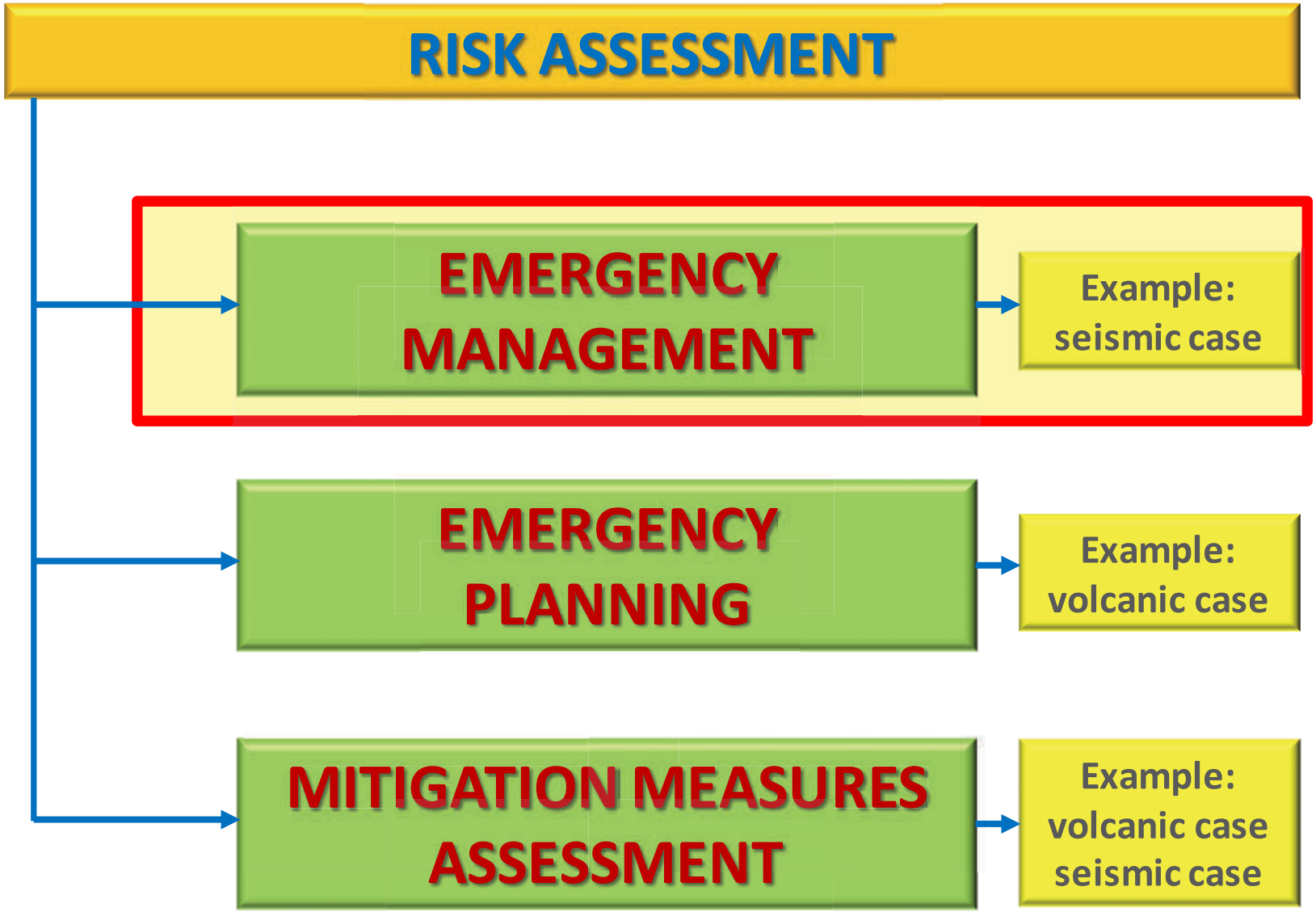
RISK ASSESSMENT AND DECISION SUPPORT



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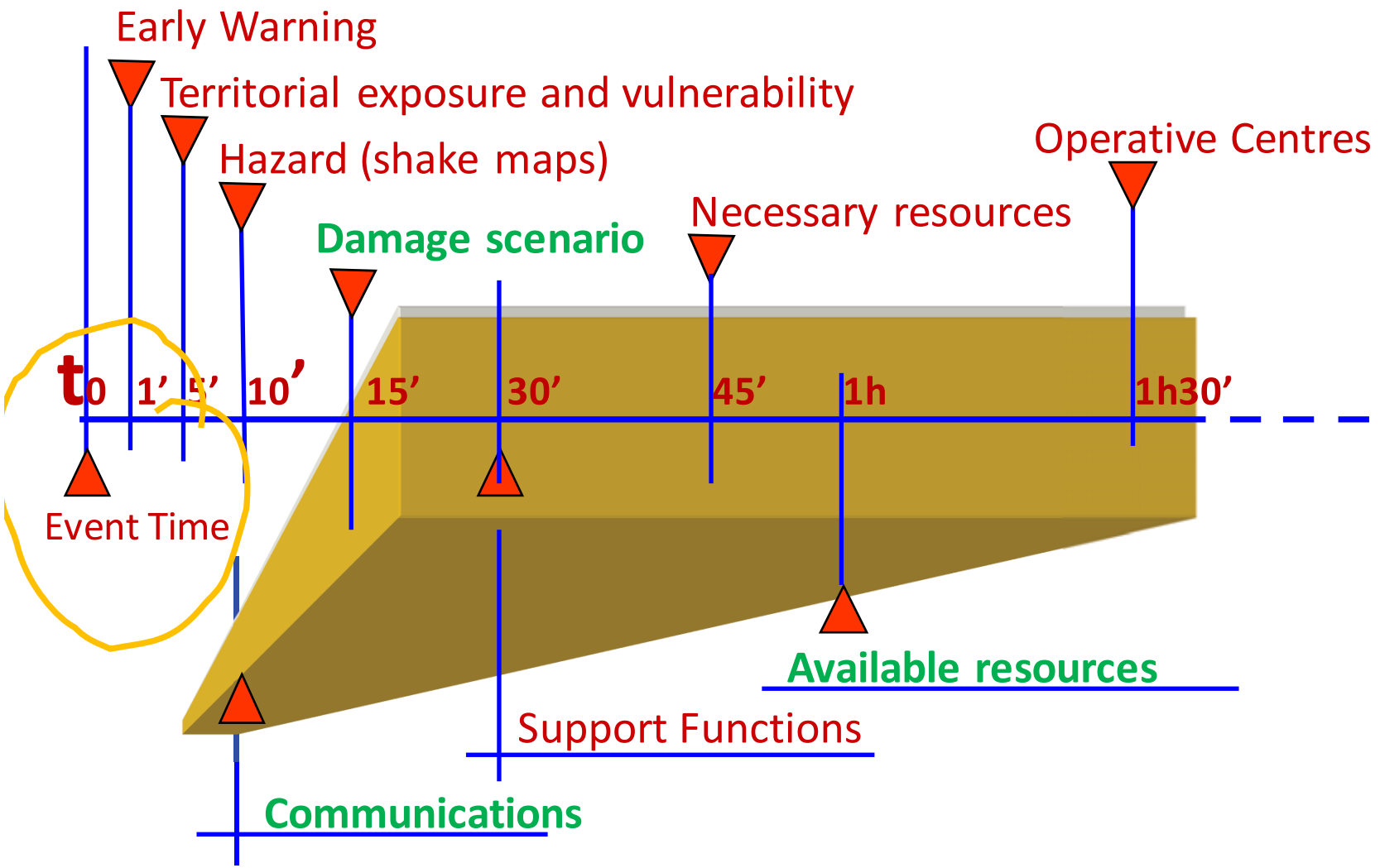
SEISMIC CASE: ACTIVATION TIME



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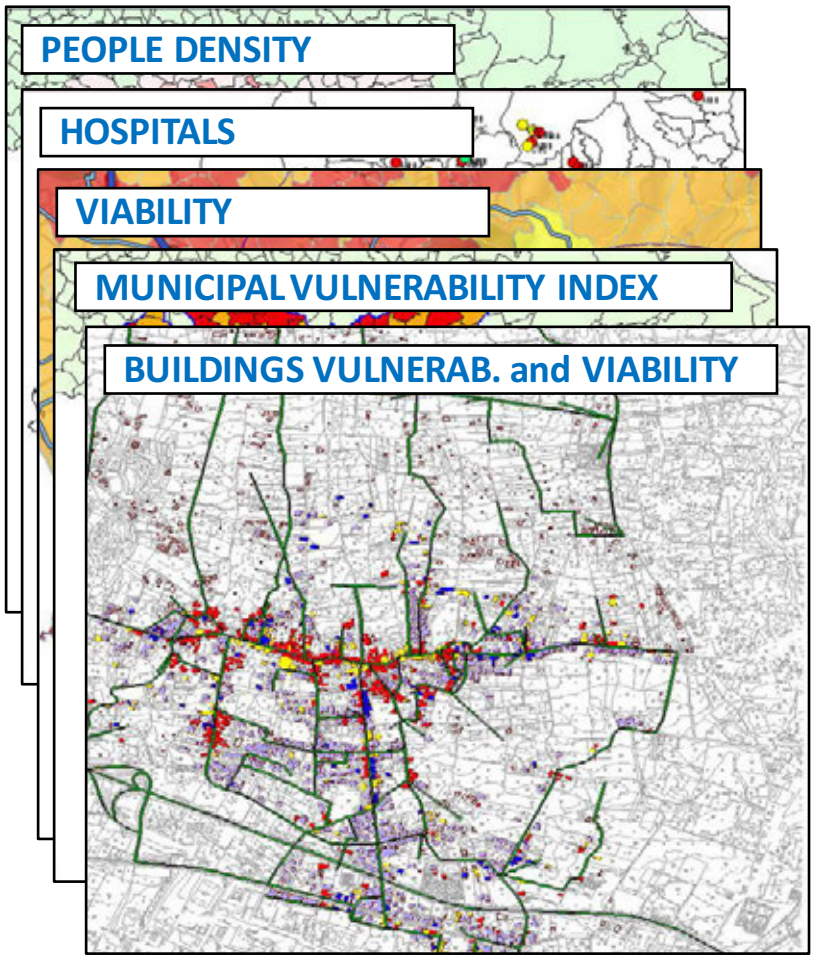
EMERGENCY MANAGEMENT

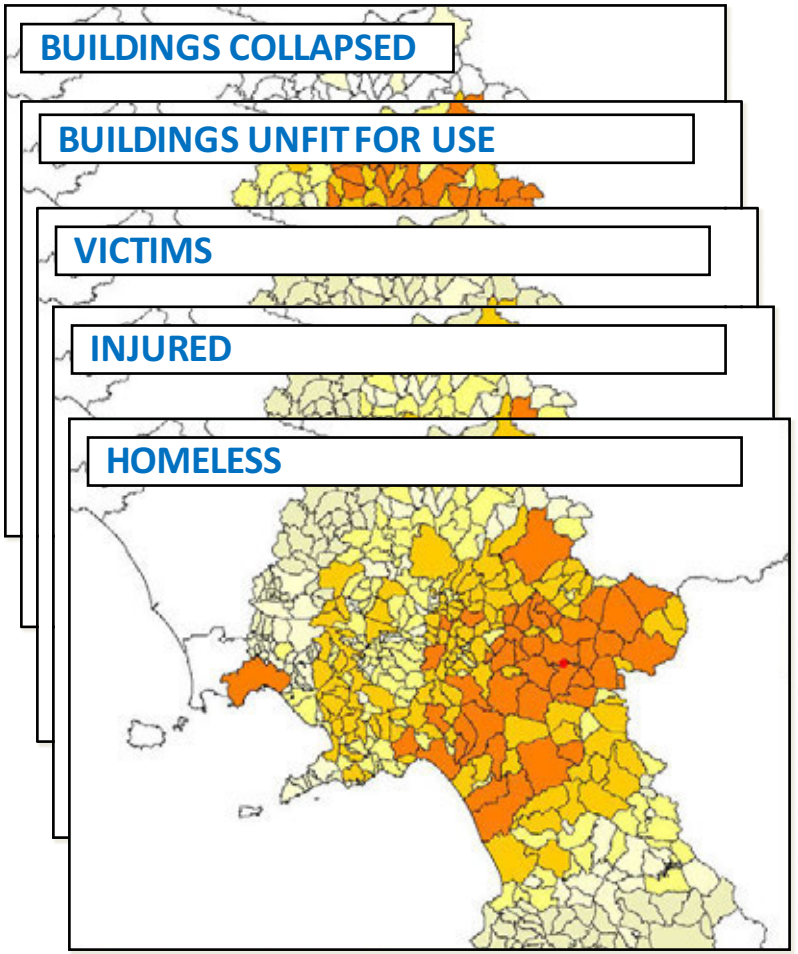
SEISMIC CASE: t0 + 15'

The System produces

1. TERRITORIAL EXPOSURE AND VULNERABILITY



2. IMPACT SCENARIO



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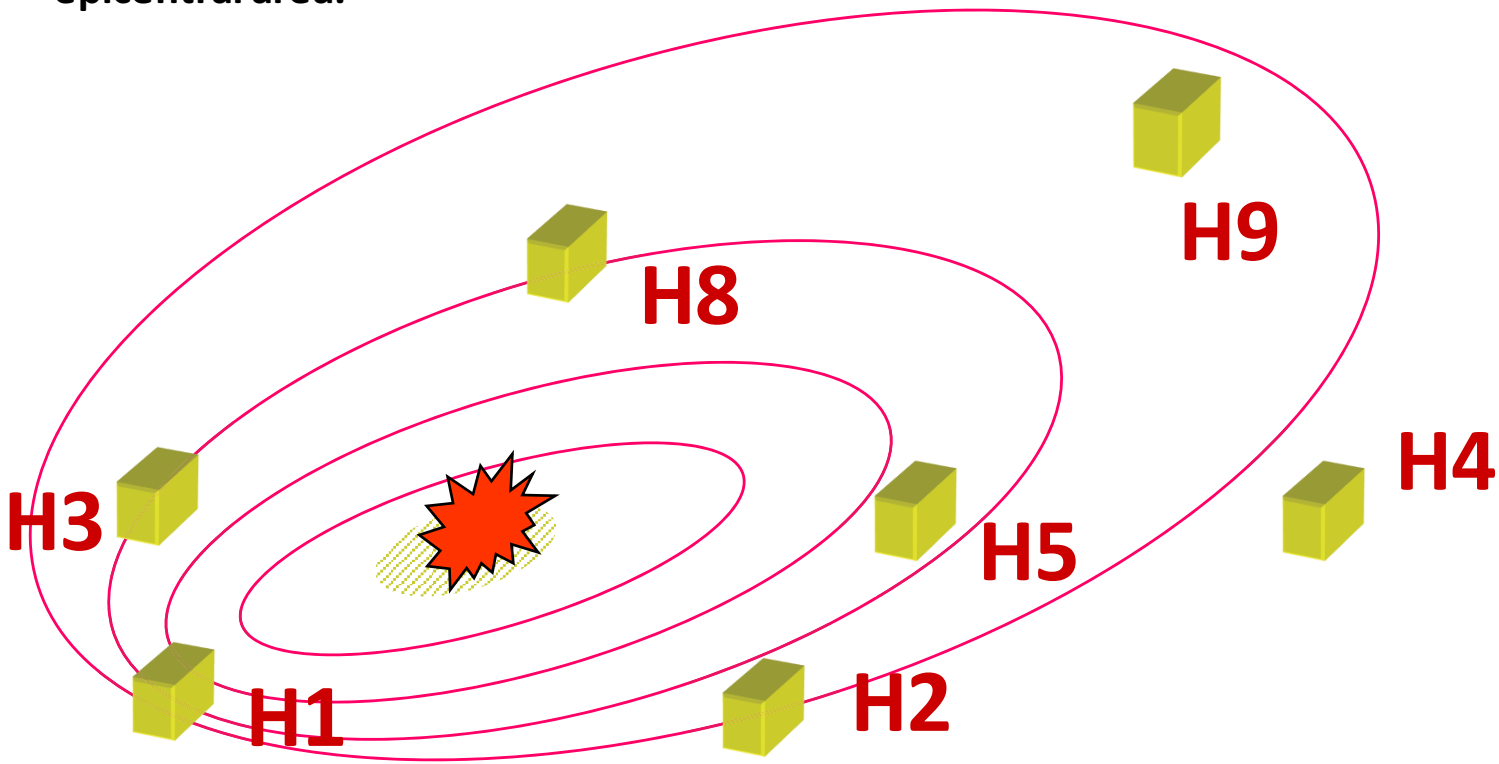
SEISMIC CASE: t0 + 30'

The System:

- analyses the HOSPITALS DATABASE, which contains number of beds available and types of healthcare;
- locates the closest Hospitals (H);
- excludes, in function of the event intensity, the Hospitals included in the epicentral area.



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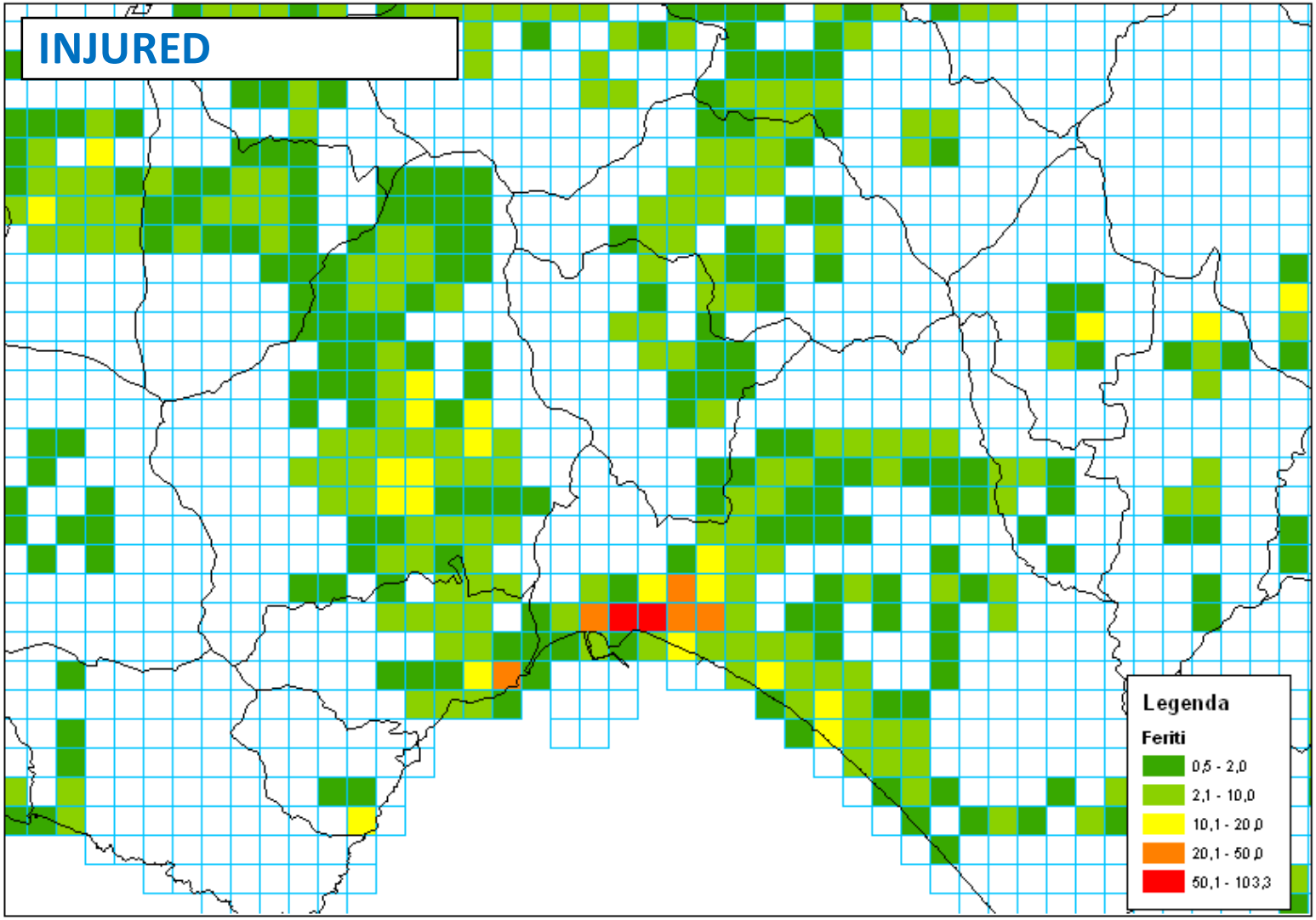
SEISMIC CASE: MASTER PROFILE



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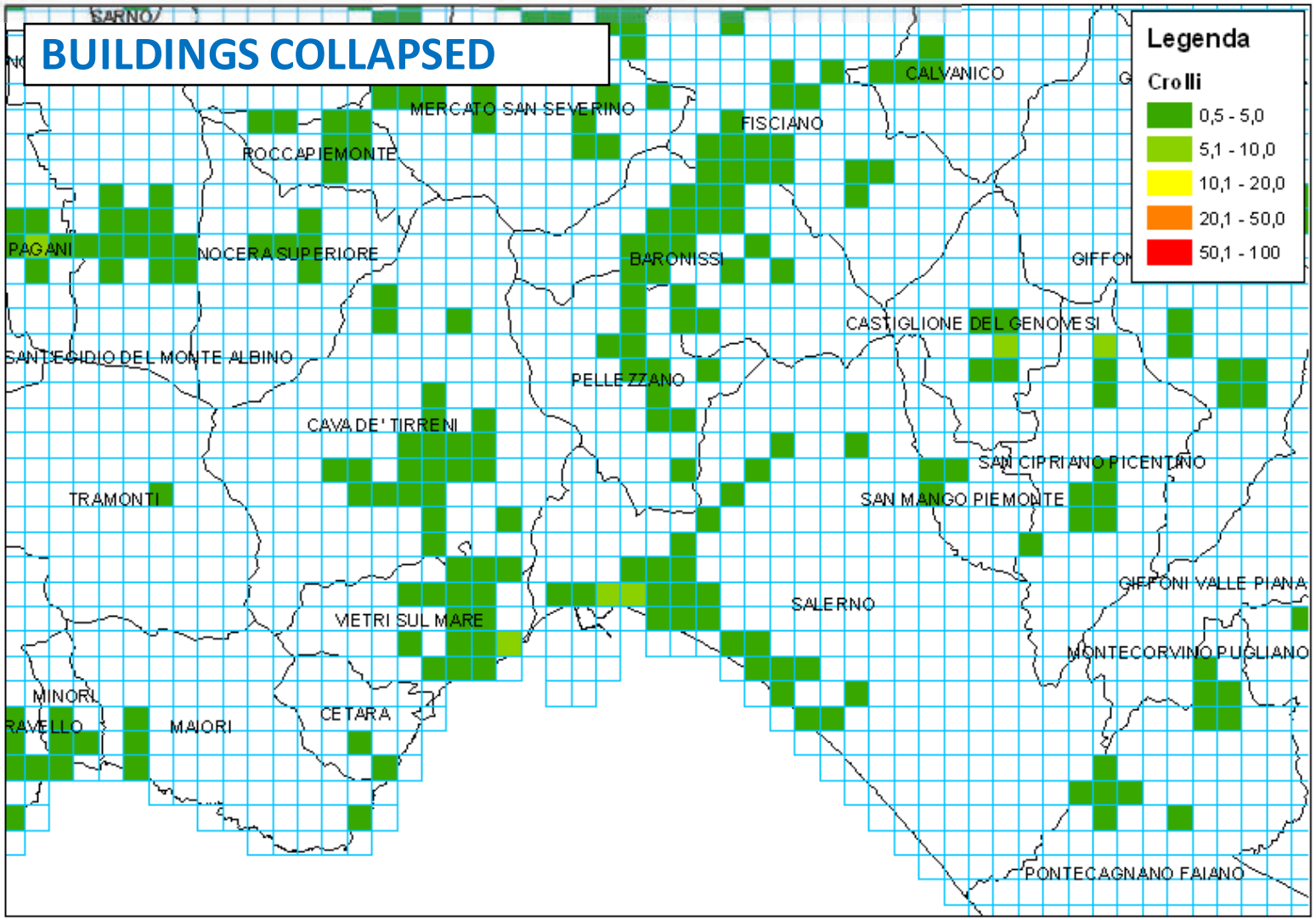

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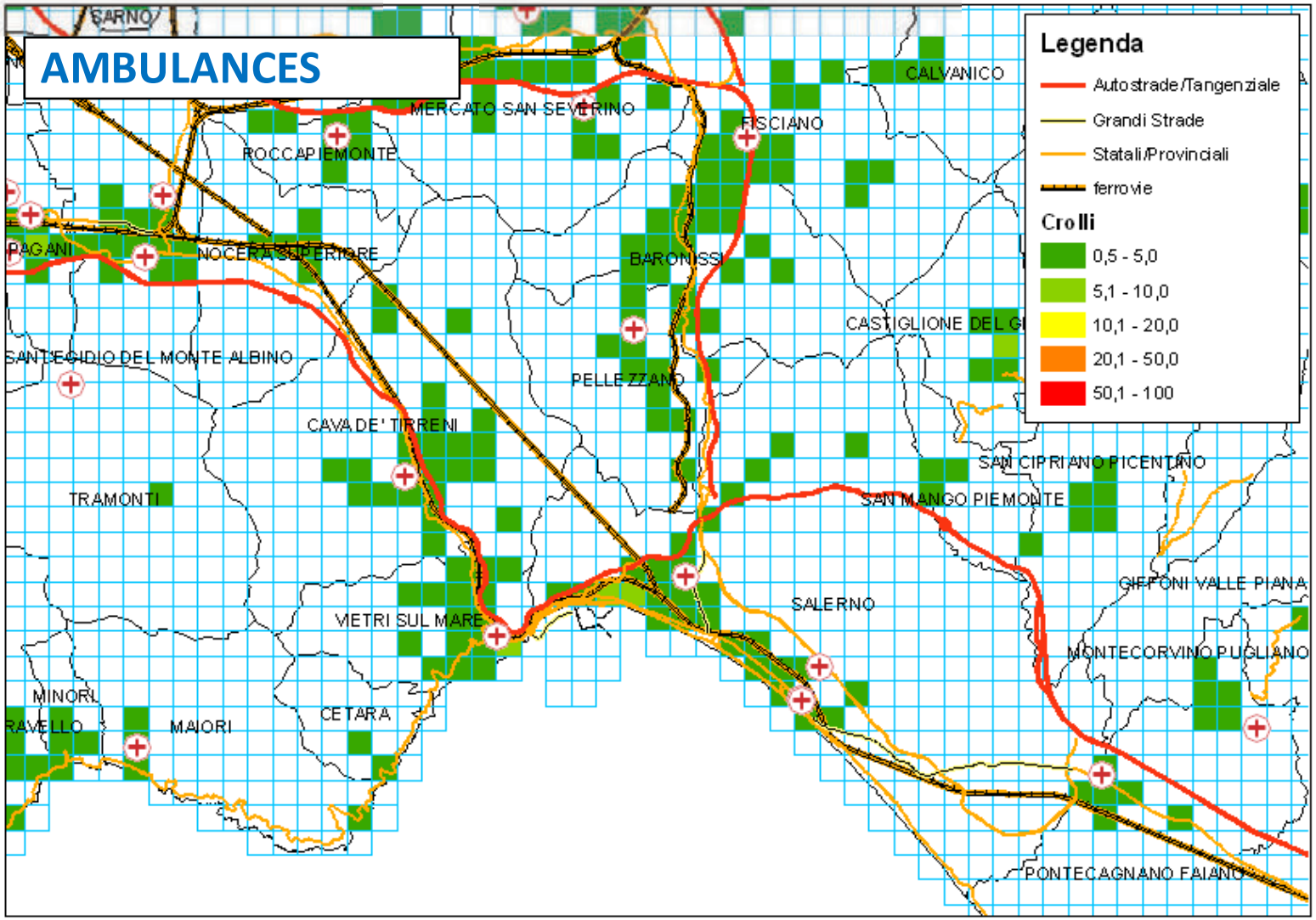

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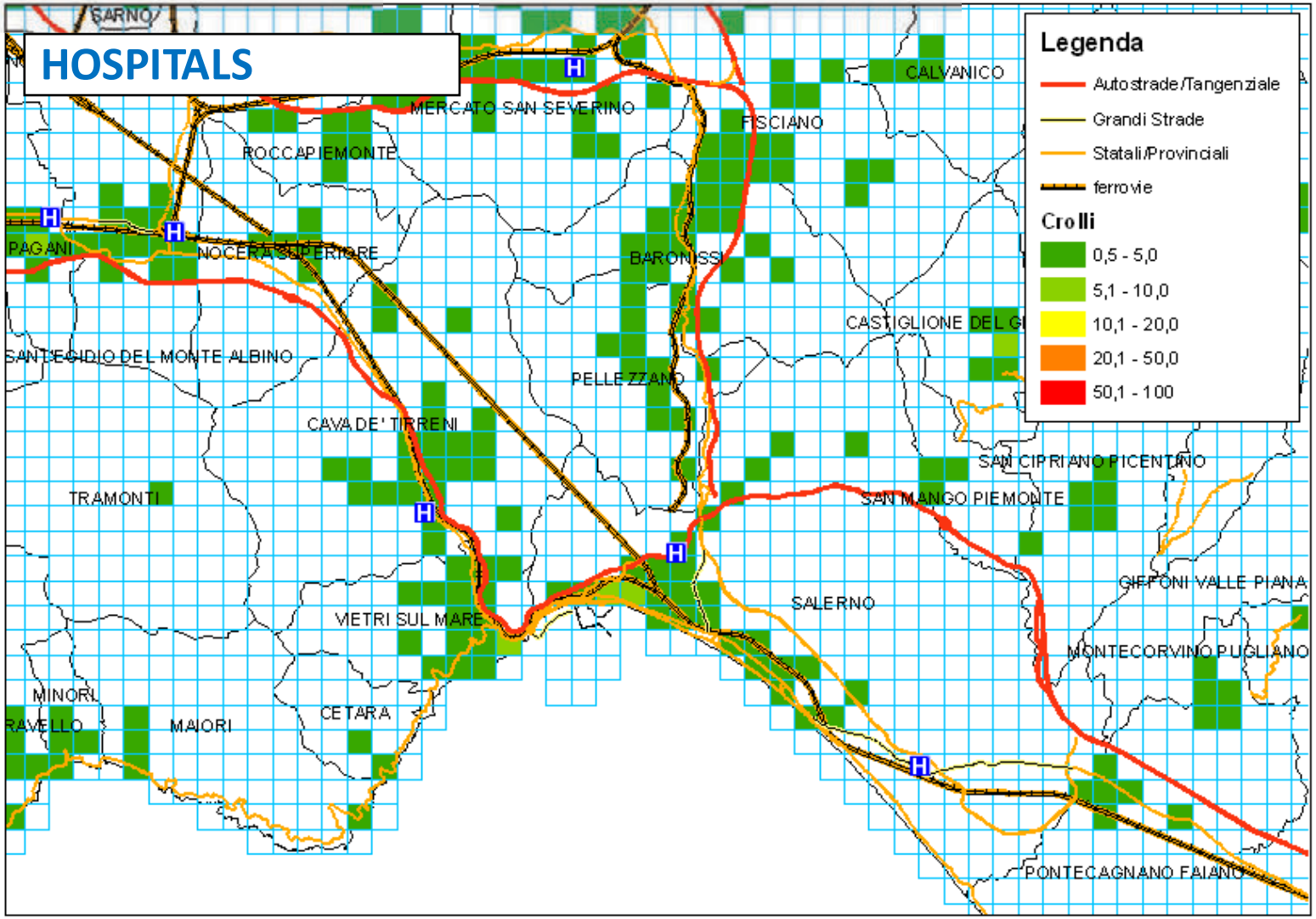

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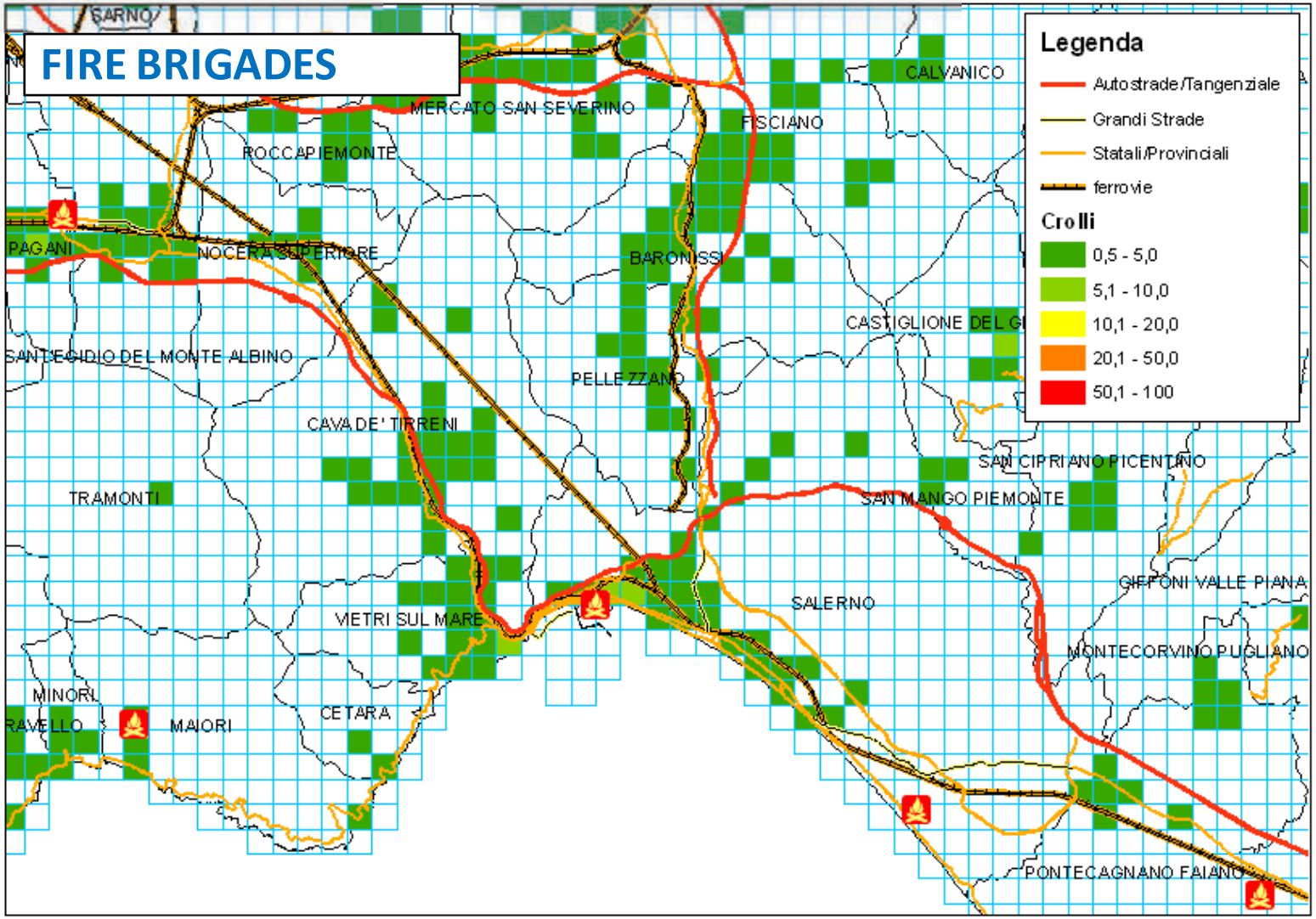

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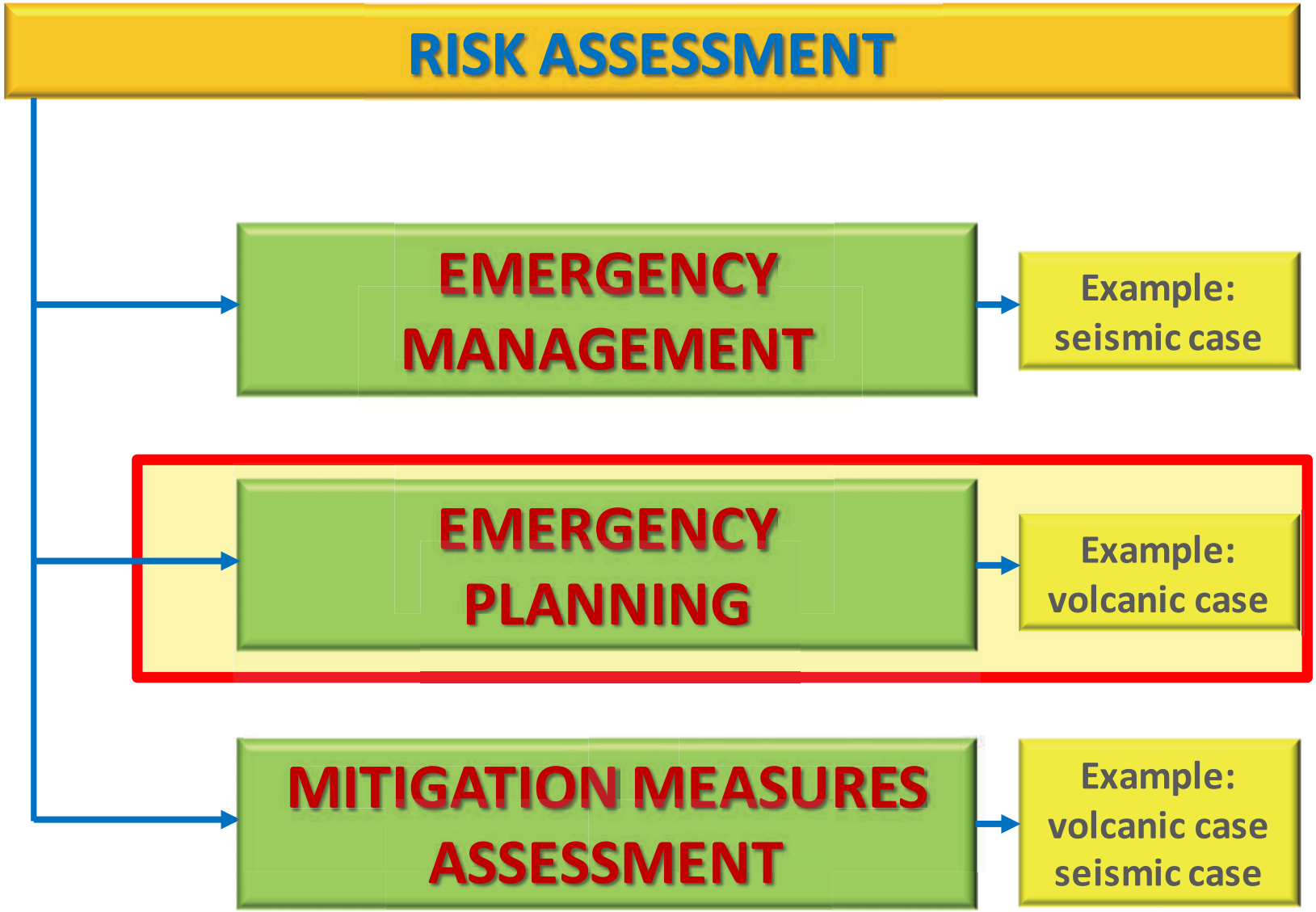

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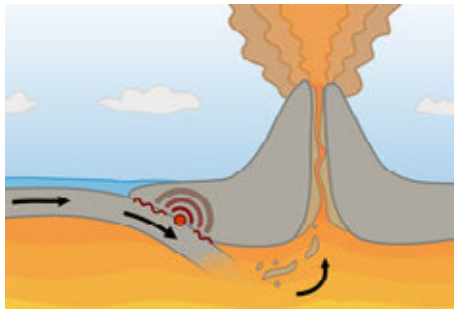
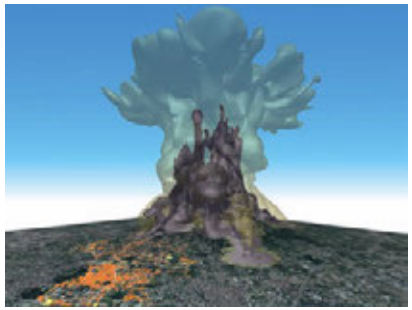
VOLCANIC CASE

Mount VESUVIUS

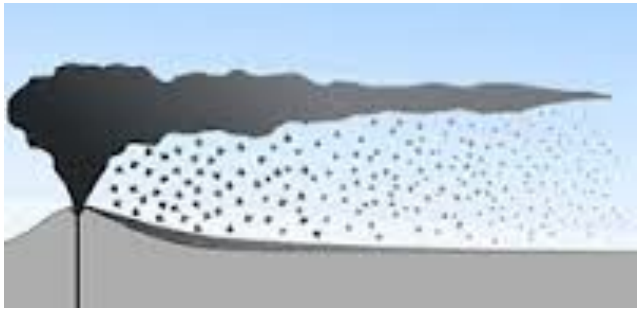
HAZARDS



EARTHQUAKES



PYROCASTIC FLOWS



ASH FALL

RISK =(Hazard) x (Exposure) x (Vulnerability)

NATIONAL EMERGENCY PLAN, Mount VESUVIUS

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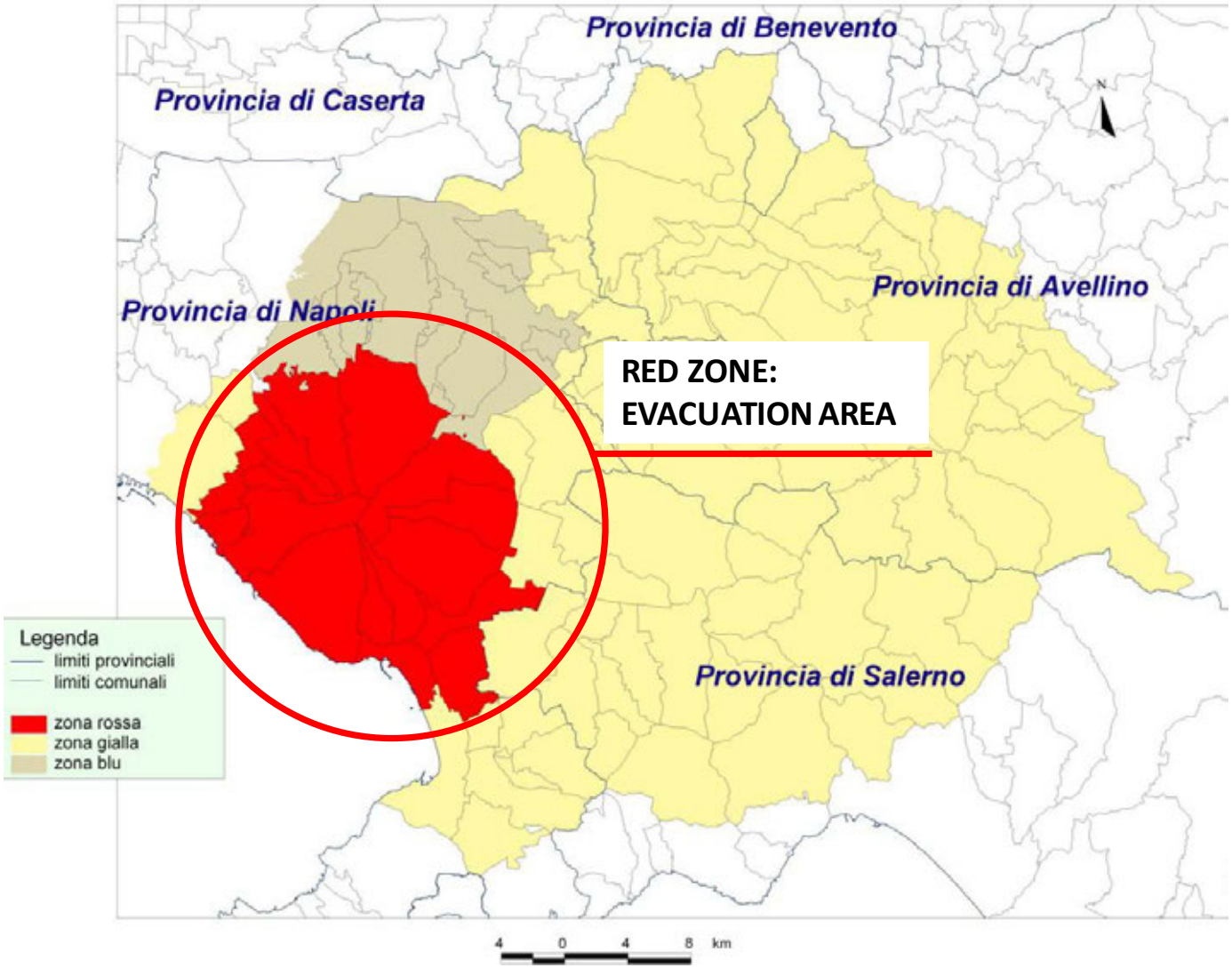
VOLCANIC CASE

NATIONAL EMERGENCY PLAN, Mount VESUVIUS



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VOLCANIC CASE

Mount VESUVIUS. PYROCLASTIC FLOWS

Bull Volcanol (2010) 72:1021–1038
DOI 10.1007/s00445-010-0379-2

RESEARCH ARTICLE

Pyroclastic flow hazard assessment at Somma–Vesuvius based on the geological record

L. Gurioli · R. Sulpizio · R. Cioni · A. Sbrana · R. Santacroce · W. Luperini · D. Andronico

MEDIUM FREQUENCY OF FLOOD

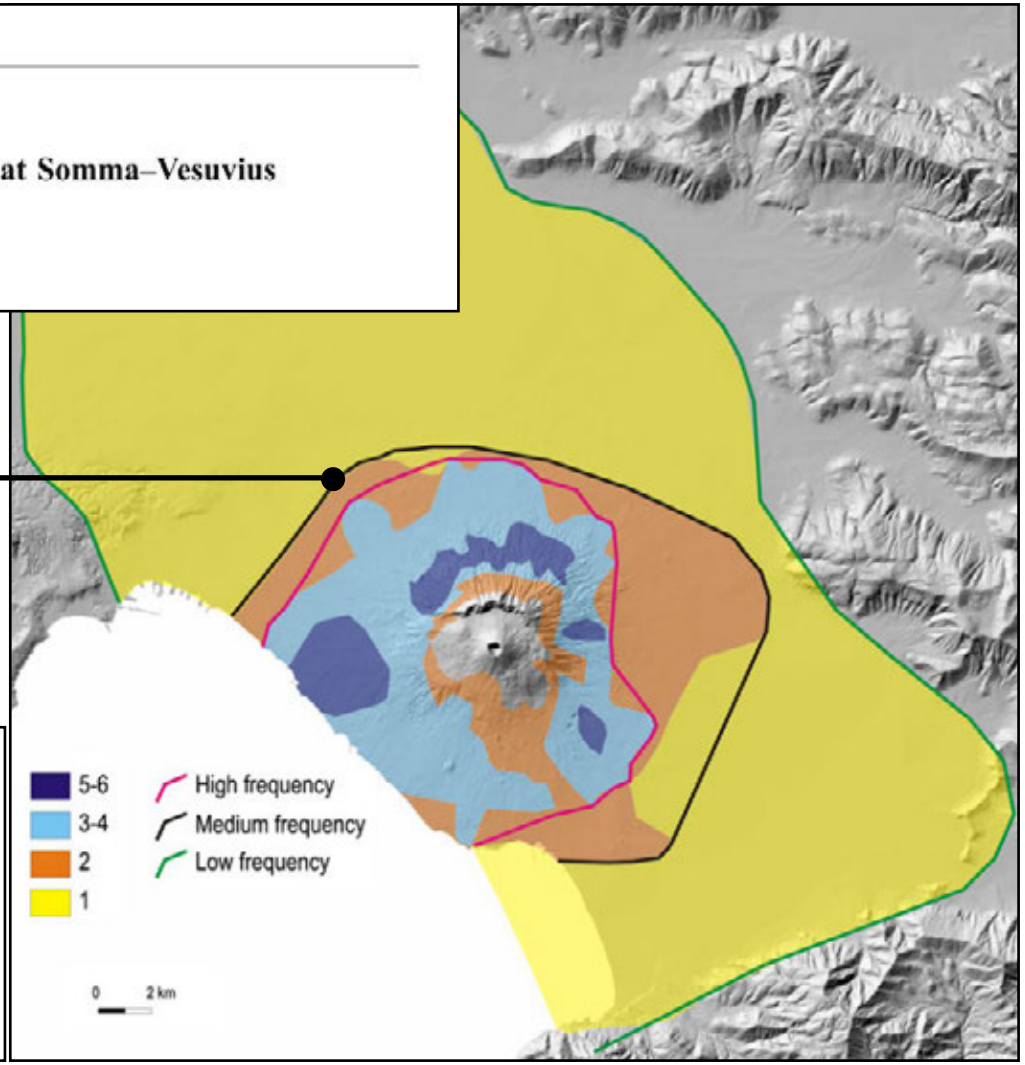

Fig. 6 PDC inundation frequency for the main eruptions of Somma–Vesuvius during the last 22 ka. The map shows areas that relate to high, medium, and low frequency of PDC inundation during the last 22 ka of activity

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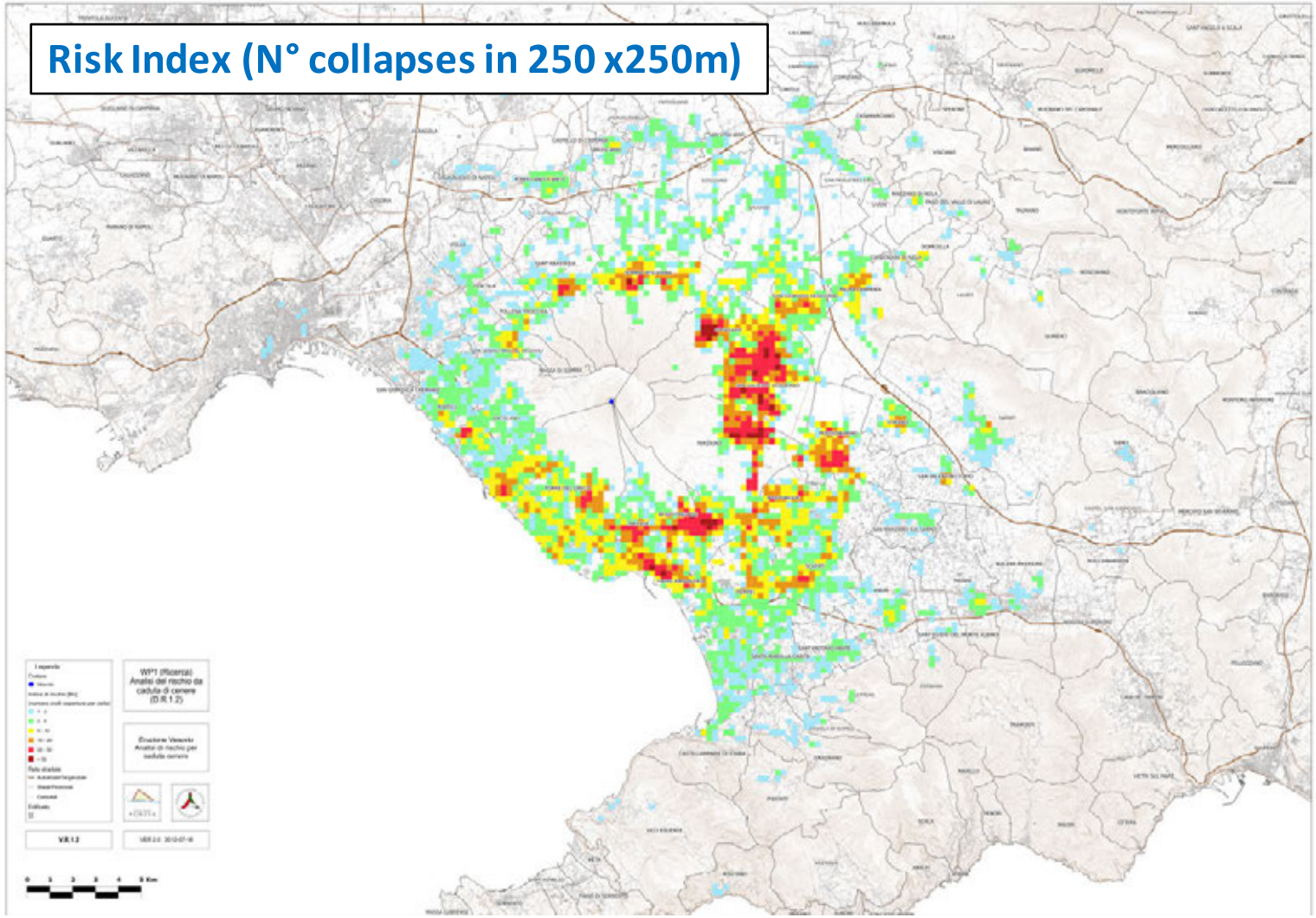
VOLCANIC CASE

Mount VESUVIUS. ASH FALL



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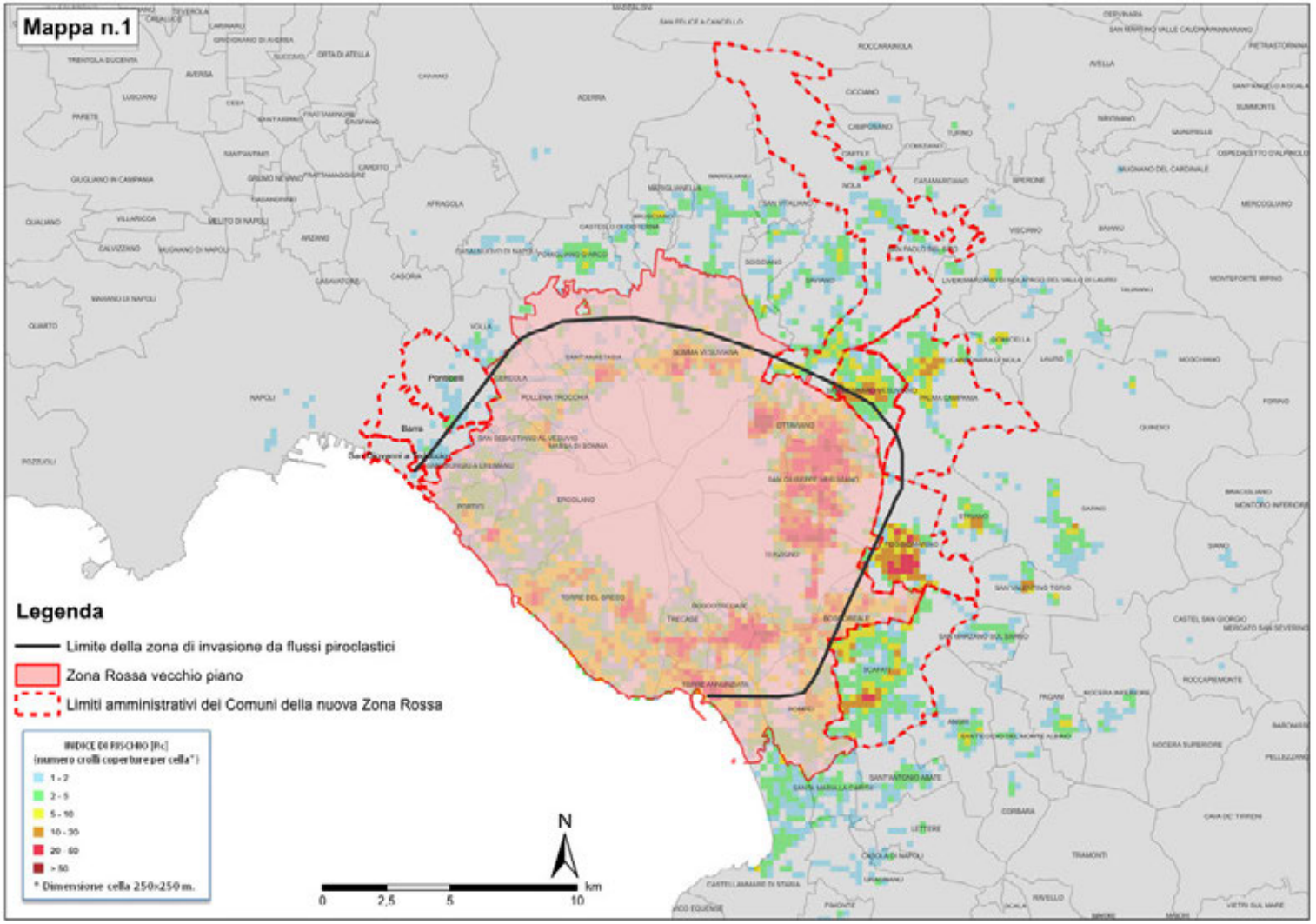
VOLCANIC CASE

Mount VESUVIUS. ASH FALL + PYROCLASTIC FLOWS



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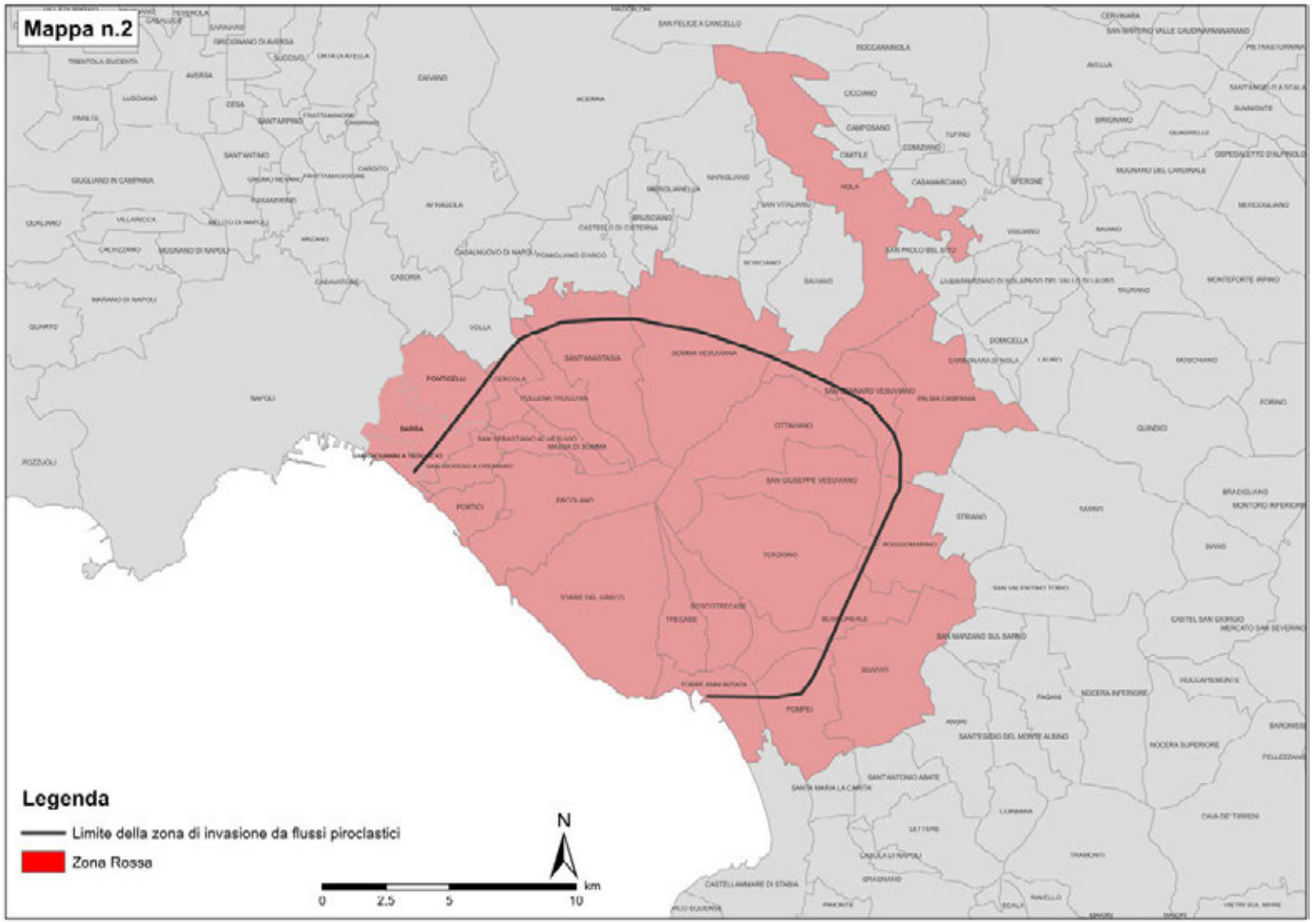
VOLCANIC CASE

Mount VESUVIUS. "RED ZONE" EXTENSION



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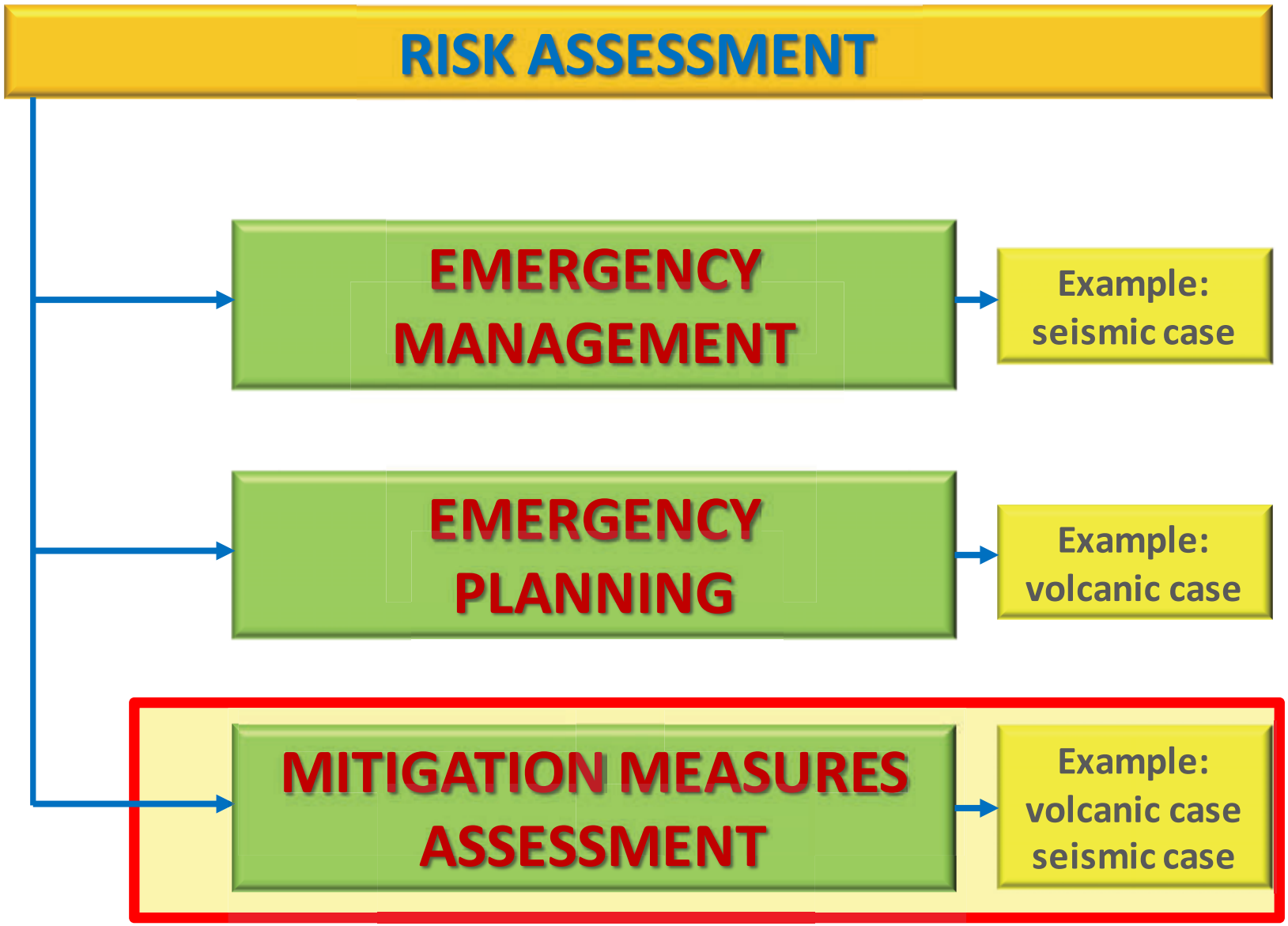
RISK ASSESSMENT AND DECISION SUPPORT



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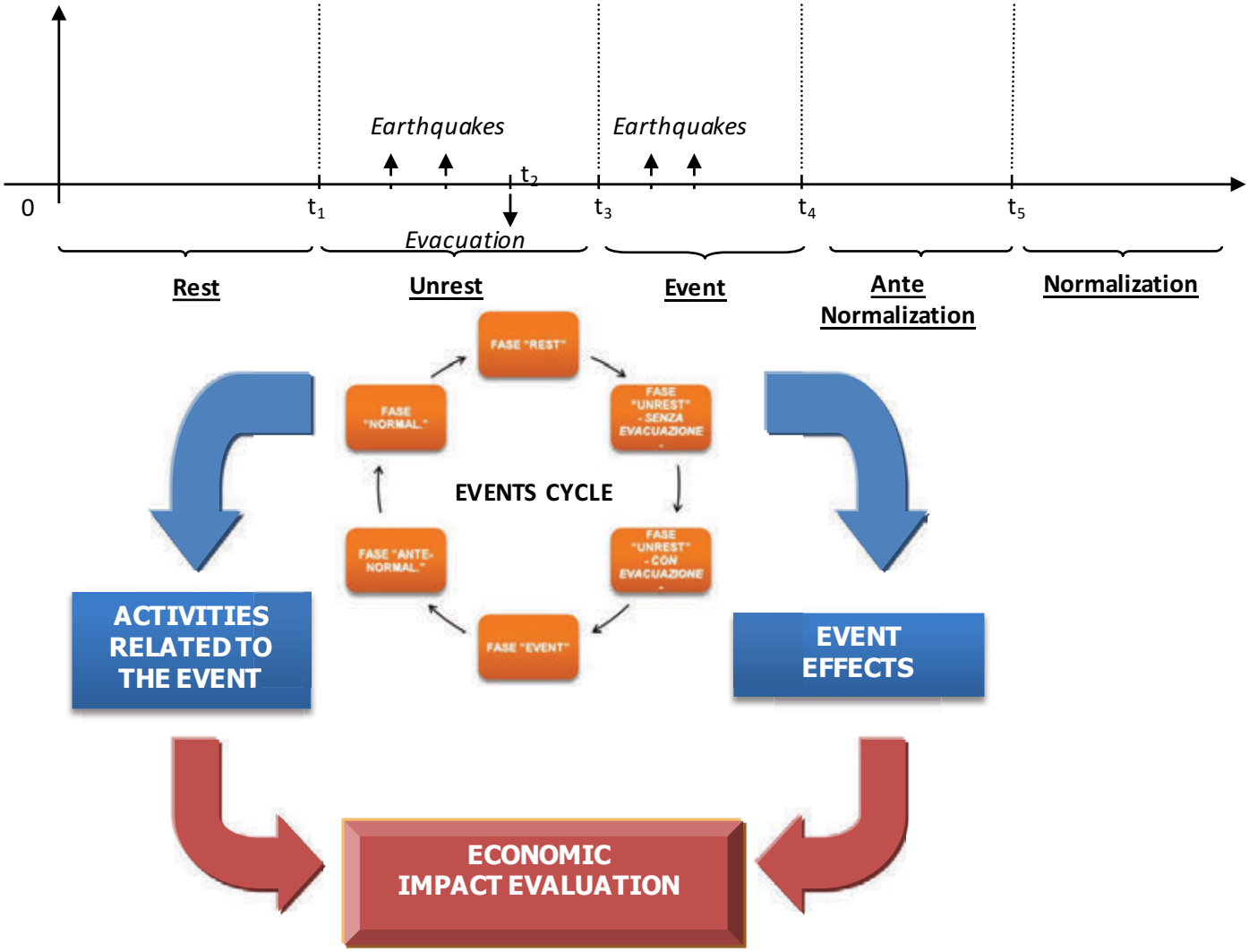
VOLCANIC CASE

MODEL OUTPUT



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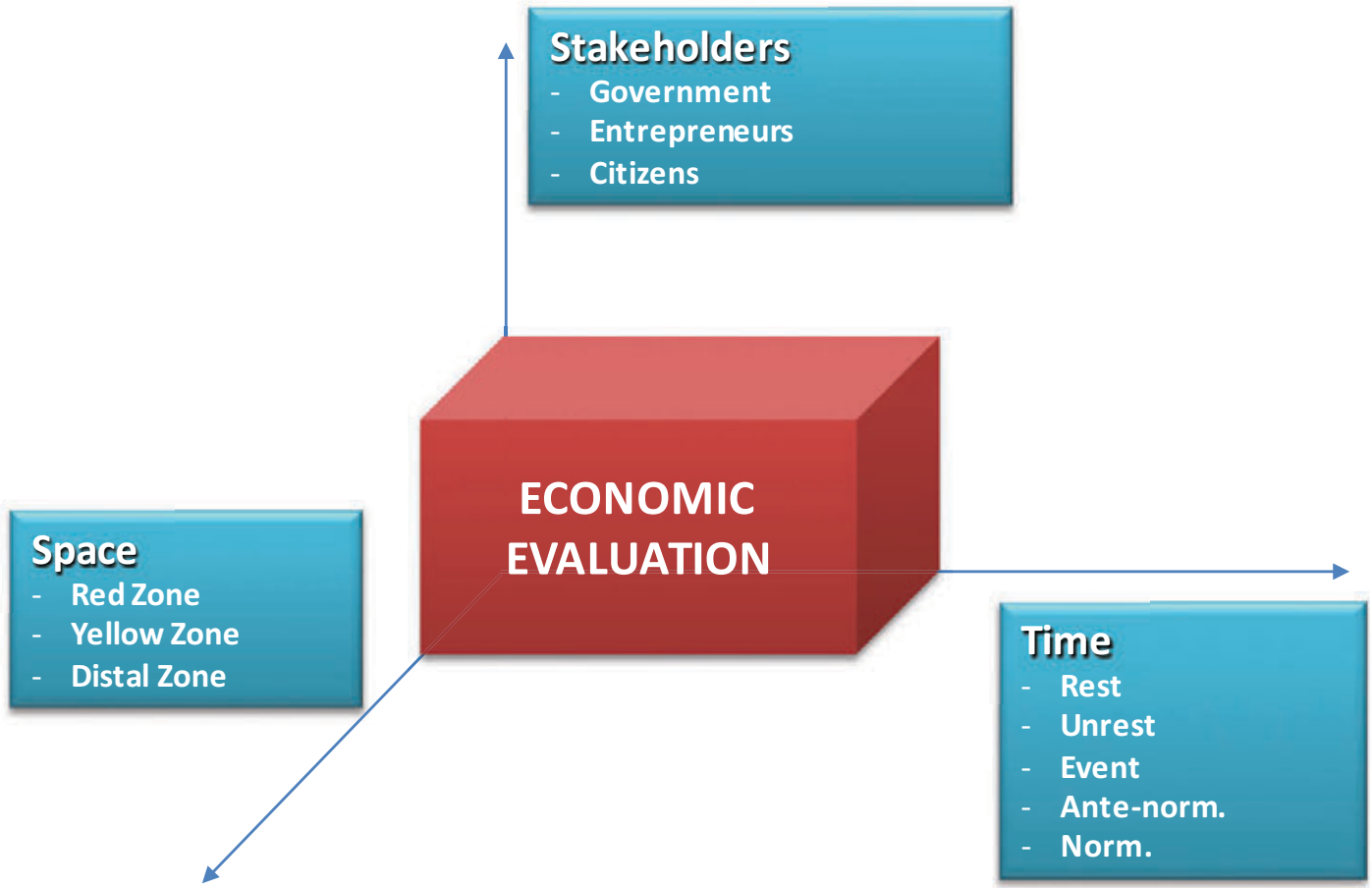
VOLCANIC CASE

MODEL STRUCTURE



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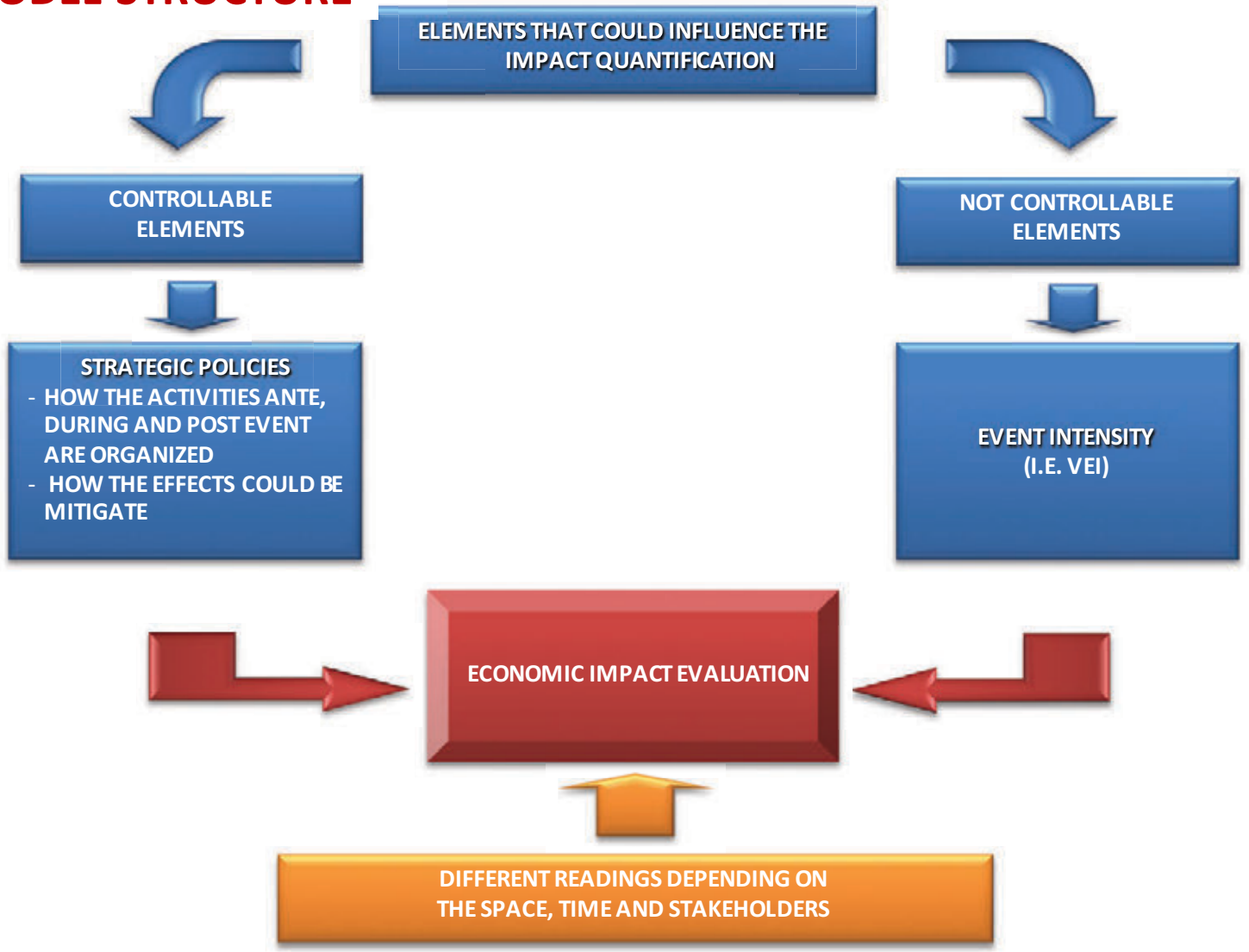

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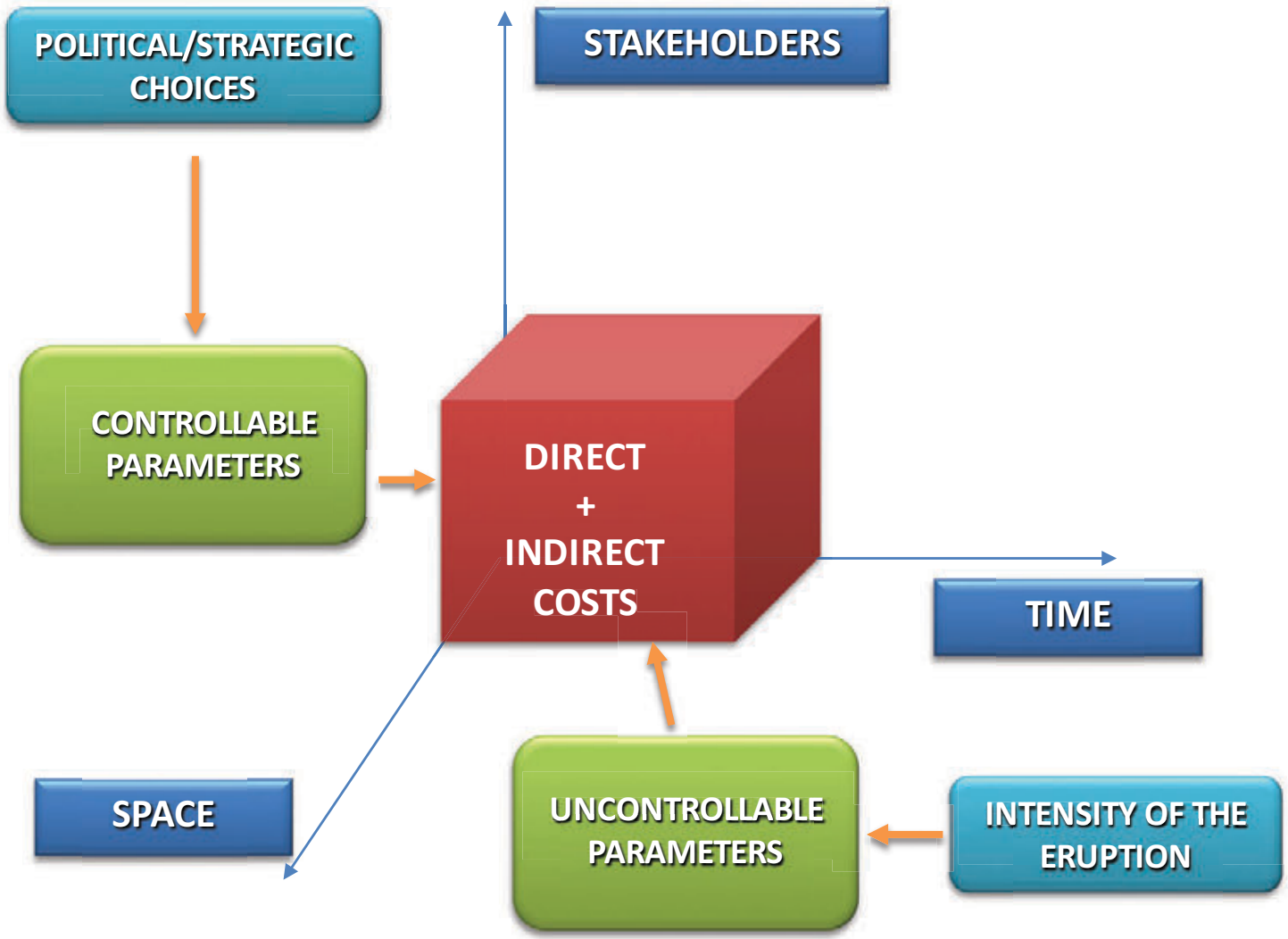

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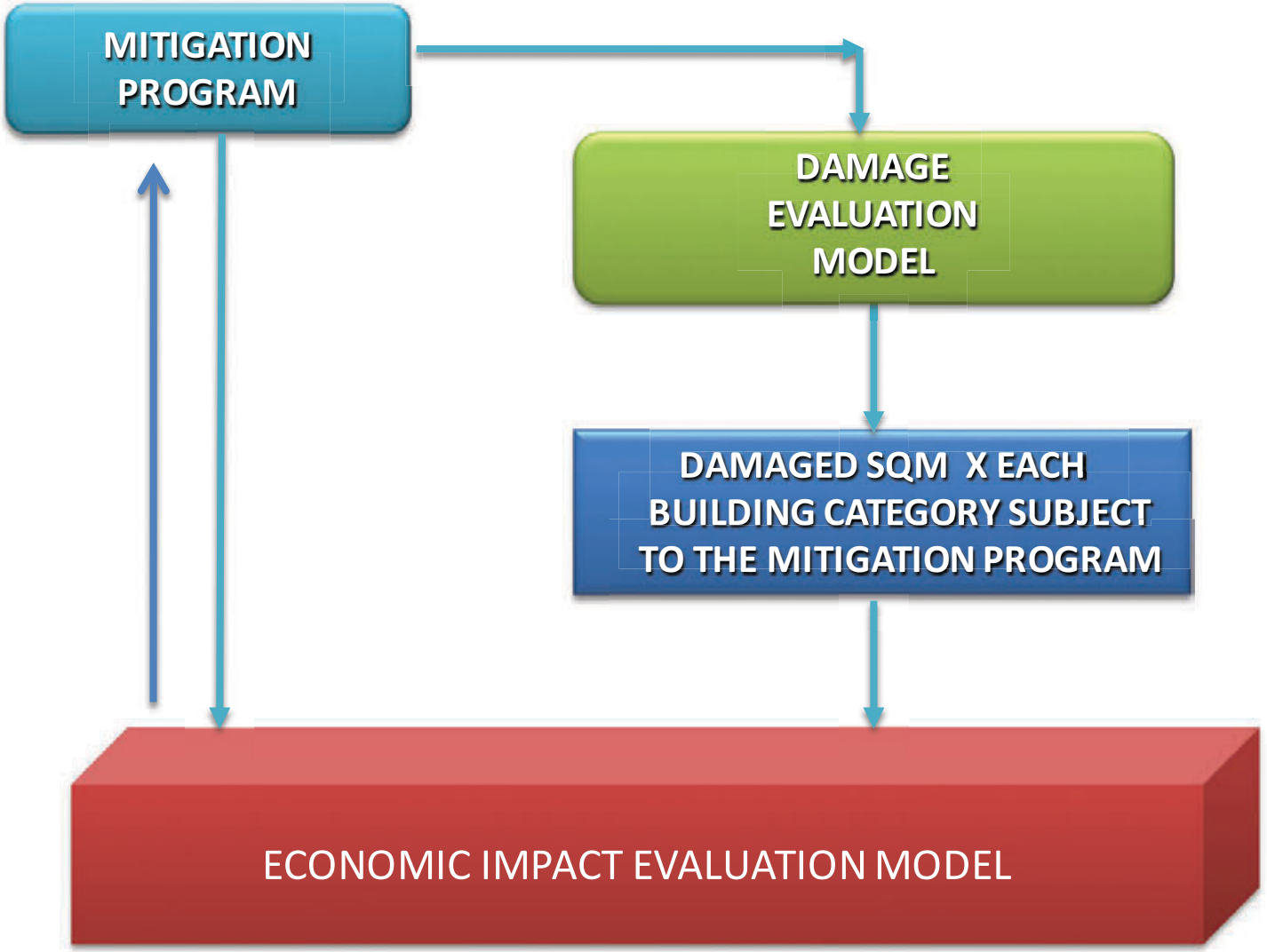
VOLCANIC CASE

MODEL ALGORITHMS INTERACTION



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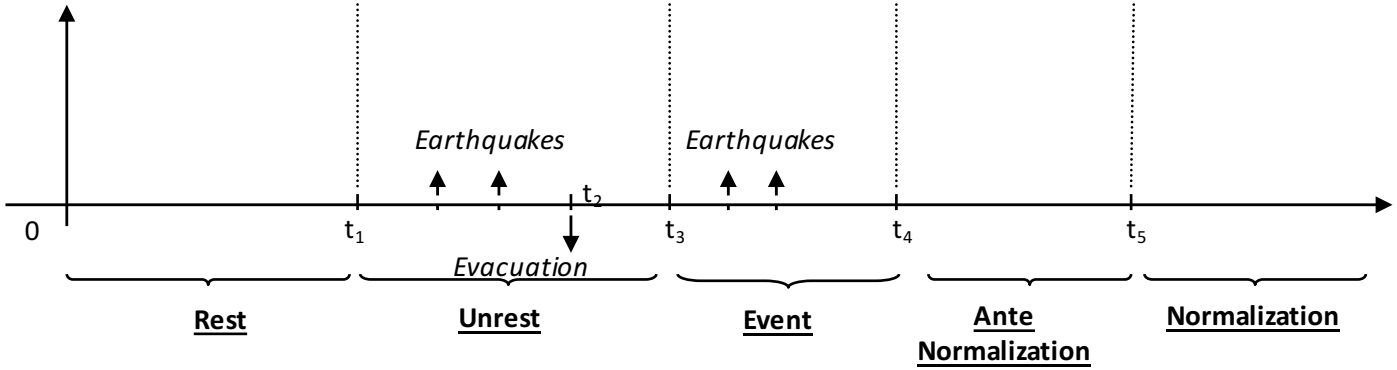
VOLCANIC CASE

RESULTS



N.	COSTS	TOTALS EQ1	TOTALS EQ1+EQ2	TOTALS EQ1+EQ2+EQ3	TOTALS EQ1+EQ2+EQ3+ ASH	TOTALS EQ1+EQ2+EQ3+ ASH+PYR
	DIRECT COSTS					
1	Volcanic System enhanced monitoring	1.000.000	1.000.000	1.000.000	1.000.000	1.000.000
2	Mitigation costs	-	-	-	-	-
3	Evacuation direct costs	86.022.314	86.022.314	86.022.314	86.022.314	86.022.314
4	Evacuation assistance costs	6.609.435.081	6.609.435.081	6.609.435.081	6.609.435.081	6.609.435.081
5	Emergency costs	756.005.294	756.005.294	756.005.294	756.005.294	756.005.294
6	Ash Cleaning-up costs	-	-	-	-	-
7	Reconstruction costs	9.673.973	162.932.083	3.349.565.174	21.784.849.613	27.138.681.140
8	Rehabilitation costs	2.609.316.337	7.786.258.980	38.179.829.705	34.815.486.236	41.074.650.182
9	Delocalization costs	-	-	-	-	-
10	Human health interventions costs	751.774.403	751.774.403	751.774.403	751.774.403	751.774.403
11	"Back home" costs	77.170.662	77.170.662	77.170.662	77.170.662	77.170.662
	INDIRECT COSTS					
12	Decrease in local value-added due to psychological effects	4.755.195.009	4.755.195.009	4.755.195.009	4.755.195.009	4.755.195.009
13	Change in Gross Local Product or in local value-added	6.498.165.846	6.618.410.056	7.846.783.186	8.586.578.302	8.717.584.540
	TOTAL COSTS	**22.153.758.918**	**27.604.203.881**	**62.412.780.827**	**78.223.516.912**	**89.967.518.625**

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VOLCANIC CASE

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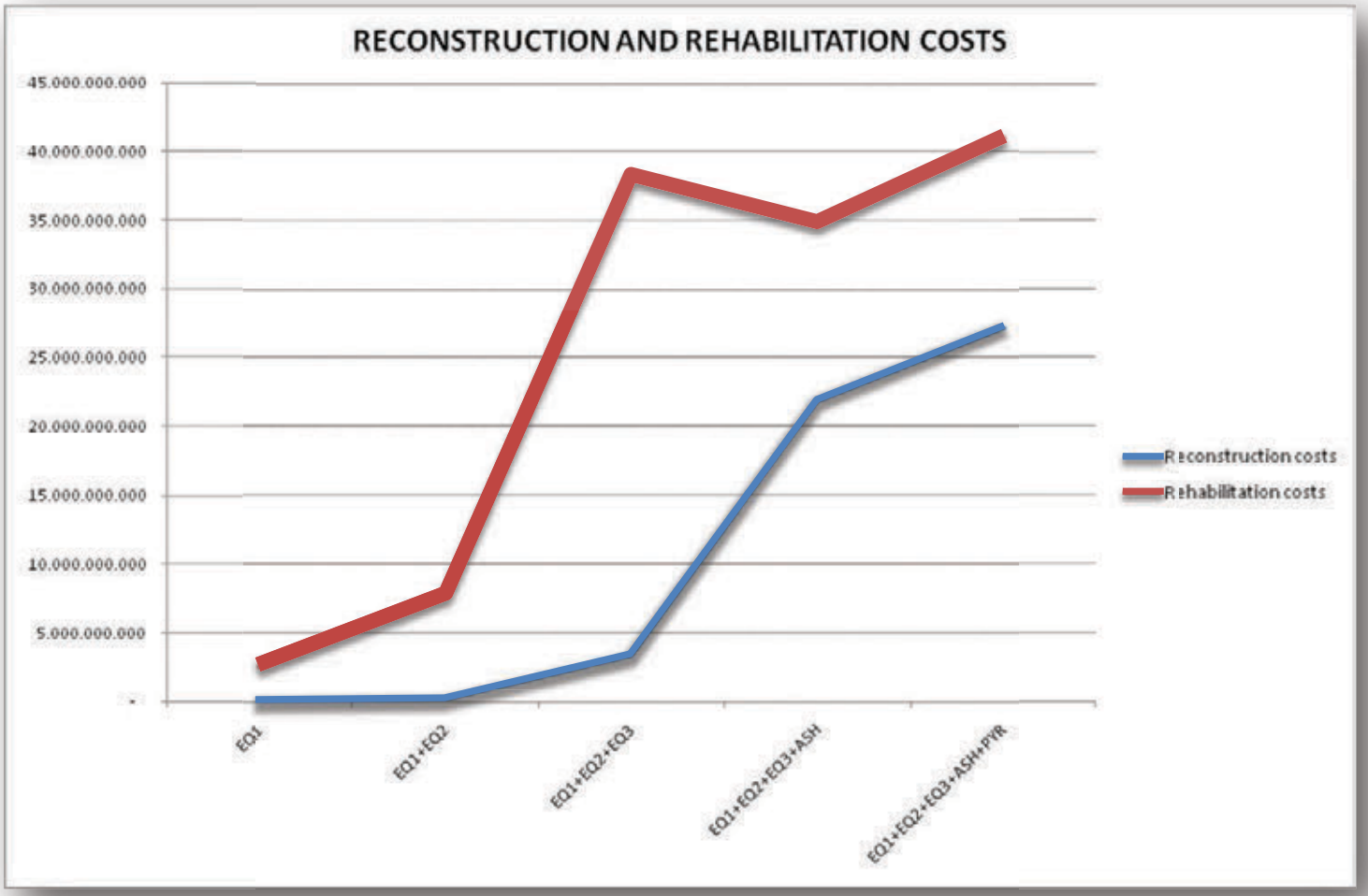

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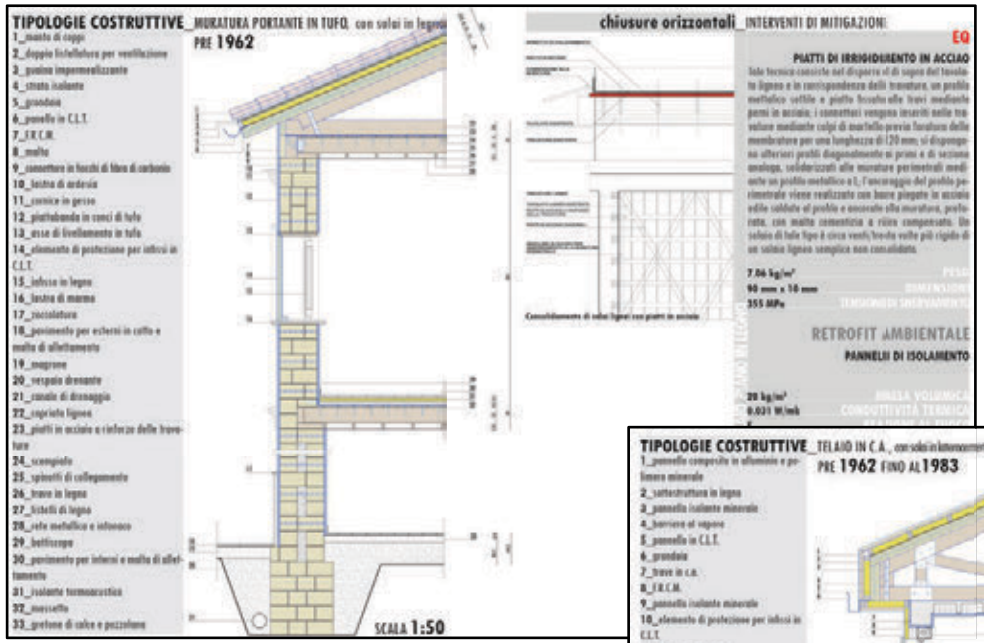
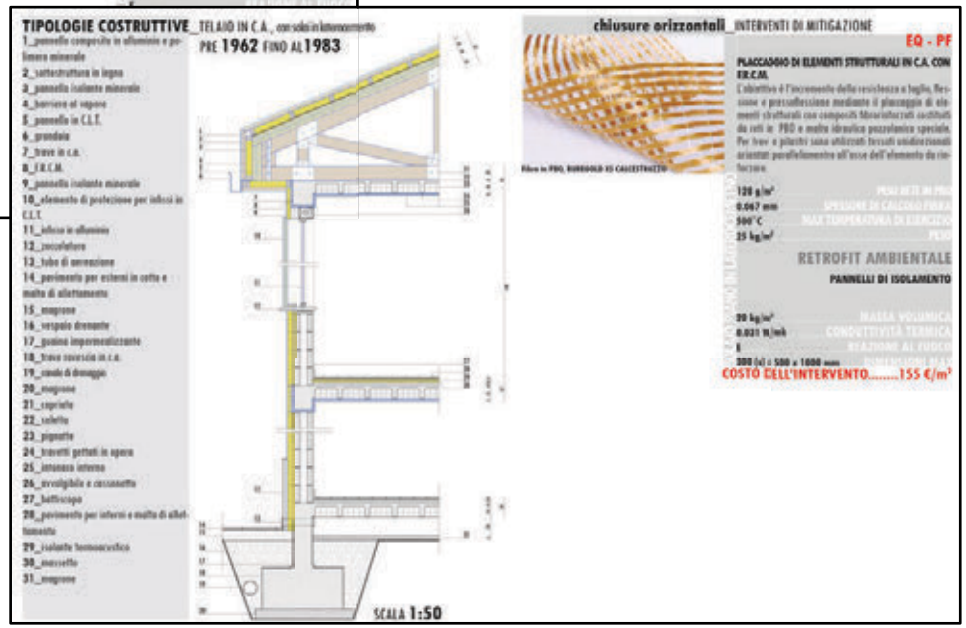
VOLCANIC CASE

MITIGATION MEASURES: TECHNOLOGICAL OPTIONS





Effectiveness and compatibility with recurring construction typologies

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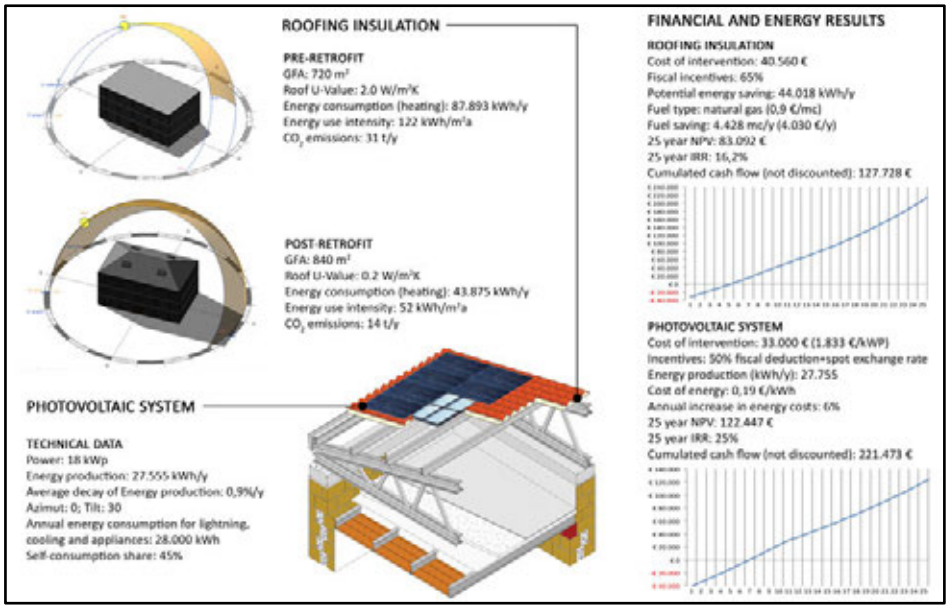
VOLCANIC CASE

MITIGATION MEASURES: TECHNOLOGICAL OPTIONS



Co-benefits assessment:

- **Multi-risk mitigation potential**
- **Urban regeneration potential**
- **Energy improvement potential**

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VOLCANIC CASE

MITIGATION MEASURES: TECHNOLOGICAL OPTIONS

EQ - EARTHQUAKE

Mitigation measures

Structural strengthening interventions with FRP (left) and FRCM (right) technologies.

Code	Mitigation option
SE.1	Placcaggio di elementi strutturali in c.a. c
SE.2	Placcaggio di elementi strutturali in c.a. c
SE.3	Placcaggio di elementi strutturali in c.a. c
SE.4	Confinamento di elementi strutturali in c
SE.5	Confinamento di elementi strutturali in c
SE.6	Placcaggio di muratura portante con FRC
SE.7	Inserimento di catene in acciaio
SE.8	CAM (Cucitura Attiva delle Murature)
SV.1	Placcaggio di tamponature con FRCM
SV.2	Placcaggio di tamponature con pannelli U
SO.1	Placcaggio di travetti con lamine FRP
SO.2	Placcaggio di solette e volte in c.a. con ru
SO.3	Placcaggio di solette e volte in c.a. con FI
SO.4	Placcaggio di volte in muratura con FRCM
SO.5	Sovrastruttura in acciaio (copertura inclir

PF - PYROCLASTIC FLOW

Mitigation measures

Kevlar protection panel (left) and special window with safety film (right).

Code	Mitigation option	Parametric cost
SV.1	Placcaggio di tamponature con FRCM	65-80 €/m2
SV.2	Placcaggio di tamponature con pannelli UHPC	12-25 €/m2
SV.3	Barriere protettive in UHPC	125-150 €/m2
AP.1	Pannelli protettivi in lamiera di acciaio	10 €/m2
AP.2	Film protettivi anti esplosione	25 €/m2
AP.3	Fogli protettivi in kevlar	60 €/m2
AP.4	Avvolgibili in acciaio / alluminio	20-30 €/m2

AF – ASH FALL

Mitigation measures

Overlapping of pitched roof on existing building

Code	Mitigation option
SO.1	Placcaggio di travetti con lamine FI
SO.2	Placcaggio di solette e volte in c.a.
SO.3	Placcaggio di solette e volte in c.a.
SO.4	Placcaggio di volte in muratura co
SO.5	Sovrastruttura in acciaio (copertur
SO.6	Getto integrativo armato con UHP
SO.7	Sovrapposizione di gusci in UHPC

LH – LAHARS

Mitigation measures

Protective barriers and retention basins may limit the risk of impact on inhabited areas.

Code	Mitigation option	Parametric cost
SE.1	Placcaggio di elementi strutturali in c.a. con tessuti FRP	230 €/m2
SE.2	Placcaggio di elementi strutturali in c.a. con lamine FRP	125-150 €/m2
SE.3	Placcaggio di elementi strutturali in c.a. con FRCM	220 €/m2
SE.4	Confinamento di elementi strutturali in c.a. con FRP	230 €/m2
SE.5	Confinamento di elementi strutturali in c.a. con FRCM	220 €/m2
SE.6	Placcaggio di muratura portante con FRCM	65-80 €/m2
SE.7	Inserimento di catene in acciaio	5-7 €/m2
SE.8	CAM (Cucitura Attiva delle Murature)	100-120 €/m2
SV.1	Placcaggio di tamponature con FRCM	65-80 €/m2
SV.2	Placcaggio di tamponature con pannelli UHPC	35-70 €/m2
SV.3	Barriere protettive in UHPC	125-150 €/m2
AP.1	Pannelli protettivi in lamiera di acciaio	10 €/m2
AP.4	Avvolgibili in acciaio / alluminio	20 €/m2 25 €/m2

Parametric costs definition

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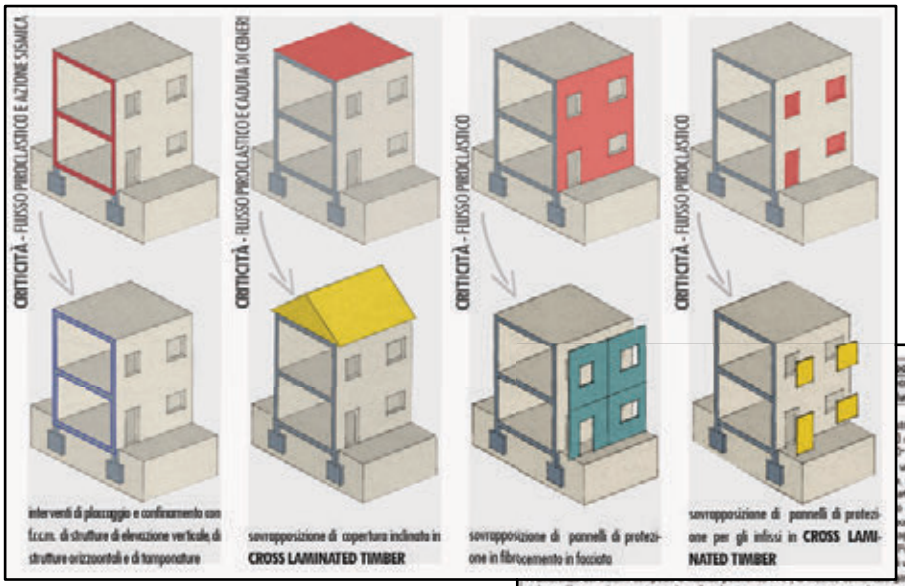
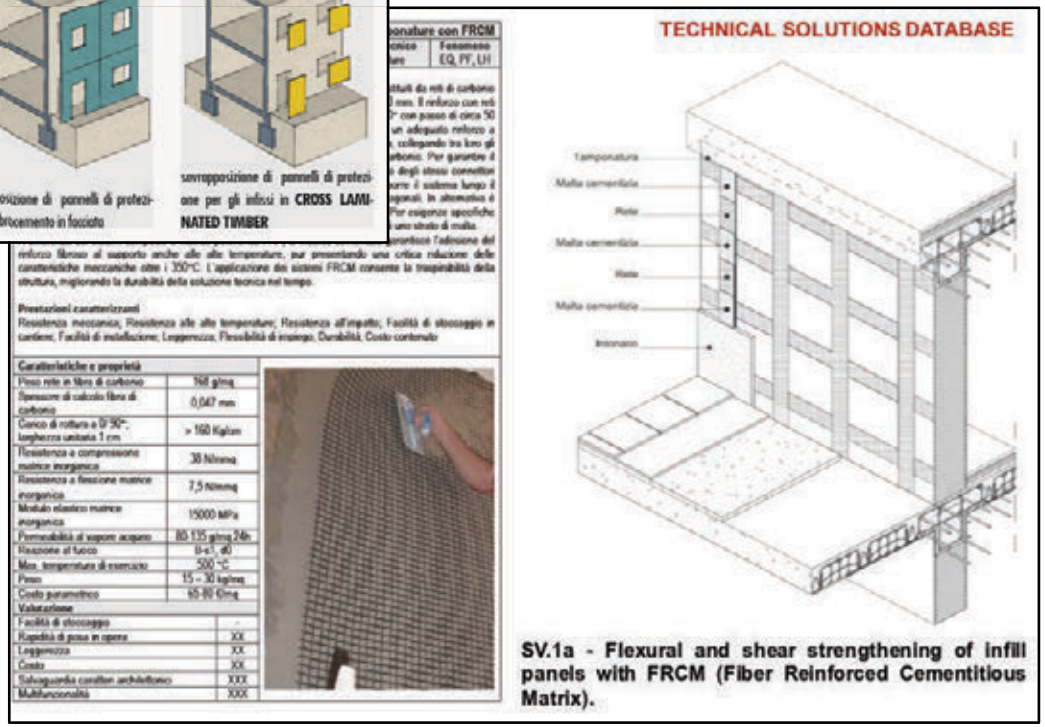
VOLCANIC CASE

MITIGATION MEASURES: TECHNOLOGICAL OPTIONS



Technical solutions database



SV.1a - Flexural and shear strengthening of infill panels with FRCM (Fiber Reinforced Cementitious Matrix).

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   - Seismic
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   - Sea flood
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   - Emergency management
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SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION

Option 0: to wait

- No impact variation

Option 1: voluntary evacuation

Option 2: mandatory evacuation

ACTIONS

- Installation of temporary camp
- Maintenance of temporary camp and assistance to population
- Quick assessment of buildings through safety surveys

COSTS

- Cost of set up and maintenance of temporary shelters
- Social and economical disruptions

BENEFITS (only if main event occurs!)

- Reduced number of dead
- Reduced number of injured
- Reduced post-event sanitary cost

MEDIA and COMMUNICATION MANAGEMENT

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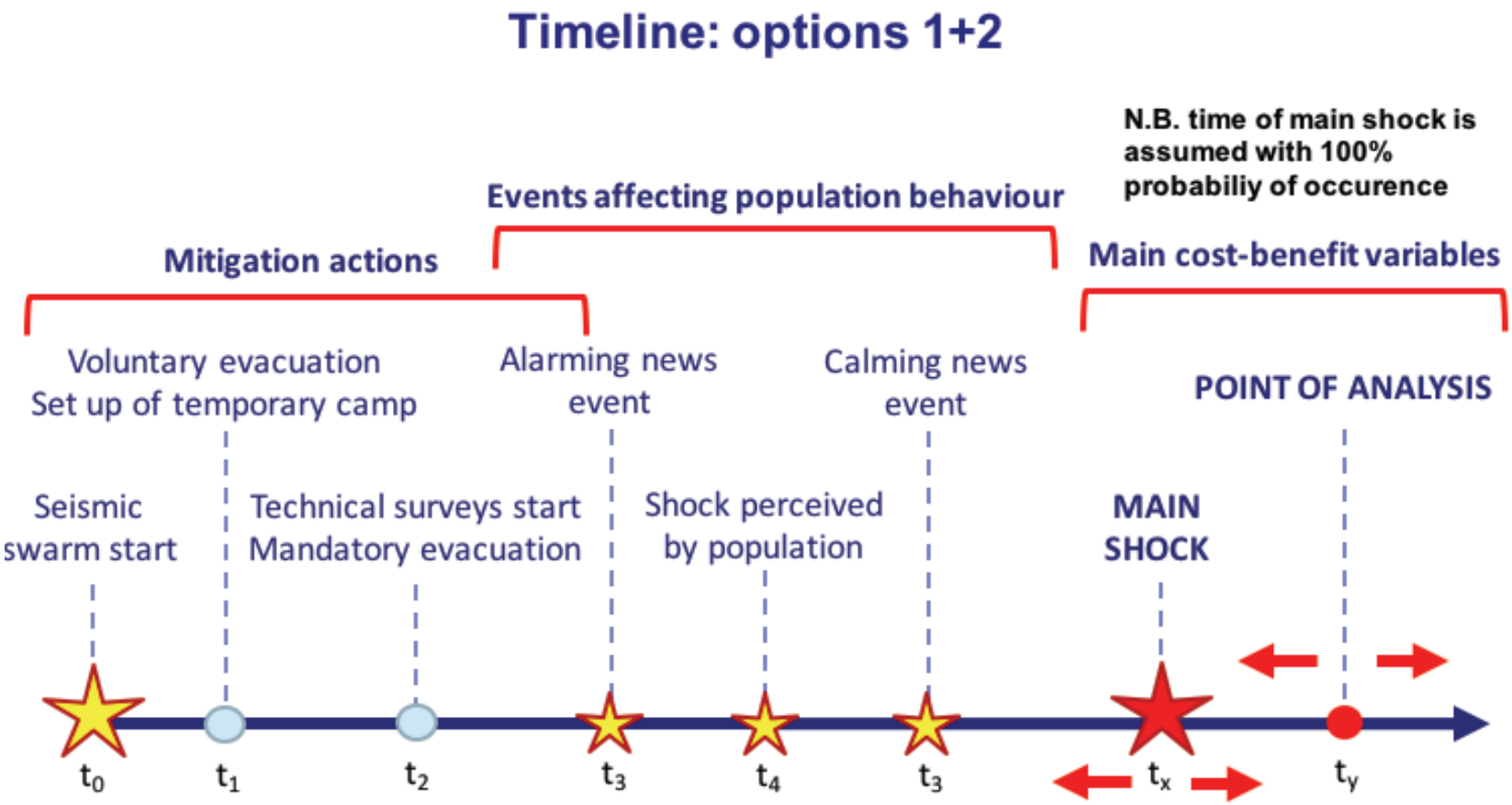
SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION



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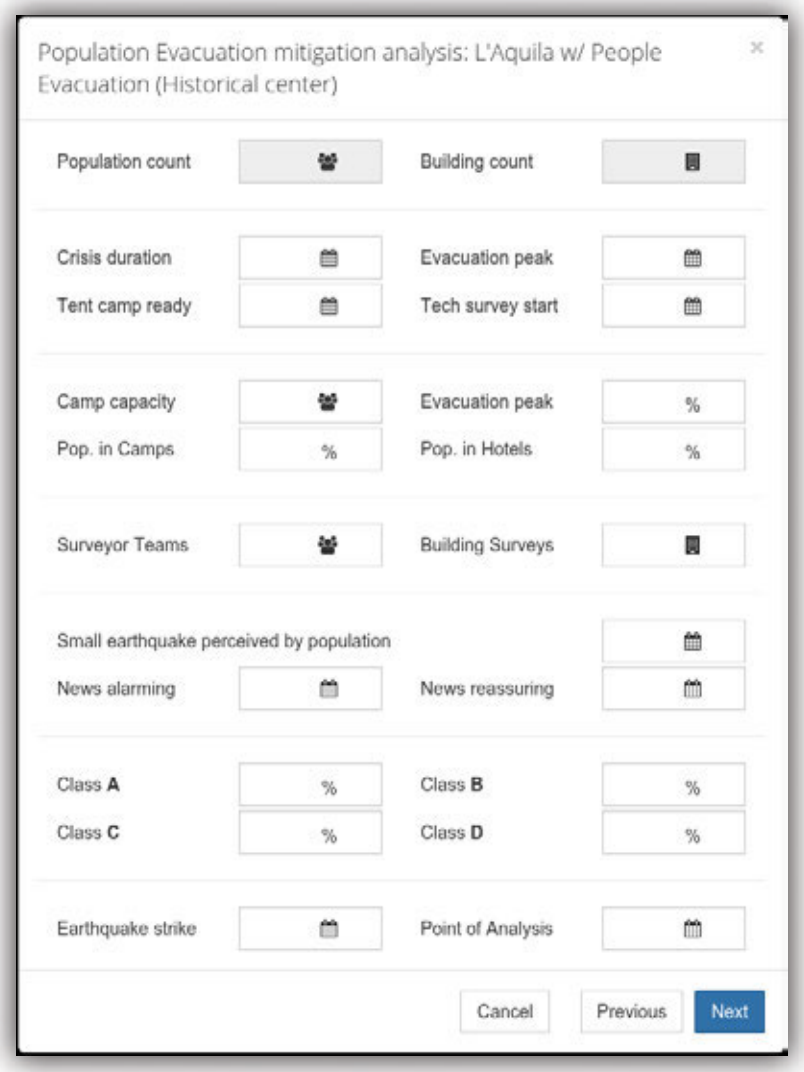
SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION



Input parameters user interface

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SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION

TOOL PARAMETERS

INSTALLATION OF TEMPORARY CAMP (day)	6
TOTAL NUMBER OF PEOPLE IN TENTS (n)	10000
TOTAL DURATION OF THE SEISMIC SWARM (days: 0-180)	90
TOTAL NUMBER OF BUILDINGS (n)	1659
TOTAL POPULATION (n)	11349
SPONTANEOUS EVACUATION PEAK (day)	30
START OF SAFETY SURVEYS (day)	8
SURVEYORS' TEAMS ON THE FIELD (n)	2
BUILDINGS SURVEYED PER TEAM PER DAY (n)	4
MAXIMUM PERCENTAGE OF SPONTANEOUS EVACUATION (%)	50
VARIABILITY DUE TO EVENTS AFFECTING POPULATION BEHAVIOUR (n)	0,4
SEISMIC SHAKE PERCEIVED BY POPULATION (day)	25
ALARMING MEDIA/PRESS EVENT (day)	45
CALMING MEDIA/PRESS EVENT (day)	50
MAIN SHOCK (day)	45
POINT OF ANALYSIS (day)	45

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SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION

Economic impact input-output (example)

INPUT (main event parameters)	
Duration of seismic swarm (days)	90
Time of main shock (day)	45
Point of analysis (day)	45

INPUT (main Evac. pre-EQ cost parameters)
Installation of temporary camp
Evacuation management
Temporary camp management

OUTPUT	NO MITIGATION	MITIGATION
CASUALTIES		
Deads	249	216
Injured	734	620
DIRECT COSTS*		
Evacuation pre-EQ	-	€ 9.171.533
Sanitary costs	€ 1.572.387	€ 1.330.165
>TOTAL DIRECT COSTS	**€ 1.572.387**	**€ 10.501.698**
INDIRECT COSTS		
Deads	€ 28.989.015	€ 24.761.713
>TOTAL INDIRECT COSTS	**€ 28.989.015**	**€ 24.761.713**

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SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION

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variated parameters

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SEISMIC SWARM CASE

SHORT TERM MITIGATION ASSESSMENT: POPULATION EVACUATION

Economic impact input-output (another example)

INPUT (main event parameters)	
Duration of seismic swarm (days)	90
Time of main shock (day)	45
Point of analysis (day)	45

INPUT (main Evac. pre-EQ cost parameters)
Installation of temporary camp
Evacuation management
Temporary camp management

OUTPUT	NO MITIGATION	MITIGATION
CASUALTIES		
Deads	249	209
Injured	734	596
DIRECT COSTS*		
Evacuation pre-EQ	-	€ 7.086.115
Sanitary costs	€ 1.572.387	€ 1.279.267
>TOTAL DIRECT COSTS	**€ 1.572.387**	**€ 8.365.382**
INDIRECT COSTS		
Deads	€ 28.989.015	€ 24.332.145
>TOTAL INDIRECT COSTS	**€ 28.989.015**	**€ 24.332.145**

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Cost-Benefit input (examples)

Mitigation scenario 1

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	50%	0%	0%	0%
B		30%	0%	0%	0%
C			30%	0%	0%

Mitigation scenario 2

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	50%	0%	0%	0%
B		30%	20%	0%	0%
C			50%	0%	0%

Calculated example

Mitigation scenario 3

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	50%	0%	0%	0%
B		0%	0%	50%	0%
C			0%	50%	0%

Mitigation scenario 4

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	50%	0%	0%	0%
B		0%	0%	20%	30%
C			0%	20%	30%

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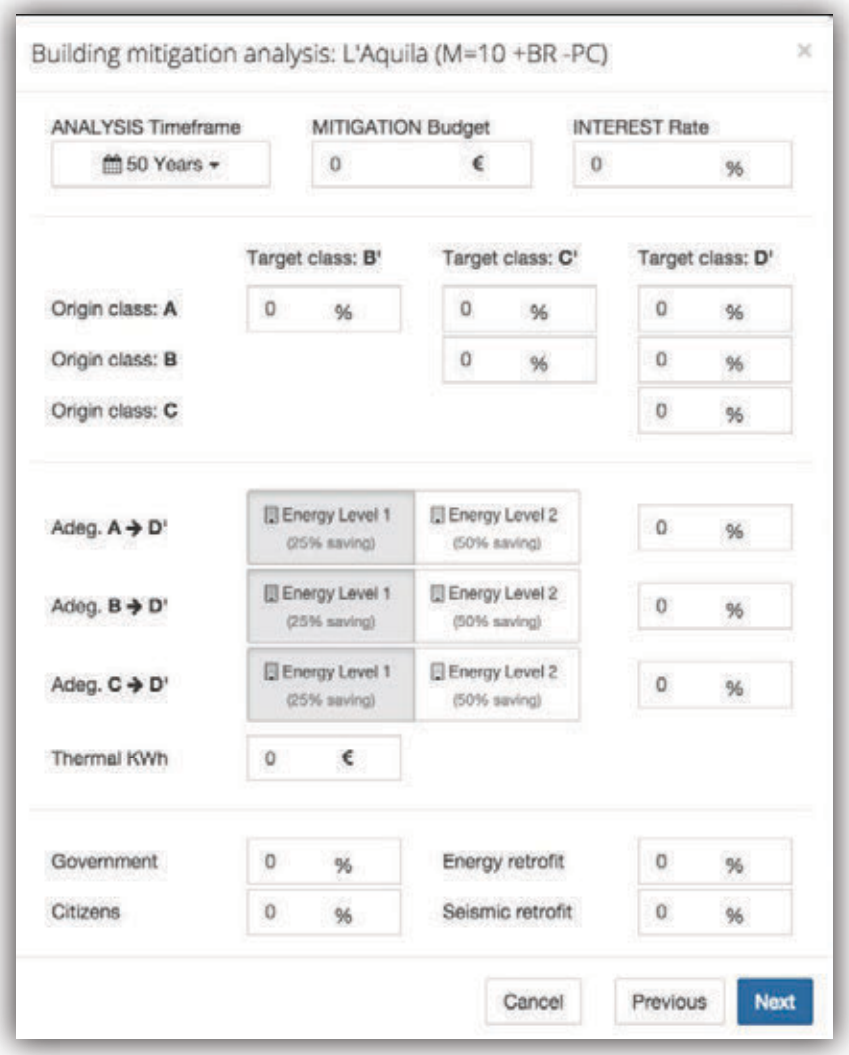
SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING



Input parameters users interface

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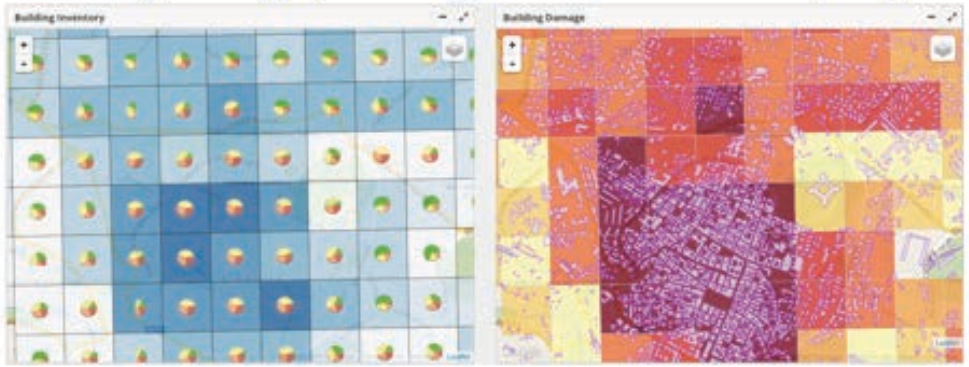
SEISMIC CASE

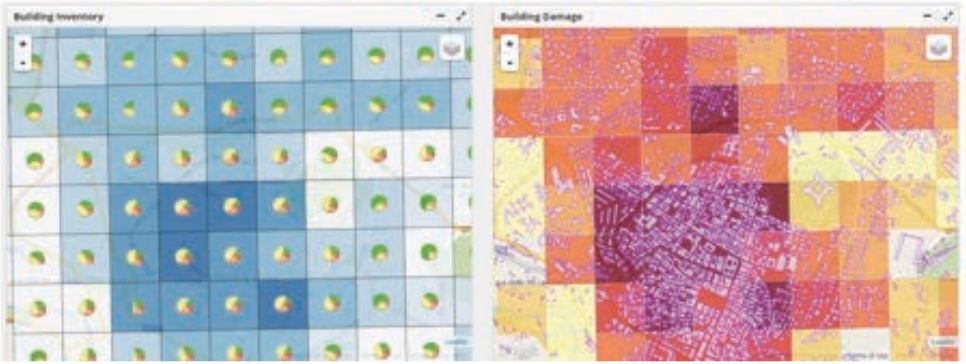
LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Calculate impact variation following mitigation action

Building damage (building distribution and Impact) – NO MITIGATION



Building damage (building distribution and Impact) – MITIGATION



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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Physical impact output
(example limited to Municipality of L'Aquila)

EVENT DATA:

SHAKEMAP 2 'grid_xyz_20090406_332', 42.33, 13.33, 8.8, 5.8

OUTPUT	NO MITIGATION	MITIGATION
CASUALTIES		
Deads	249	199
Injured	734	519
Homeless	10481	8159
BUILDINGS		
Building unsafe	2679	2031
Building losses	1301	881

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Economic impact output (example)

OUTPUT	NO MITIGATION	MITIGATION
DIRECT COSTS		
Emergency management		
Evacuation post-EQ	€ 37.248.424	€ 31.042.625
Emergency management	€ 755.985.800	€ 755.985.800
Sanitary costs	€ 1.572.387	€ 1.125.243
Reconstruction		
Rumble clean-up	€ 28.241.574	€ 19.117.124
Rehabilitation	€ 4.514.585.591	€ 3.356.701.491
Reconstruction	€ 1.323.700.805	€ 931.903.990
TOTAL DIRECT COSTS	**€ 6.661.334.581**	**€ 5.095.876.273**
INDIRECT COSTS		
Deads	€ 85.174.769	€ 68.165.296
VA Evacuation	€ 662.410.872	€ 496.808.154
VA Psycho effects	€ 129.962.133	€ 97.471.600
TOTAL INDIRECT COSTS	**€ 877.547.774**	**€ 662.445.050**
TOTAL ECONOMIC IMPACT	**€ 7.538.882.355**	**€ 5.758.321.323**

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Cost-benefit output (example)

Cost Benefit Analysis

Time Frame selection (year for EQ happening after mitigation measures implementation)	1
Direct cost (present value) without mitigation investments	7.045.684.444
Direct cost (present value) with mitigation investments	5.381.608.713
Mitigation Measure Benefit Present value	**1.664.075.732**

	Government	Citizens	Total
Global cost of Mitigation measure	***-806.038.852***	***-821.442.977***	**-1.627.481.830**
Mitigation Measure Benefit Present value	***1.664.075.732***	-	**1.664.075.732**
Co-Benefits Present Value:			
-Energy saving		-	-
-Tax incentives (Energy)	-	-	-
-Tax incentives (Retrofitting)	***-283.063.980***	***283.063.980***	-
Net Present Value	***574.972.899***	***-538.378.997***	**36.593.902**
Co-Benefits share	*-49,2%*	*-52,6%*	*0,0%*
Cost/Benefit Indicator	*0,58*	*2,90*	*0,98*

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Cost-benefit output (example)

Cost Benefit Analysis

Time Frame selection (year for EQ happening after mitigation measures implementation)	5
Direct cost (present value) without mitigation investments	5.375.118.928
Direct cost (present value) with mitigation investments	4.105.603.520
Mitigation Measure Benefit Present value	**1.269.515.408**

	Government	Citizens	Total
Global cost of Mitigation measure	***-806.038.852***	***-873.620.002***	**-1.679.658.854**
Mitigation Measure Benefit Present value	***1.269.515.408***	-	**1.269.515.408**
Co-Benefits Present Value:			
-Energy saving		-	-
-Tax incentives (Energy)	-	-	-
-Tax incentives (Retrofitting)	***-283.063.980***	***283.063.980***	-
Net Present Value	***180.412.575***	***-590.556.022***	**-410.143.446**
Co-Benefits share	*-156,9%*	*-47,9%*	*0,0%*
Cost/Benefit Indicator	*0,82*	*3,09*	*1,32*

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Cost-benefit output (example)

Cost Benefit Analysis

Time Frame selection (year for EQ happening after mitigation measures implementation)	**10**
Direct cost (present value) without mitigation investments	3.832.385.509
Direct cost (present value) with mitigation investments	2.927.238.568
Mitigation Measure Benefit Present value	**905.146.941**

	Government	Citizens	Total
Global cost of Mitigation measure	*-806.038.852*	*-921.804.427*	**-1.727.843.280**
Mitigation Measure Benefit Present value	*905.146.941*	-	**905.146.941**
Co-Benefits Present Value:			
-Energy saving		-	-
-Tax incentives (Energy)	-	-	-
-Tax incentives (Retrofitting)	*-283.063.980*	*283.063.980*	-
Net Present Value	*-183.955.892*	*-638.740.447*	**-822.696.339**
Co-Benefits share	*153,9%*	*-44,3%*	*0,0%*
Cost/Benefit Indicator	*1,30*	*3,26*	*1,91*

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SEISMIC CASE

LONG TERM MITIGATION ASSESSMENT: BUILDINGS RETROFITTING

Cost-benefit output (example)

Cost Benefit Analysis

Time Frame selection (year for EQ happening after mitigation measures implementation)	30

Direct cost (present value) without mitigation investments	990.361.242
Direct cost (present value) with mitigation investments	756.454.072
Mitigation Measure Benefit Present value	**233.907.170**

	Government	Citizens	Total
Global cost of Mitigation measure	***-806.038.852***	***-1.010.569.800***	**-1.816.608.652**
Mitigation Measure Benefit Present value	***233.907.170***	-	**233.907.170**
Co-Benefits Present Value:			
-Energy saving		-	-
-Tax incentives (Energy)	-	-	-
-Tax incentives (Retrofitting)	***-283.063.980***	***283.063.980***	-
Net Present Value	***-855.195.663***	***-727.505.820***	**-1.582.701.482**
Co-Benefits share	*33,1%*	*-38,9%*	*0,0%*
Cost/Benefit Indicator	*-16,40*	*3,57*	*7,77*

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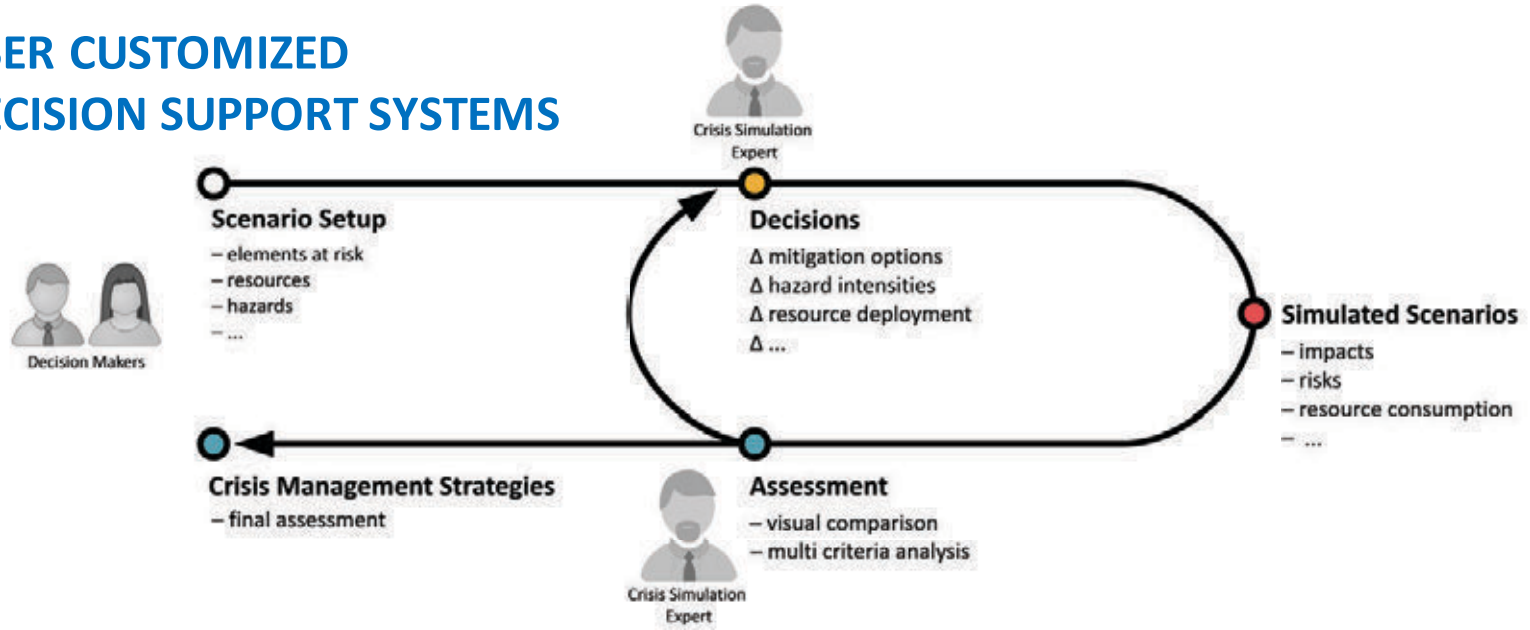
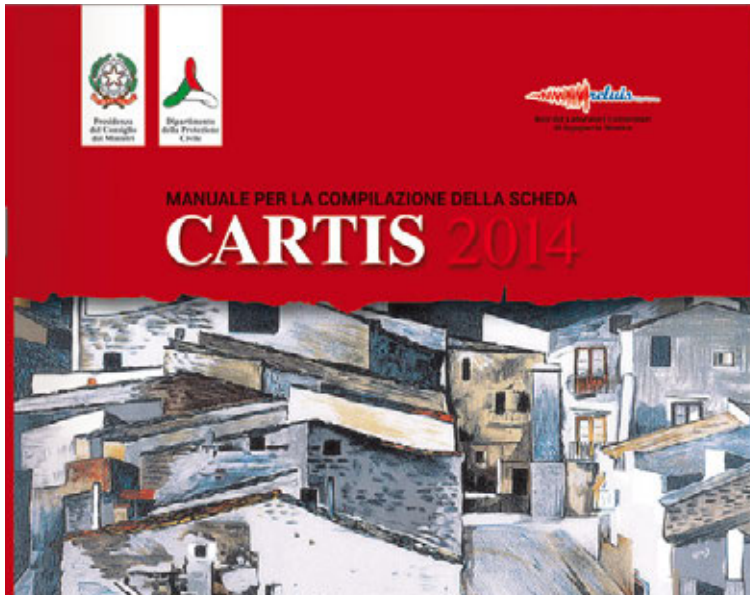
RISK ASSESSMENT AND DECISION SUPPORT

USER CUSTOMIZED DECISION SUPPORT SYSTEMS



TECHNICAL TRAINING ON DAMAGE AND VULNERABILITY ASSESSMENT



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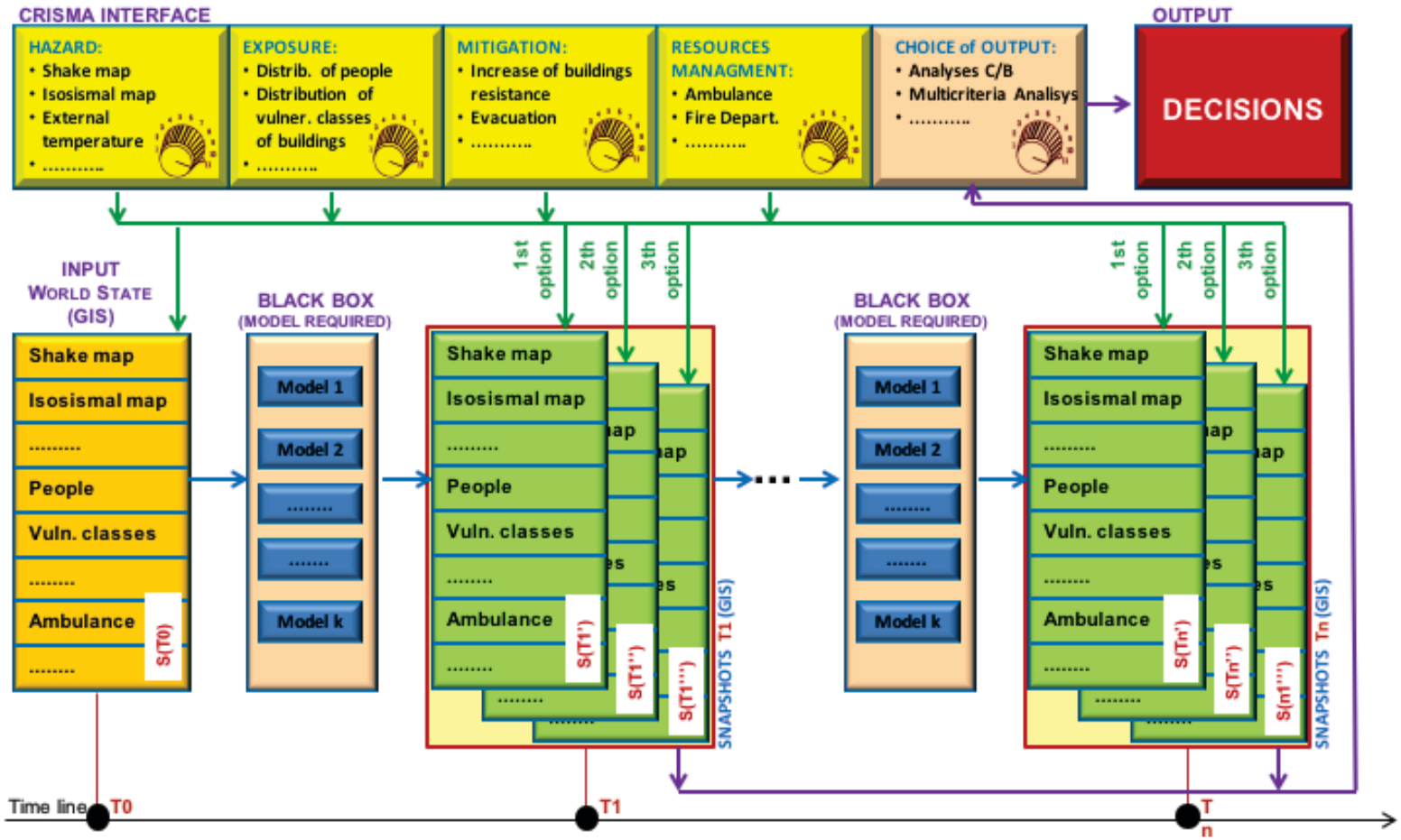
CRISMA SYSTEM

Integrated crisis management (web services based)



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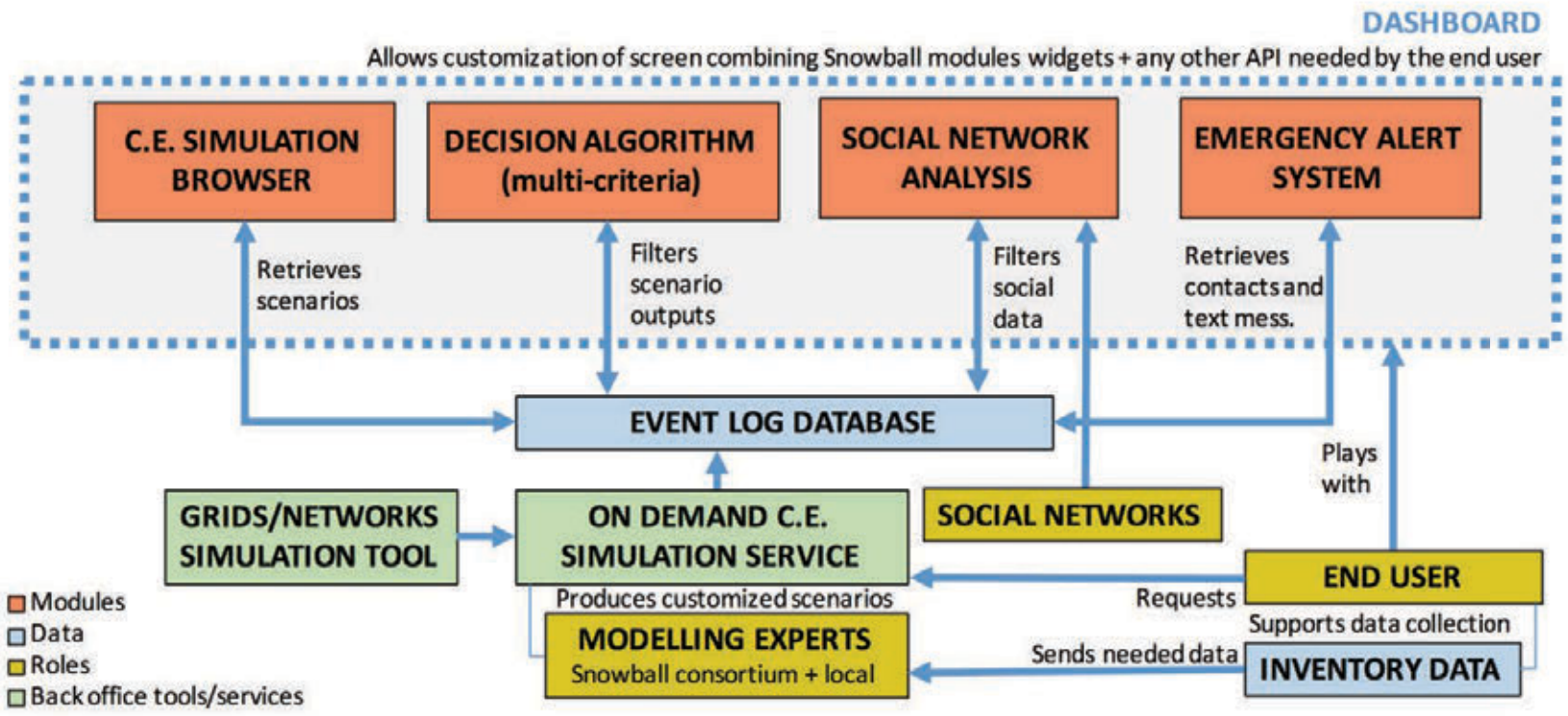
SNOWBALL SYSTEM

Cascading effects preparedness



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TECHNICAL TRAINING ON DAMAGE AND VULNERABILITY ASSESSMENT

- SEISMIC VULNERABILITY ASSESSMENT THROUGH AD HOC FORMS (CARTIS)
- VULNERABILTY FACTORS ASSESSMENT (MEDEA METHODOLOGY)
- ASSESSMENT OF POSSIBLE COLLAPSE MECHANISMS
- MITIGATION STRATEGIES ASSESSMENT
- COST/BENEFIT ANALYSES TO DEFINE THE MITIGATION STRATEGIES

Vulnerability Elements	
M 1	Absence of connection between orthogonal walls and/or tie-beams or stringcourse at different levels
M 2	Presence of stringcourses in breccia on masonries with double facings
M 3	Any floors badly connected with the walls
M 4	Masonry of low quality, reduced resistant area along one or both directions
M 5	High PERCENTAGE of openings
M 6	Foundations Inadequate to resist
M 7	Different consistencies of the fou
M 8	Presence of added buildings with
M 9	Variation of the structural system
M 10	Presence of a raising and/or a sti
M 11	Presence of staggered levels
M 12	Excessive distance between brac
M 13	Pushing structure and/or absenc
M 14	Presence of lintel with reduced b
M 15	Presence of lowered arches and/
M 16	Local reduction of the masonry s
M 17	Local discontinuities (filling of old
M 18	Presence of ridge beam of consi
M 19	Presence of openings in the prox

Vulnerability Elements	
RC 1	Preponderance of walls or frames with infill panels characterized by strong masonry
RC 2	Preponderance of frames with beams and infill panels characterized by weak masonry
RC 3	Preponderance of frames with flat beams and infill panels characterized by weak masonry
RC 4	Frames with spandrel beams along the perimeter and infill panels characterized by weak masonry
RC 5	Preponderance of frames with spandrel beams along the perimeter and RC core
RC 6	Preponderance of walls
RC 7	Isolated building
RC 8	Seismic joint according to the law
RC 9	Seismic joint not according to the law
RC 10	Absence of stocky elements
RC 11	Knee beams/ split levels
RC 12	Stocky elements for ribbon windows
RC 13	Stocky elements for other causes
RC 14	Regular and compact plan
RC 15	Regular and compact enough plan
RC 16	Not very compact plan
RC 17	Absence of bow windows
RC 18	Bow windows < 1,5m
RC 19	Bow windows > 1,5m
RC 20	Medium wheelbase < 4,5m
RC 21	Medium wheelbase ranges from 4,5 to 6m
RC 22	Medium wheelbase > 6m
RC 23	Medium size of columns at 1° level < 25cm
RC 24	Medium size of columns at 1° level ranges from 25 to 45cm
RC 25	Medium size of columns at 1° level > 45cm
RC 26	Infill panels at 1° level along 4 external sides
RC 27	Infill panels at 1° level along 3 external sides
RC 28	Infill panels at 1° level along 2 external sides
RC 29	Infill panels at 1° level along 1 external sides
RC 30	Absence of infill panels at 1° level
RC 31	Rearward columns
RC 32	Pilotis outside the frame

Collapse Mechanism	Vulnerability Factors
1. Storey shear mechanism o 	• Good embedment between the walls (with or without connections at floor levels) • Small resistance area in one or two directions (i.e. for high percentage of openings or small thickness of the walls)
2. Storey shear mechanism (upper storeys) 	• Variations in the resistance system at the upper floors (i.e variations in the wall thickness and/or presence of poorer quality masonry) • Presence of heavy roofs
3. Whole wall overturning 	• Lack of connections between orthogonal walls and/or of ties or ring beams • Large distance between walls • Thrusting roof and lack of connection between the wall and the roof
4. Partial wall overturning 	• Large distance between walls • Thrusting roof and lack of connection between the wall and the roof • High percentage of openings
5. Vertical instability of the wall 	• Presence of ring beams in breach on masonry to double wall • Poor quality of the masonry • Presence of intermediary floors with poor embedment to the walls

1. RISK ASSESSMENT
2. EXAMPLES OF RISK ASSESSMENT
   - Seismic
   - Volcanic
   - Hydrogeological
   - Sea flood
3. RISK ASSESSMENT AND DECISION SUPPORT
   - Emergency management
   - Emergency planning
   - Economic impact and mitigation measures assessment
   - User customized DSS
   - Technical training

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