



Napoli 2030

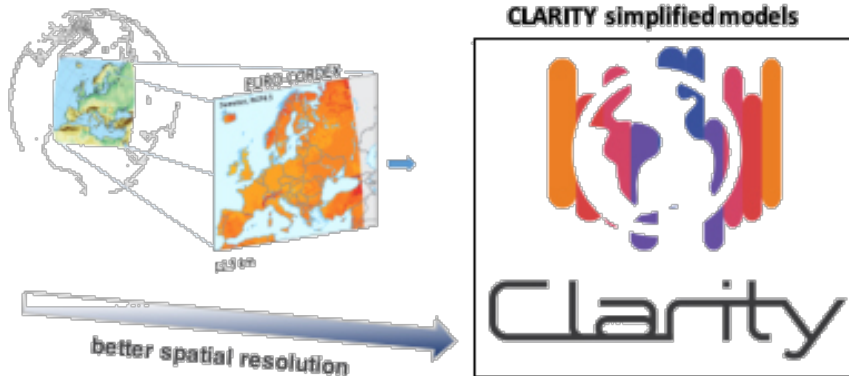
Sfide e strategie per un ambiente costruito sostenibile e resiliente

La progettazione urbana multiscalare per la resilienza climatica

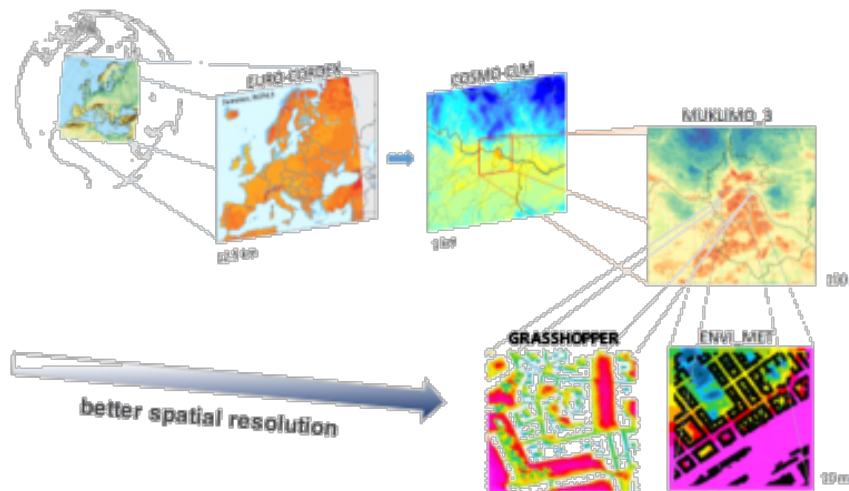
Mattia Leone, Università di Napoli Federico II - Centro Studi PLINIVS / DiARC



SCREENING LEVEL	GCM >25km	REANALYSIS, CMIP5 MODELS
	RCM 1-25km	EURO-CORDEX / RCM
	UCM 500m	URBAN MICROCLIMATE / CLARITY



EXPERT LEVEL	GCM >25km	REANALYSIS, CMIP5 MODELS
	RCM 1-25km	EURO-CORDEX RCM
	UCM 0.2-1km	URBAN MICROCLIMATE MUKLIMO_3, GIS TOOLS
	MICRO 1-250 m	PARAMETRIC DESIGN TOOLS, ENVI-MET

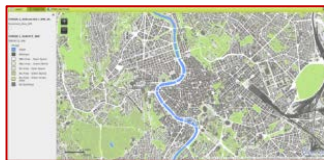


2 livelli di analisi

Video e tutorial → <https://www.gotostage.com/channel/climate-adaptation>



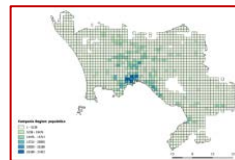
EU level Data Sources (Open data)



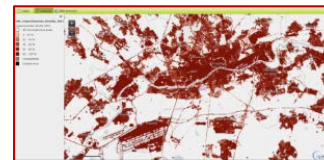
European Settlement Map (ESM)



Urban Atlas (UA)



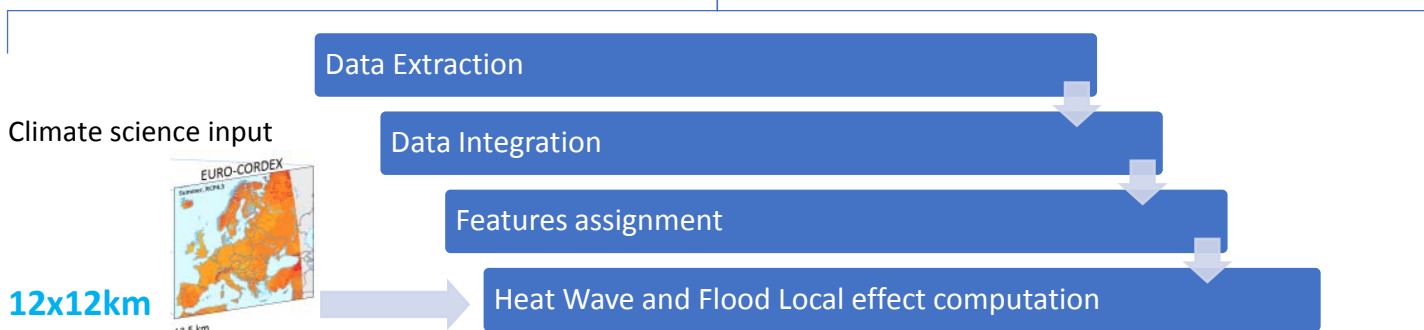
Eurostat



Imperviousness



Street tree layers (STL)

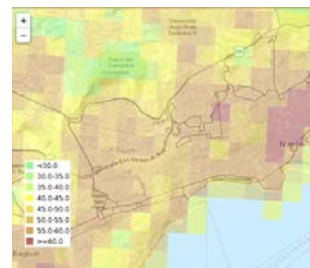


Heat Wave

Main parameters

- Albedo
- Emissivity
- Transmissivity
- Sky View Factor
- Hillshade green fraction
- Surface Temperature

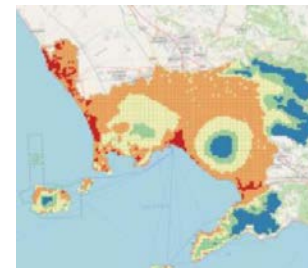
500x500m



Flooding

Main parameters

- Run off coefficient
- Watersheds
- Relative altimetry
- Streams density

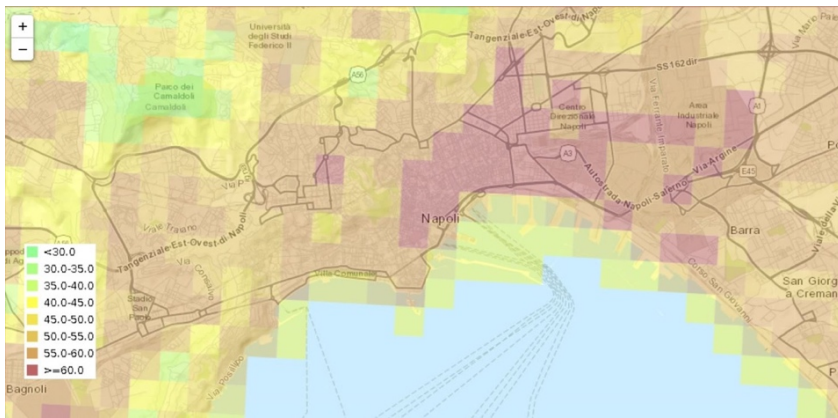




Climate projection downscaling → 12km
Climate Indicator: n. Hot Days

Available indicators:

- n. summer night
- Tn10p
- Tn75p
- n. Wet Days
- ...25 indicators for each urban area in EU



Urban microclimate analysis → 500m
Hazard Local Effect Indicator: Tmrt

Available indicators:

- Universal Thermal Climate Index (UTCI)
- Pluvial Flooding probability index



Manage Shortcuts Search Mattia Leone Edit

Comment Structures Configuration Help

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Clarity HOME STUDIES SOLUTION OFFERS SHOWCASES ADAPTATION OPTIONS MAINTENANCE

Study: Napoli validation study

vr Study Napoli validation study has been created.

STUDY FEA CITY FACTSHEET HAZARD CHARACTERIZATION **HAZARD CHARACTERIZATION - LOCAL EFFECTS** EXPOSURE EVALUATION VULNERABILITY ANALYSIS RISK AND IMPACT ASSESSMENT IDENTITY ADAPTATION OPTIONS STEP

INTRODUCTION DATA TABLE MAPS SUMMARY

generazione report automatico in modo guidato

Napoli validation study

Currently selected Study scenario: 2011_2040_RCP4.5_Occasional
Time Period: 2011 to 2040
Emissions Scenario: RCP 4.5 (effective measures)
Event Frequency: Occasional (5 years)
Study Variant: no Adaptation Options

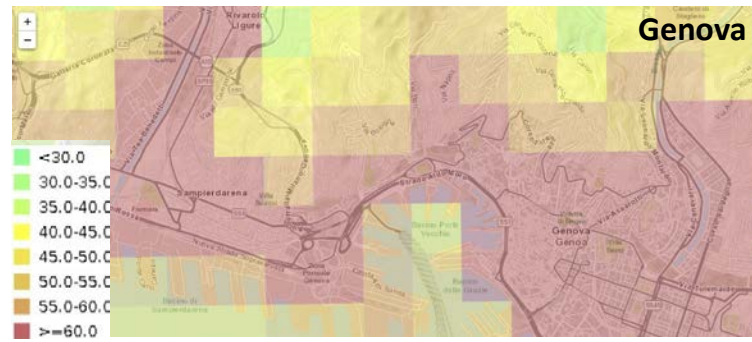
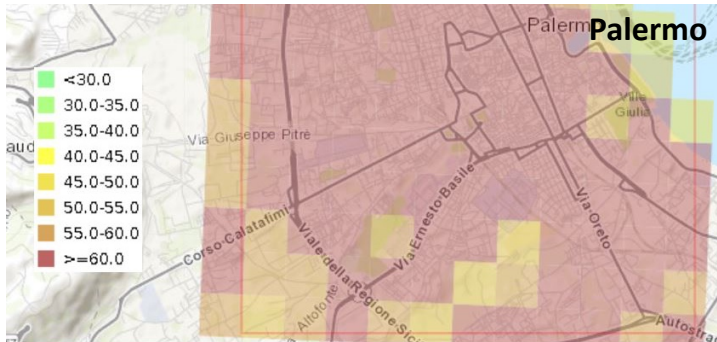
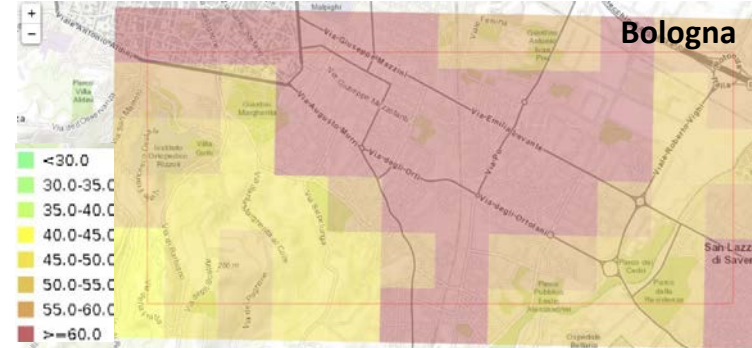
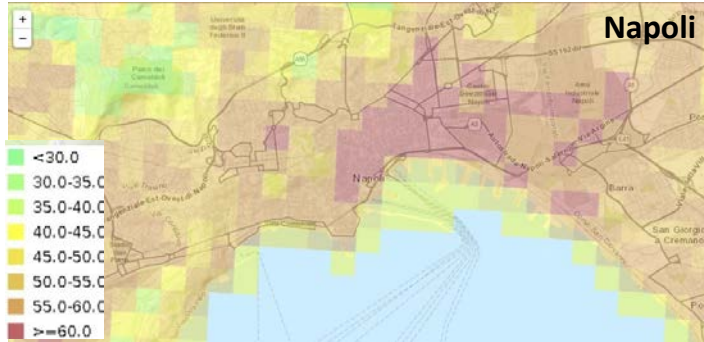
Select Scenario

disponibile gratuitamente online

<https://csis.myclimateservice.eu/>



Indicatore: Tmrt (temperatura media radiante)



Heat Wave Scenario settings

- **Livello emissioni: RCP8.5**
- **Periodo temporale: 2041-2070**
- **Frequenza: Occasionale**



Indicatore: Incremento di mortalità



STOCCOLMA

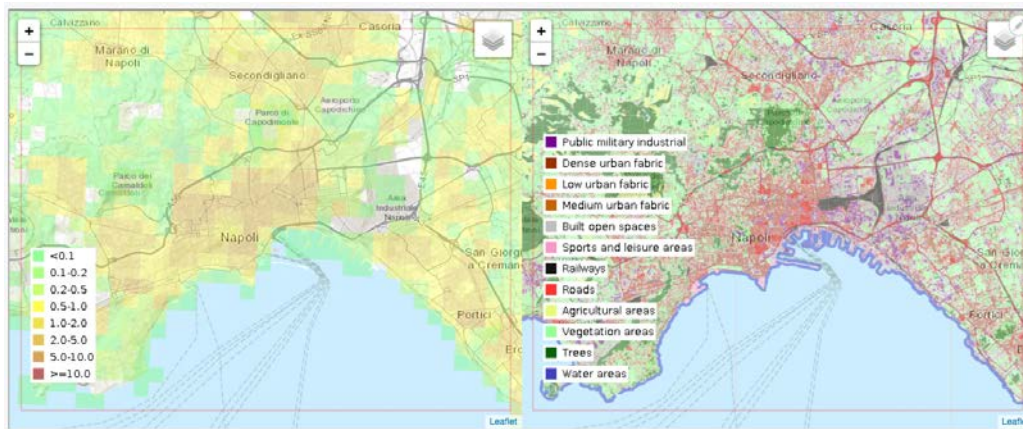
Heat Wave Scenario settings

- RCP8.5
- 2071-2100
- Rare

NAPOLI

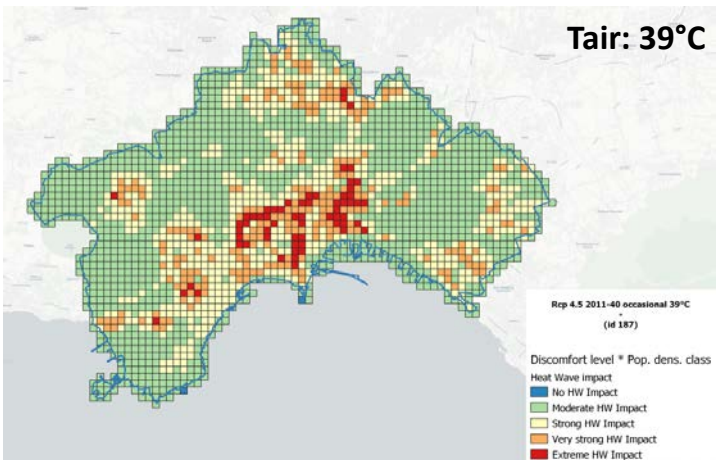
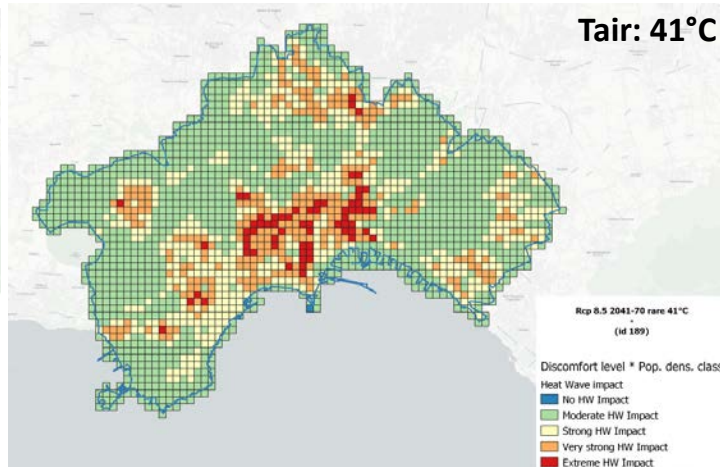
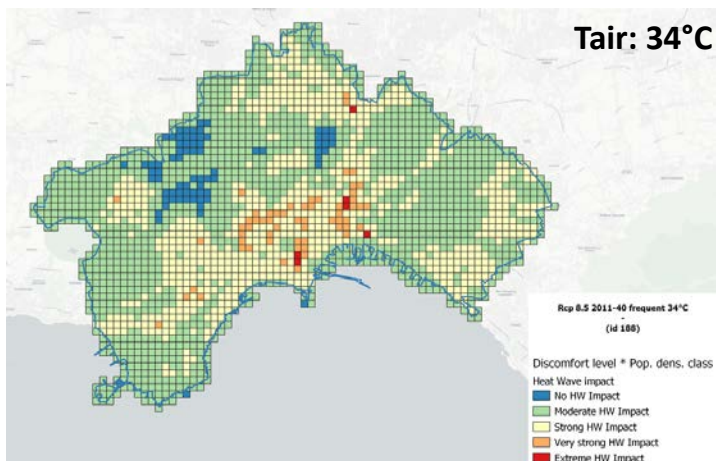
Heat Wave Scenario settings

- RCP8.5
- 2071-2100
- Occasional





Indicatore: Livello di discomfort outdoor in base alla densità abitativa



Impatti economici

- sistema sanitario
- consumi energetici



Indicatore: impatti economici su strade e edifici



NAPOLI

Flood Scenario settings

- RCP8.5
- 2071-2100
- Rare (105mm <6h)

ROADS

Water Depth (mm)	0-0,11	0,12-0,29	0,3-0,49	0,5-1	>1
DAMAGE CLASS	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
Impact €/m2	0	1	3	6	9

RESIDENTIAL BUILDINGS

Water Depth (mm)	0-0,004	0,005-0,05	0,06-0,19	0,2-0,8	> 0,8
DAMAGE CLASS	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
Impact €/m2	0	1	25	84	270

NON-RESIDENTIAL BUILDINGS

Water Depth (mm)	0-0,004	0,005-0,05	0,06-0,19	0,2-1	> 1
DAMAGE CLASS	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
Impact €/m2	0	1	16	55	247

Impatti economici

- strade – pulizia e ripristino
- edifici – riparazione danni strutturali e valore perdite beni mobili



Clarity

HOME STUDIES SOLUTION OFFERS **SHOWCASE**

Showcases overview

Home

Showcase

A Showcase is a concrete application of one or more Solution Offers, e.g. a concrete application of an Expert Service using a tailored or generic Tool or Product (Climate Service) in a specific location.

The CSIS Screening Study "Adaptation Scenarios for Metropolitan Resilience Planning in the Naples metropolitan area used in conjunction with a tailored Data Package (Heat Wave and Pluvial Flood Hazards, Population and Urban Infrastructure specific physical product, e.g. painting a 1.000m² wall building with CO2-absorbant paint in the city of Rome is another absorbant paint product)". More specifically, this particular Showcases demonstrates how the product is actually used

Relevant hazard (field_rel_haz) **- Any -** Search Full text search in title and description

Advanced options

Apply

Map showing project locations in Europe: Barcelona, Mosca, Malmö, Copenhagen, Seul, Parigi, Taichung, Lustenau.

Project cards visible: Zaryadye Park (Mosca), Cheonggyecheon Canal Restoration (Seul), Thomson Factory (Barcelona).

40+ showcases di best practices esemplari di adattamento climatico urbano

Barcellona

Mosca Malmö

Copenhagen Seul

Parigi

Taichung

Lustenau

...



Adaptation options

Home

Search Sort by **Title** Order **Asc**

Apply

ADAPTATION OPTION	EFFECTS	CO-BENEFITS	COSTS	USED IN SHOWCASES
Bioswales 	Applicable to Built open spaces Vegetation Local effects change <ul style="list-style-type: none"> heat hazard --- river flooding hazard -- Albedo = 0.16 Emissivity = 0.97 Runoff = 0.15 Surface temperature = 1.27 Transmissivity = 1 	<ul style="list-style-type: none"> Water quality: ++ Health impacts: ++ Air quality: + Biodiversity: +++ 	New: 150.00 €/m ² Retrofitting: 200.00 €/m ² Maintenance: 10.00 €/m ² /y	
Cool roofs - HIGH (SRI > 0,90) - Mineral membrane coated white reflex ultra 	Applicable to Dense Urban Fabric Medium Urban Fabric Public, military and industrial units (INDUSTRIAL) Residential buildings, Low Urban Fabric area Local effects change <ul style="list-style-type: none"> heat hazard --- Albedo = 0.86 Emissivity = 0.90 Runoff = 0.75 Transmissivity = 1 Surface temperature = 1.25 	<ul style="list-style-type: none"> GHG emissions: ++ Health impacts: ++ Air quality: ++ Cost savings: ++ 	New: 100.00 €/m ² Retrofitting: 200.00 €/m ² Maintenance: 20.00 €/m ² /y	

A Green infrastructures
BIOSWALES

ADAPTATION TARGETS

Heat Wave

Pluvial Flooding

Fluvial/Flooding / Storm Surge

DESCRIPTION



PERFORMANCE PARAMETERS

Albedo

Emissivity

Runoff

COSTS

Construction €€€

Maintenance / Management €€€

B

Co-benefits in total

Environmental

Social

CO-BENEFITS

Bioswales improve rainwater quality by removing heavy metals and other pollutants, and improve air quality through carbon sequestration from green elements. Bioswales can provide a huge variety of flora by creating habitats for wild flora, like birds and insects, thanks to differentiated types of grasses and vegetation.

A Construction materials
CANOPIES


ADAPTATION TARGETS

Heat Wave

Pluvial Flooding

Fluvial/Flooding / Storm Surge

DESCRIPTION



B

Co-benefits in total

Environmental

CO-BENEFITS

Shading systems, if integrated in public spaces can attract people, encouraging social interaction, commercial and

A Green infrastructures
URBAN AGRICULTURE

ADAPTATION TARGETS

Heat Wave

Pluvial Flooding

Fluvial/Flooding / Storm Surge

DESCRIPTION

Agricultural land offers from natural soil due to repeated tillage and various agronomic interventions. All types of crops, in general, affect the water cycle and promote environmental protection. The increase of agricultural production in cities can be promoted through the cultivation of bare soils and residual areas, as well as outdoor spaces of residential buildings. Crop types are closely related to local climatic conditions and therefore have to be carefully selected. The spatial configuration of urban land for agricultural use must also take into account the impact of urban activities in the surrounding areas (in particular vehicular pollution). Therefore, the cultivation of agricultural products intended for human consumption must be assessed based on the specific location in the city.

CLIMATE BENEFITS

The main advantage of urban agriculture is the reduction of surface run-off, ensuring a reduction in the risk of flooding in case of extreme precipitation events. Depending on the type of vegetation, the performance parameters may vary. The contribution to heat stress reduction can be relevant, but seasonality of cultivation types must be taken into account, preferring those growing during hot seasons.

B

Co-benefits in total

Environmental

Social

Economic

CO-BENEFITS

Urban agriculture offers high quality urban green spaces and preserves biodiversity by attracting birds and insects. Local food production reduces the consumption of fossil fuels and the greenhouse gas emissions associated with the transport, packaging and sale of food, thus contributing to the improvement of air quality in cities.

Agricultural areas integrated in community initiatives increase food awareness and promote a healthier diet, with potential benefits for human health. In addition, by involving residents and providing a place for cooperation and knowledge sharing, urban agriculture strengthens community cohesion and inclusion, including positively affecting mental health diseases. Finally, urban agriculture fields contribute to the aesthetic value of the city.

Local cultivation allows saving on household expenses for food. The presence of local products and markets brings benefits in terms of job opportunities and stimulus to local circular economy. Specific interactions between urban agricultural systems and their different urban environments create opportunities for technical, social and organizational innovation. Urban agriculture can help increase the values of real estate in the surrounding areas.



Ciascuna misura può essere valutata in termini di costi e comparata con i benefici in termini di riduzione degli impatti climatici

ADAPTATION MEASURES					Average cost €/ mq
GREEN SURFACES	green surface a	Bioswale	Albedo	0,16	€ 152,50
			Emissivity	0,97	
			Run-off	0,15	
			Transmissivity	1	
			Surface temperature	1,27	
	green surface b	Urban agriculture	Albedo	0,2	€ 32,50
			Emissivity	0,95	
			Run-off	0,18	
			Transmissivity	1	
green surface c	Lawns and green areas	Albedo	0,25	€ 32,50	
		Emissivity	0,96		
		Run-off	0,22		
		Transmissivity	1		
		Surface temperature	1,38		

Category: GREEN SURFACES

Typology: green surface a, green surface b, green surface c

Examples: Bioswale, Urban agriculture, Lawns and green areas

Model parameters: Albedo, Emissivity, Run-off, Transmissivity, Surface temperature

Values per typology: 0,16, 0,97, 0,15, 1, 1,27, 0,2, 0,95, 0,18, 1, 0,25, 0,96, 0,22, 1, 1,38

Average cost: € 152,50, € 32,50, € 32,50

Legend:

- Category
- Typology
- Examples
- Model parameters
- Values per typology
- Average cost



Land use visualization

Simulazione ondata di calore
stato di fatto



giorno	07-ago-15	gg-mm-aa
ora	14:00	24h
air temperature	37	°C
sun altitude	65,14	°
sun azimuth	192,35	°
global radiation	808,8	Wh/m²
wind speed	3,6	m/s
relative humidity	36	%

Tmrt
current state

Simulazione ondata di calore
post - adattamento



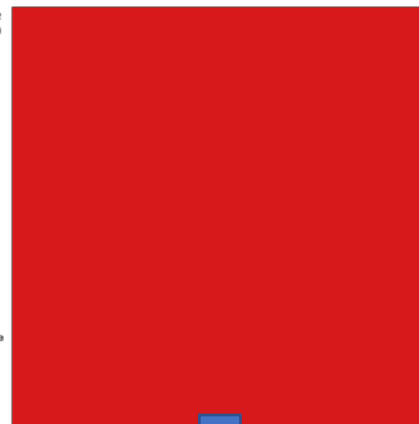
giorno	07-ago-15	gg-mm-aa
ora	14:00	24h
air temperature	37	°C
sun altitude	65,14	°
sun azimuth	192,35	°
global radiation	808,8	Wh/m²
wind speed	3,6	m/s
relative humidity	36	%

Tmrt
adaptation

Grid visualization

Simulazione ondata di calore
ripostata su griglia 250 x 250
stato di fatto

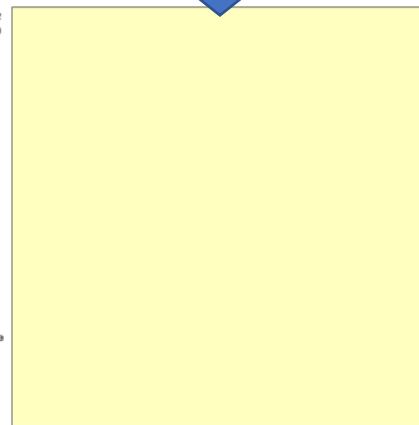
Tmrt 73,1 °C



giorno	07-ago-15	gg-mm-aa
ora	14:00	24h
air temperature	37	°C
sun altitude	65,14	°
sun azimuth	192,35	°
global radiation	808,8	Wh/m²
wind speed	3,6	m/s
relative humidity	36	%

Simulazione ondata di calore
ripostata su griglia 250 x 250
post - adattamento

Tmrt 54,9 °C



giorno	07-ago-15	gg-mm-aa
ora	14:00	24h
air temperature	37	°C
sun altitude	65,14	°
sun azimuth	192,35	°
global radiation	808,8	Wh/m²
wind speed	3,6	m/s
relative humidity	36	%



CLARITY DEMONSTRATION CASE 1 – NAPOLI
MULTISCALE+CLIMATE+RESILIENT+URBAN+PLANNING



CLIMATE PROJECTIONS

Climate change profile **Napoli**
2020-2100

STRATEGIC PLANNING

Support to the implementation of **Strategic Plans**
to meet 2030 and 2050 climate targets

CITY PLANNING

Analyses and assessment criteria for **City Planning**

DISTRICT PLANNING

Ponticelli Urban Regeneration Plan (PRU)

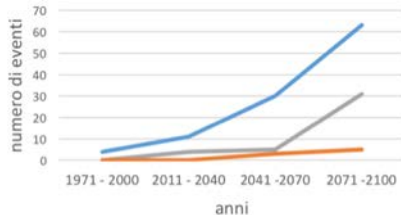
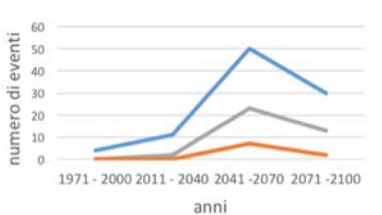
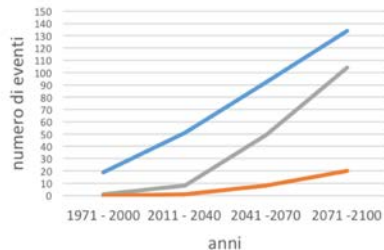
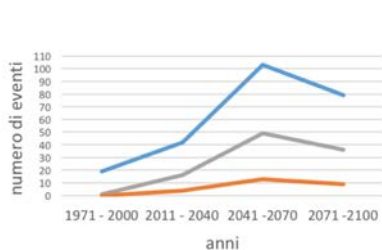
Integrazione delle soluzioni progettuali di adattamento climatico in ottica multi-scalare - dai piani strategici ai piani urbani attuativi

- Gli scenari di cambiamento climatico per l'area di Napoli sono alla base di tutti i documenti di pianificazione locale, con informazioni sugli eventi di **ondate di calore e precipitazioni estreme nel periodo 2020-2100** in termini di frequenza e intensità secondo i diversi livelli di emissioni (RCP).
- Il Comune di Napoli ha deciso formalmente di integrare gli studi di CLARITY all'interno dei propri strumenti e linee guida di pianificazione territoriale: **1. Livello strategico; 2. Livello Urbano; 3. Livello di quartiere - Piano di Rigenerazione Urbana Ponticelli (PRU).**



Heat Waves/Pluvial Flood – Caratterizzazione dell'hazard (Napoli)

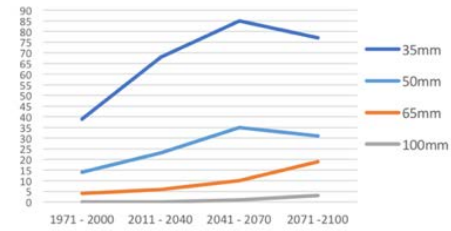
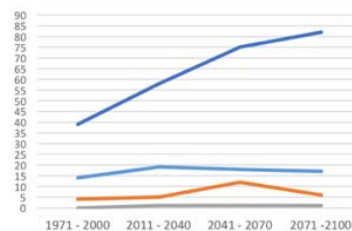
Heat Waves (3, 6 and 9 Days) for the period 1971-2100



RCP4.5

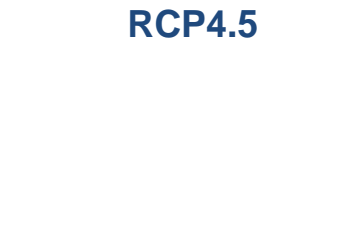
RCP8.5

Extreme precipitation events for the period 1971-2100



RCP4.5

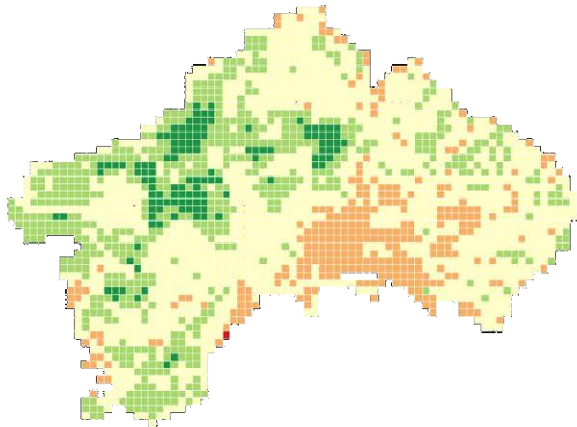
RCP8.5



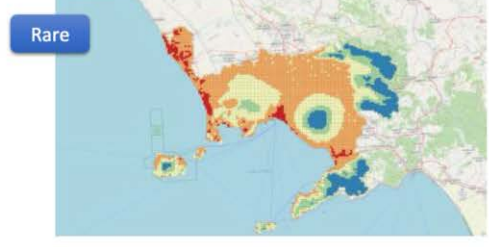
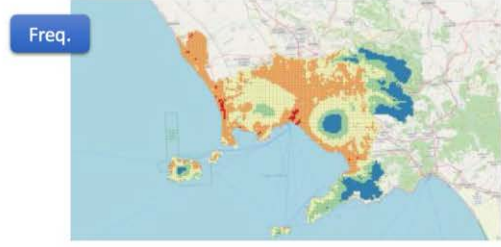
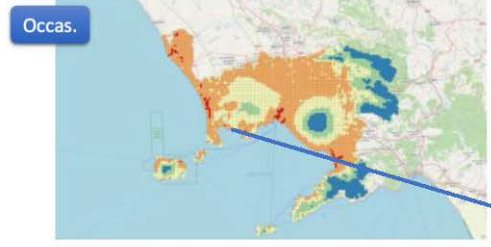
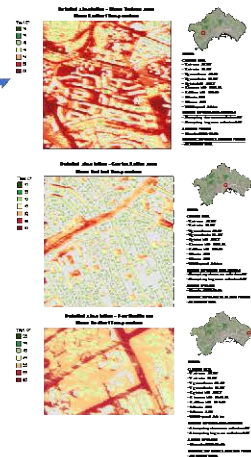
Heat Waves/Pluvial Flood – Caratterizzazione dell'hazard - effetto locale

Heat Waves
Pluvial Flood

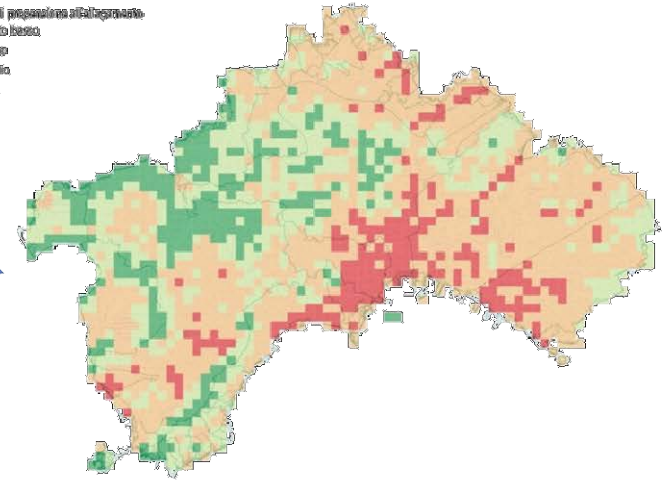
SCENARIO: rcp 8.6 frequent, 2011 - 2040, Tair 34 °C, frequency 2,766



SCENARIO: rcp 8.6 rare, 2041 - 2070, Tair 41 °C, frequency 0,066



Livello di esposizione all'allagamento



Impatto degli allagamenti sugli edifici indicatore: impatto economico per danni strutturali e di contenuto degli edifici.

Impatto economico

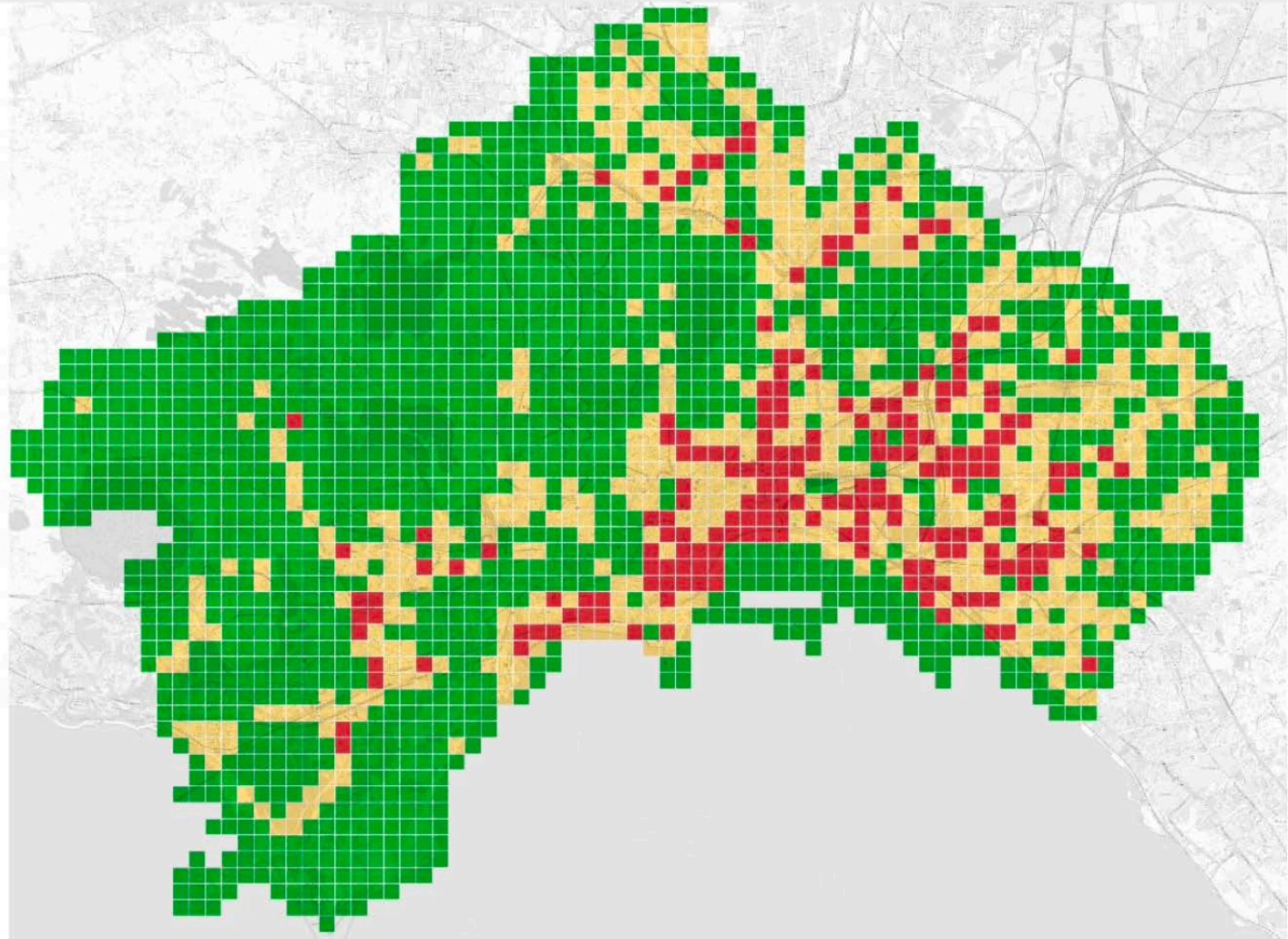
- basso
- medio
- alto

Scenario RCP 8.5

periodo:
2011 - 2040

livello di
precipitazioni:
85mm - 95mm

probabilità di
occorrenza:
occasionale



Impatto degli allagamenti sugli edifici

indicatore: impatto economico per danni strutturali e di contenuto degli edifici.

Impatto economico

€

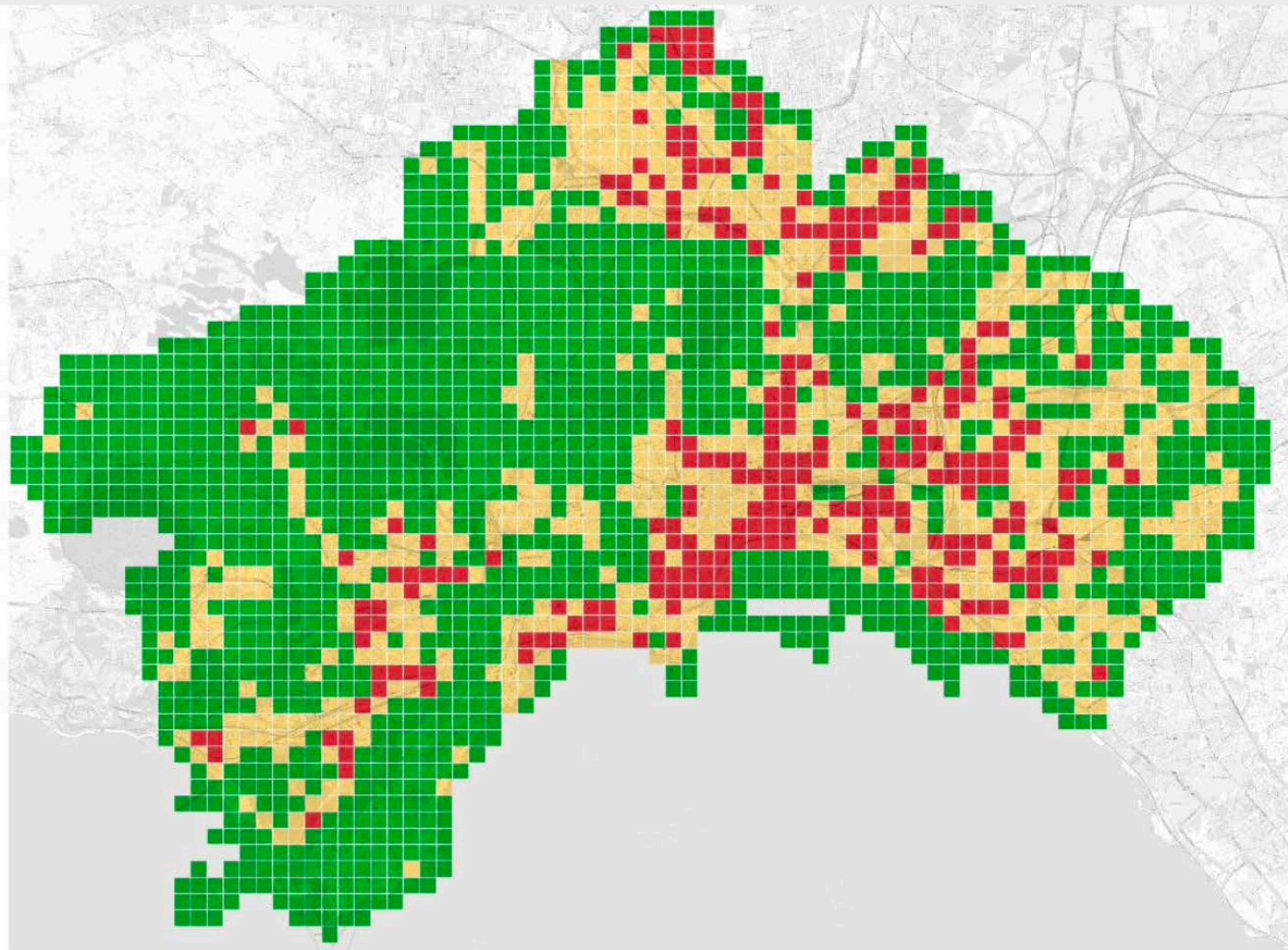
- basso
- medio
- alto

Scenario RCP 8.5

periodo:
2011 - 2040

livello di
precipitazioni:
105mm - 110mm

probabilità di
occorrenza: rara



Impatto degli allagamenti sulla rete stradale

indicatore: Impatto economico per la pulizia e la riparazione delle strade

Impatto economico

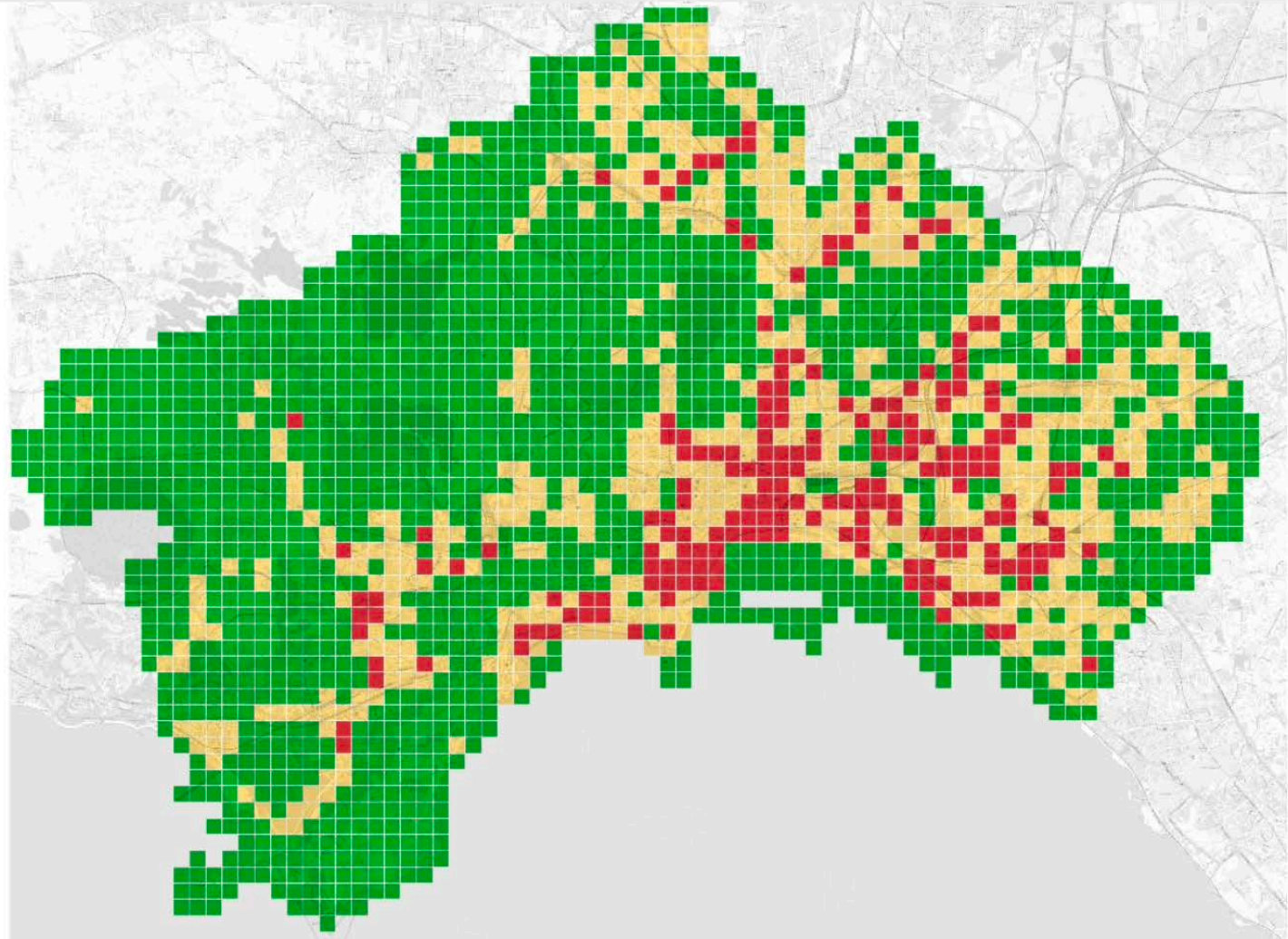
- basso
- medio
- alto

Scenario RCP 8.5

periodo:
2011 - 2040

livello di
precipitazioni:
85mm - 95mm

probabilità di
occorrenza:
occasionale



Impatto degli allagamenti sulla rete stradale

indicatore: Impatto economico per la pulizia e la riparazione delle strade

Impatto economico

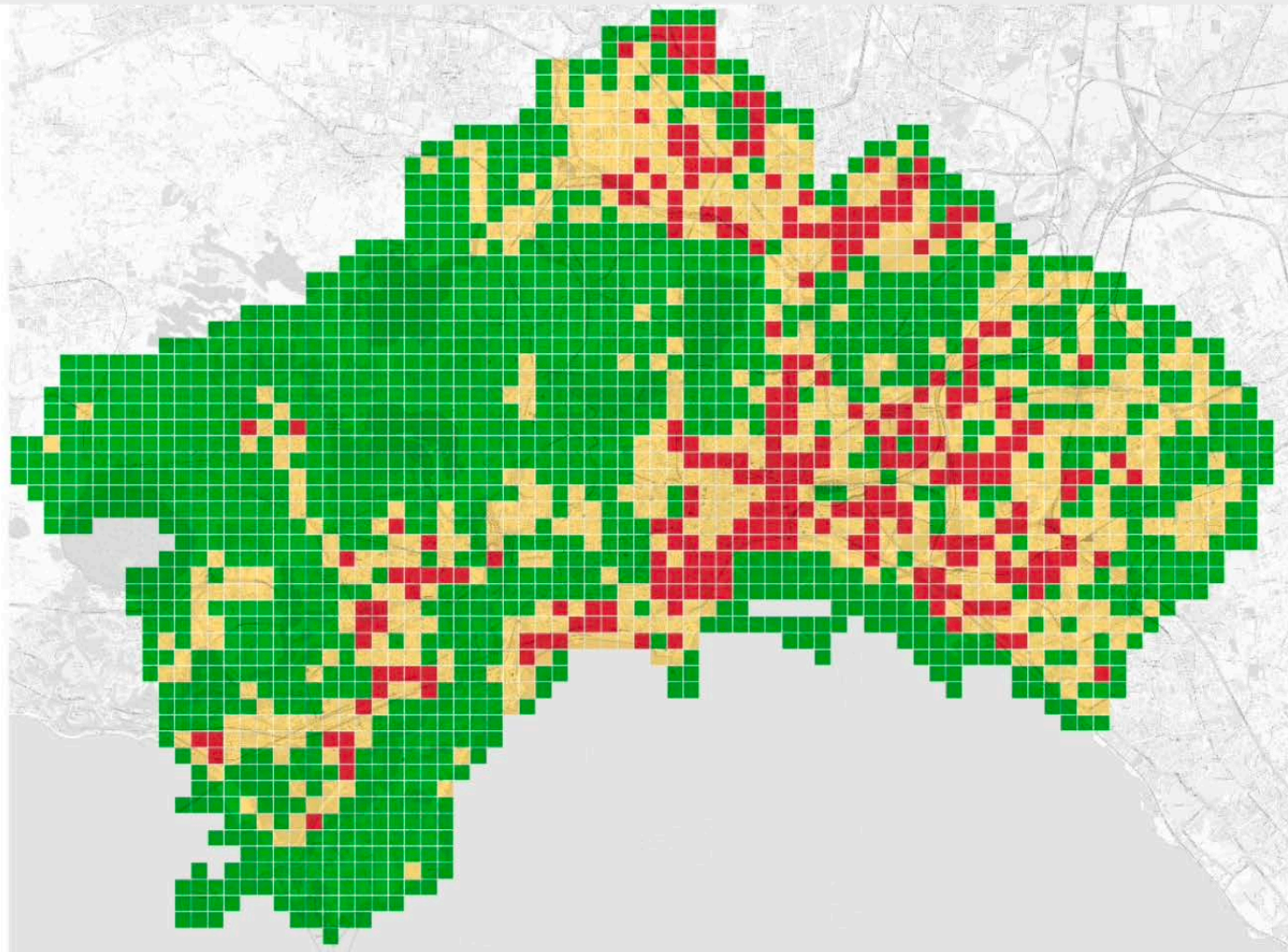
- basso
- medio
- alto

Scenario RCP 8.5

periodo:
2011 - 2040

livello di
precipitazioni:
105mm - 110mm

probabilità di
occorrenza: rara



Impatti delle ondate di calore sul servizio sanitario indicatore: Costi di ospedalizzazione in relazione alle malattie legate al calore

Costo totale
■ basso
■ moderato
■ alto

Scenario RCP 8.5

periodo:
2011 - 2040

temperatura
dell'aria:
34 °C

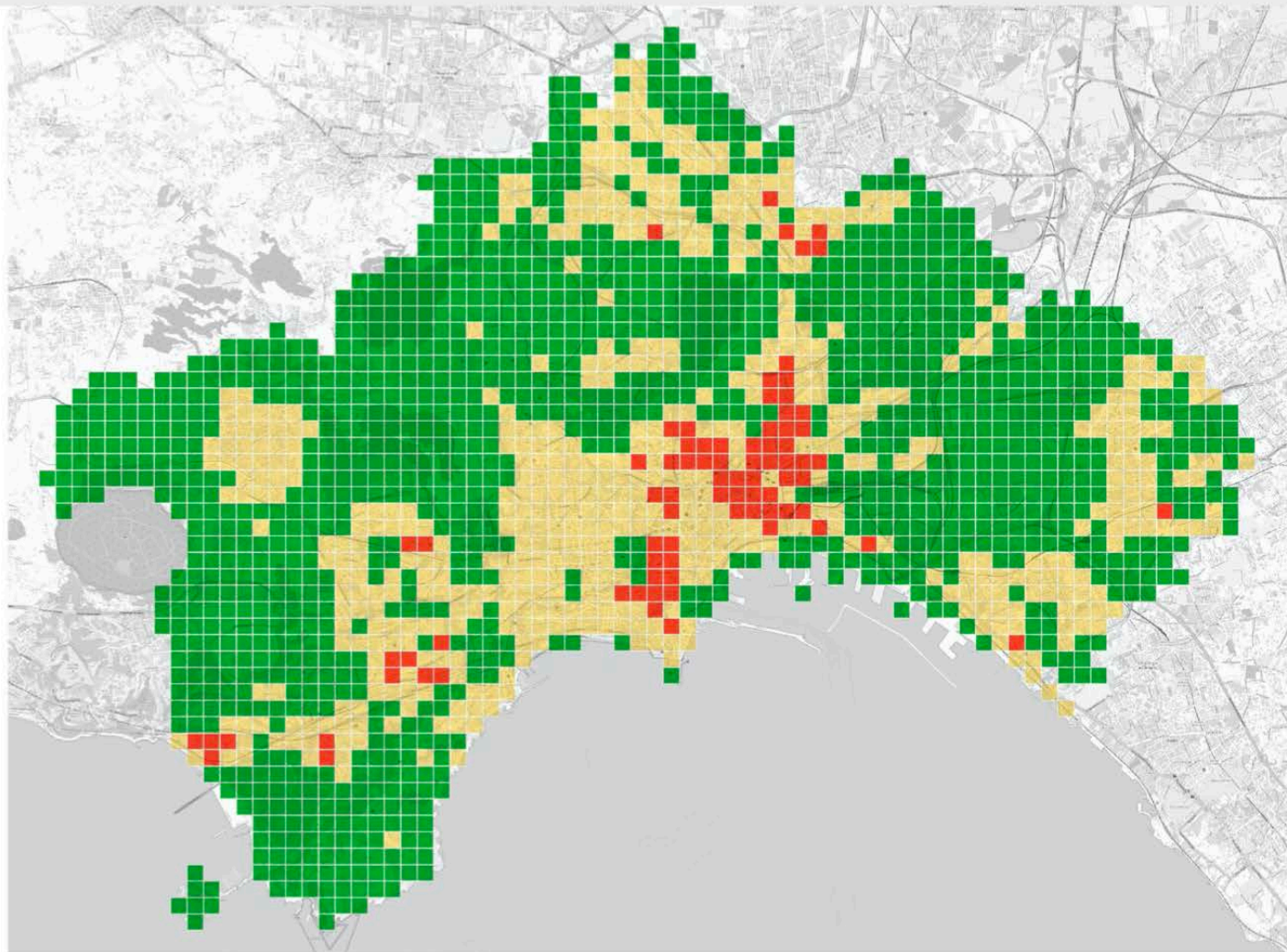
probabilità di
occorrenza:
frequente

Somma dei costi
per il comune di
Napoli

Costi diretti
920.191 €

Costi indiretti
273.050 €

Costi totali
1.193.241 €



Impatti delle ondate di calore sul servizio sanitario indicatore: Costi di ospedalizzazione in relazione alle malattie legate al calore

Costo totale

- basso
- moderato
- alto

Scenario RCP 8.5

periodo:
2011 - 2040

temperatura
dell'aria:
40 °C

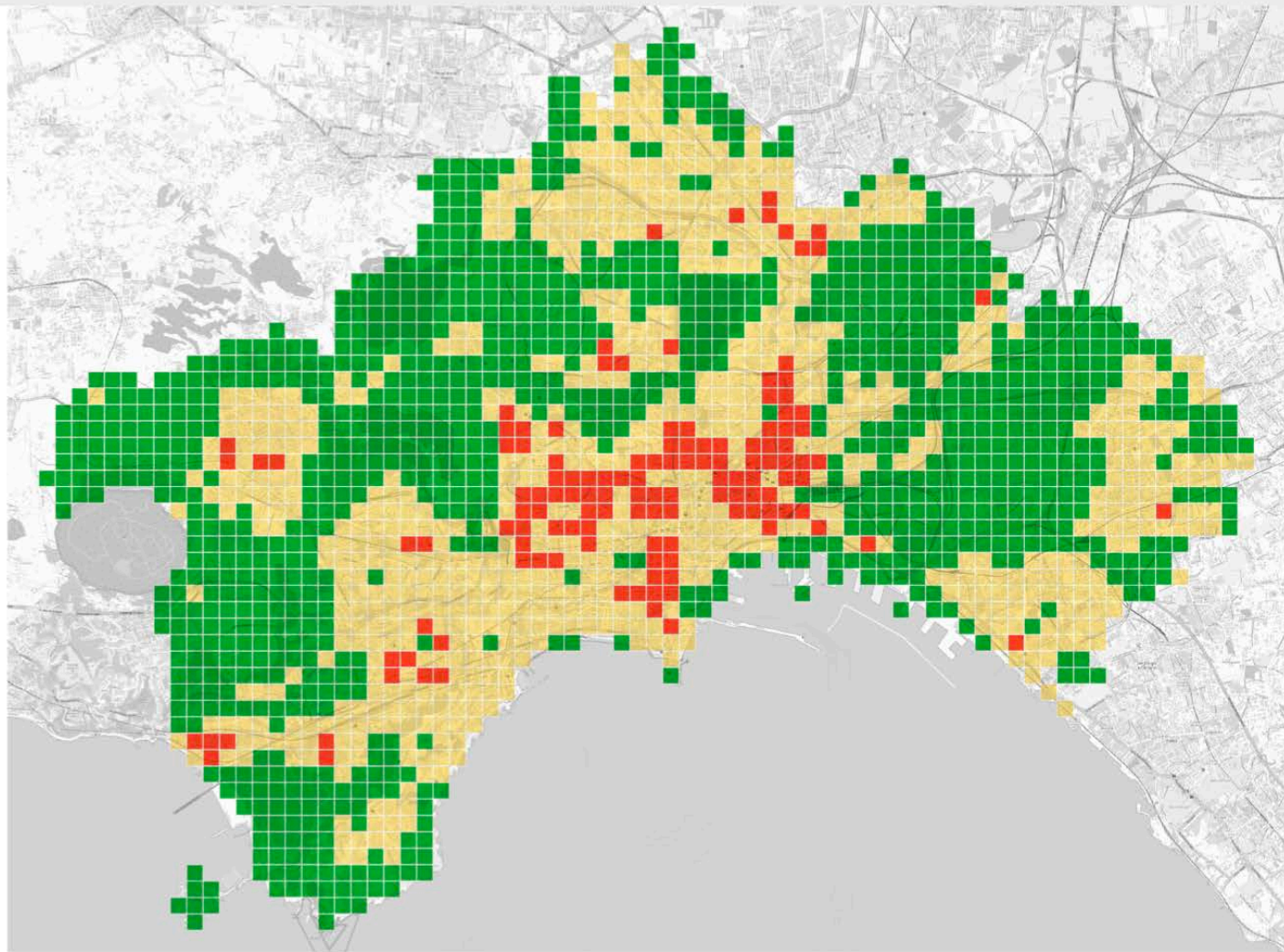
probabilità di
occorenza: raro

Somma dei costi
per il comune di
Napoli

Costi diretti
1.351.295 €

Costi indiretti
400.972 €

Costi totali
1.752.266 €



Impatti delle ondate di calore sulla popolazione

indicatore: tasso di mortalità attribuibile alle ondate di calore

tasso di mortalità
attribuibile all'ondata
di calore

- basso [0% - 5%]
- medio [5% - 8,5%]
- alto [8,5% - 12%]

Scenario RCP 8.5

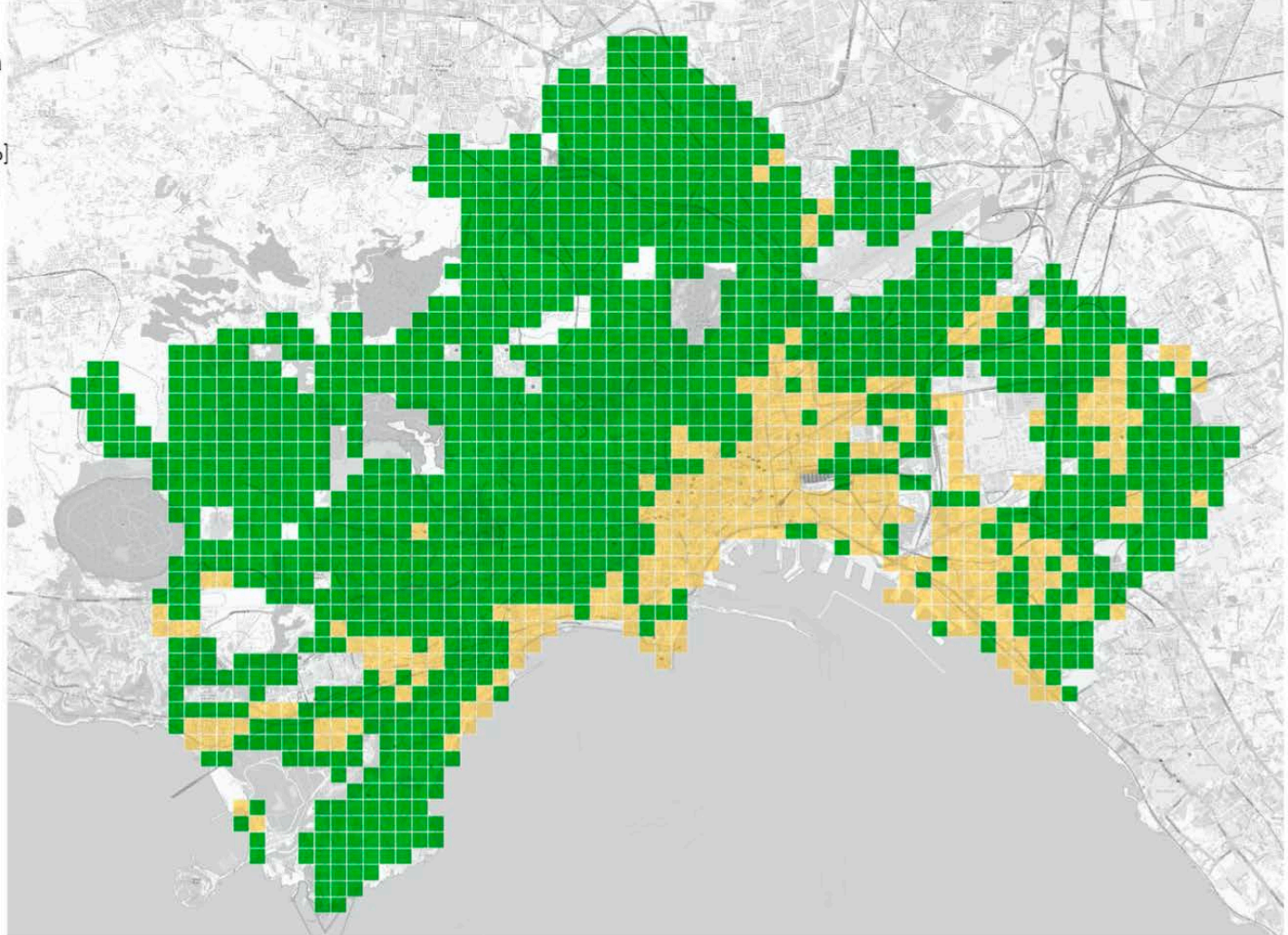
periodo:
2011 - 2040

temperatura
dell'aria:
34 °C

probabilità di
occorenza:
frequente

durata dell'ondata
di calore:
2 giorni

tasso di mortalità
medio attribuibile
all'ondata di calore:
4,1 %



Impatti delle ondate di calore sulla popolazione

indicatore: tasso di mortalità attribuibile alle ondate di calore

tasso di mortalità
attribuibile all'ondata
di calore

- basso [0% - 5%]
- medio [5% - 8,5%]
- alto [8,5% - 12%]

Scenario RCP 8.5

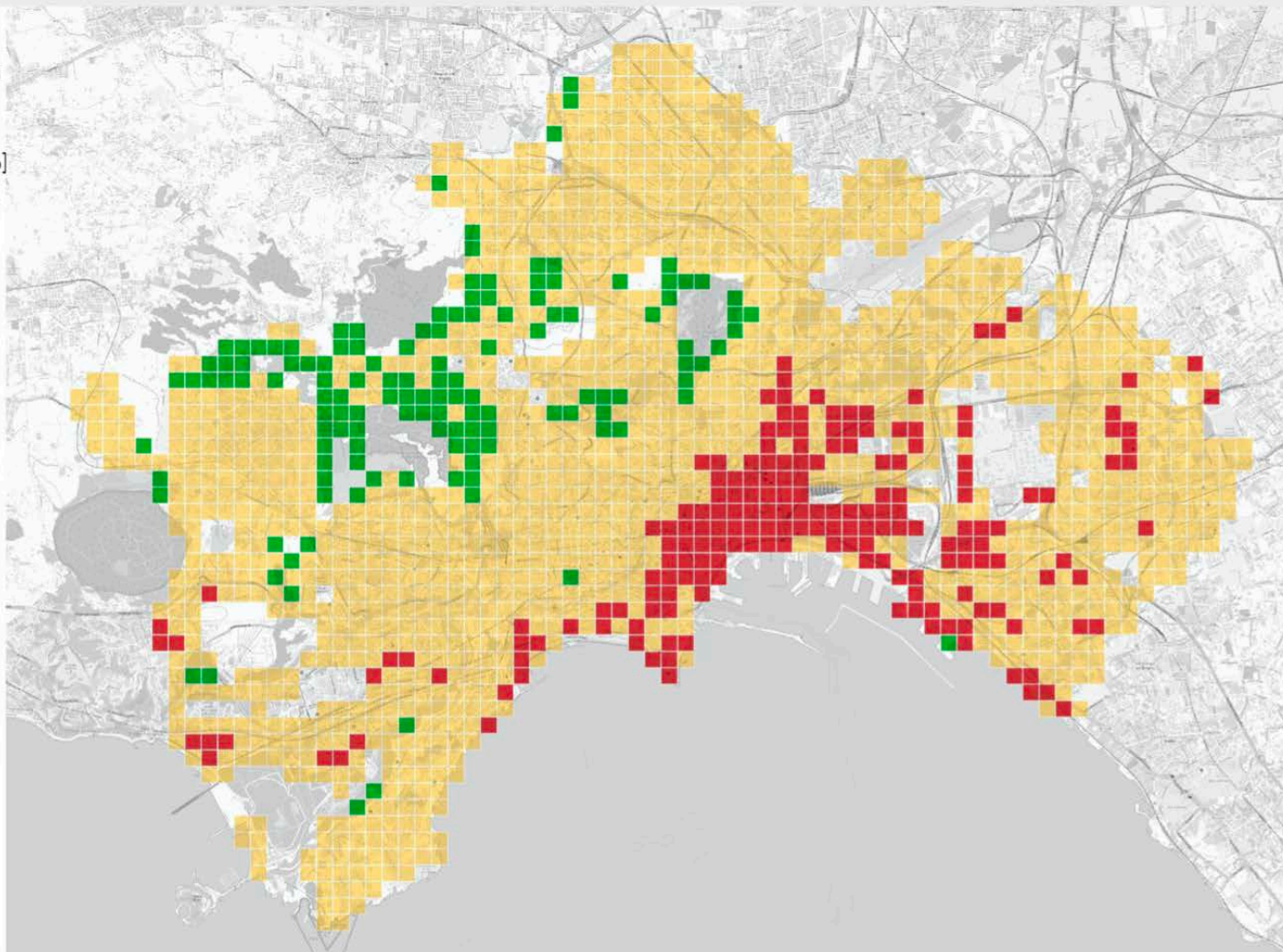
periodo:
2011 - 2040

temperatura
dell'aria:
40 °C

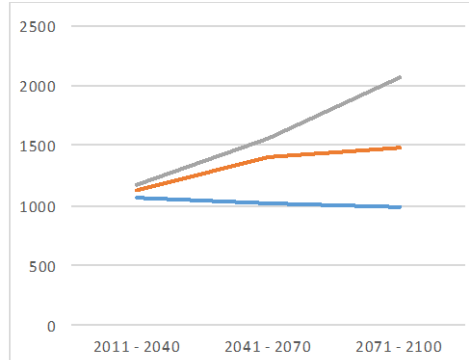
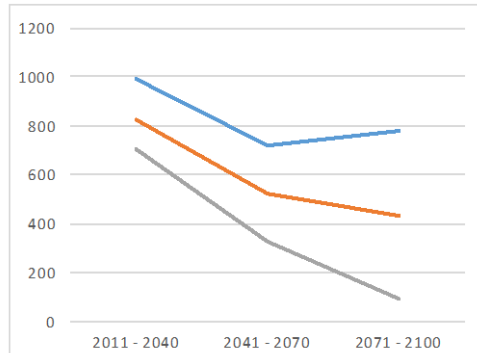
probabilità di
occorenza: rara

durata dell'ondata
di calore:
13 giorni

tasso di mortalità
medio attribuibile
all'ondata di calore:
6,9 %



Variazione dei consumi energetici in rapporto agli scenari di cambiamento climatico



HDD	historical 1970 – 2000: 1389		
	2011 - 2040	2041 - 2070	2071 - 2100
RCP 2.6	987	714	780
RCP 4.5	827	521	432
RCP 8.5	702	323	93

CDD	historical 1970 – 2000: 772		
	2011 - 2040	2041 - 2070	2071 - 2100
RCP 2.6	1057	1014	990
RCP 4.5	1128	1405	1476
RCP 8.5	1168	1551	2065

	2011-2040	2041-2070	2071-2100
Variation of heating needs in Napoli area			
RCP 4.5	-4%	-35%	-46%
RCP 8.5	-13%	-60%	-89%
Variation of cooling needs in Napoli area			
RCP 4.5	+22%	+38%	+41%
RCP 8.5	+25%	+43%	+58%

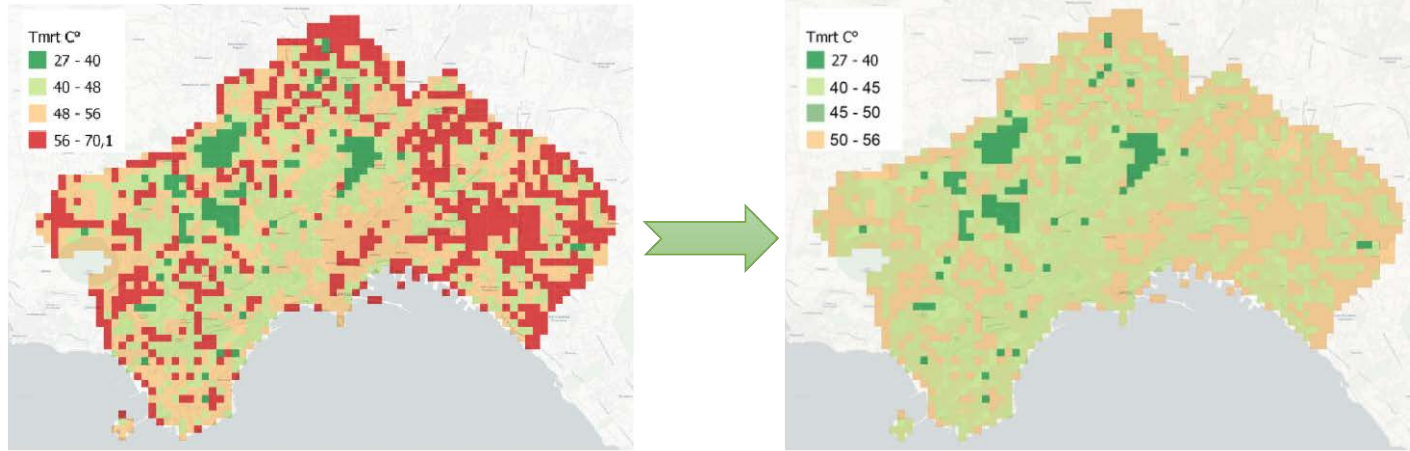
Low uncertainty	Medium uncertainty	High uncertainty
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Settore politico impattato	Impatto/i atteso/i	Probabilità dell'evento	Livello atteso di impatto	Periodo di tempo	Indicatori relativi agli impatti
Edifici	Impatto degli allagamenti sugli edifici	RCP 4.5 frequente	Low	2011-2040	Impatto economico per danni strutturali e al contenuto degli edifici
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Medium		
		RCP 8.5 occasionale	Medium		
		RCP 4.5 raro	High		
		RCP 8.5 raro	High		
		RCP 4.5 frequente	Low	2041-2070	
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Medium		
		RCP 8.5 occasionale	Medium		
		RCP 4.5 raro	High		
		RCP 8.5 raro	High		
		RCP 4.5 frequente	Low	2071-2100	
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Medium		
		RCP 8.5 occasionale	High		
RCP 4.5 raro	High				
RCP 8.5 raro	High				
Trasporto	Impatto degli allagamenti sulla rete stradale	RCP 4.5 frequente	Low	2011-2040	Impatto economico per la pulizia e la riparazione delle strade
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Medium		
		RCP 8.5 occasionale	Medium		
		RCP 4.5 raro	High		
		RCP 8.5 raro	High		
		RCP 4.5 frequente	Low	2041-2070	
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Low		
		RCP 8.5 occasionale	Medium		
		RCP 4.5 raro	High		
		RCP 8.5 raro	High		
		RCP 4.5 frequente	Low	2071-2100	
		RCP 8.5 frequente	Low		
		RCP 4.5 occasionale	Low		
		RCP 8.5 occasionale	High		
RCP 4.5 raro	High				
RCP 8.5 raro	High				
Energia	Impatto dei trend di temperature estivi e invernali sul consumo di energia	RCP 4.5	22%	2011-2040	Aumento della domanda di energia elettrica per l'aria condizionata in ambito civile
		RCP 8.5	25%	2041-2070	
		RCP 4.5	38%		
		RCP 8.5	43%		
		RCP 4.5	41%	2071-2100	
		RCP 8.5	58%	2011-2040	
		RCP 4.5	-4%		
		RCP 8.5	-13%		
		RCP 4.5	-35%		2041-2070
		RCP 8.5	-60%		
		RCP 4.5	-46%		
		RCP 8.5	-89%	2071-2100	Riduzione della domanda di gas per il riscaldamento in ambito civile

Settore politico impattato	Impatto/i atteso/i	Probabilità dell'evento	Livello atteso di impatto	Periodo di tempo	Indicatori relativi agli impatti
Pianificazione dell'uso del suolo	Isola di Calore Urbana	RCP 4.5 frequente	58,3	2011-2040	Temperatura media radiante delle aree urbane [Tmrt °C]
		RCP 8.5 frequente	57,6		
		RCP 4.5 occasionale	64,4		
		RCP 8.5 occasionale	62,3		
		RCP 4.5 raro	65,8		
		RCP 8.5 raro	65,8		
		RCP 4.5 frequente	58,9	2041-2070	
		RCP 8.5 frequente	60,3		
		RCP 4.5 occasionale	64,4		
		RCP 8.5 occasionale	65,1		
		RCP 4.5 raro	66,5		
		RCP 8.5 raro	67,2		
		RCP 4.5 frequente	59,6	2071-2100	
		RCP 8.5 frequente	62,3		
		RCP 4.5 occasionale	65,1		
		RCP 8.5 occasionale	67,9		
		RCP 4.5 raro	66,5		
		RCP 8.5 raro	72,8		
Salute	Impatti delle ondate di calore sulla popolazione	RCP 4.5 frequente	35,3	2011-2040	Livelli di stress da calore su gruppi di popolazione deboli [UTCI °C]
		RCP 8.5 frequente	35,8		
		RCP 4.5 occasionale	38,7		
		RCP 8.5 occasionale	40,2		
		RCP 4.5 raro	41,1		
		RCP 8.5 raro	41,1		
		RCP 4.5 frequente	36,3	2041-2070	
		RCP 8.5 frequente	37,2		
		RCP 4.5 occasionale	40,2		
		RCP 8.5 occasionale	40,7		
		RCP 4.5 raro	41,6		
		RCP 8.5 raro	42,1		
		RCP 4.5 frequente	36,8	2071-2100	
		RCP 8.5 frequente	38,7		
		RCP 4.5 occasionale	40,7		
		RCP 8.5 occasionale	42,6		
		RCP 4.5 raro	41,6		
		RCP 8.5 raro	46,1		
		RCP 4.5 frequente	4,3%	2011-2040	
		RCP 8.5 frequente	4,1%		
		RCP 4.5 occasionale	6,3%		
		RCP 8.5 occasionale	5,6%		
		RCP 4.5 raro	6,9%		
		RCP 8.5 raro	6,9%		
RCP 4.5 frequente	4,5%	2041-2070	Aumento del tasso di mortalità durante le ondate di calore		
RCP 8.5 frequente	4,9%				
RCP 4.5 occasionale	6,3%				
RCP 8.5 occasionale	6,6%				
RCP 4.5 raro	7,1%				
RCP 8.5 raro	7,4%				
RCP 4.5 frequente	4,7%	2071-2100			
RCP 8.5 frequente	5,6%				
RCP 4.5 occasionale	6,6%				
RCP 8.5 occasionale	7,7%				
RCP 4.5 raro	7,1%				
RCP 8.5 raro	9,8%				

Adattamento climatico e prevenzione del rischio



Adaptation costs ("ideal" strategies towards 2050)	€/m ²	€ tot Napoli
Open spaces	€ 49,38	€ 2.153.138.128,29
Buildings	€ 216,26*	€ 13.514.906.677,95
Maintenance and enhancing of sewage systems	€ 35,00	€ 2.842.172.459,38

*per m² of surface cover

valutazione costi-benefici delle principali strategie di adattamento basate sull'uso del suolo

Adattamento climatico e prevenzione del rischio

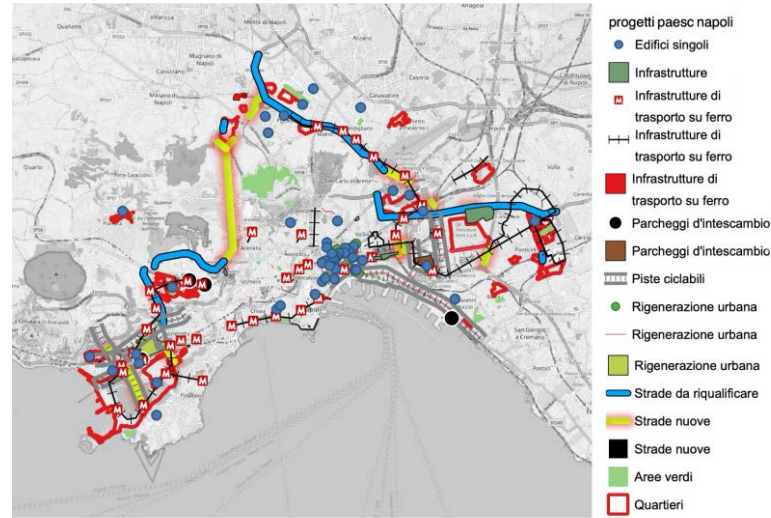


Figura 1: Classificazione dei progetti e interventi in corso nel Comune di Napoli (fonte: PLINIVS-LUPT)

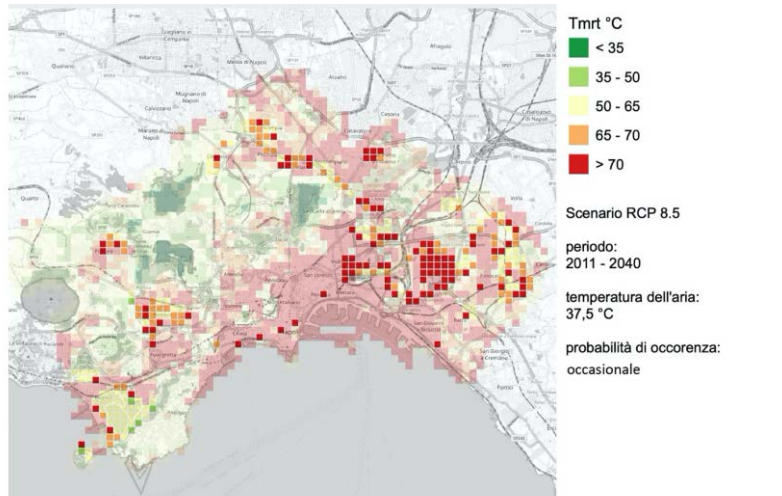


Figura 1: Evidenziazione delle celle interessate da interventi in corso o programmati, relativamente ai valori calcolati di Temperatura Media Radiante (Tmrt) (fonte: PLINIVS-LUPT)

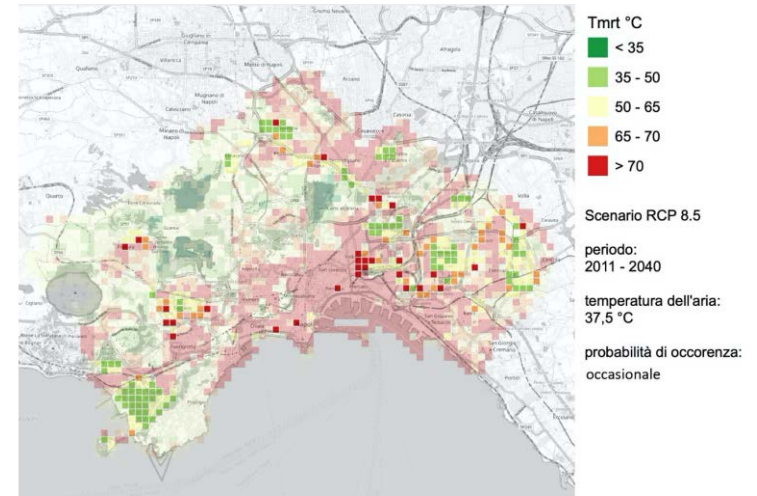


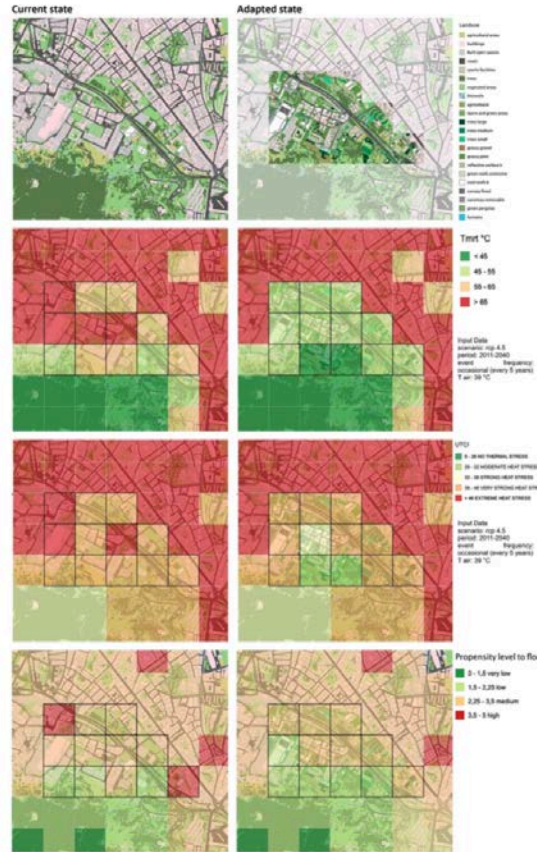
Figura 1: Analisi dei progetti e interventi in corso con indicazione del potenziale miglioramento delle condizioni di isola di calore, indicatore Temperatura Media Radiante (Tmrt) (fonte: PLINIVS-LUPT)

Adattamento climatico e prevenzione del rischio

Current state		
Land use class	m ²	%
agricultural areas	16382	2,2%
buildings	127031	16,9%
Built open spaces	240351	32,0%
roads	100763	13,4%
sports facilities	11097	1,5%
trees	124321	16,6%
vegetated areas	110469	14,7%
cool roofs b	15218	2,0%
canopy a	4936	0,7%
TOTAL	750568	100,0%

Current state

Adaptation

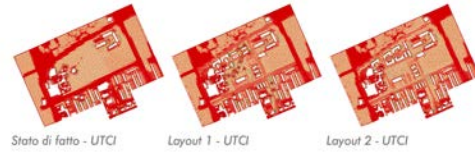
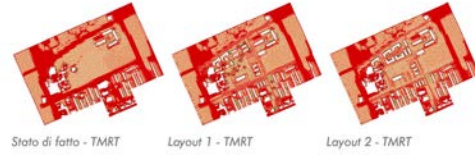
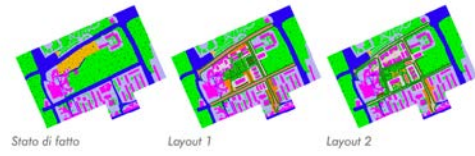


Adaptation				
	Land use class	m ²	%	€
Existing land use	agricultural areas	16257	2,2%	-
	buildings	55434	7,4%	-
	Built open spaces	59514	7,9%	-
	roads	57950	7,7%	-
	sports facilities	11097	1,5%	-
	trees	124321	16,6%	-
Adapted land use	vegetated areas	103469	13,8%	-
	green surface a	6362	0,8%	€ 970.269,81
	green surface b	15666	2,1%	€ 509.156,96
	green surface c	25129	3,3%	€ 816.684,17
	trees a	25109	3,3%	€ 10.891.025,11
	trees b	19841	2,6%	€ 5.208.313,08
	trees c	12913	1,7%	€ 1.242.872,68
	permeable flooring a	10285	1,4%	€ 719.939,88
	permeable flooring b	49082	6,5%	€ 1.717.855,32
	reflective surface b	60055	8,0%	€ 900.832,06
	green roofs b	15093	2,0%	€ 830.114,34
	cool roofs b	66802	8,9%	€ 277.226,87
	canopy a	7344	1,0%	€ 1.652.293,43
canopy b	1522	0,2%	€ 131.240,65	
canopy c	7132	1,0%	€ 624.062,06	
water bodies b	192	0,0%	€ 7.205,01	
TOTAL	750568	100,0%	€ 26.499.091,42	

- agricultural areas
- green surface b
- permeable flooring c
- buildings
- green surface c
- reflective surface b
- Built open spaces
- trees a
- green roofs b
- trees b
- trees c
- cool roofs b
- trees c
- canopy a
- permeable flooring a
- canopy b
- permeable flooring b
- canopy c
- water bodies b

Support to implementation of urban plans and project (PNRR)

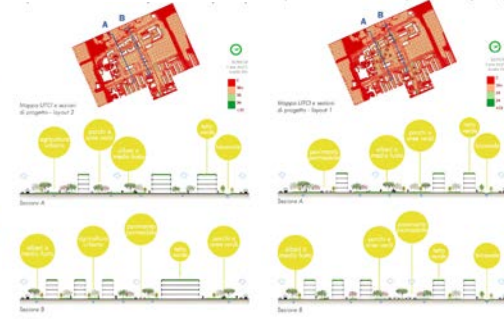
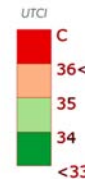
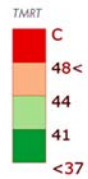
Adattamento climatico e prevenzione del rischio



Cool flooring (LOWSRI < 0,75)

- Lawns and green areas
- Roads
- Grassed joint pavements
- Extensive green roof

- Trees
- Permeable concrete
- Urban agriculture
- Built open space



Edifici, specifiche di intervento

- Tetti verdi**
I tetti verdi da prevedere sono previsti non destinati ad attività collettive (nel massimo di 100mq) e in caso di attività lavorativa, la vegetazione è dimensionata in modo da ottenere a subambito, così da garantire una riduzione a quota della temperatura dell'aria.
- Dti urbani**
Gli edifici sono da prevedere prevalentemente di tipo a capanna, con tetti spio di 15°, con una pendenza di 10° in corrispondenza della facciata di ingresso. L'orientamento degli edifici deve essere in funzione dell'impiego previsto per permettere di sfruttare l'energia solare per alimentare l'impianto di irrigazione.
- Sistemi passivi**
Prevedere e dimensionare questi sistemi di ingegneria per fornire l'energia per il riscaldamento e il raffreddamento passivo. L'orientamento e l'isolamento dell'edificio deve essere studiato in modo da garantire un adeguato assorbimento delle radiazioni e una sufficiente dissipazione, invernale.
- Indicazioni CAM**
L'edificio, in quanto a progetti degli impianti, deve essere previsto in base alle norme di riferimento (D.M. 19/02/2005) e in base alla tipologia di funzioni insediare e al numero di persone presenti nella struttura.

Indicazioni CAM

Il progetto di un nuovo edificio, deve essere previsto in base alle norme di riferimento (D.M. 19/02/2005) e in base alla tipologia di funzioni insediare e al numero di persone presenti nella struttura.

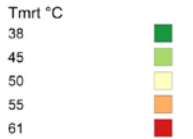
Il progetto di un nuovo edificio, deve essere previsto in base alle norme di riferimento (D.M. 19/02/2005) e in base alla tipologia di funzioni insediare e al numero di persone presenti nella struttura.

Classi acustiche UNI 11367

Descrizione	Classi
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30
Indicatore di rumore L _{eq} (dB)	1-30



Daytime average



DATI DI INPUT:

DATI CLIMATICI

- T air max **37.40°**
- T air min **28.40°**
- T ground max **65.09**
- T ground min **28.40°**
- K global h14 **823.7**
- K income h19 **1011.86**
- K diffuse h12 **299.99**
- RH max **52%**
- WIND speed **3.0 kst**

PARAMETRI DI

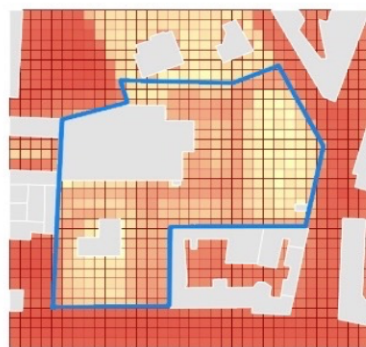
ESPOSIZIONE UMANA

- Absorption, shortwave radiation: **0.7**
- Absorption, longwave radiation: **0.97**

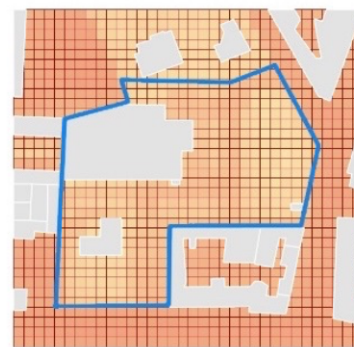
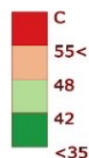
PERIODO DI ANALISI

- Media h. **07:00-20:00**

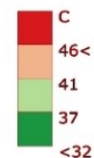
Adattamento climatico e prevenzione del rischio



Radiant Temperature
Jul 31 1:00 - Jul 31 24:00



Universal Thermal Climate Index
Jul 31 1:00 - Jul 31 24:00



Minimum Environmental Criteria (CAM land cover and urban drainage)	PERFORMANCE	BENCHMARK	RESULT
Minimum green cover ratio	48%	40%	
Minimum tree cover ratio	40%	40%	
Minimum permeable surface	68%	60%	
CLARITY indicators (Urban Heat Island and Outdoor Comfort)	PERFORMANCE*	BENCHMARK	RESULT
TMRT _{2018_baseline}	43,6	≤44	
UTCI _{2018_baseline}	34,7	≤35,5	
TMRT _{2020-2040_RCP45}	47,3	≤47	
UTCI _{2020-2040_RCP45}	40,4	≤40,5	
TMRT _{2020-2040_RCP85}	48,7	≤48,5	
UTCI _{2020-2040_RCP85}	43,1	≤43	

HAZARD/IMPACT MODELS UPGRADE AND INTEGRATION (heat waves; urban, river and coastal floods)

DEMONSTRATORS

(Napoli, Tallin, Granollers, South Westfalia)

<p>Model: WRF Area: climate Inputs: land use, albedo, soil moisture, topography, albedo, leaf area index... Outputs: Temperature, clouds, humidity, precipitation, wind...</p>	<p>Model: TELEMAC 2D Area: flooding Inputs: extreme sea levels, precipitation, discharge Outputs: flooded area and depth</p>	<p>Model: SFINCS Area: (coastal) flooding Inputs: extreme sea levels, precipitation, winds, discharge Outputs: flooded area and depth</p>
<p>Model: MATSim Area: transport Inputs: road network, POIs, public transit data, population Outputs: modal split, emissions, network loads, person km, vehicle km, trip frequency, travel time</p>	<p>Model: GTSM Area: sea level extremes Inputs: atmospheric forcing (winds and sea level pressure) Outputs: extreme sea levels at ca. 18000 stations along the global coast</p>	<p>Model: Coping Typology Area: behaviour Inputs: socio-demographic features, region type, digitalisation level, culture Outputs: climate literacy, sustainability behaviour, reaction to interventions, willingness to change</p>
<p>Model: CLARITY HWLEM Area: land use/microclimate Inputs: building type/ height, land-use type (paved and vegetated areas). Key param.: Albedo, Emissivity, Transmissivity, Sky View Factor, Hillshade green fraction, Surface Temperature Outputs: Tmrt, UTCI, Mortality rate increase, Heat-related stresses to population, Public Health costs</p>	<p>Model: DLNM (Distributed Lag Non-linear Model) Area: Human Health Inputs: air temperature (daily maximum, Nth percentile or other, depending on specific needs and application), epidemiological data (ideally including dependence on gender, age, pathology, etc.) Output: Relative Risk for human health associated to extreme temperatures</p>	<p>Model: MAED-City, MESSAGE Area: energy Inputs: demographic, socio-economic and technological parameters as well as techno-economic description of energy supply of the considered region Outputs: energy demand by sector and energy form, energy supply strategy, CO2-emission, selected KPIs</p>
<p>Model: PALM / MUKLIMO_3 Area: climate Inputs: albedo, building height, building type, pavement type, vegetation, leaf area index, water bodies, soil type... Outputs: temperature, relative humidity, wind, human comfort parameters</p>	<p>Model: WavewatchIII: wave model, adapted for the Mediterranean Area: Sea State simulation Inputs: atmospheric forcing from regional climate models (e.g. wind speed, direction) Outputs: wave characteristics (significant height, direction, period, energy, etc.)</p>	<p>Model: Infoworks ICM Area: Urban flooding Inputs: DTM (digital terrain model) pipes / river cross section data (dimensions, slopes, etc.), manholes data (location dimensions, depth) catchment data (area, slope, land use,...) others (pumps, tanks,...) rainfall data, input flows, water levels in outlets. Outputs: Flooding depths (in the urban surface in case of 2D models, and also in pipes and river links), flooding velocities and flows</p>
<p>Model: CLUMONDO Area: land use Inputs: spatial inputs: an existing land use/land systems map, population density, market access, road network, elevation, soil, soil characteristics (clay, sand, organic content, depth, drainage, pH...), current and future climate (precipitation, temperature, potential evapotranspiration), other: distribution of ecosystems, protected areas. Non-spatial inputs: statistics on current and future crop and livestock production, irrigation water use. Outputs: future land use, optimized land use</p>	<p>Model: HiREPS Area: Energy market sector model Inputs: changes in the electricity consumption for heating, cooling, transport and other demand; planned expansion of renewable and other power production in the demonstrator regions Outputs: CO2 Emission factor of electricity consumed locally in the demonstrator regions; local electricity prices; estimation of required local grid investments</p>	

Protecting citizen's health & wellbeing

Role: Demonstrator
CIC: Heat waves & health
Challenge: Heat islands especially affect areas with risk groups. The city plans measures like renewing old residential buildings and provide health and energy saving advise.
KNOWING innovation: Assessing tradeoff between construction/renovation measures of coping behaviour and mitigation goals; strategy for better citizen prepared-ness.
Follower: Zagreb, Valencia, Ho Chi Min C.

Mitigate behavioural maladaptations

Role: Follower
CIC: Heat waves & health
Challenge: Reduce heat-caused behaviour change in mobility (more trips in airconditioned cars, urban sprawl)
KNOWING Mitigation Pathways: Pathway for Urban Regions
Pathway for Coastal Regions

Secure accessibility of mountain valleys

Role: Follower
CIC: Flooding & infrastructure (river)
Challenge: Obstructed valleys and damaged infrastructure caused by floodings and landslides
KNOWING Mitigation Pathways: Pathway for River Regions
Pathway for Agricultural Regions

Regulate conditions for sustainable agriculture

Role: Follower
CIC: Soil fertility & agriculture
Challenge: Develop recommendations for including guidelines in new land-lease contracts
KNOWING Mitigation Pathways: Pathway for Agricultural Regions
Pathway for RiverRegions

Establishing sustainable forestry

Role: Demonstrator
CIC: Soil fertility & agriculture
Challenge: Climate impacts affect forestry as economic asset and element for mitigation, requiring an integrated strategy for climate resilience, reforestation & flood prevention
KNOWING innovation: Integrated planning, understanding, analyzing and communicating interdependencies, monitoring impact, manage and facilitate stakeholder engagement
Follower: Lauenburg, Zagreb, Ho Chi Min C.

Prepare for new coastal flooding risks

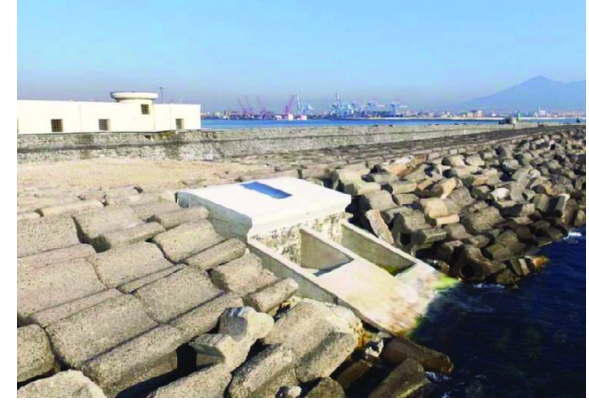
Role: Demonstrator
CIC: Flooding & infrastructure (coast)
Challenge: Sea level rise and changed atmospheric conditions increase coastal flooding risk, requiring co-created Integrated District Plan services & adaptation plan tenders.
KNOWING innovation: Expand the city focus on heat waves & pluvial flood adaptation towards coastal risks and aspects of social acceptance and behavior change
Follower: Valencia

Increase resilience to river flooding

Role: Demonstrator
CIC: Flooding & infrastructure (river)
Challenge: Pluvial and river floods pose the most critical risk according to the Urban Resilience Plan, leading to partial failures of critical infrastructures and cascading effects.
KNOWING innovation: Balancing mitigation & adaptation measures considering grey infrastructure, nature based solutions, early warning systems & real time control.
Follower: Tyrol, Ho Chi Min City

Leap-frogging adaption mitigation strategies

Role: Follower
CIC: Heat waves & health
Challenge: Develop effective and social-centred climate adaptation and mitigation strategy
KNOWING Mitigation Pathways: Pathway for Urban Regions
Pathway for River Regions



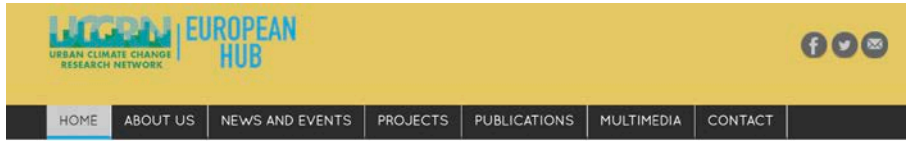
NAPOLI DEMONSTRATOR FOCUS (PLINIVS+ENEA):

Heat Waves & Health

- Improve outdoor dynamic simulation
- Integrate indoor comfort and energy consumption

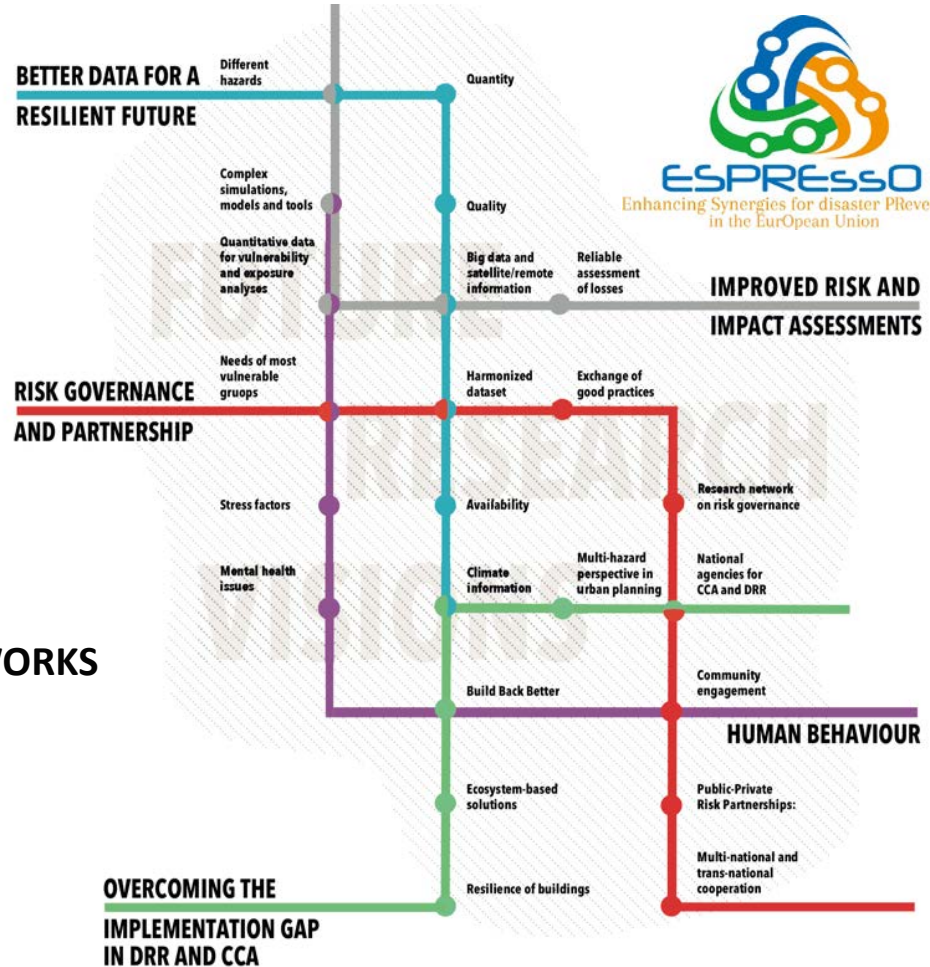
Coastal flooding & Infrastructure

- Implement hazard/impact assessment tools based on advanced wave+SLR model
- Nature Based Solutions and Water Energy Converters to integrate mitigation and adaptation

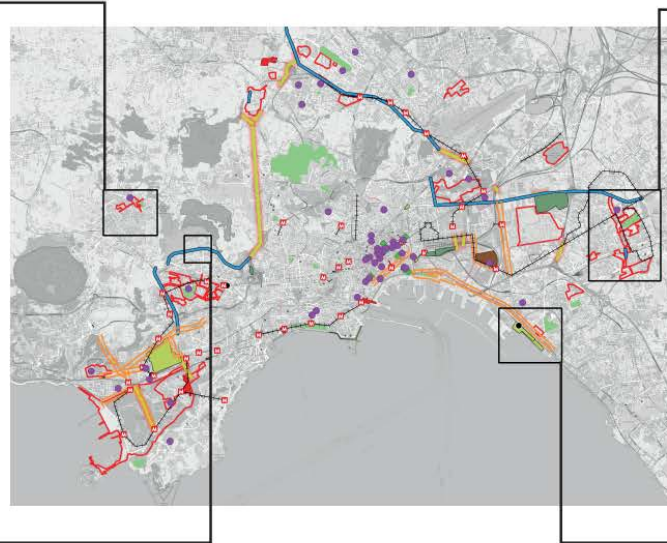


STRATEGIC EXCHANGE WITH INTERNATIONAL NETWORKS

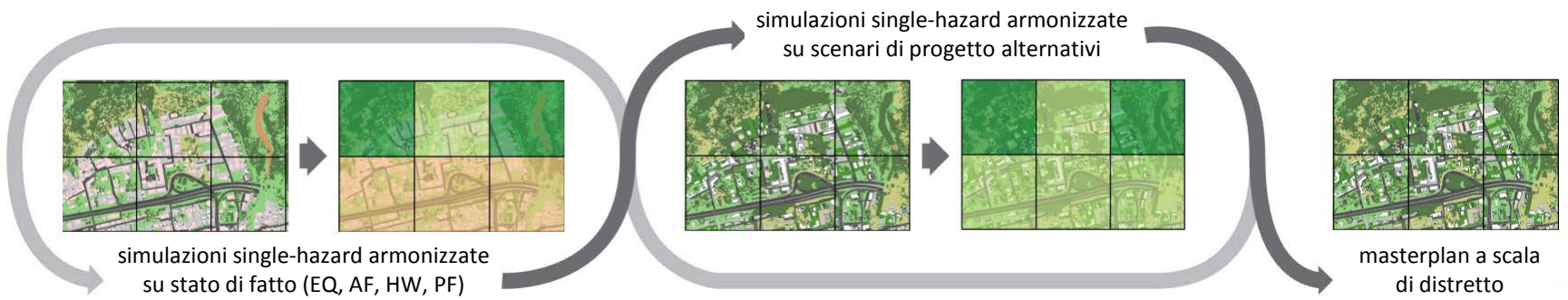
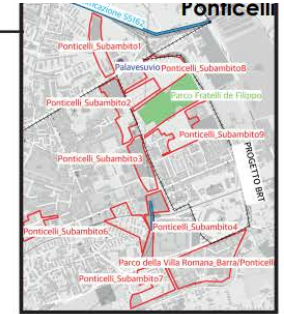
- UCCRN (www.uccrn.org)
- UCCRN European Hub (www.uccrn-europe.org)
- ESPREsSO H2020 project community
- URNet (www.urbanresilienceresearch.net)
- ICLEI (www.iclei.org)
- Climate Chance (www.climate-chance.org)
- Cité-ID - Gouvernance de la résilience urbaine (www.cite-id.com)



Dalla resilienza climatica alla resilienza multi-rischio



- Perimetri aree studio
- Perimetri aree studio
- Progetti in atto
- Edifici singoli
- Infrastrutture
- Infrastrutture di trasporto su ferro
- Infrastrutture di trasporto su ferro
- Infrastrutture di trasporto su ferro
- Parcheggi d'intescambio
- Parcheggi d'intescambio
- Piste ciclabili
- Rigenerazione urbana
- Rigenerazione urbana
- Rigenerazione urbana
- Strade da riqualificare
- Strade nuove
- Strade nuove
- Aree verdi
- Quartieri



Simulazioni di impatto single-hazard armonizzate



ERUZIONI VULCANICHE



La scala di colore con cui viene rappresentato l'impatto sugli edifici è legata alla probabilità di avere strutture edilizie residenziali con tetto collassato per accumulo di cenere, a seguito di eventi eruttivi (scenario di riferimento dei Campi Flegrei, occorrenza 80-200 anni). Correlazioni statistiche su database di danno hanno mostrato che si riscontra la più alta probabilità laddove c'è una maggiore concentrazione di edifici del tessuto storico antico. Nell'area di interesse le simulazioni mostrano valori che variano da basso a medio-alto/alto.

Simulazioni di impatto single-hazard armonizzate



ONDATE DI CALORE

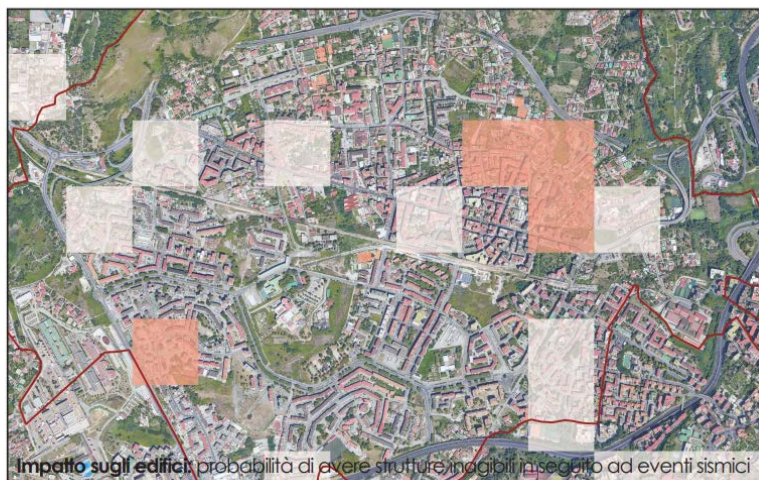


La scala di colore con cui viene rappresentato l'impatto sulla popolazione è legata ai costi di ospedalizzazione per effetto delle ondate di calore sulla persona (lo scenario di riferimento è quello con temperatura dell'aria di 41,5 °C, con occorrenza occasionale, nel periodo 2041-2070). I costi maggiori si riscontrano laddove la vegetazione arborea e/o arbustiva è scarsa o assente e l'impermeabilizzazione dei suoli particolarmente elevata. Nell'area di interesse le simulazioni mostrano valori che variano da basso a medio.

Simulazioni di impatto single-hazard armonizzate

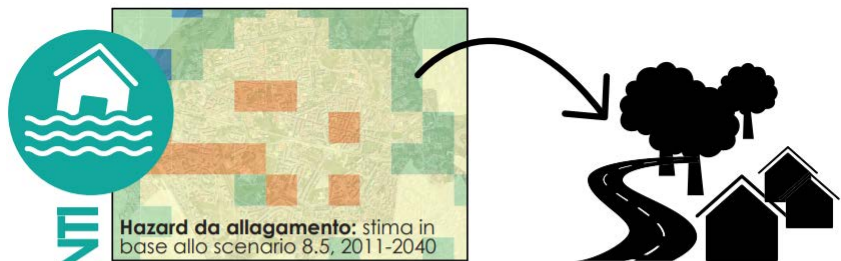


TERREMOTI

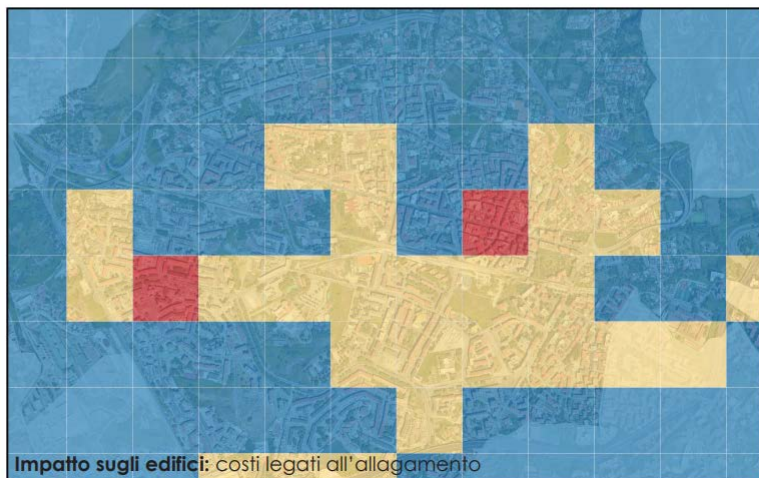


La scala di colore con cui viene rappresentato l'impatto sugli edifici è legata alla probabilità di avere strutture edilizie residenziali inagibili, a seguito di eventi sismici (scenario di riferimento dei Campi Flegrei, magnitudo 4.2 e profondità 3.2 km). Correlazioni statistiche su database di danno hanno mostrato che si riscontra la più alta probabilità laddove c'è una maggiore concentrazione di edifici del tessuto storico antico. Nell'area di interesse le simulazioni mostrano valori che variano da basso a medio-basso

Simulazioni di impatto single-hazard armonizzate

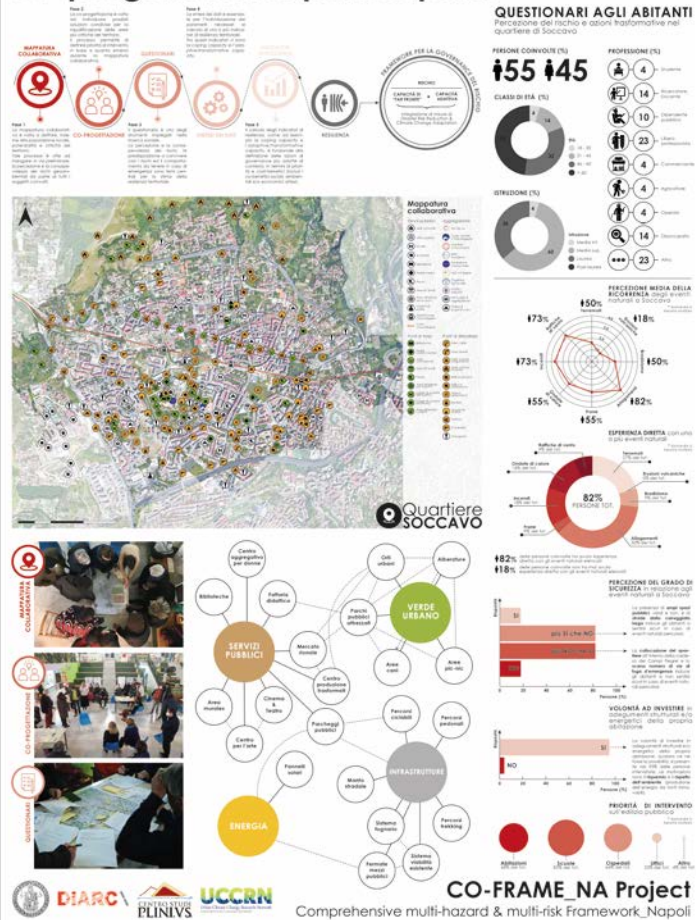


ALLAGAMENTI

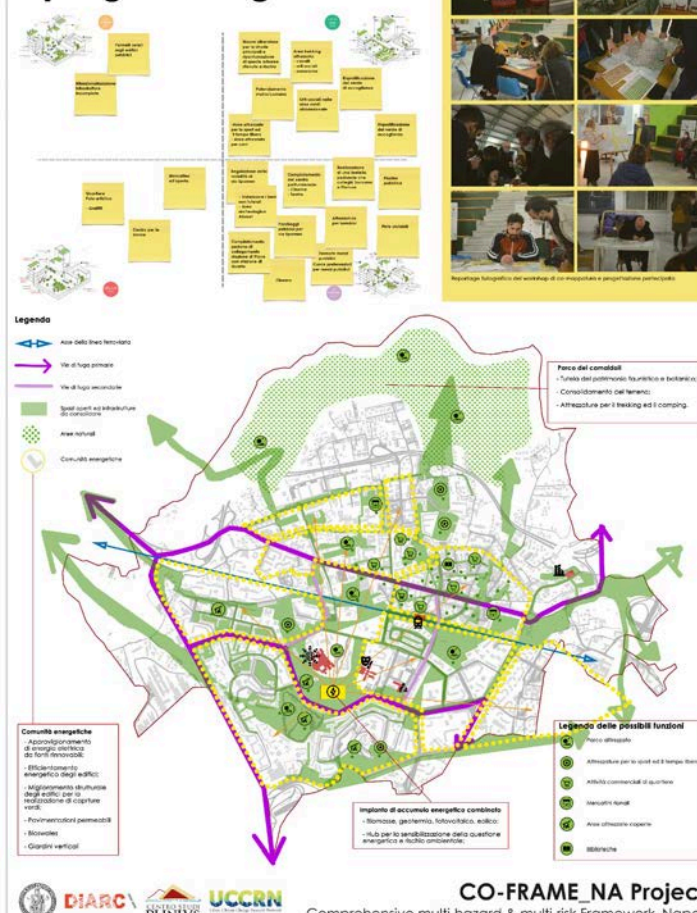


La scala di colore con cui viene rappresentato l'impatto sugli edifici è legata ai costi di ripristino per allagamento, a seguito di eventi meteorologici intensi (lo scenario di riferimento è quello con precipitazioni di 90 mm, con occorrenza occasionale, nel periodo 2041-2070). I costi maggiori si riscontrano laddove vi sono punti di forte accumulo delle acque superficiali e/o sotto superficiali ed elevata impermeabilizzazione dei suoli. Nell'area di interesse le simulazioni mostrano valori che variano da basso ad alto.

Soccavo: mappatura collaborativa & co-progettazione partecipata



I ipotesi progettuale: il progetto degli abitanti



THANKS FOR YOUR ATTENTION

Mattia Leone, PhD

University of Naples Federico II

Department of Architecture (DiARC), PLINIVS Study Centre

mattia.leone@unina.it



www.diarc.unina.it
www.plinivs.it



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