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MULTI-RISK ANALYSIS AND INFORMATION SYSTEM COMPONENTS FOR THE ANDES REGION

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Dynamic physical vulnerability: a Multi-risk Scenario approach from building- single- hazard fragility- models

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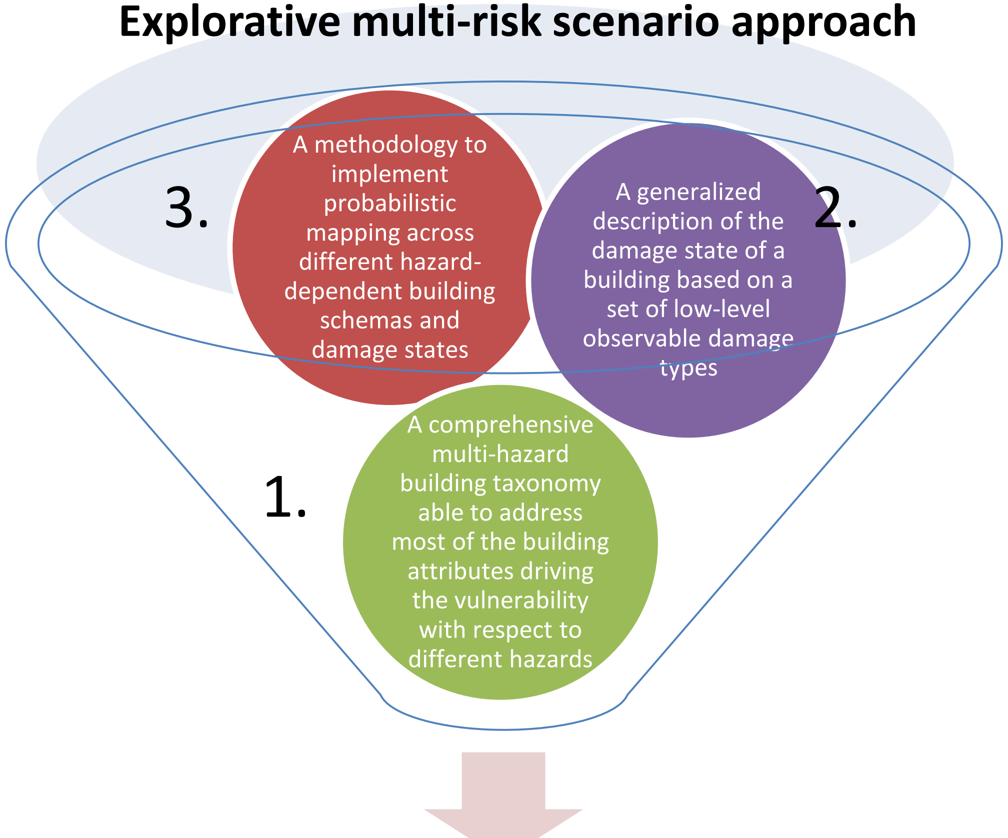
Multi- risk assessment: a global motivation

The Sendai Framework for Disaster Risk reduction (2015-2030) emphasizes the need for improved understanding of disaster risk in all its dimensions of *exposure, vulnerability, and hazard characteristics*, which streamlines the relevance of being able to construct **a holistic but rigorous multi-hazard- risk assessment framework.**

From single-hazard to multi-hazard risk assessment, including exposure and dynamic vulnerability.

Explorative multi-risk scenario approach



Dynamic physical vulnerability from building- single- hazard fragility- models

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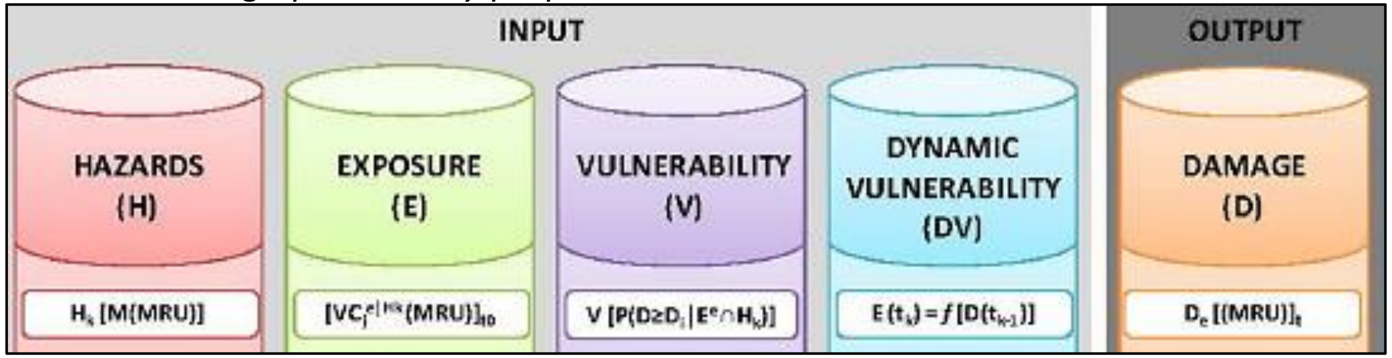
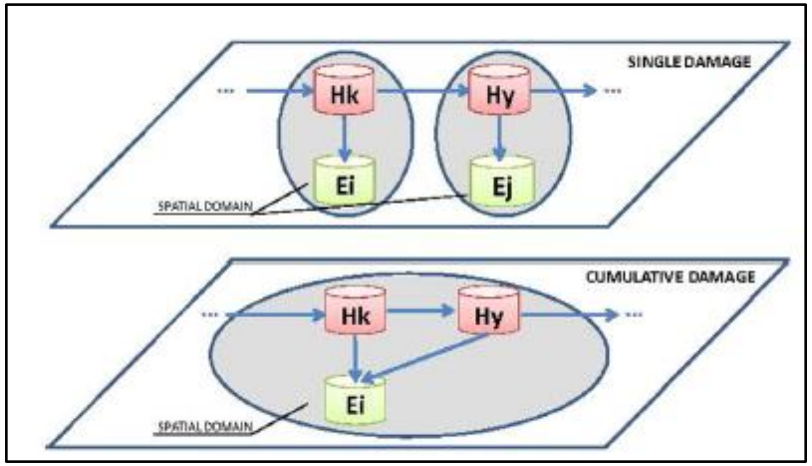
Multi- risk assessment:

General framework on Dynamic physical vulnerability

Contributing to the state of the art development:
We are building upon initially proposed theoretical ideas

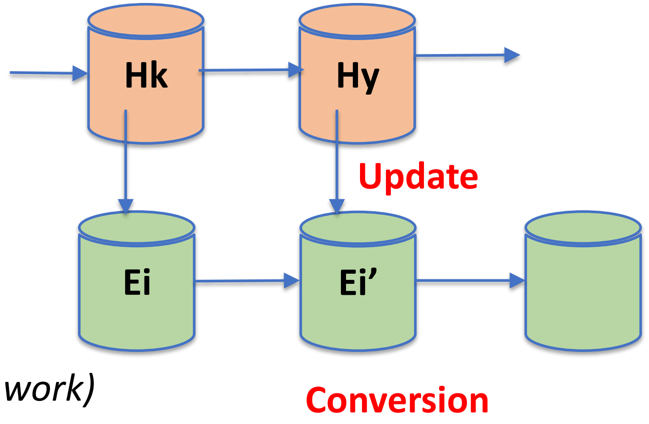


Zuccaro et al, 2018



The multi- risk assessment should consider the possible hazards and **vulnerability interactions** over the very same exposed elements.

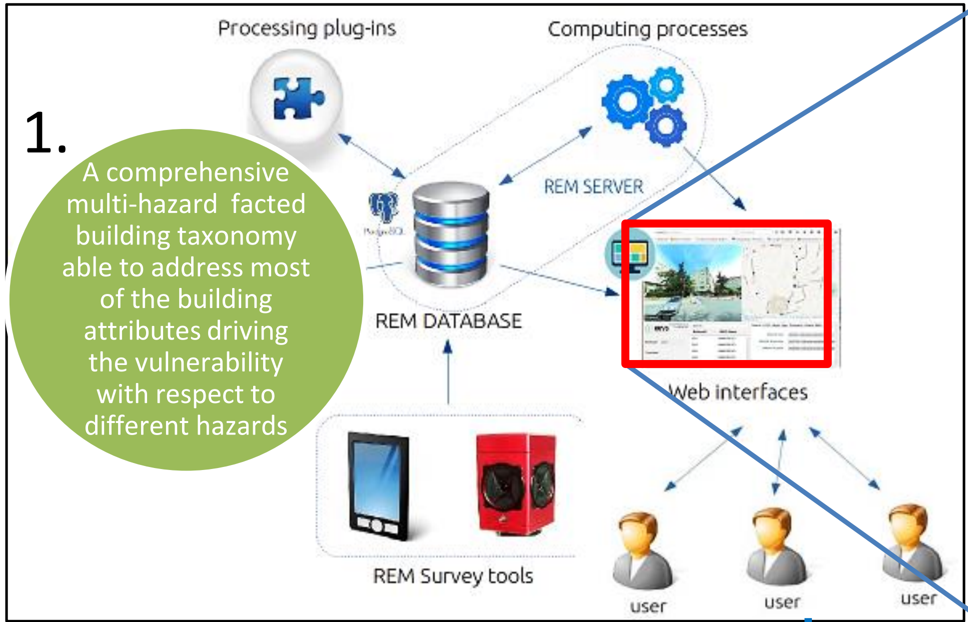
Multi-risk assessment framework comprises both multi-hazard and multi-vulnerability concepts (e.g. Carpignano et al., 2009; Garcia-Aristizabal and Marzocchi, 2012a, 2012b; Gallina et al, 2016). Under this scope, the multi- risk assessment should consider the possible hazards and **vulnerability interactions** over the very same exposed elements.



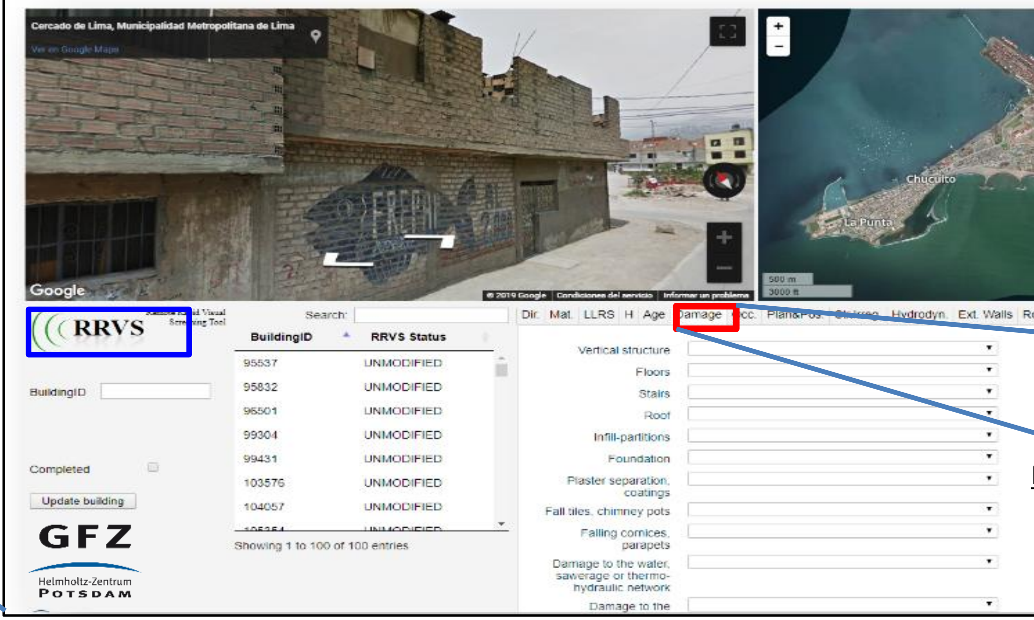
(This work)

Rapid Remote Visual Screening with a Multi- hazard- building taxonomy

1.



A comprehensive multi-hazard facted building taxonomy able to address most of the building attributes driving the vulnerability with respect to different hazards



Damage

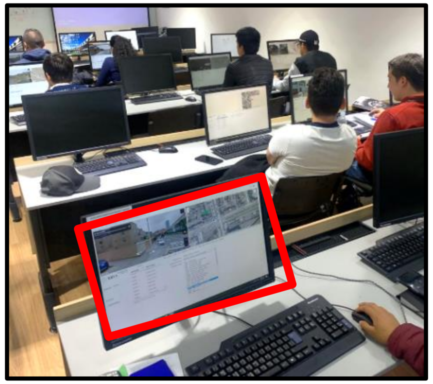
Pre- existing damage as one of the building *attribute values in the Faceted taxonomy*

(this work after Haas et al, 2016 and (Pittore et al., 2017)

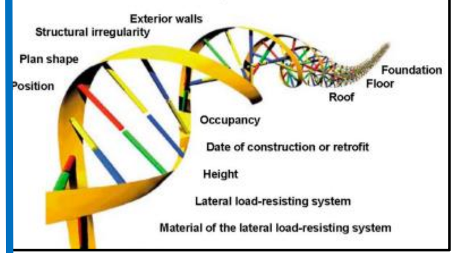
Building's structural and non-structural properties on a global scale.

Support from local experts and a wise-building sample is always advised.

Thousands of collected individual observations from sampled buildings



Standard classification system
- Risk-oriented (e.g. EMS-98, Hazus)
- Faceted (e.g. GEM v2.0)



Seismic- oriented faceted GEM building taxonomy

GEM GLOBAL EARTHQUAKE MODEL working together to assess risk

Are there any other controlling building attributes that may drive the building's vulnerability towards other hazards?

The RIESGOS Multi- hazard- faceted building taxonomy

GED4ALL RIESGOS

Brzev *et al*, 2013

e.g.
Charvet et al, 2017
Blanco-Voigt, 2015

Silva et al, 2018
Brzev *et al, 2020*

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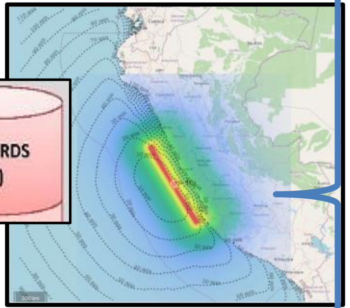
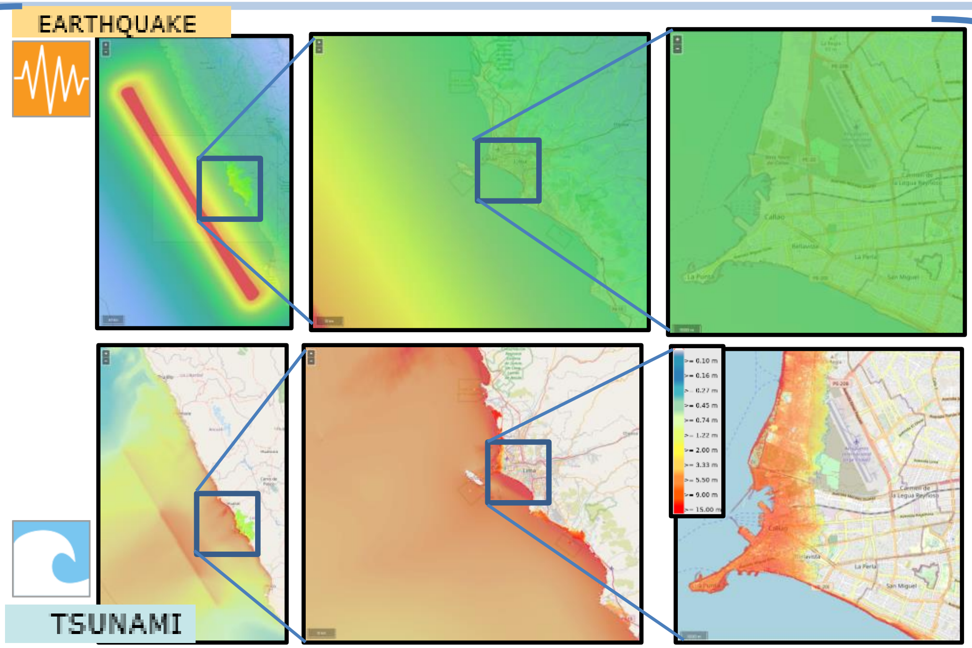
Multi-risk Scenario approach: An Earthquake- Tsunami example

Coupled multi- hazard scenarios

HAZARDS (H)

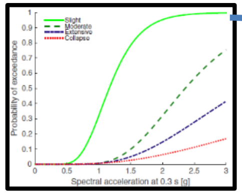


An encounter point between hazard and exposure should be considered

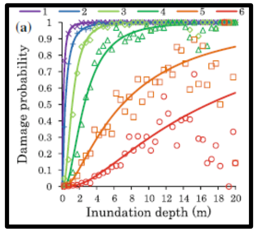


What about every hazard intensity measure geographical distribution?

e.g. Villar- Vega et al, 2017



VULNERABILITY (V)



e.g. Suppasri et al, 2013

Per every MECE building types: available set of single- hazard fragility functions developed by experts from every hazard- risk community

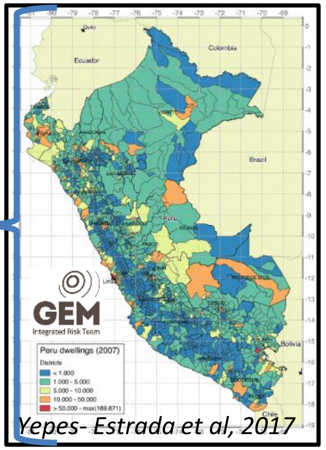
DAMAGE (D)

Cumulated- damage

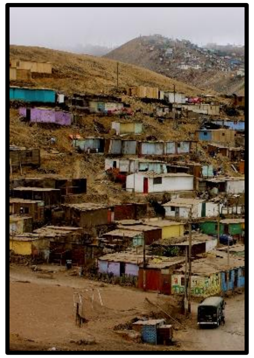
State- dependent fragility functions

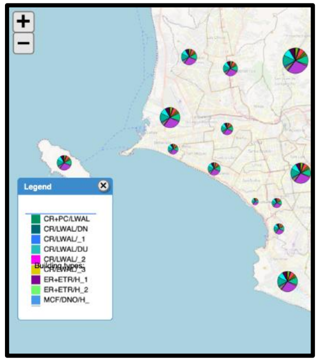
DYNAMIC VULNERABILITY (DV)

EXPOSURE (E)



Yepes- Estrada et al, 2017





MECE building types define a single- hazard- building- portfolio, but over which aggregation area?

Pre- existing damage as one of the building *attribute values in the Faceted taxonomy*! (the assumption of "intact" buildings is questioned.

A generalized description of the damage state of a building based on a set of low-level observable damage types

A methodology to implement probabilistic mapping across different hazard- dependent building schemas and damage states

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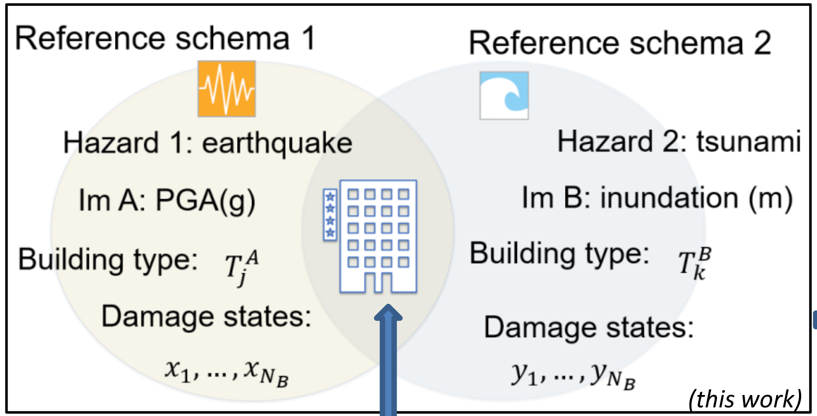
Following the damage evolution in a multi- hazard- risk scenario

The hazard acting forces and intensities are different, but some of the exposed components remain the same.



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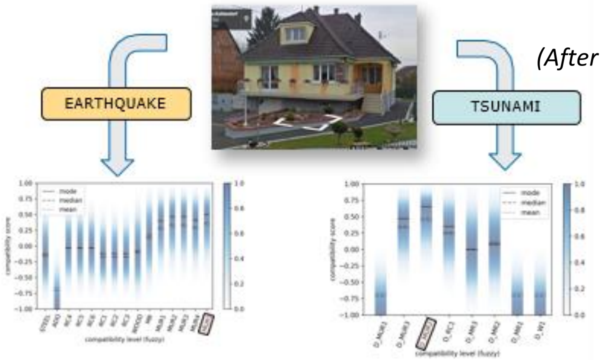
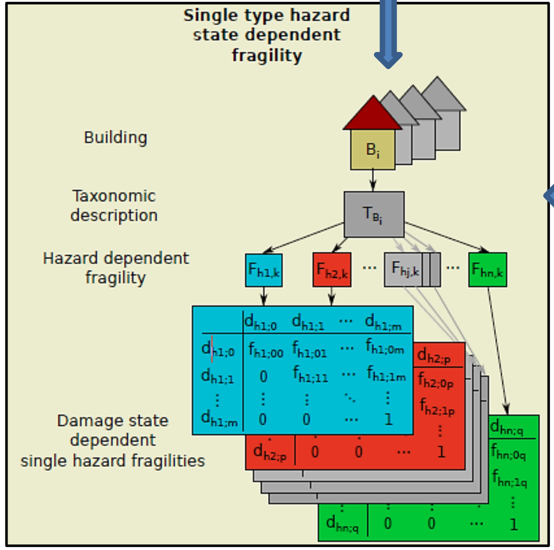


(After Pittore et al, 2018)

A methodology to implement probabilistic mapping across different hazard-dependent building schemas and damage states

Mutually exclusive, collectively exhaustive (MECE) building classes per reference hazard with associated fragility functions



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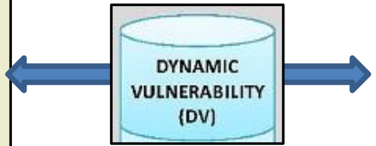
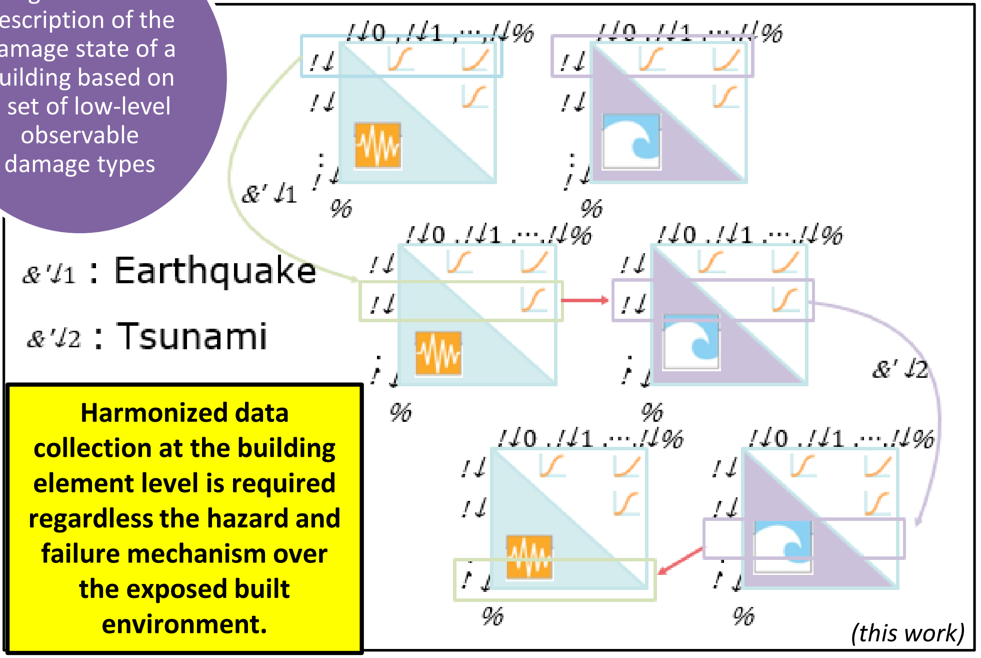


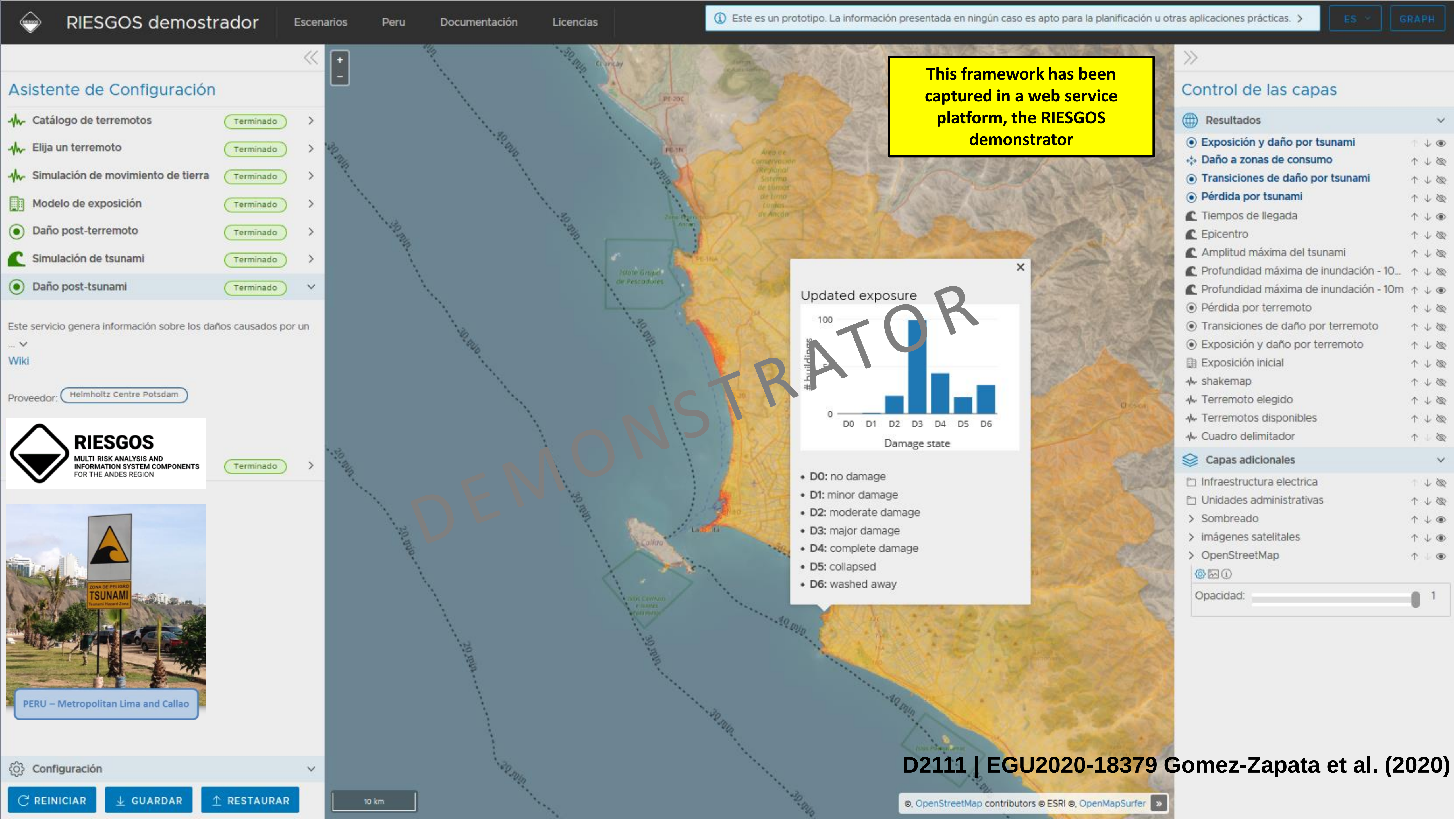
A generalized description of the damage state of a building based on a set of low-level observable damage types



Harmonized data collection at the building element level is required regardless the hazard and failure mechanism over the exposed built environment.

(this work)

This framework has been captured in a web service platform, the RIESGOS demonstrator



D2111 | EGU2020-18379 Gomez-Zapata et al. (2020)

Some Remarks

- We have been able to set up a framework for multi- hazard, multi- risk damage and multi- risk damage loss assessment. This method allows to consistently re-use existing single hazard fragility in a multi- risk framework.
- The definition of mutually exclusive, collectively exhaustive (MECE) building classes per reference hazard with associated fragility functions should be constrained at the local study area. and using a multi- hazard building faceted taxonomy in order to define the building exposure models (per every considered hazard) has shown their advantages in a multi-risk- framework.
- A comprenhensive faceted multi-hazard- building taxonomy is a fundamental piece in this multi- hazard- risk framework. This should be able to address most of the building attributes driving the vulnerability with respect to different hazards, and also the pre- existing damage over certain individual building elements. Their implementation to collect local observations over a selected building sample has high relevance in order to constrain the innitial assumptions and as actual inputs in a statistical exposure model.
- The general assumption of "intact" buildings for which the conventional single- hazard fragility functions are made is questioned and overcoming this aspect should be a general issue to be addressed by the Multi- hazard- community.
- The epistemic uncertainty in the building- portfolio exposure definition, and their link with the spacial hazard intensity distribution plays a fundamental role in a consistent multi- hazard-risk framework.
- Multi-risk vulnerability models have to consider the state dependency in order to model the accumulation of physical damage across a sequence of (different) natural events.
- A common framework across the different natural hazards- risk communities aiming for a harmonized damage- data collection at the building element level is required, not only to validate the failure mechanisms assumptions in the existing analytical fragility functions, but also to constrain a common baseline in a multi- risk framework.
- An more in deep study regarding some local and global factors -geographically speaking- that may contribute to the hazard I.M spatial variability (i.e. seismic site effects, ground motion residuals' correlation, topography, slip-rate distribution) and their resulting uncertainties, that impact the loss estimates should be systematically explored in a multi- risk framework.
- Time dependency and repair rates have been not considered so far, although their integration in the presented framework would open a new chain of future developments.

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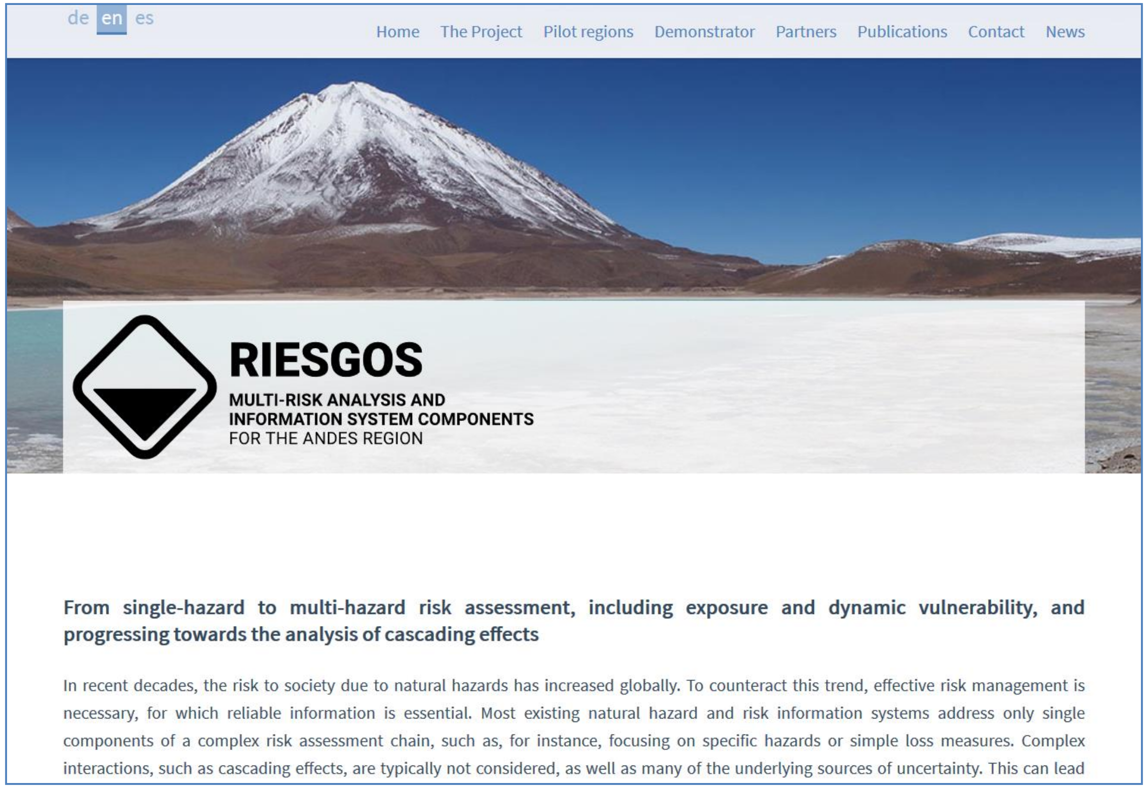

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