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Adaptation to climate change — Principles, requirements and guidelines

Adaptation au changement climatique — Principes, exigences et lignes directrices

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 7, *Greenhouse gas management and related activities*.

This document is the generic standard for adaptation to climate change.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Climate change is impacting organizations in various ways and will continue to do so for decades to come, owing to greenhouse gases emitted since the start of the Industrial Revolution. The extent of future climate change will depend on the effectiveness of efforts to limit further emissions of greenhouse gases and to manage other factors that impact radiative forcing. Therefore, climate change adaptation is required to reduce the threats and maximize the opportunities presented to organizations of all kinds by a changing climate.

In November 2016, the Paris Agreement came into force to limit global temperature rise and it established a global adaptation goal of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal". Implementation of the Paris Agreement, along with the United Nations Sustainable Development Goals (UN SDGs) as agreed in 2015, helps to drive global efforts towards actions that will reduce greenhouse gas emissions as well as build climate resilience.

Climate change impacts can be direct or indirect and can take various forms such as physical, social, financial, political, regulatory or reputational, and as such climate change adaptation has a very broad scope. This document will enable organizations to prioritize and develop effective, efficient and deliverable adaptation tailored to the specific climate change challenges they face. Its main purpose is therefore to provide organizations with a consistent, structured and pragmatic approach to prevent or minimize the harm that climate change could cause and also to take advantage of opportunities. Applying this approach enables organizations to give appropriate consideration to climate change adaptation when designing, implementing, improving and updating policies, strategies, plans and activities.

The application of this document is intended to be performed alongside other organizational priorities. This includes carrying out all climate change adaptation activities in parallel with, or integrated with, climate change mitigation activities and other sustainability priorities.

Furthermore, application of this document can assist in demonstrating to interested parties that an organization's approach to climate change adaptation is credible. This document can also be of relevance to individuals and organizations involved in purchasing, investment and insurance when seeking to understand another organization's climate change adaptation. It is designed to help organizations develop measures and report on adaptation activity in a verifiable way.

This document's approach is relevant to all sizes and types of organizations where their activities, products and services might be threatened by, or in some cases able to take advantage of, climate change. The approach within this document is iterative, supporting continual learning and improvement processes aimed at all scales, from local to multinational organizations, those in the public and private sectors, voluntary and community organizations, single, small and medium size enterprises. This document is relevant regardless of the scope of adaptation and can be used in the context of both incremental change and transformation.

The purposely non-linear nature of this document's approach allows organizations to adopt its structure no matter what stage they are at in climate change adaptation, from those just starting out to those already engaged in adaptation to those choosing to lead the way. Organizations might find themselves moving back and forth between multiple elements, depending upon the challenges they face and the lessons they learn from delivery experience. The structure is however logical, iterative and designed to be applied into the future. The structure covers:

— pre-planning;

— assessing impacts including opportunities;

— adaptation planning;

— implementation;

— monitoring and evaluation;

— reporting and communication.

In this document, the following verbal forms are used:

— “shall” indicates a requirement;

— “should” indicates a recommendation;

— “may” indicates a permission;

— “can” indicates a possibility or a capability.

Adaptation to climate change — Principles, requirements and guidelines

1 Scope

This document specifies principles, requirements and guidelines for adaptation to climate change. This includes the integration of adaptation within or across organizations, understanding impacts and uncertainties and how these can be used to inform decisions.

This document is applicable to any organization, regardless of size, type and nature, e.g. local, regional, international, business units, conglomerates, industrial sectors, natural resource management units.

This document can support the development of sector-, aspect- or element-specific climate change adaptation standards.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org

3.1
adaptation to climate change
climate change adaptation
process of adjustment to actual or expected *climate* (3.4) and its effects

Note 1 to entry: In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities.

Note 2 to entry: In some natural systems, human intervention can facilitate adjustment to expected climate and its effects.

[SOURCE: Adapted from IPCC, 2014]

3.2
adaptive capacity
ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences

[SOURCE: Adapted from IPCC, 2014]

3.3
adaptive management
process of iteratively planning, implementing and modifying strategies for managing resources in the face of uncertainty and change

Note 1 to entry: Adaptive management involves adjusting approaches in response to observations of their effects and changes in the system brought on by resulting feedback effects and other variables.

[SOURCE: IPCC, 2014]

3.4
climate
statistical description of weather in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years

Note 1 to entry: The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization.

Note 2 to entry: The relevant quantities are most often near-surface variables such as temperature, precipitation and wind.

[SOURCE: Adapted from IPCC, 2014]

3.5
climate change
change in *climate* (3.4) that persists for an extended period, typically decades or longer

Note 1 to entry: Climate change can be identified by such means as statistical tests (e.g. on changes in the mean, variability).

Note 2 to entry: Climate change might be due to natural processes, internal to the climate system, or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.

[SOURCE: Adapted from IPCC, 2014]

3.6
exposure
presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social or cultural assets in places and settings that could be affected

Note 1 to entry: Exposure can change over time, for example as a result of land use change.

[SOURCE: Adapted from IPCC, 2014]

3.7
hazard
potential source of harm

Note 1 to entry: The potential for harm can be in terms of loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Note 2 to entry: In this document, the term usually refers to climate-related physical events or trends or their physical impacts.

Note 3 to entry: Hazard comprises slow-onset developments (e.g. rising temperatures over the long term) as well as rapidly developing climatic extremes (e.g. a heatwave or a landslide) or increased variability.

[SOURCE: ISO/IEC Guide 51:2014, 3.2, modified — Notes 1 and 2 to entry have been added to reflect the definition of "hazard" in IPCC, 2014: Annex II: Glossary. Note 3 to entry has been added.]

3.8
impact
effect on natural and human systems

Note 1 to entry: In the context of *climate change* (3.5), the term "impact" is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate change or hazardous climate events occurring within a specific time period and the *vulnerability* (3.15) of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts and sea level rise, are a subset of impacts called "physical impacts".

[SOURCE: Adapted from IPCC, 2014]

3.9
indicator
quantitative, qualitative or binary variable that can be measured or described, in response to a defined criterion

[SOURCE: ISO 13065:2015, 3.27]

3.10
interested party
person or *organization* (3.11) that can affect, be affected by, or perceive itself to be affected by a decision or activity

EXAMPLE Customers, communities, suppliers, regulators, non-governmental organizations, investors, employees and academia.

Note 1 to entry: To “perceive itself to be affected” means the perception has been made known to the organization.

[SOURCE: ISO 14001:2015, 3.1.6, modified — "academia" has been added to the example.]

3.11
organization
person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

Note 1 to entry: The concept of organization includes, but is not limited to sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

[SOURCE: ISO 14001:2015, 3.1.4]

3.12
risk
effect of uncertainty

Note 1 to entry: An effect is a deviation from the expected. It can be positive, negative or both. An effect can arise as a result of a response, or failure to respond, to an opportunity or to a threat related to objectives.

Note 2 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

[SOURCE: ISO 14001:2015, 3.2.10, modified — Note 1 to entry has been modified. Notes 3 and 4 to entry have been deleted.]

3.13
sustainability
state of the global system, including environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs

Note 1 to entry: The environmental, social and economic aspects interact, are interdependent and are often referred to as the three dimensions of sustainability.

Note 2 to entry: Sustainability is the goal of sustainable development.

[SOURCE: ISO Guide 82:2014, 3.1]

3.14
transformation
change in the fundamental attributes of natural and human systems

[SOURCE: Adapted from IPCC, 2014]

3.15
vulnerability
propensity or predisposition to be adversely affected

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

[SOURCE: Adapted from IPCC, 2014]

4 Principles

4.1 General

The principles described in this clause are fundamental to the process of climate change adaptation and are the basis for the requirements described in Clauses 5 to 10. This document does not provide specific requirements for all situations and these principles provide guidance for decisions that need to be made in unanticipated situations. The principles are not requirements.

4.2 Change-oriented perspective

When adapting to climate change, an organization prepares, supports and facilitates organizational change at all relevant levels. Change may be proactive in anticipation of changing circumstances or reactive in response to conditions that have altered. The magnitude of change can range from incremental, involving minor adjustments, through to transformation.

4.3 Flexibility

The organization continually reviews, responds and adapts to new conditions, information, methods and solutions as they emerge. It uses continual learning and adaptive management processes, adopting an iterative approach to improve understanding, decision-making and implementation processes.

4.4 Mainstreaming and embedding

Climate change adaptation is most effective when it is integrated into the organization's processes (such as policies, plans, procedures and implementation).

4.5 Robustness

The organization uses appropriate methodological approaches and information sources that are relevant and lead to robust decision-making and climate change adaptation actions. Information about uncertainties is recognized as a valuable contribution to decision-making.

4.6 Subsidiarity

The organization empowers delivery of climate change adaptation at the level, scale and degree of competence that will have the greatest effectiveness depending on the adaptation issue at hand.

4.7 Sustainability

Climate change adaptation takes into account economic, social and environmental issues equitably, and balances the needs of present and future generations.

4.8 Synergy between adaptation and mitigation of climate change

Climate change adaptation is undertaken keeping in view the objective of minimizing climate change.

4.9 Systems thinking

Climate change adaptation processes include an understanding of cross-cutting (systemic) issues of the organization by examining internal and external interdependencies and linkages, for example through cause and effect relationships.

NOTE 1 Examples of interdependencies and linkages include supply chains, market forces, organizational units, functions and physical boundaries, and the enabling environment (see Annex A).

NOTE 2 Systems thinking can be used to understand the consequences of risk being transferred.

4.10 Transparency

Reports and communications on the climate change adaptation are based on an open, understandable and appropriate presentation of information for interested parties.

4.11 Accountability

The organization acknowledges and assumes responsibility for its climate change adaptation. It accepts appropriate scrutiny and also accepts a duty to respond to this scrutiny.

5 Pre-planning

Pre-planning is a process that prepares the organization to implement Clauses 6 to 10. The process is relevant when an organization initiates climate change adaptation as well as when an organization reassesses or revises its climate change adaptation.

Pre-planning involves assessing, and where necessary establishing, the capability of the organization to undertake Clauses 6 to 10 as well as identifying interested parties and how it engages with them.

NOTE Pre-planning can also be referred to as scoping.

An organization shall assess its capability to undertake Clauses 6 to 10 by:

— determining the leadership and broader governance required for the climate change adaptation process of the organization;

— identifying the human resources required including those of any project team(s) involved;

— determining roles and responsibilities;

— identifying the need for financial resources;

— identifying the required levels of expertise and knowledge, as well as information and data sources;

— identifying the moments when the organization makes strategic decisions.

The organization shall:

— document the results of its assessment, including a description of any capability gaps;

— establish a work programme that addresses these gaps;

— commit the human and financial resources to undertake this work programme;

— identify relevant interested parties;

— develop a plan to engage with relevant interested parties sufficient to understand their needs and expectations with respect to climate change adaptation.

Consultation with interested parties can also facilitate knowledge sharing about climate change adaptation as well as participation in the climate change adaptation process.

Interested parties can include:

— other units within the organization;

— suppliers;

— businesses involved in the sale, distribution or delivery of the organization's products and services;

— shareholders;

— financial institutions;

— technical institutions;

— customers and consumers;

— regulatory authorities;

— local, regional or national government organizations;

— non-governmental organizations;

— local communities;

— employees;

— unions.

6 Assessing climate change impacts including opportunities

6.1 General

The organization shall assess how its activities, products and services might be impacted by climate change.

The assessment shall be made by competent persons or organizations, either internal or external.

The assessment shall include slow onset impacts (chronic) as well as sudden impacts due to extreme events (acute).

Climate change impacts shall be assessed comprehensively, covering cross-cutting (systemic) issues including impacts directly and indirectly on the organization, for example:

— impacts on employee health, safety and productivity;

— impacts on air quality;

— damage to assets and business disruption;

— loss of coastal infrastructure;

— storm surge, flooding and contamination;

— disruption to supply chains and distribution networks;

— changes in the cost of production;

— changes in the provision of ecosystem services;

— water scarcity impacts on operations;

— changing productivity of crops and livestock;

— impacts on regulation or other government interventions;

— fiscal measures, such as incentives and punitive taxes;

— impacts on financial institutions placing a premium on investment with high risk;

— changes in the ability to raise capital due to the perceived risk;

— impacts on business opportunities;

— changes in customer requirements.

Impact assessments can involve analysing the following influencing factors:

— relevant internal and external policies;

— organizational strategies;

— life cycles of policies, plans and assets (e.g. maintenance and replacement time frames);

— climate adaptation actions taken by third parties.

The organization shall assess past and future trends in average and extreme conditions and changing variability and seasonality of relevant climate parameters.

Climate parameters can include:

— temperature;

— precipitation;

— humidity;

— sea-level rise;

— wind speed and direction;

— freeze–thaw cycles.

Advice on where an organization can source historic and future climate data can be found at national and international climate data centres, e.g. national regulatory authorities, state and local agencies, universities, national weather service providers and observatories. Information can also be obtained from numerous sources, including scientific reports, relevant climate change impact assessments, governmental and intergovernmental publications, and databases.

NOTE The Global Framework for Climate Services (GFCS) can be a valuable and reliable source of data: http://www.wmo.int/gfcs/.

Impact assessment methods can use information on changes in other non-climatic factors, for example:

— trade patterns;

— land use;

— use of natural resources;

— demographics;

— policy;

— socio-economic factors;

— technological change.

The organization shall document the data and information sources used and the criteria used for their selection.

The organization shall identify whether the impacts of climate change provide opportunities.

The most important climate change impacts (including opportunities) shall be identified.

The organization shall document the process used to assess impacts and the findings of its impact assessment.

The climate change impact assessment shall be reassessed and updated as necessary to reflect changes in business strategy, external environment and influences, and knowledge about climate change.

6.2 Impact assessment methods

6.2.1 General

There is a range of methods that can be used by the organization to gain knowledge about climate change impacts.

Methods to assess impacts can include:

— risk assessment;

— vulnerability assessment;

— thresholds analysis.

The organization should adopt the method(s) best suited to their needs.

Data (climate and non-climate) availability are significant challenges for climate change adaptation decision-making. For example, observed climate data and model-based climate projections are not always available at the desired spatial and temporal resolutions for many parts of the world.

It is valuable to first perform an impact assessment based upon historical climate trends, variability and events that have been experienced. The focus can then be upon understanding the implications of future climate change trends and climate events over the full lifespan of a decision.

6.2.2 Risk assessment

If a risk assessment approach is adopted, the risk assessment can include

— the consideration of vulnerabilities, exposure and climate change hazards, or

— the consideration of likelihoods and consequences.

6.2.3 Vulnerability assessment

If a vulnerability assessment approach is adopted, the vulnerability assessment can include:

— identification of the exposure of the organization, its activities, products and services to changes in climate and changes in climate hazards;

— determination of the sensitivity of the organization, its activities, products and services to changes in climate and changes in climate hazards;

— identification of climate impacts;

— consideration of the ability of the organization to manage the impact of these changes and hazards, i.e. its adaptive capacity (see 6.3).

6.2.4 Thresholds analysis

Thresholds analysis is an approach to prioritize where and when action will be needed by understanding the points at which a system is deemed to be no longer effective (economically, socially, technologically or environmentally) as a result of the average or extreme climatic conditions.

If a thresholds analysis approach is adopted, the analysis can include:

— identification of the system's constituent components, their dependencies and interdependencies;

— identification of systemic thresholds beyond which system performance will be unacceptably altered;

— the climatic thresholds at which operations and activities reach intolerable levels of performance.

Guidance on thresholds analysis is given in Annex B.

6.3 Assessing adaptive capacity

The organization shall assess its existing adaptive capacity to adapt to the impacts of climate change, including its:

— financial resources;

— human resources;

— technical resources;

— other organizational capabilities.

In assessing its organizational capability, the organization should analyse the extent to which the organization is capable of:

— identifying the moments when the organization makes strategic decisions that could be impacted by climate change;

— establishing leadership of, and commitment to, the adaptation process;

— mobilizing financial resources;

— ensuring key decision makers are made aware of the need to address climate change;

— ensuring it has, or is able to access, expertise on climate change adaptation;

— formalizing an organizational structure that defines roles and responsibilities clearly and permits effective delivery of actions, and can remain flexible to new opportunities for improved actions;

— mobilizing human resources (including project teams and their governance);

— engaging in meaningful and timely dialogue with interested parties;

— developing collaborative approaches to decision-making;

— ensuring it can learn from experience to improve over time, embedding knowledge and learning in decisions;

— establishing and endorsing a work programme.

The organization shall document gaps between its existing adaptive capacity and its required adaptive capacity.

6.4 Identifying opportunities

The organization should identify those opportunities that can arise from climate change, including those that result from a changing climate and those as a result of taking action. Where opportunities for action have been identified, the organization should document any trade-offs with other sustainability priorities.

Opportunities for the organization can come from expanding, evolving or emerging markets and from contributions to the organization's sustainability. Opportunities can include: new products, services, customers and markets; reputational benefits; supply chain security; improved resilience; improved processes; and innovation. Opportunities can be identified across value chains and their respective enabling environments.

6.5 Identifying uncertainties

There are inherent uncertainties in climate scenarios, climate projections and other forms of data used (including non-climate data) in adaptation decision-making, including those arising from data sourced from monitoring systems, the results of models and of impact assessments. The organization should understand sources of uncertainty and how these propagate through the forms of analysis undertaken and their implications for the results.

NOTE 1 ISO 14033 provides guidelines on systematic and methodical acquisition and review of quantitative environmental information and data with regards to, for example, uncertainty.

NOTE 2 Different climatic variables have a different level of uncertainty, e.g. the level of confidence in projected temperature trends is high, the level of confidence in projected trends in precipitation is medium, the level of confidence in projected trends in wind is low.

The organization should establish and apply quality management procedures to manage data and information, including the assessment of uncertainty, relevant to the data collection and scenarios selected in adaptation planning.

The organization shall document the influence that uncertainties have on the results of the impact assessments.

The organization shall document the methods used and assumptions made when dealing with uncertainty, along with the sources of data and information.

Levels of analysis should be appropriate to the needs of the organization.

7 Adaptation planning

7.1 General

The organization shall assemble an adaptation plan from varied sources of knowledge, information and data, in the context of existing policies, strategies, planning and decision-making processes.

The organization shall establish climate change adaptation priorities.

The organization shall incorporate and embed climate change adaptation into its policies, strategies and plans.

The organization shall:

— identify a range of potential climate change adaptation actions that address its priorities, including those related to addressing gaps in adaptive capacity;

— assess which potential climate change adaptation actions are best suited to the organization's needs and capability, using decision-making methods suited to the context of the organization and climate change;

— adopt an adaptive management approach that enables the capture of new knowledge and learning from the experiences of decision-making to inform future decisions;

— specify in its adaptation plan the resources required to ensure its implementation;

— develop its adaptive capacity to address any gap between its existing level of adaptive capacity and its required level of adaptive capacity;

— engage key decision makers and interested parties, where appropriate, throughout the adaptation planning process.

The organization shall include the following when establishing its adaptation policies, strategies and plans:

— additional benefits from enhancing capacity;

— timing of adaptation actions;

— prioritized actions including, where feasible, urgent early actions;

— the range of decision-making opportunities, the culture of decision-making and the pathways and approaches for achieving change;

— trends of climate change impacts over the full expected lifespan of decisions and actions;

— regular updating to ensure that strategic and policy directions reflect learning from the experience of those delivering it;

— an evaluation of the direct and indirect impacts of its choices of actions (e.g. transfer of risk).

7.2 Policy, strategy and planning context

The organization shall identify relevant internal and external policies, strategies and plans that affect their adaptation planning.

When establishing its adaptation policies, strategies and plans, the organization should state the relationships with:

— its other internal policies and strategies, e.g. business continuity plan, sustainability policy;

— sector specific standards, guidelines and codes of practice;

— national policies;

— legal and other requirements;

— national, regional and local adaptation plans and strategies;

— national adaptation communications;

— the nationally determined contribution under the UNFCCC Paris Agreement;

— the UN SDGs.

The organization shall identify cross-cutting (systemic) dependencies and interdependencies.

7.3 Decision-making

7.3.1 General

Decision-making shall be made at the level of governance (financial, technical) and competence commensurate with the scope of the climate change impacts identified.

The organization shall:

— identify and use reliable and appropriate sources of information;

— make available and use mechanisms that permit feedback and learning from decision-making throughout the policy, strategy and planning process.

Information sources can include science-based evidence, expert opinion, feedback and views of interested parties.

In organizations driven by policy and investment cycles, decision points (e.g. maintenance cycles and asset replacement needs) can be useful entry points for adaptation action.

Potential barriers and enablers to decision-making and adaptation action should be identified and considered during the decision-making process. These barriers and enablers should include those associated with implementation of the proposed adaptation actions. Organizations should consider actions in combination as part of the review of barriers and enablers.

7.3.2 Identification of climate change adaptation actions

Climate change adaptation actions can be categorized into hard and soft measures and both can be used in an integrated way. Examples of soft measures are linked to building adaptive capacity and include behavioural change, developing new knowledge, embedding climate change into the organization's policies and operational procedures, training, insurance, early warning systems, building standards, awareness raising, public health management reform and land-use planning. Hard measures can be grey or green measures. Grey measures usually involve structural approaches, such as infrastructure and/or buildings, e.g. dykes and sea walls for adapting to sea level rise, cooling buildings and urban areas using passive architectural solutions. Green measures involve ecosystem-based adaptation, e.g. flood protection zones, vegetation and water features for cooling urban areas, natural soil surfaces for rainwater management and agroecology.

Some climate change adaptation actions imply incremental changes within current systems and operations. Other actions imply a more fundamental transformation. Incremental adaptation comprises the extension of actions that are currently generally accepted ways of reducing losses or enhancing benefits from climate variability and extreme events, such as increasing existing flood defences, modifying weather warning systems and augmenting water supply. Transformation can involve a "step change" and uses behaviour and technology to change the economic, social or environmental components of a system fundamentally but not necessarily irreversibly. This can involve planned and responsive actions, including disruptive innovation, shifting activities to new locations or fundamental changes in administrative roles and responsibilities. It can result from single initiatives or a series of rapid incremental changes in a particular direction.

More strategic adaptations include relocation of activities to an area more appropriate to the future climate, relocation of threatened infrastructure, changes to the organization's product offerings and changes to the way input materials and components are sourced.

7.3.3 Decision-making approaches

Decision-making approaches that are particularly useful when addressing the uncertainties in climate change projections include:

— adaptation pathways;

— decision mapping;

— dynamic adaptive policy pathways;

— robust decision-making;

— adaptive policy making.

Other decision-making approaches that can be used include:

— cost-benefit analysis;

— multi-criteria analysis;

— cost-effectiveness analysis;

— real options analysis;

— systems approaches;

— planning scenarios.

The organization may also use expert or interested party judgement.

7.3.4 Short, medium and long lifespan decisions

The organization shall assess adaptation options over the expected lifespan of the decision's consequences.

— Decisions with consequences that last less than 10 years tend only to require a low decision-making capability to respond adequately, as cause and effect are clear to see without high levels of expertise.

— Decisions with consequences that last between 10 years and 20 years require a medium decision-making capability, as higher levels of expertise are needed to make sense of less obvious relationships between cause and effect.

— Decisions with consequences that last 20 or more years require a high decision-making capability, due to the uncertainty that has to be managed in the decision (i.e. increased elements of climate impacts are unknowable).

NOTE The nature of an organization's activity will influence the lifespan of its decisions. For example, in forestry, the consequences of decisions can last for decades compared to the consequences of cereal cropping choices. The challenge is to adapt the decision-making capability according to this lifespan.

The organization should have the capability to make climate change adaptation decisions at the level of expertise commensurate with the complexity of the decisions.

Decisions often have consequences that go beyond the planning horizon.

For long lifespan decisions requiring high levels of organizational capability, the organization may:

— take into account internal and external interested parties that influence and are influenced by long-term climate-relevant decisions;

— determine what level of organizational capability is required by themselves and by their relevant interested parties in order to consider climate change appropriately and over the corresponding timescales;

— design improvement strategies to address any gaps between required organizational capacity and existing organizational capacity;

— review decisions in context with other interdependent decisions.

The organization should use collaborative approaches to decision-making.

7.4 Adaptation plan

7.4.1 General

This subclause sets out the content of the adaptation plan.

The adaptation plan shall:

— state the objectives the organization aims to meet by implementing the adaptation plan;

— include a justification for the actions selected;

— state the rationale behind its formulation;

— document any assumptions made;

— note the sources of uncertainties;

— document the decision-making approach being used;

— document the information and data on which decisions are made;

— describe its relationship with existing policies and strategies;

— describe any prioritization process used and its outcomes;

— document how the adaptation actions address the most critical climate impacts and opportunities;

— state its period of validity.

The adaptation plan should take into account:

— feasible approaches to reducing impacts, including a combination of both soft and hard measures;

— appropriate and cost-effective practices for the organization;

— levels of acceptable risk;

— reduction of the level of impacts from climate change and related hazards;

— promotion of sustainable development and social licence to operate;

— realization of opportunities.

The adaptation plan can comprise more than one document.

7.4.2 Scope of the plan and boundaries of the system

The adaptation plan shall specify the scope of the plan and boundaries of the organizational system being addressed.

A system may be a region, a community, a household, a supply chain, an economic sector, a business, a population group, etc., that is exposed to specific climate hazards. Guidance on systems and setting boundaries is given in Annex A.

The adaptation plan shall address both the resilience of the organization and the system or network within which it operates, even if they are outside the direct control of the organization.

7.4.3 Baselines

Where baselines are used, they shall be clearly defined.

7.4.4 Climate change information

The adaptation plan shall state the climate change information, past, present and future and underlying greenhouse gas emission scenarios and any other scenarios used, e.g. socio-economic, demographic.

7.4.5 Impacts

The adaptation plan shall describe the past, present and future impacts, both positive and negative, and direct, indirect and cross-cutting (systemic) impacts that climate change poses to the organization's activities, products or services.

Indicators should be determined to measure the evolution of the impacts through time. The same indicators can be used for monitoring and evaluation.

7.4.6 Adaptive capacity

The adaptation plan shall:

— state the current adaptive capacity of the organization;

— state the adaptive capacity it requires to effectively implement and manage the identified adaptation;

— state the way in which the climate change adaptation process is to be embedded in the organization's policies, strategies and plans;

— use initial findings of adaptive capacity assessments as benchmarks and assess progress against this baseline at regular intervals.

The organization shall adopt a management approach that reflects the complexity of their climate change adaptation challenge.

Simple management approaches to complicated or complex adaptation challenges can be ineffective. Likewise, complex management approaches to simple adaptation challenges can be inefficient. The organization should therefore demonstrate that they understand the complexity of their climate change adaptation challenge and the appropriate level of management approaches needed for effective responses.

Indicators should be determined to measure how adaptive capacity evolves over time. The same indicators can be used for monitoring and evaluation.

7.4.7 Climate change adaptation actions

The climate change adaptation plan shall document the adaptation actions that are to be implemented to address Clauses 5 and 6 and 7.4.1 to 7.4.6, along with explanations of why some actions were adopted and others were not.

The description of actions shall include a description of the threats associated with the decision and potential benefits, if appropriate.

Each documented climate change adaptation action shall include:

— an objective;

— its description;

— its indicators;

— timescales.

Each documented climate change adaptation action should also include:

— its estimated costs and expected benefits;

— an assessment of the threats to its effective delivery;

— its current and required organizational capability;

— the needs of regulatory/economic instruments.

7.4.8 Implementation, monitoring and evaluation, reporting and communication

The organization shall prepare as an integral part of its adaptation plan:

— an implementation plan in accordance with Clause 8;

— a monitoring and evaluation plan in accordance with Clause 9;

— arrangements for reporting and communication in accordance with Clause 10.

7.4.9 Interested parties' engagement

Where the climate adaptation plan includes activities relating to interested parties, these shall be described.

8 Implementation

8.1 Leadership and commitment

Top management shall demonstrate leadership of, commitment to and accountability for implementation by:

— taking accountability for the effectiveness of the adaptation action;

— ensuring that the adaptation policy and objectives are established and are compatible with the strategic direction and the context of the organization;

— ensuring the integration of the adaptation plan into the organization's business processes;

— ensuring that the resources needed for the adaptation action are available;

— communicating the importance of effective climate change adaptation;

— ensuring that the adaptation follows a trajectory towards its intended outcomes;

— directing and supporting persons to contribute to the effectiveness of the adaptation action;

— promoting continual improvement;

— supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

8.2 Implementation plan

Implementation means transforming the climate change adaptation plan into activities.

The organization shall prepare an implementation plan that:

— documents the processes, including inputs and outputs, that ensure the actions identified in the adaptation plan are delivered;

— sets out contingencies in order to attain successful implementation where actions are found to be incapable of delivering the desired outputs;

— provides for adjustment where new learning and/or circumstances are recognized.

Developing an implementation plan is critical to the delivery of the adaptation plan and the preparation of a monitoring and evaluation plan. Among others, the implementation plan specifies barriers and enablers to delivery and measures to be taken to address these. The development of an implementation plan and a monitoring and evaluation plan is an iterative process.

The organization shall demonstrate in the implementation plan how it:

— has appropriate levels of organizational capability and resources to deliver climate change adaptation actions;

— embeds climate change adaptation processes into its policies, strategies and processes, and operational activities;

— has a formalized organizational structure identifying roles and responsibilities in implementing climate change adaptation;

— has processes to reflect upon experiences gained during the implementation process and update the implementation plan as required;

— can adapt to new opportunities for improved outputs including scalability of interventions;

— engages in timely dialogue with interested parties;

— has specified improvement objectives (incremental and/or transformation-based).

Owing to the long-term nature, variables and uncertainties of climate change, the long-term outcome of an adaptation plan cannot always be assessed within short time frames. What can be done instead is to monitor processes and use proxies that better capture the adaptation plan's likely impacts. It is therefore important to develop indicators that can be used to confirm a trajectory for the adaptation plan, so that monitoring and evaluation can be used to instigate corrective action, if necessary.

9 Monitoring and evaluation

Monitoring and evaluation are used to assess, inform and review the adaptation plan so that satisfactory progress is confirmed and indications of unsatisfactory progress are highlighted early enough, triggering when additional action is needed and allowing corrective action to be taken.

The organization shall prepare a monitoring and evaluation plan that assesses progress against the implementation plan.

The monitoring and evaluation plan should include an assessment of actions, inputs, outputs, resources, roles and responsibilities, processes, capacities and any other relevant aspects.

Monitoring and evaluation is used to inform the organization about the progress of its climate change adaptation. It can generate knowledge, learning and evidence that can then inform adaptive management.

The organization shall:

— document the results of monitoring and evaluation and determine whether the adaptation and its implementation plan are still valid;

— update its policies, strategies and plans using the outcomes of the evaluation;

— adopt a formal structure to capture learning from monitoring and evaluation to inform current and subsequent policies, strategies and plans;

— determine the periodicity of monitoring and evaluation according to policies, strategies and plans;

— evaluate the outcomes of monitoring at appropriate stages during the implementation cycle.

Ad hoc monitoring and evaluation shall also be carried out as a result of the receipt of relevant new information and on the occurrence of a significant event whether or not major impacts are experienced.

Indicators should be quantitative, where possible. Where quantitative indicators are not possible, qualitative indicators may be used. Performance tracking over time, benchmarking against other relevant organizations, and comparisons to a baseline may also be used.

NOTE A set of indicators can provide a more complete representation of an adaptation plan than a single indicator.

The organization shall determine and describe the indicators to be monitored as part of monitoring and evaluation that cover the necessary elements for the effective delivery of the adaptation plan as well as its long-term outcomes. This includes the continual assessment of:

— process inputs and outputs;

— resources;

— organizational capability and overall adaptive capacity.

Indicators should:

— be capable of being measured in the short term while relating to long-term outcomes;

— enable comparisons in order to identify and provide evidence for further and corrective actions.

NOTE Additional information about indicators can be found in the Bibliography.

The organization may identify implementation measures for monitoring and evaluation that are beyond the scope of the adaptation plan.

10 Reporting and communication

An organization may communicate its climate change adaptation to interested parties external to the organization.

Climate change adaptation communications shall:

— be accurate, verifiable, relevant and not misleading;

— be unlikely to result in misinterpretation;

— clearly state the scope of the climate change adaptation;

— not imply that the climate change adaptation is endorsed or verified by an independent third-party organization when it is not;

— not, either directly or by implication, exaggerate the significance of the climate change adaptation to which the communication relates;

— be reassessed and updated as necessary to reflect changes in climate change threats and opportunities, or the results of monitoring and evaluation;

— include qualitative or quantitative information about uncertainties.

When an organization makes an external climate change adaptation communication it shall be supported by a climate change adaptation report that is easily accessible to any interested party and is free of charge.

The climate change adaptation report shall:

— be an open, comprehensive and understandable presentation of information;

— clearly identify significant climate change impacts and opportunities;

— clearly describe the methods used to identify climate change impacts and opportunities;

— clearly explain the climate adaptation actions chosen and the justification for choosing these actions, as well as any alternative actions that were considered;

— explain the monitoring and evaluation plan as well as any relevant monitoring and evaluation results.

Annex A
(informative)

Using systems thinking to set boundaries for climate change adaptation

A.1 Systems thinking — The concept

Systems thinking is about understanding the complex, nonlinear and interconnected system in which an organization operates. Many large organizations are complex, adaptive systems in themselves, meaning that the elements that make up an organization (for example, emergency response, transport pool, supply chain, finance, procurement teams) have a complex set of interactions that are dynamic and so do not always interact in the same or a consistent way. Organizations require techniques for managing these interactions effectively. This makes the organization adaptive in nature so that it responds according to the needs or circumstances at the time.

A.2 Systems thinking — Benefits

Systems thinking can help users to consider the full set of interactions and interdependencies affecting their organization, including influences within and from outside the context within which the organization operates. The approach can be used to set boundaries around adaptation activity such that the organization filters out elements less relevant to its activities, products and services while still understanding the importance of these elements. The organization will be left with tasks within a defined boundary, or scope, which results in a manageable set of adaptation activities.

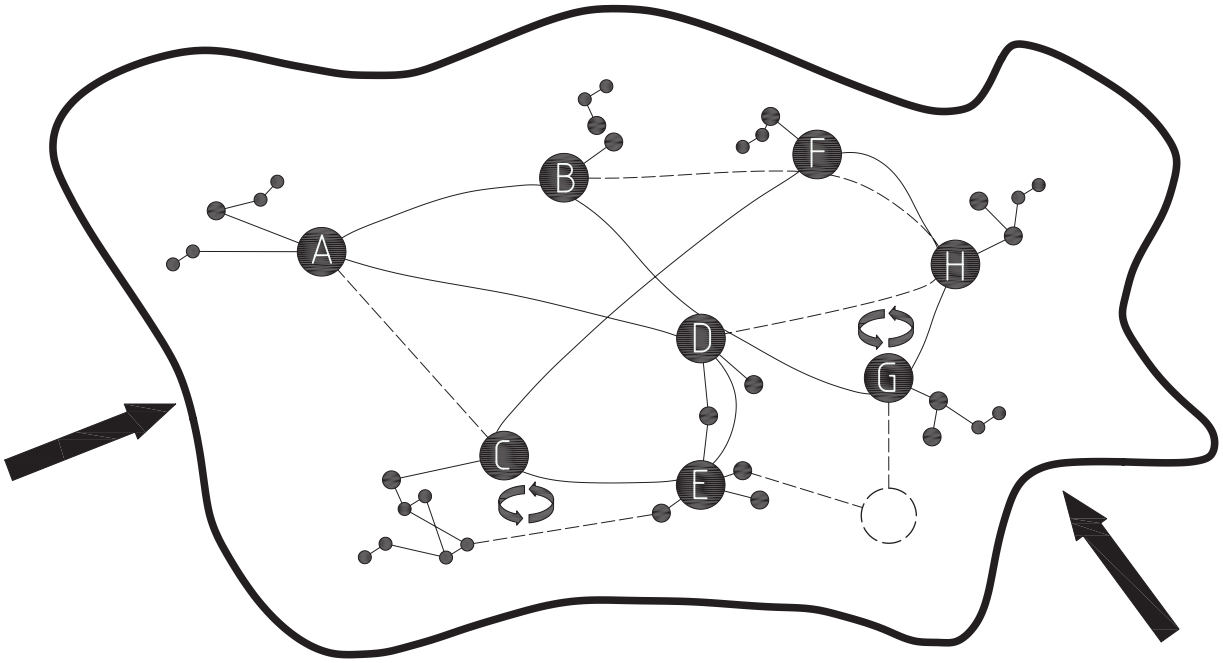
Systems thinking can help to identify positive and negative feedback loops that can attenuate or exacerbate the impacts of change. Similarly, systems thinking can help to identify unintended consequences of decisions or actions before they are implemented.

In other words, organizations can use systems thinking to identify, define and refine those activities that really matter and can be controlled by interventions. In this way, manageable boundaries can be set which make adaptation more achievable.

A.3 Interconnections, dependencies and interdependencies

Thinking about interconnected relationships in a system is crucial for understanding how an organization might be able to intervene in the system to influence the sustainable management of resources in its portfolio of activities, products and services (see Figure A.1). For example, in the case of services, this might include identifying all the interdependencies involved in bringing the service to customers, as well as the ways in which the changes in climate will impact service delivery over time.

NOTE Dependencies are one-way interconnections, meaning that organization A depends upon a product or service from organization B, but not the other way around; whereas interdependencies are two-way interconnections, meaning that organizations A and B depend upon each other. An example of the latter would be how an electricity power station depends upon rail transport for its supply of biomass, and the rail transport system depends upon electricity for its control and traction systems.



Key

A — an organization: one part of a system

key actors or stakeholders, e.g. regulators, suppliers, communities, NGOs, technology providers, clients

external factors, e.g. environmental constraints, policy and regulation, consumer preferences, advances in technology

feedback loops, e.g. new communication channels, new relationships, customer feedback, recycling or reuse of products and materials, wider social value

system boundary, e.g. geographical/place based, sector, market

relationship link, e.g. formal (contractual, transactional) and informal (knowledge exchange, business support, community relationships)

systematic intervention: new inputs, changing the total output of the system, e.g. standards or rating schemes, policy changes, product or service innovation, business model innovation, increase access to solutions, reshape supply, create user demand, implement new platforms

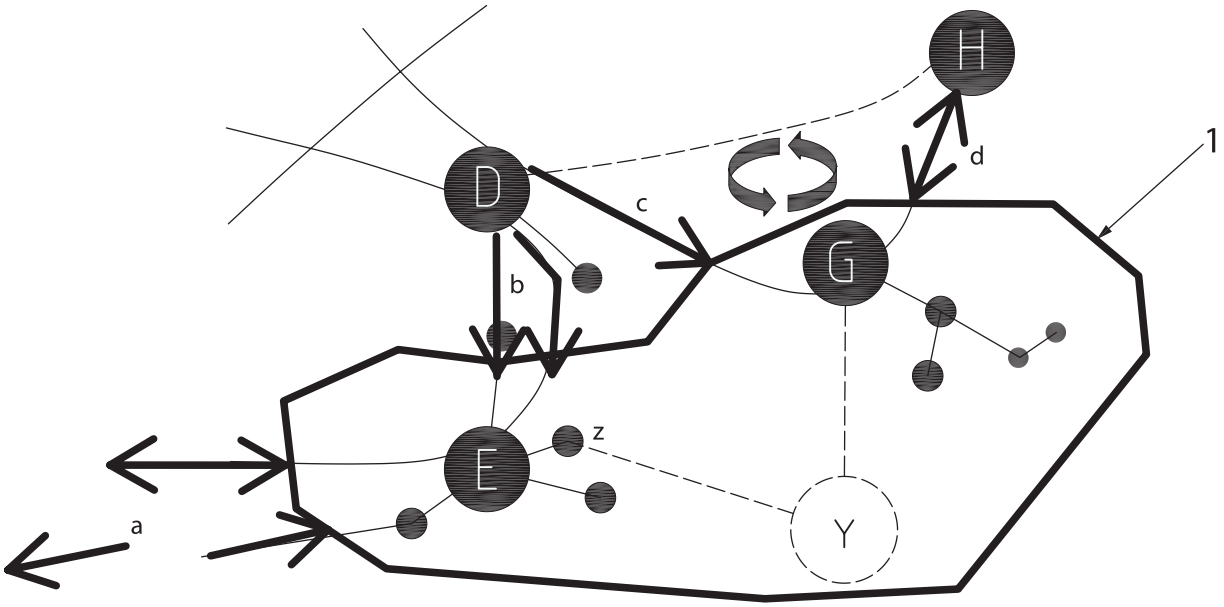
Figure A.1 — Systems concept showing a general systems concept with interventions highlighted

A.4 Mapping and identifying boundaries and sub-systems

Figure A.1 shows how eight organizations A to H are interconnected by relationships and have key actors or interested parties. A boundary has been drawn around the whole system showing external factors as outside of the boundary. An intervention is depicted between organizations G and E that would have come about through an adaptation plan.

Figure A.2 takes the systems thinking to a more granular level. It depicts a filtered system that encompasses organizations G and E as a sub-system. This is a sub-system of the system shown in Figure A.1, however, it is a system in its own right. It has its own external factors and so (inter) dependencies on external organizations shown by arrows; arrow a from organization C from Figure A.1, arrows b from organization D in Figure A.1, arrow c from organization B and arrow d from organization H. The dotted area Y is an intervention between an actor within organization E called z and G.

This is an example of how a large system of systems (see Figure A.1) can be reduced further to a smaller system of systems (see Figure A.2).



Key

1 sub-system boundary

NOTE See key to Figure A.1.

Figure A.2 — System of systems concept showing a filtered system based upon organizations E and G

Hence, the sub-system in Figure A.2 has a boundary and can be looked at as a quasi-independent grouping that could be examined (for example, for its influence on adaptation) on its own; however, users of this map will recognize that decisions, or climate and weather-related impacts, in this sub-system can impact other sub-systems because of the (inter) dependencies apparent shown by arrows a and d.

A.5 Practical examples for Figure A.2

Table A.1 shows some broad illustrations explaining the systems mapping that organizations might make, based on the map in Figure A.2. Each illustration is not meant as an exhaustive set of explanations covering every aspect shown in Figure A.2 and is offered merely to show how the concept might be used. The systems map ordinarily needs to be drawn bespoke for every organization's situation, that used here is idealized.

Table A.1 — Illustration of how the systems map from Figure A.2 might be used by some organizations

Organization E might be a...	Actor z could be a...	Organization G might be a...	Organization D could be a...	Intervention Y might involve... to solve...
Farm	Purchaser	Local feedstock distributor	Feedstock distributor located abroad	Sourcing feedstock from D to shorten supply chains as D has a good stockpile facility
Energy transmission grid	Back-up power supply connection	Local solar energy source	Energy supply abroad	Sourcing energy from D to bolster robustness and reduce costs

Table A.1 *(continued)*

Organization E might be a…	Actor z could be a…	Organization G might be a…	Organization D could be a…	Intervention Y might involve… to solve…
Local authority	Drainage maintenance team	Drainage contractor	Central government support	Sourcing expertise from D to increase capacity
Coastal town	Coastal defence team	Other coastal towns within similar region	Regional flood authority	Setting up agreements with other like-minded towns to pool resources

Annex B
(informative)

Thresholds analysis

B.1 Thresholds analysis — The concept

Thresholds analysis involves identifying the critical thresholds that will cause an organization or its systems to suffer an intolerable shift in performance. Thresholds analysis can be used to prioritize actions in climate change adaptation planning. Thresholds are also known as tipping points, as they indicate a nonlinear relationship between a controlling variable and system performance. An emerging consensus amongst many practitioners is use of the term “thresholds”. It is the term used in this document.

A threshold is a point beyond which a system is deemed to be no longer effective (economically, socially, technologically or environmentally). The aim of thresholds analysis is to identify such points, determine the current proximity to these thresholds, and develop an adaptation plan that will reduce the likelihood of crossing these thresholds.

Thresholds analysis is based on the notion that a system has a limited adaptive capacity. If the system is subjected to a hazardous event or trend or disturbance as a result of climate change, it can continue to function satisfactorily by re-organizing and adapting, up to a certain threshold. There is a limit to how much stress the system can handle. If this adaptive capacity is exceeded, the system will no longer perform as required. The capacity to avoid shifting to an undesirable state, or to intentionally adapt or transform to a new desirable state, reflects the resilience of the system.

Crossing a threshold results in a fundamental change that is not easily reversed, and it can even be irreversible. Thresholds are often not known precisely, and can be very difficult to identify. Fortunately, it is not necessary to quantify thresholds precisely to be able to apply thresholds analysis. Rather, it is critical to be aware of their possibility, and investigate the proximity to thresholds of potential concern so that, through adaptation planning, the adaptation management process learns more about the thresholds and can reduce the likelihood of crossing them, by steering the system away from the threshold, and enhancing its resilience (coping capacity). Avoiding thresholds could require incremental changes to the management of the system, or more fundamental transformation of the system. The capacity to make those changes will in some cases be within a single organization. In others, the required decisions can spread across a system of organizations that are legally independent while being interdependent when addressing a particular threshold issue.

Once a threshold has been identified, the organization can monitor relevant indicators to determine the proximity to the threshold, and determine a trigger point, at which the organization needs to take action to avoid crossing the threshold.

B.2 Steps in thresholds analysis

B.2.1 Characterize the system

Describe the key features of the system, including its boundaries, and define the problem, aims, objectives and constraints pertinent to the analysis. Describe the system’s constituent components, their internal and external dependencies and interdependencies and linkages, particularly the key controlling variables, drivers and feedbacks.

EXAMPLE Cause and effect relationships across supply chains, market forces and dependencies between organizational units.

The system description is a conceptual model of the system and can be presented as a diagram(s) or a narrative. Annex A provides guidance on characterizing the key components and relationships of the organization and other organizations within a larger system. It is also critical to understand the components and linkages of the systems within the organization.

B.2.2 Research possible climate changes

Determine the trends (slowly changing variables) and shocks (extreme climate events) that are projected under climate change, for the location of the system, and that can impact the system. Consider trends in average and extreme conditions, and change in climate variability. Clause 6 lists a wide range of climate parameters that can be relevant in different contexts. Consider the uncertainty associated with the climate change projections. Extreme events are the most uncertain elements of the climate change projections.

B.2.3 Identify thresholds

Assess the possible effects of climate change, both undesirable and desirable. Identify potential shifts that could occur as a result of the impact of projected climate trends and shocks on the key relationships of the system. Consider for each part in the system what alternative states could be possible, and under what circumstances and conditions the present state could shift into the alternative state. Consider how the organization's activities, products and services might be impacted. An analysis of the system's response to historical climate trends and climate events can be helpful. Review of performance of similar systems operating in a location where present climate is similar to the projected climate (climate analogue) could be informative.

The variables that cause the system to shift are controlling variables; the value of the variable at which the shift occurs is the threshold. The most important climate thresholds to identify are those that will cause the system to fail, with significant economic or social impact. Determine the limits of tolerance to changes in climate variables, and how much change to performance is acceptable to the organization. Thresholds could be directly related to extreme climate events, such as extreme temperature, under which electric components could fail, solar PV efficiency could drop or product quality could be affected; intense rainfall, that could exceed capacity of the storm water system; storm surge, that could lead to seawall collapse. Alternatively, impacts and associated thresholds could be related to slow variables: increasingly warm average temperatures and reduced incidence of frosts reach a point where fruit quality falls below acceptable levels; a series of failed cropping seasons could lead to bankruptcy; a trend towards smaller vehicles could cause a collapse of the market for large SUVs; sea level rise could cause increasingly frequent inundation at high tides, damaging roads and other infrastructure. Climate change impacts could affect the organization indirectly, such as through decreased availability, and/or increasing costs, of inputs.

Climate change impacts can be regulatory or reputational, as well as physical and financial.

Relevant threshold considerations could be as follows.

— What is the temperature at which the hospital air conditioning system will fail to maintain building temperature within the acceptable range — and what is the probability of a heat wave that will exceed this temperature, and what will be the impact?

— How much rainfall, over what period, can the levee withstand before being breached and flooding the town?

— How many failed crops can the farming company withstand before going bankrupt?

— What fire frequency will lead to a shift in species composition (e.g. in forest or rangeland), and what is the likelihood of this being exceeded?

— What is the point beyond which it is no longer worth repairing and upgrading a sea defence? The factors are likely to be an interconnected range of costs and benefits: financial, social, environmental and possibly political.

— What carbon footprint will be accepted by consumers without diminishing demand for a product?

B.2.4 Assess resilience

The pace and nature of climate change over the lifetimes of long decisions can be uncertain because some elements of the change are currently unknown. The thresholds approach offers help in managing uncertainty by plotting pathways of adaptive actions with their respective thresholds to extreme climate change events. Actual events are likely to fall within that range. Plans are therefore developed to bring resilience to actual climate change outcomes.

Determine the proximity to the identified thresholds, and probability of exceedance, and consider the adaptation needs to avoid crossing these thresholds. Relevant considerations are as follows.

— What climate trends/shocks will push the system towards the identified thresholds?

— What is the likelihood of these climate events occurring, and what is the consequence to the organization?

— Is it inevitable that the threshold will be crossed?

Consider the temporal context.

— Are decisions being taken by the organization that will have long-term consequences, such as decisions on building design or dam construction, for example?

— How might climate change over this period?

— Is an incremental response adequate, or is a transformation required?

The consequence can be determined by an interaction between variables: for example, a grazing enterprise can be better able to withstand a drought and avoid crossing a ground cover threshold if it has a high level of equity, and is therefore able to reduce stocking rate.

B.2.5 Identify suitable indicators

Identify suitable indicators to monitor the proximity to thresholds, and associated triggers, that will be incorporated into the adaptation plan, specifying the point at which action will be initiated, to avoid the system crossing a threshold.

EXAMPLE 1 The cooling system for a data centre will fail when the external air temperature reaches 38 °C. This temperature is the threshold; if this temperature is exceeded the air-conditioning will fail, and the servers will shut down. The adaptation plan includes monitoring the external air temperature, and installation of a water misting system to cool the external condenser units, that is activated when the external air temperature reaches 32 °C (the trigger).

EXAMPLE 2 Increasing temperatures are causing reduced yields and faster ripening of grapes, reducing the quality of wine. Incremental response: The company plants different varieties that are better adapted to the warmer climate. Transformational response: The company buys land in a cooler region and shifts its operation to a new location.

EXAMPLE 3 A long drought combined with overgrazing can cause loss of ground cover. On some soil types 30 % ground cover is a recognized threshold below which the infiltration rate is reduced leading to a shift from higher productivity perennial grasses to a degraded low-productivity system dominated by annual grasses.

EXAMPLE 4 A coastal city has flood resilience infrastructure in place to a threshold of 0,7 m sea level rise. At that point, strengthening the existing tidal barrier and raising associated sea defences to a specification resilient to 2,3 m of sea level rise will be undertaken. A range of further pathway options with trigger points have been identified to provide resilience to a threshold of 4 m sea level rise. Inevitably, sea levels will rise such that further extension of the defences will become unfavourable. It will be necessary to retreat from the coastal area. If the planning and implementation of the retreat begins early enough, it becomes a process of transformation such that costs are minimized and benefits maximized.

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