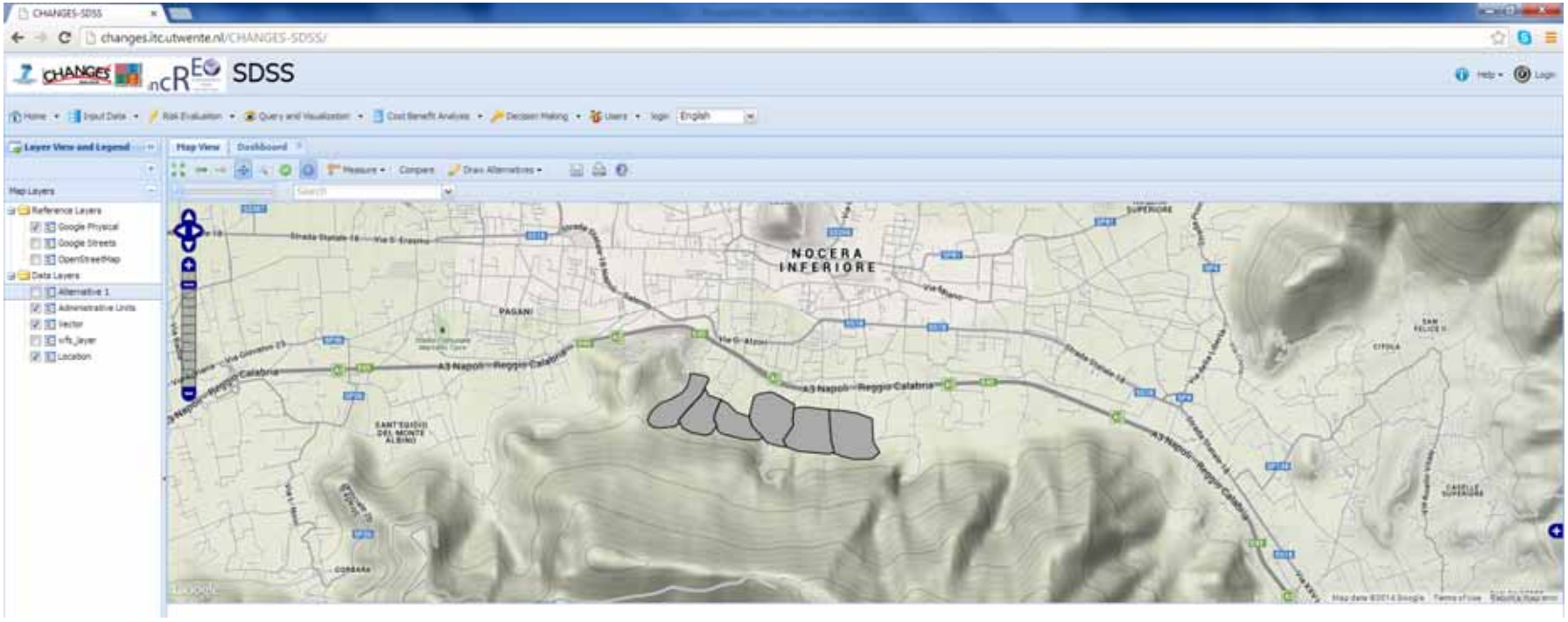
CHANGES SDSS
Analysis of (changing) risk



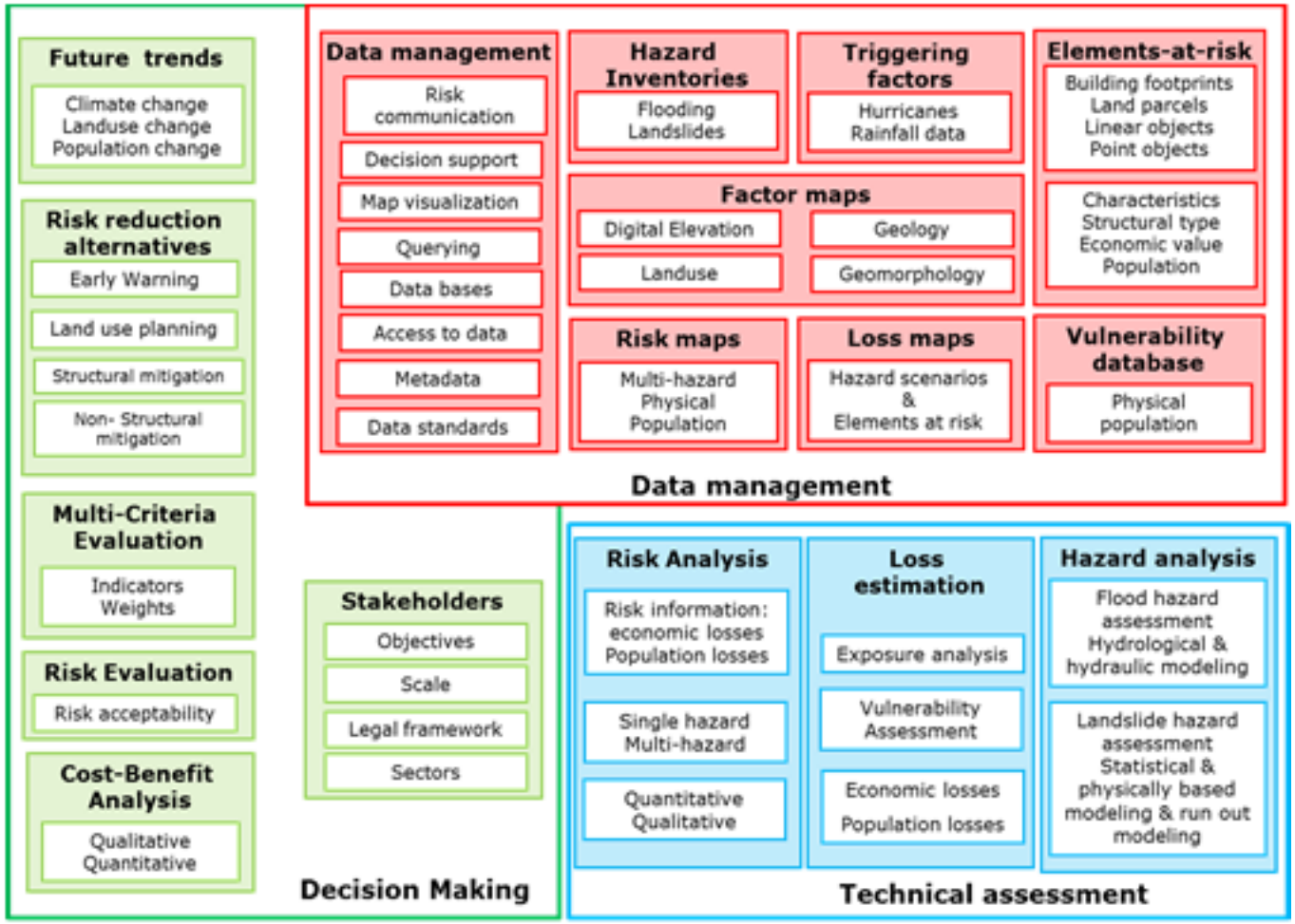
Meetings for SDSS development

- Meeting Enschede (14-15/3). Start the brainstorming work on the development of the SDSS
- Working meeting: Vienna (11/4) Presentation to CHANGEs group
- Meeting Heidelberg (29/5). Selection of candidates for 5 researcher positions
- Workshop in Barcelonnette (France) (24-29/6) First training course for new researchers
- Meeting Enschede (3-6/9). First workshop with 5 researchers
- Meeting Perugia (16 – 19/9). Presentation and discussion during the CHANGES workshop
- Heidelberg (24-25/10). Progress meeting
- Meeting Heidelberg (2-4/12). Progress meeting
- Meeting Enschede (9-13/12) . Working session.
- Etc….

Approach

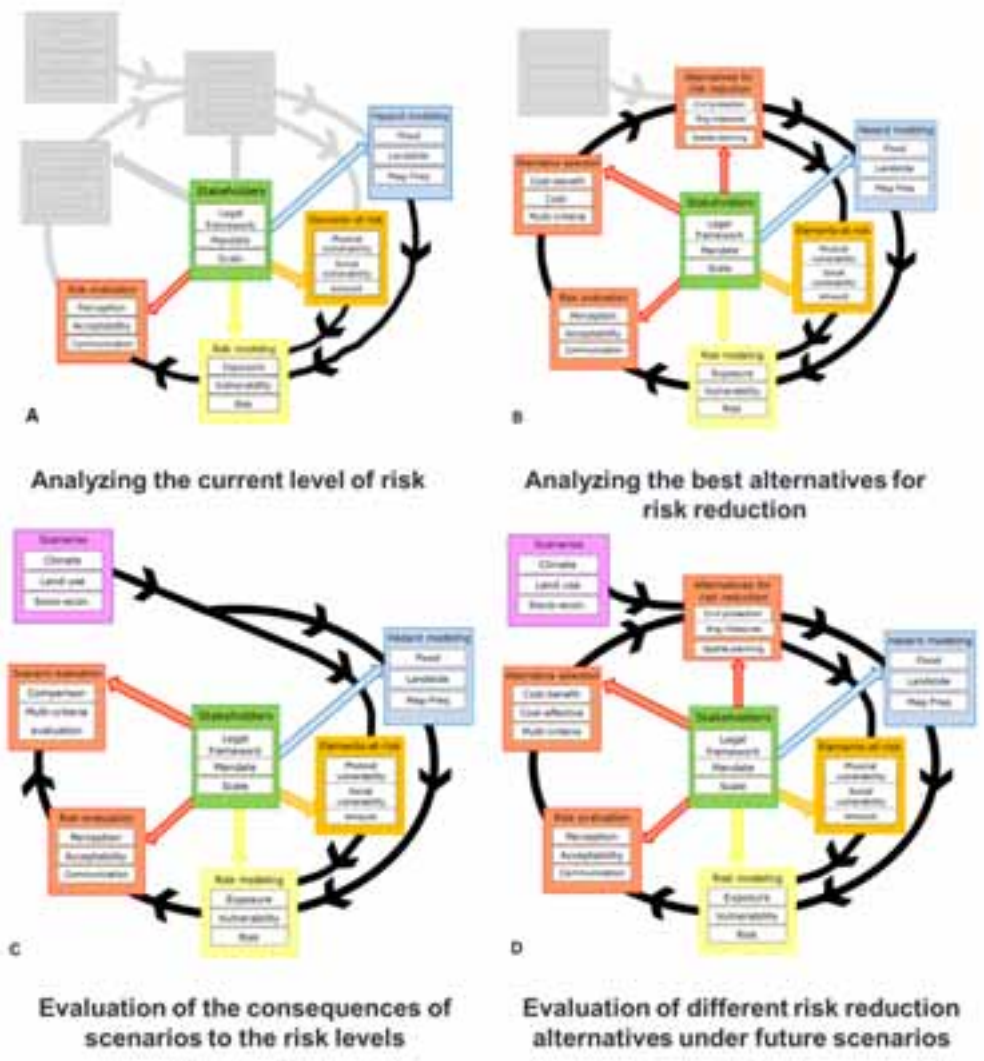
Three main components::

1) Technical assessment (hazard and risk)
2) Decision making (use cases)
3) Data management



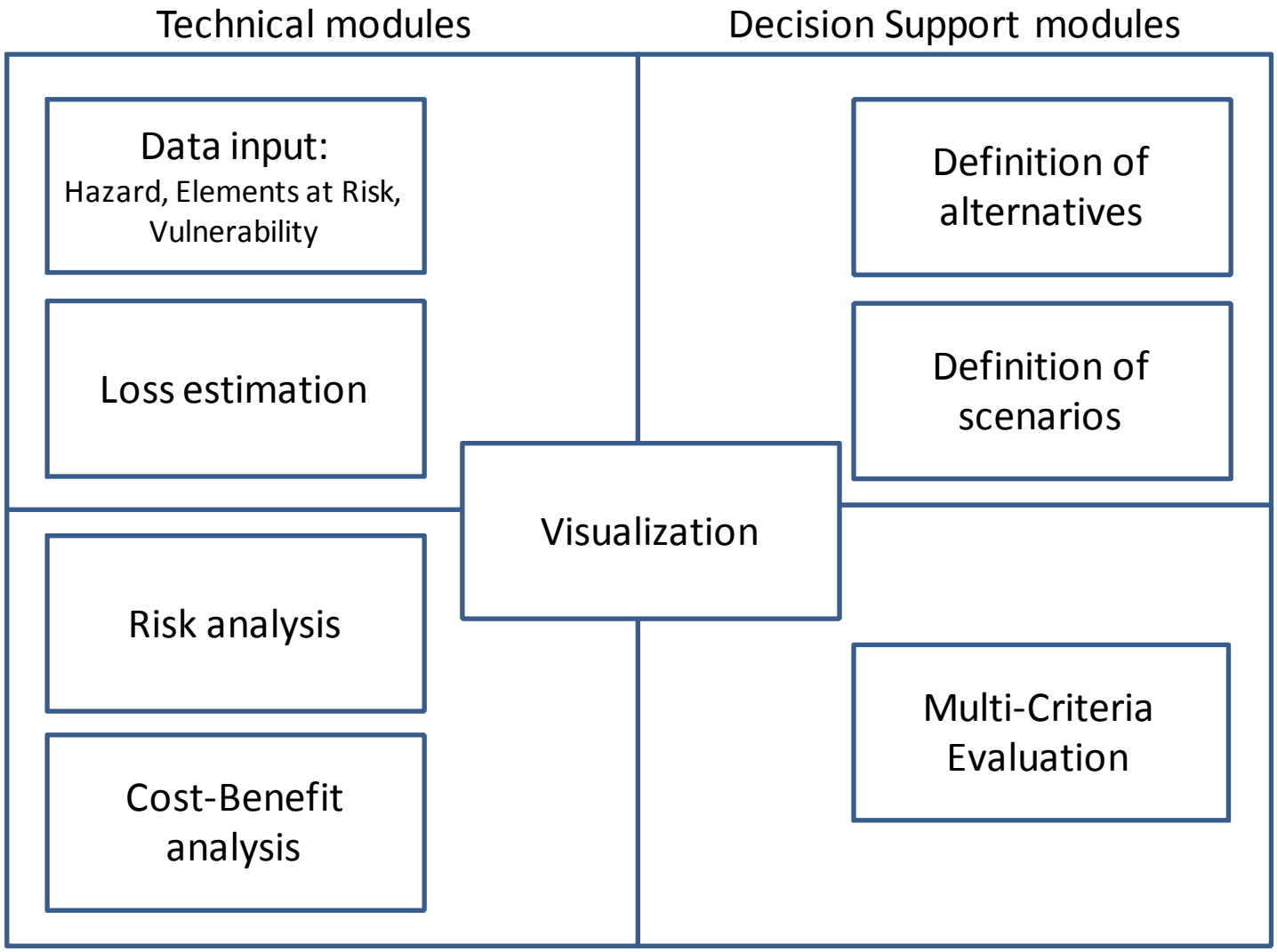
Decision making (development of use cases)

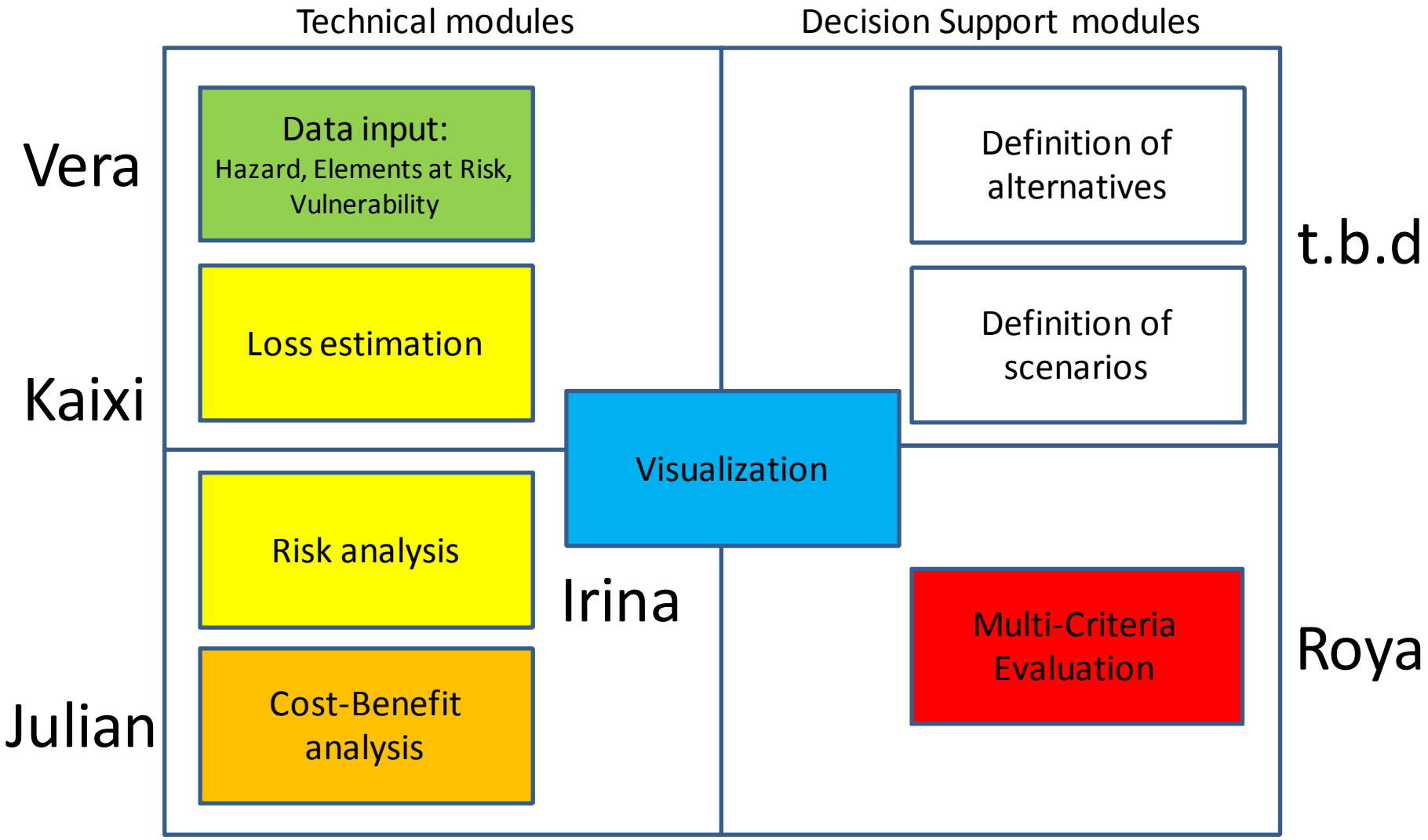
Conceptual design of the SDSS. Different colors refer to different components: green = stakeholders, Blue = organizations responsible for providing hazard maps. Orange = organizations responsible for providing elements at risk maps, Yellow = organizations responsible for providing risk modeling, Violet = Organizations that are working on the analysis of trends related to climate changes, land use change and population change, Red = end-users of the platform that use the information from the others Four different ways in which the SDSS could be used.



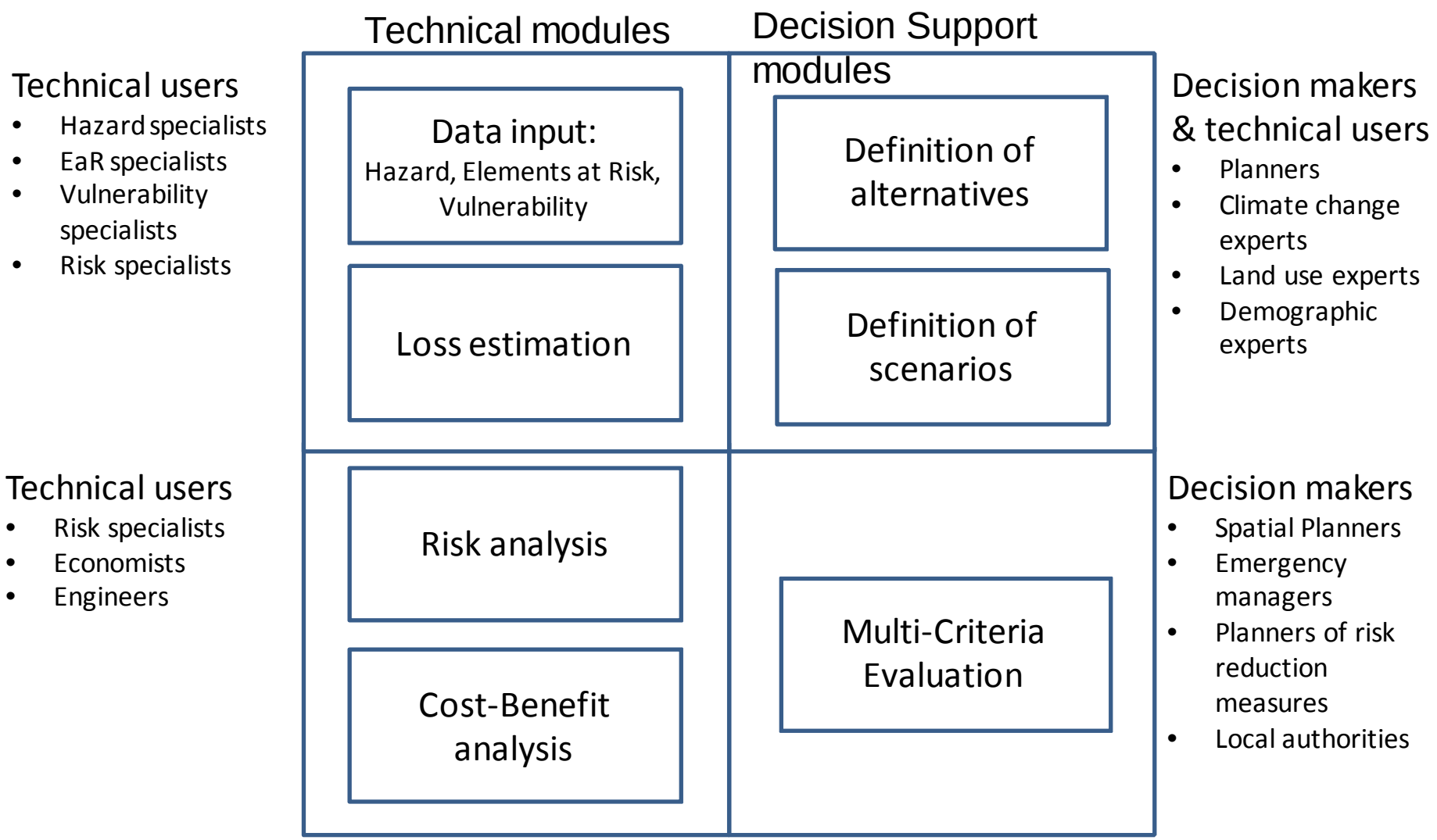
Functionality

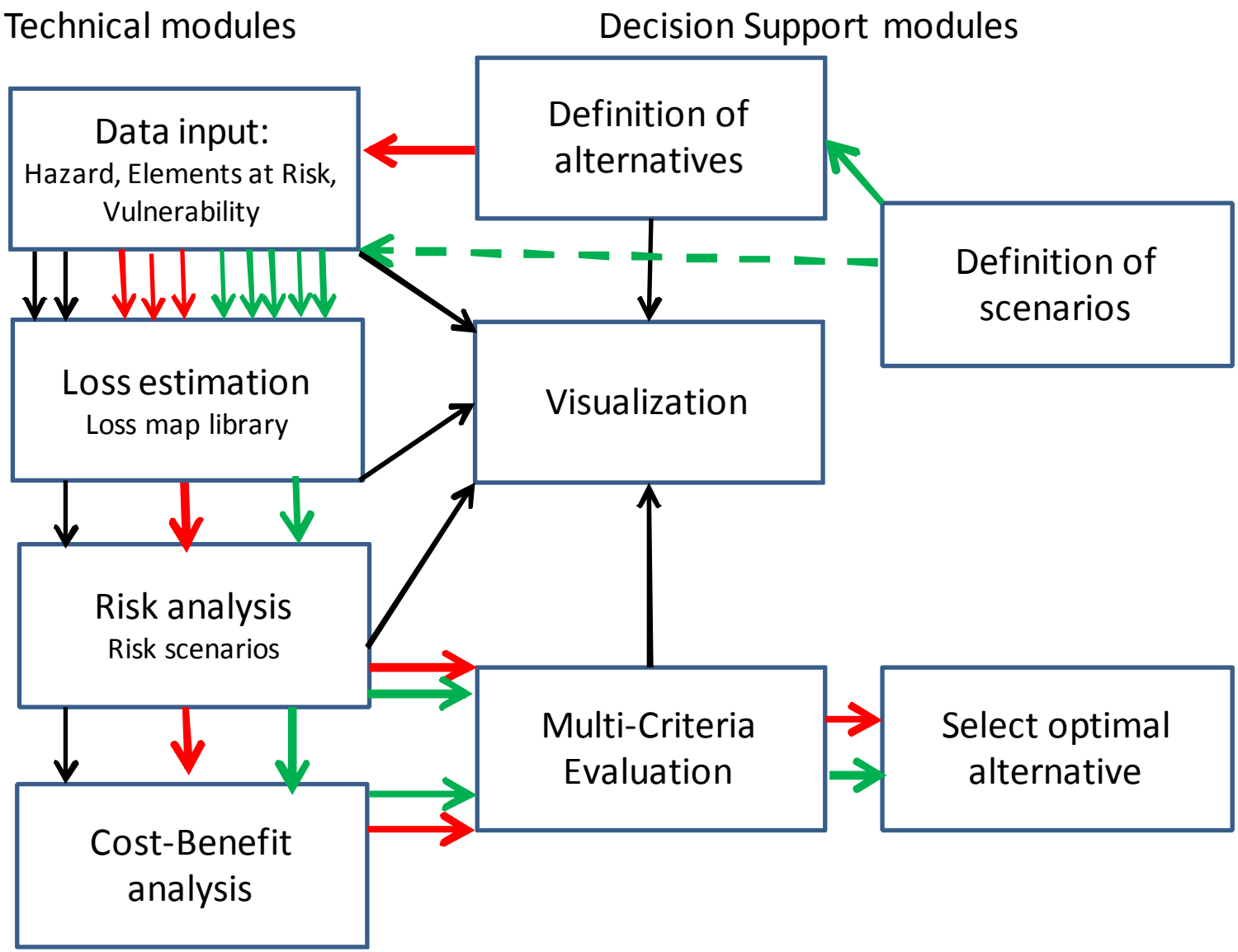
- Open Source
- Web-based
- Generic (in terms of hazards, EaR, scale)
- Users can generate own projects
- Multi-hazard
- Loss estimation (physical & population)
- Risk assessment (by spatial units)
- Analyze current risk
- Analyze risk reduction alternatives
- Analyze future trends in risk


Technical modules
Decision Support modules
Data input:
Hazard, Elements at Risk, Vulnerability
Loss estimation
Risk analysis
Cost-Benefit analysis
Visualization
Definition of alternatives
Definition of scenarios
Multi-Criteria Evaluation

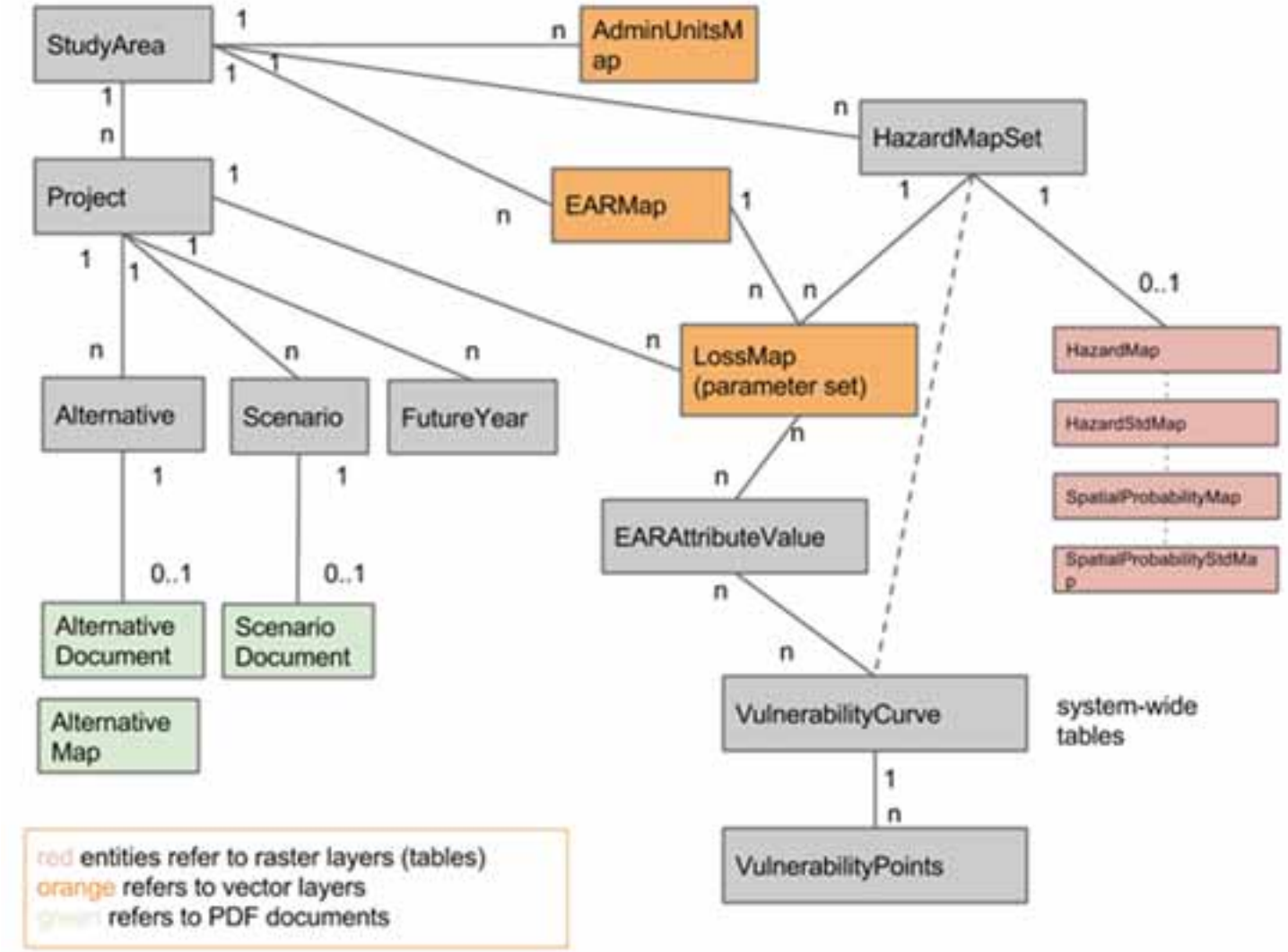

Technical modules
Decision Support modules
Vera
Data input:
Hazard, Elements at Risk, Vulnerability
Definition of alternatives
t.b.d
Kaixi
Loss estimation
Definition of scenarios
Visualization
Risk analysis
Irina
Multi-Criteria Evaluation
Roya
Julian
Cost-Benefit analysis

Users


Technical modules
Decision Support modules
Technical users
• Hazard specialists
• EaR specialists
• Vulnerability specialists
• Risk specialists
Data input:
Hazard, Elements at Risk, Vulnerability
Loss estimation
Definition of alternatives
Definition of scenarios
Decision makers & technical users
• Planners
• Climate change experts
• Land use experts
• Demographic experts
Technical users
• Risk specialists
• Economists
• Engineers
Risk analysis
Cost-Benefit analysis
Multi-Criteria Evaluation
Decision makers
• Spatial Planners
• Emergency managers
• Planners of risk reduction measures
• Local authorities

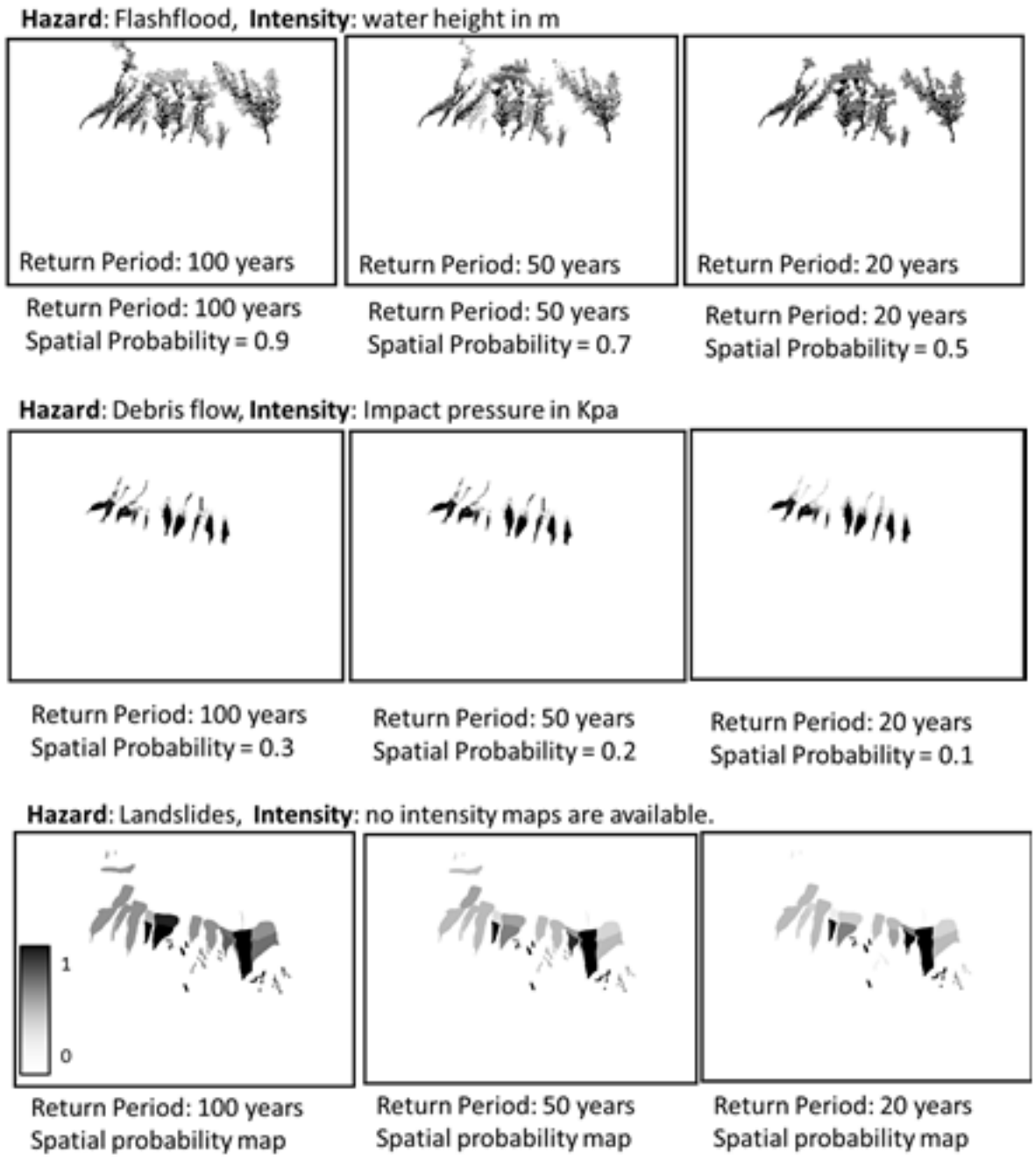

Technical modules
Decision Support modules
Data input:
Hazard, Elements at Risk, Vulnerability
Definition of alternatives
Definition of scenarios
Loss estimation
Loss map library
Visualization
Risk analysis
Risk scenarios
Multi-Criteria Evaluation
Select optimal alternative
Cost-Benefit analysis

Entity-relation diagram



Input data

- The system doesn't analyze hazard.
- Hazard data:
  - Return period
  - Intensity
  - Spatial probability
  - Raster data
- Elements-at-risk:
  - Building footprints
  - Cadastral units
  - Line elements
  - Point elements
  - Type, Value , Population
  - Vector data



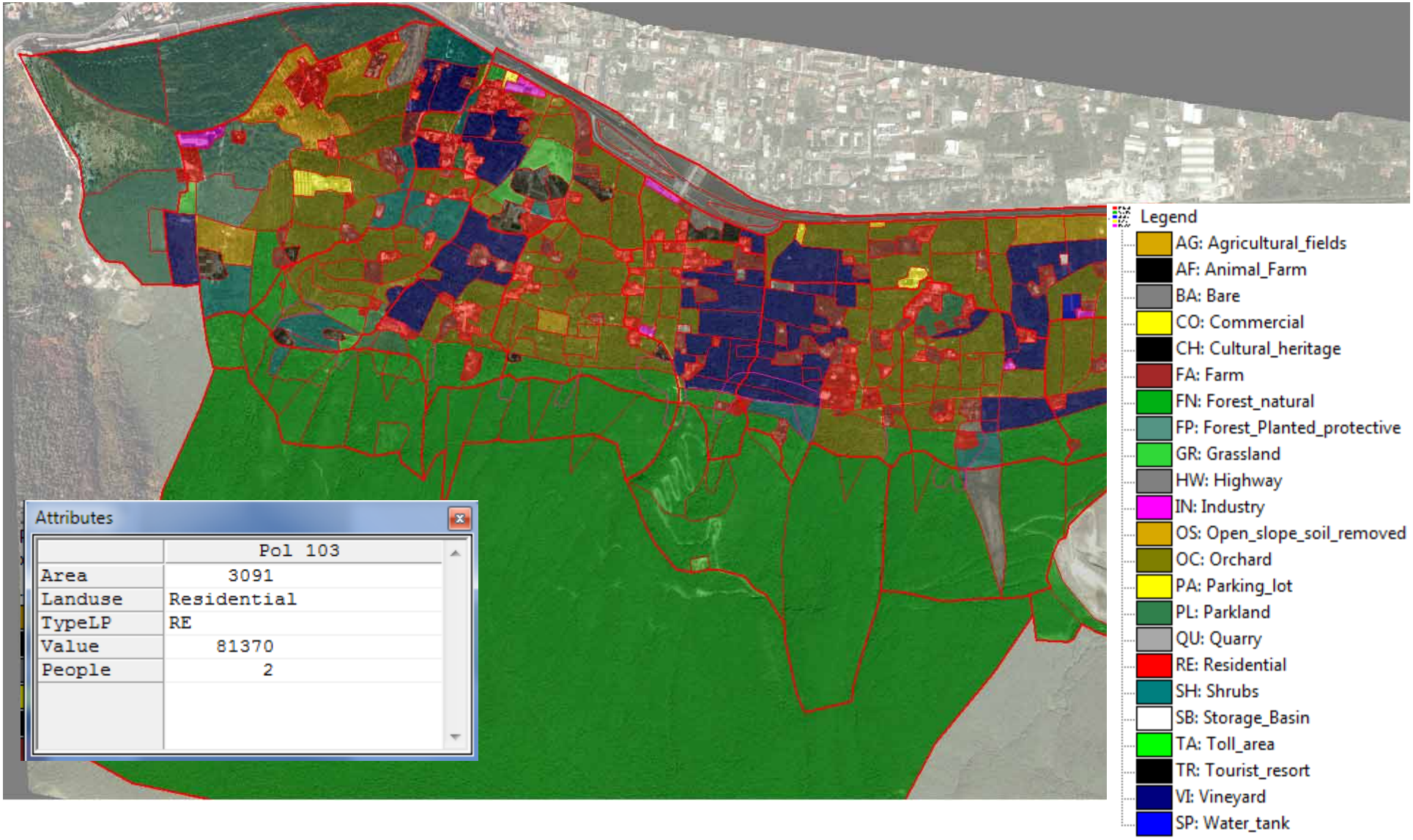
Administrative units

Building footprints

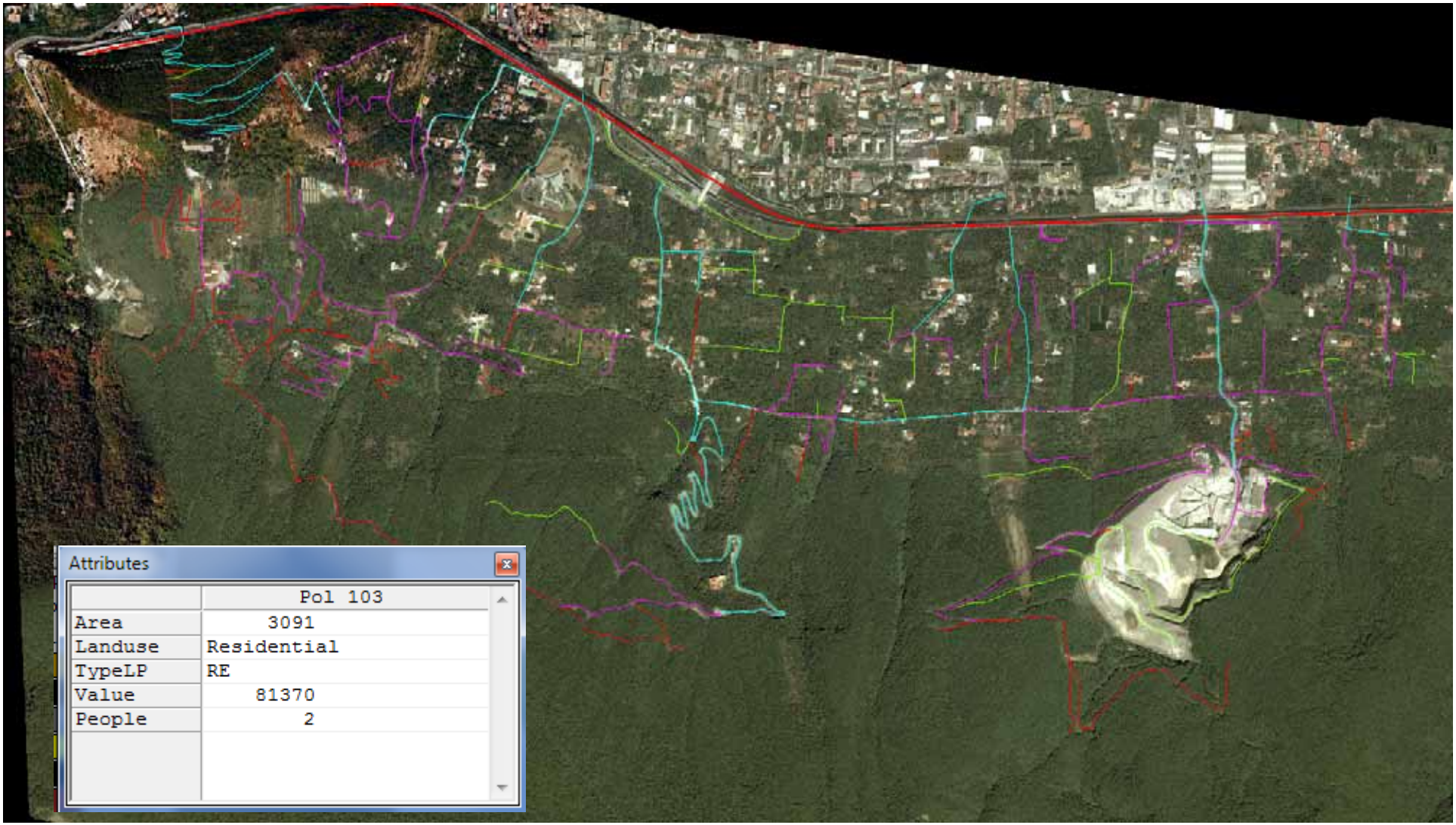
Elements at risk

Map	Column containing type information		Columns with value information	Column containing population information
	Which column	Which units		
Building footprints	Type	MA-1 : masonry 1 floor MA-2 : masonry 2 floors MA-3: masonry 3 floors RC-1 : Reinforced concrete 1 floor RC-2 : reinforced concrete 2 floors RC-3 : reinforced concrete 3 floors WO-1 : wood 1 floor	Value	People (note: these are the maximum number of people in the building)
Land parcels	Type	AF : Agricultural field BA : Bare CH : Cultural heritage CO: commercial FA : Farm FN : Forest Nature FP: Forest Planted GR: Grassland HW: Highway IN : Industry OC : Orchard PA : parking lot PL : Park land QU : quarry RE : Residential SH : Shrubs SP : Seewage Plants TA : Toll Area TR : Tourist Resort VI : Vinyeyard	Value	People (note: these are the maximum number of people in the entire land parcel)

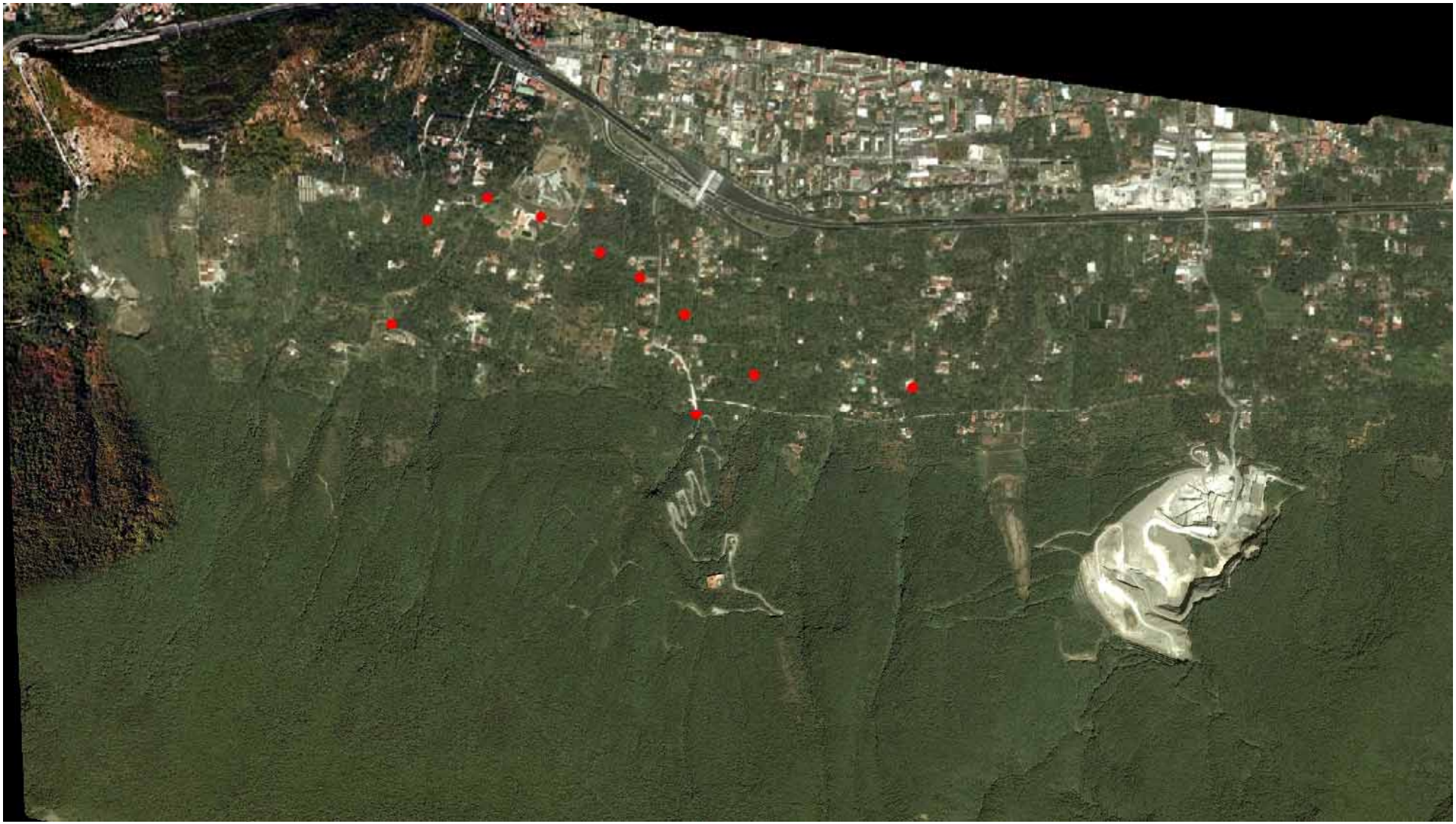
Land parcels



Line elements



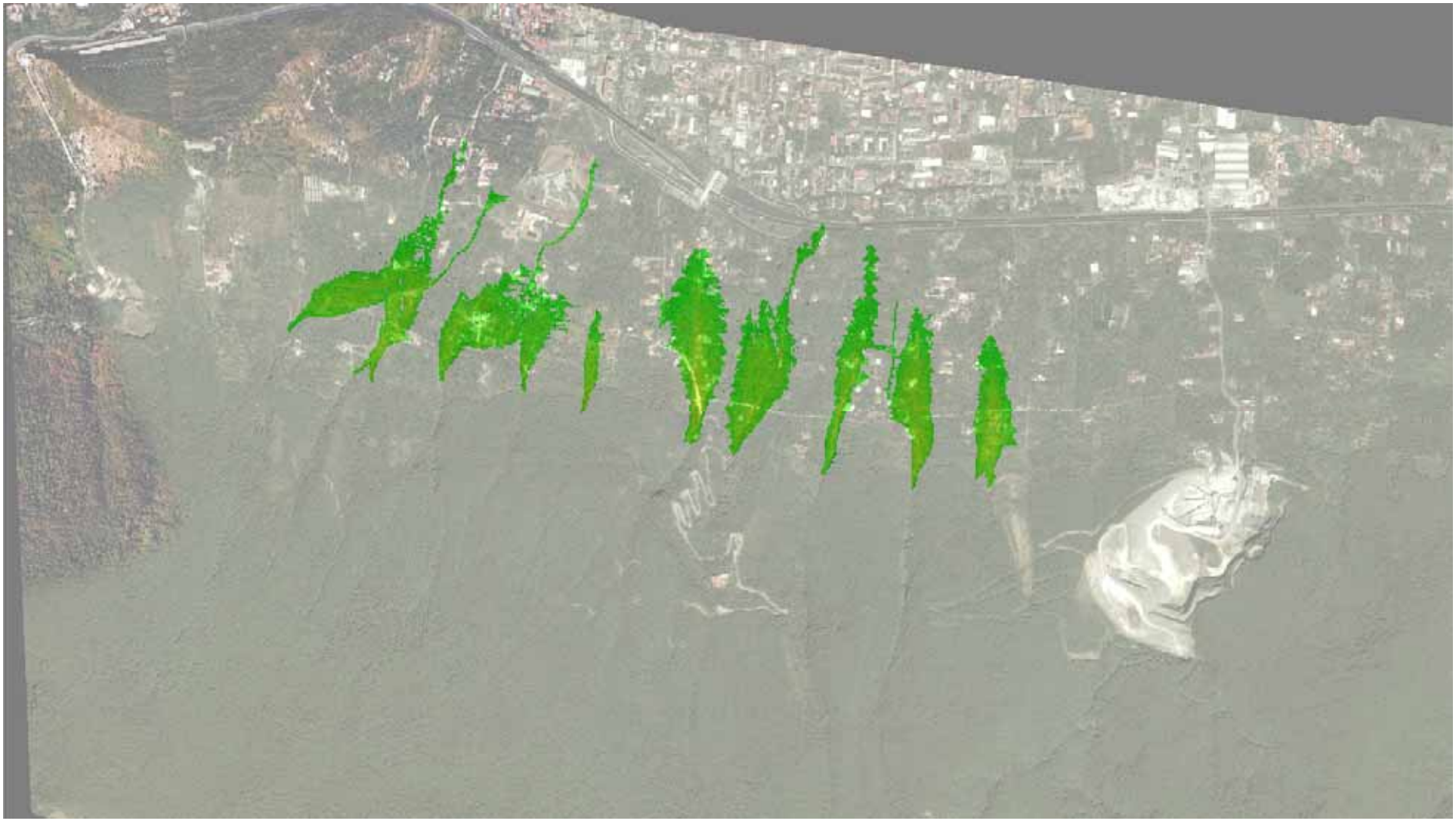
Point features



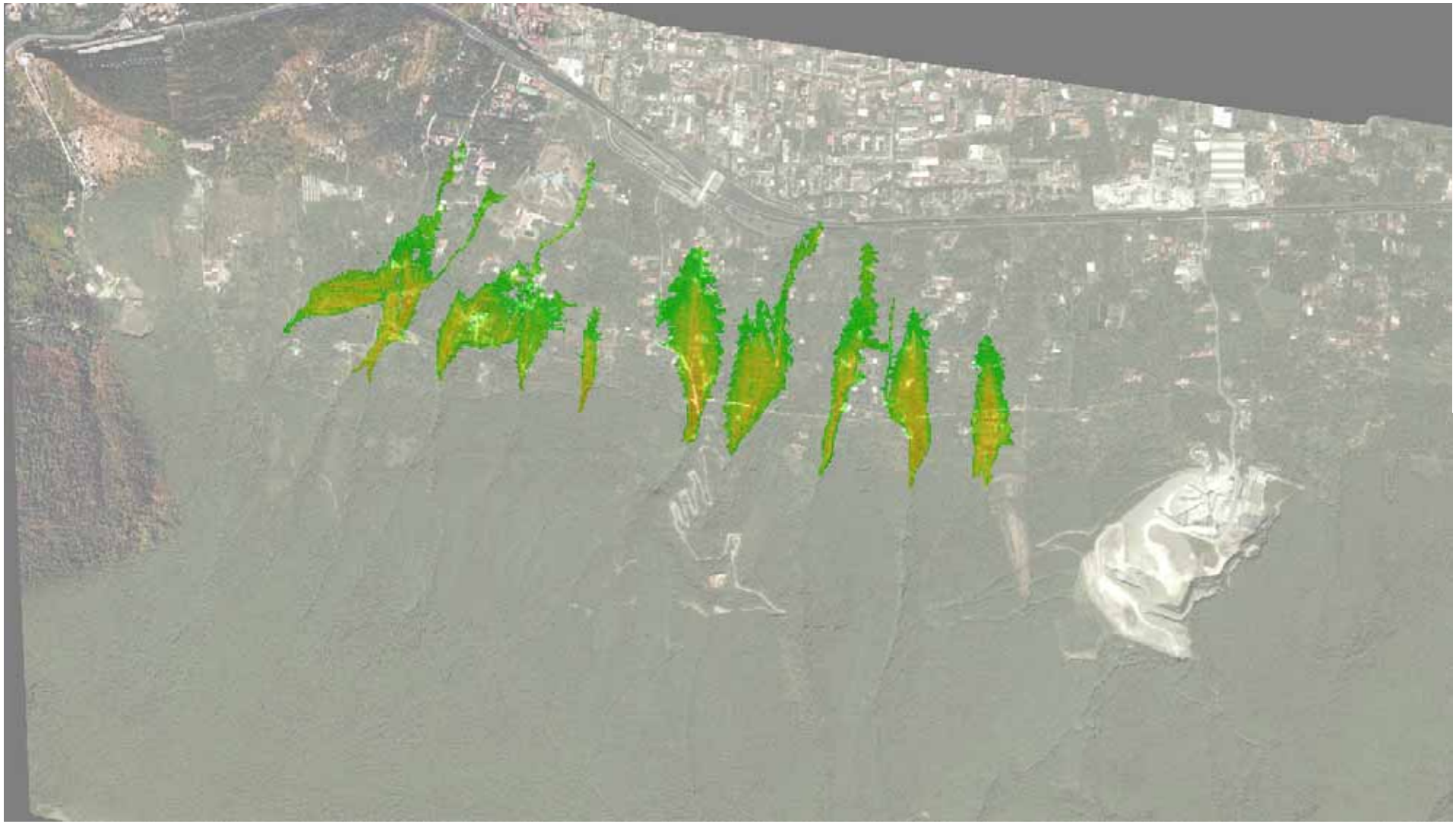
Hazard data demo dataset

Map	Hazard	Return Period	Intensity	Spatial probability	Alternative	Scenario
LS_SP_020_A0	Landslide	20	Not available	yes	0	0
LS_SP_050_A0	Landslide	50	Not available	yes	0	0
LS_SP_100_A0	Landslide	100	Not available	yes	0	0
MF_IP_020_A0	Mudflow	20	Impact pressure	1	0	0
MF_IP_050_A0	Mudflow	50	Impact pressure	1	0	0
MF_IP_100_A0	Mudflow	100	Impact pressure	1	0	0
DF_IP_020_A0	Debrisflow	20	Impact pressure	1	0	0
DF_IP_050_A0	Debrisflow	50	Impact pressure	1	0	0
DF_IP_100_A0	Debrisflow	100	Impact pressure	1	0	0
FL_DE_020_A0	Flood	20	Waterdepth	1	0	0
FL_DE_050_A0	Flood	50	Waterdepth	1	0	0
FL_DE_100_A0	Flood	100	Waterdepth	1	0	0

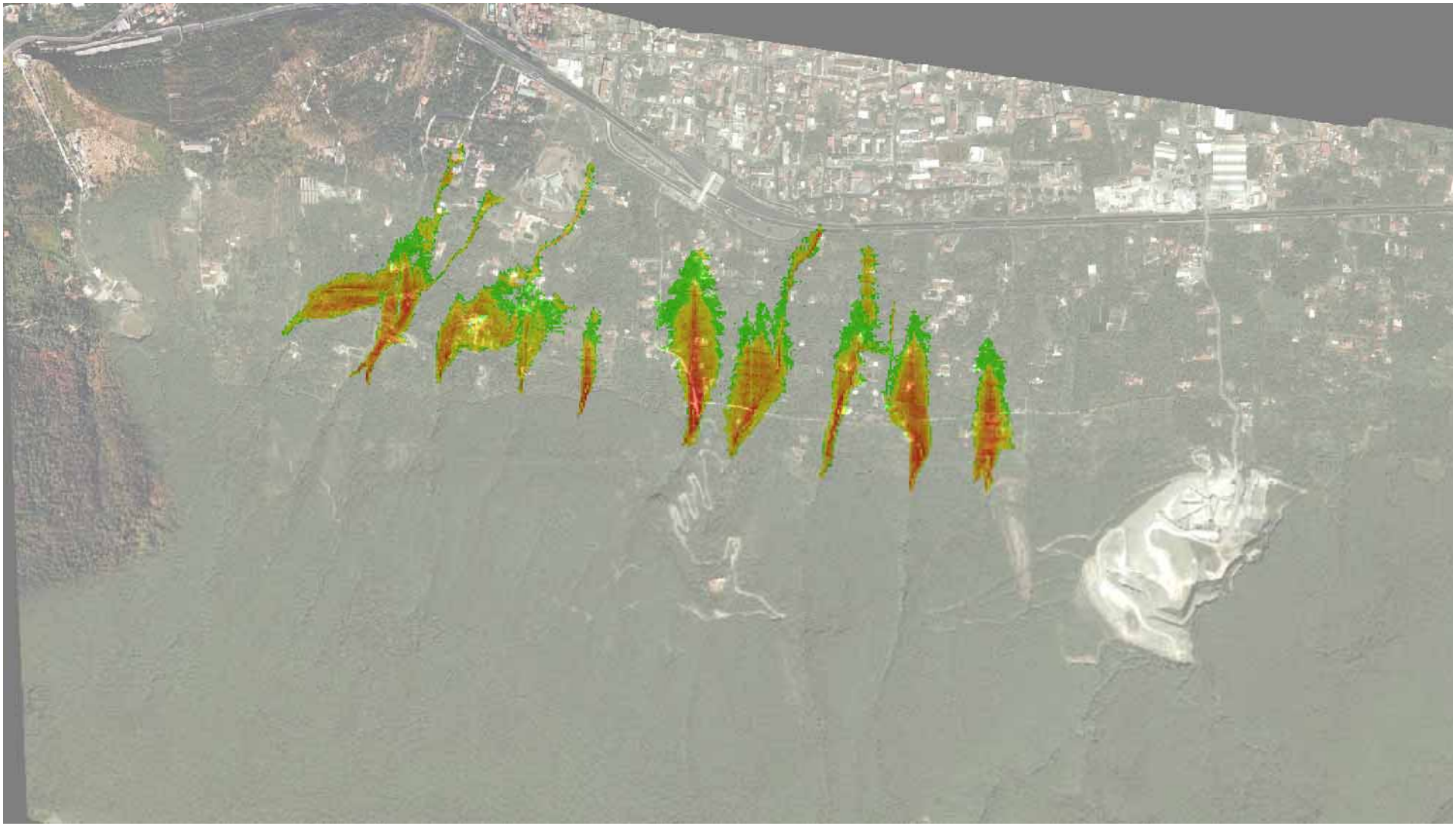
Debrisflow 20 year RP



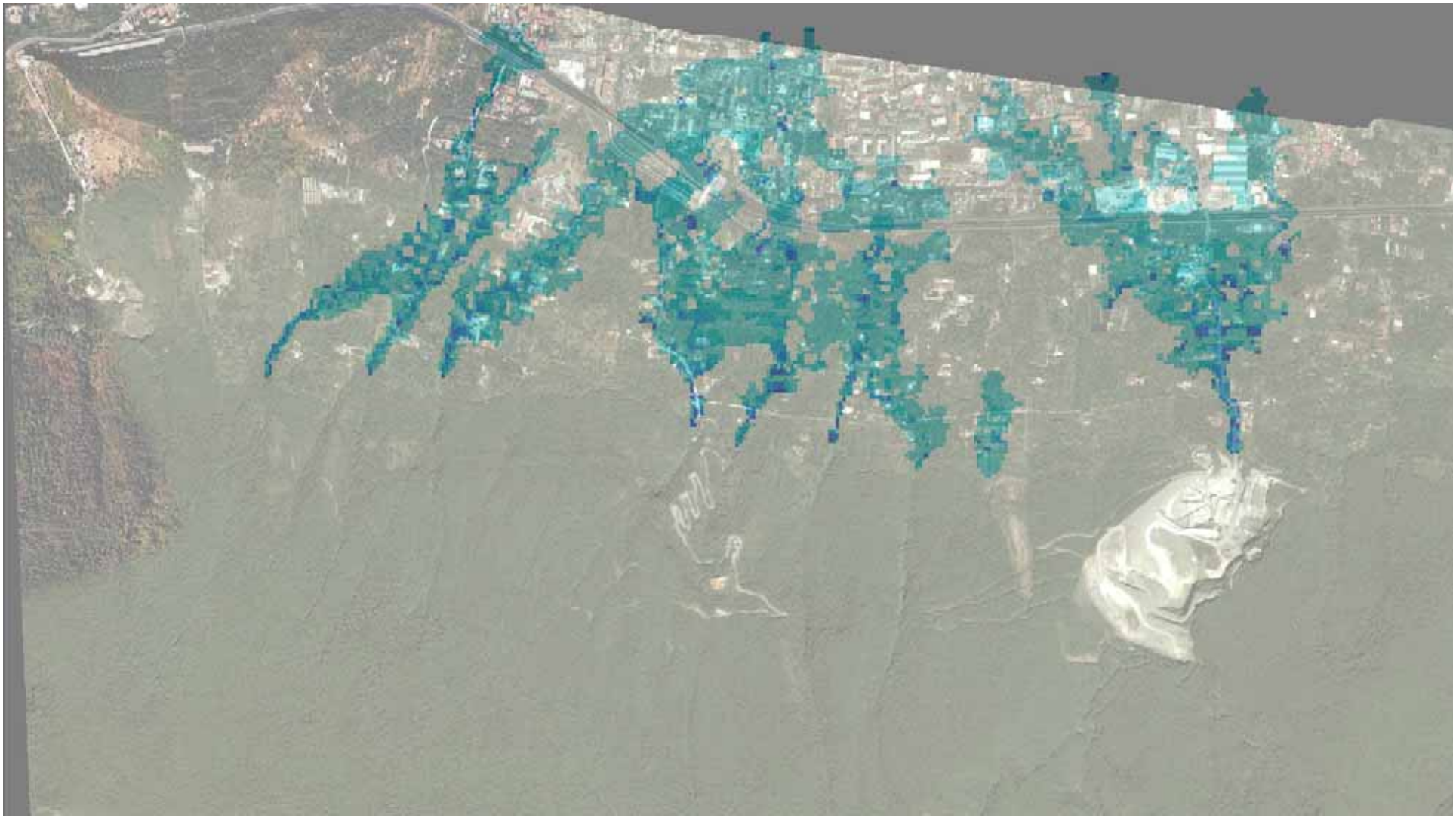
Debrisflow 50 year RP



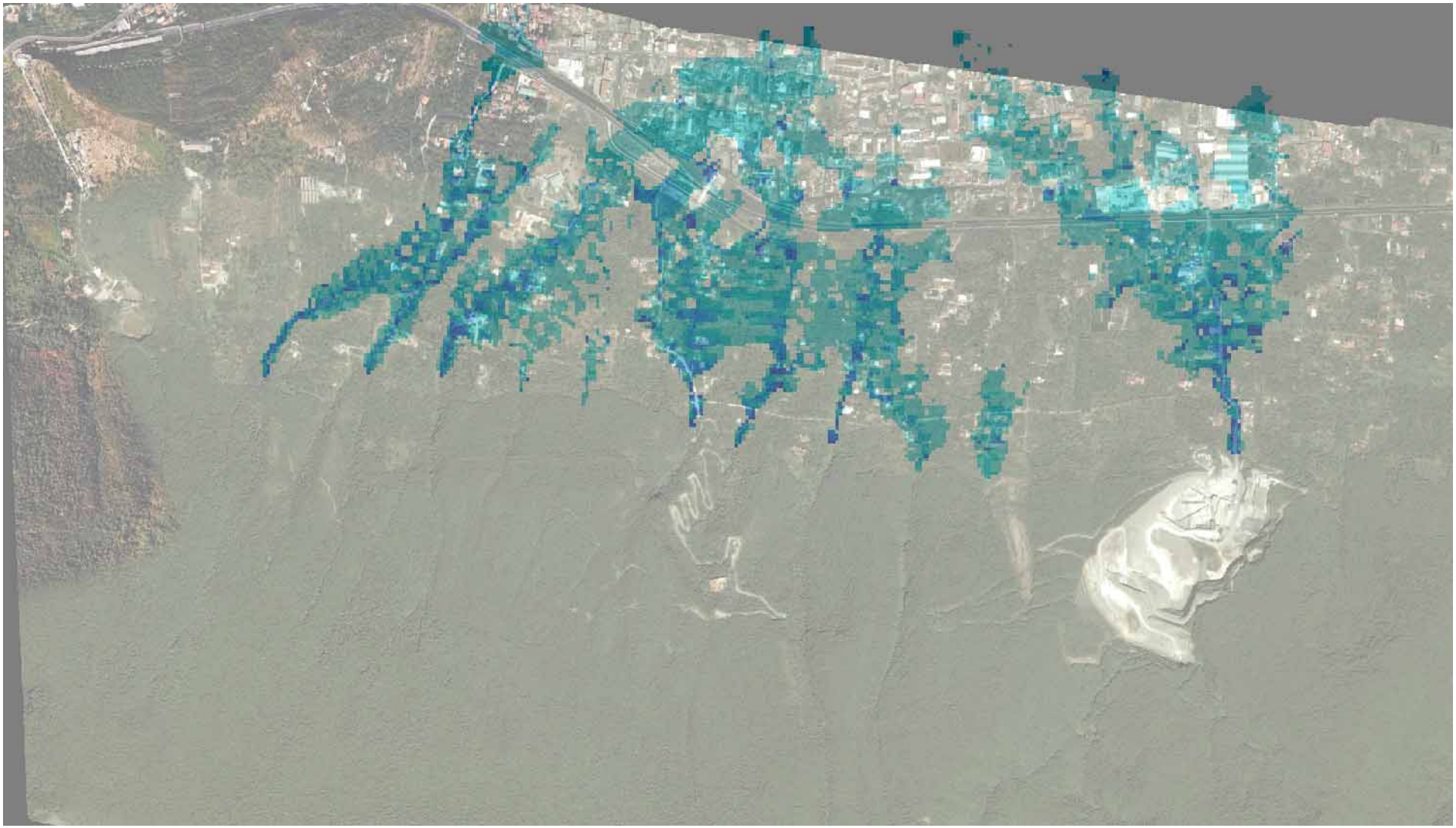
Debrisflow 100 year RP



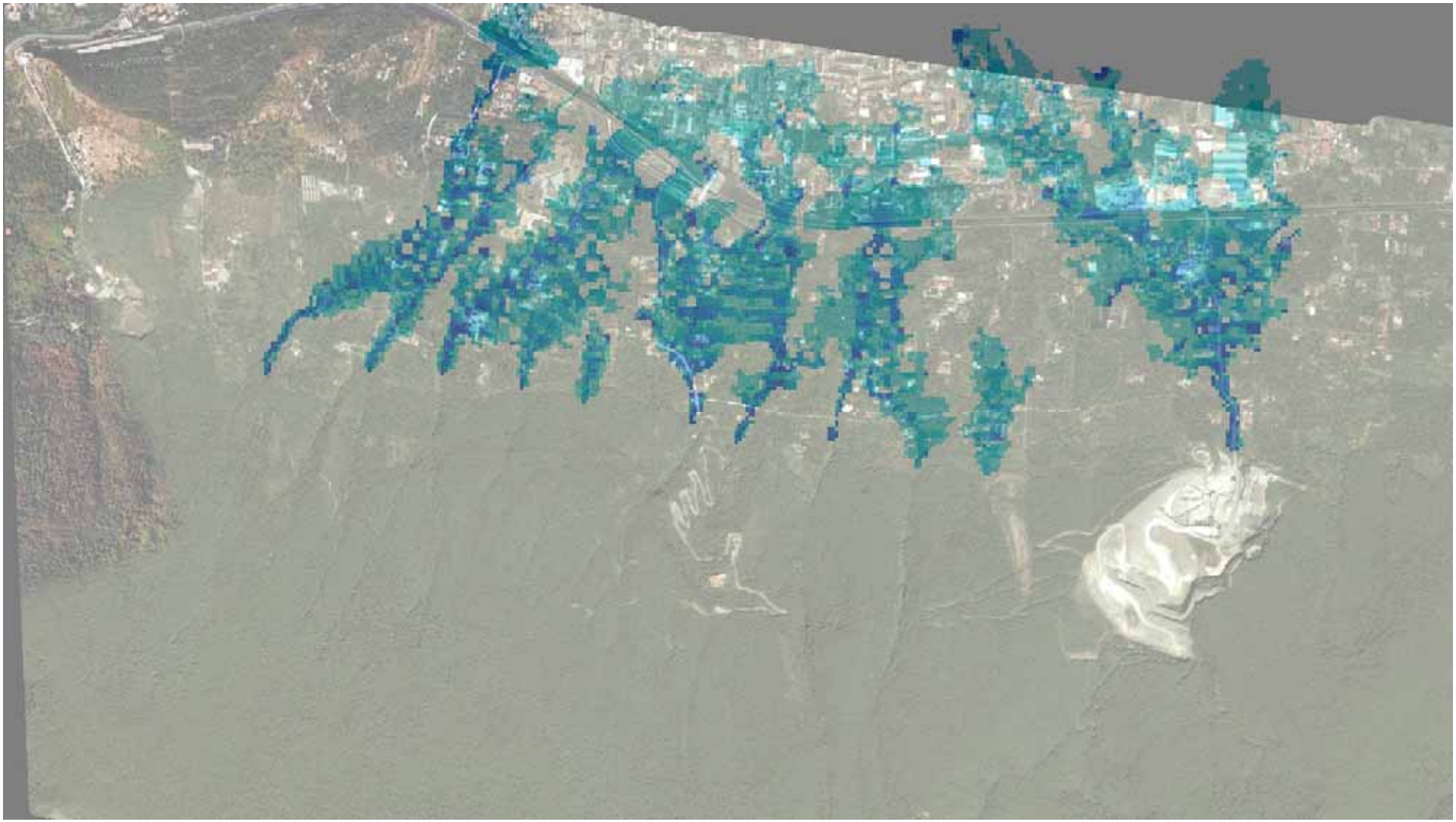
Flood 20 year RP



Flood 50 year RP

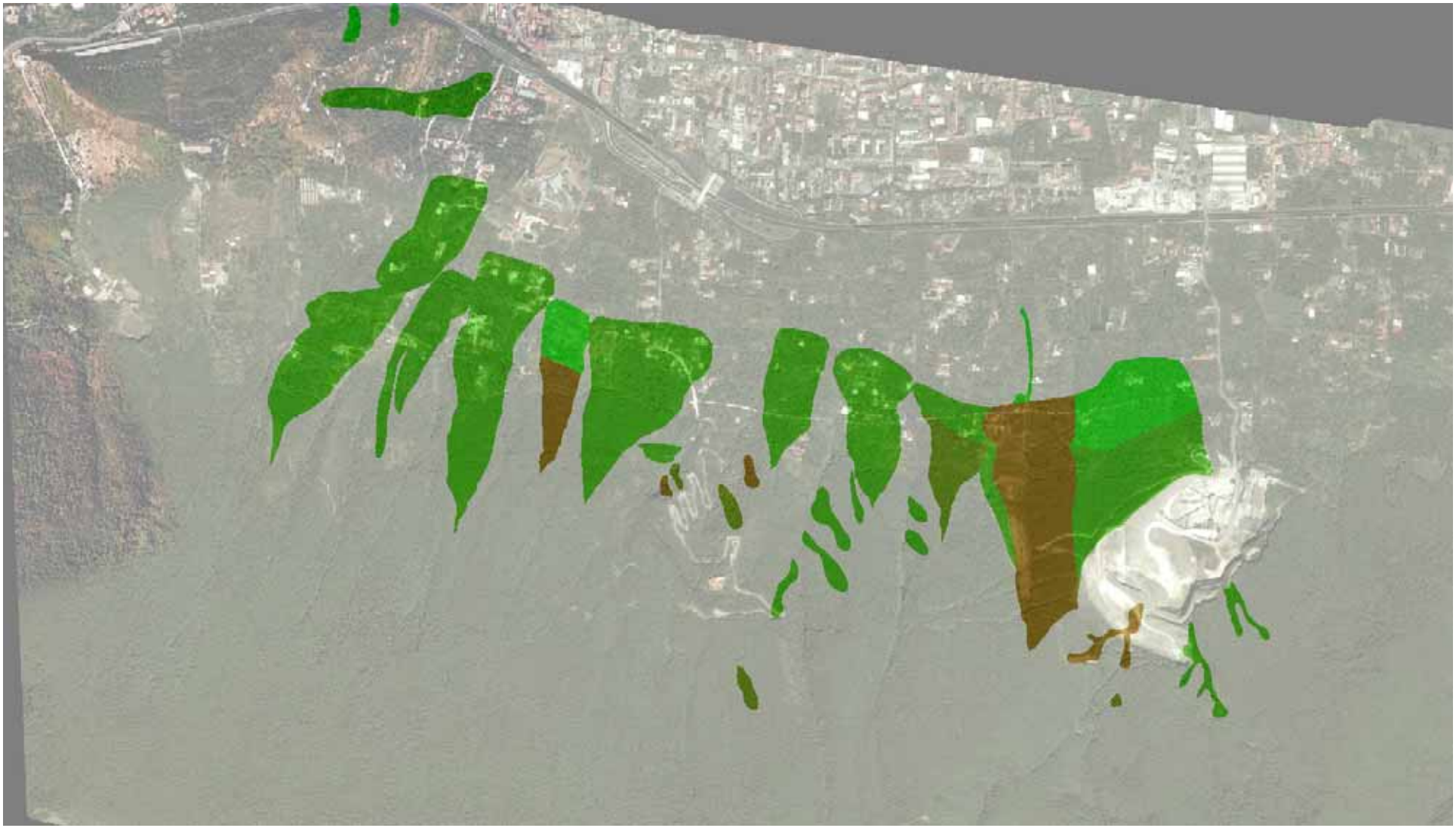


Flood 100 year RP



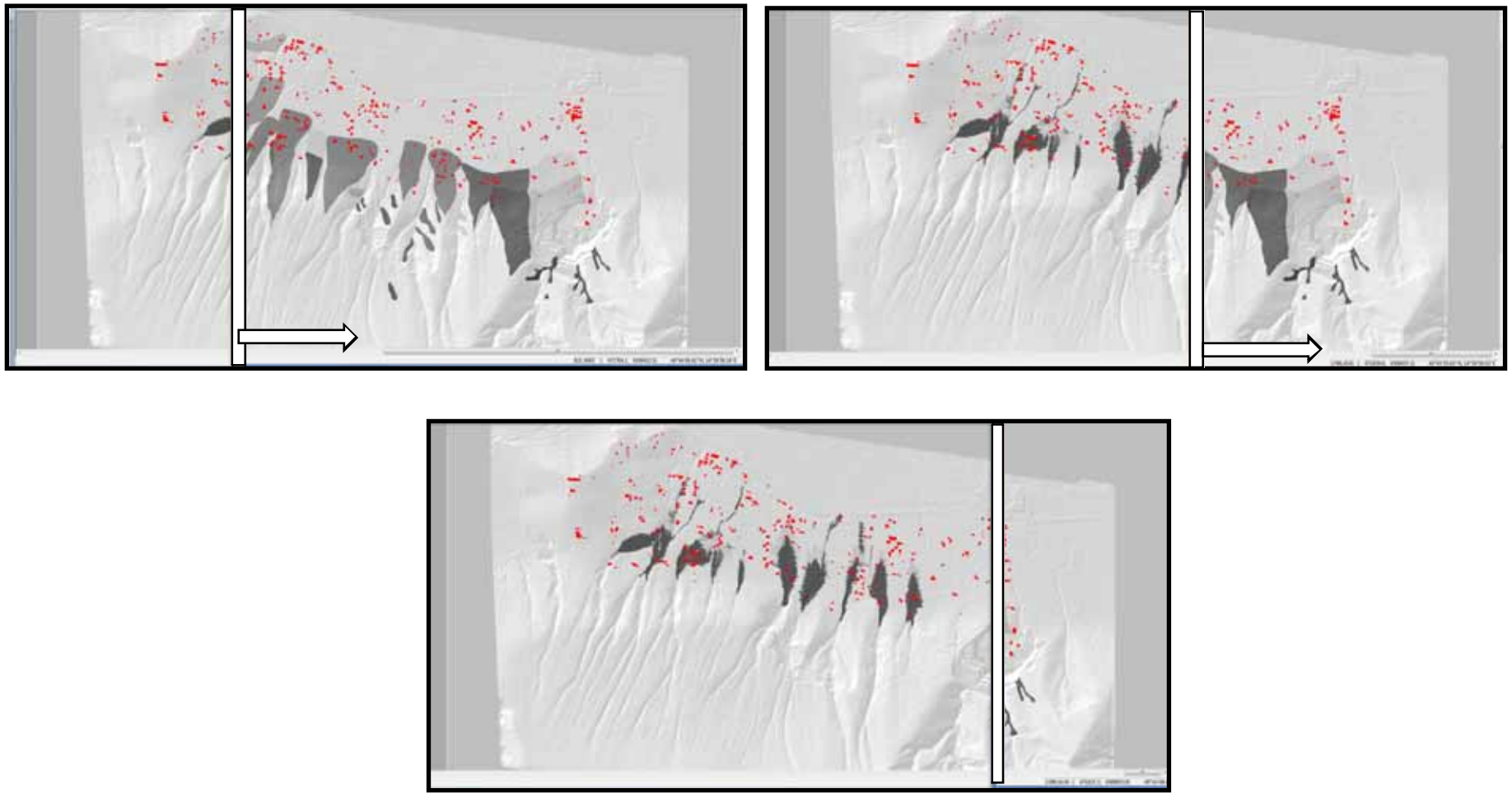
Landslide spatial probability 20 yRP

Landslide spatial probability 50 yRP

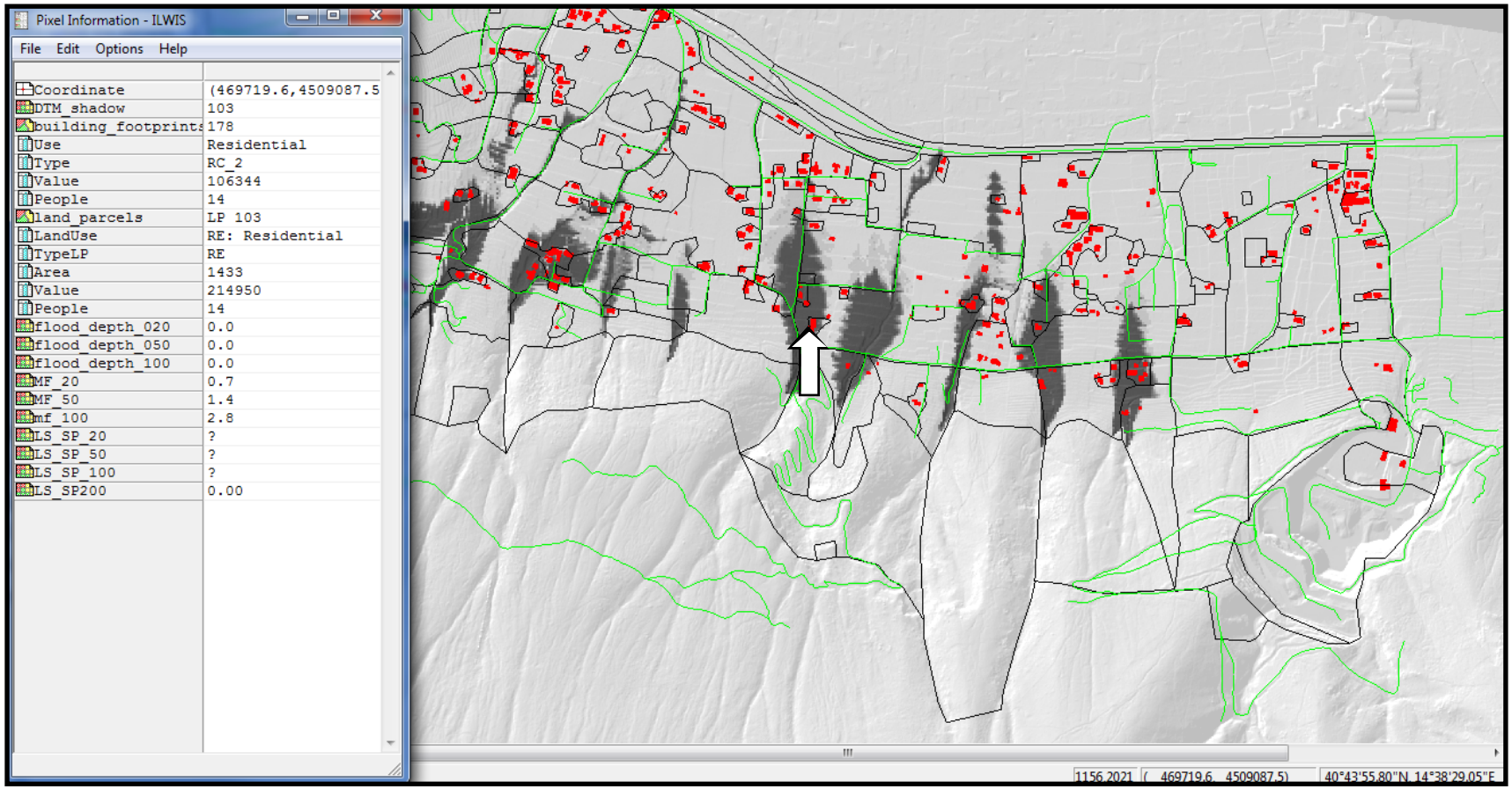


Landslide spatial probability 100 yRP

Visualisation: Image Swiping

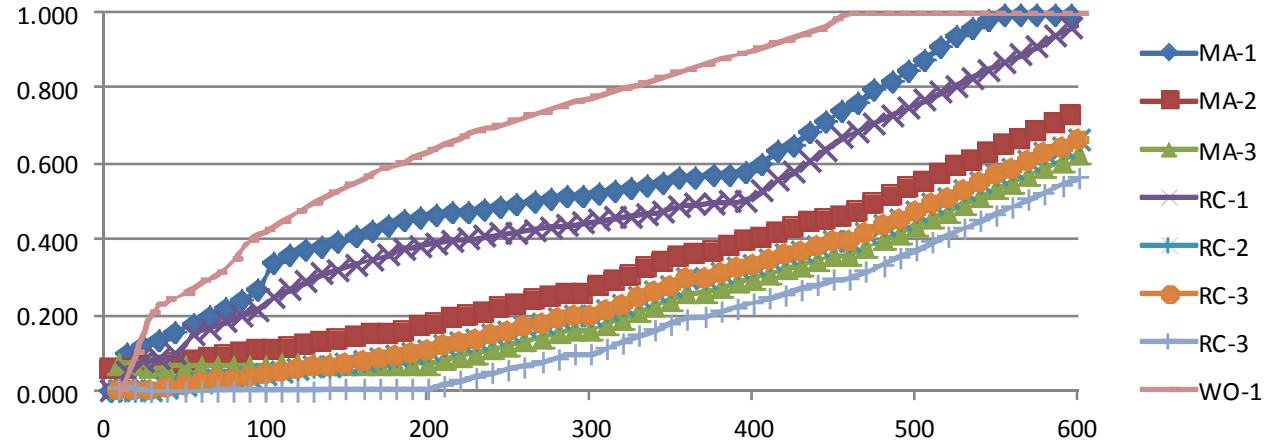


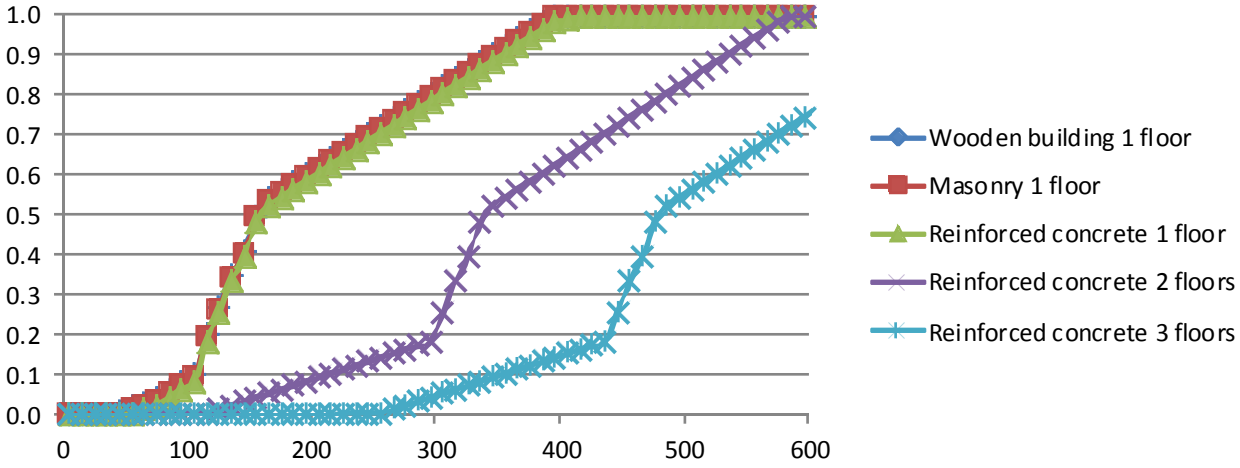
Visualization: Information at cursor position



Vulnerability curves

Hazard type	Intensity type	Buildings	Land parcels
Flood	Waterdepth (in cm)	Physical vulnerability Population vulnerability	Physical vulnerability Population vulnerability
Debris flows and mudflows	Impact pressure (in KPa)	Physical vulnerability Population vulnerability	Physical vulnerability Population vulnerability
Landslides	No intensity	Single vulnerability value per type	Single vulnerability value per type

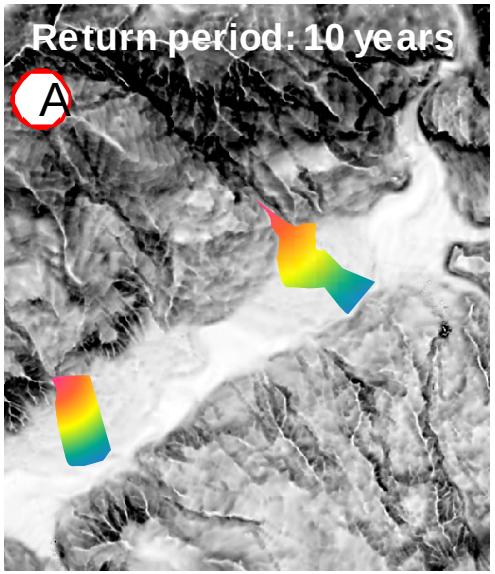


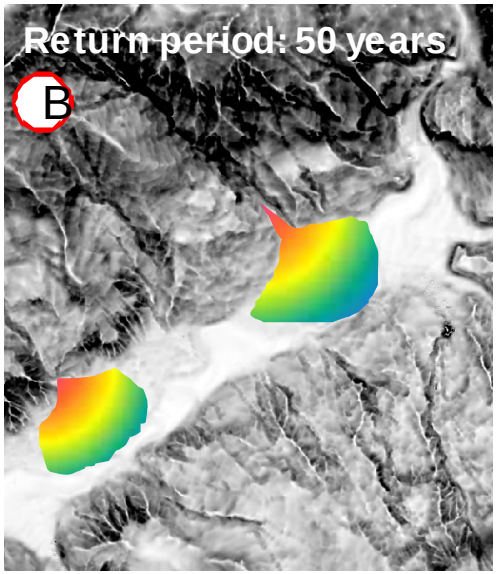


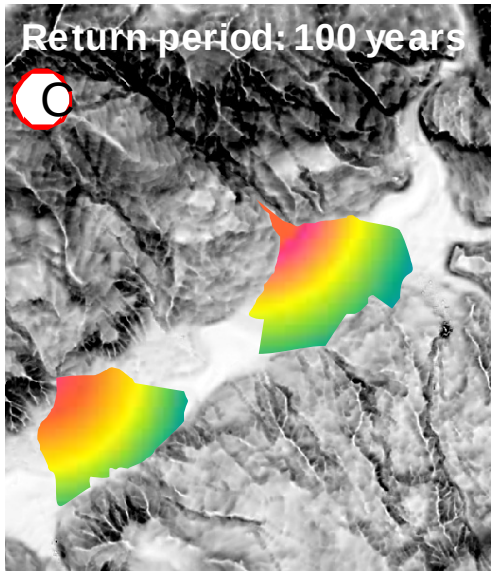
Loss estimation

- For the relevant combinations of hazard intensity and element-at-risk.
- Spatial overlay: maximum intensity and/or spatial probability per EaR unit. Subdivision of landparcels and line elements.
- Use Code Type to link it with specific vulnerability table for the hazard type & intensity type.
- Retrieve vulnerability value for EaR
- Loss = V * A * Ps
- Maps per EaR unit.

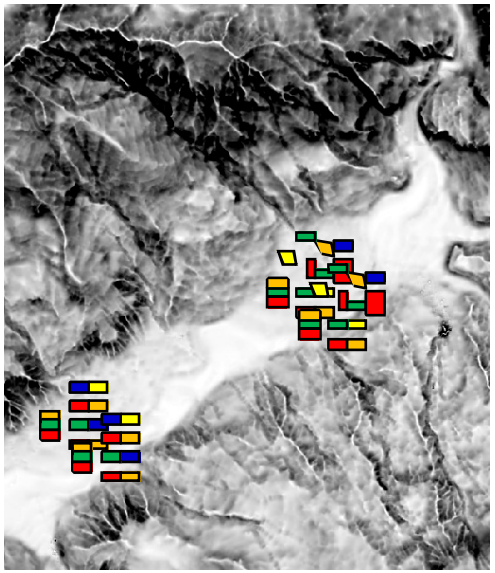
Hazard scenarios



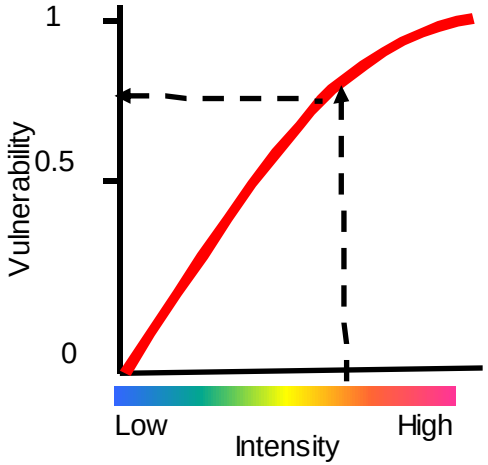


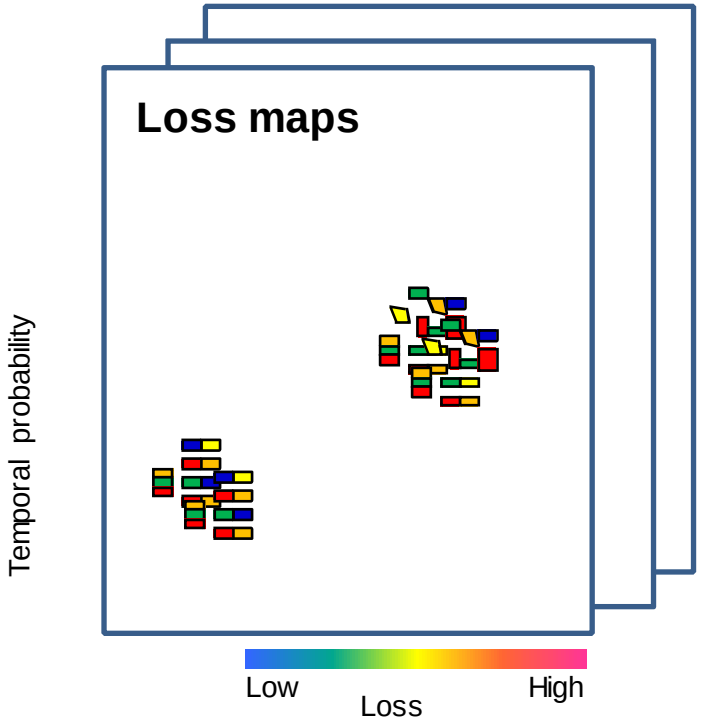


Elements-at-risk



Vulnerability



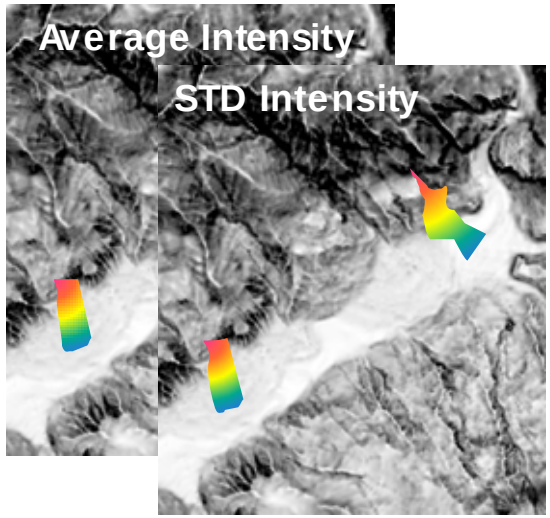


Risk Assessment

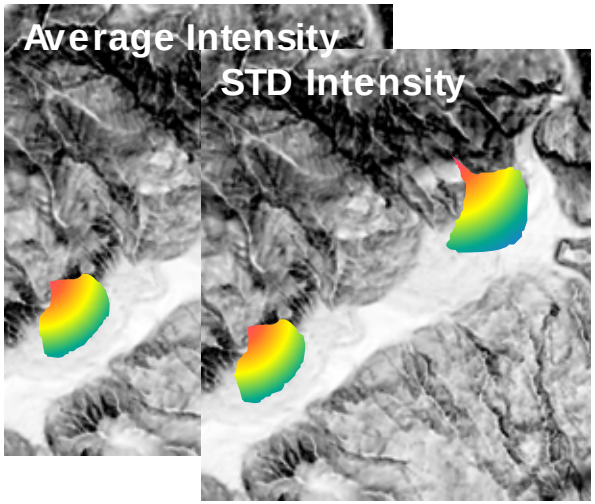
- Integration of loss maps with different scenarios
- Requires administrative unit map
- Addition of losses for elements-at-risk

Hazard scenarios

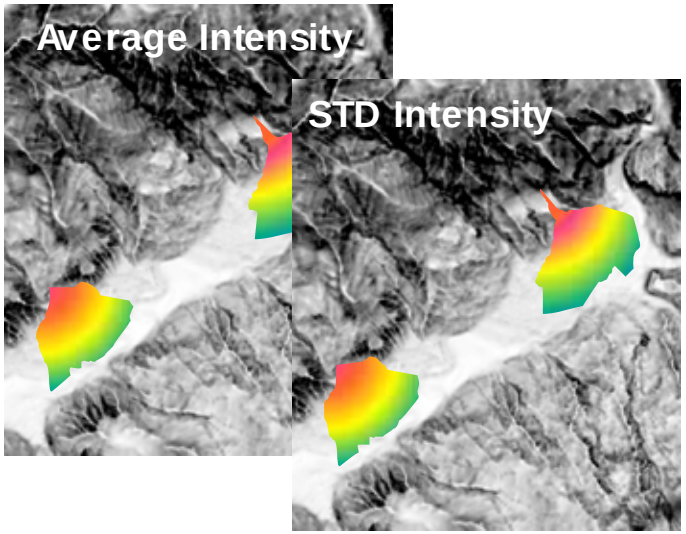
Return period: 10 (8-12)



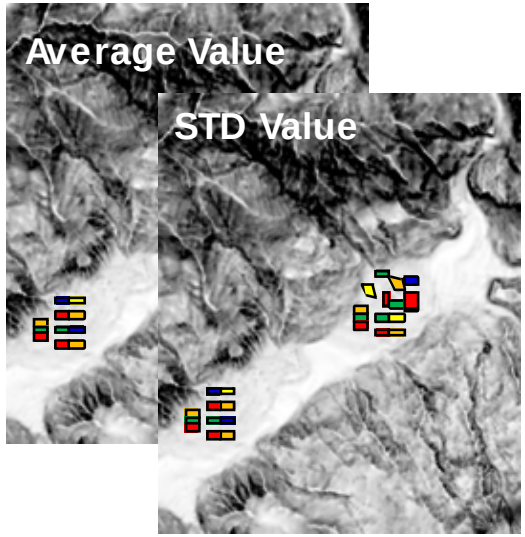
Return period: 50 (40-55)



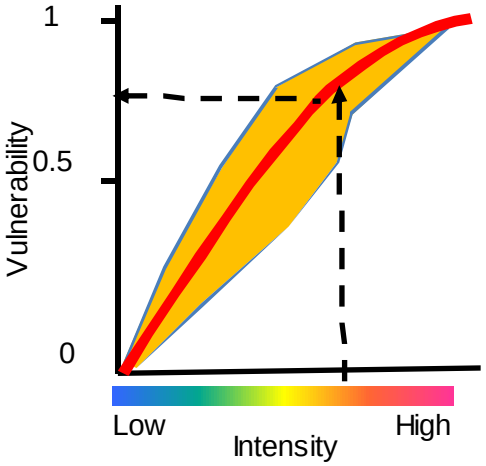
Return period: 100 (89-120)



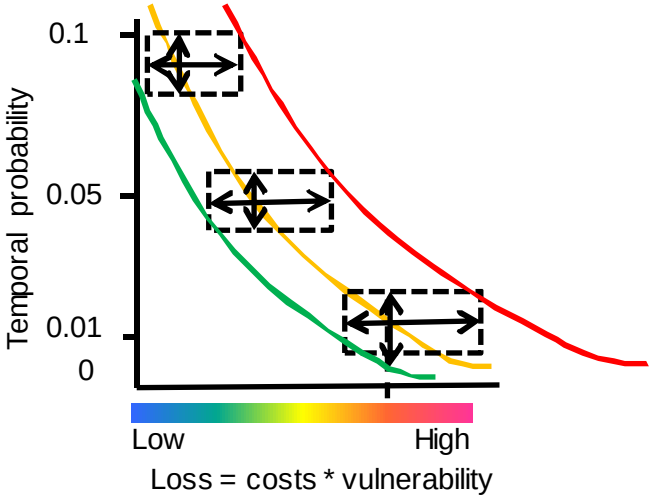
Elements-at-risk



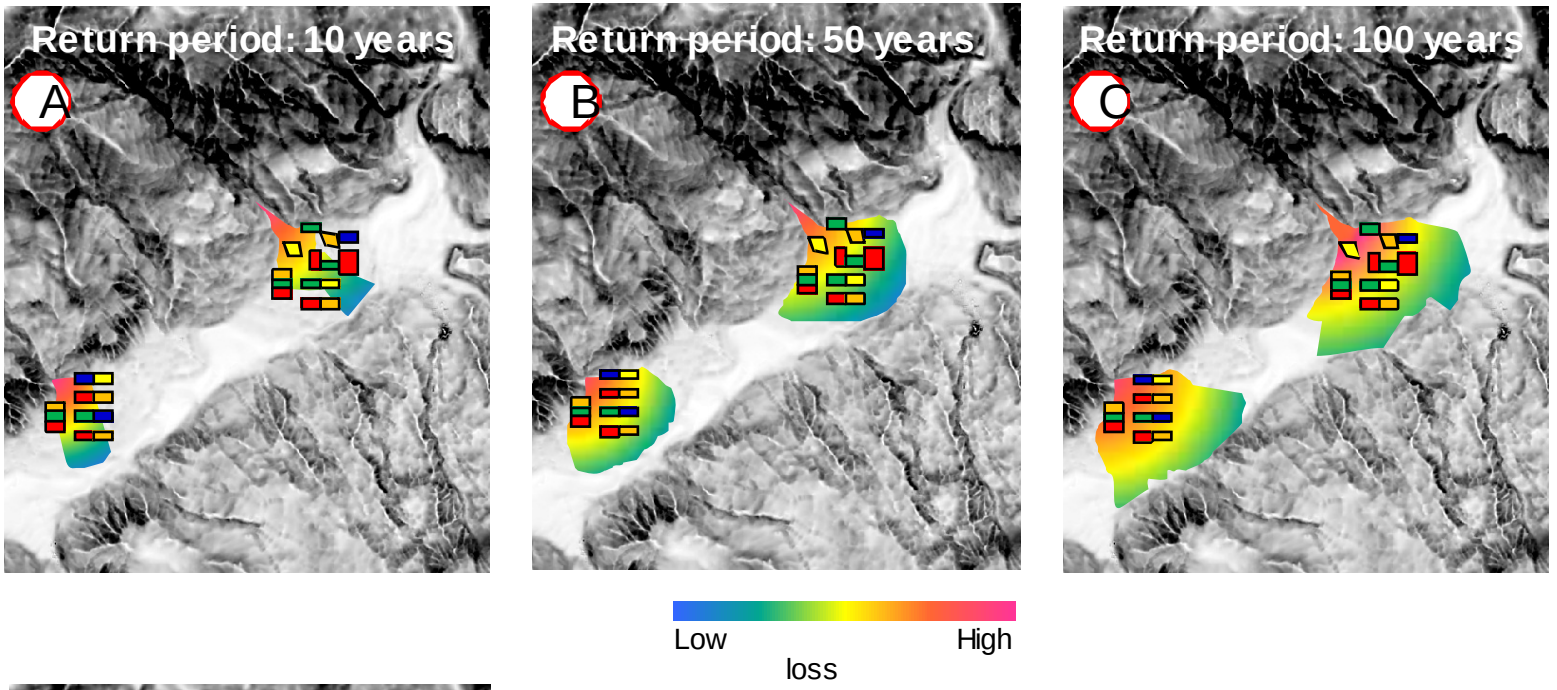
Vulnerability with uncertainty

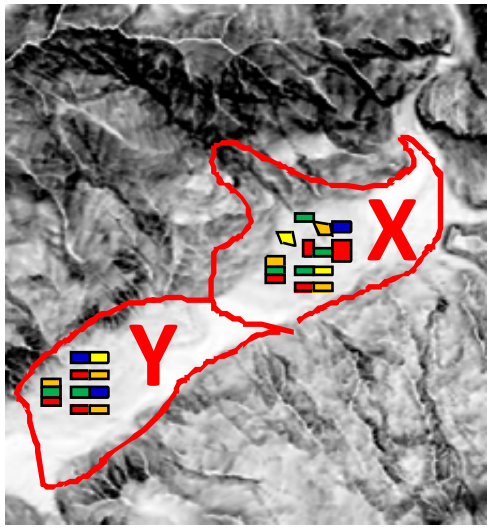


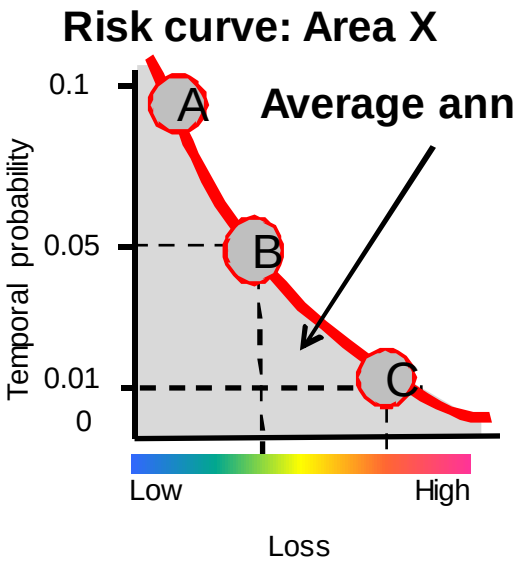
Risk curves: minimum, avergae and maximum

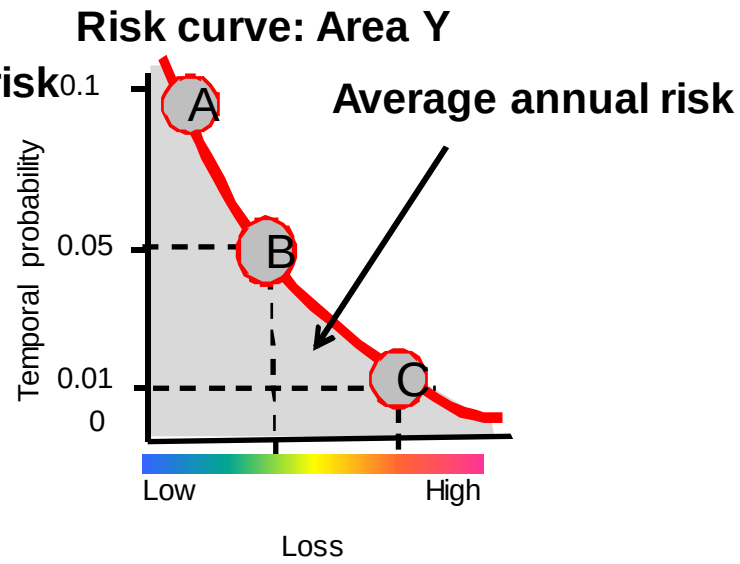


Loss maps


Return period: 10 years
A
Return period: 50 years
B
Return period: 100 years
C
Low
High
loss

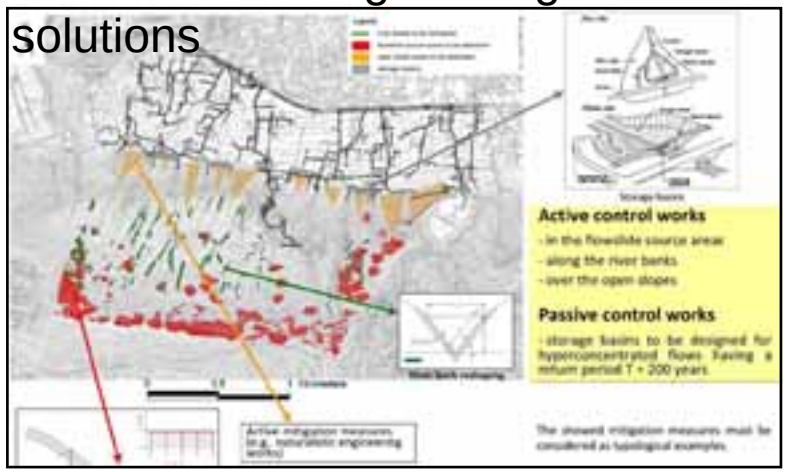

X
Y


Risk curve: Area X
Average annual risk
0.1
0.05
0.01
0
A
B
C
Temporal probability
Low
High
Loss

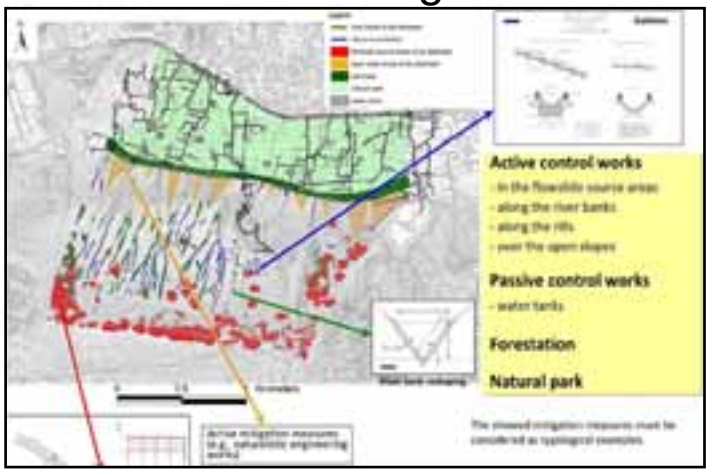

Risk curve: Area Y
Average annual risk
0.1
0.05
0.01
0
A
B
C
Temporal probability
Low
High
Loss

Risk reduction alternatives

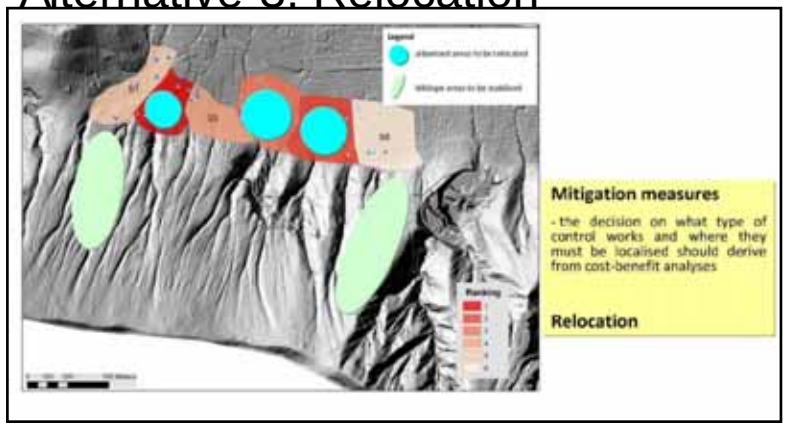
Alternative 1: Engineering solutions



Alternative 2: Ecological solutions



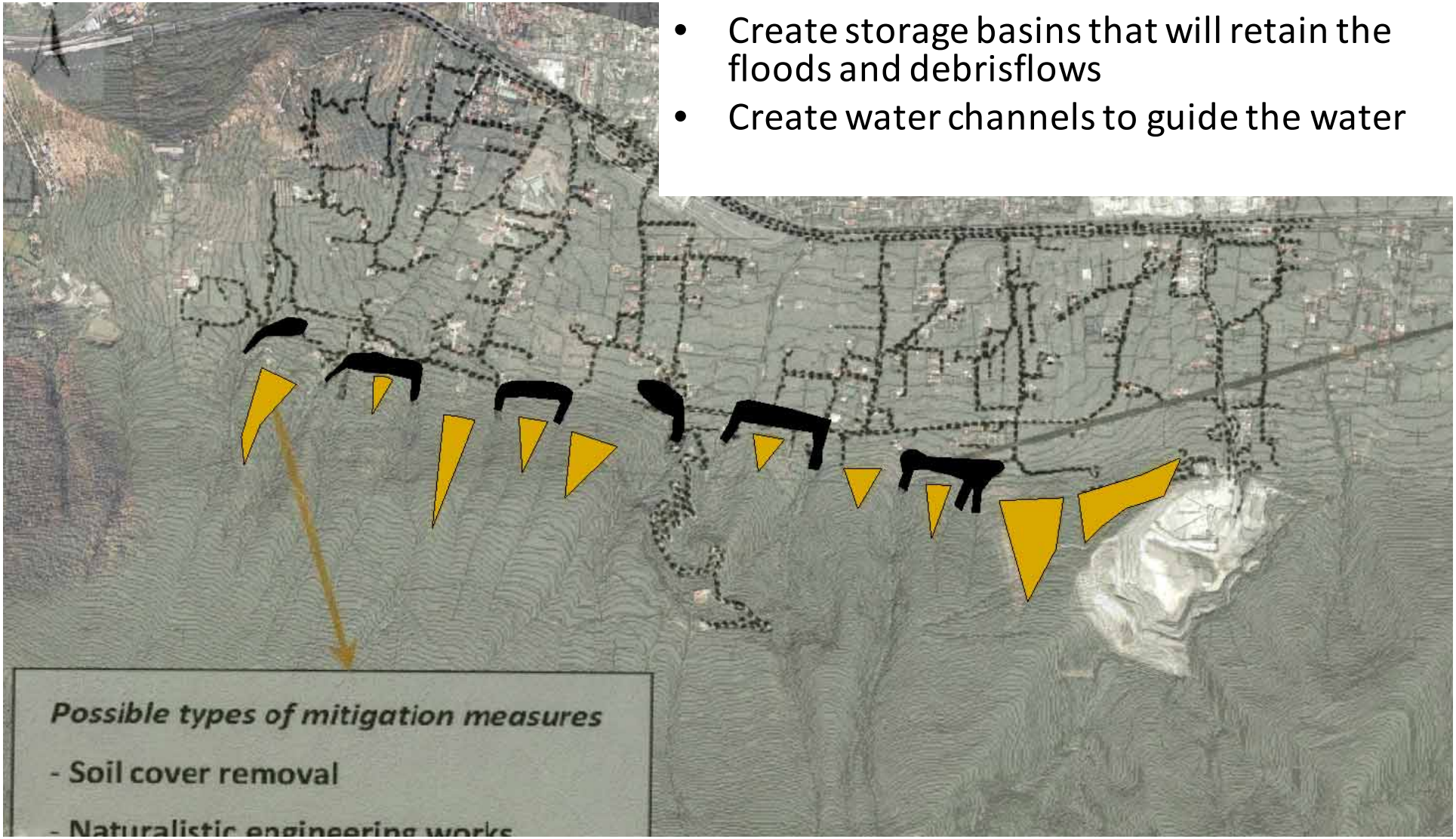
Alternative 3: Relocation



- The system allows users to define sets of risk reduction measures
  - Structural
  - Non-structural
- Re-analyze the risk
- Calculate the cost-benefit
- Select using Spatial Multi-Criteria Evaluation.

Alternative 1

- This alternative aims at constructing active and passive control works using engineering measures:
- Take out the soil in the landslide prone areas
- Create storage basins that will retain the floods and debrisflows
- Create water channels to guide the water



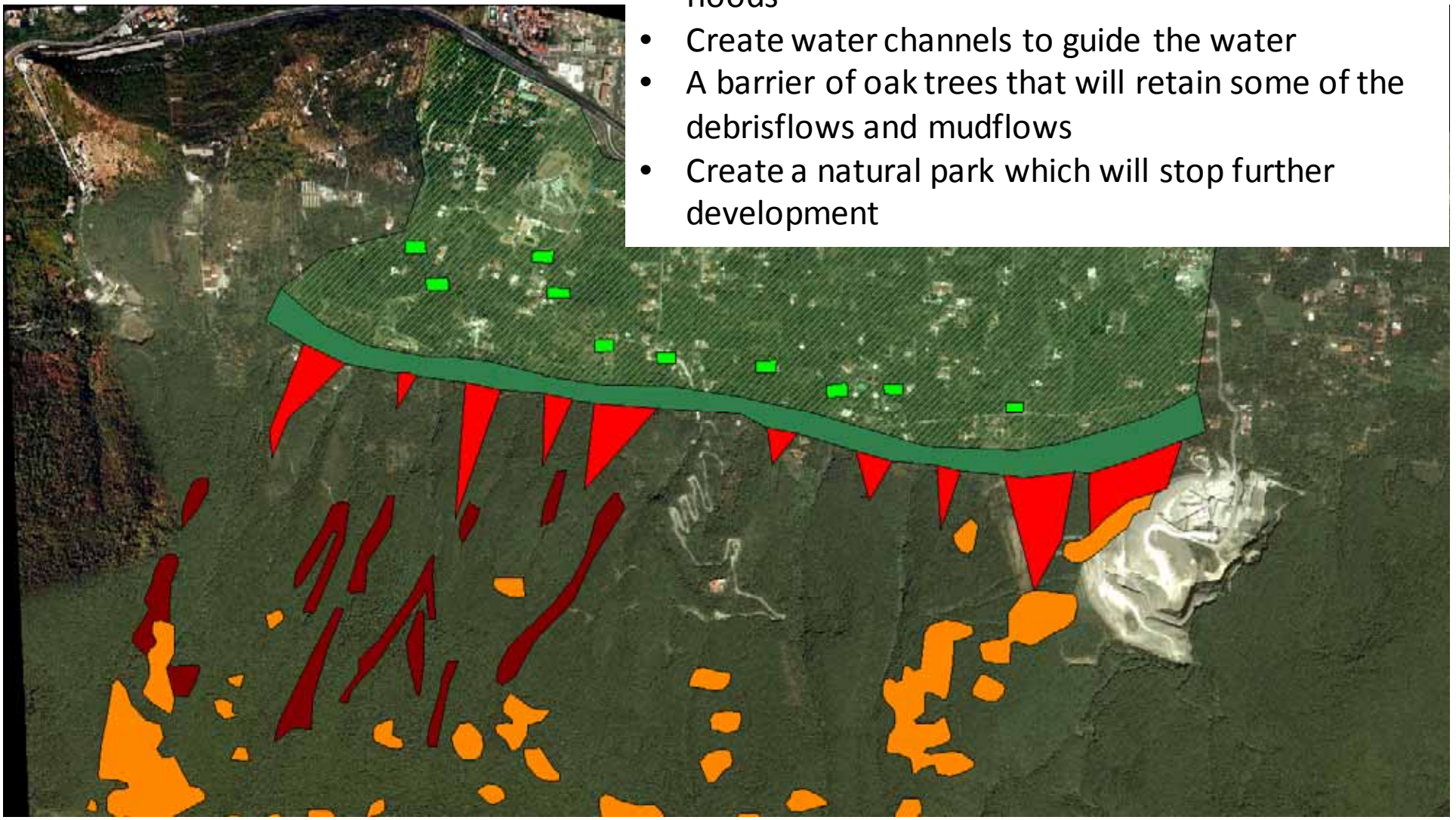
Input maps for alternative 1

Map	Hazard	Return Period	Intensity	Spatial probability	Alternative	Scenario
LS_SP_020_A1	Landslide	20	Not available	yes	1	0
LS_SP_050_A1	Landslide	50	Not available	yes	1	0
LS_SP_100_A1	Landslide	100	Not available	yes	1	0
LS_SP_200_A1	Landslide	200	Not available	yes	1	0
MF_IP_020_A1	Mudflow	20	Impact pressure	1	1	0
MF_IP_050_A1	Mudflow	50	Impact pressure	1	1	0
MF_IP_100_A1	Mudflow	100	Impact pressure	1	1	0
MF_IP_200_A1	Mudflow	200	Impact pressure	1	1	0
DF_IP_020_A1	Debrisflow	20	Impact pressure	1	1	0
DF_IP_050_A1	Debrisflow	50	Impact pressure	1	1	0
DF_IP_100_A1	Debrisflow	100	Impact pressure	1	1	0
DF_IP_200_A1	Debrisflow	200	Impact pressure	1	1	0
FL_DE_020_A1	Flood	20	Waterdepth	1	1	0
FL_DE_050_A1	Flood	50	Waterdepth	1	1	0
FL_DE_100_A1	Flood	100	Waterdepth	1	1	0
FL_DE_200_A1	Flood	200	Waterdepth	1	1	0

Elements-at-risk maps: Name	
Building_footprints	The original building footprint is used
Land_parcels	Land parcels include the new structures, and some buildings have been removed

Alternative 2

- Take out the soil in the landslide prone areas
- Use soil nailing in the upper slope to reduce the landslide susceptibility
- Create water tanks that will retain some of the the floods
- Create water channels to guide the water
- A barrier of oak trees that will retain some of the debrisflows and mudflows
- Create a natural park which will stop further development



Input maps for alternative 2

Map	Hazard	Return Period	Intensity	Spatial probability	Alternative	Scenario
LS_SP_020_A2	Landslide	20	Not available	yes	2	0
LS_SP_050_A2	Landslide	50	Not available	yes	2	0
LS_SP_100_A2	Landslide	100	Not available	yes	2	0
LS_SP_200_A2	Landslide	200	Not available	yes	2	0
MF_IP_020_A2	Mudflow	20	Impact pressure	1	2	0
MF_IP_050_A2	Mudflow	50	Impact pressure	1	2	0
MF_IP_100_A2	Mudflow	100	Impact pressure	1	2	0
MF_IP_200_A2	Mudflow	200	Impact pressure	1	2	0
DF_IP_020_A2	Debrisflow	20	Impact pressure	1	2	0
DF_IP_050_A2	Debrisflow	50	Impact pressure	1	2	0
DF_IP_100_A2	Debrisflow	100	Impact pressure	1	2	0
DF_IP_200_A2	Debrisflow	200	Impact pressure	1	2	0
FL_DE_020_A2	Flood	20	Waterdepth	1	2	0
FL_DE_050_A2	Flood	50	Waterdepth	1	2	0
FL_DE_100_A2	Flood	100	Waterdepth	1	2	0
FL_DE_200_A2	Flood	200	Waterdepth	1	2	0

Elements-at-risk maps: Name	
Building_footprints_A2	The building footprints from the green zone have been removed.
Land_parcels_A2	The green zone has been converted to parkland been converted into orchards or vineyards

Alternative 2

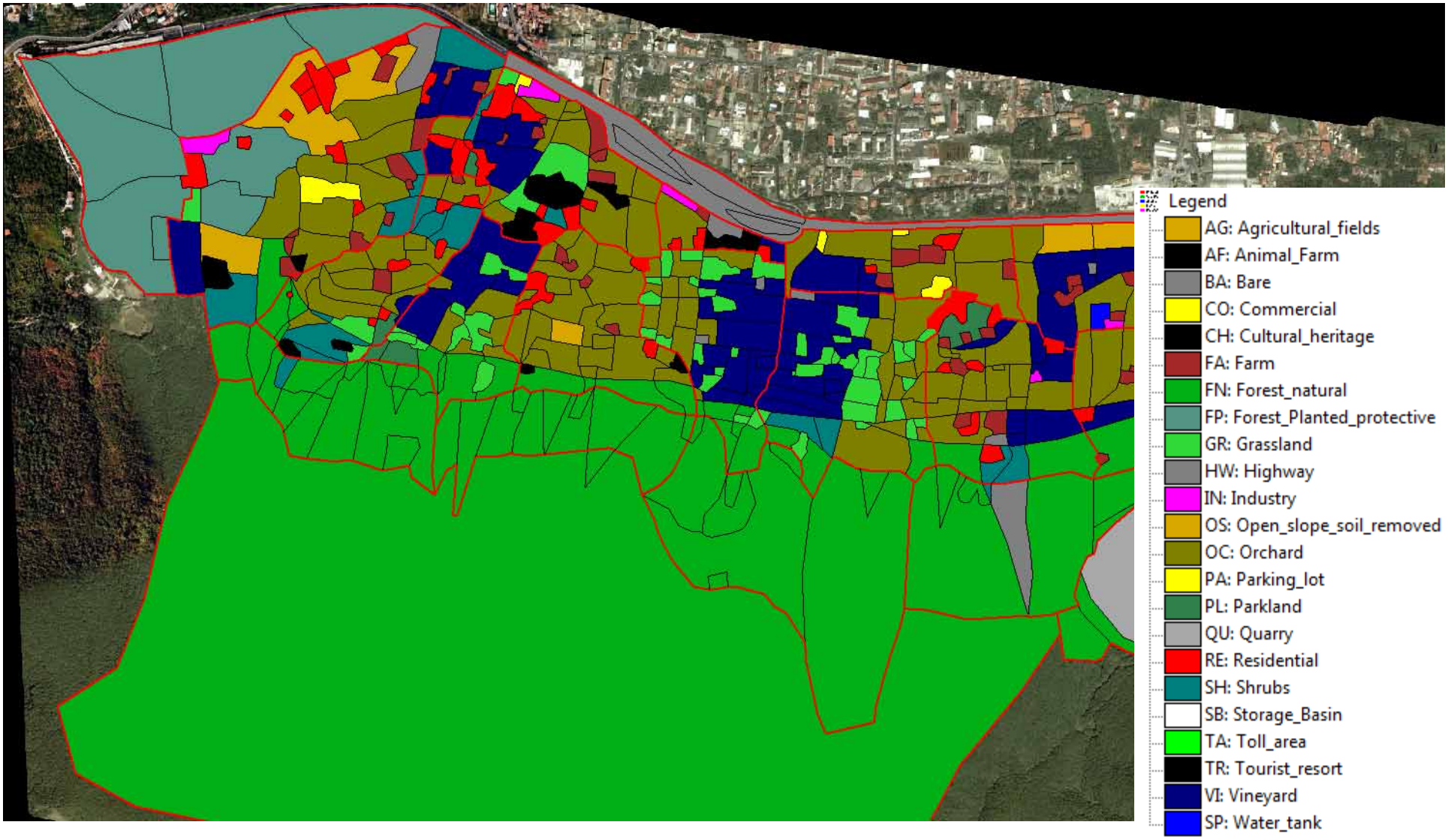
Evacuation of the elements at risk in the most endangered areas.

Input maps for alternative 2

Map	Hazard	Return Period	Intensity	Spatial probability	Alternative	Scenario
LS_SP_020_A0	Landslide	20	Not available	yes	3	0
LS_SP_050_A0	Landslide	50	Not available	yes	3	0
LS_SP_100_A0	Landslide	100	Not available	yes	3	0
MF_IP_020_A0	Mudflow	20	Impact pressure	1	3	0
MF_IP_050_A0	Mudflow	50	Impact pressure	1	3	0
MF_IP_100_A0	Mudflow	100	Impact pressure	1	3	0
DF_IP_020_A0	Debrisflow	20	Impact pressure	1	3	0
DF_IP_050_A0	Debrisflow	50	Impact pressure	1	3	0
DF_IP_100_A0	Debrisflow	100	Impact pressure	1	3	0
FL_DE_020_A0	Flood	20	Waterdepth	1	3	0
FL_DE_050_A0	Flood	50	Waterdepth	1	3	0
FL_DE_100_A0	Flood	100	Waterdepth	1	3	0

Elements-at-risk mapsName	
Building_footprints_A3	The building footprints from the most dangerous area have been removed.
Land_parcels_A3	All residential, farms, and industrial parcels have been converted into grassland

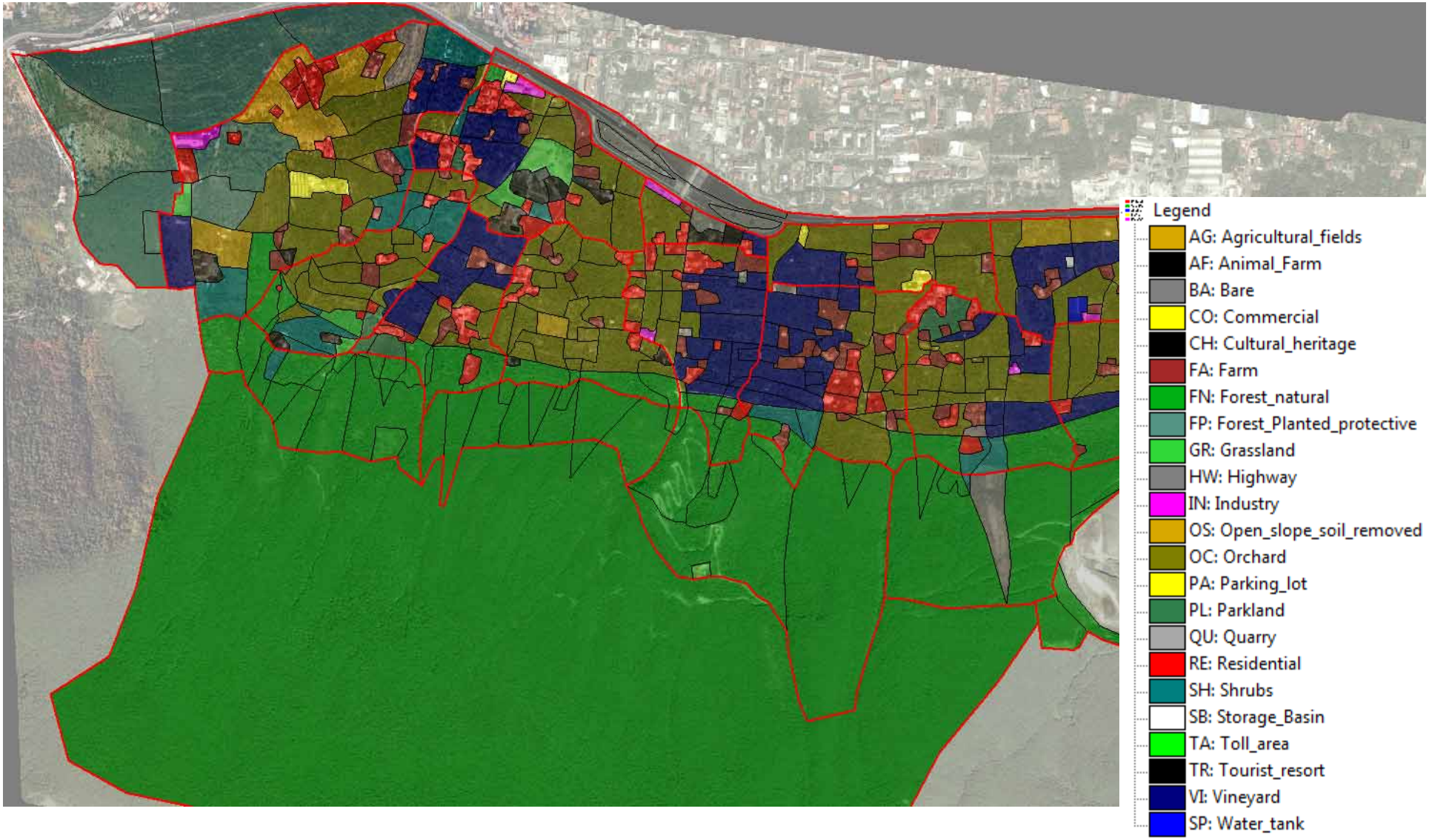
New land parcel map



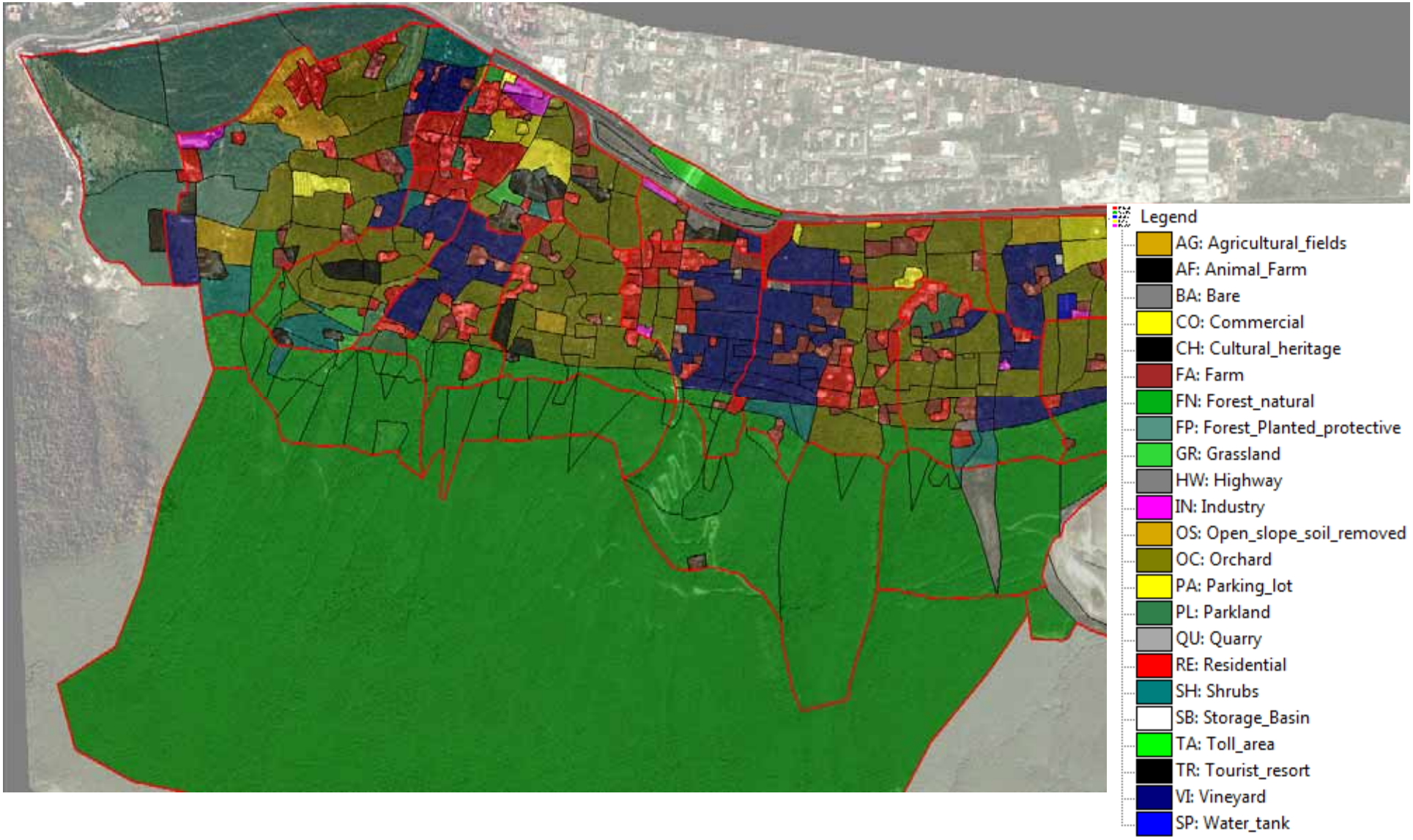
Possible scenarios

- 1: Unplanned growth & extreme climate change
- 2: Planned growth & extreme climate change
- 3: Unplanned growth & moderate climate change
- 4: Planned growth & moderate climate change

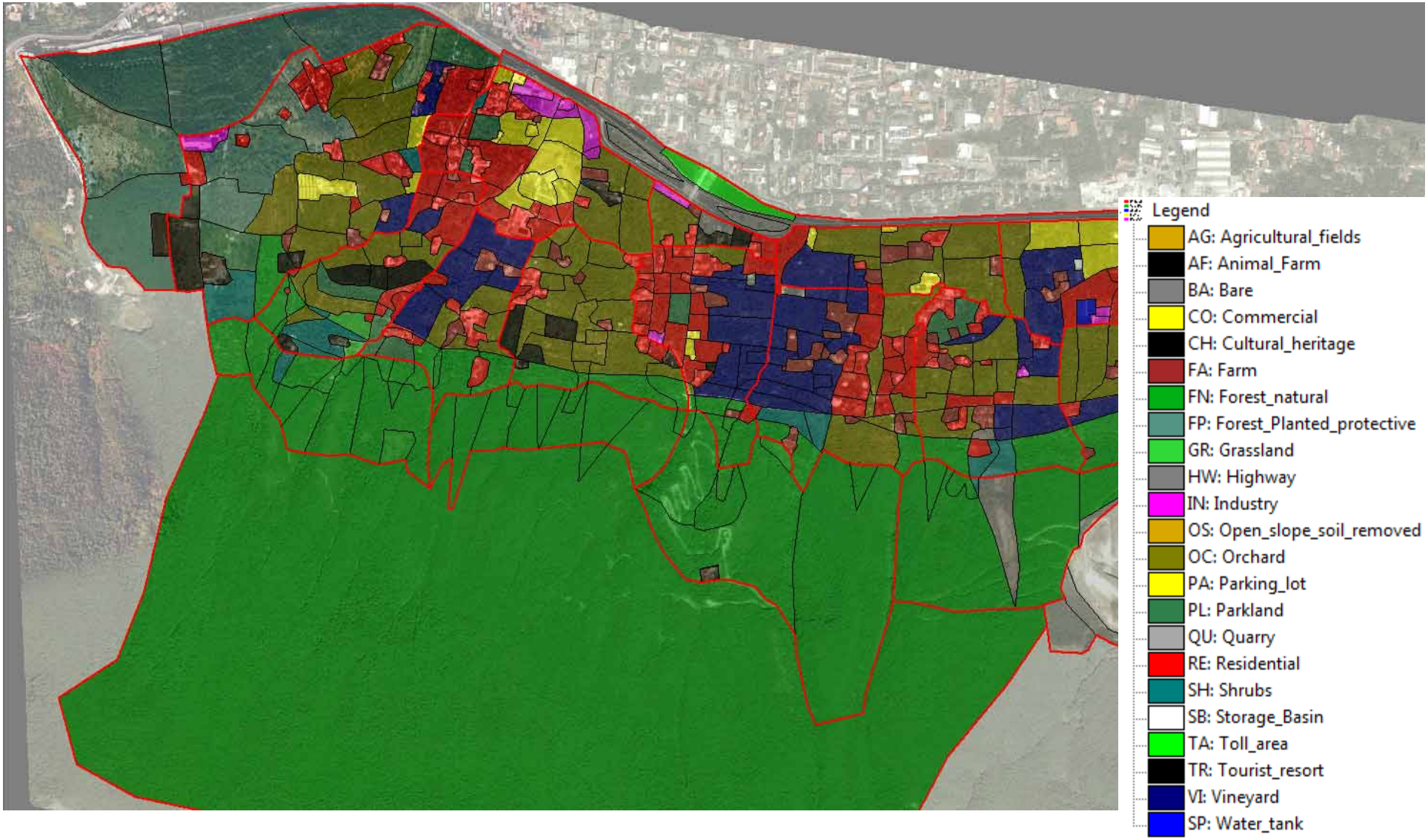
Landparcels 2014



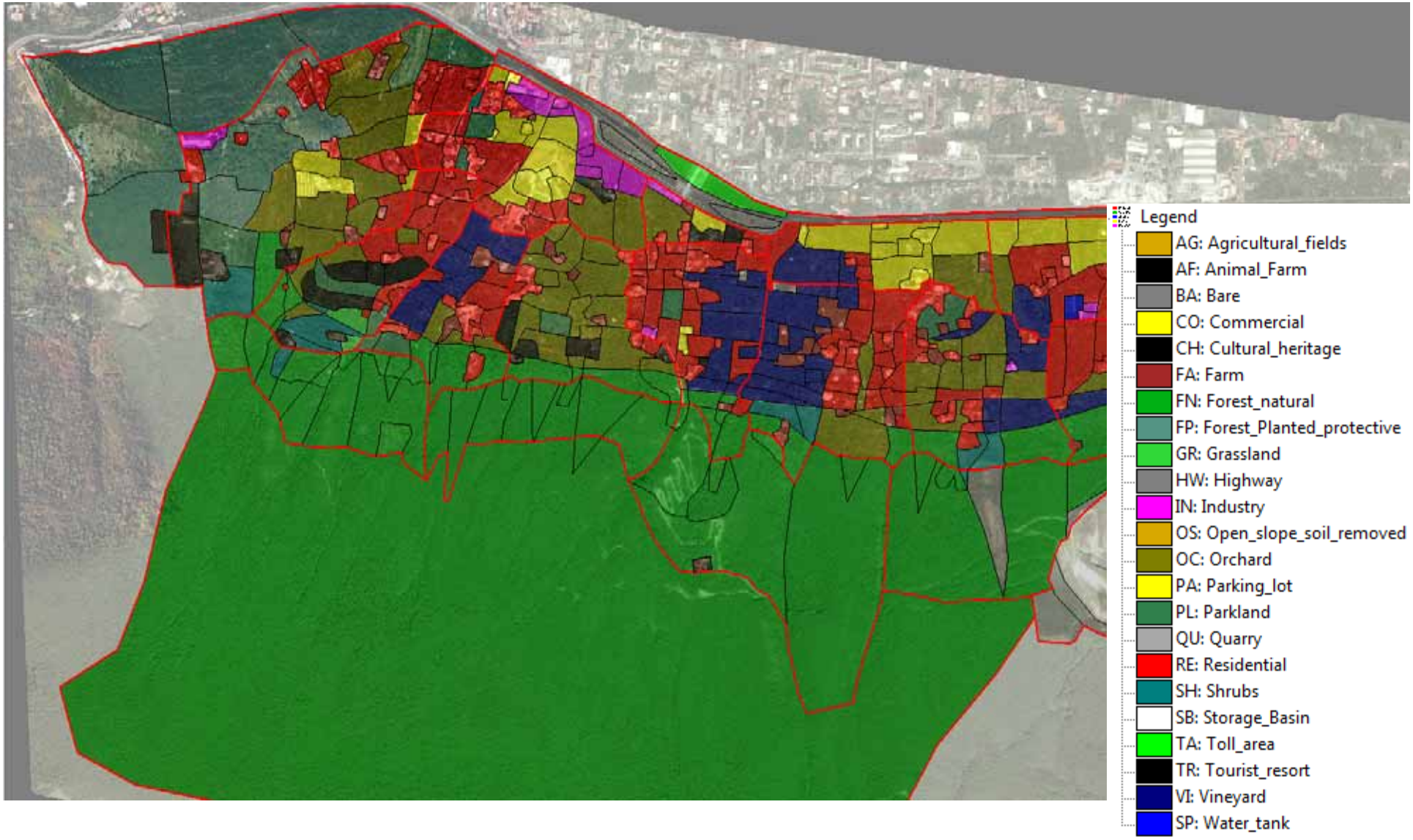
Landparcels 2020 (scenario 1)



Landparcels 2030 (scenario 1)



Landparcels 2040 (scenario 1)



Scenarios and alternatives

Scenario: Future trends	Alternative: risk reduction options	2013	Future years (reference years). User defined			
			2015	2020	2030	2040
00 (Without including any future trends)	00 (no risk reduction)	Edit/Upload	No future trends are taking into account, and all hazards, elements at risk and vulnerabilities are considered constant in future.			
	01 Structural	Edit/Upload				
	02 Relocation	Edit/Upload				
	03 Building improvement	Edit/Upload				
01 Climate change	00 (no risk reduction)	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	01 Structural	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	02 Relocation	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	03 Building improvement	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
02 Landuse change & climate change	00 (existing situation)	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	01 Structural	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	02 Relocation	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload
	03 Building improvement	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload	Edit/Upload

Scenarios and alternatives

Project ID	**1**
Project description	**Project for Nocera Study area**
Scenario ID	**02**
Future year	**2015**
Alternative Name	**Structural**
Alternative description	**Dike construction**

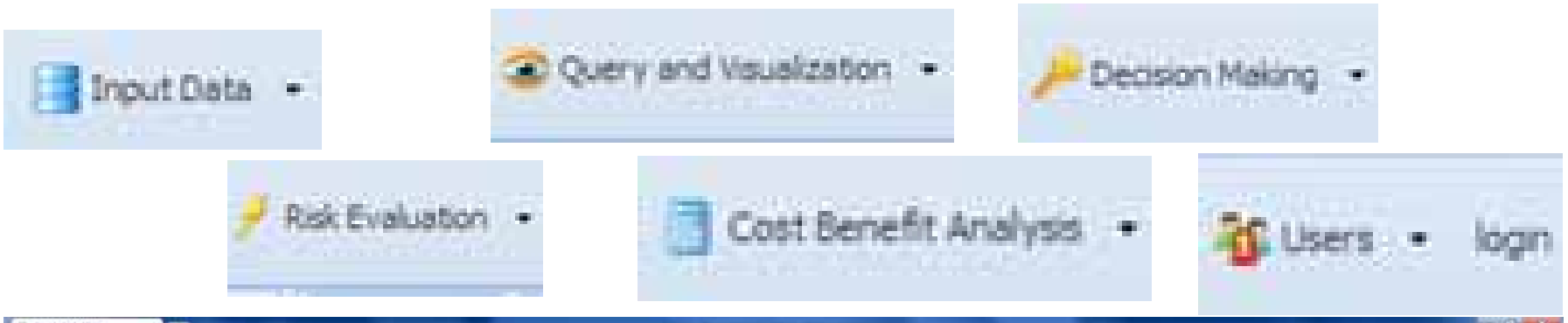
For each node this information is given

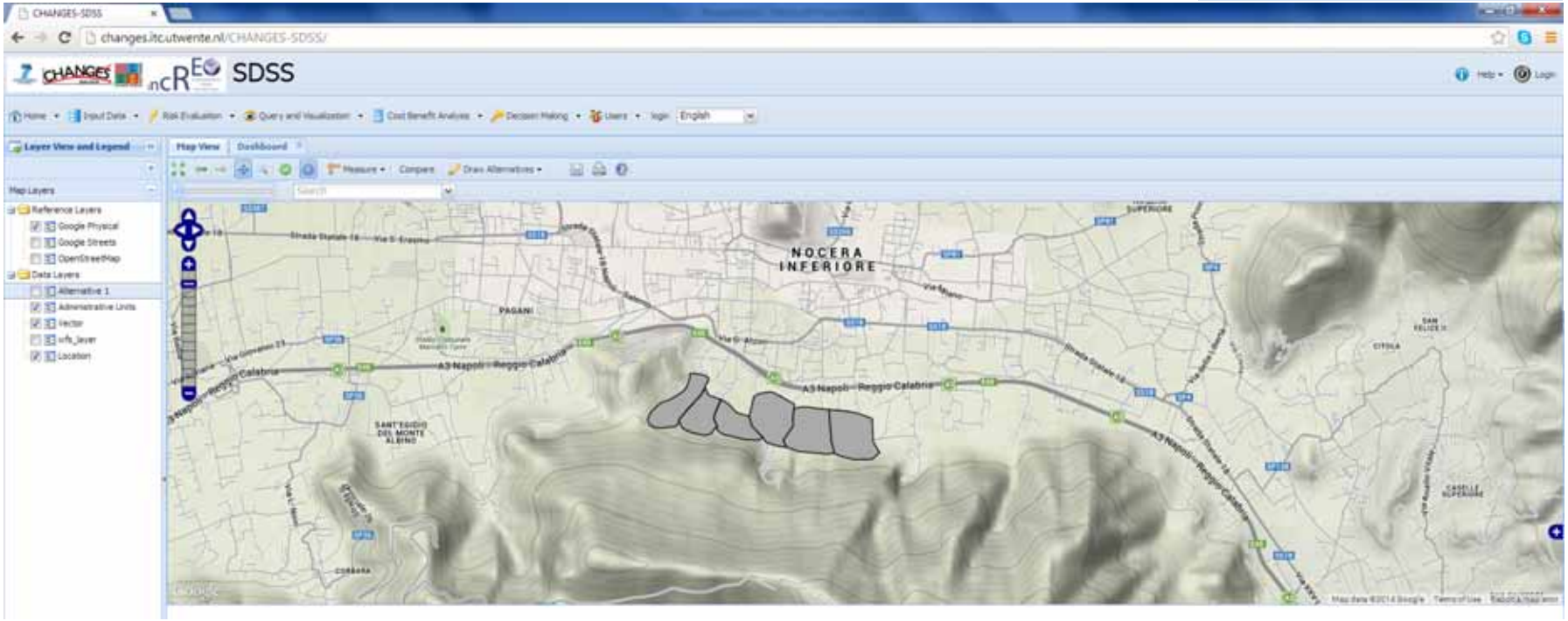
Does the node change the hazard	**Hazard Types**	**Does this change?**		**Use existing from Node**	**Upload status**	**Guiding questions: Which components change?**					
						Return Period changes?		**Intensity changes?**		**Spatial Probability changes?**	
	Flood	yes	**no**			yes	no	yes	no	yes	no
	Landslide	yes	no			yes	no	yes	no	yes	no
	Debris flow	yes	no			yes	no	yes	no	yes	no
Does the elements at risk change	**Element-at-Risk Type**	**Does this change?**		**Use existing from Node**	**Upload status**	**Does location change?**		**Does value change?**		**Does population change ?**	
	Buildings	yes	no			yes	no	yes	no	yes	no
	Land Parcels	yes	no			yes	no	yes	no	yes	no
	Linear	yes	no			yes	no	yes	no	yes	no
	Points	yes	no			yes	no	yes	no	yes	no
Calculate the losses	For Content value		yes								
	Structure value		yes								
	Population		yes								
Calculate risk	For Content value		yes								
	Structure value		yes								
	Population		yes								
Calculate Cost Benefit											

Tools to evaluate best risk reduction measures

- Cost Benefit Analysis (CBA) is used to compare costs and benefits of a one specific measures or a set of alternative measures over a period of time for a. CBA assesses the measure(s) mainly on the basis of the efficiency criterion. It requires the monetization of all the effects. The effects that cannot be expressed in monetary terms will be usually described in their original unit of measurement.
- Cost Effectiveness Analysis: (CEA) has most of the features of CBA, but does not require the monetization of either the benefits or the costs (usually the benefits). CEA does not show whether the benefits outweigh the costs, but shows which alternative has the lowest costs (with the same level of benefits). CEA is often applied when the norm for a certain level of safety has been set. CEA analyzes which types of solution is the 'cheapest' given a certain level of safety standard.
- Multi Criteria Analysis (MCE) is a tool that allows comparing alternative measures on multiple criteria. In contrast to CBA, MCE allows the treatment of more than one criterion and does not require the monetization of all the impacts. MCE results in a ranking of alternatives.

Components


Input Data
Query and Visualization
Decision Making
Risk Evaluation
Cost Benefit Analysis
Users
login


CHANGES-SDSS
changes.itc.utwente.nl/CHANGES-SDSS/
CHANGES
SDSS
Help
Login
Home
Input Data
Risk Evaluation
Query and Visualization
Cost Benefit Analysis
Decision Making
Users
login
English
Layer View and Legend
Map View
Dashboard
Measure
Compare
Draw Alternatives
Map Layers
Reference Layers
Google Physical
Google Streets
OpenStreetMap
Data Layers
Alternative 1
Administrative Units
Vector
wfs_layer
Location
NOCERA INFERIORE
PAGANI
A3 Napoli - Reggio Calabria
SANT'EGIDIO DEL MONTE ALBINO
CORBARA
CITOLA

Which name should it have?

RiskChanges