Approach to climate proofing for
water and wastewater projects

December 2023

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Abbreviations

AR4	IPCC Fourth Assessment Report
AR5	IPCC Fifth Assessment Report
AR6	IPCC Sixth Assessment Report
C3S	Copernicus Climate Change Service
CC	Climate change
CBA	Cost-benefit analysis
CEF	Connecting Europe Facility
CF	Cohesion Fund
CJEU	Court of Justice of the European Union
CMIP	Coupled Model Intercomparison Projects
CO_2	Carbon dioxide
CO_2e	Carbon Dioxide Equivalent
CPR	Regulation (EU) 2021/1060
DNSH	Do no significant harm
DWL	Design working life
EAD	Expected annual damage
EEA	European Environment Agency
EIA	Environmental Impact Assessment
ERDF	European Regional Development Fund
ESG	Environmental, social and governance
ESIA	Environmental and Social Impact Assessment
ECP	Extended Concentration Pathway
FEED	Front end engineering design
GHG	Greenhouse Gas
GIS	Geographical Information Systems
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre (European Commission)
JTF	Just Transition Fund
KPI	Key Performance Indicators
NbS	Nature Based Solutions
NECP	National Energy and Climate Plan
O&M	Operation and maintenance
PCM	Project Cycle Management
RRF	Recovery and Resilience Facility
RRP	Recovery and Resilience Plan
RCP	Representative Concentration Pathways
SEA	Strategic Environmental Assessment
TFEU	Treaty on the Functioning of the European Union
UWWTD	Urban Wastewater Treatment Directive (91/271/EEC)

Glossary

The definitions are taken from the Commission Notice — Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (europa.eu) (Commission Notice (C(2021) 5430) Technical guidance on the climate proofing of infrastructure in the period 2021-2027). Most of these definitions are taken from the IPCC Glossary[1] unless stated otherwise.

Term	Definition
Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.
Adaptive capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.
Adaptation options	The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorized as structural, institutional, ecological or behavioural.
Carbon dioxide (CO_2)	A naturally occurring gas, CO_2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land use changes (LUC), and of industrial processes (e.g. cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP) of 1.
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between

[1] IPCC Glossary accompanying the special report on global warming of 1.5℃: https://www.ipcc.ch/report/sr15/glossary/

Term	Definition
	climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.
Climate extreme (extreme weather or climate event)	The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes.'
Climate neutrality	Concept of a state in which human activities result in no net effect on the climate system. Achieving such a state would require balancing of residual emissions with emission (carbon dioxide) removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect surface albedo or local climate.
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of GHG and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.
CO_2 equivalent (CO_2-eq) emission	The amount of carbon dioxide (CO_2) emission that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO_2-equivalent emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a 100-year time horizon. For a mix of GHGs it is obtained by summing the CO_2-equivalent emissions of each gas. CO_2-equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO_2-equivalent emissions and resulting CO_2-equivalent concentrations.
Cost-benefit analysis (CBA)	Monetary assessment of all negative and positive impacts associated with a given action. Cost-benefit analysis enables comparison of different interventions, investments or strategies and reveal how a given investment or policy effort pays off for a particular person, company or country. Cost-benefit analyses representing society's point of view are important for climate change decision making, but there are difficulties in aggregating costs and benefits across different actors and across timescales.
Critical Infrastructure	an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions. Certain infrastructure is designated 'critical infrastructure' in accordance with Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (OJ L 345, 23.12.2008, p. 7). This

Term	Definition
	document can be applied to infrastructure irrespective of whether it is designated 'critical infrastructure' or not.
Cultural heritage[2]	encompasses several main categories of heritage. Tangible cultural heritage includes movable cultural heritage (paintings, sculptures, coins, manuscripts), immovable cultural heritage (monuments, archaeological sites, and so on), underwater cultural heritage (shipwrecks, underwater ruins and cities). Intangible cultural heritage includes oral traditions, performing arts, and rituals.
Disaster	Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.
Environmental Impact Assessment (EIA)	the process of carrying out an EIA as required by Directive 2011/92/EU, as amended by Directive 2014/52/EU on assessment of the effects of certain public and private Projects on the environment.
European Critical Infrastructure (ECI)	critical infrastructure located in Member States the disruption or destruction of which would have a significant impact on at least two Member States134[3].
Exposure	The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.
Extreme weather event	An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g. drought or heavy rainfall over a season).
Global Warming Potential (GWP)	An index, based on radiative properties of GHG, measuring the radiative forcing following a pulse emission of a unit mass of a given greenhouse gas in the present day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in causing radiative forcing. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.
Greenhouse gas (GHG)	Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit

[2] www.unesco.org/new/en/culture/themes/illicit-trafficking-of-cultural-property/unesco-database-of-national-cultural-heritage-laws/frequently-asked-questions/definition-of-the-cultural-heritage/

[3] See Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

Term	Definition
	radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH4) and ozone (O3) are the primary GHGs in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).
Hazard	The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.
Infrastructure	Infrastructure is a broad concept encompassing buildings, network infrastructure, and a range of built systems and assets. This is *buildings*, from private homes to schools or industrial facilities, which are the most common type of infrastructure and the basis for human settlement; *nature-based infrastructures* such as green roofs, walls, spaces, and drainage systems; *network infrastructure* crucial for the functioning of today's economy and society, notably energy infrastructure (e.g. grids, power stations, pipelines), transport (9) (fixed assets such as roads, railways, ports, airports or inland waterways transport infrastructure), information and communication technologies (e.g. mobile phone networks, data cables, data centres), and water (e.g. water supply pipelines, reservoirs, waste water treatment facilities); *systems to manage the waste* generated by businesses and households (collecting points, sorting and recycling facilities, incinerators and landfills); *other physical assets* in a wider range of policy areas, including communications, emergency services, energy, finance, food, government, health, education and training, research, civil protection, transport, and waste or water; *other eligible types of infrastructure* may also be laid down in the fund-specific legislation, for instance, the InvestEU Regulation includes a comprehensive list of eligible investments under the sustainable infrastructure policy window.
Impacts (consequences, outcomes)	The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial.
Maladaptive actions (Maladaptation)	Actions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased vulnerability to climate change, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence.
Mitigation (of climate change)	A human intervention to reduce emissions or enhance the sinks of greenhouse gases. Note that this encompasses carbon dioxide removal (CDR) options.

Term	Definition
No-regret' measures	Activities that yield benefits even in the absence of climate change. In many locations, the implementation of these actions constitutes a very efficient first step in a long term adaptation strategy. For example, controlling leakages in water pipes, land use management to avoid inappropriate development in floodplains, or maintaining drainage channels is almost always considered a very good investment from a cost–benefit analysis perspective, even in absence of climate change. (CLIMATE-ADAPT relevant webpage and JASPERS Climate Change Adaptation and Major Project Development Guide 2015).
Probability	The chance or relative frequency of occurrence of particular types of events or sequences or combinations of such events (Willows and Connell, 2003).
Pathways	The temporal evolution of natural and/or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals and actors across different scales. • **1.5°C pathway:** A pathway of emissions of greenhouse gases and other climate forcers that provides an approximately one-in-two to two-in-three chance, given current knowledge of the climate response, of global warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following an overshoot. • **Adaptation pathways:** A series of adaptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation. • **Development pathways:** Development pathways are trajectories based on an array of social, economic, cultural, technological, institutional and biophysical features that characterise the interactions between human and natural systems and outline visions for the future, at a particular scale. • **Emission pathways:** Modelled trajectories of global anthropogenic emissions over the 21st century are termed emission pathways. • **Mitigation pathways:** A mitigation pathway is a temporal evolution of a set of mitigation scenario features, such as greenhouse gas emissions and socio-economic development. • **Overshoot pathways:** Pathways that exceed the stabilization level (concentration, forcing, or temperature) before the end of a time horizon of interest (e.g., before 2100) and then decline towards that level by that time. Once the target level is exceeded, removal by sinks of greenhouse gases is required. • **Non-overshoot pathways:** Pathways that stay below the stabilization level (concentration, forcing, or temperature) during the time horizon of interest (e.g., until 2100). • **Representative Concentration Pathways (RCPs):** Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs)

Term	Definition
	and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels but also the trajectory taken over time to reach that outcome are of interest (Moss et al., 2010). RCPs were used to develop climate projections in CMIP5. The RCPs are listed below for reference should the SSP impacts not yet be available for countries or regions: o **RCP2.6:** One pathway where radiative forcing peaks at approximately 3 W m^{-2} and then declines to be limited at 2.6 W m^{-2} in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100). o **RCP4.5 and RCP6.0:** Two intermediate stabilization pathways in which radiative forcing is limited at approximately 4.5 W m^{-2} and 6.0 W m^{-2} in 2100 (the corresponding ECPs have constant concentrations after 2150). o **RCP8.5:** One high pathway which leads to >8.5 W m^{-2} in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250). • **Shared Socio-economic Pathways (SSPs):** Shared Socio-economic Pathways (SSPs) were developed to complement the RCPs with varying socio-economic challenges to adaptation and mitigation (O’Neill et al., 2014). Based on five narratives, the SSPs describe alternative socio-economic futures in the absence of climate policy intervention, comprising sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil–fuelled development (SSP5) and middle-of-the-road development (SSP2) (O’Neill, 2000; O’Neill et al., 2017; Riahi et al., 2017). The combination of SSP-based socio-economic scenarios and Representative Concentration Pathway (RCP)-based climate projections provides an integrative frame for climate impact and policy analysis. • **Transformation pathways:** Trajectories describing consistent sets of possible futures of greenhouse gas (GHG) emissions, atmospheric concentrations, or global mean surface temperatures implied from mitigation and adaptation actions associated with a set of broad and irreversible economic, technological, societal and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produced, natural resources are managed and institutions are set up and in the pace and direction of technological change.
Projection	A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized.
Residual effects	Effects that remain after mitigation action (JASPERS Climate Change Adaptation and Major Project Development Guide 2015).

Term	Definition
Resilience	The ability of a social or ecological system to absorb disturbances, while retaining the same basic structure and ways of functioning, as well as its capacity to self-organise and adapt to stress and change. There are different ways in which resilience can be framed; the Dutch Climate Changes Spatial Planning research programme provides a list. (Adapted from CLIMATE-ADAPT Glossary). It can be also described as the amount of change a system can undergo without changing state.
Risk	The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.
Risk assessment	The qualitative and/or quantitative scientific estimation of risks[4].
Risk management	Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences.
Sensitivity[5]	Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).
Slow onset events	Slow onset events include e.g., temperature increase, sea-level rise, desertification, glacial retreat and related impacts, ocean acidification, land and forest degradation, average precipitation, salinization, and loss of biodiversity. As regards the statistical distribution of a climate variable (and how it may shift in a changing climate), slow onset events will often reflect how the mean value is changing (whereas extreme events are related to the tail ends of the distribution).
Strategic Environmental Assessment (SEA)	the process of carrying out an environmental assessment as required by Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. The main steps of the SEA process are preparation of the SEA Report, publicity and consultation, and decision-making.
Urban resilience	The measurable ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming towards sustainability.

[4] Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection defines 'risk analysis' as the consideration of relevant threat scenarios, in order to assess the vulnerability and the potential impact of disruption or destruction of (critical) infrastructure. This is a broader definition than climate risk assessment.

[5] IPCC AR4 Glossary WG2: Layout 1 (ipcc.ch)

Term	Definition
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. (CLIMATE-ADAPT Glossary).
Vulnerability assessment	Identifies who and what is exposed and sensitive to change. (Adapted from Tomkins et al., 200 in Levina and Tirpak).

1. BACKGROUND

1.1 Purpose and scope

The purpose of this document is to provide advice on the implementation of Commission Notice — Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (europa.eu), and its integration in the EIA process at project level. This document will utilise methodologies outlined in the EC Climate Proofing Technical guidance, and use examples related to the implementation in the fields of water management and wastewater.

The document builds upon previous guidance from the 2014-2020 programming period. Any new aspects and guidance for the 2021-2027 programming period are presented within an orange box, as shown below. The new document is prepared in view of the new EC Climate Proofing Technical Guidance and emerging best practice.

New guidance for the 2021-2027 programming period is presented within a white box with an orange outline.

1.2 Structure

This document follows the structure of the EC Climate Proofing Technical Guidance document for climate mitigation and climate adaptation. The purpose of the document is to provide practical guidance on the implementation of the climate proofing in water and wastewater projects and provide examples and suggestions for how to approach the required tasks at each stage of the project life cycle. The document is structured in the following way, with separate sections for different types of projects. This is to help make the guidance accessible and relevant to the specific project:

Section	Section Title	Content of section
Section 0	Background	This section summarises the key drivers and reasons for undertaking a climate proofing assessment for projects. Together with section 2 it gives context and direction to the concept of climate proofing.
Section 1	Concept and process for climate proofing	This section presents some of the key concepts related to climate proofing and how they should be applied in the development of the project. This includes project and climate timescales, climate projections and scenarios, and how extra layers of detail are added as the project progresses through different stages of the project life cycle. It also includes questions that should be asked at the start of the Feasibility Study stage to ensure that aspects not considered in a strategy are brought into the Options Appraisal.
Section 2	Approach to climate mitigation	This section gives step-by-step approach on how to apply the climate mitigation (neutrality) proofing methodology for projects.
Section 4	Approach to climate resilience	This section gives step-by-step approach on how to apply the climate adaptation (resilience) proofing methodology for projects.

Section	Section Title	Content of section
Section 5	Integration of climate proofing into EIA	This section describes the links and connections between climate proofing and EIA and how the climate proofing tasks can be integrated in the project's EIA procedure.
Section 6	Preparation of high-quality climate proofing documentation	This section gives recommendations on how to prepare high-quality documentation and validation of the analysis and conclusions.

1.3 Relevant regulations, directives and commission notices

1.3.1 Paris Agreement and Nationally Determined Contributions (NDCs)

The Paris Agreement[6] is a legally binding global climate change agreement, adopted in 2015 at the Paris climate conference (COP21). The agreement sets out a framework with the aim of *"Holding the increase in the global average temperature to well below 2º C above pre-industrial levels and to pursue efforts to limit temperate increase to 1.5º C above pre-industrial levels"* (Article 2(a) of the Paris Agreement). The EU formally ratified the agreement in 2016. The key elements of the Paris agreement broadly include:

- Climate mitigation through reduction of emissions
- Transparency in reporting on progress
- Climate adaptation in dealing with the effects of climate change
- Recognition in the role of cities, regions, and local authorities
- Support of climate action in developing countries

The agreement sets the goals for climate action. Governments who signed up to the agreement (including all EU Member States) have committed to putting these key elements into action in the form of a NDC. All new investments should be consistent with the Paris Agreement and related GHG pathways in themselves, and also not contribute to an overall impediment to achieving goals and pathways.

Further Guidance: EIB support for Paris-aligned operations

The EIB Group Climate Bank Roadmap 2021-2025 sets out a vision and framework for what Paris-aligned projects are. All financing activities by the EIB need to be aligned with the Paris Agreement temperature and adaptation goals. The roadmap recognises that *"despite clarity of the overall pathway to climate neutrality, **interpretation is required** at the level of an individual operation".*

The framework builds upon existing tools such as the EU Taxonomy to determine if activities Do No Significant Harm in relation to climate mitigation or adaptation. As a matter of clarification, water and wastewater projects may meet the criteria for substantial contribution to climate mitigation.

For climate mitigation any project that significantly reduces GHG emissions in relation to the current baseline or expected future trend in GHG emissions would be considered as aligning to the Paris

[6] Text of the Paris Agreement: ADOPTION OF THE PARIS AGREEMENT - Paris Agreement text English (unfccc.int)

Agreement. At the project level the EIB Guide to Economic Appraisal and Economic Appraisal Vademecum clearly embed the shadow cost of carbon into decision making and economic appraisal.

For climate adaptation, the climate proofing process documents how all projects are resilient and adaptable to future climate change.

1.3.2 EU Green Deal

The aim of the EU Green Deal[7] is to work towards the goals of the Paris Agreement, by making Europe climate neutral by 2050. This objective is supported by the European Climate Law, which was brought into force on 29 July 2021. This binds the EU Institutions and national governments to the legal targets specified. The key elements in the EU Green Deal are to:

- Reduce greenhouse gas emissions by at least 55% compared to 1990 levels by 2030 (targets for 2030),
- Achieve net zero greenhouse gas emissions by 2050 in all sectors (climate neutrality by 2050),
- Measure progress and adjust actions accordingly, and
- Increase resilience of vulnerable communities by taking action on climate adaptation where impacts are unavoidable.

The process of climate proofing for infrastructure development in the programming period 2021-2027 aims to contribute to achieving these emissions targets while encouraging sustainable and climate resilient development.

Even if a project does not require detailed climate proofing assessment according to the EC Climate Proofing Technical Guidance, that does not necessarily give a project exemption from contributing to the overall achievement of the EU climate objectives both in terms of climate neutrality but also in terms of climate resilience.

1.3.3 National Energy and Climate Plans (NECPs)

The National Energy and Climate Plans (NECPs) set out for each EU Member State, the objectives, targets and contributions to achieving the EU 2030 and 2050 GHG emission targets and goals of the Paris Agreement. Member States may also have developed sectoral plans that feed into the NECPs.

The climate proofing process is a means of verifying a project is compatible with credible GHG pathways to 2030 and 2050 as set out in the NECPs.

[7] Text of the EU Green Deal: [EUR-Lex - 52019DC0640 - EN - EUR-Lex (europa.eu)]

1.3.4 *Energy efficiency first principle (Article 2(18) of Regulation (EU) 2018/1999)* [8]

Energy efficiency was made a priority of the EU in its approach to sustainability through introduction of the Energy Efficiency Directive, which was amended in 2018 to include the Energy Efficiency First (EE1st) principle. The amendment to the Directive includes guidelines for application of the principle in the decision-making process through use of Cost-benefit analysis, and an EE1st test with the aim that it "sets an obligation on Member States to ensure that energy efficiency solutions are considered in energy system and non-energy sectors planning, policy and investment decisions".

The Commission Recommendation on Energy Efficiency First (EU 2021/1749)[9] describes how projects in the water sector can potentially be energy intensive, referencing activities which abstract, pump, heat, cool, clean, treat and desalinate water. The guidance highlights the role new projects have in reducing overall energy demands *"Solutions to decrease the energy demand in the water sector and through water should apply to all types of projects, at all stages, along the whole supply chain, and when setting the (multi-) annual financial frameworks on regional and local level."* Relevant areas, possible solutions and measures for consideration in the water, wastewater and flood sectors are listed and referenced within this document.

A decision tree has been designed to facilitate design-making. At the level of investment, the focus of energy efficiency is on consideration of the efficiency of alternatives to ensure that the most energy-efficient option is properly considered and justified in the implementation phase of the decision-making process.

1.3.5 *Common Provisions Regulation (CPR)*

The Common Provisions Regulation (CPR)[10] governs 8 EU funds which represent a third of the EU budget. The fund is allocated to 5 common policy objectives:

1. a more competitive and smarter Europe by promoting innovative and smart economic transformation and regional ICT connectivity;
2. a greener, low-carbon transitioning towards a net zero carbon economy and resilient Europe by promoting clean and fair energy transition, green and blue investment, the circular economy, climate change mitigation and adaptation, risk prevention and management, and sustainable urban mobility;
3. a more connected Europe by enhancing mobility;
4. a more social and inclusive Europe implementing the European Pillar of Social Rights;
5. a Europe closer to citizens by fostering the sustainable and integrated development of all types of territories and local initiatives.

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[8] Text of the Regulation: EUR-Lex - 32018R1999 - EN - EUR-Lex (europa.eu)
[9] Text of the EC Recommendation: EUR-Lex - 32021H1749 - EN - EUR-Lex (europa.eu)
[10] Text of Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy (also referred as the Common Provisions Regulation): EUR-Lex - 02021R1060-20221026 - EN - EUR-Lex (europa.eu)

This Common Provisions Regulation applies to 8 funds which may be relevant to Member States:

1. European Regional Development Fund (ERDF)
2. European Social Fund Plus (ESF+)
3. Cohesion Fund (CF)
4. Just Transition Fund (JTF)
5. European Maritime, Fisheries and Aquaculture Fund (EMFAF)
6. Asylum and Migration Fund (AMIF)
7. Internal Security Fund (ISF)
8. Border Management and Visa Instrument (BMVI)

This document is mostly focused on projects seeking Cohesion Funding.

The EE1st principle is expected to be a core means of achieving climate neutrality with recital 60 of the preamble clearly stating this; “Member States should ensure the climate proofing of investments in infrastructure and should prioritise operations that respect the ‘energy efficiency first’ principle when selecting such investments.”

1.3.6 Technical Guidance on the climate proofing of infrastructure in the period 2021-2027 (Commission Notice C(2021) 5430)

This technical guidance (from here known as EC Climate Proofing Technical Guidance) document sets out the overall climate proofing methodology for infrastructure projects in the programming period 2021-2027. The methodology covers the requirements for climate proofing in several European funds, including InvestEU, ERDF, CF, and others. It has two pillars: climate neutrality (mitigation), and climate resilience (adaptation). The guidance is summarised in Figure 1-1 , and will be referenced throughout this document.

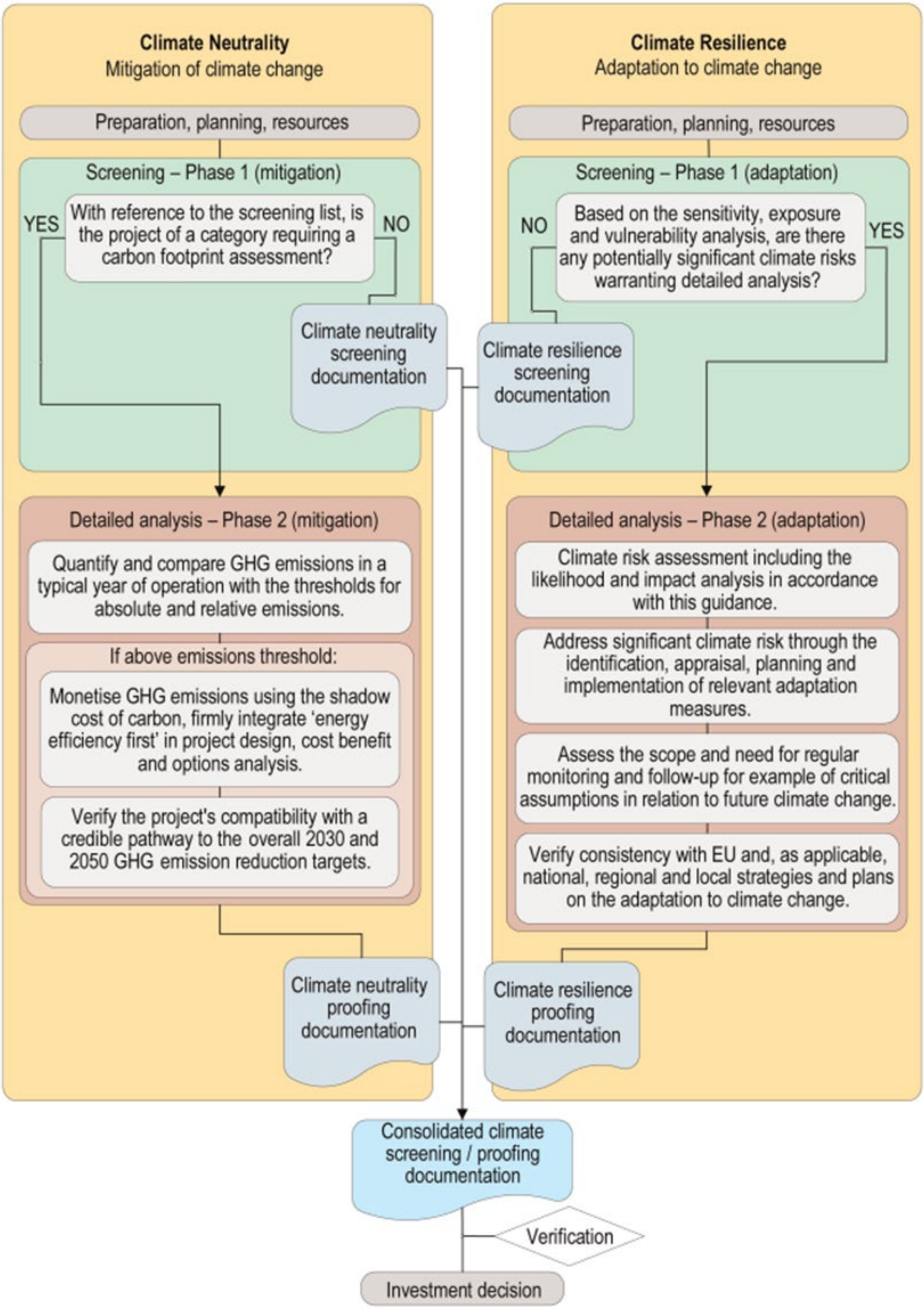


Figure 1-1. Summary of phases of climate proofing set out by the EC Climate Proofing Technical Guidance on climate proofing of infrastructure in the period 2021-2027

1.3.7 EC Economic Appraisal Vademecum and EC Cost Benefit Guide

The Economic Appraisal of projects is required to include the shadow cost of carbon emissions. Further guidance on this aspect can be found in the recently published EC Economic Appraisal Vademecum for 2021-2027 adds extra information and guidance on top of the 2014 EC Guide to Cost-Benefit Analysis of Investment Projects (commonly known as the 2014 CBA Guide). The Economic Appraisal Vademecum gives guidance on which projects should be subject to detailed or simplified economic appraisal methods. Section 1.2 of the Vademecum provides good practice for application of different approaches to economic appraisal and the appropriate level of detail for project justification, at different stages in the project lifecycle. Section 2.5 of the Vademecum provides details on the shadow price of carbon to convert net Green House Gas (GHG) emissions into a monetary value for inclusion in project economic appraisal. This shadow price can be applied to GHG emissions from a project and also avoided GHG emissions. The recommended shadow cost of carbon for 2020-2050 should be applied to projects in the water, wastewater, flood and disaster risk management sectors (presented in table 4 of the Vademecum as taken from the EIB Project Carbon Footprint Methodologies (version 11.3, January 2023) and also in Section 3.2.2.4 of the EC Climate Proofing Technical Guidance). The economic appraisal should be subject to sensitivity testing of the shadow price of GHG emissions.

Annex VII of the Economic Appraisal Vademecum gives specific sectoral application guidance for water and wastewater projects.

Section 2.8.8 and Annex II of the 2014 CBA Guide set the guidelines for how to apply the shadow cost of GHG emissions over the lifetime of the project and deal with economic discount rates.

1.3.8 Other sector specific regulations and guidance

Further Guidance:

- EIA Directive. https://ec.europa.eu/environment/eia/eia-legalcontext.htm
- Floods Directive. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32007L0060
- Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient https://climate-adapt.eea.europa.eu/metadata/guidances/non-paper-guidelines-for-project-managers-making-vulnerable-investments-climate-resilient/guidelines-for-project-managers.pdf
- Climate in the RBMPs: Microsoft Word - Guidance document n 24 - River Basin Management in a Changing Climate_FINAL.doc (europa.eu)?
- Link between impacts on habitats/species and climate - EC Guidance document on Climate change and Natura 2000: Guidelines on climate change and Natura 2000 - Publications Office of the EU (europa.eu)
- EC Revised methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC: EN.pdf (europa.eu)
- EC Guidance (2013). Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment: https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
- IPCC Sixth Assessment Report (AR6) https://www.ipcc.ch/assessment-report/ar6/
- Commission Recommendation (EU) 2021/1749 of 28 September 2021 on Energy Efficiency First: from principles to practice — Guidelines and examples for its implementation in decision-making in the energy sector and beyond: EUR-Lex - 32021H1749 - EN - EUR-Lex (europa.eu)

- Economic Appraisal Vademecum: Inforegio - Economic Appraisal Vademecum 2021-2027 - General Principles and Sector Applications (europa.eu)
- EC Guide to Cost-Benefit Analysis of Investment Projects (2014 CBA Guide): cba_guide_cohesion_policy.pdf (archive-it.org)
- EIB Group Climate Bank Roadmap 2021-2025: The EIB Group Climate Bank Roadmap 2021-2025

2. THE CONCEPT AND PROCESS FOR CLIMATE PROOFING

Section 2 builds upon the concepts referenced in the EC Climate Proofing Technical Guidance and introduces additional relevant concepts that will help progress low carbon and climate resilient projects.

2.1 What is climate proofing?

As defined by the EC Climate Proofing Technical Guidance *“Climate proofing is a process that integrates climate change mitigation and adaptation measures into the development of infrastructure projects. It enables European institutional and private investors to make informed decisions on projects that qualify as compatible with the Paris Agreement. The process is divided into two pillars (mitigation, adaptation) and two phases (screening, detailed analysis).”* Therefore, projects seeking investment should be climate proof.

The definition in the Commons Provisions Regulations Article 2(42) is *“climate proofing means a process to prevent infrastructure from being vulnerable to potential long-term climate impacts whilst ensuring that the ‘energy efficiency first’ principle is respected and that the level of greenhouse gas emissions arising from the project is consistent with the climate neutrality objective in 2050”.*

Climate proofing is carried out for the proposed project. The principles of climate proofing can be used to inform the development of project objectives, options appraisal and selection of a preferred alternative.

In practical terms a climate proof project is both of the following:

Is consistent with the ability to achieve GHG emission and climate neutrality targets by demonstrating:

- It will not generate significant GHG emissions,
- Has considered GHG emissions from alternative means of achieving project objectives (which must be compliant with EU legislation and policy (e.g. UWWT Directive).

Manages all climate hazard risks to an acceptable level through:

- Inbuilt resilience of the project to climate hazards,
- Additional adaptation measures included within the project investment, or
- A clear long term implementation plan for future adaptation measures informed by a monitoring programme (which may include measures to be implemented as part of the project investment to facilitate future adaptation).

2.2 Timescale

The timescale of the climate proofing should be the same as the intended lifespan of the investment to be financed (for reference: EC Climate Proofing Technical Guidance). This may be longer than the reference or appraisal period for cost-benefit analysis. Water and wastewater projects often use a 30-year reference period for the CBA while the actual lifespan of the infrastructure is usually much longer. For the climate proofing analysis of the infrastructure, the longer actual lifespan needs to be considered. This is important to ensure that projects do not introduce maladaptation. The climate proofing for water and wastewater projects should consider long term time periods (well over 50 years) for which the infrastructure will continue to operate (e.g., pipe networks for existing water projects can operate for well over 100 years with good maintenance).

The consequences of water and wastewater projects can extend well beyond the lifespan of the proposed infrastructure itself. For example, urban and economic development may respond to the improved level of water supply and wastewater treatment capacity in areas serviced by the project and lock-in the need for continued protection well beyond the lifespan of the infrastructure.

2.3 Climate scenarios, Projections and Trends

The climate adaptation analysis requires an understanding of the possible future impacts of climate change. **At project level for climate mitigation the targets are clearly set in the form of GHG emissions reduction targets. For project level mitigation, in almost all cases it is acceptable to use scenarios which could represent plausible conditions at a useful point in time in the future under a selected climate pathway.**

It is acceptable to approximate the timescales for when these scenarios may happen in relation to the timescale of the analysis and timescales for when future adaptation may be required (e.g., rainfall intensity in 2050 under the SSP 3-7.0 pathway will be 10% greater than now).

Scenarios describe possible conditions that could occur at any time in the future. Projections include the temporal variation in conditions. Member States may have national, regional or water basin scenarios for climate change which cannot always be compared directly to a climate change projection, such as the Shared Socio-economic Pathways (SSPs) which have superseded the previous Representative Concentration Pathway (RCP) projections produced by the IPCC (Intergovernmental Panel for Climate Change). This is important for any monitoring programme recommended by the climate proofing documentation as monitoring measures need to ensure that thresholds and trigger values for implementing adaptation measures are not misinterpreted. Until official climate impacts for SSPs are not yet available then the RCP climate impacts should be used as described in the box below.

Updated Guidance: Climate Projections

A core set of five illustrative scenarios based on the Shared Socio-economic Pathways (SSPs) are used consistently across the latest ICCP Reports: SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. These scenarios cover a broader range of greenhouse gas and air pollutant futures than assessed in earlier IPCC reports, and they include high-CO_2 emissions pathways without climate change mitigation as well as new low-CO_2 emissions pathways. Figure 2-1 shows the projected future mean global warning and sea level rise under different SSPs.

The EC Climate Proofing Technical Guidance refers to the previous Representative Concentration Pathways (RCPs).

The suggestion is to use:

- SSP 1-2.6 for the current exposure of projects, on the assumption that operation will start around the year 2030 (if not available use RCP 2.6)
- SSP 2-4.5 for the short-term exposure to 2050 (if not available use RCP 4.5)
- SSP 3-7.0 for long-term projections beyond 2050 (if not available use RCP 8.5)

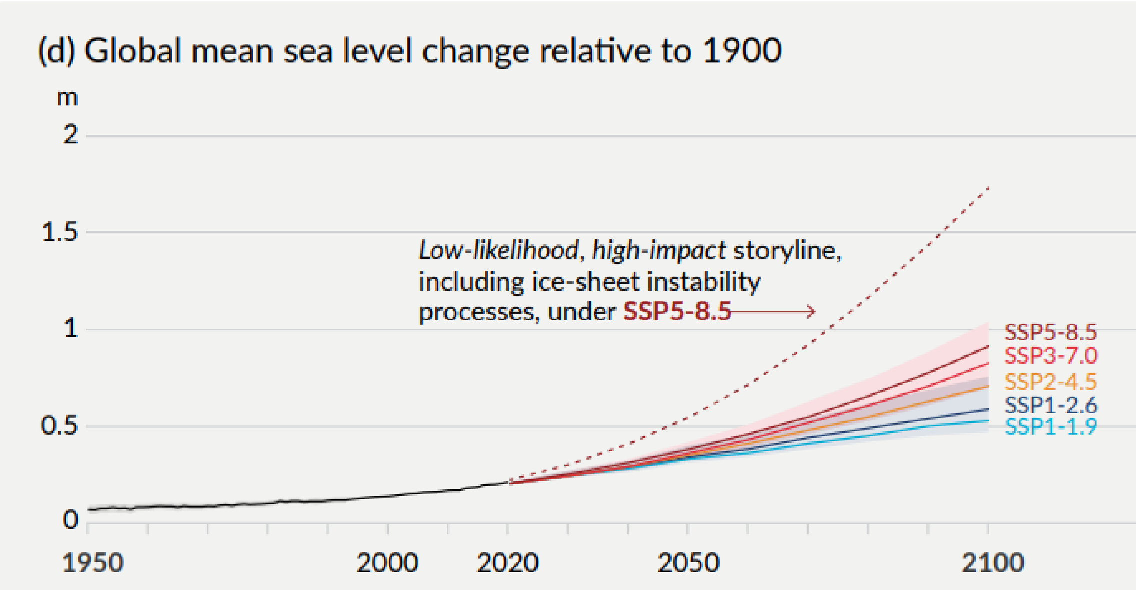


Figure 2-1. Typical Shared Socio-economic Pathways extract from Figure SPM.8 of IPCC 2021 Climate Change 2021: The Physical Science Basis (IPPC 2021[11])

Where compliant with national legislation, it can be useful to adopt a design standard that includes the future SSP 2-4.5 (or RCP 4.5) conditions. This means that a degree of resilience to climate change is inbuilt into the project design. The resulting climate resilience proofing for the climate driven project can then focus on more extreme climate change to the hazard the project is seeking to manage (e.g., SSP 5-8.5 or RCP 8.5) and the other climate hazards for which the project is not seeking to manage.

Some official datasets, such as Floods Directive Flood Hazard and Risk Maps, may adopt a single climate change scenario (e.g., peak flood discharge increase by 10%). In these situations, the data source should be clearly referenced and if possible related to a climate pathway.

[11] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. In Press.

2.4 Tasks and specialists required for different stages in project cycle management (PCM)

The golden rule is to integrate climate proofing concepts as early as possible in the project development cycle. This means ideally within the strategy development, or at the latest in the Feasibility Study stage with the screening tasks completed before the options appraisal. The climate proofing documentation should then not result in surprises or the need for substantial changes to the project.

Section 4 and Annex C of the EC Climate Proofing Technical Guidance describes the different tasks in the process to be undertaken as a project progresses through the project life cycle. This section adds extra interpretation and suggested approach without duplicating the information in the EC Climate Proofing Technical Guidance. Particularly, this section expands on the level of detail expected for each stage of the process, and how subsequent assessment and enhanced knowledge (from monitoring for example) can be used to refine the assessment carried out at previous stages of the project cycle. At each stage of the project life cycle administration, the project promoter and project team must fully consider the climate resilience and mitigation aspects that may occur at all other stages in the lifetime of the project. Figure 2-2 shows how levels of detail are built upon and the spatial scale of the climate proofing changes as projects progress through their lifecycle. The focus for this document is the Feasibility and Design Stage.

Note that the Revised EIA Directive (2011/92/EU, as amended by Directive 2014/52/EU) requires climate change vulnerability and impacts to be considered as part of the EIA process. This means that projects cannot undertake, or complete, the climate proofing process retrospectively after an EIA process has completed.

It is likely that different project teams and lead authorities will be responsible for progressing different stages of the project, and handover between stages may not be instantaneous. For example, a Feasibility Study may not commence until 5 years after approval of a strategic plan.

It is also possible for projects to be proposed outside of strategies and plans. In these situations, the strategy/plan stage tools and best practice can be applied to the options appraisal aspect of the feasibility/design stage of the project.

As a general rule, the screening for climate mitigation and resilience of the project should be undertaken in parallel with the options appraisal in the Feasibility Stage of the project. This is so that the decision to select a preferred project is based on an evidence-based comparison of the climate change impacts and risks of each option as well as embedding the energy-efficiency first, Paris Agreement and other Climate Goals at the heart of the project.

Figure 2-2 can be used as additional guidance for protect beneficiaries for projects where ownership and operation may transfer to different authorities after construction, or at the end of the operational life of the project.

Strategy/Plan

Will often be a high level plan.

For water/wastewater and flood risk projects this may be a (transboundary) national, regional or river basin level plan.

Disaster Risk Management strategic plans could be at the national, regional, county or municipality level.

Feasibility/Design

Will be progressed at the project level

However in some cases an integrated project approach may be taken.

The scale of the project could be at the catchment, river reach or municipality scale for water/wastewater or flood risk management projects.

Disaster Risk Management projects could be developed as feasibility study level based on human and administrative boundaries at the national, regional county or municipality scale.

Procurement and Construction

Contract supervision may be carried out by different or multiple authorities.

It is important that consistency with the project as approved and permitted is followed. Similar, that changes that arise during procurement or construction do not alter the conclusions of the climate proofing assessment and documentation.

The climate proofing documents should be seen as live and updates made as new information of project details change.

Operate/Maintain

The assets will be handed over to the owner or managing authority with responsibility for operation and maintenance. Including responsibility for implementation of future adaptation.

The key aspects here will be proper documentation of the handover of how operation and maintenance needs to reflect the EIA, AA and Climate Proofing requirements.

Key aspects of the Climate Proofing documentation will be the monitoring programme. It will be important to keep monitoring and adapting this as new information becomes available.

The Technical Guidance suggests the climate proofing documentation is revisited at regular intervals (e.g. every 5 or 10 years).

Decommissioning

Will likely be the responsibility of the operating and maintaining authority.

However, for some projects where restoration of the environment is proposed as part of the decommissioning phase, there should be monitoring to evaluate the success of the proposals and refinement of such.

Figure 2-2. Building block approach to add levels of detail as the project progresses.

2.4.1 *Feasibility and Design*

The consideration of climate mitigation, resilience and adaptation is important in the feasibility and design stages. The feasibility stage needs to understand the implications of design decisions and how this may affect the climate proofing of the project. The feasibility and design stages of the project may require multiple iterations as more information and improved knowledge becomes available on project CO_2e emissions and climate resilience. Examples include the successive level of detailed surveys (such as geotechnical surveys) and design decisions (such as those based on engineering and materials) that are made as a project moves through the feasibility and design stages. As a good practice to manage this process, a climate-proofing coordinator can be designated. This is especially important for multi-disciplinary projects with complex project teams. The climate-proofing manager in many cases can be an existing role on the project team, such as a Climate Change or EIA expert.

By following the Climate Proofing Guidance below, project Feasibility Studies and Design can also demonstrate a proposed project is consistent with the climate change mitigation and climate change adaptation Do No Significant Harm (DNSH) objectives of the EU Taxonomy Regulation. The operational programme DNSH assessments are required for each type of action in an operational programme. The actions may be different to the scope or scale of the specific project subject to the climate proofing documentation.

Questions to consider as lines of investigation in the options appraisal include:

- Does the type of project allow for adaptation measures to be implemented in the future or does the decision now restrict future options for adaptation?
- Is it worth being assumptive and designing for future conditions now?
- What measures can be put in place now to improve resilience of projects to climate change?
- Is it best to wait and monitor change before committing to expensive investments?
- Does the decision take into account uncertainty, which is important as the understanding of climate change impacts could change?
- Are the limits and thresholds of acceptable risk understood?

Following these lines of investigation means that robust climate resilient strategies and projects can still be achieved even with highly uncertain information. In most cases the Feasibility stage involves some steps of the EIA process (e.g., screening and scoping) and other related environment procedures and permits. Depending on the outcomes of the screening phase, the climate proofing documentation should be completed and integrated in the EIA documentation.

Good Practice – Suggested checklist of prompts for consideration when moving from a strategy to project

The strategy and plan for which the project is part of should be referred to and understood. Below is a suggested checklist of questions to help inform the Feasibility Study Options Appraisal. The feasibility study should take forward and refine the understanding from the strategy.

This suggested checklist can be used at the start of the project to ensure strategic aspects are properly considered in the project terms of reference and objectives.

- What strategic options were considered and are there any strategic alternatives to the proposed project that are less carbon intensive or more climate resilient?
- Has the strategy or plan identified any technical alternatives which can enhance adaptive capacity of the project?
- Has the strategy considered alternatives to the proposed project in terms of the full project lifecycle?
- Is there a limit to the effectiveness of the proposed project? Has the strategy plan considered this? For example, is there a maximum acceptable height for any raised flood defences, or is there a minimum flow regime for abstraction or discharge of water? Does this limit pose a constraint to the ability of the proposed project to operate under future conditions?
- What GHG pathways and climate targets did the strategy use? Have these been superseded since? Are there new policies or sectoral plans in place?
- Has the strategy considered both direct and indirect GHG emissions?
- What climate projections and scenarios did the strategy use? Have these been superseded since? Are these still valid for the proposed project?
- What approach to climate change resilience of climate driven projects does the strategy recommend? For example; Assumptive, Adaptive, Alternatives, or Acceptance approaches to managing climate uncertainty.
- Are there SEA mitigation measures specific to climate change that the project must implement?
- Are there new components or a change in the spatial extent of the project that have not been assessed in the SEA?
- Does the strategy or SEA recommend monitoring of conditions? Has any monitoring commenced since the completion of the strategy?

2.4.2 Changes as the project moves through project stages

As the project progresses through the project stages it is common for changes to occur to project design measures or scope. Where any change may result in a change to the conclusion of the Climate Proofing Phase 1 or Phase 2, for either climate neutrality or climate resilience, the climate proofing documentation should be revised.

Good Practice – Use of the climate proofing to manage changes and new information

The climate proofing monitoring programme must be handed over to the infrastructure owner or operator (these could be two different organisations) with responsibility for operation and maintenance of the infrastructure. This should also include a requirement for reporting to an oversight or supervisory body that has the authority and power to require changes should the monitoring programme introduce new information. An example would be if a Government Ministry needs to approve a change to a project which is owned by a local authority or municipality. Such new information may include new climate change projections, national impact assessments or even new technology or approaches that can prolong the lifetime or reduce maintenance requirements of the infrastructure.

Monitoring programmes may be set out in the SEA stage with clearly defined indicators and with responsible authorities assigned monitoring actions. These should be implemented prior to commencement of a project. For situations where a project is proposed outside of a strategy that has been subject to SEA, the Climate Proofing documentation may also specify a requirement for monitoring, which should be reflected in the EIA as appropriate. The Climate Proofing documentation may also recommend monitoring in addition to any SEA requirements.

3. APPROACH TO CLIMATE MITIGATION (NEUTRALITY)

For climate mitigation (neutrality) proofing, the main objectives of the two phases are:

- The screening (phase 1) identifies whether the operation of a proposed project may result in significant absolute or relative GHG emissions above 20,000 tonnesCO_2e per year, averaged over the lifetime of the project.
- The detailed assessment (phase 2) confirms that projects with significant carbon emissions are consistent with credible GHG pathways of national plans, sectoral plans and the Paris Agreement.

The estimation of GHG emissions for all projects will also provide useful information on indicators for operational programmes.

The economic appraisal of all projects at the feasibility study stage should include the shadow cost of carbon (as described in the EIB Climate Bank Roadmap, EC 2021 Economic Appraisal Vademecum and 2014 CBA Guide). The requirement for the GHG emissions of the operational phase of the project and estimation of the shadow cost of carbon has not changed for the 2021-2027 programming period.

As a good practice and for clarity, the GHG emission estimates and shadow cost of carbon should be documented in the Climate Proofing Documentation, irrespective of the climate mitigation screening outcome. The climate proofing documentation should include details on the calculation method, the estimate of and the conversion to monetary values of the GHG emissions and avoided GHG from the proposed project (if relevant). The methodology and values in the climate proofing documentation should be consistent with those in the EIA, Feasibility Study and economic appraisal documentation.

3.1 Screening of projects (Phase 1)

The EC Climate Proofing Technical Guidance recommends the screening of projects for climate mitigation should be based on a list of project categories and components which could result in GHG emissions.

3.1.1 Project components and potential sources of GHG emissions.

All of the project components need to be listed together with the potential sources and type of GHG emissions from the operational phase of each component. There is no fixed set of project components that need to be considered for inclusion, but they should cover all aspects of a project's functions and interdependencies required to achieve the effective operation of the project. Materials and equipment required for construction and commissioning of the project infrastructure do not need to be included. The production of cement for concrete as a construction material for infrastructure projects would be covered under industrial processes and is not required as part of the project GHG emission calculations.

Scope 1 (direct) and Scope 2 (indirect) GHG emissions associated with a typical year of operation are to be included. Scope 3 (indirect) GHG emissions and any emissions associated with construction, commissioning and decommissioning are to be excluded.

Table 3-1. Examples of water and wastewater project components that result in Scope 1 (direct), Scope 2 (indirect) and Scope 3 (indirect) GHG emissions.

Components with Scope 1 (direct) GHG emissions

- Raw wastwater (CH_4)
- Primary treatment and anaerobic treatment of wastewater (CO_2 and CH_4)
- Biological treatment of wastewater (CO_2)
- Sewage sludge treatment and disposal and spreading on agricultural land (CO_2 and CH_4)
- Incineration of seweage sludge (CO_2, CH_4 and N_2O)
- New permanent water reservoirs
- Maintenance activity with matierial GHG emissions.

Components with Scope 2 (indirect) GHG emissions or sequestration

- Energy use (where the operator controls the amount, frequency and rate of consumption)
  - Pumping stations and water treatment plants
  - Treatment processes
- Land use change, such as:
  - Wetland creation (for example as part of a catchment management solution to water treatment)
  - Afforestation
  - Change in land management practices
- New permanent waterbodies/reservoirs
- Maintenance activity with matierial GHG emissions.

Components with Scope 3 (indirect) GHG emissions

- **Not to be included in project carbon footprint.**
- From activities out of the control of the project operator, such as transportation of materials and chemicals for water treatment.
- GHG emissions from the supply, construction and delivery of materials
  - Concrete
  - Timber
  - Chemical production
- Administration and facilities to support the operation and maintenance are not to be included as their energy use will be negligable.

3.1.2 Screening conclusion

The project components, potential sources and type of GHG emissions, emissions calculations and shadow cost of carbon should be documented in the Climate proofing screening documentation. These will be carried through to the detailed assessment, if the project requires a detailed assessment.

The latest EIB Project Carbon Footprint Methodologies (version 11.3 of January 2023) states that only investment projects with significant GHG emissions must be assessed according to the EIB methodologies. Table 1 from EIB Project EIB Project Carbon Footprint Methodologies and Table 2 of the EC Climate Proofing Technical Guidance show which project types may require a detailed assessment (phase 2). Table 3-2 shows relevant project types to water and wastewater sectors.

Desalination plants are not listed in the screening table in the EIB guide and EC Technical Guidance. These have significant energy requirements and will probably require a detailed assessment (stage 2) particularly if they are using fossil fuels or grid electricity in countries with high grid electricity emission factor.

Table 3-2. Screening list for climate proofing of climate change mitigation, with project categories related to water and wastewater (list as presented in Table 1 from EIB Project Carbon Footprint Methodologies 2022 used to update Table 2 of the EC Climate Proofing Technical Guidance)

Screening	Categories of infrastructure projects relevant to water and wastewater projects
In general, depending on the scale of the project, a GHG assessment IS NOT required. **With reference to the climate-proofing process for climate change mitigation in the process concludes with phase 1 (screening).**	➢ Drinking water supply networks ➢ Rainwater and wastewater collection networks ➢ Small-scale industrial wastewater treatment and municipal wastewater treatment
In general, a GHG assessment IS required. **With reference to the climate-proofing process for climate change mitigation the process for this type of project categories will include phase 1 (screening) and phase 2 with a detailed analysis.**	➢ Large wastewater treatment plants ➢ Any other infrastructure project category or scale of project for which the absolute and/or relative emissions could exceed 20,000 tonnes CO_2e/year (positive or negative)

This table is to be used as a guidance only and the actual thresholds for whether an investment project has significant GHG emissions is either of the following:

- **≥+ or (–) 20,000 tonnes CO2e/year Absolute (Ab) GHG emissions**
- **≥+ or (–) 20,000 tonnes CO2e/year Relative (Re) GHG emissions**

All projects or investments that exceed these thresholds (either positive or negative) should be subject to the phase 2 detailed assessment.

Further Guidance: Absolute (Ab) GHG emissions

The Absolute (Ab) GHG emission threshold is used to identify projects which will emit or sequester significant GHG emissions during their operation.

The Absolute (Ab) GHG emissions are the annual emissions estimated for an average year of operation for the project.

The boundary for absolute emissions covers only the emissions from the proposed project.

For water and wastewater projects the absolute GHG emissions should not include agglomerations, locations and communities that will not benefit from the project infrastructure (e.g. they should not include emissions from individual septic tanks that will not be replaced through connection to the new wastewater treatment network).

Further Guidance: Relative (Re) GHG emissions

The Relative (Re) GHG emission threshold is used to compare the GHG emissions of the proposed project against an expected alternative scenario for achieving compliance with EU policy and legislation. The intention is that this is used in the options appraisal and option selection of projects. The purpose of this threshold is to determine whether the proposed project emits significantly more or less GHG emissions than an alternative project. And if this is the case detailed assessment is necessary to confirm that the proposed project is consistent with EU GHG emission targets and Paris Agreement. For water and wastewater projects the comparison may be to a counter-factual or Baseline scenario that:

- Does the minimum necessary to achieve regulatory compliance,
- Goes above and beyond the minimum for regulatory compliance through higher cost wastewater treatment which may have greater level of wastewater treatment, be more resilient to future climate related hazards, or
- Is an alternative means of achieving regulatory compliance.

The EIB Project Carbon Footprint Methodologies and EC Climate Proofing Technical Guidance have different definitions of Relative (Re) GHG emission estimates. The critical aspect here is that the comparison used to derive the Relative GHG emissions are based on the same spatial boundaries. The Climate Proofing documentation must clearly state how the Relative GHG emissions have been calculated and the method applied is clearly stated and correctly implemented. It is critical that the screening assessment uses an appropriate definition of Absolute and Relative emissions and clearly documents the definition used.

The EIB Carbon Footprint Methodology

Relative (Re) GHG emissions = "With" project (Wp) emissions - "Without" project emissions or Baseline (Be) emissions

The EC Climate Proofing Technical Guidance

Relative (Re) GHG emissions = Absolute (Ab) emissions - Baseline (Be) emissions

The boundary for relative emissions should extend to the entire region affected by the project. The With Project should have identical boundary to either the Without Project or Baseline emissions and may extend beyond the spatial boundary of the proposed project (i.e. beyond the boundary used for the Absolute emissions).

The boundary needs to include all changes from one wastewater treatment system to another as a result of the project (e.g. connection of properties currently serviced by individual septic tanks to a municipal wastewater treatment plant, or replacement of induvial water supply wells to a municipal water supply network) and communities where there is no improvement in service (e.g. properties that continue to use individual septic tanks, or individual wells).

Further Guidance: Baseline (Be) GHG emissions

The Baseline (Be) GHG emissions are the emissions that would be generated under the expected alternative scenario that reasonably represents the emissions that would be generated if the project is not carried out. It is not the before or without project GHG emissions.

The baseline for the carbon footprint estimation is not the business as usual scenario, but the likely alternative to the proposed project that in technical terms can achieve the required output, and is credible in terms of economic and regulatory requirements. There are three conditions for what constitutes the baseline scenario:

1. Socioeconomic. The baseline should be economically viable.
2. Legal. The baseline should achieve regulatory compliance.
3. Life-expired asst. The baseline should not assume continuation of assets beyond their economic life, at least not without an appropriate deterioration in quality of service or performance.

If there is no alternative scenario that meets the above conditions, then no Baseline GHG emissions are estimated. This could occur where there is no other viable means of achieving regulatory compliance with the Urban Wastewater Treatment Directive (UWWD).

The Baseline GHG emissions includes existing wastewater treatment (including unconnected properties where septic tanks or other means are used to treat wastewater) which will not change as a result of the proposed project.

Further Guidance: With Project (Wp) GHG emissions

No definition of With Project GHG emissions is provided in the EIB Project Carbon Footprint Methodologies, and the term is not referenced in the EC Climate Proofing Technical Guidance.

The With Project (Wp) GHG emissions could be inferred to be the same as the Absolute (Ab) GHG emissions plus GHG emissions that cover the entire study area so that the Relative (Re) GHG emission estimate is based on inputs that use an identical spatial boundary.

The With Project GHG emissions includes existing wastewater treatment (including unconnected properties where septic tanks or other means are used to treat wastewater) which will not change as a result of the proposed project.

Further Guidance: Without Project GHG emissions

The Without project emissions are a continuation of the current system, which unlike the Baseline scenario may not be regulatory compliant.

The Without Project GHG emissions includes existing wastewater treatment (including unconnected properties where septic tanks or other means are used to treat wastewater) which will not change as a result of the proposed project.

Absolute, Baseline and Relative emissions should be calculated for the entire project, and not just the part of a project seeking EC co-financing.

The screening documentation should be used to explain why no detailed calculations are necessary.

The climate proofing screening documentation should include details of:

- **the calculation method that will be used to estimate gross, net (as defined in the EIB Project Carbon Footprint Methodologies), absolute and relative GHG emissions for the proposed project (including sequestered GHG),**
- **the conversion of GHG emissions to monetary values using the shadow price of carbon,**
- **clarity that these values are consistent with those used in the EIA, Feasibility Study and economic appraisal documentation for the project.**

3.2 Detailed analysis (Phase 2)

3.2.1 Robust and verifiable carbon footprint estimation

The EC Climate Proofing Technical Guidance requires the GHG emissions to be calculated in the detailed analysis (phase 2) stage of the Climate Proofing analysis. The calculation of project carbon footprint is required for the project economic appraisal and so is required for all projects seeking EC co-financing.

Any more detailed analysis should always be proportionate to the findings of the screening analysis and relate to national legislative requirements and guidance.

The GHG emissions need to be calculated for each component that can potentially generate GHG emissions, that are material, during the operation of the project.

The recommended methodology for estimating GHG emissions is set out in the latest EIB Project Carbon Footprint Methodologies, along with description of which GHG are to be included, which activities generate these and the definition of Scope 1, 2 and 3 GHG emissions. Any other internationally recognised methodology and values can be used as long as it is clearly documented and explained.

Relevant Green House Gases from water and wastewater projects and their global warming potential over 100 year timeframe

- Carbon Dioxide (CO_2) 1 $kgCO_2s$
- Methane (CH_4) 28 $kgCO_2$-e/$kgCH_4$
- Nitrous Oxide (N_2O) 265 $kgCO_2$-e/kgN_2O

Figure 3-1. Relevant green house gases from water and wastewater projects and their global warming potential (from Table A1.9 of EIB Project Carbon Footprint Methodologies)

JASPERS recommends that all projects require a calculation of GHG emissions and this should be presented in the climate proofing documentation.

The latest version of the EIB Carbon Footprint Methodologies includes methodologies for wastewater treatment plants. The latest version of the methodology should be referred to. For wastewater treatment facilities the following formula should be used with reference to the values in Table 3-3. The table uses the EU average grid factor 245 gCO_2/kWh, which may require adjustment.

CF= (CFWW + ID + CFSD) x PE

Where:

- CF is the carbon footprint of the project expressed in tons CO_2e/year.
- CFWW is the CO_2e emitted per PE and per year in the wastewater treatment process (including CH_4 and N_2O).
- ID is the CO2e indirect emissions produced by the consumed electricity per PE. The electricity was evaluated for every process and for the emissions, the grid factor used was the EU average of 245 gCO_2/kWh.
- ID can be increased or reduced proportionally to the grid factor of the country's project. For example, if the project is in a country with a grid factor of 442, then the ID has to be multiplied by the factor 442/245 = 1.80.
- CFSD is the CO_2e indirect emissions produced by the sewage sludge disposal and depends on the final destination of the sludge (landfill, land use, composting etc.).
- PE is population equivalent.

Table 3-3. Calculation table for wastewater treatment facilities (from Annex 6 of the EIB Project Carbon Footprint Methodologies)

Wastewater treatment process	CFWW ($t.CO_2e$/ PE.y)	ID (tCO_2e/ PE.y)	Sludge disposal	CFSD ($t.CO_2e$/ PE.y)	Total ($t.CO_2e$/ PE.y)
Septic tanks, IMHOFF tanks	0.091	0.0000	Landfill	0.194	0.285
			Septic sludge treatment plant	0.083	0.174
			Wastewater treatment plant	0.055	0.146
			Not specified	0.111	0.202
Primary treatment	0.039	0.0044	Landfill	0.067	0.110
			Land use without further treatment	0.045	0.088
			Composting	0.033	0.076
			Incineration	0.022	0.065
Primary treatment andAnaerobic Digestion	0.039	0.0024	Landfill	0.030	0.071
			Land use without further treatment	0.020	0.061
			Composting	0.015	0.056
			Incineration	0.010	0.051
Secondary treatment without Anaerobic Digestion	0.014	0.0134	Landfill	0.112	0.139
			Land use without further treatment	0.075	0.102

Wastewater treatment process	CFWW (t.CO_2e/ PE.y)	ID (tCO_2e/ PE.y)	Sludge disposal	CFSD (t.CO_2e/ PE.y)	Total (t.CO_2e/ PE.y)
			Composting	0.056	0.083
			Incineration	0.037	0.064
Secondary treatment with Anaerobic Digestion	0.014	0.0073	Landfill	0.052	0.073
			Land use without further treatment	0.035	0.056
			Composting	0.026	0.047
			Incineration	0.017	0.038
Secondary treatment with enhanced Anaerobic Digestion	0.014	0.0064	Landfill	0.041	0.061
			Land use without further treatment	0.027	0.047
			Composting	0.020	0.040
			Incineration	0.013	0.033
Tertiary treatment (Nitrogen, Phosphorus removal) without Anaerobic Digestion	0.01	0.0156	Landfill	0.112	0.138
			Land use without further treatment	0.075	0.101
			Composting	0.056	0.082
			Incineration	0.037	0.063
Tertiary treatment (Nitrogen, Phosphorus removal) without Anaerobic Digestion	0.01	0.0086	Landfill	0.050	0.069
			Land use without further treatment	0.034	0.053
			Composting	0.025	0.044
			Incineration	0.017	0.036
Tertiary treatment (Nitrogen, Phosphorus removal) with enhanced Anaerobic Digestion	0.01	0.0075	Landfill	0.041	0.059
			Land use without further treatment	0.027	0.045
			Composting	0.020	0.038
			Incineration	0.013	0.031
Other processes					
Trickling filters, bio filters	0.017	0.0092	Landfill	0.112	0.138
			Land use without further treatment	0.075	0.101
			Composting	0.056	0.082
			Incineration	0.037	0.063
Carrousel (extended aeration)	0.015	0.0180	Landfill	0.056	0.089
			Land use without furthertreatment	0.037	0.070
			Composting	0.028	0.061
			Incineration	0.019	0.052
UASB (uplift anaerobic sludge blanket)	0.041	0.0110	Landfill	0.062	0.114
			Land use without further treatment	0.041	0.093

Wastewater treatment process	CFWW ($t.CO_2e$/ PE.y)	ID (tCO_2e/ PE.y)	Sludge disposal	CFSD ($t.CO_2e$/ PE.y)	Total ($t.CO_2e$/ PE.y)
			Composting	0.031	0.083
			Incineration	0.021	0.073

For other activities that may potentially be part of a water or wastewater project the following are included in the EIB methodology:

- For purchased electricity the estimate should be based upon country specific emissions factors (annex 1 and table A1.3 of the EIB Project Carbon Footprint Methodologies). This may be relevant for pumping stations or energy intensive infrastructure operation.
- For Reservoirs to determine CH_4 and CO_2 emissions based on the flooded surface area (annex 1 and table A1.8).
- Forestry is included in Annex 3 of the EIB Methodology.
- land use change EX-ACT tools are described in annex 4.
- Transport of sewage sludge using emission factors for various vehicle types.

Good Practice – Example of National Guidance that exceeds the EIB Carbon Footprint Methodology

The Environment Agency (England) have developed a set of carbon tools for flood risk management (LIT 7067 GOV.UK Carbon Calculator (publishing.service.gov.uk)). These include carbon estimates for many components of flood risk management schemes, including nature-based solutions. This allows for more detailed build-up of carbon footprint estimates than the EIB Carbon Footprint Methodology, and also estimates for components of a project not captured in the EIB method. The tools also allow for a clear and transparent calculation method that can easily be verified by third parties. This is especially valuable where project approval is undertaken by a different authority to the project developer. The two approaches are:

- **Carbon Modelling Tool** - top-down whole life carbon assessment and optioneering, used during the project appraisal phase to enable quick and simple carbon assessment to inform the solution selection process.
- **Carbon Calculator** - detailed bottom-up whole life carbon assessment, incrementally built up during the delivery phase, following selection of a preferred project solution option. The final Carbon Calculator assessment is used to create data points in the carbon models within the Carbon Modelling Tool. This includes Natural Flood Management (NFM) approaches to flood risk management.

3.2.2 Shadow cost of carbon and inclusion in project appraisal

The EC Climate Proofing Technical Guidance requires the shadow cost of carbon to be estimated and included in the project appraisal as part of the detailed analysis (phase 2) stage of the Climate Proofing analysis. The estimation of the shadow cost of carbon is required for the project economic appraisal and so it will be part of the projects applications seeking co-financing.

The shadow cost of carbon for the project as a whole should be calculated based on the calculated GHG emissions. This internalises in the Economic Appraisal the full cost to society from a tonne of carbon emitted. The latest values to be used as set out in Table 3-4.

Table 3-4. Shadow cost of carbon (as presented in EC Climate Proofing Technical Guidance and the EC Economic Appraisal Vademecum)

Year	€/tCO_2e	Year	€/tCO_2e	Year	€/tCO_2e	Year	€/tCO_2e
2020	80	**2030**	250	**2040**	525	**2050**	800
2021	97	**2031**	278	**2041**	552		
2022	114	**2032**	306	**2042**	579		
2023	131	**2033**	334	**2043**	606		
2024	148	**2034**	362	**2044**	633		
2025	165	**2035**	390	**2045**	660		
2026	182	**2036**	417	**2046**	688		
2027	199	**2037**	444	**2047**	716		
2028	216	**2038**	471	**2048**	744		
2029	233	**2039**	498	**2049**	772		

3.2.3 Verification of compatibility with credible Green House Gas reduction targets

This task is to verify the strategic option or project (depending on the life-cycle project stage) is compatible with national and EU greenhouse gas reduction targets. The projects should demonstrate how the absolute GHG emissions from the project are consistent with these reductions. This may need to refer to the Relative and Baseline GHG emissions to provide context for the proposed projects GHG emissions in relation to alternative means of achieving the project objectives. It may also be the case that there is no other viable alternative of achieving the project objectives. The shadow cost of carbon can be a means of appraising the proposed project against an alternative with more or less costly means of achieving regulatory compliance.

Responsibility for verification lies with the project promoter.

Ultimately, to be compatible with the EU GHG targets, all investments made now, should:

- achieve zero net carbon emissions from the date of investment to the year 2050 (and continue with no net carbon beyond 2050),
- contribute to a 55% reduction in GHG emissions by 2030, and

- not undermine efforts to achieve the Paris Agreement goal of no more than 1.5^{o} C warming.

Depending on the NECPs and any sectoral plans, some investments may need to go further than this to compensate for ongoing and other investments that cannot achieve the net zero target by 2050. Some water and wastewater projects may be those which individually may not be compatible with the EU GHG targets, but as part of a wider portfolio be compatible. The water, and wastewater sectors do not fit neatly into any of the sector-relevant decarbonisation pathways. In general water and wastewater projects should reduce GHG emissions and therefore should not be inconsistent with the Paris Agreement or national or sectoral GHG targets. Where projects need to demonstrate a portfolio approach to consistency with national and sectoral GHG targets, it is likely they will also need to demonstrate there are no better environmental options through procedures such as the EIA process. If there are no better environmental options, and the project can be given national approval, the EIA should include specific mitigation measures.

4. APPROACH TO CLIMATE RESILIENCE (ADAPTATION)

This section presents guidance for undertaking the climate resilience component of climate proofing for projects which are influenced by climate change. These types of projects are those whose operation or design may need additional measures so that they are resilient or adaptive to climate change impacts.

4.1 Resilience of investment to climate change

The purpose of climate proofing tests for resilience to climate change are to ensure that investment is only spent on infrastructure that is resilient or adaptable to future change. The EC Climate Proofing Technical Guidance clearly describes a process for assessing the climate resilience of the project. This document provides additional guidance specific to water and wastewater projects and should be read in conjunction with the EC Climate Proofing Technical Guidance.

Climate proofing for climate resilience involves identifying (1) which climate hazards the project is vulnerable to, (2) assessing the level of risk and (3) integrating adaptation measures to reduce that risk to an acceptable level. The process starts at the outset of the feasibility and options appraisal stage and should be integrated into all subsequent stages of project development. The results are used to inform decision making as the project develops. Figure 4-1 shows the progression through four main stages of work.

Preparation

- A clear description of the proposed project.

Screening for Climate Change Vulnerability

- **Sensitivity (Module 1)**. Which climate hazards influence a typical project of the type proposed, considring typical components of this type of project?
- **Exposure (Module 2)**. To what degree is the project location currently exposed to climatic hazards, and by how much will this change in the future due to climate change?
- **Vulnerability (Module 3)**. Is the project potentially vulnerable to climate change, and require a detailed risk assessment?

Climate Change Risk Assessment

- **Likelihood (Module 4)**. What is the probability for a climate hazard to occur, specific to the project?
- **Consequence or Impact (Module 4)**. How significant is the impact of the occurrence of the hazard on different aspects or components of the project?
- **Risk (Module 4)**. Is the project as a whole, or are individual project components, resilient to climate change impacts or are there risks that need to be addressed through adaptation measures?

Mitigation (adaptation measures)

- **Adaptation Options (Module 5)**. What options are available to make the project resilient to climate change?
- **Options Appraisal (Module 6).** Which adaptation options are most appropriate for the project based on the project's specificities?
- **Adaptation Planning (Module 7).** Embed climate adaptation measures within the project description, EIA process, Feasibility Study and Economic Appraisal. Include detailes of monitoring and responsibility for future adaptation.

Figure 4-1. Overview of the purpose of each stage in the climate resilience process and grouping of work into four main stages and 7 modules from the non-paper guidelines.

The process applied in the 2014-2020 programming period still applies. This document contains some additional best practice guidance which is intended to help give clarity and focus to the assessments. These changes are within the orange text boxes, such as the example below.

In the 2021-2027 programming period there is no distinction for major projects. All projects with a lifetime above 5 years seeking EU funds should be subject to climate proofing.

4.2 Project components (preparatory phase)

To undertake the sensitivity analysis it is helpful to break the project into components. Each component is then subject to the sensitivity analysis to understand which climate hazards are relevant. This helps structure and focus the assessment and ensure a more resilient project which has identified and analysed all possible climate risks.

There is no fixed set of project components that need to be considered, but they should cover all aspects of a project's functions and interdependencies required to achieve the effective operation of the project. It is recommended that the breakdown of the project into component elements is appropriate to the type and scale of the project. This will require consultation across the project team and potentially with some stakeholders.

Consideration should be given to the fact that having too many components may make assessments unwieldy. In addition, giving all elements equal weight where, in reality they have hugely different levels of significance for the project as a whole could reduce the effectiveness of the exercise. Equally too few components could over-simplify a project and the significance of a climate impact could be missed. All components should therefore be listed for consideration. Section 2 of the EC Climate Proofing Technical Guidance states that the time, cost and effort put into climate proofing should be proportionate to the benefits.

Setting the project boundaries is important so that the climate proofing assessment is proportionate to the components of the project itself and the wider interdependencies most relevant to the project area. Key components within the project boundary are construction and operations. Key components outside the project boundary are the interdependencies.

The interdependencies will vary from project to project and could include aspects such as consumer demand, population growth, economic growth, transport links, electricity and fuel, wider ICT impacts and changes in tourism. It is important to ensure the project is resilient to climate hazards impacting on interdependencies and does not contribute to impacts elsewhere. Examples include water supply projects that do not impact upon water availability for other settlements or uses. This may require working closely with other key stakeholders outside the project control and starting this collaboration and information sharing during the Feasibility Study.

If new project components are added to the project after the climate proofing screening stage these should pass through the screening stage before the climate proofing moves to the detailed assessment.

In water/wastewater projects, the typical project components to be included in the analysis are shown in the further guidance box below. The sensitivity analysis is best carried out by technical experts in the field of the project component under assessment. The EC Climate Proofing Technical Guidance recommends grouping project components into categories: on-site assets and processes, inputs, outputs and interdependencies. Significance can be considered as the level of change in design or operation that would be necessary to perform, or the ability of the project component to perform as designed if it was to be affected by a climate hazard.

Worked Example – Possible components from typical water supply and wastewater projects

The project components in bold have been selected to continue through the worked example.

Inputs	Assets	Processes	Outputs
• **Water sources,** • River or groundwater abstraction • Treatment chemicals • Human resources	• Supply pumps • **Water supply network** • Water intakes • Discharge outlets • **Wastewater Treatment plants**, • **Sewerage network** • Water storage and distribution network • Combined sewer systems and outlets • Control systems. • Existing network of pipes, pumps, tanks and any other element required for the operation of the proposed project	• Pumping and supply from sources • Water treatment and controls • Clean treated water storage • Water distribution • Wastewater treatment	• Clean drinking water, sustainable water supplies • Treated effluent • Waste products • Sewage sludge

Interdependencies

- **Power supply**
- **Access roads**
- Depending on the site boundary the following types of interdependencies may need to be considered:
  - Increased capacity to cover additional water demand for tourists and tourist activities in localities serviced by water supply
  - Induced growth in local economic activity as a result of new water supply for light industry

It should be noted that the analysis should consider components such as existing pipe networks where an existing combined, foul or surface water system is being upgraded, or where the existing pipe networks are required for the new investment to operate. This is important because the new project components may be resilient to climate change, but the overall operation of a water supply or wastewater network may not be resilient due to existing components upon which the new project relies upon. An example could be increased potential for saline intrusion into old wastewater pipes as a result of sea level rise. This increase could in turn reduce the available treatment capacity or performance of pumping stations. The same could apply for combined sewer systems where rainfall intensity will increase with climate change.

4.3 Screening of projects for vulnerability to climate change (phase 1)

4.3.1 What is the vulnerability assessment?

The objective of the screening is to understand which climate factors (hazards) the project may be vulnerable to, and whether these require more detailed assessment. The vulnerability of a project to climate change is a function of how sensitive a typical project of the type proposed is to climate hazards (sensitivity) and the presence of these hazards at the project location under current and future climatic conditions (exposure).

The scoring of sensitivity, exposure and vulnerability should be based on qualitative high/medium/low criteria. Any notable uncertainties which could influence the ability to score these should be noted. If plausible upper bounds of an uncertain data source could result in a high or medium category for climate vulnerability of a project then this should be explored further in the detailed risk assessment stage.

Sensitivity

- How sensitive are typical project components for the type of project proposed to climate hazards
- Based on knowledge of the type of componets associated with the proposed project.
- Which hazards are most relevant for this type of project, and why
- Irrelevant of location

Exposure

- Based on the location of the project it is possible to identify the degree to which the project is likely to be exposed to specific climate hazards.
- Current Climate Variability
- Future Climate Change
- Irrelevant of the project

Figure 4-2. Further description of sensitivity and exposure

For the sake of clarity and transparency the Vulnerability Assessment should be carried out for all climate hazards listed in Table 4-1 below. The reason is that Vulnerability assessment plays the role of a screening to determine which risks require a detailed risk assessment (phase 2). The comprehensive list of climate hazards in this screening phase would ensure that no hazards are missed or overlooked.

Table 4-1 groups climate hazards by a hazard category to help streamline the thinking behind the assessment. A link to the relevance of hazards to different projects is also provided. This intended as a start point, however all suggestions must be reviewed to ensure they are valid for the proposed project.

Table 4-1. Climate related hazards that should be subject to the sensitivity analysis, related climate indices and possible link to a hazard indicator.

Hazard category	Climate hazards	Related climate indices that could inform hazard (national datasets in brackets)	Relevance of hazard to water and wastewater projects	Relevance of hazard to interdependencies and operational aspects of all projects
Heat and cold	Annual / seasonal / monthly average (air) temperature	Mean temperature Heating degree days Cooling degree days	✓ Effect on treatment process efficiency.	✘
	Extreme temperature occurrences (including heat waves)	Tropical nights. Warmest three-day period Hot days Heatwave days based on apparent temperature. Climatological heatwave days Days with UTCI above a threshold	✓ Effect on water demand.	✓ Effect on the ability of humans to operate, maintain and manage systems.
	Cold spells	Frost days	✘	✓ Effect on the ability of humans to operate, maintain and manage systems.
	Freeze-thaw damage	Frost days	✓ Freeze thaw damage to infrastructure.	✘
Wind	Average wind speed	Mean wind speed	✘	✘
	Maximum wind speed / Storms (tracks and intensity)	Extreme wind speed days	✓ damage to infrastructure.	✓ impact on access roads, power supply or storm damage to administrative buildings.

Hazard category	Climate hazards	Related climate indices that could inform hazard (national datasets in brackets)	Relevance of hazard to water and wastewater projects	Relevance of hazard to interdependencies and operational aspects of all projects
Other air and atmospheric	Air quality	None. National and regional air quality monitoring should define critical thresholds.	? possible effect on treatment process.	✓ Effect on the ability of humans to operate, maintain and manage systems.
Wet and dry	Annual / seasonal / monthly average rainfall	Total precipitation	✓ effect on water resources from changes to hydrological regime.	✘ rainfall patterns do not cause a hazard
	Extreme rainfall (frequency and magnitude)	Maximum consecutive five-day precipitation Extreme precipitation total Frequency of extreme precipitation	✓ effect on pluvial flood probability and hazard to infrastructure. Effect on drainage system design parameters.	✓ effect on pluvial flood probability and hazard to access roads, power supply and administrative buildings.
	River flooding	River flood index using runoff (or Floods Directive Flood Hazard and Risk Maps)	✓ effect on river flood probability and hazard to infrastructure.	✓ effect on river flood probability and hazard to access roads, power supply and administrative buildings.
	Aridity	Aridity days Consecutive dry days	✓ effect on ability to abstract sufficient water to meet demand for irrigation.	✘
	Drought / Water availability	Duration of meteorological droughts Magnitude of meteorological droughts Duration of soil moisture droughts	✓ effect on ability to abstract sufficient water to meet all water supply demands. Effect on receiving water body assimilative capacity for discharge.	✓ Effect on the ability of humans to operate, maintain and manage systems.

Hazard category	Climate hazards	Related climate indices that could inform hazard (national datasets in brackets)	Relevance of hazard to water and wastewater projects	Relevance of hazard to interdependencies and operational aspects of all projects
	Wildfire	Days with fire danger exceeding a threshold	✓ effect on afforestation for source protection and direct fire damage to infrastructure.	✓ Effect on the ability of humans to operate, maintain and manage systems.
Snow and ice	Avalanche	None. If there is no national or regional hazard assessment, exposure to hazard will need to be inferred from a range of climate indices. • Annual/seasonal/monthly average (air) temperatures • Extreme (air) temperatures • Annual/seasonal/monthly average rainfall and snowfall (seasonality, frequency and amount) • Extreme rainfall and snowfall (frequency and magnitude) • Snowfall • Solar radiation	✓ damage to infrastructure.	✓ impact on access roads, power supply or storm damage to administrative buildings.
	Melting permafrost		✓ damage to infrastructure.	✓ impact on access roads, power supply or storm damage to administrative buildings.
	Ice flows in rivers		✓ damage to infrastructure.	✓ Effect on the ability of humans to operate, maintain and manage systems.
Coastal	Sea level rise	Relative sea level	✓ damage to infrastructure. Change to coastal flood protection design parameters.	✓ effect on coastal flood probability and hazard to access roads, power supply and administrative buildings.

Hazard category	Climate hazards	Related climate indices that could inform hazard (national datasets in brackets)	Relevance of hazard to water and wastewater projects	Relevance of hazard to interdependencies and operational aspects of all projects
	Coastal flooding	Coastal flooding (or Floods Directive Flood Hazard and Risk Maps)	✓ damage to infrastructure. Change to coastal flood protection design parameters.	✓ effect on coastal flood probability and hazard to access roads, power supply and administrative buildings.
	Coastal erosion	No climate index (Coastal Erosion Hazard and Risk Maps)	✓ damage to infrastructure. Change to coastal flood protection design parameters.	✓ effect on coastal flood probability and hazard to access roads, power supply and administrative buildings.
Oceanic	Sea water temperature	Sea surface temperature Duration of marine heatwaves	✓ for desalinisation or discharges to coastal and transitional waterbodies only.	✘
	Ocean pH	Ocean pH level	✓ for desalinisation or discharges to coastal and transitional waterbodies only.	✘
	Ocean oxygen level	Dissolved oxygen level	✓ for desalinisation or discharges to coastal and transitional waterbodies only.	✘
	Ocean salinity	Ocean salinity	✓ for desalinisation or discharges to coastal and transitional waterbodies only.	✘
Other water	Water temperature	(WFD monitoring, state of environment reports)	✓ effect on treatment process.	✘

Hazard category	Climate hazards	Related climate indices that could inform hazard (national datasets in brackets)	Relevance of hazard to water and wastewater projects	Relevance of hazard to interdependencies and operational aspects of all projects
	Water quality	(WFD monitoring, state of environment reports)	✓ effect on treatment process.	✗
Land, soil and geotechnical (typically through indirect effects of climate change)	Soil erosion		✓ damage to infrastructure from sediment deposition, impact on water quality though change in turbidity or suspended sediment.	✓ impact on access roads, power supply or to administrative buildings from sediment deposition.
	Saline intrusion		✓ effect on treatment process	
	Soil salinity		✓ effect on treatment process	✗
	Ground instability / landslide		✓ damage to infrastructure.	✓ impact on access roads, power supply or storm damage to administrative buildings.
	Dust storms	Related to aridity indices.	✓ effect on treatment process	✓ impact on access roads, power supply or storm damage to administrative buildings.
	Earthquake	(Earthquake and seismic hazard maps)	✓ damage to infrastructure.	✓ impact on access roads, power supply or storm damage to administrative buildings.
Other	Plus any others relevant to the type of project			

4.3.2 Module 1: Sensitivity

The purpose of the sensitivity analysis is to identify whether the typical instance of project components is sensitive to climate hazards (e.g. is a concrete wall sensitive to extreme rainfall). The starting point is the full list of climate related hazards in Table 4-1.

The sensitivity analysis is best carried out by technical experts in the field of the project component under assessment. The EC Climate Proofing Technical Guidance recommends three sensitivity score categories, as presented in Figure 4-3 with an additional no sensitivity category. Significance can be considered as the level of change in design or operation that would be necessary to perform, or the ability of the project component to perform as designed if it was to be affected by a climate hazard.

Defined thresholds for levels of sensitivity, with a wastewater example are presented in Figure 4-3. Any climate hazard with no impact has no sensitivity and should be assigned a score of zero (0). The numerical scores are based upon the JASPERS CCVRA guidance for the 2014-2020 programming period. A worked example is provided in Table 4-2. The overall project sensitivity is the worst sensitivity score for a climate hazard from all project components.

High sensitivity (score 3)

- the climate hazard may have a significant impact on assets and processes, inputs, outputs and transport links
- as a result of climate hazard occurring WWTP or water supply network shutdown for more than 2 days

Medium sensitivity (score 2)

- the climate hazard may have a slight impact on assets and processes, inputs, outputs and transport links
- as a result of climate hazard occurring WWTP or water supply network shutdown for 1- 2 days, pollution incident which affects non-residential properties and has medium impact for water quality

Low sensitivity (score 1)

- the climate hazard has no (or insignificant) impact
- as a result of climate hazard occurring WWTP or water supply network shutdown for up to 24 hours, minor pollution incident affecting collection system and minor impacts for water quality

No sensitivity (score 0)

- no possible impact of the climate hazard on any of the project components
- no impact on the ability to manage the infrastructure - business as usual

Figure 4-3. Suggested sensitivity criteria and scores (from the 2014-2020 programming period JASPERS CCVRA guidance) with example thresholds for a water or wastewater treatment project.

Table 4-2 presents an example of the sensitivity assessment table for a selection of hazards and project components. As said above, the Sensitivity assessment should be carried out for all climate hazards listed in Table 4-1.

Good Practice – How a climate proofing manager role can co-ordinate the process

It is good practice for a climate proofing manager to set expectations for this stage to ensure simplicity and to co-ordinate sufficient expertise, which should already be within the project team. It is important that the sensitivity analysis keeps focus and does not start to determine the scale of possible impact under different climate scenarios. It just needs to focus on whether each project component is sensitive to a possible change. The climate proofing manager could facilitate engagement with specialists and experts to provide meaningful exposure information to the project team.

Table 4-2. An example sensitivity assessment for the water supply project components

Hazard Category	Climate Hazards	Inputs	Assets and Processes	Outputs	Global score
		Ground Water Aquifer (Water Source)	Water treatment plant and treatment processes	Quantity and quality of water supplied	
Heat and cold	Annual / seasonal / monthly average (air) temperature	1 Possible degradation of raw water quality through increased turbidity.	2 Impact on efficiency of treatment processes	1 Possible impact on quality of treated water.	**2**
	Extreme temperature occurrences (including heat waves)	0 no impact on groundwater sources (see drought for secondary effects of heat waves on water resources)	2 Possible increase in the concentration of pollutants on the influence with effect on the treatment process,	1 Additional demand for water during heatwaves.	**2**

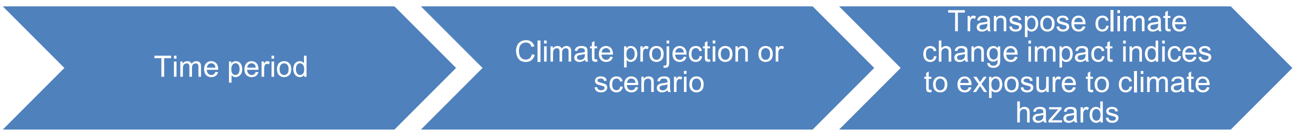
4.3.3 Module 2: Exposure

The exposure analysis involves determining the extent to which the project location is likely to be affected by climate related hazards, now and in the future. This is determined firstly through understanding current climate conditions and then secondly through consideration of the likelihood of future change and how this will affect hazards.

The exposure assessment is often best undertaken in parallel or following the sensitivity assessment. In some circumstance it is possible to use the Exposure Assessment alone, for example early in project development, to 'rule out' potential project locations such as for reasons of existing and increasing flood risk or for sea level rise.

The EC Climate Proofing Technical Guidance requires the screening (phase 1 adaptation) to cover the exposure in the project location, and other locations where project interdependencies may be affected, for example water supply projects where the water resources sources are remote from the treatment and distribution facilities. This could be extended to cover the zone of influence of a project on climate hazards, as evidence to support cumulative impact assessment in the EIA.

A suggested workflow for undertaking the exposure analysis is presented in Figure 4-4.



- Define and document the lifespan of the proposed infrastructure. This should reflect the operational lifetime of the project.
- Consider if lifespan of economic development in response to the project is longer than the lifespan of the project investment.
- Based on these select a time period for the future exposure assessment. Should always be more than 50 years.

- Select the most appropriate climate change projection.
- If looking 50 years into the future, all SSP pathways have very similar sea level rise projection. However in 100 years there are notable differences in impacts between SSP pathways.

- Project specific analysis of hazards and existing hazard and risk maps (e.g. flood hazard maps) have already transposed climate change indices into a hazard.
- For other climate impacts, indices expert judgement and interpretation of how the climate impact affects climat related hazards will be required.
- Score the baseline and future exposure from 0 to 3.

Figure 4-4. Suggested workflow for exposure analysis.

4.3.3.1 Time period

The lifespan of the proposed infrastructure needs to be documented. The climate proofing must consider this full time period.

For water and wastewater projects the climate proofing documentation needs to consider and assess the effect of changes to conditions for abstraction or discharge. This can either be either embedded in the project development design conditions and fully described in the Feasibility Study, or through the climate proofing vulnerability and risk assessment stages.

4.3.3.2 Climate projection of scenario

Climate projections and assessment of impacts should be based on best practice and available guidance, taking into account the state-of-the-art science for vulnerability and risk analysis and related methodologies in line with the most recent Intergovernmental Panel on Climate Change reports.

This means that:

- The latest IPCC assessment and reports available must be referenced (currently this is the 6th Assessment Report AR6), in terms of the Shared Socio-Economic Pathways (SSPs).
- The climate proofing documentation must state what projections are relevant for the climate proofing. Which projections and timescales are used in setting the project design criteria, and which are used for the climate proofing.
- Where available within local, national or European scale climate impact assessments, the SSPs should be used as a projection of future climate conditions.
- If the SSPs are not available, then the respective RCP pathway should be used, with a clear statement on why the older RCP climate impact data is comparable to the SSP projection and appropriate for use.
- It is not necessary to use all RCP or SSP projections and a useful selection of climate projections should be used to streamline and focus the climate proofing document.
  - *Present day conditions, records and recent trends may be used for the current exposure.*
  - *If data for climate impacts of SSP 1-1.9 or SSP 1-2.6 projections is available for a specific hazard this may also be used to inform the current exposure because this scale of climate change is already expected to occur, and may already be the conditions in the first year of operation of the project.*
  - *For future exposure the expectation is that water, wastewater and flood management infrastructure will continue to operate for a significant length of time and so more extreme SSP 3-7.0 or SSP 5-8.5 (or RCP 6.0 or RCP 8.5) projections in the year 2100 should be used.*
  - *For disaster risk management projects where land use change is proposed the same long term timescale and high climate projection should be used.*
  - *For projects which propose shorter term investment such as the development of disaster emergency response plans or purchase of equipment then a shorter time period to 2060 and lower climate projection (SSP 2-4.5 or RCP 4.5) could be used, because all climate projections are similar to the year 2060.*

The EC Climate Proofing Technical Guidance sets out the data sources that can be used to inform the screening. All data sources used to determine present and future exposure must be documented in the climate proofing documentation.

The exposure must be informed by official or nationally/regionally adopted climate data. The use of academic research should not be used if it is not part of an adopted national or regional dataset. Climate change modelling is a highly complex specialist field and should not be necessary for the climate proofing process. This may require input from experts or stakeholders outside of the core project team to translate climate projections and indices into useful description of future hazards.

The preference for information on climate impacts should be in order below so that local and high-resolution impact data, where available, is used in preference to broad scale assessments:

1. Project specific analysis of climate hazards which influence the project design where available (e.g. hydrological and hydraulic models used to develop and design flood risk management infrastructure, water resource models for water supply projects, receiving waterbody diffuse pollution models).

2. Existing national risk maps and inventories such as Floods Directive flood hazard and risk maps, coastal erosion risk maps, landslide and flash flood risk zones and maps.

3. Official national climate change, datasets, assessments and reports.

4. EU climate indicators and assessments, at Regional or Member State level (e.g., data published on C3C Copernicus Climate Data Explorer, or EEA reports based on CMIP5 and EURO-CODEX data).

5. IPCC AR6 climate impacts.

For the 2021-2027 programming period the IPCC Sixth Assessment Report (AR6) should be used as the primary source of climate projections, with reference to any European or national research on climate hazard specific projections. Where these are not available comparable RCP data should be used. For reference, please see Section 2.3 of this document above.

The Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6) completed in 2022 includes a dedicated chapter on the climate change impacts, risks and vulnerability to Europe[12].

The AR6 reports use the term Global Warming Levels (GWL) which refers to global climate-change emissions relative to pre-industrial levels, expressed as global surface air temperature.

A core set of five illustrative scenarios based on the Shared Socio-economic Pathways (SSPs) are used consistently across the latest ICCP AR6 Reports: SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and

[12] Bednar-Friedl, B., R. Biesbroek, D.N. Schmidt, P. Alexander, K.Y. Børsheim, J. Carnicer, E. Georgopoulou, M. Haasnoot, G. Le Cozannet, P. Lionello, O. Lipka, C. Möllmann, V. Muccione, T. Mustonen, D. Piepenburg, and L. Whitmarsh, 2022: Europe. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1817–1927, doi:10.1017/9781009325844.015.

SSP5-8.5. These scenarios cover a broader range of greenhouse gas and air pollutant futures than assessed in earlier IPCC reports, and they include high-CO_2 emissions pathways without climate change mitigation as well as new low-CO_2 emissions pathways.

Figure 4-5 shows when the different GWLs are projected to occur under the different SSPs. The IPCC AR6 Technical Summary (Box TS2.2) states common set of reference years and time periods for describing climate impacts. These are the near-term (2021-2040), mid-term (2041-2060) and long-term (2081-2100). It is clear that all SSPs result in a similar GWL in the near term, with divergence starting in the mid-term and significant variation in the long-term. This exposure section of the climate proofing document focuses on the exposure of the project location to the resulting climate hazards.

The first year of operation for the project is expected to be in the middle of the near-term (2021-2040) time period and so conditions under a 1.5 °C warmer world will be used as the data of the current exposure. If the SSP 1-1.9 or SSP 1-2.6 are followed then this will also reflect the future long-term exposure of the project location.

The lifetime of the project infrastructure is 100 years and so the long-term (2081-2100) time period will be used for the future exposure. It is not possible to confirm which SSP or GWL will occur in the long-term and so the exposure of the project location will be assessed where comparable data for determining exposure to the hazard data for the SSP 2-4.5 (similar to a 3 °C GWL) and SSP 3-7.0 (similar to a 4 °C GWL). This will allow for the climate proofing risk assessment consider any limits to the adaptive capacity of the proposed project.

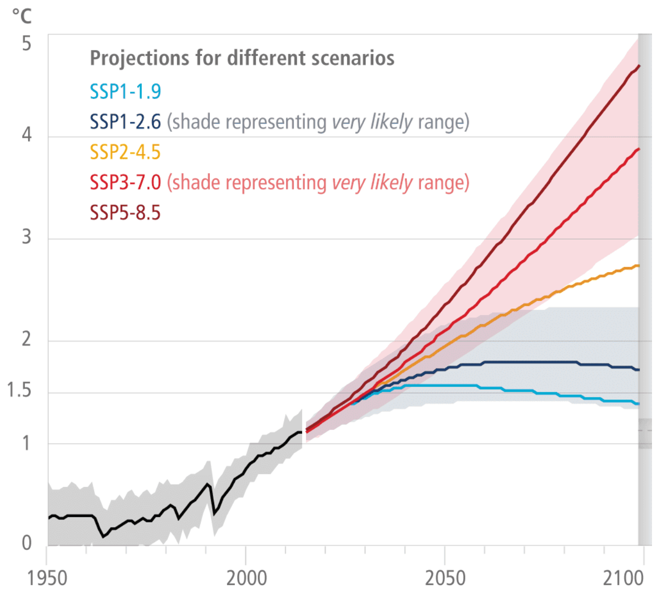


Figure 4-5. Global surface temperature change in °C relative to 1850-1900 for five Shared Socio-economic Pathways (Figure TS.4(a) from Technical Summary to the 6th Assessment Report[13]).

[13] Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama

The project should select the most appropriate projections and scenarios for the analysis. National guidance may set the framework for this decision or specify the pathway(s) or scenario(s) to be used.

For many climate hazards, national maps, impact and risk assessments will be available. For example, the 2nd cycle Floods Directive Flood Hazard and Risk Maps should be a readily available data source to inform the screening analysis.

The recommendation for the screening tasks is to ensure the process reflects the range of plausible uncertainty in the projections.

Because of the uncertainty in the timing of future climate projections, climate proofing for projects with a long lifetime (i.e. 30 years or longer) should use scenarios instead of projections. Where possible the scenarios should be described with some context on the possible timescales for when these scenarios may be expected (e.g. a medium range future scenario may be expected to occur between 30 and 70 years in the future from now). A practical application of this is to assign the:

- SSP 1-2.6 pathway for the current exposure, this is on the assumption that the first year of the operation of the proposed project is likely to be close to the year 2030. Using this climate pathway reflects the possible scale of locked in climate change to this date.
- SSP 2-4.5 (or RCP 4.5) pathway for the exposure to 2050 to 2070 (or longer to 2081-2099 if the project lifetime is closer to 100 years),
- followed by the SSP 3-7.0 (or RCP 8.5) for longer term exposure to climate related hazards.

This is acceptable because in terms of direct climate impacts, such as sea level rise as shown in Figure 2-1, the SSP pathways are similar until the 2050-2070s and then start to diverge with significantly different impacts by 2100.

The application of scenario SSP 2-4.5 will require regular monitoring of climate change, impacts, and the level of resilience.

The alternative is to use only scenario SSP 3-7.0 as a precautionary approach.

4.3.3.3 Transpose climate change impact indices to exposure to climate hazards

Past and recent climate trends should not be used for scoring the future exposure as often the future trajectory of climate change impacts are not captured. They can be used for informing the current exposure. Relying on trends alone for the impact assessment could result in the development of projects that are not resilient to climate impacts from the range of plausible futures.

The Climate Proofing Documentation must present the scoring table and method used for assigning an exposure score to each climate hazard. The scoring method should explicitly mention a data source and thresholds which link a climate index or indicator to a climate hazard. Table 4-1 presents how European climate indices relate to the climate hazards for climate proofing.

A suggestion for scoring the current and future exposure to climate hazards is presented in Figure 4-6. This follows the JASPERS CCVRA guidance from the 2014-2020 programming period and includes suggestions for maximising the value of existing hazard and risk maps, such as those produced for the

(eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 37–118, doi:10.1017/9781009325844.002.

EU Floods Directive. Any climate hazard which the project components or interdependencies is not exposed to now, or in the future, will be given a score of zero (0).

The exposure scores must:

- **Be based on the conditions without the project in place but at the time of the first year of operation,**
- **Be evidence based with the data sources used documented in the exposure section of the climate proofing report.**

Where there is no quantitative information to determine the future exposure, the score should be based on the likely scale of future impacts with qualitative justification documented.

High exposure (score 3)

- **Any hazard**: hazard has occurred (current exposure) or expected to occur (future exposure) a number of times in five years
- **Flood hazard**: For climate hazards where hazard or risk mapping is available this would be exposure in the high probability maps (e.g. for flood hazard and risk maps this may be the 10% AEP (Annual Exeedence Probability))
- **Extreme temperature**: Region with very high average temperatures in summer (above 23 ºC) and a large number hot days (Tmax≥35 ºC). Very high average temperatures in summer (over 23 ºC). Heat waves have a frequency ≥ 1 event per year

Medium exposure (score 2)

- **Any hazard**: hazard has occurred (current exposure) or expected to occur (future exposure) twice in 10 years
- **Flood hazard**: For climate hazards where hazard or risk mapping is available this would be exposure in the medium probability maps (e.g. for flood hazard and risk maps this may be the 1% AEP)
- **Extreme temperature**: The average summer temperature exceeds 20 ºC. Heat waves have a frequency of 1 event every 1-5 years

Low exposure (score 1)

- **Any hazard**: hazard has occurred occurred (current exposure) or expected to occur (future exposure) once in 25 years
- **Flood hazard**: For climate hazards where hazard or risk mapping is available this would be exposure in the low probability maps (e.g. for flood hazard and risk maps this may be the 0.1% AEP)
- **Extreme temperature**: The average summer temperature has acceptable values (≤20 ºC). Heat waves have a frequency ≤ of 1 event every 5 years

No exposure (score 0)

- **Any hazard**: there is no possibility that the hazard can occur in the project location (e.g. an inland project cannot be exposed to coastal erosion)
- **Flood hazard**: For climate hazards where hazard or risk mapping is available the project location is outside of the low probability maps (e.g. for flood hazard and risk maps this may be the 0.1% AEP)
- **Extreme temperature**: Heat waves are not expected

Figure 4-6. Suggested exposure criteria and score for selected climate hazards (from the 2014-2020 programming period JASPERS CCVRA guidance and EC Climate Proofing Technical Guidance).

For most climate hazards the current and future exposure will be at a regional or national scale.

For the current climate (i.e., the first year of operation of the proposed project), exposure can be assessed by considering the recent history of the project location and where this has been impacted by climate hazards such as flooding, drought, high temperatures or coastal erosion. For water and wastewater projects future water resource and receiving water body hydrology should already have been modelled and should include current and future baseline scenarios.

For climate hazards where detailed hazard and risk mapping data, such as the Floods Directive Flood Hazard and Risk Mapping is available the exposure score for these climate hazards should be based on the worst exposed component of the project. Using this level of detail in the screening stage with readily available spatial information will help focus the risk assessment.

For a project investment with multiple wastewater treatment plants in different localities the most exposed component will set the exposure score. Some hazards can be assessed on a regional or river basin scale (e.g., drought, extreme temperature), others on a coastal or transitional water body scale (e.g., sea level rise, coastal erosion) and others such as flood and landslide risk will have significant spatial variability and where possible should be assessed at the project component scale. This is because a scenario for a 20% increase in flood peak flow could have significantly different impact on flood level on a localised scale (e.g., flood impacts could vary significantly upstream and downstream of a bridge or a location protected by raised flood defences).

Other studies to inform the design of the project infrastructure may have been carried out. Examples include flood risk modelling for a Flood Risk Assessment to ensure the infrastructure is not at risk of flooding. In this situation Flood risk modellers would be developing hydraulic models to inform design of flood relief projects. Climate change scenarios can easily be added as an extra model scenario.

For other climate hazards which are not part of the core project objectives, the EIA will detail the evolution of the baseline environment with and without the proposed with climate change. This analysis for the EIA process may not be ready to inform the exposure analysis (usually carried out before the options appraisal stage of the Feasibility Study). In these cases, a simple assessment of the relative change in the climate hazard under the selected climate projection and the timescale of the assessment would be sufficient.

An example of an exposure scoring assessment for selected hazards is presented in Table 4-3. **The exposure assessment should be done for all climate hazards listed in Figure 4-3 and for which the sensitivity assessment was carried out.** This must be supplemented with a description and justification for the climate scenarios and projections, and data sources used. The supplementary description is so that future revisions to a climate adaptation plan can be transparent and consistent.

Table 4-3. Exposure assessment for the project location

Hazard Category	Climate Hazard	Exposure score			Score justification and data sources
		Current exposure (2021-2040 period) SSP 1-1.9, 1.5^{0}C GWL or equivalent	Future exposure (2081-2100 period) SSP 2-4.5, 3^{0}C GWL or equivalent	Future exposure (2081-2100 period) SSP 3-7.0, 4^{0}C GWL or equivalent	
Heat and cold	Annual / seasonal / monthly average (air) temperature	2	3	3	Global and European temperatures (EEA climate change indicators). Data available for SSP 1-2.6 used for current exposure, and SSP 5-8.5 used for both future exposure scores.
	Extreme temperature occurrences (including heat waves)	2	2	3	EURO-CORDEX CMIP5 data. Number of days human health heat wave per year. Data available for RCP4.5 used for current exposure and future exposure comparable to SSP 2-4.5, with 6 days and 23 days respectively. RCP8.5 used for future exposure comparable to SSP 3-7.0 with 40 days.
	Cold spells	2	1	1	National meteorological institute data for current exposure to cold spells. Future projections in all scenarios have an increase in winter temperatures. Cold spells are still possible, but the likelihood is reduced.

4.3.4 Module 3: Vulnerability

The vulnerability analysis is a simple combination of sensitivity of project aspects and exposure of the project location to climate hazards (or drivers). A simple matrix should be produced with the climate hazards (or drivers) mapped across. This shows how vulnerable the project is to specific climate-related hazards in its current location and enables prioritisation of the climate hazards the project is most vulnerable to. The score for each climate hazard is the sensitivity score multiplied by the highest of the current and future exposure score for that climate hazard. If the climate hazard has high vulnerability, then these must progress to the detailed risk assessment. Any medium vulnerability hazards should be considered to move forwards to the detailed risk assessment as there is a possibility that further analysis could help improve the resilience of the project to climate change.

Vulnerability = Sensitivity score x Exposure score

		Exposure score			
		0	1	2	3
Sensitivity score	0	0	0	0	0
	1	0	1	2	3
	2	0	2	4	6
	3	0	3	6	9

High vulnerability (score ≥6)
- Project is vulnerable to this climate hazard
- Take forward to detailed assessment (phase 2)

Medium vulnerability (score 3<6)
- Project may be vulnerable to this climate hazard
- Consider taking forwards to detailed assessment (phase 2)

Low (or zero) vulnerability (score ≤2)
- Project is not vulnerable to this climate hazard
- Do not progress to detailed assessment

Figure 4-7. Vulnerability scoring approach (top: score formula, left: score matrix, right: score description and implication)

If the sensitivity, exposure and vulnerability analysis is carried out for each proposed project option it is possible to compare options to determine which is likely to be the most resilient to climate change, and which may require more adaptive measures or mitigation for impacts. This can be used as the evidence to inform the options appraisal. The simplicity of this type of matrix can also be a valuable stakeholder and public engagement tool.

If the vulnerability assessment concludes that the project is not vulnerable to any climate hazards, and that conclusion has been duly justified, there may be no need to undertake further risk assessment.

An example vulnerability table for selected hazards and project components is presented in

Table 4-4. It is often useful to create separate vulnerability table for where vulnerability may differ for components. An example vulnerability matrix for all hazards is presented in Table 4-5. **The presentation of the Vulnerability assessment should include all climate hazards listed in Figure 4-3 above and for which the Sensitivity and the Exposure assessment have been done.**

Table 4-4. Example project vulnerability assessment table.

Hazard Category	Climate Variables	Global Sensitivity	Current (2021-2040 period) SSP 1-1.9, 1.5^{0}C GWL or equivalent		Future (2081-2100 period) SSP 2-4.5, 3^{0}C GWL or equivalent		Future (2081-2100 period) SSP 3-7.0, 4^{0}C GWL or equivalent	
			Exposure	Vulnerability	Exposure	Vulnerability	Exposure	Vulnerability
Heat and cold	Annual / seasonal / monthly average (air) temperature	2	2	**4**	3	**6**	3	**6**
	Extreme temperature occurrences (including heat waves)	2	2	**4**	2	**4**	3	**6**
	Cold spells	2	2	**4**	1	**2**	1	**2**

Table 4-5. Example vulnerability summary for water supply components

		CURRENT EXPOSURE				FUTURE EXPOSURE (worst case)			
SENSITIVITY		0	1	2	3	0	1	2	3
	0	Average wind speed Sea water temperature Soil salinity				Average wind speed Sea water temperature Soil salinity			
	1	Ocean acidity, pH and salinity Dust storms	Air quality Soil erosion			Ocean acidity, pH and salinity Dust storms		Air quality Soil erosion	
	2	Annual / seasonal / monthly average rainfall	Aridity Fresh water temperature	Annual / seasonal / monthly average (air) temperature Extreme temperature occurrences (including heat waves) Cold spells Freeze-thaw damage			Cold spells Freeze-thaw damage	Annual / seasonal / monthly average rainfall Aridity Fresh water temperature	Annual / seasonal / monthly average (air) temperature Extreme temperature occurrences (including heat waves)
	3	Avalanche Melting permafrost All Coastal Hazards Saline intrusion	River flooding Earthquake Fresh water quality	Maximum wind speed / Storms (tracks and intensity) Extreme rainfall (frequency and magnitude) Drought Wild Fire Ice flows in rivers Ground Instability / landslides		Avalanche Melting permafrost All Coastal Hazards Saline intrusion	Ice flows in rivers Earthquake	Maximum wind speed / Storms (tracks and intensity) Ground Instability / landslides Fresh water quality	Extreme rainfall (frequency and magnitude) River flooding Drought Wild Fire

4.4 Module 4: Risk assessment (phase 2)

4.4.1 What is the risk assessment?

The climate risk assessment should only be carried out for climate hazards with a high or medium vulnerability. Each of these climate risks should be assessed in terms of likelihood (probability of occurrence) and impact (severity of the consequence if the climate hazard were to occur). **The vulnerability assessment is based on <u>the type of investment</u>. This risk assessment is for <u>the proposed project over the lifetime of the project</u>.** At this stage we are considering the likelihood of the particular impact of the hazard e.g., the likelihood and consequence of a wastewater treatment plant becoming inundated by floodwater resulting in a major pollution incident. The Risk Assessment should be informed by specific studies developed for the project (e.g., hydrological, hydrogeological, geological).

This greater level of scrutiny as part of a risk assessment includes for example longer 'cause-effect' chains linking climate hazards to the performance of the project. It should consider all the project components identified as at risk. It should cover all aspects of the project for example, technical, environmental, social and financial aspects. It is quite possible that the risk assessment will highlight issues which have not previously been identified through the vulnerability assessment.

The project promoter or beneficiary must define the level of acceptable risk[14]. Defining this is critical as it sets the scene for the scale of adaptation measures. All risks must be managed to an acceptable level[15] with the climate proofing documentation used to demonstrate this. Some acceptable risks may be already defined in construction standards and so would be inbuilt into the project. The level of acceptable risk can vary by climate hazard and can be either quantified over a range of climate change projections or scenarios or described in a qualitative manner. The selection should be proportionate to the risk itself. The Managing Authority must verify that the definition of acceptable risk is robust and appropriate.

The climate change risk assessment can be based on either qualitative or quantitative assessment. The approach should reflect the level of vulnerability of the project and uncertainty in the climate impact data. If impacts are highly uncertain and cannot be effectively modelled without crude assumptions a quantitative assessment may imply greater precision than is possible.

Project components and climate hazards can be grouped together for the risk assessment where the impacts, in-built resilience of the component or approach to mitigation would be similar. This helps in developing a useful, concise and meaningful climate proofing document.

In the detailed assessment the selection of pathway and scenarios has some implications on the climate proofing tasks:

- Using the high SSP 3-7.0 (or RCP 8.5) pathway may not require any stress testing analysis. It would be appropriate for investments with a high capital cost, or those where a precautionary (or assumptive) approach is justified. This may however result in over-adaptation.

[14] Refer to section 3.3.2.4 of the EC Climate Proofing Technical Guidance.
[15] Refer to section 3.3.2.5 of the EC Climate Proofing Technical Guidance.

- Using the lower SSP 2-4.5 (or RCP 4.5) pathway is more suitable for investments which have multiple viable adaptive pathways to a range of different future climate projections or scenarios. This means that the current investment is suited to a more certain climate pathway over a shorter term, and future adaptations can be designed with the latest climate projections at the time of the adaptation. More work on stress-testing the investment to a range of possible futures is required if a lower pathway is selected.
- For some projects it is worthwhile understanding the medium and long-term resilience of the infrastructure. For example, only the SSP 2-4.5 (or RCP 4.5) pathway may be required for assessing risk over the next 30 or 50 years as all pathways follow a similar trajectory in the AR6 impacts. Then to assess longer term resilience it may be necessary to assess the project against a broader range of climate pathways as recommended by the EC Climate Proofing Technical Guidance (SSP 3-7.0 or RCP 8.5) because after 2050 the impacts start to diverge as shown in Figure 2-1.

Further Guidance: Inbuilt resilience to climate hazards to water availability or receiving waterbodies

At the outset of the detailed risk assessment stage, it is worth understanding the inbuilt resilience to climate change of vulnerable project components and interdependencies.

For water and wastewater projects detailed modelling of water sources and receiving water bodies for discharges would be expected. This modelling should include sensitivity tests for changes in water resources and also changes in the flow regime of receiving water bodies. The findings of this analysis should determine whether the project has inbuilt resilience to climate change for these climate hazards.

The design of the water and wastewater system to accommodate future change in water supply and receiving water body flow regime should be considered as inbuilt resilience and not a climate adaptation measure.

Site specific risk assessments (e.g., flood risk, landslide risk) for key infrastructure, such as wastewater treatment plants, would also be carried out as part of the project feasibility study and used to inform the project design. For example, flood risk analysis would use readily available flood hazard data from the 1st or 2nd cycle Floods Directive and in some cases may also be informed by site specific detailed hydrological and hydraulic modelling of the baseline and with-project scenario. The analysis will also have determined an appropriate safety factor (freeboard). The design standard and safety factor requirements for the proposed infrastructure may be set by national legislation and guidance. The risk assessment should be used to determine if the proposed project has inbuilt resilience to these climate hazards.

The siting of key infrastructure and project components outside of hazard zones should be considered as inbuilt resilience to climate hazards and not a climate adaptation measure.

If the risk is acceptable, then the project has sufficient inbuilt resilience to the specific future climate hazard it is intended to manage.

The adaptation measure modules 5 to 7 describe the decision-making process for what to do if the project does not have sufficient inbuilt resilience to climate change.

Unlike the exposure assessment, the risk assessment should assume the project is in place.

The inbuilt resilience to other climate hazards, should be determined through an understanding of the design of project components vulnerable to these hazards.

4.4.2 Module 4: Probability or Likelihood

The EC Climate Proofing Technical Guidance presents suggested qualitative and quantitative scales for scoring the probability or likelihood of the risk occurring. The terms probability and likelihood are interchangeable. These are the same as the previous JASPERS CCVRA guidance for the 2014-2020 programming period and presented in Figure 4-8, with extra recommendations for assigning scores based on hazard and risk mapping (such as the EU Floods Directive Flood Hazard and Risk Maps produced by Member States). The method, scale, data and approach used must be explained in the climate proofing documentation. The probability score is that of the occurrence of the climate hazard that would impact the project.

Almost certain (score 5)

- Incident if very likely to occur, possible several times.
- 95% chance of occuring (over lifetime of project).
- Project component is shown as exposed in high probability hazard and risk maps (e.g. present day or future 10% AEP flood hazard map).

Likely (score 4)

- Incident is likely to occur.
- 80% chance of occuring (over lifetime of project).
- Project component is shown as exposed in medium probability hazard and risk maps (e.g. 2% AEP present day or future flood hazard map).

Possible (score 3)

- Incident has occured in a similar country / setting.
- 50% chance of occuring (over lifetime of project).
- Project component is shown as exposed in medium probability hazard and risk maps (e.g. 1% AEP present day or future flood hazard map).

Unlikely (score 2)

- Given current practices and procedures, this incident is unlikely to occur.
- 20% chance of occuring (over lifetime of project).
- Project component is shown as exposed in low probability hazard and risk maps (e.g. 0.1% AEP present day or future flood hazard map).

Rare (score 1)

- Highly likely to occur.
- 5% change of occuring (over lifetime of project).
- Project component is not shown as exposed in any climate hazard or risk map (e.g. less than 0.1% AEP change of flooding).

Figure 4-8. Suggested likelihood or probability criteria and scores (from the 2014-2020 programming period JASPERS CCVRA guidance and EC Climate Proofing Technical Guidance).

4.4.3 Module 4: Severity, consequence, or magnitude

The severity, consequence or magnitude of an impact is also scored. Table 4-6 presents a suggestion for scoring the severity of the risk. The scores should account for how well the project can cope with the impact and what level of risk is tolerable. The method, scale, data and approach used must be explained in the climate proofing documentation.

The EC Climate Proofing Technical Guidance requires scoring of the severity of an impact from each climate hazard by risk area. The process is replicated with an overall climate hazard overall severity taken from across the risk areas. There is no set requirement to use all of these risk areas, and the overall severity can be based on a method that the project promoter deems appropriate. The method, classes and scores must be documented. The previous 2014-2020 programming period JASPERS CCVRA guidance only covered the engineering, asset and operational impact. The Non-paper Guidelines do include the following aspects recommended in the EC Climate Proofing Technical Guidance, and so this is not a new requirement.

Table 4-6. Example suggestion for indicators to score the impact of climate hazards on different risk areas to a project (taken from EC Climate Proofing Technical Guidance)

	Magnitude of consequence				
Risk areas	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
Asset damage / Engineering / Operational	Impact can be absorbed through normal activity	An adverse event that can be absorbed by taking business continuity actions	A serious event that requires additional emergency business continuity actions	A critical event that requires extraordinary / emergency business continuity actions	Disaster with the potential to lead to shut down or collapse or loss of the asset / network
Safety and Health	First aid case	Minor injury, medical treatment	Serious injury or lost work	Major or multiple injuries, permanent injury or disability	Single or multiple fatalities
Environment	No impact on baseline environment. Localised in the source area. No recovery required	Localised within site boundaries. Recovery measurable within one month of impact	Moderate harm with possible wider effect. Recovery in one year	Significant harm with local effect. Recovery longer than one year. Failure to comply with environmental regulations / consent	Significant harm with widespread effect. Recovery longer than one year. Limited prospect of full recovery
Social	No negative social impact	Localised, temporary social impacts	Localised, long-term social impacts	Failure to protect poor or vulnerable groups*. National, long-term social impacts	Loss of social licence to operate. Community protests
Financial (for single extreme event or annual average impact)**	x % IRR(***) < 2% of turnover	x % IRR 2-10% of turnover	x % IRR 10-25% of turnover	x % IRR 25-50% of turnover	x % IRR > 50% of turnover
Reputation	Localised, temporary impact on public opinion	Localised, short-term impact on public opinion	Local, long-term impact on public opinion with adverse local media coverage	National, short-term impact on public opinion; negative national media coverage	National, long-term impact with potential to affect the stability of the government

	Magnitude of consequence				
Risk areas	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
Cultural Heritage and cultural premises	Insignificant impact	Short term impact. Possible recovery or repair.	Serious damage with wider impact to tourism industry	Significant damage with national and international impact	Permanent loss with resulting impact on society
The ratings and values suggested here are illustrative. The project promoter and climate-proofing manager may choose to modify them. (*): Including groups that depend on natural resources for their income/livelihoods and cultural heritage (even if not considered poor) and groups considered poor and vulnerable (and often that have less capacity to adapt) as well as persons with disabilities and older persons. (**): Example indicators – other indicators that may be used including costs of: immediate / long-term emergency measures; restoration of assets; environmental restoration; indirect costs on the economy, indirect social costs. (***): Internal Rate of Return (IRR).					

4.4.4 Module 4: Risk Assessment

The methodology applied, datasets used and definitions for each classification for likelihood, impact and risk must be documented. A suggested matrix for the risk assessment is presented in the EC Climate Proofing Technical Guidance, with suggested calculation method described below. This can be adapted to suit project specifics, but clear reasoning and the methodology must be documented.

Again, for aspects of a project or climate impacts that are highly uncertain, further analysis may be warranted. This should be proportionate to the scale of any adaption, mitigation or change in design. For uncertainties which do not have a significant influence on project design or adaptive capacity it is not necessary for further analysis. The uncertainty should be noted and captured in the monitoring programme.

For some projects it may be appropriate for the impact analysis in phase 2 to include additional risk assessment(s) for the potential of an investment to impact upon on water resources or receiving waterbodies used by other communities, settlements and ecosystems within the zone of influence of a project.

		Probability score				
		1	2	3	4	5
Severity score	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

Risk = Likelihood score x Severity score

Extreme Risk (score ≥20)

- Mitigation measures to major risks must be considered for the project.

High Risk (score ≥12)

- Mitigation measures to major risks should be considered for the project.

Medium Risk (score ≥8)

- Mitigation measures to major risks should be considered for the project. Monitoring of these risks may be sufficient.

Low Risk (score ≥4)

- Monitoring of these risks should be part of the project adaptation plan.

Negligable Risk (score ≤3)

- No adaptation plan for these risks is likely to be necessary.

Figure 4-9. Risk scoring approach (top: score formula, left: score matrix, right: score description and implication)

Each risk mapped on the matrix should be accompanied with a textual description to substantiate and validate the assessment. A description of the climate hazard and project components that relate to each risk should be included. In some projects it will be important to differentiate the risk from the same climate hazard to different project components (e.g., landslide risk to treatment plant 1, treatment plant 2, the supply network and on interdependencies of the project as a whole). **For the risk classes, it is important to also detail what the implications of a high/medium/low classification is (e.g., high risk must have mitigation measures, moderate risk must be monitored, or similar). This should reflect the level of acceptable risk to the project promoter. This is so that the climate adaptation measures are proportionate and prioritise the biggest risks.** Suggested sub-headings could for each higher risk climate hazard include:

- Assessment of vulnerability – taken from the vulnerability assessment
- Climate-related critical thresholds and impacts – defines the levels of probability and consequence that are critical for that risk;
- Interactions – implications for wider community and impacts from other elements e.g., wider transport or power disruption;
- Probability – scored on the basis of pre-defined thresholds;
- Consequence – scored on the basis of pre-defined thresholds;
- Risk rating – probability score multiplied by consequence score to give overall risk score;
- Management of risk – adaptation measure approach to be adopted;
- Residual risk – risk rating after implementation of the adaptation measures

Table 4-7. Example risk assessment table.

		Probability score				
		1	2	3	4	5
Severity score	1					
	2	Land instability / landslide	Extreme precipitation		Soil erosion Floods	
	3	Freeze thaw	Extreme temperature / heat waves	Fire		
	4			Water availability / drought		
	5					

4.5 Modules 5 to 7: Adaptation measures (phase 2)

4.5.1 Module 5: Adaptation options

By considering climate mitigation and resilience at the outset of the strategy and feasibility study stages, the decision to select the proposed project should meet the minimum requirements and should have embedded as many climate resilient aspects as possible. This does not mean the most climate resilient, project option will have been selected to proceed as other objectives and priorities need to be balanced. The climate proofing process should identify residual climate impacts and the potential for future adaptation.

The first task is to determine the level of risk that can be tolerated. This should be informed by the identification of thresholds and limits in the vulnerability and risk analysis stages.

A high-level strategic decision on the best approach to managing the climate risk should be made. The Non-Paper Guidelines and CCVRA process for the 2014-2020 programming period recommended five strategic options, which remain appropriate. Further guidance is provided below for possible adaptation strategies for each risk identified.

An adaptation plan should be produced for all medium, high and extreme risks (i.e. the outcome of the climate proofing resilience risk assessment). This should include:

- **Systematic assessment of the suitability and viability of measures in the adaptation plan. For each risk this must cover:**
    - **How adaptation measures achieve an acceptable level of risk.**
    - **A clear presentation and reasoning on whether a low regret, or flexible/adaptive approach is more appropriate. This can be presented in the form of a decision**

tree that covers a range of projections or scenarios over the lifetime of the project.

- **If flexible or adaptive adaptation strategies are recommended the threshold and timescales for implementation of these must be specified.**

- **A statement on the stage of the project life cycle for implementation of the identified adaptation measures. This should include a timetable for implementation so that it is clear which measures are to be included within the project investment, and which should be implemented in the future in response to the outcomes of monitoring and the necessary lead time to complete such measures.**

Further Guidance: Approach to adaptation options

The Non-Paper Guidelines include further guidance on how to approach and undertake the identification of adaptation options.

- **Accept the risk** – conscious decision that no action is needed either because existing processes/systems are sufficient to manage the risk or assets not worth sustaining given the potential impacts.
- **Share the risk** – offsetting risks by sharing (e.g. via insurance or working in partnership with others)
- **Avoid the risk** – physically moving the project to avoid or reduce risk likelihood (e.g. moving location out of the floodplain)
- **Reduce the risk** – introducing measures to reduce the consequences of the risks occurring (e.g. flood defences, evacuation plans, passive cooling, etc.)
- **Exploiting positive opportunities** – introducing new activities, practices or behaviours to take advantage of a changing climate (e.g. building opportunities for outdoor recreation into flood management solutions – outdoor recreation likely to be more popular with higher temperatures)

Further Guidance: Types of Adaptation (from IPCC SR15 Annex I Glossary)

The IPCC AR6 glossary provides some further elaboration on the type of adaptation options, and the limits to adaptation that should be considered.

- **Incremental adaptation**
  Adaptation that maintains the essence and integrity of a system or process at a given scale. In some cases, incremental adaptation can accrue to result in transformational adaptation.
- **Transformational adaptation**
  Adaptation that changes the fundamental attributes of a socioecological system in anticipation of climate change and its impacts.
- **Adaptation limits**
  The point at which an actor’s objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.
  - ***Hard adaptation limit:*** No adaptive actions are possible to avoid intolerable risks.
  - ***Soft adaptation limit:*** Options are currently not available to avoid intolerable risks through adaptive action.

Further Guidance: Adaptive, Assumptive and Reactive Approaches for Climate Driven Projects

The following are types of measures which perform well under conditions of uncertainty. *Definitions adapted from: European Commission (2011). Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient.*

Nature-based Solutions (NbS): these are approaches that use natural processes and materials to manage risks. They establish using natural processes over time, are inherently adaptable, and so can make investments more climate resilient and can prolong life of an asset. The concept is new and the performance of NbS is less certain, so despite always having a positive benefit, do have limitations.

No regret options: measures that are worthwhile now (in that they would deliver net socio-economic benefits which exceed their costs) and continue to be worthwhile irrespective of the nature of future climate. Such measures will, as a rule, be cost neutral. It is important to understand why no regret options have not already been undertaken as an adaptation strategy could help address the existing constraints and barriers to implementation.

Low regret options: measures for which the associated costs are relatively low and for which, bearing in mind the uncertainties with future climate change, the benefits under future climate change may potentially be large.

Flexible or adaptive management options: these involve implementing incremental adaptation rather than undertaking large-scale adaptation option at high cost in one go. This means that measures should be designed so that they make sense today, but allow for incremental change as more information becomes available. For example, a viable approach to ensure that the appropriate level of resilience will be reached at a relevant time frame in the future may include delaying measures while exploring options and working with other stakeholders to find the most appropriate solutions . The monitoring and systemic appraisal phases should be used to inform performance of options, and adjust options if necessary. Alternative option paths should be documented early on, so that the specific project design and the implementation strategy can still be adjusted and changes be brought forward later on in the adaptive management stages.

Robust adaptation options: Adaptation measures based on a flexible approach that do not preclude adaptive steps at a later stage; options that perform well though not necessarily optimally.

Win-win options: measures that have the desired results in terms of minimising the climate risks or exploiting potential opportunities, but also have other social, economic or environmental benefits. This can include measures that are introduced primarily for reasons other than climate change but also deliver desired adaptation benefits. For instance, this could be introduction of measures to improve water efficiency in agriculture, industry or buildings.

Insurance and other financial investments: Climate change risk cover through financial instruments is an alternative and/or supplement to that from investments in real assets. They may prove less robust over time as risk cover from financial intermediaries may become very expensive or not be offered at all.

Soft (non-structural) measures: Measures such as reallocation of resources, behavioural change, changes to operation of a facility (e.g. changing operating rules for a hydropower plant) and might lead to real improvement in levels of resilience or adaptability by itself or in combination with other measures. Another example is land use planning to ensure that exposure in risk areas does not increase, or to ensure forestry activities, for example, are carried out in a sensitive manner and do not increase risk.

In addition to these approaches, there are some situations where an assumptive approach can be justified.

Assumptive options: Where projects are designed to a future climate projection or scenario. To avoid maladaptation and high regret investments, these would typically be:

- High value investments where the additional cost of building to a future design standard is not significantly higher than designing the present-day conditions.
- Projects which include a significant freeboard, safety factor or headroom in the design, which is substantially greater than the increase in design levels from climate change (i.e. climate change is small). This could also be where the risk is significant and a high degree of projection is justified (e.g. flood protection to a nuclear power station).
- Where there is a high degree of confidence in the future climate projection or pathway.
- Where few or no adaptive pathways are viable (see Decision Tree section).

Build back better: Is where recovery and reconstruction is planned in a way that ensures a more resilient and sustainable conditions for future communities. Disaster risk management plans should be in place so that effective and planned emergency response actions can be taken to reduce the risk to life and enable quick recovery.

Further Guidance: Green approaches to climate resilience

A catalogue of measures approach can be taken to ensure that green approaches to climate resilience are properly considered. The benefit of a catalogue is that it can contain in one place details of typical impacts, actions or mitigation to make an asset more climate resilient and also to prolong life of an asset.

Examples of green approaches which are more adaptive to changes in conditions are:

if main climate risks in water and wastewater is soil erosion, planting root stabilising plants in riparian /runoff zones, management of agricultural land and crop cover, leaky barriers, design of swales or treatment wetlands in wastewater outlets, may all be adaptive green solutions. Examples of design considerations to make an investment greener and more adaptable to climate change:

- Green bank protection around treatment plants, pipe crossings, inlets and outlets. Inherently more adaptable to changes in river flows and water level fluctuation.
- Wetland restoration and creation to create an ecosystem that can adapt to change for outlets and discharge points.
- Upstream catchment management to treat water at source.
- Green buffer zones to reduce erosion.
- For localised flood protection measures around key water and wastewater infrastructure
- Design to exceed, with overflow channels, which will reduce the likelihood of defence failure.
- Design to not exceed to reduce failure as overtopping.
- Robust drainage and ancillary features.
- Measures to also reduce water levels and frequency of operation. This may include upstream attenuation.

Further Guidance: Libraries and catalogues for measures to improve adaptive capacity

The EU Climate-ADAPT website is a portal with substantial case studies and background information to identify relevant and recent options for adapting to climate change in different sectors. The searchable website allows project teams to identify the most relevant case studies https://climate-adapt.eea.europa.eu/.

Catalogue of Measures approaches such as those used in River Basin Management Plans and Flood Risk Management Plans set out useful typologies of measures to address certain types of flood risk or water quality problems. These catalogues can also include details such as the adaptive capacity of a typical instance of a measure.

Some examples of alternatives and climate resilience measures for climate change adaptation in water/wastewater projects are presented in Table 4-8. The alternatives should have been considered early in the strategy before project objectives are set because these require full consideration of project location.

Table 4-8. Examples of alternatives and adaptation measures for climate change adaptation (adapted from EC Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment)

Type of impact	Alternatives	Adaptation measures
Heat waves	It is unlikely that infrastructure can be located away from exposed locations.	Ensure that the proposed project is protected from heat exhaustion (e.g., through shading). Encourage design optimal for environmental performance and shading. Reduce thermal storage in a proposed project (e.g., by using different materials and colouring).
Droughts	Many of the alternatives could also supplement the proposed project to reduce demand or capacity requirements, Consider alternative water sources. Consider back-up water sources. Consider if alternative discharge points need to be considered for example reduced river or groundwater levels could alter discharge requirements (e.g., need for greater water treatment due to reduced flow in receiving waterbodies). Water use reduction strategies and policies can be both alternatives and mitigation for adapting to water scarcity. Introduce technologies and methods for capturing storm water for re-use.	Ensure that the proposed project is protected from the effects of droughts.
Wildfire / fires	Consider less exposed locations for sensitive project components.	Use fire-resistant construction materials. Create a fire-adapted space around the project (e.g., use fire-resistant plants).
Extreme rainfall, river flooding and flash floods	Consider less exposed locations or routes for sensitive project components.	Consider changes in construction design that allow for rising water levels and ground water levels (e.g., build on pillars, anchoring of pipelines, surround any flood-vulnerable or flood-critical infrastructure with flood barriers that use the lifting power of approaching floodwater to automatically rise, set up backwater valves in drainage-related systems to protect interiors from flooding caused by backflow of wastewater, etc.). Flood resilient design of facilities, to withstand flood risk. Improve the project's drainage. Potentially through Sustainable Drainage Systems as a Nature-based Solution. Incorporate flood risk management measures and infrastructure into the project.
Storms / high wind	Consider less exposed locations for sensitive project components.	Construction standards should ensure inbuilt resilience by default.

Type of impact	Alternatives	Adaptation measures
Landslides	Consider less exposed locations for sensitive project components.	Protect surfaces and control surface erosion (e.g., by quickly establishing vegetation — hydroseeding, turfing, trees). Can include Nature-based Solutions (NbS) and catchment management. Put in place designs that control erosion (e.g., appropriate drainage channels and culverts).
Rising sea levels	Consider less exposed locations for sensitive project components.	Consider changes in construction design to be resilient to rising sea levels. Incorporate coastal flood and erosion protection measures and infrastructure into the project.
Cold spells and snow	Consider less exposed locations for sensitive project components.	Ensure that the project is protected from cold spells and snow (e.g., deeper pipework).
Freeze-thaw damage	It is unlikely that infrastructure can be located away from exposed locations.	Ensure that the project (e.g., key infrastructure) is able to prevent moisture from entering the structure (e.g., by using different materials or engineering practices).

4.5.2 Appraisal of adaptation options

Understanding residual risk is key to the appraisal of adaptation options. In EIA and Appropriate Assessment, the concept of residual risk is well established. These principles of revisiting the impact assessment with adaptation options in place, together with economic appraisal techniques such as MCA and CBA can be used to confirm the viability, and if necessary, the selection, of the most appropriate adaptation options. It is not always necessary to select a preferred climate adaptation measure. The outcome should be to identify which adaptation options can reduce the risk to the acceptable level.

The appraisal should also identify the measures to enable future adaptation that should be in-built into the proposed project design (e.g., use of materials in wastewater treatment plants that are resilient to extreme temperature and moisture).

4.5.3 Adaptation planning

Where climate resilience measures are to be incorporated into the project investment, these must be included in the project description and if required subject to the relevant environmental impact assessments (EIAs). The project costs should reflect the cost of climate change adaptation measures to be implemented as part of the investment. The costs of in-built climate resilience are not required to be stated. Future adaptation costs may not need to be included, subject to national guidelines and legislation.

An adaptive approach to managing climate risk must have a monitoring programme with clear responsibilities assigned to stakeholders, owners and authorities responsible for operating the infrastructure. Monitoring should be considered as an essential climate resilience measure for all projects and especially for projects where an adaptive pathway has been chosen. The monitoring programmes should set out the following:

- Clear thresholds for each hazard that would trigger the implementation of additional measures;

- The frequency of review of the climate proofing documentation to capture the evolving conditions with climate change;
- How the project is performing and operating; and
- The condition and maintenance of the project investment and to help identify if decisions in relation to future adaptation need to be made.

Monitoring is also important if the adaptation decision is to accept an increase in risk to a community or to infrastructure. In this situation the monitoring keeps the level of acceptable risk under review.

Good Practice – Information on climate resilience measures to include in the climate proofing documentation

It is good practice to document the following in the climate proofing documentation and for information to be consistent across all project documentation.

- Description of climate adaptation or resilience measures to be inbuilt into the project.
- Cost of adaptation measure to be implemented as part of the project investment: this needs to be identified and built into the CBA analysis.
- Potential costs of inaction: costs that project developers could face if the risks were realised and no adaptation measures had been incorporated. This may be challenging to estimate, but such an estimate can be used to justify climate resilience and adaptation measures, or to confirm if any remaining residual risks are acceptable. The focus of any costs should be for expensive adaption and resilience measures, and for the highest risk hazards which are not proposed to be mitigated.
- Description of possible future adaptation measures for the proposed project.
- Risk owners: Identify who will be responsible for managing this risk and implementing future adaptation, including owner and responsibilities for monitoring (this could be different organisations).
- Residual risks that will remain after all resilience and adaptation measures are considered. These residual risks should be a focus for monitoring of climate hazards and impacts to the project.

Table 4-9. Example risk assessment matrices with mitigation measures for a typical water and wastewater project (land instability/landslide, extreme precipitation, flood and soil erosion hazards)

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Land Instability / landslides**
Vulnerability	**High**
Description of component and inbuilt resilience	Two surface water abstraction point from different rivers. One groundwater abstraction point. Water resource modelling confirms that abstraction of the required volume across all three water sources for on average 300 days per year, reducing to 275 days per year by 2052 and potentially in the worst case to 200 days per year by 2092. The required volume includes for a 5% increase in the serviced population, which is in line with projected population increase to 2070. The environmental flow limit which sets the threshold for the abstraction assumes no increase on agricultural abstraction of river or groundwater within the catchments. Four wastewater treatment plants are proposed, each discharging to river waterbodies. The rivers all have sufficient low flow in the 2092 climate change scenario to accommodate the maximum discharge rate without any water quality degradation or impacts. Two of the wastewater treatment plants are located above the 0.1% AEP with climate change flood level and access is not constrained to these. The other two wastewater treatment plants cannot be located outside of future flood risk areas and are both exposed to the 1% AEP with climate change flood hazard with flood water up to 1m deep. These are located within 10m of the riverbank.
Probability of the hazard affecting the project.	1 Rare All project components are located outside of torrent and landslide hazard zones.
Consequences if the hazard occurs.	2 Minor Will result in deposition of debris and sediment that will require removal for the flood defence to continue to operate. No structural instability likely.
Risk Score	2 Negligible risk
Adaptation strategies	Accept risk. Monitor climate change impacts.
Residual risk score	2 Negligible risk
Adaptation Owner	Asset owner / Beneficiary National climate authority
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	N/A - Inspection and monitoring costs included in the ongoing maintenance. Climate monitoring included in responsibilities of relevant authorities.

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Extreme precipitation**
Vulnerability	**High**
Description of component and inbuilt resilience	Two surface water abstraction point from different rivers. One groundwater abstraction point. Water resource modelling confirms that abstraction of the required volume across all three water sources for on average 300 days per year, reducing to 275 days per year by 2052 and potentially in the worst case to 200 days per year by 2092. The required volume includes for a 5% increase in the serviced population, which is in line with projected population increase to 2070. The environmental flow limit which sets the threshold for the abstraction assumes no increase on agricultural abstraction of river or groundwater within the catchments. Four wastewater treatment plants are proposed, each discharging to river waterbodies. The rivers all have sufficient low flow in the 2092 climate change scenario to accommodate the maximum discharge rate without any water quality degradation or impacts. Two of the wastewater treatment plants are located above the 0.1% AEP with climate change flood level and access is not constrained to these. The other two wastewater treatment plants cannot be located outside of future flood risk areas and are both exposed to the 1% AEP with climate change flood hazard with flood water up to 1m deep. These are located within 10m of the river bank.
Probability of the hazard affecting the project.	2 Unlikely Extreme rainfall is likely to occur during the project lifetime, however the storm water drainage network for each component has been designed to protect from the consequences of extreme rainfall.
Consequences if the hazard occurs.	2 Minor Infrastructure is designed with associated measures to avoid extreme rainfall from damaging the flood defence embankment. Any damage that would occur from rainfall intensity greater than the design standard could be repaired within weeks of the event, and would unlikely result in failure of the embankment during a flood event.
Risk Score	4 Low risk
Adaptation strategies	Accept risk. Monitor climate change and impacts. Future adaptation is possible. Drainage network can be expanded in the future to increase storage capacity.
Residual risk score	4 Low risk
Adaptation Owner	Asset owner / Beneficiary. National climate authority
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	N/A - Inspection and monitoring costs included in the ongoing maintenance.

Component	Water Sources & Wastewater Treatment Plants	
Climate Hazards	**Floods**	**Soil erosion**
Vulnerability	**Medium**	**High**
Description of component and inbuilt resilience	Two surface water abstraction point from different rivers. One groundwater abstraction point. Water resource modelling confirms that abstraction of the required volume across all three water sources for on average 300 days per year, reducing to 275 days per year by 2052 and potentially in the worst case to 200 days per year by 2092. The required volume includes for a 5% increase in the serviced population, which is in line with projected population increase to 2070. The environmental flow limit which sets the threshold for the abstraction assumes no increase on agricultural abstraction of river or groundwater within the catchments. Four wastewater treatment plants are proposed, each discharging to river waterbodies. The rivers all have sufficient low flow in the 2092 climate change scenario to accommodate the maximum discharge rate without any water quality degradation or impacts. Two of the wastewater treatment plants are located above the 0.1% AEP with climate change flood level and access is not constrained to these. The other two wastewater treatment plants cannot be located outside of future flood risk areas and are both exposed to the 1% AEP with climate change flood hazard with flood water up to 1m deep. These are located within 10m of the river bank.	
Probability of the hazard affecting the project.	4 Likely Flooding of two wastewater treatment plants is likely to occur.	4 Likely Erosion of the river bank is likely to impact on two wastewater treatment plants and the river water abstraction inlets.
Consequences if the hazard occurs.	2 Minor Local repairs to inlet structures at abstraction points is possible through standard inspection and maintenance works.	2 Minor Local repairs to inlet structures at abstraction points is possible through standard inspection and maintenance works.
	5 Catastrophic Significant flood damage to the waste water treatment plants could occur with associated pollution of watercourses, and long repair times leading to insufficient capacity for wastewater treatment.	5 Catastrophic Significant flood damage to the waste water treatment plants could occur with associated pollution of watercourses, and long repair times leading to insufficient capacity for wastewater treatment.
Risk Score	8 Medium risk (river water source abstraction inlet structures)	8 Medium risk (river water source abstraction inlet structures)
	20 Extreme (2 wastewater treatment plants in flood hazard zones)	20 Extreme (2 wastewater treatment plants in flood hazard zones)
Adaptation strategies	Reduce risk. An assumptive (precautionary) approach to protecting infrastructure now, against future climate hazard, should be taken. This is due to the potential pollution of watercourses and impact on the availability of wastewater treatment capacity. River abstraction inlet points and river banks adjacent to the wastewater treatment plants should be protected through bank protection measures following Nature-based Solution principles. Wastewater treatment plants exposed to flooding should be protected by raised flood defences. Compensatory storage for displaced flood volume should be sought on the opposite river bank in the form of floodplain reconnection and wetland creation.	
Residual risk score	5 low risk (flood and erosion control measures reduce the likelihood to 1 Rare)	
Adaptation Owner	Asset owner / Beneficiary. Municipality to secure land on opposite bank for floodplain reconnection and wetland creation.	
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	€ 500,000 for raised flood protection around each wastewater treatment plant. € 350,000 natural bank protection.€ 500,000 floodplain reconnection and wetland creation	

Table 4-10. Example risk assessment matrices with mitigation measures for a typical water and wastewater project (freeze-thaw, water availability/drought, extreme temperature/heat wave and fire hazards)

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Freeze-thaw**
Vulnerability	**Medium**
Probability of the hazard affecting the project.	1 Rare Project infrastructure is designed using materials and site layout to reduce the likelihood of freeze-thaw action causing an impact on project operation. Exposure to the hazard is expected to decrease with climate change.
Consequences if the hazard occurs.	3 Moderate Damage to infrastructure can be repaired within days. Could result in pollution of watercourses, subject to location of damage.
Risk Score	3 Negligible risk
Adaptation strategies	Accept risk. Monitor climate change and condition of infrastructure.
Residual risk score	3 Negligible risk
Adaptation Owner	Asset owner / Beneficiary National climate authority
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	N/A - Inspection and monitoring costs included in the ongoing maintenance. Climate monitoring included in responsibilities of relevant authorities.

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Water availability / Drought**
Vulnerability	**High**
Probability of the hazard affecting the project.	3 Possible Detailed modelling of water resources used to develop the project confirmed that sufficient resources are likely to be available under a range of different climate scenarios. It is possible that extreme drought conditions could occur which could result in a reduction in the ability to service the full water demands.
Consequences if the hazard occurs.	4 Major Lack of water supply for abstraction would have significant impact on the wellbeing of the population served, tourism industry and potential knock-on effects on Agricultural irrigation needs.
Risk Score	12 High risk
Adaptation strategies	A package of adaptation measures is necessary. Reduce risk. Enhanced monitoring climate change and water resource availability to enable early warnings of potential water scarcity. Reduce risk. Programme for enhanced detection and repair of leaks throughout the system. Share risk. Water use awareness campaigns and best practise measures to reduce water demand for public, agriculture and local businesses. Limits to adaptation exist and will require establishment of drought management plans, which may include tankers to deliver water from other regions, and alternative water sources. Water resources modelling at the national scale confirms sufficient water resources are available in neighbouring river basins to supply the project area with the deficit in demand after other adaptation measures are implemented.
Residual risk score	6 Low risk (adaptation measures reduce the likelihood of the severe consequences)
Adaptation Owner	Asset owner / Beneficiary, Regional water authorities, Regional emergency planning authorities, National Government subsidies and grants for reducing domestic, business and agricultural water use.
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	€ 350,000 water use awareness campaign. € 50 million (water use subsidies and grants). Ongoing monitoring, inspection and leakage detection is covered in the ongoing duties of the infrastructure operator. Future transfer of water by tanker from neighbouring river basins is excluded.

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Extreme temperature / heat waves**
Vulnerability	**Medium**
Probability of the hazard affecting the project.	2 Unlikely The occurrence of extreme temperatures and heat waves will increase, however the probability of events effecting the project components is unlikely.
Consequences if the hazard occurs.	3 Moderate Increase in water consumption for cooling, which could add extra pressure on water availability. Potential for reduced water quality as a result of increased water temperature.
Risk Score	6 Low risk
Adaptation strategies	Accept risk. Monitor climate change and water resources, temperature and quality.
Residual risk score	6 Low risk
Adaptation Owner	Asset owner / Beneficiary. National climate authority
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	N/A – cost already covered in the ongoing duties of the operator and national authorities monitoring climate impacts

Component	**Water Sources & Wastewater Treatment Plants**
Climate Hazards	**Fire**
Vulnerability	**Medium**
Probability of the hazard affecting the project.	3 Possible 1 wastewater treatment plants is located in close proximity to large forest areas.
Consequences if the hazard occurs.	3 Moderate Temporary interruption to wastewater treatment processes due to loss of power, inability of staff to access facilities, or inability to deliver input materials for treatment process.
Risk Score	9 Medium risk
Adaptation strategies	Reduce risk. Ensure fire resistant materials used in the construction of storage units.
Residual risk score	6 Low Risk
Adaptation Owner	Asset owner / Beneficiary
Adaptation Cost to be included in the project investment (excl. inbuilt measures)	€ 50,000 extra costs for enhanced fireproofing of storage units and installation of extra fire hydrants.

5. INTEGRATION OF CLIMATE PROOFING INTO EIA

This section presents the links and connections between the climate proofing tasks and the project's EIA procedures. Annex D of the EC Climate Proofing Technical Guidance is a comprehensive guide on the considerations for embedding climate proofing into the EIA process. This is not replicated here. In this section we provide a summary of guiding principles for incorporating climate change considerations in EIA. This demonstrates how the climate proofing tasks can feed into the EIA process, and in turn are refined by the progression of the EIA screening, scoping and assessment. It can be used as a factsheet for project promoters and project teams.

The climate proofing looks ahead over the full life cycle of the project, but the EIA project description needs to be carefully defined. The Commission Notice regarding application of the Environmental Impact Assessment Directive (2021/C 486/01)[16] states *"Any change or extensions to projects within the meaning of point 24 of Annex I or point 13(a) of Annex II of the EIA Directive that are likely to have significant effects on the environment, shall be made subject to a requirement for a development consent."* The same applies for multi-stage projects. The best practice is to undertake the EIA process for the full project. But where impacts of future stages cannot yet be understood or assessed the EIA procedure should be for "principal decision", which is defined as the stage which sets the parameters (i.e. the limits, thresholds, maximum scale, etc.) for other implementing decisions in the future. The principal decision would not be amended in the future. Given that if future climate adaptations are not likely to occur until at least 20 years into the future the principal decision approach is not likely:

- If it is justified to take an assumptive approach and design the project to protect or have in-built resilience to future climatic conditions all works are to be included in the EIA project description and subject to EIA procedures.
- If the justification of a project now is inextricably linked to a future adaptation to be justified then the future adaptation must be part of the project description and the EIA procedure. This situation is unlikely as it would raise concerns about the viability of the investment if it is justified on the basis of an uncertain climate future. It would imply the project is not required yet.
- Any in-built measures to facilitate future adaptation (e.g., stronger foundations) are to be included in the project description. The actual future adaptation (e.g., to raise flood defences, refurbishment to extend the proposed useful life of infrastructure, change reservoir operating rules or increased operating capacity of infrastructure) may require an EIA procedure in the future.
- Securing land for future adaptation (e.g., reserving land for future extension of flood defences or expansion of water treatment plants) is not likely to be part of the proposed project. Instead, it would likely be part of a land use or development zoning plan and therefore subject to the SEA process of that plan, as appropriate. When the future expansion is proposed, as a project in the future, this should be subject to the appropriate provisions in the Revised EIA Directive as a new project.

[16] Commission notice regarding application of the Environmental Impact Assessment Directive (Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) to changes and extension of projects - Annex I.24 and Annex II.13(a), including main concepts and principles related to these 2021/C 486/01 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.C_.2021.486.01.0001.01.ENG&toc=OJ%3AC%3A2021%3A486%3AFULL

5.1 Stakeholder engagement

The consideration of current climate risks and future climate change should be integrated throughout the project development and EIA processes, and should not simply be considered as an 'add-on' to project development and appraisal. As such, stakeholder engagement can be carried out as part of the environmental procedures. For some aspects the project will require detailed stakeholder engagement to help develop a deliverable, practical and acceptable project. This would be determined by the project team and beneficiary as appropriate to the specific project.

Good Practice – Guiding Principles for Incorporating Climate Change in EIA, with Reference to Stages of the Climate Proofing Process

Incorporating climate change in EIA

- Build climate change into the assessment process at an early stage
- Tailor the climate change assessment to the context of the project

Identifying climate change issues in EIA

- Bring together all relevant stakeholders who need to be part of the decision making
- Understand how climate change and other environmental aspects interact with each other

Challenges for addressing climate change in EIA

- Consider the impact that predicted changes in climate will have on the proposed project over a long timescale and the projects resilience and ability to cope
- Consider long term-trends, with and without the proposed project
- Manage complexity and be comfortable with uncertainty

Assessing effects related to climate change in EIA

- Consider climate change at the outset
- Analyse the evolving baseline trends
- Take an integrated approach to planning and assessment, investigating relevant thresholds and limits
- Seek to avoid climate change effects from the start, before considering mitigation or compensation, and Assess alternatives that make a difference in terms of climate change
- Use ecosystem-based approaches and green infrastructure as part of project design and/or mitigation measures
- Assess climate change and biodiversity synergies and cumulative effects, which can be significant

(adapted from EC (2013) Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment)

Good Practice – Integrating the Climate Proofing and EIA processes

The table below shows how climate change can be integrated into the EIA process in parallel with climate proofing (adapted from table 12 of the EC Climate Proofing Technical Guidance).

EIA process	Key considerations
Screening (not formally part of EIA, applicable to Annex II projects)	Would implementing the project be likely to have significant effects on, or be significantly affected by, climate change issues? Is an EIA required?
Scoping (as appropriate)	What are the key climate change issues likely to be? Who are the key stakeholders and environmental authorities with an interest in climate change and how will they be involved in the EIA? What do they think are the key issues? What is the current situation relating to climate change and how is it likely to change in the future? What is the climate change policy context, what are the objectives and targets?
EIA report / Information and consultation	What methods, tools and approaches will be most helpful in understanding and assessing key climate change issues? What alternatives are there to tackle key climate change issues? How would implementing them affect climate change objectives? How can we avoid adverse effects on climate change? If we cannot, how can they be reduced or offset? How can the positive effects be maximised? How could climate change be integrated into the project (e.g., undertake climate proofing)? Have the ways of identifying climate change, managing uncertainty, etc. been clearly explained?
Decision making / Development consent	How can climate change issues be integrated into development consent and the final project?
Monitoring	How will the effects on climate change be monitored? How will the EIA-mitigation measures be monitored? How will adaptive management be evaluated?

6. PREPARATION OF CLIMATE PROOFING DOCUMENTATION

This section gives recommendations for preparing the climate proofing documentation and validation of the analysis and conclusions.

6.1 What is climate proofing documentation?

For climate mitigation, the key element of the climate proofing documentation should be the evidence-based screening decision, and where required, the consistency of the project with greenhouse gas pathways.

For climate resilience, the climate proofing documentation should include an overview of the adaptive measures, possible future pathways and monitoring for thresholds and triggers for the future adaptation of the preferred scheme.

Annex B of the EC Technical Guidance describes the expected contents of the climate proofing documentation.

Annex B.2 of the EC Climate Proofing Technical Guidance on climate proofing documentation

Indicatively, the documentation should include:

Introduction:

- Describe the infrastructure project and outline how it addresses climate change, including financial information (total investment costs, EU contribution).
- Contact details (e.g., the organisation of the project promoter)

Climate-proofing process:

- Describe the climate-proofing process from initial planning to completion, including the integration into the project development cycle and coordination with environmental assessment processes (e.g., EIA).
- Mitigation of climate change (climate neutrality):
- Describe the screening and its outcome.
- Where phase 2 (detailed analysis) is undertaken:
    - Describe the GHG emissions and compare with the thresholds for absolute and relative emissions. As applicable, describe the economic analysis and the use of the shadow cost of carbon as well as the options analysis and the integration of the principle of ‘energy efficiency first’.
    - Describe the project’s consistency with relevant EU and National Energy and Climate Plans, the EU target for emission reductions by 2030 and climate neutrality by 2050. How is the project contributing to the objectives of these plans and targets.
    - For projects with an intended lifespan beyond 2050, describe the compatibility with operation, maintenance and eventual decommissioning under circumstances of climate neutrality.
    - Provide other relevant information, for instance about the baseline for the carbon footprint (see section 3.2.2.3).

Adaptation to climate change (climate resilience):

- Describe the screening and its outcome, including adequate details of the sensitivity, exposure and vulnerability analysis.
- Where phase 2 (detailed analysis) is undertaken:
    - Describe the climate risk assessment including the likelihood and impact analysis and identified climate risks.
    - Describe how the identified climate risks are addressed by relevant adaptation measures, including the identification, appraisal, planning and implementation of these measures.

- Describe the assessment and outcome with regard to regular monitoring and follow-up for example of critical assumptions in relation to future climate change.
- Describe the project's consistency with EU and, as applicable, national, regional and local strategies and plans on the adaptation to climate change, and national or regional disaster risk management plans.

Information about the verification (where applicable):

- Describe how the verification has been undertaken.
- Describe the main findings.

Any additional relevant information:

- Any other pertinent issues required by this guidance and other applicable references.
- Describe any tasks related to climate proofing, which are deferred to a subsequent stage of the project development, for instance to be carried out by the contractor during the construction or by the asset manager during the operation.
- List of published documents (e.g., related to the EIA and other environmental assessments).
- List of key documents available with the project promoter.

6.1.1 Continuity of the standard in documentation for the 2021-2027 programming period

In the 2021-2027 programming period there will be no unified EU application form and the MSs will be free to adopt their national procedures and templates for projects approval. The climate proofing documentation should still meet the level of detail and documentation of evidence as required by the MPAF as used in the 2014-20 programming period. Clarity in presentation is important for independent verification that is required in the EC Climate Proofing Technical Guidance. The location of where in the project document this is, is dependent upon the Managing Authority requirements. Following this recommended structure may help this verification and national approval.

6.2 Verification of the climate proofing documentation

Responsibility for verification lies with the Managing Authority. Annex B.3 of the EC Climate Proofing Technical Guidance describes how the Managing Authority may wish to seek independent expert verification of the documentation.

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