitivities were not included in this analysis for the following reasons:

Multipliers: The ONS multipliers applied in this study do not incorporate high/low sensitivity variants, and as such, this was not reflected in the Wood Mackenzie report.

Price Sensitivities: Price sensitivities were deliberately excluded to present a single conservative view of GVA. Wood Mackenzie's base price deck was used throughout to ensure that the economic contribution of the project was not overstated.

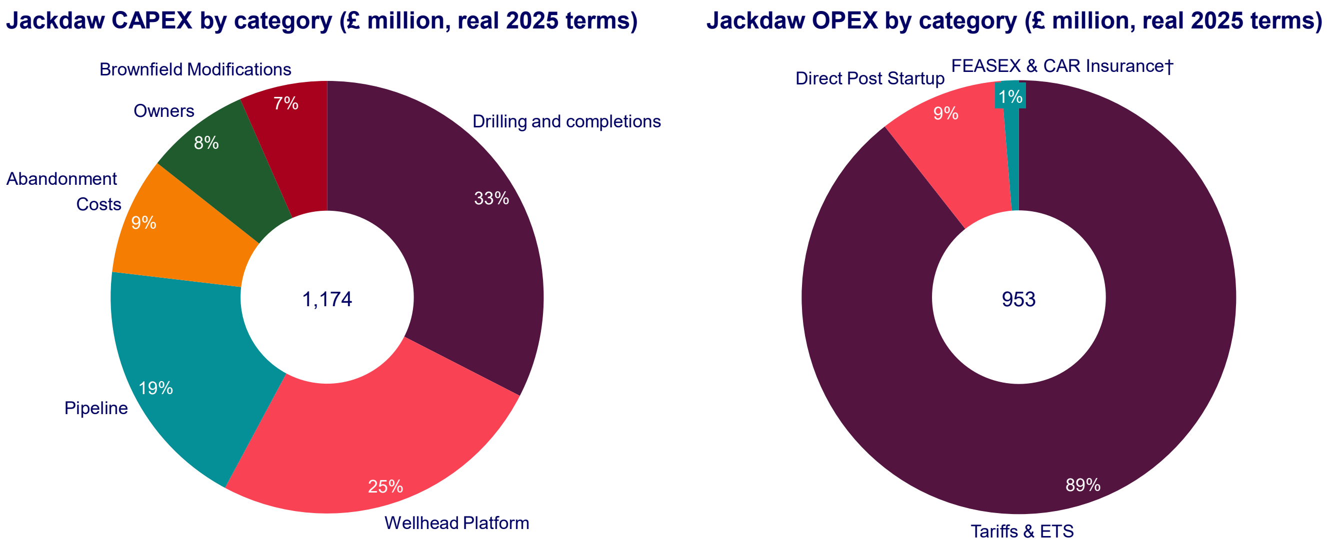
Capital Costs: Given that the majority of the Jackdaw Project scope has been completed and the associated costs incurred at the time of writing the report, there is a high degree of confidence in the CAPEX figures underpinning the model. As a result, the scope for meaningful cost sensitivity analysis was considered limited.

15.3 ITEM 15C

Please refer to Figure 14 for the Jackdaw Project CAPEX and OPEX by year. Decommissioning costs are included as CAPEX at end of field life in the diagram below. Please refer to Figure 15 for the breakdown of the Jackdaw Project CAPEX and OPEX.

[redacted]

Figure 14: Jackdaw CAPEX and OPEX profile.



Source: Adura | FEASEX = Feasibility & Execution / CAR Insurance = Contractor’s All Risks Insurance

Figure 15: Jackdaw CAPEX and OPEX breakdown.

16 ITEM 16

16. We anticipate that information within the Supply Chain Action Plan (SCAP) and the Standard Economic Template (SET) may be relevant to considering the information provided in relation to job creation / retention, the supply chain and contribution to economic growth - **please provide these if so**.

Please also provide, if not included in the SCAP or SET:

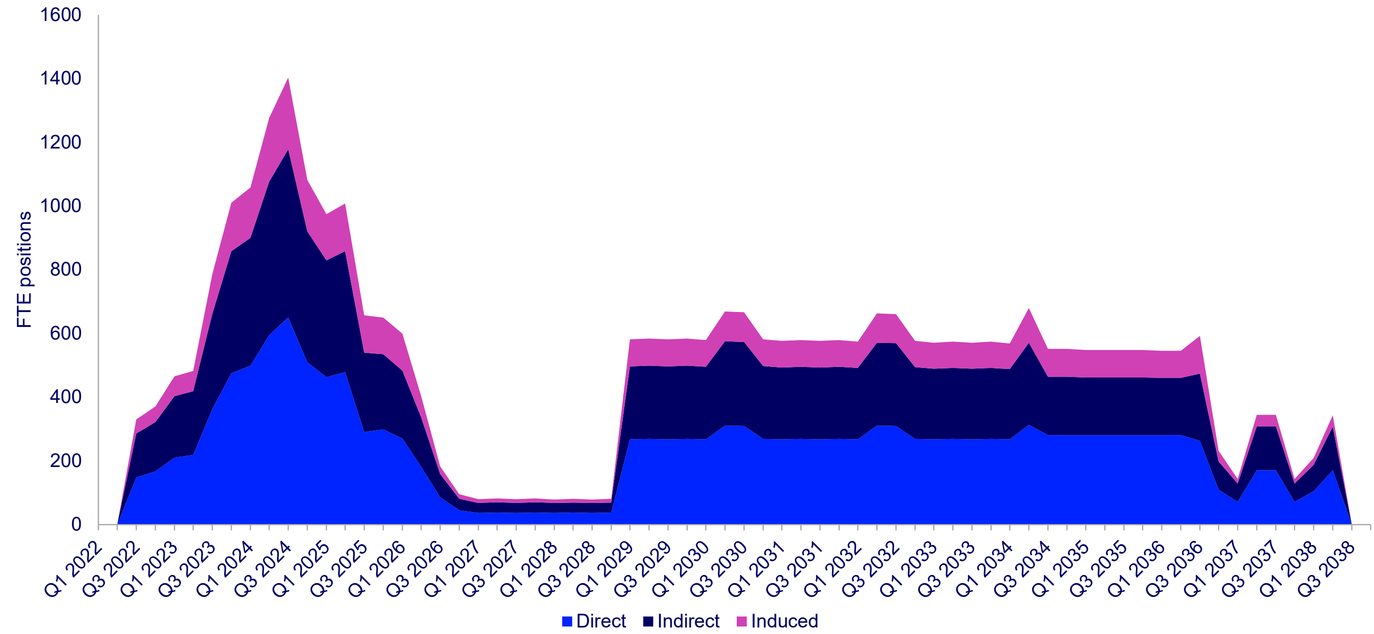
a. Any other information relevant to considering the indirect and induced effects for each year of the Jackdaw project's lifespan or which might put those aspects into context, such as:
   i. An annual profile of the indirect and induced jobs to be generated during the **construction** and **operational** phases.
   ii. The geographic location of the 30 supply chain companies with whom contracts have been placed - as mentioned elsewhere in the further information provided.
   iii. The percentage UK content of the supply chain linked to the project.
   iv. iv. An overview of tier 1 supply chain companies linked to the project e.g. the names of companies, an indication of what they were supplying, approximate contract values.
   v. The geographic location of the + 1,000 supply chain jobs supported by the project - as mentioned elsewhere in the further information provided.
b. Detail of the methodology used to reach the figures associated with the abovementioned indirect and induced jobs.
c. Any uncertainty analysis relating to the indirect and induced jobs to be 'generated' by the project (i.e. high / low sensitivities).

The SCAP and SET have not been provided due to their commercial confidentiality. The following responses provide the information requested and the relevant sources.

16.1 ITEM 16A

16.1.1 ITEM 16A(I)

Figure 16 provides an overview of the direct, indirect, and induced employment delivered as a result of the Jackdaw Project. Jackdaw's employment peaks in the development phase, having provided over 1,400 jobs (directly, indirectly, and induced). Over the lifetime of the field there would be a consistent level of employment averaging at nearly 500 jobs a year in direct, indirect and induced employment - this includes 273 direct jobs which exist on the Shearwater host installation and additional 27 Jackdaw-specific jobs (see response to items 19a and 19b).



Source: Adura, Wood Mackenzie, Scottish Government GVA and employment multipliers

Figure 16: Jackdaw overall UK employment (direct, indirect, and induced).

16.1.2 ITEM 16A(II)

For this item 16a(ii), we have considered the location of the supply chain company, whilst the response to item 16a(v) addresses the location of the work undertaken.

There are currently 117 supply chain companies based in the UK which have been contracted to support the Jackdaw Project, each of which is critical to the delivery of the Jackdaw Project. A further 19 companies have been contracted from abroad.

As shown in Figure 17, the UK supply chain for the Jackdaw Project is distributed across Scotland, England, Wales, and the Isle of Man. Adura recognises that the location of the supply chain business does not necessarily reflect the residence of the employee. Figure 18 provides a snapshot of the area of residence of Adura's workforce across all operating platforms on 3 June 2026 which can be used as a proxy for the distribution of the workforce on the Jackdaw Project. The North East of England in particular is set to benefit from operations taking place in Scotland.

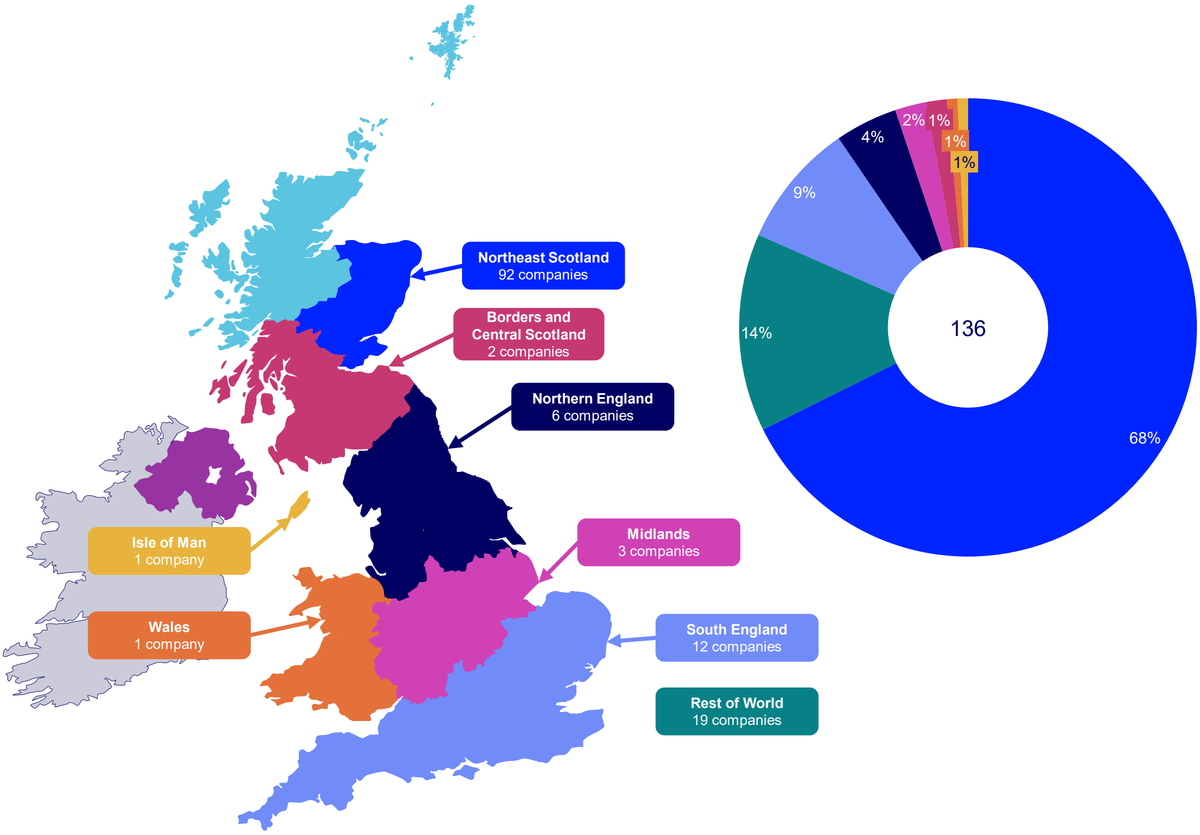
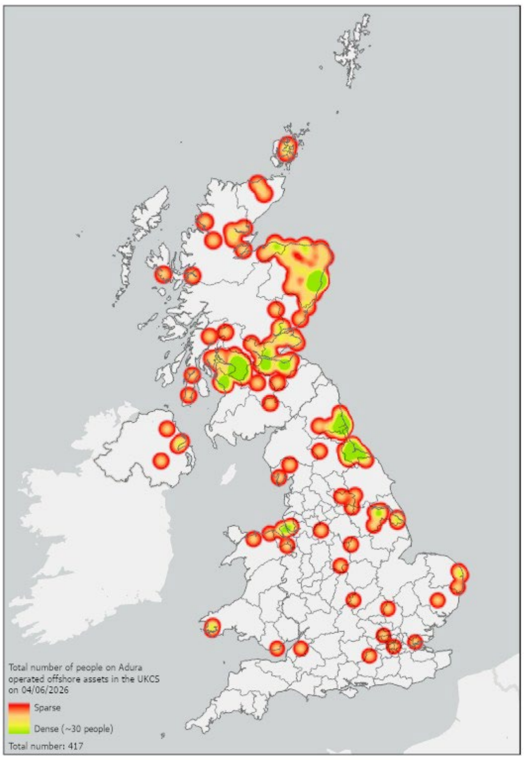


Figure 17: Supply chain company locations.

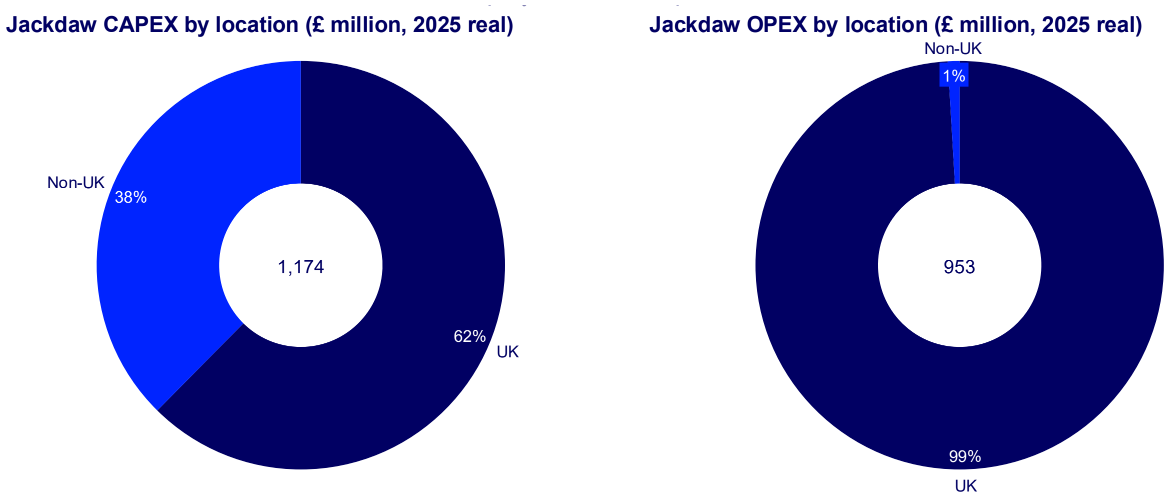


Source: Adura – GDPR restricts ability to share more specific data on individuals working on Adura assets.

Figure 18: Heat map of workforce primary residence across Adura's offshore operating locations 3rd June 2026.

16.1.3 ITEM 16A(III)

Further to the CAPEX and OPEX yearly profile shown in 15.3, nearly two thirds of CAPEX spend and 99% of OPEX is situated in the UK. See Figure 19.



Source: Adura, Wood Mackenzie analysis | CAPEX includes decommissioning

Figure 19: UK vs non-UK spend.

16.1.4 ITEM 16A(IV)

Table 11 lists the primary suppliers for the Jackdaw Project against the key product or service they are providing. Note that whilst values have been made available in the table, the suppliers have requested that this information remains confidential for commercial reasons.

Table 11: Tier 1 supply chain companies (redacted)

Company	Product/Service	Contract Value (£ million)
[redacted]	Wellhead Platform EPCI	[redacted]
[redacted]	Subsea ECPI	[redacted]
[redacted]	Brownfield Modifications	[redacted]
[redacted]	Drilling Rig ([redacted])	[redacted]
[redacted]	Well Services	[redacted]
[redacted]	Well Services	
[redacted]	Well Services	
[redacted]	Well Services	
[redacted]	Well Services	

16.1.5 ITEM 16A(V)

The response to this question considers the physical location of the work undertaken by the workforce – the location of the supply chain companies and the workforce itself has been addressed in item 16a(ii).

Supply chain jobs are split between offshore and onshore to account for the different functions of the workforce – from operation and maintenance, to safety and back office staff. Figure 20 shows that of the jobs made available for the Jackdaw Project, a relatively small majority is based offshore, with a significant number of jobs across wells, subsea, wellhead platform, and brownfield modifications being delivered by onshore workers.

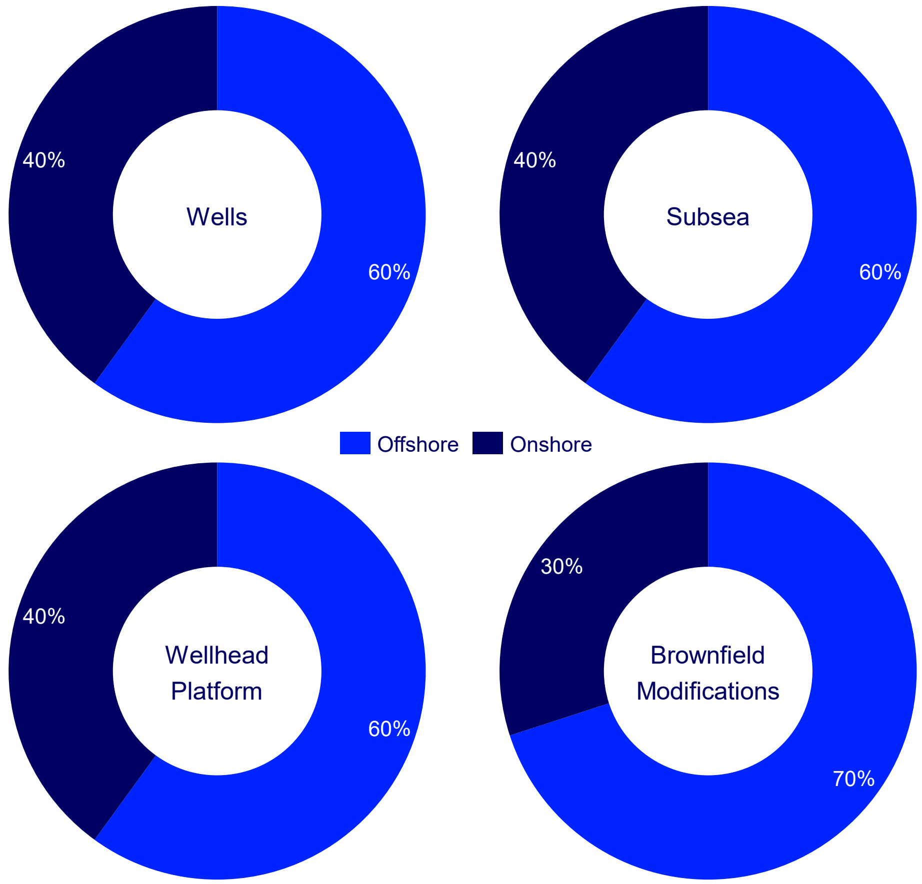


Figure 20: Supply chain job locations.

16.2 ITEM 16B

Employment Methodology

- For the employment analysis, the number of UK-based direct jobs was provided by Shell. Wood Mackenzie then used its own assumptions for non-UK-based jobs following the work breakdown structure from Shell and contractor reports. Type I industry-specific employment multipliers were applied to obtain the combined direct and indirect employment, and Type II multipliers were applied to obtain the direct, indirect, and induced employment.
- Employment is modelled to 2038, when it is assumed the main elements of the decommissioning will have been completed, although there are decommissioning cost models for further work out to 2043.

- For the employment analysis, the number of UK-based direct jobs was provided by Shell. Wood Mackenzie then used its own assumptions for non-UK-based jobs following the work breakdown structure from Shell and contractor reports. Type I industry-specific employment multipliers were applied to obtain the combined direct and indirect employment, and Type II multipliers were applied to obtain the direct, indirect, and induced employment.
- Both the GVA and employment multipliers were sourced from the Scottish Government's Analytical Tables; these were projected forward using the 2001 to 2021 Compound Annual Growth Rate (CAGR).
- In terms of Scottish Government multiplier classifications, drilling and completions activities are covered by "Oil and Gas Extraction" and Oilfield services are covered by "Mining Support".
- The "Water Transportation" category has been used to capture the workforce associated with supply/standby vessels and shuttle tankers.

16.3 ITEM 16C

High/low sensitivities were not included in this analysis for the following reasons:

Direct Employment: Given that most of the Jackdaw Project scope has already been completed and the associated costs incurred, there is a high degree of confidence in the employment figures used for the development phase of the model. For the operational phase, staffing levels on platforms and vessels are relatively rigid in nature, with minimum operating requirements and finite bed space capacity acting as practical constraints on employment variability. This limits the extent to which a meaningful high/low sensitivity range could be applied.

Indirect and Induced Multipliers: The Scottish Government multipliers applied in this study do not incorporate high/low sensitivity variants, and as such, this was not reflected in the Wood Mackenzie report.

17 ITEM 17

17. Pages 13 & 14 reference skills development and innovation initiatives that Shell supports, **please provide**:

a. Clarification on the extent to which the 'Skills Transition' programmes are linked to the Jackdaw project and the extent to which Jackdaw supports these programmes.
b. The number of apprentices trained, if any, as a direct result of the Jackdaw project.
c. Information on any specific provisions to train and upskill workers - both for work on the Jackdaw project and for the transition to green technologies in the North Sea.

17.1 ITEM 17A

Adura is the lead industry partner for the Aberdeen Energy Transition Skills Hub which is the largest skills hub in Scotland. Opened in 2025, the hub is the anchor project of the city's Energy Transition Zone.

The Aberdeen Energy Transition Skills Hub, and the other programmes listed in Section 3.1.3, are funded through the voluntary reinvestment of Adura's UK profits. Activities such as the Jackdaw Project enable Adura to maintain its leading position at the forefront of the UK energy sector while sustaining investment in programmes that empower both new and existing workers to drive the energy transition forward.

17.2 ITEM 17B

In total, there are currently 73 apprentices with contractor companies working on the Jackdaw Project. Approximately 35 have completed their trade certification during the Jackdaw Project and about 20 skilled workers who have obtained a second trade certificate.

Table 12: Apprentice involvement in Jackdaw.

Discipline	Apprentices involved	Direct/Indirect
Welding	20	Direct
Plate work	20	Direct
Industrial pipefitting	6	Direct
Scaffolding	9	Indirect
Logistics	5	Indirect
Automation	3	Indirect
Crane and lifting operations	3	Indirect
Industrial painting	2	Indirect
Industrial measurement	2	Indirect
Industrial mechanics	2	Indirect
Non-destructive testing	1	Indirect

More broadly, Adura's funding contributes to the development of apprentices through both direct programme participation and broader industry initiatives detailed in section 3.1.3.

17.3 ITEM 17C

Adura has a highly skilled, future-ready workforce. Employees receive comprehensive on-the-job training that meets immediate operational needs and builds capability, as well as supporting long-term career progression. Adura is creating a resilient and adaptable workforce equipped to meet the demands of today's energy system while preparing them for evolving roles in the energy sector.

18 ITEM 18

18. The further information provides a breakdown on 'Direct Employment from the Jackdaw Project' in Appendix 1 (page 16). Please provide:

a. Confirmation of the total jobs under column 'Present - First Gas (mid 2026)' (the individual rows sum to 802).
b. Clarification as to whether the 'jobs created' from 'Present-First Gas' are new jobs, or a continuation of jobs included under the '2023 Present' column?
c. An explanation for the reduction between the respective 'jobs created' totals within the last two Columns of the table.
d. If available, a profile - for each year of the Jackdaw **project's lifespan** - of:
   i. the types of direct jobs to be created i.e. not only the details of jobs already provided in Appendix 1 but also those beyond 'first gas produced'.
   ii. the estimated salaries and any other relevant metric of quality appertaining to the jobs of those employed on the Jackdaw installation and those located remotely (e.g. office-based) who would additionally be directly involved in the project.
e. Any uncertainty analysis relating to the direct jobs to be generated by the Jackdaw project (i.e. high / low sensitivities).

18.1 ITEM 18A

Table 12 shows the breakdown of jobs against the four key project scopes, updated from Part 3 Relevant Information to the Project (Shell, 2025) to reflect the latest available figures.

Table 13: Corrected direct employment table

Project Scope	Types of Job	Jobs Created	
		2023 - October 2025	October 2025 - First Gas (2026)
Wells	Offshore Rig Mechanic; Drilling Engineer; Roustabouts; Logistics Coordinator; Coiled Tubing Technician	267	267
Subsea	DSV Captain; ROV Engineer; Welder; Vessel Crew; Subsea Engineer; Offshore Diver; Offshore Doctor and Diving Medical Crew	310	310
Wellhead platform	Mechanical Technician; Instrument Technician; Scaffolder; Work Package Engineer; Commissioning Lead; Offshore Cook; Cost Engineer; Buyer; Planner; Project Engineer; Completions Engineer	420	130
Brownfield modifications	Mechanical Technician; Instrument Technician; Scaffolder; Work Package Engineer; Commissioning Lead; Offshore Cook; Cost Engineer; Buyer; Planner; Project Engineer; Completions Engineer	120	95
TOTAL		**1117**	**802 (corrected)**

18.2 ITEM 18B

The job numbers listed under the "Present-First Gas" column represent a continuation of jobs in the "2023-Present" period. The reduced figures observed for Wellhead Platform and Brownfield Modifications reflect the successful completion of specific project tasks within these categories.

18.3 ITEM 18C

The reduced figures observed for Wellhead Platform and Brownfield Modifications reflect the successful completion of specific project tasks within these categories. As a result, fewer jobs are required for the remaining tasks up to first gas.

18.4 ITEM 18D

18.4.1 ITEM 18D(I)

In addition to our response to 18A, and Appendix 1 of Part 3 Relevant Information to the Project (Shell, 2025), Table 14 provides the breadth of jobs created and/or supported by the Jackdaw Project. This has been separated into development only and development and operation roles:

Table 14: Types of direct jobs created/supported by Jackdaw

Development Only		Development and Operations	
Thermal Insulators	M/LWD Engineer	HVAC Technician	OSV Crew
Instrument Pipefitters	Directional Driller	Process Technician	Helicopter Pilot
Pipefitters	Mud Engineer	Electrical Technician	Helicopter Ground Crew
Riggers	Cementer	Process Engineer	Crane Operator
Design Engineer	Wireline Engineer	Mechanical Engineer	Flotel/W2W Captain
Project Support	Wireline Operator	Electrical Engineer	Flotel/W2W Deck Crew
Roughneck	Medic	Project Manager	Flotel/W2W Marine Crew
Derrickman	Stewards	Commercial Manager	Inspectors
Assistant Driller	Radio Operator	Geologist	Reservoir Engineer
Driller	HSE officer	Geophysicist	Environmental Scientist
Tool Pusher	Company Representative	OSV Captain	Painters/ Blasters
Offshore Installation Manager	Pipelay Vessel Captain		
Rig Electrician	Pipelay Vessel Crew		
Mudlogger	Onshore Waste Processing Operator		
Data Analyst			

18.4.2 ITEM 18D(II)

Specific salaries for current Shearwater roles are included in our response to Item 19C. It is anticipated that the Jackdaw Project roles will be broadly similar.

Looking more broadly at the quality of these roles, Offshore Energies UK (OEUK) has collaborated with employment specialists, employers and trade unions to produce reports and agreements, available on their website, outlining salaries and other compensation for workers in the energy sector, as follows:

- Average basic salary for an offshore oil and gas worker at technician level is £69,695 and at craft level is £64,796, according to the Energy Services Agreement published on the OEUK website. This is based on 161 days worked plus 28 days of holidays. This does not include overtime or other allowances (OEUK, 2025).
- Entry-level roles can range between £43,200 and £61,530 based on the same working days and holidays annually (OEUK, 2025).
- Senior technical and managerial roles can exceed £100,000–£150,000 annually (OEUK, 2025a).
- Non-Monetary Benefits often include comprehensive training programmes, health and safety certifications, and career development opportunities. The shift patterns combined with an annual leave entitlement of 28+ days provides opportunities for long breaks from work and more time off than within other sectors (OEUK, 2025a).

18.5 ITEM 18E

High/low sensitivities were not included in this analysis for the following reason:

Direct Employment: Given that most of the development scope has already been completed and the associated costs incurred, there is a high degree of confidence in the employment figures used for the development phase of the model. For the operational phase, staffing levels on platforms and vessels are relatively rigid in nature, with minimum operating requirements and finite bed space capacity acting as practical constraints on employment variability. This limits the extent to which a meaningful high/low sensitivity range could be applied.

19 ITEM 19

19. The further information provides a breakdown of 'Direct Shearwater Jobs Safeguarded by Jackdaw' in Appendix 2 (page 17). Please provide:

a. Clarification on whether the 300 jobs safeguarded on Shearwater referenced on pages 1 & 5 is a rounded figure of the 273 jobs quoted in Appendix 2.
b. Clarification on whether the 273 jobs to be safeguarded on Shearwater would extend over the lifespan of the Jackdaw project and, if not, an annual profile of the safeguarded jobs.
c. The estimated salaries and any other relevant metric of quality appertaining to those jobs safeguarded on Shearwater.
d. Should the Jackdaw project impact on other infrastructure beyond Shearwater, Adura may wish to provide information on those aspects – for example should the project extend the life of, or better utilise, any existing infrastructure; or support the managed decommissioning of legacy infrastructure. This could include, if applicable, the extent to which the project could become part of a 'low carbon' hub by sharing infrastructure with offshore wind, hydrogen or CCS projects, or could de-risk future opportunities such as a carbon storage, hydrogen or offshore wind project or 'low carbon' hub.

19.1 ITEM 19A

The 300 jobs on Shearwater are comprised of the current 273 jobs for operating the Shearwater host installation, plus 27 new Full Time Equivalent (FTE) roles required for the Jackdaw-specific activities.

19.2 ITEM 19B

We expect that the 273 jobs will remain in service for the life of Jackdaw as the Shearwater host installation will require regular maintenance of the processing units and power generators. The number is consistent with the organisational structure in place today, and there are no major demand variations forecast during the life of the Jackdaw field.

19.3 ITEM 19C

Jackdaw and Shearwater are material to Adura's overall business and the safeguarding of jobs across the salary grades in Adura. Hence salary data for Adura staff and contractors by grade is provided in Table 15 and Table 16, below.

Table 15: Adura salaries by grade (redacted)

Adura Grade	Technical (£/pa)	Non-Technical (£/pa)
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Salary data is confidential and not to be shared publicly
Note: Technical covers engineering and offshore roles, and non-technical includes any support functions

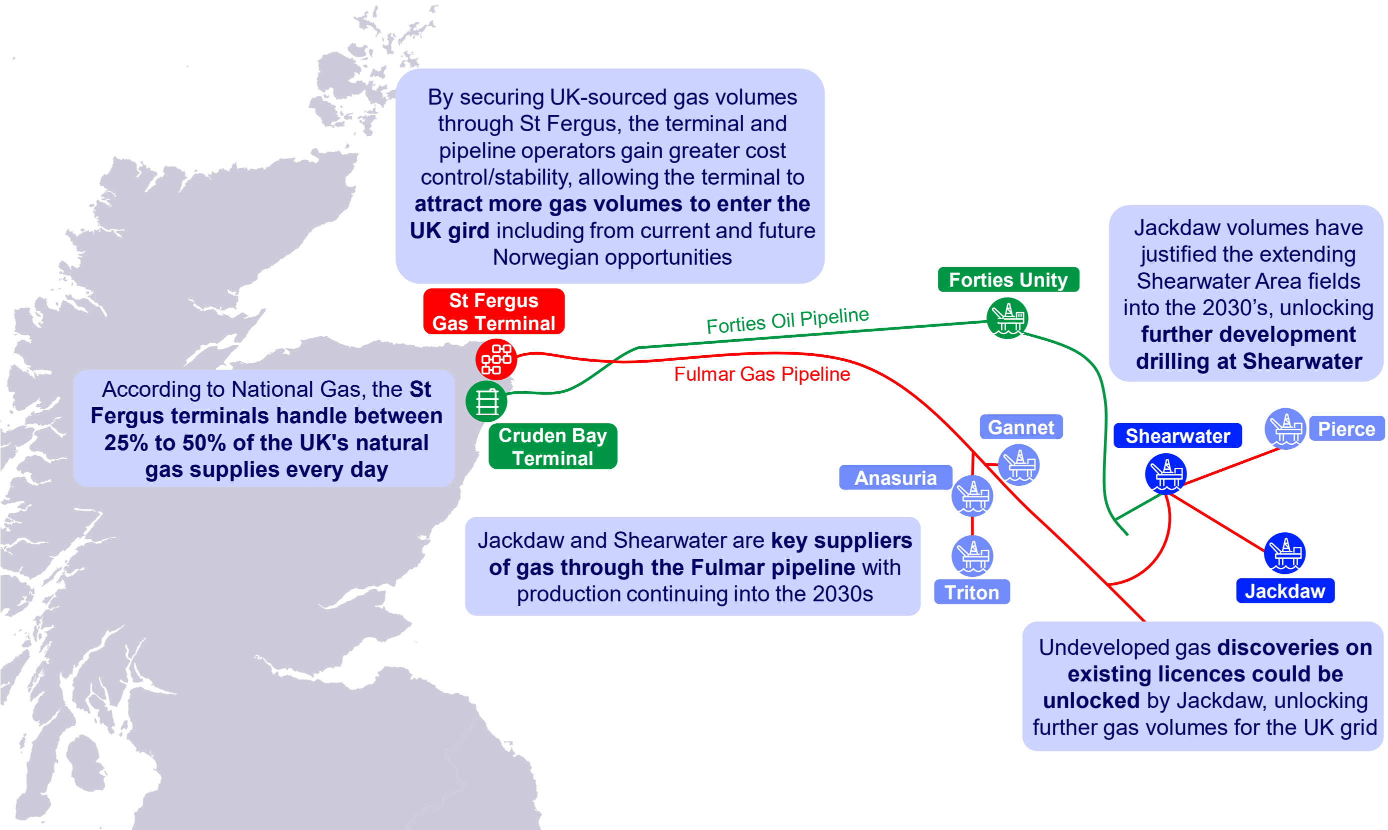
Table 16: Shearwater contractor salaries (redacted)

Contractor	Role	Base rate (£/pa)
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Salary data is confidential and not to be shared publicly
Note: Salaries based on 161 days (7 hours per day) worked plus 28 days holiday

19.4 ITEM 19D

The Jackdaw Project has been designed and developed to make the most of new and existing infrastructure. As shown by Figure 21 below, the Jackdaw Project will directly extend the lifetime of the Shearwater host installation, whilst also ensuring utilisation of pipelines. Together this can provide greater cost control and ensure that assets remain economic.



St Fergus Gas Terminal and associated pipeline and the Forties infrastructure are not Adura assets, however they are a critical part of the value chain for the UK and show clearly how Jackdaw will utilise existing assets to maximise economic output and supply the UK.

Figure 21: Jackdaw and supported infrastructure

20 ITEM 20

20. In regard to the section titled 'The Role of Jackdaw Gas in the UK Energy System' (pages 7-9) please provide a non-corrupted version of figure 4-3.

Please find below Figure 23, a non-corrupted version of Figure 4-3 – Future UK Gas Supply by Source (Wood Mackenzie independent verification).

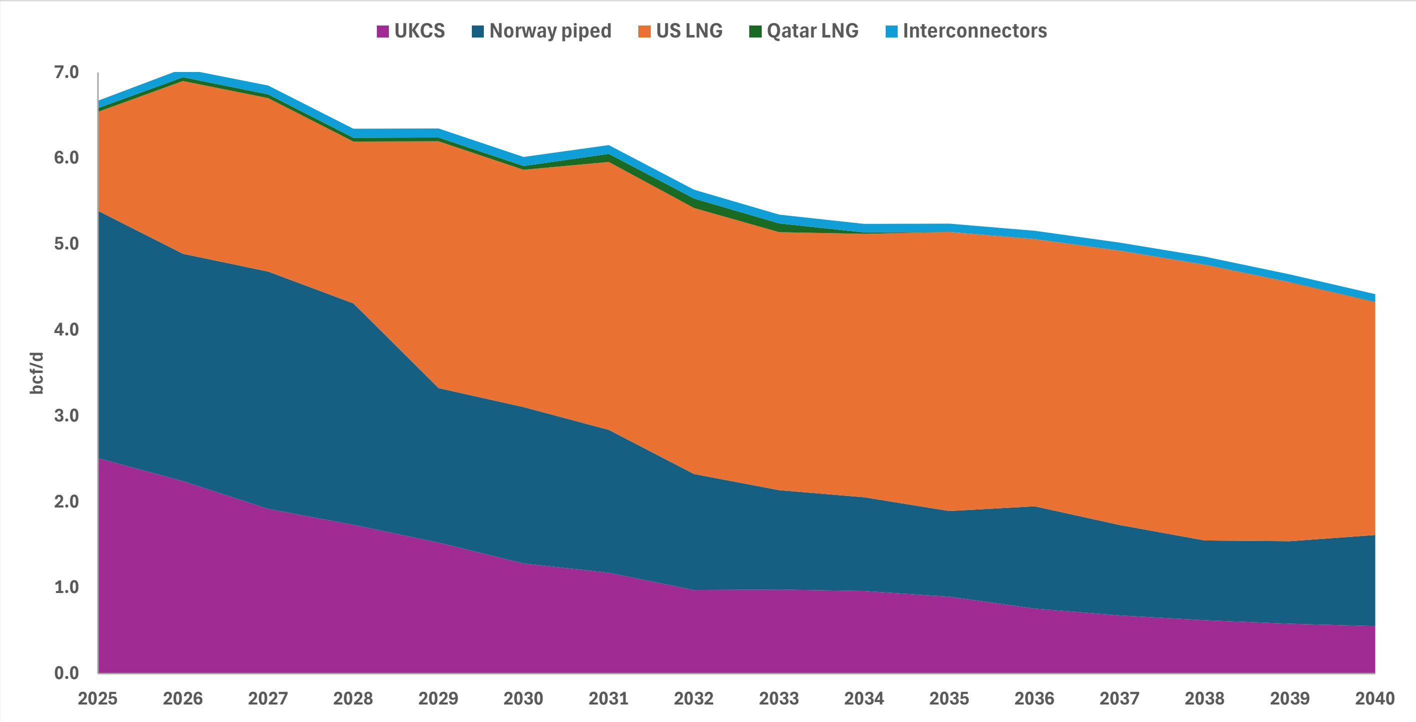


Figure 22: Future UK Gas Supply by Source (Wood Mackenzie independent verification).

APPENDIX 1 BASELINE ENVIRONMENT DETAILED INFORMATION

Appendix 1 provides a high-level summary of relevant scientific literature relating to the current state of the environment. This Appendix has been prepared by Adura by drawing on a range of respected, publicly available scientific sources. This Appendix summarises and paraphrases information from those sources and does not express the views or opinions of Adura. While efforts have been made to reflect the content of the underlying sources accurately, the summaries necessarily involve simplification and are not intended to constitute an exhaustive description of every aspect of that source. Readers should refer to the original sources for the full analysis

GLOBAL SURFACE TEMPERATURE

The Met Office reports that over the past century, global temperatures have risen significantly, largely due to increased GHG emissions. Currently, the Earth's average surface temperature is approximately 1.1°C higher than pre-industrial levels (see Figure 23) (Met Office, 2026a). Temperature data collected worldwide indicate this warming trend.

Figure 23 illustrates the correlation between atmospheric CO_2 levels and the global mean temperature (Met Office, 2026a). This relationship highlights temperature as a key climate indicator. According to the WMO, recent years have been among the warmest on record; notably, 2024 was the warmest year to date, with an estimated global near-surface temperature about 1.55°C ± 0.13°C above the 1850–1900 baseline (WMO, 2025).

According to the IPCC (IPCC, 2023) "*global net anthropogenic GHG emissions were 59 Gt CO_2eq (+/- 6.6 Gt CO_2eq) in 2019*", with "*the largest share and growth in gross GHG emissions occurring in CO_2 from fossil fuels combustion and industrial processes, followed by methane*". Furthermore, the IPCC (IPCC, 2023) state that "*in 2019, approximately 79% of global GHG emissions came from the sectors of energy, industry, transport and buildings together and 22% from agriculture, forestry and other land use*".

More recently updated GHG emission estimates indicate that total global GHG emissions were 55.4 $GtCO_2$eq (+/- 5.1 $GtCO_2$) in 2023, of which CO_2 emissions from fossil fuel combustion and industry contributed 37.8 $GtCO_2$eq (+/- 3.0 $GtCO_2$) (Forster *et. al*, 2025).

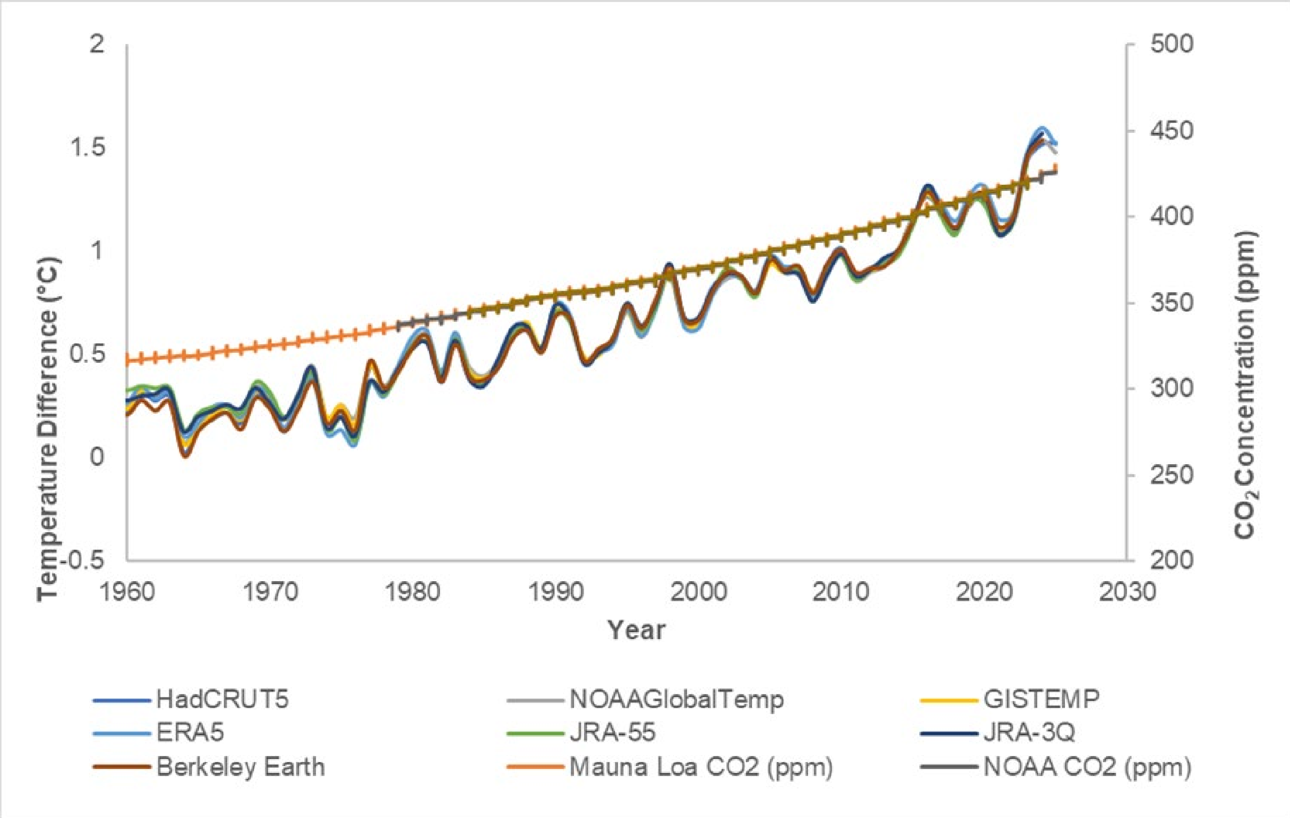


Figure 23: Correlation between carbon dioxide concentrations in the atmosphere and annual global mean temperature difference from pre-industrial conditions [Extrapolated (Met Office, 2026a)].

The Emissions Database for Global Atmospheric Research (EDGAR) provides country by country estimates of GHG emissions (excluding land use, land use change, and forestry) from 1990 to 2024 (EDGAR, 2025). EDGAR estimates that total global GHG emissions during this period have risen by 65%. Furthermore, EDGAR provides estimates of country by country fossil fuel based CO_2 emissions from 1990 to 2024. During this period, global fossil fuel-based CO_2 emissions have risen by 75%.

The Intergovernmental Panel on Climate Change (IPCC) AR6 (IPCC, 2023) states a "*near-linear relationship between cumulative CO_2 emissions and global temperature rise.*" and that *"Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and the Greenhouse Gases occur in the coming decades."* (IPCC, 2021).

EXTREME WEATHER AND CLIMATE EVENTS

An extreme weather event is defined by the IPCC as "*an event that is rare at a particular place and time of year*" and an extreme climate event is defined as "*a pattern of extreme weather that persists for some time, such as a season*" (IPCC, 2021).

According to the IPCC, "*Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones and, in particular, their attribution to human influence, has strengthened since [the fifth IPCC Assessment Report 2014] AR5*" (IPCC, 2021).

Current observations reported by the IPCC of global temperature extremes, heavy precipitation and droughts are presented in further detail below and summarised in Figure 24. Table 18 summarises information obtained from IPCC of the projected increases in frequency and intensity increase of these extreme weather events relative to the 1850-1900 baseline.

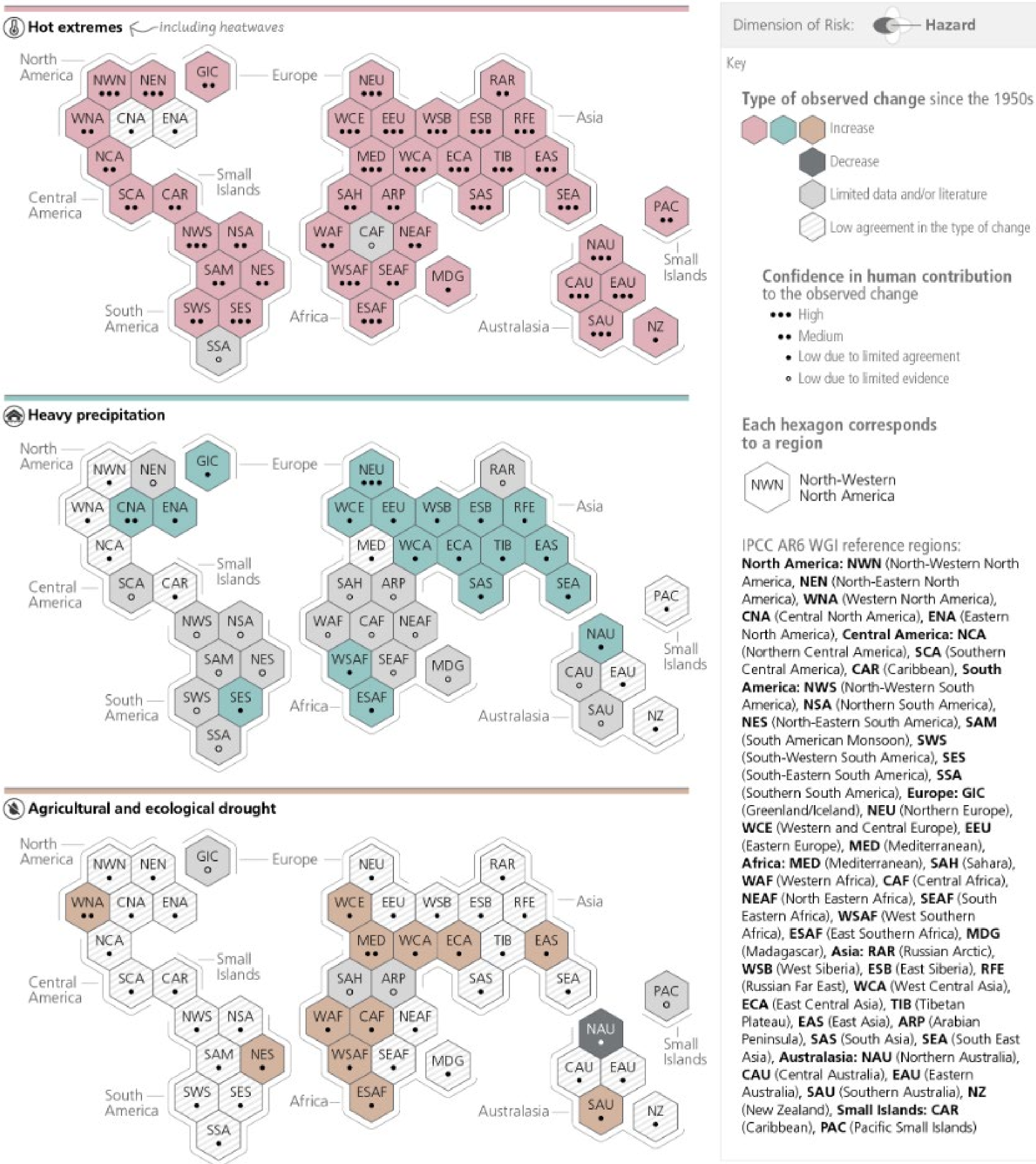


Figure 24: Summary of globally observed changes since the 1950s in temperature extremes (including heatwaves), heavy precipitation and drought, and the confidence level in the role of human influence to the observed changes (IPCC, 2023).

Temperature Extremes

According to the IPCC, since 1950 there has been an increase in frequency and intensity of global hot extremes and a decrease of cold extremes. Heatwaves have also become more intense, longer lasting, and more frequent worldwide. These trends are likely evident across Europe, Asia, Australia, and North America, with moderate to high confidence in Africa and South America. Notably, land-based minimum temperatures have increased around 3 times more than global surface temperatures since the 1960s, particularly in the Arctic (IPCC, 2021).

Heavy Precipitation

The IPCC notes that heavy precipitation events have increased in frequency and intensity across most global land regions. Since 1950, the annual maximum precipitation occurring over a day and 5‑day periods has likely increased in more regions than it has decreased. At the continental scale, heavy precipitation has likely intensified across North America, Europe, and Asia. However, there remains very low confidence in observed changes in extreme precipitation occurring over shorter periods (i.e. less than a day) due to limited data and a small number of relevant studies (IPCC, 2021).

Droughts

Droughts are defined by the IPCC as extended periods of significantly reduced moisture, often affecting large regions, in which limited water availability results in adverse impacts on natural systems and economic sectors (IPCC, 2021). The four common types of drought types are: meteorological drought, agricultural drought, ecological drought and hydrological drought. These are defined further by the Met Office in Table 17.

Global observations noted by IPCC show that droughts have become more widespread and impactful in recent decades. While drought trends vary by region and drought type, there is strong evidence that agricultural and ecological droughts have increased globally from the 1950s onwards (IPCC, 2021).

Table 17: Definitions of common drought types (Met Office, 2026b).

Drought Type	Definition
Meteorological	A period of below-average precipitation for a region, lasting from weeks to months or longer.
Agricultural	Occurs when reduced rainfall and higher temperatures lower soil moisture, limiting water availability for crops and/or natural vegetation.
Ecological	Develops when prolonged soil moisture deficits and heat causes stress or damage to ecosystems such as forests, wetlands and greenlands.
Hydrological	Occurs when persistent lack of rainfall reduces water availability in rivers, lakes, reservoirs and groundwater, impacting water supply.

According to Sergio *et. al*, globally there is no clear long-term trend in meteorological drought based on global precipitation records, with observed changes limited to a few regions rather than representing a global pattern (Sergio *et. al*, 2022). Sergio *et. al* further state that increases in temperature have raised atmospheric evaporative demand, causing soils, vegetation, rivers, and reservoirs to dry out more rapidly. This has led to more severe and longer-lasting agricultural and ecological droughts, even in some regions where rainfall has not declined significantly. This drying effect has been the strongest in warm seasons and is particularly noticeable in mid-latitude and subtropical regions (Sergio *et. al*, 2022).

According to IPCC, drought indices that incorporate temperature-driven evaporation e.g. (Standardised Precipitation-Evapotranspiration Index (SPEI)) indicate slightly greater increases in drought frequency and severity over recent decades than precipitation-only indices (e.g. Standardised Precipitation Index (SPI)), particularly in regions experiencing drying such as Western and Southern Africa, the Mediterranean, and East Asia. This is consistent with observed declines in soil moisture. Figure 25 shows observed worldwide trends in drought and precipitation indices from 1951-2016 (IPCC, 2021).

Rodell & Li report that satellite observations over the past two decades also confirm that extreme dry events are occurring more frequently and with greater intensity. These datasets show an increase in both the duration and spatial extent of droughts across multiple continents, linked closely to global warming (Rodell & Li, 2023).

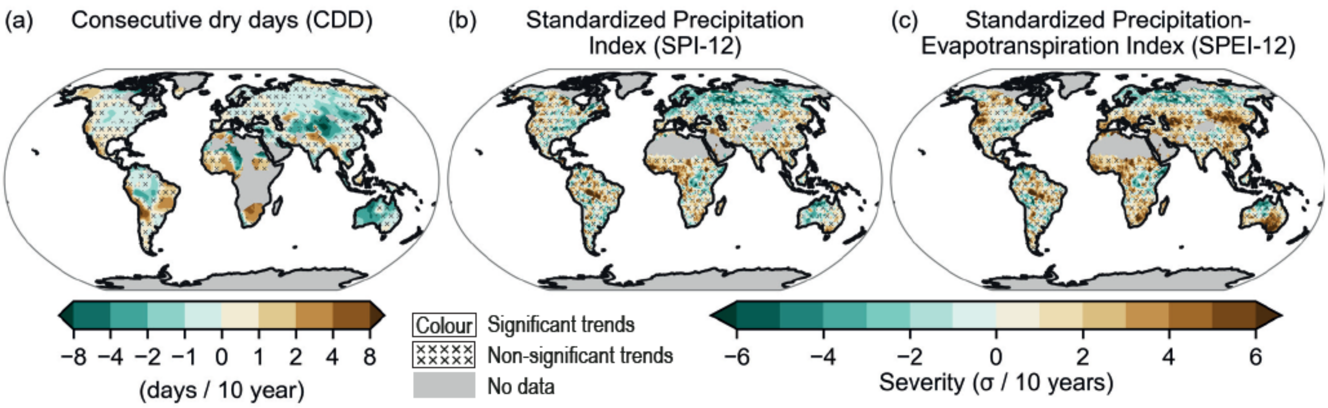


Figure 25: Observed linear trend for (a) consecutive dry days (CDD) during 1960–2018, (b) SPI and (c) SPEI during 1951-2016 (IPCC, 2021).

According to the IPCC, overall current global observations indicate that droughts are becoming more intense, longer-lasting, and more damaging, particularly for agriculture and ecosystems. As stated by the IPCC in AR6 (IPCC, 2023), *"human influence has contributed to increases in agricultural and ecological droughts in the dry season in some regions due to increases in evapotranspiration. The increases in evapotranspiration have been driven by increases in atmospheric evaporative demand induced by increased temperature, decreased relative humidity and increased net radiation over affected land areas."*

Table 18 summarises the IPPC projected increase in frequency and intensity of hot temperature extremes, heavy precipitation and agricultural and ecological droughts under 1.5°C, 2°C and 4°C warming scenarios (IPCC, 2021).

Table 18: Projected changes in the intensity and frequency of hot temperature extremes over land, extreme precipitation over land, and agricultural and ecological droughts in drying regions (IPCC, 2021).

	1850-1900 Baseline*	Current Observations (1°C)	Future Global Temperature Increase		
			1.5°C	2°C	4°C
Hot temperature extremes over land**					
Frequency per 10 years	Once	Now likely occurs 2.8 times (1.8 – 3.2)	Will likely occur 4.1 times (2.8 – 4.7)	Will likely occur 5.6 times (3.8 – 6.0)	Will likely occur 9.4 times (8.3 – 9.6)
Intensity Increase	-	+1.2°C warmer	+1.9°C warmer	+2.6°C warmer	+5.1°C warmer
Frequency per 50 years	Once	Now likely occurs 4.8 times (2.3 – 6.4)	Will likely occur 8.6 times (4.3 – 10.7)	Will likely occur 13.9 times (6.9 – 16.6)	Will likely occur 39.2 times (27.0 – 41.4)
Intensity Increase	-	+1.2°C warmer	+2.0°C warmer	+2.7°C warmer	+5.3°C warmer
Heavy precipitation over land***					
Frequency per 10 years	Once	Now likely occurs 1.3 times (1.2 – 1.4)	Will likely occur 1.5 times (1.4 – 1.7)	Will likely occur 1.7 times (1.6 – 2.0)	Will likely occur 2.7 times (2.3 – 3.6)
Intensity Increase	-	+6.7% wetter	+10.5% wetter	+14.0% wetter	+30.2% wetter
Agricultural & ecological droughts in drying regions****					
Frequency per 10 years	Once	Now likely occurs 1.7 times (0.7 – 4.1)	Now likely occurs 2.0 times (1.0 – 5.1)	Now likely occurs 2.4 times (1.3 – 5.8)	Now likely occurs 4.1 times (1.7 – 7.2)
Intensity Increase	-	+0.3 standard deviations drier	+0.5 standard deviations drier	+0.6 standard deviations drier	+1.0 standard deviations drier

*Projected changes are shown at global warming levels of 1°C, 1.5°C, 2°C, and 4°C and are relative to a baseline of 1850–1900 which represents a climate without human influence.

**Hot temperature extremes are defined as the daily maximum temperatures over land that were exceeded on average once in a decade (10-year event) or once in 50 years (50-year event) during the 1850–1900 baseline.

***Extreme precipitation events are defined as the daily precipitation amount over land that was exceeded on average once in a decade during the 1850–1900 baseline.

****Agricultural and ecological drought events are defined as the annual average of total column soil moisture below the 10th percentile of the 1850–1900 baseline. Intensity changes are expressed as fractions of standard deviation of annual soil moisture.

GLOBAL MEAN SEA LEVEL

According to the IPPC, global mean sea level rose by approximately 0.16 m (0.12 - 0.21 m) between 1902 and 2015. The rate of sea level rise has increased significantly in recent decades, reaching 3.6 mm per year (3.1 – 4.1 mm per year) between 2006–2015. This is approximately 2.5 times higher than the mean rate of 1.4 mm per year (0.8 – 2.0 mm per year) observed during 1901–1990 (IPCC, 2021).

WMO reports that between 2015 to 2025, the mean rate of sea level rise was approximately 4.75 ± 0.3 mm per year (WMO, 2026). In recent years, satellite observations show that global mean sea level rose rapidly by around 5mm during 2023 and 2024, driven by a strong El Niño that ended in early 2024. Sea level remained similarly high in 2025 as conditions shifted toward a weak La Niña, resulting in a smaller annual rise than the previous period. By the end of 2025, global mean sea level was approximately 11 cm higher than in 1993. Figure 26 shows the change in global mean sea level from the start of satellite records in 1993 to 2025 (WMO, 2026).

According to the IPCC recent sea level rise is primarily driven by mass loss from glaciers and ice sheets at a rate of 1.8 mm per year (1.7 – 1.9 mm per year) during 2006–2015 and this exceeds the contribution from thermal expansion of ocean water over the same period at a rate of 1.4 mm per year (1.1 – 1.7 mm per year). According to the IPCC, ice loss from the Greenland and Antarctic ice sheets has increased substantially, contributing to an acceleration in sea level rise (IPCC, 2021).

According to the WMO, while sea level has increased across nearly all oceans since 1993, the fastest rises have occurred in parts of the Pacific, particularly the tropical and south-western regions, whereas slower rises have been observed in the eastern Pacific, southern Indian Ocean, and parts of the North Atlantic (WMO, 2026).

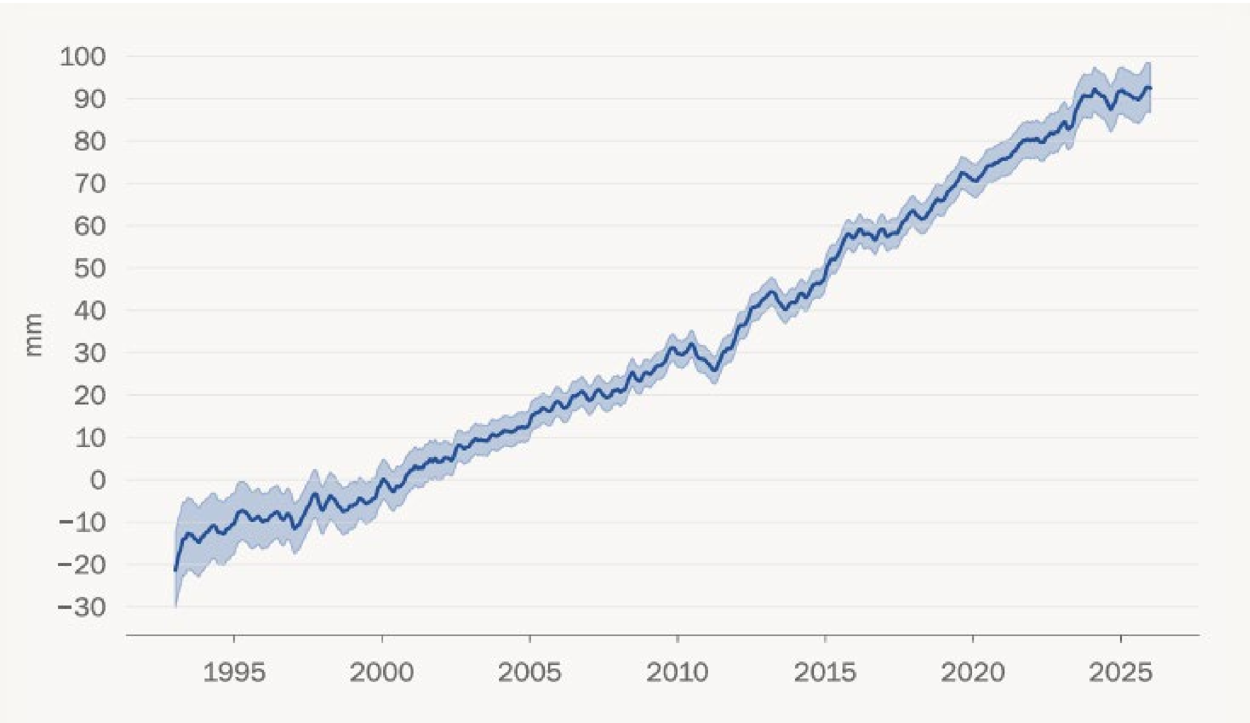


Figure 26: Global mean sea level change (change from January 1993 in mm) shown for 1993–2025 (with the seasonal cycle removed from the data and uncertainty represented by the shaded area) (WMO, 2026).

According to the IPCC's Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC, 2019), "*the dominant cause of global mean sea level rise since 1970 is anthropogenic forcing*". Ice sheet mass loss has intensified, with Antarctic ice mass loss tripling and Greenland ice mass loss doubling in the most recent decade compared to the previous one. The IPCC concludes this ongoing acceleration represents a key risk for long-term coastal impacts (IPCC, 2019).

CRYOSPHERE CHANGES

The IPCC's Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC, 2019) highlights that, *"Over the last decades, global warming has led to widespread shrinking of the cryosphere, with mass loss from ice sheets and glaciers, reductions in snow cover and Arctic sea ice extent and thickness, and increased permafrost temperature."* The IPCC also reports that between 2006 and 2015:

- The Greenland Ice Sheet lost ice at an average rate of 278 ± 11 Gt per year (equivalent to 0.77 ± 0.03 mm per year of global sea level rise), mainly from surface melting.
- The Antarctic Ice Sheet lost ice mass at an average rate of 155 ± 19 Gt per year (0.43 ± 0.05 mm per year), largely driven by the rapid thinning and retreat of major glaciers flowing out of the West Antarctic Ice Sheet.
- Glaciers outside of Greenland and Antarctica have lost ice mass at an average rate of 220 ± 30 Gt per year (equivalent to 0.61 ± 0.08 mm per year sea level rise) (IPCC, 2019).

The IPCC also reports that since the 1980s, permafrost has warmed to record levels, with warming of up to 2–3°C observed at depths of approximately 10–20 m in some locations compared with temperatures recorded 30 years ago. Further reporting by the IPCC states that the rate of permafrost temperature increase was around 0.29°C ± 0.12°C between 2007 to 2016 across polar and high mountain regions worldwide. According to the IPCC, an estimated 1460-1600 Gt organic carbon is stored in arctic and boreal permafrost, almost double the amount of carbon currently in the atmosphere. While there is some evidence that thawing permafrost may be increasing CH_4 and CO_2 emissions, scientific agreement on this is limited. The IPCC reports that thawing permafrost, combined with retreating glaciers, has also reduced the stability of slopes in many high-mountain regions (IPCC, 2019).

The IPCC reports that between 1979 and 2018, Arctic sea ice declined during all months throughout the year, with sea ice reductions in September being around 12.8 ± 2.3% per decade. Additionally, the IPCC reports that Arctic sea ice has thinned, with much older ice disappearing. According to the IPCC, these losses have amplified warming in the Arctic to more than twice the global average. In contrast, Antarctic sea ice shows no clear long-term trend due to strong regional differences (IPCC, 2019).

WMO reports that in 2025, both Arctic and Antarctic sea-ice extents remained below their respective 1991–2020 averages throughout the year, as shown in Figure 27. WMO further reports that Arctic sea ice recorded one of the lowest annual average extents since 1979, at 10.10 ± 0.33 million km² (approximately 0.9 million km² below the long-term mean). WMO noted that Antarctic sea ice also remained notably low, with the 2025 annual average ranking as the third lowest on record, at 10.81 ± 0.26 million km², exceeded only by the unusually low extents observed in 2023 and 2024 (WMO, 2026).

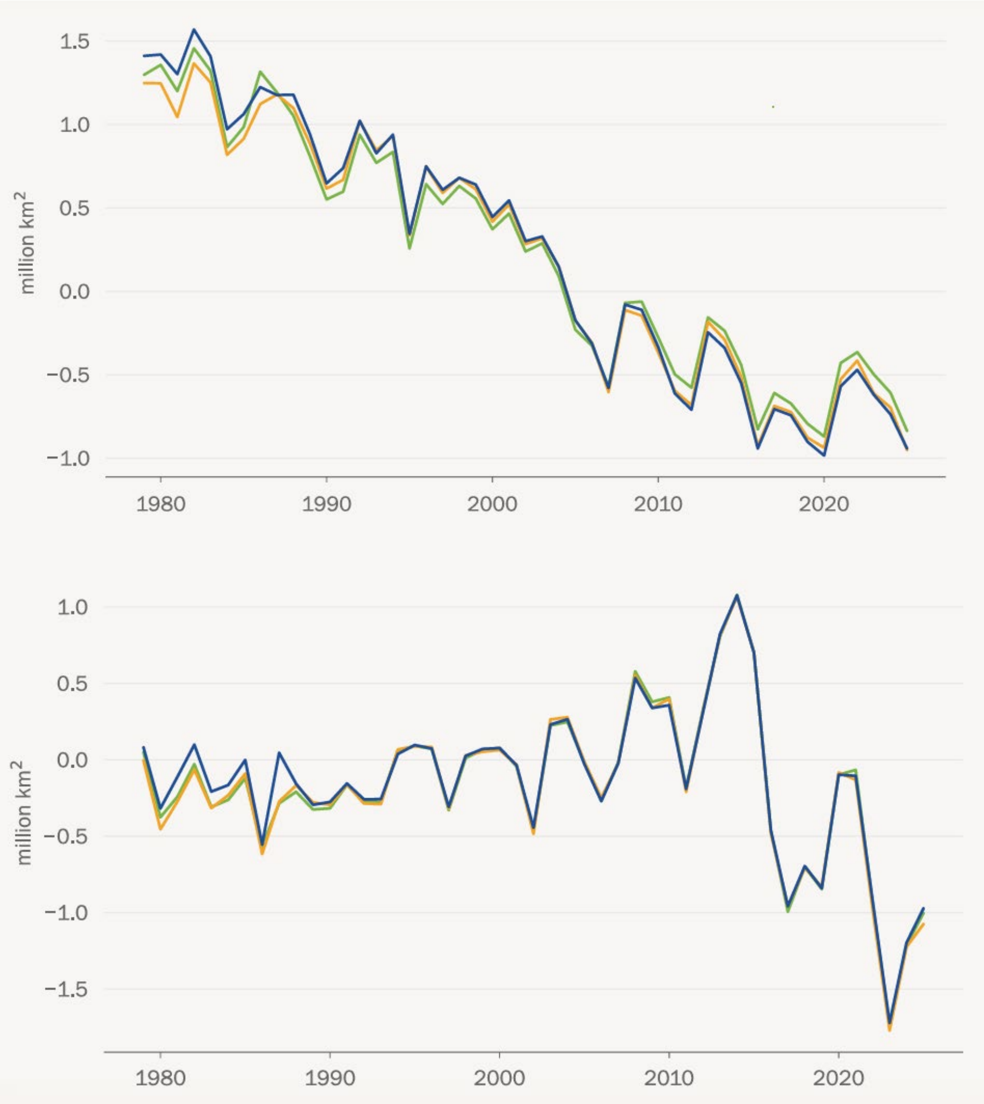


Figure 27: Annual Arctic (upper panel) and Antarctic (lower panel) sea-ice extent anomalies in millions of square kilometres from 1979-2025 (relative to the 1991–2020 average). Data sets from 3 sources are shown: the USA National Snow and Ice Data Center (NSIDC), Japan Aerospace Exploration Agency (JAXA) and OSI SAF (WMO, 2026).

OCEANIC CHANGES

OCEANIC WARMING

Ocean Surface Temperatures

The IPCC reports that the ocean surface has warmed significantly since pre-industrial times. The IPCC further reports that, compared to the late 1800s (1850–1900), the average ocean surface temperature has increased by around 0.88°C (0.68°C – 1.01°C) in 2011-2020. The IPCC considers that most of this warming, around 0.6°C (0.44°C - 0.74°C) has occurred since 1980, showing that ocean warming has accelerated in recent decades (IPCC, 2021).

Figure 28, using data from the Met Office, shows the change in global average sea-surface temperature from 1850 to 2025, expressed as a difference relative to the 1981-2010 average (with values below 0°C indicating cooler conditions and values above 0°C indicator warmer conditions than the reference period). A long-term increase in global sea-surface temperatures is reported by the Met Office, with especially rapid warming since the late 20th century. This trend is visible in both independent datasets (HadSST4 and ERSSTv5) shown in Figure 28, reinforcing the conclusion of the Met Office that the world's oceans are warming over time (Met Office, 2026a).

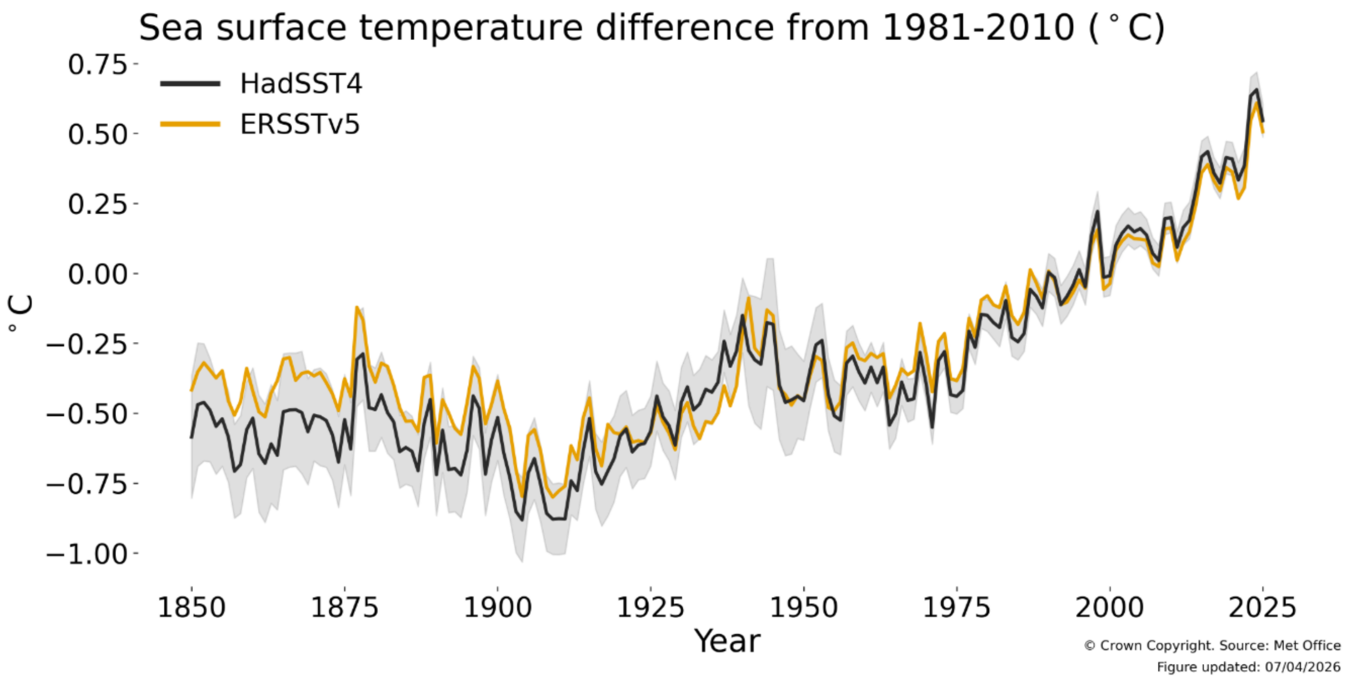


Figure 28: Annual global mean sea-surface temperature difference from 1850 to 2025 relative to the 1981-2010 average (Met Office, 2026a).

Ocean Heat Content

Annual ocean heat content from 1960-2025, from the WMO, is shown in Figure 29. According to the WMO, in 2025 global ocean heat content in the upper 2,000 m of the ocean reached a new record since observations began in the 1960s, surpassing the previous record set in 2024 by 24 ± 16 ZJ. The WMO also reports that the rate of ocean warming increased to 11.0–12.2 ZJ per year over 2005–2025, more than double the 1960–2005 rate of 3.05–3.91 ZJ per year (WMO, 2026).

Observations show that global ocean heat content has increased steadily since the 1970s, with the rate predominantly driven by human influence (IPCC, 2021). WMO reports global ocean heat content rose by an average of 5.8 ± 0.5 ZJ per year across the ocean basin between 1971 and 2025. Over the same period, the deep ocean (2,000–6,000 m) also warmed, at a rate of 1 ± 0.2 ZJ per year (WMO, 2026).

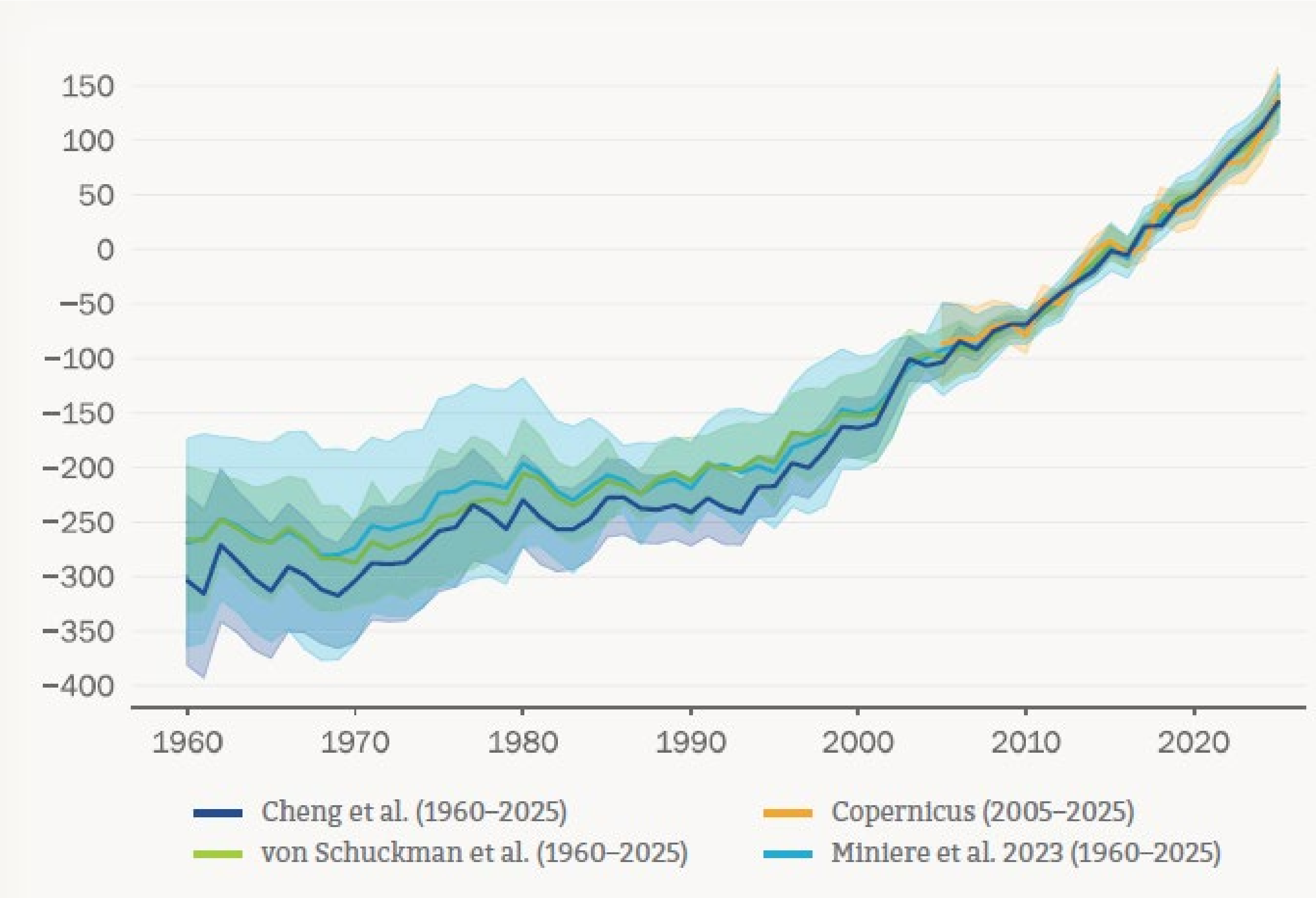


Figure 29: Annual global ocean heat content (zettajoules (ZJ) down to 2,000 m depth for the period 1960–2025. One ZJ is the equivalent of 10^{21} Joules. The shaded area represents the uncertainty (WMO, 2026).

The IPCC reports that marine heatwaves have become more frequent, longer, and more intense, since the 1980s. During the 1982-2016 reference period, their global frequency doubled, the average number of marine heatwave days per year increased from approximately 2.5 to 5 days, and their intensity rose by around 0.15°C. According to the IPCC, marine heatwaves are projected to increase several-fold this century, particularly in tropical oceans and the Arctic (IPCC, 2019).

At the same time, the IPCC considers that the upper ocean has become more stratified due to surface warming and freshening, reducing mixing with deeper waters. This stratification is expected to continue increasing throughout the 21st century, with important effects on ocean circulation and ecosystems (IPCC, 2019).

OCEANIC ACIDIFICATION

The physical-chemical process by which the ocean absorbs CO_2 is often called the air-sea CO_2 exchange and carbonate chemistry system, which involves a sequence of linked physical and chemical steps.

Atmospheric CO_2 diffuses across the air-sea interface into surface seawater, with the rate of uptake controlled by factors including:

- The CO_2 partial-pressure gradient between air and surface ocean
- Wind speed and turbulence

- Sea temperature (with colder waters absorbing more CO_2).

When atmospheric CO_2 concentrations exceed those in surface waters, net transfer occurs into the ocean.

Once dissolved in seawater, CO_2 reacts with water to form carbonic acid, which subsequently dissociates. This process reduces the concentration of carbonate (CO_3^{2-}) ions while increasing bicarbonate (HCO_3^-) and hydrogen (H^+) ion concentrations. The resulting shift in carbonate chemistry toward a less alkaline state is commonly referred to as ocean acidification (IPCC, 2023).

According to the IPCC, since the 1980s the ocean has absorbed an estimated 20-30% of anthropogenic CO_2 emissions, leading to increased ocean acidification. As a result, surface ocean pH has fallen by around 0.017 – 0.027 pH units per decade since the late 1980s, as shown by the WMO in Figure 30. For over 95% of the ocean's surface, the drop in pH is now outside the range of normal, natural fluctuations and, according to the IPCC, is likely to have been caused by human driven activities (IPCC, 2019).

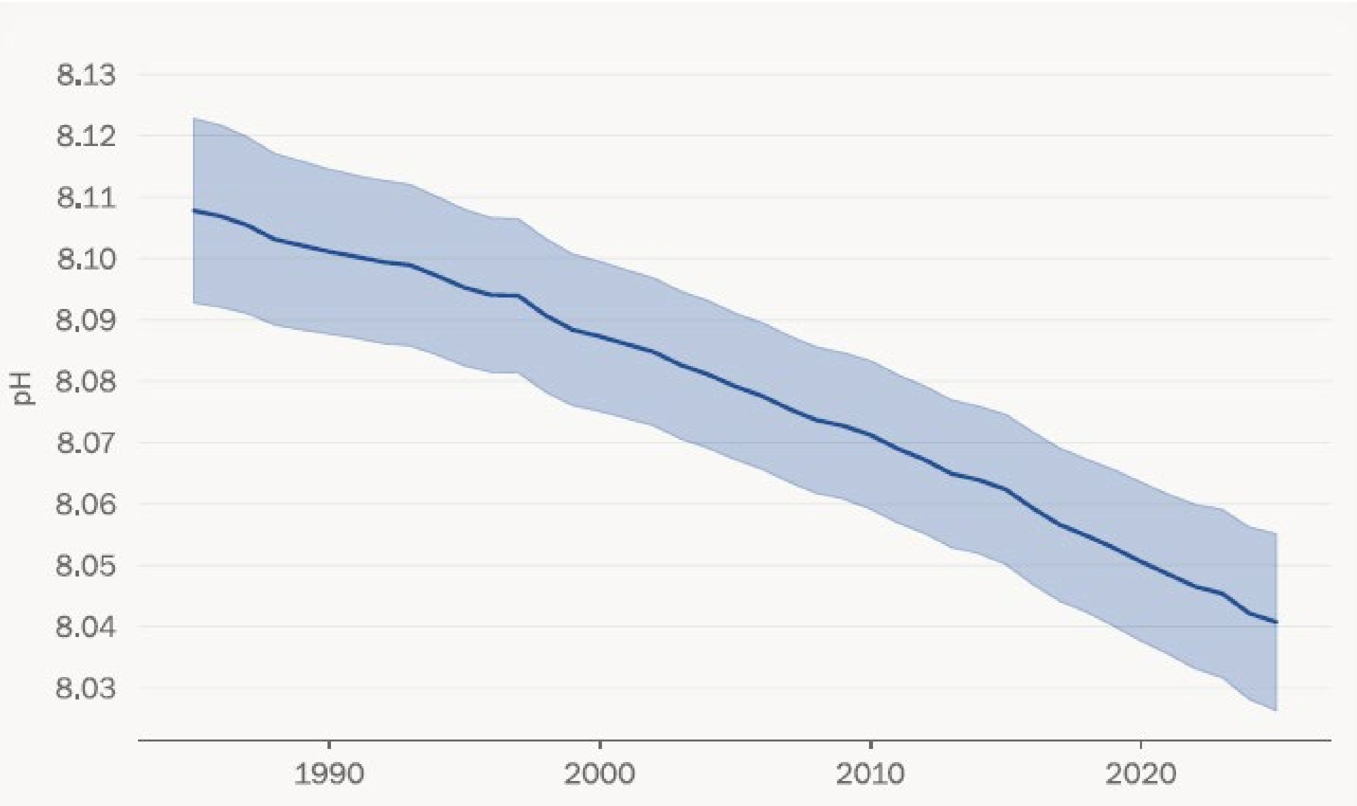


Figure 30: Annual global mean surface ocean pH from 1985 to 2025. The dark line represents the central estimate, while the shaded area indicates the uncertainty range (WMO, 2026).

The WMO reports that regional patterns in surface ocean pH change are uneven. The strongest declines in surface pH have been observed by the WMO in the Indian Ocean, Southern Ocean, eastern equatorial Pacific, northern tropical Pacific, and parts of the Atlantic Ocean. Collectively, these regions represent approximately 47% of the sampled global ocean and, according to the WMO, exhibit rates of surface ocean acidification that exceed the global mean (WMO, 2026).

BIODIVERSITY

Biodiversity is the variety of life on Earth and the natural systems that support it. It is essential as it underpins the fundamental biological and ecological processes that sustain life. Biodiversity is the essential foundation and regulator that enables ecosystem services, supporting clean air and water, food production, climate regulation, pollination, disease control, and other critical processes essential to human survival and wellbeing.

According to the WWF, habitat loss and fragmentation are the leading causes in all global regions of biodiversity decline, driven primarily by the conversion of natural ecosystems such as forests, wetlands, and grasslands into agricultural land, urban areas, and infrastructure. According to the WWF, this is followed by pressures from overexploitation, invasive species, and disease. Additional threats include climate change, which is most frequently highlighted by the WWF in Latin America and the Caribbean, and pollution, which is particularly prominent in North America and the Asia-Pacific region (WWF, 2024).

According to the IPCC, a diverse ecosystem is more resilient to environmental changes like climate change. However, climate change has caused widespread and detectable changes across marine, terrestrial and freshwater ecosystems worldwide. Figure 31 shows the confidence levels of the IPCC associated with climate change impacts on changes to ecosystem structure, species range shifts and changes in seasonal timing in terrestrial, freshwater and ocean ecosystems globally (IPCC, 2022).

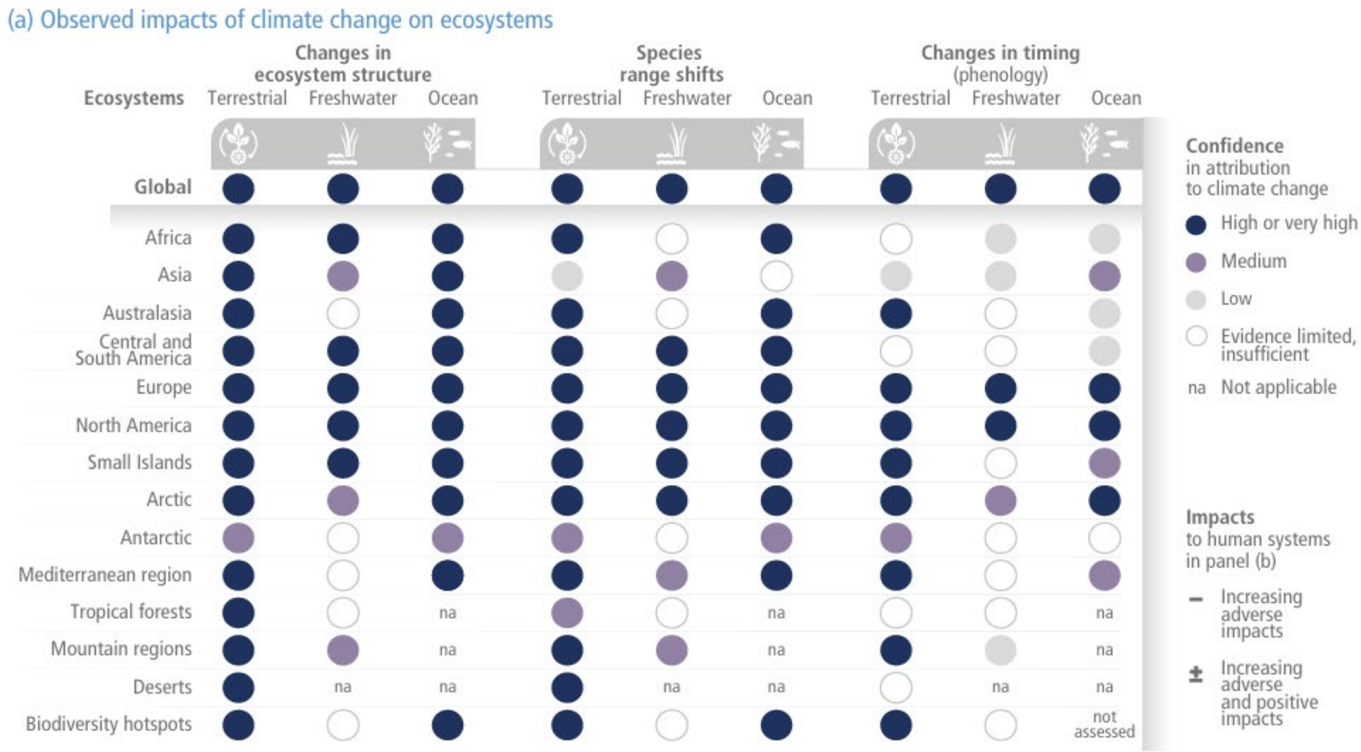


Figure 31: Observed global and regional impacts on ecosystems (IPCC, 2022).

According to the IPCC, these impacts have occurred earlier than previously projected, and over broader geographic areas with more severe consequences. As stated by the IPCC, many organisms show biological responses such as altered physiology, growth rates, population size, geographic range shifts, and changes in seasonal timing. These responses are often insufficient to keep pace with the rapid rate of recent climate change. As an example and as stated by IPCC, Figure 32 illustrates the observed shifts in the latitudinal geographic ranges of different marine species from 1955 to 2015 and shows a decline in marine species richness around the equator and in the Arctic (IPCC, 2022).

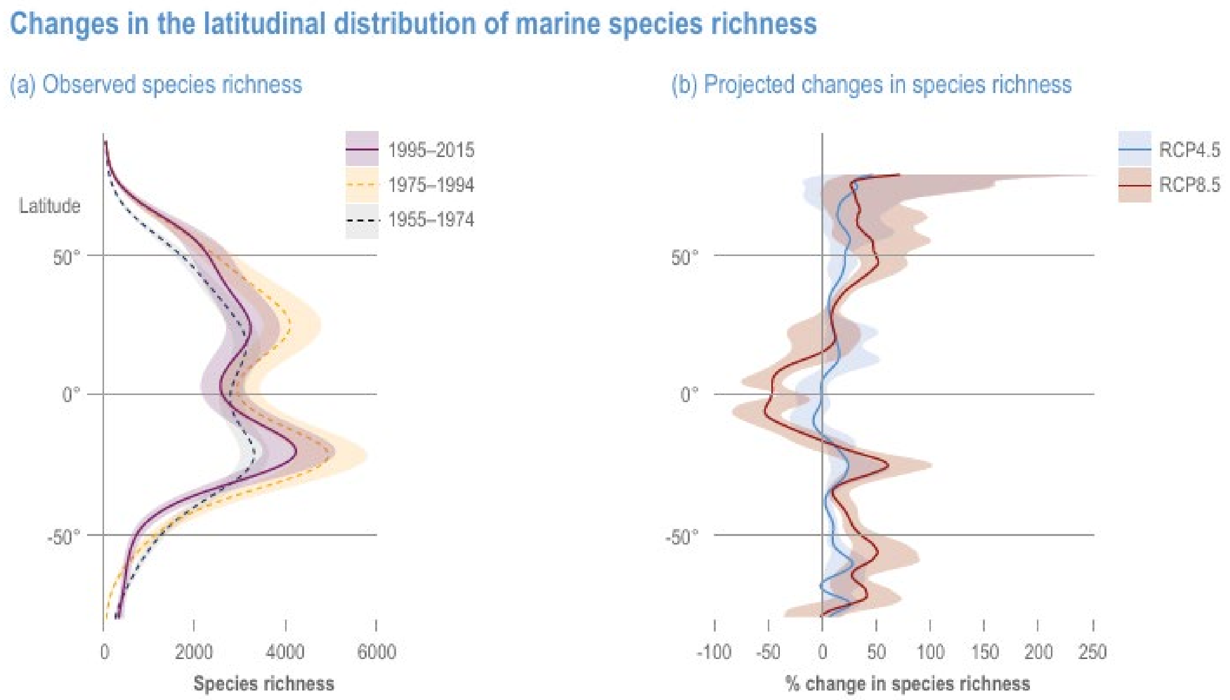


Figure 32: Changes in the latitudinal distribution of observed marine species richness (based on 48,661 marine species) for three historical periods (1955-1974, 1975-1994, 1995-2015) (IPCC, 2022).

As a result, climate change has driven local species losses and increased the prevalence of disease. In some cases, these pressures have contributed to climate-driven extinctions (IPCC, 2022).

In addition, ecosystems are being structurally reorganised, alongside intensified wildfire activity and increases in burned area, with climate change driving an estimated 15.8% increase in global burned area between 2003 and 2019 (Burton, 2024). The capacity of ecosystems to deliver key services, such as food production, water regulation, and climate buffering, has declined.

"The Living Planet Index (LPI) [tracks] recent changes in nature from 1970 to the present by tracking the size of animal populations and how they are changing and is an early warning indicator of increasing extinction risk and the potential loss of ecosystem function and resilience", as shown in Figure 33 (WWF, 2024).

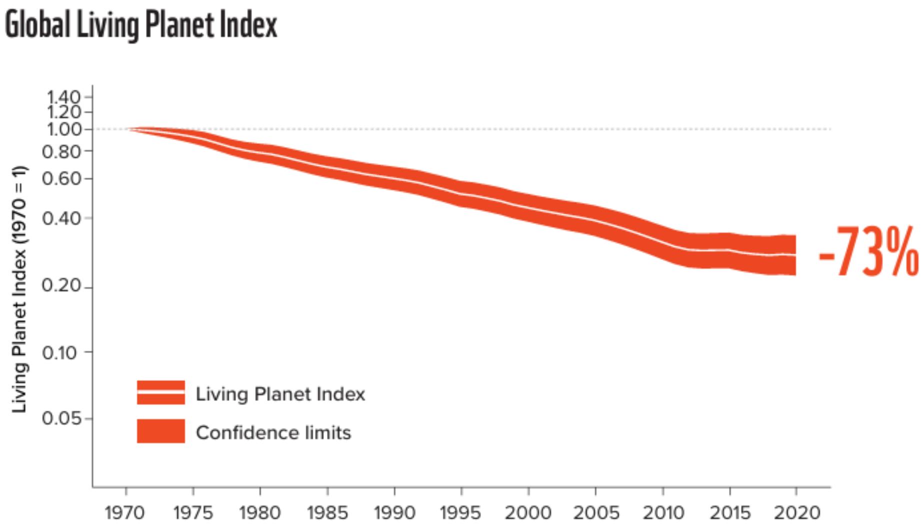


Figure 33: The global Living Planet Index (1970 to 2020) based on 34,836 monitored populations representing 5,495 vertebrate species. The index is shown by the white line, with shaded areas illustrating statistical uncertainty (WWF, 2024).

Figure 34 shows the steepest declines have occurred in freshwater ecosystems (85%), followed by terrestrial (69%) and marine systems (56%) (WWF, 2024). These trends reflect changes in population abundance rather than absolute species extinctions, but they signal ecosystem stress according to WWF.

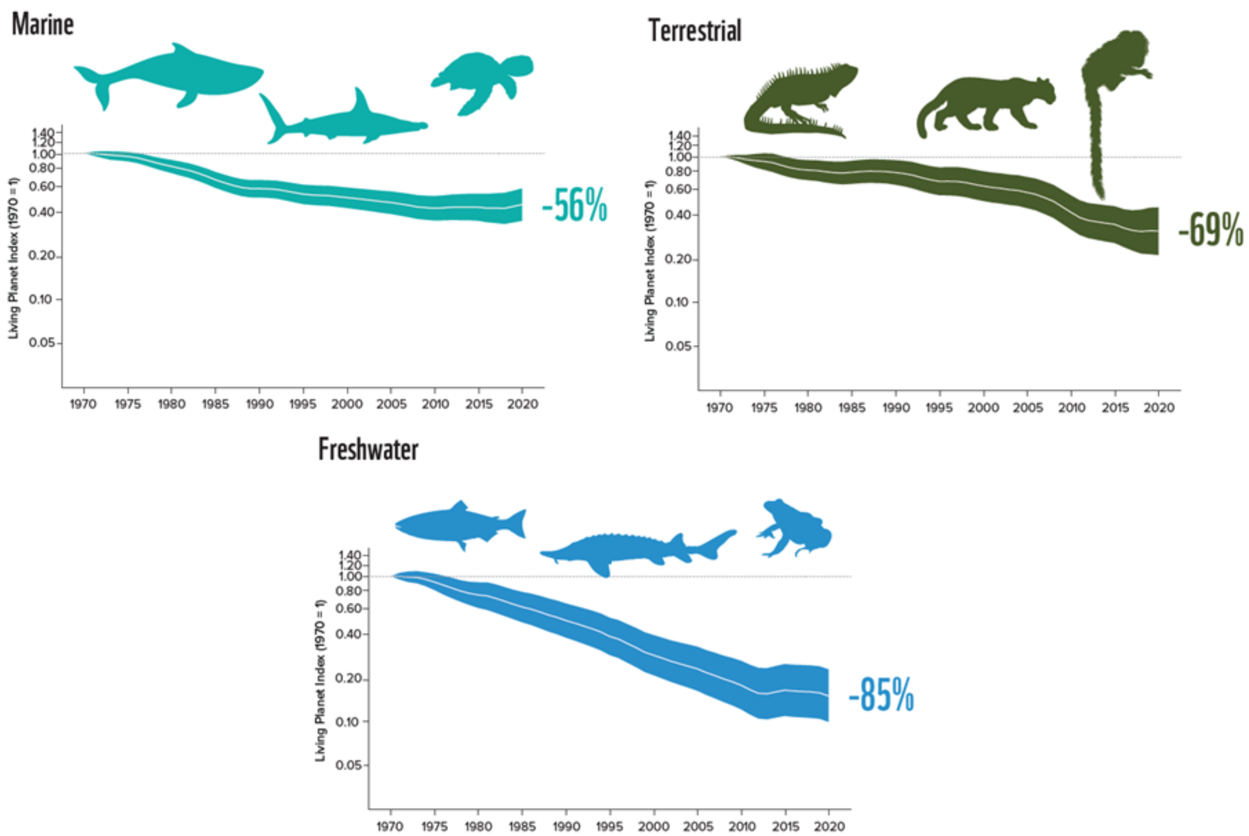


Figure 34: The Living Planet Index trends by ecosystem type (1970-2020), incorporating data from 16,909 populations of 1,816 marine species, 11,318 populations of 2,519 terrestrial species and 6,609 populations of 1,472 freshwater species (WWF 2025).

Coral Reefs

Coral reefs are a key example of highly biodiverse ecosystems, supporting around 25% of all marine species while occupying just 0.2% of the ocean (IPCC, 2019). However, according to the IPCC, coral reefs are currently undergoing rapid global biodiversity loss, with mass coral bleaching primarily driven by ocean warming and further exacerbated by ocean acidification. (IPCC, 2022).

The ongoing fourth global coral bleaching event (January 2023 - present), as reported by NOAA and shown in Figure 35, has affected the majority of the world's reefs. According to NOAA, approximately 84.4% of the world's coral reefs have experienced bleaching level heat stress, with mass bleaching documented in at least 83 countries and territories, making this the largest global bleaching event to date. The previous record was set during the third global coral bleaching event (2014–2017), which affected 68.2% of the world's reef area, with earlier events in 1998 and 2010 (NOAA, 2025).

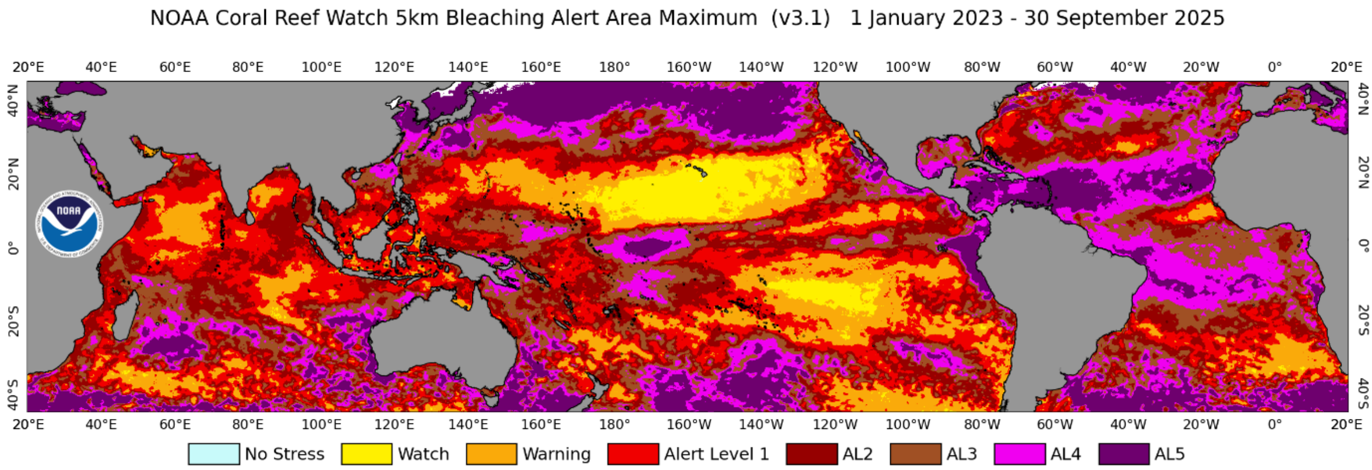


Figure 35: NOAA Coral Reef Watch's 5 km Bleaching Alert Area Maximum product (January 2023–September 2025) showing the highest accumulated heat stress experienced by coral reefs globally, with darker colours indicating conditions capable of causing reef-wide bleaching and severe coral loss (NOAA, 2025).

As live coral declines, the complex habitats that sustain diverse fish, invertebrates, and microbial communities are lost, leading to reductions in species richness, shifts in community composition, and diminished ecosystem functioning. Repeated bleaching, combined with ocean acidification, overfishing, and pollution, is reducing reef resilience and increasing the risk of local extinctions.t

POPULATION AND HUMAN HEALTH

According to the IPCC, climate-related health risks are increasing, affecting physical health, nutrition, longevity, and mental well-being, while also placing increasing pressure on healthcare systems (IPCC, 2022).

Figure 36 from the IPCC summarises the observed global and regional impacts of climate change on human systems, highlighting the levels of confidence associated with these impacts and indicating whether they are increasing adverse and/or positive outcomes. Figure 36 also focuses on impacts related to water scarcity and food production, human health and well-being, and cities, settlements, and infrastructure (IPCC, 2022).

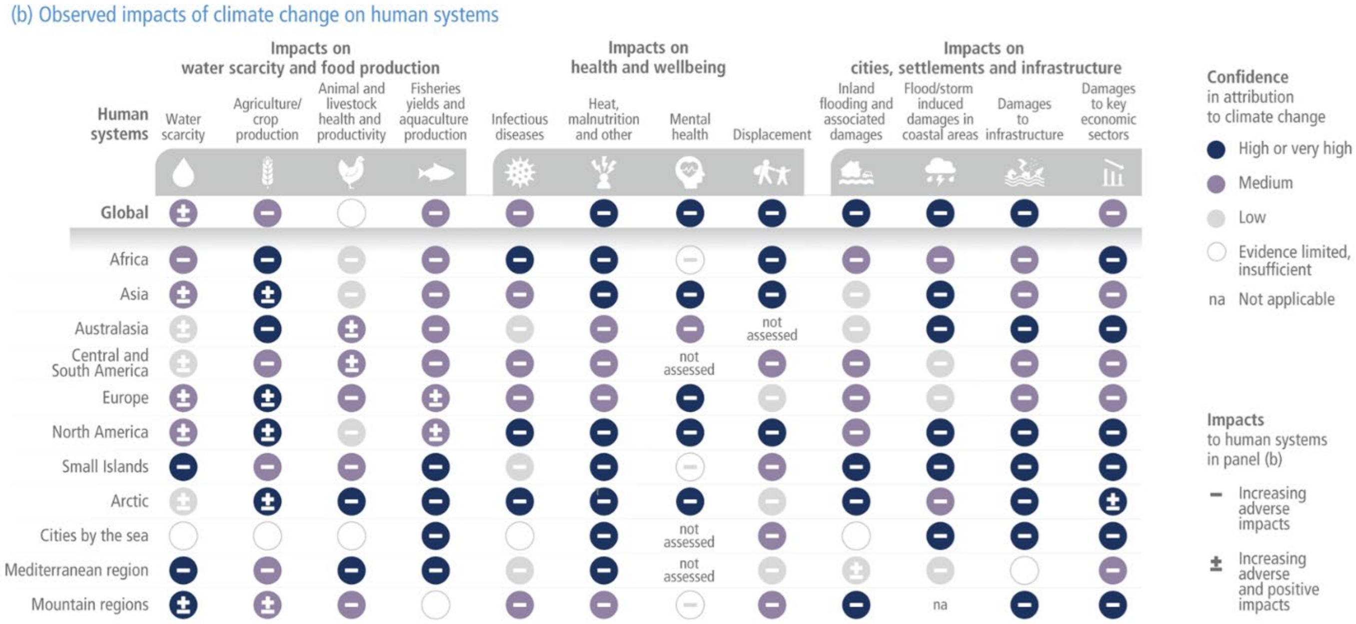


Figure 36: Observed global and regional impacts of climate change on human systems (IPCC, 2022).

Climate-Sensitive Diseases and Health Outcomes

Although malaria cases have declined globally due to improvements in healthcare and socioeconomic conditions, warming temperatures have contributed to the disease spreading to higher altitudes. Observed changes in temperature, rainfall, humidity, and human mobility are also strongly associated with increases in dengue worldwide, chikungunya across multiple regions, and tick-borne diseases such as Lyme disease in North America and Europe. Higher temperatures, heavy rainfall, and flooding have been linked to increased incidence of diarrhoeal diseases, including cholera, other gastrointestinal infections, and food-borne illnesses, while flooding events have also disrupted public health services and increased exposure to water- and vector-borne diseases.

In addition, the IPCC reports that climate extremes such as wildfires, storms and floods are associated with elevated risks of respiratory infections and higher rates of adverse mental health outcomes in affected populations (IPCC, 2022).

Heat-Related Health Impacts

Heat is becoming a growing health risk due to expanding urban areas, more frequent and intense high-temperature events, and aging populations. Over the past two decades, the number of working hours lost because of heat has increased considerably, and some regions are already experiencing heat levels that reduce people’s ability to work safely and effectively.

Some recent heatwave-related health impacts can be partly attributed to climate change; however, other factors including age, pre-existing health conditions, housing quality, socioeconomic status, and the capacity of public health systems also play an important role. Extreme heat events have also negatively affected mental health, well-being, cognitive performance, and can increase irritability and aggression. According to the IPCC, evidence indicates a consistent association between elevated temperatures and adverse mental health outcomes. (IPCC, 2022).

Food and Nutrition Security

According to the IPCC, observed climate variability and change have been associated with increased food insecurity in many regions, particularly in low- and middle-income countries. These conditions have been linked to multiple forms of malnutrition, including undernutrition and obesity. The IPCC reports that climate change affects all four aspects of food security: availability, stability, access, and utilisation. Impacts extend beyond insufficient calorie intake to include poor diet quality and diet-related chronic diseases (IPCC, 2022).

The IPCC reports that globally the scale of malnutrition remains severe: more than 690 million people are undernourished, 144 million children are stunted (chronic undernutrition), 47 million are wasted (acute undernutrition), and over 2 billion people suffer from micronutrient deficiencies. The IPCC further reports that in 2019 135 million people across 55 countries experienced acute hunger requiring urgent assistance (IPCC, 2022).

The IPCC considers that climate change contributes to malnutrition by reducing crop yields, increasing food price volatility, disrupting food supply chains, and limiting access to nutrient-dense foods. The IPCC reports that studies across multiple global regions show that higher temperatures are associated with reduced dietary diversity, while areas exposed to higher precipitation tends to improve diet diversity (IPCC, 2022).

At the same time, the IPCC further reports that climate change is also linked to rising rates of obesity, particularly in low- and middle-income countries. It's reported that heat exposure can reduce physical activity, increase reliance on processed and calorie-dense foods, and raise the cost of fresh produce. As a result, according to the IPCC, food insecurity increasingly coexists with obesity and diet-related chronic diseases, including diabetes and cardiovascular disease. The IPCC reports that globally 38.3 million children under five are overweight, 2.1 billion adults are overweight or obese, and diabetes prevalence has nearly doubled over the past 30 years (IPCC, 2022).

According to the IPCC, populations exposed to extreme weather events such as droughts, floods, and storms have experienced reduced access to sufficient and nutritious food, contributing to higher risks of malnutrition and illness (IPCC, 2022).

MATERIAL ASSETS, CULTURAL HERITAGE AND THE LANDSCAPE

MATERIAL ASSETS

Material assets, including buildings, infrastructure, and other physical resources, are increasingly affected by climate change and wider environmental pressures. Many assets were designed for past climatic conditions and are therefore vulnerable to more frequent and intense extreme weather events such as flooding, heatwaves, storms, and coastal erosion. Rising temperatures can accelerate material degradation and reduce the performance and lifespan of buildings and infrastructure, while flooding and erosion can cause direct damage, disruption, or loss of assets (IPCC, 2022).

These physical risks to material assets do not occur in isolation but interact with broader socio-economic conditions. Rising global temperatures, increasing frequency and intensity of extreme weather events, and long-term environmental degradation are interacting with existing socio-economic vulnerabilities such as inequality, population growth, urbanisation, and resource dependence. These interactions are amplifying risks to livelihoods, food and water security, public health, infrastructure, and economic stability, with disproportionate impacts on the poorest populations, particularly in low-income countries and climate-sensitive regions (IPCC, 2022).

Economic losses from climate change result from negative impacts on key inputs, including reduced crop yields, reduced water availability, and decreased outdoor work productivity due to heat stress. The largest losses occur in sectors that are directly exposed to climate conditions, such as agriculture, forestry, fisheries, energy, and tourism, with impacts varying by region (IPCC, 2022).

Energy and Industrial Water Use

According to the IPCC, water availability is a critical determinant of the performance, reliability, and longevity of energy sector material assets, particularly hydropower and thermoelectric power plants, which together account for 94.7% of global electricity generation in 2019 (IPCC, 2022). Climate change is already undermining these assets through altered precipitation patterns, reduced river flows, rising water temperatures, and an increasing frequency of extreme events such as droughts, floods, and storms. These pressures reduce power plant efficiency, constrain cooling systems, accelerate wear and degradation of infrastructure, and can cause direct physical damage to generation facilities, transmission networks, and associated assets. At the same time, rising ambient temperatures increase electricity demand for cooling, placing further stress on existing energy infrastructure (IPCC, 2022).

Hydropower assets are particularly sensitive to changes in water availability and flow regimes. Evidence from multiple regions shows that droughts and altered runoff patterns have significantly reduced hydropower output, lowering utilisation rates and reducing the economic value of installed infrastructure (IPCC, 2022).

Thermoelectric power generation infrastructure is more consistently affected by water scarcity and elevated temperatures. Insufficient cooling water availability during droughts and heatwaves leads to widespread reductions in operational capacity, forced shutdowns and long-term efficiency losses. On a global scale, drought years during the 1981–2010 period led to an average 3.8% reduction in thermoelectric power output compared to long-term average values (IPCC, 2022). According to the IPCC, these impacts increase operating costs, shorten asset lifespans, and expose energy systems to heightened risks of disruption and reduced energy security (IPCC, 2022).

Overall, there is high confidence that climate change has already reduced the performance and utilisation of hydroelectric and thermoelectric energy assets globally, primarily due to drought, altered river flows, and rising water temperatures (IPCC, 2022).

Extreme Weather and Climate Events

Extreme weather and climate-related events have led to growing losses through damage to material assets, including buildings, transport networks, utilities, and other critical infrastructure, as well as through disruption of supply chains and essential services (IPCC, 2022). Damage to these physical assets increases recovery and rebuilding costs, reduces asset lifespans, and undermines the reliability of economic and social systems. Consequently, these impacts caused by extreme weather and climate events have slowed economic growth, particularly in developing countries, and have disproportionately affected vulnerable populations and livelihoods (IPCC, 2022).

According to the IPCC, economic losses from climate-related disasters continue to rise, placing increasing pressure on public finances, insurance systems, and long-term development pathways, while climate risks remain insufficiently integrated into investment, planning, and adaptation decisions (IPCC, 2022). According to the OECD, severe climate disasters reduce regional GDP by up to 2.2%, with long lasting losses of around 1.7% persisting for at least 5 years after an event (OECD, 2025). Material asset damage is particularly evident in highly exposed regions and sectors.

Food and Natural Resource Production Systems

Climate change is increasingly affecting the material assets that underpin food and natural resource production systems, including agricultural land and soils, irrigation and drainage infrastructure, forestry and fisheries assets, storage facilities, and processing equipment. Damage to, or reduced performance of, these assets is limiting the capacity of agriculture, forestry, fisheries, and aquaculture to meet growing demand from an increasing human population, while also driving economic losses through lower productivity, asset degradation, repair and replacement costs, and operational disruptions across these sectors (IPCC, 2022). Over the past 50 years, human-driven warming has slowed improvements in agricultural productivity, particularly in mid- and low-latitude regions. Trends in agricultural total factor productivity (TFP), defined as the ratio of aggregate agricultural outputs (crops and livestock) to aggregate inputs (land, labour, fertiliser, machinery, etc.), show that although global TFP increased between 1961 and 2015, long-term climate change substantially constrained this growth. Specifically, climate trends reduced global TFP growth by an estimated cumulative 21% over the 55-year period compared with a counterfactual scenario without climate change (IPCC, 2022). According to Ortix-Bobea *et al.*, the negative impacts were more pronounced in Africa, Latin America, and the Caribbean, where reductions in TFP growth of approximately 26–34% were observed (Ortiz-Bobea *et al.*, 2021).

According to the IPCC, rising temperatures have also degraded crop and grassland quality and increased annual variability in harvests. Figure 37 from the IPCC presents the increase in food production loss events since the 1960s experienced by aquaculture, fisheries, livestock and crops. According to the IPCC, the observed direction of impact and confidence in attribution from climate change to crop yield productivity across four major crop types globally: maize, rice, soybean and wheat, with predominately negative impacts (IPCC, 2022).

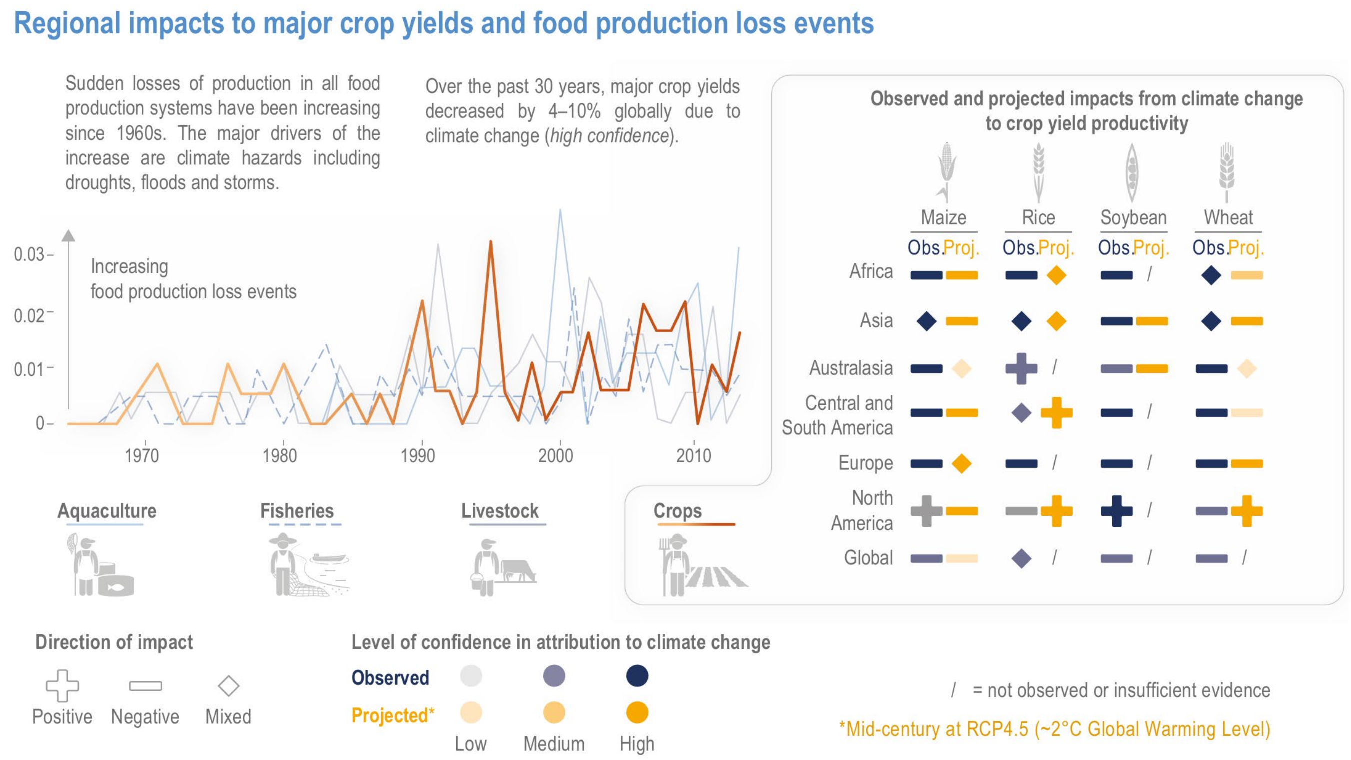


Figure 37: Food production loss events affecting aquaculture, fisheries, livestock and crops (left panel) and regional impacts on crop yield productivity (right panel) (IPCC, 2022).

The IPCC reports that in marine and freshwater systems, warming waters and ocean acidification have already had measurable negative effects on farmed aquatic species. In wild fish populations, sustainable yields have decreased by 4.1% between 1930 and 2010 due to ocean warming (IPCC, 2022).

Figure 38 presents the global frequency of food production loss events between 1961 and 2013 across crops, fisheries, livestock, and aquaculture (IPCC, 2022).

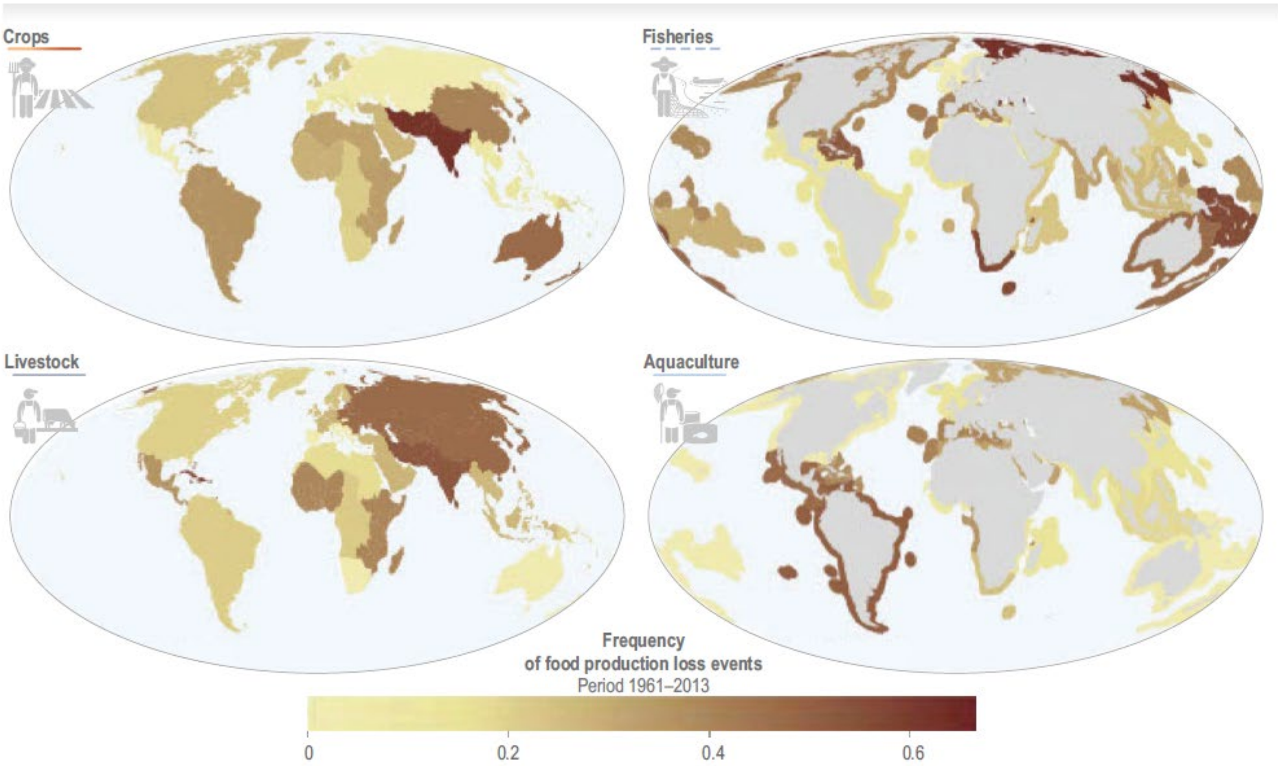


Figure 38: Frequency of food production loss events from 1961 to 2013 for crops, fisheries, livestock, and aquaculture (IPCC, 2022).

According to the IPCC, extreme weather and climate events, such as droughts, floods, wildfires, and marine heatwaves, reduce food production and raise food prices, putting food security, nutrition, and livelihoods at risk. Figure 39 below shows that the frequency of climate-related food production loss events has increased globally over recent decades, including a rise in large-scale losses exceeding 20 million tonnes (IPCC, 2022).

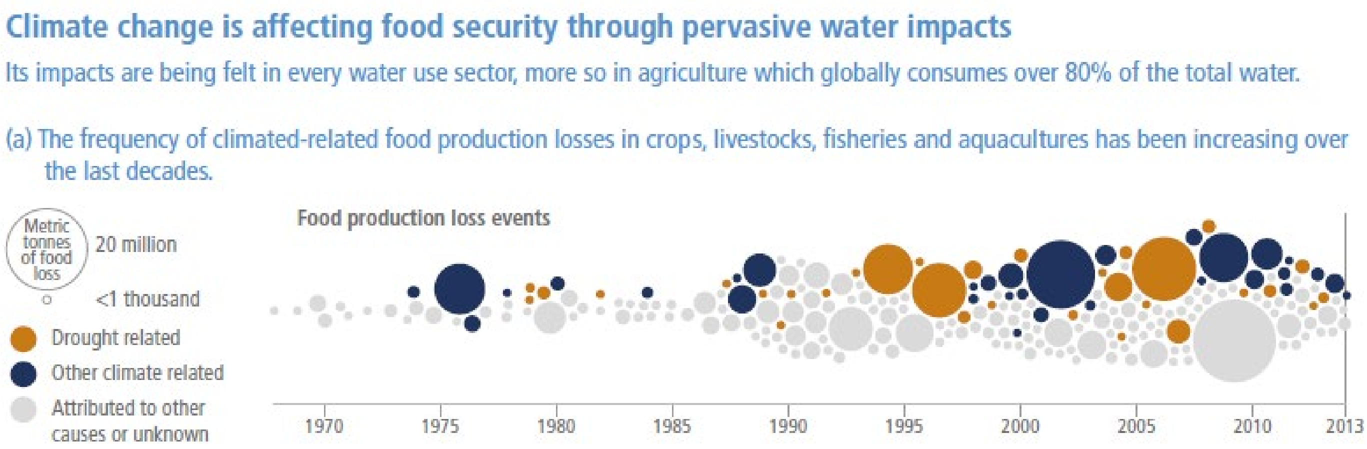


Figure 39: Frequency of climate-related food production losses in crops, livestock, fisheries and aquacultures (IPCC, 2022).

In Europe, according to the IPCC, the impacts of extreme heat and drought have increased in severity over the past 50 years. These events have caused significant economic losses across livestock, forests and crop systems, including repeated reductions in wheat production in 2012, 2016 and 2018. Heat and drought have also damaged forests, leading to reduced timber production and sales (IPCC, 2022).

The IPCC reports that marine heatwaves have resulted in major losses in fisheries and aquaculture, including well-documented events along the west coast of North America (2013–2016) and the east coast of Australia (2015–2016, 2016–2017, and 2020) (IPCC, 2022).

CULTURAL HERITAGE

Cultural heritage is increasingly recognised as vulnerable to environmental change and climate-related pressures, particularly where heritage assets are closely connected to natural processes, landscapes and long-established patterns of settlement (UNESCO, n.d.). Rising temperatures, sea-level rise, coastal erosion, flooding, wildfires and changes in soil moisture are contributing to the deterioration or loss of tangible cultural heritage (physical products of human creativity such as historic buildings, archaeological sites and cultural landscapes) and intangible cultural heritage (living traditions including practices, expressions, knowledge and skills passed down through generations) (European Parliamentary Research Service, 2024; IPCC, 2022). These risks are often exacerbated by the age and design of historic structures, which were not developed to withstand current or projected climate conditions (European Parliamentary Research Service, 2024; Historic England, 2026), and by the concentration of heritage assets in environmentally sensitive locations such as coastal and riverside areas (IPCC, 2022).

While the physical impacts of climate change on the environment are increasingly well documented, the effects on cultural heritage are less consistently monitored (IPCC, 2022).

Traditional farming practices are an example of cultural traditions that are being affected by environmental change. Indigenous and small-scale farmers often rely on local knowledge and farming methods that promote biodiversity, maintain soil health, and use natural pest control. These approaches support the cultivation of a diverse range of crops, increasing genetic diversity and helping crops withstand climate-related stresses (IPCC, 2022). However, most agricultural research, funding and support are focused on a small number of major crop species, with limited research and innovation directed towards smaller or “minor” crops. As a result, many Indigenous and small-scale farmers are shifting away from diverse cropping systems towards a narrower range of major crops. This trend can reduce the resilience of food systems, making them more vulnerable to pests, disease, and drought, and can also lead to the loss of Indigenous and local knowledge. (IPCC, 2022).

THE LANDSCAPE

Globally, the landscape is undergoing rapid and interconnected change as climate change and other environmental pressures intensify and interact. Rising temperatures, shifting precipitation patterns, sea-level rise, and more frequent and severe extreme weather events are altering terrestrial, freshwater, coastal, and marine environments, accelerating the degradation of natural systems and the transformation of human-managed landscapes (IPCC, 2021; IPCC, 2023).

River Landscapes and Connectivity

Global analysis of river flows shows spatially complex patterns, with reduced flows in regions such as the Mediterranean, southern Australia, and northeastern Brazil, and increased flows in northern Europe. More than half of global rivers currently experience periodic drying, reducing river connectivity and altering river corridor landscapes (IPCC, 2022).

According to the IPCC, in high-latitude and high-altitude streams, shrinking glaciers, reduced snow cover, earlier snowmelt and altered precipitation patterns are increasing flow intermittency, resulting in streams drying up more often. This is changing source stream landscapes, reducing their reliability as permanent features and affecting how water moves through downstream landscapes (IPCC, 2022).

Lake Landscapes

Changes to the global water cycle is altering how water is stored in lakes, leading to lake levels rising, falling, or remaining stable depending on local conditions. Although it is difficult to attribute changes at individual lakes directly to climate change, consistent patterns observed across large regions and over long time periods provide stronger evidence of a climate change influence. There is also growing evidence that climate change is leading to the loss of small, temporary ponds, which collectively cover a greater global area than permanent lakes. This is resulting in a widespread but often overlooked, simplification of freshwater landscapes (IPCC, 2022). In mountain regions, according to the IPCC, lakes fed by melting glaciers are increasing in size as glaciers retreat. On the Tibetan Plateau, higher water storage is linked to glacier melt, thawing permafrost, and changes in rainfall and runoff. These processes are reshaping high-altitude landscapes by forming new lakes, changing drainage patterns, and increasing the risk of landscape instability (IPCC, 2022).

APPENDIX 2 FUTURE BASELINE DETAILED INFORMATION

Appendix 2 provides a high-level summary of relevant scientific literature relating to the projected state of the environment under lower-, intermediate- and higher-warming futures across key environmental receptors. This Appendix has been prepared by Adura by drawing on a range of respected, publicly available scientific sources. This Appendix summarises and paraphrases information from those sources and does not express the views or opinions of Adura. While efforts have been made to reflect the content of the underlying sources accurately, the summaries necessarily involve simplification and are not intended to constitute an exhaustive description of every aspect of that source. Readers should refer to the original sources for the full analysis.

The graphics, charts and tables presented are drawn from the following IPCC publications: IPCC (2019a), IPCC (2019b), IPCC (2021a), IPCC (2021b), IPCC (2022a), IPCC (2022b) and IPCC (2023).

GLOBAL SURFACE TEMPERATURE

Across every emissions pathway assessed by the IPCC, global average surface temperatures are projected by the IPCC to keep rising until at least the middle of the century, as shown in Figure 40. Without substantial and rapid cuts to CO_2 and other GHG emissions in the coming decades, warming levels of 1.5°C and 2°C are projected by the IPCC to be surpassed at some point during the 21st century.

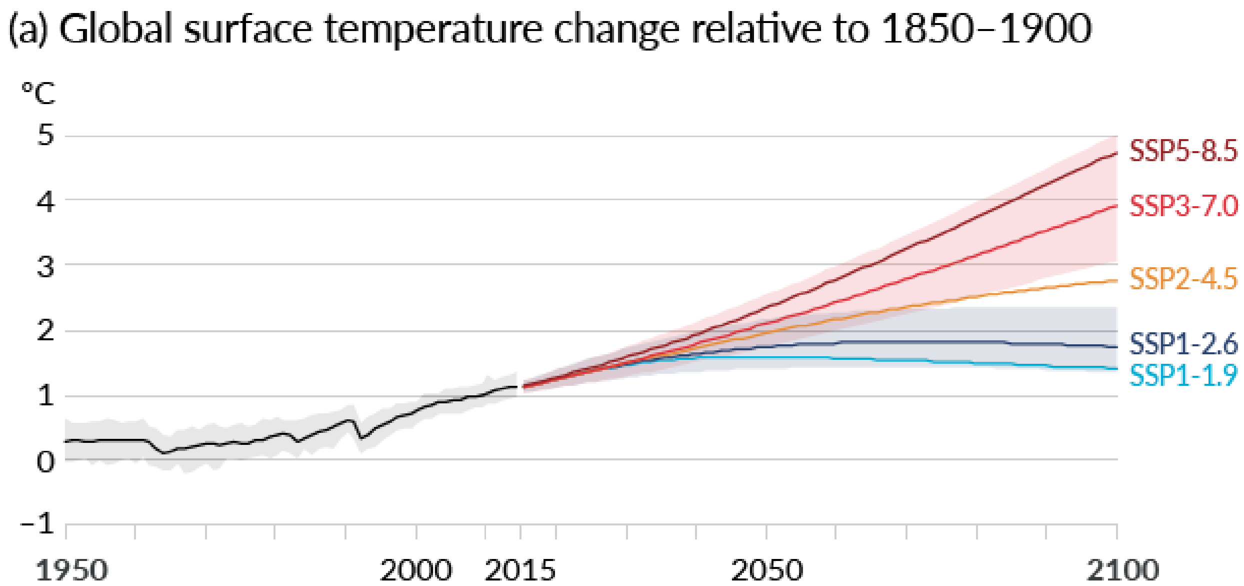


Figure 40: Global surface temperature change projections (relative to pre-industrial 1850-1900 baseline) (IPCC, 2021a).

The IPCC projected global surface temperatures for three periods (2021-2040, 2041-2060 and 2081-2100) which are reported in Table 19. According to the IPCC, relative to the 1850–1900 baseline, mean global surface temperatures during 2081–2100 are very likely to increase by between:

- 1.0°C and 1.8°C under the very low GHG emissions pathway (SSP1-1.9).
- 2.1°C to 3.5°C under the intermediate GHG emissions pathway (SSP2-4.5).
- 3.3°C to 5.7°C under the very high GHG emissions pathway (SSP5-8.5).

Table 19: Projected changes in global surface temperature (relative to the 1850-1900 baseline) for selected 20-year periods across the five illustrative emissions scenarios (IPCC, 2021).

Scenario	Near Term (2021-2040)		Mid Term (2041-2060)		Long Term (2081-2100)	
	Best Estimate	Very Likely Range (°C)	Best Estimate	Very Likely Range (°C)	Best Estimate	Very Likely Range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

EXTREME WEATHER AND CLIMATE EVENTS

Figure 41 shows illustrative IPCC projections how, as global temperatures rise, extreme weather and climate events are projected by the IPCC to become more widespread, more intense, and affect more regions of the world. Table 20 summarises the IPPC projected increase in frequency and intensity of hot temperature extremes, heavy precipitation and agricultural and ecological droughts under 1.5°C, 2°C and 4°C warming scenarios (IPCC, 2021).

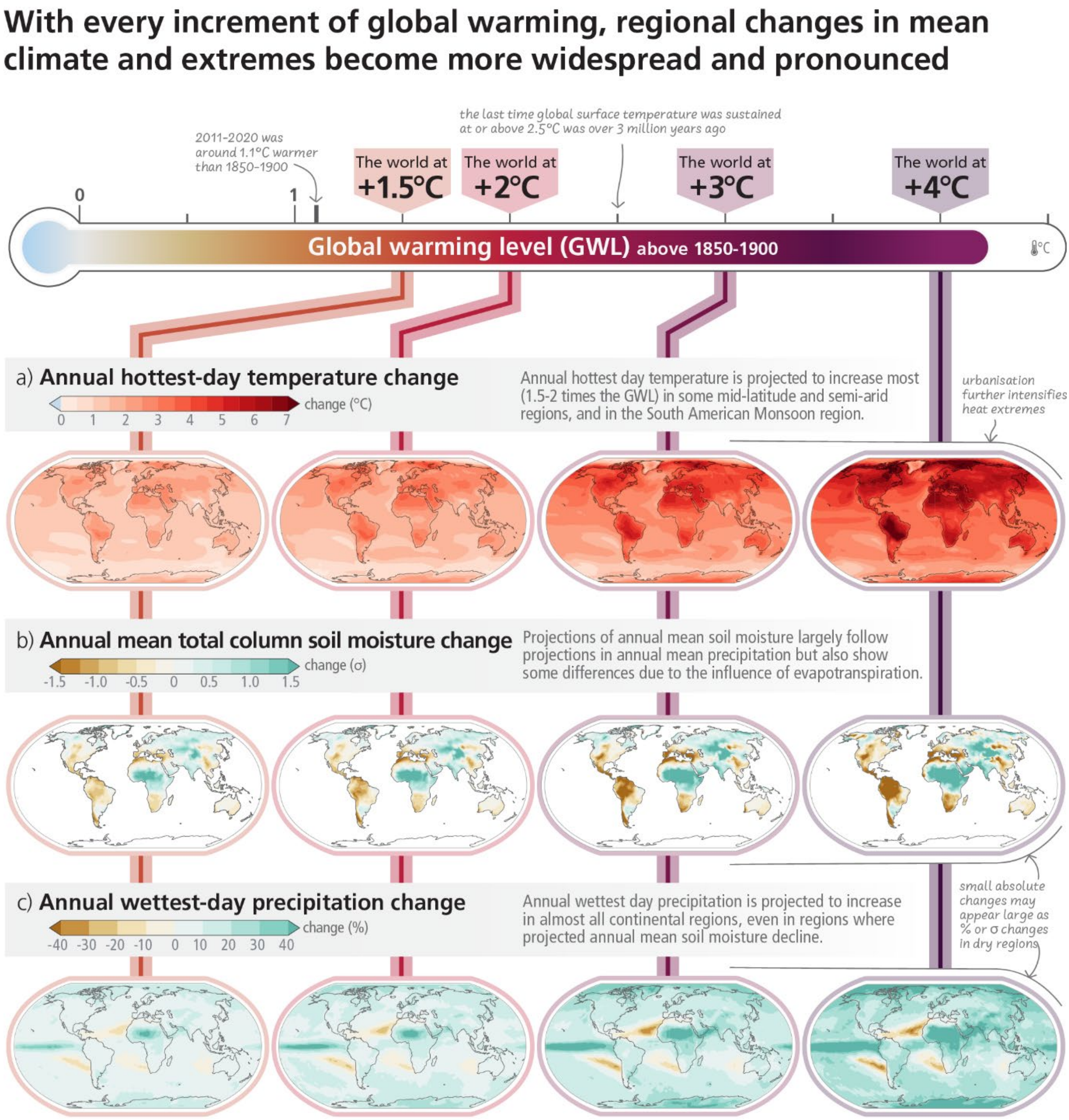


Figure 41: Projected global changes relative to the 1850–1900 baseline at warming levels of 1.5°C, 2°C, 3°C and 4°C, showing changes in (a) annual hottest-day temperature change, (b) annual mean total column soil moisture change, and (c) annual wettest-day precipitation change (IPCC, 2023).

Table 20: Projected changes in the intensity and frequency of hot temperature extremes over land, extreme precipitation over land, and agricultural and ecological droughts in drying regions (IPCC, 2021).

	1850-1900 Baseline*	Current Observations (1°C)	Future Global Temperature Increase		
			1.5°C	2°C	4°C
Hot temperature extremes over land**					
Frequency per 10 years	Once	Now likely occurs 2.8 times (1.8 – 3.2)	Will likely occur 4.1 times (2.8 – 4.7)	Will likely occur 5.6 times (3.8 – 6.0)	Will likely occur 9.4 times (8.3 – 9.6)
Intensity Increase	-	+1.2°C warmer	+1.9°C warmer	+2.6°C warmer	+5.1°C warmer
Frequency per 50 years	Once	Now likely occurs 4.8 times (2.3 – 6.4)	Will likely occur 8.6 times (4.3 – 10.7)	Will likely occur 13.9 times (6.9 – 16.6)	Will likely occur 39.2 times (27.0 – 41.4)
Intensity Increase	-	+1.2°C warmer	+2.0°C warmer	+2.7°C warmer	+5.3°C warmer
Heavy precipitation over land***					
Frequency per 10 years	Once	Now likely occurs 1.3 times (1.2 – 1.4)	Will likely occur 1.5 times (1.4 – 1.7)	Will likely occur 1.7 times (1.6 – 2.0)	Will likely occur 2.7 times (2.3 – 3.6)
Intensity Increase	-	+6.7% wetter	+10.5% wetter	+14.0% wetter	+30.2% wetter
Agricultural & ecological droughts in drying regions****					
Frequency per 10 years	Once	Now likely occurs 1.7 times (0.7 – 4.1)	Now likely occurs 2.0 times (1.0 – 5.1)	Now likely occurs 2.4 times (1.3 – 5.8)	Now likely occurs 4.1 times (1.7 – 7.2)
Intensity Increase	-	+0.3 standard deviations drier	+0.5 standard deviations drier	+0.6 standard deviations drier	+1.0 standard deviations drier

*Projected changes are shown at global warming levels of 1°C, 1.5°C, 2°C, and 4°C and are relative to a baseline of 1850–1900 which represents a climate without human influence.

**Hot temperature extremes are defined as the daily maximum temperatures over land that were exceeded on average once in a decade (10-year event) or once in 50 years (50-year event) during the 1850–1900 baseline.

***Extreme precipitation events are defined as the daily precipitation amount over land that was exceeded on average once in a decade during the 1850–1900 baseline.

****Agricultural and ecological drought events are defined as the annual average of total column soil moisture below the 10th percentile of the 1850–1900 baseline. Intensity changes are expressed as fractions of standard deviation of annual soil moisture.

GLOBAL MEAN SEA LEVEL

Figure 42 shows how sea level rise is projected by the IPCC to continue, and how the projected speed and total amount of rise depends on future GHG emissions.

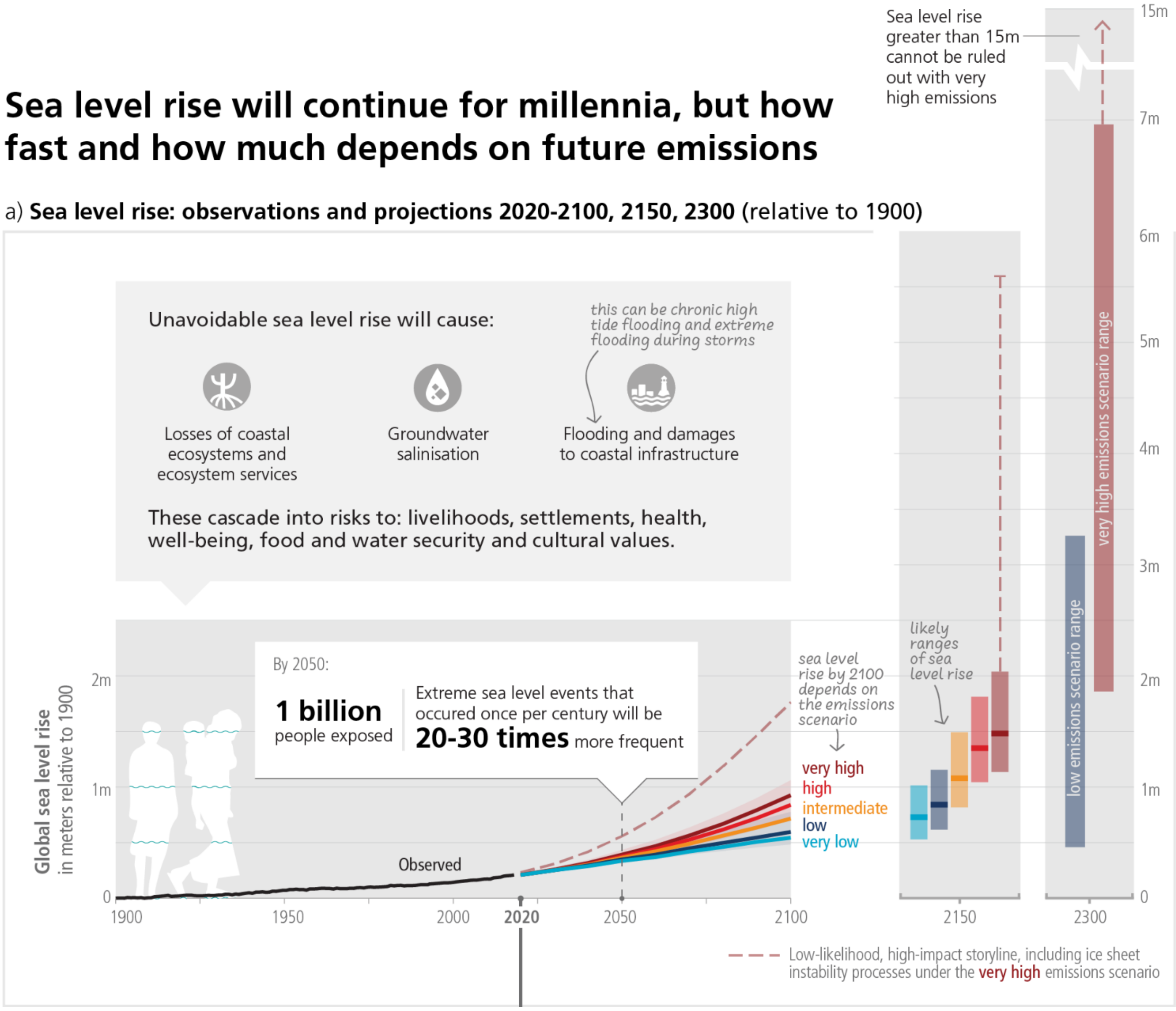


Figure 42: Projected global sea level rise under different emissions scenarios. (IPCC, 2023).

CARBON SEQUESTRATION CAPACITY

Figure 43 shows how the Earth's land and ocean carbon sinks are projected by the IPCC to absorb a smaller proportion of CO_2 emissions as total emissions increase, leaving more CO_2 accumulating in the atmosphere by 2100 under higher-emissions scenarios. In the lower emissions scenarios, most emitted CO_2 is projected to be absorbed by land and ocean sinks, while in the higher emissions scenarios, more than half of emitted CO_2 is projected to remain in the atmosphere (IPCC, 2021).

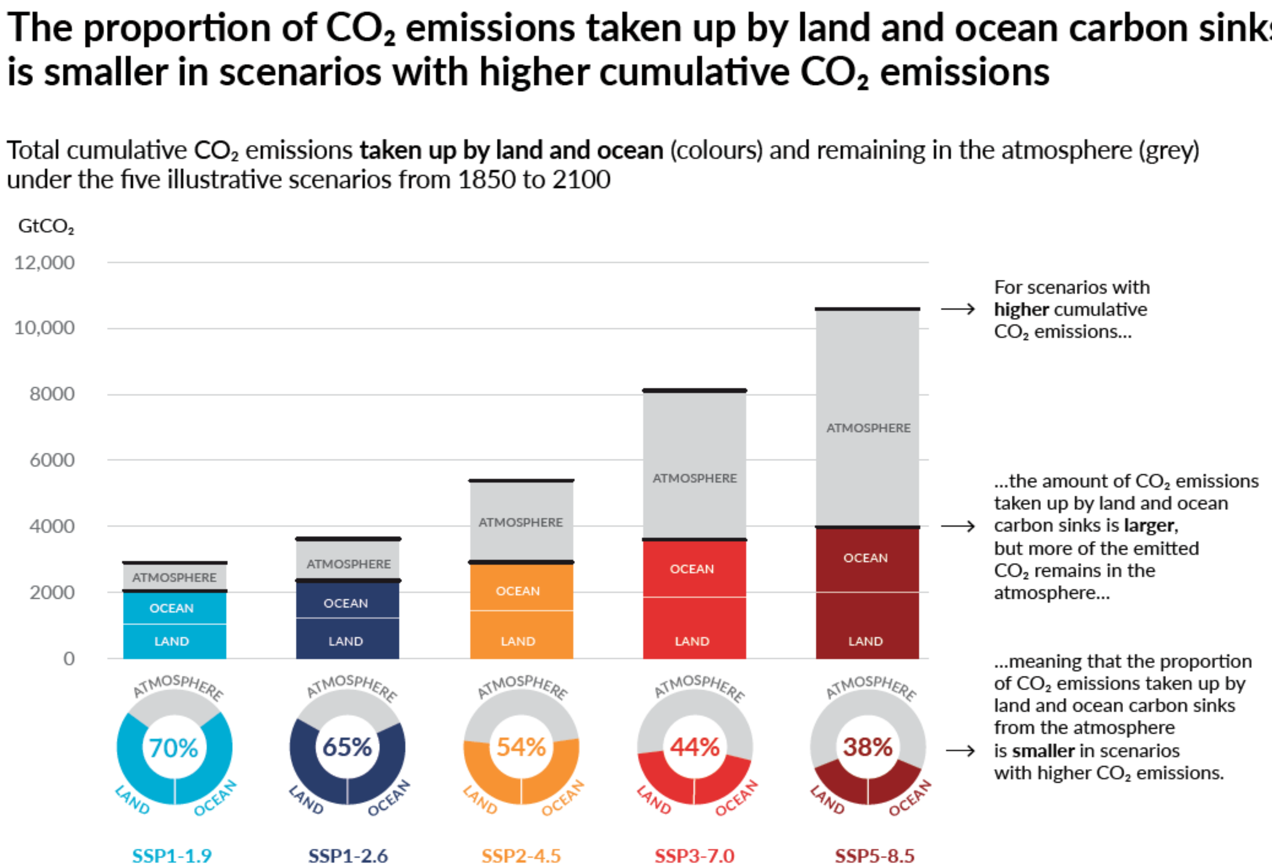


Figure 43: Cumulative anthropogenic CO_2 emissions taken up by land and ocean sinks by 2100 under the five SSPs. (IPCC, 2021b).

CRYOSPHERE CHANGES

SEA ICE

The Arctic is projected by the IPCC to become virtually sea-ice-free in September at least once before 2050 under all five illustrative scenarios considered (as shown in Figure 44), with higher levels of warming leading to more frequent occurrences. By contrast, there is low confidence by IPCC in projections of Antarctic Sea-ice decline.

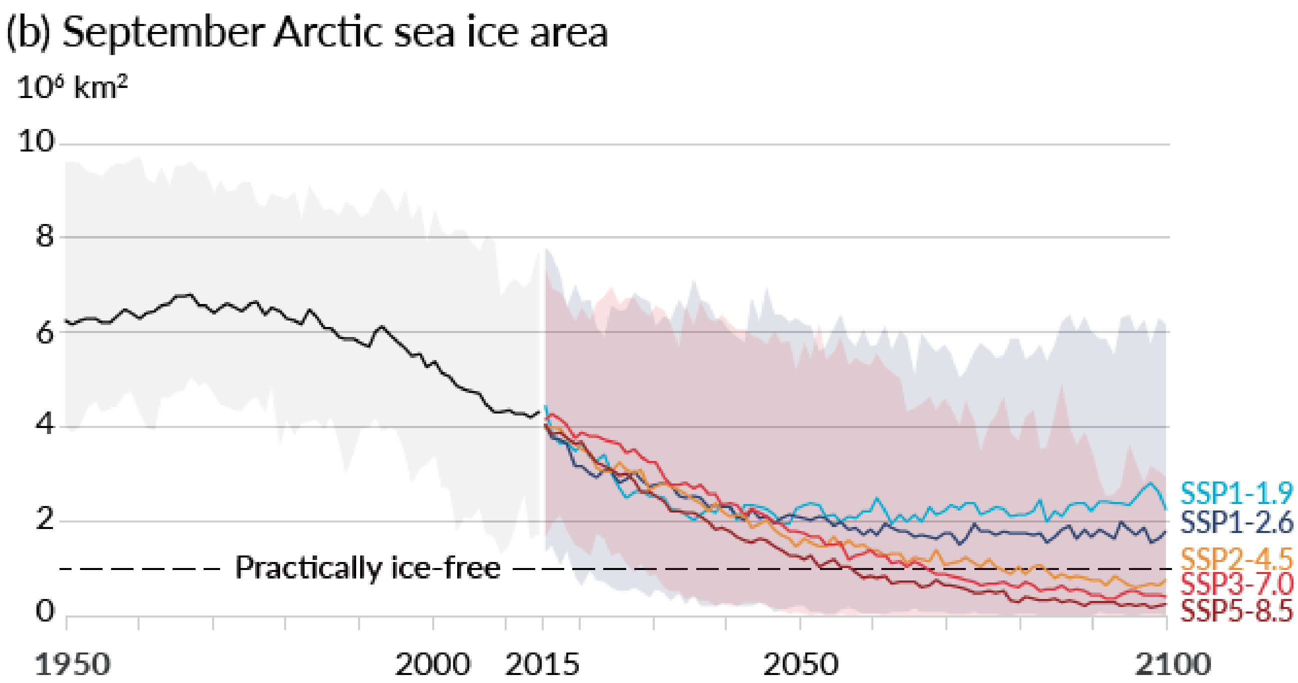


Figure 44: Projected changes in September Arctic sea-ice area under different future emissions pathways (IPCC, 2021).

GLACIERS

As shown in Figure 45, glaciers are projected by the IPCC to continue to lose mass under all emissions scenarios for several decades, even if global temperatures stabilise, due to delayed response.

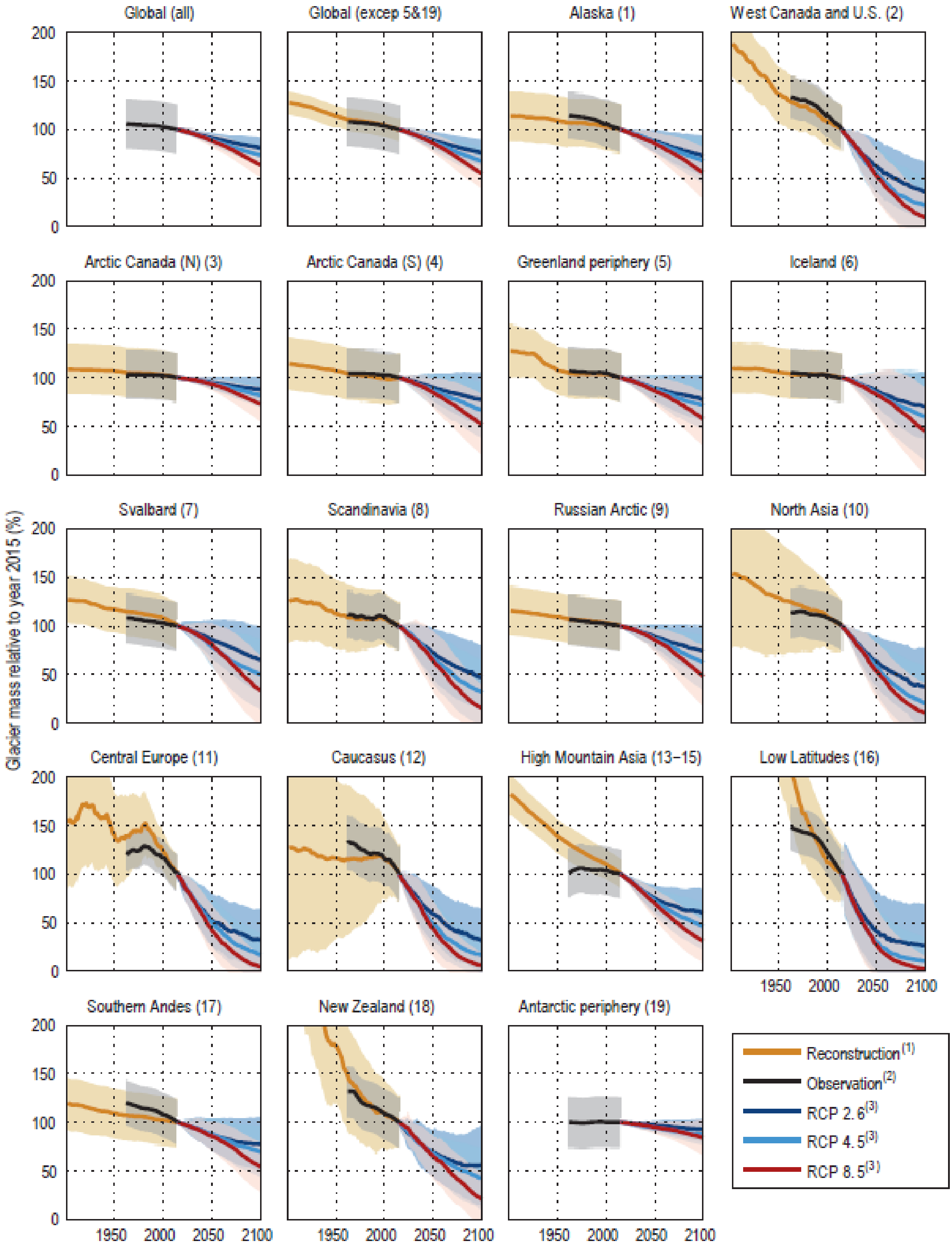


Figure 45: Projected global and regional glacier mass changes under different emissions scenarios. The shading shows the uncertainty envelope around the central estimate, derived from the spread of multiple climate model simulations (IPCC, 2021a).

OCEANIC CHANGES

At least 83% of the global ocean surface is projected by the IPCC to warm over the 21st century. Warming is projected by the IPCC to continue until at least 2300, even under low-emissions scenarios, due to slow deep-ocean circulation. Figure 46 displays the probability ratio of marine heatwaves (i.e. how much more likely marine heatwaves are compared with pre-industrial conditions) under two IPCC emissions scenarios for 1985-2014 and 2081-2100.

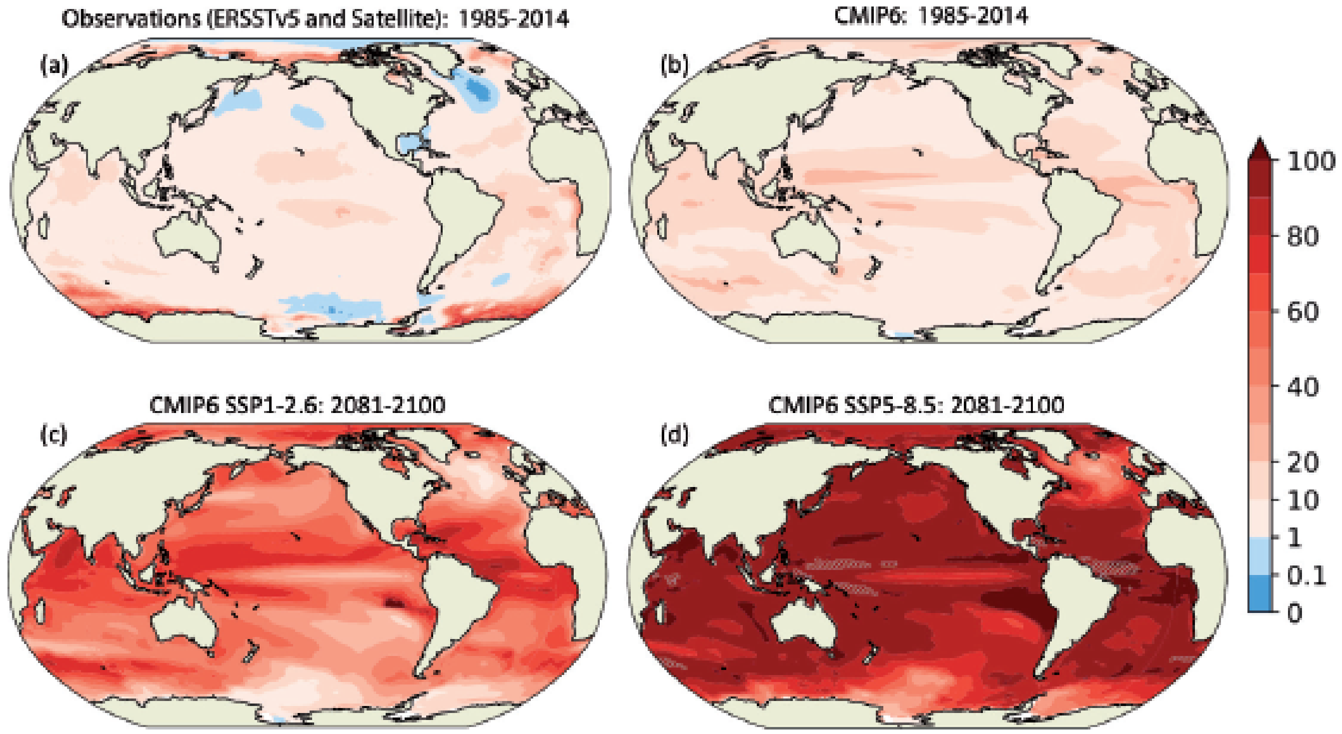


Figure 46: The probability ratio of marine heatwaves under low and high emissions scenarios for the 1985-2014 and 2081-2100, relative to pre-industrial conditions (IPCC, 2021a).

BIODIVERSITY

Figure 47 shows the percentage loss of terrestrial and freshwater biodiversity projected by IPCC at global warming levels of 1.5°C, 2°C, 3°C and 4°C, relative to the pre-industrial period.

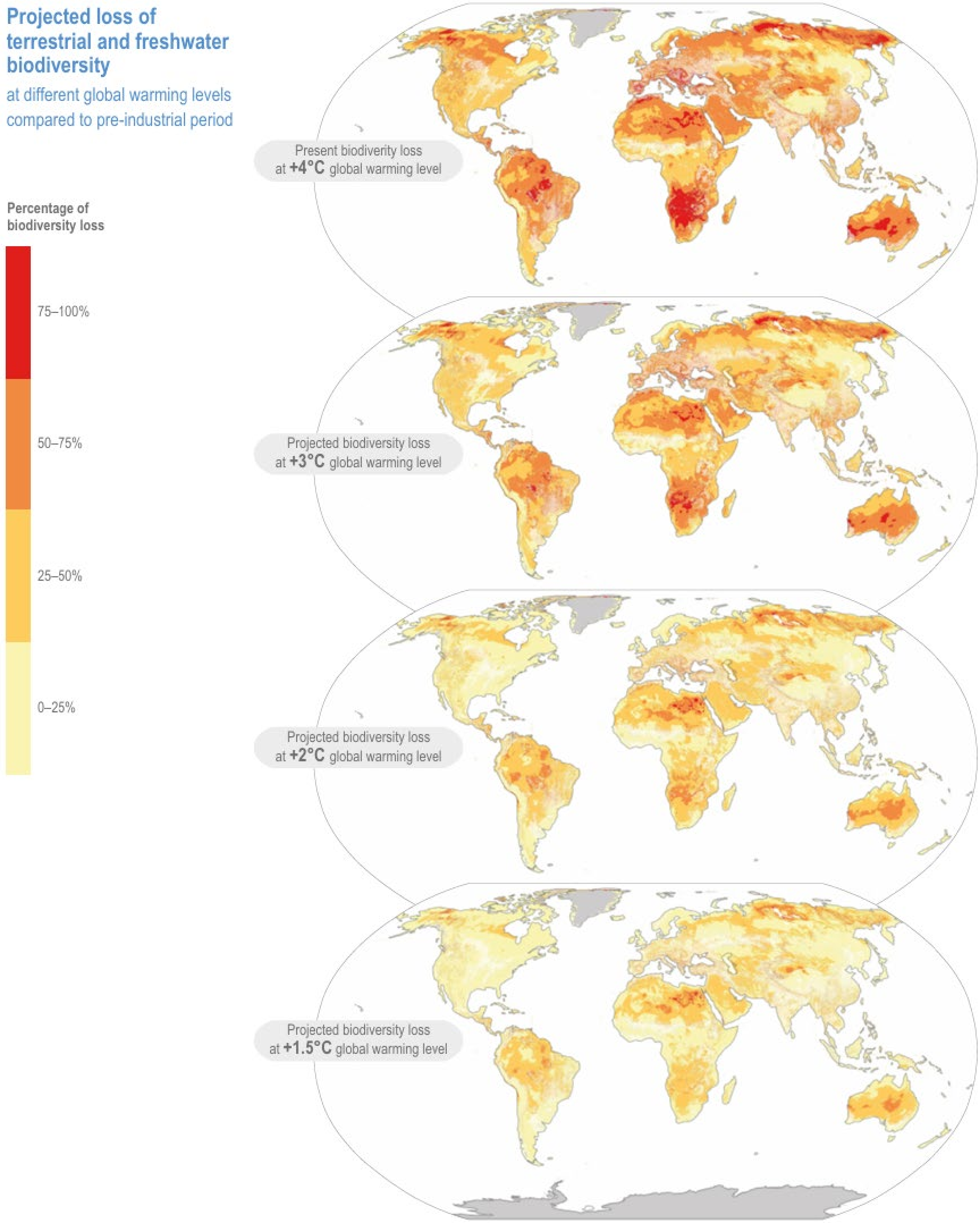


Figure 47: Projected loss of terrestrial and freshwater biodiversity at global warming levels of 1.5°C, 2°C, 3°C and 4°C (IPCC, 2022).

Figure 48 illustrates how the impacts of climate change on natural and human systems are projected by the IPCC to become more severe and more widespread as global temperatures increase, assuming no additional adaptation measures are taken. Panel (a) shows the IPCC projected increase in biodiversity loss as global temperatures increase. Panel (b) illustrates the IPCC projected number of days per year with dangerous heat-humidity conditions affecting human health. Panel (c) presents the IPCC projected changes in food production, including impacts on maize yields and fisheries, under higher warming levels.

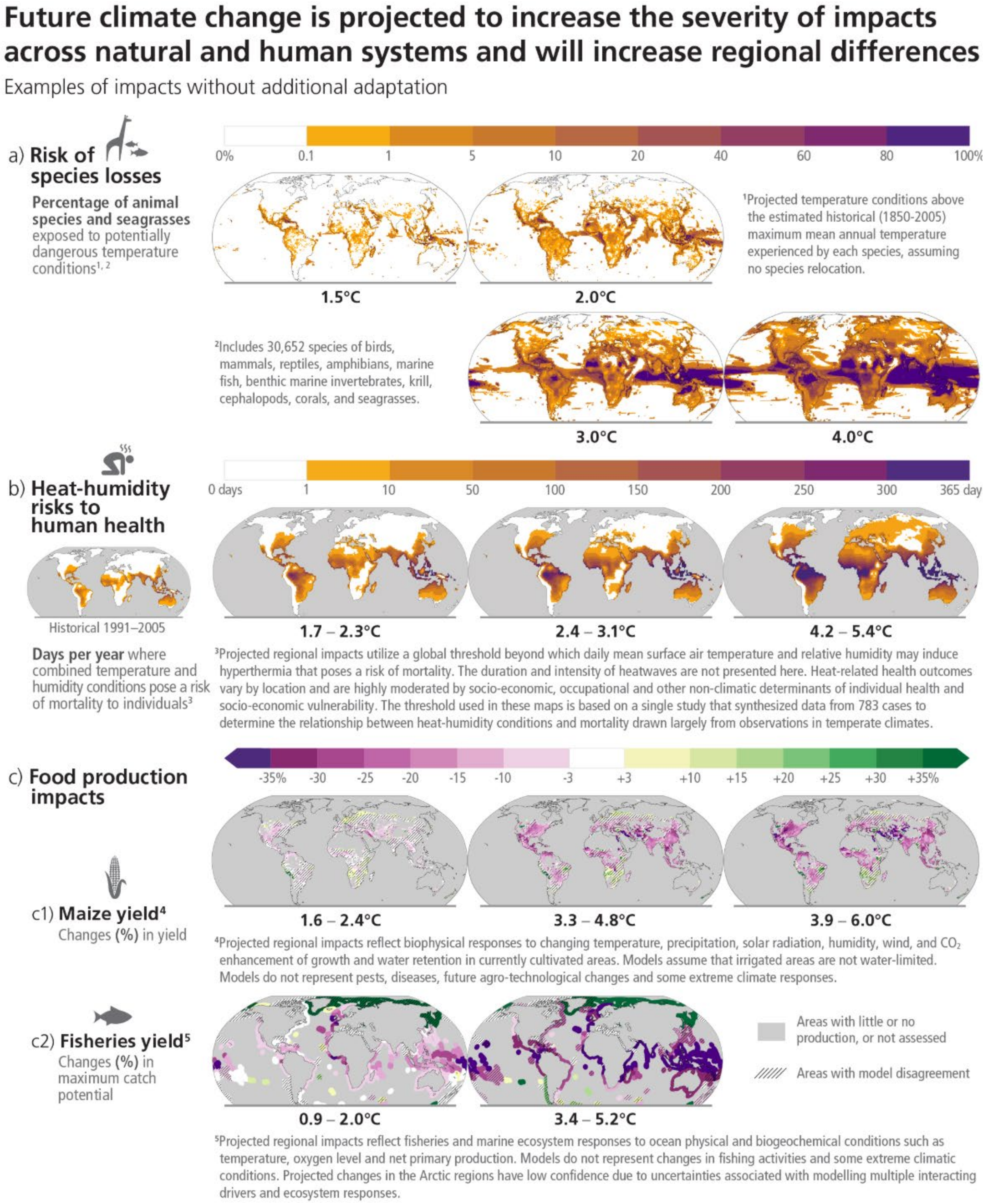


Figure 48: Projected impacts of climate change on natural and human systems at increasing levels of global warming, showing changes relative to historical conditions and assuming no additional adaptation (IPCC, 2023).

POPULATION AND HUMAN HEALTH

CLIMATE–SENSITIVE DISEASES

Figure 49 shows the IPCC projected changes in the potential abundance of Aedes aegypti (the primary vector of Dengue fever, Zika virus, Chikungunya, Yellow fever) under low and high emissions scenarios for 2090-2099 (related to a 1987-2016 baseline). The red regions on the map indicate areas where abundance is projected by the IPCC to increase, while the blue regions indicate areas where abundance is projected by the IPCC to decrease.

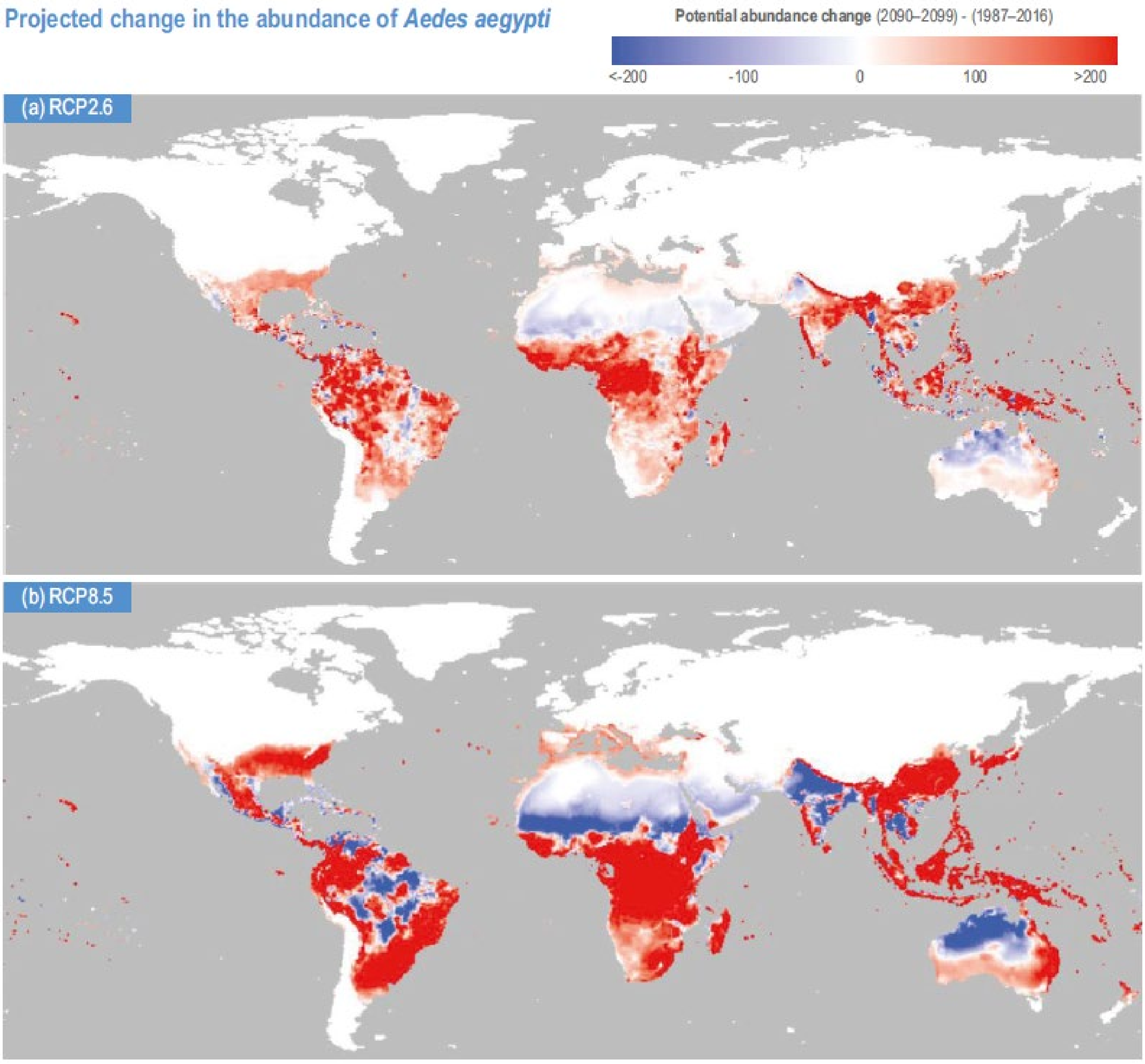


Figure 49: Projected changes in the potential abundance of Aedes aegypti (the primary vector of Dengue fever, Zika virus, Chikungunya, Yellow fever) under low and high emissions scenarios for 2090-2099 (related to 1987-2016) (IPCC, 2022).

MATERIAL ASSETS, CULTURAL HERITAGE AND THE LANDSCAPE

MATERIAL ASSETS

Water Scarcity

Figure 50 describes the level of policy effort needed, according to the IPCC, to address water scarcity by 2050, based on both IPCC projected water stress (using the Water Scarcity Index, WSI) and the uncertainty in those IPCC projections drawing on five climate models, three hydrological models and three future SSPs. Policy challenges are classified by the IPCC as low (monitoring and review), medium (moderate changes to water systems), or high (major, transformative changes). According to the IPCC, low challenges occur where projected water scarcity remains low (WSI < 0.4) and uncertainty is stable; medium challenges occur where either projected water scarcity remains low but uncertainty increases, or water scarcity increases (WSI > 0.4) with stable uncertainty; and high challenges occur where both projected water scarcity and uncertainty increase. Areas shown in white represent locations projected by the IPCC to have very low water scarcity (WSI < 0.1) or very low water demand (IPCC, 2022).

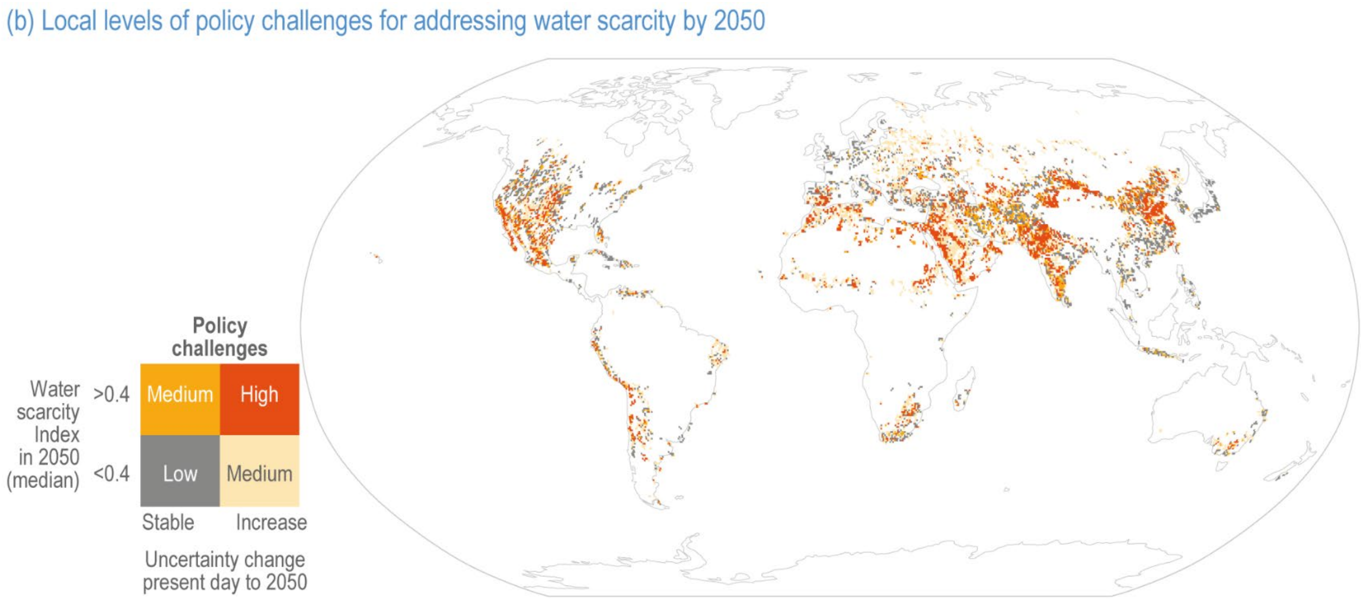


Figure 50: Level of policy effort needed to address water scarcity by 2050, based on both the expected level of water stress (using the Water Scarcity Index, WSI) and their level of uncertainty. The projections combine five climate models, three global hydrological models and three SSPs (IPCC, 2022)

Key Infrastructure Risks

Figure 51 presents examples of key regional risks and impacts projected by IPCC, along with their associated confidence levels, under warming scenarios of up to 4°C. According to the IPCC, examples relevant to material assets project the increasing risk of coastal flooding to infrastructure in Europe with rising global temperatures, and the growing costs and damages affecting key infrastructure in the Arctic (IPCC, 2022).

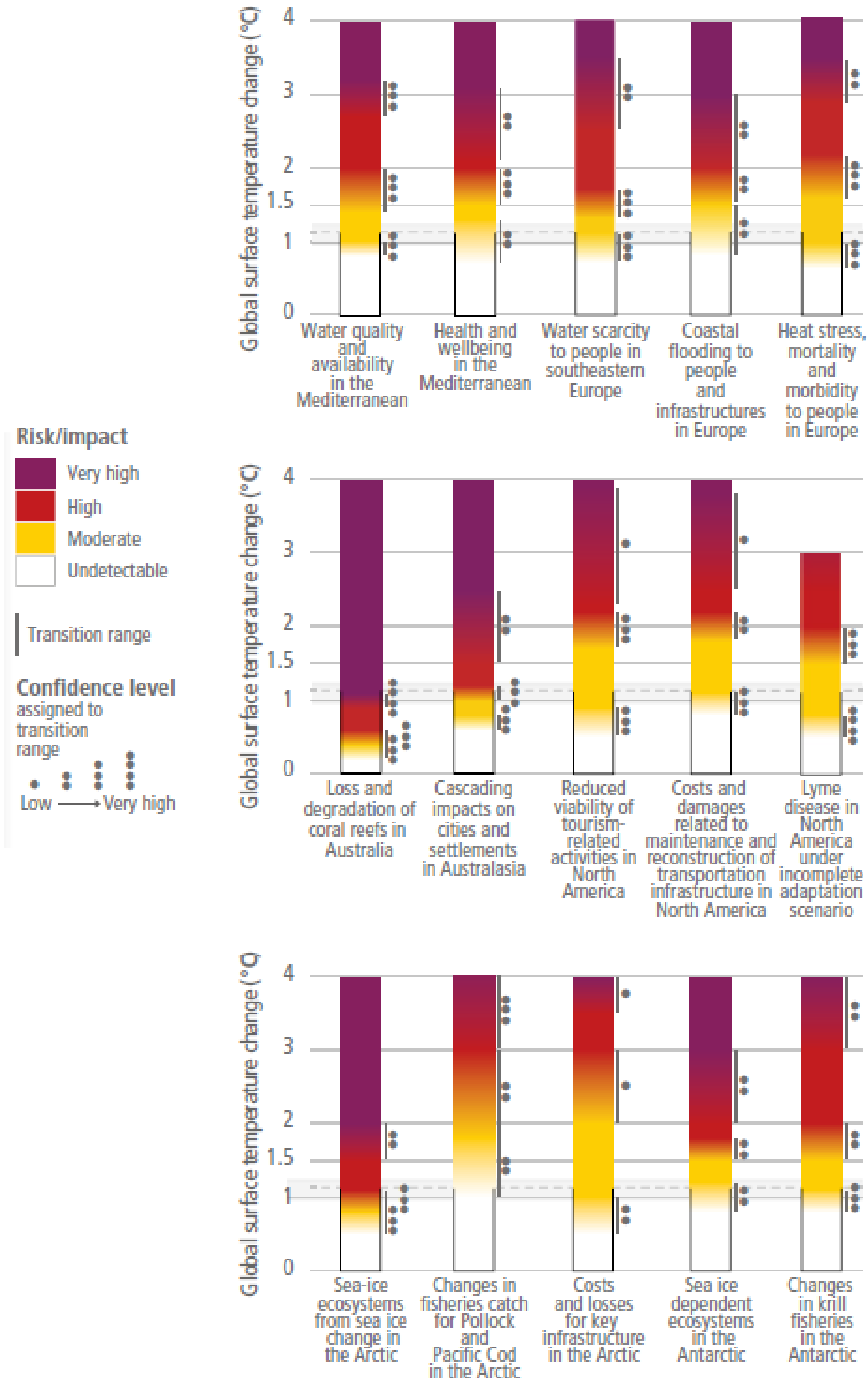


Figure 51: Examples of regional key risks/impacts and their associated confidence levels under warming scenarios up to 4°C (IPCC, 2022).

Agriculture

Figure 52 shows where wheat production is projected by the IPCC to increase or decrease globally, and how total global wheat production is projected by the IPCC to change through the 21st century, relative to a historical baseline (1983-2013).

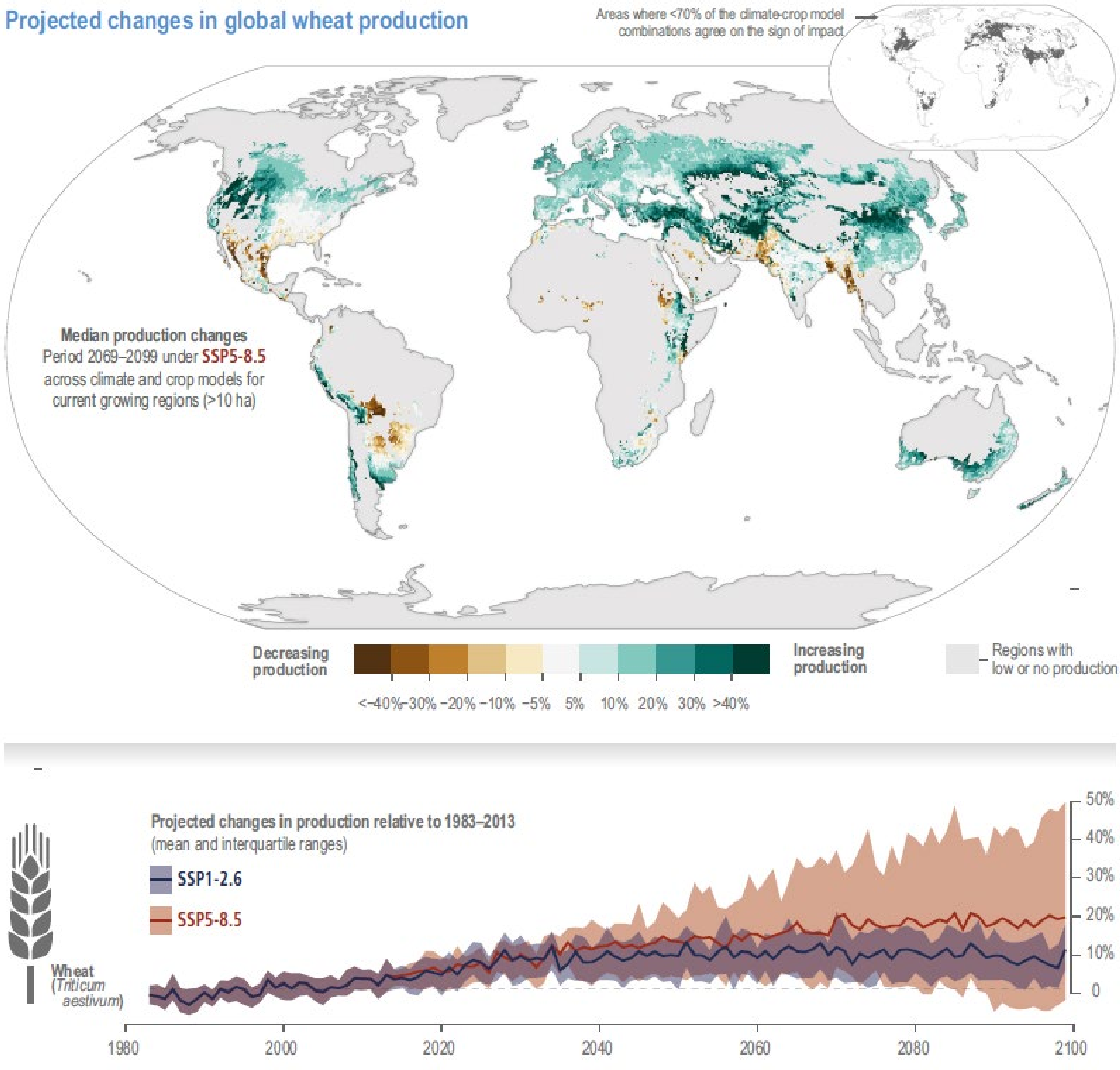


Figure 52: Projected changes in global wheat production. The upper panel shows projected production changes for 2069-2099 under a high emissions scenario, while the lower panel shows the projected changes for a low and high emissions scenario relative to a 1983-2013 baseline (IPCC, 2022).

Figure 53 illustrates the IPCC projected number of days per year when cattle are exposed to extreme heat stress, relating to a combination of high temperature and humidity under different emissions scenarios. According to the IPCC, extreme heat stress conditions could reduce animal welfare, productivity, fertility, and survival.

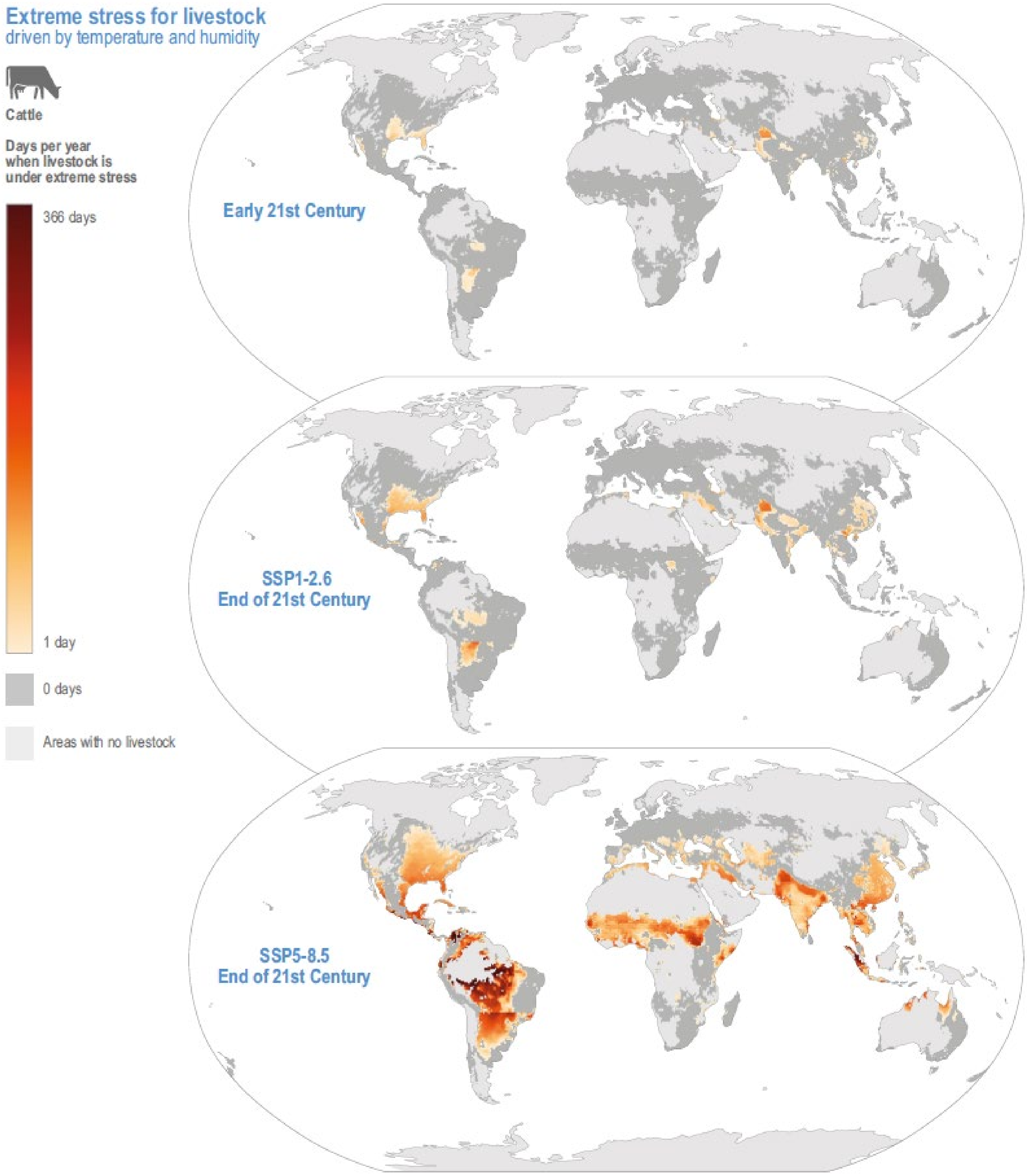


Figure 53: Projected changes in extreme heat stress for livestock (cattle) related to increasing temperature and humidity under a low emissions scenario and a high emissions scenario (IPCC, 2022).

Productivity

Figure 54 illustrates how rising temperature and humidity are projected by the IPCC to reduce human physical work capacity for outdoor labour, particularly under higher future warming scenarios.

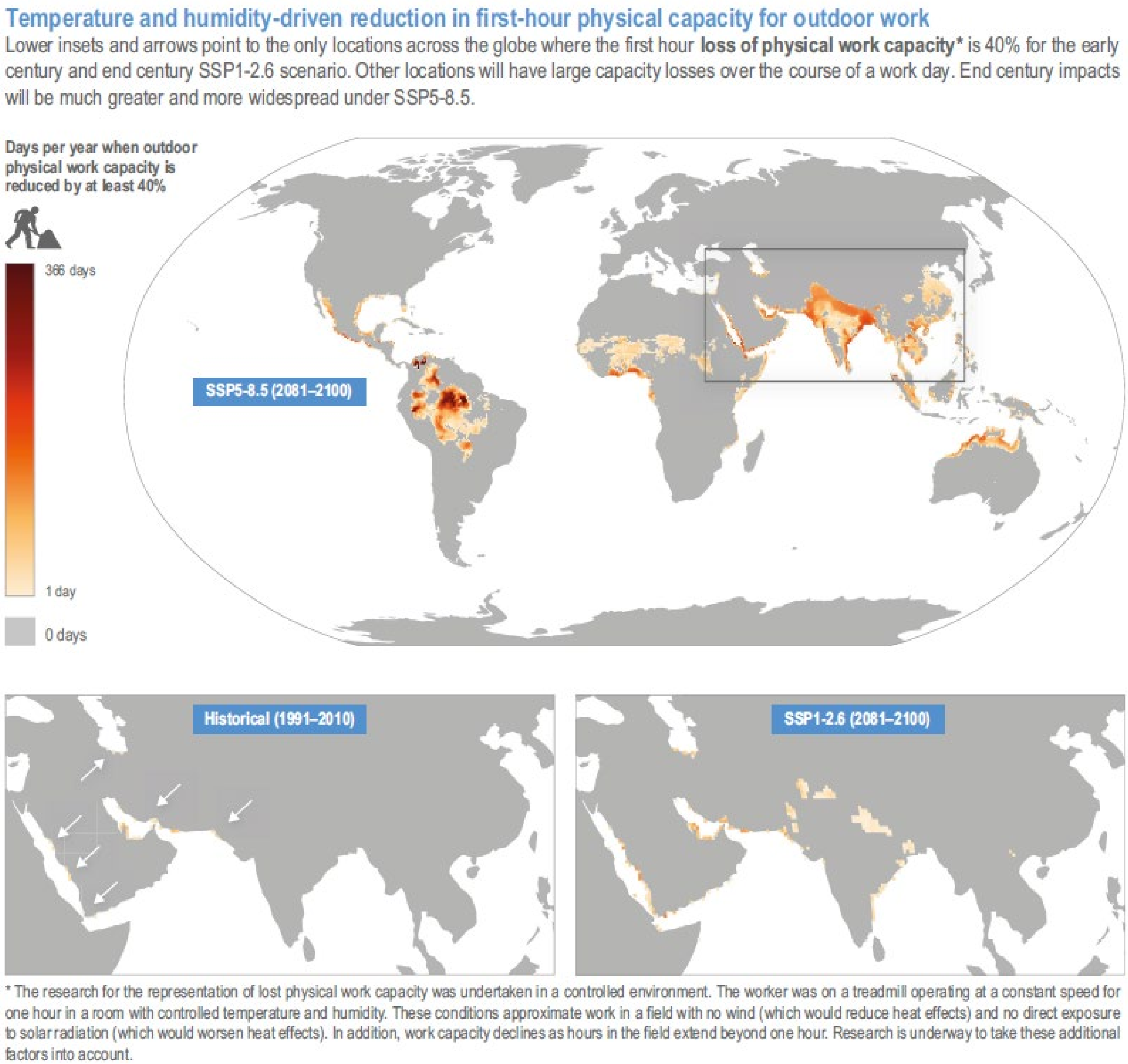


Figure 54: Temperature and humidity-driven reduction in physical work capacity for humans working outdoors for a low emissions scenario and a high emissions scenario (relative to a 1991-2010 baseline) (IPCC, 2022).

CULTURAL HERITAGE

Projecting changes to cultural heritage is inherently challenging due to its intangible, place-specific, and context-dependent nature, which is difficult to quantify or model (Richards and Brimblecombe, 2025). In addition, there is a general lack of consistent, long-term data on cultural heritage and their vulnerability, further limiting the ability to make robust predictions (Crowley *et al.*, 2022). Figure 55 presents water-related adaptation responses, including current benefits, co-benefits with mitigation, potential negative effects, and their future effectiveness and remaining risks projected by the IPCC under different levels of global warming. As shown in Figure 55, according to the IPCC there is low confidence in evidence on Indigenous knowledge and local knowledge based adaptations on water-related adaptation responses.

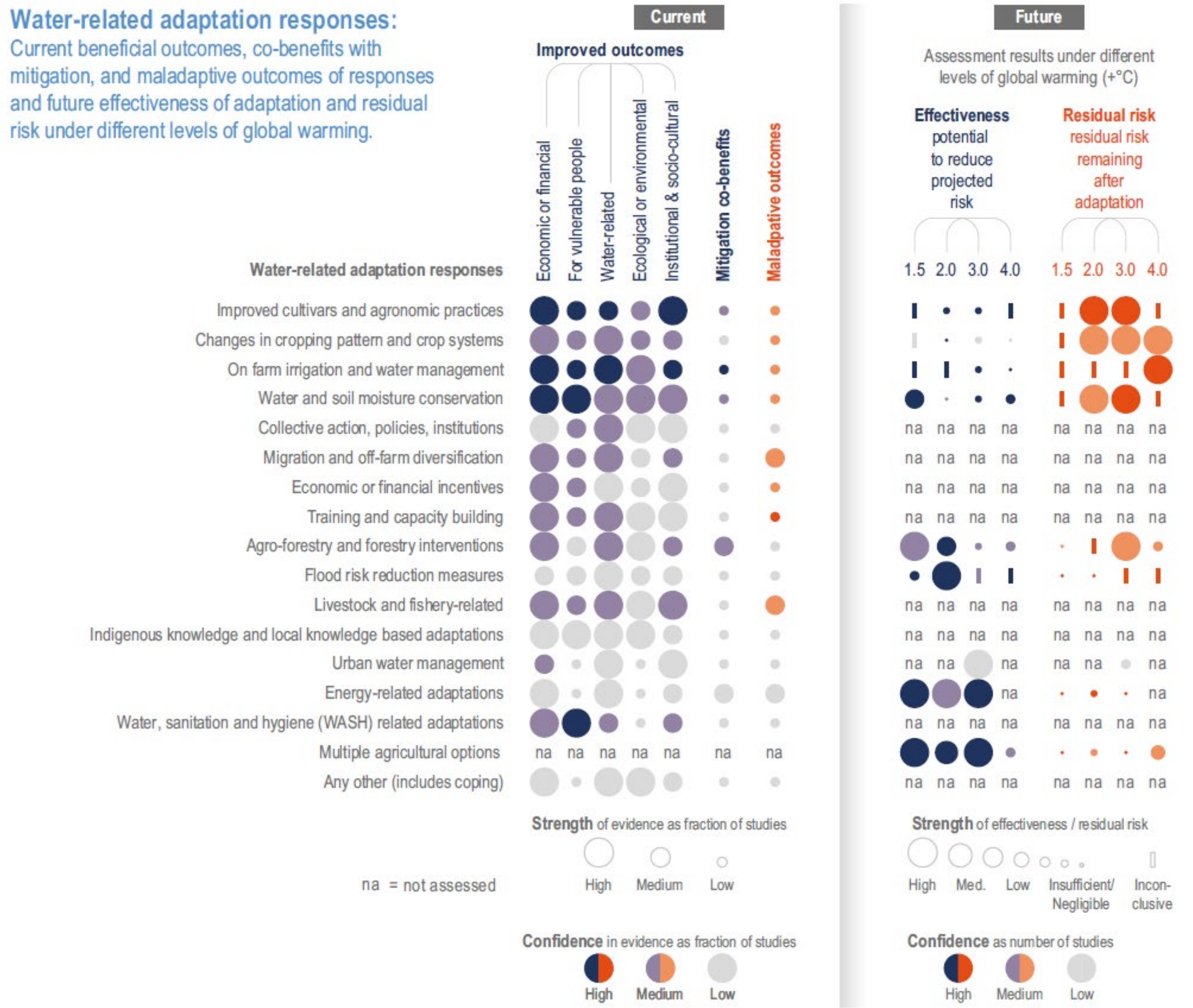


Figure 55: Water-related adaptation responses, including current benefits, co-benefits with mitigation, potential negative effects, and their future effectiveness and remaining risks under different levels of global warming (IPCC, 2022).

Sea-level rise and related coastal hazards are projected by the IPCC to pose increasing climate risks to African heritage over the coming decades. Figure 56 illustrates the coastal cultural and natural heritage sites across Africa that are projected by the IPCC to be at risk from sea-level rise and erosion by 2100 under a high emissions scenario (IPCC, 2022).

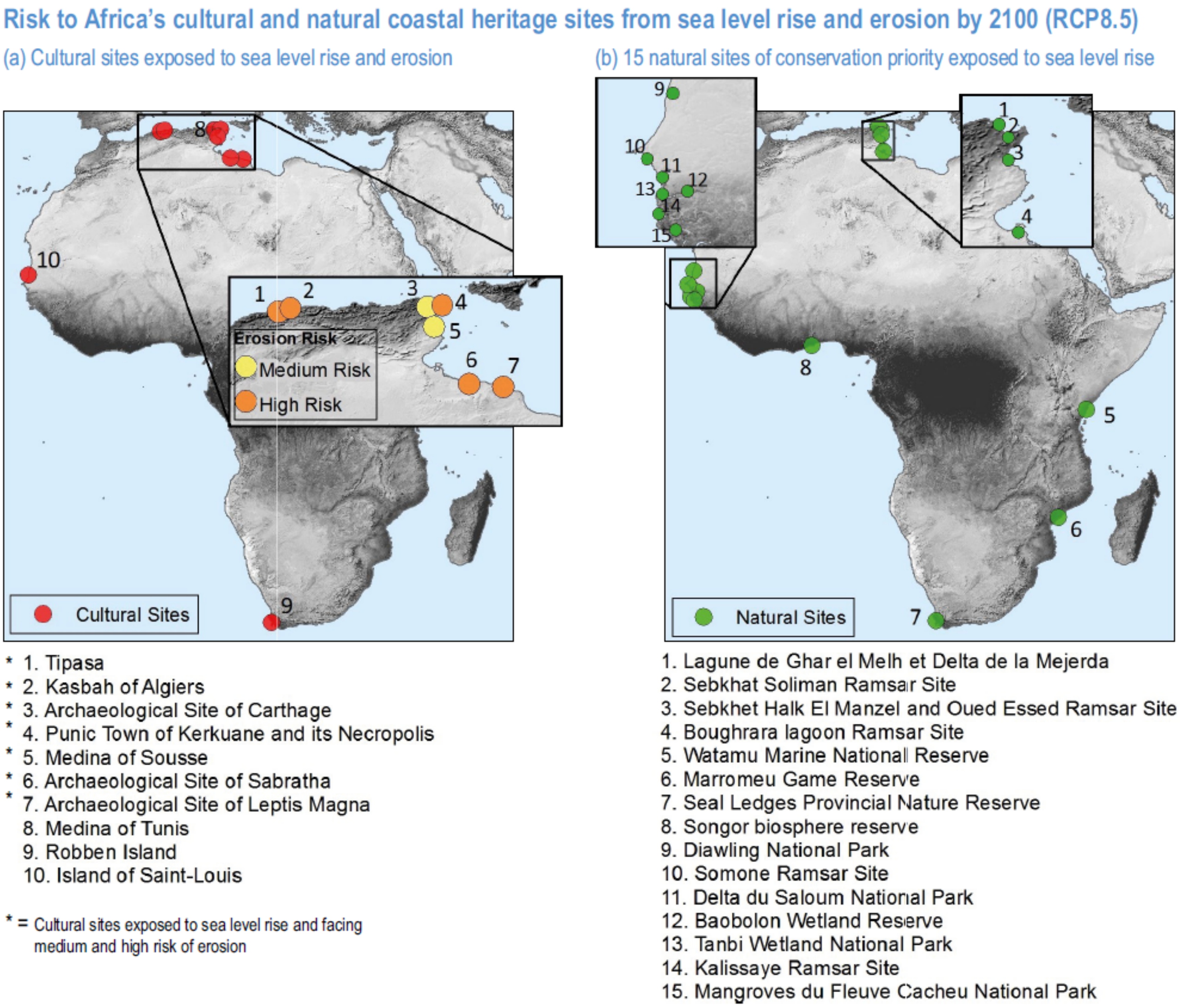


Figure 56: Risk to Africa's cultural and natural coastal heritage sites from sea level rise and erosion by 2100 under a high emissions scenario (RCP8.5) (IPCC, 2022).

Figure 57 illustrates the IPCC projected increase in risk to World Cultural Heritage sites across the Mediterranean from flooding and erosion associated with sea-level rise by 2100 under a high emissions scenario.

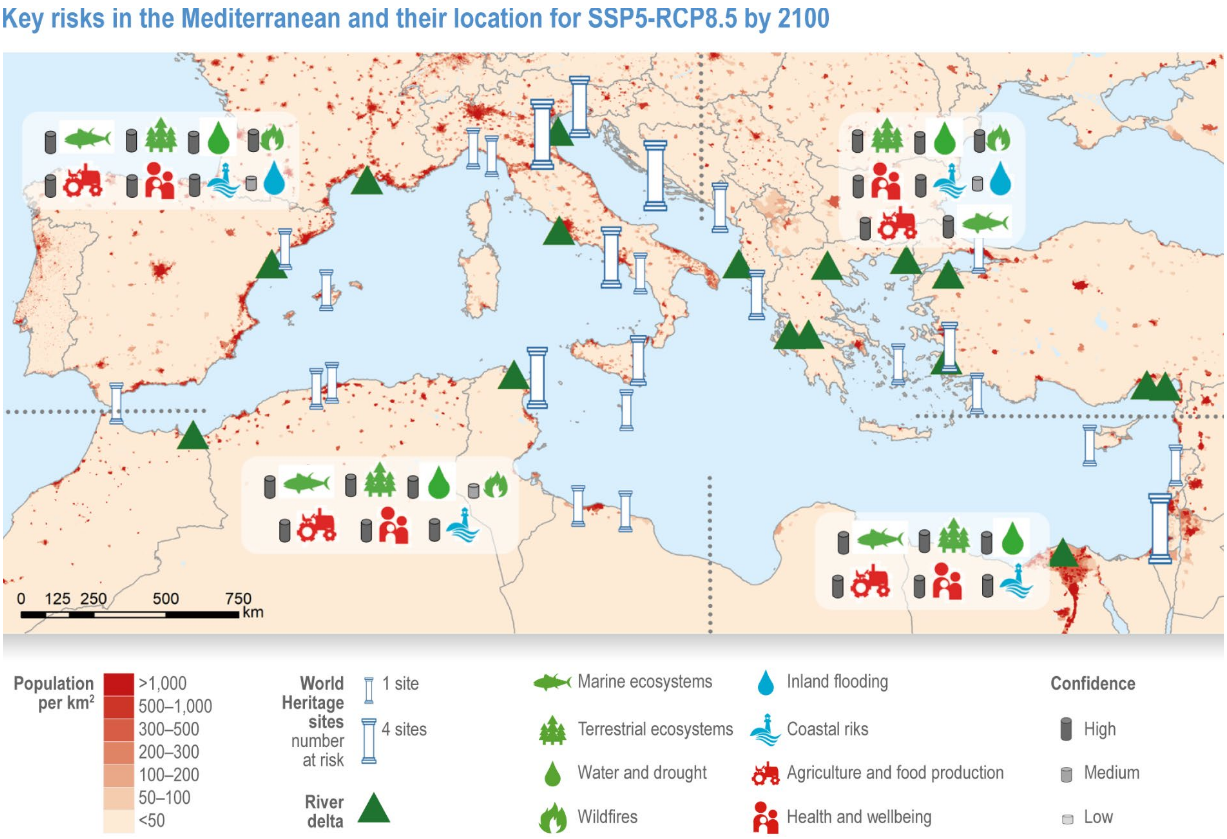


Figure 57: Key risks in the Mediterranean and their location across the Mediterranean region under a high emissions scenario (SSP5-RCP8.5) by 2100 (IPCC, 2022).

THE LANDSCAPE

Figure 58 presents the spatial distribution of current and future Northern Hemisphere lakes that, according to the IPCC, may experience intermittent winter ice cover under climate warming, with light grey areas indicating current conditions and coloured areas showing IPCC projected future changes. The figure indicates that lakes, which currently experience intermittent winter ice cover are projected by the IPCC to see a progressive reduction in ice cover duration as global temperatures increase from 2°C to 3.2°C, 4.5°C and 8°C above the 1970–2010 baseline. Under higher warming scenarios, the extent and duration of lake ice cover are projected by the IPCC to decline further, with some locations projected to lose seasonal ice cover entirely.

Figure 59 shows the IPCC forecasted changes in river ice duration across the Northern Hemisphere under the RCP4.5 scenario, approximately equivalent to a 2°C increase, for the period 2080-2100 compared with 2009-2029. The black reference lines indicate, according to the IPCC, ice duration during the period of 2009-2029, while blue shading indicates increases in ice duration, and grey areas represent land where rivers cannot be observed using the available data. The figure shows that, according to the IPCC, ice duration for rivers is expected to decline across much of the Northern Hemisphere, with the largest changes occurring in areas where rivers currently experience seasonal ice cover. In these regions, the ice season is projected by the IPCC to become shorter in the future, with deeper pink-to-red shading showing greater decreases in ice duration, compared with the baseline period, showing a projected broad reduction in the persistence of river ice under warming conditions. Overall, the figure demonstrates a widespread spatial reduction in river ice duration projected by the IPCC under a moderate warming scenario, consistent with a warming-driven decline in seasonal ice cover (IPPC, 2022)

Overall, both figures show a pattern of decreasing ice cover in lakes and rivers respectively under warming conditions, with greater reductions associated with higher temperature increases."

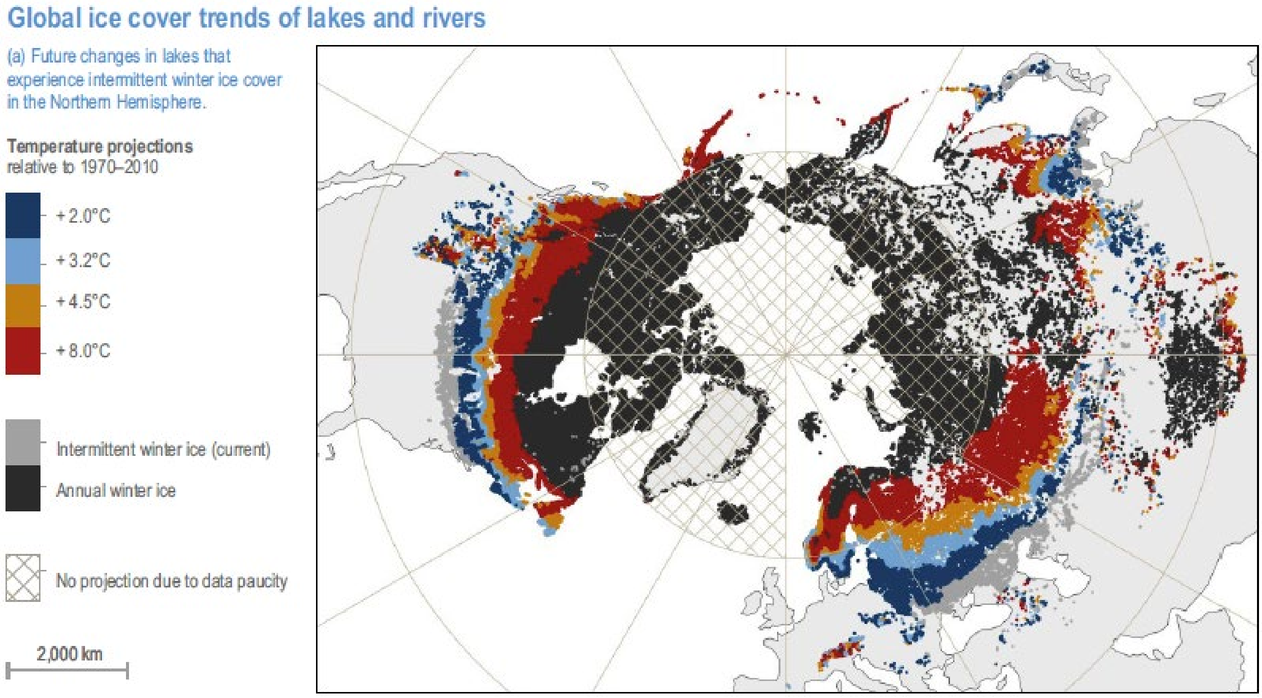


Figure 58: Projected changes in lakes that experience intermittent winter ice cover in the Northern Hemisphere under warming scenarios of 2°C, 3.2°C, 4.5°C and 8°C relative to a 1970-2010 baseline (IPCC, 2022).

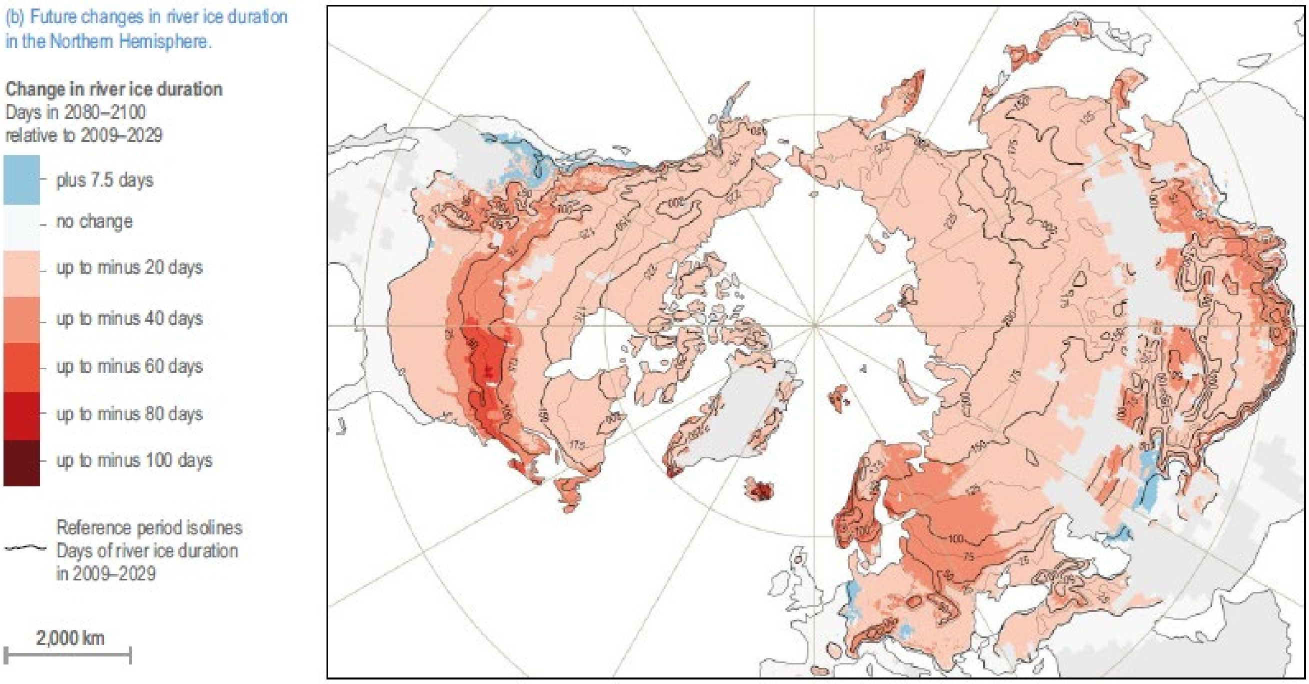


Figure 59: Projected changes in river ice duration across the Northern Hemisphere under the RCP4.5 scenario (around 2°C increase) for 2080–2100, compared to 2009–2029. White areas show rivers with no ice in the baseline period (zero days). Reference lines indicate ice duration during 2009–2029. Colours show changes in ice duration (in days), with blue indicating increases. Grey areas represent land where rivers cannot be observed using available data (IPCC, 2022).

APPENDIX 3 MODEL ASSUMPTIONS AND LIMITATIONS

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
AR6 scenarios, including SSPs, CurPol and ModAct				
AR6 scenarios represent plausible futures for the 'human-environment' system, which vary based on set assumptions on socio-economic conditions and emission mitigation strategies (including in relation to energy systems). Shared Socio-economic Pathways, SSPs) were used to assess climate outcomes. SSPs are defined as baseline socio-economic narratives or storylines used to frame climate futures; they vary across population, income, inequality, technological change, trade, and lifestyle patterns, rather than prescribing a single emissions outcome (IPCC, 2019). For the IPCC (2022) Working Group III Report, a large ensemble of future scenarios were collated from modelling frameworks or studies in existing literature ('the AR6 database'). Each scenario was categorised in accordance with their likelihood of exceeding projected global warming levels (i.e. warming category, C1-C8), climate policies, population, GDP, energy (e.g. fossil fuel use by 2100) and cumulative emissions (refer to the Key Scenario Characteristics and Assumptions column for further information). The AR6 database include the five SSPs used for the Working Group I Report but cover a wider set of scenarios that are more varied in terms of assumptions and outcomes (IPCC, 2022). IPCC (2022) also assess two reference scenarios (Current Policies (CurPol) – climate policies as per 2020 with only gradual strengthening and Moderate Action (ModAct) – Nationally Determined Contributions (NDCs) as formulated in 2020 with some further strengthening). These reference scenarios can be used to provide insight into how different mitigation strategies could achieve Paris Agreement temperature goals (IPCC, 2022).	Scenario driven mitigation pathways which evaluate climate impacts and improve analytical framing by employing standardised models integrating socioeconomic data. This approach contributes to the assessment of the feasibility and implications of different ambition levels. The scenarios are used to support understanding of possible climate outcomes, impacts and risks, and mitigation futures.	The AR6 scenarios emission projections are typically presented as a median and interquartile. This is due to the spread of individual modelling scenario outcomes across each scenario group. Each AR6 scenario projection is derived from thousands of individual modelling scenarios (which were then grouped based on key characteristics and assumptions).	The key assumptions for SSPs include: - The socio-economic drivers are exogenous narrative pathways used to generate emissions baselines (Ministry for the Environment, New Zealand, 2024a) and Integrated Assessment Modelling (IAM) link these drivers to energy demand, emissions, and mitigation outcomes (IPCC, 2023b). - Baseline scenarios typically assume no additional climate policies beyond those already in place, allowing comparison with stronger mitigation scenarios (IPCC, 2023a). Emission scenarios grouped into categories (C1–C8) based on their likelihood of exceeding global warming levels (e.g. 1.5°C, 2°C, >3°C) derived from modelled emissions pathways and IAM results (IPCC, 2024). The key assumptions include: - The categories group emission scenarios based on the level of global warming they achieve by 2100, ranging from pathways consistent with limiting warming to around 1.5°C (C1) to those with much higher temperature increases (IPCC, 2024). - Many of the lower-temperature pathways assume rapid reductions in emissions increasing use of carbon dioxide removal technologies (IPCC, 2023b). - Categories aggregate heterogeneous pathways into single groups, masking differences in underlying assumptions or policy choices and intra-category variability (IPCC, 2023c; IIASA, 2022). CurPol and ModAct are intended to show the effect of gradual policy strengthening versus stronger action, rather than represent a single	General AR6 scenarios: – Large uncertainty in projections across AR6 scenario database, each scenario is associated with range of highly uncertain assumptions about behaviour, technology (e.g. deployment of Carbon Dioxide Removal (CDR) and Carbon Capture Usage and Storage (CCUS)) and investment. Scenarios are not assigned a probability. – Future scenarios are projections (i.e. plausible futures) and not predictions or forecasts. Scenarios and projections are contingent on assumptions being realised. The SSPs are narrative frameworks, not forecasts; used in models to explore a range of plausible futures rather than assign probabilities (IPCC, 2019). – Does not represent up to date global oil and gas production (historic and forecast) or climate models / modelling frameworks published after 2021. – Projections are based on a 2020 base-year (i.e. CurPol and ModAct reference scenarios are based on climate policies and NDCs, as per 2020). – Scenario database contains a vast amount of data from heterogenous sources, so the comparability of the data is less straightforward (Cointe, 2024). – Projections are typically presented as median values and interquartile ranges. There are limitations to using the median values as the AR6 database does not represent a statistical sample (Achakulwisut *et al.*, 2023). – Oil and gas supply and demand is primarily generated by IAMs which are simplified representations of complex systems and do not represent market behaviour or responses to geopolitical

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
			policy forecast (IPCC, 2023d). They are used as reference cases to compare current-policy outcomes with stronger mitigation cases (IPCC, 2023f). Both reflect near- to medium-term policy real-world policy decisions and commitments rather than scenarios that are deliberately constructed to achieve a specific outcome or targets (IPCC, 2023b). They assume that policies are implemented as planned, which may not reflect real-world delays or failures. (IPCC, 2023c). Key characteristics for the CurPol and ModAct reference scenarios include (IPCC, 2022; Achakulwisut *et al.,* 2023): - CurPol (consistent with limiting warming to 4°C (>50%)) ○ Fossil fuels remain important and are locked in. ○ Assumes continuation of existing implemented policies by the end of 2020 (≈ policy baseline) (IPCC, 2023a; IPCC, 2023g). - ModAct (consistent with limiting warming to 3°C (>50%)) ○ Moving away from coal, some lock-in in fossil fuel investments, growth in renewables. ○ Assumes moderate strengthening of policies, often aligned with NDCs or incremental mitigation efforts (partial implementation of climate goals) inferred from AR6 comparisons (IPCC, 2023c).	shocks well (Asefi-Najafabady *et al., 2020).* - Not all variables are consistently reported across the AR6 model-scenarios. - IAMs do not reflect the risk of failure of the technologies or measures on which they rely (Achakulwisut *et al.,* 2023). - Structural differences across IAMs (e.g. sector coverage, technology representation) reduce comparability (Kikstra *et al.*, 2022). - IAMs typically do not separate energy and non-energy uses of fossil fuels (Achakulwisut *et al.,* 2023). - Wide range of possible outcomes due to uncertain socio-economic development, technological change, and policy responses across pathways (Piarini *et al.*, 2024; Nicholls *et al.,* 2022). - Uncertainty is structural: the SSPs encode different futures for socioeconomic development rather than probabilistic forecasts. The main uncertainty lies in future demographic, economic, institutional, and technological trajectories (IPCC, 2019). - The SSPs do not determine climate outcomes on their own; actual warming depends on the emissions pathway paired with the socioeconomic storyline (IPCC, 2023e). - Wide uncertainty in socioeconomic drivers (GDP growth 2.7–4.1%/yr; population ~8.5–9.7bn by 2050) (IPCC, 2023a). - The speed and cost of technological innovation, such as clean energy deployment, are uncertain and vary across scenarios. (IPCC, 2023b). - Even if emissions pathways are known, there remains uncertainty in how the climate system will respond, meaning similar SSPs can lead to different

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
				temperature outcomes. (IPCC, 2024; Kikstra *et al.,* 2022). – Different models use different methods and assumptions, which means results for the same SSP can vary significantly depending on the model used (IPCC, 2023b). – SSPs rely on integrated assessment models and simplified representations of complex socio-economic systems.to explore different futures (Ministry for the Environment, New Zealand, 2024a). – Limited representation of feedback from climate impacts to socioeconomic development (one-directional framework) (IPCC, 2024). – Human factors such as behaviour change, lifestyle shifts, and political dynamics are simplified or only partially represented in the models. (IPCC, 2023b). C1-C8 emissions scenario categories: – There is high uncertainty about whether carbon dioxide removal technologies can be deployed at the scale and speed assumed in many scenarios (IPCC, 2023b). – Climate system uncertainty (e.g., transient climate response i.e. how sensitive temperatures are to emissions) affect how pathways map to warming levels (IPCC, 2024). – Many scenarios rely heavily on large-scale carbon dioxide removal technologies, which are not yet proven at the required scale in the real world (IPCC, 2023b). – Categories aggregate heterogeneous pathways into single groups, masking differences in underlying assumptions or policy choices and intra-category variability (IPCC, 2023c; IIASA, 2022). – Differences in how models represent sectors (such as agriculture or industry)

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
				require harmonisation, which introduces simplifications (IPCC, 2023b). CurPol and ModAct scenarios: – Projections are based on a 2020 base-year (i.e. CurPol and ModAct reference scenarios are based on climate policies and NDCs). – Uncertainty is driven by how quickly current policies tighten, whether announced measures/policies are implemented, whether pledges are translated into enforceable measures and how sectoral transitions unfold (IPCC, 2023d). – These scenarios typically lead to a wide range of emission outcomes (e.g., ~2.2–3.5°C median warming for policy-based pathways), reflecting uncertainty in policy ambition and effectiveness (IPCC, 2023c). – Political, economic and social changes (such as elections or economic crises) are not captured in baseline policy continuation assumptions and could significantly alter policy trajectories (Re IPCC, 2023b). – These pathways do not represent what would be required to meet international climate goals such as limiting warming to 1.5°C, so they are not suitable for assessing Paris-aligned futures. (IPCC, 2023a).
IEA STEPS/APS/NZE				
Scenarios derived from the IEA's Global Energy and Climate (GEC) model. Each scenario is defined as follows: – CPS – Current Policies – STEPS – Stated Policies – APS – Announced Pledges – NZE – Net Zero Emissions	Scenario-driven approach to examine future energy trends. To explore the impact of policies and targets (for STEPs and APS) on energy	The GEC model projects CO_2 emissions from fuel combustion and industrial processes associated with the projected energy demand / consumption for each scenario. The GEC model derives energy demand / consumption by modelling iterative interactions between energy supply and	– CPS (*excluded from IEA, 2024*): • Includes only policies already enacted into law, excluding announced intentions (IEA, 2025c). • No new long-lead time oil and gas projects required.	– Scenarios are exploratory and not predictions. Scenarios and projections are contingent on assumptions being realised (IEA, 2025b). – The scenarios depend heavily on assumptions about policy implementation, especially in APS and NZE. For example, the scenarios assume

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
Contrary to the scenarios within IPCC (2023h) AR6, the scenarios in IEA (2024) do not represent an ensemble of multiple modelling scenarios and are derived from the IEA's GEC Model, a bottom-up modelling framework which uses macroeconomic drivers, socio-economic inputs and policies to design and calculate a range of future energy scenarios. Macroeconomic drivers, such as economic activity and population are generally kept constant across all scenarios, with other factors that drive fossil fuel production and consumption (e.g. fossil fuel prices, energy demand, policies) varying between scenarios. The IEA (2025b) World Energy Outlook 2025 has been released which updates the scenario of the IEA (2024) World Energy Outlook 2024. IEA (2025b) does not include the APS scenario, includes a new Current Policies Scenario (CPS), and the NZE scenario is no longer a limited-overshoot scenario, as warming peaks above 1.6 °C and exceeds 1.5 °C for several decades before returning below 1.5 °C by 2100. The APS scenario was excluded from IEA (2025b), pending updated NDC clarity. The formal base year for the GEC Model outputs for the IEA (2025b) World Energy Outlook 2025 is 2023, however, 2024 estimates for energy production and demand are used, where available (IEA, 2025e).	systems (from a defined set of starting conditions). To explore pathways for the energy sector to achieve emission goals (e.g. NZE scenario).	demand and determining equilibrium price that balances energy supply and demand. **Supply module** Oil supply is modelled at the country level using an asset-based approach, incorporating: – Historical production rates; – Production profiles and estimated decline rates; – Review of upstream, planned and announced upstream projects, using information gathered for the IEA Medium-Term Oil Market Report (covers period up to 2030); – Decision modes of industry to develop new reserves; – Economic assumptions and financial risks (including to capture 'attractiveness' of investment in oil and natural gas fields); and – Values of remaining technically recoverable resources (based on the United States Geological Survey, USGS) to define the upper bound of resource availability but do not constrain production in policy-driven scenarios. Natural gas production is modelled in a similar approach to oil, however, it is assumed that natural gas is primarily traded regionally. The model accounts for declines in oil and natural gas fields, derived from the UCube database of Rystad Energy. Decline rates and post-peak production profiles for oil and gas assets are informed by asset-level databases such as Rystad Energy's UCube, supplemented by expert judgement and quality assurance processes undertaken by the IEA. The UCube database is refined to include individual oil and natural gas assets only if >50% of historical data points are of high confidence level or > 66% are medium confidence level and only if assets have <4% speculative data with no missing	– STEPS (IEA, 2024): • Based on current stated and announced policies (including planned policies), reflecting today's policy trajectory already implemented or credibly announced, but excludes aspirational targets (IEA, 2025d). • Represents the "direction of travel" under today's policy settings and market conditions. • Assumes incremental energy transition, not structural transformation. • Oil demand peaks around 2030 and gradually declines. • Gas demand continues to grow until 2036 and then plateaus. • There is an ongoing need for new oil and gas supply. – APS (*excluded from IEA, 2025b*): • Assumes full and timely implementation of announced pledges (e.g., NDCs, net-zero targets) (IEA, 2025a). • Assumes full implementation of all announced pledges (NDCs + net-zero) (IEA, 2025a). – NZE: • A normative pathway assuming rapid global decarbonisation, net-zero CO_2 by 2050, and strong policy + technology deployment (IEA, 2023). • No probabilities are assigned to pathways pathway designed to achieve net zero emissions by 2050. • Oil and gas demand rapidly declines to 2050. • No new long-lead time oil and gas projects required.	stated pledges become implemented policies and that current policies are strengthened. There is uncertainty about how countries will update their climate commitments (NDCs) in future policy cycles (post-2025). (IEA, 2025a). – Policy delivery risk (gap between announcements and implementation central in APS) (IEA, 2025a). – Future technology costs and adoption rates (such as renewables, hydrogen, or carbon capture) remain uncertain (IEA, 2024). – Large uncertainty in projections associated with range of highly uncertain assumptions about behaviour, technology (e.g. CDR and CCUS) and investment. – Energy demand projections depend on uncertain factors such as economic growth and electrification trends (IEA, 2024). – Focussed on energy system and does not capture economy-wide feedback (e.g. labour markets, inflation). – Some emerging technologies or behavioural changes may not be fully represented due to modelling constraints (IEA, 2024). – NZE scenario is associated with temporary overshoot of 1.5 °C (IEA, 2025b). – Considering alignment of emissions with STEPS / APS / NZE scenarios alone ignores range of other plausible climate-energy futures. – The modelling focuses primarily on the energy system and does not fully capture broader socioeconomic dynamics compared to IPCC frameworks (IEA, 2024). – The GEC model relies on estimates of the remaining technically recoverable resources, rather than the (often more widely quoted) numbers for proven

Description	Purpose	Method for Projecting Future Emissions from Existing and Approved Projects	Key Scenario Characteristics and Assumptions	Uncertainties/limitations
		values. Assets with company-level data only were also excluded. **Demand and transformation module** Demand is based on projections for energy consumption across key sectors, including industry, transport, buildings under the which take account of technological advances and technology costs (factoring in fossil fuel prices, end-use prices and CO_2 prices). Electricity and heat production is calculated to determine fuel consumption and associated CO_2 emissions. **Equilibrium price** The final energy demand / consumption is derived by determining the equilibrium price the balances supply and demand. The GEC model prioritises projects based on their profitability (net present value) and applies real-world constraints for each country, such as operating costs, development timelines for new developments, and operating costs. Where demand cannot be met, this indicates prices should increase and the model is re-run.		reserves. Resource estimates are subject to a considerable degree of uncertainty, as well as the distinction in the analysis between conventional and unconventional resource types. – Increased uncertainty in policy ambition tracking without APS benchmark scenario. Discontinuity reduces comparability across editions (IEA, 2025a,b). – Reflects dependence on evolving policy datasets rather than stable methodological framework (IEA, 2025b).

APPENDIX 4 DETAILED CONTEXTUAL INFORMATION USED TO ASSESS SIGNIFICANCE

NATIONAL OR DEVOLVED ADMINISTRATION CARBON BUDGET AND NDCS

This Appendix expands on Sections 5.3.2 and 5.3.2.1 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) which contextualise the Jackdaw Project Scope 3 emissions within the UK's carbon budgets and NDCs.

Use of Carbon Budgets

Carbon budgets are widely used by governments and regulators to support effective GHG emissions management. For governments, carbon budgets form the basis of national climate policy and help track progress toward legally binding targets e.g. the UK carbon budgets under the Climate Change Act 2008. Regulators use them to monitor sector performance and ensure alignment with broader climate objectives. For example, the UK reduced its territorial GHG emissions to 423 MtCO_2e by 2023 (CCC, 2025), representing a decrease by almost 50% compared with 1990 levels, demonstrating how structured, long-term approaches such as the use of carbon budgets, can drive significant GHG emissions reductions.

Since carbon budgets typically become more stringent over time, they encourage ongoing GHG emissions reductions rather than relying on one-off improvements. This approach has been shown to work more broadly, with 36 countries reporting sustained GHG emissions reductions for more than 10 years as of 2022 (CCC, 2025). The use of carbon budgets demonstrates their effectiveness as a policy tool for driving sustained GHG emissions reductions and supporting the achievement of long-term climate goals, such as those outlined in the Paris Agreement.

UK Carbon Budget

The UK operates within a legally binding framework of carbon budgets, established under the Climate Change Act 2008, which set limits on the total amount of GHG emissions the UK can emit over successive five-year periods. These budgets are primarily based on GHG emissions arising from the combustion and consumption of fuels and products within the UK economy, including energy used for electricity generation, heating, transport, and industrial processes. In this context, GHG emissions associated with the Jackdaw Project can be considered alongside the UK's carbon budgets to understand their relative contribution to national GHG emissions limits and the broader pathway to net zero.

The UK Climate Change Committee (CCC) published its advice on the 7th Carbon Budget, 'the Balanced Pathway', in February 2025, setting out a GHG emissions reduction pathway from 2025 to Net Zero by 2050 that aligns with UK's legislated carbon budgets and stated Nationally Determined Contributions (NDCs). For the five-year period 2038-2042, the CCC has recommended a total GHG emissions limit of 535 Mt CO_2e.

Additionally, the 7th Carbon Budget incorporates demand for oil and gas which, together with GHG emissions attributed to the energy use, can be used to place the Jackdaw Project's Scope 3 emissions within the context of the UK carbon budget and assess the impact of such GHG emissions.

UK Hydrocarbon Demand

This section expands Section 5.4.2.4 of the Part 1 Jackdaw Scope 3 Emissions Assessment (Shell, 2025) which details the UK's oil and gas supply gap and how UK gas demand during Jackdaw's expected production period will exceed domestic supply.

Although there is a strong drive towards transitioning to renewable energy use, fossil fuels still play a critical role in meeting the UK's energy needs. In 2023, the UK's total GHG emissions was 423.3 $MtCO_2e$ (CCC, 2025) with contributions from the following sources:

- Surface transport (i.e. cars, heavy goods vehicles (HGVs), vans, etc.) which has been the greatest source of GHG emissions in the UK since 2015 with 102.8 $MtCO_2e$ emitted in 2023.
- Residential buildings' total GHG emissions were around 52.2 $MtCO_2e$. Gas usage for space heating and hot water accounted for 80% of these GHG emissions.
- Electricity supply accounted for approximately 37.8 $MtCO_2e$ of GHG emissions, with 30% resulting from unabated gas use for power generation.

However, to achieve UK Net Zero targets by 2050, electricity demand is anticipated to rise significantly with the shift towards large-scale electrification. Electricity usage is projected to increase by approximately 50% by 2040 compared to 2023 levels and will be driven by the uptake of electric vehicles (EVs), heat pumps and industrial electrification (CCC, 2025). Unabated gas-fired power generation is expected to decline to 7% by 2030, 3% by 2035, and 2% by 2040, with a complete phase-out expected by 2050 (CCC, 2025). Deployment of carbon capture, usage and storage (CCUS) to capture emissions from industrial processes will further reduce GHG emissions being released to atmosphere and decrease the environmental impact of gas used for electricity generation (CCC, 2025). Despite these mitigation measures, there is still an expected demand for oil and gas, but domestic production will decline out to 2050.

The UK is a net importer of gas and, according to the NSTA, gas imports accounted for 61% of the UK's total gas supply in 2024 (NSTA, 2025). The import gap can be seen in Figure 60.

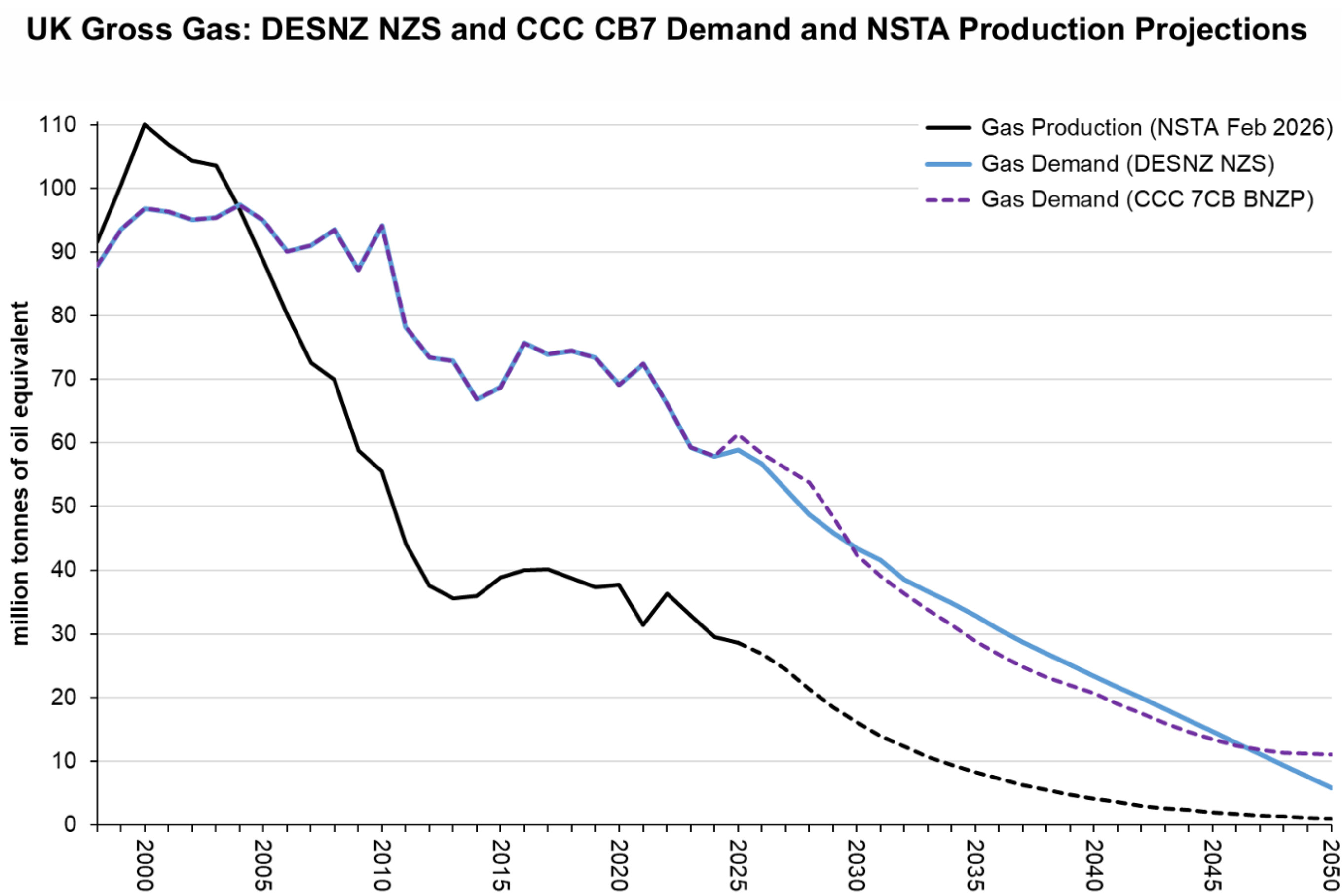


Figure 60: UK Gross Gas: DESNZ Net Zero Strategy and CCC 7th Carbon Budget & Demand and NSTA Production Predictions (NSTA, 2026).

SECTORAL BUDGETS OR REDUCTION STRATEGIES

The offshore oil and gas industry operates within a well-established framework of sector-specific GHG emissions reduction targets, decarbonisation strategies and regulatory mechanisms. These include the North Sea Transition Deal (NSTD), the NSTA Stewardship Expectation 11 and Emission Reduction Action Plan (ERAPs) as part of the Oil and Gas Authority (OGA) Strategy.

North Sea Transition Deal

The NSTD is a UK government-industry agreement designed to help the offshore oil and gas sector move towards a low-carbon, Net Zero future while still supporting jobs and energy security.

The NSTD aims to achieve a 60 Mt reduction in operational GHG emissions by 2030, including 15 Mt from the progressive decarbonisation of UK Continental Shelf (UKCS) production, with the overall total also incorporating GHG emissions savings from CCUS and hydrogen initiatives (BEIS, 2021).

The NSTD is built on five key outcomes:

1. Supply Decarbonisation
2. CCUS
3. Hydrogen
4. Supply Chain Transformation
5. People & Skills

Under Supply Decarbonisation, the offshore oil and gas sector has committed to the following actions to support the energy transition:

- **Emissions reduction targets:**

  The oil and gas sector aims to cut production GHG emissions by 10% by 2025, 25% by 2027, and 50% by 2030 (against a 2018 baseline), as part of its pathway towards achieving Net Zero by 2050 (BEIS, 2021).

- **Improved emissions stewardship:**

  Companies will follow the NSTA's Stewardship Expectation 11, to actively reduce GHG emissions from both new and existing assets.

- **Streamlined emissions monitoring and reporting:**

  Industry, regulators and the UK Government will develop standardised monitoring and reporting systems to make tracking GHG emissions easier and more consistent.

- **Reduced emissions and flaring through a Methane Action Plan:**

  The sector will create and commit to a Methane Action Plan, outlining measures to enhance the monitoring and reporting of GHG emissions, alongside setting a specific methane reduction target. Specifically, the sector is committed to:

  - Aligning with the World Bank 'Zero Routine Flaring' Initiative by ending routine flaring ahead of 2030.
  - Meeting methane intensity targets set by the Oil and Gas Climate Initiative (OGCI) of 0.25% (with a more ambitious target of 0.20%) (BEIS, 2021).

- **Electrification investment:**

  The sector will invest £2–3 billion to power offshore operations with electricity (including renewables), helping to reduce GHG emissions (BEIS, 2021).

North Sea Transition Authority's Stewardship Expectation 11

Stewardship Expectation 11 was introduced in 2021 (NSTA, 2021) and defines the NSTA's expectations on the upstream oil and gas industry to minimise GHG emissions, as far as reasonably practicable, to support delivery of the UK's Net Zero GHG emissions targets.

The Expectation focuses on three main areas:

- **Create a culture of GHG emissions reduction within the UK Continental Shelf (UKCS):**
  - Embed GHG emissions reduction into decision-making across the UKCS.
- **Consider GHG emissions across the full lifecycle:**
  - From exploration and development through production to decommissioning.
  - Includes improving energy efficiency, reducing flaring/venting, and maintaining high production efficiency.
- **Collaborate on Net Zero solutions:**
  - Work with industry and other sectors (e.g. renewables) to support and enable potential energy integration developments such as electrification, CCUS, hydrogen developments etc.

Stewardship Expectation 11 was introduced to align the upstream oil and gas industry with UK and Scottish Net Zero legislation, ensuring that operators both maximise economic recovery and actively reduce GHG emissions.

Emission Reduction Action Plans (ERAPs)

The NSTA issued the revised OGA Strategy which came into force on 11th February 2021. The revised OGA Strategy (OGA, 2021) introduced a Central Obligation requiring the upstream oil and gas industry to:

> *a. Secure that the maximum value of economically recoverable petroleum is recovered from the strata beneath relevant UK waters; and, in doing so,*
>
> *b. Take appropriate steps to assist the Secretary of State in meeting the net zero target, including by reducing as far as reasonable in the circumstances greenhouse gas emissions from sources such as flaring and venting and power generation, and supporting carbon capture and storage projects.*

Both the NSTA and industry are legally required to comply with the OGA Strategy which is the key legal driver behind GHG emissions reduction requirements.

In March 2024, the NSTA issued an OGA Plan (OGA, 2024) on GHG emissions reductions from oil and gas extraction to support delivery of the Central Obligation set out in the revised OGA Strategy. As part of the OGA Plan, the NSTA sets an expectation that operators will invest in reducing GHG emissions across their oil and gas activities, including the deployment of technologies to improve power generation efficiency, optimisation of processes to reduce GHG emissions from existing assets, and the incorporation of GHG emissions reduction technologies and monitoring in new and planned developments.

The development and implementation of ERAPs are identified by the NSTA as necessary requirements to meet the Central Obligation in relation to investment and efficiency. Specifically, operators are required to (OGA, 2024):

1. *Produce an Emissions Reduction Action Plan ('ERAP') for each asset which, among other things, summarises and assesses applicability of available emissions abatement and emissions monitoring opportunities and technologies, and sets out planned emissions reduction initiatives, including for logistics emissions.*
2. *Implement and execute in a timely manner the ERAP produced in accordance with Requirement 1.*

These requirements in the OGA Plan build on and are consistent with the NSTA's Stewardship Expectation 11.

CURRENT AND FUTURE GHG INTENSITY OF AN ACTIVITY

This section expands Section 5.4.2.2 and Section 5.4.2.4 of the Part 1 Jackdaw Scope 3 Assessment (Shell, 2025) which compared the estimated GHG intensity of Jackdaw gas against GHG intensities from the IEA and NSTA. Estimated Jackdaw gas intensity was also compared against imported LNG intensity.

As outlined by ISEP (ISEP, 2026), industry good practice can include the use of GHG intensity metrics to help place a project's emissions into context. This is particularly relevant where a project meets an established demand, as it *"provides useful context in cases where a project is meeting an established demand, such as for electricity generation, and may have a GHG benefit by displacing a legacy source (e.g. renewable generators displacing gas-fired baseload)" (ISEP, 2026)*.

The use of GHG intensities acts as an effective benchmark, allowing for comparisons between different sources of supply, regardless of their overall total GHG emissions. By expressing GHG emissions per unit of output (e.g. per unit of gas produced), intensities allow for an assessment of how efficiently a project delivers energy relative to alternatives and whether it represents a lower carbon option within an existing system of demand.

The lower the GHG intensity of a product, the more carbon-efficient the product is, and therefore the more favourable it is from a climate perspective. GHG intensities should be reduced as far as practicable, driving continuous improvement across the value chain.

It is therefore paramount that any fuels consumed as nations transition to Net Zero have the lowest value chain GHG emissions which can be assessed by considering the GHG intensity of the fuels. This helps to mitigate the overall warming attributed to getting fuels to their point of end use (i.e. extracting, processing and delivering fuels) which ensures that hydrocarbon demand is met by the lowest-emitting and most efficient sources available.

GHG Intensities Attributed to Imported Gas

The UK is a net importer of gas and, according to the NSTA, gas imports accounted for 61% of the UK's total gas supply in 2024 (NSTA, 2025) in order to meet UK gas demand requirements.

The use of imported products can impact the overall GHG emissions of those products because carbon intensity of oil and gas production can vary significantly depending on where production occurs. For example, in 2020, the carbon intensity of imported crude oil ranged from around 10 kg CO_2e/bbl to 70 kg CO_2e/bbl (NOIA, 2023), demonstrating that the GHG emissions associated with refined products, which are eventually consumed by end users, can have a significant range of impact depending on where the crude oil used to produce those products was sourced. Similarly, gas sourced from UK waters or from Norwegian waters (transported via pipelines), is typically around 4 to 8 times less carbon intensive than imported Liquified Natural Gas (LNG) from outside those waters (BCC, 2025; OEUK, 2023; Rystad Energy, 2024).

While GHG emissions from gas combustion are broadly consistent, at around 350 kgCO_2e/boe, emissions associated with upstream operations, transportation and processing can vary significantly depending on the source and supply chain. As an example and shown in Figure 61, imported LNG from the United States can result in an additional 57 kgCO_2e/boe (i.e., 85 kg CO_2e/boe minus 28 kgCO_2e/boe) being emitted compared to domestically produced UK gas due to the additional processes of liquefaction, long-distance transportation and regasification.

These differences indicate that domestic production offers an opportunity to influence the overall carbon intensity of oil and gas supply. By sourcing fuels with lower upstream GHG emissions, it is possible to achieve a degree of GHG emissions reduction associated with their use, even where end-use combustion emissions remain unchanged.

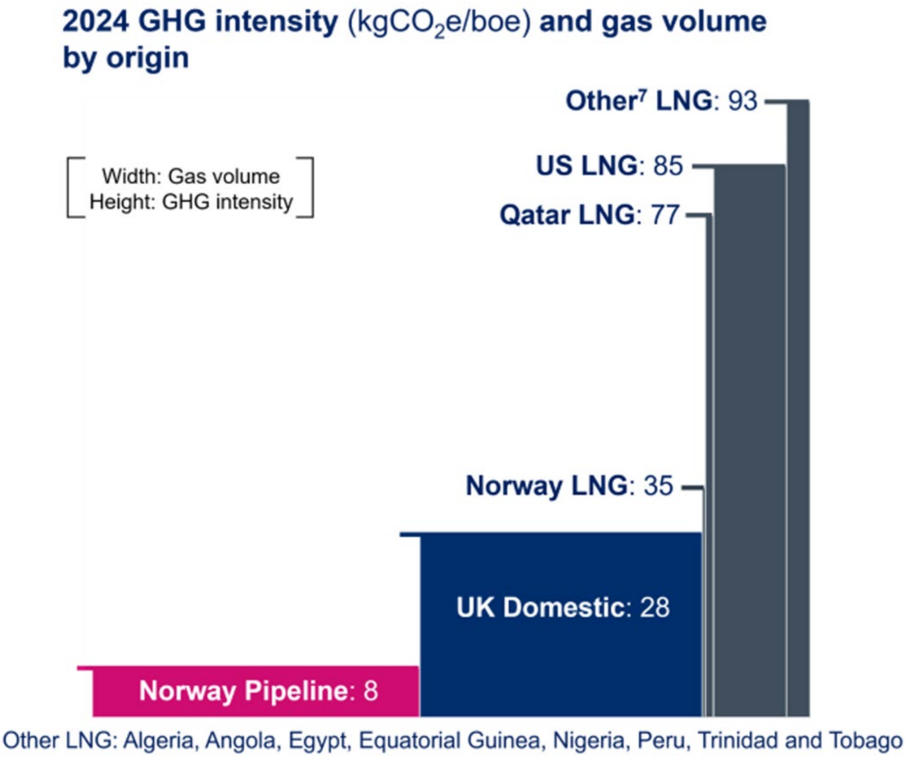
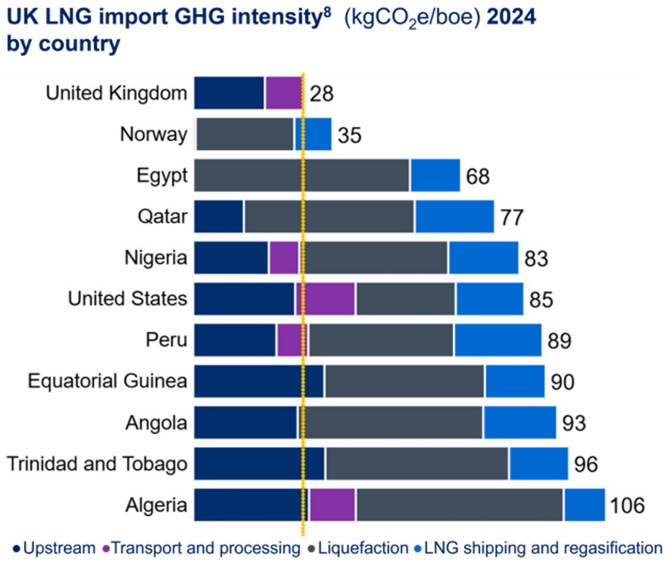


Figure 61: 2024 GHG Intensity ($kgCO_2e$/boe) and Gas Volume by Origin (NSTA, 2025).

Jackdaw Emissions vs. Imported LNG Emissions

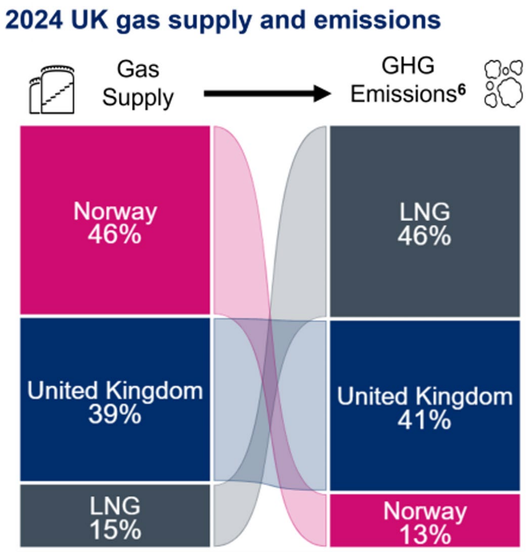
The NSTA average GHG emissions intensity of producing and processing UK domestic gas in 2024 was 28 $kgCO_2e$/boe which was comprised of an emissions intensity of 18 $kgCO_2e$/boe for upstream operations and 10 $kgCO_2e$/boe for transport and processing. Jackdaw's estimated upstream operations GHG emissions intensity is 8.5 kg CO_2e/boe which compares favourably with the UK average of 18 $kgCO_2e$/boe. Assuming the average 10 $kgCO_2e$/boe for transport and processing is added to the Jackdaw upstream operations GHG emissions intensity of 8.5 kg CO_2e/boe, its overall GHG emissions intensity would be 18.5 $kgCO_2e$/boe, which is below the UK average intensity of 28 $kgCO_2e$/boe.

UK imported LNG has an average GHG emissions intensity of 85 kg CO_2e/boe which includes production, processing, liquefaction, shipping and regasification. A breakdown of UK LNG import GHG intensity by country is shown in Figure 62. According to the NSTA, in 2024 imported LNG accounted for only 15% of total UK gas supply but contributed the largest share of associated GHG emissions at 46% (NSTA, 2025). This is shown in Figure 63.



[8] The LNG value chain stages include: Upstream, Transport and processing, Liquefaction, LNG shipping and Regasification.

Figure 62: UK LNG import GHG Intensity (NSTA, 2025).



[6] Excludes emissions for 0.5 MMboe of the UK's 2024 natural gas supply (0.5% of gross supply) from Belgium and the Netherlands, which do not have associated value chain intensity values.

Figure 63: 2024 UK gas supply and associated emissions (NSTA, 2025).

The end-use combustion of Jackdaw gas is estimated to emit around 18.3 $MtCO_2e$ with a further 1 $MtCO_2e$ emitted from production via Jackdaw (Shell, 2025). Based on import data (NSTA, 2025), replacing the expected production of gas from Jackdaw with US LNG (as Norwegian pipeline gas is at capacity) could result in an approximately 4 $MtCO_2e$ of additional emissions as shown in Table 21. Hence importing LNG could result in around 20% more CO_2e emissions than producing the same gas domestically.

Table 21: Difference in Overall CO_2e Emissions Between Imported Gas and Jackdaw Gas, based on total Jackdaw lifetime Production of 58,766 mboe.

Source	Tonnes CO_2e
Average Transport and Processing Intensity 10 $kgCO_2e$/boe. (NSTA, 2025)	587,660
Jackdaw Gas Intensity 8.5 $kgCO_2e$ /boe (Shell, 2022)	499,511
Total	**1,087,171**
Average Import Emissions @ 85 kg CO_2e /boe (NSTA, 2025)	4,995,110
Difference	**3,907,939**

Under the CCC's Balanced Pathway, UK gas demand is expected to continue through to 2050. Meeting this demand with imported gas is likely to result in higher global GHG emissions than doing so with domestic supply, due to the higher carbon intensity of imported LNG compared to UK-produced gas. This is reflected in NSTA analysis that reports LNG imports made up only 15% of total UK gas supply but contributed the largest share of associated GHG emissions at 46% (NSTA, 2025).

EXISTING AND EMERGING NATIONAL OR LOCAL POLICY OR REGULATIONS

Methane emissions management is an increasingly important focus within the UK offshore oil and gas sector, reflecting its significant role in near-term climate change.

Recent increases in atmospheric methane concentrations have accelerated since 2006 (IPCC, 2021) and methane possesses a much higher degree of radiative forcing than CO_2. Radiative forcing is a measure of how strongly a substance affects Earth's energy balance and describes how much additional heat is trapped in the atmosphere when the concentration of a gas increases. An increase in radiative forcing results in an increase in surface temperature.

As a result, there is increased regulatory, investor, and stakeholder scrutiny of methane emissions within the oil and gas industry. This has driven the development and adoption of enhanced measurement, reporting, and mitigation frameworks, such as the Oil and Gas Methane Partnership (OGMP) 2.0, which aims to improve transparency and accuracy in methane emissions reporting and support more effective emissions reductions.

Mitigating Methane Emissions

Methane accounts for about 16% of radiative forcing from long-lived greenhouse gases and is therefore a material driver of present warming alongside CO_2 and nitrous oxide (N_2O) (WMO, 2025). Methane's atmospheric lifetime is approximately nine years due to its removal mainly via chemical oxidation, making it far less persistent in the climate system than CO_2 (WMO, 2025). Therefore, reducing methane emissions can deliver relatively rapid climate benefits compared to CO_2 reduction, with the rate of warming slowing within decades rather than centuries.

As a result, methane is no longer treated as a secondary consideration relative to CO_2 emissions, but as a key component of overall GHG emissions management. When methane reductions are strong, rapid and sustained, they can rapidly slow the rate of warming and improve air quality. Mitigating methane emissions is therefore a credible priority for immediate action across energy, waste and agriculture systems (IPCC, 2021; WMO, 2025).

Oil and Gas Methane Partnership 2.0

The Oil and Gas Methane Partnership (OGMP) 2.0 is a comprehensive reporting framework developed by the United Nations Environment Programme (UNEP) and the Climate and Clean Air Coalition (CCAC). OGMP 2.0 is widely regarded as the global gold standard for methane reporting. Methane emissions are increasingly linked to regulatory expectations (e.g. NSTA and EU methane regulations), as well as investor requirements and Environmental, Social and Governance (ESG) reporting. OGMP aims to improve the accuracy and transparency of methane emissions reporting, drive real, measurable reductions in methane emissions and support global climate targets, including Net Zero goals.

The OGMP 2.0 Framework (OGMP, 2025a) has been designed by members to be the cornerstone of the Mineral Methane Initiative with four key objectives:

1. Provide assurance to governments and the public that methane emissions are responsibly managed, thus helping inform policy decisions.
2. Enable companies to demonstrate credible progress in reducing emissions and supporting climate goals, thus reinforcing natural gas as a desirable fuel for use through the energy transition.

3. Improve methane reporting and reduction performance through transparency, collaboration and best practice sharing.
4. Expand participation in the OGMP 2.0 to drive significant sector-wide methane reductions in line with initiative targets.

OGMP 2.0 aims to enhance transparency, accuracy, and consistency in methane emissions reporting from the oil and gas sector by incorporating a 5-Level reporting framework, as shown in Figure 64 (OGMP, 2025b). The time frame for companies to achieve the OGMP 2.0 reporting requirements for gold standard is 3 years for all operated assets and 5 years for non-operated assets.

Adura is a signatory to OGMP 2.0 and is currently reviewing the status of each of its assets against the OGMP 2.0 framework.

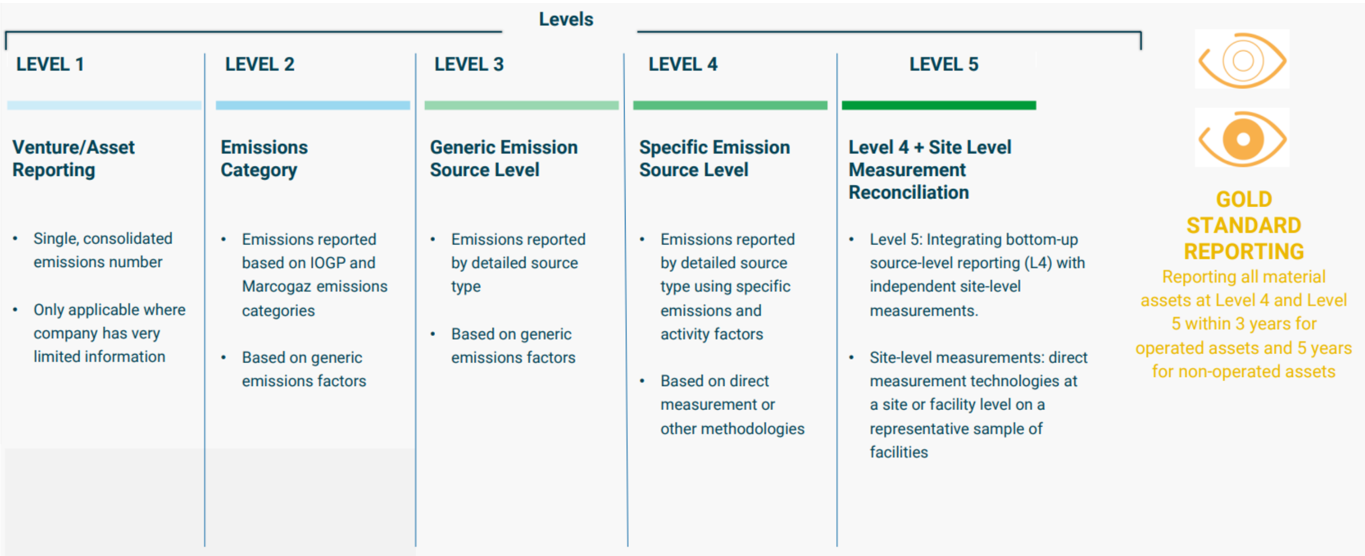


Figure 64: OGMP 2.0 Reporting Levels (OGMP, 2025b).

Benchmarking UK Methane Intensity Against Other Countries

The UK oil and gas industry is also aligned to the OGCI 2025 methane intensity commitment (also reflected in the NSTD Supply Decarbonisation commitments) which stipulates a methane intensity target for the sector of "well below" 0.2% by 2025. Methane intensity is calculated by dividing the total methane emissions for each year as reported by natural gas production to give a percentage of methane emitted per cubic metre. UK oil and gas methane intensity in 2023 was circa 0.13% and was on target for 0.12% in 2024 (NSTA, 2025a) which is below the OGCI commitment.

Alternatively, methane intensity can be reported on a production basis. The latest data for 2024, compiled by the NSTA indicates the UK's methane emissions intensity is 1.5 kgCO_2e/boe, compared to a global methane intensity average of 15 kgCO_2e/boe (Figure 65). The UK's relatively favourable methane emissions intensity performance is supported by its progress in reducing absolute methane emissions by more than 50% since 2018 according to NSTA data (NSTA, 2025a).

The estimated Shearwater (host installation) and Jackdaw combined methane intensity is 0.44 kgCO_2e/boe which is below the UK average of 1.5 kgCO_2e/boe. This supports the case that domestic production can reduce overall supply chain emissions when meeting UK demand.

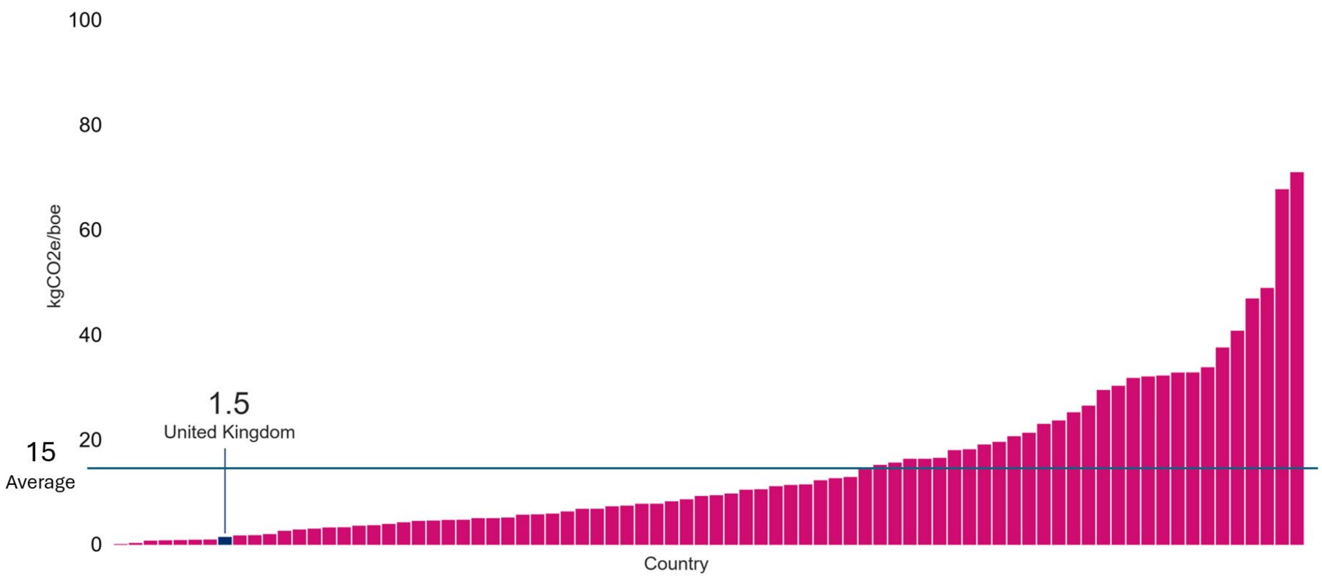


Figure 65: Methane Intensity (kgCO_2e/boe) by Country in 2024 (NSTA, 2025a).

EXPERT ADVICE OF GUIDANCE BODIES

UNEP analysis indicates that limiting warming to 1.5°C by 2100 remains technically possible. The analysis reports that total global GHG emissions reached 57.7 GtCO_2e in 2024, a 2.3 per cent increase from 2023 levels. Figure 66 shows that 10% of those GHG emissions are attributed to production of fuel and roughly half of those GHG emissions are attributed to methane. This indicates that the efficient use of hydrocarbons can play a role in reducing the overall GHG emissions attributed to such use, with a particular emphasis on reducing methane emissions.

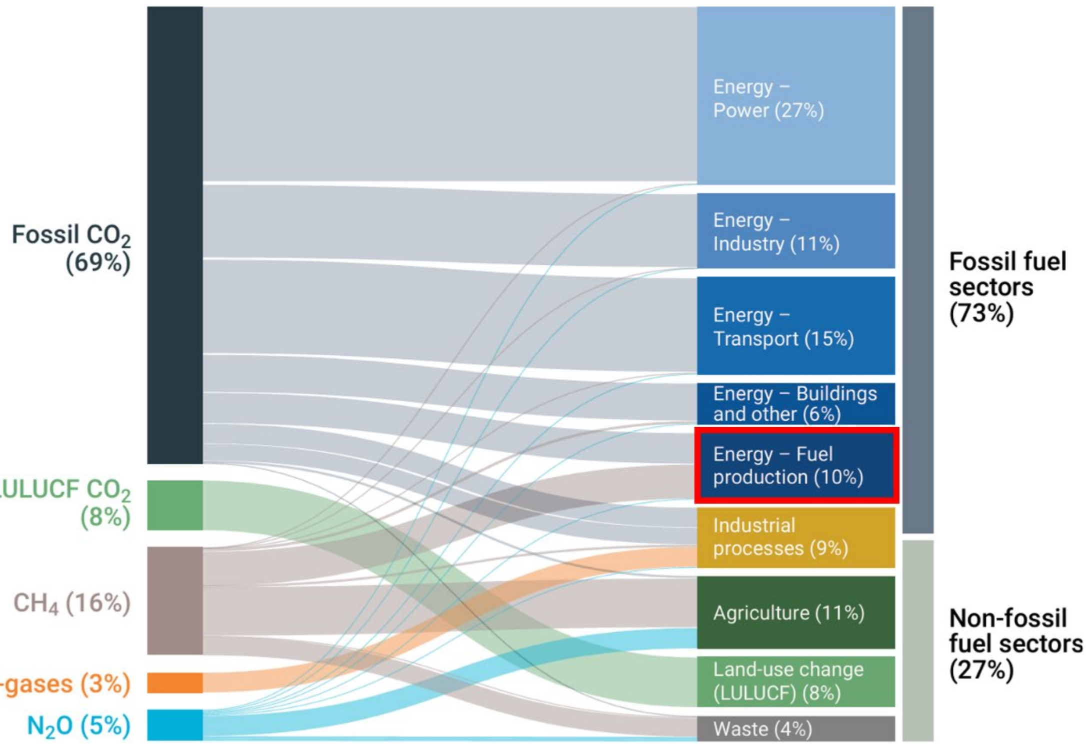


Figure 66: Total NET GHG emissions by gas, sector and Fossil or Non-fossil category in 2024 (UNEP, 2025).

Efficient Use of Hydrocarbons

Studies have been undertaken to attribute GHG emissions from actively producing or under-construction oil and gas fields in relation to available carbon budget needed to limit warming to 1.5°C (Trout *et al.*, 2022). However, such studies appear not to consider the proportion of these emissions associated with the energy used in the production of the fuel. In its Emissions Gap Report, UNEP report that 10% of global GHG emissions are attributed to energy used in fuel production as shown in Figure 66 (UNEP, 2025). As all GHG emissions have an impact on the climate, it is prudent to use all fossil fuel reserves efficiently.

Much of the GHG emissions attributed to getting gas to market will be as a result of fuel gas use, flaring, venting, etc. in the value chain. The GHG intensity of the gas can therefore be considered as a measure of efficiency in the gas value chain and can be used to examine the impact of producing gas in different locations and importing them to the UK.

Table 22 shows this impact as losses, acknowledging that if all the gas reserves were produced some would be 'lost' along the value chain because of fuel gas use, flaring, venting, etc. Except for the UK, the countries included in

Table 22 are those where both gas reserves data was available (Trout *et al.*, 2022) and GHG intensity data was available for gas consumed in the UK (NSTA, 2025). For the UK the methodology in Trout *et al.,* (2022) was applied to gas reserves data from the NSTA to estimate the attributed GHG emissions. The results of this analysis show that gas imported as LNG is not an efficient use of those reserves when lower intensity domestic reserves are available. In other words, to deliver US LNG to the UK, GHG emissions equivalent to around a quarter of the carbon content of the gas will be emitted in the process, with much of this a result of the liquefaction, shipping, and regasification stages in the LNG value chain (NSTA, 2025). Hence reducing losses in the value chain can reduce impact of fuel use on the climate.

Table 22: Indicative Losses Attributed to Selected Gas Reserves.

Country	Gas Reserves (mboe)*	Attributed Emissions (Gt CO_2e)**	Intensity*** (tonne CO_2e/mboe)	Losses (Gt CO_2e)	Losses (%)
Egypt	6,697,609	2.1	68	0.46	22%
Qatar	34,705,793	11.0	77	2.67	24%
Nigeria	5,479,862	1.7	83	0.45	27%
US	84,633,425	26.9	85	7.19	27%
Algeria	13,395,218	4.3	106	1.42	33%
UK	600,000	0.2	28	0.02	8%

Notes:
**based on data from Trout et al., 2022 and NSTA, 2024*
***based on data from Trout et al., 2022*
**** taken from NSTA, 2025*

Reducing Methane Emissions

Together, the IPCC and WMO evidence supports prioritising methane reductions as a pragmatic near-term complement to the essential long-term task of reaching Net Zero CO_2 (IPCC, 2021; WMO, 2025). As presented in the sections above, the UK oil and gas industry is taking action on methane and UK gas production has a very low methane intensity target, placing it among the lowest internationally.

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