CEN-CENELEC GUIDE 32

Guide for addressing climate change adaptation in standards

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CEN and CENELEC decided to adopt this CEN-CENELEC Guide 32 through decisions BT C165/2015 and D152/C107 respectively.

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Contents

Page

European foreword

CEN and CENELEC develop European Standards (EN) and other publications, including Technical Specifications (TS), Technical Reports (TR) and Workshop Agreements (CWA). The European Standardization System has made a significant contribution to the creation of a common European market, embedded in a global economy, and in disseminating the knowledge incorporated in these publications through its network of CEN and CENELEC (national) Members.

To be able to meet the global climate challenges CEN and CENELEC developed this Guide for addressing climate change adaptation in standards under the mandate in support of the implementation of the Communication [COM(2013) 216 final] (M/526) relating to the EU Strategy on Adaptation to Climate Change.

This Guide complements the already existing CEN Guide 4 'Guide for addressing environmental issues in product standards'.

This CEN/CENELEC Guide has been prepared by a subgroup of CEN/SABE/ENIS-Team "Products and services: Environmental Issues in Standardization" under the supervision of CEN and CENELEC Technical Boards.

Further help for addressing climate change adaptation in standards is available at the CEN Environmental Helpdesk (CEN/EHD) which can be contacted through http://www.cen.eu/CEN/services/ehd, and the CEN-CENELEC website.

Introduction

Ranges of climatic conditions have always been determined and specified for the proper functioning of products. For example, accumulators usually have a certain temperature range, in which their full storage capacity can be exploited. Another example is outdoor clothing that may be moisture-repellent or water-tight, which means that it is suited for high air moisture or also for heavy rainfall. Thus far, the climatic parameter values relevant to a product have been based on the climatic conditions prevailing in the area where the product will be used. However, projections, e.g. by the IPCC (Intergovernmental Panel on Climate Change)[1)], and experience gained in the past years all over the world have shown that analysis of the past and current climate is not sufficient for being protected against climate change impacts such as temperature rise, severe weather events (e. g. damage and disruption caused by the Elbe flooding in 2013 and flooding of River Thames in 2014, damage due to drought and heat in Europe in 2003, etc.). Some products, in particular those with long lifetimes, could be affected by climate change. For example, a building material that can be damaged or degraded by severe weather or a piece of process machinery that can only operate within specific temperature limits. It will therefore be necessary in the future to consider not only climatic conditions resulting from the past, but also future situations of high probability according to e.g. the IPCC.

Design decisions that do not take account of climate based risks throughout the whole life may result in products that are not fit for purpose. Therefore product standards that ignore the effects of climate change may be failing at their main objective of ensuring fitness for purpose, further embedding vulnerability into our infrastructure and economy.

In addition, weather already affects all stages of the life cycle of products. For example, raw material acquisition can be affected if materials are sourced from regions that are especially vulnerable to weather disasters; water intensive production processes can be compromised during times of drought; and severe weather events regularly cause supply chain disruption. These impacts range from slight to significant; they can be short-term or long-term; they can occur at global, regional or local level and they can be different on each stage of a standardization subject's life-cycle.

In some cases, these risks are being underestimated and not adequately dealt with. Therefore, even in the absence of climate change considerations, there is a benefit to improving resilience to the current climate. Provisions in product standards can help organizations and communities to be more prepared for the impacts of severe weather events and to adapt to climatic change.

Climate change adaptation is a field which is constantly evolving. It should therefore be noted that this Guide is based on the best available knowledge. The dynamic nature of climate change strengthens the need to be considered in the standard development or revision process at a very early stage.

This Guide is intended for use by all those involved in the drafting of standards. Standards writers are not expected to become climate change adaptation experts but, by using this Guide, they are encouraged to:

— emphasize that taking into account aspects of climate change is a complex process that requires to look beyond the common boundaries of a special standardization subject;

— identify and understand basic principles that need to be considered when thinking about adaptation to climate change and

— integrate climate change adaptation provisions in standards.

This Guide proposes a step-by-step approach, based on the principle of life-cycle thinking (see also 3.2), as illustrated in Figure 1.

1) http://www.ipcc.ch/.

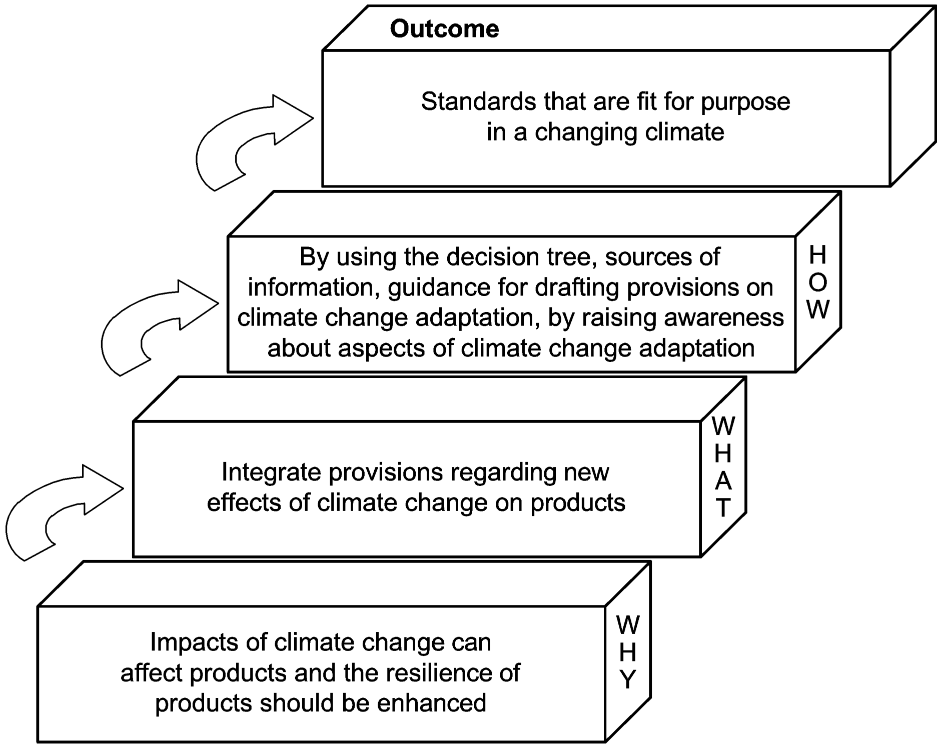

Figure 1 — Step-by-step approach for inclusion of climate change issues

1 Scope

This Guide provides guidance on addressing aspects of climate change adaptation in European standardization documents. This Guide is applicable to product (including design), service, infrastructure and testing standards. For the purposes of this Guide, the definition of the term “product” has been expanded to cover all these aspects.

It is intended to be applicable to both "climate-influenced products" and "climate resilience products" (see the definitions). It is primarily intended for standard writers and aims to enable them to:

— identify relevant climate impacts;

— include climate change adaptation considerations in new or revised standardization documents.

Whenever a new standard is drafted or an existing standard is revised or intended to be revised, the TC-secretaries and their technical committee chairman/convenors are encouraged to actively promote the application of this Guide.

2 Terms and definitions

For the purpose of this document, the terms and definitions given in CEN Guide 4 and the following apply.

2.1
climate
average and variability of weather at a given location over a period of time, normally 30 years

Note 1 to entry: The definition of climate is based on the IPCC definition.

2.2
climate change
change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer

Note 1 to entry: The definition of climate change is based on the IPCC definition.

Note 2 to entry: Both natural processes and human activity can cause climate change.

2.3
climate change adaptation
process of adjustment to actual or expected climate change and its effects

Note 1 to entry: The definition of climate change adaptation is based on the IPCC definition.

2.4
climate change factor
multiple that describes the difference between the current and the future climate or their effects

2.5
climate-influenced product
product whose fitness for purpose may be affected if climate change is ignored

2.6
climate information
information relating to the current, future or past climate or its effects

2.7
climate projections
time-dependent information about the future climate, modelled on the basis of plausible assumptions about future greenhouse gas emissions and climatological relationships

Note 1 to entry: The definition of climate projections is based on the IPCC definition.

2.8
climate resilience product
product whose main aim is to reduce vulnerability to climate hazards, such as flood barriers

2.9
flexibility
extent to which a design decision can be altered as more information becomes available

2.10
hazard
circumstance or situation where life, health, property, infrastructure, livelihoods, service provision or environmental resources are threatened

Note 1 to entry: The definition of hazard is based on the IPCC definition.

2.11
infrastructure
set of interacting or interdependent structural elements (system) that provide basic physical and organizational structures needed for the functional operation of society, enterprise or the services and facilities necessary for an economy

Note 1 to entry: These vital functions are generally ensured by products, systems and processes that are often subject of standards.

Note 2 to entry: As examples of functional operation of society and economy following demands can be called: basic supply (e.g. production, storage and distribution of water, food, energy and products), habitation, communication, finance, health including emergency service and public administration including civil protection and public security.

2.12
life cycle assessment
LCA
compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

[SOURCE: EN ISO 14044:2006, 3;2]

2.13
life-cycle thinking
LCT
consideration of all relevant environmental aspects (of a product) during the entire (product) life-cycle

[SOURCE: IEC Guide 109:2003, 3.10]

2.14
product
good, service, infrastructure or test

Note 1 to entry: The definition from CEN Guide 4 is broadened for the purposes of this Guide.

2.15
resilience
capacity of a social, ecological or economic system to cope with hazardous events or disturbance, responding or reorganizing in ways that maintain its essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation

Note 1 to entry: The definition of resilience is based on the IPCC definition.

2.16
sensitivity
degree to which a system is affected, either adversely or beneficially, by climate variability or change

Note 1 to entry: The definition of sensitivity is based on the IPCC definition.

2.17
severe weather
weather event or combination of events that has significant effects or consequences

Note 1 to entry: These events include heat waves, droughts, heavy precipitations, floods and storms that affect both society and the economy.

Note 2 to entry: In addition severe weather is rare and occurs at a certain place at a certain time.

2.18
thresholds
level of magnitude of a climate variable (e.g. temperature) at which an effect or impact occurs

2.19
vulnerability
propensity or predisposition to be adversely affected

Note 1 to entry: Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

[SOURCE: IPCC: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Glossary. Cambridge]

2.20
weather
physical state of the atmosphere at a particular time or in an even short period of time at a specific location

Note 1 to entry: The weather is characterized using quantifiable parameters. These parameters are fundamental variables of the weather (weather elements) such as temperature, humidity, air pressure, wind direction and wind speed, cloud cover, precipitation, and visibility.

3 Approach for integrating climate change adaptation provisions in standards

3.1 General

This clause contains basic principles and approaches that should be considered by standard writers and provides guidance for integrating climate change adaptation provisions in standards.

In drafting provisions, standard writers should consider relevant aspects and impacts of climate change at all stages of the product-, service- or testing-lifecycle (see Figure 1). In addition, standard writers should advocate a risk based approach to taking account of climate impacts on fitness for purpose.

3.2 Life-cycle thinking

This Guide refers the life cycle of a product. Figure 2 shows how the stages of goods, services and testing relate. Life cycle assessment is not an appropriate approach for adaptation. However, life cycle thinking can help to make sure all relevant aspects of a product are considered.

a) Good and infrastructure standards:

For the purposes of this Guide the following stages of a good or infrastructure life cycle are defined (based on CEN Guide 4):

1) acquisition;

2) production;

3) use;

4) end-of-life.

b) Testing standards:

CEN-CENELEC Guide 33, Guide for addressing environmental issues in testing standards, explains that testing can take place in different stages of a products life cycle and defines the following life-cycle stages of testing:

1) sampling;

2) sample preparation;

3) testing;

4) reuse, recycle, recover.

With normative testing of products their required properties and their suitability for the intended use should be checked, proven and possibly classified. These tests usually simplify the real operating conditions in form of the laboratory simulation. In this case, both the maximum load to be expected, as well as a number of combinations of possible impacts, can be applied. On this basis, products and systems with respect to their suitability for the application, for example suitability for one or more climatic zones can be tested and classified, if necessary.

To adapt the testing standards to climate change it should be therefore examined, starting from the scientific climate projection, whether:

— the climatic conditions of the tests are to be adjusted, if necessary, for example for road surface, which can optionally be subjected to a much higher temperature in summer,

— the test methods for climatic simulation, if necessary, should be adapted due to higher frequent changes of extreme conditions, e. g. climatic chamber for reproduction of the aging process of protective coatings, and

— new normative test methods are to be developed for products and systems that can contribute to improving resilience, such as mobile flood protection systems, for which there is currently no standards on tests exist.

Each stage of testing might be influenced by climate change.

c) Service standards:

For the purposes of this Guide the following stages of services life cycle are defined (based on CEN Guide 15):

1) acquisition;

2) promotion;

3) service provision;

4) end of service provision.

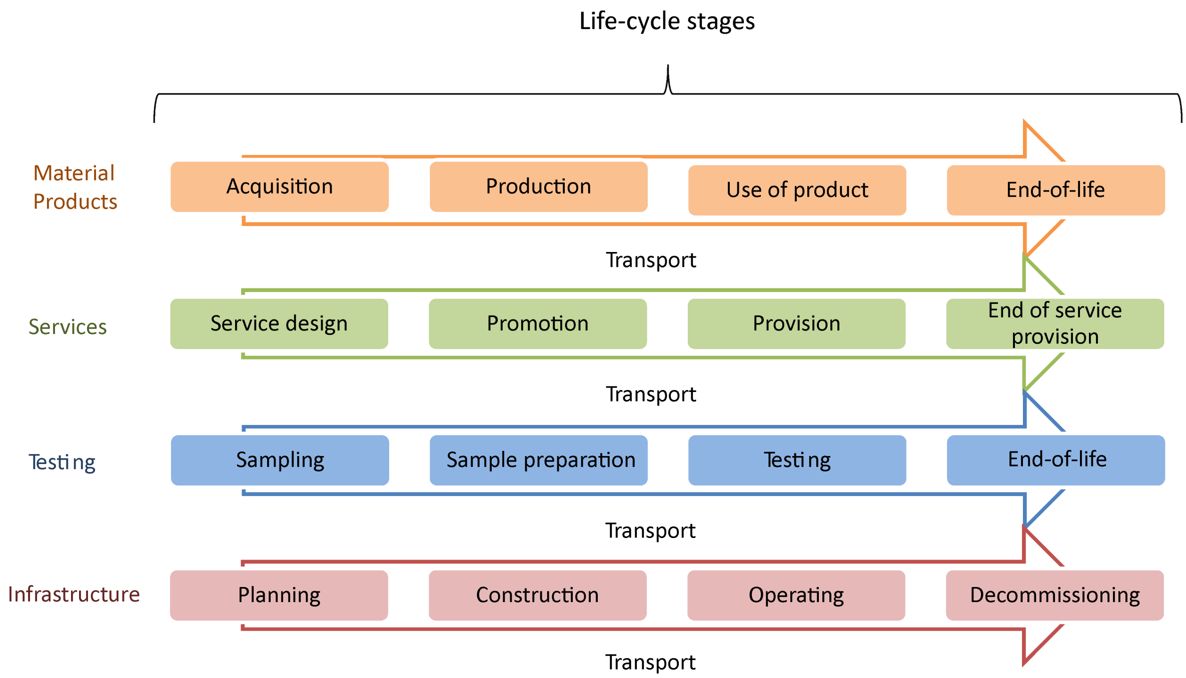

Figure 2 — Life-cycle stages

Climate drivers
Annual / seasonal / monthly average (air) temperature Extreme (air) temperature (frequency and magnitude) Annual / seasonal / monthly average precipitation Extreme precipitation (frequency and magnitude) Average wind speed Maximum wind speed Humidity Solar radiation

Secondary effects/ climate related drivers
Sea level rise (SLR) (plus local land movements) Sea/ water temperatures Water availability Storm (tracks and intensity) including storm surge Flood Ocean pH Dust storms Coastal erosion Soil erosion Soil salinity Wild fire Air quality Ground instability/ landslides/ avalanche Urban heat island effect Growing season length Icy conditions/ ground frost Thawing of permafrost

Impacts
Physical damage
Loss of access
Behaviour change
Health effects
Social change

Consequences	Life cycle stages			
	1	2	3	4
Changes to prices and availability of inputs	X	X		
Disruption to supply of raw materials	X	X		
Changes in demand		X		
Changes in user requirements			X	
Effects on quality/ performance			X	
Effects on chemical or mechanical processes			X	X
Transport disruption	X	X	X	X

Figure 3 — Climate drivers, impacts and consequences for life-cycle stages

3.3 Use of a risk based approach

It is now “unequivocal” that the climate system is warming and extremely likely that human activity is the dominant cause, in accordance with IPCC 5th Assessment Report. However, plenty of uncertainty remains in terms of the rate and geographical distribution of this change and the effects it will have.

Adapting to climate change involves making decisions in the face of uncertainty. There are uncertainties relating to the rate and geographical distribution of changes in climate variables and there are modelling uncertainties. Most importantly, however, there are uncertainties relating to how climate change will translate into impacts on materials, processes and systems and what the consequences of these impacts will be for society. The use of a risk-based approach to adaptation allows for uncertainties to be acknowledged and embraced in the decision making process and for climate risks to be considered alongside and on an equal footing to other risks that are routinely managed.

NOTE Risk is determined in general by the probability of damage occurring as a realization of the hazard and the expected extent of damage as the consequences in case of a realization of the hazard. This definition differs from ISO 31000 in wording and is nevertheless consistent with the ISO definition. Here, the uncertainty can be determined as the probability of a damage occurring and the effects of uncertainty (or hazard) on objectives as the consequences.

For risk-based analysis, it is necessary to identify and evaluate all relevant risks. For the risk assessment both the probability and the expected extent of impacts should be quantified as far as possible. Currently, the probability of the possible impacts of climate change, e. g. severe weather events, is mostly based on computational modelling. Therefore, it shall be examined in the context of risk management, which extent of impacts in case of a risk realization is still acceptable for the affected communities and businesses. This can inform the necessary measures for the adaptation. It can also be used to evaluate a range of adaptation options. Individuals and organizations have different objectives and attitudes to risk (how much risk they are prepared to accept) so in many cases it is not appropriate to standardize the outcome of a risk assessment, especially in an organization. However, at the level of the product, the main objective should be seen as fitness for purpose and standards writers may in some cases see merit in standardizing the level and type of adaptation required using a risk based approach.

3.4 Taking into account climate change and severe weather events

3.4.1 Impacts of climate change and severe weather

Standards writers are quite used to taking into account weather risks, when drafting provisions. The impacts of severe weather events include flood or storm damage, health effects and disruption to energy supply, transport or supply chains. Here, they are encouraged to also take into consideration the impacts of a changing climate, i.e. those that arise from an increasing frequency and intensity of weather events or from trends in monthly or seasonal averages. The impacts of such trends include a reduction in water available for production and use stage processes and an increase in ground instability affecting buildings or infrastructure assets. Exposure to both severe weather and the impacts of climate change depends heavily on geographical factors, for example, urban areas are particularly exposed to temperature rise and sea level rise and its associated impacts are more of a concern for coastal zones, islands, areas already below sea level or offshore locations.

a) Changes to long-term averages:

The impacts of changes to long-term averages include effects on water and other ecosystems and food production. The impacts of severe weather events include flood or storm damage, health effects and disruption to energy supply, transport or supply chains. These changes shall be considered for standards that imply long term consequences. For products, if there are any long term consequences of design decisions, these are almost always going to occur in the use and end of life phases of products that have long life times.

b) Severe weather events:

In addition to average changes in climate severe weather events are expected to become more common.

Risks based on severe weather events are relevant throughout the whole life cycle. Such risks can be underestimated due to:

1) weather events being seen as something familiar and unavoidable;

2) over the last few years the frequency of severe weather events has increased, while the risk perception has stayed the same.

3.4.2 Current and future climate risks

Due to climate change, future climate risks will be different from those in the present or recent past. Therefore, when considering the use and end of life stages of products with long life times, future climate risks that draw on climate projections need to be considered.

For the other life cycle stages (and for whole life cycle if the product life time and planning horizon is short), only the current climate risk is relevant. However, current climate risks can be underestimated due to:

— weather events and the effects of climate being seen as something familiar and unavoidable;

— the perception of risk not keeping up with the effect that climate change has already had on the level of risk.

3.4.3 Adaptation measures

A variety of adaptation measures are available to organizations, ranging from technological solutions and management responses to strategic changes. For example, flood walls, backup systems for business data, remote working, emergency plans or diversified supply chains.

Product standards, however, can only include measures that involve a change to the design of the product itself. The next section describes this in more detail.

3.5 Design

Design decisions for products and production processes are an important way of dealing with climate change related issues in all stages of a life cycle.

In particular, the exposure or operating conditions for products and systems may change substantially (e.g. the maximum temperature in summer for the design of asphalt pavement or for the cooling load). In addition, new products and systems may be needed or increasingly required to control new hazards, e.g. against heavy rain.

NOTE The EU approach to the circular economy considers design as a life cycle stage (see Bibliography). However, for the purposes of this Guide design sits outside the life cycle as the means by which impacts across the whole life are managed.

Ways in which product standards could contribute to adaptation include:

— taking into account extreme end use conditions within appropriate calculations, changing material composition or structure to adapt to the expected changes in operating conditions, testing in relation to changed end use conditions or new hazards (interfaces to testing standards); and

— increasing maintenance to achieve the planned life of products and in spite of the changed end use conditions (interfaces to service standards).

EXAMPLE Initial discussions about the adaptation of the standards to climate change in Germany (DIN) have concluded that it is necessary that:

a) the standards writers know, understand and can assess the implications of climate change and

b) climate scientists know which climate data with which accuracy are needed for standardization.

For this reason, DIN is considering developing a standard for climate data with the involvement of climate scientists, weather experts and standards writers.

3.6 Systems

In most cases, products are interacting components of whole systems that provides a function to society or the economy.

For example within a railway system, track is designed to interact with the earthwork it sits upon, the rail is designed to match the vehicle wheel, the earthwork is designed to support the track and electrification masts, the wheel and its suspension are designed to match the rail characteristics, etc. Drainage can affect earthwork stability and track geometry which in turn can impact upon the efficiency of electricity power current collection and rail/ wheel grip. Standard writers should therefore identify whether their standardization subject interfaces with any climate influenced products and take steps to make sure that their standard does not constrain adaptation at these interfaces. This may include consideration of supply chain and other processes internal to the organization.

In addition, new components will have to interface with existing components and there will be a range of different lifetimes between individual components. Any timescales for the consideration of climate change within standards will need to take into account the interface of components with different ages and lifetimes.

4 Guidance for integrating climate change adaptation provisions in the product standard

4.1 General

This section describes how to integrate provisions regarding effects of climate change. It covers each life cycle stage and provides examples of climate change impacts and climate change adaptation provisions.

Tables 1 to 6 give examples of recommendations for each stage of the life cycle that should be reflected while integrating provisions on climate change adaptation.

Depending on the nature of the relevant climate impact and the scope of the standard, standard writers should decide if such provisions need to be included in a standard as requirement, recommendation or statement.

The attention of standards writers is drawn on possible counterproductive effects in case adaptation measures result in more GHG emissions than before the revision of concerned standards.

Such a warning should also be included in the decision trees (for both new and existing standards).

4.2 Acquisition

Climate change related impacts on the acquisition of raw materials include:

— supplier disruption due to weather event, in particular where suppliers are in vulnerable locations, such as near rivers, on flood plains or in areas of water scarcity;

— raw material production affected by climate change, in particular for agricultural products where climate is a key input or raw materials whose production requires high volumes of water.

Table 1 gives recommendations for adaptation provisions related to acquisition of raw materials.

Table 1 — Acquisition stage related examples

Examples of provisions in standards	Choices, limitations or win-wins
	Any change in raw materials: - can affect quality, emissions, energy use at any life cycle stage; - can affect the costs of making the product and taking it to market; - could have implications for resource scarcity or end-of-life options. NOTE These apply to all of the following examples.
Give preference to materials that can be sourced from more than one place.	A choice between social objectives and resilience occurs where the production/ export of the material with only one source is essential to support livelihoods.
For agricultural products, consider different ingredients or new climate resilient varieties.	The limit to this is where the more vulnerable ingredients or varieties are vital for sustaining a poor rural community. Changing raw material qualities and increased costs for raw material due to poorer harvests.
Design for flexibility so that adjustments can be made later on as more information becomes available.	Reorganization measures for existing products, processes and buildings, especially for historical buildings, can´t be carried out without any limitations.
Give preference to materials without climate sensitive production processes.	
Give preference to materials, the extraction of which will not increase the vulnerability of the area of origin.	
Provide suitable information for the producer e.g. information about boundary conditions.	

4.3 Production

Climate change related impacts on production processes include:

— impacts on staff comfort or health and safety due to severe weather and its impacts;

— impacts on climate, weather or temperature sensitive production processes, such as those reliant on cooling, water use, energy supply, using long-lived assets;

— impacts on outdoor activities that are weather dependant.

Decisions related to manufacturing processes are normally made in the short term e.g. purchasing or leasing of machinery, planning of production processes, recruitment of staff and training, in which case only the current climate should be considered. An exception might be the procurement of machinery that is expected to last a long time.

For adaptation of products and production to climate change as a possible subject of standardization it is also helpful that the processes for the design of products and production are systematically and continually examined. Therewith the adaptation in time should be ensured.

Table 2 gives recommendations for adaptation provisions related to production.

Table 2 — Production stage related examples

Examples of provisions in standards	Choices, limitations or win-wins
Encourage use of water efficient process equipment.	There may be choices to make between water efficiency and energy efficiency, quality or costs as well as with sensitivity to temperature or other weather variables.
Avoid designs that require weather or temperature sensitive production processes or equipment.	There may be choices to be made between temperature/ weather sensitivity and water or energy efficiency, quality or costs.
Choose materials that can be easily stockpiled i.e. those that do not degrade quickly and can be easily stacked.	
Design aids and recommendations, such as maps including information about driving rain zones, should be updated with projected climate information for appropriate future time periods, where this is available.	The limit to this is where the right kind of future climate information is not available.

4.4 Service Provision

Climate change related impacts on service provision include:

— impacts on staff or customer comfort or health and safety due to excessively high temperatures or inclement weather;

— impacts on staff or customer travel due to severe weather or flooding;

— impacts on climate, weather or temperature sensitive equipment or consumables, such as those reliant on cooling, water use or energy supply;

— impacts on outdoor activities that are weather dependant.

These impacts can lead to either a disruption, where service provision ceases entirely or to a change in the quality of the service provided. Decisions related to service provision are normally made in the short term e.g. purchasing or leasing of machinery, planning of production processes, recruitment of staff and training, in which case only the current climate should be considered. However, if resources, such as equipment or premises require longer planning horizons, the future climate conditions should be taken into account.

Table 3 gives recommendations for climate change adaptation provisions related service provision.

Table 3 — Service provision related examples

Examples of provisions in standards	Choices, limitations or win-wins
Ensure buildings can function and provide thermal comfort in a changing climate.	There may be choices to be made between water efficiency and energy efficiency, quality or costs.
Put in place remote working arrangements.	There may be choices to be made between quality or costs e.g. of providing associated information and communications equipment.
Put in place flexible working arrangements.	There may be choices to be made between quality.
Use business continuity plans and procedures to minimize the impact of a disruption when it occurs including plans for recovery.	
Give preference to equipment that is not weather sensitive.	There may be choices to be made between quality or costs.
Design aids and recommendations, such as maps including information about driving rain zones, should be updated with projected climate information for appropriate future time periods, where this is available.	The limit to this is where the right kind of future climate information is not available..
Include different design approaches depending on the geographical factors of area of use and provide relevant supporting information e.g. maps.	

4.5 Use

The impacts of climate change on the use stage include:

— impacts on the effectiveness of a product that is climate or weather sensitive;

— impacts of climate change on users lead to changing requirements of products, especially for users in vulnerable locations or those with vulnerable supply chains;

— impacts on maintenance requirements.

In order to protect the fitness for purpose of the product throughout the whole of its life it is necessary to first have a clear understanding of the expected life time. Where this is longer than about 10 years, design decisions should take into account how the climate will change over this time frame. For products with shorter lifetimes, climate change may not be looked at as having potential impact unless e.g. the end of life of the product, service or process has long term effects and is climate sensitive (as in case of landfilling).

Table 4 gives recommendations for climate change adaptation provisions related to the use stage.

Table 4 — Use stage related examples

Examples of provisions in standards	Choices, limitations or win-wins
Choose materials that are more robust, heat resistant, porous, waterproof (depending on the context).	Any change in raw materials or design: - can affect quality, emissions, energy use at any life cycle stage; - can affect the costs of making the product and taking it to market; - could have implications for resource scarcity or end-of-life options; - will have implications for the functioning and vulnerability of the whole system.
Choose materials that are more robust, heat resistant, porous, waterproof (depending on the context).	
Design for resilience/ resistance e.g. changed dimensions.	
Design for durability including improved reparability and maintainability.	
Optimize the lifetime.	This will have implications for resource efficiency.
Design for portability so it can be moved and kept safe from weather hazards e.g. smaller, lighter, movable, easily assembled/ disassembled, can be controlled remotely, own power source, etc.	
Inclusion of information for users e.g. operating instruction that take into account climate change related impacts.	Uncertainties with respect to climate change and knowledge gaps.
Include different design approaches depending on the geographical factors of area of use and provide relevant supporting information, e.g. maps.	

4.6 End-of-Life

Climate change related impacts on a product at the end of its life include:

— some disposal or reprocessing activities may be weather or temperature sensitive;

— reusability can be affected by increased weather related wear and tear;

— product in the waste stage can no longer be landfilled or incinerated, or it may become harmful to health and environment.

Table 5 gives recommendations for climate change adaptation provisions related to the end of life operations.

Table 5 — End-of-Life stage related examples

Examples of provisions in standards	Choices, limitations or win-wins
Development of a systematic evaluation procedure for cases of damage.	No known limitations or decision conflicts/No example provided.
Assess that products at end of life will not be negatively affected by climate change in their reuse, recycling, recovery, disposal or decommissioning and look for new/alternative end-of-life options if necessary.	

4.7 Transportation

Transportation needs to be considered at all stages of the life cycle.

Climate change related impacts to products during transportation (including transport of raw materials, product to market or product at the end of its life) include:

a) weather events cause disruption to transport infrastructure leading to delays, in particular if travelling over long distances or through affected regions:

   1) transport infrastructure can be damaged by severe weather events or thawing of permafrost;

   2) loss of access e.g. due to flooding;

b) product is damaged or degraded during transport due to temperature or humidity.

Table 6 gives recommendations for climate change adaptation provisions related to transportation.

Table 6 — Transportation stage related examples

Examples of provisions in standards	Choices, limitations or win-wins
Traffic planning (not through vulnerable regions).	Longer delivery routes may lead to delay and higher costs.
Consider the location of raw material production (see acquisition).	
Choose the most resilient way of transport.	Choose the optimum between resilience and reduction of GHG emissions.
Choose new/ alternative ways of packaging.	Balance between waste and GHG emissions.

5 Checklist for relevance and decision trees

5.1 Checklist for relevance

If the answer to any of the following eight questions is yes then climate change adaptation considerations are relevant to the development of your standardization document(s).

— Does the production or service delivery depend on the supply of water (high volumes or specific quality), energy, agricultural or forestry products?

— Is the climate or water a key input into the production process?

— Does production or service provision involve any outdoor activities?

— Are there any climate, weather or temperature or humidity sensitive production processes, such as those reliant on cooling, water use or energy supply?

— Is the standard for a test method that is sensitive to temperature or humidity?

— Is the effectiveness of the product be affected by the weather or climate?

— Does the weather or climate influence what properties are required of the product?

— Are disposals or reprocessing activities likely to be weather or temperature sensitive?

If you answered no to the above questions but the answer to any of the following four questions is yes then climate change adaptation considerations may be relevant to the development of your standardization document. Document your decision being explicit about the reason.

— Does the product rely on the supply of specific raw materials or inputs from a specific region?

— Is production or service provision likely to rely on staff occupying premises where of health, safety and comfort could be compromised by weather?

— Is the design lifetime of the product more than 10 years including its reuse? Is reusability important?

— Does your standard deal with transportation or its transport involved in any stage of the life-cycle?

If you answered no to all of the above questions the climate change adaptation considerations are not relevant to the development of your standardization document(s).If you answered yes to any of the above questions you should continue to read this Guide to determine whether or not climate change adaptation is relevant.

5.2 Decision trees

Before you start using the decision tree, identify the full range of potential climate related impacts using Clause 4 of this Guide. When you reach the end, look up the coloured boxes in Table 7.

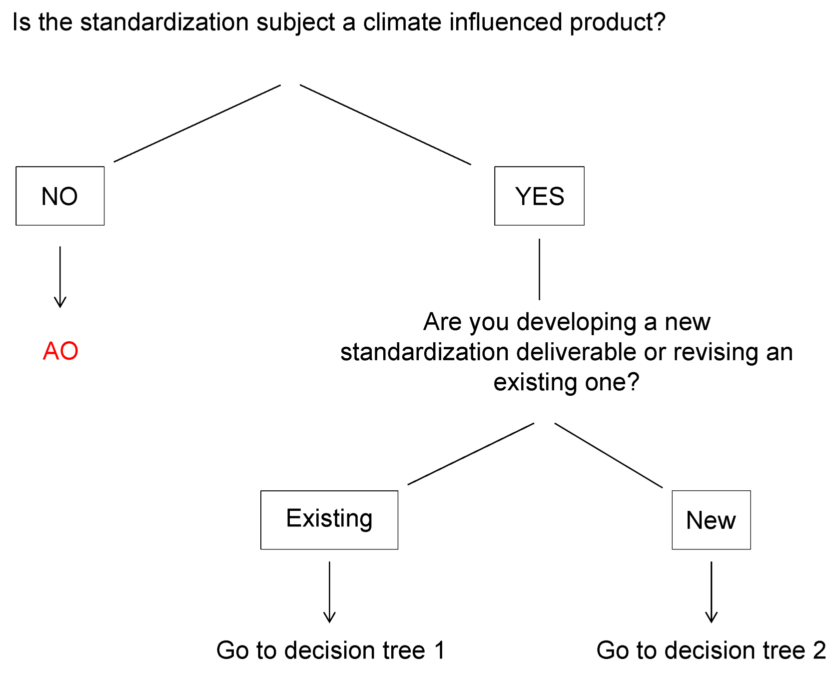

Figure 4 — Preliminary decision

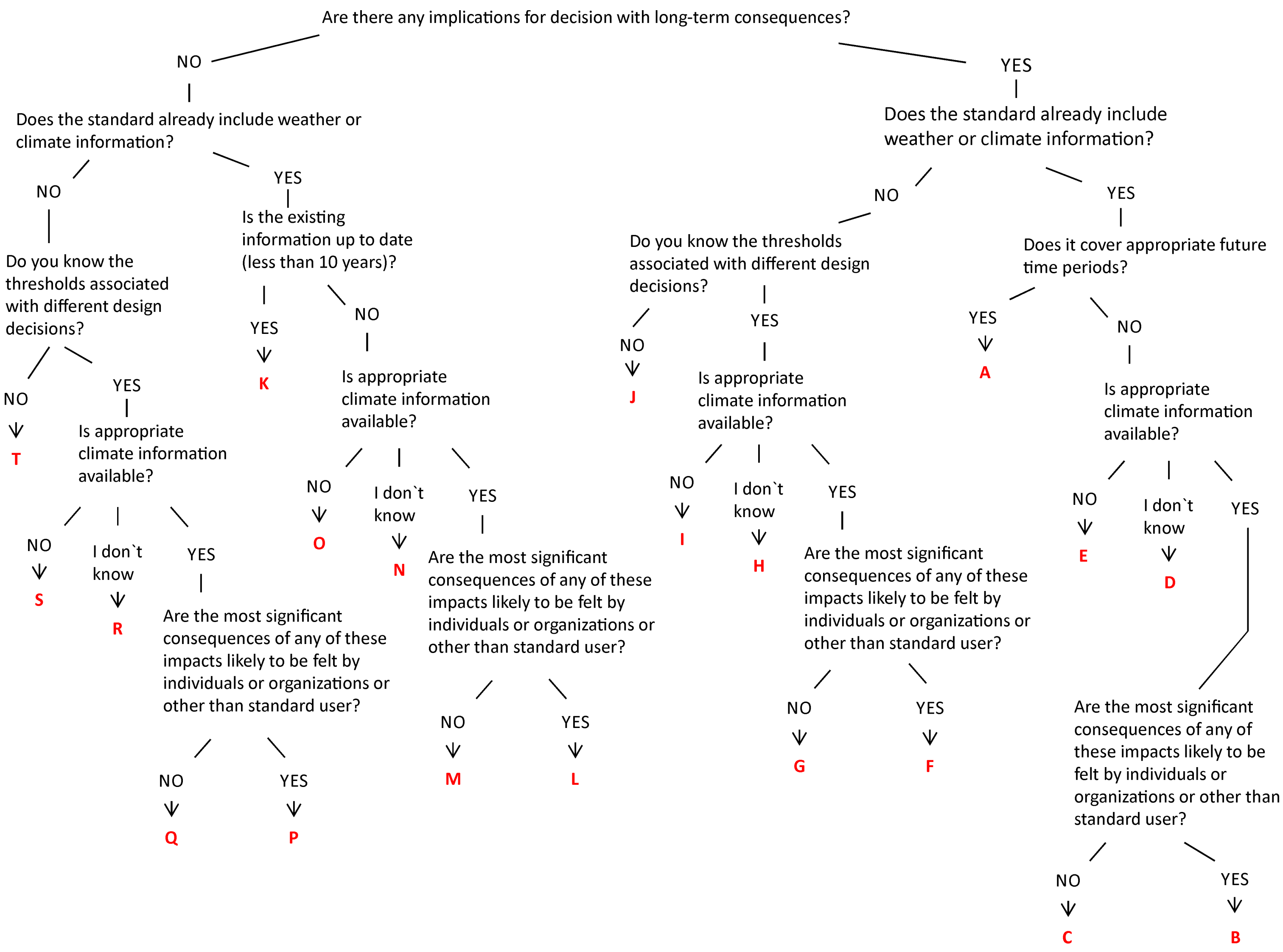

Figure 5 — Decision tree 1 - review existing standardization deliverables

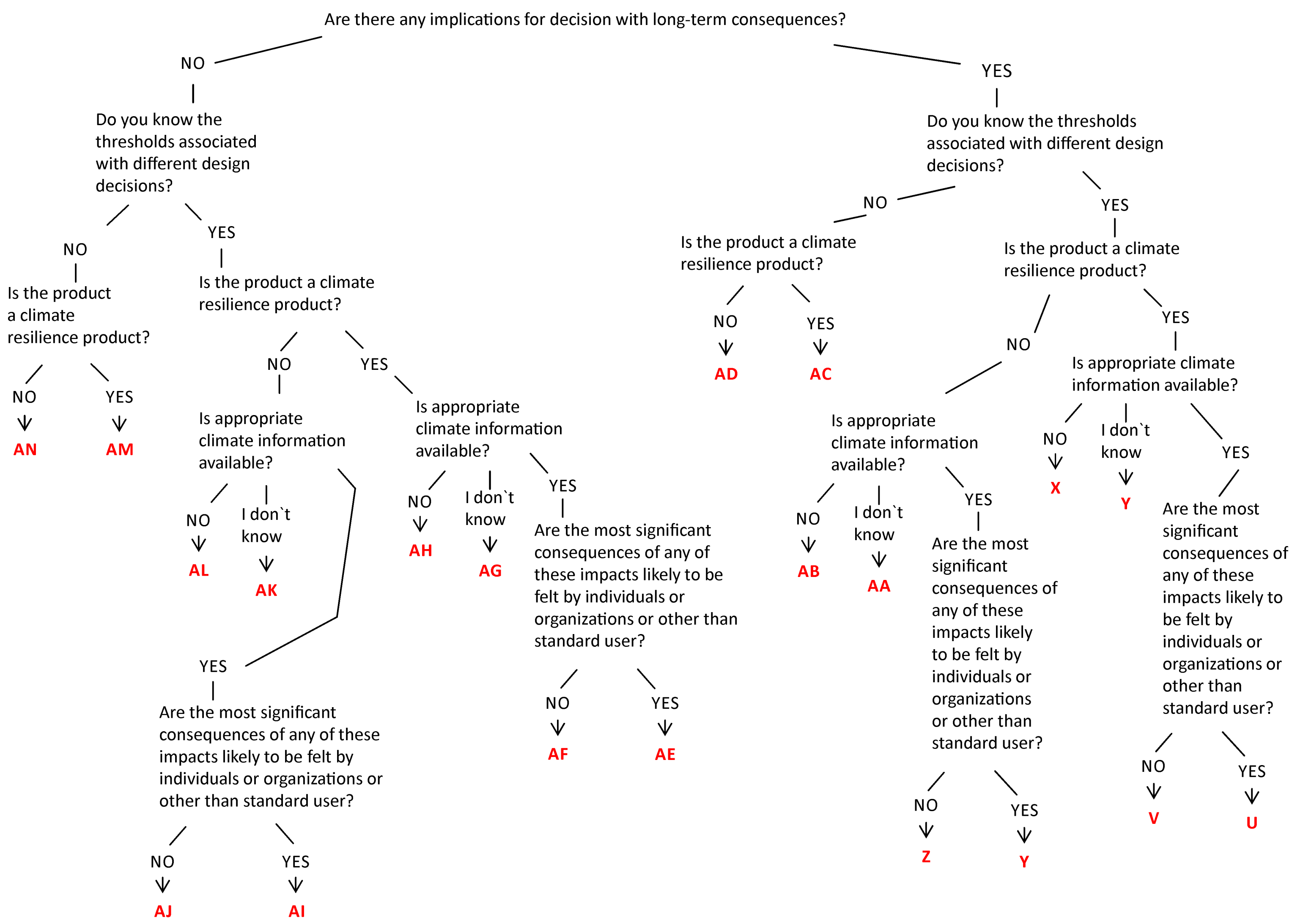

Figure 6 — Decision tree 2 - drafting new standardization deliverables

Table 7 — Checklist

Research	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
Identify a range of adaptation options that could be incorporated in product design	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Identify which climate variables are relevant to the climate related impacts including the time period over which they need to be measured and averaged. Check available information sources to see if relevant information is available. Then start decision tree again.				■				■						■				■					■				■						■				■				
Identify any thresholds that are described or implied in existing climate information	■	■	■		■						■	■	■		■																										
Consider carrying out or commissioning research to identify thresholds										■										■									■	■									■	■	
Identify the projected change in relevant climate variables, including the range of uncertainty throughout the design lifetime and end-of-life		■	■			■	■														■	■			■	■															
Consider commissioning research to generate climate information for all appropriate time periods and locations					■				■						■				■					■				■						■				■			
Research to identify an appropriate climate change factor					■				■															■				■													
Check whether existing information covers everything that you need	■										■	■	■																												

Information in standards	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
Include appropriate future climate information (or a signpost to these) within the standard, replacing any existing climate information where necessary																																									
Replace old climate information with up to date climate information																																									
Consider the use of a climate change factor to update the existing climate information to take account of climate change																																									
Give extra consideration to the intended lifetime of product and consider inclusion of climate information from multiple time periods																																									
Include guidance on how to use future climate information (or a signpost to this) within the standard																																									
Climate related impacts on the acquisition and production stages may occur in other regions of the world not currently considered. Make sure climate information takes this into account																																									

Provisions in standards	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
Define what level of risk or what level of impact the product needs to be resilient to																																									
Consider no regrets options i.e. those that yield benefits even in the absence of climate change and where the costs are relatively low																																									
Consider adaptive measures: i.e. options that make provision now for future adaptation																																									
Consider designing for exceedance i.e. Design for ‘X’, check sensitivity of product/ component against ‘X+’																																									
Consider 'designing for degraded performance': Check what happens if the product/ component performs at below design capacity																																									
Consider how provisions can encourage increased resilience to indirect impacts from weather and climate e.g. through flood, drought or disruption from weather events																																									
Consider the requirement for labelling that indicates thresholds relevant for use and end of life phase impacts																																									

The standard development process	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
Agree when climate information will need updating																																									
Set out a process for incorporating the outputs of research as part of standards revision (including how and when)																																									
Make time for a discussion of uncertainty and roles in decision-making																																									
Only a watching brief is required																																									

Annex A
(informative)

Climate change in Europe — Climate change overview

A.1 General

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. So the diagnosis worsens since the global warming could be up to 4,8 °C from now to the end of the 21st century[2)].

Climate change threatens the different regions of Europe in different ways, although all regions will experience climate change through a mix of gradual changes (such as increasing temperature or changes to biodiversity) and rapid ones (such as flooding). Moreover, some severe weather events have increased, with more frequent heat waves, forest fires and droughts in southern and central Europe. Heavier precipitation and flooding is projected in northern and north-eastern Europe, with an increased risk of coastal flooding and erosion. Northern Europe could also experience higher and heavier snow-loads and more fluctuations around zero degrees causing freeze thaw weathering. A rise in such events is likely to increase the magnitude of disasters, leading to significant economic losses, public health problems and deaths.

2) IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

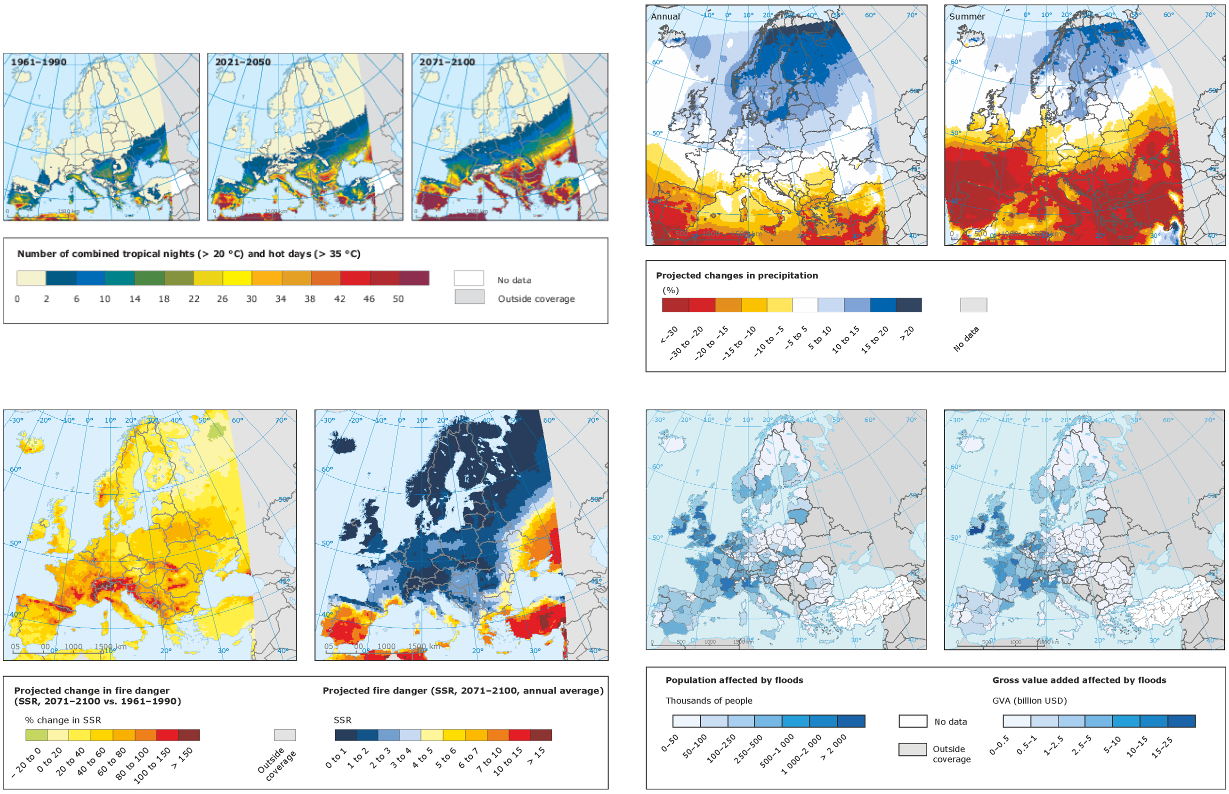

Figure A.1 — Projected impacts of climate change and associated threats. Based on EEA report Climate change impacts and vulnerability in Europe (2012) and Communication from the Commission for an EU Strategy on adaptation to climate change 16.4.2013[Source: http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN]

A.2 Impacts from these projections

Impacts vary across the EU depending on climate, geographic and socioeconomic conditions. All the countries in the EU are exposed to climate change (see Figure 2 below). However, some regions are more at risk than others. The Mediterranean basin, mountain areas, densely populated floodplains, coastal zones, outermost regions and the Arctic are particularly vulnerable. Additionally, three quarters of the population of Europe live in urban areas, which are often ill-equipped for adaptation and are exposed to heatwaves, flooding or rising sea levels.[3)]

3) European Environment Agency, 2013. Adaptation in Europe: Addressing risks and opportunities from climate change in the context of socio-economic developments — 132 pp. (http://www.eea.europa.eu/publications/adaptation-in-europe).

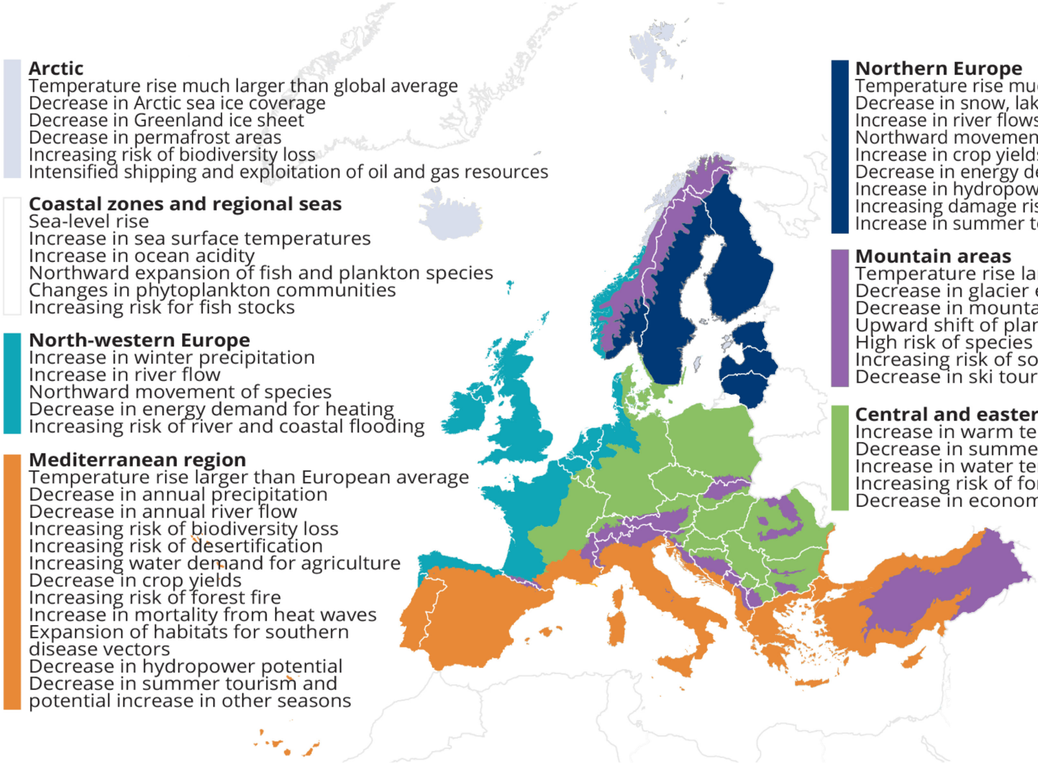

Figure A.2 — Key observed and projected impacts from the climate change for the main regions in Europe. Based on European Environment Agency Adaptation in Europe Addressing risks and opportunities from climate change in the context of socio-economic developments 2013

[Source: see Footnote 3)]

Annex B
(informative)

Business case examples

B.1 Legal standards for protection against floods in the Netherlands

The Dutch Delta Programme (Deltaprogramma) is aimed at flood risk management and sufficient supply of fresh water in the Netherlands. It acknowledges both socio-economic developments and climate change. Key elements are updated safety standards for primary flood defence systems. In these standards prognoses for increased sea water levels as well as increased water flows in the main rivers are included. The main elements of the programme, including the safety standards, are included in legislation.

Climate change is expected to result in elevated levels of water in the sea and in the main rivers in the Netherlands. The latter will occur in wintertime and is due to increased precipitation in the hinterland. According to projections of the Dutch Meteorological Office sea levels could increase with 0,25 m to 0,85 m in the year 2085 and 50 cm to several meters in 2300. Peak-flows of Rhine and Meuse could increase to 18 000 m^3/ and 4 600 m^3/s according to the KNMI-scenarios 2006. In 1995, elevated water levels in Dutch rivers resulted in the evacuation of about 250 000 persons. According to the climate projections these high discharge levels of water in rivers may occur more often in the future.

Following these events, the so called Deltacommission was installed, with the task to investigate how the Netherlands should be protected against the consequences of climate change in the time frame up to the year 2200. The Deltacommission concluded that the safety task was urgent: the climate changes, the sea level rises and discharges of rivers increase, whereas 25% of the dikes do not comply to the existing standards. Furthermore, they concluded that the safety standards had to be renewed in order to be consistent with future prognoses of water levels.

The advice of the Deltacommission resulted in a Deltadecision on water safety. Updated standards are key in this decision. These standards are based on a risk-approach: everyone behind a dike or a dune can count on a protection level of 10-5; the chance that a person will lose his life due to flooding shall be less than 1:100 000/year. In these standards the climate prognoses of the Dutch Meteorological Office have been included. Authorities in charge of water management shall realize that flood protecting systems should comply with these standards. These systems consist of smart combinations of measures to prevent flooding (strengthening of dikes, dams and dunes, and more space for rivers), as well as measures to limit effects of floods. The yearly costs for the execution of the Deltaprogramma are in the order of 1 to 1,5 billion Euros.

Based on the standard 10^{-5} risk level, the National government has set new standards for (parts of) dikes. Depending on the locations and the associated risks, they are divided into six classes: from 1:300 to 1:100 000 (frequency of a flood/ year). These standards will be included in the new water legislation.

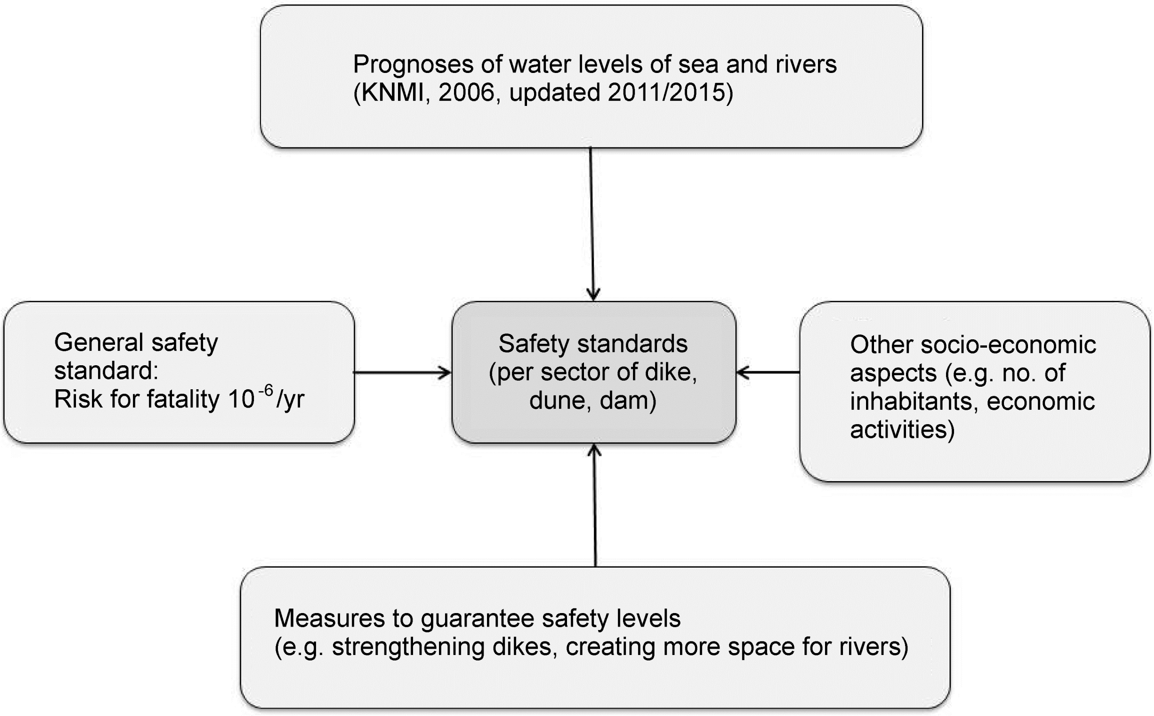

Figure B.1 — Safety standards

B.2 Legal safety standards for prevention of regional nuisance from excess water

The design of water systems (capacity, lay-out) in the Netherlands is based on standards for the risk of inundation of areas due to precipitation. In these standards prognoses for future precipitation are taken into account.

The Dutch Waterlaw obliges provinces to set standards to prevent regional disturbance from excess water. Background is the realization of sufficient capacity for storage and discharge of surface water. For different areas, standards have been introduced. These relate the chance of inundation to the economic value of the land, and the potential damage. A basis for these standards are climate-scenarios of the Dutch national meteorological institute (2011, updated 2014).

The desired protection level results in requirement for the design of the water system, as well as measures that local and regional authorities shall take to ensure that the water system meets the standards. This is especially important since Infrastructures for storage and discharge of water, such as sewage water systems, generally have a long life time. Examples of measures are:

— creating space for maintaining water;

— prevention of building in low and wet areas;

— use of soil surface materials that allow for infiltration of water in soil;

— adaptation of sewage water systems.

B.3 Drainage systems

a) The issue:

The purpose of drainage is to collect and transfer rainwater to water bodies or sewers so as to prevent water-logging or flooding. Design choices, such as the diameter of pipes and other hydraulic and environmental considerations can affect the rate at which water can be removed. Since these choices also have implications for other objectives, such as cost and aesthetics, the design of a drainage system needs to take account of the flow of water that is expected. This varies spatially, in line with the climate while climate change is expected to increase the frequency of extreme rainfall events across the UK.

b) Implications for standards:

In the UK, drainage design is standardized in the national annexes to:

1) BS EN 12056-3 for the design of roof drainage systems and

2) BS EN 752 for the design of underground drainage systems.

The approach given in these two documents is consistent with statutory guidance on compliance with the Building Regulations for England.[4)]

In addition the standards use the language of 'return periods', for example when talking about heavy rainfall events in relation to design categories (see Table B.1 below). This is not compatible with climate change because the climate continues to change over the course of the period of time given as the 'return period'.

Table B.1 — Four categories of design rainfall intensity presented in BS EN 12056-3:2000

Cat 1	Return period of 1 year	suggested for use with eaves gutters and flat roofs
Cat 2	Return period of 1.5 x Design life of the building	suggested use with valley and parapet gutters for normal buildings
Cat 3	Return period of 4.5 x Design life of the building	suggested use with valley and parapet gutters for higher risk buildings
Cat 4	Maximum probable rainfall	suggested use on the highest risk buildings

c) The response:

The standard development process:

The BSI Technical Committee that oversees the two standards is exploring how to update the rainfall intensity information so that drainage systems can be designed for the future climate. They are working with the climate science community and adaptation experts to identify how this can be achieved and, if appropriate information is not available, what other advice can be given through provisions in the standards in the interim.

4) Approved Document H Drainage and waste disposal:

http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_H_2015.pdf

d) Updating the information:

Currently, modelled future weather only provides daily rainfall volumes; whereas drainage design requires knowledge of sub daily rainfall (the current maps show intensities for two minute and five minute durations). It is therefore not a simple case of replacing the data with climate model output.

There was discussion about whether the rainfall intensity information should at least be updated so that it is more up to date than 1941-1970. Rainfall series exists for 1961-1990[5] which is also the control date used by the UNFCCC. However, this dataset used less sub-daily information in its analysis and it has no output specifically aimed at two minute and five minute peak intensities. There was a feeling that, since the climate change effect is likely to have been small between 1981 and 2010, it would not be worth doing a major piece of work to reprocess the historical data. So it was decided that 1941-1970 could be considered as a suitable control instead of 1961-1990. The only concern over this position was that the newer dataset suggested some locations as “hot spots” in comparison to the older dataset, for hourly rainfall depths. This suggests that either the two and five minute maps in the standards under-predict intensities or that these hot spot effects are spurious.

There is agreement that any climate information that is presented in revised standards should be presented in terms of percentiles rather than return periods.

e) Including new provisions:

A staged approach which involves examining the sensitivity to increased rainfall when upgrading existing underground drainage systems has already been proposed for the revision of BS EN 752. The Technical Committee agreed that these revisions should draw attention to the need to ‘design for exceedance’ to account for the uncertainties arising from the impacts of climate change on rainfall intensities.

It is thought that many roof drainage designers were applying spurious accuracy to the rainfall intensity information provided by the standards rather than using the map with a return period equal to or greater than the design return period, as recommended. Again there needs to be more emphasis on ‘designing for exceedance’, however, new ways of presenting this advice are also being discussed. For example, instead of relating the exceedance period to design life, using confidence levels for different categories of design rainfall intensities, such as 99% (1/100) for category 2 and 99,6% (1/250) for category 3.

In the absence of future rainfall intensity information, the committee are considering providing advice on the appropriate uplift (or climate change factor) to be applied until appropriate rainfall information is available. Climate change factors are given in the National Planning Policy Framework[6] but these have limited evidence base in particular for return periods of 50 years and 500 years. Work is ongoing in this area.

This could be based on daily data which is thought to be fairly robust and then applying relationships from research. There are several research projects with existing or emerging outputs in this area.

There has also been some discussion on how the standards could improve resilience in the absence of an adequate understanding of future rainfall intensities, such as by requiring that the consequence of failure be taken into account when choosing design approaches or by specifying systems that are more flexible to upgrading in the future.

f) Research:

The Technical Committee have identified some research needs:

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5) Institute of Hydrology (1999). Flood estimation handbook. Institute of Hydrology (reprinted 2008 by the Centre for Ecology and Hydrology).

6) DCLG (2012) National Planning Policy Framework. Crown Copyright ISBN: 978-1-4098-3413-7.

1) to improve modelled future hourly rainfall information;

2) to understand how the sub-hourly distribution of rainfall was derived for the existing maps; this needs to be understood before it can be applied to hourly rainfall to get the two minute and five minute peak rainfall intensity;

3) to identify an appropriate climate change factor to apply to the existing maps.

B.4 Network Rail: Weather and Railway Infrastructure

a) The issues:

Network Rail (NR) is the organization responsible for running, maintaining and developing Britain's railway infrastructure including its tracks, signalling, bridges, tunnels, coastal defences, level crossings and many of its stations. They have recognized the link between weather resilience and reliability, which they seek to continually improve. The UK government also has aims for improved resilience in the nation's infrastructure and reducing the costs of running the railway.

Network Rail undertakes research and planning activities relating to weather and climate change in order to meet this aim of improved reliability as well as to improve knowledge related to asset behaviour.

b) Implications for standards:

Network Rail uses both European and internal standards to control many aspects of design and operation, some of which are influenced by the weather and therefore potentially by climate change. For example, NR has developed flood guidance for the design and siting of railway infrastructure that is broadly in alignment with UK planning guidelines. The information below relates to the identification of weather envelopes that have been used to define "weather thresholds" included within operational standards that can help to mitigate the impacts of severe weather.

c) The response:

Network Rail undertook a study in 2012 to identify correlations between weather data and infrastructure fault data over an 8 year period[7)]. The work was undertaken to support future planning (the five years up to 2019), although previous research by the Rail Safety and Standards Board (RSSB) has looked at impacts up to the 2040s[8)].

Weather data was sourced from the Met Office for 10 weather stations and fault data was extracted from NR information system. More recently this work has been repeated with higher resolution weather data and also extended to include earthworks which are known to be highly vulnerable to extreme rainfall.

This work is published annually to:

1) identify assets most vulnerable to weather;

2) identify thresholds when failure rates increase significantly from the norm;

3) identify the gap between modern infrastructure (designed to European and NR weather standards) and the performance of legacy infrastructure.

7) Network Rail and Office of Rail Regulation (2012) Weather and Climate Change Resilience Programme.

8) RSSB (2011) Impact of climate change on coastal rail infrastructure (T643).

Weather thresholds can then be assigned to 'normal', 'adverse' and 'extreme' (relating to different levels of reliable operation) and written into operating standards.

The new knowledge is also being used to inform investment planning within and beyond the current planning period and the industry’s climate change adaptation thinking more widely.

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[3] ISO/TR 14062, *Environmental management — Integrating environmental aspects into product design and development*

[4] IEC Guide 109:2003, *Environmental aspects — Inclusion in electrotechnical product standards*

[5] ISO Guide 51, *Safety aspects — Guidelines for their inclusion in standards*

[6] CEN Guide 4:2008, *Guide for addressing environmental issues in product standards*

[7] CEN Guide 15, *Guidance document for the development of service standards*

[8] CWA 16633:2013, *Ageing behaviour of Structural Components with regard to Integrated Lifetime Assessment and subsequent Asset Management of Constructed Facilities*

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