EnergyMed GREEN INNOVATIONS ! 24 > 26 Marzo 2022

COMUNE DI NAPOLI

CENTRO STUDI PLINIVS

DiARC dipartimento di architettura università degli studi di napoli federico II

Napoli 2030
Sfide e strategie per un ambiente costruito sostenibile e resiliente

La pianificazione per la resilienza multirischio. Integrare la riduzione del rischio da disastri, l'adattamento climatico e la gestione dell'emergenza

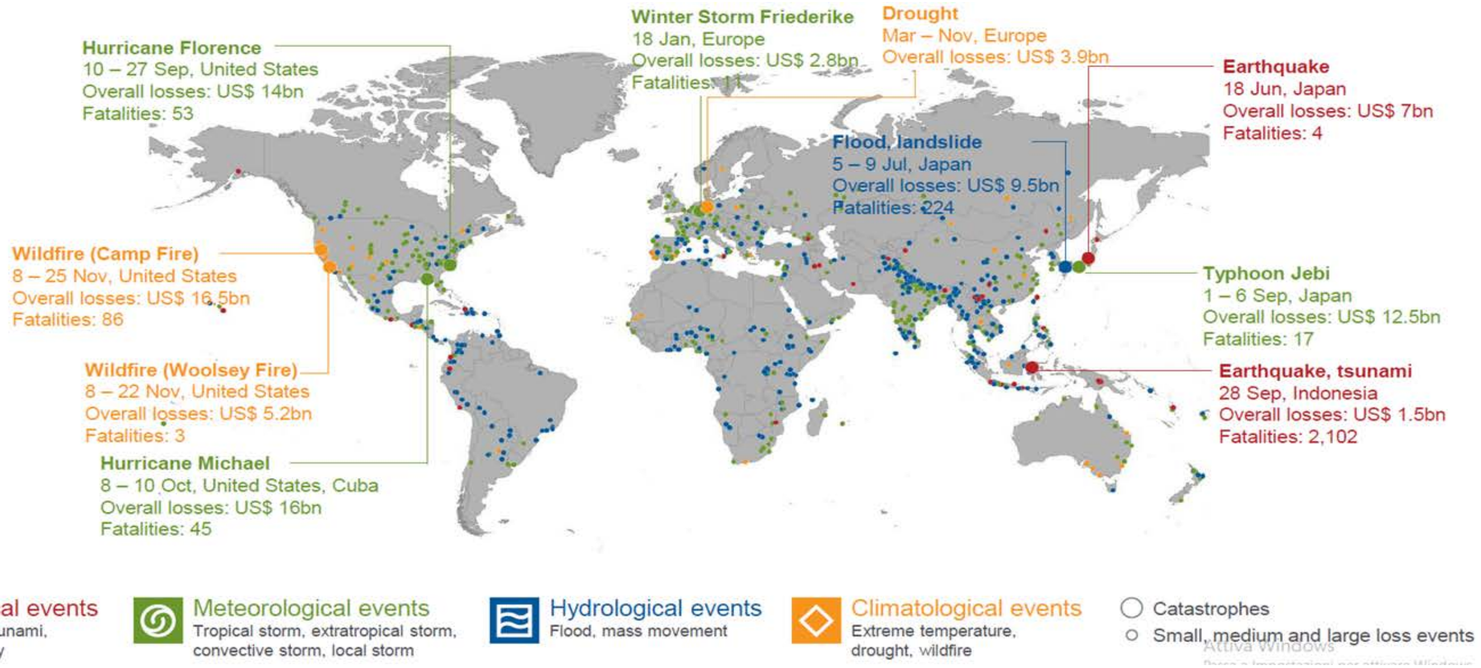
Giulio Zuccaro, Università di Napoli Federico II - Centro Studi PLINIVS

Uragano Katrina, 2005
http://www.lefotochehannosegnatounepoca.it/

Tsunami Indonesia, 2018
http://www.lefotochehannosegnatounepoca.it/

Terremoto Haitì, 2010
http://www.escuelapedia.com/terremoto-en-haiti/

LOSS EVENTS WORDWIDE, 2018 GEOGRAPHICAL OVERVIEW, 2018



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FONTE: Muchich Re, NatCatSERVICE, 2019: https://www.munichre.com/site/corporate/get/params_E-1484416526_Dattachment/1744638/2019_Jan-Jun_worldmap.pdf

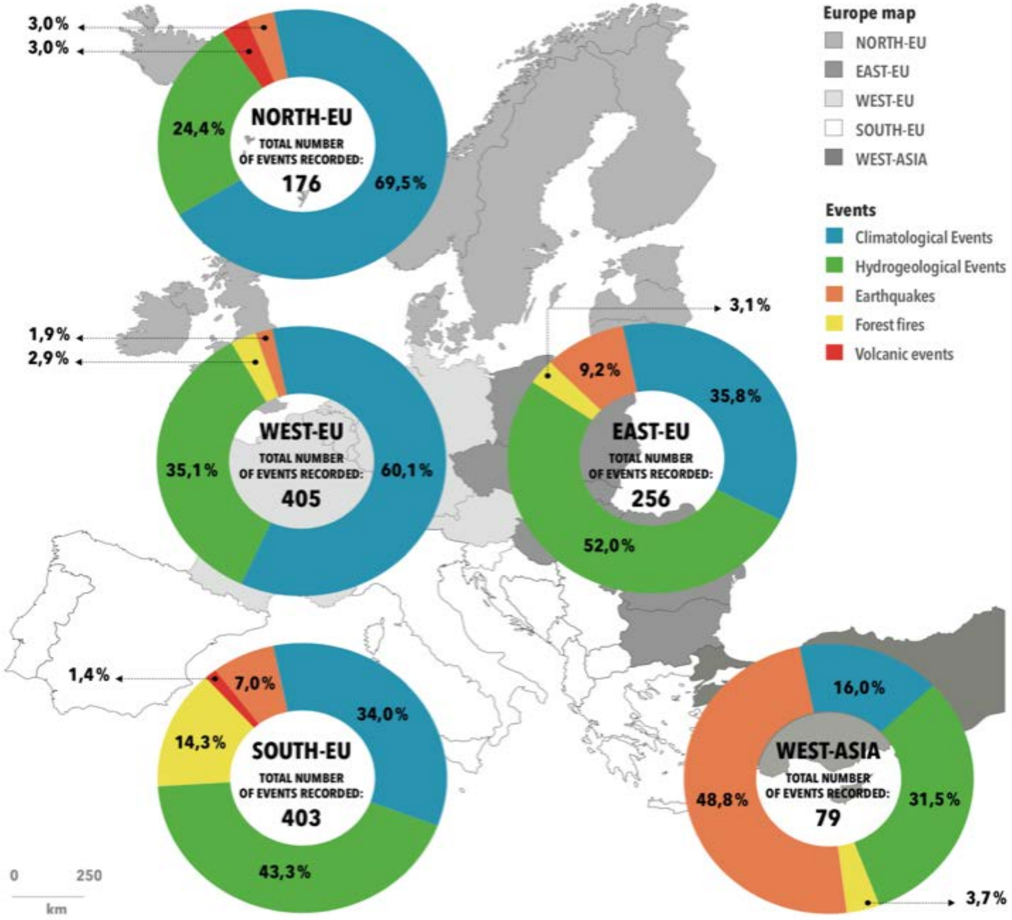

Figure 8: Map of natural events recorded in the EM-DAT catalogue and grouped according to the geography of Europe. Events (total 1402) are from 1903(earthquakes), 1906(volcanic and hydrogeological), 1928 (climatological), 1949 (wildfires). Events are not recorded based on intensity and losses. Source: EM-DAT catalogue, EEA.

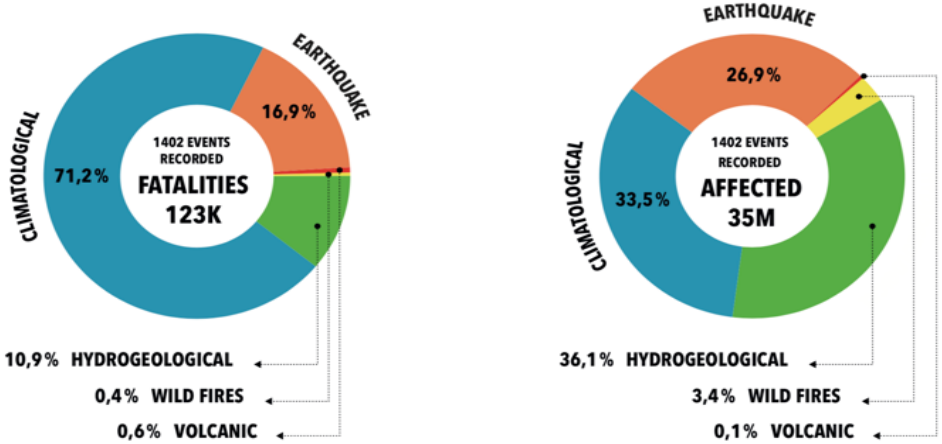

Figure 9: Percentage distribution of fatalities and affected (deaths, homeless, injured) for each type of natural event considered (1402 events recorded from 1903 - 2018).

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FONTE: EPREssO EU Project - Vision Paper. Available at:
http://www.espressoproject.eu/images/deliverables/ESPREssO_D5.5.pdf

Sendai Framework for DRR,

2030 Agenda for Sustainable Development,

DRMKC Science for DRM 2017 report

EEA 2017 report on CCA and DRR

Global Risk Report, 2018

The New Urban Agenda

Paris Agreement on Climate

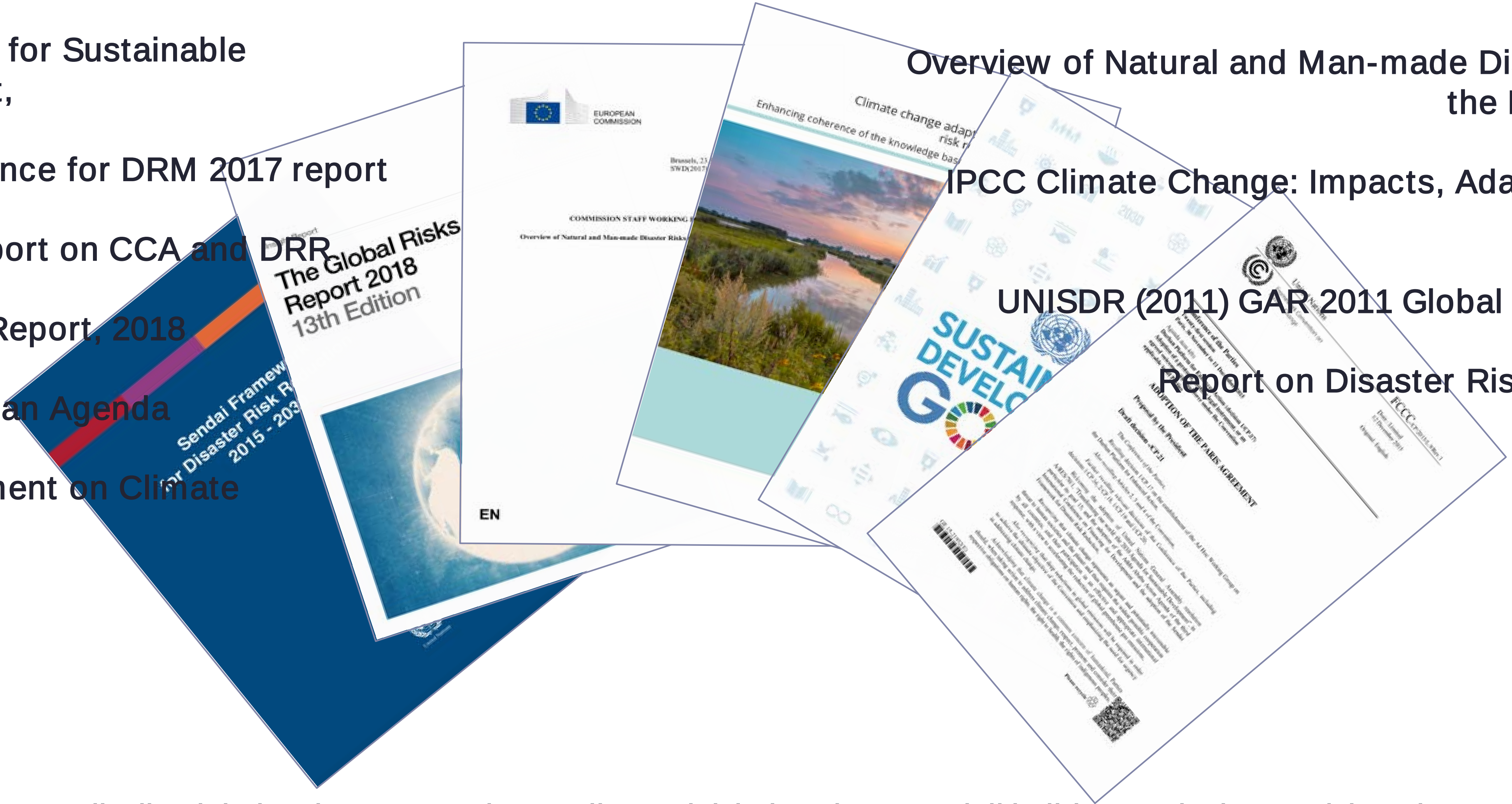
EU Action Plan on the Sendai Framework for DRR 2015-2030

Overview of Natural and Man-made Disaster Risks the EU may face

IPCC Climate Change: Impacts, Adaptation, and Vulnerability

UNISDR (2011) GAR 2011 Global Assessment

Report on Disaster Risk Reduction



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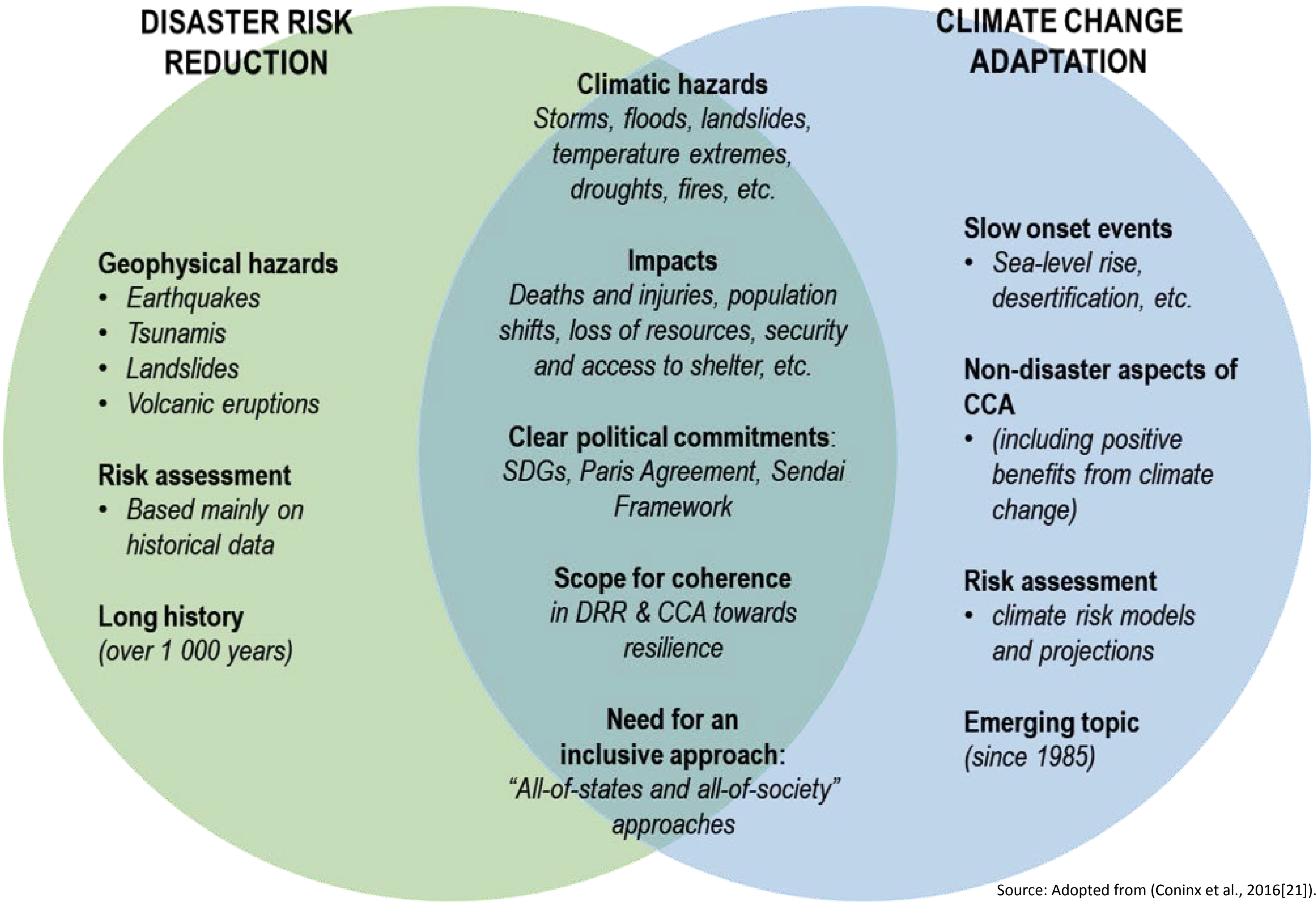
A livello globale ed europeo esistono diverse iniziative, documenti di indirizzo e piani operativi per la riduzione del rischio da disastri e per l’adattamento al cambiamento climatico

Climate change adaptation and Disaster risk reduction – different origins, common goals

Integrating the **Sendai Framework** for Disaster Risk Reduction, the **Paris Agreement** on climate change, and the 2030 **Sustainable Development Agenda** (Global Platform for Disaster Risk Reduction) is important to build a more sustainable, resilient, and equitable future.

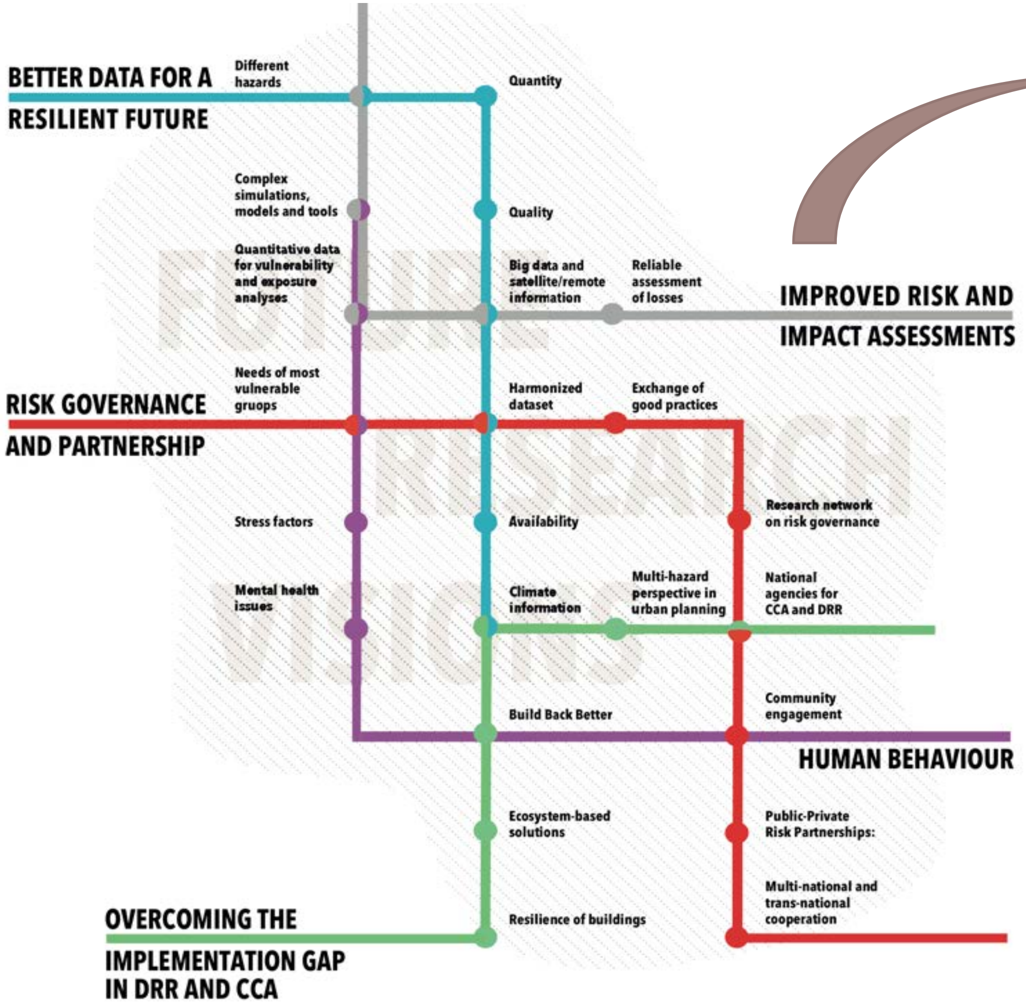


Source: Adopted from (Coninx et al., 2016[21]).

Key commonalities and differences in disaster risk reduction (DRR) and climate change adaptation (CCA)

Il contributo al prossimo programma di ricerca europeo

Cinque tematiche confluite nel programma di ricerca Horizon Europe



Ampio spazio alle tematiche
Della RRD e ACC

RISK = HAZARD x EXPOSURE x VULNERABILITY

HAZARD : probability that in a specific area, a specific event occours during a specific time;

EXPOSURE: extension, quantity and quality of different element at risk (population, buildings, infrastructure, economy, etc…) in the examined area, likely to be affected by the event;

VULNERABILITY: the probability of elements at risk to show damage or changes under effect of natural hazard;

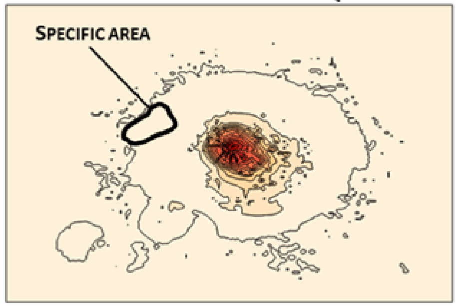
EXPOSURE EVALUATION
buildings distribution on the **vulnerability classes** in the examined area

HAZARD

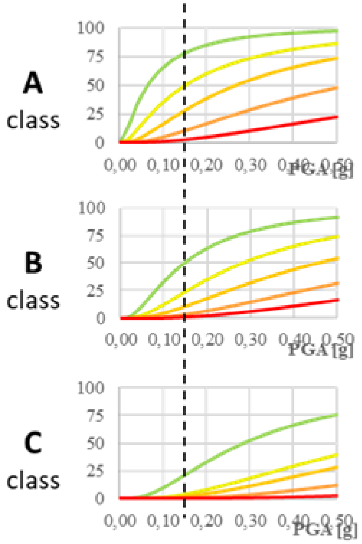
Scenario: PGA is given by shakemap;

Map: PGA is given, in a specific point of Italian map, by probabilistic evaluations

EXAMPLE SHAKEMAP L'AQUILA2009



VULNERABILITY



For a given PGA value (for example 0.15 g) the buildings distribution on the level of damage for each class can be estimated.

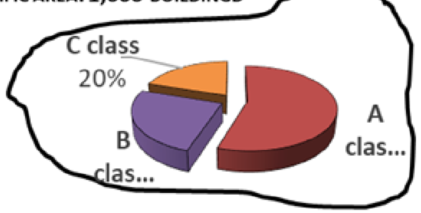
	A	B	C
D0	23%	73%	83%
D1	28%	27%	17%
D2	22%	13%	2%
D3	18%	7%	2%
D4	8%	2%	0%
D5	2%	1%	0%

EXPOSURE

Buildings distribution on the **vulnerability classes** in the examined area allows to evaluate number of buildings for each vulnerability class.

Exploiting, then, the vulnerability curves, the number of buildings for each level of damage is estimated

SPECIFIC AREA: 1,000 BUILDINGD



	A	B	C	TOT
D0	550*23%	250*73%	200*83%	427
D1	550*28%	250*27%	200*17%	224
D2	550*22%	250*13%	200*2%	186
D3	550*18%	250*7%	200*2%	119
D4	550*8%	250*2%	200*0%	52
D5	550*2%	250*1%	200*0%	180

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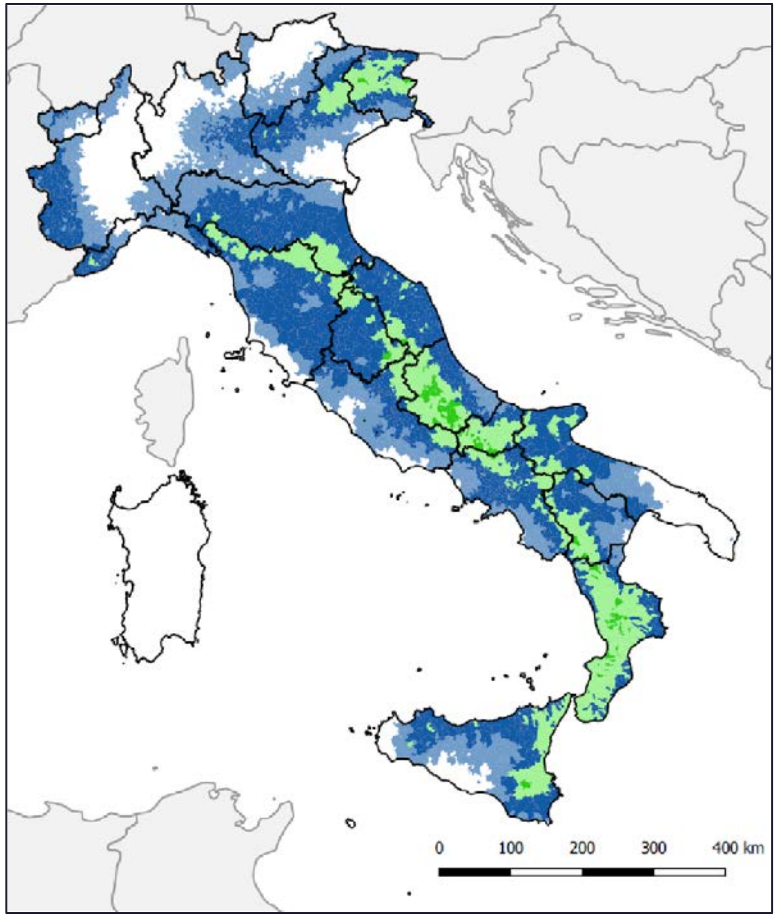
CONDITIONAL DAMAGE MAP [TT = 475y]
Medium Damage

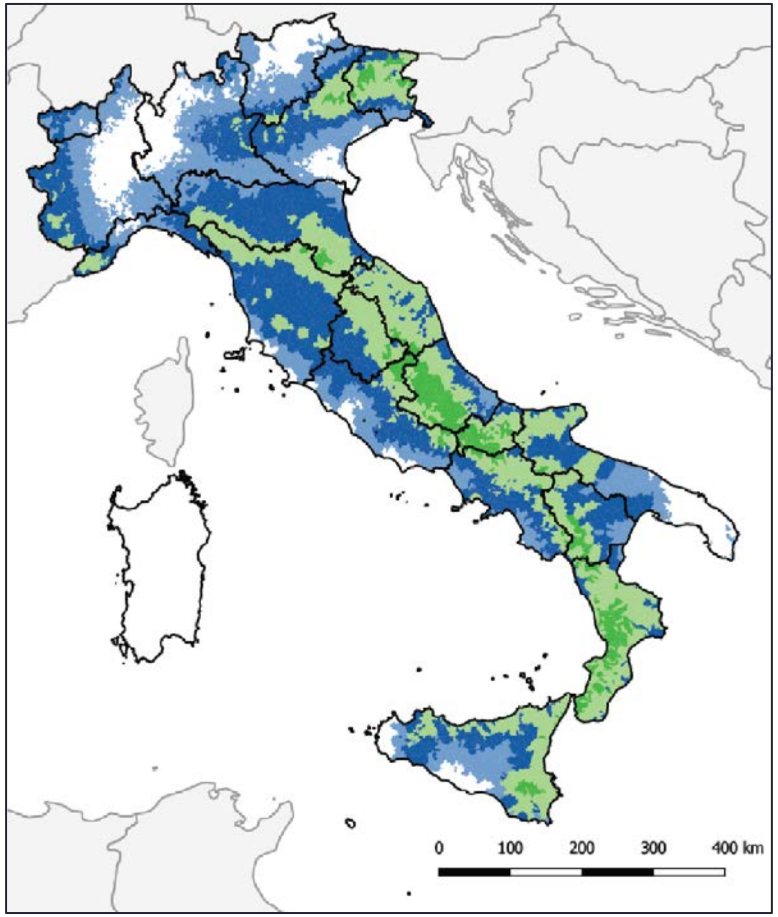
Suolo di tipo A



Legenda [%]

- 0.00 – 0.50
- 0.50 – 1.00
- 1.00 – 1.50
- 1.50 – 2.00
- 2.00 – 2.50
- 2.50 – 3.00
- 3.00 – 3.50
- 3.50 – 4.00
- 4.00 – 4.50
- 4.50 – 5.00

Suolo di tipo B



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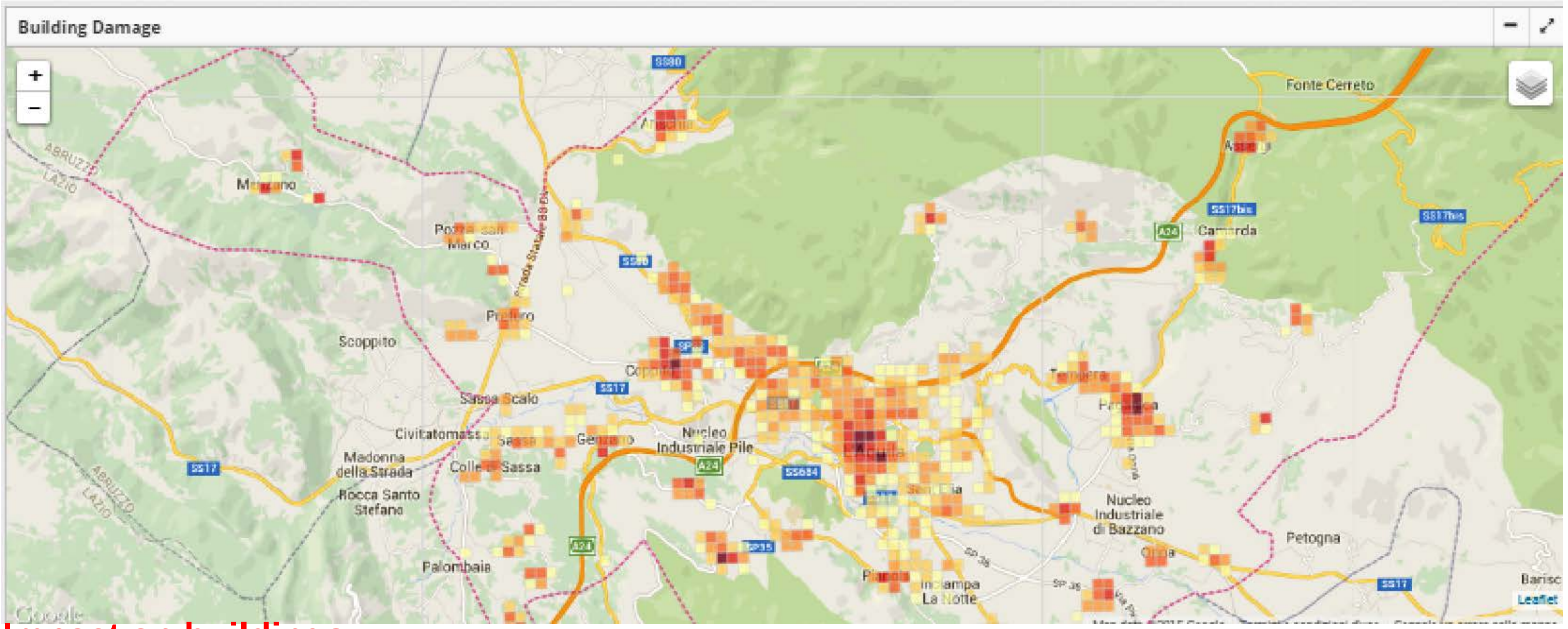
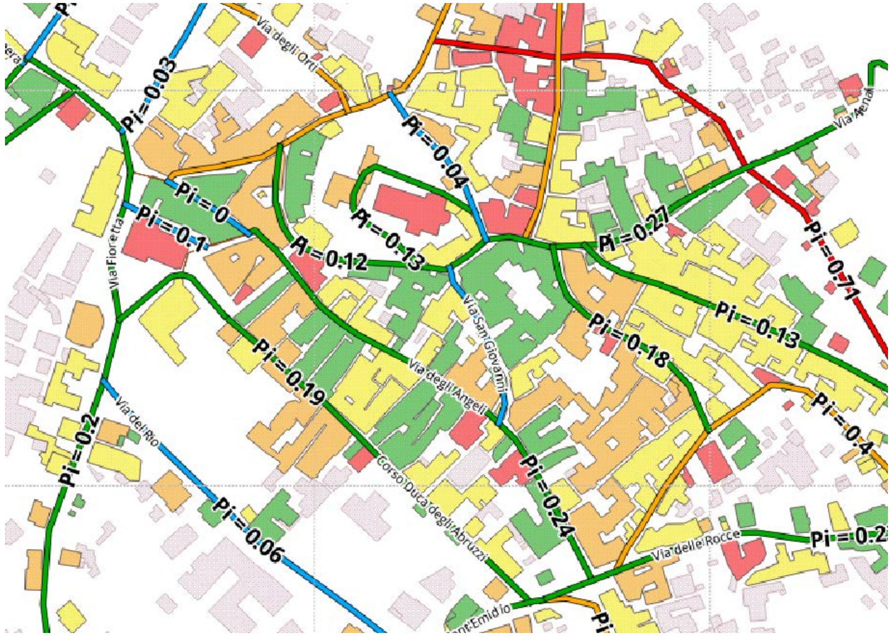
Seismic and energy retrofitting of residential buildings: a simulation-based approach. *UPLanD - Journal of Urban Planning, Landscape & environmental Design* (con Zuccaro, G.), v. 1, n. 1, p. 11-25

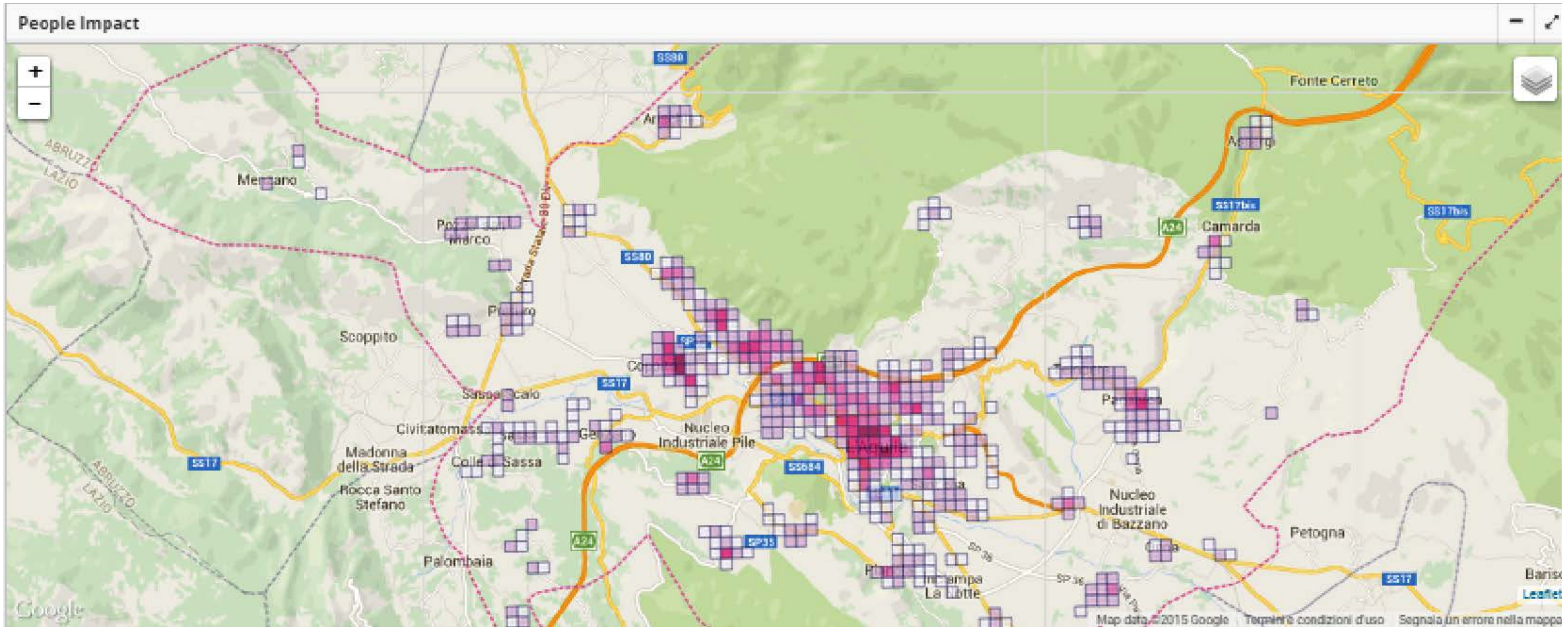
Seismic Events



Impact on buildings



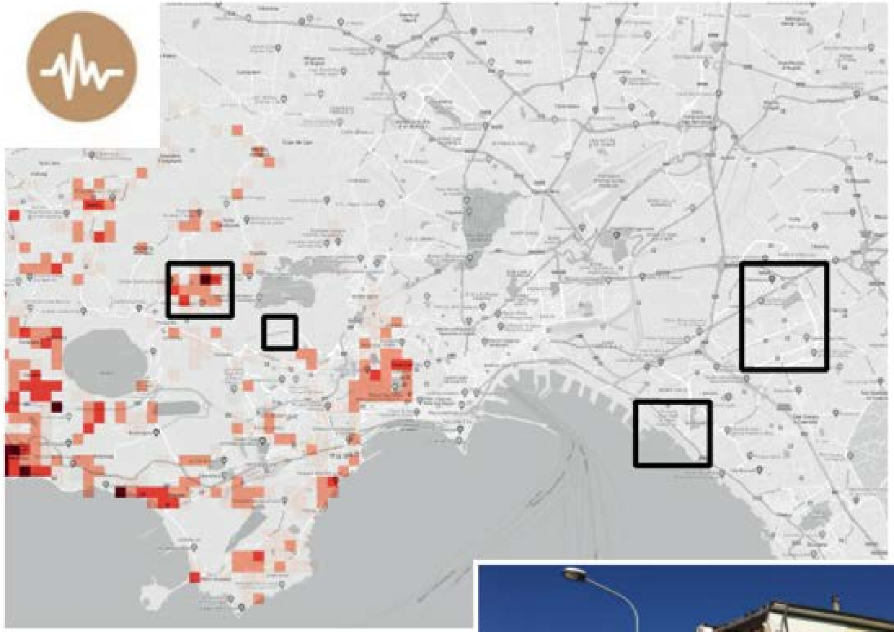
Probability of interruption of road links



Impact on people

Terremoto

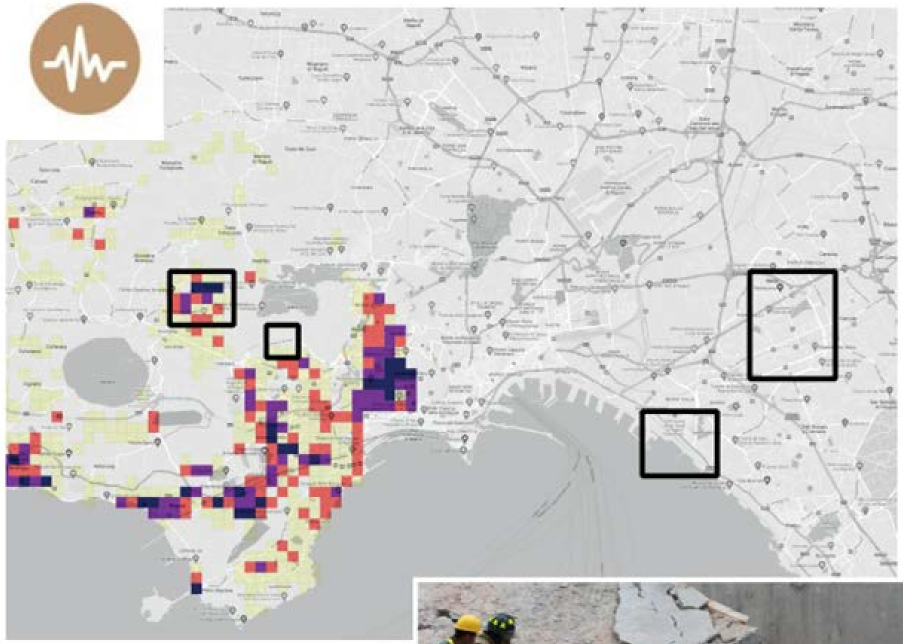
dettagli evento
Terremoto di origine vulcanica ai Campi Flegrei
Magnitudo: 4.2
Profondità epicentro: 3.2 Km



Perimetro aree studio

Impatto sismico
edifici persi

- 0.010 - 0.020
- 0.020 - 0.050
- 0.050 - 0.100
- 0.100 - 0.209



Perimetro aree studio

Impatto sismico
vittime

- 0.001 - 0.005
- 0.005 - 0.010
- 0.010 - 0.020
- 0.020 - 0.053

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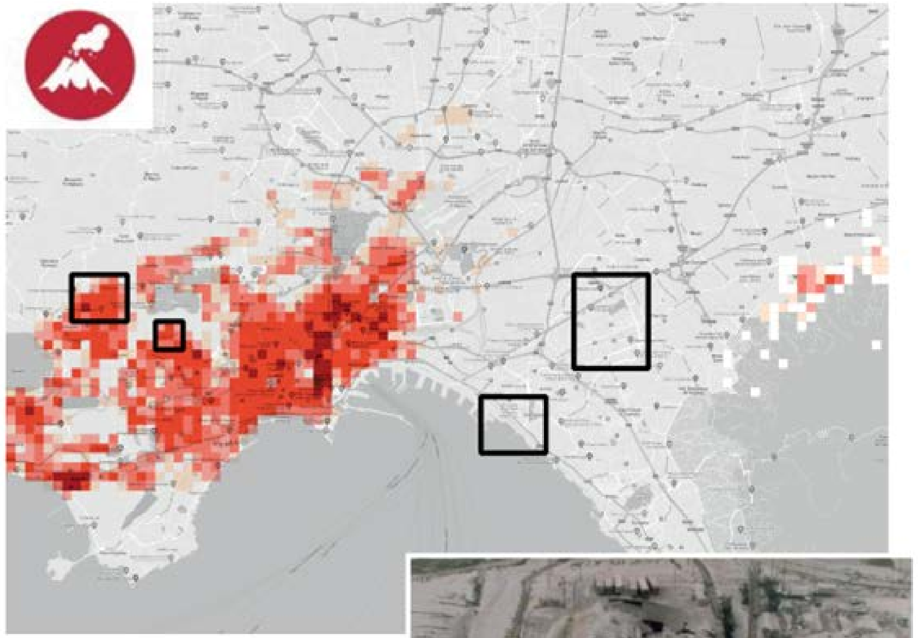
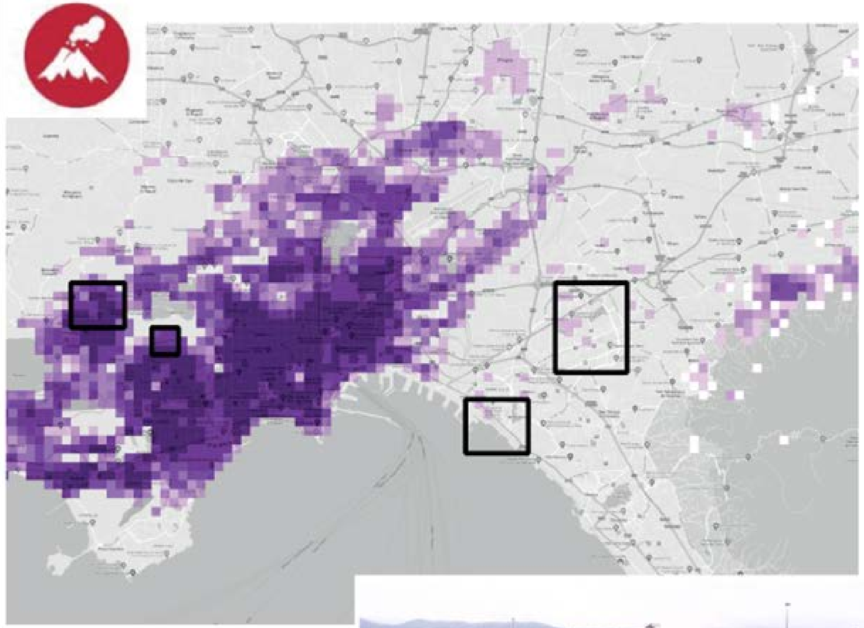
Eruzione vulcanica

dettagli evento
Eruzione dei vulcani Vesuvio e Campi Flegrei
Tipo di eruzione: sub-pliniana
Occorrenza: 60 – 200 anni



Perimetro aree studio

Impatto eruzione vulcanica
coperture collassate
- 0.5 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50



Perimetro aree studio

Impatto eruzione vulcanica
senza tetto
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 500

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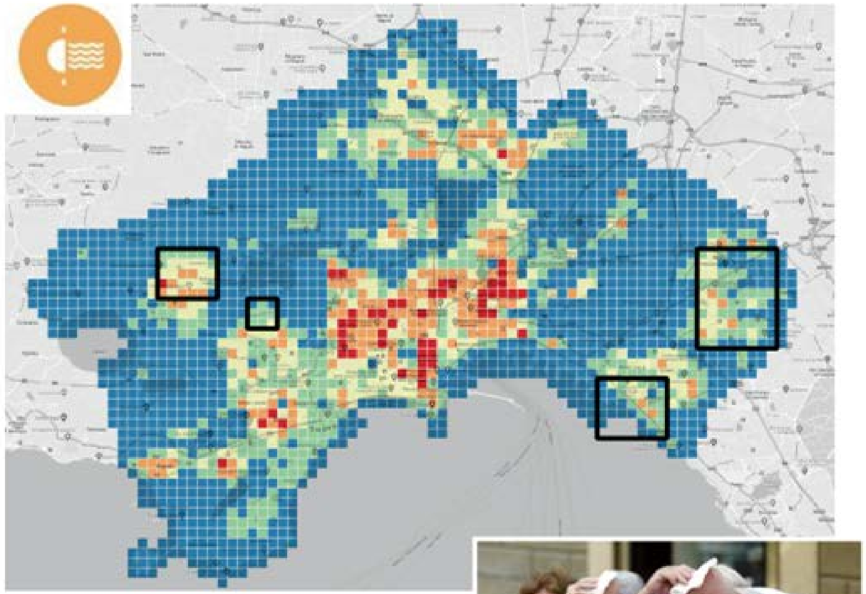
Ondata di calore

dettagli evento
Periodo: 2041-2070
Occorrenza: occasionale (5 volte in 30 anni)
Temperatura dell'aria: 41,5° C

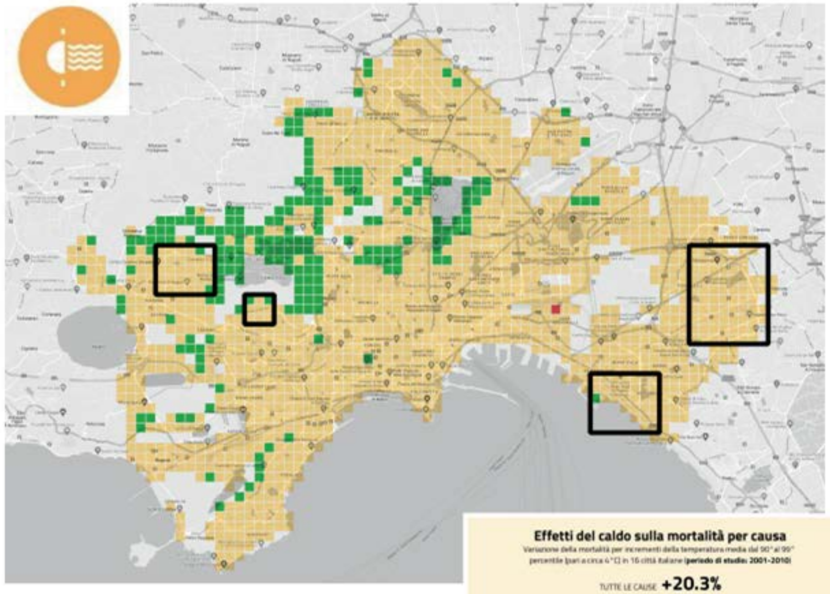


Perimetro aree studio

Impatto da ondata di calore

costi di ospedalizzazione attribuibili a andata di calore

- 0 - 500
- 500 - 1500
- 1500 - 2500
- 2500 - 4000
- 〉4000



Perimetro aree studio

Impatto da ondata di calore

aumento di mortalità attribuibile a ondata di calore

- basso (0% - 5%)
- medio (5% - 8,5%)
- alto (8,5% - 12%)

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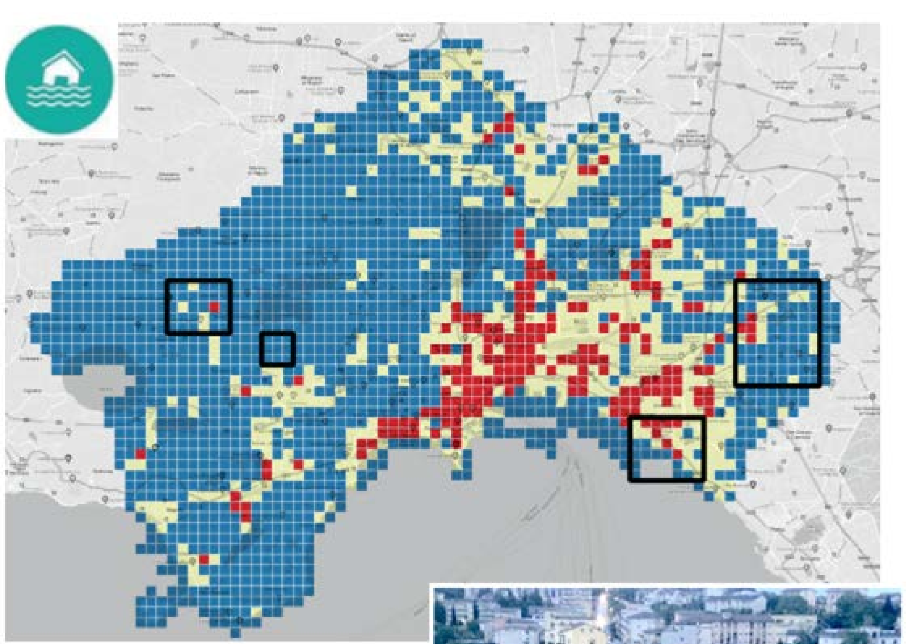
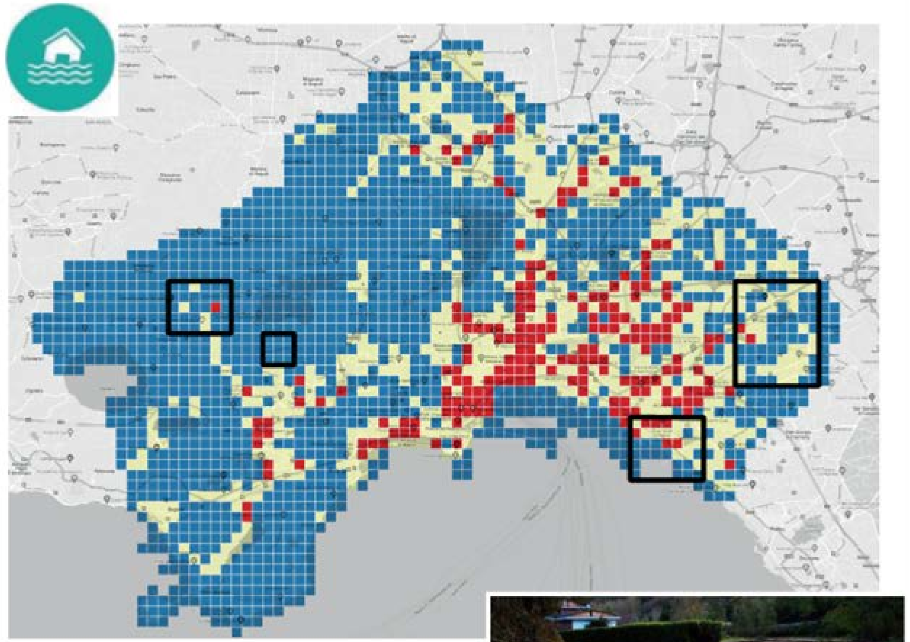
Allagamento pluviale

dettagli evento
Periodo: 2041-2070
Occorrenza: occasionale (5 volte in 30 anni)
Precipitazioni: 90mm



Perimetro aree studio

Impatto da allagamento
costi allagamento edifici
- basso*(0- 30k)
- medio*(30k - 300k)
- alto*(> 300k)



Perimetro aree studio

Impatto da allagamento
costi allagamento strade
- basso
- medio
- alto

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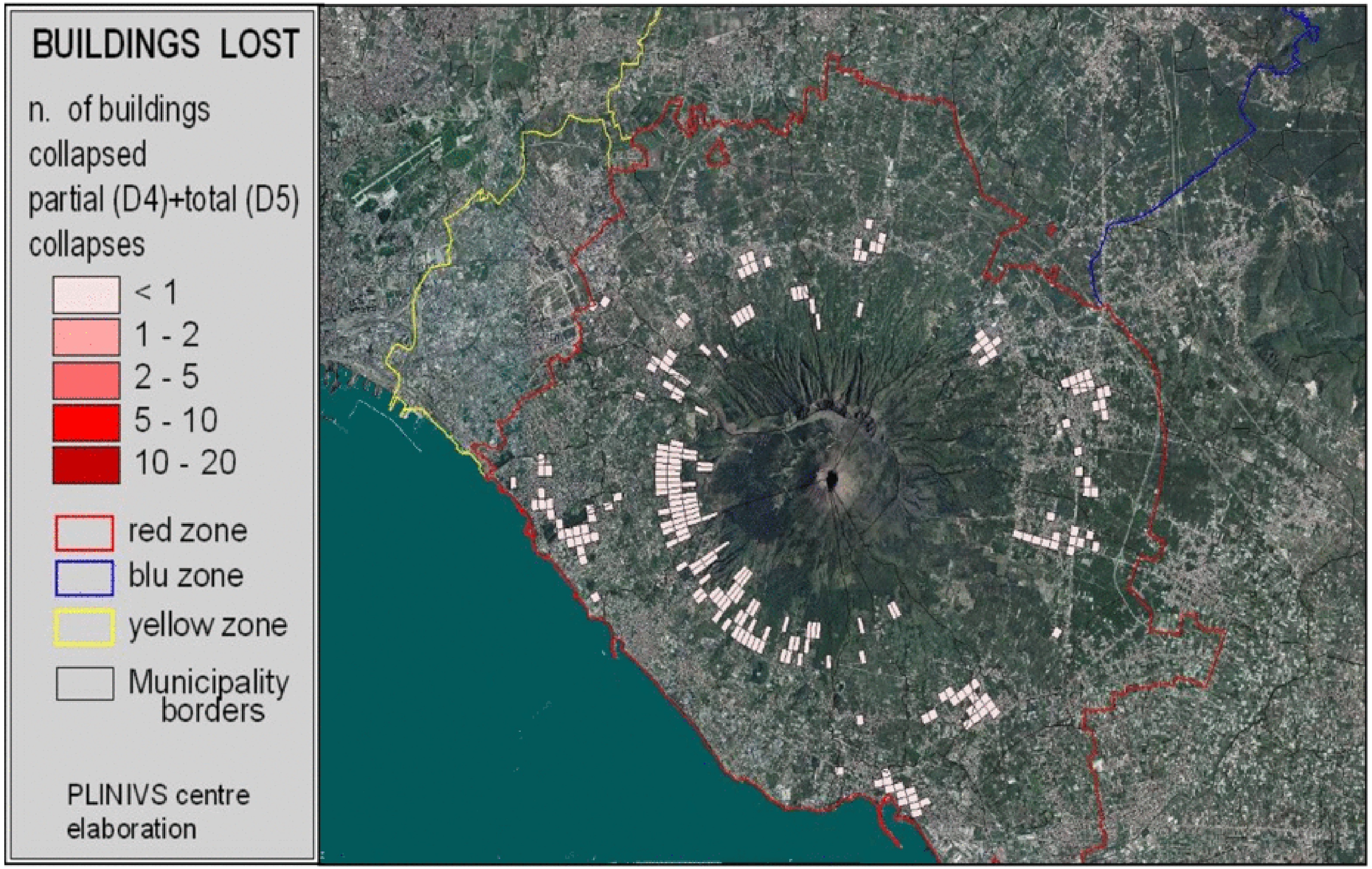
Events	Buildings Lost (D4+D5+fired)				Casualties				
Sequence	By Step	Cumul	Fired	Total	Population in the Area (%)	Killed by Step	Killed (Cumulative)	Injuries by Step	Injuries Cumul.
EQ 1 (VI)	46	46	0	0	42%	2	2	6	6

- EQ

Volcanic Eruptions

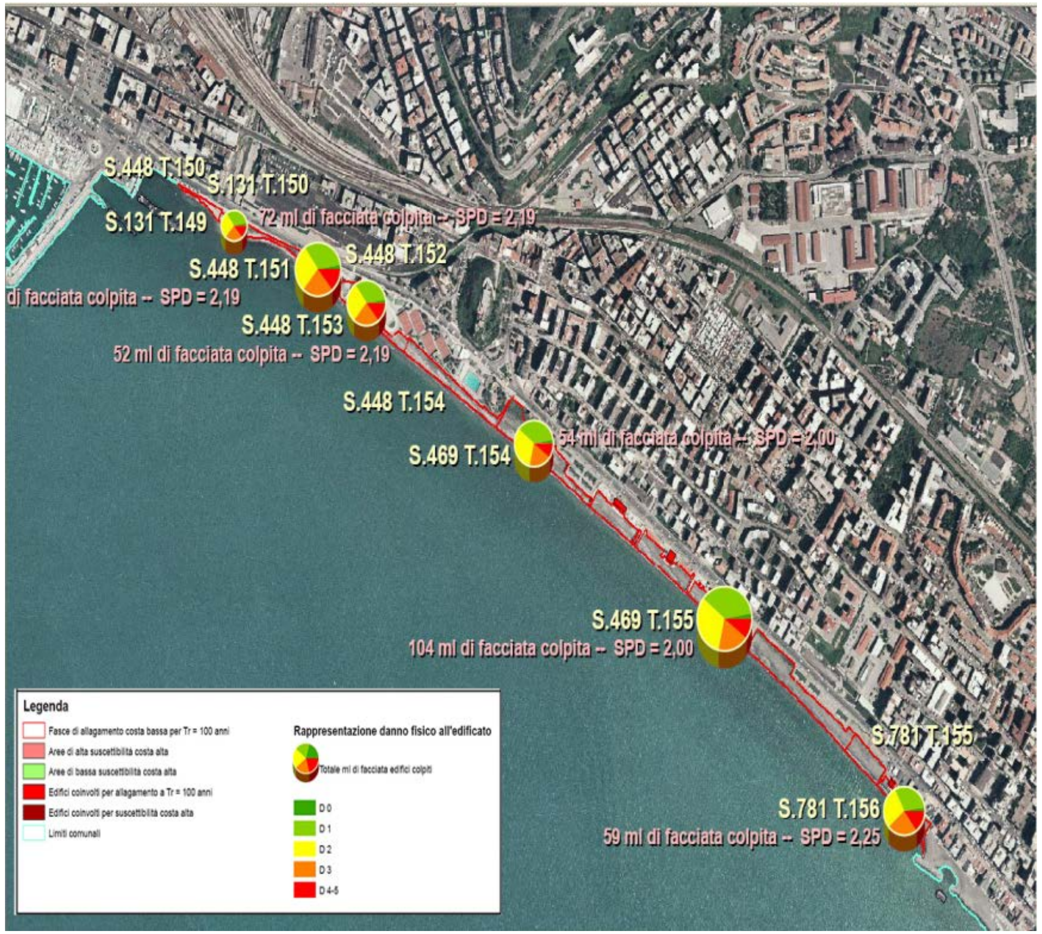


Zuccaro, G., Leone, M.F. (2012). Building technologies for the mitigation of volcanic risk: Vesuvius and Campi Flegrei, *Natural Hazards Review*, Vol. 13, Issue 3, pp. 221-232

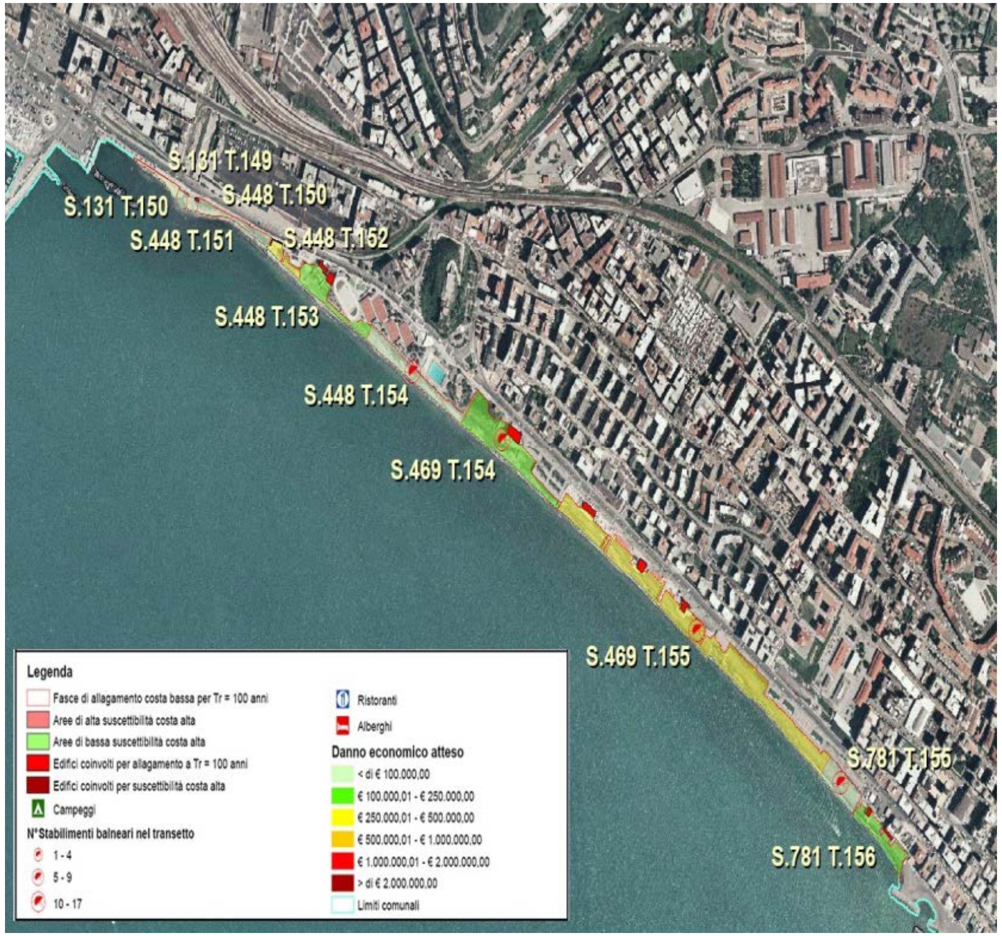
HAZARD and EXPOSURE

Coastal Flood

STRUCTURAL DAMAGE



ECONOMIC DAMAGE



DISASTER RISK, CLIMATE CHANGE AND ECOLOGICAL TRANSITION
RISK ASSESSMENT AND GOVERNANCE

Leone, M.F. (2020). Vulnerability to natural hazards. In Losasso, M., Lucarelli, M.T., Rigillo, M. (2020). Adapting to the Changing Climate. Knowledge Innovation for Environmental Design. Maggioli, Santarcangelo di Romagna. 77-82.

single- or multi-risk

single or multiple element(s) at risk, categorized in "vulnerability classes"

RISK ASSESSMENT FRAMEWORK ⇒ RISK = HAZARD x EXPOSURE x VULNERABILITY

quantitative indicators

single- or multi-hazard

for each element at risk and hazard considered, expressed through "vulnerability functions"

Consolidated approach for disaster risk assessment in the field of geophysical hazards (UNDRO, 1980, updated by the UNDRR 2017 Terminology), harmonized in the context of climate change (IPCC-AR5, 2014).

as defined in the "Risk Assessment Framework"

RISK GOVERNANCE FRAMEWORK ⇒

$$\text{RESILIENCE} = \frac{\text{RISK}}{\text{ADAPTIVE CAPACITY} + \text{COPING CAPACITY} + \text{TRANSFORMATIVE CAPACITY}}$$

quantitative + qualitative indicators

DRR/CCA integration supporting the full DRM cycle

Risk Governance Framework to support the full DRM cycle and support sustainable and resilient development pathways (elaborated from diverse sources).

Approccio Multi-risk & Cascading

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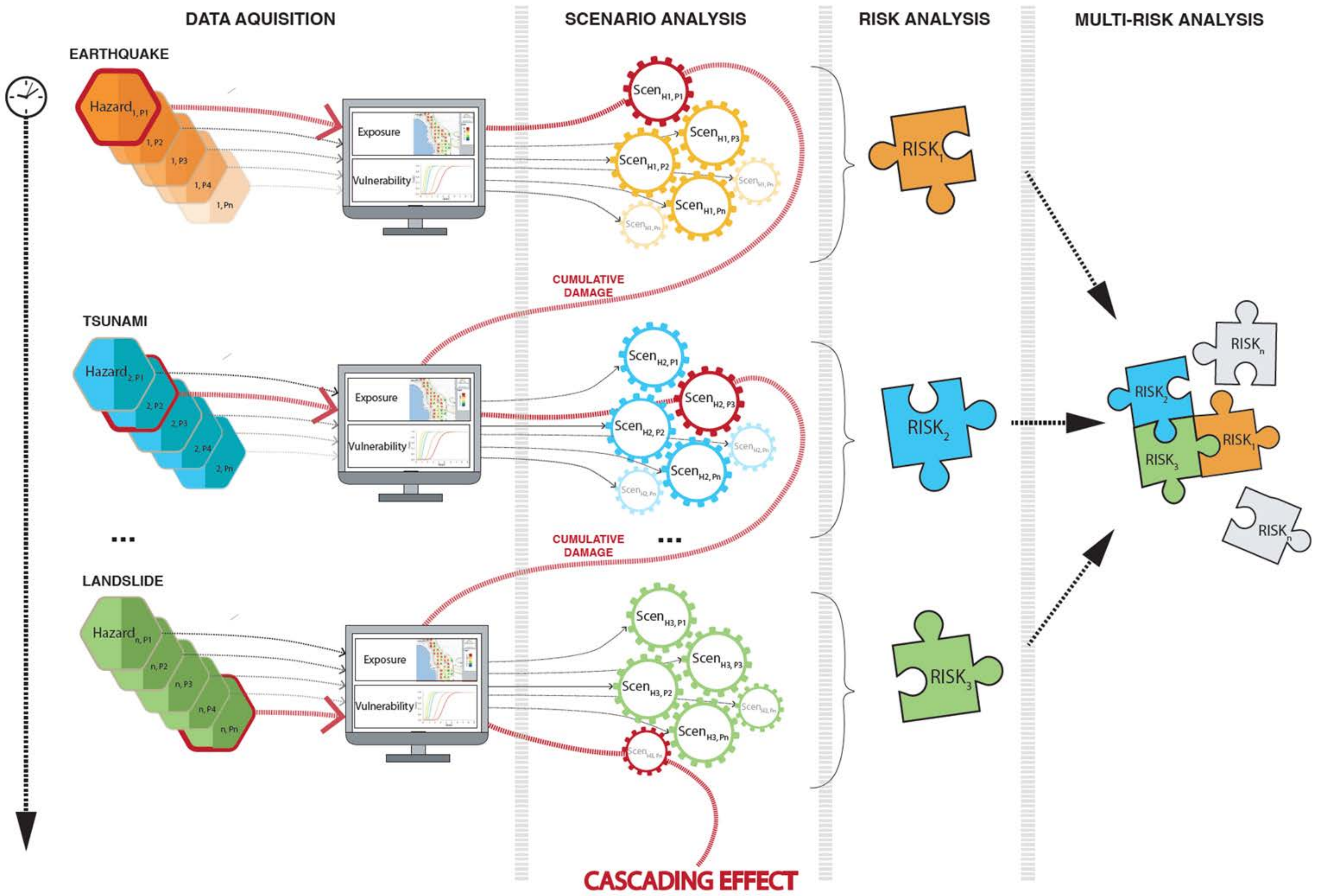
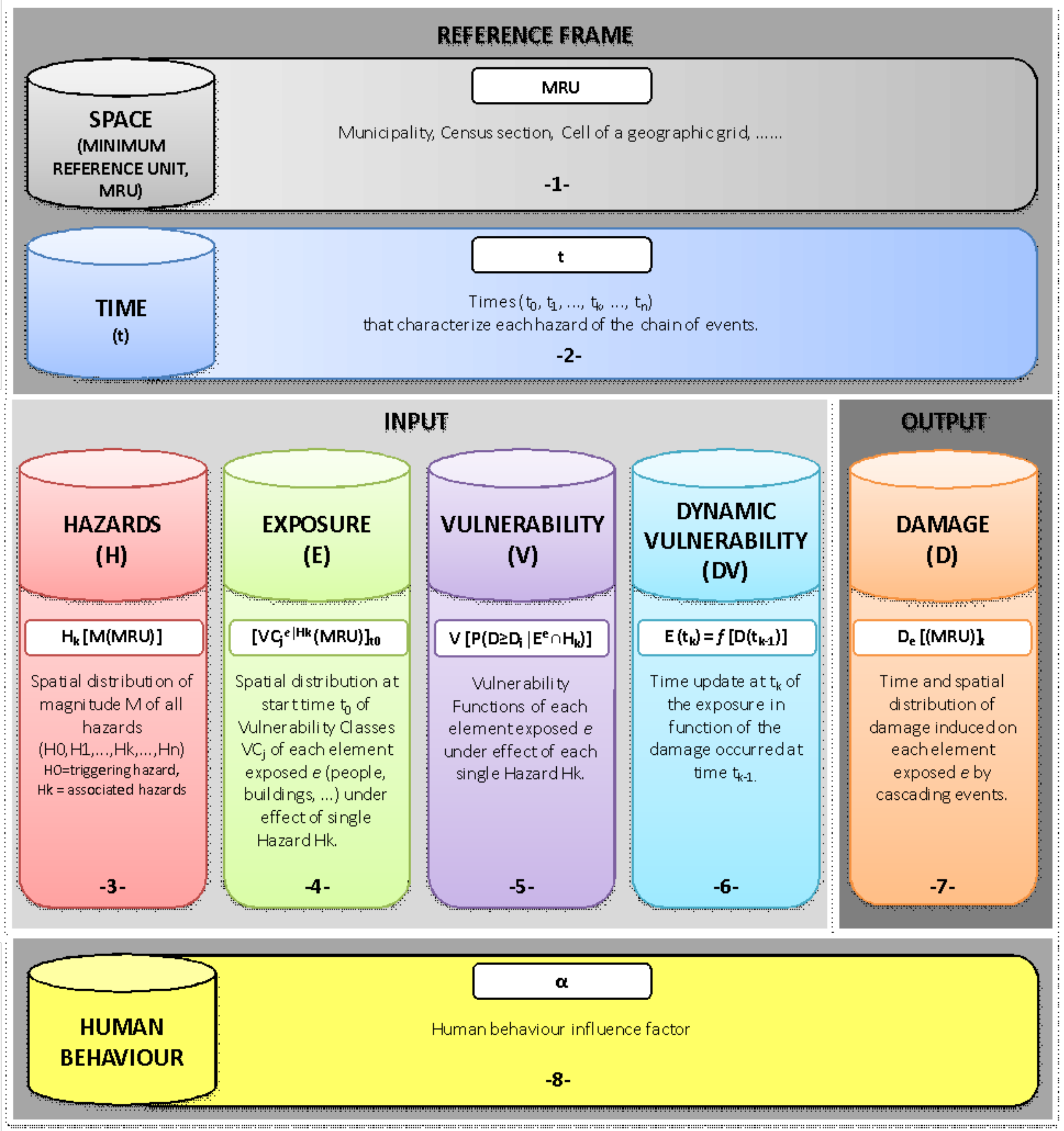
Multi-risk approach



MULTI-RISK ASSESSEMENT FRAMEWORK ELEMENTARY BRICKS

1. Space:
   Minimun Reference Unit, MRU
1. Time: timeline
2. Hazard: spatial magnitude of all hazards in timeline
3. Exposure: spatial distribution of Vulnerability classes at t_0
4. Vulnerability: vulnerability functions of each element exposed under effect of each single hazard
5. Dynamic vulnerability: routine to update the exposure
6. Damage: OUTPUT
7. Human behaviour: human behaviour influence factor



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- Risk (to reach the level damage “l”)

$$\mathbf{RISK_l} = \int_m q_m \left[\int_i (H_i) * (V_{l,i,m}) \right]$$

- Scenario (to reach the level damage “l”)

$$\mathbf{SCENARIO_l} = \int_m q_m \left[\int_i (H_i) * (V_{l,i,m}) \right]$$

- Hi — probability of occurrence of the event characterized by magnitude “i”, in a given time and in a given site.
- $V_{l,i,m}$ — probability to reach the damage level “l” for a vulnerability class “m”
- q_m — percentage of element exposed of class “m”.

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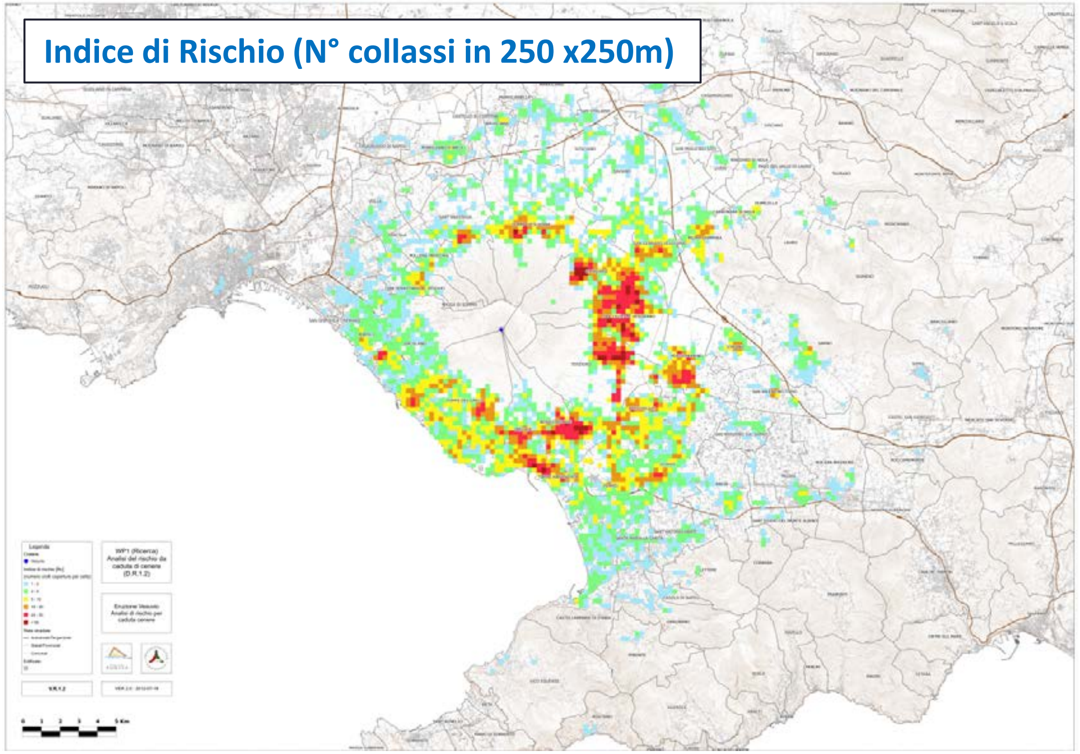


Mesh: 250x250m

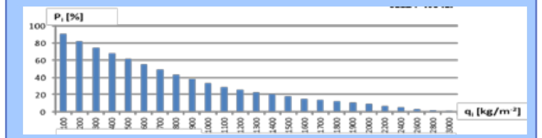
Damage: NUMBER OF ROOFS COLLAPSED.

Wind: ALL DIRECTION (with different probability)

RISK INDEX

$$Rc = \sum_{i=1}^{n-1} Nc(q_i) \cdot (P_i - P_{i+1}) + Nc(q_n) \cdot P_n$$

where:
P_i = probability of exceeding the load q_i;
$Nc(q_i)$ =number of roofs collapsed due to the load q_i;
n =total number of load levels considered, in the present case n=25.
P_i-P_{i+1} =probability that the load produced by ash fall deposits is ranged between q_i and q_{i+1}.



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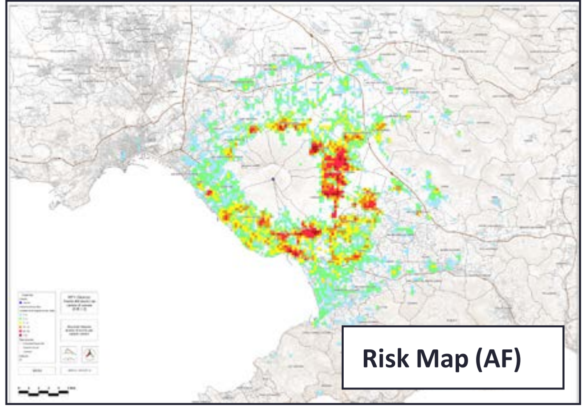
Durata eruzione: 15 ore

[h]	0	1	2	3	4	5	6	8	10	15
HOMELESS [%]		0.3	8	22	35	46	57	75	92	100
ROOFS COLLAPSED [%]		0.5	10	**26**	39	50	60	77	92	100



Risk Map (AF)

About 25% of roofs collapses already after three hours, with the significant achievement of areas outside the Red 1 and Red 2 areas of the Vesuvius Emergency Plan.

OPERATIVE ACTION

The importance of controlling the evolution of phenomena in time and space can no longer be ignored.

Example: enlargement of the Red zone of Vesuvius causes high probability of extensive ash fall resulting in considerable damage expected to buildings in a few hours.

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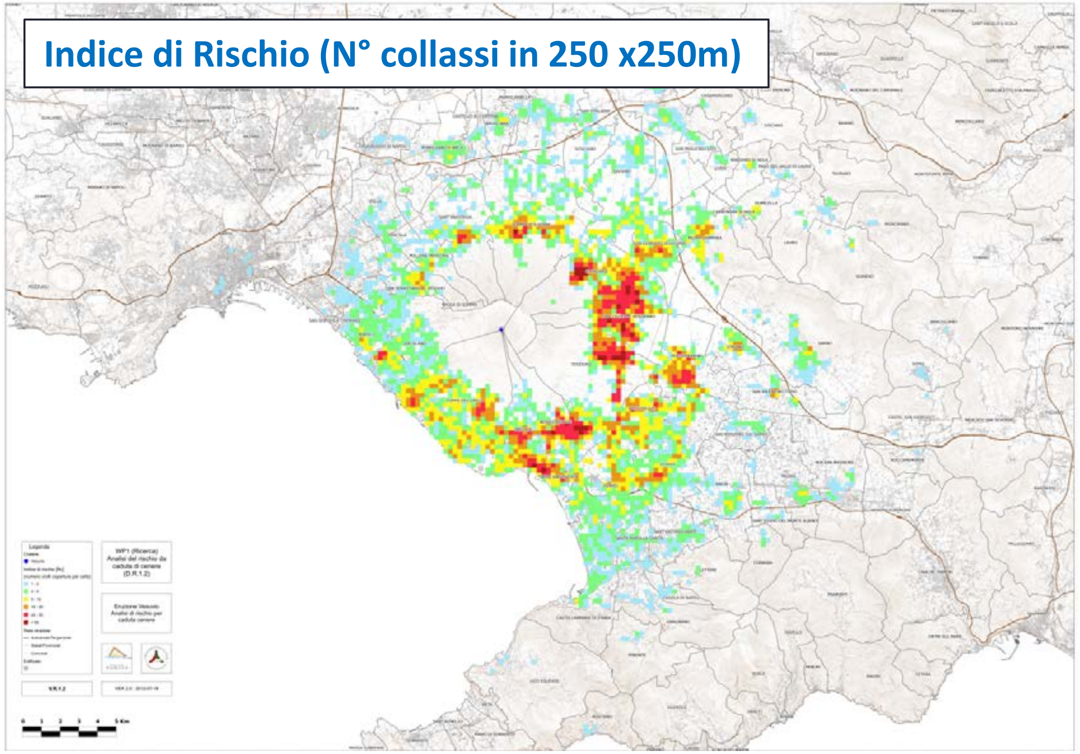

Mesh: 250x250m

Damage: NUMBER OF ROOFS COLLAPSED.

Wind: ALL DIRECTION (with different probability)

RISK INDEX

$$Rc = \sum_{i=1}^{n-1} Nc(q_i) \cdot (P_i - P_{i+1}) + Nc(q_n) \cdot P_n$$

where:

P_i = probability of exceeding the load q_i;

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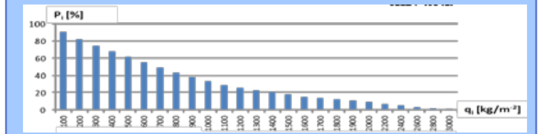

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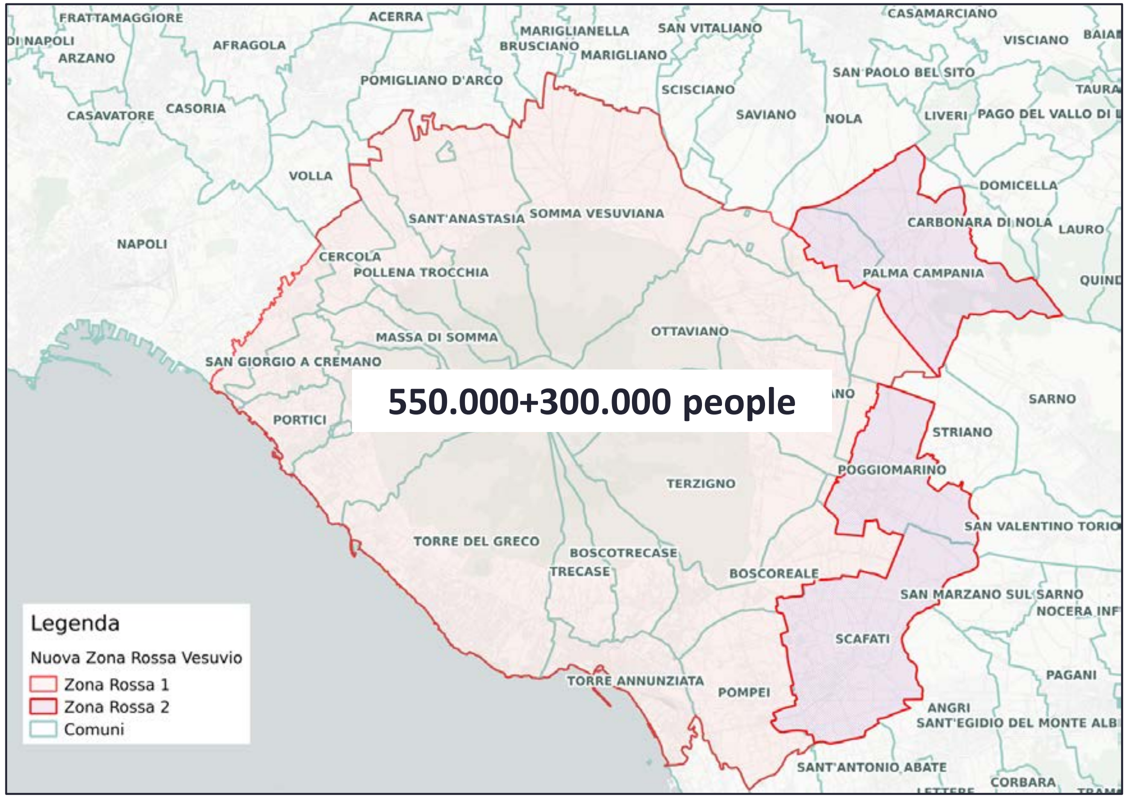

550.000+300.000 people

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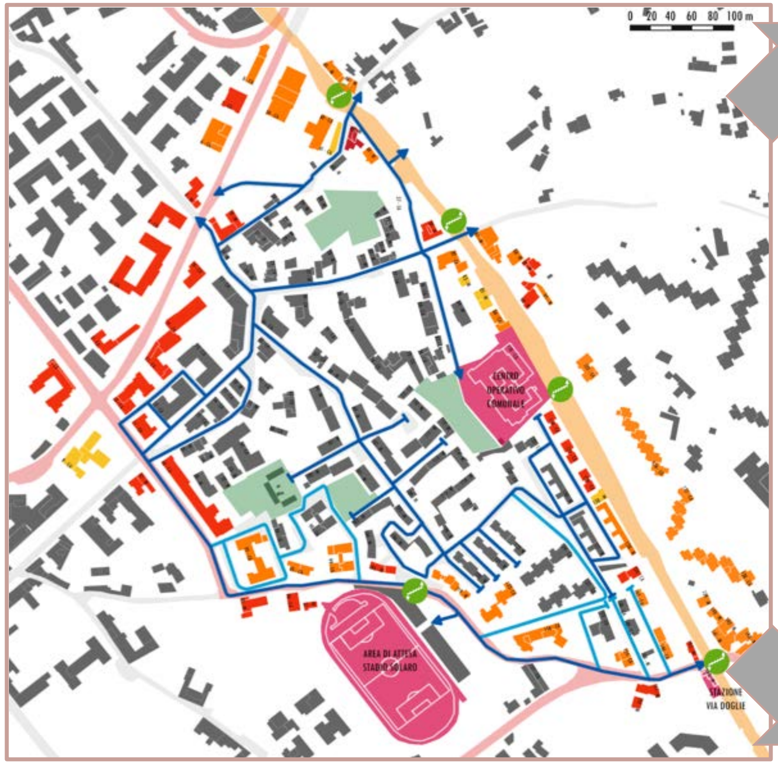
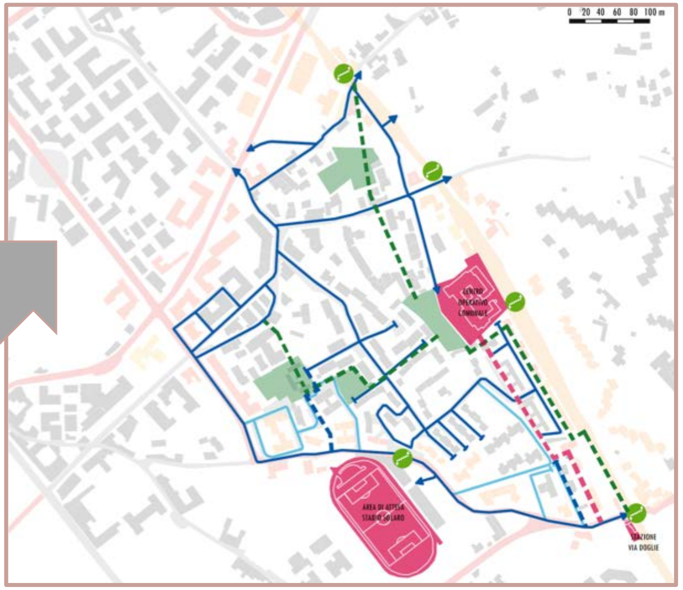
Comune di Ercolano, Italia

Rischio alluvione e isole di calore: misure di DRR & CCA

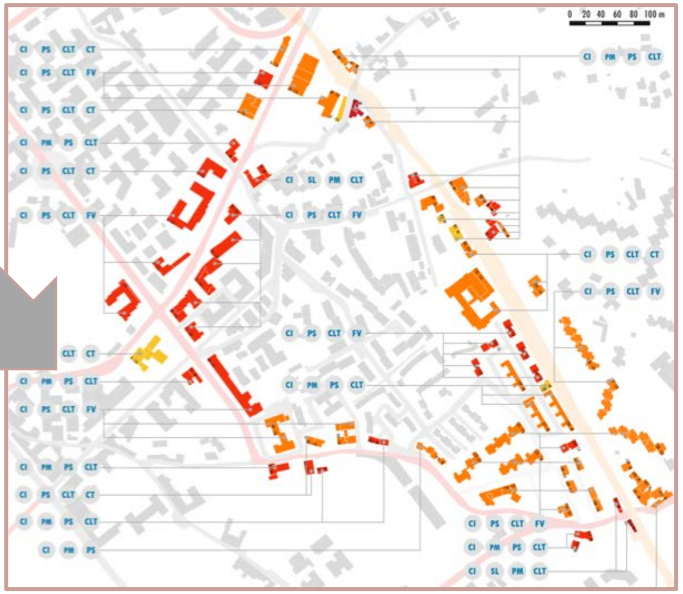
Coupling emergency planning with land use planning and building regulations





Escape routes accessibility

- public roads
- private roads
- strategic buildings
- pedestrian accesses
- green areas
- new public roads
- new pedestrian paths
- new escape routes



Building retrofitting (seismic, volcanic, energy, climate)

- CI overlapping sloped roof
- SL wood floors strengthening
- SF steel floors strengthening
- PM masonry reinforcement
- PS r.c. structure reinforcement
- CLT provisional CLT elements
- CT thermal insulation
- FV uphfrc suspended facade

CENTRO STUDI PLINIVS

Zuccaro, G., Leone, M.F. (2014). The mitigation of volcanic risk as opportunity for an ecological and resilient city, *TECHNE - Journal of Technology for Architecture and Environment*, 7, pp. 101-108.

Seismic and energy retrofitting of residential buildings: a simulation-based approach. *UPLanD - Journal of Urban Planning, Landscape & environmental Design* (con Zuccaro, G.), v. 1, n. 1, p. 11-25

Mitigation scenarios settings

Mitigation scenario 1
Enhanced seismic improvement

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

Mitigation scenario 2
Enhanced seismic improvement with 100% level 1 energy retrofit

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	30%	50%	100%	0%
B		0%	50%	100%	0%
C			50%	100%	0%

Mitigation scenario 3
Enhanced seismic improvement with 100% level 2 energy retrofit

	B'	C'	D'	D'Energy1	D'Energy2
A	0%	30%	50%	0%	100%
B		0%	50%	0%	100%
C			50%	0%	100%

Financial variables settings

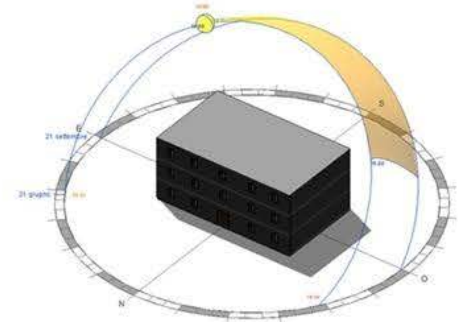
TAX INCENTIVES	
Seismic retrofitting (share)	65%
Seismic retrofitting (years)	10
Energy retrofitting (share)	50%
Energy retrofitting (years)	10
COST SHARING	
Government contribution for Seismic retrofitting	60%
Government contribution for Energy retrofitting	40%

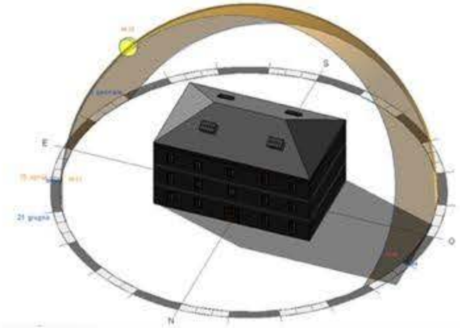
Key "level 1" energy retrofitting actions (-25% consumption)	Key "level 2" energy retrofitting actions (-50% consumption)
• Thermal plaster application • Glazing system substitution • Roof insulation	• External insulation application • Glazing system substitution • Roof insulation • HVAC system substitution

Coupling seismic risk mitigation and energy efficiency

Comune di Poggiomarino, Italia

Rischio eruzione vulcanica e isole di calore: misure di DRR & CCA





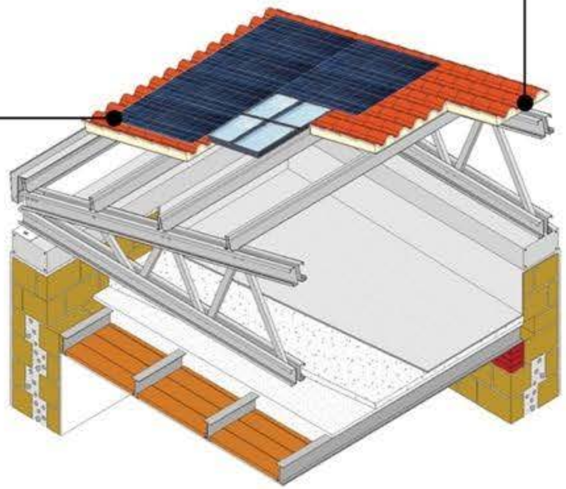
ROOFING INSULATION

PRE-RETROFIT
GFA: 720 m²
Roof U-Value: 2.0 W/m²K
Energy consumption (heating): 87.893 kWh/y
Energy use intensity: 122 kWh/m²a
CO_2 emissions: 31 t/y

POST-RETROFIT
GFA: 840 m²
Roof U-Value: 0.2 W/m²K
Energy consumption (heating): 43.875 kWh/y
Energy use intensity: 52 kWh/m²a
CO_2 emissions: 14 t/y

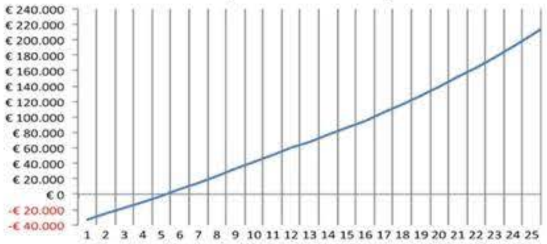
PHOTOVOLTAIC SYSTEM

TECHNICAL DATA
Power: 18 kWp
Energy production: 27.555 kWh/y
Average decay of Energy production: 0,9%/y
Azimut: 0; Tilt: 30
Annual energy consumption for lightning, cooling and appliances: 28.000 kWh
Self-consumption share: 45%

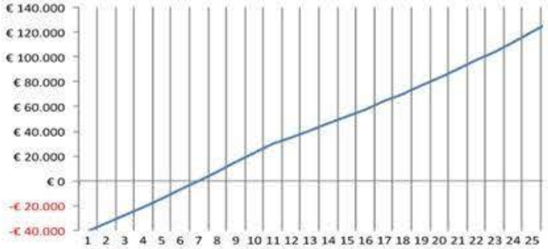


FINANCIAL AND ENERGY RESULTS

ROOFING INSULATION
Cost of intervention: 40.560 €
Fiscal incentives: 65%
Potential energy saving: 44.018 kWh/y
Fuel type: natural gas (0,9 €/mc)
Fuel saving: 4.428 mc/y (4.030 €/y)
25 year NPV: 83.092 €
25 year IRR: 16,2%
Cumulated cash flow (not discounted): 127.728 €



PHOTOVOLTAIC SYSTEM
Cost of intervention: 33.000 € (1.833 €/kWP)
Incentives: 50% fiscal deduction+spot exchange rate
Energy production (kWh/y): 27.755
Cost of energy: 0,19 €/kWh
Annual increase in energy costs: 6%
25 year NPV: 122.447 €
25 year IRR: 25%
Cumulated cash flow (not discounted): 221.473 €



CENTRO STUDI PLINIVS

Coupling Seismic, Volcanic and Energy Retrofitting

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Conclusioni

- La pianificazione territoriale per la resilienza multi-rischio richiede approcci di analisi basati su scenari di simulazione in grado di quantificare gli impatti fisici ed economici dovuti a rischi naturali (geofisici e climatici), tecnologici o natech.
- Strumenti e servizi avanzati consentono un processo di personalizzazione dei modelli e dei loro output sulla base di esigenze specifiche degli stakeholder e delle comunità, al fine di evidenziare le opportunità di integrazione di misure DRR e CCA a livello locale.
- Per supportare il processo decisionale e la programmazione dei finanziamenti, le opzioni alternative di pianificazione (ordinaria e di emergenza), nonché le strategie di riduzione del rischio e di adattamento climatico devono essere valutate attraverso solide analisi multi-criterio e costi-benefici.
- Le valutazioni devono evidenziare i vantaggi delle opzioni di mitigazione e adattamento non solo in rapporto alla riduzione degli impatti attesi rispetto alle diverse categorie di hazard, ma anche in "tempo di pace", dimostrandone i co-benefici sociali, ambientali ed economici.


China
East China Sea
Taiwan
Grazie per la cortese attenzione.