WP 2: Evaluating changes in exposed elements at risk and their vulnerability

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Roxana Ciurean & Thomas Glade (University of Vienna, Austria)

29. November 2012 – Dortmund, Germany

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Structure

Part 1: Rational

Thomas Glade & Dagmar Schröter

Part 2: Global changes - mountain land use patterns & ecosystem services

Žiga Malek

Part 3: Quantifying uncertainties in vulnerability assessment

Roxana Ciurean

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WP 2: *Evaluating changes in exposed elements at risk and their vulnerability*

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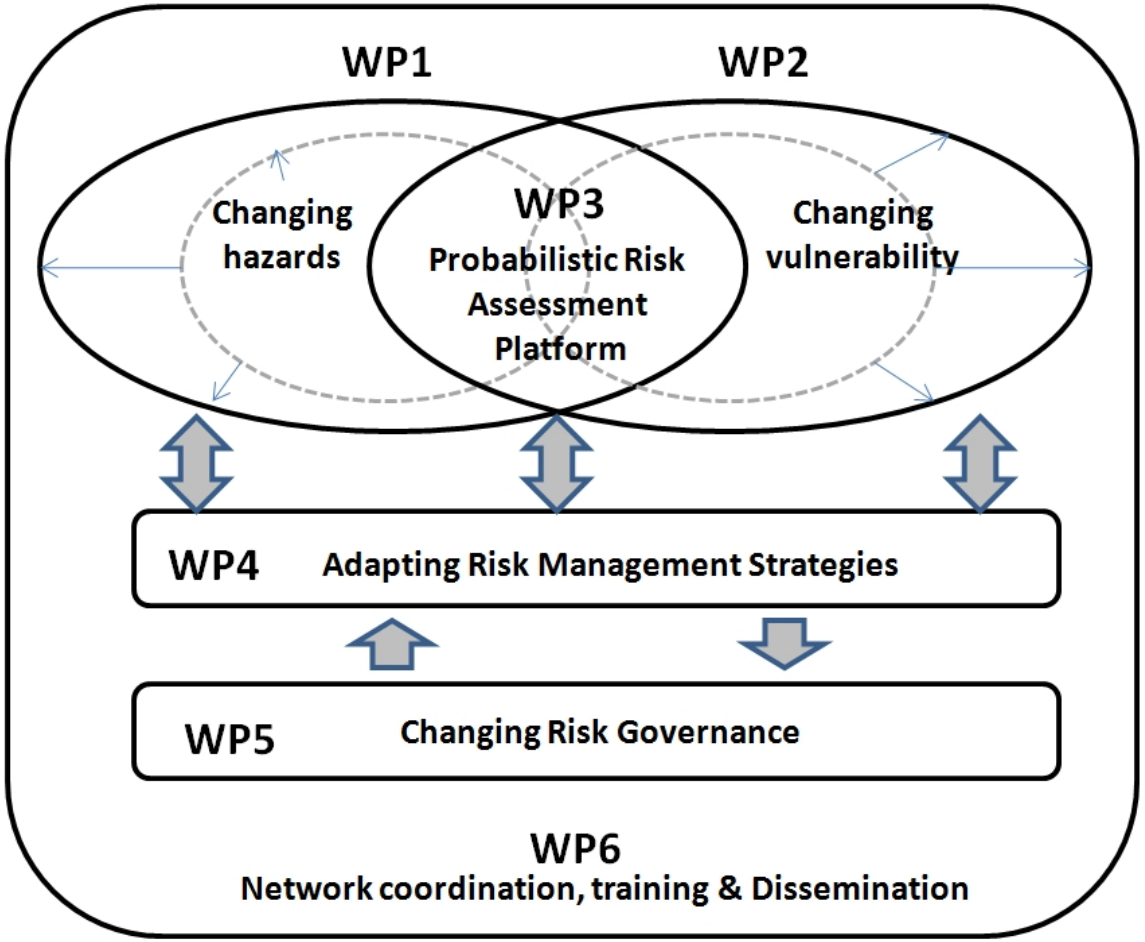

WP 2

- Type: Research training
- 72 Person months
- Start month 3
- End month 48

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WP2 description

Participant short name	IIASA	UNIVIE	CCRM	PC-FVG	UNIL	R&D
Person-months:	26	26	5	5	5	5

Objectives: The overall aim of this Work Package is to …

… evaluate environmental changes, triggered by global change (including climate change), and to

… interact with economic development, leading to changes in exposed elements at risk.

Topic Actions

(TA-2.1) Assessment of the current vulnerability situation based on historical developments.

•ESR/ER: no direct ESR involvement. By IIASA and UNIVIE

•Deliverable: D2.1 Assessment of the current vulnerability situation based on historical developments. Delivery date: M+16.

(TA-2.2) Analysis of expected changes in ecosystems and land use patterns in relation to global change and future socio-economic development.

- ESR-04: duration 36 months; starting: M+5, ending: M+41. With IIASA (26 months) and secondment with CCRM (5 months) and PC-FVG (5 months).

(TA-2.3) Expressing uncertainties in vulnerability and value of infrastructure, buildings and land use to hydro-meteorological hazards focussing on both physical vulnerability as well as societal vulnerability approach in order to obtain a holistic approach.

•ESR-05: duration 36 months; starting: M+6, ending: M+42. With UNVIE (26 months) and secondment with UNIL (5 months) and R&D (5 months).

Research topics within WP2

Nr.	Title of the position – ESR's & ER	Principal host institute	Secondment institute (or joint supervision)	WP	Start of Research Period
…	…	…	…	…	…
ESR-04	Analysis of expected changes in ecosystems and land use patterns in relation to climate change and future economic development.	IIASA (26)	CCRM (5) PC-FVG (5)	2	M+3
ESR-05	Expressing uncertainties in vulnerability and value of infrastructure, buildings and land use to hydro-meteorological hazards	UNIVIE (26)	UNIL (5) R&D (5)	2	M+5
…	…	…	…	…	…
ER-02	Development of web-based decision support tool for risk management	ITC (12)	UNIVIE (6) GEOMER (3) R&D (3)	4	M+22

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ESR 04:

Effects of global changes on mountain land use patterns and ecosystem services in a comparative case study: Italian Alps and Romanian Carpathians

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Land use/cover changes in mountains

- European mountain areas witnessed contrasting trends: most of the land (%) transformed to more extensive, more “natural” land use/cover – urbanisation in the valleys
- Mountain ecosystems among most vulnerable to global changes (Schröter et al. 2005) – low recovery rates + increased pressures (Körner et al. 2005)
- Small scale and subtle land use/cover changes can lead to a variety of negative consequences

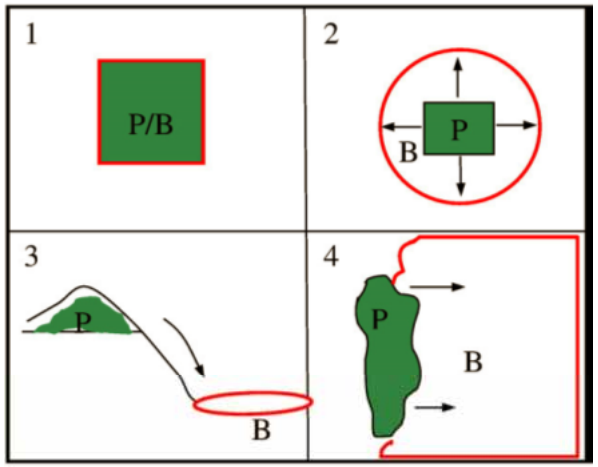
Micu 2011

ziare.com 2012

Land use/cover changes in mountains

Mountain Ecosystem services

- until recently focus only on timber and water supply
- freshwater and energy supply, maintaining biological diversity, carbon storage, minerals, forest and agricultural products, protection from natural hazards, and tourism and recreation



Fisher et al. 2009

Gesselschaft für ökologische Forschung, 2003

Example: Andermatt, Switzerland

Objectives

- To identify the causal relationships behind land use/cover changes in mountain areas with identification of local socio-economic and biophysical variables and variables of global change

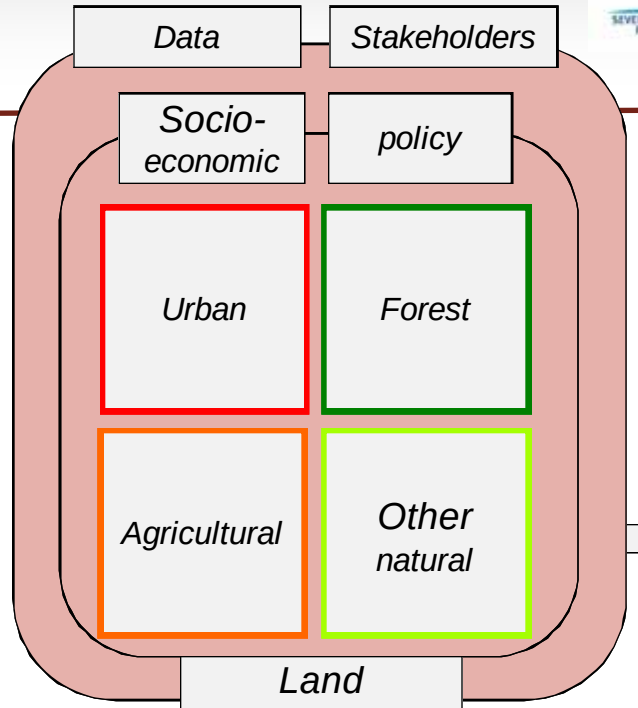
- To develop local land use change scenarios, based on an understanding of the local system and within the context of global change scenarios and spatially allocate them

- To describe the provision of mountain ecosystem services and their possible changes under proposed scenarios of land use change in the context of global change

Methodology

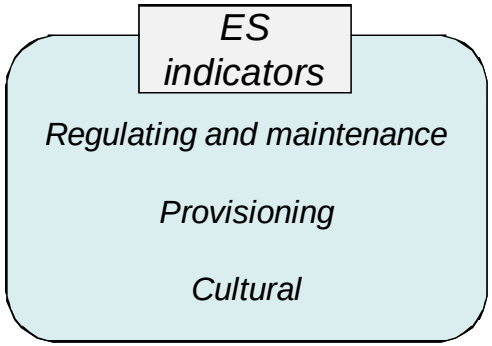
To identify the driving forces behind land use changes in mountain areas

System dynamics model

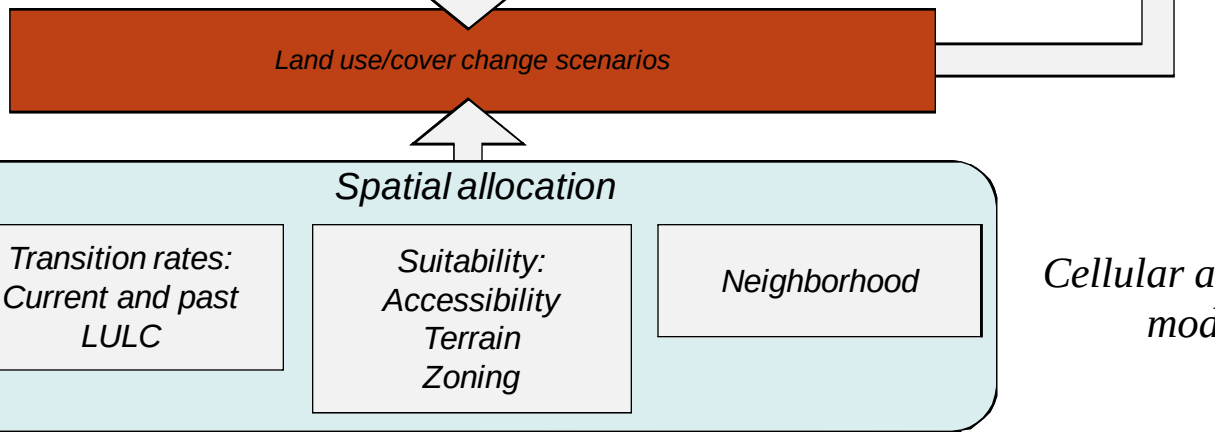


To describe the provision of mountain ecosystem services

Ecosystem services matrix



Developing local land use change scenarios

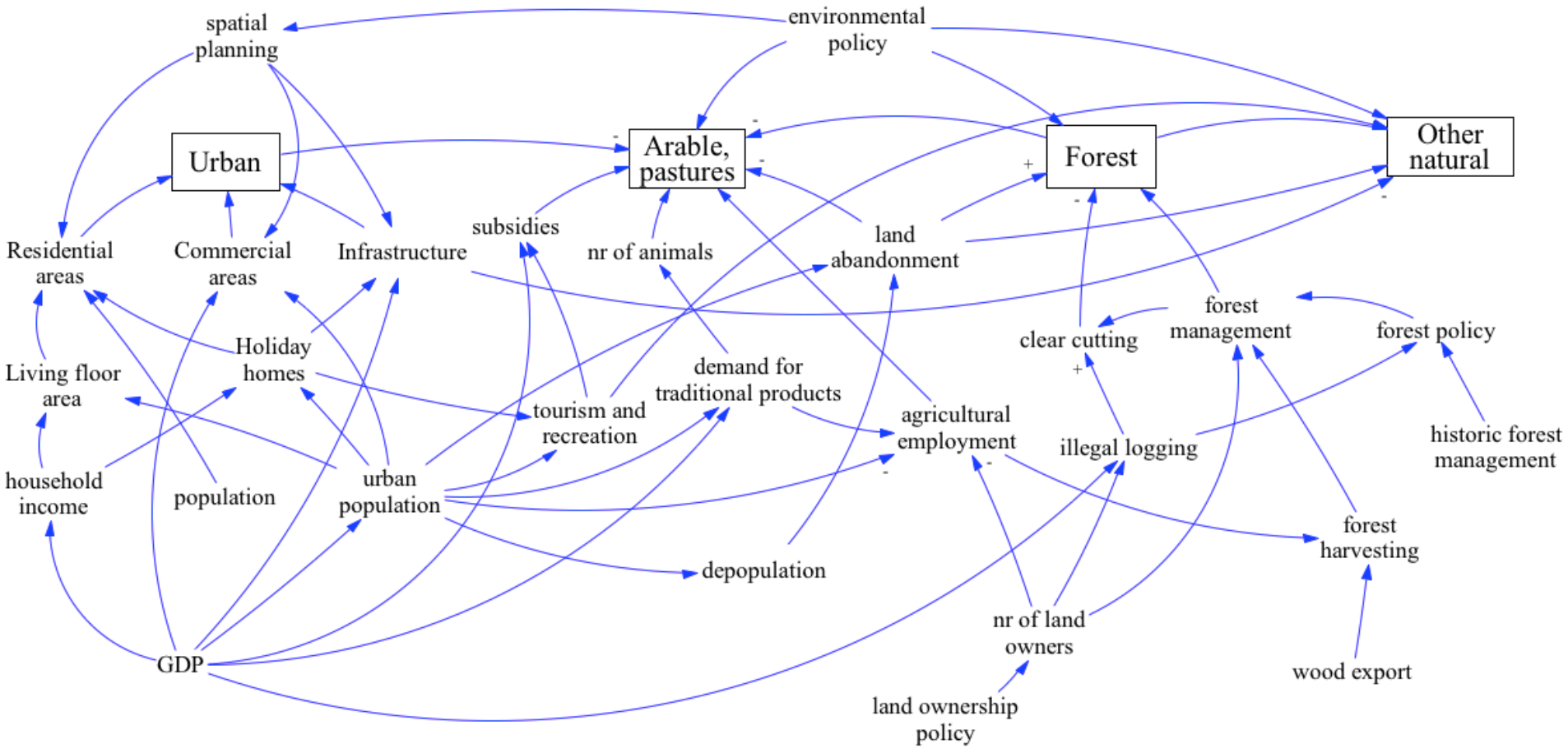


Remote sensing

Cellular automata model

Land use change

To identify the driving forces behind land use changes in mountain areas and link them to local socio-economic and biophysical variables and global change

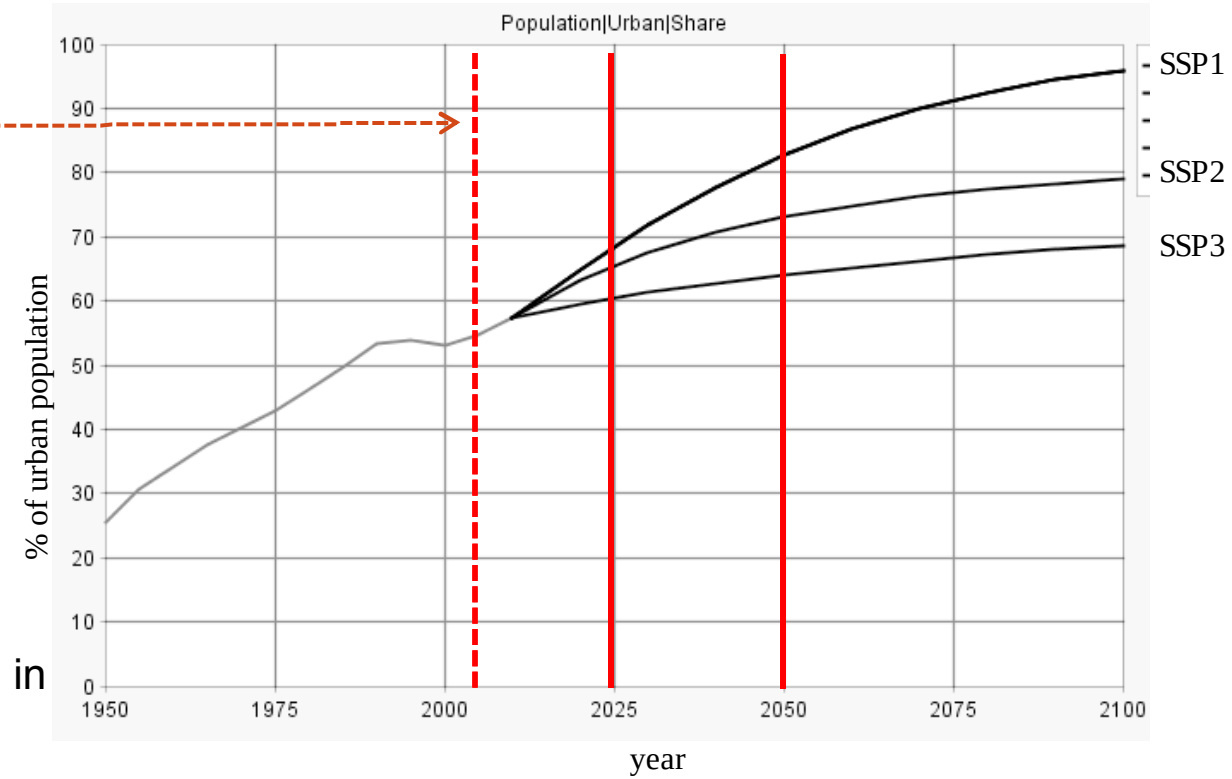


A model of causal relationships of land use/cover changes in the areas

Scenarios

- Scenarios: “If future development results in specified changes, how might this lead to changes in the land use pattern?”
- Shared Socio-economic Pathways (Kriegler et al. 2010)
- Qualitative narrative storylines (stakeholders and other researchers on the project)
- Quantification of scenarios (land use requirements)

Italy 45 m^2/person
Romania 17.5 m^2/person



Projection of urban population in Romania (IIASA 2012)

Scenarios

- **Sustainability:** Lower fossil fuel dependency, inequality reduction, environmental friendly economy, strict and successful policy implementation

→ No urbanization on risk areas, no deforestation, maintenance of open areas

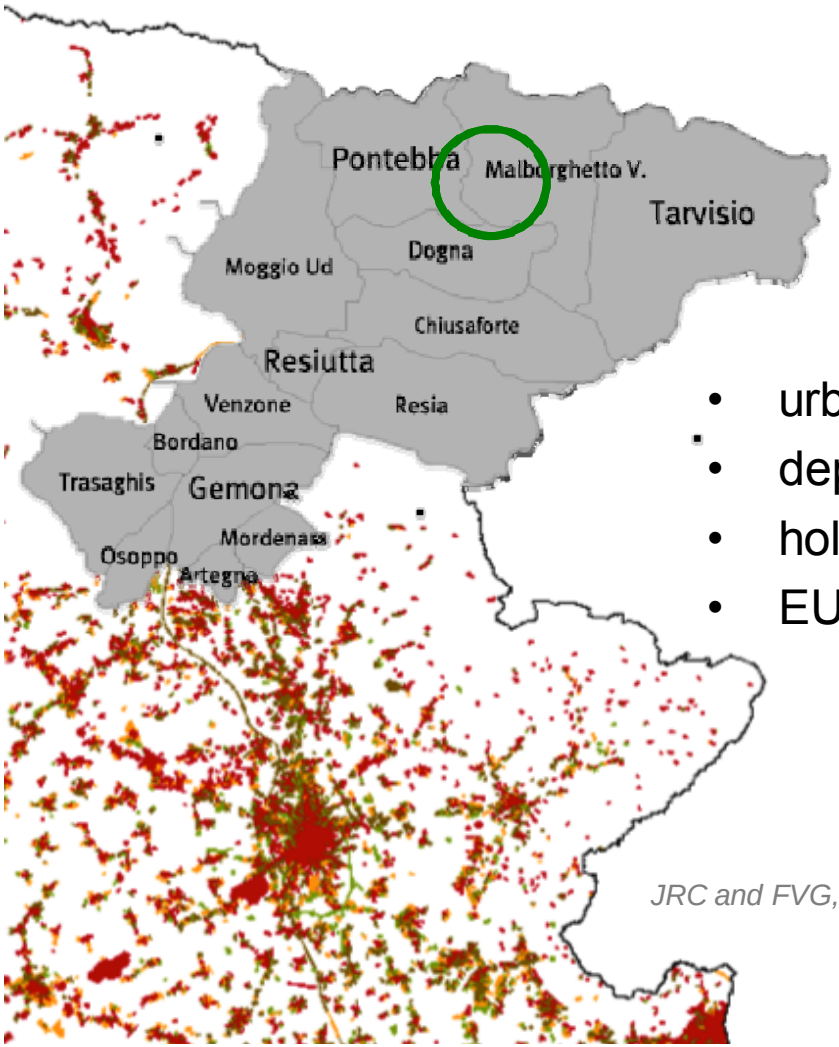
- **Fragmentation:** localization, poverty increase, poor collaboration between economies, restriction in trade, lack of planning and policy

→ Unregulated urbanization, unregulated forestry, loss of open areas

- **Inequality:** effective globalization for the developed, policy concerning the population ineffective, lead by global energy corporations

→ Regulated urbanization in accessible areas, unregulated in remote ones, deforestation in remote areas

Case study perspective: Italy



JRC and FVG, 2000

Google Earth, 2012

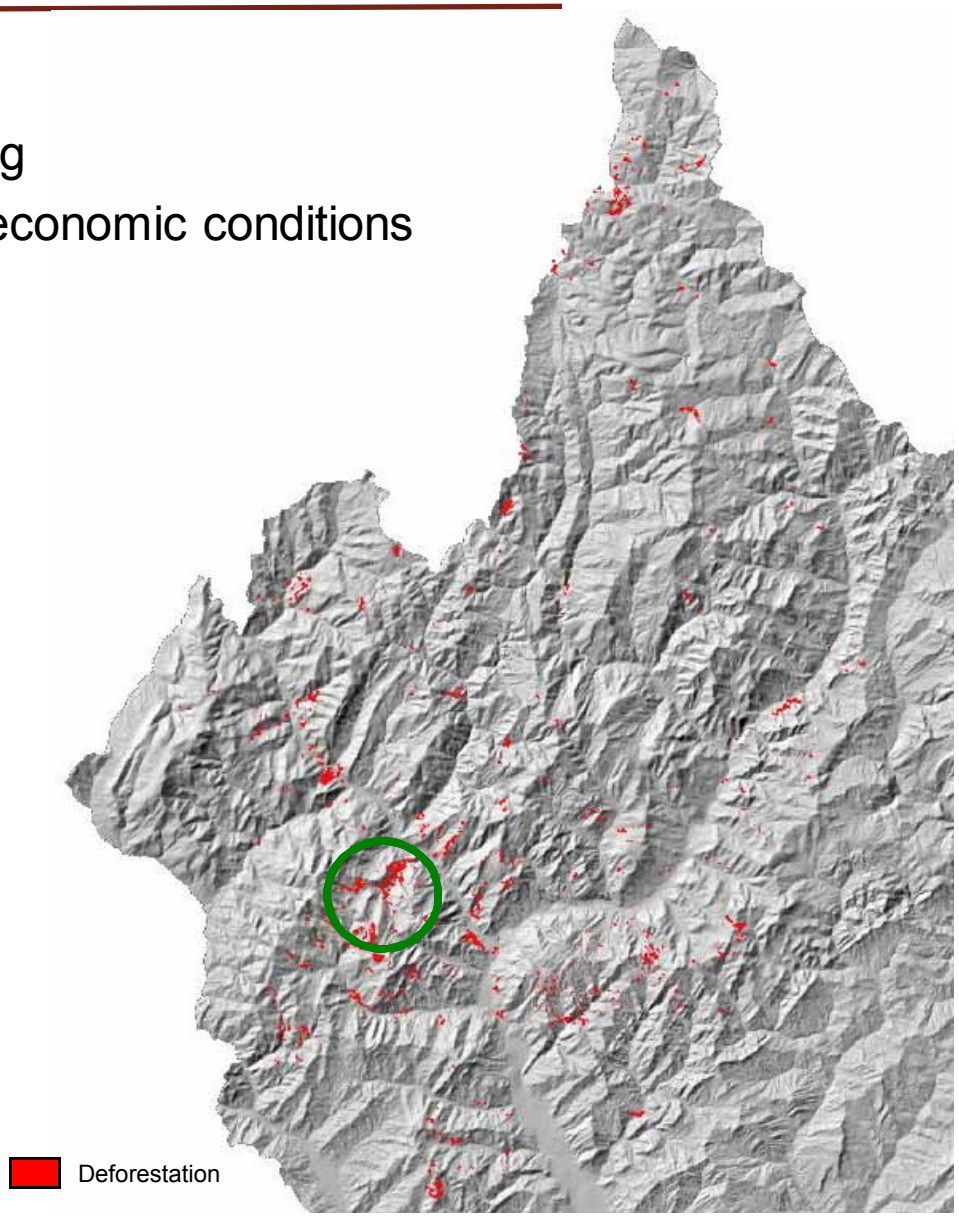
- urbanization of high risk areas
- depopulation
- holiday homes
- EU expansion, Schengen?

Protezione Civile, FVG, 2011

Case study perspective: Romania

- reforestation and abandonment
- vs. deforestation and subsistence farming
- land ownership reforms and poor socio-economic conditions
- breakdown of local industry
- depopulation
- illegal logging, clear-cuts

Micu 2011



Expected innovations

- Analysing past land use changes by **exploring relationships** and use them to build future scenarios
- **"Before and after"** effects of land use changes: hydro-meteorological hazards
- **New set of scenarios** of global change (based on RCP & SSPs)
- Stakeholders: which land use management **options** are **preferable** in terms of consequences
- **Comparative** approach

ESR 05:

Quantifying uncertainties in vulnerability assessment of infrastructure, buildings and land use to hydro-meteorological hazards

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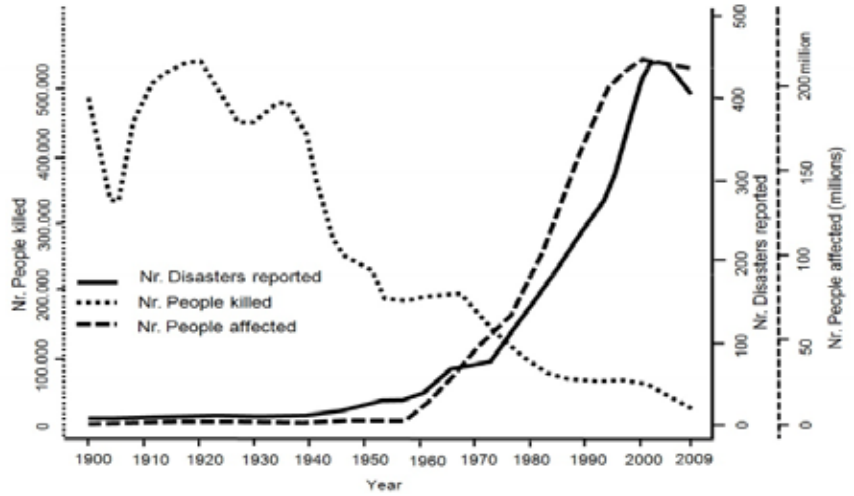
Vulnerability assessment within QRA



Natural disaster summary 1900 – 2010 (Source: EM-DAT, CRED, 2010)

The underlying characteristics of the environment and society makes them susceptible to damage and losses

→ Role of vulnerability in determining hazard risk levels

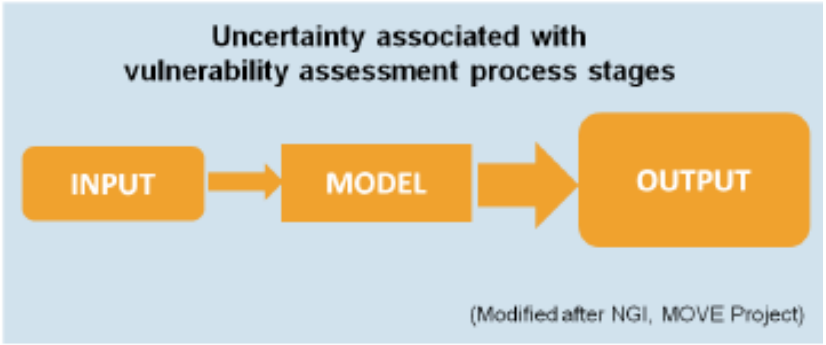
Challenge:
Address vulnerability to natural hazards in an environmental (incl. climate) and socio-economic changing context

Uncertainty in vulnerability assessment

Vulnerability – multi-dimensional, scale-dependant, site-specific, dynamic (Vogel and O'Brien (2004)

→ Physical and socio-economic dimensions of vulnerability

Uncertainty analysis:



- enhances communication between various stakeholders
- supports decision making for better risk management
- helps dealing with future (global) change

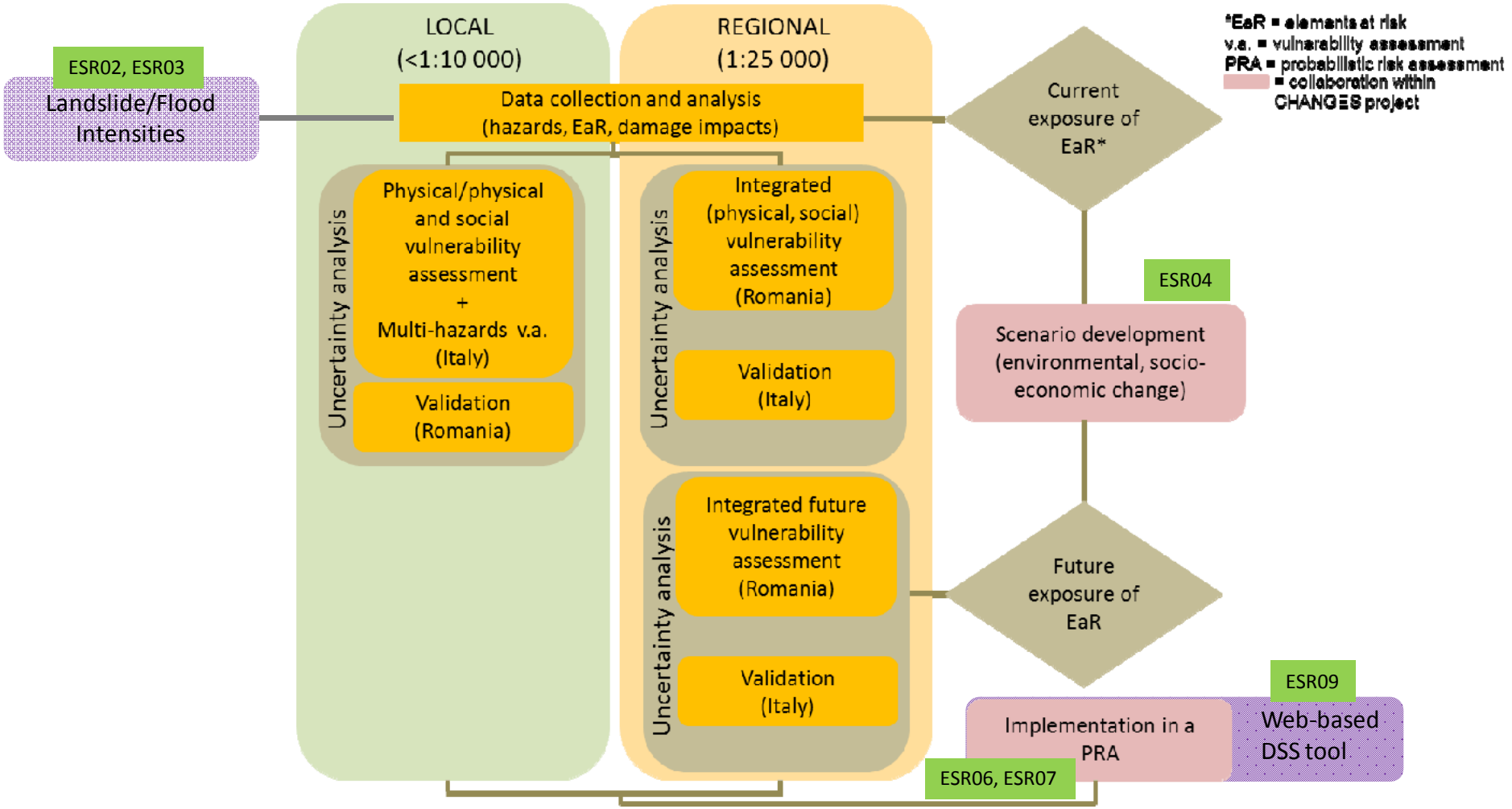
Objectives

- To estimate uncertainty in vulnerability and value of different elements at risk exposed to hydro-meteorological hazards

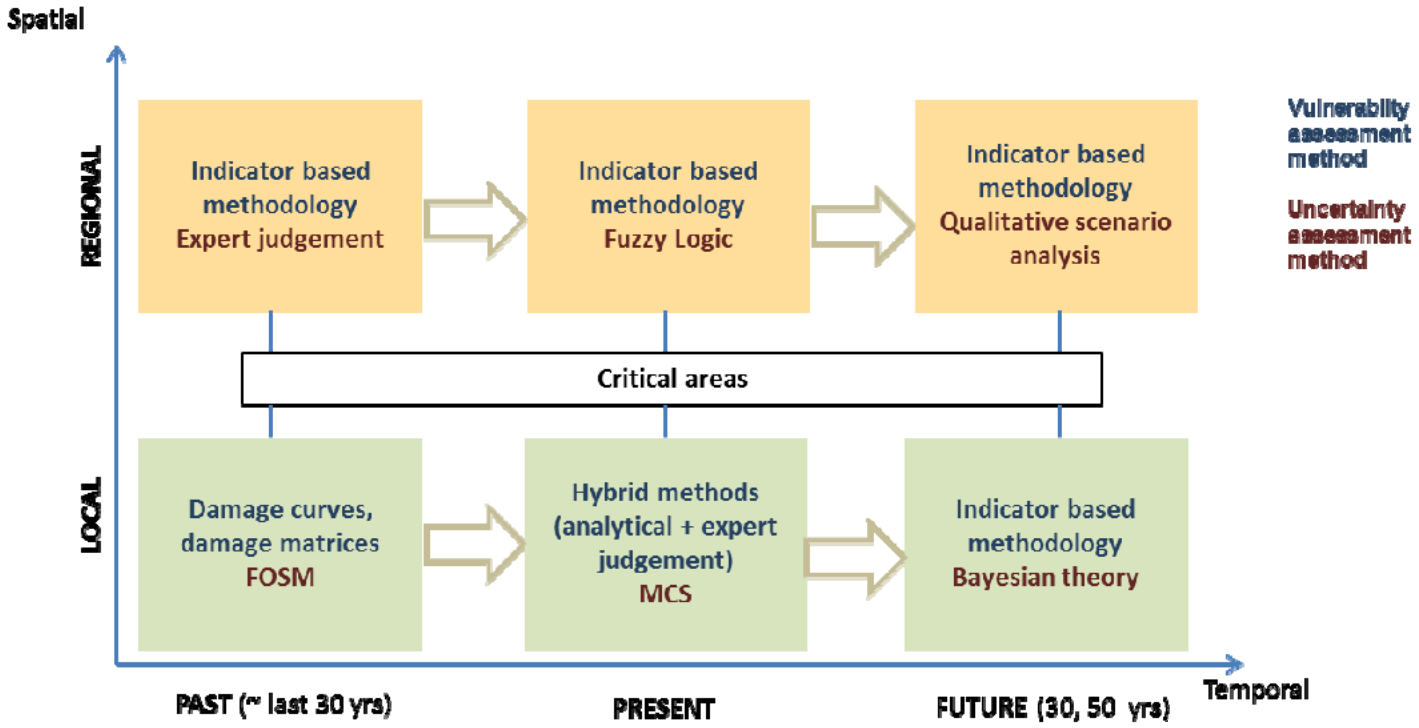
- To develop and validate the methodology of vulnerability assessment and associated uncertainty in two case study areas, at local and regional scale

- To evaluate the changes in exposed elements at risk and their vulnerability based on projections of future global change (environmental - including climatic changes, as well as changes in socio–economic development) considered within the CHANGES project

Methodology (1/2)



Methodology (2/2)



- **Elements at risk**: infrastructure (transportation), buildings, land cover, population
- **Hazards**: (slides, debris flows, rock falls) and floods (incl. flash-floods)

Case studies

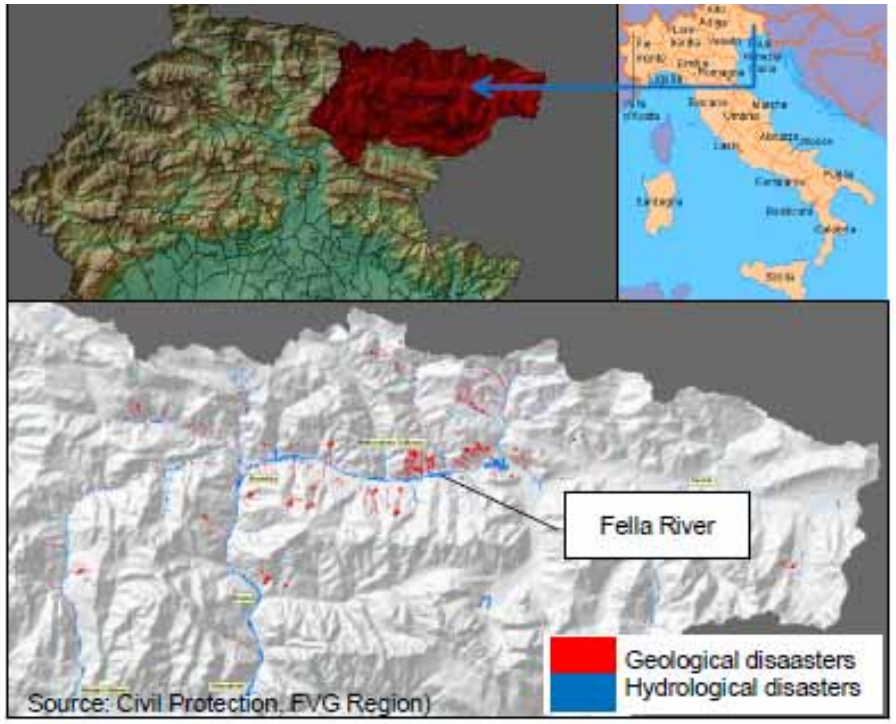
Friuli-Venezia-Giulia (NE Italy)

Regional: Fella River basin (706 km²)
Local: Malborghetto-Ugovizza, Pontebba

Geographic setting:
- alpine area
- precipitation regime: > 2000 mm/yr (intensive and erosive showers)
- forests cover > 70% area

Hazards:
- floods (e.g. catastrophic event August 2003)
- debris flows

Socio-economics:
- sparsely populated area (<15 pers/ km²)
- developed region (infrastructure)



(Source: Civil Protection, FVG Region)

Case studies

Buzău County (SE Romania)

Regional: Carpathian and Subcarpathian area (~ 3000 km²)

Local: Nehoiu, Patîrlagele, Siriu, Chirleşti

Geographic setting:

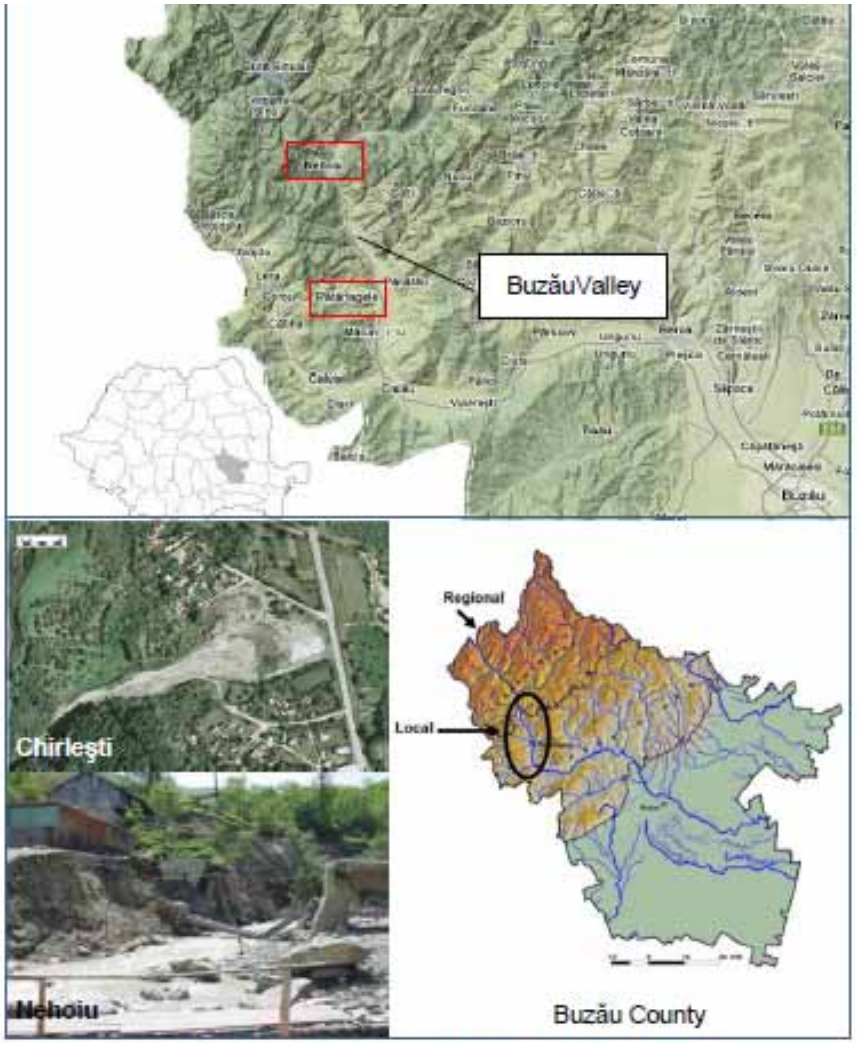
- mountainous and hilly area (complex lithology)
- precipitation regime: 500 -1000 mm/yr (large variability, torrential rainfalls)
- forests cover > 70% area

Hazards:

- flash floods (e.g. events 2004, 2005)
- deep seated-, shallow slides, debris flows, rock falls

Socio-economics:

- populated area (90 – 150 pers/ km²)
- developing region



Source: Institute of Geography (Romanian Academy)

Key innovations and links

- Uncertainty in vulnerability assessment
- Integrated methodology of vulnerability assessment
- Vulnerability within a dynamic (spatial and temporal) environmental (incl. climatic) and socio - economic context

- ESR04, ESR07, ESR09

Direct outputs:

→ Regional scale - vulnerability maps incl. uncertainties (floods, landslides)

→ Local scale – vulnerability/damage curves, maps incl. uncertainties (floods, landslides)

→ Future vulnerability / exposure of elements at risk

→ Vulnerability assessment for multi-hazards

First results

Phase 1: Elaboration of the research plan, data collection and analysis. Stage 1.4: Data mining and analysis

Inventory of elements at risk database development (elements at risk, damages) in Romania (regional, local) – collaboration with ESR04, ESR07, MSc ITC

Source	Data type
Statistical County Direction	Population and residences census (2002 – commune level); population and residence census (2011 – county level); statistical directory 2004, 2011; locality sheet 1990, 2000, 2010 (commune level); demographic sheet 2000 – 2005 (per commune)
County Agriculture Direction	Land distribution and type per locality for 2010 and 2011 (commune level) without property distribution per type of owner
Office for Cadastre and Land Registration	Statistical Situation of Terrains (SSTs) only for 2001; land distribution and type per locality (commune level) without property distribution per type of owner for 1990
County Council	Buzău County tourism and agro-tourism development strategy (2010 – 2015); Buzău County (socio-economic) sustainable development plan (2007 – 2013)
Nehoiu local authorities (town hall – spatial planning office, volunteer service)	Social investigation (persons affected by 2005 flash flood); registration forms and documentation for hydro-meteorological hazards in 2005, 2006, 2010 (from Local Committee for Emergency Situations); geotechnical reports for building construction; hydro-technical feasibility report along Nehoiu Valley (2010); General Urbanistic Plan – Nehoiu
Nehoiu Library, NGOs	Archive documents, photos, references, newspaper articles, etc.
Field work in Nehoiu Valley	Inventory of elements at risk (bridges, buildings, hydro-works, roads) with classification, type, location (gps); partial landslide inventory (location, size, date of occurrence); flash flood extension and water height (in random locations)

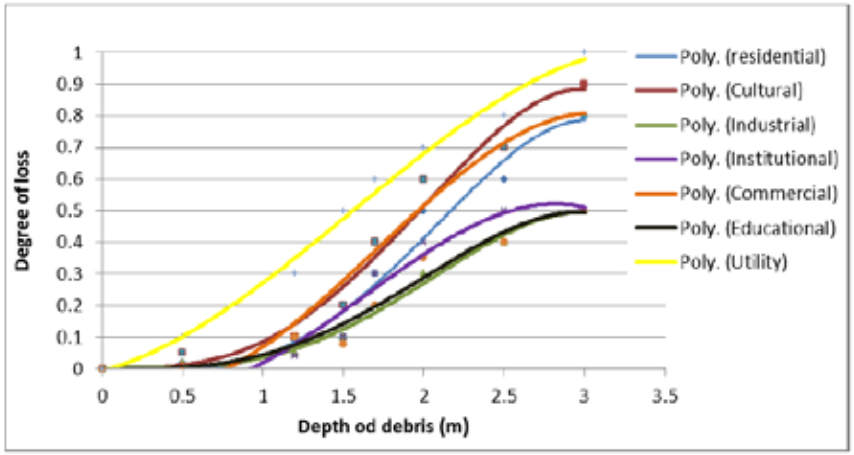
Development of a reporting protocol for hydro-meteorological hazards in Romania – event and consequence documentation (Type A: Disaster managers - Emergency Situation Inspectorate, Buzau; Type B: Hazard and risk experts)

First results

Phase 1: Elaboration of the research plan, data collection and analysis. Stage 1.4: Data mining and analysis

Preliminary analysis of physical vulnerability of buildings to landslides (Nehoiu catchment, Romania)

Date	Type	Area (m^2)	Depth of material (m)
09.07.2010	Landslide	-	2.5
21.05.2010	Landslide	-	3
19.05.2005	Earth slide	-	1.7
19.05.2005	Landslide	-	2.
19.05.2005	Earth slide	-	0.5
24.03.2007	Landslide	-	1.2
15.07.2004	Landslide	-	1.5



Vulnerability functions for different types of buildings

Type	Description	Vulnerability
Residential	Single or multiple unit houses, group of apartments, hotels, motels and boarding houses, one or two dwelling units	0.8
Commercial	Department stores, grocery stores, portions of shopping centers, and any other place designed for the display and sale of merchandise	0.6
Industrial	Factories, power plants, etc.	0.4
Institutional	Public institutions buildings (e.g. town halls, police sections, hospitals, nursing homes, ambulatory health care centers, prisons and jails, adult day care or child care, etc.)	0.3
Cultural	Churches, museums, monasteries, cultural centers, etc.	0.6.
Educational	Elementary schools, middle or junior high schools, high schools, kindergartens, universities, etc	0.3
Utility and Miscellaneous Occupancy	Barns, carports, garages, greenhouses, storage buildings, etc.	0.9

Work in progress

- Improve and validate the vulnerability curves for landslides; create vulnerability curves for floods
- Integration of data (elements at risk) and vulnerability curves in the web-GIS platform as a part of the internet based DSS
- Vulnerability assessment at regional scale (colab. with ESR07 – risk assessment at regional scale)

Conclusions

- (TA-2.1) Assessment of the current vulnerability situation based on historical developments.
  - Submitted the report
- *(TA-2.2) Analysis of expected changes in ecosystems and land use patterns in relation to global change and future socio-economic development.*
  - *Analysing past land use changes by exploring relationships and use them to build future scenarios*
  - *“Before and after” effects of land use changes: hydro-meteorological hazards*
  - *New set of scenarios of global change (based on RSP & SSPs)*
  - *Stakeholders: which land use management options are preferable in terms of consequences*
  - *Comparative approach*

Conclusions

- (TA-2.3) Expressing uncertainties in vulnerability and value of infrastructure, buildings and land use to hydro-meteorological hazards focussing on both physical vulnerability as well as societal vulnerability approach in order to obtain a holistic approach.
  - Uncertainty in vulnerability assessment
  - Integrated methodology of vulnerability assessment
  - Vulnerability within a dynamic (spatial and temporal) environmental (incl. climatic) and socio - economic context

Thanks for your attention!

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