Umwelt Bundesamt

German Environment Agency

9. November 2022

How to perform a robust climate risk and vulnerability assessment for EU taxonomy reporting?

Recommendations for companies

Content

Disclaimer

This publication provides recommendations on how to implement the requirements for a robust climate risk and vulnerability assessment in accordance with the Commission Delegated Regulation (EU) 2021/2178 (EU Taxonomy Climate Delegated Act) *(Update from December 2022: These requirements were specified in the Draft Commission Notice of 19 December 2022 (not legally binding). The recommendations at hand are in line with this notice.)* as legally compliant as possible. Any views expressed are the views of the authors and no official position of the German Environment Agency. The recommendations have been prepared with the utmost care including comments and advice from relevant experts on the EU Taxonomy, i.e. from the European Commission's Directorate-General for Climate Action (DG CLIMA), auditors and companies. However, in the event of any ambiguity, only the current official version as published in the official promulgation organ provided for this purpose shall apply. The given recommendations and **any legal references and information are not legally binding and do not constitute legal advice in individual cases. The publication cannot and is not intended to replace legal advice**. As such, the authors cannot give a guarantee that implementing the recommendations will result in a legally compliant climate risk and vulnerability assessment as required by the Climate Delegated Act. The use of this publication does not constitute any contractual relationship. All legal disputes arising from or in connection with this publication are subject exclusively to German law. The place of jurisdiction is the seat of the German Environment Agency.

1 Introduction

The EU Taxonomy is a classification system for "environmentally sustainable" economic activities in the EU.[1] It is based on Regulation (EU) 2020/852 (EU Taxonomy Regulation), which entered into force on June 2020 (see Box 1). The aim of the EU Taxonomy is to clearly define economic activities that contribute to the fulfilment of the objectives of the European Green Deal. Based on this classification, financial flows are to be directed. For taxonomy-aligned activities, companies will receive easier access to capital markets. It is likely that public subsidies and benefits at the EU level will be based on criteria of the EU Taxonomy as well.

The EU Taxonomy requires large listed companies operating in the EU to report on their contribution to selected environmental objectives: (1) climate change mitigation, (2) climate change adaptation, (3) the sustainable use and protection of water and marine resources, (4) the transition to a circular economy, (5) pollution prevention and control, (6) the protection and restoration of biodiversity and ecosystems.[2]

For reporting on their contribution to the goals of climate change adaptation and mitigation, companies need to carry out a "robust climate risk and vulnerability assessment" for certain economic activities listed in the Commission Delegated Regulation 2021/2139 (Climate Delegated Act), a supplement to the EU Taxonomy Regulation. The objective of such an assessment is to identify appropriate adaptation solutions that can reduce physical climate risks material to the economic activity. It is likely that such a climate risk and vulnerability assessment will also be part of the requirements for the other environmental objectives of the EU Taxonomy. This document contains recommendations for conducting a "robust climate risk and vulnerability assessment" according to the requirements of the Climate Delegated Act. The

[1] Additional background information and explanations on the EU Taxonomy: https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-taxonomy-faq_en.pdf

[2] All companies falling under EU regulations for non-financial reporting (currently the Non-Financial Reporting Directive - NFRD) have to report against the EU Taxonomy. Besides large listed companies this also includes large banks and insurance companies operating in the EU. In the future, the NFRD will be replaced by the Corporate Sustainability Reporting Directive (CSRD) as a key regulation on non-financial reporting.

focus of the recommendations lies on economic activities in the manufacturing sector. However, the general approach to climate risk and vulnerability assessments and much of the content can apply to other economic activities, even if they are not explicitly mentioned.

These recommendations are in line with the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR6) and the international standard EN ISO 14091 ("Adaptation to climate change - Guidelines on vulnerability, impacts and risk assessment"). Both provide state-of-the-art frameworks for climate risk assessments worldwide. The recommendations are also based on the experience of the authors with climate risk assessments in Germany and internationally, on the national and subnational levels. Further best practices, available guidance and state-of-the-art science for vulnerability and risk assessments and related methodologies taken into account include the Climate Impact and Risk Assessment for Germany 2021 (KWRA 2021), the UK Change Climate Risk Assessment (CCRA3), the European Environment Agency report "National climate change vulnerability and risk assessments in Europe 2018" (EEA Report No 1/2018), and the EU Technical Guidance on Climate Proofing of Infrastructures (Commission Notice 2021/C 373/01).

Box 1: Legislation on the EU Taxonomy

The legislation on the EU Taxonomy consists of the **Taxonomy Regulation** (Regulation (EU) 2020/852), which was adopted by the European Parliament and the European Council, and several Delegated Regulations, which were or will be adopted by the Commission to operationalise the Taxonomy Regulation. These Delegated Regulations include, in particular:

- The **Disclosures Delegated Act**[3] (Commission Delegated Regulation (EU) 2021/2178), which specifies the content and presentation of information to be disclosed as well as the methodology to comply with that disclosure obligation.
- The **Climate Delegated Act** (Commission Delegated Regulation (EU) 2021/2139), which contains the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation. Furthermore, this act defines so-called "do no significant harm" (DNSH) criteria for the other environmental objectives of the Taxonomy Regulation.
- The **Complementary Climate Delegated Act** (Commission Delegated Regulation (EU) 2022/1214) adds energy generation from nuclear and gas to the list of economic activities covered by the Taxonomy, including the requirements for taxonomy alignment of these activities.
- The **Environment Delegated Act** with the technical screening criteria regarding a) sustainable use and protection of water and marine resources b) the transition to a circular economy c) pollution prevention and control d) the protection and restoration of biodiversity and ecosystem. This act is currently in preparation.

Legal requirements regarding the robust climate risk and vulnerability assessment

The detailed legal requirements regarding the robust climate risk and vulnerability assessment are defined in the Climate Delegated Act (Commission Delegated Regulation (EU) 2021/2139). Unless otherwise stated, we refer to this EU Delegated Regulation when explaining the legal requirements. *(Update from December 2022: These requirements were specified in the Draft Commission Notice of 19 December 2022 (not legally binding). The recommendations at hand are in line with this notice.)*

[3] The names "Climate Delegated Act", "Disclosures Delegated Act" etc. are used by the European Commission. See https://ec.europa.eu/info/law/sustainable-finance-taxonomy-regulation-eu-2020-852/amending-and-supplementary-acts/implementing-and-delegated-acts_en (17.08.2022).

What role does climate change adaptation play in the EU Taxonomy?

Adaptation to climate change is relevant for all companies that want to achieve taxonomy alignment: adaptation can make a substantial contribution to increased climate resilience, but is also a generic requirement for the other environmental objectives.

(1) If you adapt your business to climate change, you can report associated investments (CapEx) as taxonomy-aligned under certain conditions listed in Annex II of the Climate Delegated Act. Another way to contribute to the adaptation objective is to help other companies to adapt. You can report the turnover from such enabling activities as taxonomy-aligned if you meet specified technical screening criteria. The enabling activities currently listed do not include technical screening criteria according to which they themselves need to be adapted to climate change.

(2) Even if you don't plan to make major adaptation investments or help others to adapt, climate adaptation is an important condition for reporting your business activities as taxonomy-aligned. This is due to the so-called "do no significant harm" (DNSH) criteria, which state that activities that contribute to one environmental objective – e.g. climate change mitigation – are only taxonomy-aligned if they do not significantly harm other environmental objectives, such as climate adaptation. As of yet, the DNSH criteria on climate change adaptation have been specified and adopted for the environmental objective of climate change mitigation (in the Climate Delegated Act). The draft technical screening criteria for further environmental objectives refer to these DNSH criteria as well, but are not yet adopted.[4]

Where is a robust climate risk and vulnerability assessment required?

The demonstration of a robust climate risk and vulnerability assessment is part of the

- technical screening criteria regarding the substantial contribution to climate change adaptation.
- DNSH requirements to climate change adaptation for climate change mitigation (already) and (likely in future for) all other environmental objectives (biodiversity, pollution, etc.).

As a result, it is a requirement that all economic activities must meet in order to achieve taxonomy alignment.[5] In addition to the climate risk and vulnerability assessment, companies must also demonstrate – or at least plan – adaptation solutions to reduce physical climate risks and meet the taxonomy requirements. The main similarities and differences between the DNSH requirements and the technical screening criteria regarding a substantial contribution to climate change adaptation are shown in Table 1.

In the following, no general distinction is made as to whether the robust climate risk and vulnerability assessment is used to meet the DNSH requirements or the requirements for substantial contribution to climate change adaptation. This distinction is only addressed if a different approach is required depending on the intended application.

[4] See draft technical screening criteria on "sustainable use and protection of water and marine resources", "transition to a circular economy", "pollution prevention and control", "protection and restoration of biodiversity and ecosystems". Platform on Sustainable Finance (2022a, 2022b) Part A - Methodological report March 2022, Part B – Annex: Technical Screening Criteria. March 2022.

[5] For a few enabling activities, such as "9.1. Engineering activities and related technical consultancy dedicated to adaptation to climate change", a climate risk assessment does not have to be submitted for the enabling activity itself, but for the economic activity that is supported by the enabling activity to adapt to climate change.

Table 1: Comparison of requirements for DNSH and substantial contribution to climate change adaptation

Nr.	Do no significant harm (DNSH) to climate change adaptation	Substantial contribution to climate change adaptation*)
1.)	Delegated Regulation (EU) 2021/2139 from 4 June 2021 (Climate Delegated Act) ANNEX 1; Appendix A	Delegated Regulation (EU) 2021/2139 from 4 June 2021 (Climate Delegated Act) ANNEX 2
2.)	"The physical climate risks that are material to the activity have been identified by performing a robust climate risk and vulnerability assessment."	"The physical climate risks that are material to the activity have been identified by performing a robust climate risk and vulnerability assessment."
3.)	"an assessment of adaptation solutions that can reduce the identified physical climate risk has been performed"	"an assessment of adaptation solutions that can reduce the identified physical climate risk has been performed"
4.)	"For existing activities and new activities using existing physical assets, the economic operator implements physical and non-physical solutions ('adaptation solutions'), over a period of time of up to five years, that reduce the most important identified physical climate risks that are material to that activity. An adaptation plan for the implementation of those solutions is drawn up accordingly." "For new activities and existing activities using newly-built physical assets, the economic operator integrates the adaptation solutions that reduce the most important identified physical climate risks that are material to that activity at the time of design and construction and has implemented them before the start of operations."	"The economic activity has implemented physical and non-physical solutions ('adaptation solutions') that substantially reduce the most important physical climate risks that are material to that activity."

Key: Nr. 1.) legal source Nr. 2.) - 4.) requirements to be fulfilled.

*) For adapted activities. The substantial contribution requirements for enabling activities are slightly different.

2 Terminology

In companies, the term "risk" is used in a variety of ways. In order to describe the process of a climate risk and vulnerability assessment in a comprehensible manner, consistent terminology is important. Following the Climate Delegated Act, the assessment of physical climate risks has to consider the state-of-the-art methodologies "in line with the most recent report of the Intergovernmental Panel on Climate Change" (IPCC). In 2022, this is IPCC assessment report six (IPCC AR 6). The proposed terminology in the following is compatible with the terminology used in this IPCC report as well as in the international standards for adaptation to climate change and climate risk assessments (ISO 14090/14091).

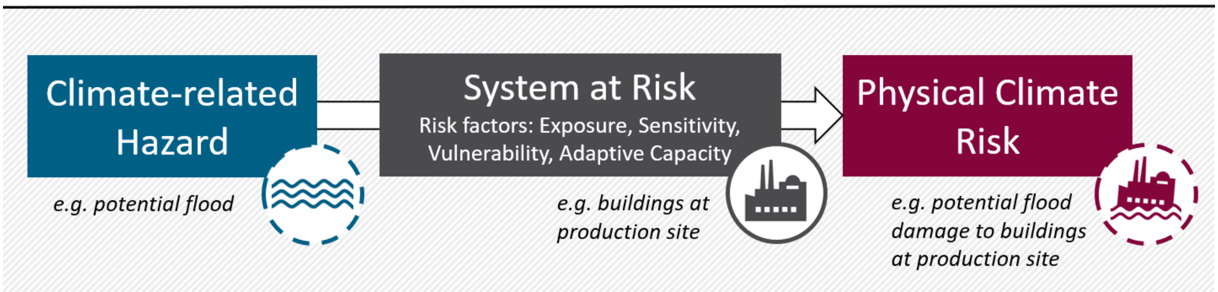
The following recommendations are based on the terms defined in Box 2 below.

Box 2: Central terms (derived from ISO 14090f. / IPCC AR 6)

- Physical climate risk: the "potential for adverse consequences for human or ecological systems" from climate-related hazards (IPCC AR 6).[6] [7]
- Climate-related hazard: a hazard is a "potential source of harm" (ISO 14090/14091). Climate-related hazards are the "potential occurrence of a natural or human-induced physical event or trend that may cause loss […]" or adverse effects (IPCC AR 6). Examples for climate-related hazards are extreme weather events or sea-level rise.
- Adaptive capacity: "The ability of systems […] to adjust to potential damage, to take advantage of opportunities, or to respond to consequences." (IPCC AR 6)
- Exposure: "The presence of […] assets in places and settings that could be adversely affected." (IPCC AR 6)
- Sensitivity: "Degree to which a system or species is affected, either adversely or beneficially, by climate variability or change." (IPCC AR 6)
- Vulnerability: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt." (IPCC AR6)

According to these definitions, a physical climate risk for a system can occur if the system is exposed to and sensitive for a climate-related hazard. Additionally, other factors determine the physical climate risk of a system (see Figure 1).

Figure 1: From climate-related hazards to physical climate risks



Source: adelphi

A climate risk assessment is equivalent to a "climate risk and vulnerability assessment" as required by the criteria for EU Taxonomy alignment, as long as the relevant aspects of vulnerability are included, namely: (i) sensitivity or susceptibility; and (ii) a lack of coping or adaptive capacity. As vulnerability is a component of risk according to IPCC AR6, the following recommendations only speak of conducting a climate risk assessment for better readability.

[6] For climate adaptation experts: ISO 14091 differentiates between risks with and without potential future adaptation. In the following, physical climate risks with and without adaptation are referred to only as "physical climate risks" or just "climate risks" for simplicity.

[7] In IPCC AR6 "in the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change". Under the definitions of the Task Force on Climate-related Financial Disclosures (TCFD) and the International Financial Reporting Standards (IFRS), potential adverse consequences due to human responses to climate change by mitigation are referred to as transitory risks. Physical climate risks refer to every potential negative consequence due to impacts of climate change. According to IPCC AR6, physical climate risks "result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making".

3 Overview: key steps of a climate risk assessment

To perform a taxonomy-compliant climate risk assessment based on the ISO 14091[8] and experiences with climate risk assessments, we recommend four steps, which are part of two distinct phases (see Figure 2):

In a first step, as part of the preparation phase, you determine the lifespan for the taxonomy-compliant economic activities of your company and identify the objects of investigation for your risk assessment (e.g. production sites) (see Section 4.1).

The second step in the preparation phase is to identify the potentially relevant climate-related hazards to be investigated by screening climate-related hazards[9] listed in the Climate Delegated Act, Annex I, Appendix A (see Section 4.2).

The third step is the risk assessment itself, as part of the implementation phase (see Section 0). For the assessment of the current risks, we recommend the depiction of the climate-related hazards using past climate trends and, where available, decadal climate forecasts as substitutes for climate projections.[10] For the assessment of future risks, a range of climate projections based on future scenarios needs to be considered. In case an economic activity has a lifespan of less than ten years, no assessment of the future risks and scenarios is necessary. For activities with a longer lifespan, current and future climate risks based on climate projections have to be considered (see Table 2).

Table 2: Time horizons of the climate risk assessment

	Current climate risks **Now until 10 years from now** **Climate Risk Assessment using climate trends and forecasts[11]**	**Future climate risks** **10 to 30 years from now** **Climate Risk Assessment "using [...] climate projections for the existing range of future scenarios, including at least 10- to 30-year climate projection scenarios for major investments."**
Activities with an expected lifes of less than ten years"	X	
Activities with an expected life of ten years or more	X	X

We consider this step-by-step approach important to identifying and assessing adaptation solutions in the fourth step (see Section 4.4). To fulfil the final objective of the climate risk assessment, you need to identify adequate and effective adaptation solutions to reduce the risks

[8] For climate adaptation experts: ISO 14091 recommends three phases: preparation, implementations and external communication. The latter is not addressed here.

[9] In accordance with the terminology listed above, we refer to this step as screening of climate-related hazards. In the Climate Delegated Act this step is not named consistently. It is described as a screening of "physical climate risk from the list in Section II" while referring to a list named "Classification of climate-related hazards".

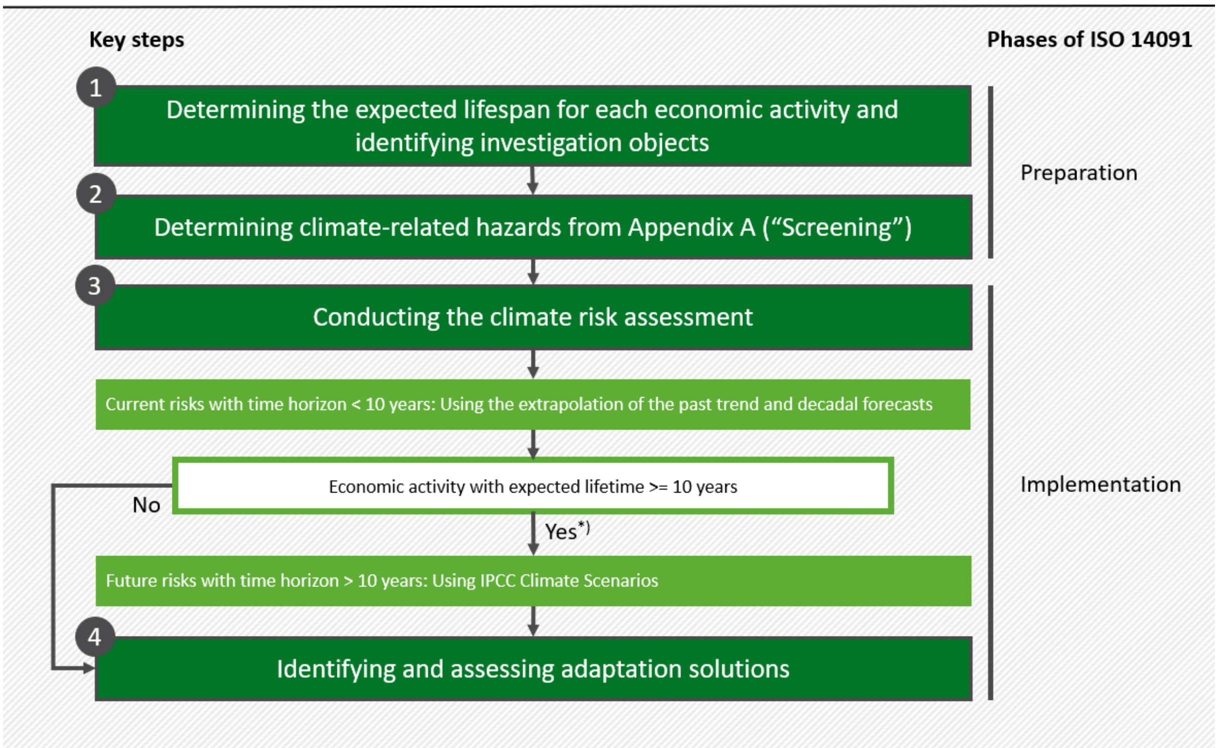
[10] The Climate Delegated Act states that, for climate risk assessments with a time horizon of less than ten years, climate projections are to be used at the smallest appropriate scale, at a minimum. However, for this period, climate projections based on climate models are not trustworthy. Therefore, we interpret the legal requirements to mean that that decadal climate forecasts are to be used as substitutes, if available. Furthermore, we recommend the use of past climate trends, i.e. extrapolating the climate developments of recent years into the future.

[11] Deviating from this wording, the Climate Delegated Act states that, for climate risk assessments with a time horizon of less than ten years, climate projections are to be used at the smallest appropriate scale, at a minimum (see previous footnote).

that are material to your economic activity. This step also includes the determination of the adaptive capacity for current and future adaptation solutions, i.e. an understanding of available resources, existing plans for adaptation and effective adaptation solutions to physical climate risks.

We interpret the legal requirements to mean that it is necessary to document each outlined step and decision (see Section 4.5). Such documentation provides evidence of your thorough consideration and may be requested by auditors when assessing whether a company has followed the rules in determining whether its economic activities are taxonomy-aligned. The notes may also be useful as a basis for an expanded climate risk assessment.

Figure 2: Key steps of the climate risk assessment (under the EU Taxonomy)



*) Exception: for investigation objects in the category "procurement", our interpretation of the legal requirements is such that a consideration of the current risks should be usually sufficient, regardless of the lifetime of the economic activity (see Section 4.1.2).

Source: adelphi

4 Climate Risk Assessment

4.1 Preparation: Determining the expected lifespan for each economic activity and identifying investigation objects

To meet the requirements for a robust climate risk assessment under the Climate Delegated Act, we recommend you determine the expected lifespan for each taxonomy-relevant economic activity and split up the activities into investigation objects. We interpret from the legal requirements that each decision, including the most important arguments related to prioritisation, must be documented to enable auditing (see Section 4.5).[12]

[12] For climate adaptation experts: to meet the requirements of ISO 14091, the first step is to clarify who will carry out the climate risk assessment along with the relevant framework and approach. To this end, you should be clear about the objectives, methods and process of your assessment. As per ISO 14091, the process should be iterative and participative. Assessments should therefore still

4.1.1 Determining the expected lifespan for each economic activity

The requirements for climate risk assessments from the Climate Delegated Act distinguish between activities with an expected lifespan of (1) less than ten years and (2) at least ten years.[13]

Depending on this timeline, you may or may not have to use future IPCC climate scenarios. Therefore, the expected lifetime has to be defined for all economic activities under consideration.

In accordance with the "going concern" principle, it is reasonable to assume in general that any economic activity will continue on a permanent basis.[14] Only if there are concrete reasons not to do so, a life span of less than ten years can be assumed. For example, if it is likely that the demand for a considered product will decline significantly, it is reasonable to assume that it has to be withdrawn from the market in the coming years. Our interpretation of the legal requirements is such that these reasons must be documented to enable auditing.

4.1.2 Determining investigation objects for economic activities in the manufacturing sector

The investigation objects for your climate risk assessment are the systems that carry out the taxonomy-relevant economic activities. In the manufacturing industry, these are usually productions sites as well as the associated procurement and transportation between sites.[15]

The EU Taxonomy requires the reporting of taxonomy-aligned KPIs (CapEx, turnover, OpEx). We interpret the legal requirements to mean that the KPI-generating sites must be examined individually for material climate risks and the site-specific KPIs are then aggregated for reporting purposes. Although not defined in the legal text, this interpretation can be technically justified – otherwise, adaptation solutions might not be meaningfully determined on a "state-of-the-art" (site-specific) basis.

The identification of investigation objects in procurement and transportation is more complex than for production sites. We therefore recommend paying attention to proportionality concerning the level of detail when selecting investigation objects in the areas of procurement and transportation. According to the Climate Delegated Act, only the material climate risks are to be identified. Therefore, we interpret the legal requirements in such way that it is sufficient to

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be adjusted during the process and steps can change again if necessary (e.g. if the data basis changes). In addition, all relevant specialists and departments should be included in the analysis; this can be done either by telephone queries by a person with primary responsibility or by joint discussions and coordination in a working group. In addition, an initial inventory should determine which processes and knowledge on climate risks already exist in your company, who the interested parties are and what external developments need to be considered. These activities are obvious for corporate managers and therefore not described in detail.

[13] Requirement in Delegated Regulation 2021/2139: "The climate risk and vulnerability assessment is proportionate to the scale of the activity and its expected lifespan, such that:

a) for activities with an expected lifespan of less than 10 years, the assessment is performed, at least by using climate projections at the smallest appropriate scale;

b) for all other activities, the assessment is performed using the highest available resolution, state-of-the-art climate projections across the existing range of future scenarios consistent with the expected lifetime of the activity, including, at least, 10 to 30-year climate projections scenarios for major investments."

[14] The going concern principle must be applied in the valuation of assets and liabilities for the annual financial statements. "The valuation [of assets and liabilities] must be based on the assumption that the company will continue as a going concern, unless this is precluded by factual or legal circumstances." states §252 (2) HGB (Handelsgesetzbuch - German Commercial Code) (Translation by the authors). The going concern principle is also required in the international accounting standards of the IFRS, specifically in IAS 1. (Source: IFRS Foundation (2021) Going concern - a focus on disclosure).

[15] Climate change can also change the demand for certain products (and therefore related economic activities). In some cases, demand-related risks are also classified under physical climate risks – for example in the reporting for the Carbon Disclosure Project (CDP). In the Climate Delegated Act, there is no such specification. We therefore interpret the legal requirements in such way that demand risks do not need to be considered for a taxonomy-compliant climate risk assessment. However, we recommend clarifying whether relevant demand-related risks are to be expected due to climate change (e.g., in conversation with one or more persons from sales).

examine procurement and transportation only in areas where there is a potential for significant risks.

4.1.2.1 Production sites

First you need a list of all sites (production, administration, etc.) where the assessed economic activities take place.

Some economic activities of manufacturing companies may take place at production sites exclusively dedicated to a specific activity or product (e.g. production of cement). In this case, we interpret the legal requirements to mean that a climate risk assessment must be conducted for the entire production site or sites.

Other economic activities in the manufacturing sector take place at production sites where other, non-taxonomy-related manufacturing processes occur. For example, manufacturing certain chemicals or manufacturing energy-efficient building equipment are taxonomy-eligible economic activities which are often on sites where other production takes place. In order to meet the legal requirements of the Climate Delegated Act, it is sufficient to assess only those parts of the site where the relevant production processes take place. However, there are several reasons to conduct a climate risk assessment of the entire site in any case, at least for current risks (for reasons and considerations, see Annex A.3).

4.1.2.2 Procurement

To account for any physical climate risks, we interpret the legal requirements as follows: the entire list of economic activities that require taxonomy alignment must be checked in a proportionate manner to confirm whether there is any relevant dependence on individual suppliers or individual supplier countries or, where applicable, geographical regions. For example, in 2021, due to a prolonged drought in Taiwan, it was feared that the lack of water would affect the production of microchips. This would have further exacerbated the shortage of chips that already existed at the time.

This check will obviously be carried out in cooperation with one or more persons responsible for purchasing.[16] If there are relevant dependencies on certain suppliers, supplier countries or geographical regions, we interpret the legal requirements to mean that a climate risk assessment must take place for those suppliers or regions, as well. In order to maintain proportionality, however, we recommend a less detailed approach here than for the investigation of your own sites. It seems appropriate not to look in detail at the production sites of individual suppliers but to consider climate risks on a regional or national level, possibly focussing on clusters of key suppliers. It should also be taken into consideration how easily key production inputs can be substituted in case supply chains are interrupted. If there are no relevant dependencies on individual suppliers, supplier countries or, if applicable, geographical regions, no further steps are required.

Timeframe

Key suppliers can usually be changed in much less than 10 years. Therefore, in most of the cases the assessment of the current risks (time horizon up to 10 years) should be sufficient. The assessment of future climate risks is only necessary in cases where the dependency on a supplier or a region seems to be very strong.

[16] In the context of other legal obligations such as the proposed EU Corporate Sustainability Due Diligence Directive, many companies will also extend their supply chain management in the future – having physical climate risks in mind in this context can help supply chain managers to conduct efficient integrated supply chain assessments and make sound decisions.

4.1.2.3 Transportation between sites

If an economic activity involves essential transportation between sites, a climate risk assessment must be carried out for associated investigation objects in a proportionate manner, according to our interpretation of the legal requirements. For example, the automotive industry is organised on the basis of a division of labour, and components are manufactured and processed at different locations. Here, extreme weather events can lead to temporary interruptions, such as the low water level in the Rhine leading to supply disruptions in 2018 and in 2022.

4.2 Preparation: Determining climate-related hazards from Appendix A ("Screening")

After having identified the relevant investigation objects, the relevant climate-related hazards have to be identified. The EU Taxonomy contains an extensive catalogue of climate-related "hazards that are to be taken into account as a minimum" (Climate Delegated Act, Annex I, Appendix A) (see Table 3). These climate-related hazards consist of "acute" climate-related (extreme) events and "chronic" climate trends that change over time (e.g. slow-onset events). According to the Delegated Regulation, the provided list of climate-related hazards is only indicative. Therefore, additional climate-related hazards occurring in Europe are listed in the description of the following table.

Table 3: Climate-related hazards according to the EU Taxonomy*

	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	Changing temperature (air, freshwater, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow/ice)	Coastal erosion
	Heat stress		Precipitation or hydro-logical variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Permafrost thawing		Saline intrusion	Solifluction
			Sea level rise	
			Water stress	
Acute	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial, pluvial, ground water)	Subsidence
			Glacial lake outburst	

Source: Delegated Act 2021/2139, Annex 1, Appendix A (European Commission 2021)

* In Europe, the following climate related hazards also apply: increased UV radiation, increasing CO_2 concentration (marine waters), decreasing water quality (marine waters, surface water, groundwater), reduced water levels (surface water, groundwater), changing humidity, storm surges.

The first step of a climate risk assessment is to screen and select climate-related hazards from this list that "may affect the performance of the economic activity during its expected lifetime"

(Climate Delegated Act, Annex I, Appendix A). You only need to assess the materiality of risks for these climate-related hazards. It therefore saves a lot of time and effort to filter out hazards at the very beginning of the assessment that cannot affect the respective investigation objects. These are those climate-related hazards that (1) do not occur at the location of the investigation object and/or (2) cannot cause negative impacts for system elements of the investigation object leading to a significant impairment of the performance of the economic activity.

4.2.1 Filtering out hazards based on their spatial occurrence

Some climate-related hazards, such as heat and heavy rain, can occur anywhere. Other climate-related hazards are location-specific and can therefore be eliminated on the basis of the geographical location before a climate risk assessment takes place. Examples are permafrost thawing for activities in the Central European lowlands, or coastal erosion for inland locations or land-locked countries. Clarification of which climate-related hazards need to be included in the climate risk assessment can be made using the following guiding question:

Is the occurrence of the climate-related hazard possible for the investigation object (production site, procurement, transportation)? (Yes/No)

Climate-related hazards for which you can answer "no" to the guiding question do not need to be considered in the climate risk assessment. See Annex A.1 for common definitions of all climate-related hazards to be screened, as well as guidance on how to answer the guiding question above. Hazards that can occur anywhere are listed in Table 7, locally specific hazards can be found in Table 8.

To document your selection of potentially relevant climate-related hazards, we recommend noting why you selected or did not select each hazard to enable auditing.

4.2.2 Filtering out hazards based on the possibility of significant adverse effects on the performance of the economic activity

The fact that a climate-related hazard can potentially occur at the location of an investigation object does not automatically imply that this hazard is capable of causing adverse effects. For example, a cement manufacturer does usually not have to worry about long-term changes in wind patterns at its production sites.

Therefore, it has to be considered which system elements can hypothetically be affected by potentially occurring climate-related hazards at all and if these potential adverse effect(s) could significantly affect the performance of the economic activity (for production sites: within the boundary of the site). In this context, we recommend that you subdivide the investigation objects into system elements that are decisive for their functionality. For example, for an industrial site, this could include buildings, building parts, or the workforce (Table 4). This procedure is helpful to not overlook any possible impact areas of the climate-related hazard and to identify where possible climate risks may exist. These are also the system elements where adaptation solutions can be implemented later on.[17]

See Annex A.1 for definitions of climate-related hazards, past events as well as information on potential adverse effects of the hazards on companies. For each hazard that has not already been sorted out by its spatial occurrence in the previous step, we recommend you to answer the following questions:

[17] A division of the investigation objects into subsystems is also described in Annex D of EN ISO 14091.

1. ***Would one or more of the relevant system elements of your investigation object be negatively affected if the climate-related hazard occurred in its most extreme form, including in combination with other climate-related hazards? (Yes/No)***
2. ***If so, could the potential adverse effect(s) on system elements significantly impair the performance of the economic activity (for production sites: within the boundary of the site)? (Yes/No)***

Climate-related hazards that would not have a negative impact on any relevant system, even in their most extreme form, do not need to be considered further. The question of whether the performance of the economic activity is significantly impaired for the investigation object depends largely on its function and size. Significant adverse effects have noticeable consequences for the contribution of the investigation object to the economic activity. Examples are business interruptions caused by flood or reputational losses caused by heat related health impacts for employees. In contrast, an example of a non-significant negative impact would be minimally increased maintenance costs for trees and plants on production sites.

Table 4: Filtering out hazards based on the possibility of significant adverse effects for an industrial site (example with fictitious values)

		Climate-related hazards (EU Taxonomy)					
		Heat wave/ Heat stress	**Storm (including blizzards, dust and sandstorms)**	**Drought / Water stress**	**Heavy precipitation (rain, hail, snow/ice)**	**Temperature variability**	**Changing wind patterns**
System elements (industrial site)	Buildings in general	0	1	0	0	0	0
	Superstructures on buildings	1	1	0	0	?	0
	Basements	0	0	0	1	0	0
	Indoor operating facilities	0	0	0	1	0	0
	Outdoor operating facilities	1	0	0	1	0	0
	Indoor warehouses	0	0	0	1	0	0
	Outdoor warehouses	1	0	0	1	0	0
	Access to the site, site traffic (car, truck, train, ship)	1	0	0	1	0	0
	Regional accessibility (car, truck, train, ship)	0	1	0	1	0	0
	Water supply	1	0	1	0	0	0
	Power supply	1	1	1	1	0	0
	Other piped supply	0	1	0	0	0	0
	Production process	0	0	1	0	0	0
	Employees	1	?	0	?	?	0
	To be assessed?	Yes	Yes	Yes	Yes	Yes	No

Key:

0 – No significant adverse effect possible (in worst case of occurrence)

1 – Significant adverse effect possible (in worst case of occurrence)

? – Uncertain, if significant adverse effect is possible

Hazards with uncertain effects on the performance of the economic activity should be considered further. As in step 4.2.1, in order to be able to eliminate hazards, you must write down a rationale that makes your decision comprehensible.

4.3 Implementation: Conducting the climate risk assessment

4.3.1 Overview

In the climate risk assessment, the materiality of the physical climate risks is estimated for each system element of the investigation object. The risk arises from each climate-related hazard that may affect the performance of the economic activity. The assessment has to be conducted for the current situation (until ten years from now) and subsequently for different future scenarios (approx. 2031-2060).

The Climate Delegated Act distinguishes between two time periods: one of up to ten years and one for ten years or more. Therefore, this recommendation defines the current state as the period up to ten years. The future is specified as the period from 2031 to 2060, since climate data is often available for this 30-year period.

To assess the overall materiality of the physical climate risks (Section 4.3.5) you need to

- understand significant interrelationships between the climate-related hazards and the system elements of the investigation object (Section 4.3.2),
- gather information on current and future climate-related hazards (Section 4.3.3), and
- gather information on the sensitivity of the possibly affected system elements (Section 0).

Following state-of-the-art methodologies, the sensitivity to climate-related hazards must usually be assessed by different people in the company who have the necessary experience and knowledge. However, the processing and preparation of suitable climate data for a climate risk assessment requires specialised knowledge. In order to perform a successful climate risk assessment, this expertise must be available within the company (rare), be built up or be brought in externally. For external support, there are consultancies offering climate risk assessments as a service.

4.3.2 Understanding impact relationships

Many impacts of climate-related hazards are obvious, such as damage to buildings from flooding or storm events. Other impacts of climate-related hazards occur in succession or reinforce each other. It is not possible to fully investigate all impact relationships leading to physical climate risks. However, a robust climate risk assessment requires a basic understanding of how climate-related hazards can affect the system elements of each investigation object and lead to significant impacts on performance. For reasons of proportionality, we suggest building on existing knowledge about past impacts of climate-related hazards to understand substantial impact relationships.

Not all impacts of climate-related hazards occur in a direct manner; many occur in succession.[18] For example, storm events can damage energy infrastructure and cause power outages. If there is insufficient backup power supply, this can indirectly paralyze production processes. Furthermore, risks can exacerbate each other. Some risks even arise only through the combined effect of several climate hazards. For instance, the combination of drought, storm, and

[18] For climate adaptation experts: Non-linear impacts of climate-related hazards can trigger so-called cascading effects. Through these complex domino effects, hazards can also lead to impacts at other locations, for example supply chain interruptions due to flooding at sites of abroad suppliers (see Section 4.1.2.2 on procurement).

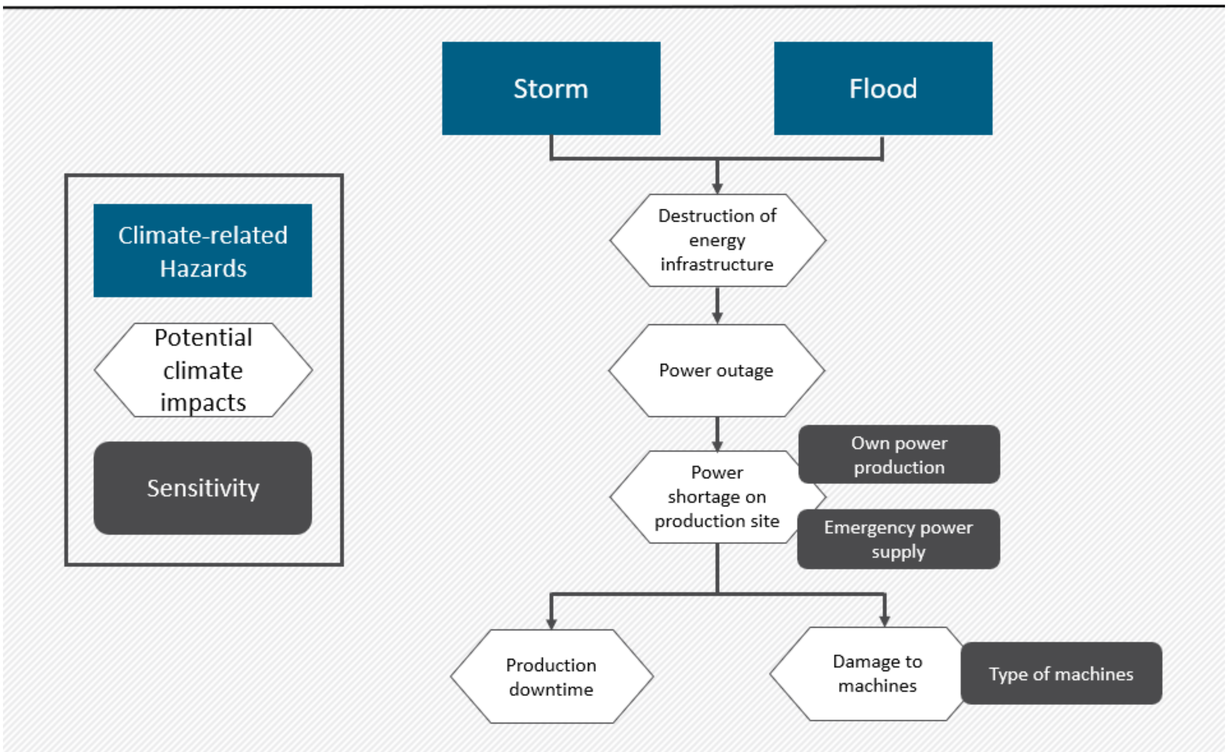
temperature-related pests can lead to an increased risk of falling trees. Some risks are also amplified by successive hazards; for example, the risk of flooding is intensified when heavy rainfall hits dried-out soils.

To familiarise yourself with the impact relationships of climate-related hazards, it is useful to ask the following guiding questions:

1. ***Has the investigation object been adversely affected or nearly affected by impacts of climate-related hazards in your company or in comparable companies in the last one or two decades?***
2. ***How did these adverse effects arise? (directly/through successive impacts/through combined hazards)***
3. ***What could have happened if the climate-related hazards had been stronger or had occurred simultaneously?***

If indirect impacts are identified – which can significantly impair the contribution of the investigation object to the economic activity – it can be helpful to visualise their effects in flowcharts. In this way, a better understanding of non-obvious impact relationships can be created and communicated within the company. Visualisations of causal relationships can also be used for the identification of leverage points for adaptation solutions at the end of the climate risk assessment. One established visualisation method is the creation of so-called climate impact chains. Impact chains depict significant impacts from the climate-related hazard (e.g. heat wave) to the actual risk for the company (e.g. operational interruptions) (see Figure 3).

Figure 3: Example of a climate impact chain



Source: adelphi

Climate impact chains do not have to be based on complex analyses and model calculations; they are also suitable as a visualisation tool for qualitatively identified impact relationships. A simple way to begin the creation of climate impact chains is to add further upstream or downstream impacts to identified (eventually clustered) impacts in an iterative way. In addition to the climate-related hazards at the beginning of each impact chain, it can also be useful to depict other important risk factors (namely the exposure and the sensitivity, see Chapter 2). These factors can be noted in the margins, for example, or incorporated directly into the impact chain flowcharts. You probably need to rearrange the impact chains several times until all important factors are incorporated. In any case, the impact chains should be seen as a living document rather than an ultimate depiction of impact relationships. More guidance on developing impact chains can be found in ISO 14091.

4.3.3 Gathering information on climate-related hazards

Climate-related hazards are the "potential occurrence of a natural or human-induced physical event or trend that may cause loss" or adverse effects. Examples of climate-related hazards are extreme weather events or sea-level rise. For a robust climate risk assessment, we recommend gathering and assessing information on climate-related hazards for each investigation object (see Section 4.1).[19] The scope of the data used may vary to achieve the objectives of the climate risk assessment in a proportionate manner. We recommend that you first assess the current climate-related hazards. For activities with a lifetime of more than ten years, future climate-related hazards should be assessed next. We consider this stepwise approach important to deriving adaptation solutions for different time periods based on the climate risk assessment.

Climate data rarely represent an assessed hazard directly; rather, climate parameters are used as indicators to assess climate-related hazards. For example, the number of heat days with maximum temperatures above 30 °C may be an indicator for heat waves. Depending on the investigated impacts of the climate-related hazard, different indicators are useful. For example, for the impact of heat waves on human health, not only the presence of heat days is important, but also whether it cools down at night and how long the heat lasts. A suitable indicator could therefore be the occurrence of a certain number of consecutive heat days and tropical nights (minimum temperature above 20 °C). Specialist expertise is required for the preparation of suitable climate data and their explanation for a climate risk assessment.

4.3.3.1 Current climate-related hazards (time horizon less than 10 years)

To gather information on the significance of climate-related hazards for the next 10 years, you can ask the following guiding question:

What has been the trend for the climate-related hazard over the past one or two decades in the region of the investigation object and in the widersurrounding area/across regions?

Looking at past changes and events is a good starting point for analysing current climate-related hazards. If a certain extreme weather event has disrupted operations more frequently in recent years and if climate change is likely to make such events more frequent and/or intense, then it is probable that such disruptions will happen more frequently in the next decade (if no action is taken). However, it is important to bear in mind that trends are often not linear and that the climate can exhibit a high degree of variability.

To consider all available information, as stated in the Climate Delegated Act, an attempt must be made to access external sources of information. National meteorological services provide information on climate parameters and their trends. It should be investigated whether the municipality in which the investigation object is located or a regional or national authority has already conducted a climate risk assessment. If so, this should be a good source of information. If

[19] For large sites, you need to consider whether there are spatial differences in the magnitude of the climate hazard (e.g., river location); if so, divide the site into multiple investigation objects.

no public climate risk assessment is available, see Annex A.1 for information and sources on trend and exposure to climate-related hazards in general.

The Climate Delegated Act (Annex 1, Appendix A) specifies that "climate projections at the smallest appropriate scale" are to be used for periods of less than ten years. However, there are no valid climate projections for this time period, only climate forecasts based on weather models[20]. As a result – additional to an extrapolation of the past trends - we interpret the Climate Delegated Act in such way that you need to check whether your estimates match available decadal climate forecasts from meteorological services, e.g. the German Weather Service (DWD).

4.3.3.2 Future climate-related hazards (time horizon of more than 10 years)

The assessment of future climate hazards requires information about possible future climate change – based on the information about the current state of these hazards. The Climate Delegated Act specifies that the climate risk assessment for activities with a lifetime of at least 10 years is to be based on state-of-the-art climate projections with the highest available resolution "across the existing range of future scenarios". A footnote in the Regulation further specifies that future scenarios include the IPCC's Representative Concentration Pathway (RCP) scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.5.[21] However, our interpretation of the legal requirements is such that not all scenarios have to be considered to represent the existing range of future scenarios. Until mid-century the differences between scenarios are often smaller than the bandwidth within one scenario. Therefore, it is sufficient to compare an optimistic and a pessimistic case representing the existing range of climate model outcomes without investigating all four scenarios.[22] We recommend using the 15th and the 85th percentile of the RCP8.5 scenario as the optimistic and pessimistic cases. Depending on your objectives, you may also assess the RCP2.6 and the RCP8.5 scenarios to cover the existing range of scenarios.

To gather information on the significance of future climate-related hazards, you can ask the following guiding questions:

1. ***How can the frequency and the intensity of each climate-related hazard change in the future in the region of the investigation object and in the surrounding region/across regions?***
2. ***How wide are the ranges of future scenarios? What could be a worst and best case?***

Local and regional climate risk assessments can also provide a good basis of information for the assessment of long-term hazards, provided that they are based on highest-resolution data for the above-mentioned range of future scenarios. Box 3 answers questions on future climate-related hazards and related data. Additionally, Annex A.1 summarizes some general indicative information on trends and the future developments of the hazards. However, the interpretation of climate data must take place individually for each climate-related hazard and investigation object.

[20] International: WMO LC Annual-to-Decadal Climate Prediction (metoffice.gov.uk); Germany: Wetter und Klima - Deutscher Wetterdienst - Dekadische Klimavorhersage - Klimavorhersagen der nächsten Wochen bis Jahre (dwd.de).

[21] However, the most recent generation of global climate scenarios outlined in IPCC AR6 are the Shared Socioeconomic Pathways (SSP) scenarios, which are not yet regionalised. Once high-resolution data are available for these scenarios with proportional effort, we interpret the legal requirements in such way that these data should be preferred.

[22] However, the requirements of the Climate Delegated Act could also be interpreted otherwise. The German translation of the legal text "across the existing range of future scenarios" as "für die bestehende Reihe von Zukunftsszenarien" could be understood as a requirement to consider all four RCP-Scenarios.

Box 3: Climate scenarios and climate data

What are relevant climate scenarios?

Scenarios are “a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships” (IPCC AR6). In the context of climate impact research, climate scenarios and socio-economic scenarios are particularly relevant.

The RCP scenarios that are mentioned in the EU Taxonomy are climate scenarios. They were introduced in IPCC AR 5. Each RCP scenario maps different assumptions on how much greenhouse gases affect the energy balance of the Earth and atmosphere – the so-called Representative Concentration Pathways (RCPs) with different “radiative forcings” (2.6, 4.5, 6.0, 8.5).

Socio-economic scenarios make assumptions about socio-economic developments. From this, conclusions can be drawn about changes that have an influence on sensitivity or adaptability – for example the age structure, financial possibilities or the degree of land sealing in certain regions. Socio-economic scenarios have been incorporated in the most recent SSP (shared socioeconomic pathways) climate scenarios from IPCC AR 6 (in 2021/2022).

What are climate projections at the highest available resolution?

Climate projections depict possible developments of the future climate. They are the result of the application of climate models based on climate scenarios.

Climate models depict the climate system under the assumption of certain interactions and framework conditions. Different climate models can project different changes – even under the same climate scenario. Therefore, it is state-of-the-art to combine the output of different plausible climate models for one climate scenario into so-called climate ensembles. This enables the consideration of a range of possible climate developments based on a single climate scenario.

For each climate scenario, first global models are run. These have a coarse resolution (usually about 100 km*100 km), i.e. they cannot properly represent regional differences, for example due to topography (differences in altitude). In order to obtain better validity, global climate models are regionalised with regional climate models.

What climate data should be considered for a taxonomy-aligned climate risk assessment?

For the RCP scenarios RCP2.6, RCP4.5 and RCP8.5 regional climate models with approx. 12.5 km*12.5 km resolution are available on the European level (see Table 5). There are further regionalised data with 5 km*5 km resolution available for Germany – the highest resolution data for that country. For other European countries there might be higher resolution climate data as well. Based on our understanding of the legal requirements, it needs to be checked if such data is available.

The RCP 6.0 scenario is not suitable for a climate risk assessment as no regionalised data exists and available global climate data with a resolution of approx. 100 km*100 km would not provide additional insight.

When comparing climate ensembles of different scenarios, not only the median trajectory of the ensembles should be considered, but also their ranges. Especially until mid-century, the projected medians (mid-model value) of ensembles of different scenarios differ less than the range of the ensemble of one scenario. Therefore, it is useful to consider an optimistic case and a pessimistic case for at least one scenario. For precautionary reasons, we recommend the consideration of the

RCP8.5 scenario, which assumes low climate change mitigation. Considering an optimistic and a pessimistic case means that, instead of the median of the model results, values at the upper and lower end of the model range are selected (for example, the 15th and 85th percentiles). Which of the two statistical values represents the optimistic and the pessimistic case depends on the impact type of the hazard and the selected climate parameters. For example, low rainfall is an optimistic case for the hazard “flood”, but a pessimistic case for the hazard “drought”.

What climate data are available for a climate risk assessment?

The data for climate ensembles have been collected in the Coupled Model Intercomparison Project (CMIP) Phase 5 and 6 (global) and the Coordinated Regional Downscaling Experiment (CORDEX) (regional, e.g. for Europe), which are available for download on various websites. Visualisation and analysis of this data require special software or programming skills. Regionalised climate ensembles with the highest possible resolution can be requested from national meteorological services (e.g. the German Weather Service, DWD, in Germany). For all EU Member States as well as most EEA Member Countries, the country profiles on the European Climate Adaptation Platform Climate-ADAPT provide information about meteorological observations, climate change impact and vulnerability assessments, climate projections and services as well as adaptation portals and platforms. The information is updated on a regular basis (at least every two years) and can provide an entry-point to look for more detailed information.

Much easier is the visualisation of the data in interactive online tools. This provides an immediate impression of changes in important climate parameters. Depending on the climate-related hazards to be assessed and the proportionate detail of the climate risk assessment, these publicly available data can form an adequate basis for conducting a climate risk assessment. However, some climate-related hazards listed in the Climate Delegated Act such as soil erosion, subsidence, or wildfires require information based on impact models. In addition, for the best possible operationalisation of climate hazards, it can be useful to calculate more complex climate parameters that go beyond the basic climate parameters presented (e.g., successive heat days and tropical nights).

For Germany, the climate projection data of the DWD can be visualised in a user-friendly way in the DWD Climate Atlas. Global (CMIP5, CMIP6) and regional (CORDEX) data can be visualised in the interactive IPCC-Atlas. Additional visualised climate data can be retrieved from the European Climate Data Explorer.

A very user-friendly tool is provided by the European Environment Agency (EEA): the EEA interactive hazard report assigns climate data and further information to climate-related hazards using indicators. The underlying hazard classification is based on the most recent IPCC AR6 and differs from the hazard classification in the Climate Delegated Act, but the divergent classifications are compatible in many respects (see Annex A.2 for a translation matrix). The resolution of the climate data visualised in the EEA report itself is aggregated at the level of subnational basic regions (Nomenclature of Territorial Units for Statistics: NUTS-2). Therefore, based on our understanding of the Climate Delegated Act, the data visualised in the EEA report is only sufficient for climate-related hazards and indicators where no higher resolution data is available. Regardless, the EEA hazard report can be a good basis for taxonomy-aligned climate risk assessments, because it provides links to higher resolution data sources (e.g. in the European Climate Data Explorer).

Table 5 summarizes the climate data sources to be considered for a taxonomy-aligned climate risk assessment.

Table 5: Climate data for a taxonomy-aligned climate risk assessment

Data	Resolution	To be considered for a taxonomy-aligned climate risk assessment?
Germany: DWD Climate Model Ensemble (to be requested); online visualisation of basic parameters: DWD-Klimaatlas	5 km*5 km	For Germany
Other countries: highest-resolution regionalised climate data (to be requested); for national information and points of contact: Climate-ADAPT country profiles	Higher resolution than regional climate data (see below)	Outside Germany, if available
Regional (e.g. Europe): CORDEX (Data download: Copernicus Climate Data Center); online visualisation of basic parameters: Interactive IPCC-Atlas	Approx. 12.5 km*12.5 km (Europe, Mediterranean) – approx. 25km*25km (other regions)	If no appropriate higher resolution national data is available
Europe: European Climate Data Explorer (mostly based on EURO-CORDEX and ERA reanalysis data)	Ranging from approx. 11 km*11 km to approx. 56 km*56 km	If no appropriate higher resolution national or regional data is available (e.g. for certain climate-related hazards or indicators)
EEA Hazard Report (mostly based on EURO-CORDEX and ERA reanalysis data)	Subnational basic regions (NUTS-2)	If no appropriate higher resolution national or regional data is available (e.g. for certain climate-related hazards or indicators)

4.3.4 Gathering information on the sensitivity of system elements

Sensitivity is the degree to which a system is affected, either negatively or positively, in case certain climate-related hazards occur (see Box 2 in Chapter 2). For a taxonomy-aligned climate risk assessment, it is sufficient to consider sensitivities to adverse impacts.

For a robust climate risk assessment, we recommend you consider the sensitivity for each system element of your investigation object. The system elements were determined in the preparation phase (see Section 4.1.2). The sensitivity towards the remaining hazards can be considered based on two guiding questions:

1. ***If relevant system elements of the investigation object have already been affected or nearly affected by the particular climate-related hazard: To which degree was each system element negatively affected or would have been affected?***
2. ***To which degree would each relevant system element be negatively affected if the hazard occurred (as experienced by comparable investigation objects)?***

In addition to experience available for the investigation object, extreme events (e.g. loss or damage) of other comparable investigation objects (e.g. other production sites) with high intensity should be used as a basis for answering the guiding questions. Information on losses and damage at comparable companies or locations should also be included in the evaluation, if available and useful.

4.3.5 Assessing the overall physical climate risks

Physical climate risks are the "potential for adverse consequences" from climate-related hazards for the system elements of your investigation object (see Box 2 in Chapter 2). Based on the gathered information and considerations on impact relationships, hazards and sensitivity, you can determine the materiality of these climate risks.

Given the manifold effects of risk components and the different types of data and information, we recommend a qualitative assessment procedure. For this purpose, the system elements of the investigation object and the relevant climate-related hazards are arranged in a climate risk matrix (see Table 6). The respective materiality of the climate risks is entered there in a participatory process. The person in charge should therefore not decide on the rating alone, but involve all relevant experts in the decisions, i.e. in a workshop.

First, the current climate risks should be estimated. We interpret the legal requirements to mean that a risk estimate for the next 10 years must be considered in any case in order to derive adequate adaptation solutions for this time period. Based on the previous considerations and available information, we recommend that you answer the following guiding question:

How material is the potential for adverse consequences from each climate-related hazard for each system element of your investigation object within the next ten years? (low/medium/high)[23]

Second, when the lifetime of the economic activity is at least ten years, the Climate Delegated Act states that the future climate risks have to be estimated. Based on the assessments of the current risks, you have to assess these future risks under different climate scenarios. According to our interpretation of the legal requirements, this separate assessment of future climate risks is necessary as a basis for the identification of adaptation solutions that go beyond the ten-year period.

The main components of the assessment of future climate risks are the expected changes in climate-related hazards and the range of these changes (see Section 4.3.3.2).[24] For each case or climate scenario, we recommend that you answer the following guiding question:

How material is the future potential for adverse consequences from each climate-related hazard for each system element of your investigation object (10-30 years from now)? (low/medium/high)

The magnitude of the current or future climate-related hazard is not known for some hazards, because the required scientific basis is lacking or insufficient. How to deal with uncertainties in the climate risk assessment is a decision for the company's management (or the people responsible for the climate risk assessment). Companies with a lower appetite for risk may assess climate risks as "high" when climate-related hazards are highly uncertain but significant sensitivities exist. This makes clear that the company does not underestimate the resulting climate risks and signals the need for action. Organisations with a higher appetite for risk may rate the same risks as "medium".

[23] Depending on the available information and existing risk management structures, a more differentiated risk scale can be useful (e.g. with five levels). However, we recommend being careful to avoid pseudo accuracy when using too differentiated risk scales.

[24] If there are reasonable indications that the sensitivity of your system elements will also change in the future (e.g. due to demographic developments), it makes sense to consider these changes as well. However, impacts of future adaptation solutions should not yet be considered in this assessment. They will be considered in the next step (see Section 4.4).

Table 6 shows where high and medium climate risks may exist in principle.[25] In many cases, this assessment is enough to derive action requirements and assess adaptation solutions (see Section 4.4). An aggregation of climate risks at the level of economic activities is not useful, as possible adaptation solutions are usually considered at the level of system elements.

Table 6: Climate risk estimate for an industrial site (example with fictitious values)

		Climate-related hazard (EU Taxonomy)											
		Heat wave/ Heat stress			Storm (including blizzards, dust and sandstorms)			Flood - fluvial			etc. ...		
		Current risk	RCP8.5 - optimistic	RCP8.5 - pessimistic	Current risk	RCP8.5 - optimistic	RCP8.5 - pessimistic	Current risk	RCP8.5 - optimistic	RCP8.5 - pessimistic	Current risk	RCP8.5 - optimistic	RCP8.5 - pessimistic
System elements (industrial site)	Buildings in general	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low
	Superstructures on buildings	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low
	Basements	Low	Low	Low	Low	Low	Low	Medium	Medium	High	Low	Low	Low
	Indoor operating facilities	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Outdoor operating facilities	Low	Low	Medium	Low	Low	Low	Medium	Medium	High	Medium	Medium	High
	Indoor warehouses	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low
	Outdoor warehouses	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	High	High	High	High
	Access to the site, site traffic (car, truck, train, ship)	Low	Low	Low	Low	Low	Low	Medium	Medium	High	Low	Low	Medium
	Regional accessibility (car, truck, train, ship)	Low	Low	Low	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	High
	Water supply	Low	Low	Low	Low	Low	Low	Low	Low	Low	High	High	High
	Power supply	Low	Low	Medium	Low	Low	Low	Low	Low	Medium	Low	Medium	High
	Other piped supply	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Production process	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	High
	Employees	High	High	High	Low	Low	Low	Low	Low	Low	Low	Low	Low

Key: Low risks | Medium risks | High risks

4.4 Implementation: Identifying and assessing adaptation solutions

To meet the requirements for EU Taxonomy alignment, it is necessary to assess adaptation solutions “that can reduce the identified physical climate risks” (Annex 1, Appendix A of the Climate Delegated Act).

In order to identify effective adaptation solutions, you need to know the framework conditions for climate adaptation in your company. As a result, for a comprehensive climate risk

[25] Table 6 is the result of the “climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity” as required in the Climate Delegated Act, Annex 1 Appendix A.

assessment, the adaptive capacity must also be determined, i.e. the ability "to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC AR 6). Knowing the adaptive capacity, adaptation solutions can be planned realistically and in a targeted manner. Adaptation solutions depend on the current adaptive capacity (e.g. potential financing) and, at the same time, changes in future adaptive capacity (e.g. through trainings) can be an adaptation solution.

One particularly relevant factor for adaptive capacity is the resource availability for the implementation of adaptation solutions. In addition to financial resources, the working time of professionals and technical requirements should also be considered here. Furthermore, processes, structures and knowledge contribute to the adaptive capacity of your organisation. We recommend that you consider the following:

1. ***What resources are currently available to adapt to the identified physical climate risks and how are these resources likely to change in the future (based on existing plans)?***
2. ***What adaptation solutions are available to effectively reduce the identified physical climate risks? What measures are missing?***

To better determine adaptive capacity, it can help to use indicators such as the budget or people available to implement adaptation solutions, the number of employees trained to deal with extreme weather, the existence of a heat (-health) action plan, or the capacity of drainage systems. Knowledge of this data may be located in different divisions of your company (e.g. finance, human resources, facility management). Therefore, it makes sense to formally or informally include all relevant departments in the adaptive capacity assessment and adaptation planning.

Building on the assessment of the adaptive capacity, you can ask yourself:

3. ***What adaptation solutions can be implemented to reduce the physical climate risks material to your economic activity? What adaptation solutions would be most adequate?***

Our interpretation of the legal requirements is such that a list of adequate and effective adaptation solutions, including an assessment (e.g. qualitative cost-benefit ratio), seems necessary. If no medium or high climate risks have been identified in any significant system element, such a list together with the screening should be sufficient to formally fulfil the DNSH requirements regarding adaptation to climate change.

For high climate risks in key system elements, an adaptation plan must be prepared for implementing adaptation solutions to meet the DNSH requirements. In the case of medium climate risks, it is plausible that the company's responsible persons decide on a case-by-case basis whether it makes sense to implement adaptation solutions and create an adaptation plan.[26] For existing assets, adaptation solutions that significantly reduce the "most important identified physical climate risks" must then be implemented within five years. When new assets are put into operation, adaptation solutions must already be implemented for commissioning. The implemented adaptation solutions must also meet certain requirements, e.g. being "consistent with local, sectoral, regional or national adaptation strategies and plans".

If financially relevant adeptation solutions are taken to reduce individual climate risks, additional requirements for a significant contribution to climate adaptation may be considered

[26] In this context, we also recommend integrating monitoring and evaluation of the adaptation solutions (e.g. via indicators) into the adaptation plan in order to ensure that the adaptation solutions are actually effective and to be able to adjust them in good time if this is not the case.

(Annex 2 of the Climate Delegated Act). These requirements for substantial contribution depend on the economic activity and include DNSH requirements for other environmental objectives.

4.5 Documentation

Reporting according to the EU Taxonomy is usually audited by chartered accountants. For this purpose, documentation must be available that shows how figures are calculated and how qualitative information is justified. With regard to the robust climate risk and vulnerability assessments to be submitted for taxonomy alignment, we interpret the legal requirements to mean that (1) the preparatory steps performed, (2) the assessments made and (3) the assessment results must be documented in a comprehensible manner to allow auditing.

This documentation is of course also useful internally, for example to update the climate risk assessments if necessary or to doublecheck whether the rationales, assessments and corresponding decisions taken are sound and justified.

4.6 Validity

The EU-Taxonomy requirements do not state how often you need to update the robust climate risk and vulnerability assessment. From a technical point of view, we recommend an update at least every three years for current risks and every five years for future risks, given that our understanding of climate change and its impacts is rapidly changing. Relevant investments may be a reason for an ad hoc update.

Annex

A.1 Climate-related hazards (EU Taxonomy): Definitions and information for climate risk assessments (Germany, Europe)

Table 7: Climate-related hazards that can potentially occur anywhere

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Changing temperature (air, freshwater, marine water) Long-term mean temperature changes in air and water.	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned. The global mean air temperature has risen until 2021 since the early-industrial period around 1,1 °C – with great regional differences (see NASA 2022a).	Changing average temperatures mainly affect the production in agriculture, forestry, and fisheries. They are also relevant for other activities related to ecosystems, like ecosystem restoration, tourism or water uses, i.e. cooling water. Rising temperatures can further lead to health problems due to more disease vectors or prolonged times for allergens (see KWRA 2021a).	High All of Germany is expected to be affected by rising temperatures. The mean temperatures will rise most strongly in mountain regions and the Southeast (see KWRA 2021b).	Germany: The mean temperature between 1881 and 2018 has risen by 1.5 °C (see UBA 2019). Increased positive temperature anomalies have been observed in recent decades (see DWD n. y.[28]), a trend which will continue in future decades (see KWRA 2021b). Europe: Europe in general warms faster than the global average; the last decade was about 2.0 °C warmer compared to pre-industrial levels. "Particularly high warming has been observed over eastern Europe, Scandinavia and at eastern part of Iberian Peninsula" (EEA 2022a). In the future, all regions in Europe are expected to face higher mean temperatures. Especially northern and eastern Europe will experience high warming levels in winter while the Mediterranean will face the highest average temperature rise in summer (see IPCC 2021a).

[27] In Germany, a generally high exposure is given to those climate-related hazards which can cause many high climate risks according to the Climate Impact and Risk Assessment 2021 for Germany (KWRA): Heat, decreasing mean precipitation, increasing mean temperature, heavy rain, drought and strong winds (see KWRA, Partial Report 6, p. 73). Climate-related hazards also include so-called upstream climate impacts (= purely physical impacts of climate change, e.g. floods and flash floods). For these, the related climate risks were assessed in the KWRA. The climate risk levels in the present and mid-century (assuming a strong climate change) were adopted.

[28] The last access on all websites referenced in the tables 7 and 8 was on August 24th 2022.

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
				More information on trends and projected changes in the annual mean temperature at the European land area, its sub-regions (see EEA 2022b) and in the European seas (see EEA 2021a) can be found in the interactive index-based EEA report on Europe's changing climate hazards.
Temperature variability Extend of day-to-day or month-to-month changes between temperatures at one location	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned.	Changes in temperature variability have similar effects than mean temperature rise (see there). Extreme temperature differences can also have a negative effect on building materials, i.e. road surface, or rails	Currently no general estimate available.	Europe: For both 1.5 °C and 2.0 °C warming scenarios, temperature variability is very large over the Mediterranean. "This irreducible spread caused by internal variability of up to 10 °C is much larger than the average temperature changes." (Suarez-Gutierrez et al. 2018). If temperature extremes are linked with the projected rises in mean temperature over Europe, northern central, central and parts of eastern Europe could face the highest increases in temperature variability (see Suarez-Gutierrez et al. 2018).
Cold wave/frost A spell of cold weather over a wide area; including late frosts and alternate frosts.	Europe / Germany: cold wave February 2018, late frost in spring 2021 (see German Federal Office of Statistics 2021).	Extreme cold can have a negative impact on materials and production processes as well as human health. Late frosts are a risk for fruit cultivation in particular, e.g. at the time of fruit blossoming.	Currently no general estimate available.	Europe: A decrease of cold waves can be observed all over Europe already today. They are expected to disappear gradually under a scenario exceeding global warming by 3 °C (see IPCC 2021a, Naumann et al. 2020). However, this does not mean that there are no more frost days in Europe: The risk for late frost in Europe has increased significantly from 1959 to 2017. The highest increase was observed in the coastal and eastern parts of Europe, in which the initial risk used to be low (see EEA 2021b, Zohner et al. 2019).
Heat wave "A period of abnormally hot weather often defined with reference	Europe: Heat wave 2003 (death toll: ca. 70,000 all over Europe), 2006, 2007, 2010, 2014, 2015, 2017,	Heat waves are leading to worsened air quality and hygiene in buildings and capacity losses.	High Already today, a high climate risk	Germany: Heat waves are observed increasingly since the 1970s (see DWD n. y.). In future, all regions, but urban areas especially

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
to a relative temperature threshold, lasting from two days to months." (IPCC 2021b) **Heat stress**[29] "A range of conditions in […] organisms when the body absorbs excess heat during overexposure to high air or water	2018 (death toll: 8,700 in Germany), 2019 (6,900 in Germany) and 2022 (see EEA 2022c, Winklmayr et al. 2022). Germany: new temperature records in July & August 2018	Heat impairs physical and mental performance - especially in non-air-conditioned rooms or when working outdoors. Heat can also damage materials (e.g. through deformation) and thus lead to the impairment of means of production and infrastructure.	to human health, especially in urban areas and in already warm regions such as along the rivers Rhine and Spree, exists (see KWRA 2021a).	because of Urban Heat Island (UHI) effects, will experience more hot days (see KWRA 2021a). Europe: "Prolonged heat waves of extreme heat are projected to increase substantially across Europe under all considered scenarios and especially in southern regions. […] Hot days with temperatures above 30 °C have increased throughout Europe. The number of hot days in Europe may increase fourfold by the end of the century under a high-emissions scenario, with the largest absolute increases in southern Europe." (EEA 2022c)
***Changing humidity** Rising air temperatures contribute to a higher capacity of water vapor stored in the atmosphere (see NOAA 2018)	Europe: The heat wave of 2003 reached fatal wet bulb temperatures at only 26°C leading to 50,000 deaths (see NOAA 2020).	High temperatures combined with very humid weather conditions restrict the body's ability to cool down through transpiration. Eventually, the body overheats, resulting in death. The upper physiological limits for the human body are wet-bulb temperatures of 35 °C while already lower temperatures may have fatal human health impacts (see Raymond et al. 2020). Simply speaking, the more humid the air the smaller	Currently no general estimate available.	Trend for Europe: Current climate models do not predict deadly wet-bulb temperatures in Europe in the upcoming decades (see NASA 2022b). However, in Southern and Southeastern Europe wet-bulb temperatures that were coming close to the deadly limit of 35 °C have already been registered (see Hinsdale based on Raymond et al. 2020, Raymond et al. 2020)

[29] Heat stress is a consequence of a heat wave. Therefore, no additional classification is required for this hazard.

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
		the necessary temperature to put people in danger. Especially elderly or pre-diseased people and those working outside are vulnerable to wet-bulb temperatures (see NASA 2022b).		
***Increased UV radiation** The sun constantly transmits ultraviolet (UV) radiation.	"In Europe, Norway, the Netherlands, Denmark, Sweden and Germany had the highest rate of new melanoma cases per 100,000 population in Europe in 2018 […] For Nordic countries, exceptionally long periods of clear skies and recorded dry and warm conditions seem to be the main cause for unusually high UVI values in summer 2018." (European Climate and Health Observatory n. y.)	UV radiation affects human health: UVA is causing tanning and it may also enhance the development of skin cancers. UVB is causing sun burning, promotes skin ageing and skin cancer. UVC is held back by the atmosphere (see WHO 2016).	High (see KWRA 2021a)	Europe: "UV radiation trends have varied significantly throughout the past decades. While an increasing trend in UV radiation has been observed for southern and central Europe since the 1990s, it has decreased at higher latitudes. […] Climate change is modifying UV exposure and affecting how people and ecosystems respond to UV. […] Future regional UV radiation projections under climate change depend mostly on cloud trends, aerosol and water vapour trends and stratospheric ozone. […] Furthermore, rising temperatures associated with climate change result in behavioural changes, such as increasing time outdoors and shedding of protective clothing that lead to more UV radiation exposure and skin cancers than with lower temperatures. […] Although social behaviours are hard to predict, the effects of human behaviour in response to temperature increases are likely to be a more important factor for skin cancer rates than the increase in UV radiation itself" (EEA n. y.)
Changing precipitation patterns and types - rain Changes in either the geographical (quantity),	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned.	Changing precipitation mainly affect water management and ecosystems as well as the	High The regions with the lowest	Germany: In Germany, mean precipitation has risen slightly since 1881, mainly in winter. The annual precipitation is expected to increase slightly until the end of the century. Moreover, a

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
temporal or seasonal distribution (variability) of rain		production in agriculture and forestry. This is also relevant for other activities related to water uses like tourism and inland shipping.	precipitation rates are located in the East of Germany (see DWD n. y.). However, an increase of dry summer days is projected all over Germany (see KWRA 2021a).	(slight) shift in precipitation distribution among seasons can be observed. This trend might continue in the future. Heavy precipitation events are expected to increase (see DWD n. y.). Europe: "Annual precipitation has been increasing in northern Europe and decreasing in the south, with no discernible trend either way in central Europe; these trends are likely to continue in the future. Summer rains — […] vital to natural ecosystems and agriculture — show signs of decreasing in central and southern Europe, with no change projected for northern Europe" (EEA 2021c). However, "[w]inter rain has increased in most of northern Europe and decreased in limited areas of southern Europe" (EEA 2021d).
Heavy precipitation - rain The precipitation amount exceeds 15 to 25 l/m2 in 1 hour or 20 to 35 l/m2 in 6 hours (see DWD Encyclopaedia n. y.a)	Europe: Heavy rain 2021 in central Europe, connected with flash floods incl. the Ahr valley (Germany); torrential rain in August 2022 leading to disruptions in transport infrastructure in London, Paris and Marseille (The Guardian 2022)	Heavy precipitation can cause damage to buildings and infrastructure as well as to agriculture. Flooding triggered by heavy precipitation poses a risk to all economic activities connected to the area affected.	High Generally, heavy precipitation events may occur everywhere (see DWD n. y.)	Europe: "Various indices of heavy precipitation show considerable increases in northern Europe, smaller increases in central Europe and no significant change in southern Europe, for both the past and the future" (EEA 2021e). Generally, precipitation extremes are expected to increase in all regions if global warming exceeds 2 °C (see IPCC 2021a). In Europe both intensity and likelihood of similar heavy rain events like the one leading to the flood disaster in the Ahr valley in 2021 will increase with ongoing climate warming (see World Weather Attribution 2021).

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Flood - pluvial, ground water "An unusual accumulation of water above the ground caused by […] heavy rain, melting snow or rapid runoff from paved areas." (EEA Glossary n. y.)	Floods in Middle and Western Europe in Summer 2021. For recent examples of flash floods triggered by heavy rain events, see floodlist.com/europe.	Flash floods triggered by heavy precipitation poses a risk to people, ecosystems, production processes and critical infrastructures as well as buildings, and can thus severely impact all economic activities connected to the area affected.	Climate risk of flash floods was estimated to be medium to high. Buildings and infrastructures especially at risk due to flash floods are those located close to (flowing) waters and in narrow valleys in regions with high altitude differences (see KWRA 2021c)	Europe: Most floods in southern Europe were pluvial and flash floods which also pose a serious risk to other European regions. The projected increase of heavy rainfall events all across Europe leads, together with increasing urbanisation rates, to an increase of pluvial floods. "Small catchments, steep river channels and cities are particularly vulnerable due to large areas of impermeable surfaces where water cannot penetrate" (IPCC 2021a).
Flood - fluvial "The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged." (IPCC 2021b)	Floods in Middle and Western Europe in Summer 2021	Floods can severely impact transport and critical infrastructures as well as buildings and production processes.	Climate risk of fluvial floods was estimated to be medium to high. Buildings and infrastructures especially at risk due to fluvial floods are those located close to (flowing) waters (see KWRA 2021c)	Europe: River flood hazards have increased in western and central Europe by 11 % but decreased by 23 % in eastern and southern Europe per decade since the 1960s. Within the last 30 years, the highest number of floods in the last 500 years have been observed. These observed trends are projected to continue due to the increased number and magnitude of extreme precipitation events (see IPCC 2021a).

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Changing precipitation patterns and types - hail Changes in either the geographical (quantity), temporal or seasonal distribution (variability) of hail	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned.	Hail with diameter > 2 cm can cause damages to cars. Heavy hail, with diameters > 5 cm, can cause massive damage to facilities, infrastructure and unprotected products as well as to agricultural production. Hail with diameters > 10 cm has been only observed in individual cases in tropical regions (see DWD 2022).	Currently no general estimate available	Forecasting hail is very difficult as a specific form of thunderstorms must appear. Moreover, hailstorms are regionally limited which leads to difficulties in the observation with stationary monitoring stations. Europe: Generally, statistics and projections regarding hailstorms are subject to high uncertainties due to “the limited number of stations and the stochastic nature of hailstorms” (EEA 2021f). However, studies suggest that both the likelihood and the size of hailstorms might increase in Europe as a result of climate change (Raupach et al. 2021). Under a moderate scenario from a temperature increase of 2.6 °C by the end of the century, the occurrence of hailstorms with hailstones larger than 5 cm is projected to increase about 30-40 % all across Europe “with an even greater increase in parts of Italy, on the eastern Adriatic coast, and in southern France” (Munich Re 2020). For the business as usual (BAU) scenario, the risk of extreme hailstorms even doubles for central and eastern Europe, Italy, Southern France and the Adriatic coast. For hailstones larger than 2 cm, which still is enough to cause severe damage on crops, the risk increases by 10-20 % all over Europe in the moderate and up to 80 % in the BAU scenario. In the latter, Italy, parts of Germany and Eastern Europe face the highest increase (see Munich Re 2020).
Heavy precipitation – hail Storm with hailstones with a minimum diameter of 1.5 cm (see DWD 2022), classified as thunderstorm (see also DWD Encyclopaedia n. y.b)	Germany: Hailstorm in Reutlingen 2013, Hailstorm in Wolfsburg 2013 (damaging 28.000 mostly brand-new cars of VW) (see DPA 2013)			
Changing precipitation patterns and types – snow/ice Changes in either the geographical (quantity), temporal or seasonal	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned.	Snow and ice pressure can damage buildings and infrastructures if their structural design is inadequate. In addition, snow and ice can	Currently no general estimate available	Forecasting snow and ice is very difficult as there are several necessary conditions, amongst others a rain event must appear at the same time with certain temperatures. Europe:

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
distribution (variability) of snow or ice.		temporarily impair the usability of transportation infrastructure. Snow and ice can also be relevant to agriculture, forestry, and the tourism and outdoor event industries.		"Annual snowfall and snow cover extent have generally decreased across Europe, especially at lower elevations. Snowfall is projected to decrease substantially in future in central and southern Europe, where it could almost disappear in many low-elevation regions. In northern Europe, snowfall may increase or decrease, depending on the altitude and emissions scenario. Snow seasons have generally become shorter in northern, western and eastern Europe as a result of earlier snowmelt in spring. The length of the snow season is projected to decrease substantially in future, with reductions of more than 100 days by the end of the century in some regions." (EEA 2022c)
Heavy precipitation – snow Heavy snowfalls are events at which big amounts of snow are falling in a short period of time leading to disruptions of infrastructural services (own definition)	Europe: Heavy snowfalls January 2019			
Heavy precipitation – ice Either a precipitation event containing mainly ice pellets or hypothermic rainwater freezing immediately after getting in touch with hard objects both leading to glaze (see DWD Encyclopaedia n. y.c).				

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Precipitation or hydrological variability Changes in the availability of water and water levels due to variations in one or more component(s) of the hydrological cycle (condensation, (evapo)-transpiration, precipitation, infiltration & runoff). This hazard can cause the following hazards listed below: drought, water stress, reduced water levels (surface water, groundwater).	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned Extreme events related to drought, water stress and reduced water levels are listed below.	Steady water availability and water levels are important for different water users, such as ecosystems, fishery, inland shipping, and for water withdrawal as for drinking, irrigation, production, cooling, cleaning, etc.	The climate risks of low surface water levels have been estimated to be medium to high. The risks of low groundwater levels have been estimated to be low to high (see KWRA 2021c).	Europe: "Generally, key changes in the hydrological system for central Europe include alterations in the seasonal distribution, magnitude and duration of precipitation, an increase in evapotranspiration in areas where water is available and a reduction of the snow season"(Stagl et al. 2013). "Annual peaks in daily river discharge (a proxy for extreme floods) have been increasing in north-western and parts of central Europe but decreasing in southern and north-eastern Europe. Fifty-year river flood levels are projected to increase across most of Europe, especially in central and central-eastern Europe. Expected changes in southern Europe are more varied and uncertain, with decreases projected for some regions but increases for many others, including regions where overall precipitation is projected to fall." (EEA 2021e)
Drought "An exceptional period of water shortage for existing ecosystems and the human population (due to low rainfall, high temperature, and/or wind)." (IPCC 2021b)	Drought in Europe 2018	Droughts can have severe impacts on agriculture, silviculture and forestry. If the water level drops low enough, transportation via rivers and production dependent on river water cooling processes are impaired.	High The East of Germany and some parts of central Germany are the countries' driest regions with negative water balances (see KWRA 2021a).	Europe: An increase of droughts is observed in the Mediterranean while a decrease in northern Europe is observed. Locally contrasting observations are made for eastern, western and central Europe (see IPCC 2021a). "Future projections suggest a small drop in the magnitude of droughts in northern Europe, but substantial increases in central Europe under higher emissions scenarios, and even larger increases in southern Europe" (EEA 2021g).

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Water stress “[A] situation where there is not enough water of sufficient quality to meet the demands of people and the environment” (EEA 2021h)			Low to Medium (see KWRA 2021c)	About 30 % of Europe’s population is affected by water stress during an average year. The situation is expected to worsen as climate change is increasing the frequency, magnitude, and impact of droughts (see EEA 2021i)
Wildfire Large and destructive fire of vegetation including field, forest and bush fire. Increasing heat waves contribute to an expansion of fire-prone areas as well as longer fire seasons (see EEA 2021j).	Greece: More than 100 people died during the Attica fires of 2018. Extreme wildfires in Portugal 2017, Sweden 2018 and south-eastern Europe in 2021	Wildfires can cause fires at sites and transportation infrastructure, with associated risks for staff and assets. Wild fires and resulting actions can cause severe business interruptions.	Climate risks of wildfire in forests is estimated as low to medium (see KWRA 2021a)	Europe: The potential for wildfires has increased from 1980-2019, especially in southern, western and central Europe. While increased efforts in fire management counteract the trend of fire outbreaks in most of Europe, climatic conditions aggravate the potential for wildfires especially in southern Europe and the Mediterranean. Moreover, it is projected that new fire-prone regions will emerge in western, central and northern Europe (see IPCC 2021a).
***Reduced water levels (surface water, groundwater)** Reduced water levels of surface waters are a consequence of drought. Reduced water levels of groundwater are a consequence of drought, increasing mean temperatures, decreasing mean	Germany: Very low water levels at the Rhine river in 2022 (see Reuters 2022).	Low surface water levels may affect cargo shipping, cooling processes and other water intensive uses. Low groundwater levels may pose problems for the production of water for purposes of the food industry.	The climate risks of low surface water levels have been estimated to be medium to high. The risks of low groundwater levels have been estimated to be low to high (see KWRA 2021c).	“The frequency and severity of low flows are projected to increase, making streamflow drought and water scarcity more severe and persistent in SEU [Southeastern Europe] and WCE [Western Central Europe] […] but decreases are projected in most of NEU [Northern Europe] except southern UK. […] Groundwater abstraction rates reach up to 100 million m^3/year across WCE and SEU, and exceed 100 million m^3/year in parts of SEU. Low recharge rates lead to a depletion of groundwater resources in parts of SEU and WCE, increasing the impacts on water scarcity in SEU. Groundwater pumping and declines in groundwater discharge already threaten environmental flow limits in many

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
precipitation as well as increased withdrawal.				European catchments, especially in SEU, extending to almost all basins and sub-basins within the next 30-50 years. The combined effect of increasing water demand and successive dry climatic conditions further exacerbates groundwater depletion and lowers groundwater levels in SEU but also WCE. Declines in groundwater recharge of up to 30% further increase groundwater depletion especially in SEU and semi-arid to arid regions. Even in WCE and NEU projected increases in groundwater abstraction will impact groundwater discharge, threatening sustaining environmental flows under dry conditions." (IPCC 2021a)
***Decreasing water quality – surface water** Less water in water bodies leads to an increased share of chemical and biological pollutants. Additionally, algae growth is fostered through rising water temperatures and reduced mixing. Also, storm water can cause uncleaned sewage to enter surface water.	Mass dead of fish in Dreisam river and Rhine river in Switzerland and Germany 2018 (see Deutsche Welle n. y.)	Decreased water quality can have severe impacts on the fishing industry, other ecosystem-dependent water uses and tourism (see KWRA 2021c). The food industry in regions in which drinking water production is dependent on river dams or other surface waters are vulnerable.	Climate risks were estimated as medium to high for biological and chemical water quality in surface waters (see KWRA 2021c)	Europe: "The changes in climate have increased water temperatures of rivers and lakes, decreased ice cover, thereby affecting water quality and freshwater ecosystems. […] More frequent and severe droughts and rising water temperatures are expected to cause a decrease in water quality. Such conditions encourage the growth of toxic algae and bacteria, which will worsen the problem of water scarcity that has been largely caused by human activity. […] The increase of cloudburst events (sudden extreme rainfall) is also likely to influence the quality and quantity of fresh water available." (European Commission n. y.)
***Decreasing water quality - groundwater** "Ground-water is an integral part of the natural water cycle.	-	Groundwater is a main source of drinking water. Also, the food industry is vulnerable to decreasing groundwater quality.	Climate risks to groundwater quality was estimated to be	"Climate change may affect groundwater quality, through interdependencies between pollution and over-abstraction. For example, if an aquifer is over-abstracted, the concentrations of nutrients and chemicals may increase, because pollutants will be less diluted. Over-abstraction in

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Once degraded or depleted, it can take years or decades for ground-water to recover. […] Over-abstraction of water from coastal freshwater aquifers may also result in saline intrusion into the underlying seawater." (EEA 2022d)			low to high (see KWRA 2021c).	water-stressed areas can also cause groundwater pollution if saline or polluted waters are drawn into the aquifer. The rise in average sea level and the increase in storm surges predicted as a result of climate change may lead to coastal groundwater aquifers across the EU-27 being further affected by seawater intrusion. Climate change is expected to increase the demand for water for irrigation in Europe. For example, increasing temperature may allow the expansion of agricultural activities in northern latitudes and, in turn, increase demand for water for irrigation in this region. The integrated management of water demand at river basin level is essential to prevent unsustainable over-abstraction in areas where water stress prevails." (EEA 2022d)
Changing wind patterns Wind patterns changing in intensity and distribution	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned		Currently no general estimate available.	Europe: Data from the EUs Earth Observation Programme Copernicus shows that except for northern Europe, most regions in Europe experienced a decrease in mean wind speeds at 100 m between 1979 and 2020 (see Energy Monitor 2021). Projections suggest that especially southern Europe will face a decrease in average wind speeds in summer while northern will experience increasing speeds in winter (see IPCC 2021a). More information on trends and projected changes in mean wind speeds in Europe and its sub-regions can be found in the interactive index-based EEA report on Europe's changing climate hazards (see EEA 2021k).
Storm (including blizzards, dust and sandstorms)	Storm Xavier 2017, Storm Eleanor (in Germany: Burglind) 2018, Storm David	Storms and tornadoes can cause severe damages on infrastructures and buildings	High	Europe: "There is moderate confidence in projections that the frequency and intensity of storms will increase in northern

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Storm: wind speed from 75 to 88 km/h Heavy storm: wind speed from 89 to 102 km/h Hurricanesque storm: wind speed from 103 to 117 km/h (see DWD Encyclopaedia n. y.d, translation by adelphi)	(in Germany: Friederike) 2018, Storm Ciara (in Germany: Sabine) 2020	and thus interrupt supply chains or production processes. Tornadoes can cause severe damages on infrastructures and buildings and thus interrupt supply chains or production processes.	It is uncertain how climate change will affect intensity and frequency of storms in Germany (see DWD n. y.).	and central Europe. For southern Europe, storm intensity is expected to increase but with a decrease in their frequency" (EEA 2021l).
Tornado "A tornado is an air column in contact with the ground, rotating about a more or less vertically oriented axis and located under a cumuliform cloud" (DWD Encyclopaedia n. y.e translation by adelphi)	Europe: Tornado in the South Moravian Region 2021, Czech Republic; Tornado in Paderborn, Germany 2022		Currently no general estimate available.	The influence of climate change on tornado formation remains unclear.
Soil degradation Soil degradation refers to the process(es) by which soil declines in quality and is thus made less fit for a specific purpose, such as crop production (see OECD Glossary 2001).	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned	Soil degradation has negative impacts on agriculture and forestry since crops are not provided with a sufficient amount of nutrients.	Climate risks to productivity of soils are estimated to be medium to high (see KWRA 2021d).	Europe: Increasing urbanisation rates and intensification of agriculture are leading to an increase of soil degradation (see EEA 2020). Based on the assumption of a temperature rise of 2 °C, "8% of the territory of Europe were characterised to have a high or very high sensitivity to desertification" (IPCC 2021a).

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany[27]	Information and sources on trends of the climate-related hazard
Soil erosion Removal of soil material, often natural (water, wind) but amplified or even triggered by human activities (e.g. agriculture) (see UBA 2022).		Organic matter and nutrients can be washed out or blown away leading to severe impacts on agriculture or forestry. Also, the statics of buildings or transport infrastructures can be endangered through soil erosion.	Climate risks connected to soil erosion by wind or water are estimated to be medium to high.	"Soil loss by erosion is the main cause of soil degradation in the Mediterranean region. In some areas, soil erosion cannot be reversed, while in others nearly complete removal of soil has been observed." (EEA 2020). Under future climate projections, the increase of rainfall might increase soil erosion. Yet, this effect might be compensated by an increasing vegetation cover due to higher temperatures. However, in the near future, human activities are projected to further increase soil erosion stronger than climate change (see IPCC 2021a).
Landslide "Mass-movement landforms and processes involving the downslope transport, under gravitationary influence of soil and rock material en masse." (EEA Glossary n. y.)	Germany: Triggered by heavy floods in the Ahr valley in 2021 landslides occured	Landslides can severely impact the statics of transport and critical infrastructures as well as buildings.	Climate risk of landslides was estimated to be low to medium (see KWRA 2021d).	Germany: "The length of endangered sections of the federal motorway and rail networks could double by the end of the century" (KWRA 2021b). Europe: Increased precipitation patterns are expected to increase the risk of landslides. In the European Alps and the Carpathians, the risk of shallow landslides is projected to increase (see IPCC 2021a).
Subsidence Process by which an area of land (gradually) sinks to a lower level than the land surrounding it (may be caused by both natural processes and human activities) (see NOAA n. y.)	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned	Subsidence can severely impact the statics of transport and critical infrastructures as well as buildings.	Currently no general estimate available.	Europe: Land subsidence was observed to contribute to relative mean sea level rise. Therefore, the intertidal flats in the Dutch Wadden Sea are at risk in the near future (see IPCC 2021a). Generally, increasing drought risks increase the risk for subsidence gradually. Especially buildings built on poor foundations such as clay-rich soil are at risk of being affected by subsidence (see SwissRe 2021).

Table 8: Climate-related hazards that can just occur in specific regions

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Where can it occur?	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany [30]	Information and sources on trends of the climate-related hazard
Permafrost thawing "Progressive loss of ground ice in permafrost, usually due to input of heat." (IPCC 2021b)	In very cold areas; in Europe permafrost mainly occurs on Norway, Sweden and the Alps (but also in other mountain areas as the Pyrenees)	Norway: Buildings get destabilised by thawing permafrost (see The Barents Observer 2018)	Permafrost thawing leads to destabilisation of the ground and can thus damage buildings and infrastructure.	Currently no general estimate available.	Europe: Permafrost in the European Alps and Scandinavia is observed to reduce due to rising temperatures. For the European part of the Russian arctic, increased temperatures from 0.5 to 2.0 °C have been observed. This dynamic will continue even under conservative future projections which has severe impacts on the stability of infra-structures (see IPCC 2021a).
Glacial lake outburst "A sudden release of water from a glacier lake, including any of the following types – a glacier-dammed lake, a pro-glacial moraine-dammed lake or water that was stored within, under or on the glacier." (IPCC 2019)	In regions close to waterbodies dammed from or underneath glaciers or moraines	-	Floods triggered by glacial lake outbursts can have severe impacts on transport and critical infrastructures as well as buildings, production processes and tourism.	Currently no general estimate available	Europe: A historic review listed 14 reported floods resulting glacial lake outburst in the European Alps. On a global level, glacial lake outbursts still happen on a regular level but the periodic nature of these events are observed to diminish. However, it was concluded that this observation is due to long responding time dynamics which are expected to increase in the context of global warming (Harrison et al. 2018).
Cyclone, hurricane, typhoon Beyond 32 m s^{-1}, a tropical storm is called a hurricane [eastern and western of the American continent], typhoon [Northwestern Pacific, or	Cyclones: Indian Ocean & southern Pacific Ocean; Hurricanes: Atlantic Ocean	USA: Hurricane Katrina 2005, Hurricane Sandy 2012	Storms can cause severe damages on infrastructures and buildings and thus interrupt supply chains or production processes.	Currently no general estimate possible	Europe: "The simulation of extra-tropical cyclones in climate models remains a scientific challenge in spite of significant recent progress in modelling techniques" (EEA 2021m). However, the frequency of extratropical cyclones will increase

[30] In Germany, a generally high exposure is given to those climate-related hazards which can cause many high climate risks according to the Climate Impact and Risk Assessment 2021 for Germany (KWRA): Drought and strong winds. Climate-related hazards also include so-called upstream climate impacts (= purely physical impacts of climate change, e.g. floods and flash floods). For these, the related climate risks were assessed in the KWRA. The climate risk levels in the present and mid-century (assuming a strong climate change) were adopted.

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Where can it occur?	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany [30]	Information and sources on trends of the climate-related hazard
cyclone [Indian Ocean & southern Pacific Ocean], depending on geographic location" (IPCC 2012) Any cyclonic-scale storm that is not a tropical cyclone is called extratropical cyclone. In the Mediterranean, extratropical cyclones are called Medicanes.	and north-eastern Pacific Ocean; Typhoon: north-western Pacific Ocean Europe: Medicane all over Europe, except for Scandinavia (and Scotland)	Europe: Medicane Numa 2017, Medicane Ianos 2021			up to 30 % which further increases the amount of heavy precipitation events in winter whereas the frequency of cyclones is projected to decrease in the Mediterranean in summer (see EEA 2021n).
Ocean acidification "A reduction in the pH of the ocean, accompanied by other chemical changes (primarily in the levels of carbonate and bicarbonate ions), over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO_2) from the atmosphere […]."(IPCC 2021b) ***Increasing CO_2 concentration- marine waters**[31]	Acidification rates in European seas are the same as on the global level. However, the most northern seas become acidic even faster.	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned	The ecological balance of the oceans will be impacted by their acidification: Coral reefs and mussels are vulnerable against low pH values which leads to the loss of habitat for many fish impacting other fish. Thus, the fishing industry (including clammers) will be impacted by ocean acidification.	Climate risks to decreasing marine water quality was estimated to be medium to high (see KWRA 2021c).	Europe: Ocean acidification is already observed for all seas and oceans surrounding Europe and it is projected to increase under future climate scenarios: "Ocean acidification will develop into a major risk for marine food production in Europe under 4°C […], affecting recruitment of important European fish stocks […]. Acidification is also projected to negatively affect marine shellfish production and aquaculture in Europe with 4°C" (IPCC 2021a)

[31] Ocean acidification is a result of increased CO_2 concentration in marine waters. Therefore, no additional classification is required for this hazard.

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Where can it occur?	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany [30]	Information and sources on trends of the climate-related hazard
***Decreasing water quality – marine waters**[32]					
Saline intrusion Influx of sea water into an area of fresh water.	In coastal areas	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned	Saline intrusion mainly affects the drinking water management as well as the production in agriculture and forestry. Due to its effect on ecosystems it is also relevant for activities like ecosystem restoration or tourism. If buildings are exposed to the incoming salt they might be damaged through accelerated corrosion.	Effects of saline intrusion on groundwater quality was estimated to be medium to high (see KWRA 2021c).	Europe: Groundwater extractions or drainage systems are already observed to cause saline intrusions. Future projections state that “[d]uring summer, seawater will also penetrate estuaries further upstream in response to reduced river flow and SLR [sea level rise] and result in more frequent closure of water inlets in the downstream part of the rivers in a period when water is most needed.” (IPCC 2021a).
Sea level rise “An increase in the mean level of the ocean. Eustatic sea level rise is a change in global average sea level brought about by an alteration to the volume of the world ocean. Relative sea level rise occurs where there is a net increase in the level of the ocean relative to local land movements.	In coastal areas	This is a chronic hazard with slow continuous changes – thus no extreme events can be mentioned	Sea level rise leads to higher storm surge levels, which can pose a risk to people, ecosystems, and structural systems, and can thus severely impact all economic activities connected to the area affected.	Climate risk of sea level rise was estimated to be medium to high (see KWRA 2021c).	Europe: “Relative sea level has risen along the European coastlines. In the future, sea level rise will increase almost everywhere affecting coastal floods, storm surges and coastline recession” (IPCC 2021a). The relative sea level is expected - under a high-emissions scenario - to be greater than 0.60 m along most of the European coastline (with the exception of the northern Baltic Sea and the northern Atlantic coasts) (see EEA 2021o).

[32] Ocean acidification and the warming of the oceans both contribute to plankton growth negatively affecting the water quality. In extreme cases (mostly fostered by a severe nutrient run-off from mainland areas), dead zones (hypoxia) may occur that turn parts of the oceans to biological deserts (The Ocean Foundation).

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Where can it occur?	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany [30]	Information and sources on trends of the climate-related hazard
Climate modelers largely concentrate on estimating eustatic sea level change. Impact researchers focus on relative sea level change." (EEA Glossary n. y.)					
Flood - coastal "An unusual accumulation of water above the ground caused by high tide" (EEA Glossary n. y.)	In coastal areas	Germany: Strom surges caused by Storm Tilo 2007 and Cyclone Xaver 2013		Climate risk of coastal floods (storm surges) was estimated to be medium (see KWRA 2021c)	Europe: "With some limitations to the data, historical once-in-a-hundred-years coastal floods are projected to occur several times a year on the Mediterranean Sea and the Black Sea coasts, at least once a year along most other European coasts under a high-emissions scenario and at least once a decade along the remaining European coasts even under lower emissions scenarios", with the exception of the northern Baltic coast due to land uplift (see EEA 2021p).
***Storm surges**[33]					
Coastal erosion "The landward displacement of the shoreline caused by the forces of waves and currents." (EEA Glossary n. y.)	In coastal areas	Germany: Storm Axel causes 180 meters of coastal land loss on Rugia 2017	Coastal erosion can destroy buildings, transport infrastructure and negatively influence touristic potentials.	Climate risk of coastal erosion was estimated to be medium to high (see KWRA 2021c)	Europe: Coastal erosion will increase on sandy shorelines as a result of the projected sea level rise, however, erosion rates and quantitative amounts are difficult to project (IPCC 2021a).
Solifluction	Sub-polar regions with permafrost; Highlands	This is a chronic hazard with slow		Currently no general	

[33] More intense storm surges are a result sea level rise and have the same implications as coastal floods. Therefore, no additional classification is required for this hazard.

Climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)	Where can it occur?	Past Events (examples)	How can it affect companies directly and indirectly?	Exposure to the climate-related hazard in Germany [30]	Information and sources on trends of the climate-related hazard
Surface removal due to water enrichment above frozen ground.		continuous changes – thus no extreme events can be mentioned		estimate possible	
Avalanche “A mass of snow, ice, earth or rocks, or a mixture of these, falling down a mountainside.” (IPCC 2021b)	In mountainous areas	Ca. 100 avalanche operations within 3 days in 2022 as a consequence of sunny weather accompanied by heavy wind and snowfall	Increased avalanche risks may impact touristic activities.	Currently no general estimate possible	Europe: “Climate change will significantly affect the duration and extent of seasonal snow cover in mountain regions. While these changes are predictable, the effects on the frequency and characteristics of avalanches remain elusive. The overall frequency of avalanches is likely to decrease. As snow cover decreases at lower elevations, the area where avalanches can occur decreases. At higher elevations, where snowfall is still abundant, and might increase in intensity, changes to the avalanche regime might be less prominent. The frequency of human-triggered avalanches might not change, because this depends mainly on the number of winter recreationists.” (Strapazzon et al. 2021)

A.2 Translation matrix for climate-related hazards: IPCC/EEA to EU Taxonomy classification

Information portals for climate data are often based on other classifications of climate-related hazards than those specified in the Climate Delegated Act. One important classification originates from the IPCC AR6 (IPCC 2021c), in which climate-related hazards are referred to as climate impact drivers (CIDs). The IPCC classification is, for example, the basis for the categorisation of climate-related hazards in the interactive EEA report "Europe's changing climate hazards". The following matrix maps the climate-related hazards from the Climate Delegated Act into this IPCC respectively EEA classification. It shows that most hazards from the Climate Delegated Act are covered by the classifications of the IPCC (23 out of 28) or the EEA (18 of 28). Information portals based on these classifications can thus provide far reaching inputs for taxonomy-aligned climate risk assessments. However, it should be noted that many climate-related hazards of the Climate Delegated Act cannot be allocated to a single CID category, but have to be divided.

Table 9: Translation matrix for climate-related hazards - IPCC/EEA to EU Taxonomy classification

CID category from IPCC AR6 (including climate-related hazards from EEA hazards report)	EU Taxonomy climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)			
	Temperature-related	Wind-related	Water-related	Solid-mass related
Mean air temperature (EEA)	▶ Changing temperature (air)			
Extreme heat (EEA)	▶ Temperature variability ▶ Heat wave ▶ Heat stress			
Cold spell	▶ Temperature variability ▶ Cold wave/frost			
Frost (EEA)	▶ Cold wave/frost			
Mean precipitation (EEA)			▶ Changing precipitation patterns and types (rain) ▶ Precipitation or hydrological variability	
River flood			▶ Flood (fluvial)	

CID category from IPCC AR6 (including climate-related hazards from EEA hazards report)	EU Taxonomy climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)			
	Temperature-related	**Wind-related**	**Water-related**	**Solid-mass related**
Heavy precipitation and pluvial flood (EEA: Heavy precipitation and river flood)			▶ Heavy precipitation (rain) ▶ Flood (pluvial, ground water) ▶ EEA: Flood (fluvial)	
Landslide				▶ Landslide
Aridity (EEA)			▶ Changing precipitation patterns and types (rain) ▶ Precipitation or hydrological variability ▶ Drought ▶ Water stress	
Hydrological drought (EEA: drought)			▶ Changing precipitation patterns and types (rain) ▶ Precipitation or hydrological variability ▶ Drought ▶ Water stress	
Agricultural and ecological drought (EEA: drought)			▶ Precipitation or hydrological variability ▶ Drought ▶ Water stress	
Fire weather (EEA)	▶ Wildfire			
Mean wind speed (EEA)		▶ Changing wind patterns		
Severe wind storm (EEA)		▶ Storm (including blizzard, dust and sandstorms) ▶ Tornado		
Tropical cyclone		▶ Cyclone, hurricane, typhoon		

CID category from IPCC AR6 (including climate-related hazards from EEA hazards report)	EU Taxonomy climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)			
	Temperature-related	**Wind-related**	**Water-related**	**Solid-mass related**
Sand and dust storm		► Storm (including blizzard, dust and sandstorms)		
Snow, glacier and ice sheet (EEA)			► Glacial lake outburst	
Permafrost	► Permafrost thawing			
Lake, river and sea ice				
Heavy snowfall and ice storm		► Storm (including blizzard, dust and sandstorms)	► Changing precipitation patterns and types (snow/ice) ► Heavy precipitation (hail, snow/ice)	
Hail			► Changing precipitation patterns (hail) ► Heavy precipitation (hail)	
Snow avalanche				► Avalanche
Relative sea level (EEA)			► Sea level rise ► Saline intrusion	
Coastal flood (EEA)			► Flood (coastal) ► Saline intrusion	
Coastal erosion			► Coastal erosion	
Mean ocean temperature (EEA)	► Changing temperature (marine water)			
Marine heatwave (EEA)				
Ocean acidity			► Ocean acidification	

CID category from IPCC AR6 (including climate-related hazards from EEA hazards report)	EU Taxonomy climate-related hazard (from Delegated Regulation 2021/2139, Annex I, Appendix A)			
	Temperature-related	**Wind-related**	**Water-related**	**Solid-mass related**
Ocean salinity (EEA: Ocean chemistry)				
Dissolved oxygen (EEA: Ocean chemistry)				
Air pollution weather	▶ Changing temperature (air)		▶ Changing precipitation patterns and types (rain)	
Atmospheric CO_2 at surface	▶ Wildfire			
Non-attributable	▶ Changing temperature (freshwater)			▶ Soil degradation ▶ Soil erosion ▶ Subsidence ▶ Solifluction

A.3 Explanations: determination of the scope

These explanations aim to clarify why the procedure outlined in Section 4.1.2 for determining the investigation objects is in line with the Climate Delegated Act.

Background

Up to now, climate risk assessments in companies have mainly focused on sites and, in the case of infrastructure companies, networks or vehicles (e.g. trains). Furthermore, scientific publications discuss and companies have occasionally started to analyse supply chains on climate risks (Loew, Braun & Rink, 2022; Lühr, Kramer, Lambert, Kind & Savelsberg, 2014).

The EU Taxonomy, however, considers economic activities. For some of these activities – e.g. "acquisition and ownership of buildings" – the subject of the required climate risk assessment is obvious. But when it comes to, for example, the "manufacture of organic basic chemicals", the "manufacture of batteries" or the "manufacture of renewable energy technologies", the subject of the assessment (e.g. which sites) must be clarified. Finally, companies often undertake not only taxonomy-eligible economic activities but also economic activities that are not considered in the EU Taxonomy. Furthermore, a company may only want to achieve taxonomy-alignment for part of its taxonomy-eligible economic activities.

Determining the scope: Production sites

Some economic activities may be located at dedicated production sites (e.g. cement production). In this case, we interpret the legal requirements to mean that a climate risk and vulnerability assessment must be carried out for the production site or sites.

Other economic activities (e.g. chlorine production) are located at production sites where other, non-taxonomy-eligible economic activities also exist. Here, our interpretation of the legal requirements is as follows: it is generally possible to only analyse the parts of the site where the relevant production processes take place. Nevertheless, there are several reasons for considering the entire site:

- The distinction between which parts of the site to screen and which to avoid is likely to require more effort than taking the entire site into account.
- The set of economic activities that are expected to be taxonomy-aligned may not be complete from the outset, or additional economic activities may be intended to become taxonomy-aligned in future years.
- It should also be noted that reporting enterprises must not only report on the economic activities with which they generate turnover, but also on activities with which they may not appear on the market. This includes, for example, the energy refurbishment of real estate or operating expenses for existing energy generation plants, even for companies in the manufacturing sector. These economic activities also take place at company locations.
- It does not seem to make much sense to not include the entire site in the analysis; after all, this is how any existing physical climate risks can be identified and, if necessary, reduced.

Determining the scope: Procurement

For some companies, the supply chain is also exposed to significant physical climate risks. While this is obvious for businesses that use agricultural raw materials, the supply of other materials or commodities may be affected due to extreme weather events and other climate change impacts as well. Some studies conclude that, in the case of the German economy, the physical climate risks in the supply chain are higher than at German production sites (e.g. Hirschfeld & Lindow, 2016; Lühr et al., 2014). These assessments assume that, for example, key production sites or infrastructure can fail due to extreme weather events, which can interrupt global supply chains. As a result, climate risk assessments should include the supply chain as a matter of principle.

If the purchasing department is already systematically reducing procurement risks with conventional measures, then

- these conventional measures are very likely to reduce physical climate risks as well (Loew et al., 2023)[34],
- the purchasing department can identify which suppliers and which supplier countries have significant dependencies.

Based on this, we interpret the legal requirements as follows: companies must check whether there is a relevant dependency for individual suppliers or supplier countries for the entire list of economic activities that require taxonomy alignment. If applicable, they can also consider geographical regions. That stated, we recommend this process take place in a proportionate manner, as outlined in Section 4.1.2.2. Obviously, this check happens in coordination with one or more responsible individuals from purchasing.

Determining the scope: Transportation between sites

Please see Section 4.1.2.3 for information on determining the scope of transportation between the company's sites.

[34] This is a result of interviews with employees in companies, which are rather advanced in managing physical climate risks. The results will be published in Q1 / 2023 by Loew et al. (2023) Management von Klimarisiken in Unternehmen: Grundlagen, Anleitungen, Stand der Praxis und Empfehlungen. [Managing climate risks in companies: Fundamentals, Guidance, State of Practice and Recommendations] Publication series UBA Climate Change.

Imprint

Publisher

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Completion: 11/2022