Multi-Hazard Indicators

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MEDiate

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1. Research Scope

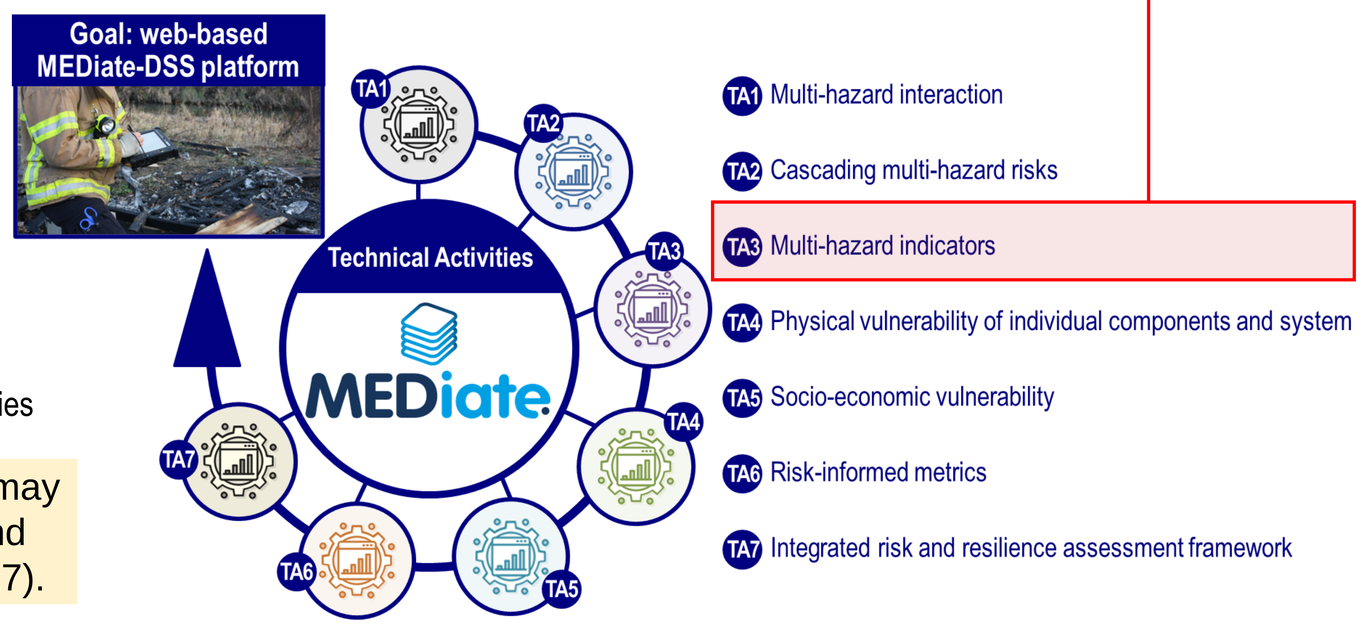
MEDiate: Multi-hazard* and Resilient-informed system for Enhanced Local and Regional Disaster risk management

- MEDiate aims to enhance assessment of disaster risks and to improved disaster risk management and governance by:
  - ✓ Developing a decision-support system (DSS)
  - ✓ Considering multiple interacting natural hazards and cascading impacts
  - ✓ Using a novel resilience-informed, service-oriented, and people-centred approach
- **Testbeds**: Oslo (Norway), Nice (France), Essex (UK), and Múlaþing (Iceland)
- **Project Consortia:** A multi-disciplinary team of 18 partners from six European countries

***Multi-hazard (MH)**: the specific contexts where hazardous events may occur **simultaneously, cascadingly or cumulatively over time**, and taking into account the **potential interrelated effects** (UNDRR, 2017).

2. Aim of Research

To develop and test multi-hazard indicators that are suitable for use in risk-based assessments and decisions making in disaster risk management.



3. Methods: the process of developing multi-hazard indicators

Systemic literature review

Studies include multi-hazard analysis:
- Multi-layered single-hazard: 87
- Multi-hazard (MH): 84

MH indicator types: MH interactions, MH joint probability, Hazard probability, Hazard intensity, Hazard frequency, Composite indicators

Stakeholder workshops

A total of 55 participants shared their preferences at focus group workshops in Oslo (6), Nice (21), Essex (22), and Múlaþing (6).

Indicator selection

i1. Trends in co-occurrence frequency
i2. Joint return period (JRP)
i3. Spatial distribution of co-occurrence

Application to testbeds

Testbed	Multi-hazard pair	Interaction typology
Oslo	Coastal and riverine flood	Multivariate
Nice	Extreme heat and drought	Temporally compounding
Essex	Extreme wind and rainfall	Spatially compounding
Múlaþing	Heavy rain and landslide	Preconditioned and triggering

4. Results

Fig 1-4 show results of the **MH indicator application to the testbeds**, drawn from the single hazard variables listed in the table below.

The application of **indicators i1, i2, and i3** varies by the relevant **multi-hazard pairs** in each testbed, depending on the **available datasets.**

Captured the **complex dynamics of MH assessment** and explored for effectively communicating by **co-developing MH indicators with the stakeholders**.

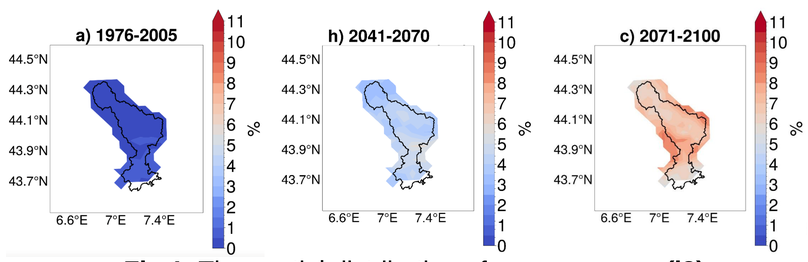


Fig 1. The spatial distribution of co-occurrence **(i3)** - at least one co-occurrence event of drought and heatwave each year from 1970 to 2100 across **TB2.**

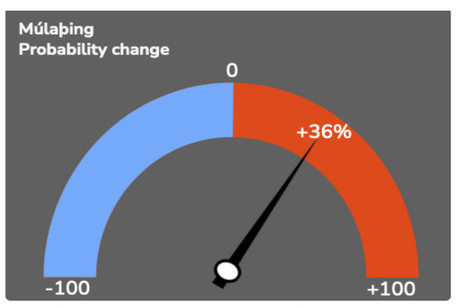


Fig 2. The probability of JRP **(i1)** for heavy rain (1:50 years) and landslide (sNAPI – 1:2 years) events increases by 36% in the future (2020–2100) compared to the baseline (1979–2017) in **TB4.**

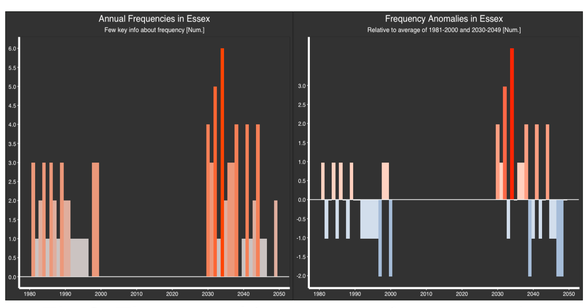


Fig 3. The annual frequency of compound events **(i2)** of extreme wind and rainfall for two periods (1981-2000 and 2030-2049) in **TB3.**

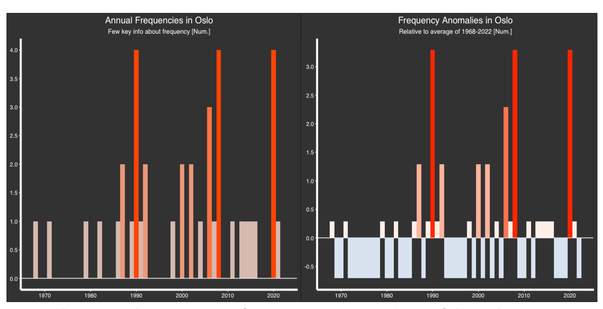
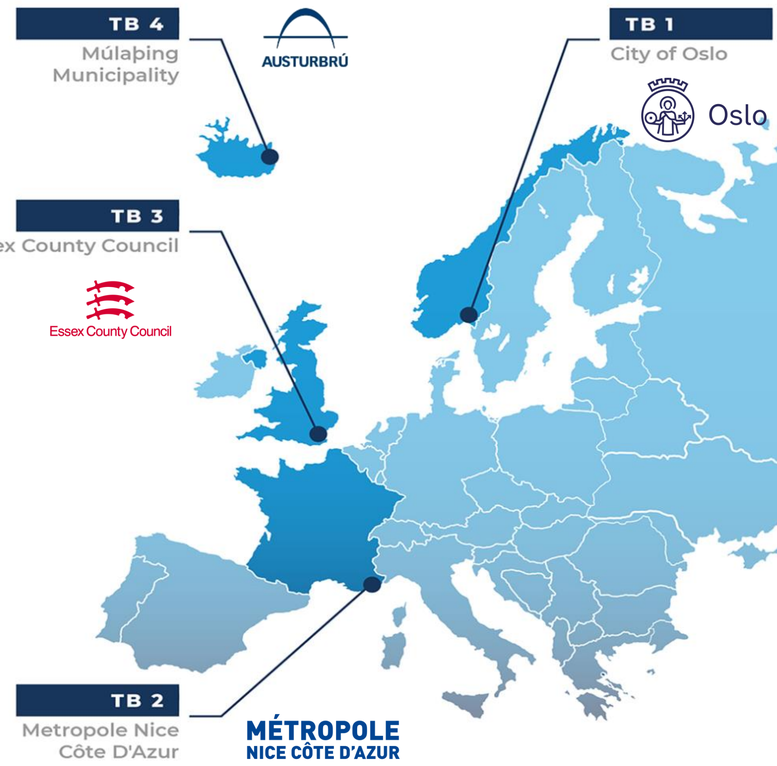


Fig 4. The annual frequency of multivariate compound events **(i2)** of coastal and riverine floods from 1968 to 2022 in **TB1**



5. Next step

The MH indicators will be:
- Incorporated into the risk and resilience assessment (TA7).
- Tested through a series of stakeholder workshops across the testbeds.
- Presented through the Web-based MEDiate DSS platform.

▼ **Multi-hazard indicators drawn from assessment of the primary interacting hazards** (TA1)

Test beds	Multi-hazard pairs	Interaction type	Single hazard variables	Threshold (percentile)		N. of joint extreme events		Multi-hazard indicators		
				Baseline	Future	Baseline	Future	i1	i2	i3
Oslo	Coastal and riverine flood	Multivariate	Weekly average surge height (m)	90th	90th	20	27	v	v	
			Weekly average river flow (m^3/s)	90th	90th					
Nice	Extreme heat and drought	Temporally compounding	Standardised Precipitation Index (SPI3)	<=1	<=1	-	-	v		v
			3 consecutive hot days	90%	90%					
Essex	Extreme wind and rainfall	Spatially compounding	Daily maximum wind speed of gust at 10m (m/s)	97th	97th	46	115	v	v	
			Daily precipitation (mm)	90th	85th					
Múlaþing	Heavy rain and landslide	Preconditioned and triggering	1d rain/1d rainfall intensity/scaled and Normalised API* (sNAPI)	90th	90th	54	184	v	v	
				90th	85th					
			…							
			5d rain/sNAPI	90th	90th	46	71			
				85th	90th					

* API: Antecedent Precipitation Index

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