

*School of Civil, Environmental and Land Management Engineering  
M.Sc. programme in Civil Engineering for Risk Mitigation*

Geospatial Data Processing to Support Seismic Emergency Management

 POLITECNICO DI MILANO



## **WebGIS Services to Support Locational Choices of Shelters**

**Presented by:** Group 1

**Supervised by:** Professor Daniela Carrion, Professor Maria Pia Boni and Professor Scira Menoni

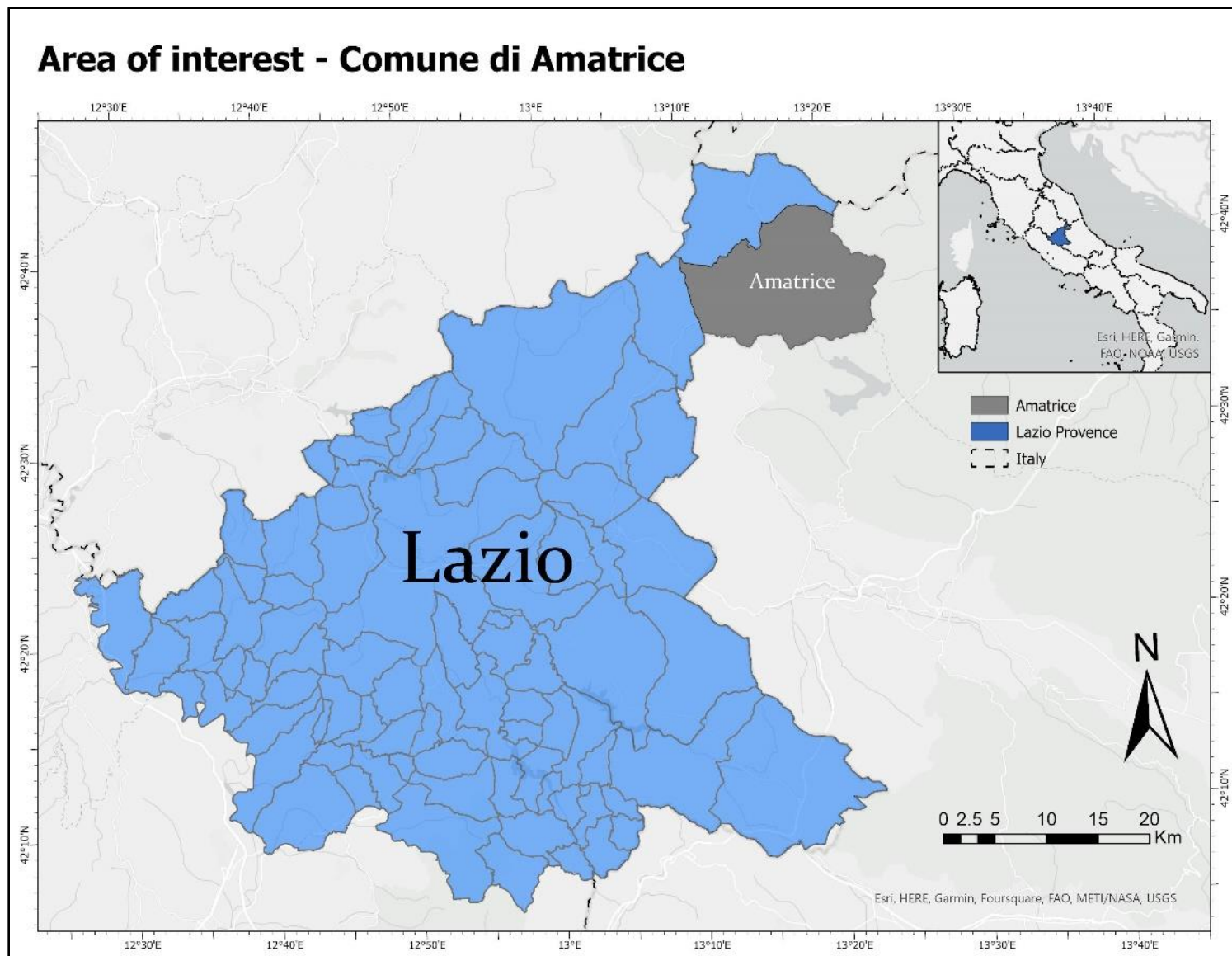


# Introduction

Emergency plan for shelter locations in **Amatrice, Italy**

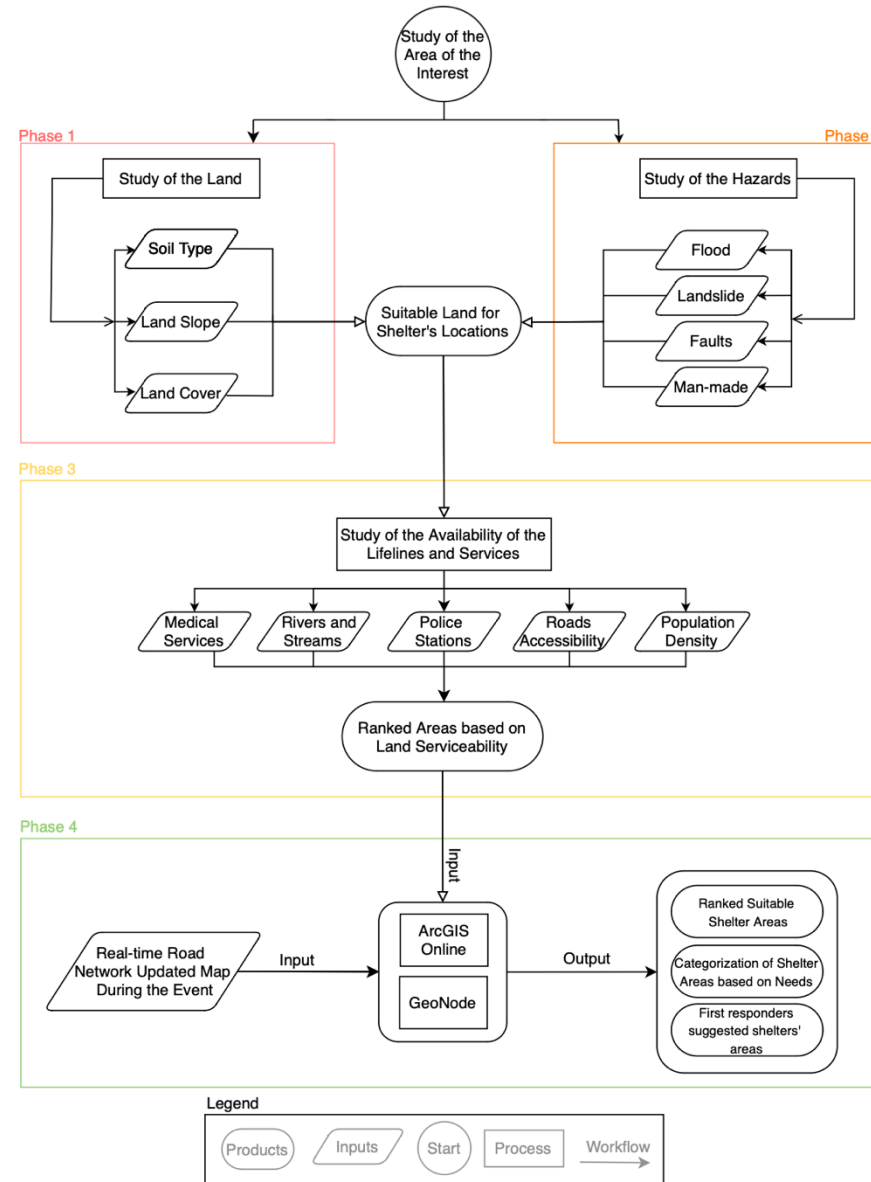
Using Geospatial data to identify **suitable shelter locations** during and after the event

**WebGIS platform** to visualize and access the computed data. Factors like accessibility and facilities considerations will be analyzed to choose suitable shelter locations



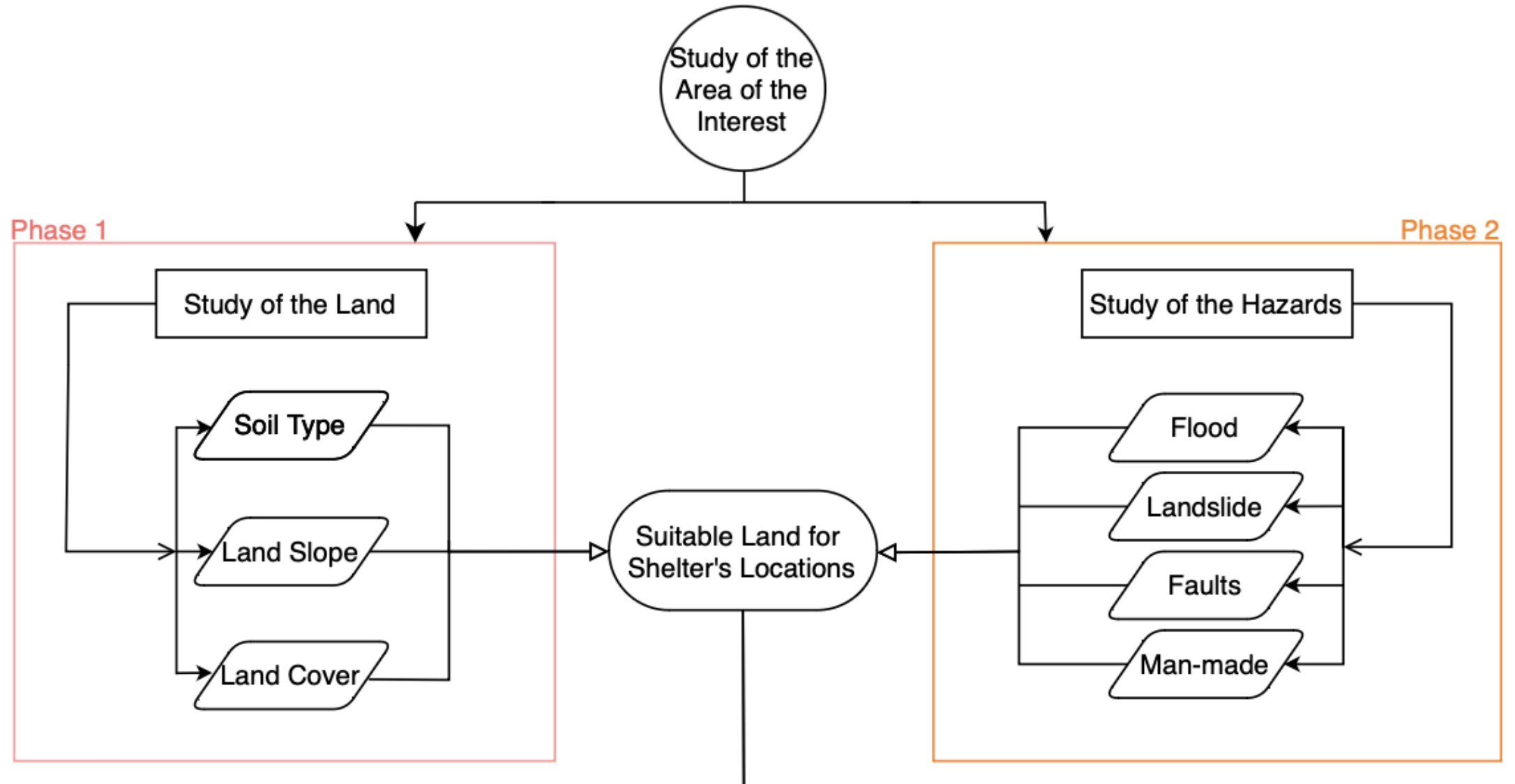


# Framework



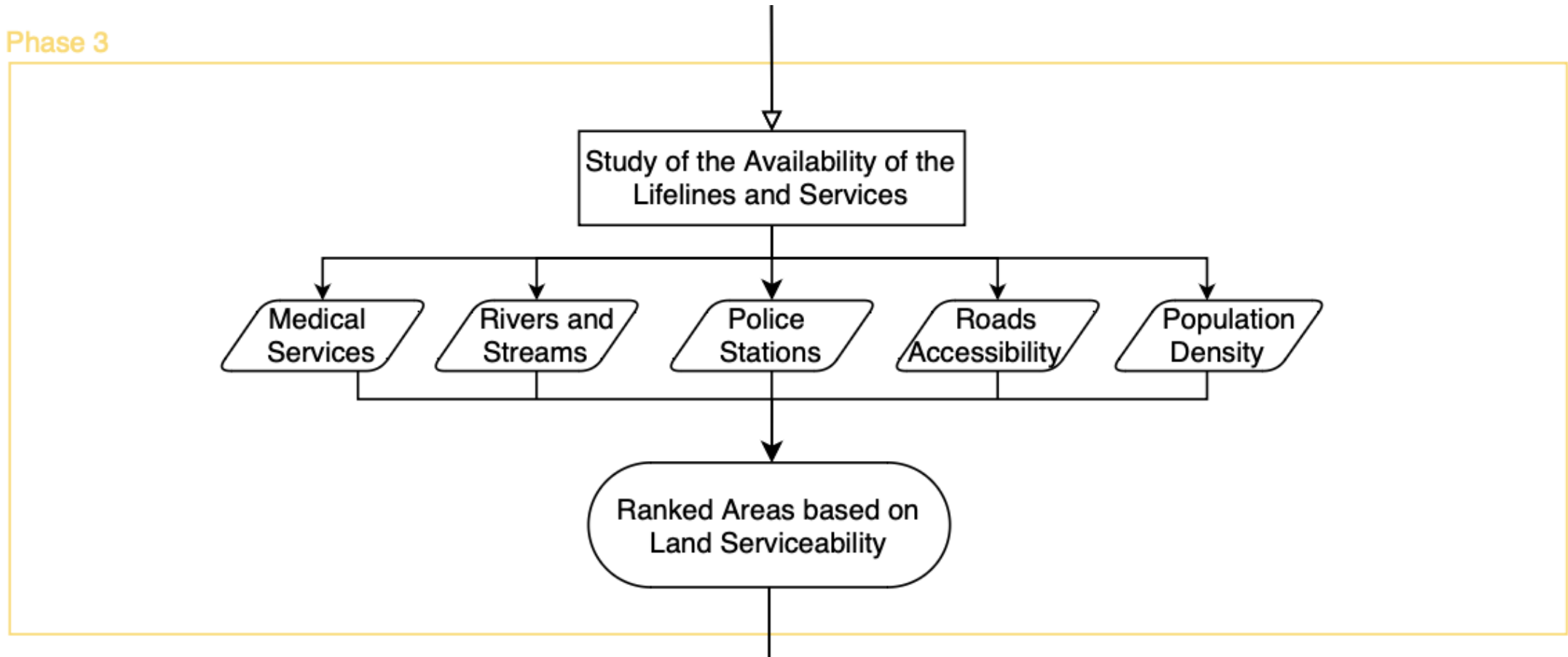


# Framework



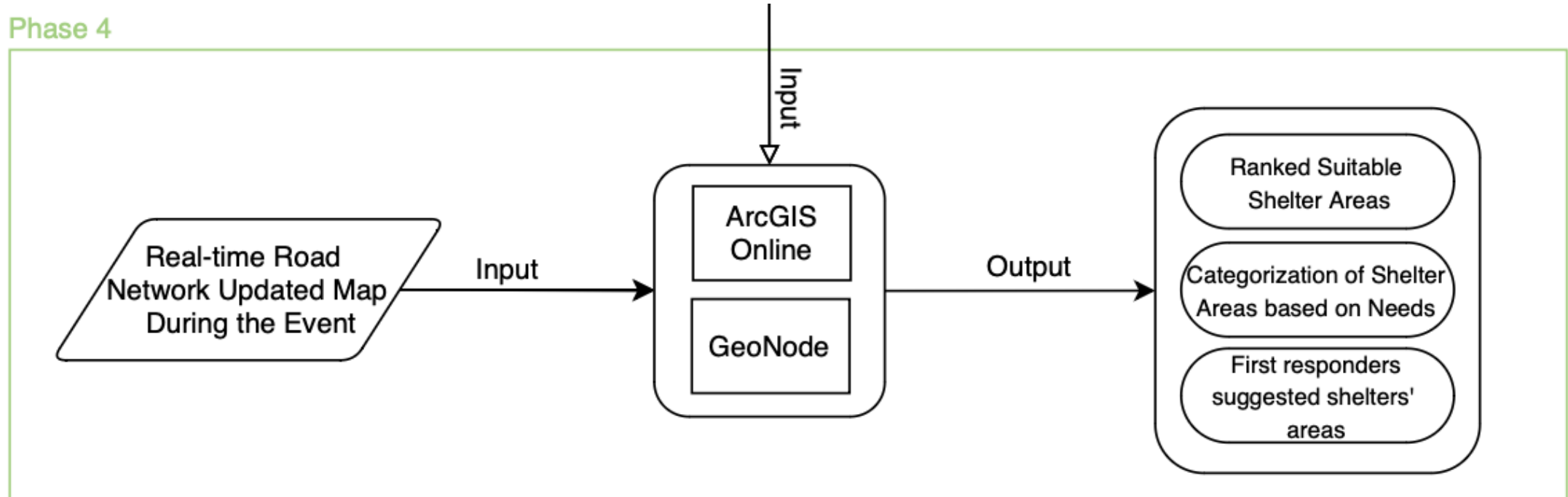


## Phase 3





## Phase 4





# Weights Assignment

Phase	Layers	Classification	Interpretation	Suitability Weights	Main Weight
	Slope	$\theta \leq 2^\circ$ & $\theta > 10^\circ$	Unsuitable	0	7
		$2^\circ < \theta \leq 4^\circ$	Neutral	2	
		$4^\circ < \theta \leq 10^\circ$	Suitable	5	

Phase 1

Flood Hazard	Susceptible areas	Unsuitable	0	-
	Un-susceptible areas	Suitable	1	

Phase 2

Population Density	No. of People <20	Less suitable	1
	21 < No. of People < 50	Neutral	1,23
	No. of People > 51	Suitable	1,35

Phase 3



# Estimated Number of Evacuees

## Inhabitants



## SAR Team

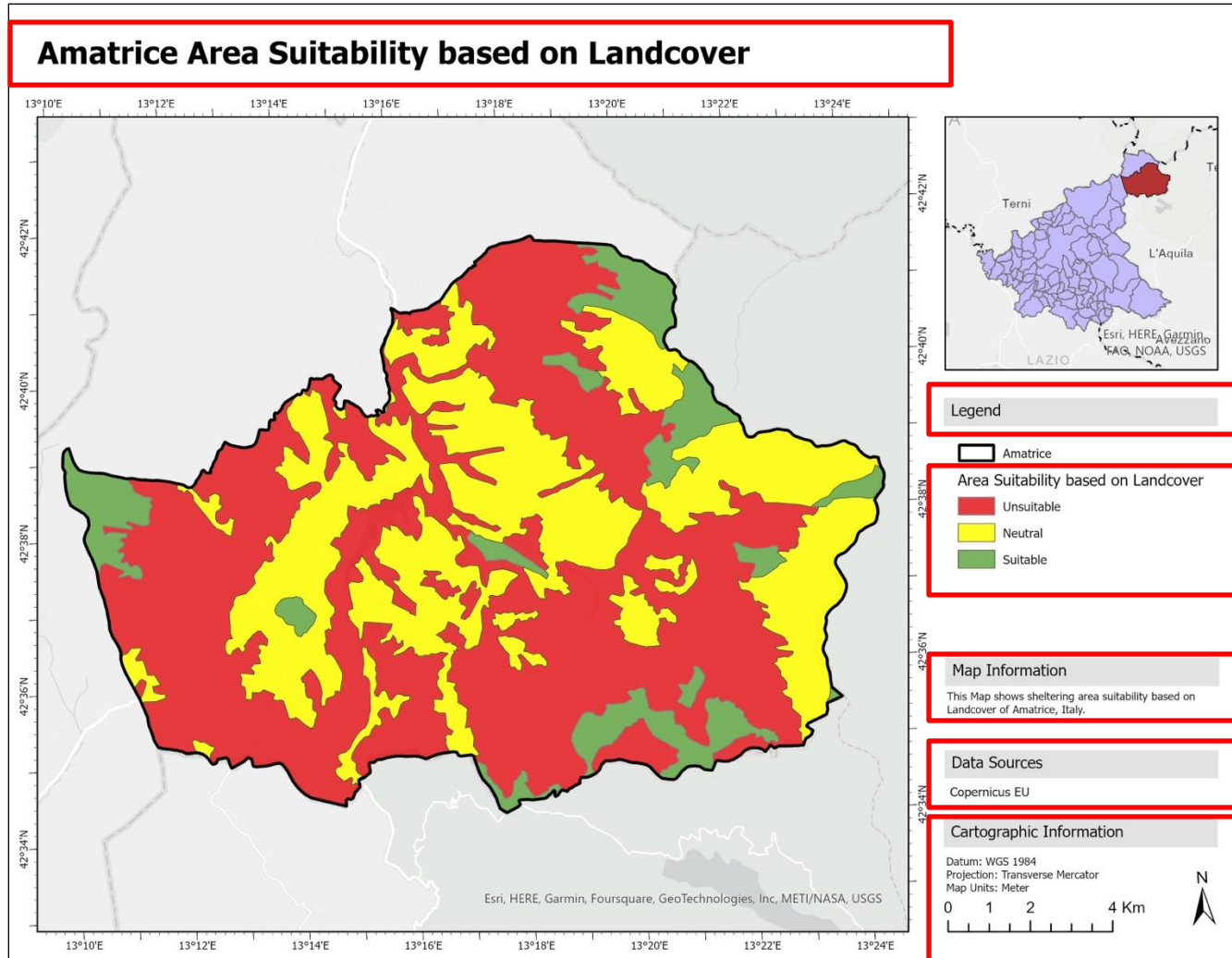


$$\textit{Estimated Number of Evacuees} = 2689 + 200_{(SAR)} = 2889$$



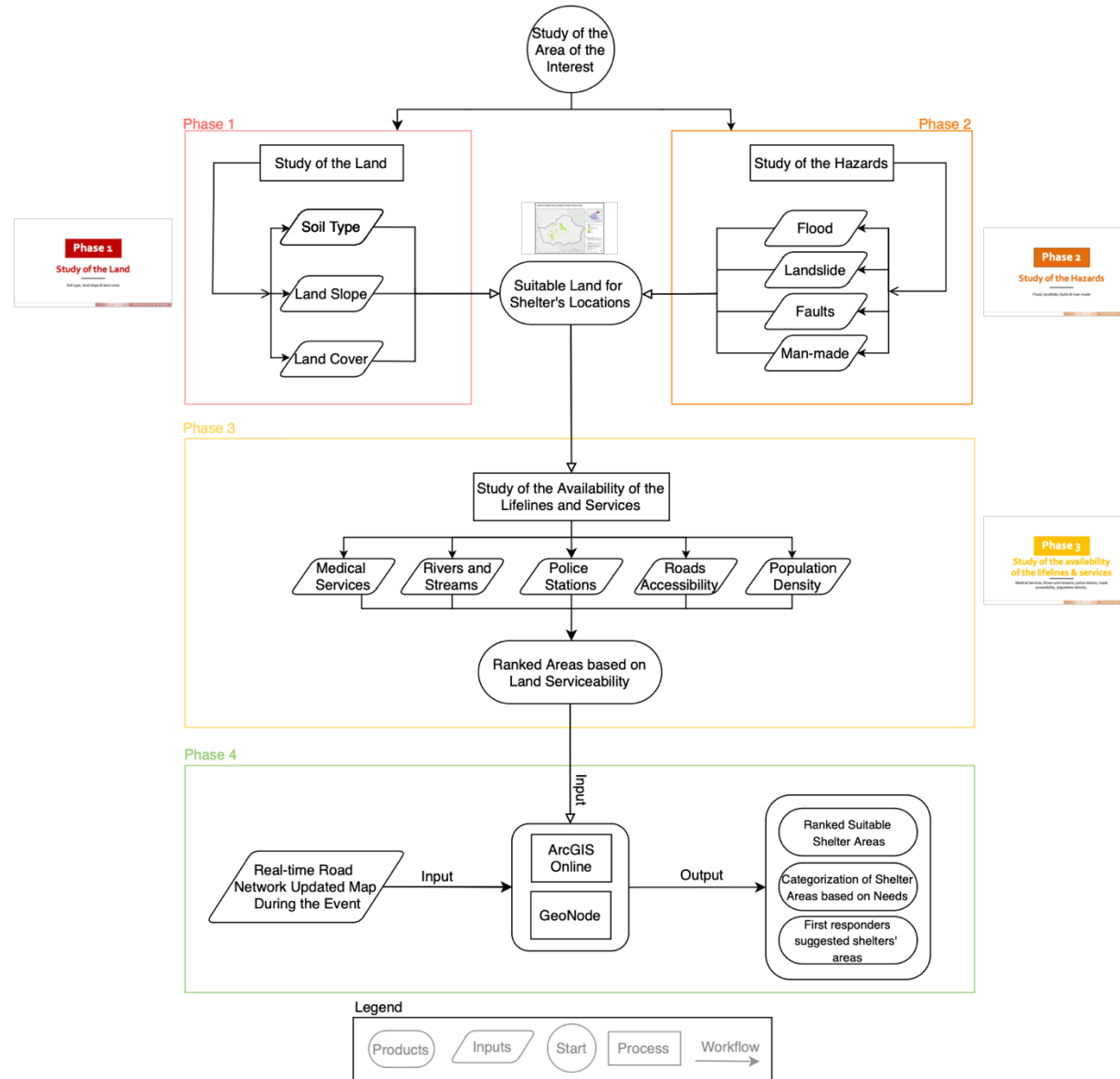


# Map Template





# Workflow



# Phase 1

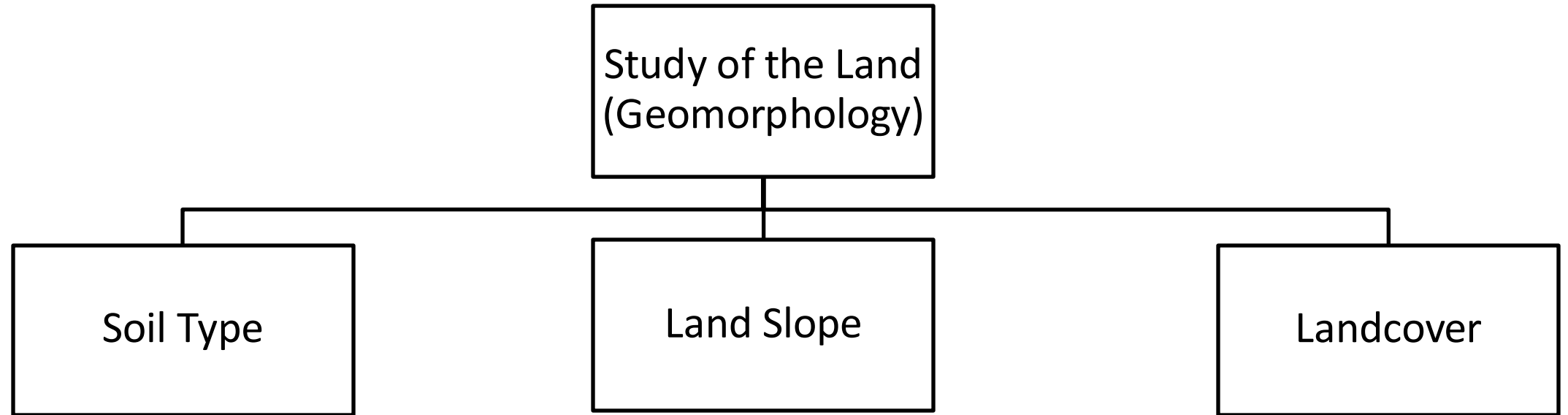
## Study of the Land

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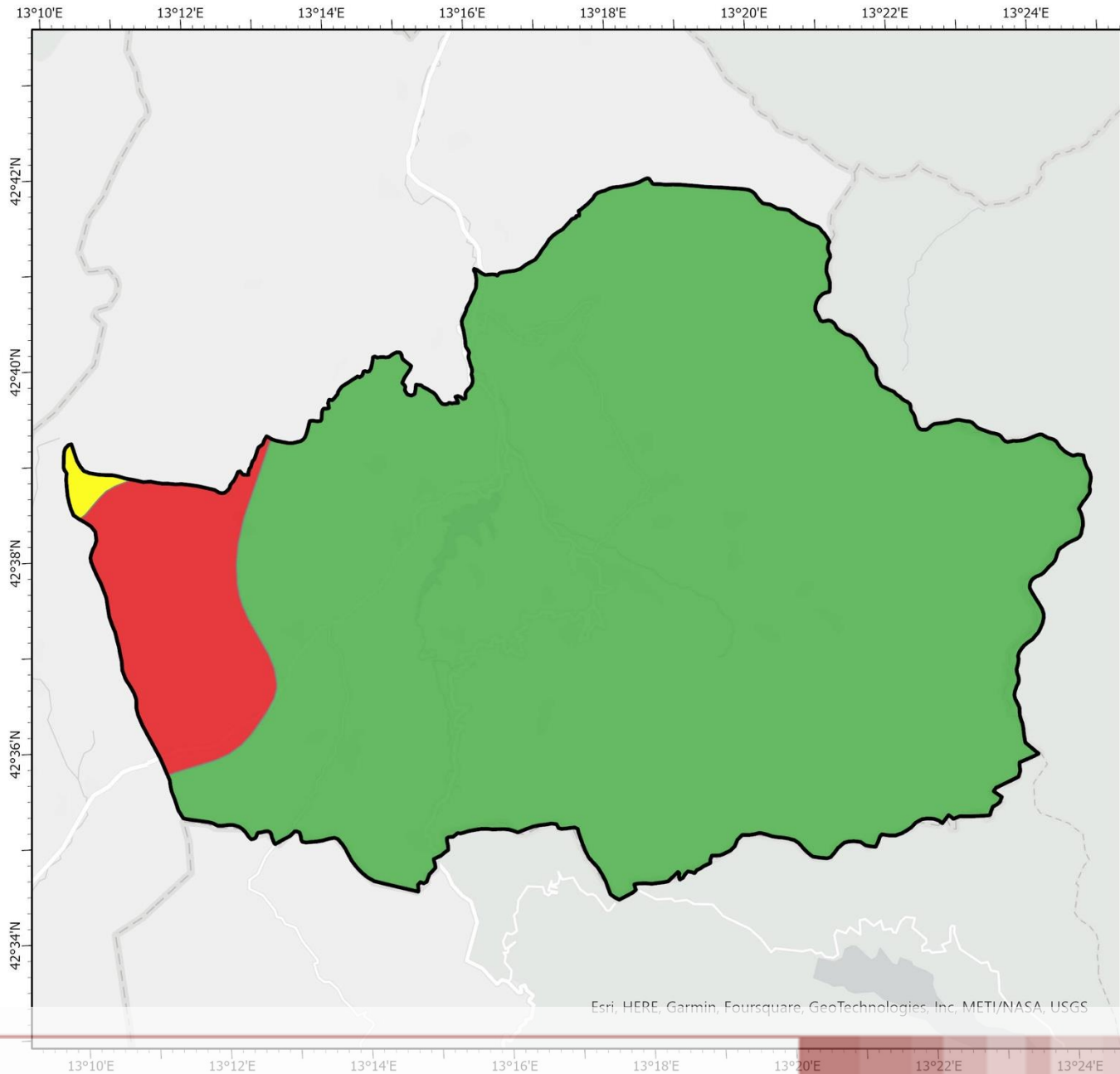
Soil type, land slope & land cover



## Study of the land (Phase 1)



# Amatrice Area Suitability based on Soil Type



## Legend

- Amatrice
- Area Suitability based on Soil Type
  - Unsuitable
  - Neutral
  - Suitable

## Map Information

This Map shows sheltering area suitability based on Soil Type of Amatrice, Italy.

## Data Sources

BGR's IHME1500

## Cartographic Information

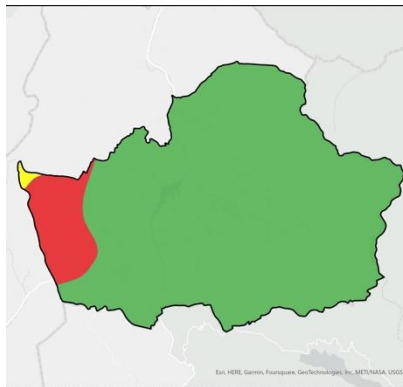
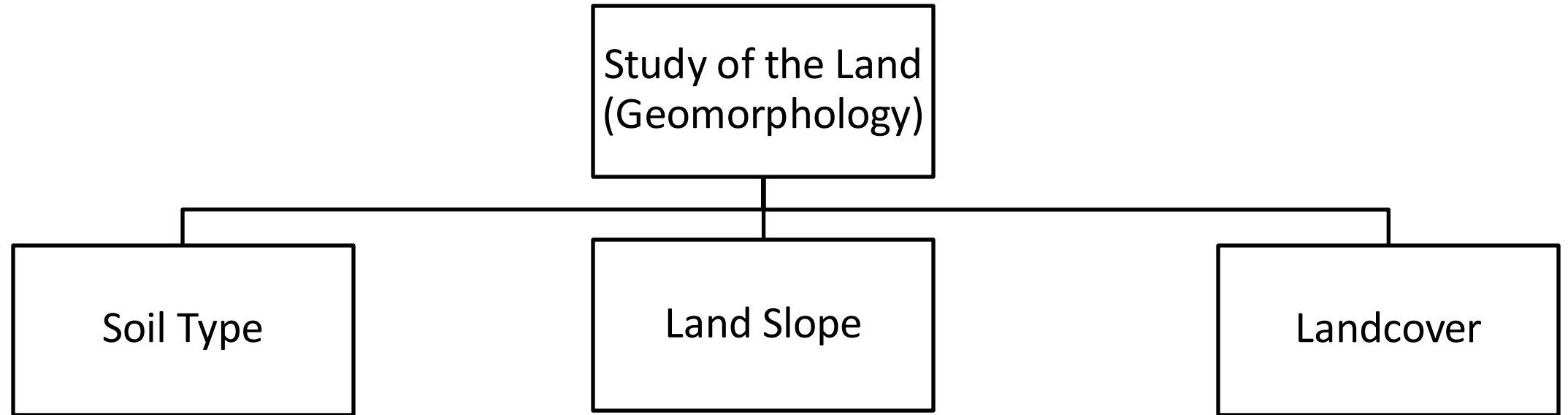
Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter

0 1 2 4 Km

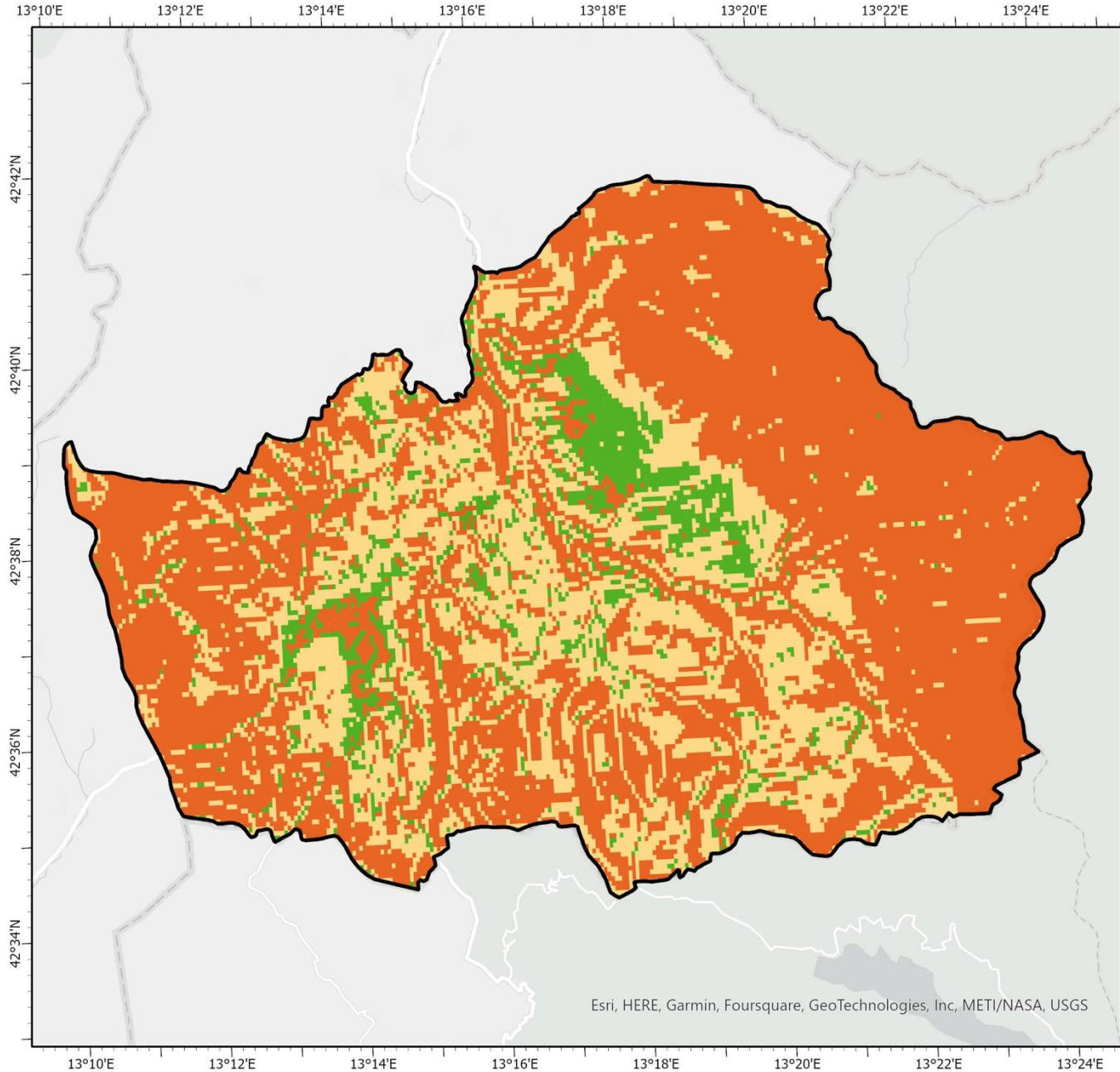




# Study of the land (Phase 1)



# Amatrice Area Suitability based on Slope



## Legend

- Amatrice
- Area Suitability based on Slope
  - Unsuitable
  - Neutral
  - Suitable

## Map Information

This Map shows sheltering area suitability based on slope of Amatrice, Italy.

## Data Sources

Regional Geoportal Lazio

## Cartographic Information

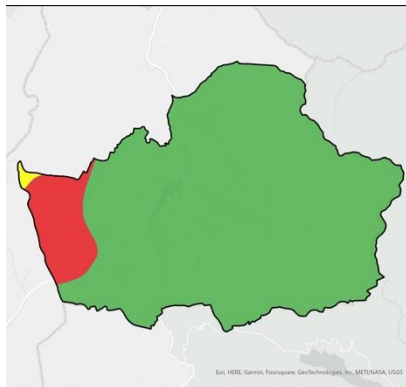
Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



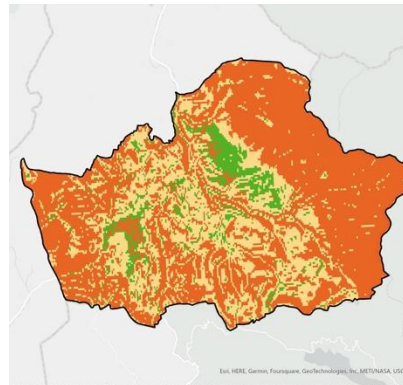
# Study of the land (Phase 1)

Study of the Land  
(Geomorphology)

Soil Type



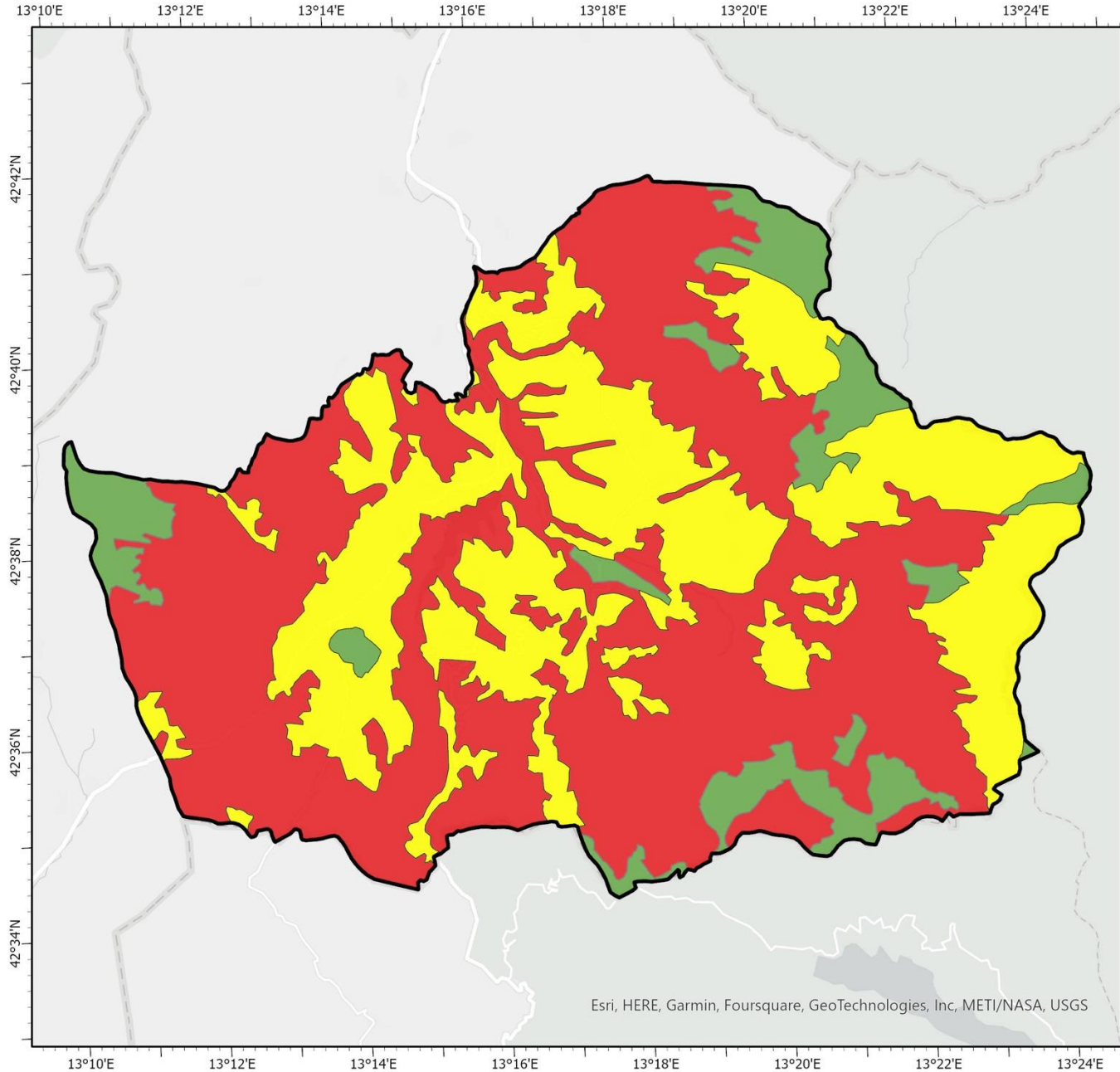
Land Slope



Landcover



# Amatrice Area Suitability based on Landcover



## Legend

- Amatrice
- Area Suitability based on Landcover
  - Unsuitable
  - Neutral
  - Suitable

## Map Information

This Map shows sheltering area suitability based on Landcover of Amatrice, Italy.

## Data Sources

Copernicus EU

## Cartographic Information

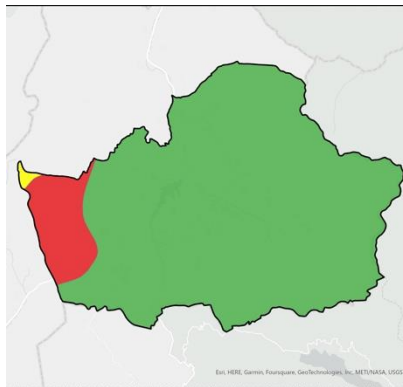
Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



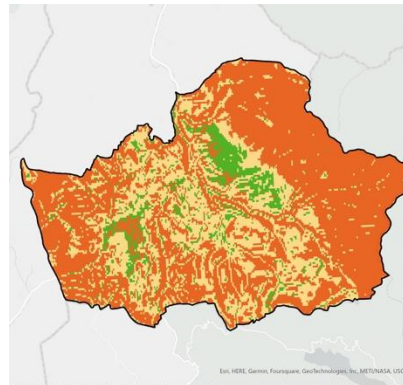
# Study of the land (Phase 1)

Study of the Land  
(Geomorphology)

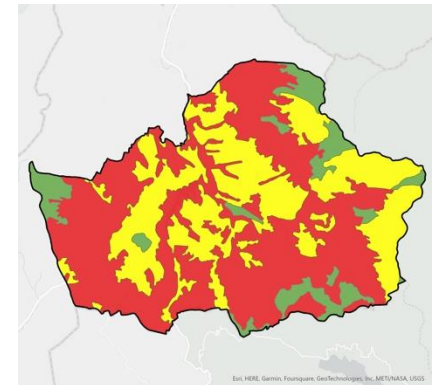
Soil Type



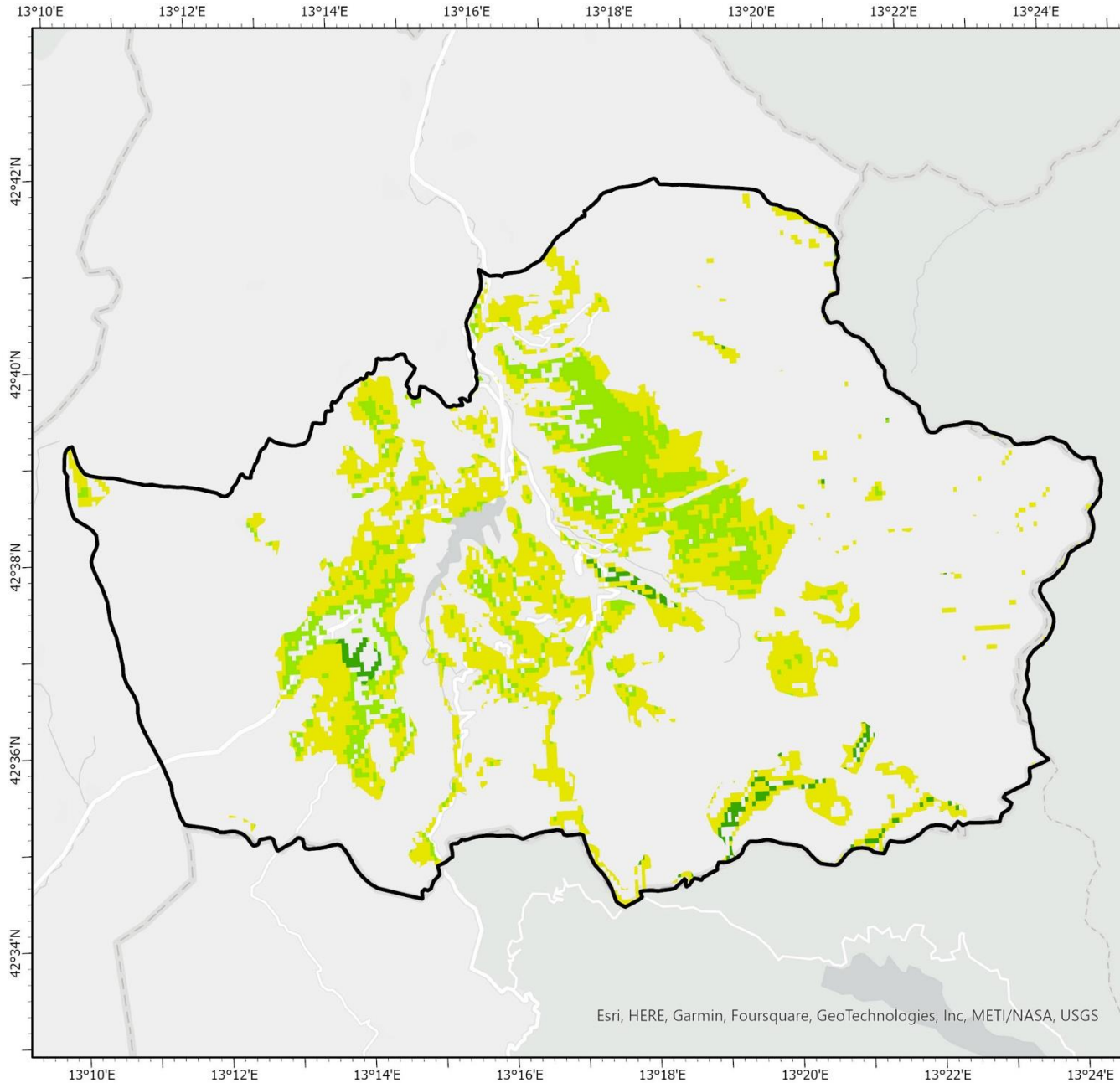
Land Slope



Landcover



# Amatrice Sheltering Area Suitability (Study of the land)



## Legend

- Amatrice
- Area Suitability
  - Suitable
  - High Suitability
  - Very High Suitability

## Map Information

This Map shows sheltering area suitability for phase 1 "Study of the land" of Amatrice, Italy. Layers used to produce this map: Soil Type, Land Slope, and Landcover.

## Data Sources

Copernicus EU, BGR's IHME1500, Regional Geoportal Lazio

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



# Phase 2

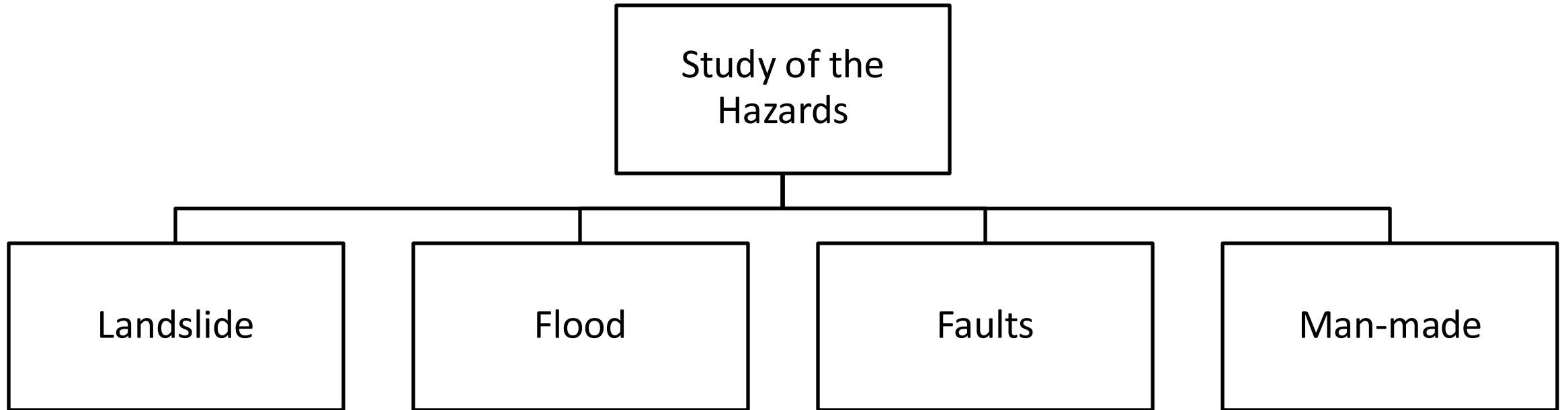
## Study of the Hazards

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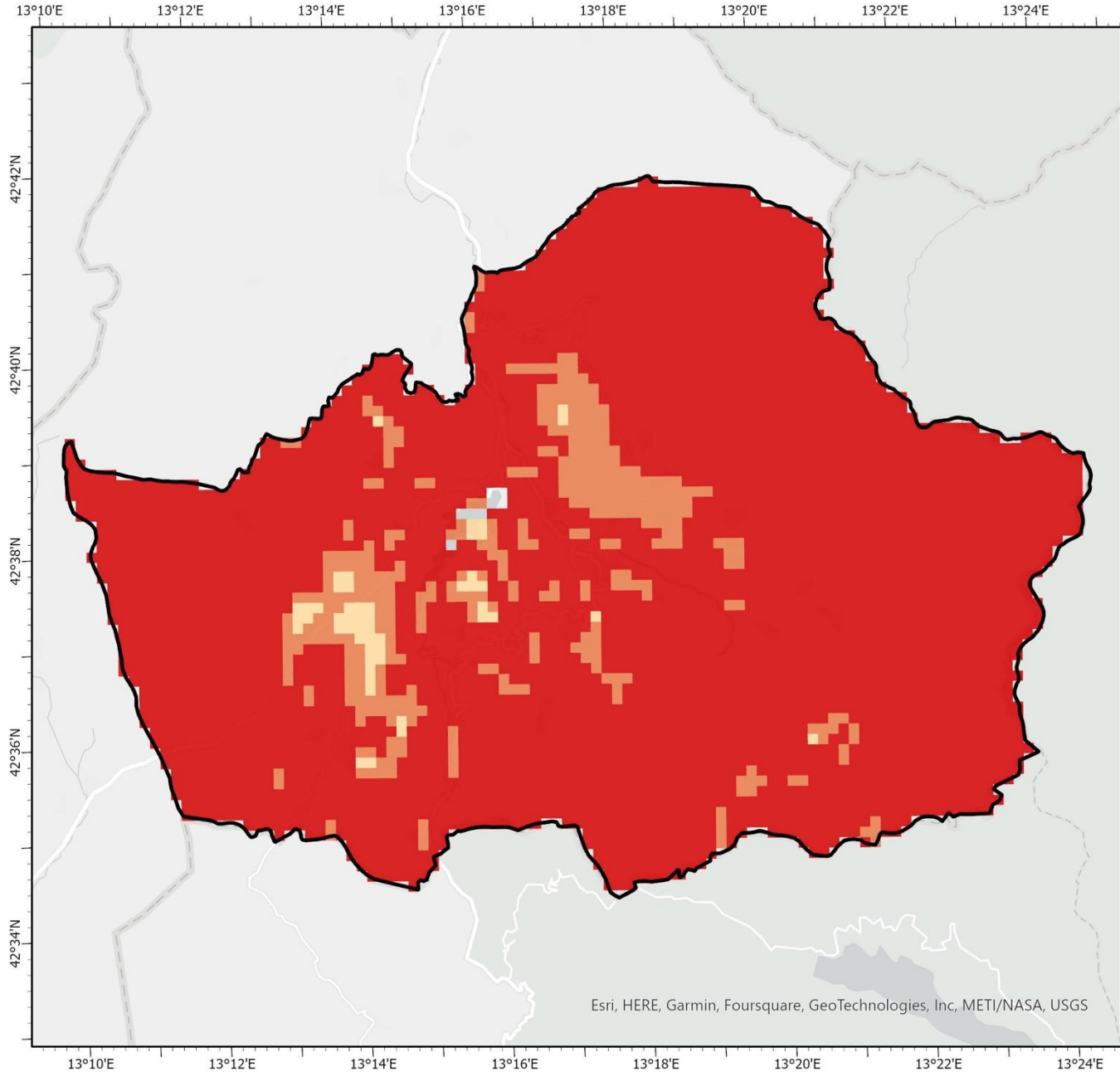
Flood, landslide, faults & man-made



## Study of the Hazards (Phase 2)



# Amatrice Landslide Hazard Map



## Legend

- Amatrice
- Landslide Hazard Level
  - Hazardous
  - Low Hazard
  - Very Low Hazard

## Map Information

This Map shows landslide hazard classification for Amatrice, Italy.

## Data Sources

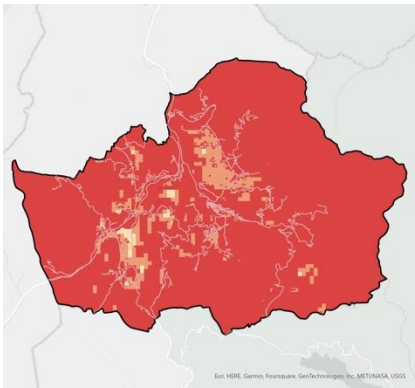
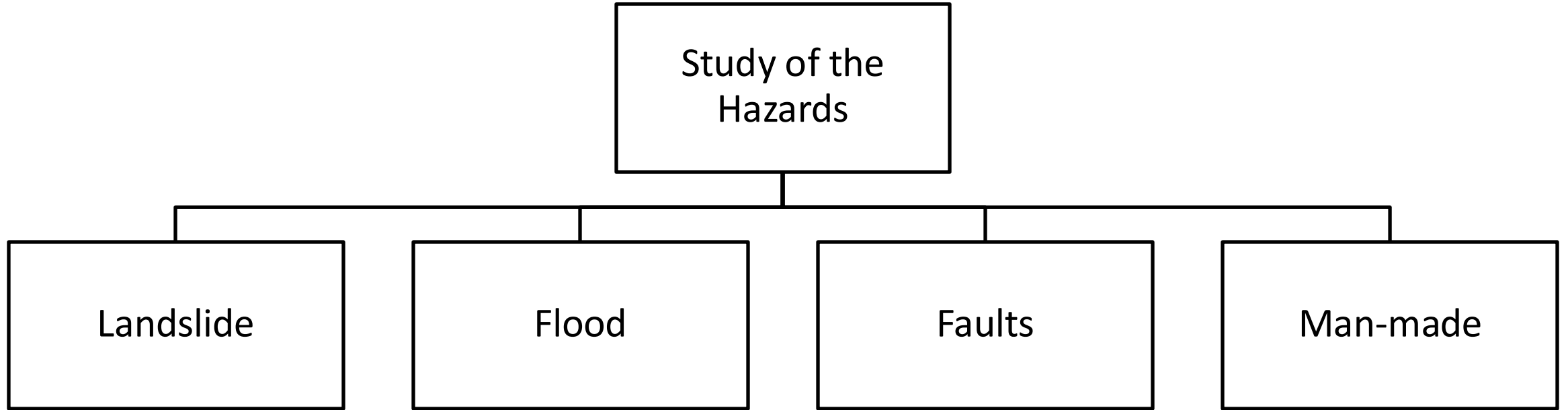
European Commission JRC

## Cartographic Information

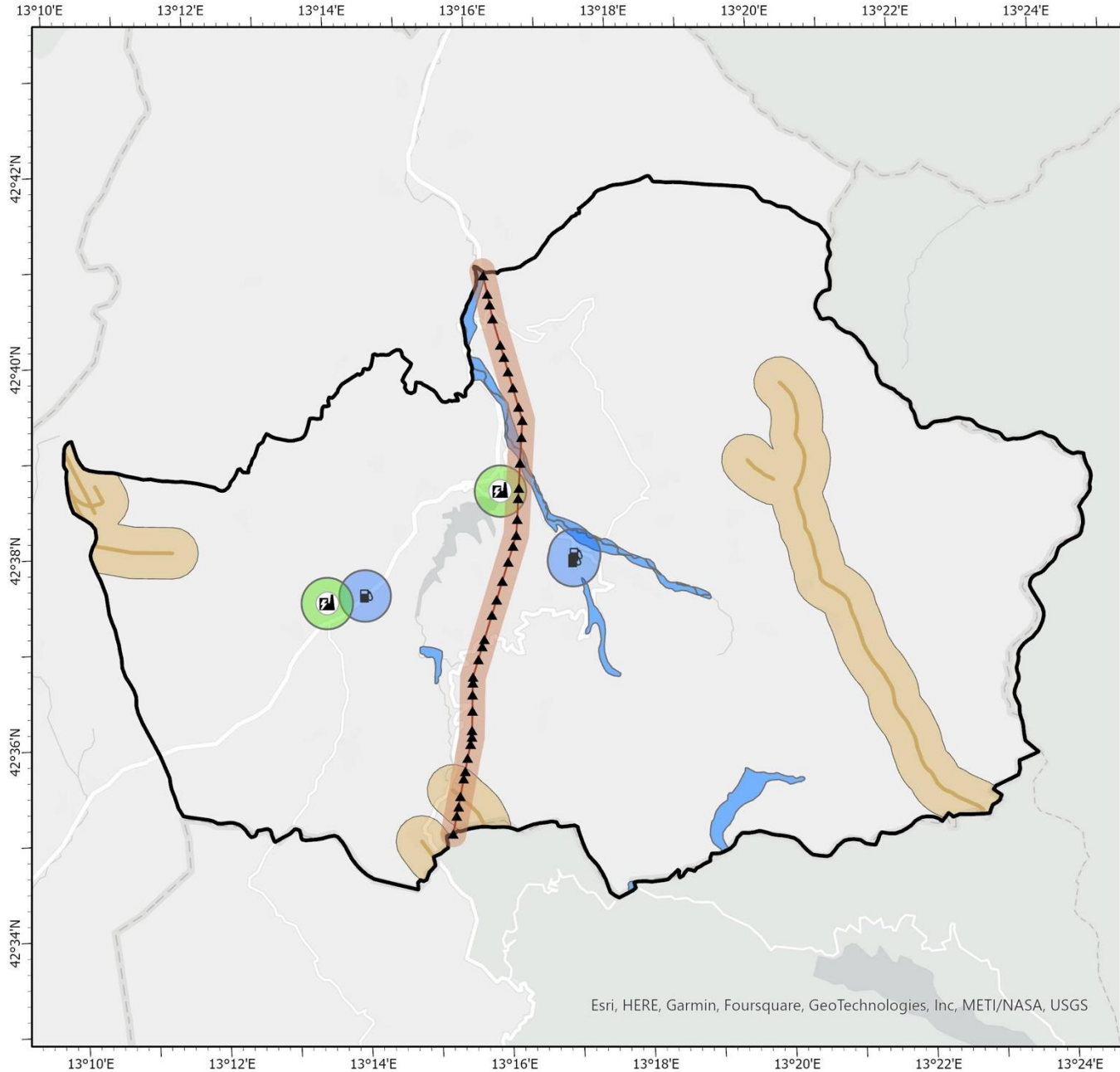
Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



## Study of the Hazards (Phase 2)



# Amatrice Hazard Map



## Legend

- Amatrice
- Power Plants
- Fuel Stations
- Power Towers
- Faults
- Power Line
- Flood Hazard
- Buffer (500m)
- Buffer (500m)
- Buffer (250m)
- Buffer (500m)

## Map Information

This Map shows hazards and manmade hazards considered for Amatrice, Italy.  
Layers presented: Faults, Flood Hazard, Power Plants, Fuel Stations, and Power Towers

## Data Sources

Regional Geoportal Lazio, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter





# Study of the Hazards (Phase 2)

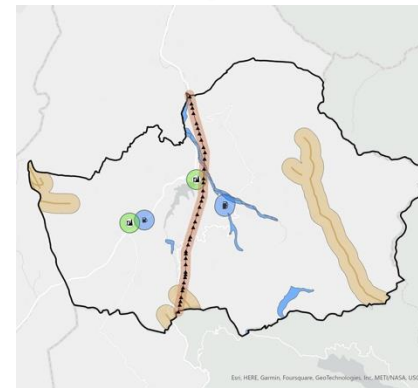
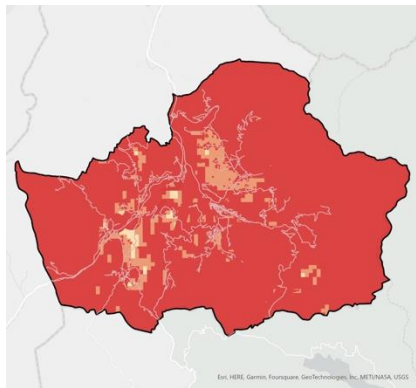
Study of the Hazards

Landslide

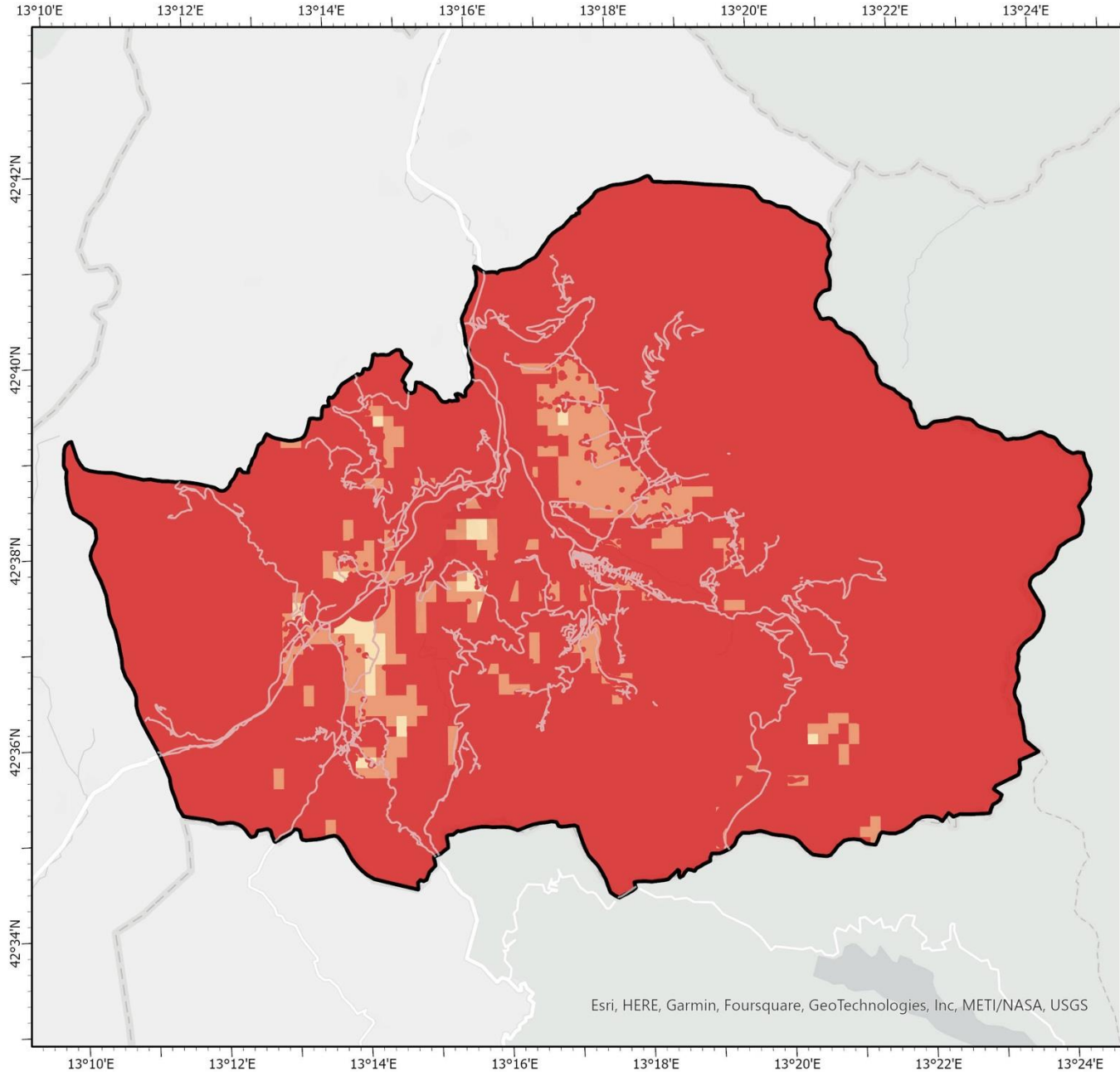
Flood

Faults

Man-made



# Amatrice Hazard Level Map "phase 2"



## Legend

- Amatrice
- Road Network
- Hazard Level**
  - Hazardous
  - Low Hazard
  - Very Low Hazard

## Map Information

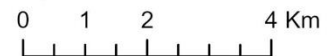
This Map shows hazard classification for Amatrice, Italy. It is produced considering:  
- Natural Hazards: Landslide Hazard, Flood Hazard  
- Manmade Hazard: Fuel Station, Power Plant, and Power Towers

## Data Sources

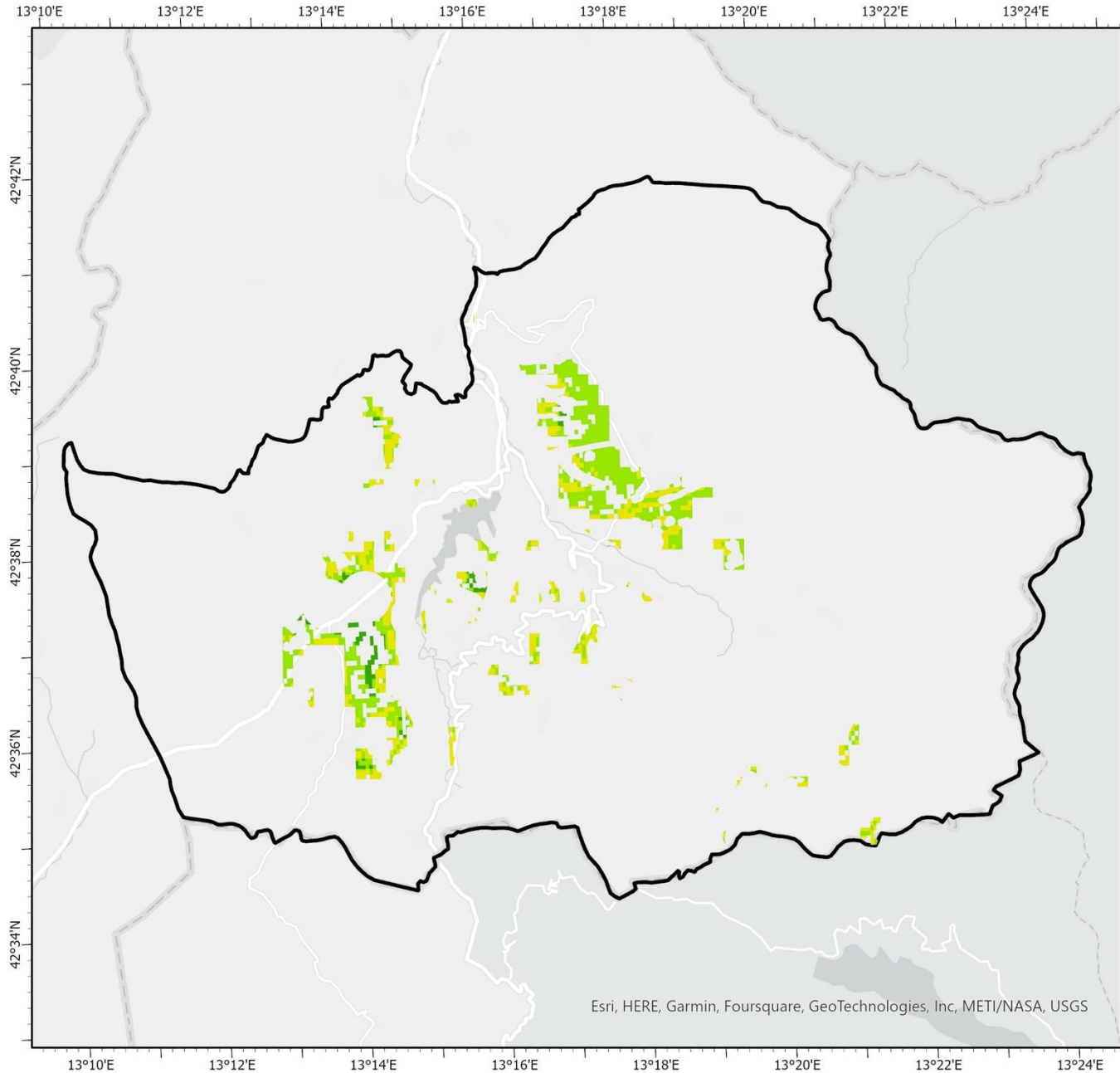
European Commission JRC, Regional Geoportal Lazio, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



# Amatrice Suitable Area for Shelter's location (Phase 1 &2)



## Legend

- Amatrice
- Sheltering Suitability Area
  - Neutral
  - High
  - Very High

## Map Information

This Map shows suitable area for shelter's location for Amatrice, Italy. It is a product of Phase 1 and Phase 2.

## Data Sources

European Commission JRC, Regional Geoportal Lazio, BGR's IHME1500, Copernicus EU, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



# Phase 3

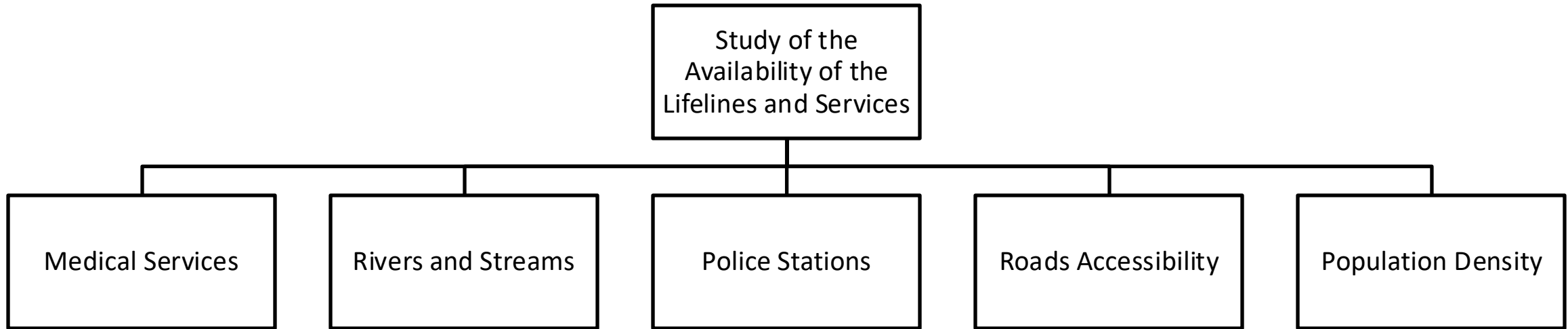
## Study of the availability of the lifelines & services

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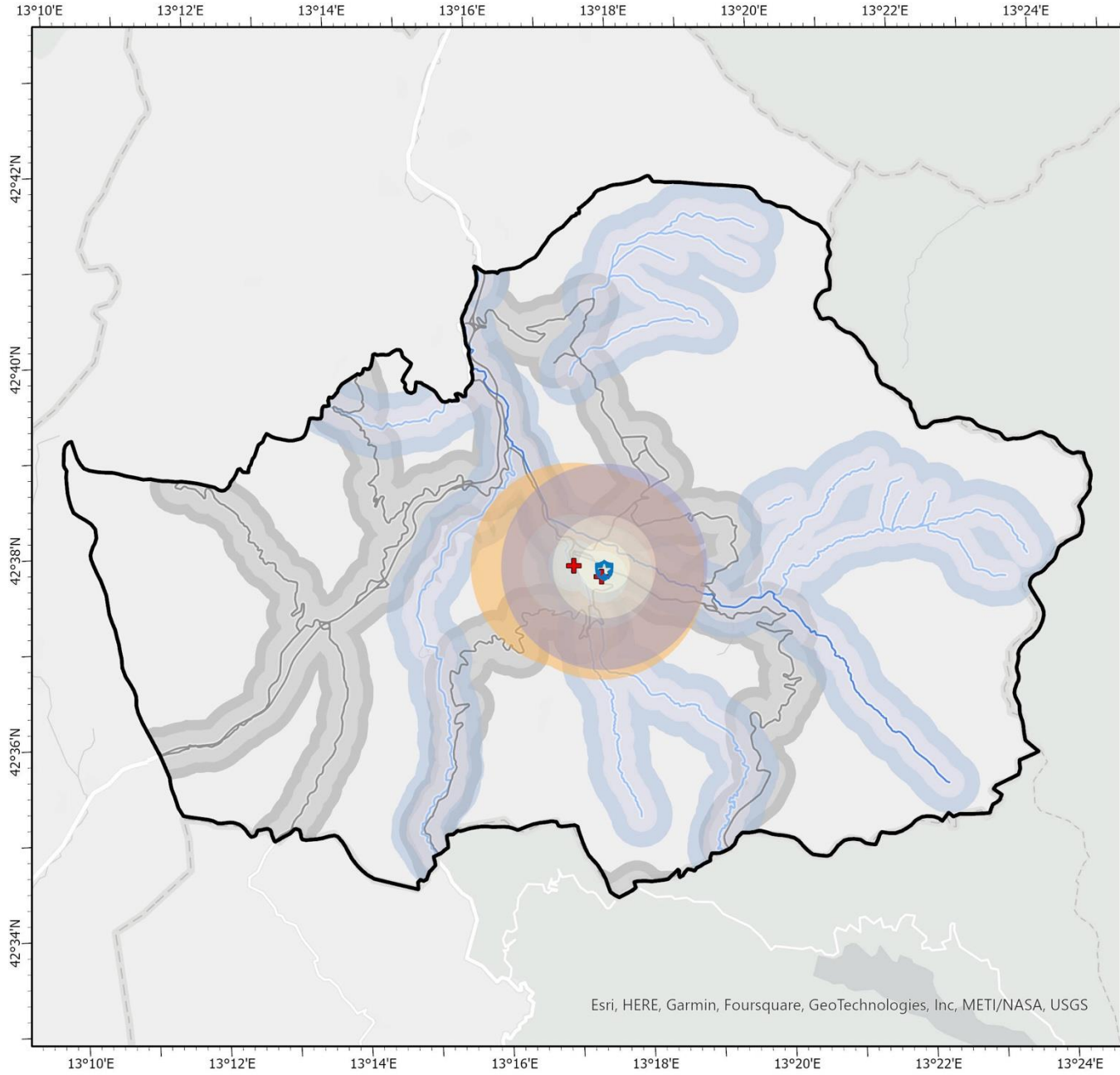
Medical Services, Rivers and streams, police station, roads  
accessibility, population density.



# Study of the availability of the lifelines & services



# Amatrice Lifelines and Services Map



## Legend

- Amatrice
- Police Station
- Medical Services
- Road Network
- River
- Main Streams
- Police Buffer 500 m
- Police Buffer 1000 m
- Police Buffer 2000 m
- Road Buffer 50 m
- Road Buffer 300 m
- Road Buffer 500 m
- Medical Buffer 500 m
- Medical Buffer 1000 m
- Medical Buffer 2000 m
- Water Buffer 50 m
- Water Buffer 300 m
- Water Buffer 600 m

## Map Information

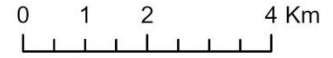
This Map shows the lifelines and services used to rank the areas based on serviceability (Phase 3) for Amatrice, Italy. Layers used: Medical Services, Police Stations, River, Streams, and Road Network.

## Data Sources

OpenStreetMap

## Cartographic Information

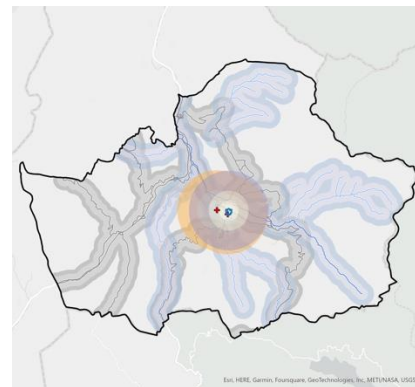
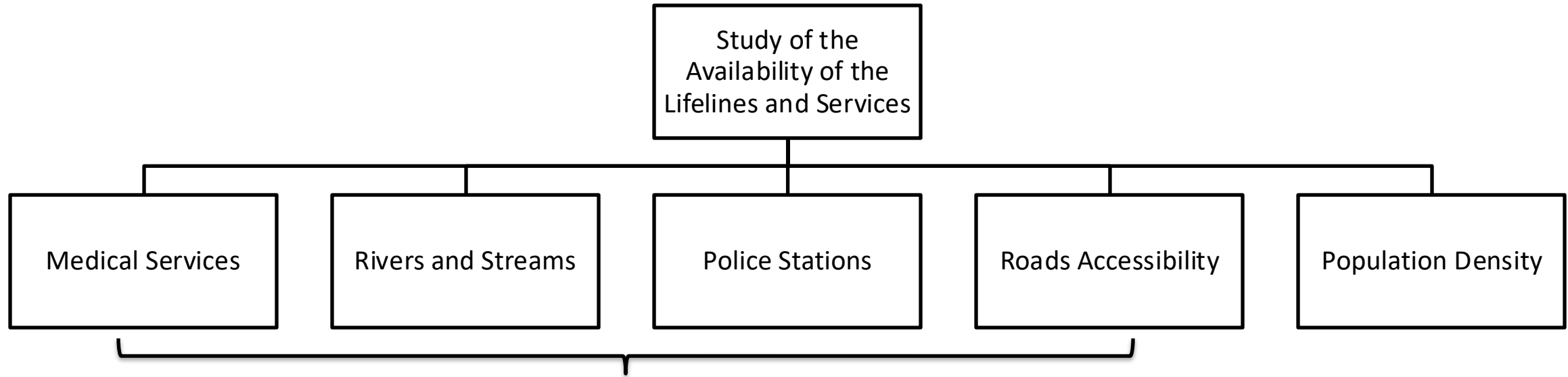
Datum: WGS 1984  
 Projection: Transverse Mercator  
 Map Units: Meter



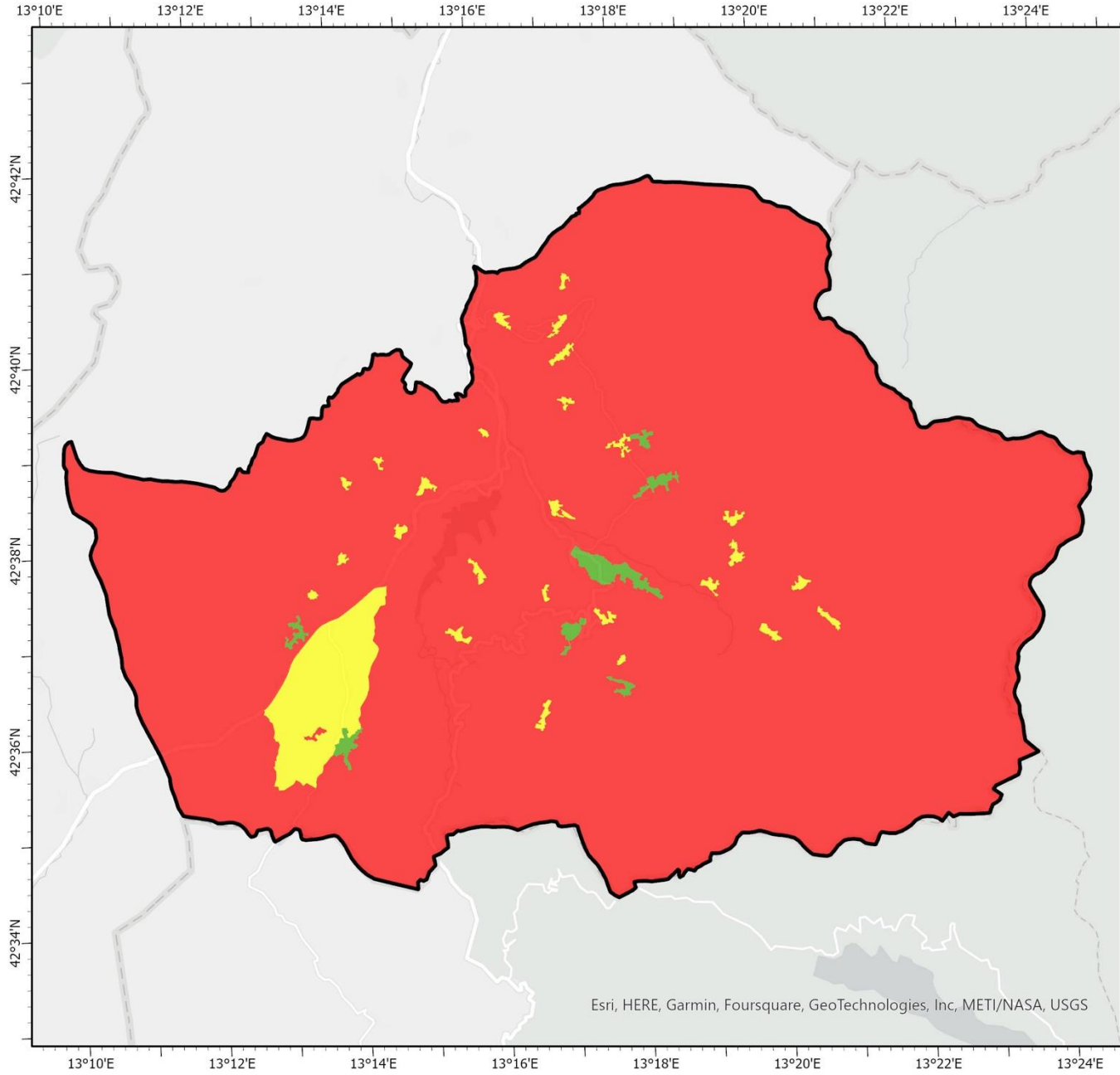
Esri, HERE, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS



# Study of the availability of the lifelines & services



# Amatrice Area Suitability Map based on Population Density



## Legend

- Amatrice
- Population Density Area Suitability
  - Less Suitable
  - Neutral
  - Suitable

## Map Information

This Map shows the Population density area suitability which is used to rank the areas based on serviceability (Phase 3) for Amatrice, Italy.

## Data Sources

Regional Geoportal Lazio

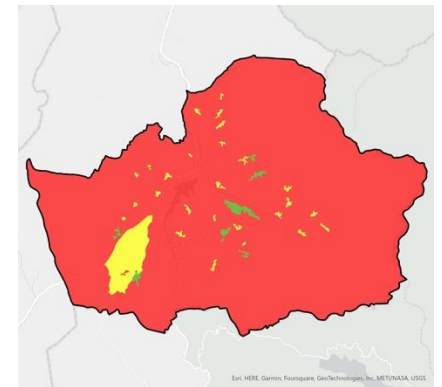
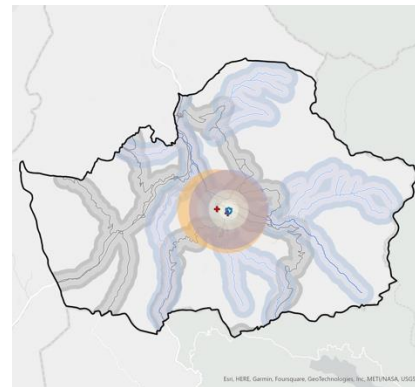
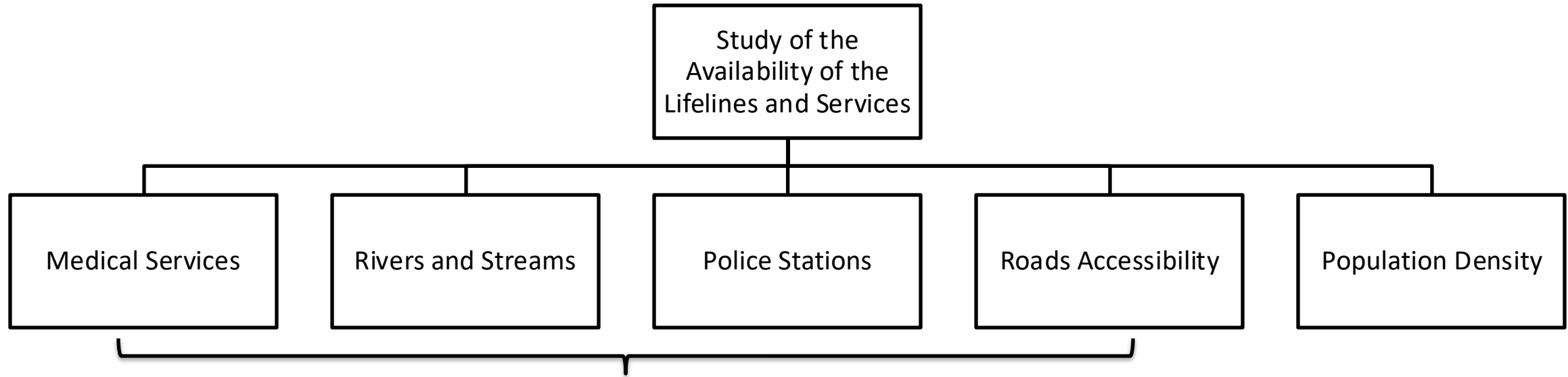
## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter

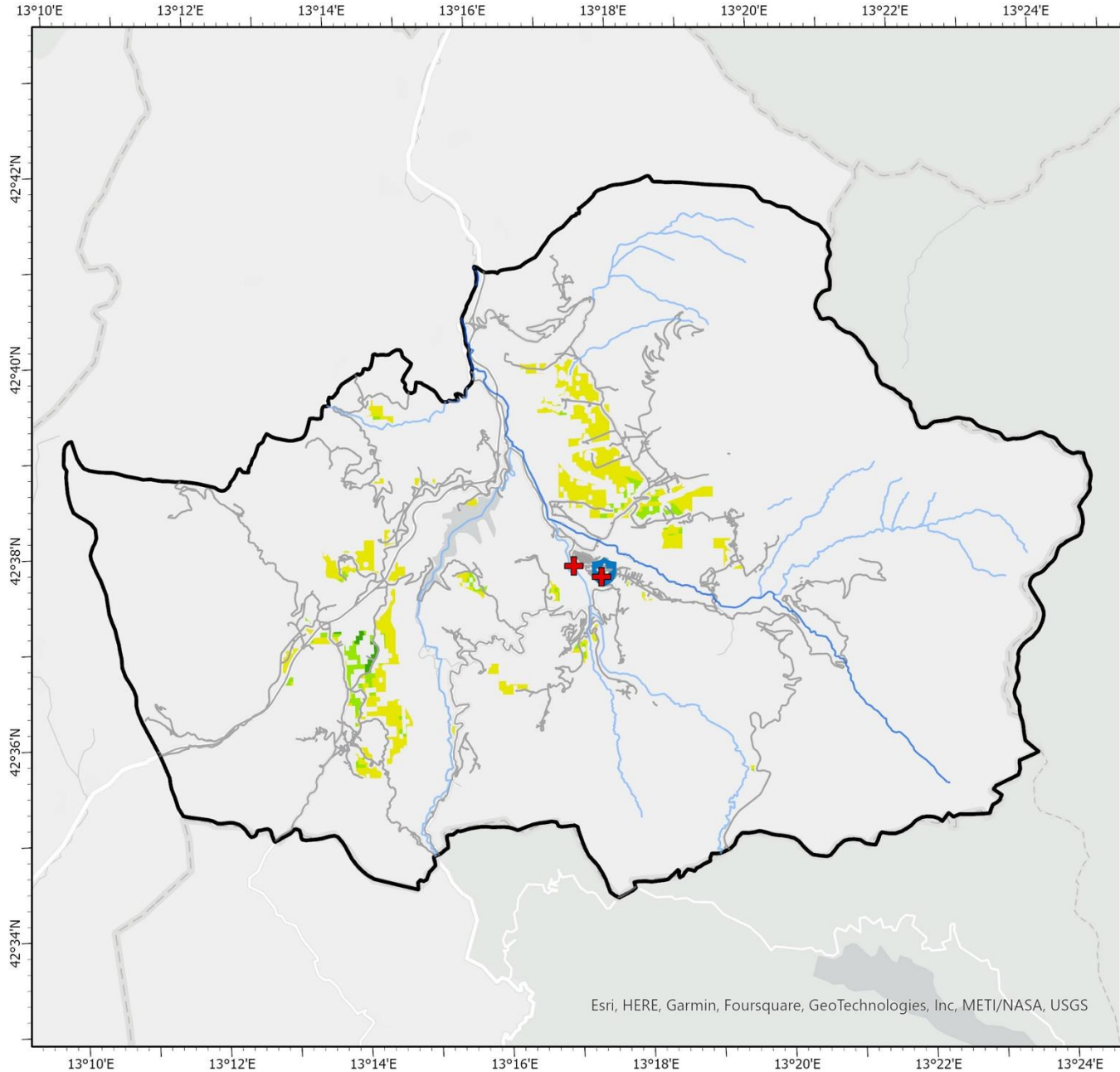




# Study of the availability of the lifelines & services



# Amatrice Area Suitability after Applying Serviceability Factors



## Legend

- |                  |                           |
|------------------|---------------------------|
| Amatrice         | Area Suitability Suitable |
| Road Network     | High Suitability          |
| Police Station   | Very High Suitability     |
| Medical Services |                           |
| River            |                           |
| Main Streams     |                           |

## Map Information

This Map shows Suitable Sheltering Areas after applying serviceability factors for Amatrice, Italy.  
Layers used to produce the map: Soil Type, Slope, Landcover, Landslide Hazard, Flood Hazard, Faults, Fuel Stations, Power Plants, Power Towers, Police Station, Medical Services, Roads, River, Streams, and Population Density.

## Data Sources

Copernicus EU, BGR's IHME1500, Regional Geoportal Lazio, European Commission JRC, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter

# Phase 4

## Suitable shelter areas

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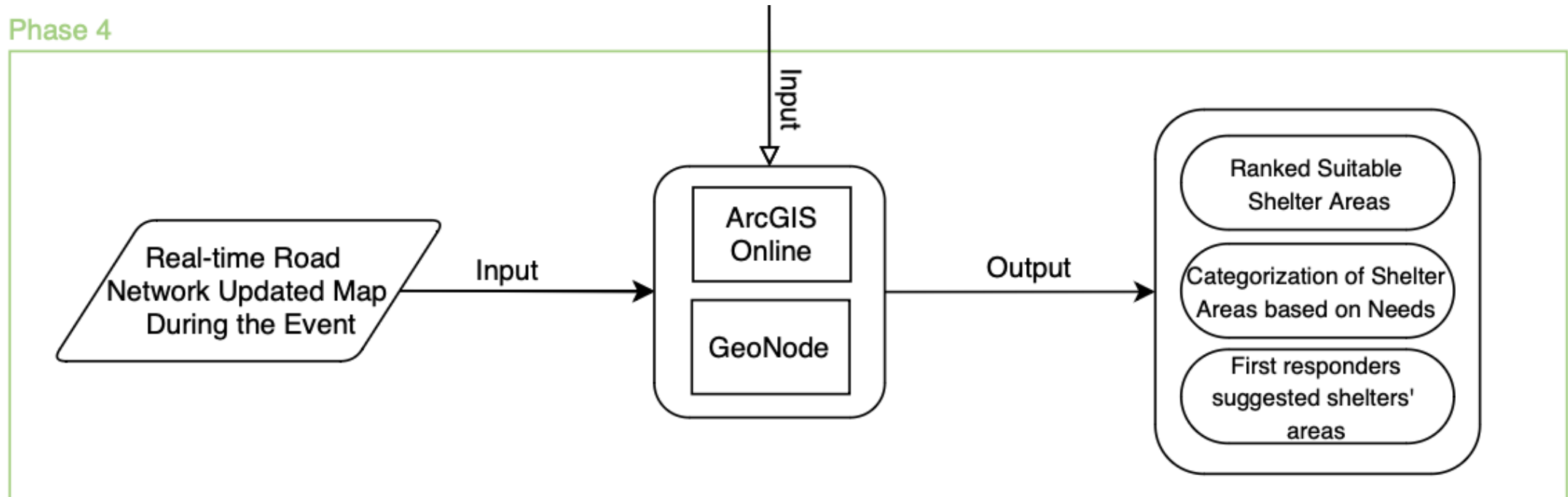
Ranked, based on needs & first responders suggested areas



## Workflow: Phase 4

11/11/2015

### Phase 4





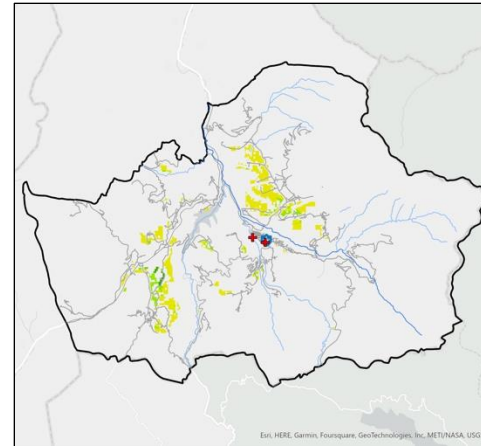
## Workflow: Phase 4

Phase 4

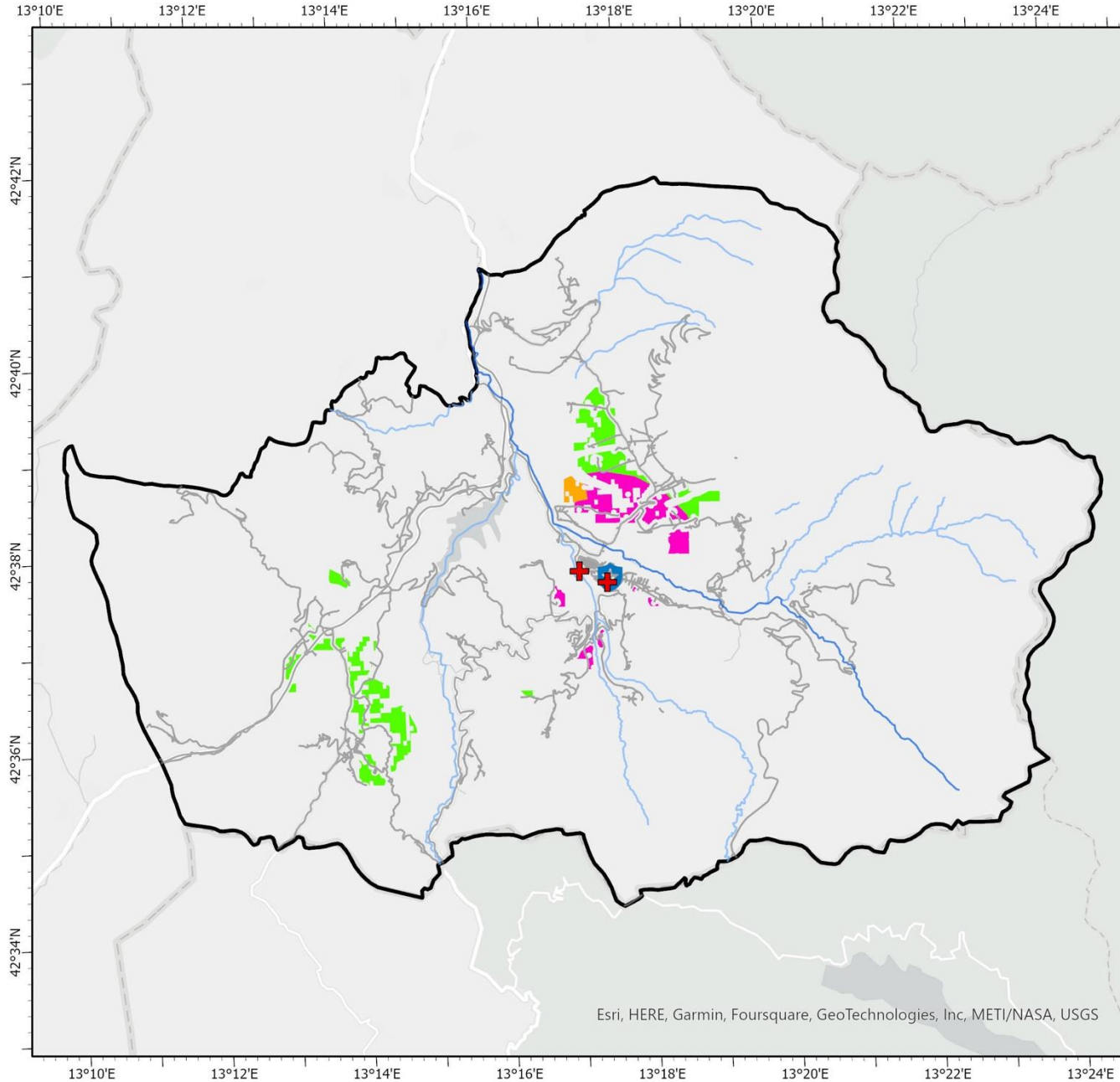
Ranked Suitable  
Shelter Areas

Categorization of Shelter  
Areas based on Needs

First responders  
suggested shelters'  
areas



# Amatrice Categorization of Shelter's Areas Based on Needs



## Legend

- Amatrice
- Road Network
- Police Station
- Medical Services
- River
- Main Streams
- Suitable Proximity According to
  - Populated Areas
  - Police Stations, and Medical Services
  - Police Stations, Medical Services, and Populated Areas

## Map Information

This Map shows Categorization of Shelter's Areas Based on Needs for Amatrice, Italy.

## Data Sources

Copernicus EU, BGR's IHME1500, Regional Geoportal Lazio, European Commission JRC, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter



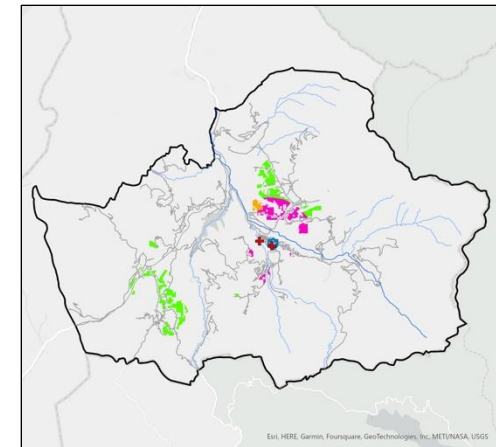
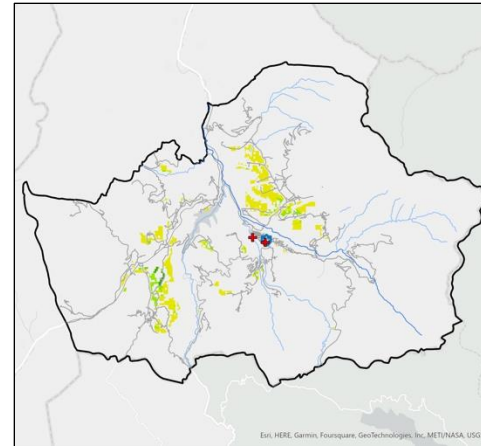


## Workflow: Phase 4

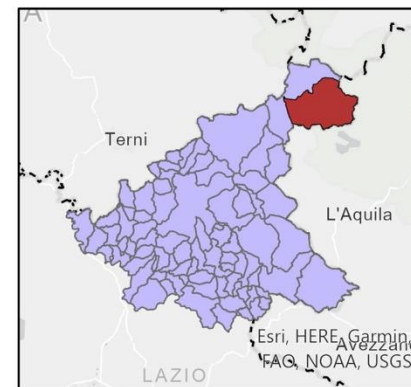
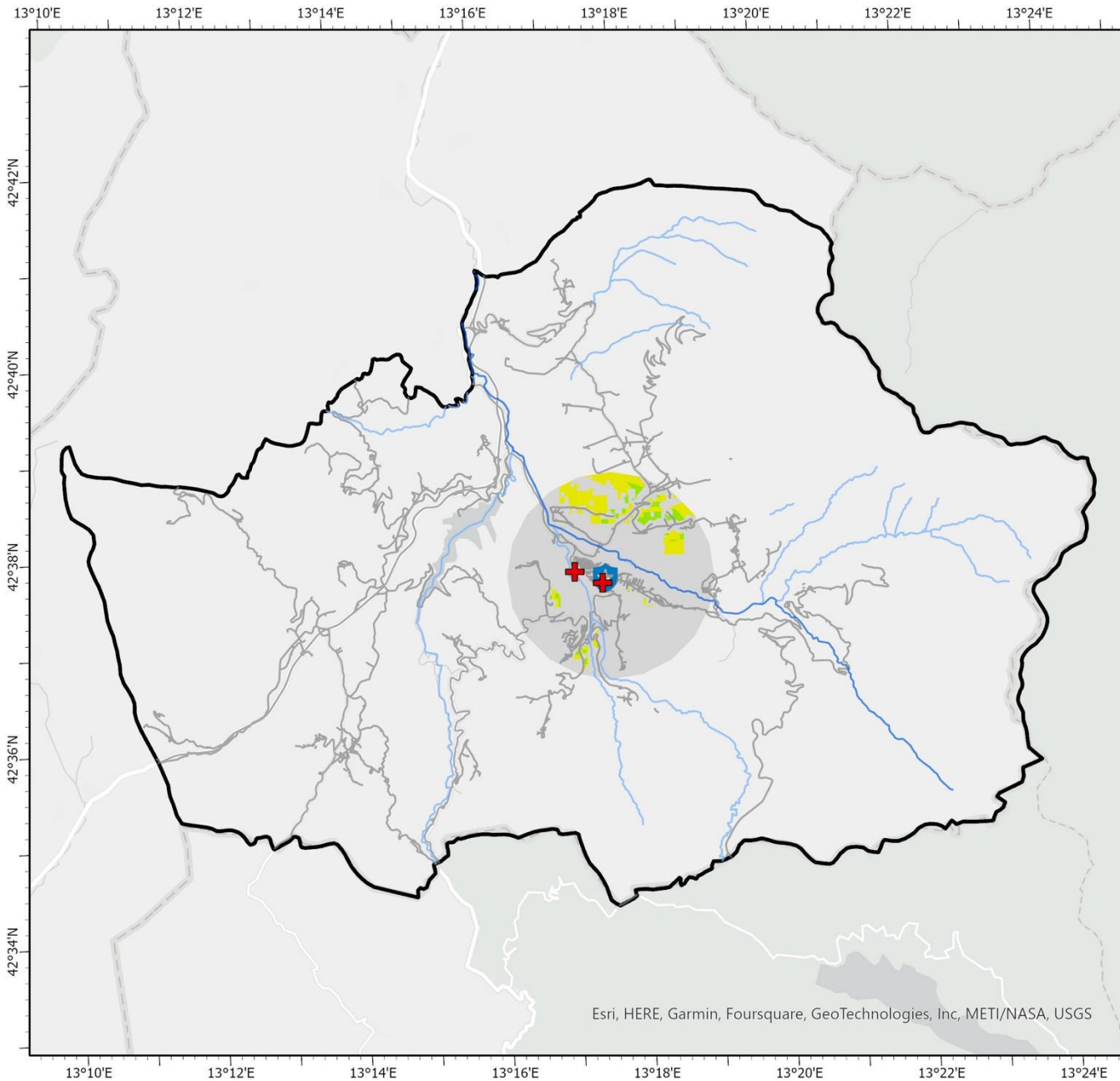
Ranked Suitable  
Shelter Areas

Categorization of Shelter  
Areas based on Needs

First responders  
suggested shelters'  
areas



# Amatrice Suggested Shelter's Areas for First Responders and Civil Protection



## Legend

- Amatrice
- Road Network
- Police Station
- Medical Services
- River
- Main Streams
- Buffer (2000m)
- Area Suitability
  - High Suitability
  - Suitable
  - Very High Suitability

## Map Information

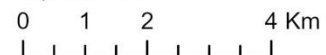
This Map shows suggested shelter's areas for first responders and civil protection for Amatrice, Italy.

## Data Sources

Copernicus EU, BGR's IHME1500, Regional Geoportal Lazio, European Commission JRC, OpenStreetMap

## Cartographic Information

Datum: WGS 1984  
Projection: Transverse Mercator  
Map Units: Meter





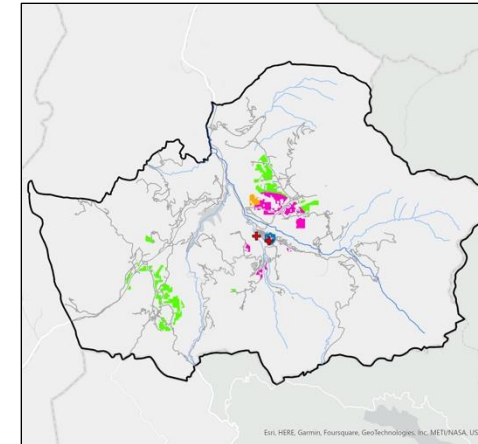
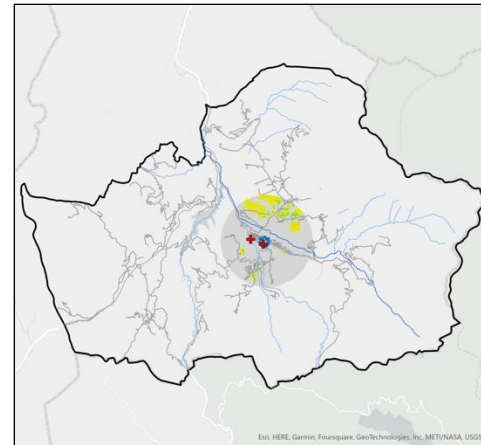
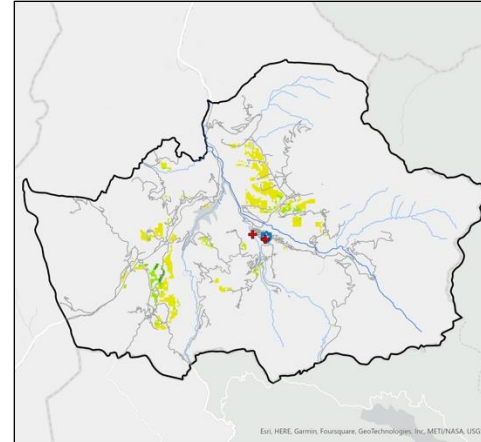


# Workflow: Phase 4

Ranked Suitable Shelter Areas

Categorization of Shelter Areas based on Needs

First responders suggested shelters' areas





## Why?

To publish the final maps online, on a WebGIS platform using ArcGIS Online and GeoNode.

## Added value

- Dynamic exploration of spatial data: interactive tools.
- Real-Time Access: up-to-date information by incorporating real-time data.





Suitable shelter areas

## Earthquake Emergency shelter areas in Amatrice



Use forward and back arrows to navigate slides, and display the legend from the bottom left corner.

The app includes:

Slide 1: Suitable shelter locations

Slide 2: Categorization based on needs

Slide 3: First responders suggested shelters location

**You can measure the areas, locate coordinates, and calculate distances for each map/slide.**

**Select features to display its information and classification.**

Explore

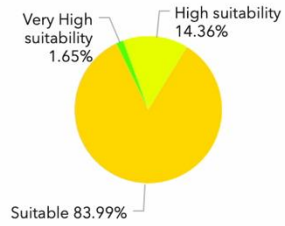
Activate Windows

Go to Settings to activate Windows.

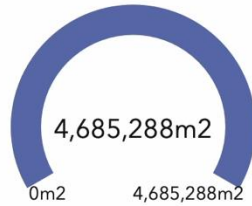


# ArcGIS Online: Dashboard

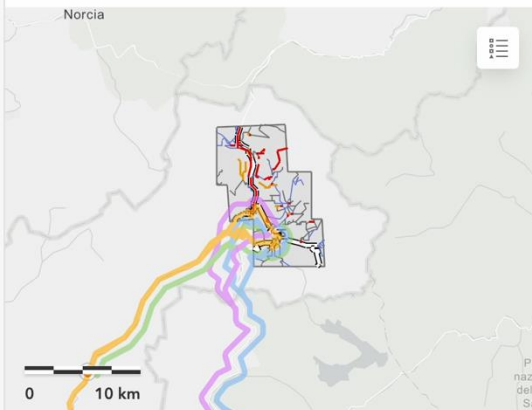
## Suitability



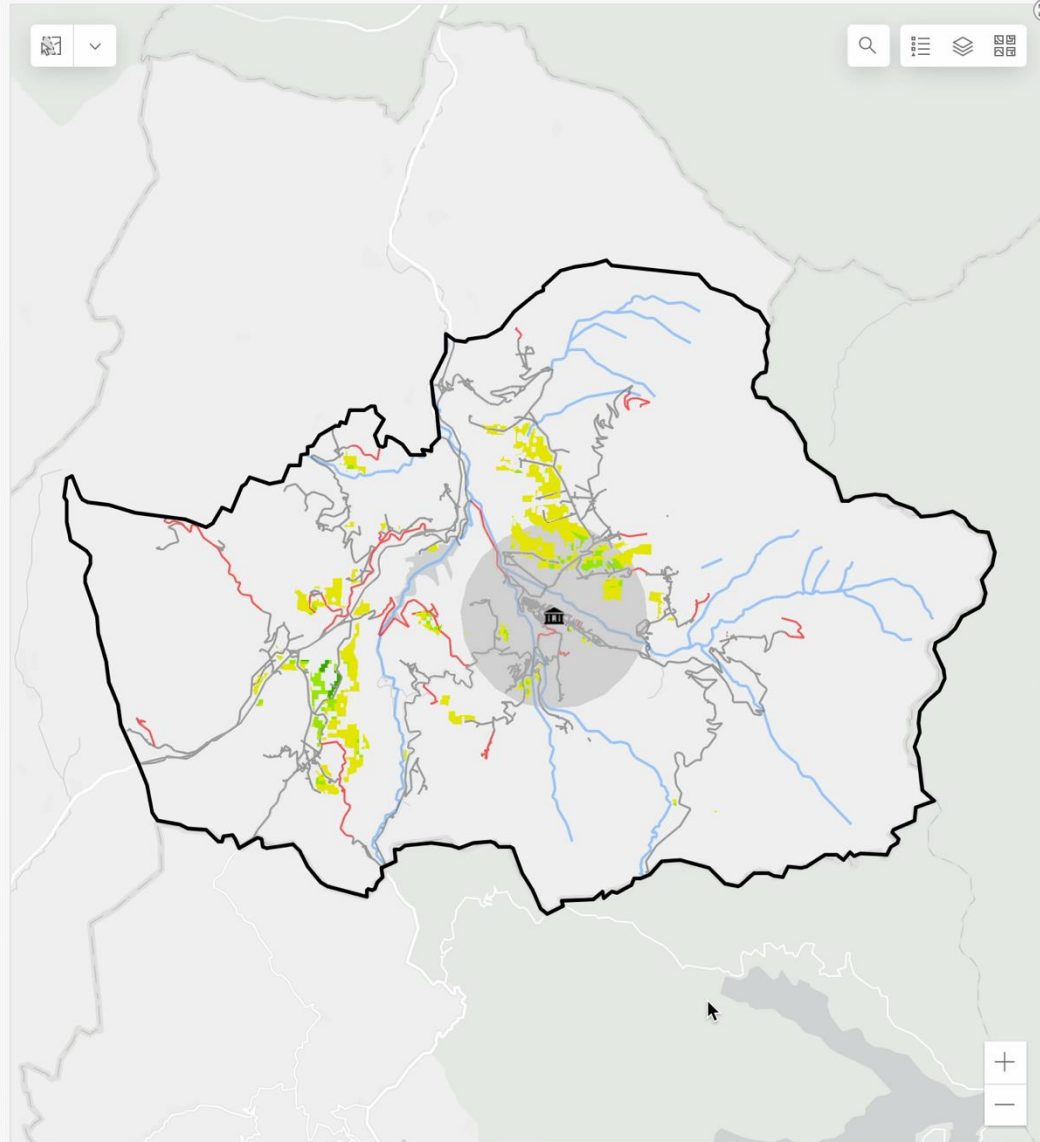
## Area (m2)



## Emergency Access Routes of Amatrice



Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, ... Powered by Esri



Esri, HERE, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

- Polizia Stradale Amatrice
- Centro di emergenza sanitaria "campo sportivo A. Sbardella"
- Ospedale Grifoni
- Farmacia Mauro Di Mauro Dott. Massimiliano

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The center

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Police stations

---

Medical services

---

Suitable shelter locations

- High suitability
- Suitable
- Very High suitability

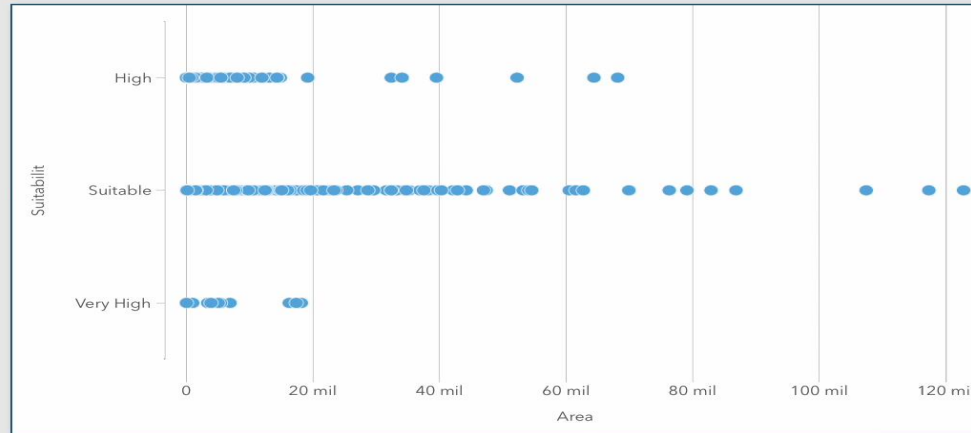
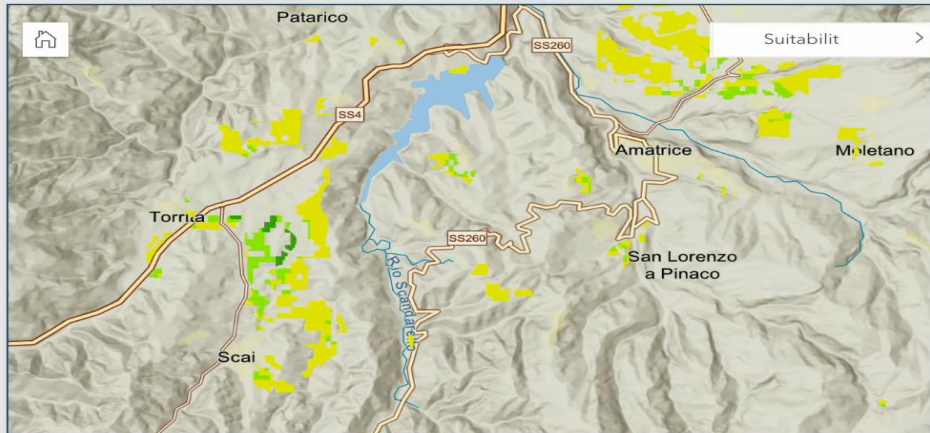
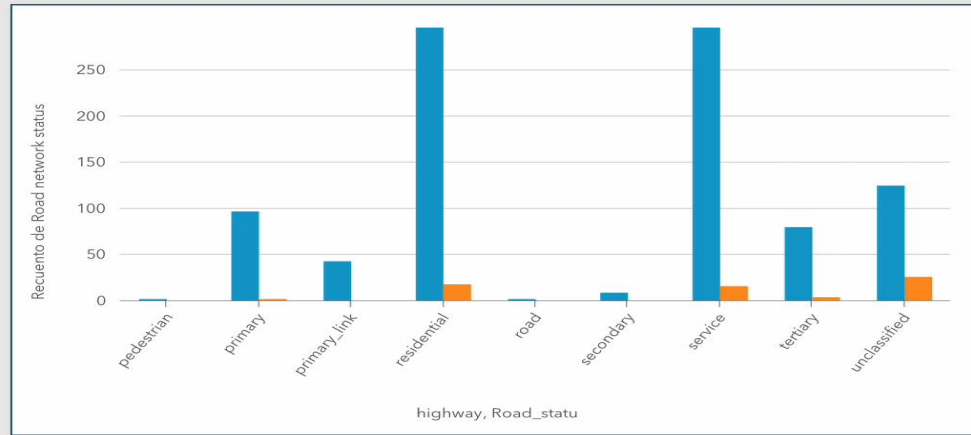
---

Buffer\_2000 m

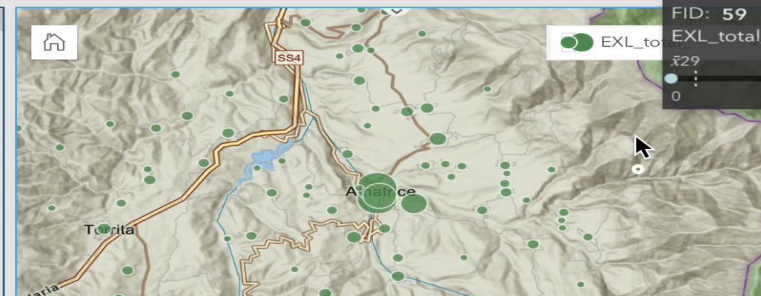
Powered by Esri



# ArcGIS Online: Insight



	Suitable	C	High Suitability	E	Very High Su...	G
1	<Sin datos>	<Sin datos>	High Suitability	<Sin datos>	Very High Suitability	<Sin datos>
2	Area	Population	Area	Population	Area	Population
3	5203.13	1156	4.52	1	16242.65	3609
4	2267.08	503	3039.72	675	17346.22	3854
5	232.72	51	7479.74	1662	5006.33	1112
6	825.94	183	2098.98	466	973.67	216
7	4874.66	1083	494.18	109	6876.71	1528
8	44201.38	9822	6669.23	1482	18141.68	4031
9	42131.84	9362	3416.69	759	3363.19	747
10	16425.03	3650	6925.69	1539	5385.52	1196





# GeoNode Application

File Machine View Input Devices Help

Welcome! - example.com - Mozilla Firefox

Welcome! - example.com x +

http://geonode 110%

Data Maps About

Search user1

## Amatrice Shelter

Committed to finding suitable shelter for Amatrice.

Discover Amatrice

### Search for Data.

Search

Advanced Search

Discover the available datasets.

Privacy & Cookies Policy

US 14:22

Right Ctrl



### Traditional Workflow Problems Vs.

- Scalability
- Computational Cost
- Updatability
- Licensing and Integration

### Google Earth Engine

- Scalable
- Computations on Clouds
- Can be Connected to the Satellites
- Free (to some extent)



# Suggestions for Future Works

The image displays the Google Earth Engine web interface. The top navigation bar includes the Google Earth Engine logo and a search bar. Below the navigation bar, there are tabs for 'Scripts', 'Docs', and 'Assets'. A sidebar on the left shows a list of scripts with categories like 'Owner (5)', 'Writer', 'Reader (4)', 'Archive (1)', and 'Examples'. The main area is divided into a script editor and a map view.

The script editor shows the following code:

```
73 // Return a panel that holds the label and color box
74 - return ui.Panel({
75     widgets: [colorBox, label],
76     layout: ui.Panel.Layout.Flow('horizontal')
77 });
78 };
79
80 // Add the legend entries to the legend panel
81 legend.add(makeRow('red', 'Unsuitable Soil (LowSlope)'));
82 legend.add(makeRow('green', 'Suitable Soil'));
83
84 legend.add(makeRow('orange', 'Neutral Soil'));
85 legend.add(makeRow('red', 'Unsuitable Soil (HighSlope)'));
86
87 // Add the legend to the map
88 Map.add(legend);
89
```

The map view shows a soil suitability map of Italy. A legend in the bottom right corner identifies the soil types by color:

- Unsuitable Soil (LowSlope) - Red
- Suitable Soil - Green
- Neutral Soil - Orange
- Unsuitable Soil (HighSlope) - Red

A large inset image on the right side of the screen provides a magnified view of a specific region on the map, showing a detailed pattern of soil suitability colors (red, green, and orange) across a landscape.





**Thank you!**