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SPONGE LAND(SCAPE)

An interdisciplinary approach for the transition to resilient communities

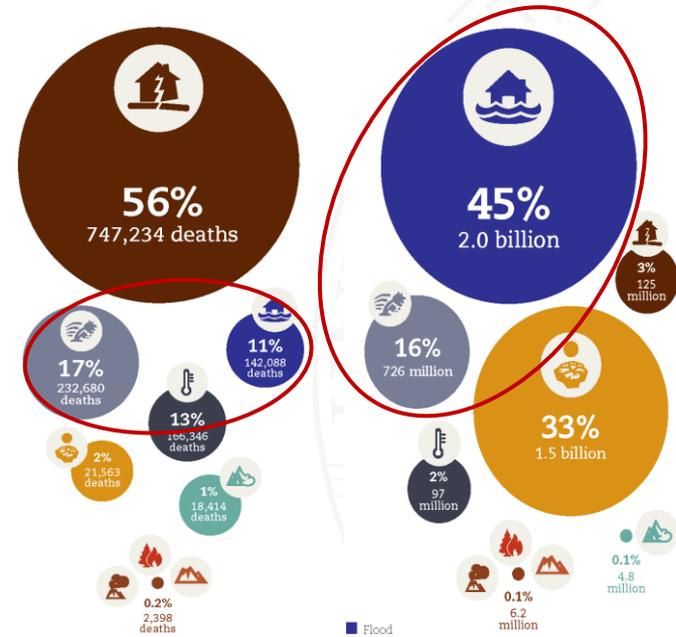
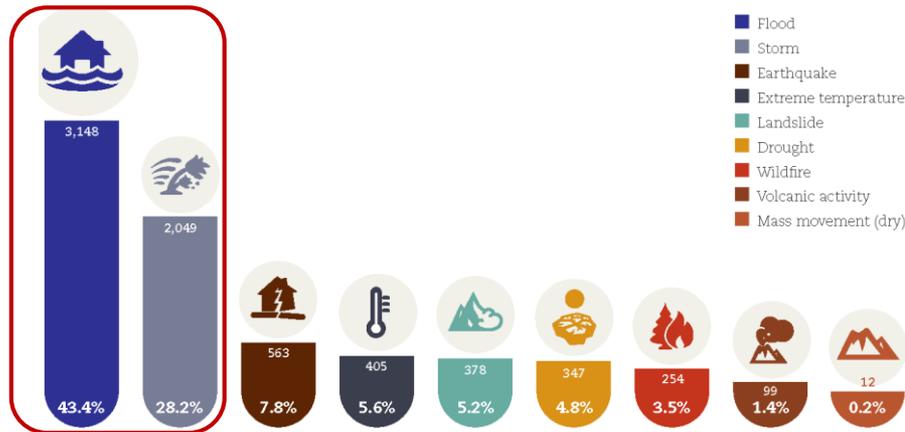
Filippo Carlo Pavesi, Michele Pezzagno, Stefano Barontini

University of Brescia, Department of Civil, Environmental, Architectural Engineering and Mathematics

EGU2020: Sharing Geoscience Online, 6 May 2020

SSS8.11 Soil function and ecosystem services in a changing global environment

Data on natural disasters shows that cities worldwide are increasingly exposed to the risk of negative consequences



Storms and floods are among the main causes of casualties and economic losses

Climate change

Urbanization

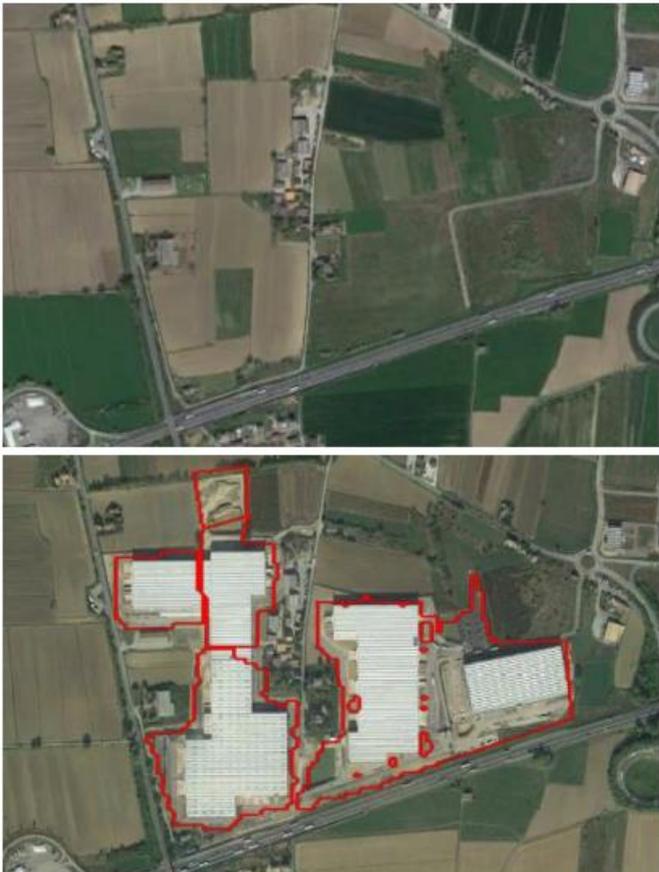
Land use transformation

Contributes to →

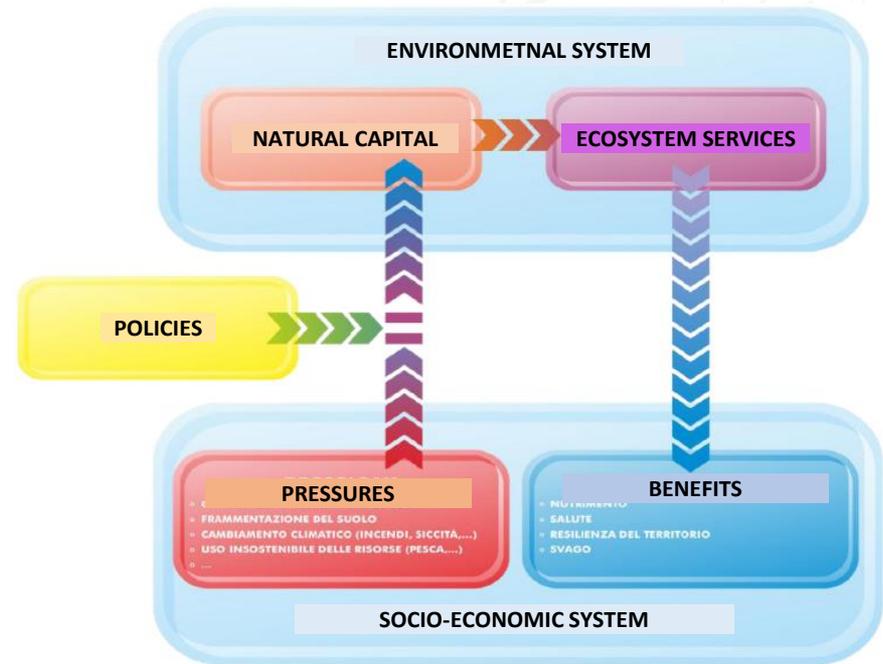
Increase hydrological hazard and risk

Requirement to achieve the transition to resilient communities (1/2)

Reduce soil sealing (cfr. No net land take by 2050? EU vision)



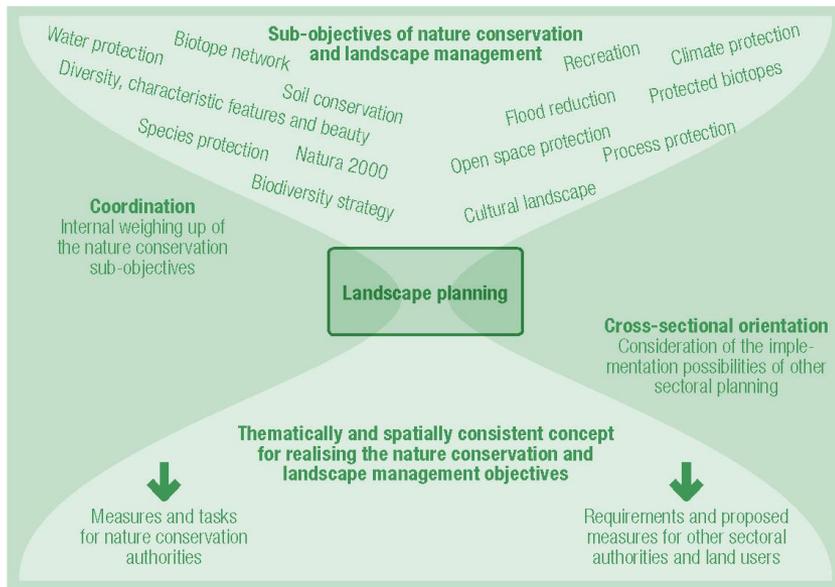
Improve the benefits of ecosystem services as part of the plan strategies (cfr. Millenium Ecosystem Assessment, 2005; Comitato Capitale Naturale, 2018)



Requirement to achieve the transition to resilient communities (2/2)

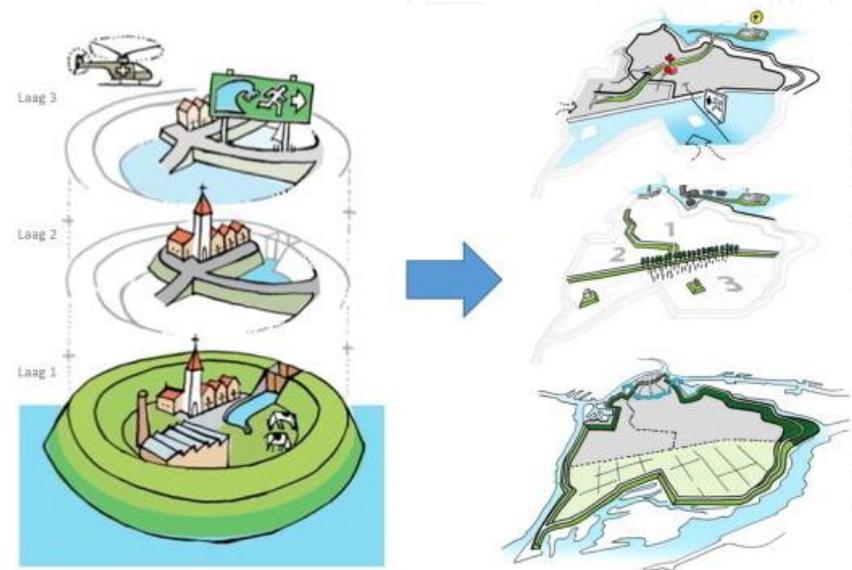
Enhance the key role that landscape planning can play in environmental protection

(cfr. Landscape planning, The basis of sustainable landscape development, 2008. German Federal Agency for Nature Conservation)



Coherent different disciplinary approaches, in a system aimed at a territorial *Multi Layer Safety*

(cfr. Policy Document on Water Safety, 2009-2015, Netherlands)



State of the art in territorial practices

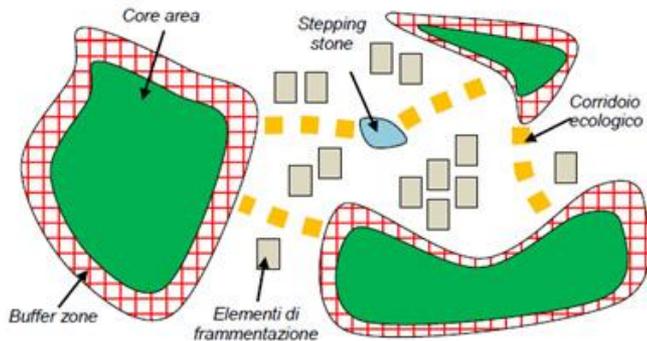
Soil sealing issue <i>General planning</i>	LEVEL	Hydraulic issue <i>Sectorial planning</i>
Absence of a directive <i>Net zero land occupation target by 2050</i>	EUROPEAN	Flood directive 2007/60/CE <i>River basin coordination</i>
In Italy, absence of a National Law (<i>Parliamentary debate going on for many years</i>)	NATIONAL	Hydrogeological planning update to Flood risk management plans
Different ways of measuring soil sealing (<i>Regional regulations</i>)	BASIN/ REGIONAL	Hazard and risk maps realized according to a unique European protocol

In order to address these critical issues **we propose a method to classify rural areas** which considers both **landscape and hydrological peculiarities**, in order to identify, at the regional scale, **the most suitable areas to plan and design the landscape**

Defining SPONGE LAND(SCAPE)

SPONGE LAND(SCAPE) aims at extending the affirmed concept of SPONGE CITIES to rural areas.

SPONGE LAND(SCAPE) is an approach to land management that may contribute to the mitigation of hydrogeological hazard and risk, by means of preserving the regulating soil ecosystem services. At the same time it will improve both the resilience level of urban areas and the ecosystems living conditions.



Which are the most suitable areas?

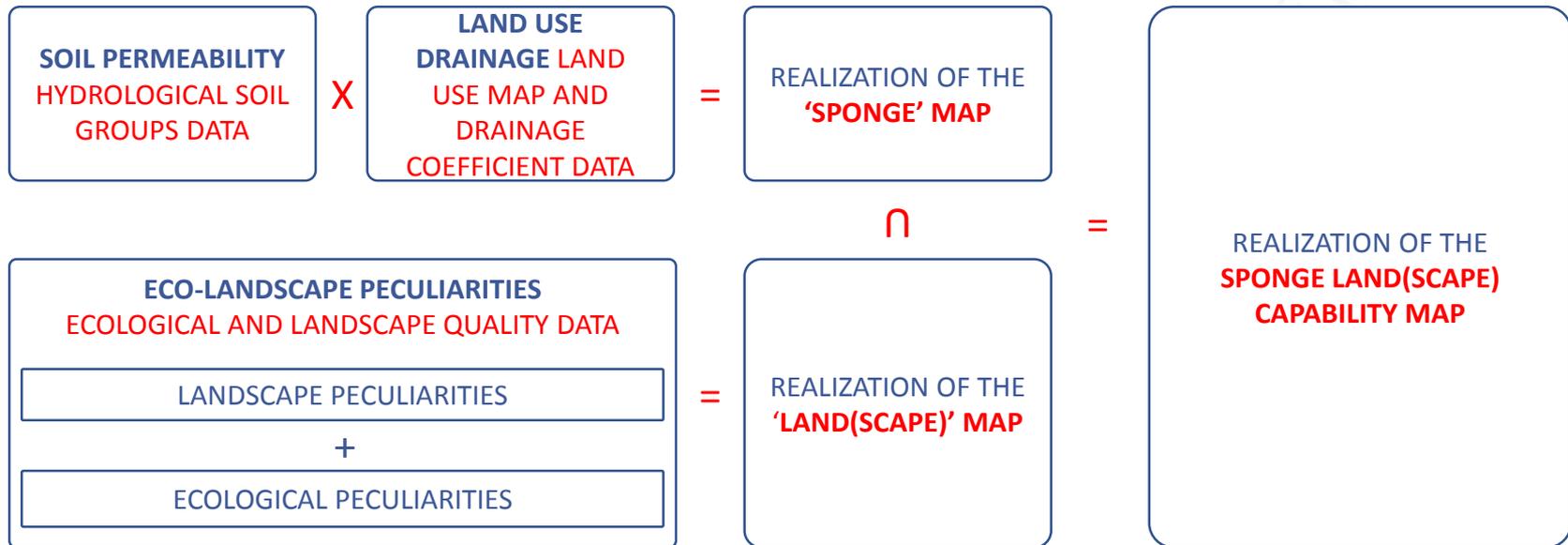
In order to address these **critical issues** we propose a **method to classify rural areas** which considers both landscape and hydrological peculiarities, in order to identify, at the regional scale, the most suitable areas to plan and design the landscape.

We therefore propose to identify such a kind of landscape with the definition of a “sponge land(scape)”, which aims at extending the affirmed concept of “sponge cities” to rural areas.

This approach to land management **may contribute to the mitigation of hydrogeological hazard and risk, by means of preserving the regulating soil ecosystem services.** At the same time it will improve both the resilience level of urban areas and the ecosystems living conditions.

SPONGE LAND(SCAPE) design principles to build a capability map

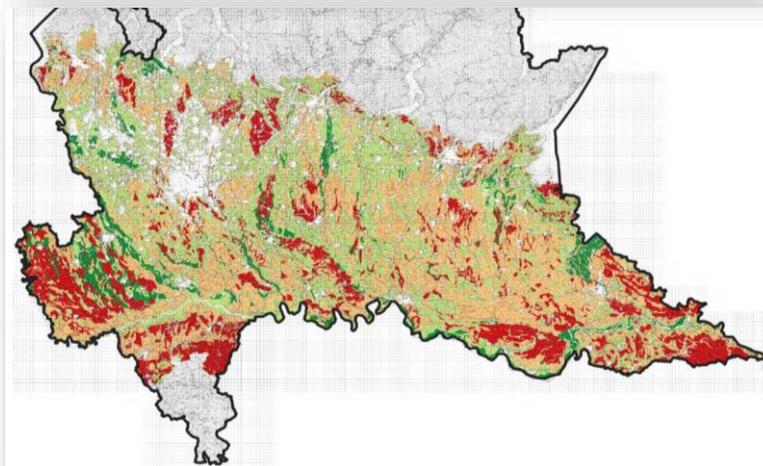
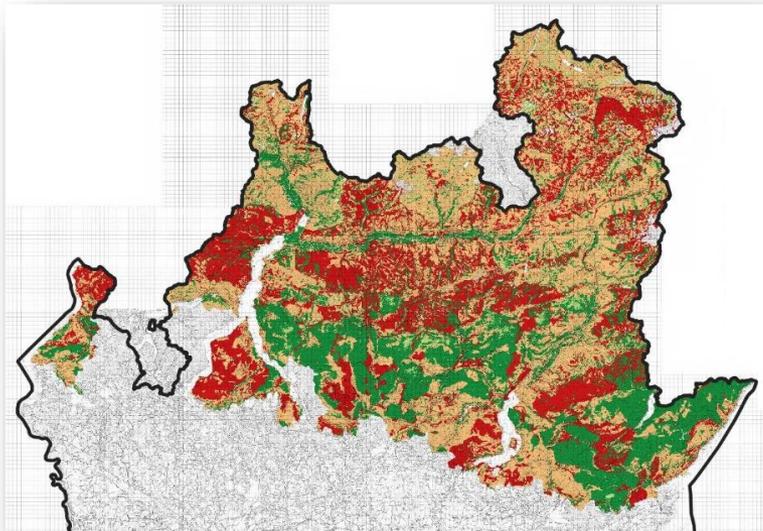
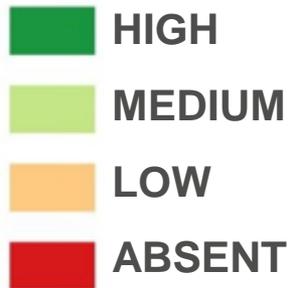
METHOD



Realization of 'SPONGE MAP'

Case study: Regional level (Lombardy Region, Italy)

SPONGE EFFECT



MOUNTAIN AREA

> LATITUDE
< SPONGE EFFECT

Data:

- Hydrological map
- Land use map (vector)
- Drainage coefficient (table)

PLAIN AREA

< LATITUDINE
< SPONGE EFFECT

Data:

- Soil map (vector)
- Hydrologic soil group data (table)
- Land use map (vector)
- Drainage coefficient (table)

Realization of 'LAND(SCAPE)' map

Case study: Territorial level (Brescia Province, Lombardy Region, Italy)

*ECOLOGICAL OR LANDSCAPE
PECULIARITIES -
PROTECTION LEVEL ANALYSIS*

STRONGLY PROTECTED AREAS

+

MEDIUM PROTECTED AREAS

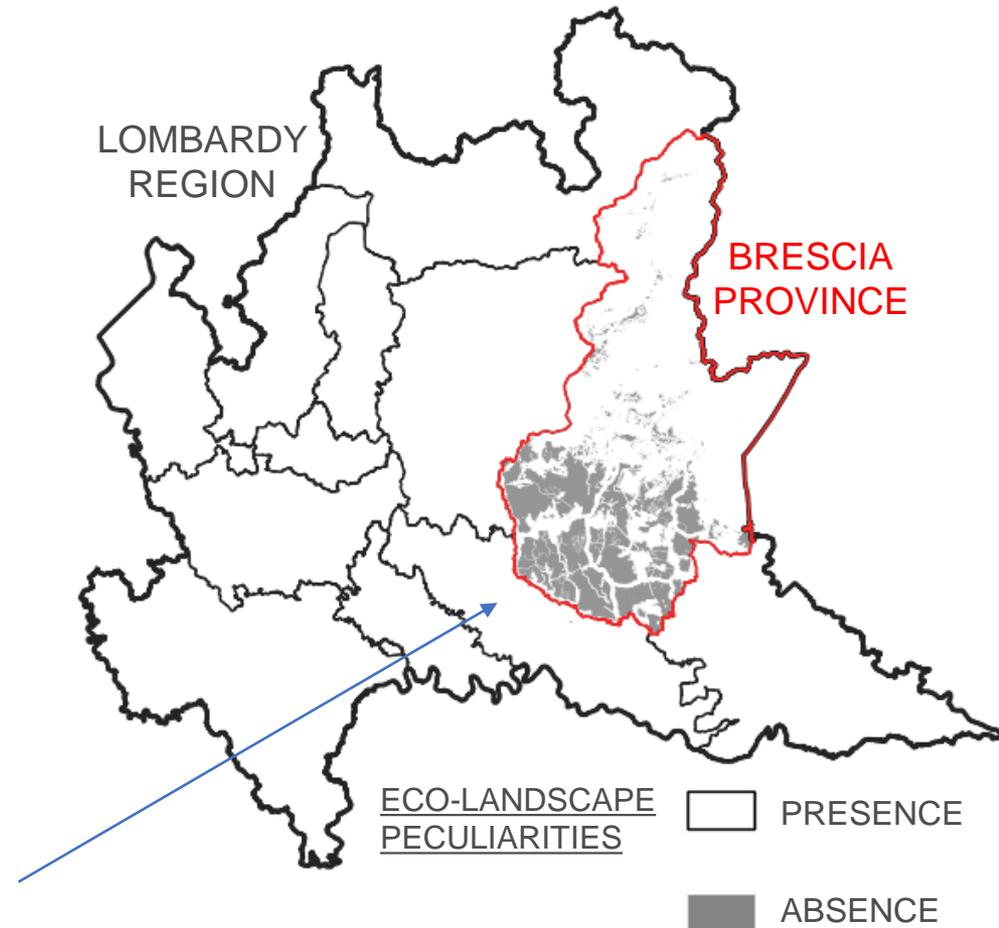
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LESS PROTECTED AREAS

=

'LAND(SCAPE)' MAP

aggregation of areas with ecological or landscape peculiarities, **useful for spatial planning**



SPONGE LAND(SCAPE) capability map

'LAND(SCAPE)' MAP

'SPONGE' MAP

CAPABILITY MAP

Case study
plain area

ECO-LANDSCAPE
PECULIARITIES

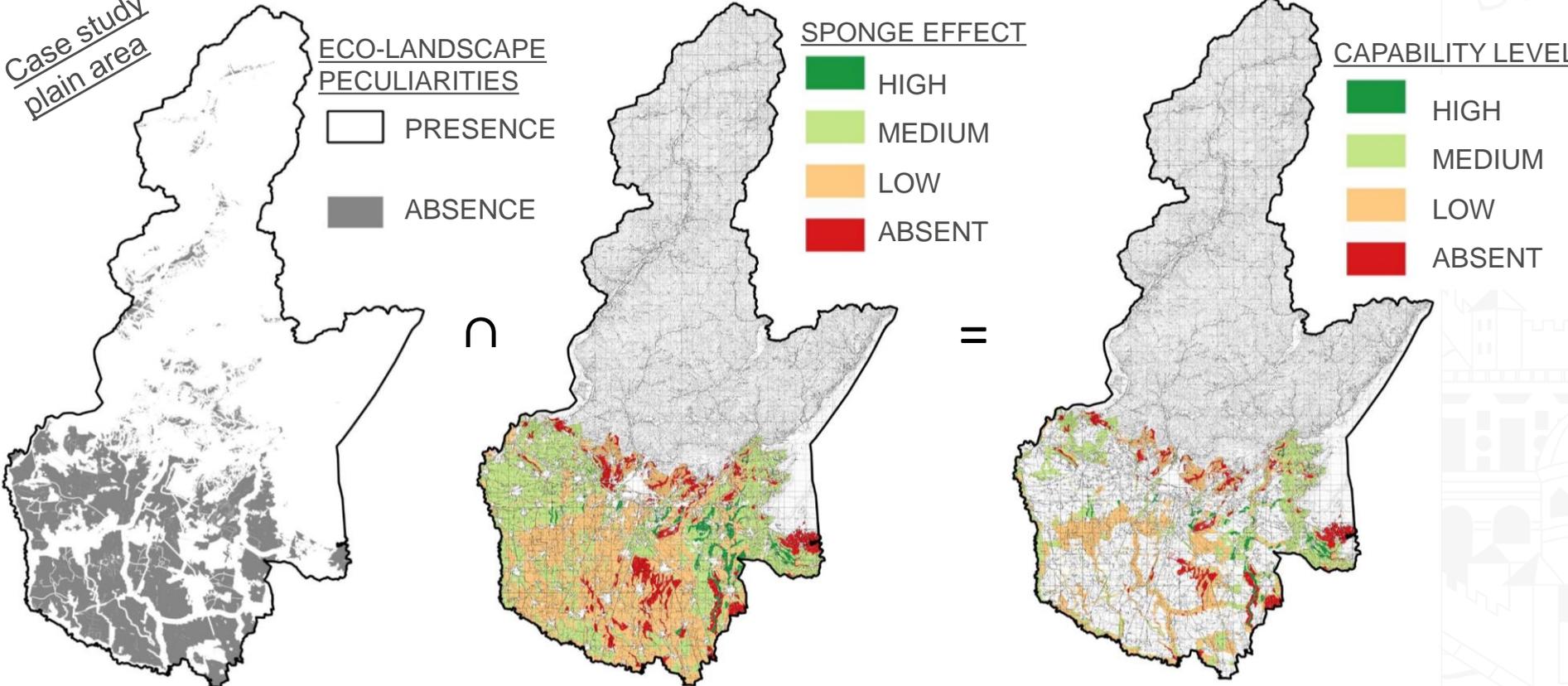
- PRESENCE
- ABSENCE

SPONGE EFFECT

- HIGH
- MEDIUM
- LOW
- ABSENT

CAPABILITY LEVEL

- HIGH
- MEDIUM
- LOW
- ABSENT

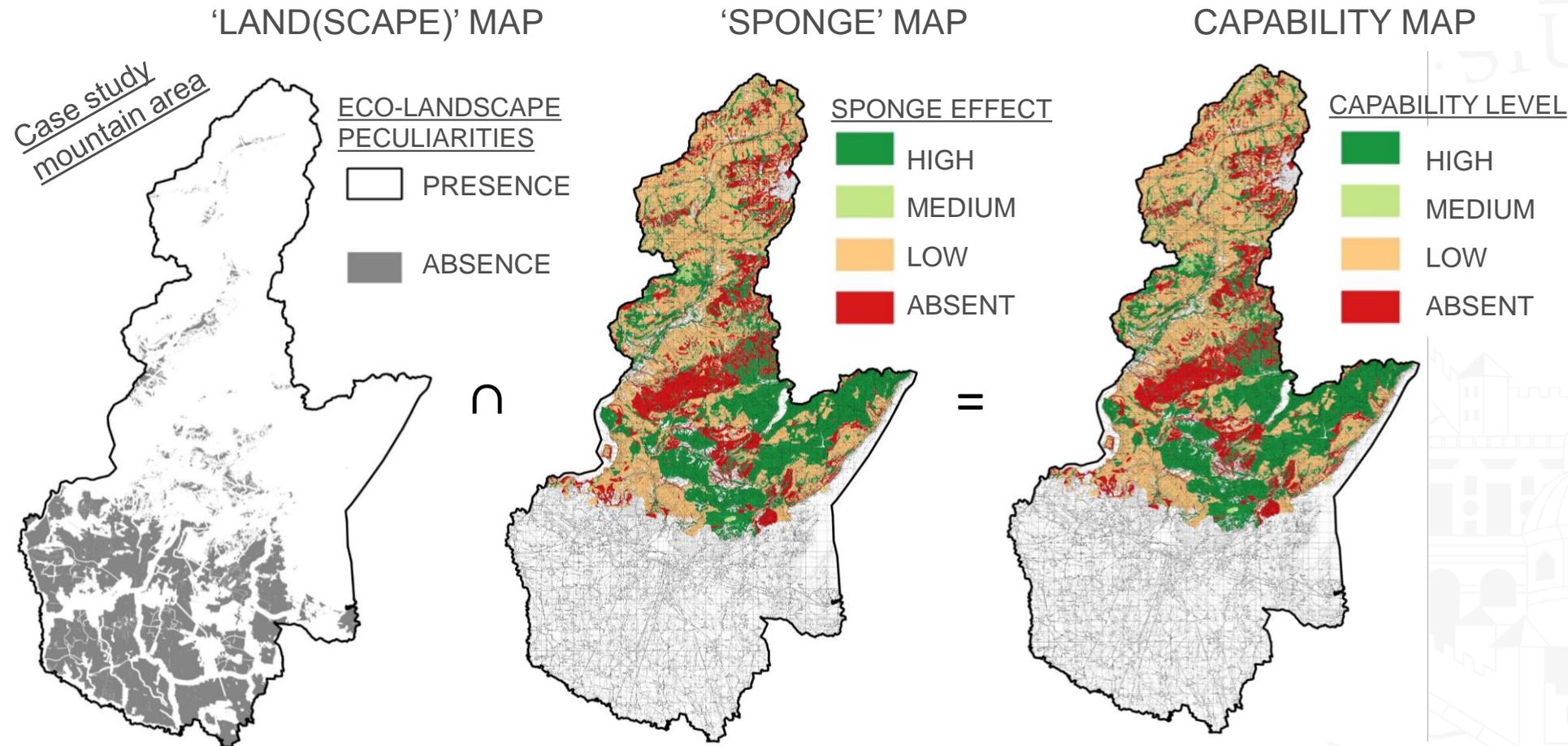


In plain areas there are minor opportunities

WHICH SPONGE LANDSCAPING **ACTIONS** ARE NEEDED?

Targeted actions (green solutions), in support of a system already based on hydraulic engineering (gray solutions)

SPONGE LAND(SCAPE) capability map



In mountain areas there is more potential
WHICH SPONGE LANDSCAPING ACTIONS ARE NEEDED?
Extended actions, for the governance of hydrogeological instability
and landscape design for water retention

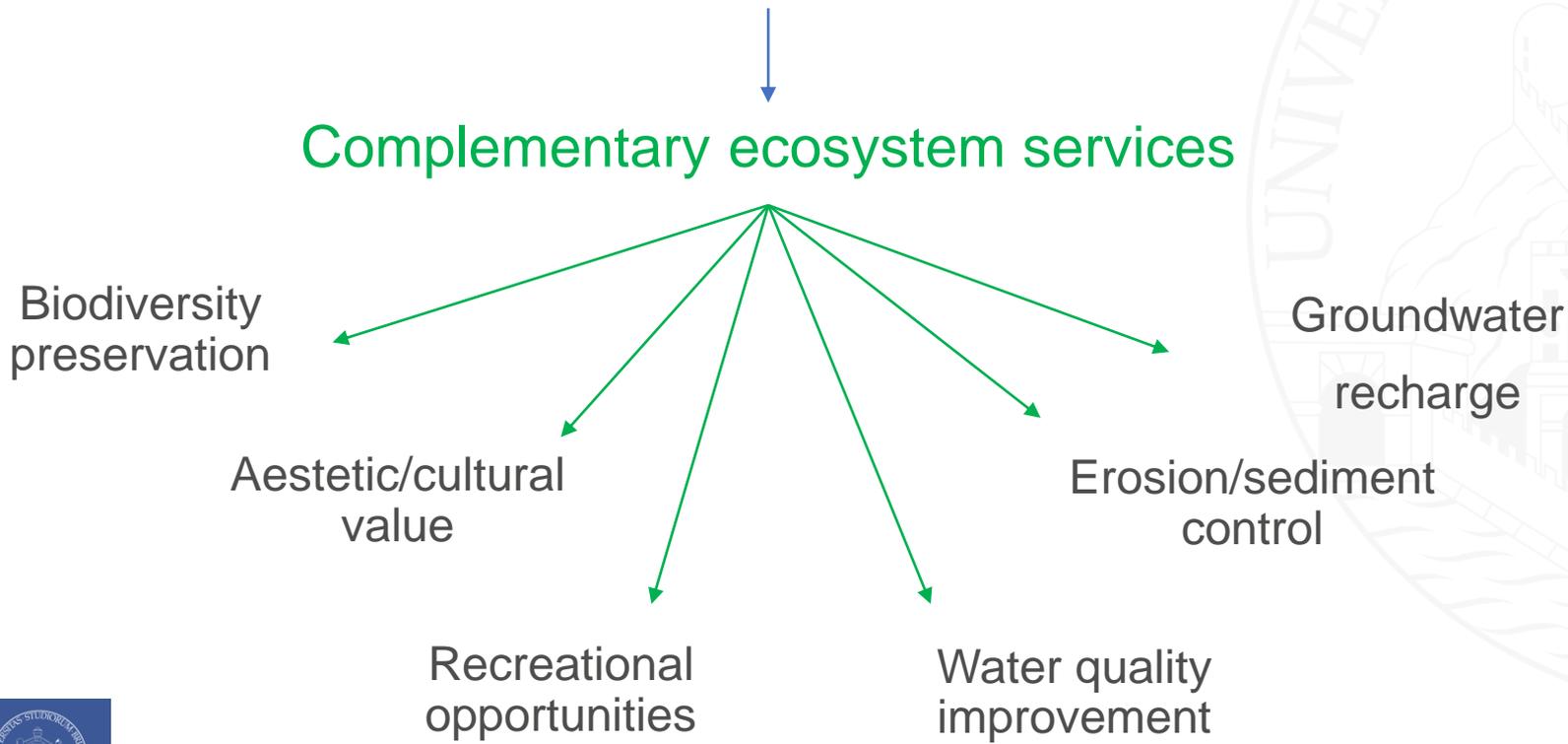
Data integration in GIS made possible to **create new maps** which allow priority area to emerge for "sponge landscaping actions", such as the adoption of Nature Based Solution or Natural Water Retention Measures.

These **contribute both to the mitigation of hydraulic risk** and to the **maximization of other complementary ecosystem services** (e.g. biodiversity preservation, climate change adaptation and mitigation, erosion/sediment control).

Measures for SPONGE LAND(SCAPE) design

Natural Water Retention Measures (NWRM)

Useful to retain runoff water and to infiltrate or release it with controlled flow (ecosystem regulation service)



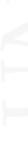
Measures for SPONGE LAND(SCAPE) design

	Ecosystem Services				Multifunctionality value						
	ES7 - Flood Risk Reduction	ES4 - Biodiversity Preservation	ES5 - Climate Change Adaptation and Mitigation	ES8 - Erosion/Sediment Control							
<table border="1"> <tr><th colspan="2">Legend</th></tr> <tr><td> High</td></tr> <tr><td> Medium</td></tr> <tr><td> Low</td></tr> <tr><td> Absent</td></tr> </table>	Legend		 High	 Medium	 Low	 Absent					
Legend											
 High											
 Medium											
 Low											
 Absent											
F13 - Peak flow control structures in managed forests	3	2	0	3	8						
F3 - Afforestation of reservoir catchments	2	3	3	3	11						
F4 - Targeted planting for "catching" precipitation	2	2	3	3	10						
F6 - Continuous cover forestry	2	3	3	2	10						
F9 - Sediment capture ponds	2	3	1	1	7						
F1 - Forest riparian buffers	2	3	0	1	6						
F10 - Coarse woody debris	2	3	0	1	6						
F5 - Land use conversion	1	3	3	3	10						
F2 - Maintenance of forest vocer in headwater areas	1	2	3	3	9						
F11 - Urban forest parks	1	3	3	1	8						
F12 - Trees in urban areas	1	3	3	1	8						
F7 - "Water sensitive" driving	1	3	0	3	7						
F8 - Appropriate design of roads and stream crossing	1	3	0	3	7						
F14 - Overland flow areas in peatland forests	1	2	1	3	7						

MOUNTAIN AREAS



Forest NWRM



Redesign of the wooded landscape

Data Source: <http://nwrn.eu/>

Measures for SPONGE LAND(SCAPE) design

	Ecosystem Services				Multifunctionality value										
	ES7 - Flood Risk Reduction	ES4 - Biodiversity Preservation	ES5 - Climate Change Adaptation and Mitigation	ES8 - Erosion/Sediment Control											
<table border="1"> <tr><th colspan="2">Legend</th></tr> <tr><td style="background-color: #2e8b57; color: white;"> </td><td>High</td></tr> <tr><td style="background-color: #90ee90;"> </td><td>Medium</td></tr> <tr><td style="background-color: #ffcc99;"> </td><td>Low</td></tr> <tr><td style="background-color: #ff0000; color: white;"> </td><td>Absent</td></tr> </table>	Legend			High		Medium		Low		Absent					
Legend															
	High														
	Medium														
	Low														
	Absent														
A2 - Buffer strips and hedges	3	1	2	3	9										
A8 - Green cover	3	1	2	3	9										
A1 - Meadows and pastures	3	0	2	3	8										
A9 - Early sowing	3	0	2	3	8										
A5 - Intercropping	2	2	1	2	7										
A4 - Strip cropping along contours	2	0	0	3	5										
A10 - Traditional terracing	2	0	0	3	5										
A11 - Controlled traffic farming	2	0	0	2	4										
A12 - Reduced stocking density	2	0	0	2	4										
A13 - Mulching	2	0	0	1	3										
A3 - Crop rotation	1	1	0	1	3										
A6 - No till agriculture	0	2	2	3	7										
A7 - Low till agriculture	0	0	1	0	1										

PLAIN AREAS



Agriculture NWRM



Reconstruction of the traditional Lombard Po plain landscape

Data Source: <http://nwrn.eu/>



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