Natural hazards and cascading impacts: an innovative approach for climate change mitigation

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Natural hazards

Natural hazards are "those elements of the physical environment, harmful to man and caused by forces extraneous to him."[1] The term "**natural hazard**" refers to all atmospheric, hydrologic, geologic (especially seismic and volcanic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, or their activities adversely.
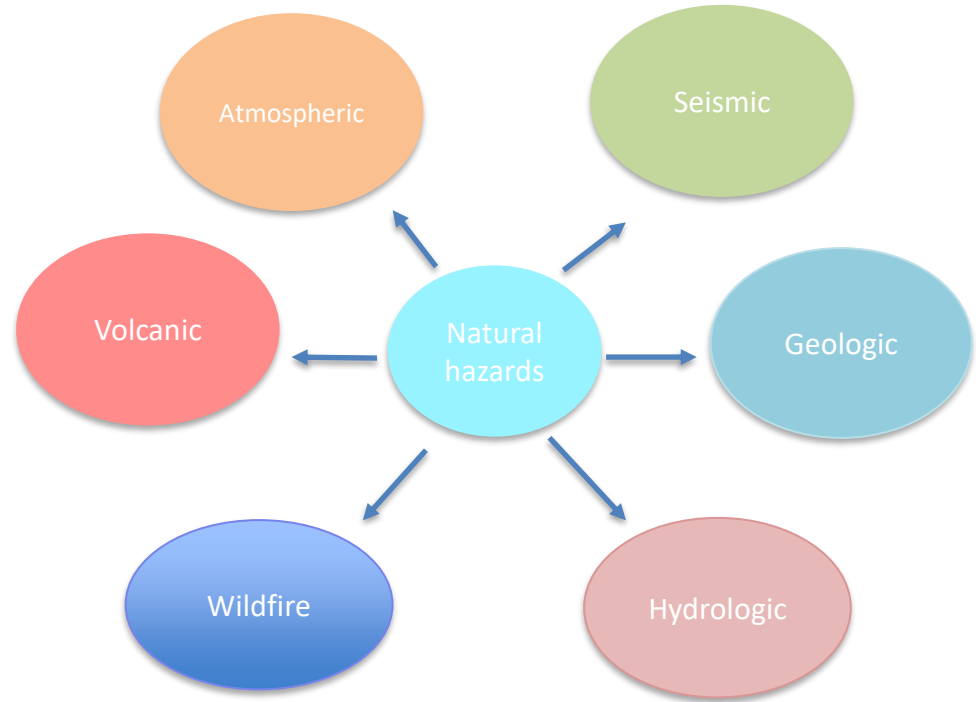
[1] Burton, I., Robert W. Kates and Gilbert F. White. The Environment as Hazard (New York: Oxford University Press, 1978).

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Natural hazards and risks in Europe

- Natural hazard events can still cause high economic, environmental and human losses

- Between 1980 and 2020, climate-related extremes caused economic losses of around half a trillion euros and led to between 85 000 and 145 000 human fatalities across Europe.
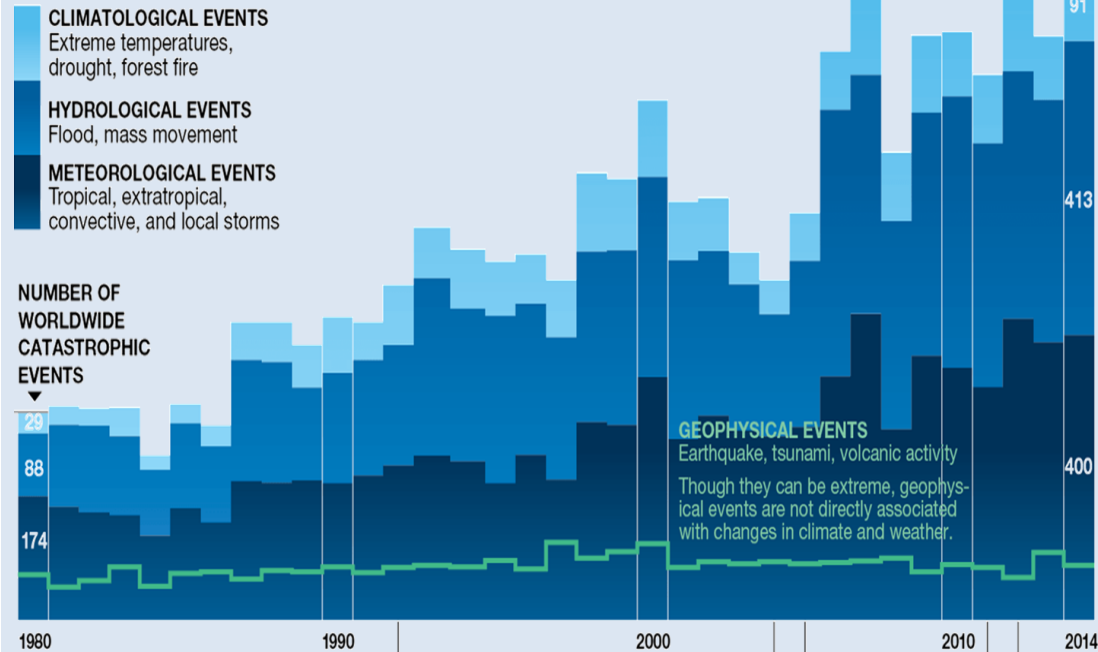
- (Source: European Environment Agency, February 2022)

Earthquake in Zagreb (Croatian), March 22, 2020

Flooding in Emilia (Italy), May, 2023

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Changes in hazards

- Although analysing trends in economic losses is difficult, climate-related extreme events are becoming more common.

- Need to consider the long-term implications of natural hazards and the related multiple risks

CLIMATOLOGICAL EVENTS
Extreme temperatures, drought, forest fire

HYDROLOGICAL EVENTS
Flood, mass movement

METEOROLOGICAL EVENTS
Tropical, extratropical, convective, and local storms

NUMBER OF WORLDWIDE CATASTROPHIC EVENTS
▼

GEOPHYSICAL EVENTS
Earthquake, tsunami, volcanic activity

Though they can be extreme, geophysical events are not directly associated with changes in climate and weather.

29
88
174

91
413
400

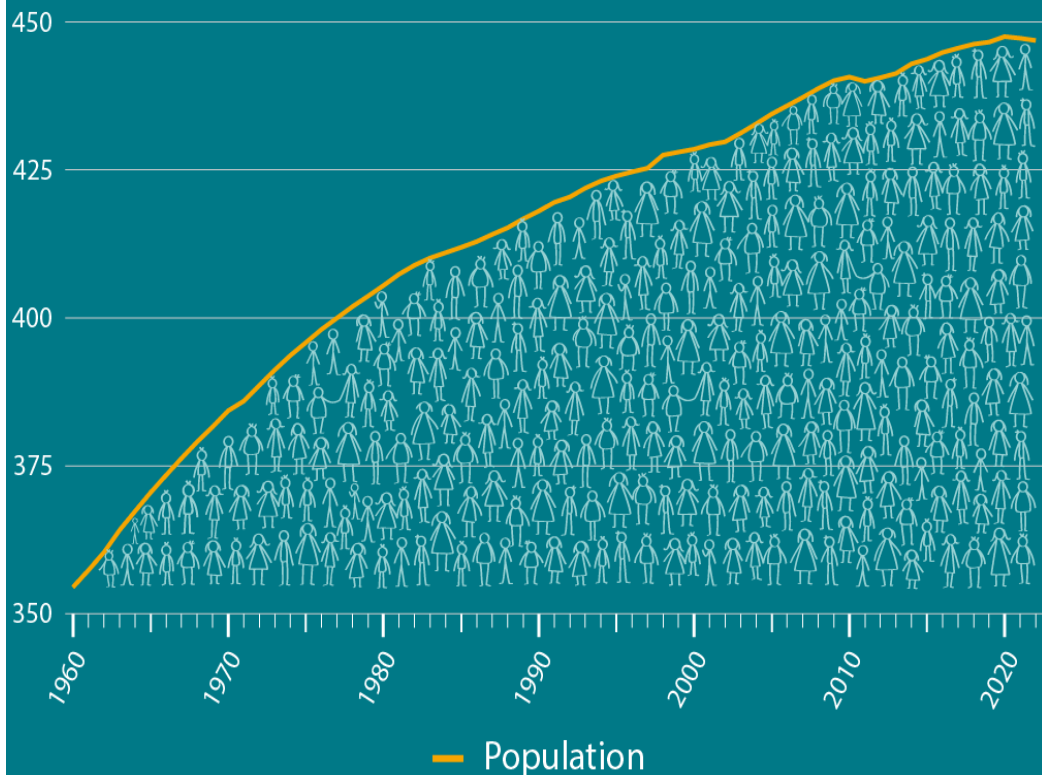1980   1990   2000   2010   2014

Changes in risks

- risk processes comprise exposure and vulnerability components

- exposure and vulnerability features and their future dynamics are particularly complex to quantify

EU population, 1960-2022
(on 1 January, million persons)

Challenges

- Different phases of both hazards and risks processes are often addressed separately, not with an integrated approach.

- Risk analyses are not performed from a multi-disciplinary perspective, integrating physical, economic, and social impacts

- Compounding and cascading effects of hazards are not regularly included within risk and resilience assessments.

Consequently, decision makers struggle to comprehensively understand local hazard change impacts, thus failing to successfully plan integrated adaptation and impact mitigation strategies.

MEDiate Project

HORIZON Europe Call 2021

Disaster-Resilient Society - DRS02

Improved Disaster Risk Management and Governance

HORIZON-CL3-2021-DRS-01-03

Enhanced assessment of disaster risks, adaptive capabilities and scenario building based on available historical data and projections.

MEDiate Project

Multi-hazard and Risk-informed system for Enhanced Local and Regional Disaster risk management

MEDiate aims to deliver a **decision-support system (DSS)** for disaster risk management considering multiple interacting natural hazards and cascading impacts using a novel resilient-informed, service-oriented and people-centred approach that accounts for forecasted modifications in the hazard (e.g., climate change), vulnerability/resilience (e.g., aging structures and populations) and exposure (e.g., population decrease/increase), building on the consortium's existing strengths in this domain.

MEDiate Consortium

The consortium consists of **18 partners**: from Norway, Netherlands, Austria, France, Italy, Iceland, United Kingdom

- 8 partners: **research centers and industries**
- 6 partners: **Universities**
- 4 partners: **local and regional authorities**

Coordinator

Consortium

A multi-disciplinary team

- Representatives of scientific areas: meteorological, environmental and geophysical scientists, civil and risk engineers.

- Social scientists, information technologists, business economists.

- Disaster managers (local/regional authorities).

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MEDiate Objectives

Improving multi-hazard assessments of natural hazards and highlighting potential trends due to climate change. The project will develop improved modelling of **how** the natural hazards interact and cascade at various scales and how these hazards will change with time due to the changing climate.

Improving **multi-hazard risk assessments** accounting for interactions and trends in their components. The project will prioritize the improvements in the modelling of risk to the built environment and people given these interacting and increasing hazards and changes to both exposure and vulnerability/resilience.

Providing decision makers with a means of visualising the components of disaster risk and resilience, the stakeholders' preferences and the effect of different actions and alternate futures on possible scenarios for an area, considering the multiple hazards that are present and how these (and other risk components) may change with time.

Advancing beyond the state-of-the art in multi-hazard hazard and risk approaches by developing dynamic and future-centric risk-framing tools that effectively address the decision-making needs of various stakeholders, including local government, businesses and citizens. These tools will be integrated into the computational engine of the MEDiate Decision Support System (DSS), providing sufficient flexibility that will enable different decision makers to tailor the analyses and visualisations in line with their specific priorities.

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Objectives

- Develop models of compounding and cascading effects and to apply these within risk and resilience assessments

- Implement these models within an accessible, user-friendly IT system so that end users can understand, quantify and visualise future multi-risk situations (scenarios).

- The scenarios will account for ongoing trends in terms of hazard, demographics, geographic dependencies and vulnerability
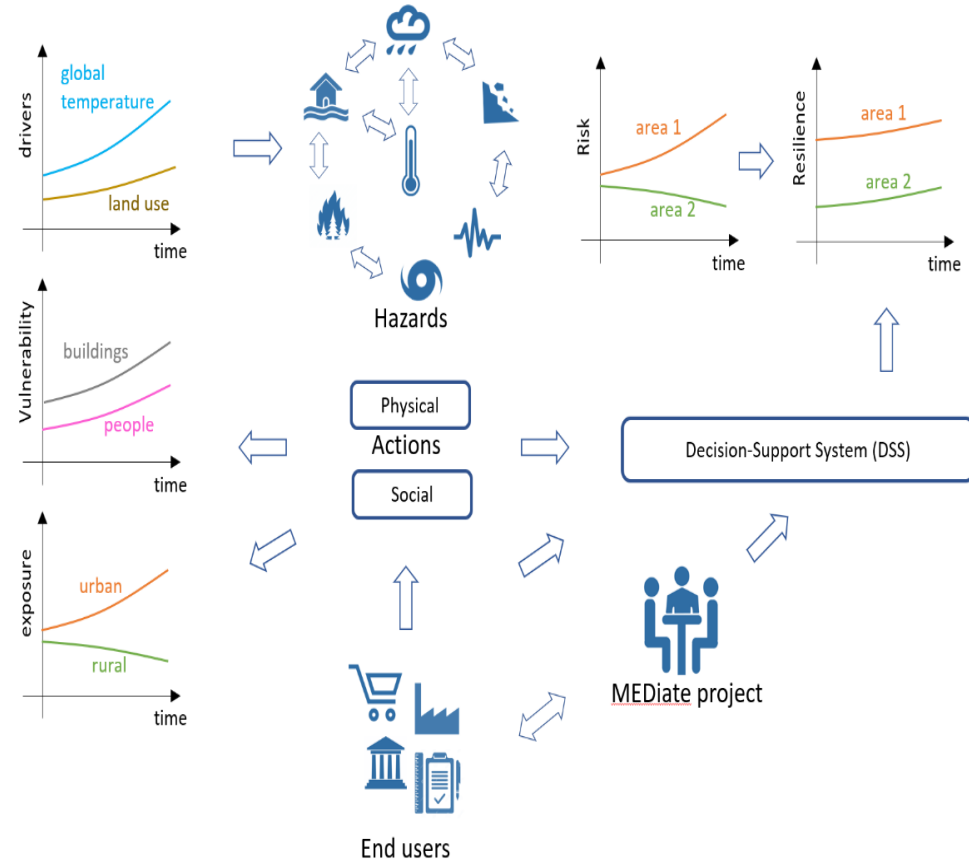
Risk-informed Decision Support System

- providing an assessment framework and web services for a Decision Suuport System (DSS) that will be readily adaptable for various end users

- Use of a novel resilient-informed, service-oriented and people-centred approach that accounts for forecasted modifications in the hazard, vulnerability and exposure.

Multi-hazard Disaster Risk Assessment
Scientific Models and Scenarios

Service-oriented and Multi-Objective Optimisation

Decision makers' requirements and preferences

Context-driven Solutions Implementation of actions and support policy improvements

Risk-informed decisions

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Testbeds - Validation

The DSS will be validated and verified within the project by means of four testbeds that will be co-developed with project partners who will be end users of the DSS in those testbeds.

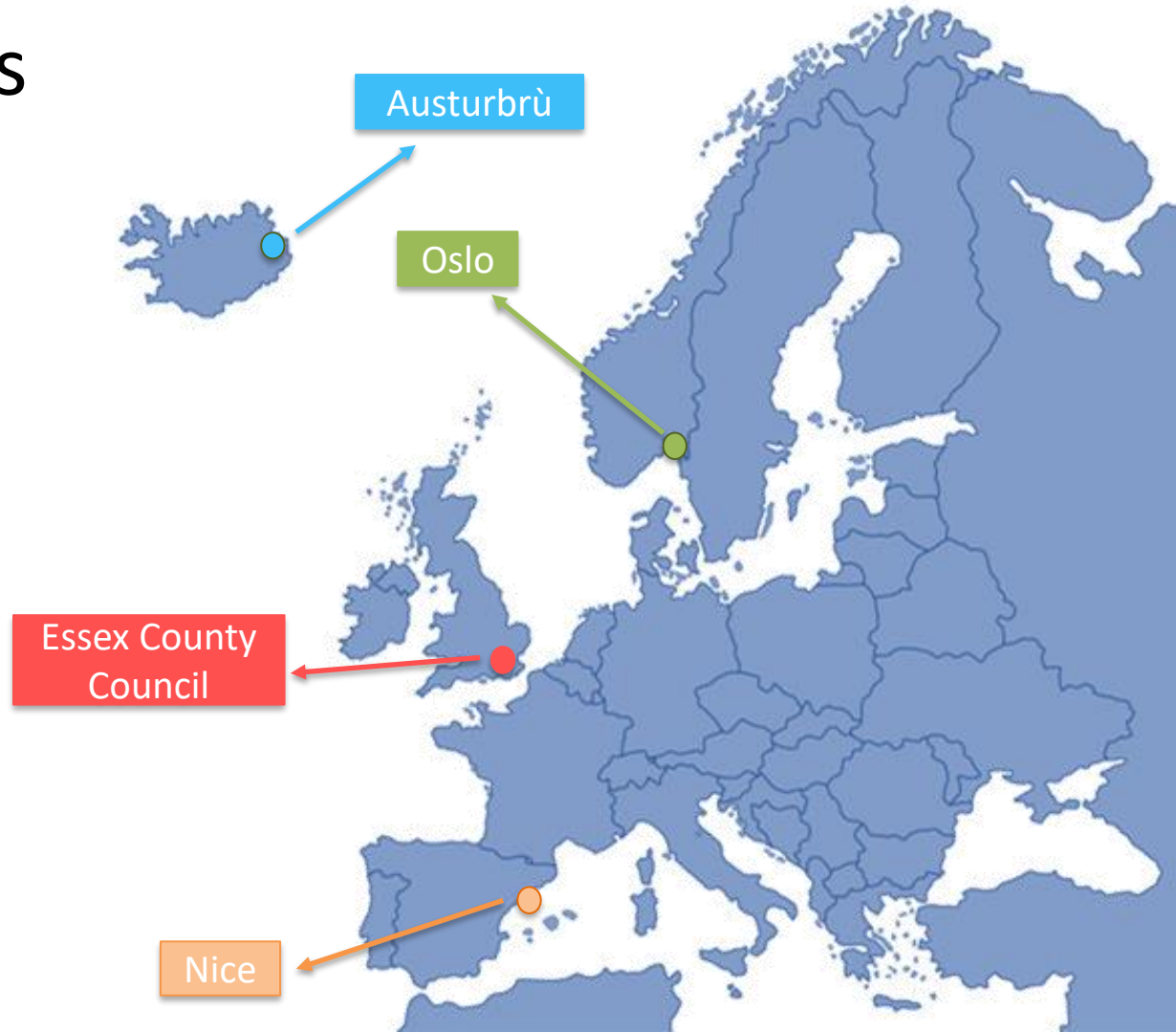| Testbed	Main hazards
Oslo	Flooding, extreme rain/snowfall, landslides, storm surge, earthquakes
Nice	Earthquakes, flooding (river floods & flash floods), landslides, heatwaves
Essex	Flooding, heatwaves
Austurbrú	Avalanches, landslides, mudflows

MEDiate Testbeds

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MEDiate has partners in four European countries that all face urgent problems related to a variety of interacting natural hazards

Austurbrù

Oslo

Essex County Council

Nice

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MEDiate Testbeds natural hazard

Main hazards:
Forest fires
Floods
Storm
Landslides
Earthquakes

Main hazards:
Floods
Landslide
Storm
Heatwaves
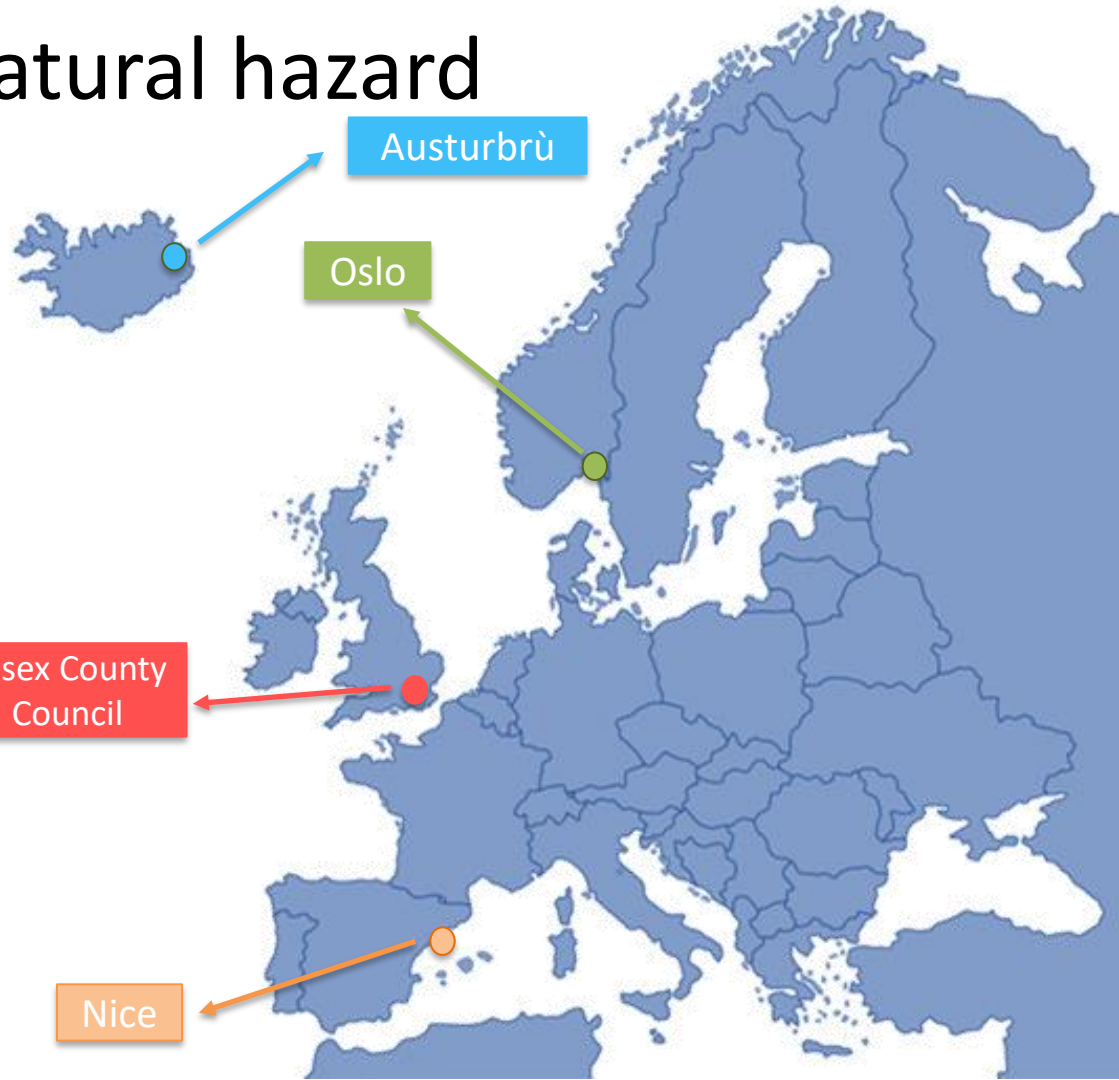Forest fires

Main hazards:
Flood
Drought

Main hazards:
Floods
Landslides
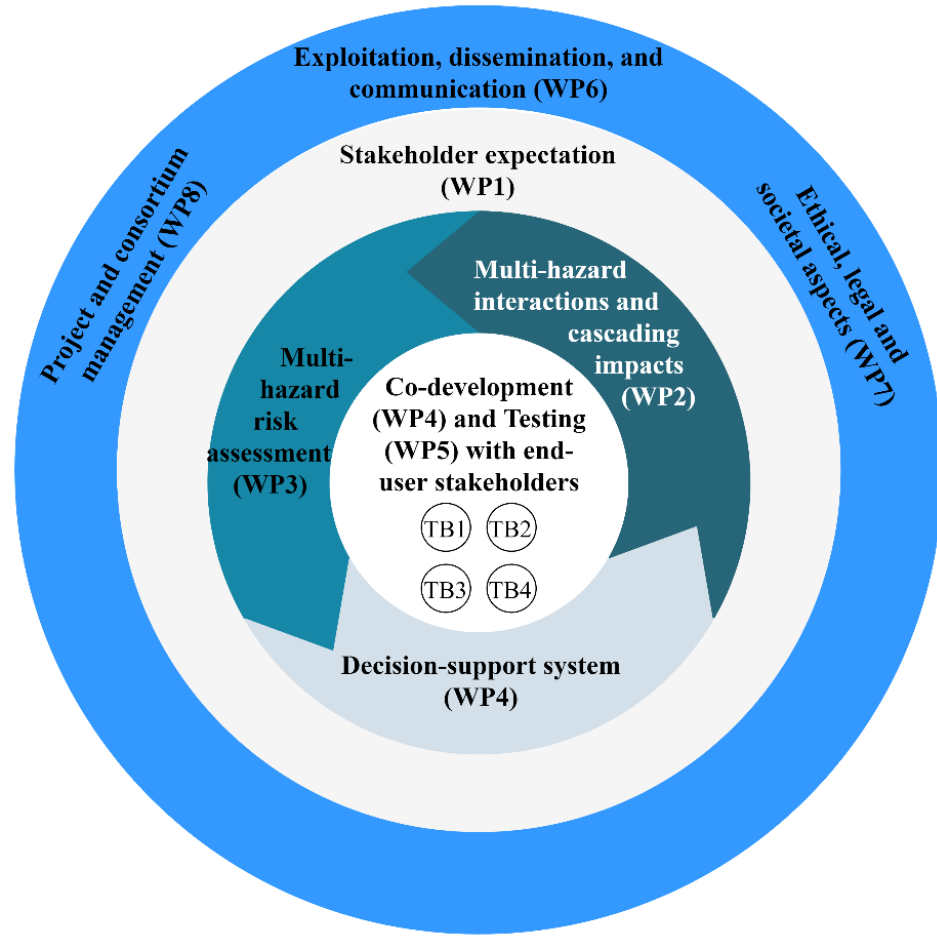Storm

Austurbrù

Oslo

Essex County Council

Nice

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Work Plan

- Stakeholder expectation

- Multi-hazard and cascading impacts

- Multi-risk assessment

- Co-design, co-development of framework for Decision Support System

- Testing and validation with end-users

Best practice

MEDiate will follow an approach that complies with international recommendations for best-practice.

- The UN Sendai Framework for Disaster Risk Reduction, aiming to to substantially reduce disaster loss by 2030

- The EU approach to assessing disaster risks, particularly highlighting the importance of accounting for climate change impacts

- The World Bank encouraging to move towards risk assessments that can guide decision makers towards a resilient future.

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Thank you for your attention!

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SCAN ME

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