Mid-term meeting
Dortmund, 27-29 November 2012

WP3
Development of a probabilistic risk assessment platform

or: *how to join loose ends*

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ESRs: **Haydar Hussin, Veronica Zumpano**

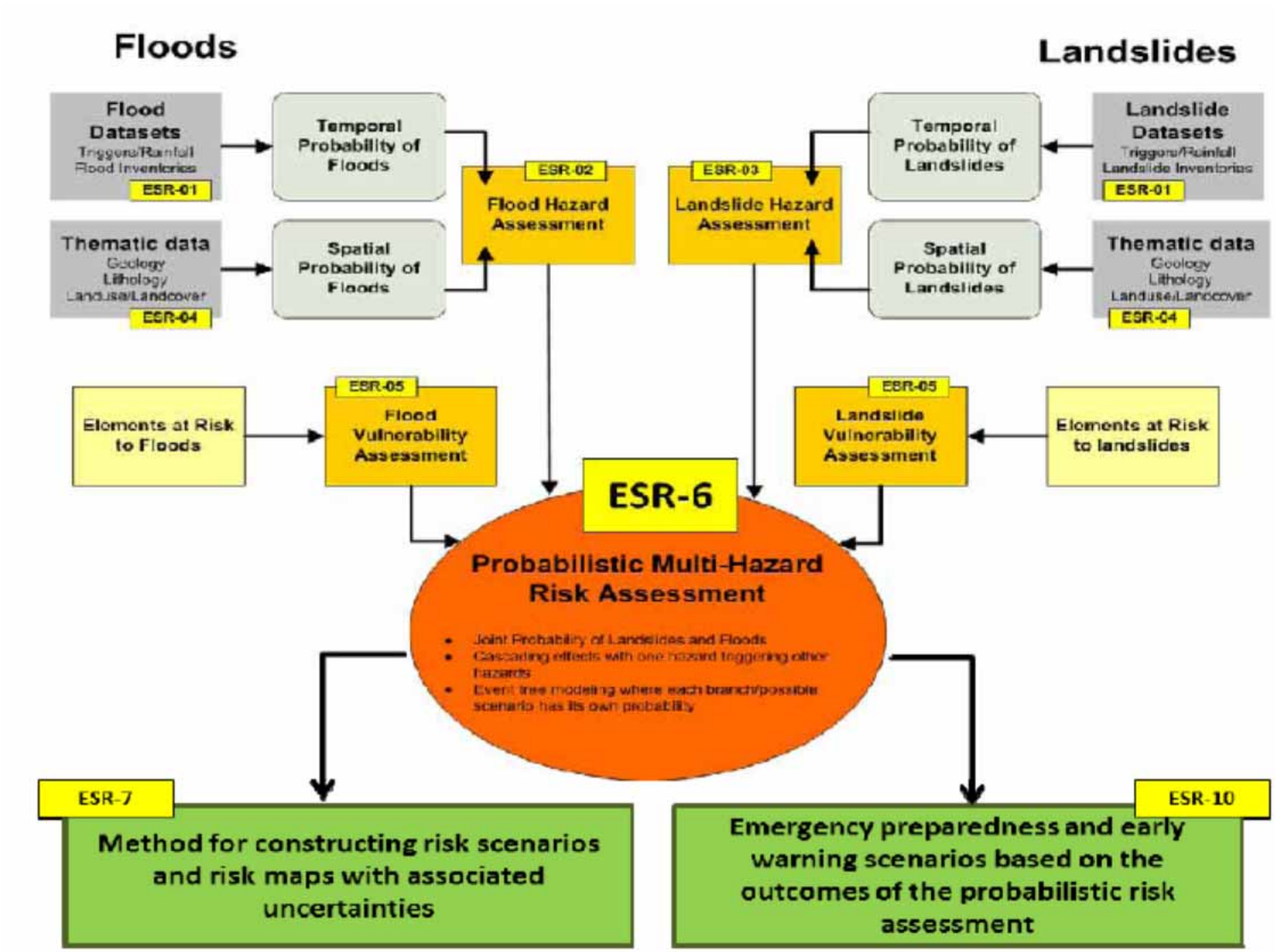
content

- WP3 – objectives, achievements
  Peter Zeil, Paola Reichenbach
- TA-3.1 - inventory on tools/software for risk assessment
  Haydar Hussin
- TA 3.2 - tool for probabilistic risk assessment
  Haydar Hussin
- TA 3.4 - risk scenarios
  Veronica Zumpano
- WP3 – challenges
  Peter Zeil, Paola Reichenbach
- conclusions

objectives

- integrate techniques for probabilistic hazard assessment (<- WP1) with
- the uncertainty due to future environmental changes, and society concerns (<- WP2), and
- resulting exposure and vulnerability from the analysis of WP2,
- to develop a platform for Quantitative Risk Assessment (QRA),
- to facilitate the evaluation of risk scenarios, and
- improve emergency preparedness and early warning

workflow


Floods
Landslides
Flood Datasets
Triggers/Rainfall
Flood Inventories
ESR-01
Temporal Probability of Floods
ESR-02
Flood Hazard Assessment
ESR-03
Landslide Hazard Assessment
Temporal Probability of Landslides
Landslide Datasets
Triggers/Rainfall
Landslide Inventories
ESR-01
Thematic data
Geology
Lithology
Landuse/Landcover
ESR-04
Spatial Probability of Floods
Spatial Probability of Landslides
Thematic data
Geology
Lithology
Landuse/Landcover
ESR-04
Elements at Risk to Floods
ESR-05
Flood Vulnerability Assessment
ESR-05
Landslide Vulnerability Assessment
Elements at Risk to landslides
ESR-6
Probabilistic Multi-Hazard Risk Assessment
Joint Probability of Landslides and Floods
Cascading effects with one hazard triggering other hazards
Event tree modeling where each branch/possible scenario has its own probability
ESR-7
Method for constructing risk scenarios and risk maps with associated uncertainties
ESR-10
Emergency preparedness and early warning scenarios based on the outcomes of the probabilistic risk assessment

achievements

- An Inventory of software tools for probabilistic risk assessment and their applicability in a European context has been compiled (D3.1)
- A course on “”Probabilistic risk assessment” has been organized in Stryszawa (Krakow, Poland), 22-23 September 2011.
- Sharing of knowledge & expertise: ESR06 and ESR07 have relevant exchanges and discussions with ESR01, ESR02 and ESR03 (WP1) and ESR04 and ESR05 (WP2) and ESR10.
- Visits field test sites:
  - September 21th, 2011 (Wieprzówka catchment, Poland)
  - March 31st to April 4th, 2012 (Friuli-Venezia-Giulia region, Italy)
  - Sept 17th to Sept 19th, 2012 (Buzău County, Romania)

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WP-3 deliverable TA-3.1

ESR-06
Haydar Hussin
Consiglio Nazionale delle Ricerche, Italy
CNR-IRPI

WP-3 deliverable TA-3.1

An inventory report on tools and software for risk assessment of hydro-meteorological hazards

Criteria and considerations for the inventory:

- Hazard and Risk definition
- Consideration of Risk Components
- Specific or non-specific for natural hazards
- Type of natural hazards
- Flexibility
- Advantages/Disadvantages
- Transparency of the methodology
- Open source/platform or commercially available?
- Can the tools be used in Europe?

WP-3 deliverable TA-3.1

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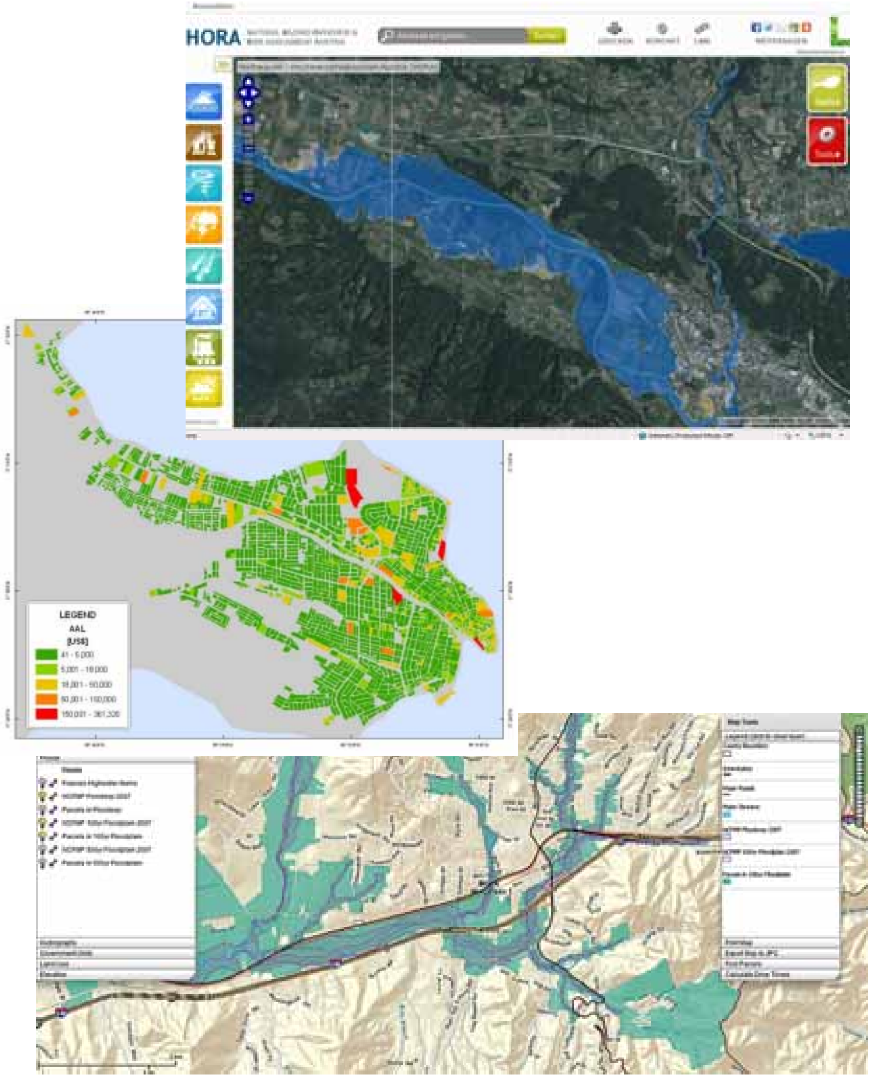
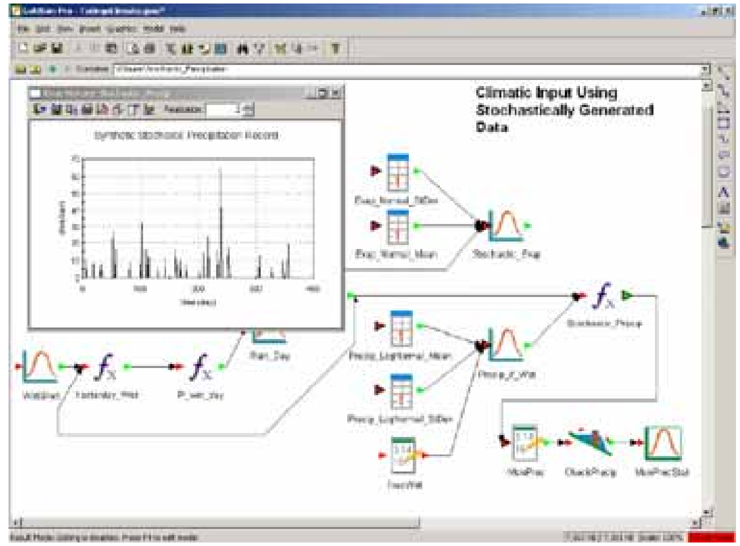
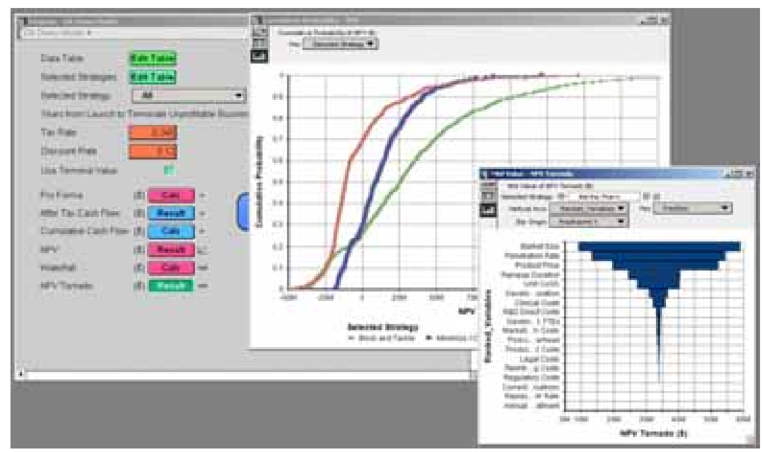
Single and Multi-Hazard Risk Assessment tools



Non-GIS/Hazard specific risk software





WP-3 deliverable TA-3.1

Tool / software name:
PerilAUS
Developed by (reference):
Risk Frontiers (Frontiers, 2012)
http://www.riskfrontiers.com/perilaus.htm

Inputs:
Spatial and historic data on past events
Outputs:
Maps of hazard and damage

Hazard:
Definition of hazard (type of hazard):
Bushfires, floods, landslides.....

Frequency assumption/consideration of past events:
Catalog of past events (qualitative)

Multi-hazard treated separately or jointly:
Only visualization, no joint probabilities

Risk/Vulnerability:
No vulnerability assessment
Elements at risk based on postal code

Flexibility:
Scale of tool:
Historic events and qualitative risk based on local to regional levels of counties and their postal codes

Applicability to Europe:
Historic events only for Australia

Final Expert Judgment:
Usefulness:
For planners and experts to assess most probable hazardous events in a qualitative manner

Transparency:
Access is available to temporal catalog and historic events

State of the art:
Good Visualization, and catalog constantly updated

Uncertainty Assumptions:
How good is the historic catalog?...this depends on the expert that compiled and inputted the data

WP-3 deliverable TA-3.1

Tool/Software	Specific for	Single or Multi	Type of Risk	Main advantages	Main disadvantages
CAPRA-GIS	Yes	Multi	Quantitative	• Full-scale probabilistic risk assessment • Loss estimation for each element at risk	• Hazard and vulnerability modules are for South-America • Simplified models for landslide and flood hazard
Gold…					…ssment …nnot be …ility …th- …ide …tly
Hazu…				assessment with uncertainty and loss estimation	…or Europe.
Hora	Yes	Single	Qualitative	• Very simple to understand for any type of user • Can be accessed through the internet through a web-GIS	• Not an actual risk assessment, but a flood zonation visualization • Very generalized and not for a local detailed scale
RiskScape	Yes	Multi	Quantitative	• Detailed focus on elements at risk and vulnerability assessment • Calculates loss estimation	• Originally developed for New Zealand and losses given in NZ dollars • Visualization options are limited

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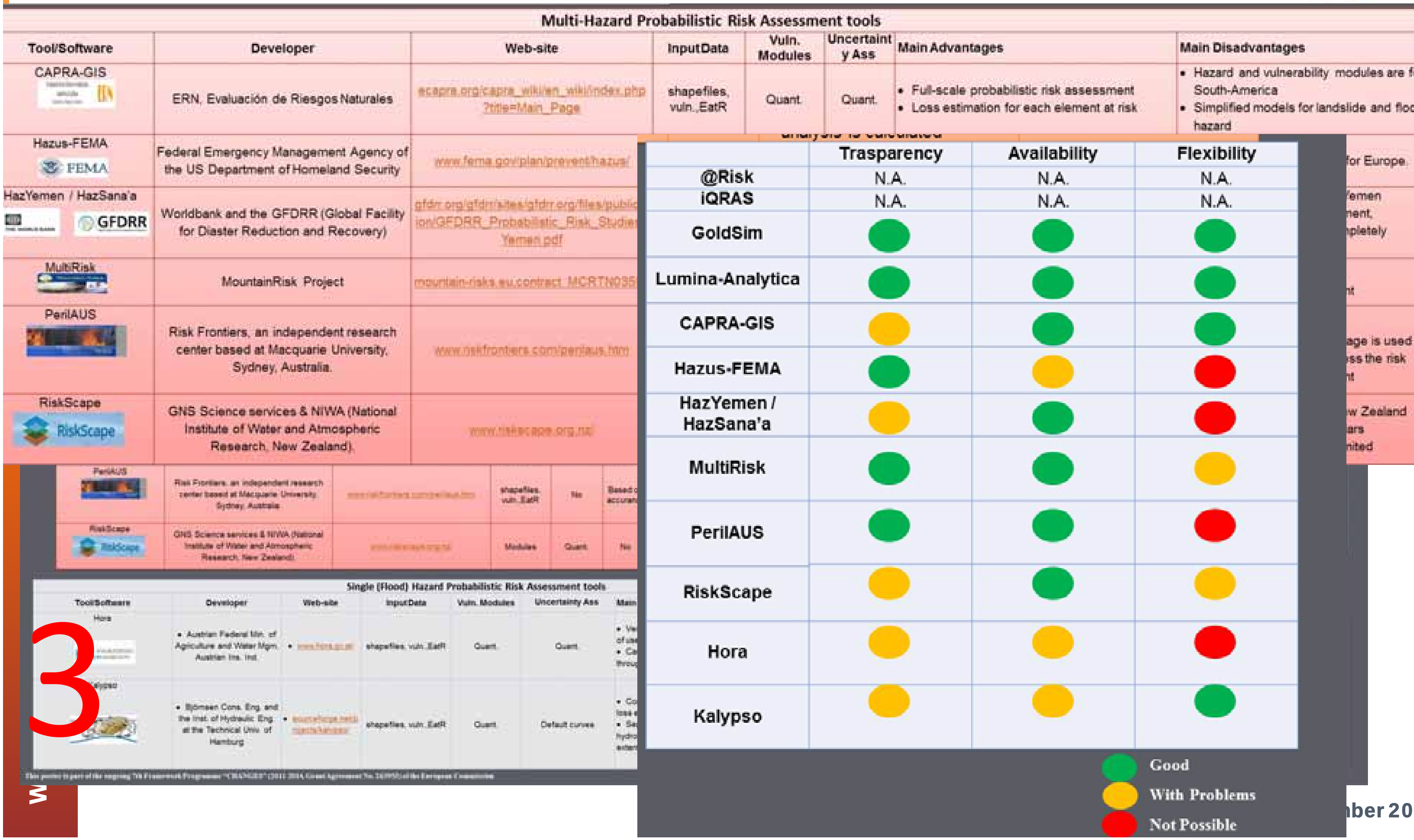
WP-3 deliverable TA-3.1

Conclusions:

- 9 tools (+ 2 non-GIS/Hazard specific) assess hydro-meteorological hazards
- Some are qualitative and can only be applied to certain regions (e.g. South-America, Australia), with 4 tools are able to be used for Europe
- Only 3 tools are truly probabilistic that quantify risk and include uncertainty
- Hazards are treated independently
- Future changes and scenarios are not explicitly assessed

WP-3 deliverable TA-3.1

Exploring probabilistic tools for the development of a platform for Quantitative Risk Assessment (QRA) of hydro-meteorological hazards in Europe



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ESR-06 progress presentation

ESR-06
Haydar Hussin
Consiglio Nazionale delle Ricerche, Italy
CNR-IRPI

ESR-06 progress report

Probabilistic risk assessment of hydro-meteorological hazards in Europe

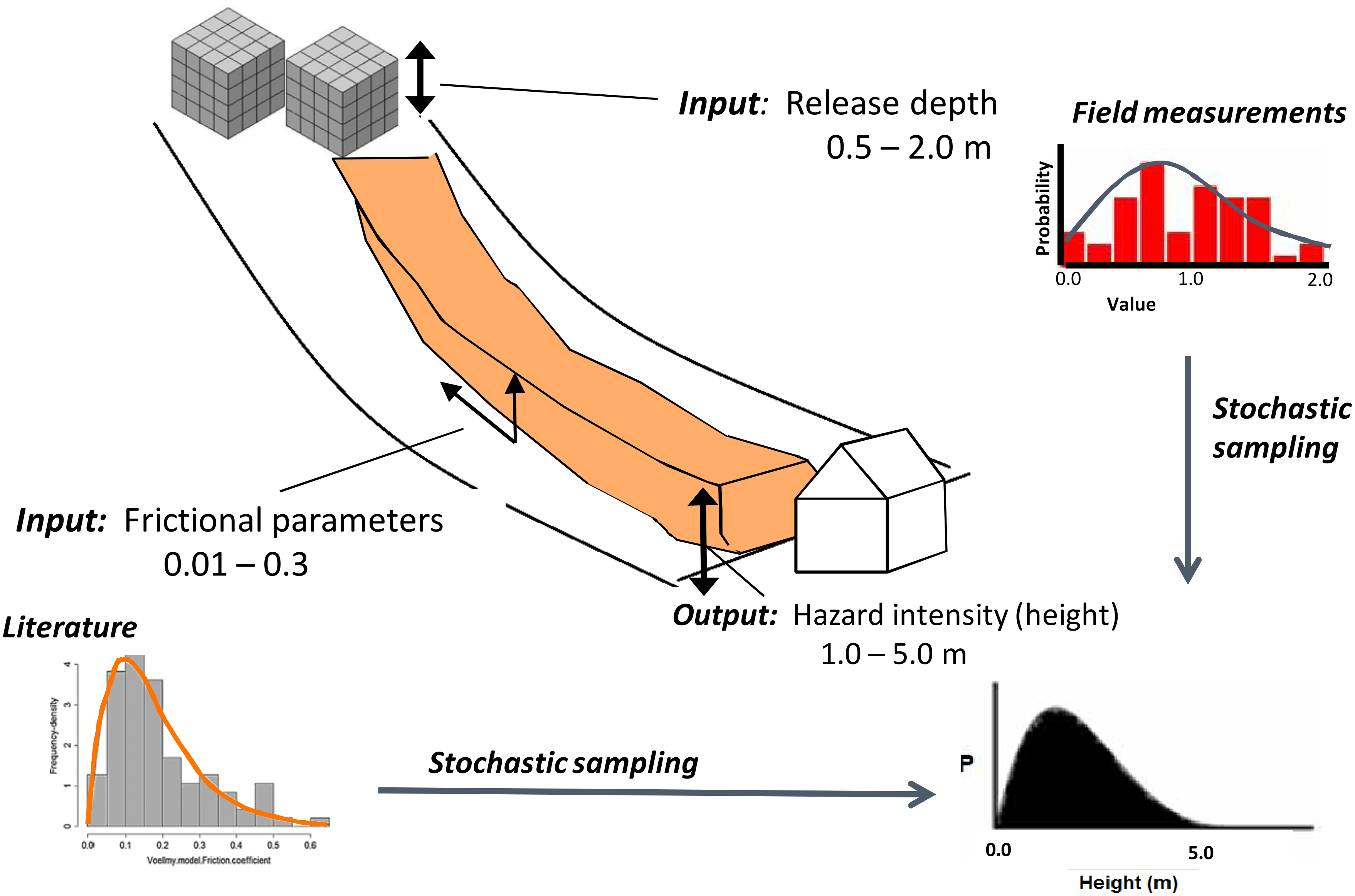
Main objective:

To apply, assess and improve the use of probabilistic methods for the quantitative risk assessment of local hydro-meteorological hazards (landslides and floods), focusing on the analysis and quantification of uncertainty in the estimation of direct losses.

- Not one single methodology for probabilistic risk assessment of hydro-meteorological hazards.
- Important to study different statistical and deterministic approaches to adapt them to probabilistic methods.
- Better understanding of the use of probabilistic risk and its advantages for evaluating direct losses from landslides and floods in mountain areas.

Practical example of probabilistic uncertainty

Run-out model for landslides, uncertainty inputs → uncertainty output



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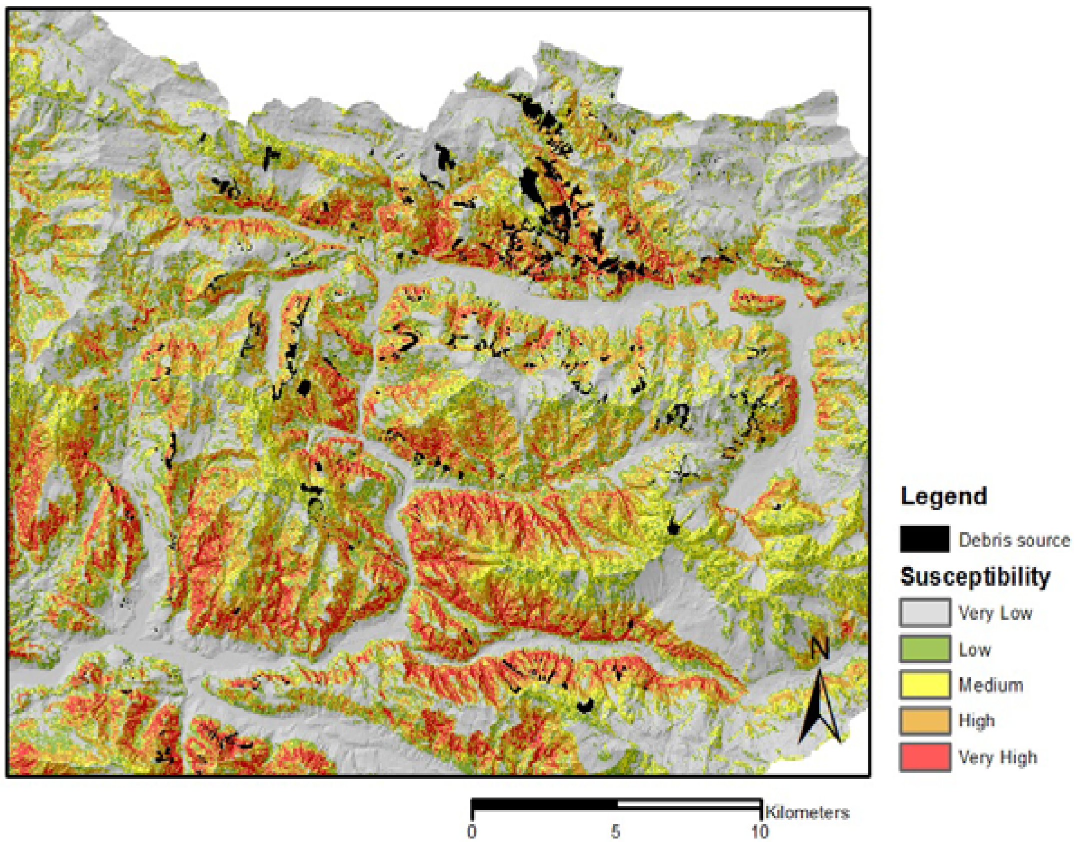
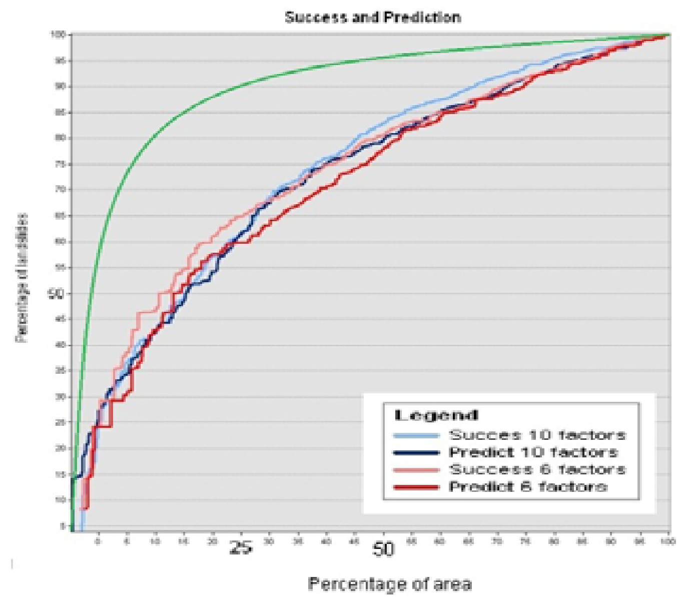
Landslide Susceptibility Assessment for spatial probability and input for medium scale run-out models

- **Fella River case study area in Italy**

- Data gathering and analysis (maps and landslide inventories)
- Bayesian Bivariate statistical model (Weights of Evidence)

- Work is in progress and prediction rate needs to be increased

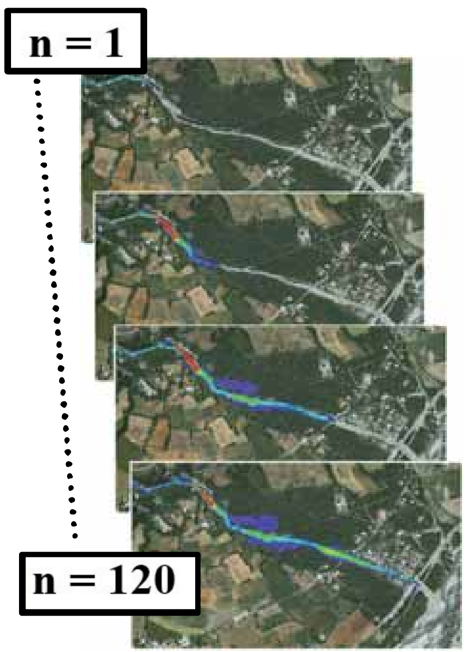




Factors	Map classes	Source density
Slope (°)	0-12	4.46362E-05
Lowest classes	12-21	6.91883E-05
	47-55	0.000909634
Highest classes	55-88	0.001117702
Landuse	Natural pasture	0.000427184
Lowest classes	Heath and scrubs	0.00133787
	Sparse vegetation	0.010385384
Highest classes	grasland	0.01327986
Internal relief (m/ha)	0-30	2.83627E-05
Lowest classes	30-47	8.85567E-05
	98-113	0.000833036
Highest classes	113-139	0.001093165
Geology	Sandstone and mudstones	2.1754E-05
Lowest classes	Moraines and glacial deposits	7.56924E-05
	Dolomites	0.00074563
Highest classes	Oolitic and bioclastic limestones	0.001424293
Profile curvature (100 m-1)	-1.0 to 0.0	0.000315953
Lowest classes	-3.0 to -1.0	0.000367343
	8.0 to 13.0	0.00134704
Highest classes	5.0 to 8.0	0.001458535

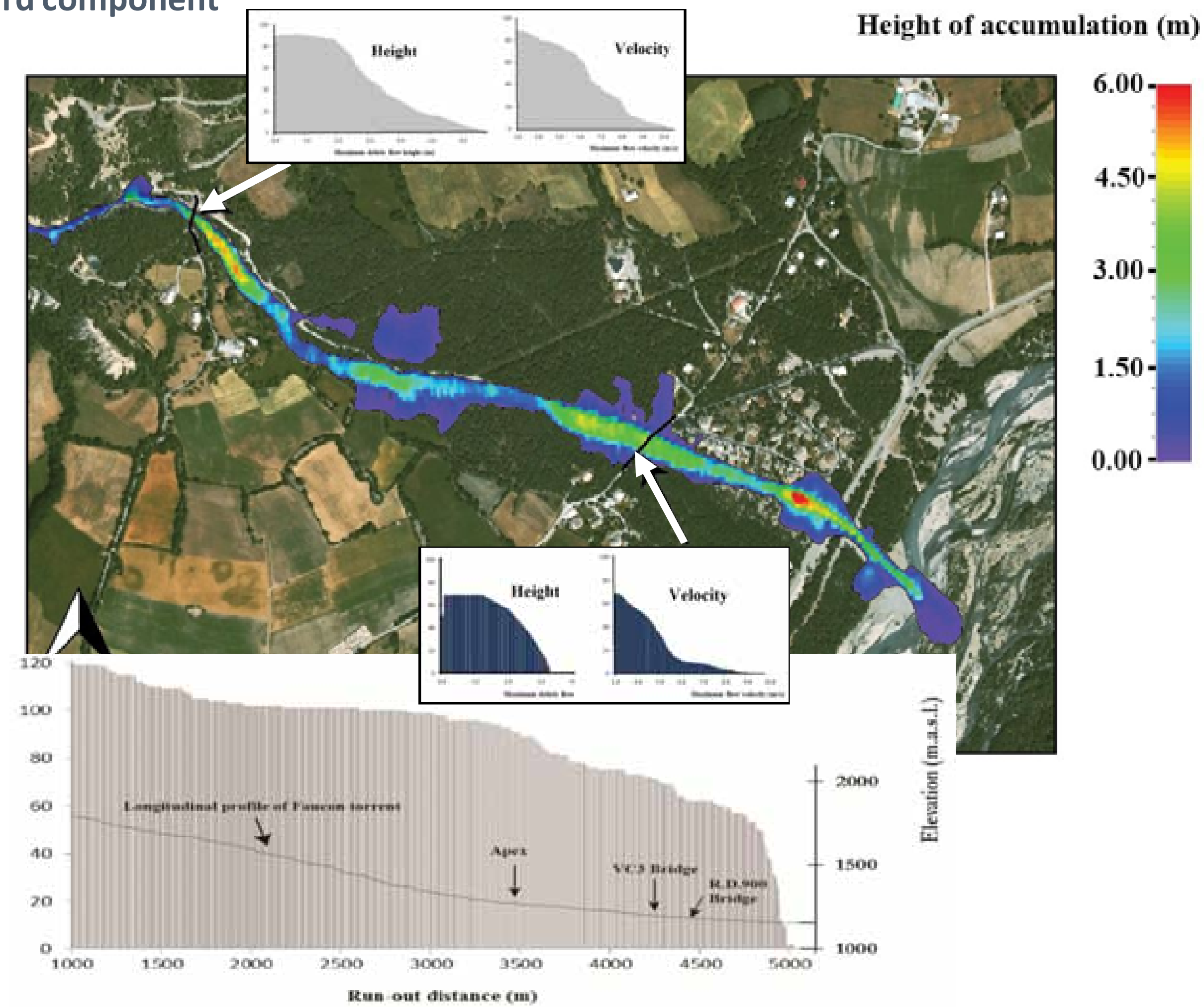
Hazard intensity as a probability distribution (pdf)
Local scale (site specific)

- Output of the hazard assessment and input in the probabilistic risk assessment
- Covers all possible hazard scenarios
- Includes **uncertainty** of the hazard component



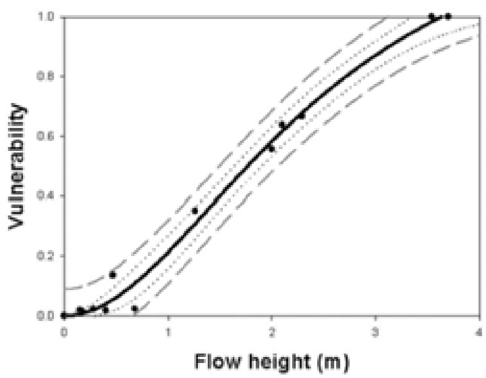
(Hussin et al., 2012)

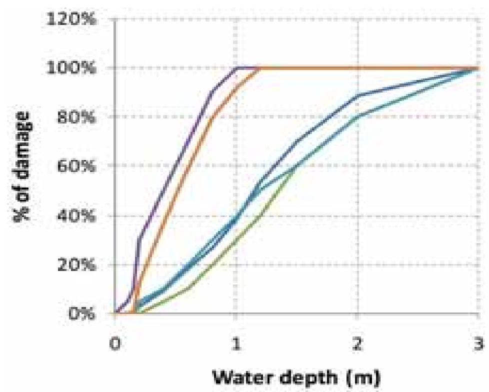
Probabilities



Uncertainty in vulnerability of Alpine hazards (landslides and flash-floods)

- Collecting existing vulnerability functions
- Classification of buildings (structural and occupancy types)
- Uncertainty of the vulnerability must be included in the PRA

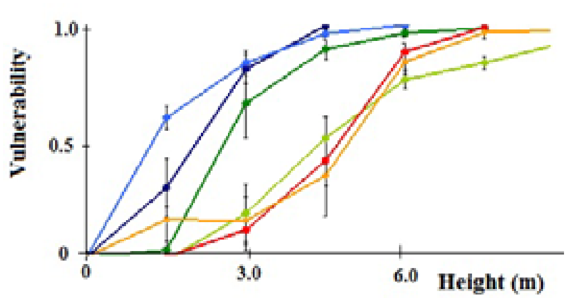




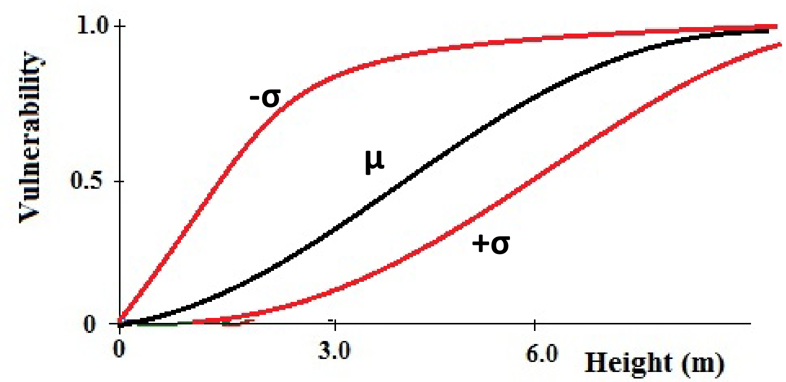
Structural	Type 1	Masonary
	Type 2	Wood
	Type 3	Steel
	Type 4	Mixed

Occupancy	Type 1	House
	Type 2	Storage
	Type 3	Church
	Type 4	Factory

Aggregation



Uncertainty



Literature study:

- **Landslides:**

Hazus (2006), Fuchs et al. (2007); LessLoss (2007), Akbas et al. (2009), Li et al. (2010), Quan Luna et al. (2011)

- **Flash-floods:**

Kelman (2002), Aglan et al. (2004), Hazus (2004, 2006), Scawthorn et al. (2006), Ortiz et al. (2011)

Collaboration with CHANGES Project and ITC:

- Ciurean and Glade (2012)
- Veronica Zumpano
- Rodrigo Lopez Rangel
- Aroshaliny Godfrey

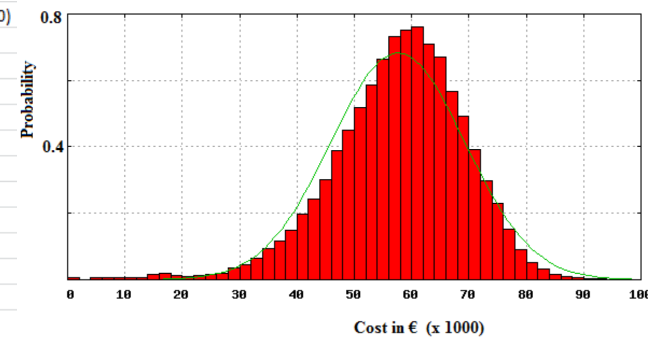
WP3 - Developing a probabilistic risk assessment platform

WP3 - Developing a probabilistic risk assessment platform

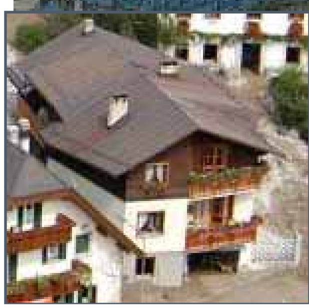
Uncertainty in the replacement cost of elements at risk

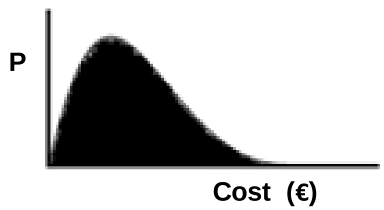
- Uncertainty due to the lack of knowledge of the cost of all buildings and contents
- Classification of buildings (structural and occupancy types)
- Classification of contents (number of floors, rooms and inhabitants)
- Determine monetary value of elements

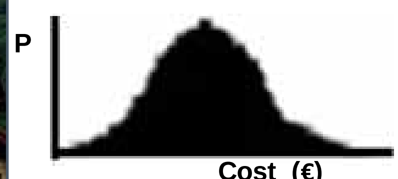
Building occupancy	class	Cost (x1000)
Type 1 (residential)	House	60
Type 1	House	88
Type 1	House	192
Type 1	House	89
Type 1	House	121
Type 1	House	73
Type 1	House	94
Type 1	House	165
Type 2 (Miscellaneous)	Storage	13
Type 2	Storage	9
Type 2	Storage	28



Mean and standard deviations







Estimating value of buildings inside the study area from overall information on costs of specific building types from regional and national databases.

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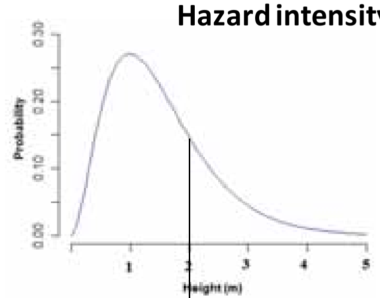
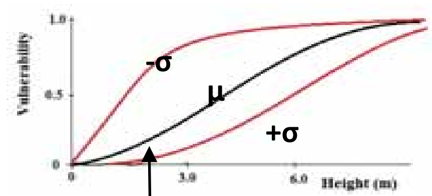
Proposed method for combining uncertainties in the loss estimation

Hazard intensity

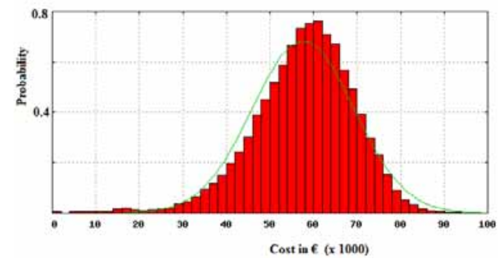


Vulnerability



X

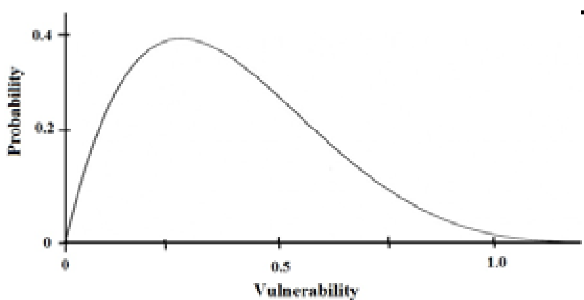
Replacement Cost P(Cost)



Mean and standard deviations

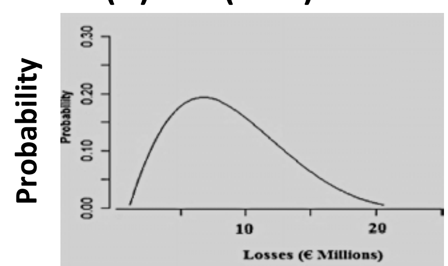
	Vulnerability	Cost	Absoulte damage (h)	Hazard intensity (h)	Loss estimation
-σ	V(h)	€	V(h)* €	h	€
μ	V(h)	€	V(h)* €	h	€
+σ	V(h)	€	V(h)* €	h	€

Probability of damage P(V)



Monte Carlo
(FOSM)

P(V) X P(Cost)

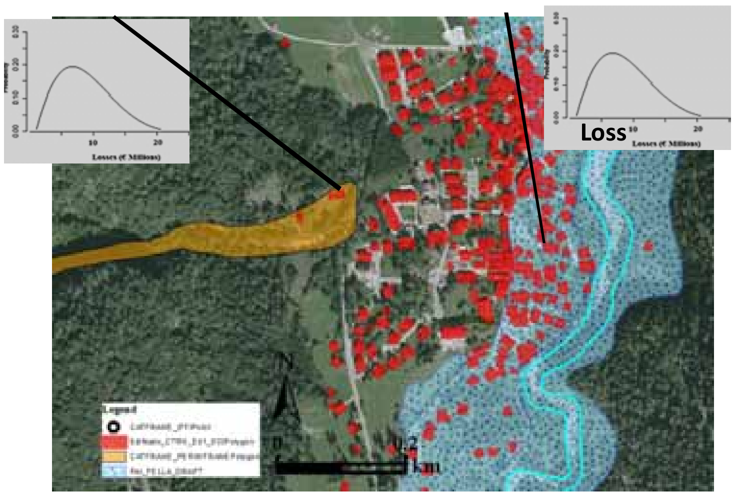


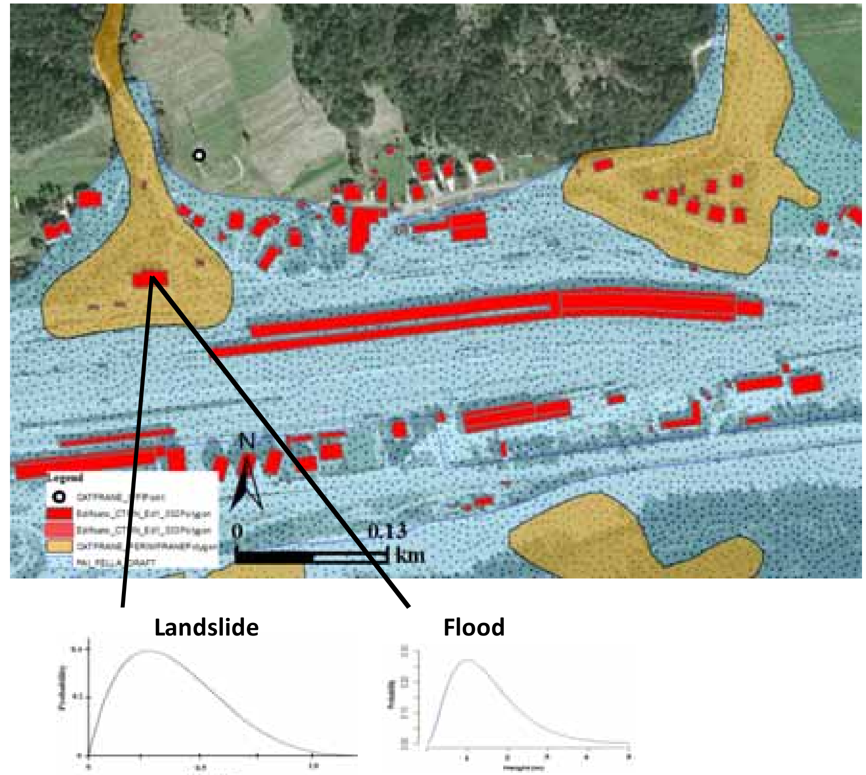
Losses (€)

Single event
(Return Period) !!

Proposed multi-hazard loss estimation

- Landslide and flood occurring at same time (same return period)
- Losses need to be aggregated for the whole unit or area being assessed for total losses
- Overlapping hazards





- **Assuming both losses are independent**

The sum of the loss distributions is the convolution element A and element B

$$A(x) \quad B(y)$$

$$(A*B)(z) = \int_{-\infty}^{+\infty} A(z-y)B(y)dy = \int_{-\infty}^{+\infty} B(z-x)A(x)dx$$

- **Dependent**

The sum is the joint probability of loss of elements A and B

$$f_{A+B}(z) = \int_{-\infty}^{\infty} f_{A,B}(x, z-x)\mathrm{d}x = \int_{-\infty}^{\infty} f_{A,B}(z-y, y)\mathrm{d}y.$$

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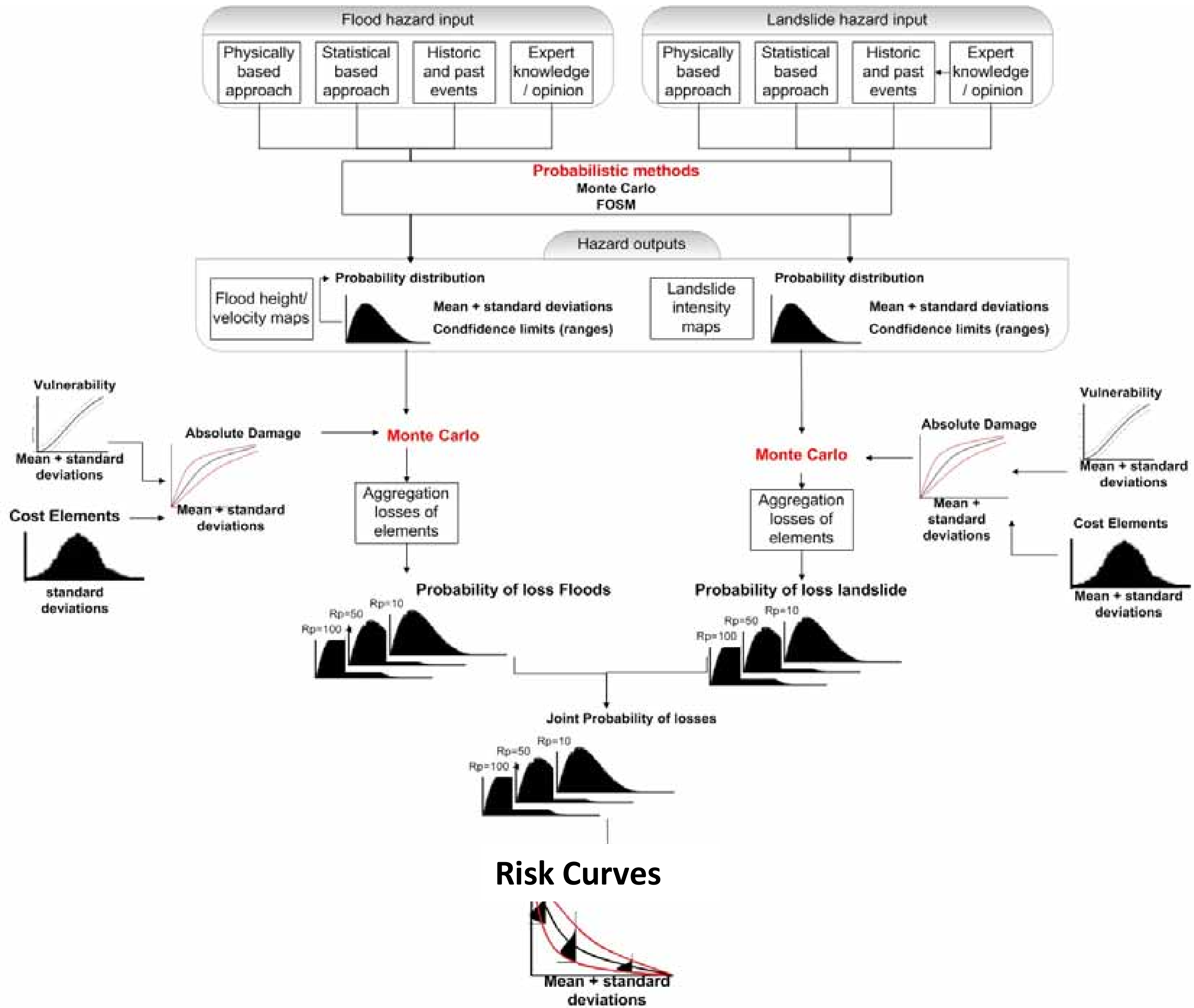

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Thank you

ESR-06
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Consiglio Nazionale delle Ricerche, Italy
CNR-IRPI

Changing Hydro-meteorological Risks
as Analyzed by a New Generation of European Scientists

Mid-term meeting
Dortmund, 27-29 November 2012

Development of a method for constructing risk scenarios and risk maps with associated uncertainties

ESR 07 - Veronica Zumpano
Institute of Geography, Romanian Academy

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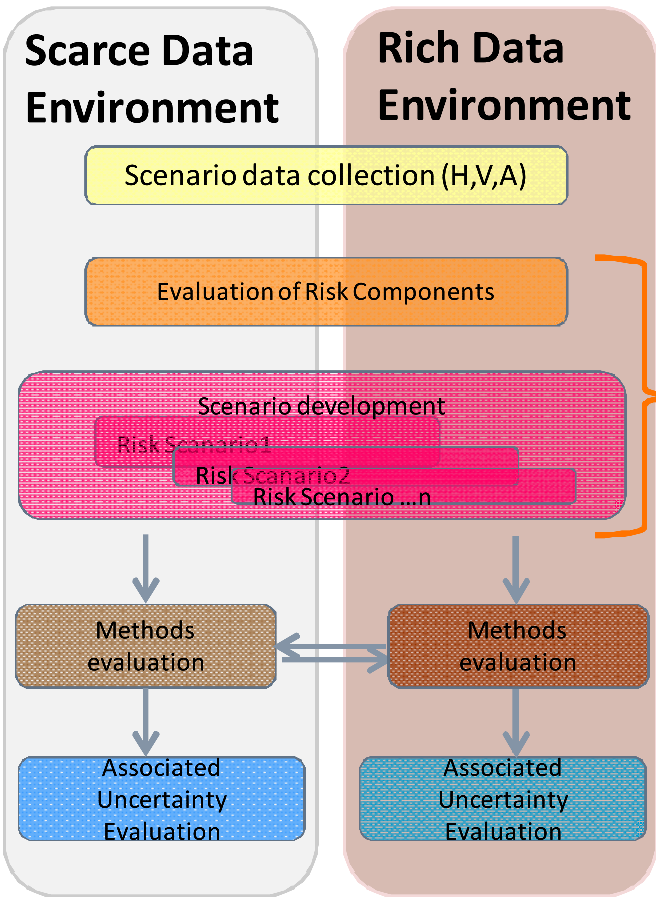
Aim of the Study

- Scenarios (IPCC, 2008): *''A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold.''*
- Useful instrument for decision makings (facing the environmental risks, risk management and risk reduction measures planning)



- **Methodology for risk scenarios**

(climate and socio-economical changes; uncertainty)

Implemented Formative Scenario Approach

Ref.: Formative Scenario Analysis
Scholz and Tietje (2002)
Mazzorana et al. (2009)
Mazzorana and Fuchs (2010)

- **Outputs:**

- Regional scale scenarios (Buzau County and Friuli Venezia Giulia Region)
- For different return period time (short, middle, long term)

Progress and Collaborations

1) Literature review
2) Review of the PRA tools (**WP3 Deliverable**) (collaboration with Haydar H.(ESR06) and Korbinian B.(ESR02)
3) Definition of the **research topic**
4) **Data Collection** Romanian Case study (collaboration with Roxana C. (ESR05) and Ziga M.(ESR04):
   - **Statistical data** (population, buildings) at commune level
   - **Interviews** Socio-economical and landuse changes
   - Field trip for **buildings inventory** in Nehoiu Catchment
   - Buzau County tourism and agro-tourism development strategy (2010 – 2015) and (socio-economic) **sustainable development plan** (2007 – 2013)

Progress and Collaborations

5) Developing of an **element at risk inventory** at commune level for Buzau County at regional scale (collaboration with Roxana C. (ESR05) and Juliette C. (ESR10)and Geomer , S. Jäger)

6) First **draft of susceptibility map** of Buzau County using WofE (collaboration with CNR IRPI : P. Reichenbach, S. Sterlacchini and Haydar H.(ESR06)

Progress

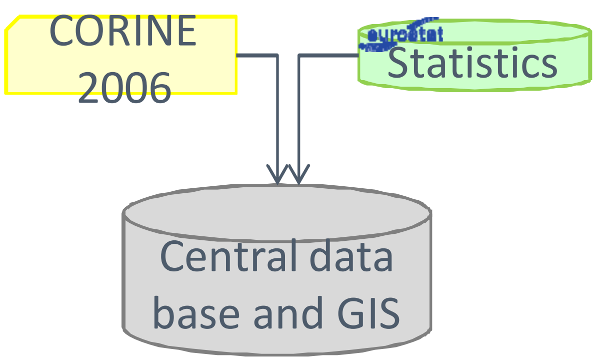
DataBase for the Element at Risk Inventory in Buzau County

Period of secondment at Geomer GmbH under the supervision of Dr S. Jager

Why??

- Database inventory for the elements at risk still missing
- Data are scattered along a lot of institutions in Romania

Method: Basic European Assets Map (BEAM) Geomer GmbH



Progress

1. Identify the data needed

2. Data collection at commune level (NUTS5):

Internet:

Buzau statistical office website

In Buzau:

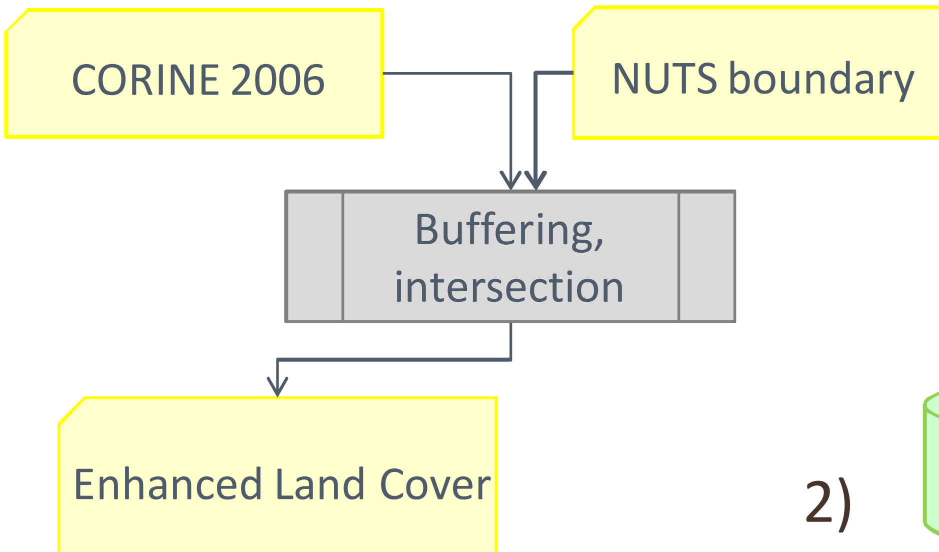
Buzau statistical office:

Population and residence census (2011): **general info; Statistical directory 2004, 2011**; locality sheet 1990, 2000, 2010 (commune level); demographic sheet 2000 – 2005 (per commune) **buildings per category , facilities, type of occupancy, area, # rooms per residence;**

3. Data organization (buildings, lifelines, people etc…)
4. Starting to build the GDB

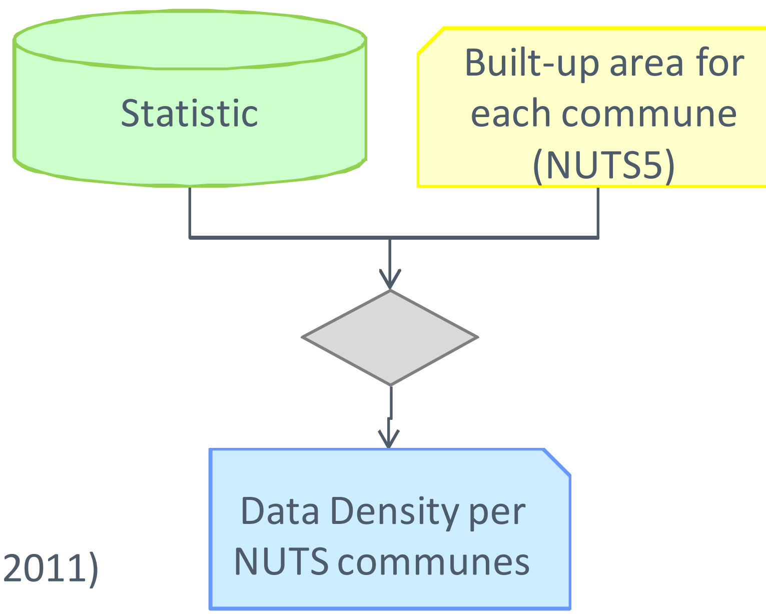
Progress

1)



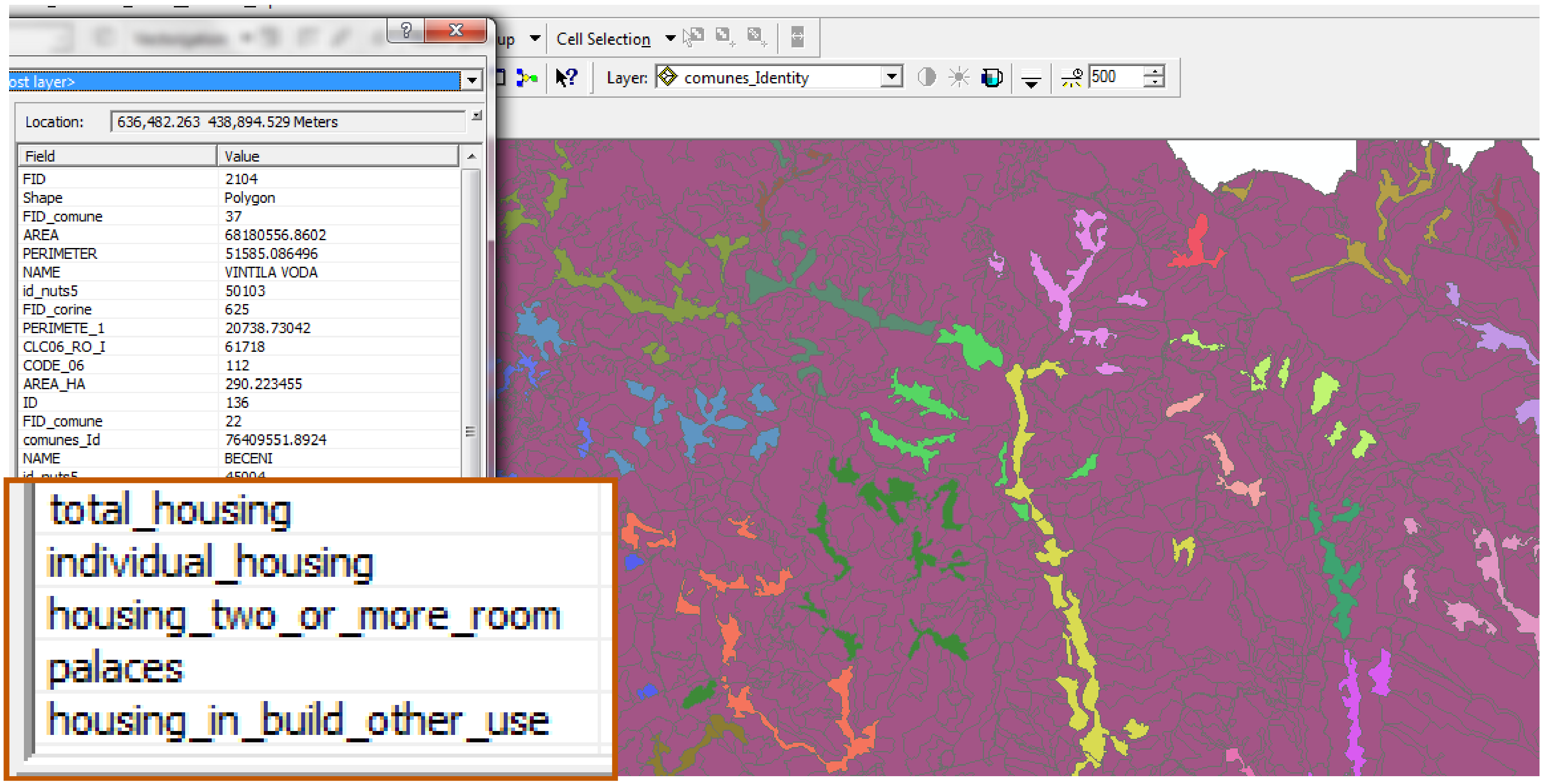
(Jager,2011)

2)



(Jager,2011)

Progress



Example: type housing, density (n°/km^2)

Progress

Susceptibility Map for Buzau County using Weight of Evidence

(collaboration with CNR IRPI : S. Sterlacchini ,P. Reichenbach and Haydar H.(ESR06)

(Romero-Calcerrada and Luque, 2006; Poli and Sterlacchini, 2007; Lynen et al., 2007; Masetti et al.,2008; Romero-Calcerrada et al., 2008; Debba et al., 2009; Duke and Steele, 2010; Regmi et al., 2010).

1. Preparation of the dataset : training/validation points (landslide scarps points), raster layers (lithology, slope, aspect, curvature, landuse, altitude etc…)

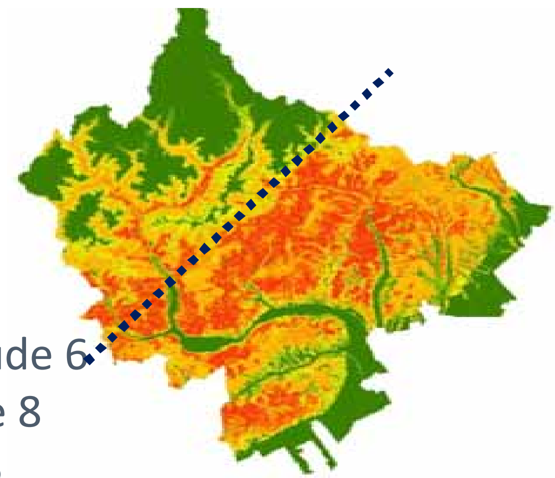
2. Running the analysis for different test considering:
   - Raster layers
   - Class Numbers of each layer
   - Positive and negative weight in the frequency tables of the variables
   - Expert judgment

Progress

Susceptibility Map for Buzau County using Weight of Evidence

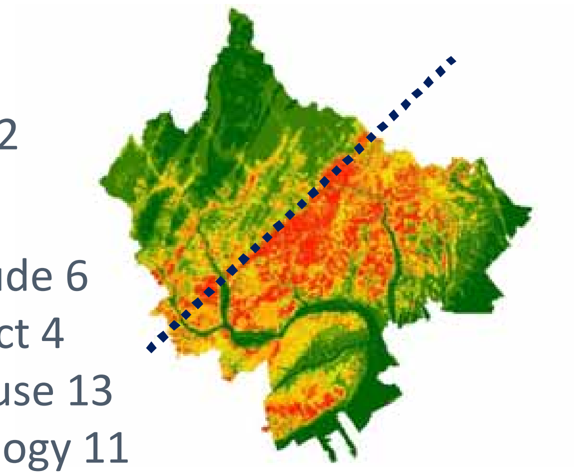
W_pprb maps:

T1



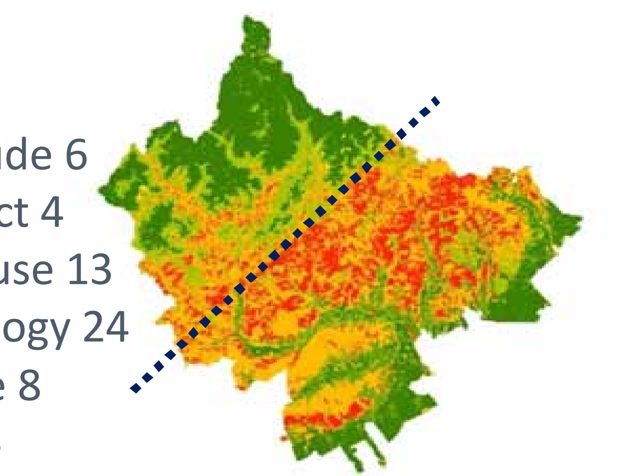
altitude 6
slope 8
soil 5

T12



altitude 6
aspect 4
landuse 13
lithology 11
slope 8
soil 5

T4



altitude 6
aspect 4
landuse 13
lithology 24
slope 8
soil 5

- Over estimation for Sub-Carpathians (distribution of landslides)
- Strong influence of geology and landuse (Subcarpathians); strong influence of slope and geology (Carpathians):
- Splitting the area in two environments (Carpathians/Sub-Carpathians)

Perspectives

up to January 2013:

- Finalizing the susceptibility analysis for Buzau County
  new tests with different layers
- Testing the methodology for Formative Scenario Approach
- Develop a regional landslide risk map for Buzau County (collaboration with Roxana C. ESR05)

Thank you for your attention!!

challenges

- Organization and availability of data where the access is restricted (e.g. Poland, Rumania)
- The schedule of the ESR6 and ESR7 are not completely applicable to/synchronized with the workflow of the project
- Recruitment of ER01: the eligibility criteria are difficult to meet; not only the duration of research experience (> 4yrs), but also the threshold of the time elapsed since the award of the MSc degree (< 5yrs). The required ER for WP3 should have extensive practical experience in developing a Web-GIS platform, which is difficult to acquire under these criteria.

conclusions