Integrated Approaches to Assessing the Impacts of Multi-Risk Events Triggered by Natural Hazards

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Introduction

The **occurrence of disasters related to natural hazards has increased** in recent decades due to the growing exposure of urban population and effects of climate change. This context can increase highly complex risks and create multidimensional vulnerabilities. **Technological risks further aggravate these considerations**, especially as the distance between inhabited and industrial areas has been decreasing over time and as the number of infrastructures and their interrelationships has been increasing.

All those complex systems, which could act in combination - with or without coincidence in time, could impact potentially dependent elements at risk. Indeed, under certain conditions, different combinations of natural and technological hazards are likely to occur, e.g., an earthquake followed by a tsunami, floods impacting facilities, domino effect between industries, cascade effect between infrastructures.

When these complexities are not properly accounted for by decision-makers, it can lead to ineffective or even misguided risk management strategies.

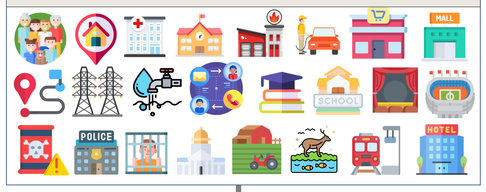
Objective

This study seeks, by **integrating different approaches** (dependability analysis, multi-hazard modeling, geographical representations), **to assess the potential consequences of the multi-risk events at a local scale** considering the influence of territorial specificities and stakeholder areas of intervention.

We analyze the **complex cause-and-effect interrelationships of the critical infrastructures** (e.g. transportation networks, energy systems, water supply, and emergency services) exposed to hazardous events and **underline the resulting disruptions to basic services for the population (e.g. disruption of routes or evacuation of people)**

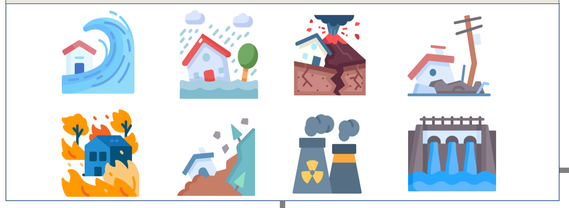
Methodology

1a- Identification of local issues

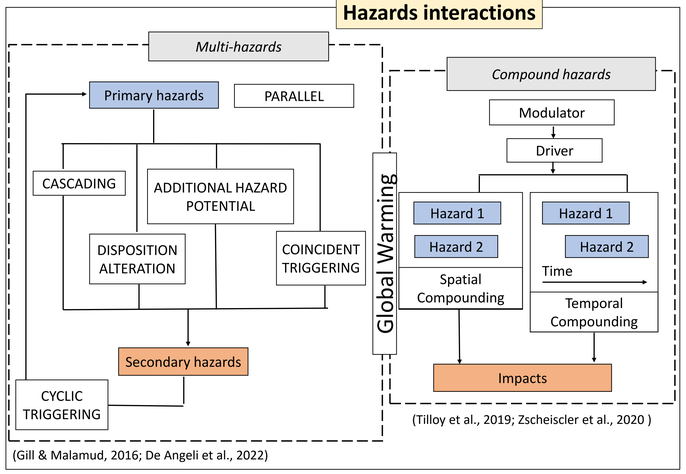


1- Territory analysis

1b- Selection of hazards on the territory



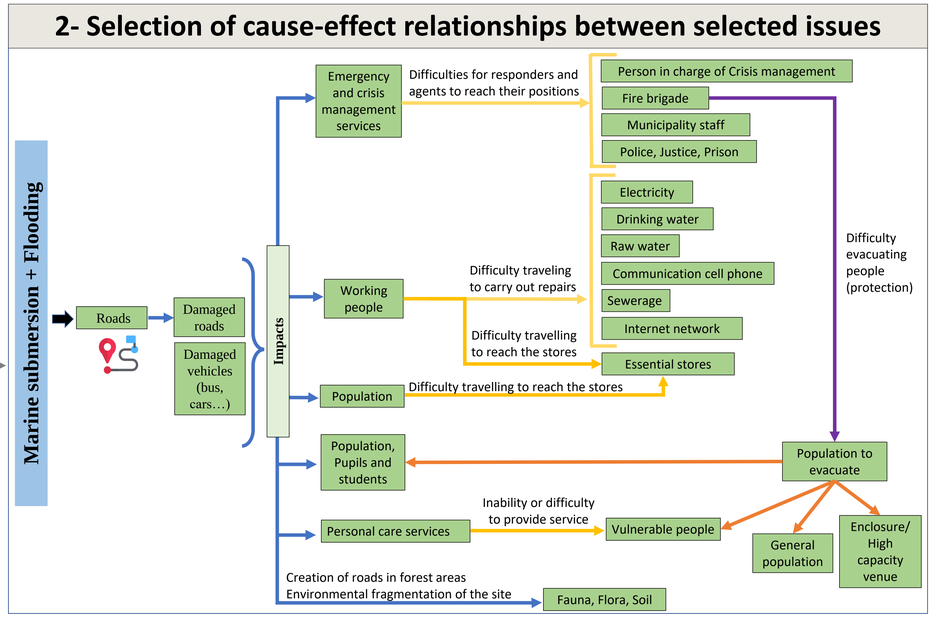
Hazards interactions



(Gill & Malamud, 2016; De Angeli et al., 2022)

(Tilloy et al., 2019; Zscheiscler et al., 2020)

2- Selection of cause-effect relationships between selected issues



3- Setting up scenarios

Modeling/Historical data/Spatial analysis

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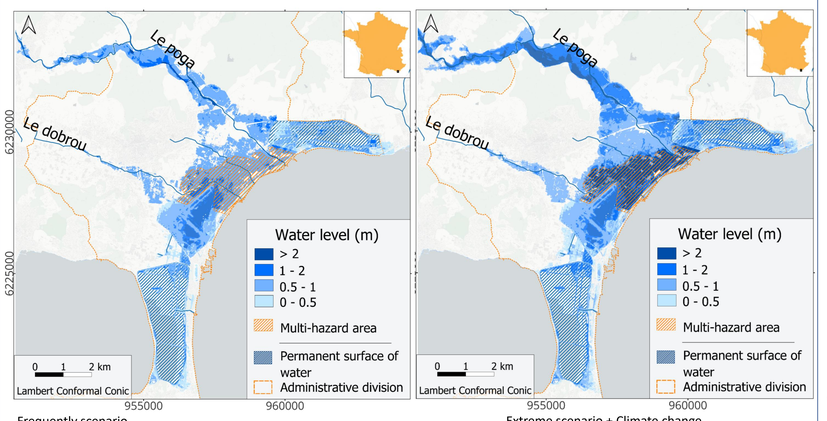
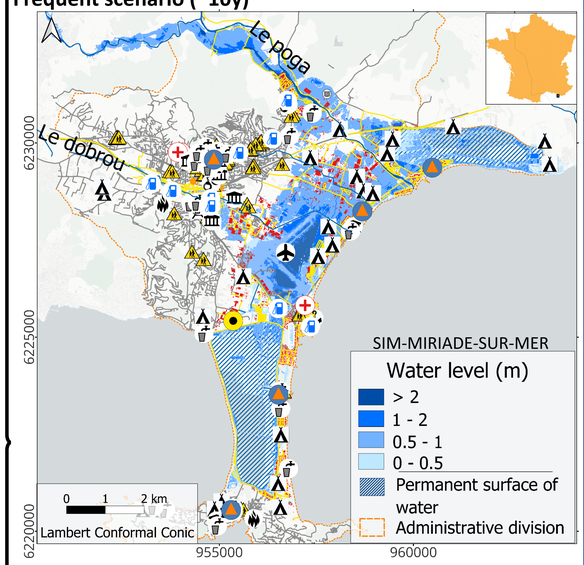


Frequently scenario
Source: DREAL PACA (2013)

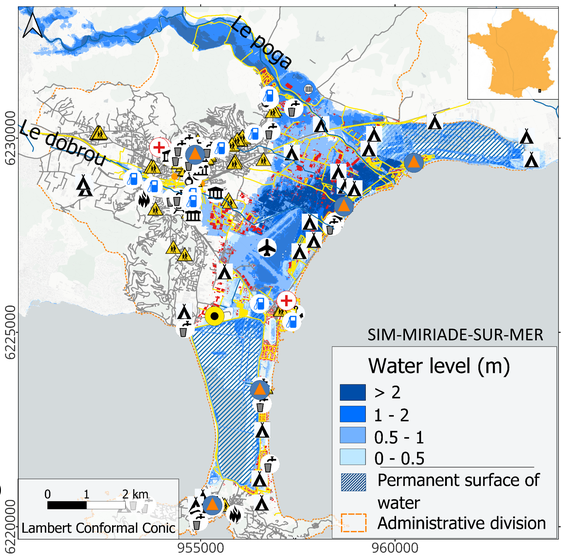
Extreme scenario + Climate change
Source: DREAL PACA (2013)

4- Mapping of multi-hazard impacts on the critical infrastructures (roads) for the different scenarios

Frequent scenario (~10y)



Extreme scenarios (~100y)



Source: DREAL PACA (2013) and BD TOPO® (2024)

Road
Impacted road
Electrical station
Drinking water
Police station
Prison
Fire station
Train station
Town hall/emergency siren
Building
Hospital
School
Cultural heritage
Camping
Care home
Fuel station
Port
Airport
Wastewater treatment plant

Key findings

- Interviews with local, departmental, and regional actors involved in risk management across South France territories has shown that the **existing tools are insufficient and require improvements to ensure effective multi-risk management**
- An **integrated assessment approach provides a comprehensive of multi-hazard-risk events**
- Accounting for **hazard interactions helps identify areas of high vulnerability**

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Acknowledgments

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Contact