Risk Assessment

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Presentation structure

1. Introduction
2. Multi-Hazard Inventory
3. Life-cycle Impacts
4. Risk Assessment
5. Risk Management and Decision Making
6. International Standards and Guidelines
7. Conclusions

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01

Introduction

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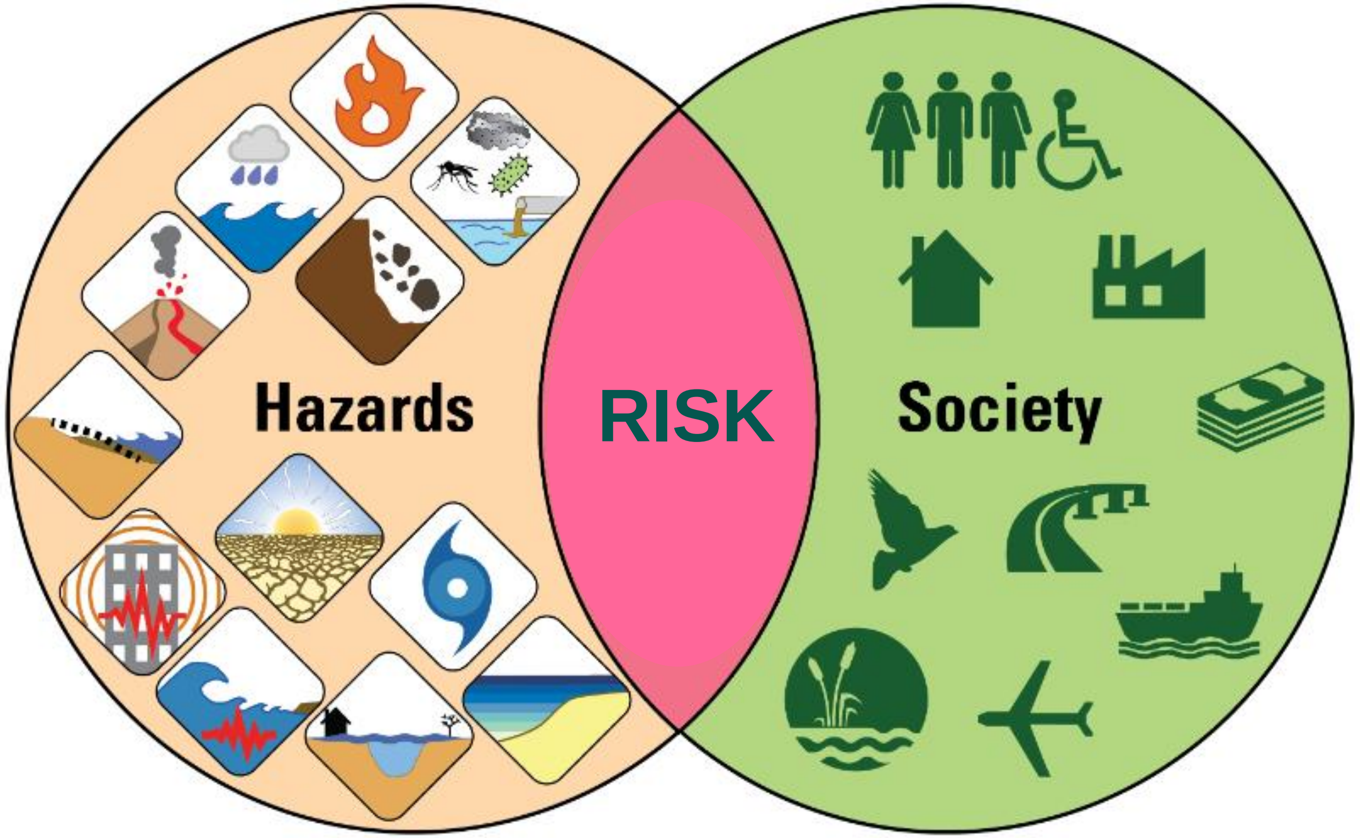
RISK
Combination of the probability of an event and its negative consequences



HAZARDS
Sources/situations with the potential to cause harm (e.g., injury, damage, loss)

CONSEQUENCES FOR SOCIETY
The impact or outcome if the hazard causes harm in **human life**, property, environment, and economic activities

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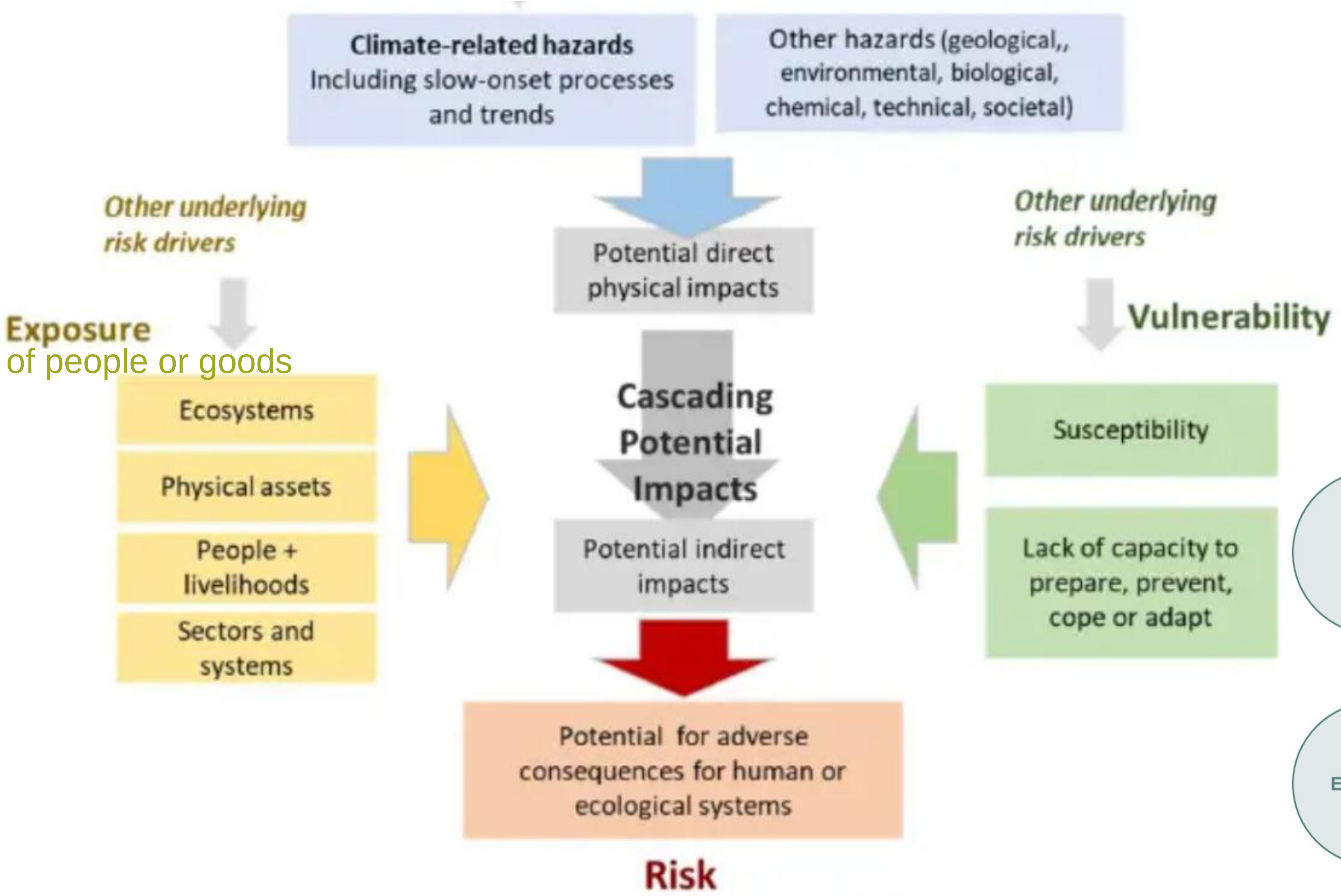
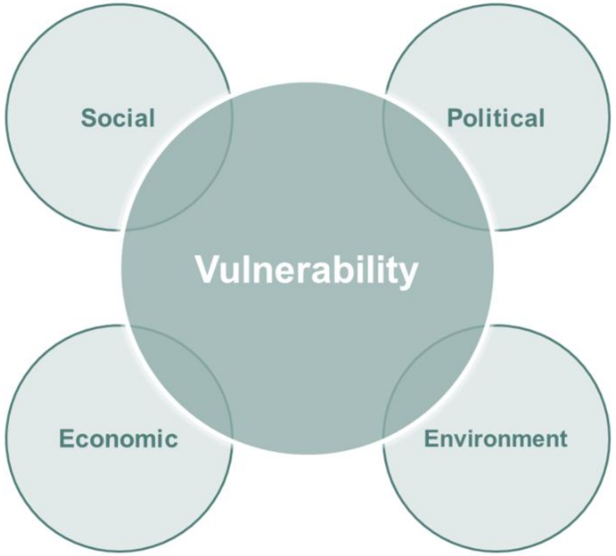
HAZARDS

with a severity/intensity
and a probability of occurrence





Risk assessment

Definition

Risk assessment is a systematic process of identifying and evaluating potential hazards and their associated consequences to **human life**, property, environment, and economic activities.

Purpose

Provides a **structured framework** for analyze the probability and consequences of adverse events, enabling organizations to **prioritize resources**, implement **mitigation measures**, and develop effective **emergency response plans**.

Scope

Natural hazards: earthquakes, floods, hurricanes, extreme temperature events, *etc.*

Technological hazards: industrial accidents, structural failure, toxic waste release, cyber hazard, *etc.*

Societal Hazards: disinformation, organized crime, governance failure, geopolitical hazards, *etc.*

Key Stakeholders in Risk Assessment

Government Agencies

Federal, state, and local government agencies use risk assessment for decision-making, emergency planning, land use planning, and resource allocation.

Private Industry

Companies use risk assessment for for operational safety, environmental environmental compliance, insurance purposes, and business business continuity planning.

Insurance Industry

Insurance companies use risk assessment to evaluate exposure, set exposure, set premiums, and develop risk transfer products.

International Organizations

Organizations such as the United Nations, World Bank, and various professional societies promote standardization and best practices in risk assessment globally.

Academic Institutions

Universities and research organizations develop new new methodologies, conduct fundamental research, and and provide training in risk assessment techniques.

Historical Development of Risk Assessment

1

Ancient Civilizations

Developed rudimentary approaches to managing natural disasters and human-made hazards

2

Mid-20th Century

Modern risk assessment emerged, driven by the need to address increasingly complex technological systems and growing environmental and safety concerns

3

1960s-1970s

The development of probabilistic risk assessment (PRA) in the nuclear industry marked a significant milestone. The Reactor Safety Study (WASH-1400) established many fundamental principles still used today.

4

1990s-2000s

Integration of GIS, remote sensing technologies, and advanced computational models assessment capabilities

02

Multi-Hazard Inventory

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Natural Hazards

Geological Hazards

> sudden onset and potential for widespread impact

- Earthquakes
- Volcanic eruptions
- Landslides
- Tsunamis
- Ground subsidence

Meteorological & Hydrological Hazards

> increasingly influenced by climate change

- Wildfires
- Hurricanes and tornadoes
- Severe thunderstorms
- Floods and droughts
- Extreme temperature events

Natural Hazards

World Meteorological Organization
EXECUTIVE COUNCIL
Seventy-Sixth Session
27 February to 3 March 2023, Geneva

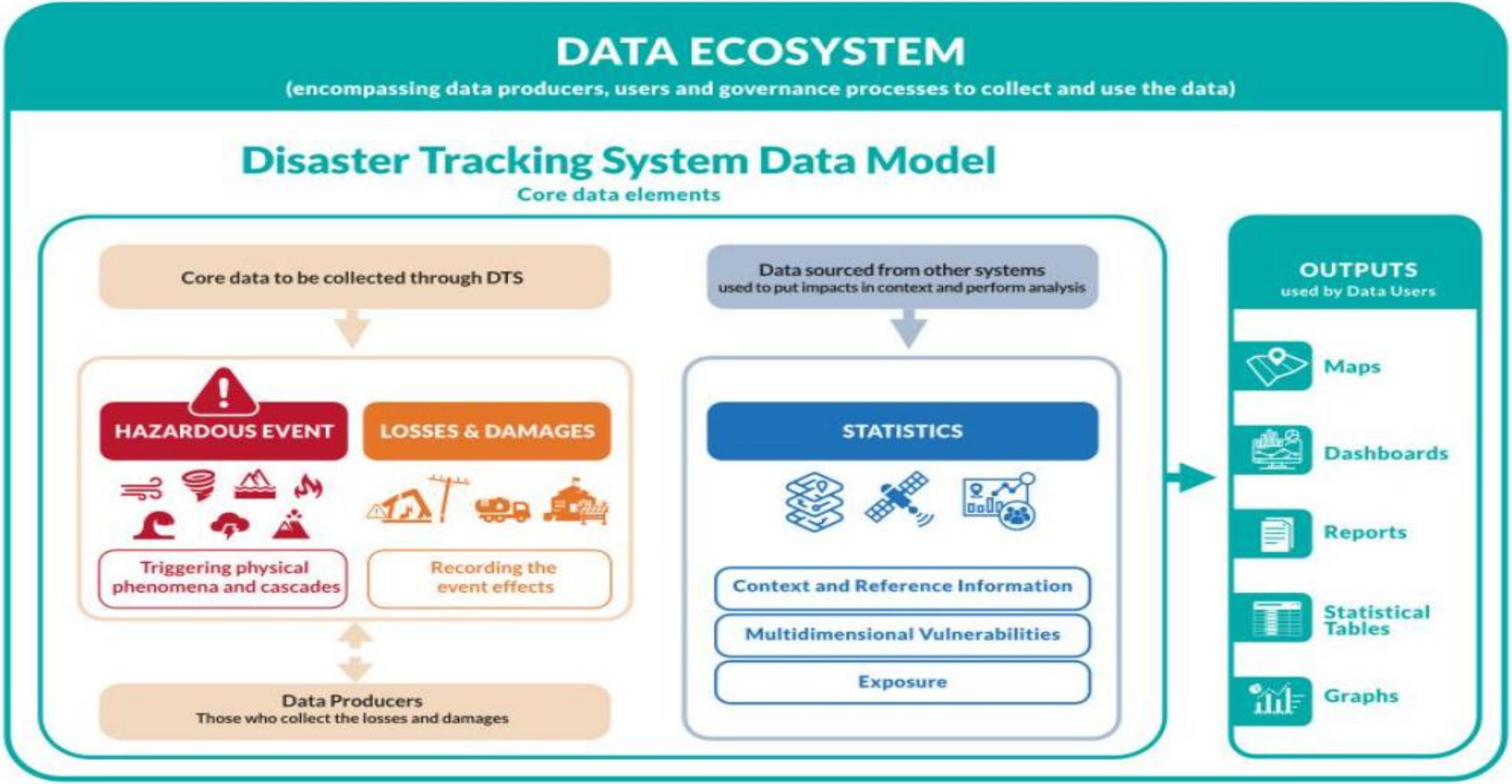
EC-76/Doc. 3.1(11)

Submitted by:
Chair

28.II.2023

APPROVED

Disaster Tracking System



Technological Hazards

Industrial accidents	Chemical spills, gas leaks, explosions
Nuclear/radiological	Reactor meltdowns, radioactive material leaks
Fires (human-caused)	Industrial fires, electrical fires
Transportation accidents	Train derailments, plane crashes, shipwrecks
Autonomous system failure	Self-driving cars misinterpreting road signs or pedestrians
Structural failure	Dam collapses, bridge failures, building collapse
Hazardous materials	Toxic waste release, flammable storage facility fires
Power or utility failures	Grid blackouts, water supply disruptions
Oil and gas accidents	Pipeline rupture, offshore oil rig explosion
Cyber hazards	Infrastructure hacking (e.g. power grid, water systems)
AI in critical systems	Malfunction in AI controlling power grids or healthcare devices

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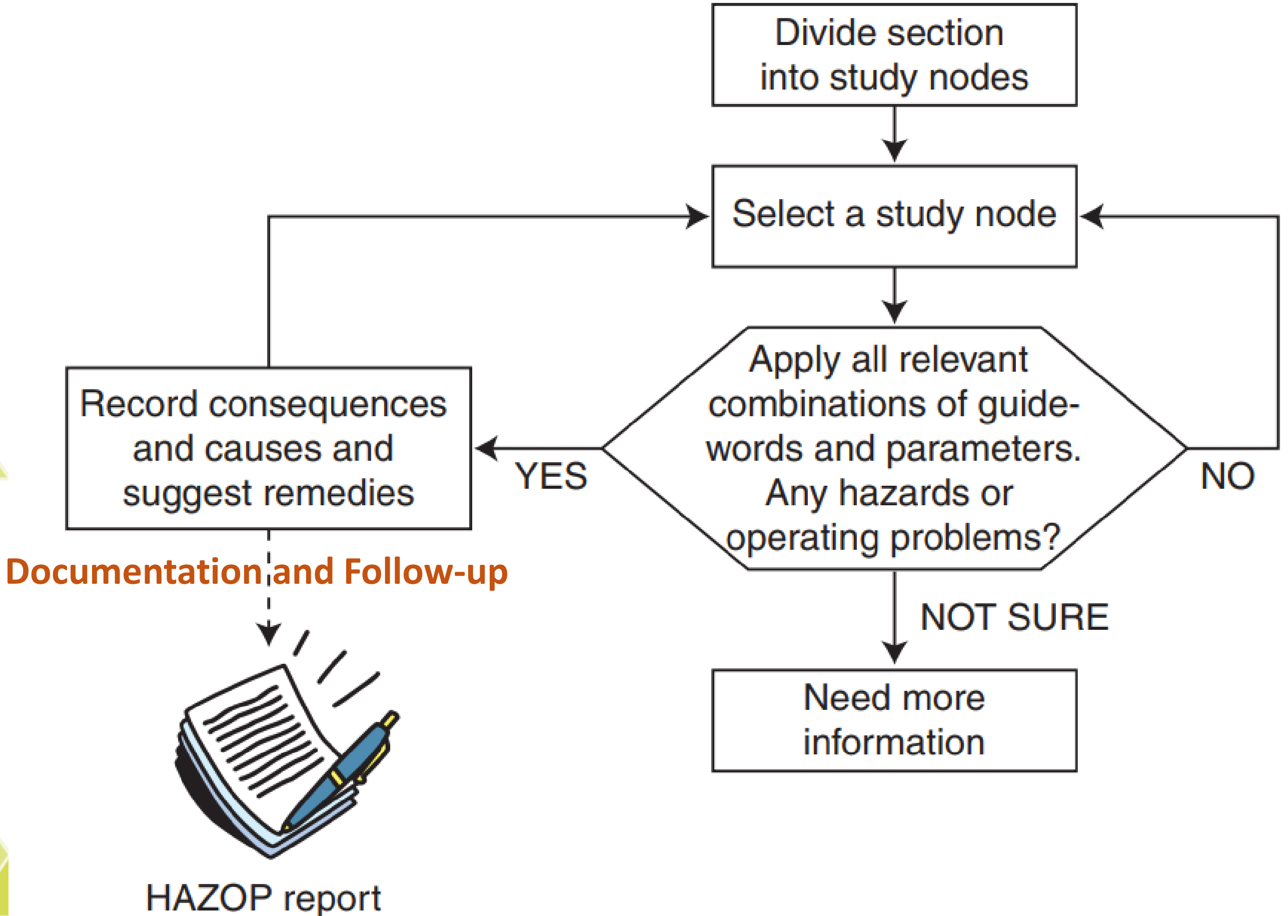
HAZOP Methodology

A structured methodology for identifying potential HAZards and OPerability problems in industrial processes.

Originally developed for the chemical industry, it has been adapted for use in various other industries.



Node definition - Dividing the process into manageable study nodes, each representing a specific piece of equipment or process step.

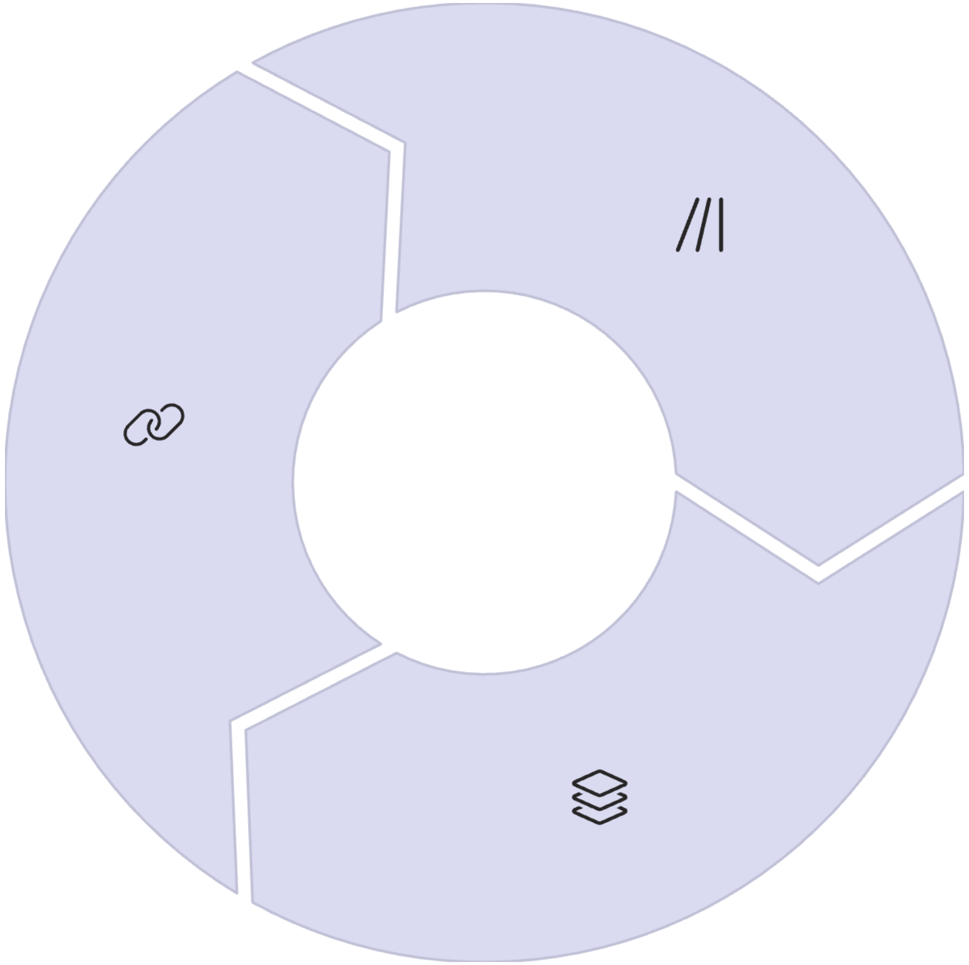
Deviation Analysis - Systematically examining each node using guide words that represent potential deviations from design intent (NO, MORE, LESS, AS WELL AS, PART OF, REVERSE, OTHER THAN).

Guide Word	Meaning	Example with Flow
NO	Complete negation of the design intent	No flow when flow is intended
MORE	Quantitative increase	Higher flow rate than intended
LESS	Quantitative decrease	Lower flow rate than intended
AS WELL AS	Qualitative modification/increase	Additional substances in the flow

Hazard Interaction

Triggering Relationships

One hazard event triggers another, such as earthquakes triggering landslides or volcanic eruptions triggering tsunamis.



Cascading Effects

A sequence of failures that propagate through interconnected systems, such as an earthquake damaging power systems, which affects water treatment and communications.

Compound Events

Simultaneous or sequential occurrence of multiple hazards with greater combined impacts than the sum of individual impacts, such as hurricanes producing both wind damage and flooding.

Multi-Hazard Integration

Natech (Natural Hazard Triggering Technological Disasters) Events

Natech events occur when natural hazards trigger technological accidents, creating compound disasters with potentially severe consequences. These events highlight the importance of considering natural hazards in the design and operation of technological systems.

Historical Examples

- Fukushima nuclear accident (2011):
  Triggered by the Tohoku earthquake and tsunami

- Hurricane Katrina (2005):
  Multiple industrial accidents along the Gulf Coast

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Multi-Hazard Integration

Common Risk Metrics

Probabilistic approaches to characterize hazard :
> Frequency
> Intensity
> Spatial distribution

Integrated Modeling Platforms

Assessment methodologies combine:
> Historical data analysis
> Multi-Physics modeling
> Remote sensing

Scenario-Based Approaches

Agent-Based Modeling - Simulates the behavior of individual agents (people, organizations, systems) and their interactions

Virtual and Augmented Reality - visualize and communicate risk information

Portfolio Risk Management

Treats collections of assets or systems as portfolios and assesses total risk considering correlations between different hazards and locations.

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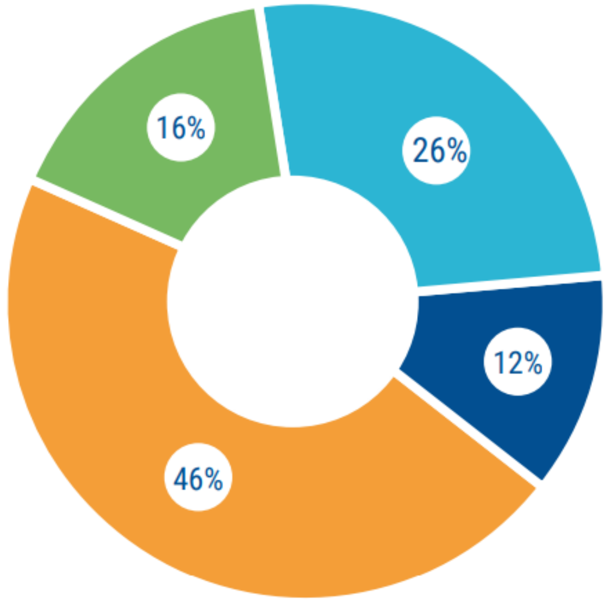
Multi-Hazard Early Warning Systems (MHEWS)

UNDRR United Nations Office for Disaster Risk Reduction

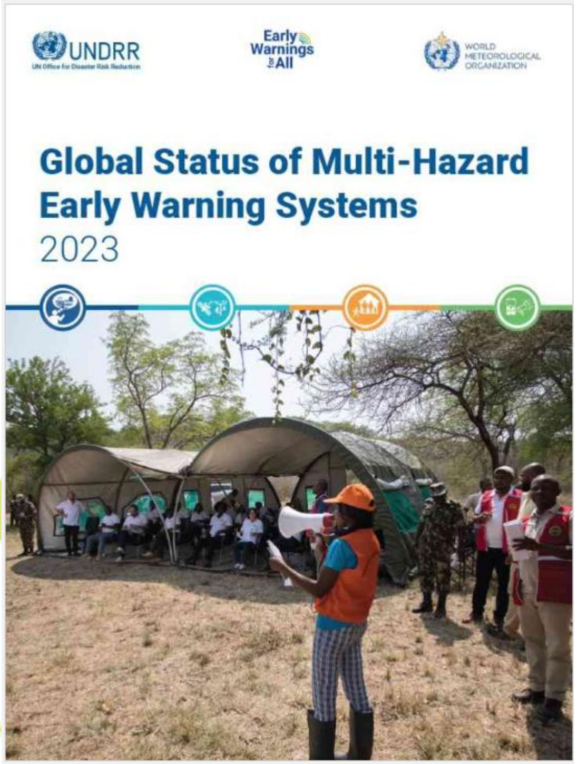
Contribution of the pillars to the MHEWS improvement

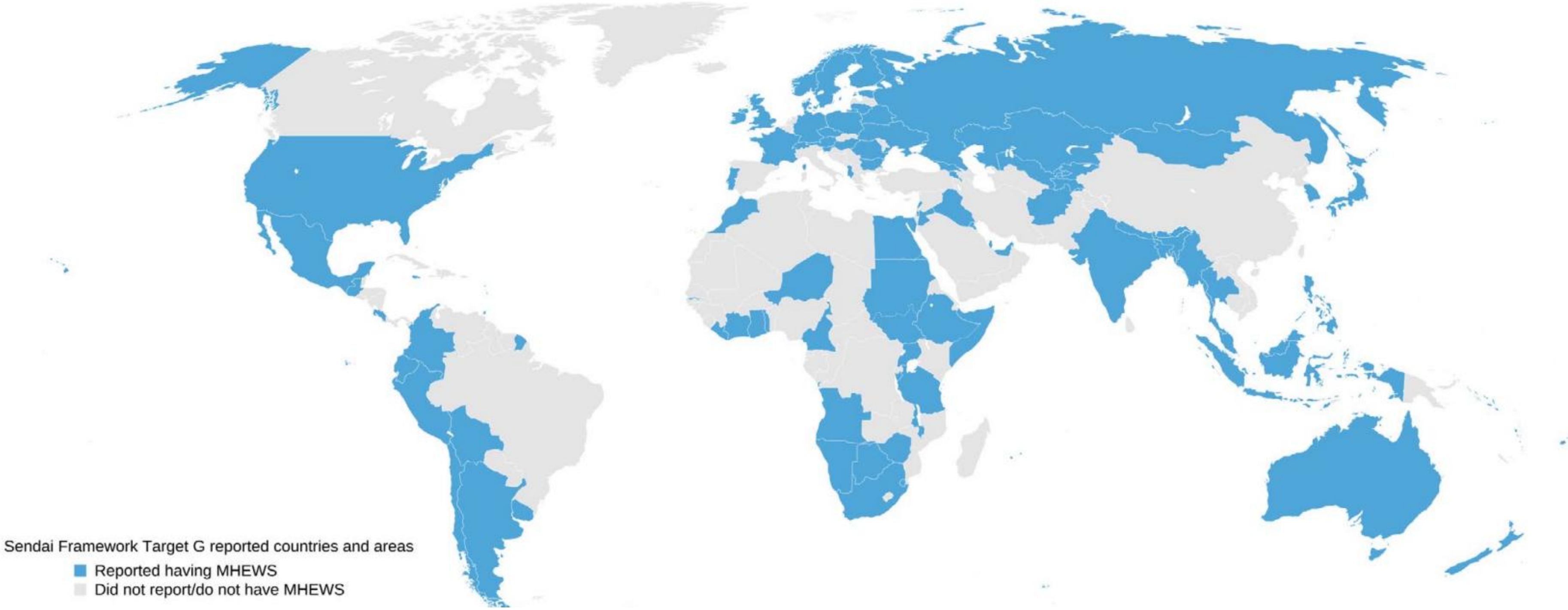


- Pillar 1: Disaster risk knowledge [G-5]
- Pillar 2: Detection observations, monitoring, analysis and forecasting [G-2]
- Pillar 3: Warning dissemination and communication [G-3]
- Pillar 4: Preparedness to respond [G-4]

Multi-Hazard Early Warning Systems (MHEWS)

UNDRR United Nations Office for Disaster Risk Reduction





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Life Cycle Impacts

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Life Cycle Assessment: ISO 14040/14044

LIFE CYCLE ASSESSMENT (LCA) is an increasingly important tool in **ENVIRONMENTAL IMPACT MANAGEMENT**

ISO 14040 and ISO 14044 provide detailed requirements for conducting an LCA. It includes specifications for choosing impact categories, category indicators, and characterization models.

> A comprehensive view of the environmental impacts associated with all stages of a product's life from raw material extraction to disposal.

Life Cycle Assessment: ISO 14040/14044

LCA helps to quantify the environmental pressures related to goods and services (products), the environmental benefits, the trade-offs and areas for achieving improvements taking into account the full life cycle of the product.

LCA includes:

- **Life-Cycle Inventory** is the collection and analysis of environmental interventions data (e.g. emissions to e.g. air and water, waste generation and resource consumption) which are associated with a product from the extraction of raw materials through production and use to final disposal, including recycling, reuse, and energy recovery.

- **Life-Cycle Impact Assessment** is the estimation of indicators of the environmental pressures in terms of e.g. climate change, summer smog, resource depletion, acidification, human health effects, etc. associated with the environmental interventions attributable to the life-cycle of a product.

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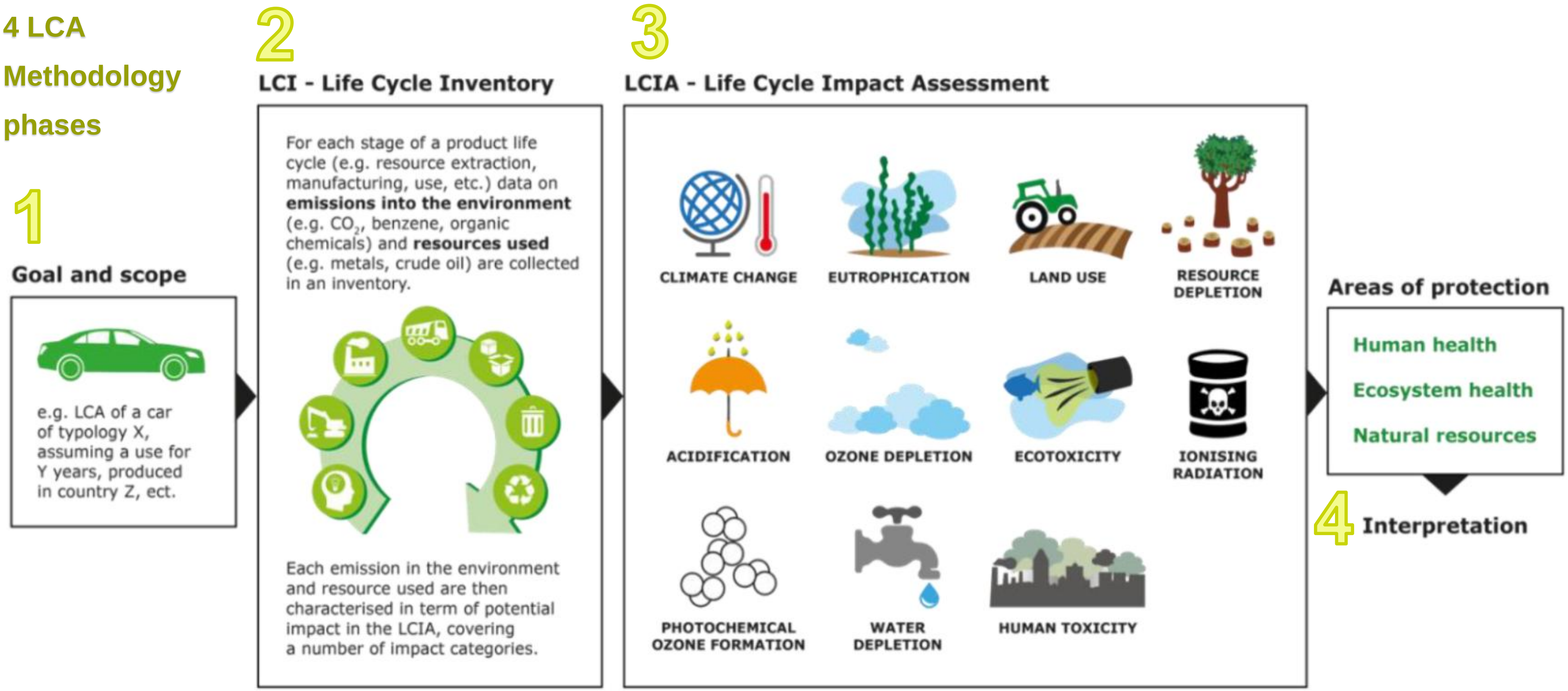
Life Cycle Assessment: ISO 14040/14044

4 LCA Methodology phases



Cristobal-Garcia, J., Pant, R., Reale, F. and Sala, S., *Life cycle assessment for the impact assessment of policies*, Publications Office, 2016, https://data.europa.eu/doi/10.2788/318544

Life Cycle Assessment: ISO 14040/14044

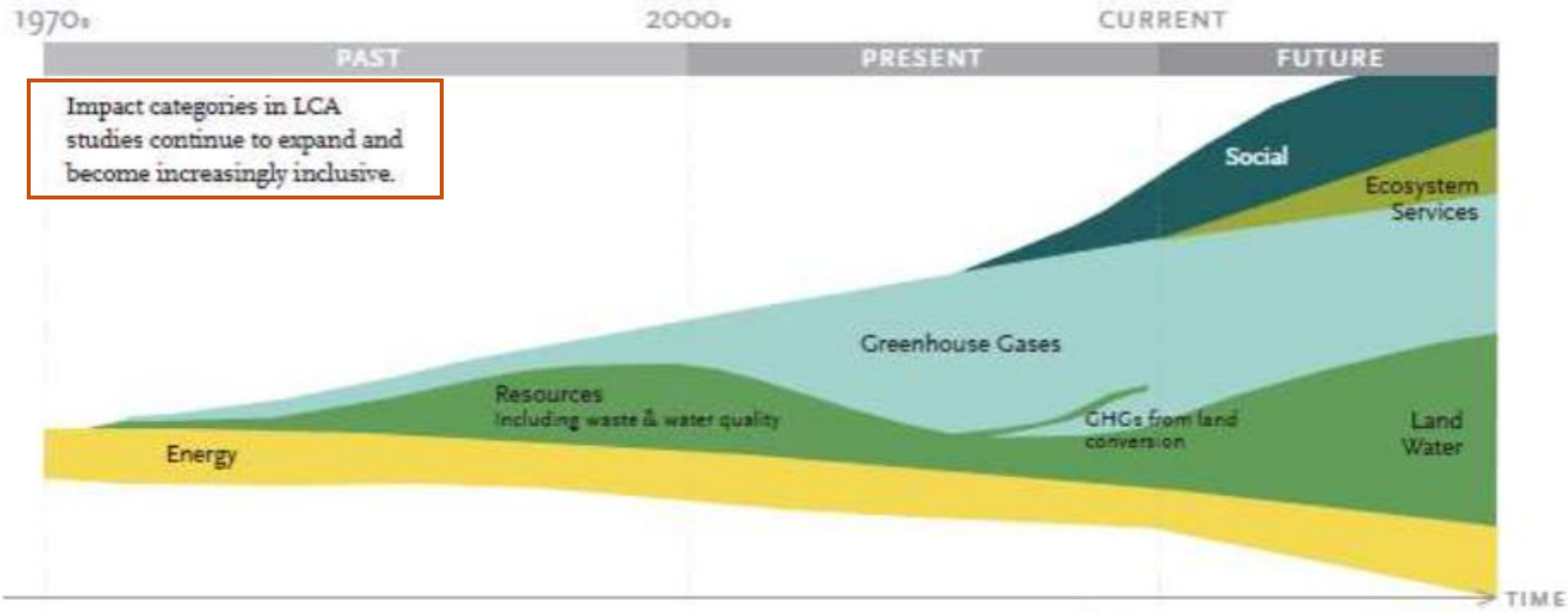
Once the inventory data on the life cycle of product are compiled, the **Life Cycle Impact Assessment** (LCIA):

Steps	Example
Classification requires assigning the material/ energy inputs and outputs inventoried to the relevant impact category.	During the classification phase, all inputs/ outputs that result in emissions of greenhouse gasses (e.g. CO_2, methane, etc.) are assigned to the climate change impact category.
Characterisation refers to the calculation of the magnitude of the contribution of each classified input and output to their respective impact categories, and aggregation of the contributions within each category. This is carried out by multiplying the inventoried values by the relevant characterisation factor for each impact category considered. The characterisation factors are substance- or resource-specific.	when calculating climate change impacts, all the greenhouse gas emissions previously inventoried in the LCI are weighted in terms of their impact intensity relative to carbon dioxide (expressed as kg of CO_2 equivalents).
Normalisation is the step in which the life cycle impact assessment results are multiplied by normalisation factors to calculate and compare the magnitude of their contributions to the impact categories, relatively to a reference unit. As a result, dimensionless, normalised results are obtained.	In the Product Environmental Footprint (PEF) the normalization factors are expressed as impact per capita, based on a global value. For example, the factor for climate change is $8.1 \cdot 10^3$ kg CO_2eq./person.
Weighting supports the interpretation and communication of the results of the analysis. In this step, normalised results are multiplied by a set of weighting factors (in %) which reflect the perceived relative importance of the life cycle impact categories considered. Weighted results of different impact categories may then be compared to assess their relative importance. They may also be aggregated across life cycle impact categories to obtain a single overall score.	The weighting factor in the Product Environmental Footprint (PEF) for climate change is about 21%, representing the relative relevance of this impact compared to the other categories.

Life Cycle Assessment

All potential impacts should be considered as far as possible in a holistic and integrated manner.

The impact categories considered in LCA could shift in terms of spatial and temporal resolution.



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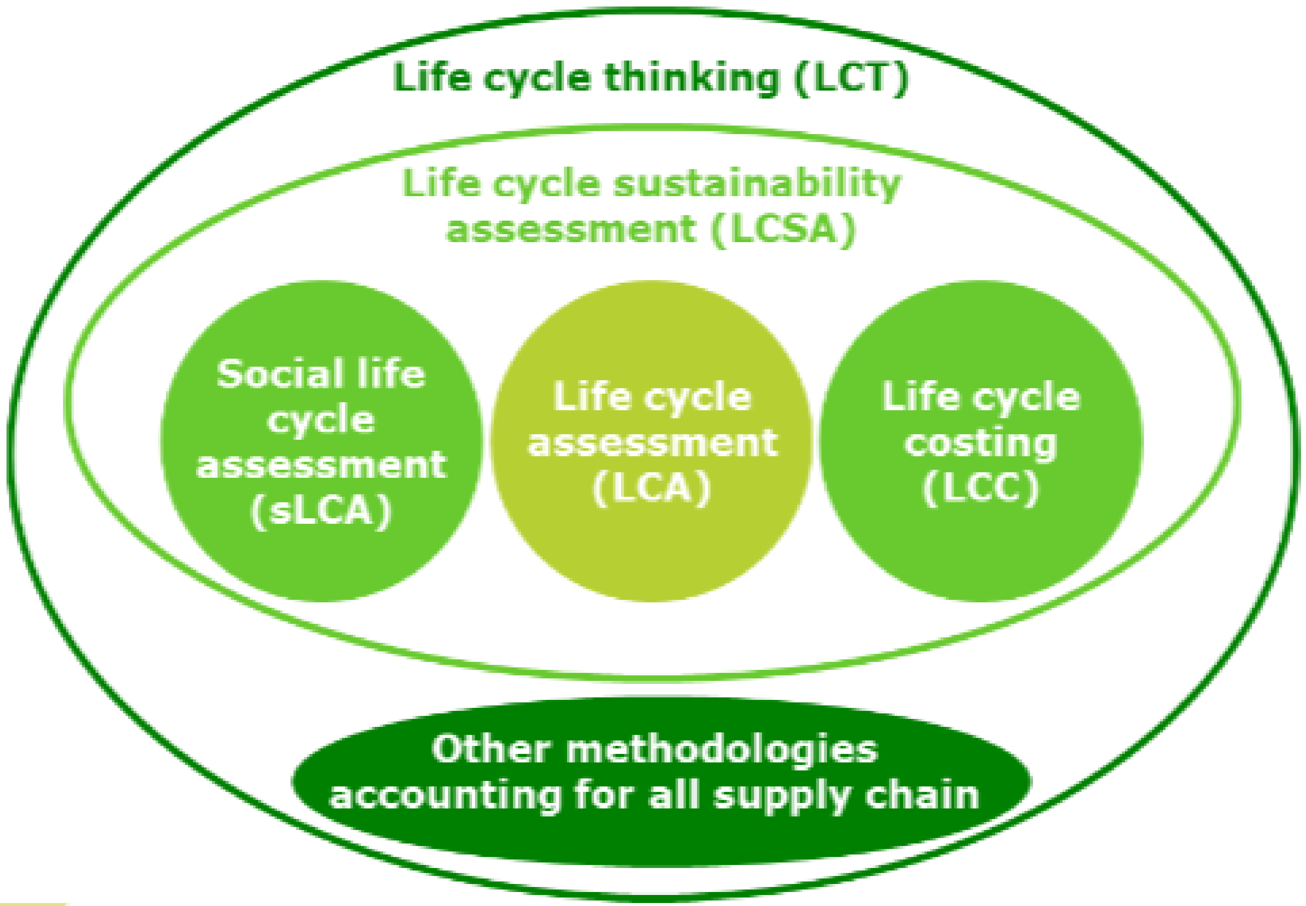
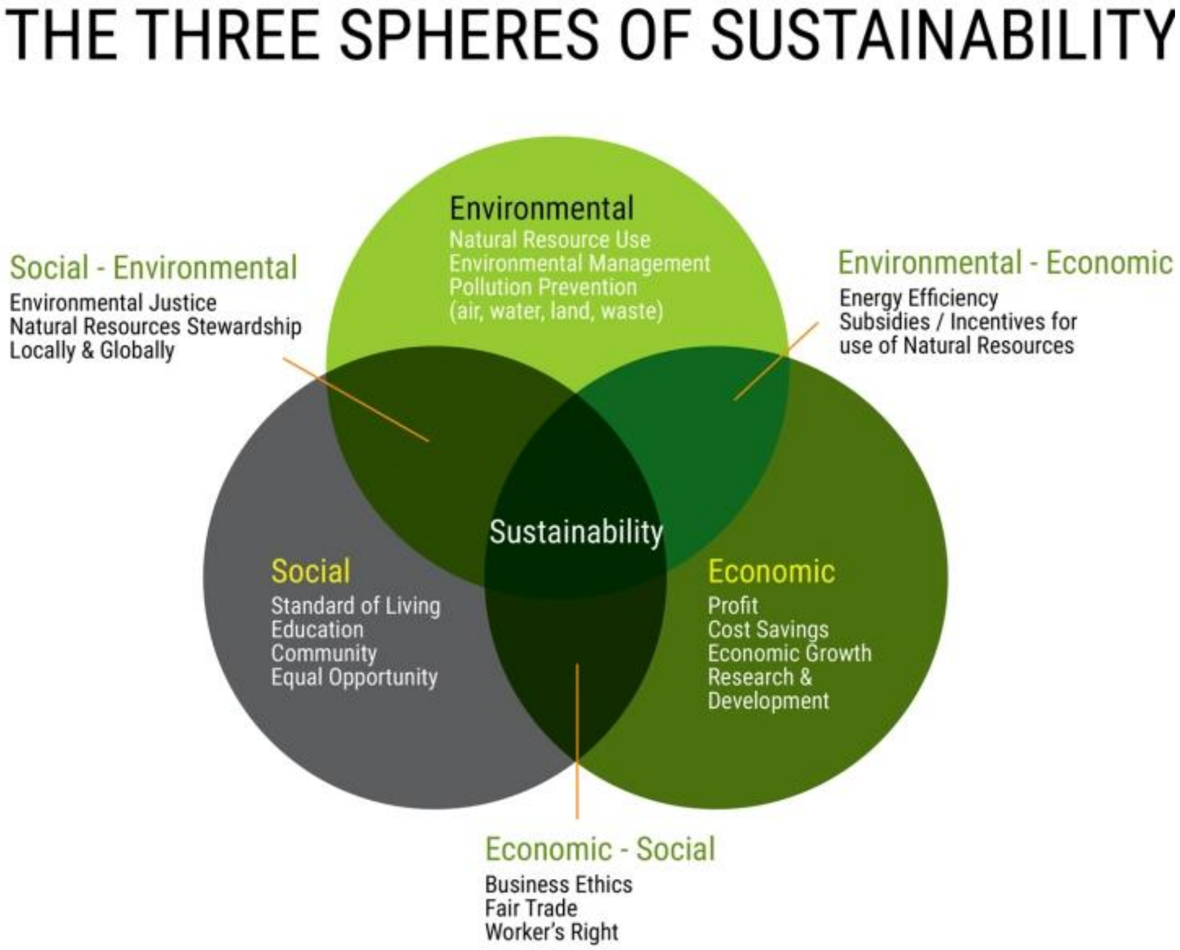
Life Cycle Assessment





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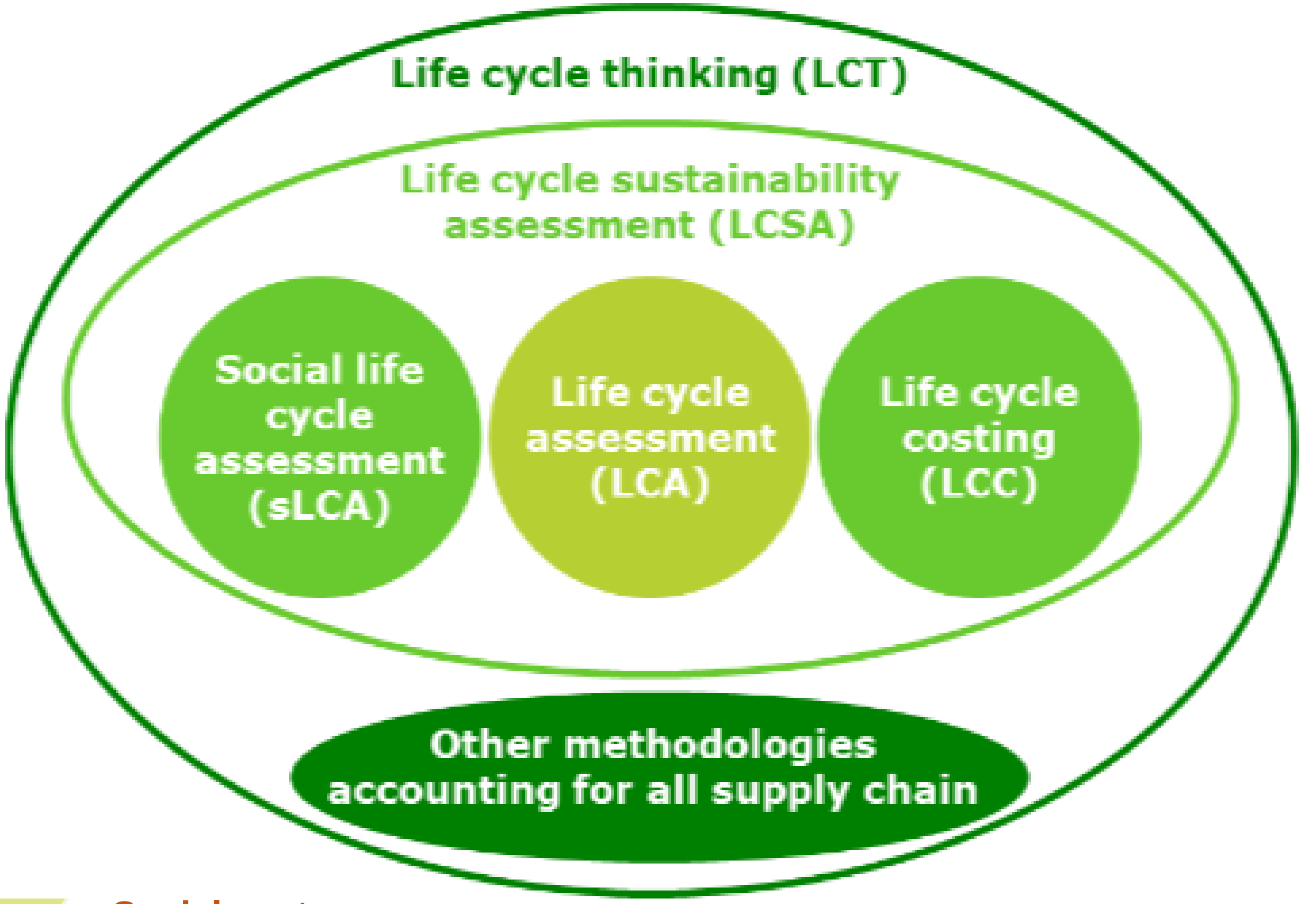
Life Cycle Assessment



Social costs

Environmental costs

Life Cycle Cost (LCC):

Direct Costs - Estimates the cost of repairing or replacing damaged buildings, infrastructure, and contents.

Indirect Economic Effects - Broader economic impacts, such as reduced tourism, increased transportation costs, and long-term changes in property values.

Business Interruption Analysis - Economic losses due to business closures and reduced economic activity during and after events.

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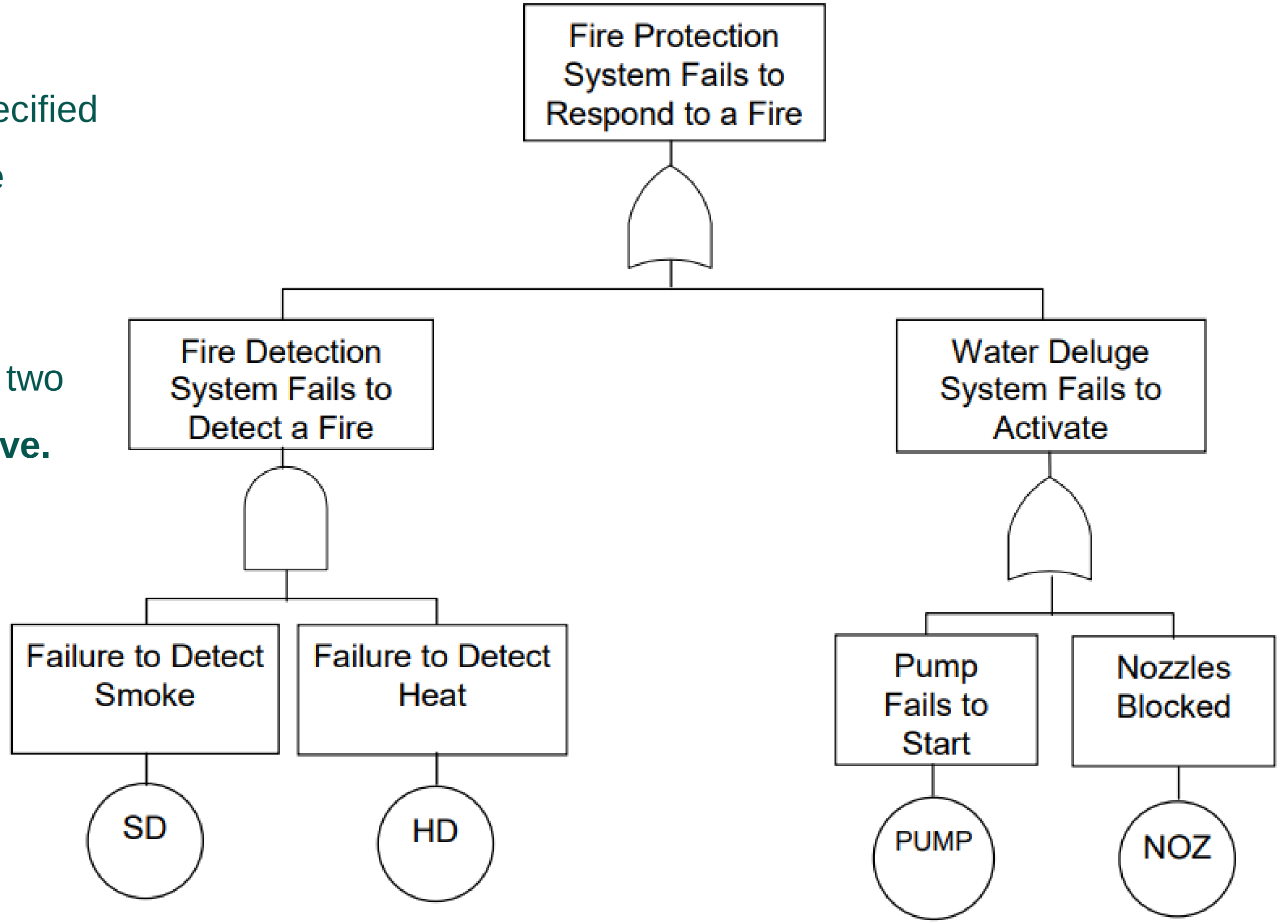
Fault Tree Analysis (FTA)

Fault Tree Analysis is a deductive methodology that works backward from a specific undesired event (top event) to identify all possible combinations of component failures and human errors that could cause the event. It provides a systematic approach for understanding system failure mechanisms and quantifying system reliability.

A fault tree represents the causes of a specified system failure mode in terms of the failure modes of the system components.

The analysis of the fault tree can produce two types of result: **qualitative** and **quantitative.**

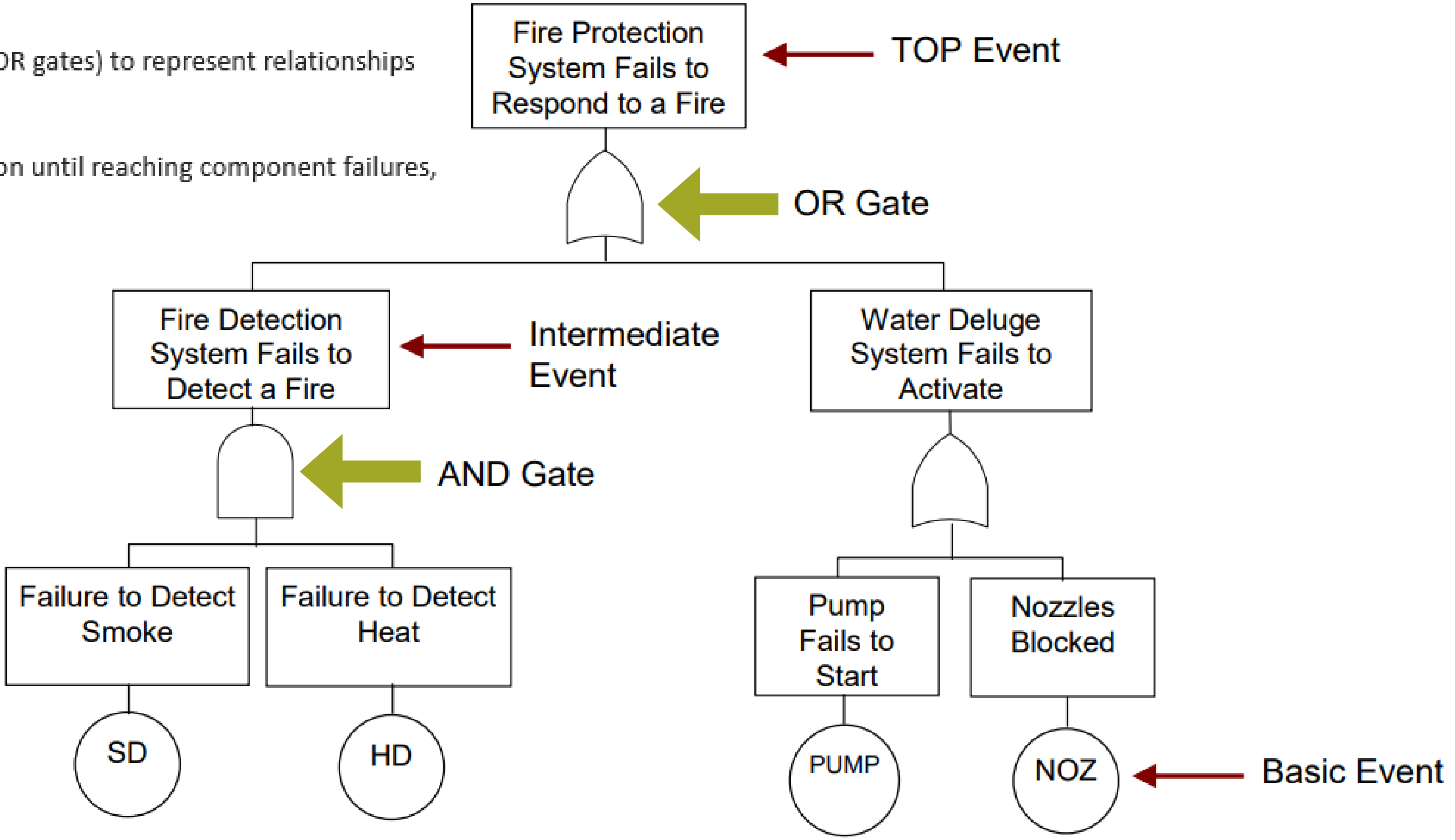


Fault Tree Analysis (FTA)

Fault Tree Construction

- Top Event Definition: Clearly specifies the undesired event to be analyzed
- Immediate Cause Identification: Identifies all immediate causes that could directly lead to the top event
- Logic Gate Application: Uses Boolean logic (AND/OR gates) to represent relationships relationships between events
- Basic Event Identification: Continues decomposition until reaching component failures, failures, human errors, or external events

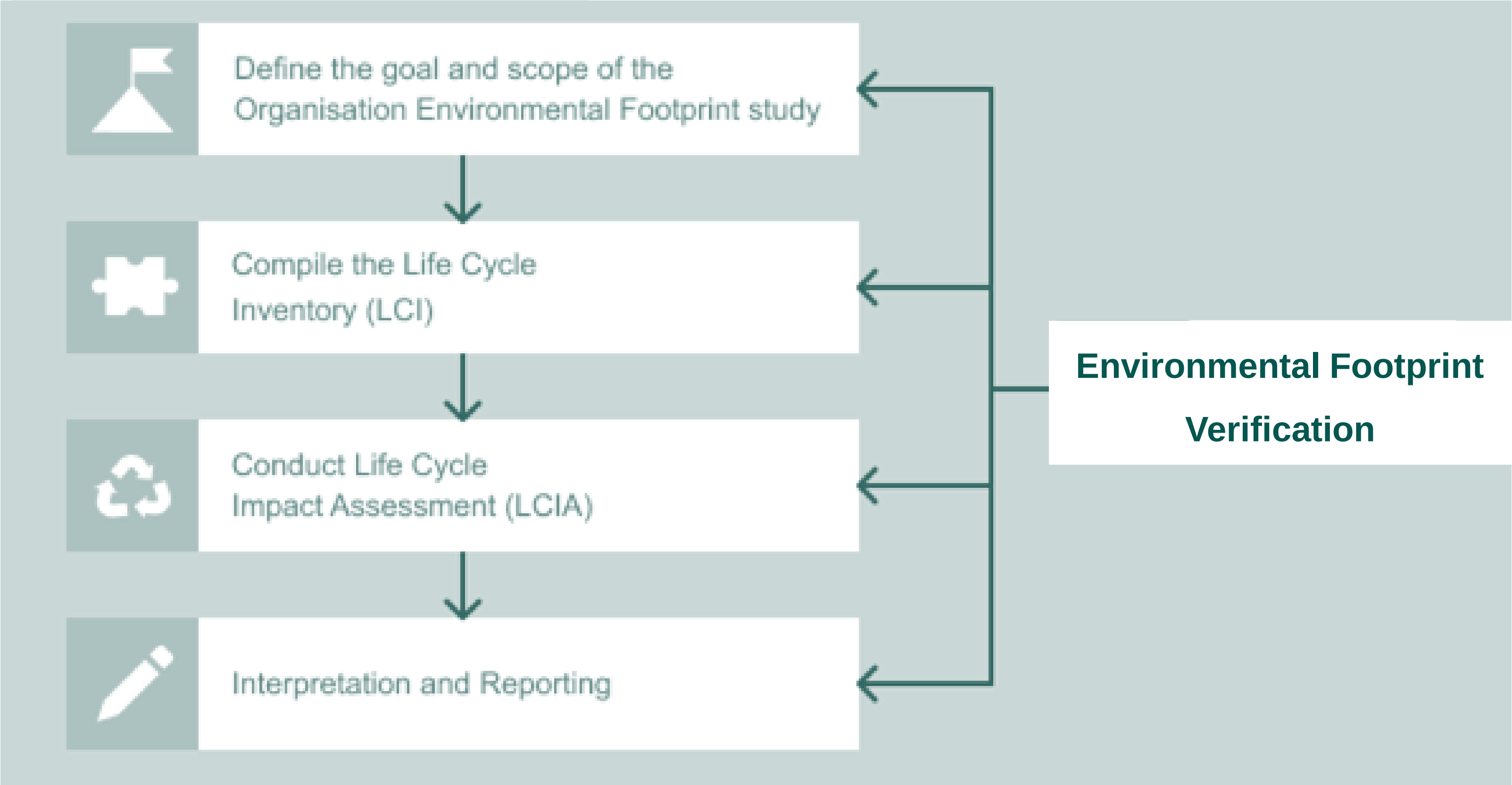
Symbol	Name	Causal Relation
	OR	Output event occurs if at least one of the input events occur.
	AND	Output event occurs if all input events occur.
m	VOTE	Output event occurs if at least m of the input events occur.
	PRIORITY AND	Output event occurs if all input events occur in sequential order from left to right.
	NOT	Output event occurs if the input event does not occur.



Organisation Environmental Footprint (OEF)

E.g.: **The Organisation Environmental Footprint (OEF)** is a Life Cycle Assessment (LCA) method

Phases of an OEF study



Organisation Environmental Footprint (OEF)

- Quantify the environmental impacts of organisations
- Builds on existing approaches and international standards
- Reduce the environmental impacts of organisations taking into account supply chain activities
- Detailed requirements for modelling the environmental impacts of the flows of materials and energy, and the emissions and waste streams associated with the product portfolio

Failure Mode and Effects Analysis (FMEA)

Systematic methodology for analyzing potential failure modes of system components and their effects on system performance and safety.

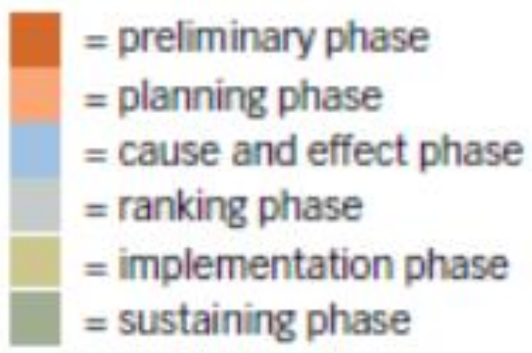
It provides a structured approach for identifying and prioritizing potential failures and developing prevention and mitigation measures.

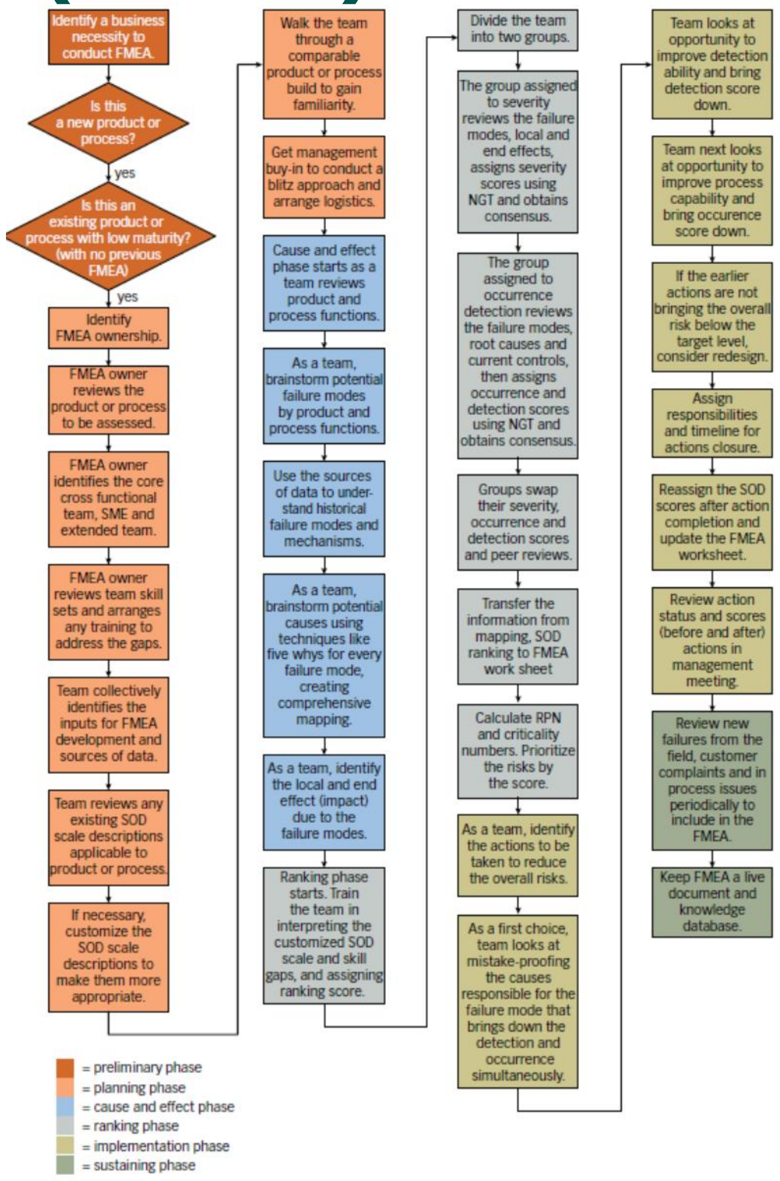
System Definition

Failure Mode Identification

Cause and Effect Analysis

Risk Assessment





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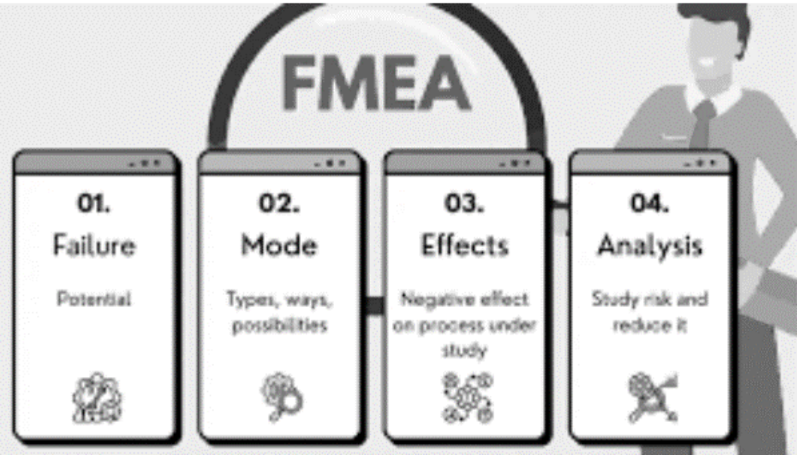
Failure Mode and Effects Analysis (FMEA)



Risk Priority Number (RPN) Calculation

RPN = Severity × Occurrence × Detection

Where each factor is rated on a scale from 1 to 10:

- Severity: 1 (minor) to 10 (catastrophic)
- Occurrence: 1 (very unlikely) to 10 (very likely)
- Detection: 1 (certain detection) to 10 (no detection)

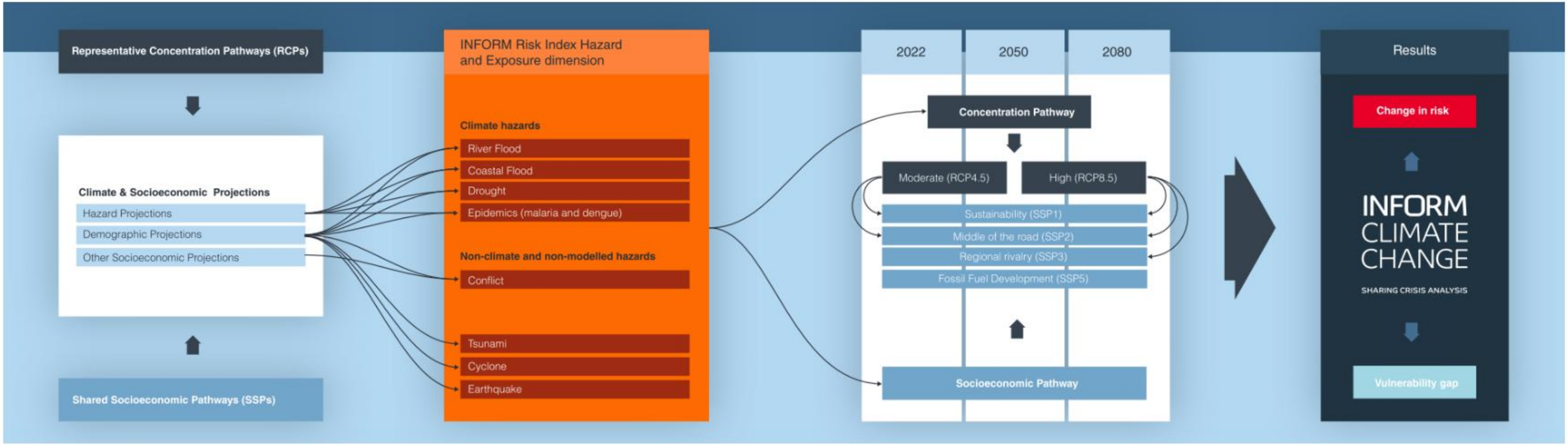
Failure mode and effects analysis for tablet packaging

Process step/input	Potential failure mode	Potential failure effects	Severity	Potential causes	Occurrence	Current controls	Detection	RPN	Actions recommended	Responsibility	Actions taken	Severity	Occurence	Detection	RPN
What is the process step/input under investigation?	In what ways does the key input go wrong?	What is the impact on the key output variables (customer requirements) or internal requirements?	How severe is the effect to the customer?	What causes the key input to go wrong?	How often does cause of failure mode occur?	What are the existing controls and procedures (inspection and test) that prevent the cause of the failure mode? **Should include an SOP number.**	How well can you detect cause or failure mode?		What are the actions for reducing the occurrences of the Cause or improving detection?	Who's responsible for the recommended action?	What are the completed actions taken with the recalculated RPN? **Be sure to include completion month/year.**				
Sealing/ temperature	Temp. too high	Burned blister pack	10	Wrong setting	6	Verification of batch record	7	420	Provide infrared temperature device to operator	M. Peña	Temperature device implemented (8/11)	10	4	2	80
Sealing/ temperature	Temp. too high	Blister pack not sealed completely	9	Wrong setting	6	Verification of batch record	7	378	Provide infrared temperature device to operator	M. Peña	Temperature device implemented (8/11)	9	4	2	72
Sealing/ press time	Too much time	Burned blister pack	10	Machine not set properly	5	Verification of batch record	7	350	Provide a visual display to see time elapsed	J. Rodriguez	Visual display implemented (10/11)	10	3	2	60
Sealing/ press time	Not enough time	Blister pack not sealed completely	9	Machine not set properly	5	Verification of batch record	7	315	Provide a visual display to see time elapsed	J. Rodriguez	Visual display implemented	9	3	2	54

RPN = risk priority number
SOP = standard operating procedure

INFORM Climate Change Tool

https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change/INFORM-Climate-Change-Tool



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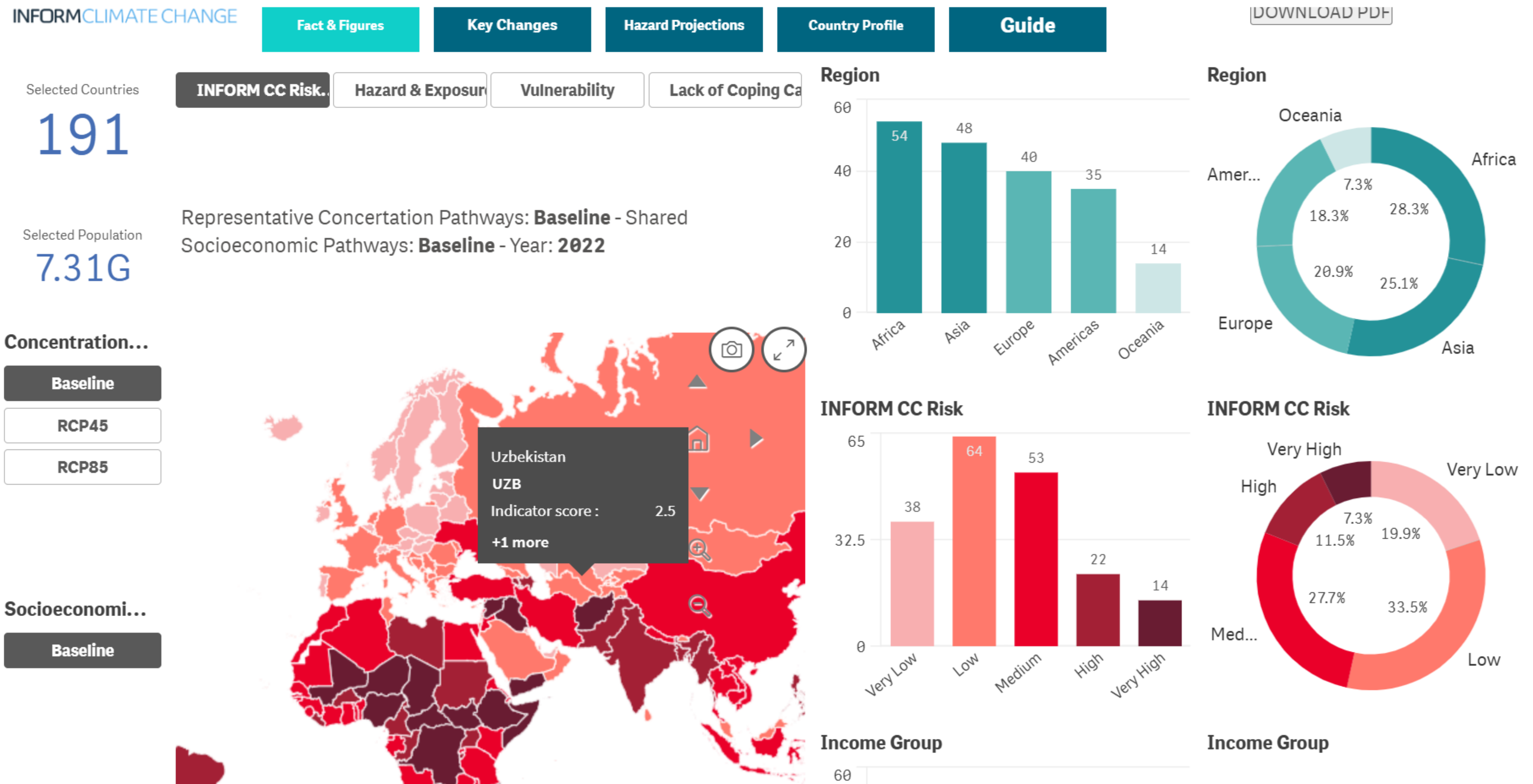
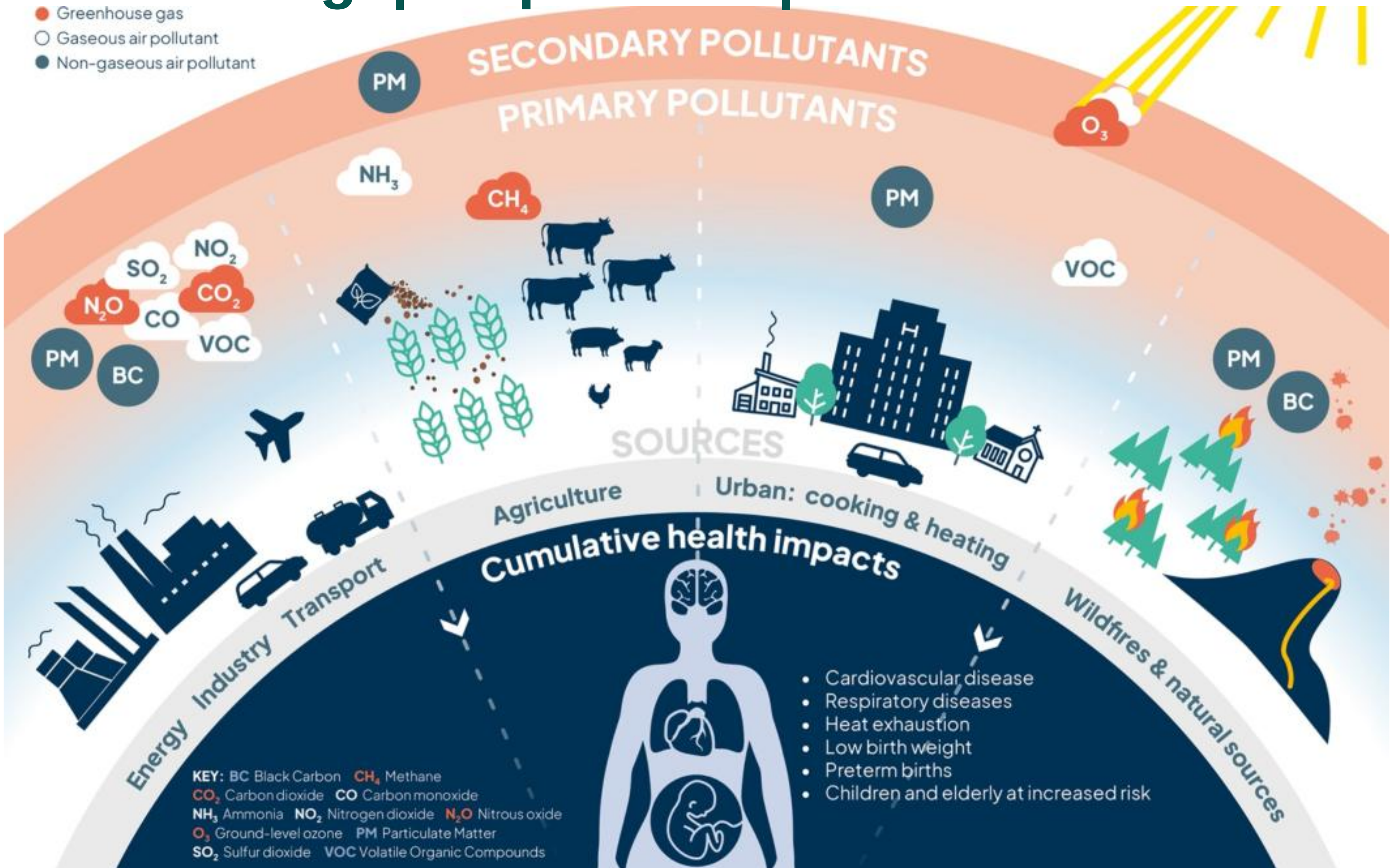


Examples of air pollution-extreme weather events

https://www.healtheffects.org/announcements/critical-moment-air-pollution-climate-and-health

Climate change| air pollution| health connections



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Risk Assessment

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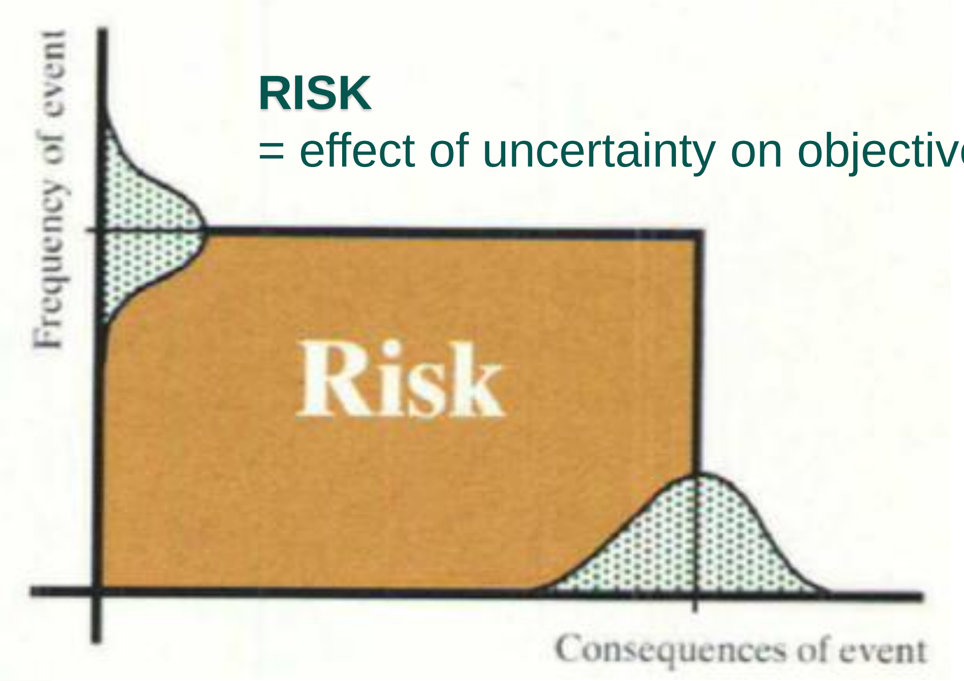
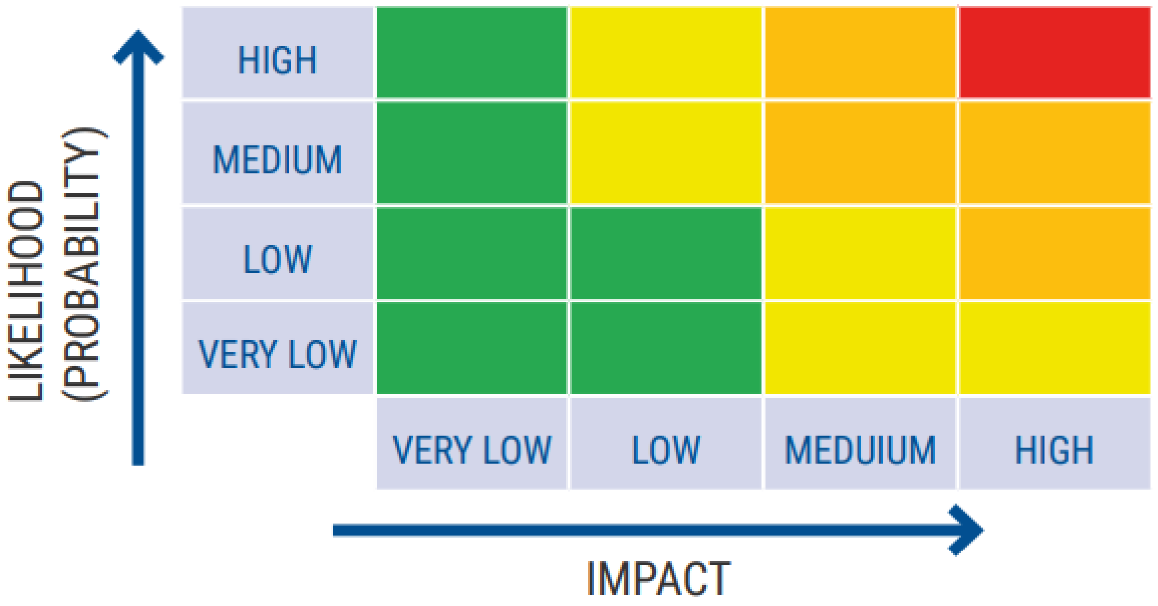
Risk Management

RISK
= effect of uncertainty on objectives





LOW RISK	MODERATE RISK	HIGH RISK	CRITICAL RISK
NO SEVERE HAZARD EXPECTED	BE AWARE	BE PREPARED	TAKE ACTION

Quantitative vs. Qualitative Risk Assessment

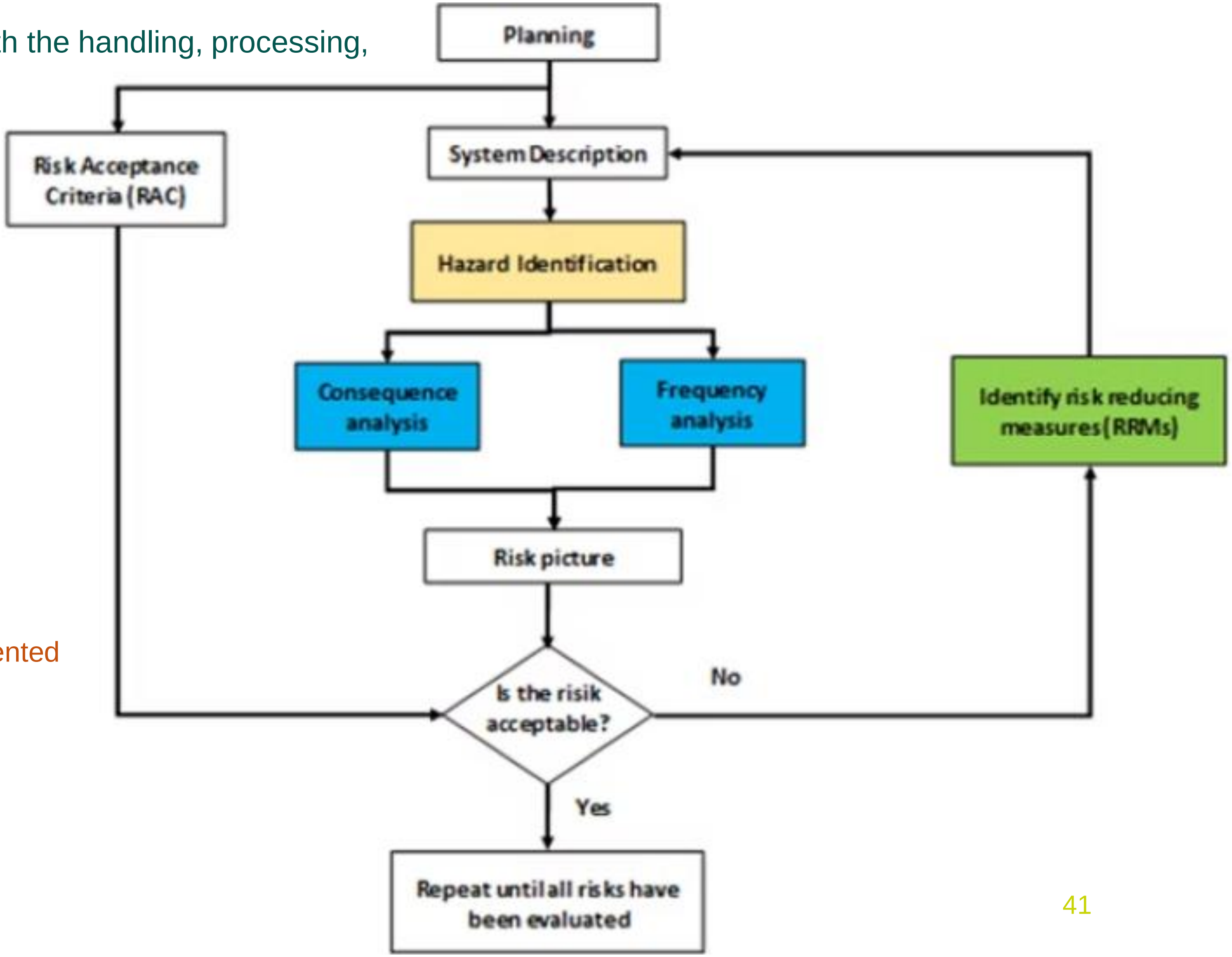
- Uses numerical methods to estimate probability and consequences
- Provides precise risk estimates that can be compared across different hazards
- Requires extensive data and mathematical models
- Results expressed as numerical risk metrics (e.g., (e.g., annual expected losses)
- Suitable for cost-benefit analysis

- Uses descriptive categories and expert judgment
- Typically uses risk matrices combining likelihood and consequence categories
- Useful when quantitative data are limited or rapid assessment is required
- Results expressed as risk levels (e.g., low, medium, high)
- Easier to communicate with non-technical stakeholders

Semi-quantitative approaches combine elements of both methods providing a middle ground between precision and practicality

Quantitative Risk Assessment (QRA)

Framework for analyzing the risks associated with the handling, processing, and storage of hazardous materials.



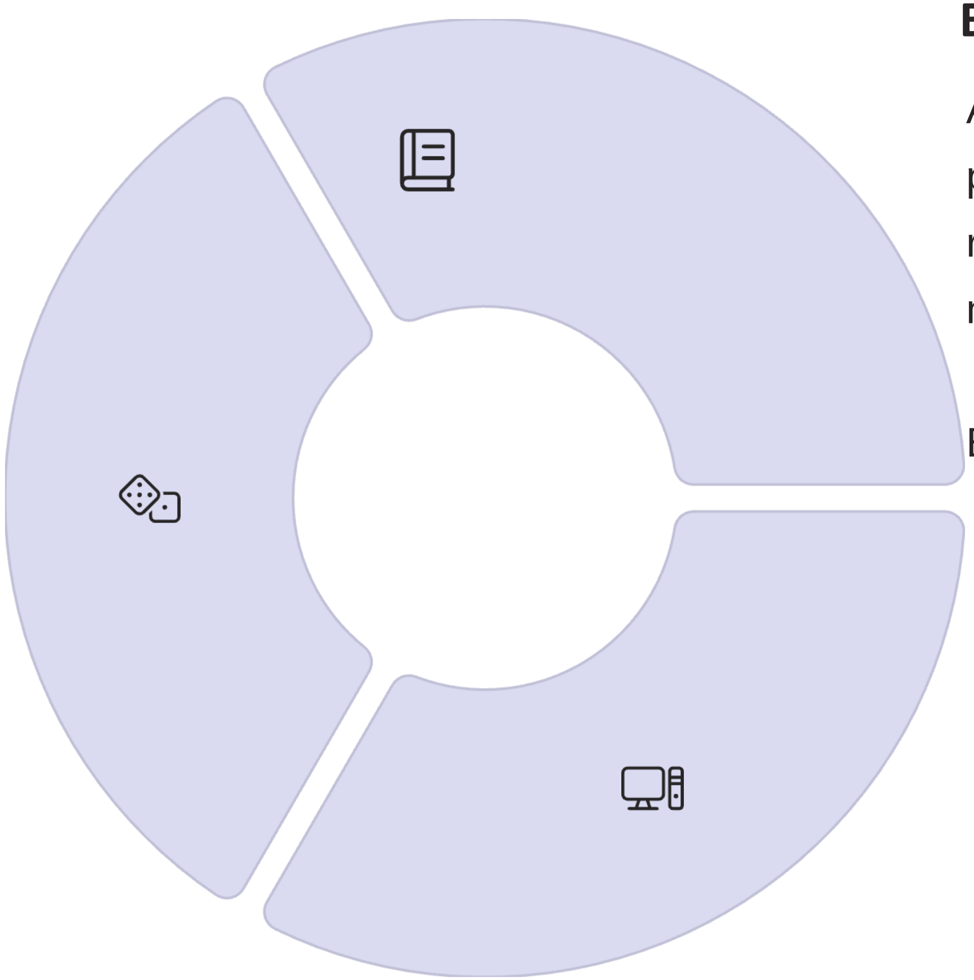
Hazard Identification

Systematic identification of all potential accident scenarios that could result in significant consequences, using methodologies such as HAZOP, What-If analysis, and historical accident review

Risk Characterization

Integrates consequence and frequency results to provide quantitative risk estimates, typically presented as individual risk contours and societal risk

Uncertainty in Risk Assessment



Aleatory Uncertainty

Natural variability in physical processes that cannot be reduced through additional research.

Examples:
- Random nature of earthquake
- Material properties variability

Epistemic Uncertainty

Arises from incomplete knowledge and can potentially be reduced through additional research, data collection, or improved modeling.

Examples: uncertainty in model parameters.

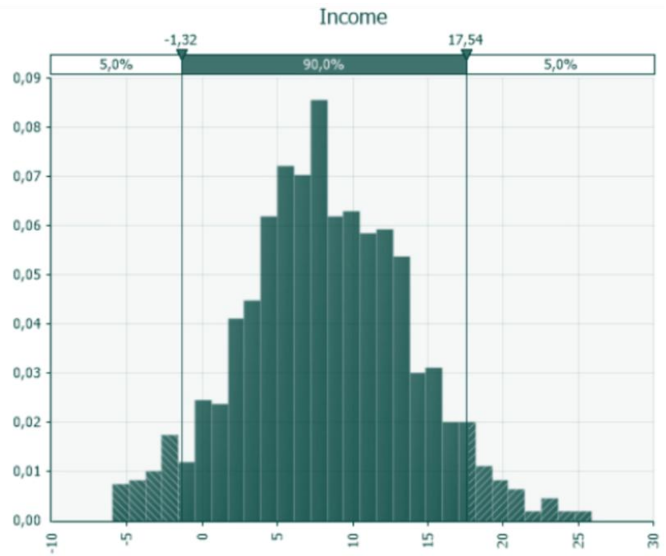
Model Uncertainty

Relates to the choice of models and their ability to represent real-world processes accurately. Different models may produce different results even with identical input data.

Uncertainty Analysis Methods

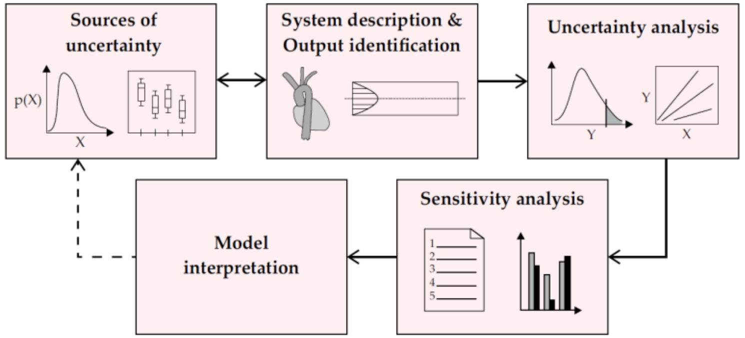
Monte Carlo Simulation

Uses random sampling from probability distributions to propagate uncertainty through risk models. Provides probability distributions of risk estimates rather than single-point values.



Sensitivity Analysis

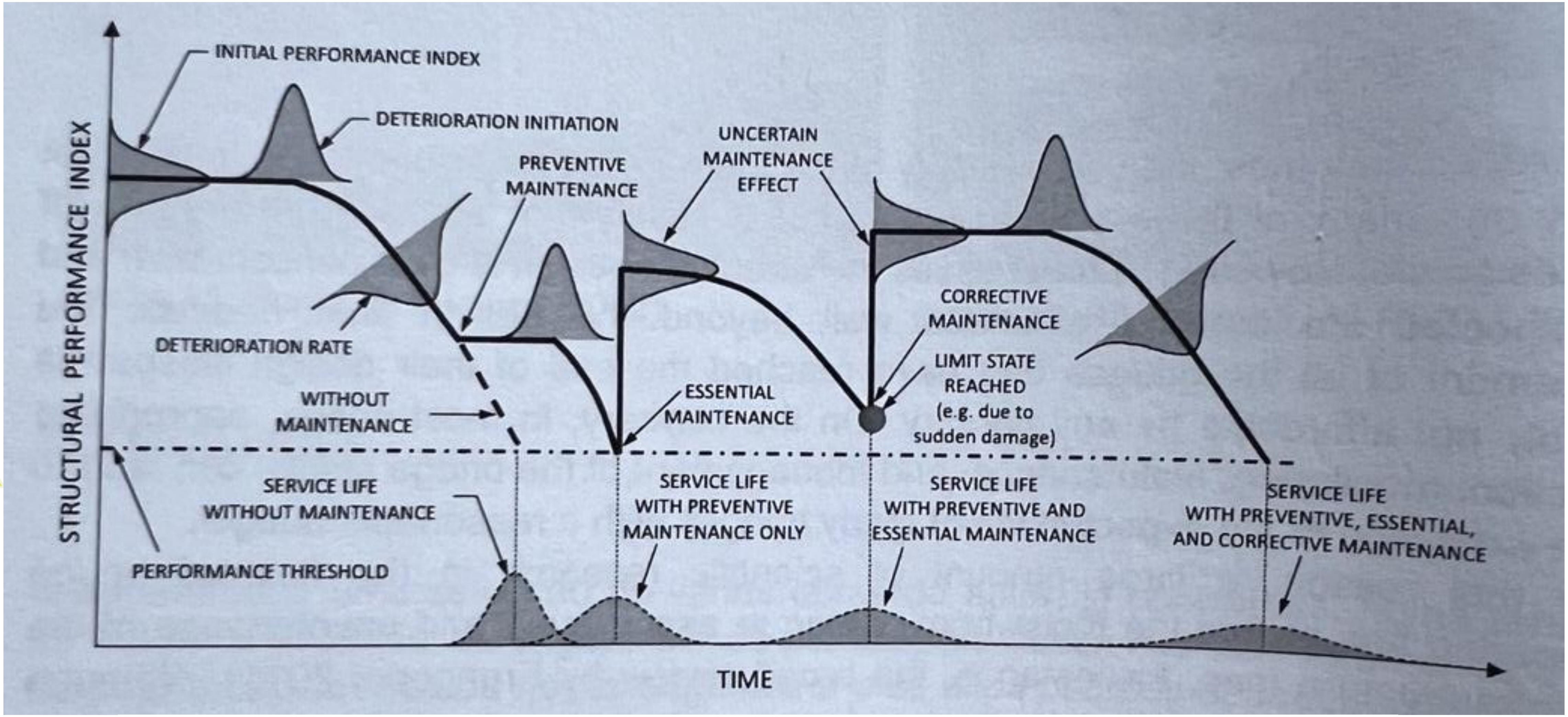
Examines how changes in input parameters affect risk estimates. Helps estimates. Helps identify the most important sources of uncertainty uncertainty and guides data collection priorities.



Expert Elicitation

When empirical data are limited, expert judgment can be used to used to estimate parameter values and their associated uncertainties. uncertainties. Formal elicitation procedures help minimize bias and bias and ensure consistency.

E.g.: Bridge failure probability along its lifetime



In Frangopol, D. M. & P. Bocchini, 2011. “Bridge service life estimation and extension based on reliability, maintenance and management”. ASCP’2011 – 2º Congresso Nacional sobre Segurança e Conservação de Pontes. P. J. S. Cruz, C. Rebelo, T. Mendonça. Coimbra, Portugal.

E.g.: Climate Risk Assessment

EEA Report 01/2024
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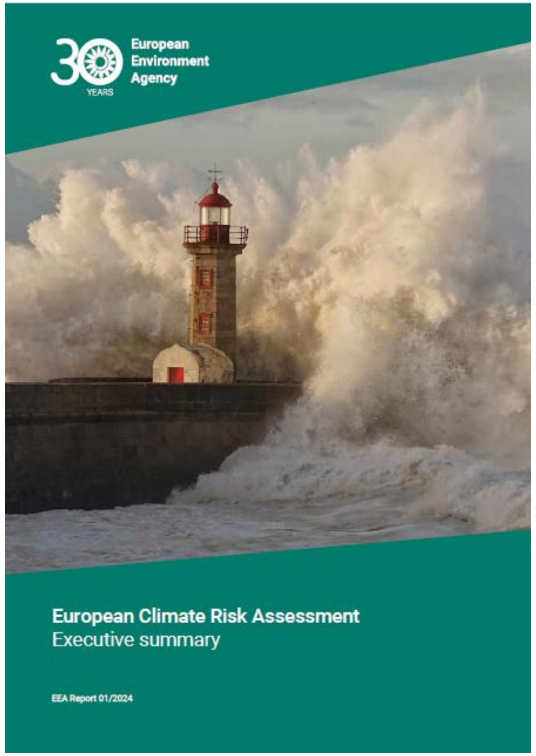

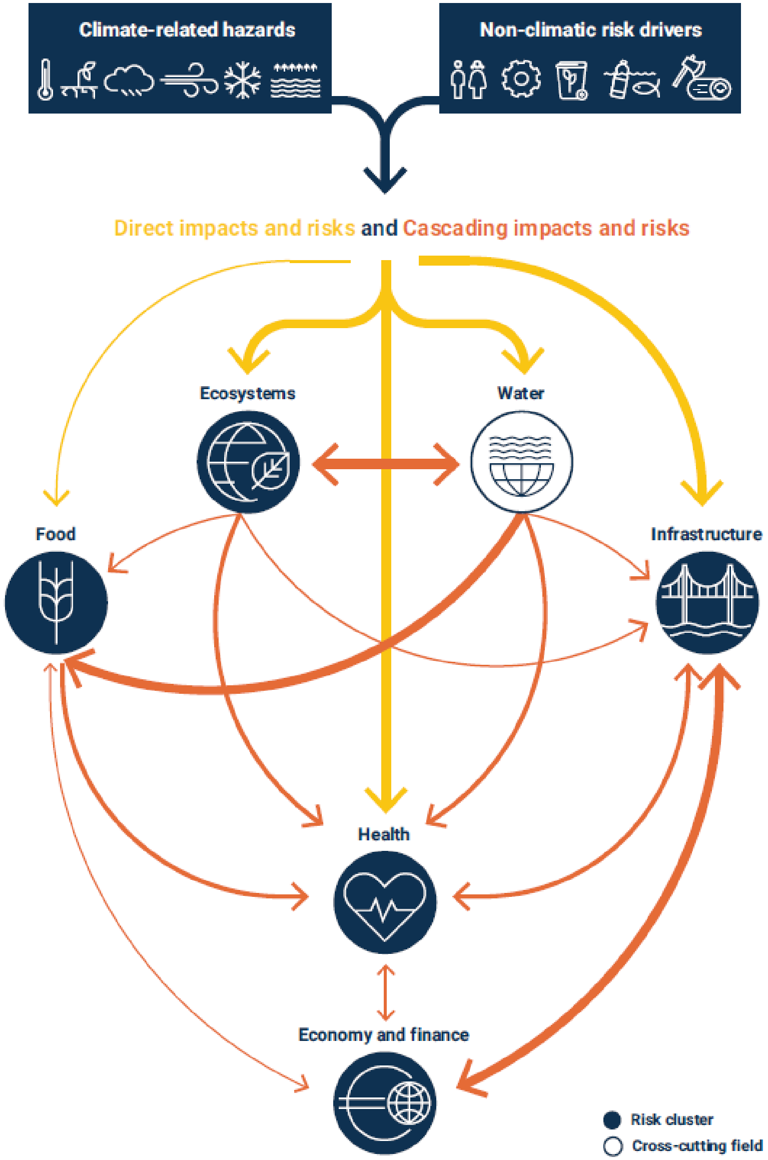

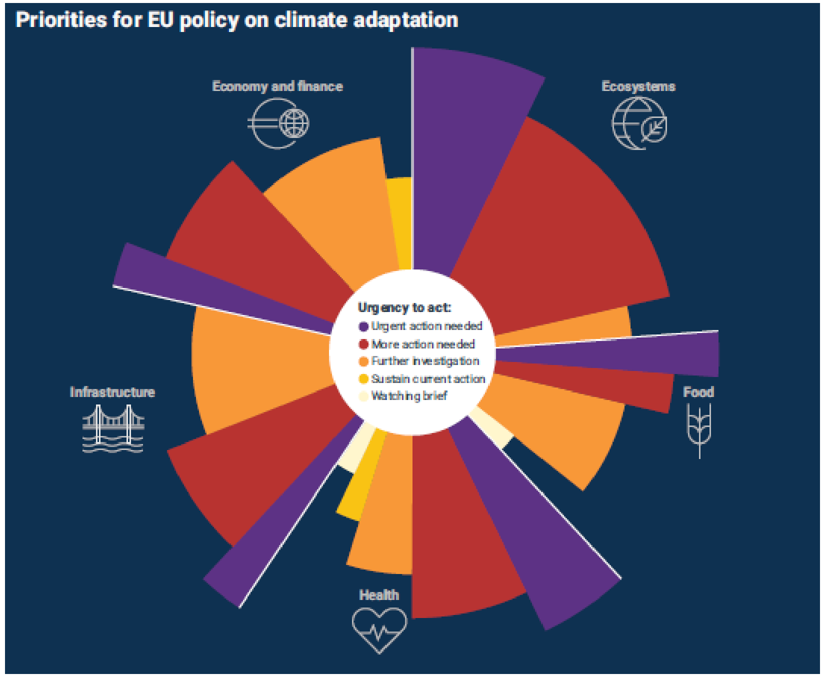

Climate risks by cluster

Ecosystems
- Coastal ecosystems
- Marine ecosystems
- Biodiversity/carbon sinks due to wildfires*
- Biodiversity/carbon sinks due to wildfires
- Species distribution shifts
- Ecosystems/society due to invasive species
- Soil health
- Aquatic and wetland ecosystems
- Biodiversity/carbon sinks due to droughts and pests
- Cascading impacts from forest disturbances

Food
- Crop production*
- Crop production
- Fisheries and aquaculture
- Food security due to higher food prices
- Food security due to climate impacts outside Europe
- Livestock production

Health
- Heat stress — general population
- Population/built environment due to wildfires*
- Population/built environment due to wildfires
- Wellbeing due to non-adapted buildings
- Heat stress — outdoor workers*
- Pathogens in coastal waters
- Health systems and infrastructure
- Infectious diseases
- Heat stress — outdoor workers

Infrastructure
- Pluvial and fluvial flooding
- Coastal flooding
- Damage to infrastructure and buildings
- Energy disruption due to heat and drought*
- Energy disruption due to heat and drought
- Energy disruption due to flooding
- Marine transport
- Land-based transport

Economy and finance
- European solidarity mechanisms
- Public finances
- Property and insurance markets
- Population/economy due to water scarcity*
- Population/economy due to water scarcity
- Pharmaceutical supply chains
- Supply chains for raw materials and components
- Financial markets
- Winter tourism

Note: *Hotspot region: southern Europe

Notes: Urgency to act for 36 major climate risks for Europe, grouped into five risk clusters. Six risks are assessed both at the pan-European level and for southern Europe, which is a hotspot region. The widths of the segments ('pies') indicates the number of risks per cluster belonging to different urgency categories. Risk names are shortened in comparison to the main report.

Source: EEA.

European Environment Agency

Risk Assessment → Risk Management

The analytical component that involves:

- Identifying hazards
- Analyzing potential consequences
- Estimating likelihood of occurrence

Provides the scientific and technical foundation for understanding risk levels and their distribution

The broader **decision-making** process that:

- Uses risk assessment results
- Develops strategies for reducing, transferring, or accepting risks
- Implements mitigation measures
- Monitors effectiveness

Includes policy development, resource allocation, and implementation

feedback
to improve assessment methodologies

05

Risk Management and Decision Making

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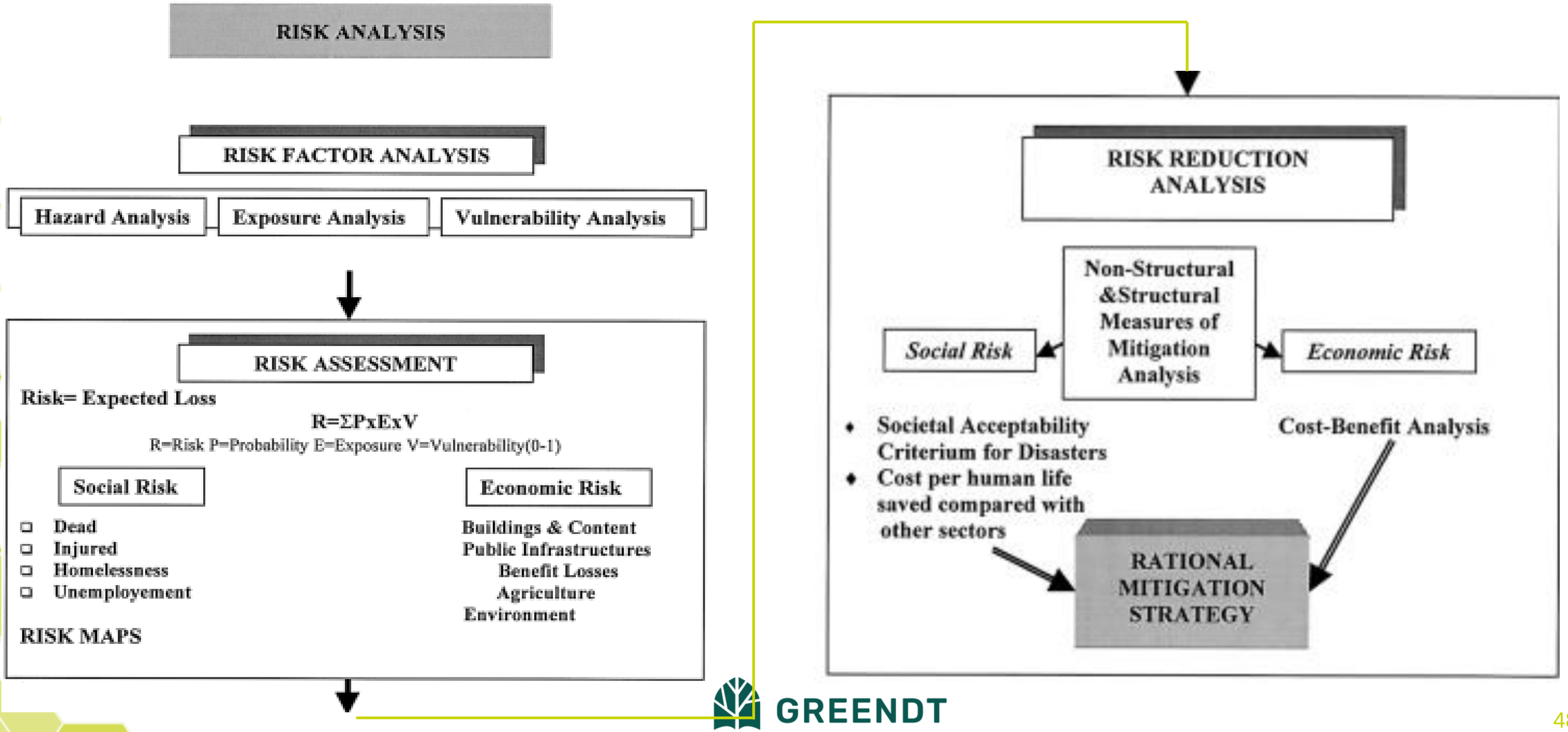
Risk Assessment → Risk Management



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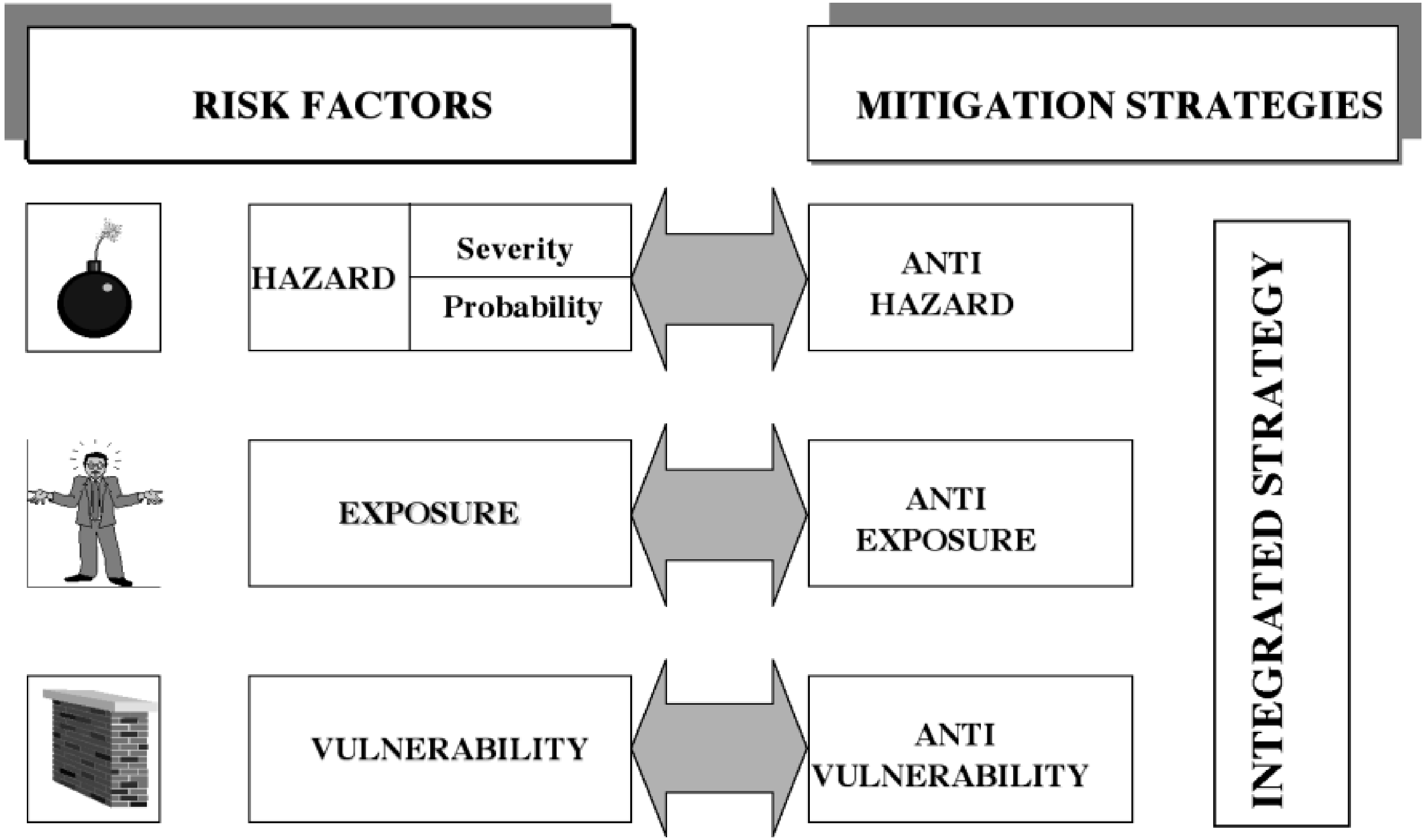
Risk Management



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Treat the Risks

After risk assessment, the next step is to create a **RISK MANAGEMENT PLAN**.

This is where you determine how to address the identified risks:

- Look at the risks and figure out the best way to address them. Options include **avoiding** the risk, **transferring** it (e.g., through insurance), or **accepting** it if it's within your tolerance level.
- Not every risk will be treated the same way. You'll need to decide based on its severity and potential impact on your organization.
- Once you've decided, take action. This could involve **changing processes**, **purchasing insurance**, or implementing **monitoring systems** to track ongoing risks.
- Once the treatment is in place, continuously **monitor** its effectiveness. If things aren't working as expected, reassess and adjust your plan.

06

International Standards and Guidelines

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International Standards and Guidelines

UNDRR United Nations Office for Disaster Risk Reduction

UNDRR Sendai Framework

Adopted in 2015 to prevent new and reduce existing disaster risk .

Requires an all-of-society engagement.

Emphasizes the importance of understanding disaster risk through systematic **risk assessment** and **monitoring.**

Promotes the development of national and local disaster risk assessments and the use of **risk information for decision-making.**

ISO *International Organization for Standardization*

ISO 31000 Risk Management

Principles and guidelines for **risk management**, including **risk assessment** as a key component.

ISO/IEC 31010 Risk management — Risk assessment techniques

ISO Guide 73 Risk management — Vocabulary

ISO 14001 Environmental management systems – Requirements with guidance for use

Industry-Specific Standards

NRC Regulatory Guides (nuclear)

CCPS Guidelines (chemical)

ICAO Standards (aviation)

IMO Guidelines (maritime)

…

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UNDRR Sendai Framework

UNDRR United Nations Office for Disaster Risk Reduction

2015-2030

Scope and purpose

The present framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or manmade hazards as well as related environmental, technological and biological hazards and risks.
It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors

Expected outcome

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries

Goal

Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience

UNDRR Sendai Framework

UNDRR United Nations Office for Disaster Risk Reduction

Priorities for Action

There is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas.

Priority 1

Understanding disaster risk

Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment

Priority 2

Strengthening disaster risk governance to manage disaster risk

Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk

Priority 3

Investing in disaster risk reduction for resilience

Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation

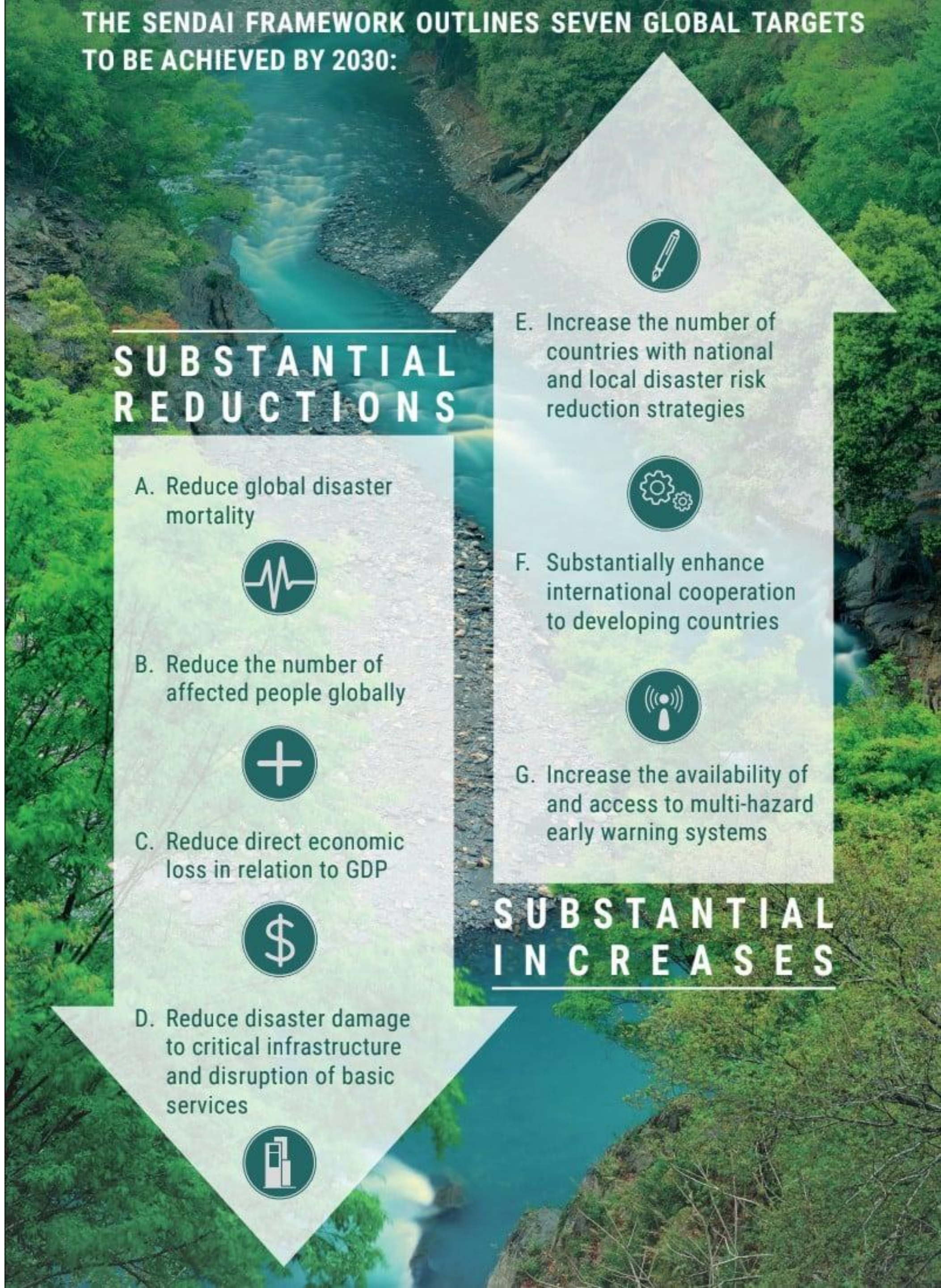
Priority 4

Enhancing disaster preparedness for effective response, and to "build back better" in recovery, rehabilitation and reconstruction

Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases

UNDRR Sendai Framework

UNDRR United Nations Office for Disaster Risk Reduction



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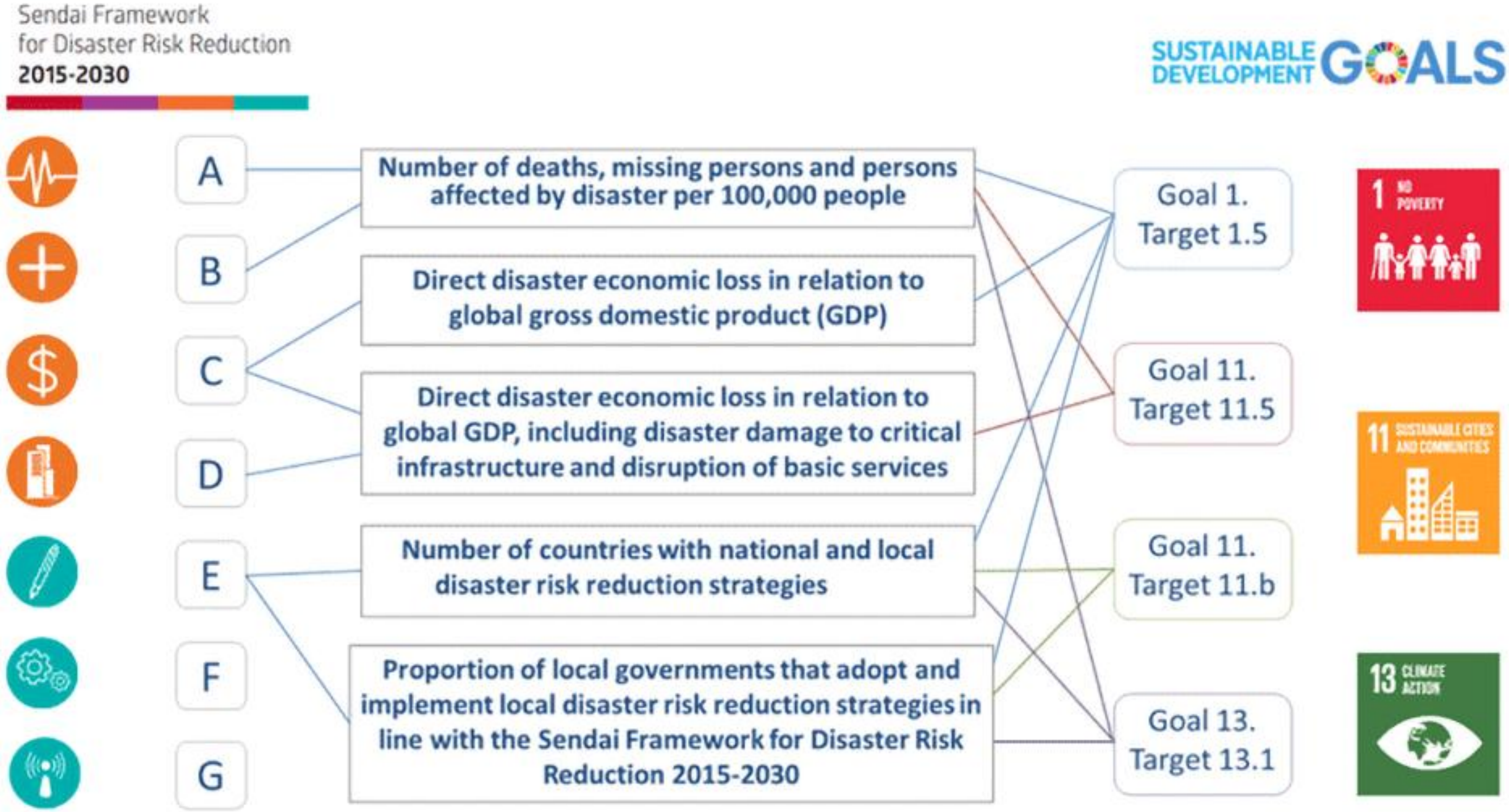
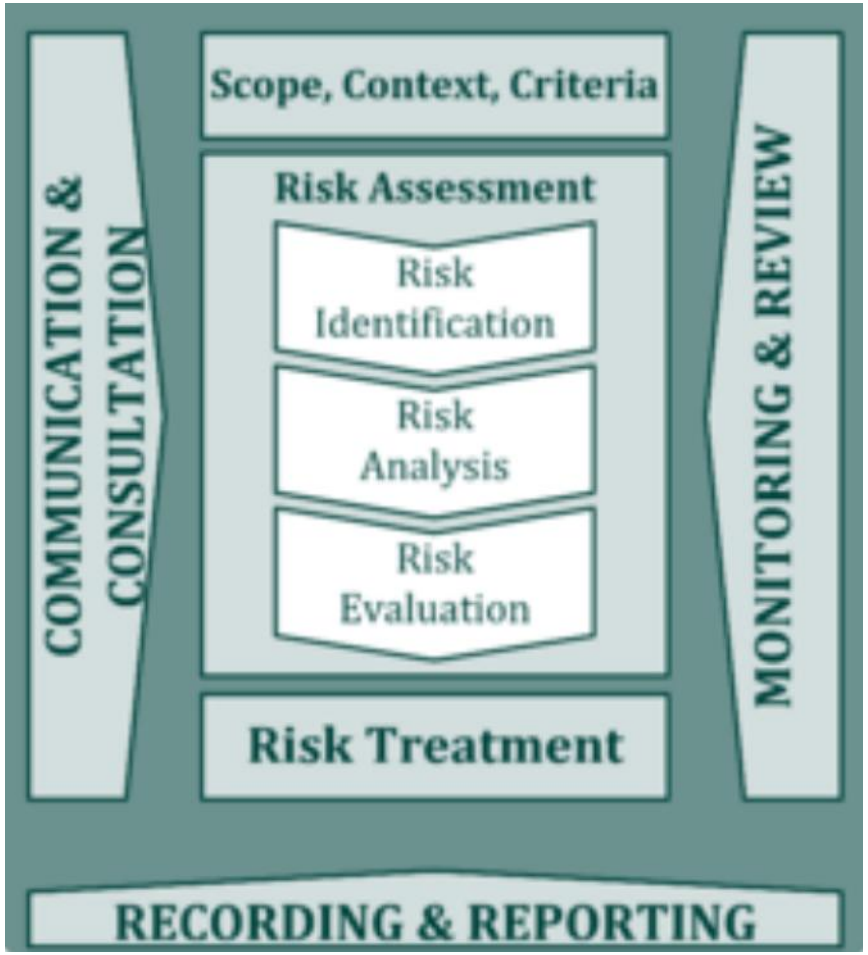
UNDRR Sendai Framework



Risk Management: ISO 31000

Help organizations to protect their assets, achieve their goals, and improve decision-making

- Standard risk management **principles, framework and process**
- **Guidance** for implementing risk management practices
- Tools for **contextualizing risk** management to any organization
- Criteria for **monitoring**, **reviewing** and continually **improving** risk management
- Foundation for **integrating risk management** throughout an organization



Risk Management: ISO 31000

Risk Aggregation

Combines risks from different hazard types while avoiding double-counting and considering correlations between different scenarios. This aggregation provides total risk estimates for decision-making.

Risk Ranking

Prioritizes different risk scenarios based on their likelihood and consequences. This ranking guides the allocation of resources for risk reduction measures.

Risk Reduction Strategies

Develops integrated approaches for reducing both natural hazard and technological risks. These strategies may include structural modifications, procedural changes, and emergency planning improvements.

Monitoring and Review

Establishes procedures for monitoring risk levels and updating risk assessments as conditions change. This monitoring considers changes in facility operations, natural hazard understanding, and regulatory requirements.

07

Conclusions

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Key Principles for Effective Risk Assessment

Systematic Approach - Ensures comprehensive coverage of relevant hazards, pathways, and consequences while maintaining logical consistency throughout the assessment process.

Scientific Rigor - Requires grounding in sound scientific principles, use of validated methods, and explicit treatment of uncertainty and limitations.

Stakeholder Engagement - Ensures that assessments address relevant concerns and are useful for decision-making by involving affected parties in the assessment process.

Transparency and Documentation - Builds confidence in assessment results and enables independent review and continuous improvement.

Adaptive Management - Risk assessment is an ongoing process that must evolve as conditions change and new information becomes available.

The Future of Risk Assessment

Increasing Complexity

Risks and systems will require more sophisticated assessment methodologies and greater integration across disciplines and sectors.

Technological Advancement

Will provide new tools and capabilities for risk assessment while also creating new types of risks that require assessment.

Climate Change

Will continue to alter the risk landscape and require adaptive approaches to risk assessment and management.

Globalization

Will increase the interconnectedness of risks and require greater international cooperation in risk assessment and management.

Democratization

Of risk assessment tools and information will enable broader participation in risk assessment and management processes.

Risk assessment is ultimately about helping society make better decisions in the face of uncertainty.

As risks continue to change and become more complex, the importance of rigorous, comprehensive, and adaptive risk assessment will only increase.

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THANKS

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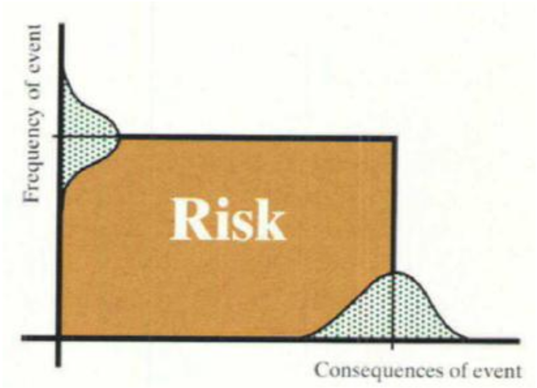
Practical Activity in groups - Risk Management ISO 31000

1. Risk Identification

- Risk event
- Causes
- Expected Consequences



2. Risk matrix

Probability / Impact	1 (Low)	2 (Moderate)	3 (High)	4 (Very High)	5 (Almost Certain)
1 (Low)	1	2	3	4	5
2 (Moderate)	2	4	6	8	10
3 (High)	3	6	9	12	15
4 (Very High)	4	8	12	16	20
5 (Almost Certain)	5	10	15	20	25

Risk Scoring Table

1 to 5: **Low risk** – No immediate action required, but monitor periodically.

6 to 10: **Medium risk** – Requires attention but not urgent.

11 to 15: **High risk** – Needs to be addressed promptly.

16 to 20: **Very high risk** – Immediate action required to mitigate.

21 to 25: **Critical risk** – Must be addressed immediately, with urgent mitigation actions in place

3. Risk Treatment Plan

- Risk description
- Risk level
- Proposed Action (avoiding /transferring /accepting)