

# **Torino project**

## **Hazard and Exposure analysis**

Progress Update

*April 21, 2017*

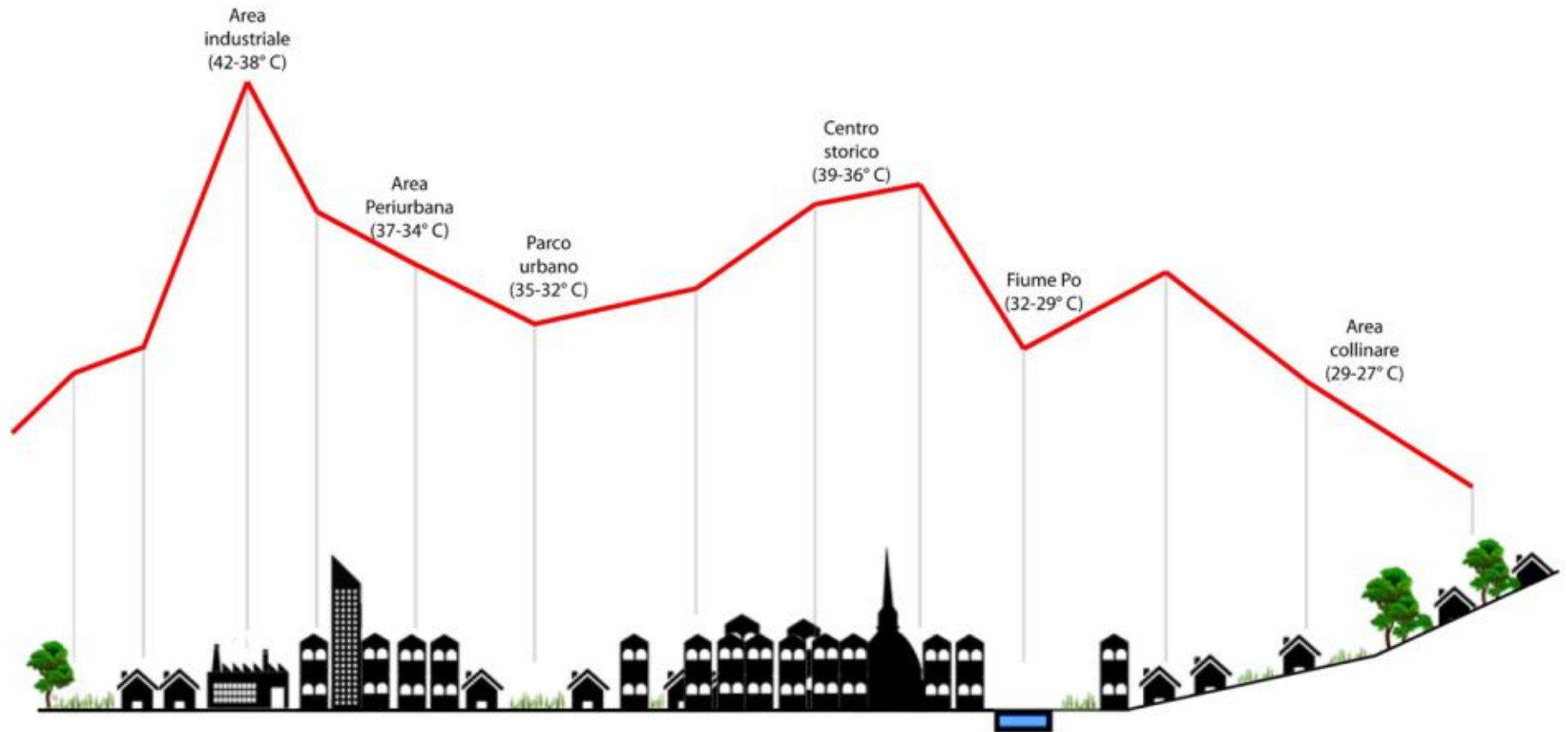
## **Develop and systematize a multi-hazard assessment**

- Define the two most impactful hazards (Urban Heat Island and Flood)
- Collect and harmonize existing hazard data for the prioritized hazards.
- Using the results, develop a multi-hazard representation and characterization.



## **Exposure assessment**

- Develop an exposure inventory of critical infrastructure and residential and commercial areas.
- Develop the loss calculation for the population portfolio and residential areas.
- Develop the technical and institutional mainstreaming process for the exposure and loss information, in order to better inform the strategic planning process.

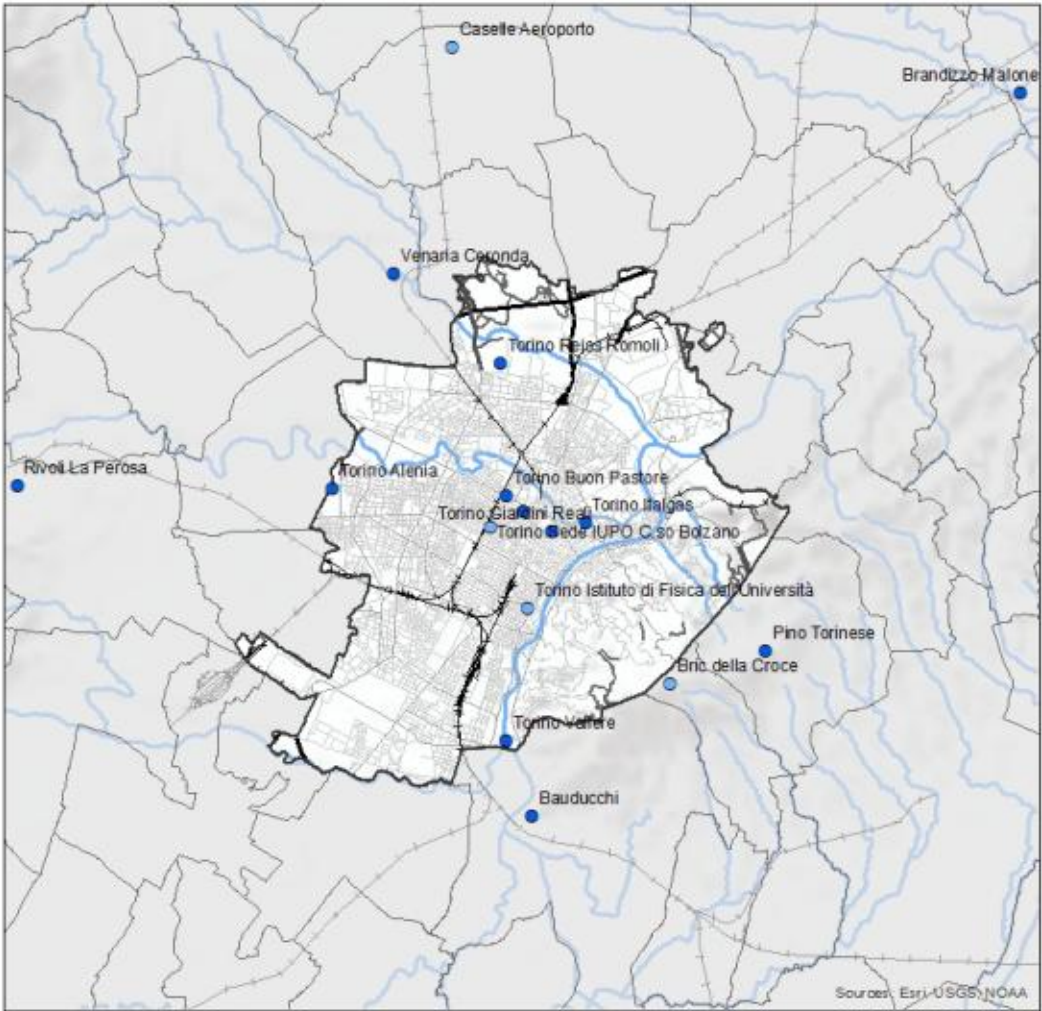


- Analysis of maximum temperature recorded by network of meteorological stations around Torino (ARPA and SMI)
- Selection of heat wave events with available satellite data

Extreme Event Dates	
<b>11 August 2003</b>	<b>23 August 2011</b>
<b>23 July 2004</b>	<b>22 August 2012</b>
<b>21 July 2006</b>	<b>6 July 2015</b>
<b>22 July 2006</b>	<b>22 July 2015</b>
<b>20 August 2009</b>	<b>7 August 2015</b>

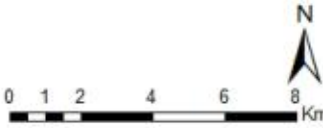
Name	Maximum Temperature (°C)		
	8/11/2003	7/21/2006	7/22/2015
Bric Della Croce	34	31.4	30.2
Caselle Aeroporto	37.1	35.5	34
Pino Torinese	36.4	33.7	34.4
Venaria Ceronda	39.1	36.3	34.5
Torino Reiss Romoli		36.1	35
Torino Alenia		35.6	35.4
Brandizzo Malone		35.5	35.6
Torino Via Della Consolata		36.8	36.1
Rivoli La Perosa		35.4	36.9
Bauducchi	38.2	34.9	37
Torino Vallere	39.7	36.7	37
Torino Istituto Di Fisica Dell'universita'	39.4	36	37.5
Torino Giardini Reali		36.6	39.5
Torino Sede Iupo C.So Bolzano	39.7	36.5	
Torino Buon Pastore	40.6		
Torino Italgas			

Stazioni meteorologiche totali



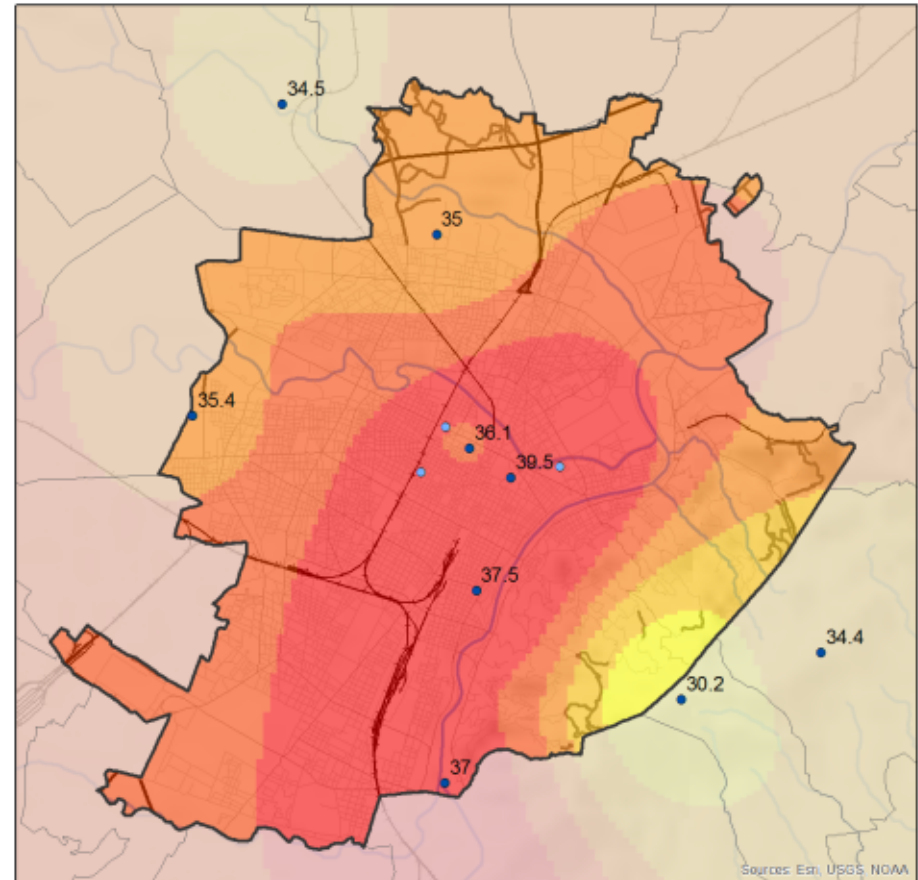
Legenda

- Stazioni Arpa Piemonte
- Stazioni SMI
- Confini comunali
- +— Linea ferroviaria
- A\_ Autostrada
- B\_ Strade extra-urbane principali
- C\_ Strade extra-urbane secondarie
- D\_ Strade di scorrimento
- E\_ Strade di quartiere
- Fiumi



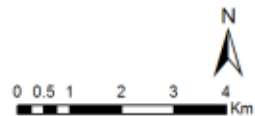
Temperature massime (C°)  
22.07.2015

- Mapping of Historical Extreme events
- Interpolation with data available



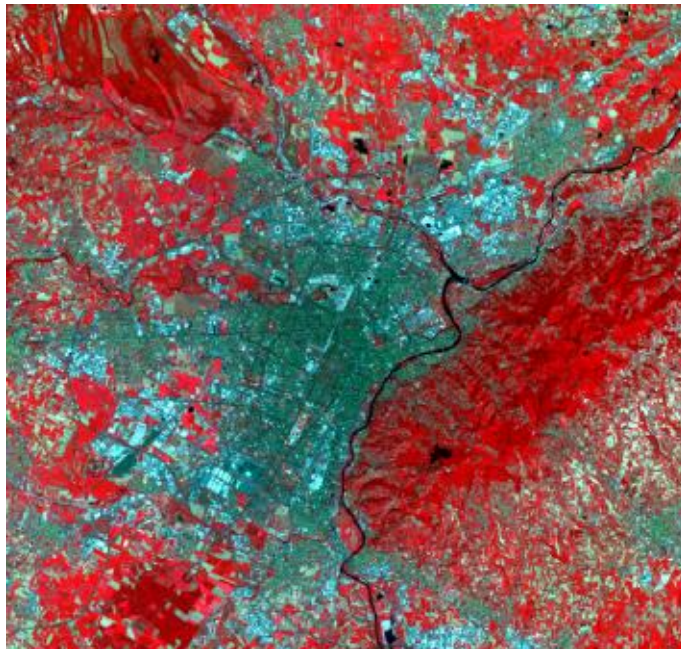
## Legenda

- Stations\_22.07.2015
- Stazioni non usate
- Max. Temp. (°C)\_22.07.2015**
  - 30.2 - 33.35
  - 33.36 - 34.93
  - 34.94 - 35.69
  - 35.7 - 36.41
  - 36.42 - 40.6
- A\_ Autostrada
- B\_ Strade extra-urbane principali
- C\_ Strade extra-urbane secondarie
- D\_ Strade di scorrimento
- E\_ Strade di quartiere
- Fiumi
- Confini comunali
- Linea ferroviaria

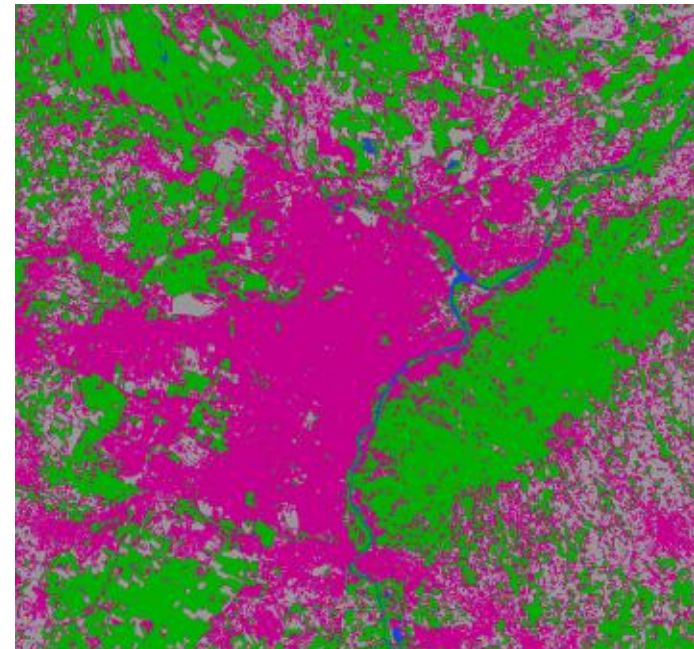




- Landsat and ASTER satellites collect visible, near-infrared, and thermal bands
- Processing of imagery to calculate land cover, vegetation density, and surface temperature

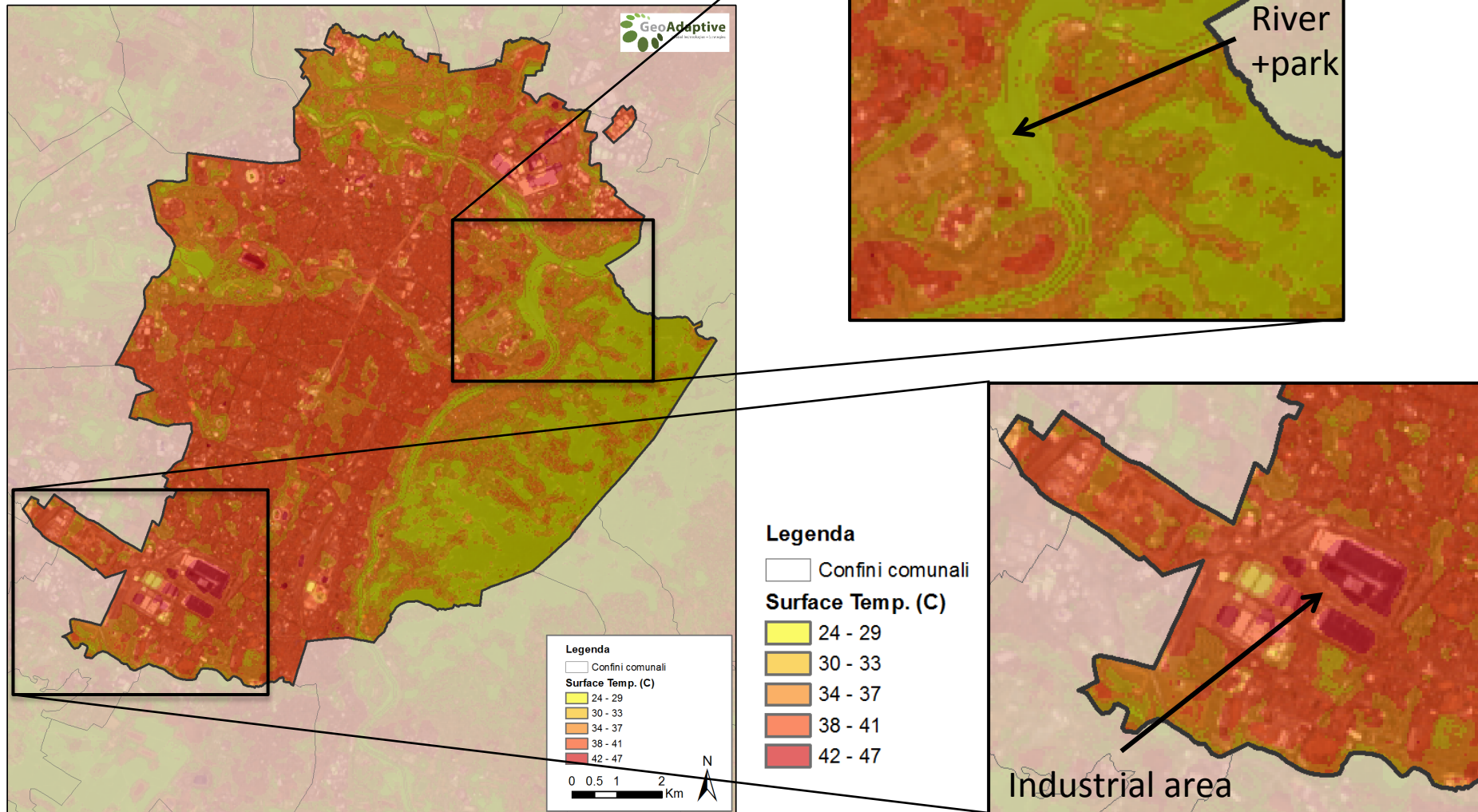


False color composite (2006)



Simplified land cover (2006)  
purple = developed, green = vegetated, blue = water

**Landsat 8 - Surface Temperature - 22 July 2015**







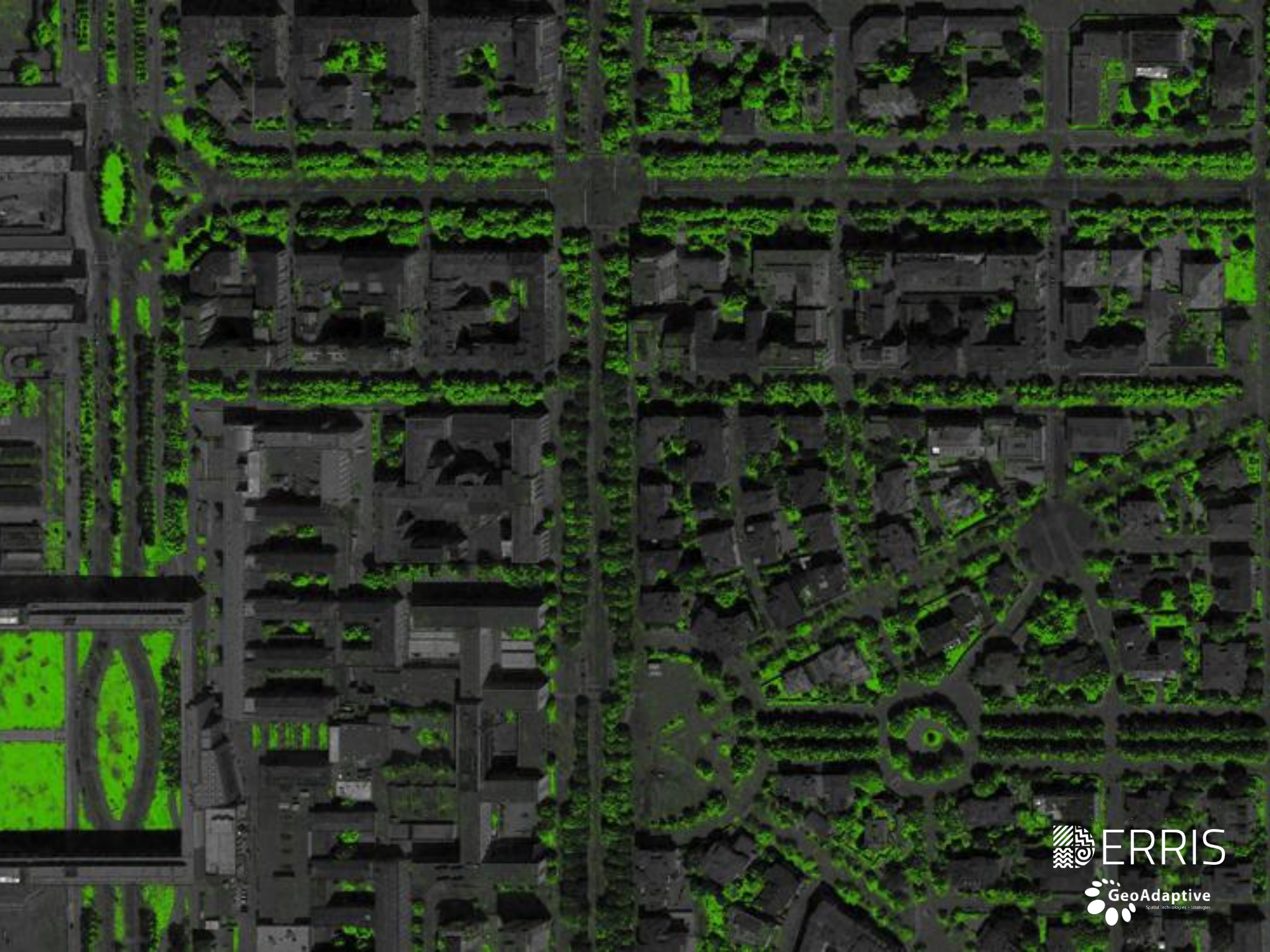
ERRIS




GeoAdaptive

Building the future of cities





 ERRIS

 GeoAdaptive  
Spatial Technologies + Strategies





**35,3° C**

22 luglio 2015

**temperatura massima re  
sull'asse in oggetto**

 **ERRIS**

 **GeoAdaptive**  
Spatial technologies & strategies











An aerial photograph of a city street grid, likely in Rome, showing a dense pattern of buildings and streets. A prominent yellow diagonal line runs from the bottom left towards the center of the image.

temperatura massima registrata  
sull'asse in oggetto

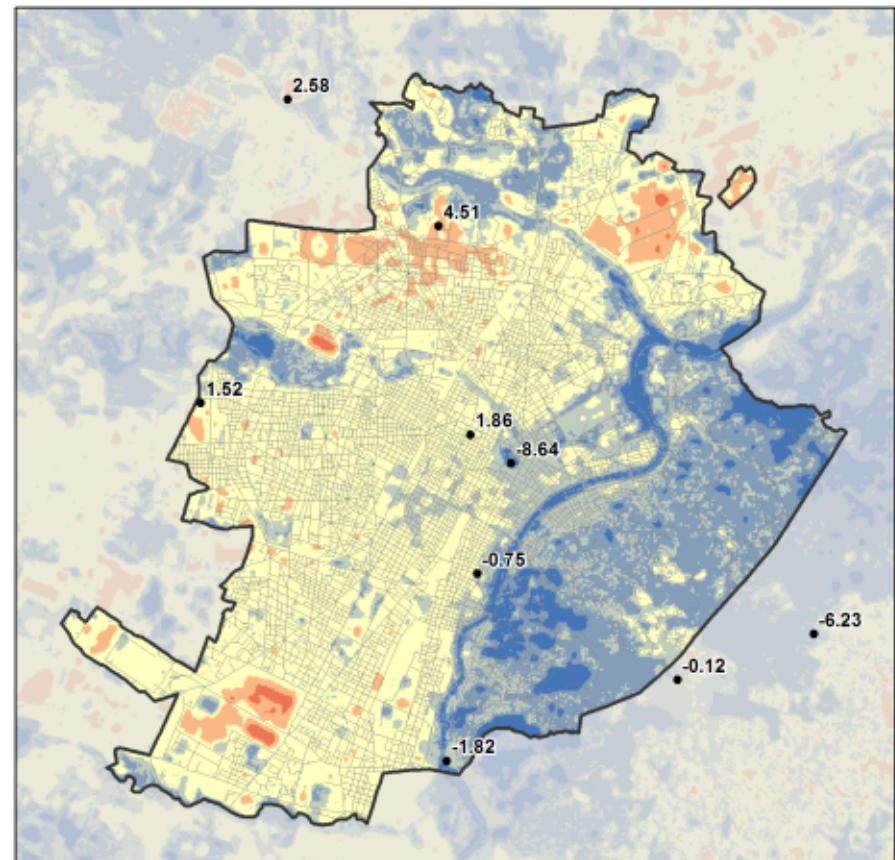
38,9° C

22 luglio 2015

 ERRIS

 GeoAdaptive  
spatial intelligence & strategies

- Calculated difference between satellite-derived temperature and readings from meteorological stations (see right)
- Satellite analysis results highlight hotter areas in industrial zones and cooler areas with open water and vegetation

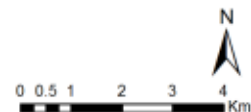


## Legend

- Hydrometeorological Stations
- Rete stradale

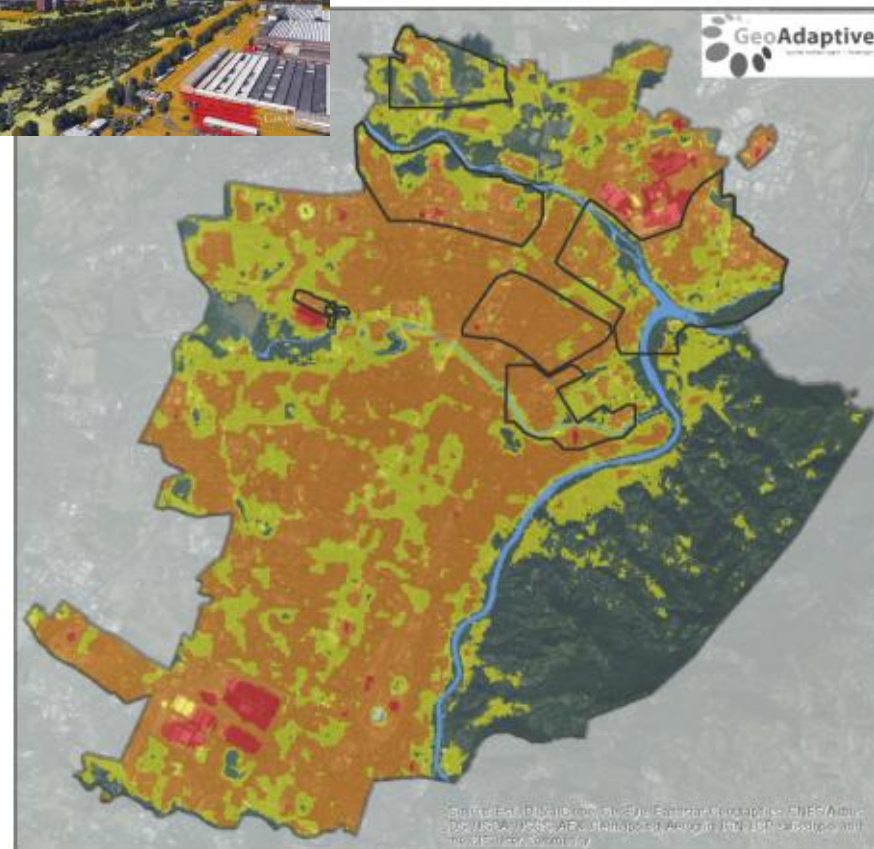
## Satellite vs. Interpolated Temp. (°C)

Blue	-10.48804092 - -7.589416561
Dark Blue	-7.58941656 - -3.973012169
Light Blue	-3.973012168 - -0.356607777
Yellow	-0.356607777 - 3.259796615
Orange	3.259796616 - 6.876201007
Red-Orange	6.876201008 - 10.4926054
Red	10.49260541 - 12.47286187

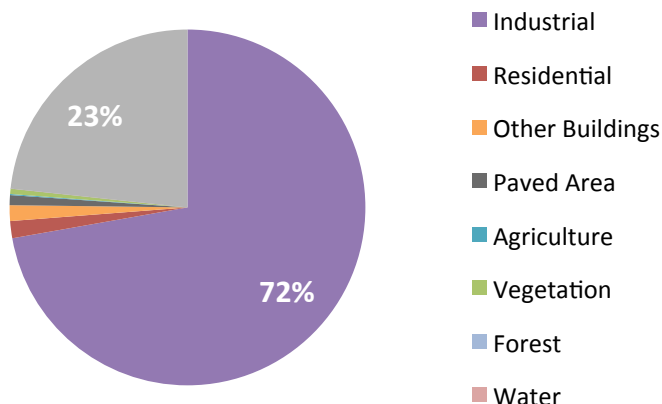




- **Low hazard:** temperature within one standard deviation of the mean
- **Moderate hazard:** temperature between one and two standard deviations above the mean
- **High hazard:** temperature greater than two standard deviations above the mean



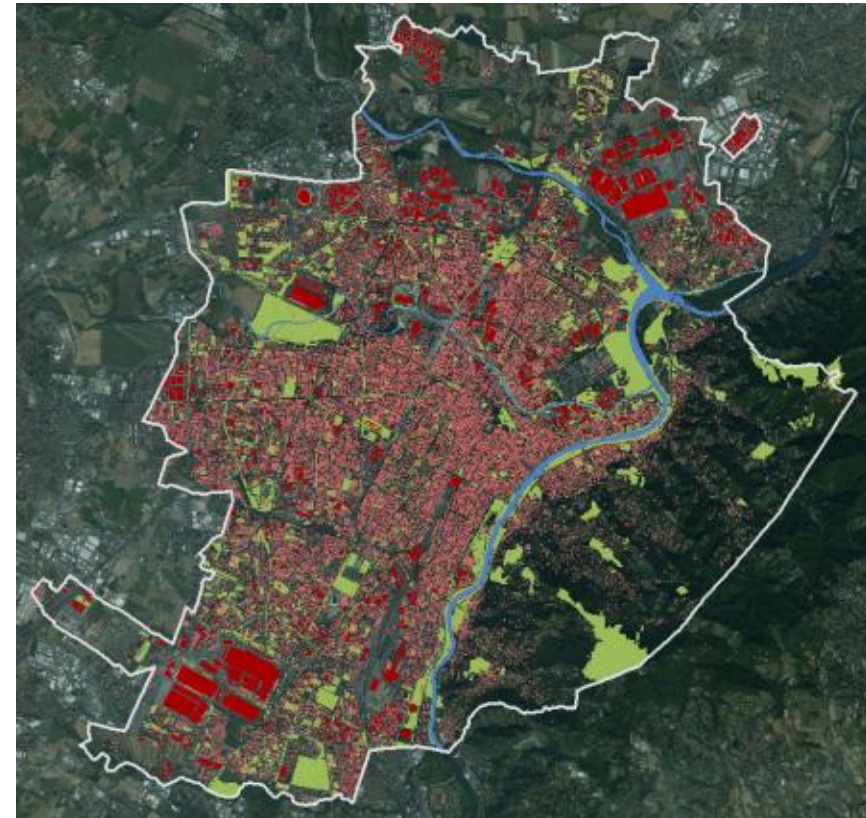
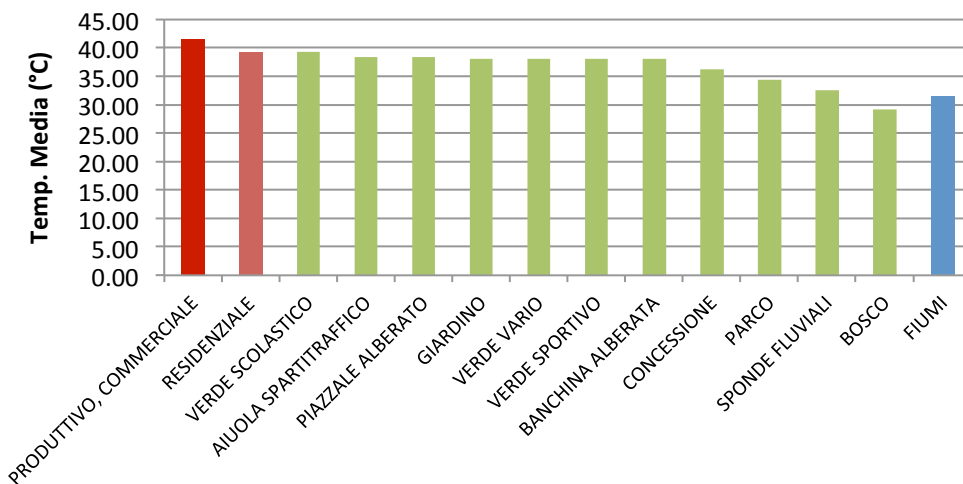
**Land Use within High Hazard Areas**

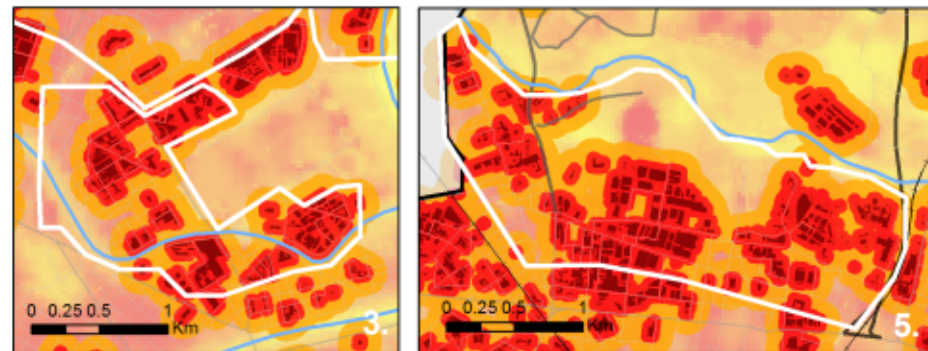
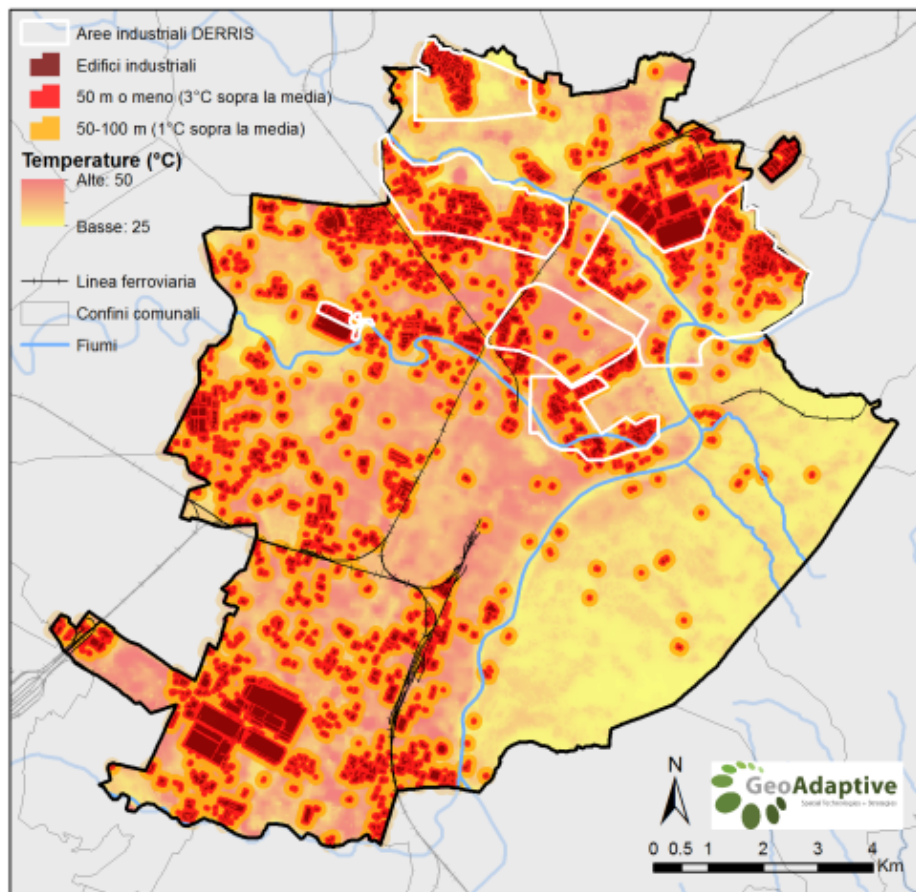




# Temperature by Land Use (average of 2006 & 2015)

LAND USE	TYPE	AVERAGE TEMP. (°C)	AREA (HA)
BUILDING	COMMERCIAL	41.52	757.03
	RESIDENTIAL	39.21	1930.73
GREEN SPACE	SCHOOL AREA	39.25	186.22
	FLOWERBED	38.38	63.43
	TREES SQUARE	38.32	31.46
	GARDENS	38.10	252.37
	GREEN AREAS NOT IDENTIFIED	38.09	69.30
	GREEN SPORTIVE AREAS	38.08	12.77
	TREES AVENUE	38.06	179.96
	PARK	34.33	543.95
	FLUVIAL ROUNDS	32.58	22.96
	WOOD	29.12	60.79
WATER	RIVERS	31.43	237.46

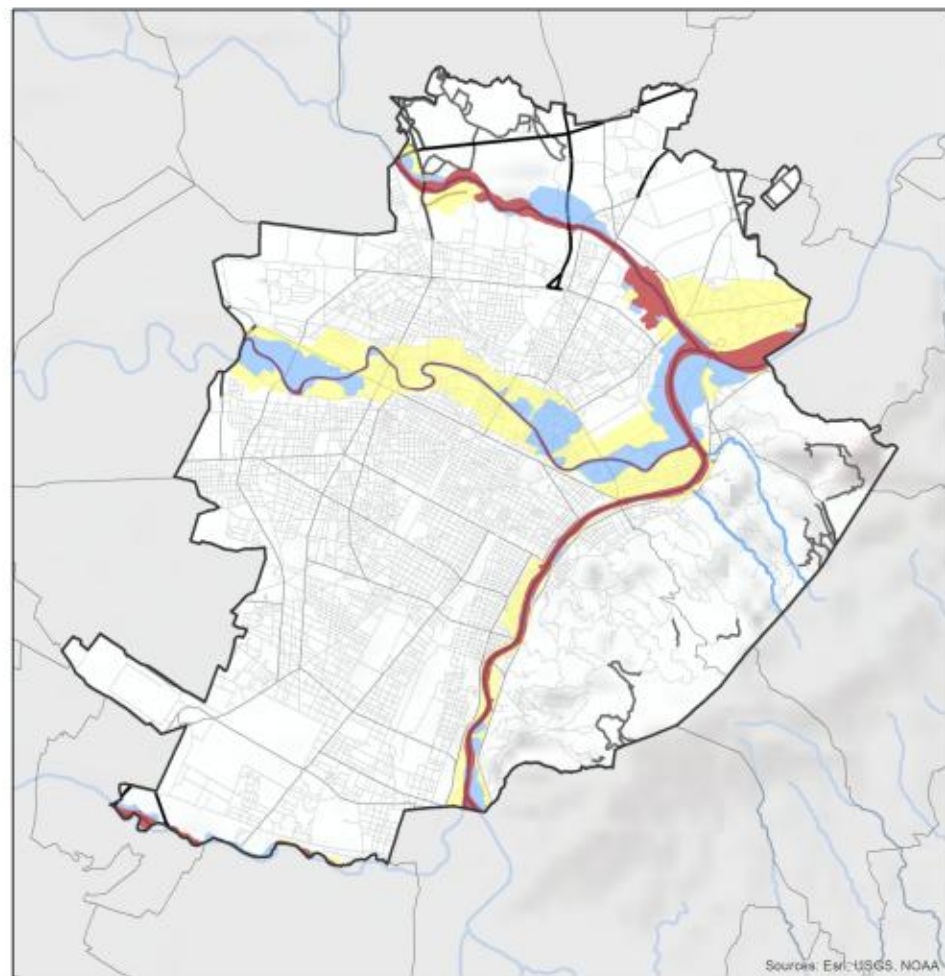




- 3 C ° Temperature increase at a distance of 50m from industrial areas,
- 1 C ° at a distance between 50 and 100 meters
- 48% of the city is under these 2 buffer zones

Source Direttiva Alluvioni  
2007/60/CE

- Between 20 and 50 years, frequent floods
- Between 100 and 200 years, low frequent floods
- For 500 years, rare floods.



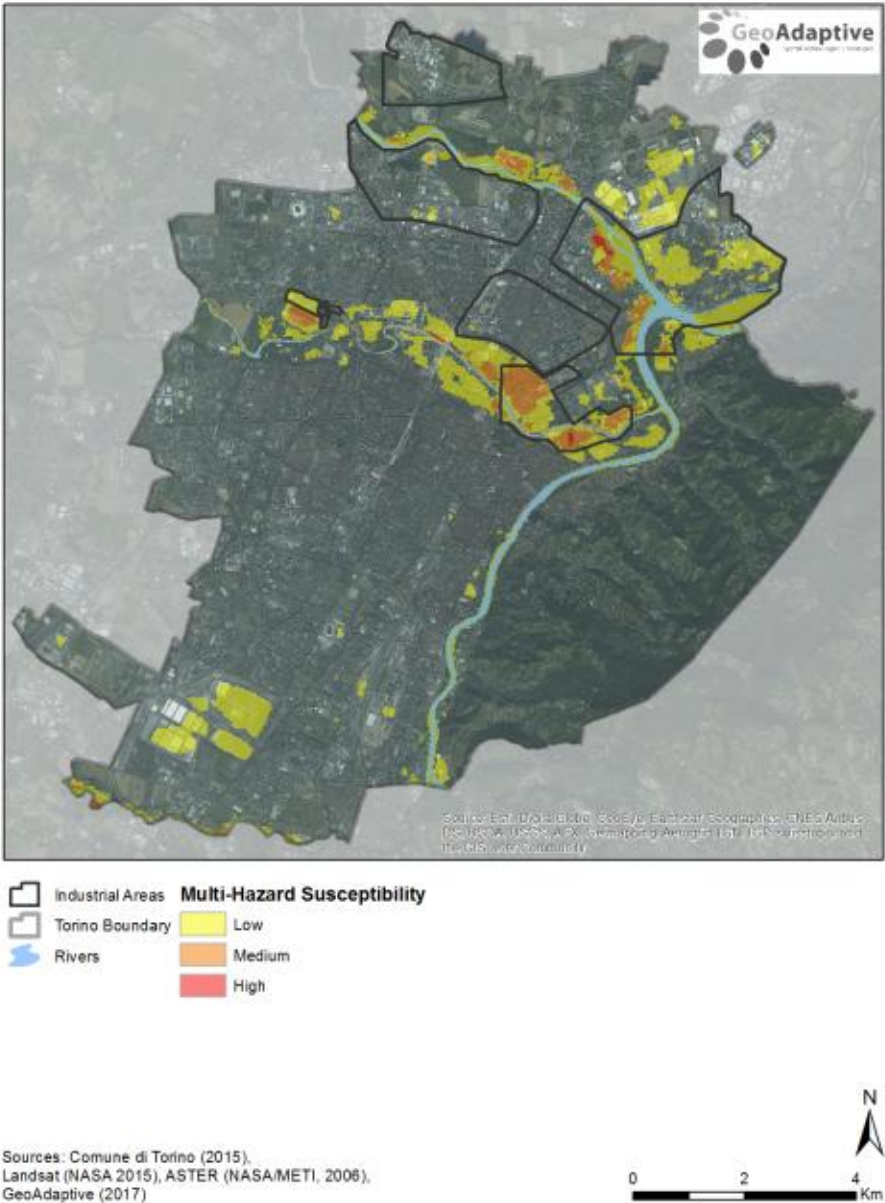
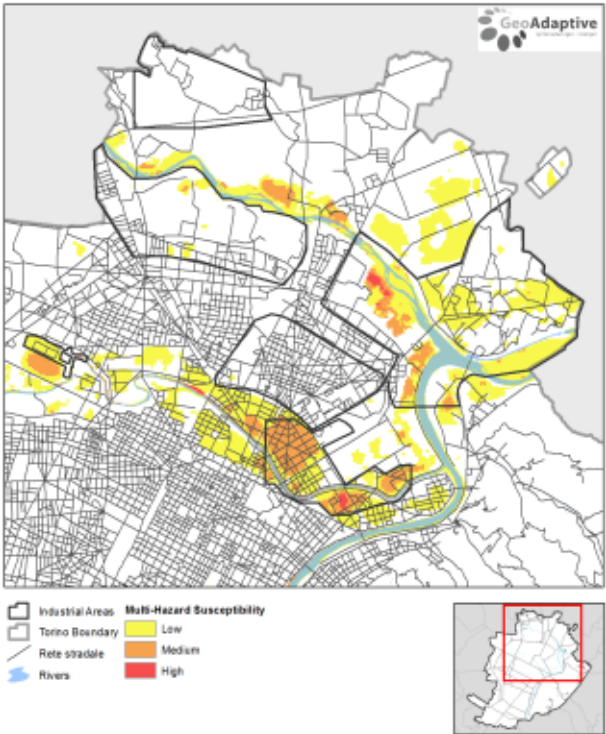
## Legenda

- |               |                                   |
|---------------|-----------------------------------|
| Scenario H    | B_ Strade extra-urbane principali |
| Scenario M    | C_ Strade extra-urbane secondarie |
| Scenario L    | D_ Strade di scorrimento          |
| Corsi d'acqua | E_ Strade locali                  |
| A_ Autostrade | Limiti                            |



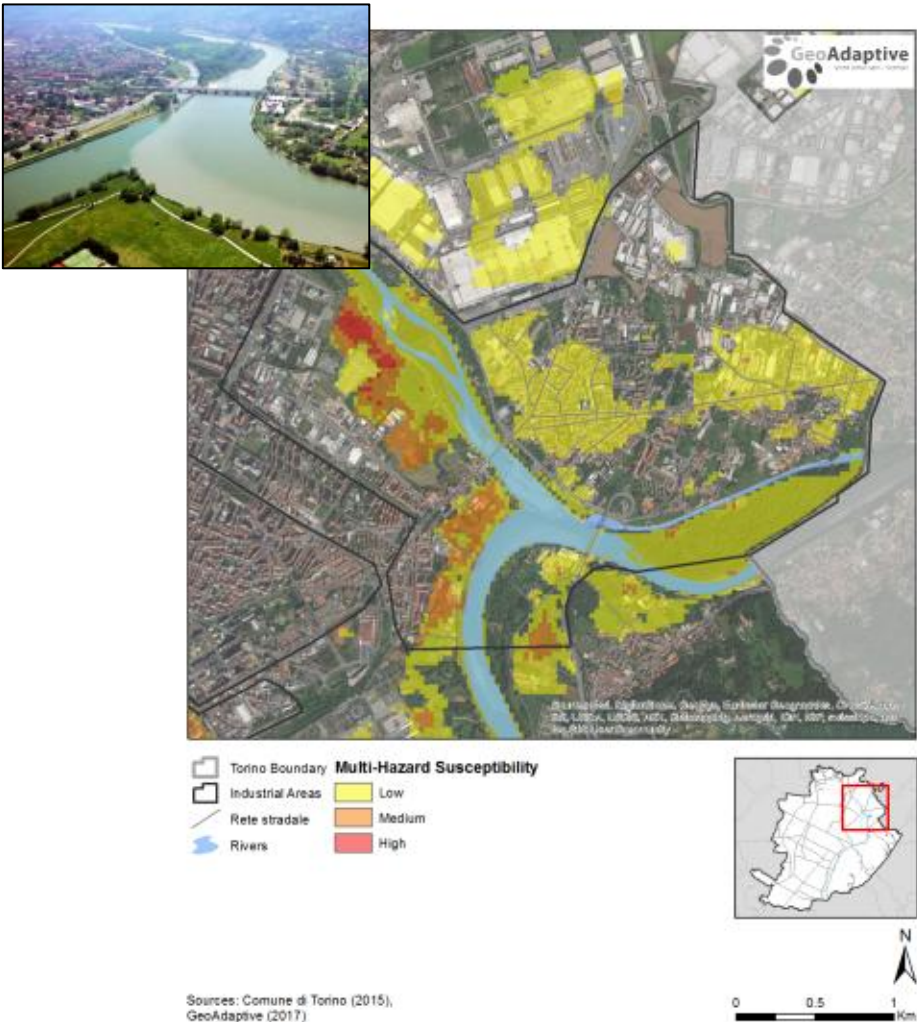


The results of the urban heat island analysis were combined with the fluvial inundation zones to determine areas of overlap, where residents and businesses may be exposed to both flooding and extreme heat.

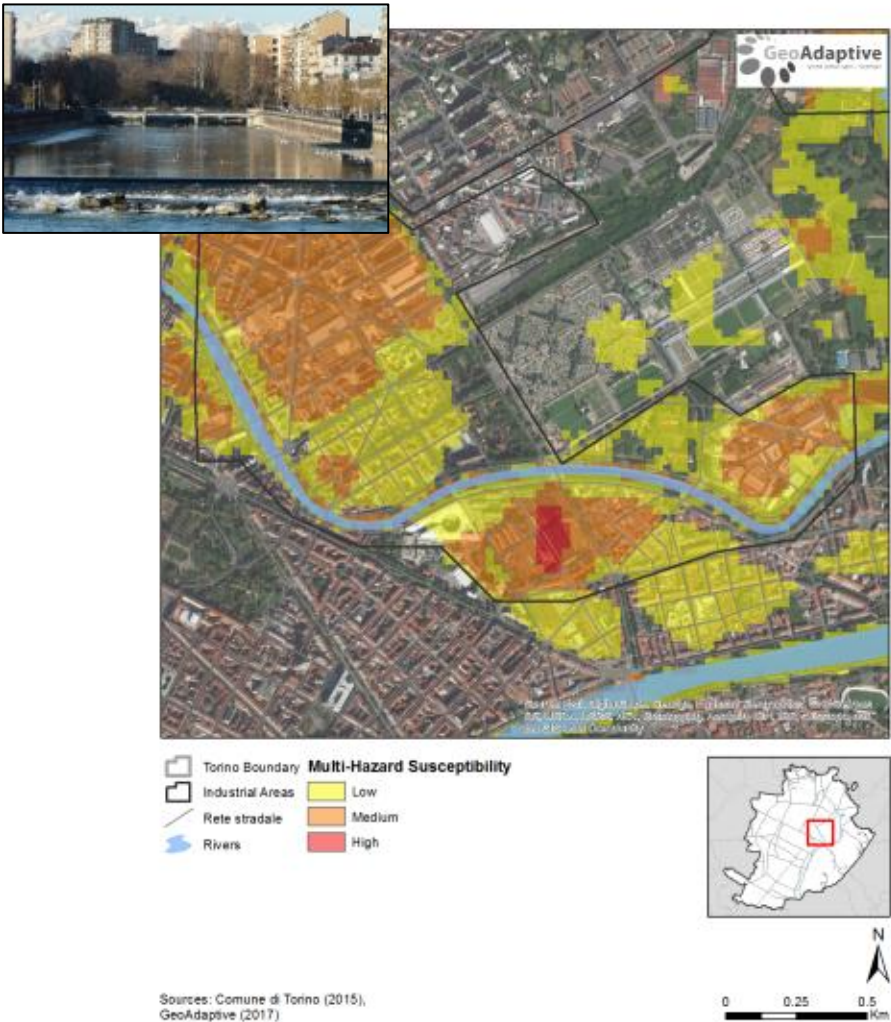




Industrial Area 1 Multi-Hazard Exposure



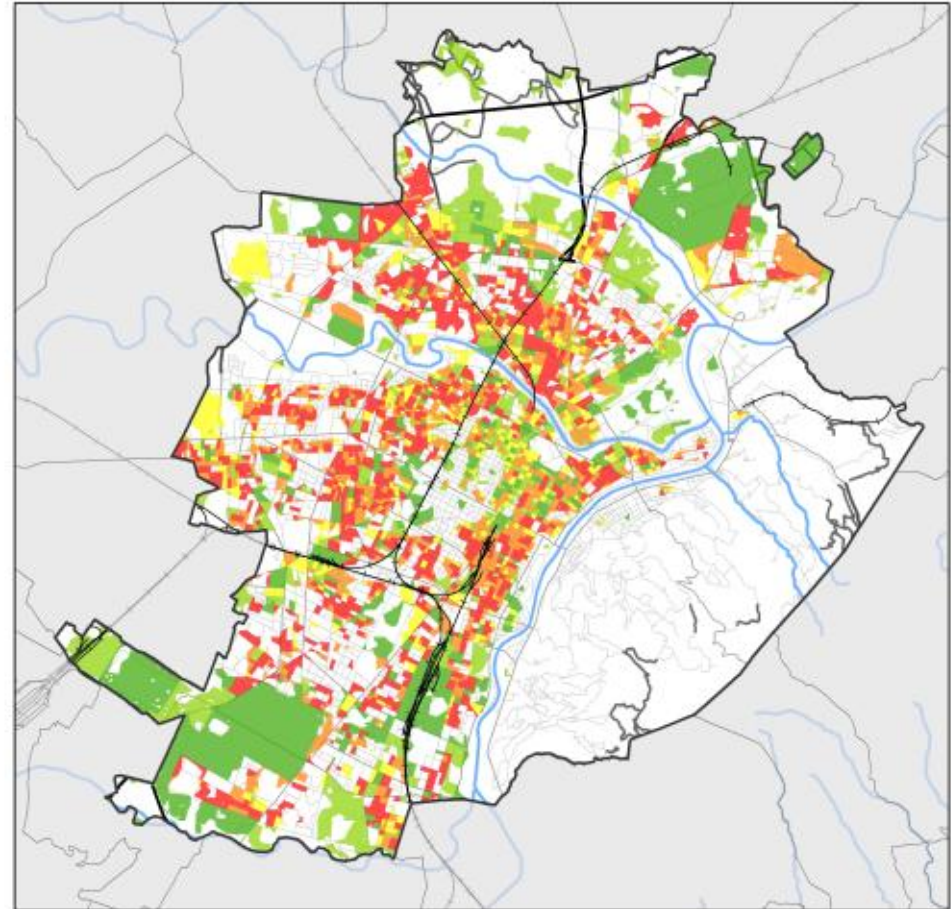
Industrial Area 3 Multi-Hazard Exposure









Indicators	Source	Category	Type of hazard
<b>Exposure</b>			
<b>1 Population</b>			
1.1 Over 65	ISTAT	P27+ 28+ 29	UHI, Flood, Multi
1.2 Under 5	ISTAT	P14	UHI, Flood, Multi
1.3 Women over 65	ISTAT	(P27+ 28+ 29)-(P45 + P43 + P44)	UHI, Multi
<b>2 Physical</b>			
2.1 Hospitals and health center	GEOPORTALE		UHI, Flood, Multi
<b>Vulnerability</b>			
<b>3 Social</b>			
3.1 Elementary education	ISTAT	P50	UHI, Flood, Multi
3.2 Unemployment	ISTAT	P128	UHI, Flood, Multi
3.3 Living alone	ISTAT	P6+ P7 + P8	UHI, Flood, Multi
<b>4 Physical</b>			
4.1 Building age after 1960	ISTAT	E11 + E12 +E13 + E14 + E15 +E16	UHI, Multi

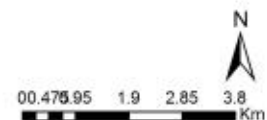
- Scenario M and H
- Population Over 65

## UHI Human Exposure



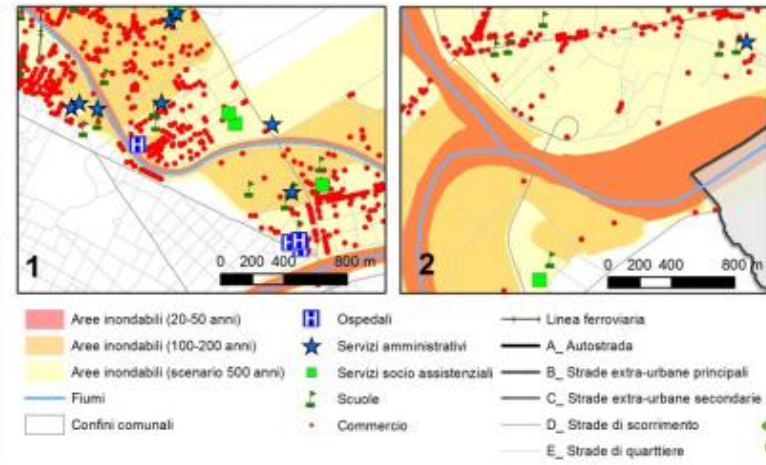
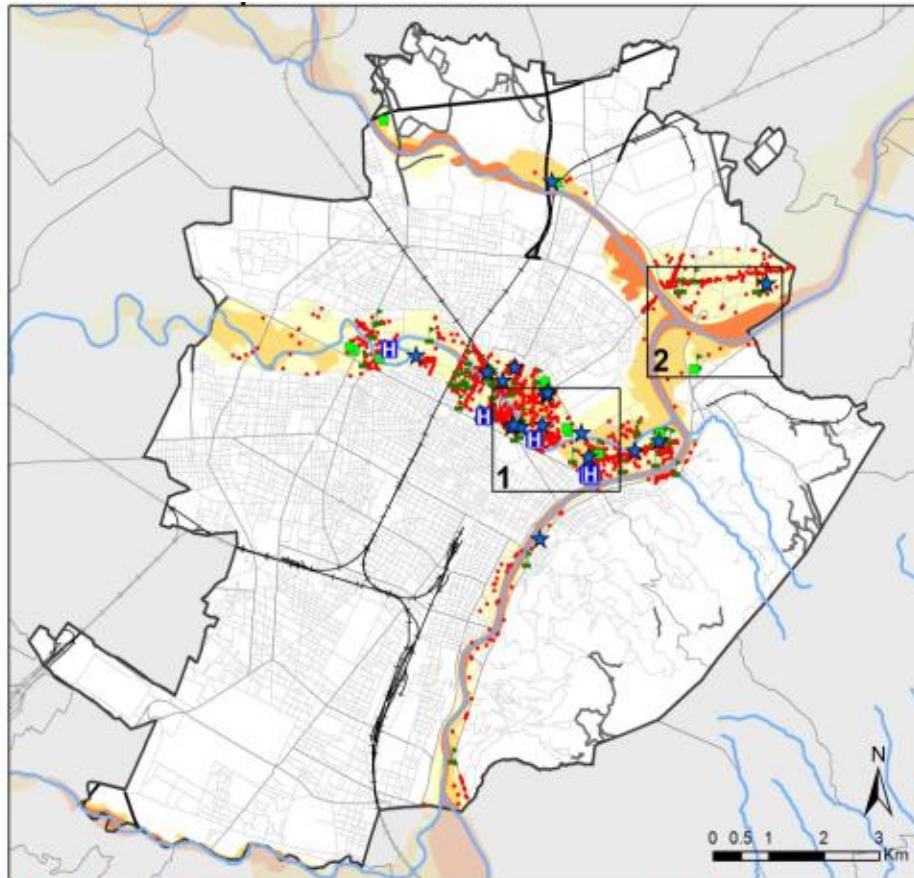
### Legenda

<b>UHI_M_exp</b>	 Confini comunali
<b>new_Ov65</b>	 Linea ferroviaria
 0	 Fiumi
 0 - 10	 A_ Autostrada
 10 - 25	 B_ Strade extra-urbane principali
 25 - 50	 C_ Strade extra-urbane secondarie
 50 - 100	 D_ Strade di scorrimento
	 E_ Strade di quartiere





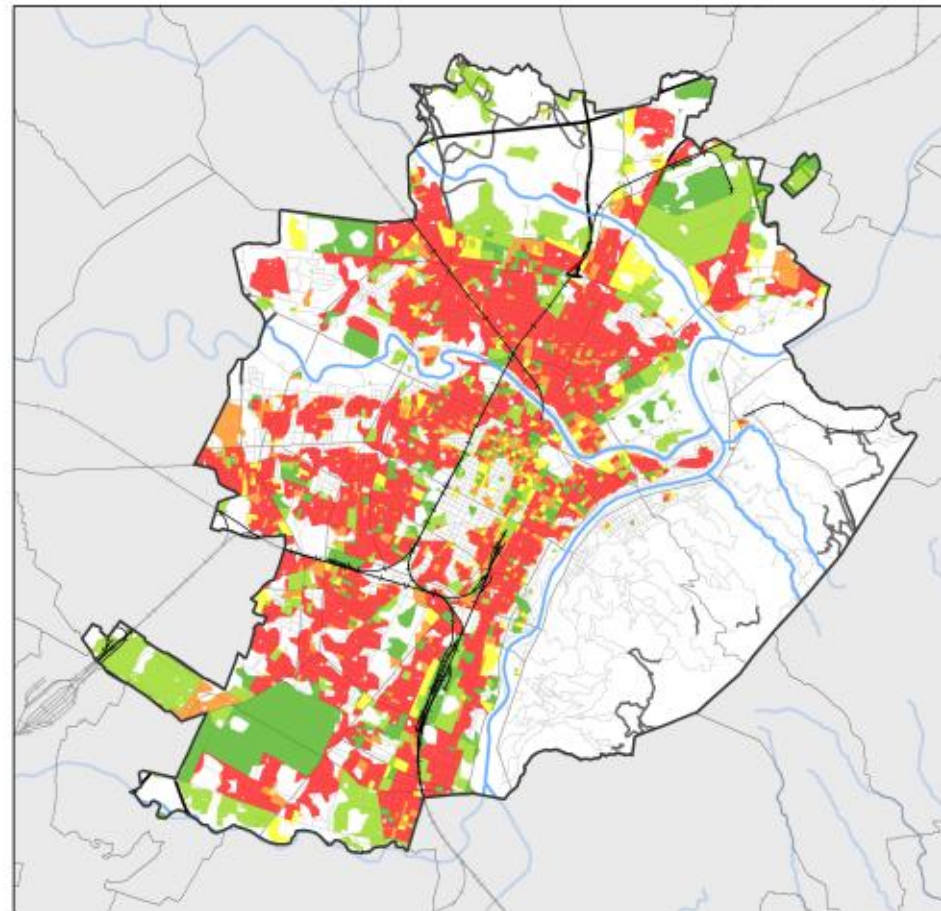
# Flood Physical Exposure



	UHI	Floods	Multi-hazard
Hospitals	24	6	5
Administrative services	133	22	7
Social care service	93	16	23
School	444	53	65
Comercial	23.503	2.458	1.426



- Scenario M and H
- Population Unemployment



### Legenda

<b>new_Unempl</b>	Confini comunali
0	Linea ferroviaria
0 - 10	Fiumi
10 - 25	A_ Autostrada
25 - 50	B_ Strade extra-urbane principali
50 - 100	C_ Strade extra-urbane secondarie
	D_ Strade di scorrimento
	E_ Strade di quartiere