Quantifying Uncertainties in Vulnerability Assessment of Infrastructure and Buildings to Hydro-meteorological Hazards

Progress Report

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- Research framework and objectives
- Results and progress Ob.1, Ob.2, Ob.3 (+)
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- Overview (2014)

Research framework and objectives

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Objective 1:
RQ 1.1, 1.2: State-of-the art

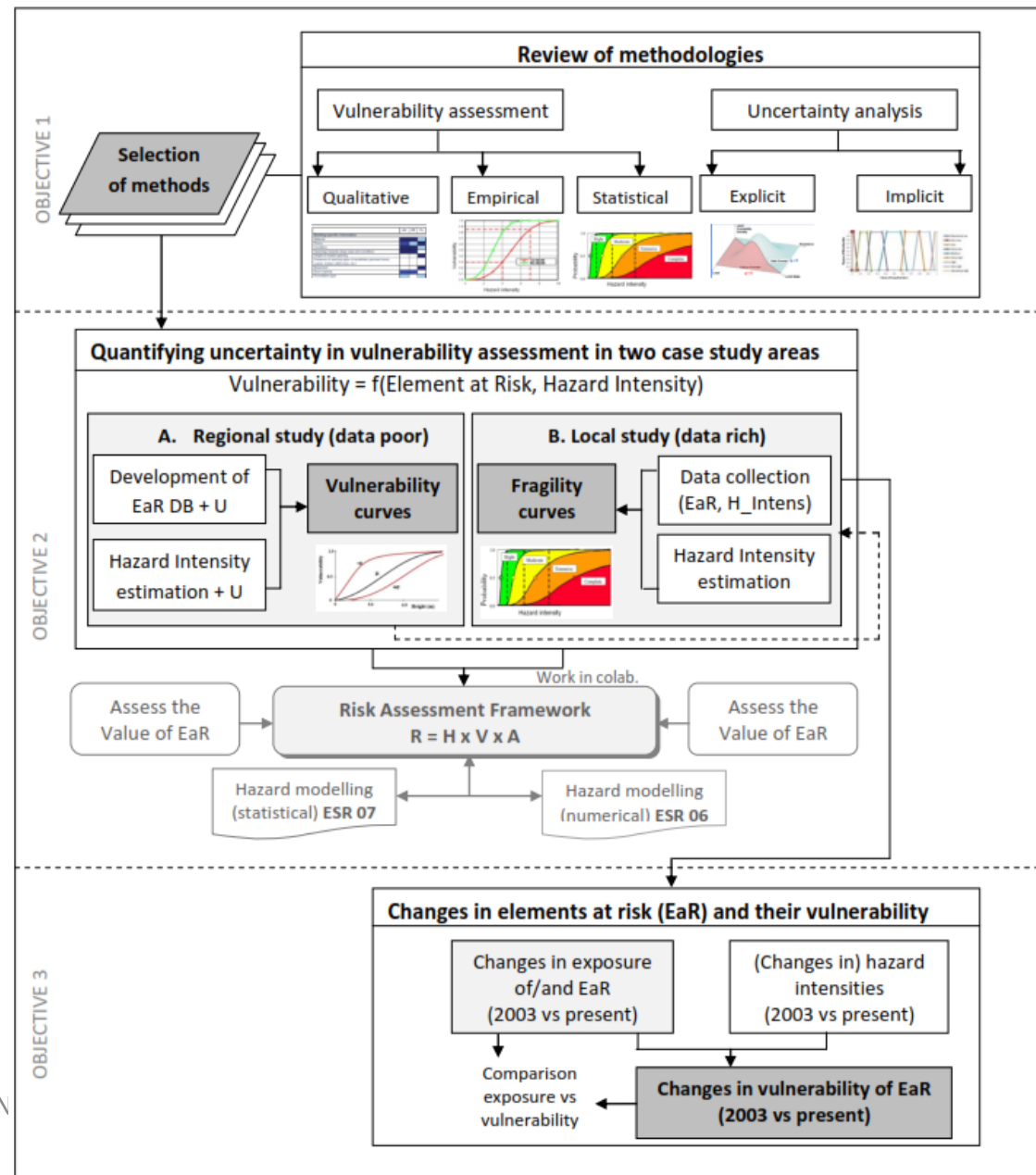**Objective 2:**
RQ 2.1: Regional study (A)
RQ 2.2: Local study (B)

Objective 3:
RQ 3.1: Changes in exposure
RQ 3.2: Changes in vulnerability
RQ 3.3: Comparison between
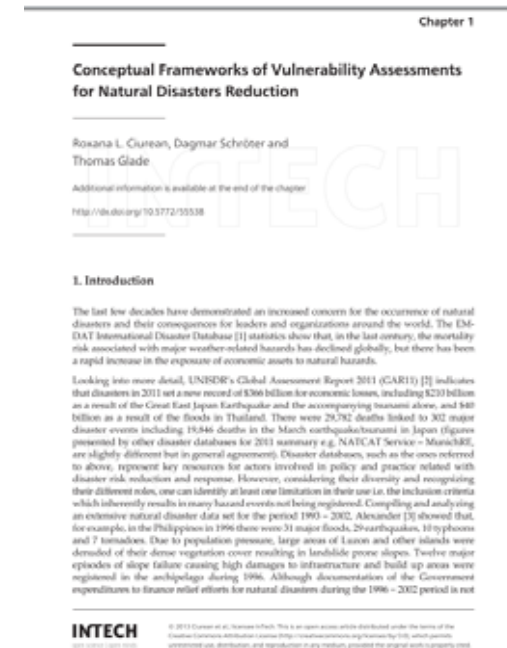changes in exposure & vulnerability

4/14/2014

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Results and progress Objective 1

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RQ 1.1: State-of-the art – vulnerability assessment methods

APPROACHES TO DISASTER MANAGEMENT - EXAMINING THE IMPLICATIONS OF HAZARDS, EMERGENCIES AND DISASTERS

ISBN 978-953-51-1093-4

Book edited by:

Prof. John Tiefenbacher

Director, James and Marilyn Lovell Center for Environmental Geography and Hazards Research, Department of Geography, Texas State University-San Marcos, USA

RQ 1.2: State-of-the art – uncertainty analysis in vulnerability assessment to hydro-meteorological hazards *(in progress)*

Chapter 1

Conceptual Frameworks of Vulnerability Assessments for Natural Disasters Reduction

Roxana L. Ciurean, Dagmar Schröter and Thomas Glade

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RQ 2.1: Regional study (Buzău County, Romania)

In progress:
Uncertainty assessment of physical vulnerability
Using FOSM (modified after Kaynia et al., 2008)
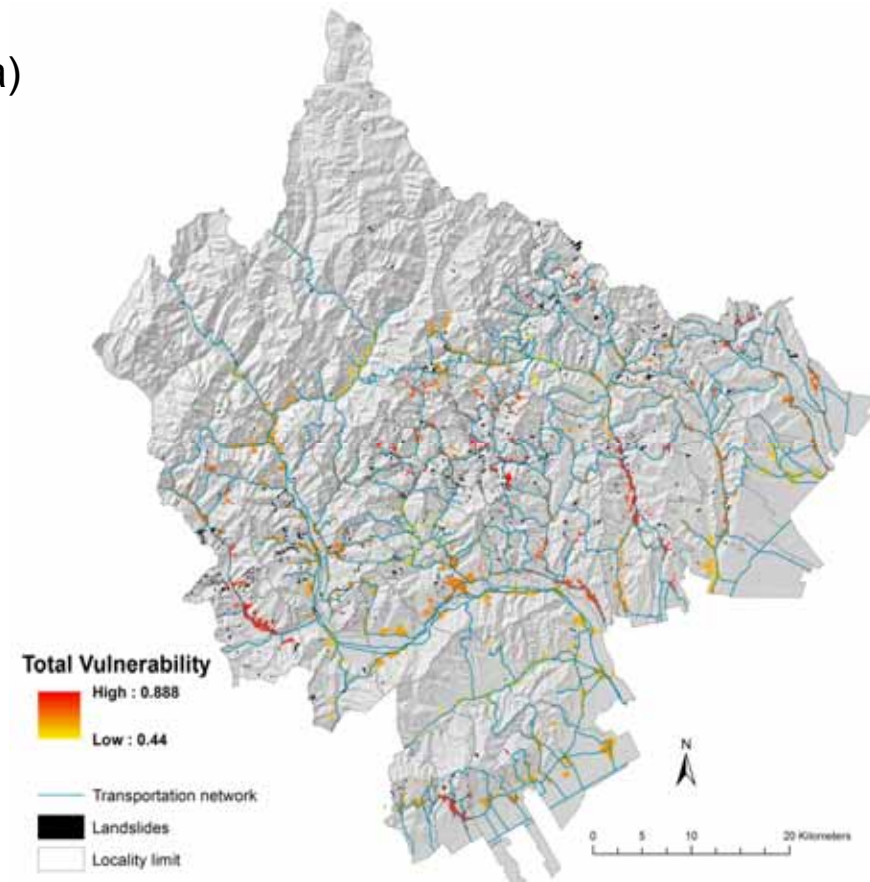
$$E(Y) = Y[E(X_1), \dots, E(X_n)]$$

$$\sigma^2(Y) \approx \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{\partial Y}{\partial X_i}\Big|_E \cdot \frac{\partial Y}{\partial X_j}\Big|_E \cdot \rho_{ij} \cdot \sigma(X_i) \cdot \sigma(X_j)$$

e.g. Expected value and standard deviation for susceptibility of structures:

$$E(S_{STR}) = 1 - [1 - E(\xi_{STY})][1 - E(\xi_{SMN})].$$

$$\sigma_P(S_{STR}) = \left\{ \begin{array}{l} [E(\xi_{SMN}) - 1]^2 \cdot E^2(\xi_{STY}) \cdot COV^2(\xi_{STY}) + \\ + [E(\xi_{STY}) - 1]^2 \cdot E^2(\xi_{SMN}) \cdot COV^2(\xi_{SMN}) \end{array} \right\}^{0.5} \cdot$$

Total Vulnerability
High : 0.888
Low : 0.44

— Transportation network
■ Landslides
□ Locality limit

N

0   5   10   20 Kilometers

V = f(Susceptibility, Intensity)
Susceptibility = $1 - (1 - F_{str})(1 - F_{mnt})$
Intensity = f(volume, velocity)
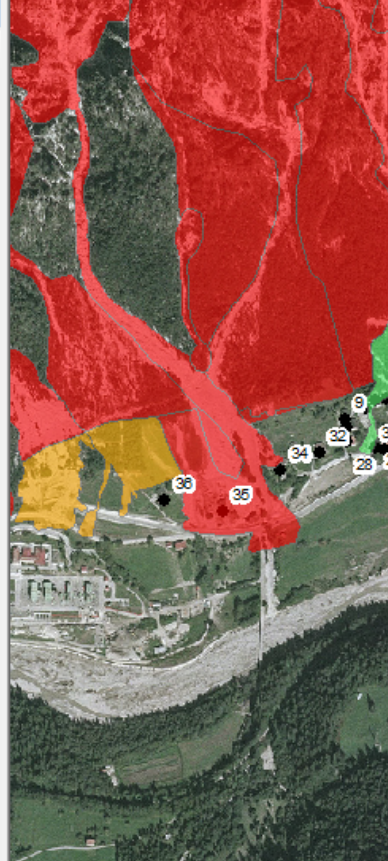
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RQ 2.2: Local study (Malborghetto Valbruna, Italy)

ESR06/Univ. Trieste
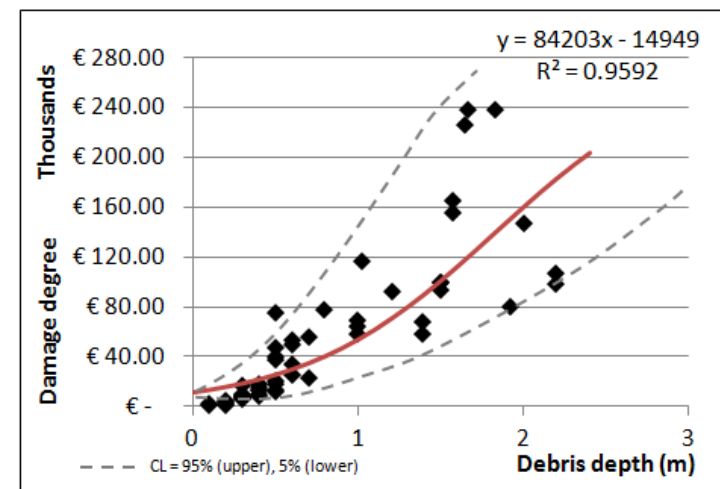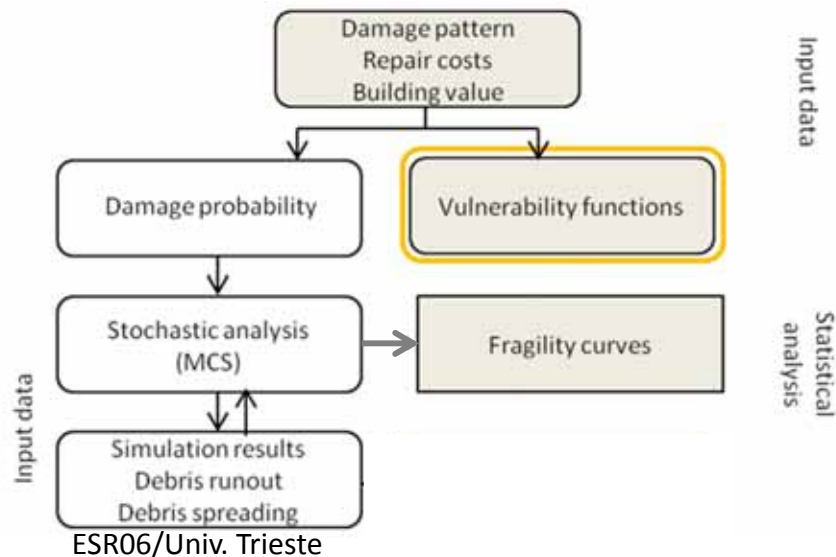
Empirically derived vulnerability curve (Standard sigmoid logistic function; damage pattern – Papathoma-Köhle et al., 2012)

Field name	Explanation/Definition	Observations
ID	0 = mapped in the field 1 – mapped from Google Street View	The time was not enough to finish mapping all buildings in the field, thus I used GSV to finish the inventory
REPORTDAT	11/13/2013	Date when the mapping was performed
BUILDINGID	1000	The number the building is attributed; used for mapping purposes
PHOTOID	124 - 128	The photo number associated with pictures taken at each house; this way the photos are identified in the photo folder
FLOORNO	Here, the ground floor counts as the first floor	0 = no floors, the house has not been mapped, only identified on the ortophoto and sometimes photos taken 1 = house with no levels, only ground floor 3 = house with too levels and 1 ground floor
Maintenan	Visual inspection of the state of maintenance	NULL or empty cell = not mapped G = good M = medium P = poor
age	The date of construction was approximated using the 'numero rosso' sign on the buildings and the building material of construction and design (to determine whether it is 1971 or 19031971)	NULL or empty cell = not mapped 1903 = < 1903 (houses with 'numero rosso') 19031971 =between two known building codes 1971 = >1971 (new building code)
FRONTOPEN	Front = the main entrance into the building (also where the GPS point was taken)	Number of openings (all possible types: doors, windows, other)
RIGHTOPEN	Right = with respect to the front	Idem, NULL = not available, 0 = no oppenings
LEFTOPEN	Left = idem	Idem, NULL = not available, 0 = no oppenings
BACKOPEN	Back = idem	Idem, NULL = not available, 0 = no oppenings
SURROUNDIN	Only the closest existent bodies between the slope or river, and the mapped building	B = building CW = concrete wall H = hamlet MX = mixt (hamlet and building, building and wall, trees and hamlet, etc.) OT = other R = river T = trees W = wall (other than concrete)
0FLOORUSE,1FLOORUSE, 2FLOORUSE	The type of use of the ground floor, first floor and second floor – estimated based on visual inspection	NULL or empty cell = not mapped; NA = not available, GA = garage, BE = bedroom, K = kitchen, LR = living room, MX =

In progress:
-Testing different distribution functions (Exponential, Gumbel, Gamma)
- Use debris flow modeling results (Univ. Trieste/Haydar) to develop fragility curves (hybrid)

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RQ 3.1: Changes in exposure (*in progress*)
- Flood and landslide hazard maps (PAI)
- Building inventory
- Building value

RQ 3.2: Changes in vulnerability (linked with RQ2.2, colab. with Haydar)

RQ 3.3: Comparison between changes in exposure & vulnerability (linked with RQ 3.1 and 3.2)

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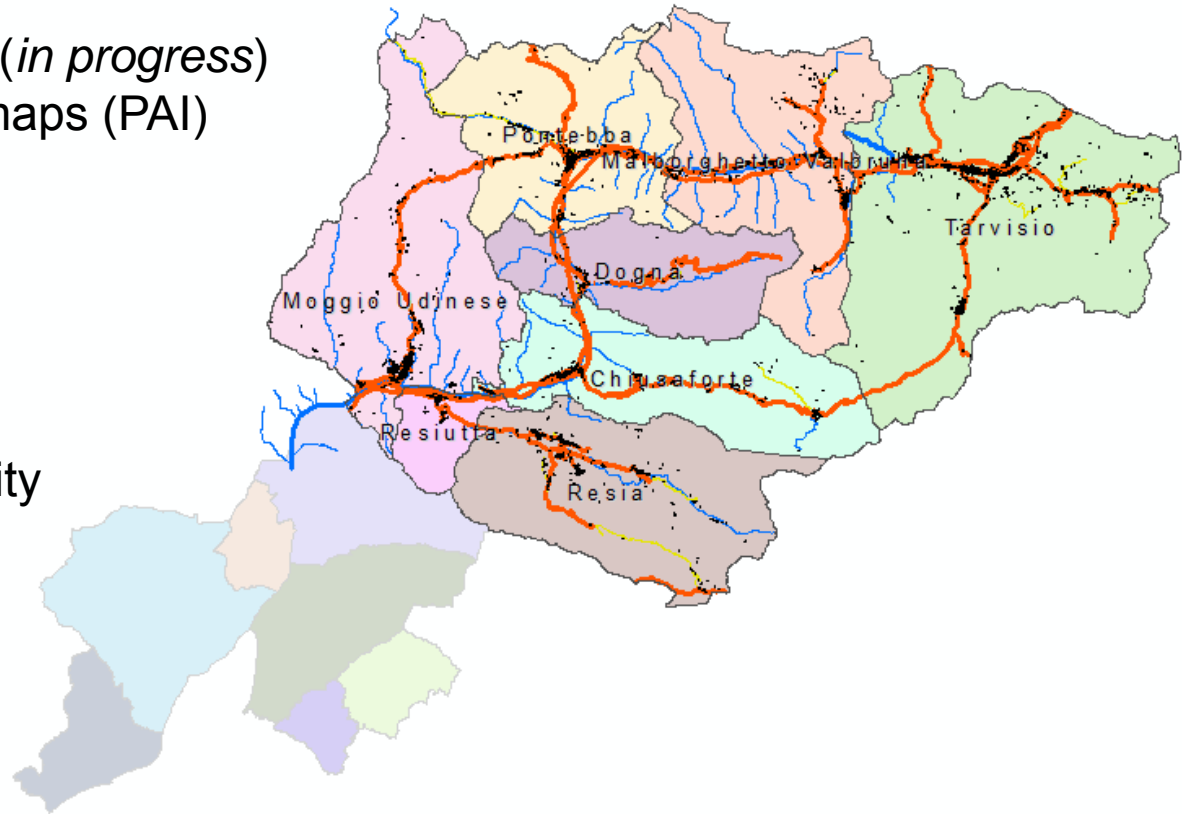
■ Assessing vulnerability of buildings to hydro-meteorological hazards using an expert based approach. Application to Nehoiu Valley, Romania (in colab. with Aroshaliny Godfrey, former M.Sc. Student ITC) (*draft paper*)
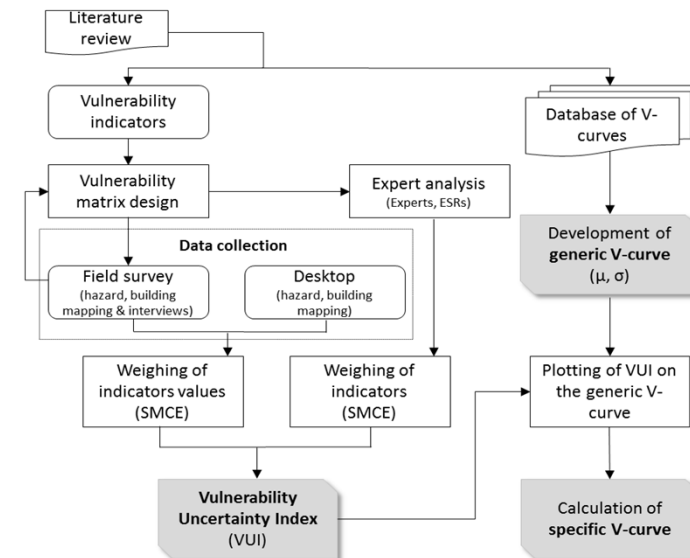
■ Regional damage assessment of the August 2003 debris flows event in Malborghetto Valbruna, FVG, Italy (in colab. with Lixia Chen, visiting researcher at ITC) (*in progress*)

CHANGES Meeting, 7 - 11 Ap
Switzerland

Contribution to CHANGES Book
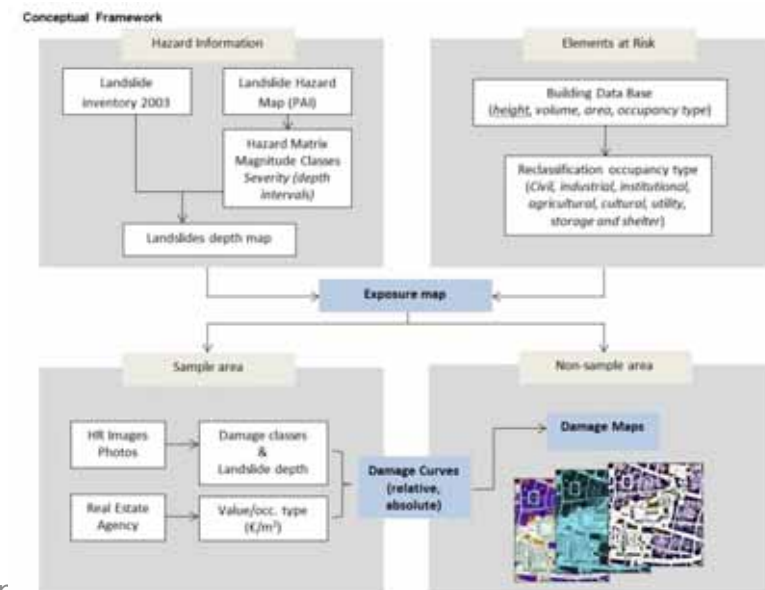
Proposal for the book of the CHANGES project:
Analysis and Management of Changing Hydro-Meteorological Risks in Europe
@ 31. March 2014

Book Editors (Van Westen, Mostert, Malet, Glade, Greiving)
Chapter 5: Analyzing changes in exposure, vulnerability and risk

Linked to WP 2 & 3 of the CHANGES project
Approximate number of pages: 60
- Chapter lead editor: Glade
- Co-editor: Schröter, Micu, Boerboom, van Westen
- Contributions from: Glade, Micu, Malek, Zumpano, Ciurean, Hussin, Jaeger, Assman, Zeil, Kienberger, Mueller, Boerboom, Van Westen, Godfrey

Focus: state of the art, research gaps, future needs, methodological approaches, results not included in journal papers

- Historical development of exposure and vulnerability (4 pages,~ 2 figures)

- Analyzing changes in exposure (5 pages, ~ 2 figures)

- Analyzing changes in vulnerability (8 pages, ~ 2 figures)

- Dealing with uncertainties (6 pages, ~ 3 figures)

Overview (2014)

Period	Activity	Objective
16 – 30 March	Short secondment ITC	Damage assessment - Italy
27 April – 2 May	EGU (presentation, poster)	Regional vulnerabiltiy analysis – Romania; holistic framework for physical vulnerability analysis
June*	Short secondment ITC	Finalization of damage assessment - Italy
July*	Short secondment Padova	Finalization of changes in vulnerability - Italy
August*	Short secondment Lausanne	Work related with the CHANGES book
September/ October*	Dissemination activity Italy, Romania	
November	CHANGES Final Conference	
December	End of contract	

*To be discussed

Thank you for your attention!

We are the CHANGE…

Challenges and opportunities

The challenge of...

Finishing in time (!)
-Time constraints given the current work progress
- Finding additional funding after termination of the contract
- Finding a job ☺

The opportunity to...

- Access funds through different sources (national/international, EURAXESS, etc.)
- Continue research work based on available CHANGES data after graduation (PostDoc?)