METHODOLOGY TO PLANNING GREEN INFRASTRUCTURE TO MITIGATE LANDSLIDE RISK

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Green Infrastructure (GI) consist of a network of natural and semi-natural areas strategically planned with other environmental features, designed and administered to provide a wide range of ES.
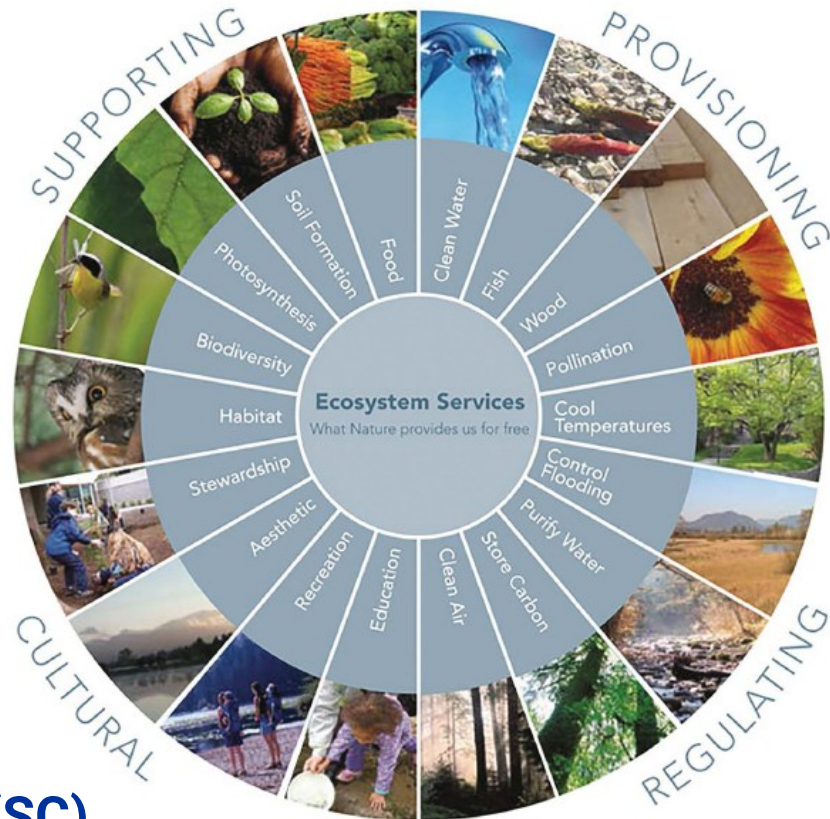
GI can mitigate the effects of climate change and extreme events that they pose, managing, for example, the devastating power of floods or landslides, re-establishing spaces and functions.

ECOSYSTEM SERVICES

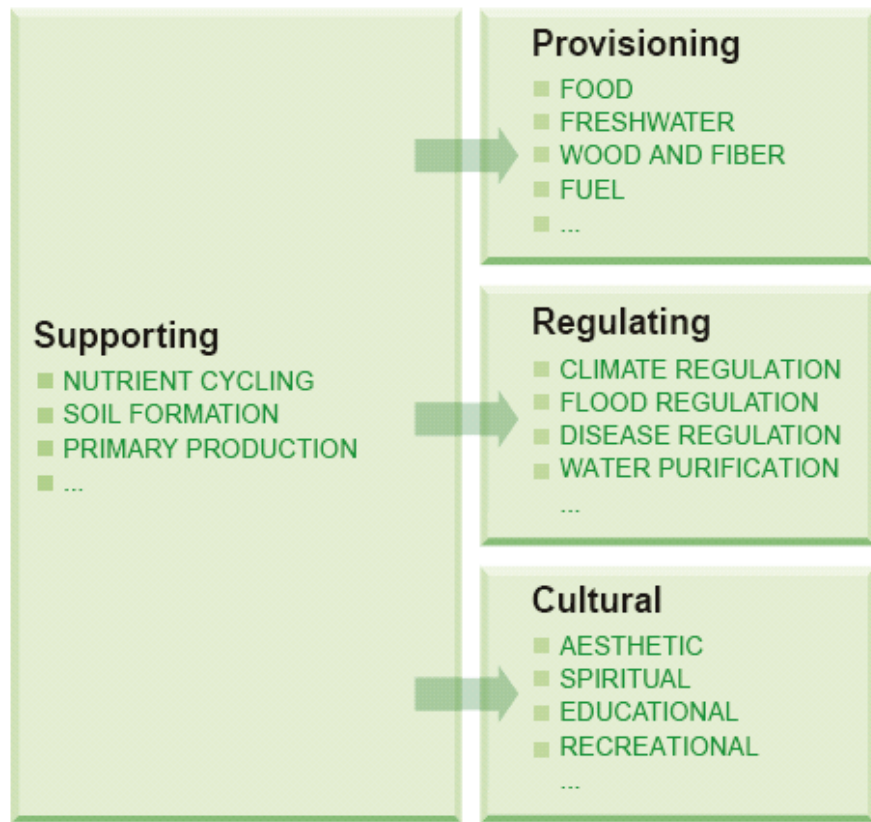**Ecological Integrity (EI)**

Provisioning (SA)

Cultural (SC)

Regulating (SR)

Erosion control (SRec)

Classification of ecosystem services according to the Millennium Ecosystem Assessment (MEA)

EUROPEAN UNION POLICIES

- Seventh Environment Action Programme - 7EAP – (Decision No 1386/2013/EU)

- EU Biodiversity Strategy (COM/2011/244 final)

- The 2013 European Commission Strategy on Green Infrastructure (COM/2013/0249)

- Regional Policy 2014-2020

- Water Frame Directive (2000/60/CE),

- Nitrates Directive (91/676/EEC)

- Floods Directive (COM(2006)15)

- EU Strategy on Adaptation to Climate Change

- AGENDA 2030

Exploring Nature-based Solutions of the European Environment Agency (EEA)

EEA Technical report | No 12/2015

Exploring nature-based solutions
The role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards

ISSN 1725-2237

European Environment Agency

Develop a methodology for the effective planning of a GIs network that can help public policies.

The methodology's application highlights how it is possible to identify the contact points between the protection of ecological integrity and the mitigation of landslide risk.

METHODOLOGY

MACRO-PHASE 1

Evaluation of ESs offered by the different types of land use

MACRO-PHASE 2

Identification of land uses that maximize the *ecosystem erosion control* (SRec) service in areas of high and very high hazard;

MACRO-PHASE 3

Designing a network that maximizes the multi-functionality of the GIs.

SE

Santolini et al.

CLC

	Local climate regulation	Global climate regulation	Air quality regulation	Flood protection	Water regulation and supply	Storage capacity	Nutrient regulation	Habitat refugium and biodiversity	Recreation	Aesthetic and amenity	Erosion regulation	Pollination
Continuous urban fabric	0	0	0	0	0	0	0	0	0	0	0	0
Discontinuous urban fabric	0	0	0	0	0	1	0	1	0	0	0	0
Industrial or commercial units and road and rail network	0	0	0	0	0	0	0	1	0	0	0	0
Mineral extraction site	0	0	0	0	0	0	0	2	0	0	0	0
Green urban areas	4	2	3	1	3	2	1	3	4	4	2	2
Arable land	3	1	0	1	2	4	1	2	1	1	0	1
Vineyards + fruit trees	3	1	1	1	2	2	2	3	3	4	3	5
Pastures or natural grassland	3	1	1	1	3	4	2	2	4	3	4	2
Ruderal herbaceous-shrub veg.	3	1	1	2	3	3	3	1	1	0	3	2
Hygro-nitrophilous herbaceous vegetation	3	1	1	2	3	3	4	3	1	1	3	2
Marsh vegetation	5	4	5	2	3	5	5	5	4	5	4	3
Bushy grassland	4	3	3	3	4	4	4	4	1	3	5	3
Shrub	4	3	3	4	4	4	4	4	1	3	5	3
Canebrake	4	3	3	3	3	4	4	3	1	2	4	3
Hygrophilous vegetation	5	4	5	4	3	5	5	4	2	5	4	5
Bare rock	0	0	0	1	1	0	0	3	4	4	0	0
Ruderal wood	4	3	3	3	3	4	3	2	1	0	4	4
Broad-leaved forest	5	4	5	4	5	5	5	4	5	5	5	5
Coniferous forest	5	4	5	4	5	5	5	4	5	5	5	5
Thermophilic forest	5	4	5	4	4	5	5	4	5	5	5	5
Hygrophilous wood	5	4	5	5	5	5	5	5	5	5	5	5
Mesophilic forest	5	4	5	4	5	5	5	4	5	5	5	5
Water courses	1	0	0	2	5	5	3	4	5	5	0	0
Water bodies	2	1	0	1	5	5	1	4	5	5	0	0

Note: 0 = no relevant capacity; 1 = low relevant capacity; 2 = relevant capacity; 3 = medium relevant capacity; 4 = high relevant capacity; and 5 = very high relevant capacity.

Source : R. Santolini, E. Morri, G. Pasini, G. Giovagnoli, C. Morolli, G. Salmoiraghi
Assessing the quality of riparian areas: the case of River Ecosystem Quality Index applied to the Marecchia river (Italy)

SE

CLC

CLC_label	CLC	IE	Sa	Sr	Sc
tessuto urbano continuo	111	0	0	0	0
tessuto urbano discontinuo	112	1	0	0	0
aree industriali o commerciali	121	0	0	0	0
reti stradali e ferroviarie e spazi accessori	122	1	0	0	0
aree portuali	123	0	0	0	0
aeroporti	124	1	0	0	0
aree estrattive	131	1	0	0	0
discariche	132	1	0	0	0
cantieri	133	0	0	0	0
aree verdi urbane	141	3	0	2	2
aree sportive e ricreative	142	2	0	1	2
seminativi in aree non irrigue	211	3	2	1	1
seminativi in aree irrigue	212	3	2	1	1
risaie	213	3	1	0	0
vigneti	221	2	1	1	2
frutteti e frutti minori	222	3	1	2	2
oliveti	223	2	1	1	2
prati stabili	231	3	1	2	2
colture annuali associate a permanenti	241	3	2	1	1
sistemi colturali e particellari complessi	242	3	1	1	1
aree prevalentemente occupate da colture a	243	2	2	1	2
aree agroforestali	244	3	1	1	1
boschi di latifoglie	311	4	2	4	5
boschi di conifere	312	4	2	4	5
boschi misti	313	5	2	4	5
aree a pascolo naturale e praterie d'alta quo	321	4	1	3	3
brughiere e cespuglieti	322	4	1	3	5
aree a vegetazione sclerofilla	323	3	1	2	3
aree a vegetazione boschiva e arbustiva in e	324	3	1	2	2
spiagge, dune, sabbie	331	1	0	0	3
rocce nude, falesie, rupi, affioramenti	332	1	0	0	2
aree con vegetazione rada	333	1	0	0	1
aree percorse da incendi	334	1	0	0	0
ghiacciai e nevi perenni	335	0	0	1	2
paludi interne	411	3	1	1	1
torbiere	412	4	1	2	3
paludi salmastre	421	3	0	1	1
saline	422	0	0	1	1
corsi d'acqua, canali e idrovie	511	3	1	1	5
bacini d'acqua	512	3	1	1	5
lagune costiere	521	3	2	1	4
estuari	522	3	2	1	3
fascia marina costiera	523	2	1	1	3

SCALE OF VALUES	
0	no capacity
1	low capacity
2	relevant capacity
3	average capacity
4	high capacity
5	very high capacity

MACRO-PHASE 2

Identification of land uses that maximize the *ecosystem erosion control* (SRec) service in areas of high and very high hazard;

- the classification of land uses providing the ecosystem service SRec;

- the identification of high (P3) or very high (P4) hazard areas mapped by *Hydrogeological Basin Authorities*;

- the intersection between the patches that maximize the SRec service in combination with the high-hazard areas (P3) and very high-hazard areas (P4).

MACRO-PHASE 3

Designing a network that maximizes the multi-functionality of the GIs.

involves the design of networks capable of connecting patches that maximize the combination of IE and SRec.

Cost distance analysis

$$I_e = i^{\cos^k \alpha}$$

LEGEND

Hydrographic basin former 'Central Campania' Basin Authority
Administrative boundary of Campania Region
Italy
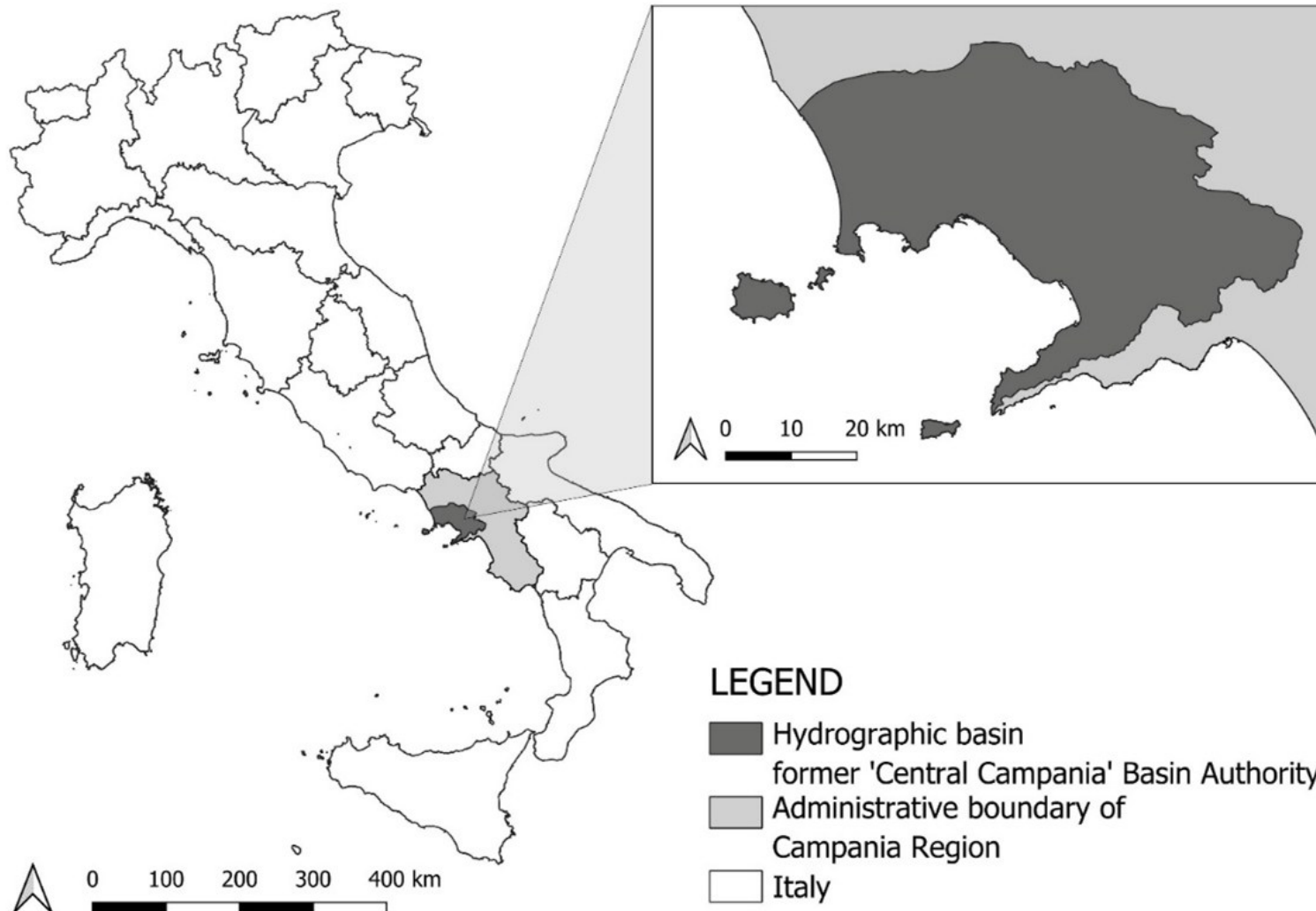
135,800 ha of land in high hazard (P3)
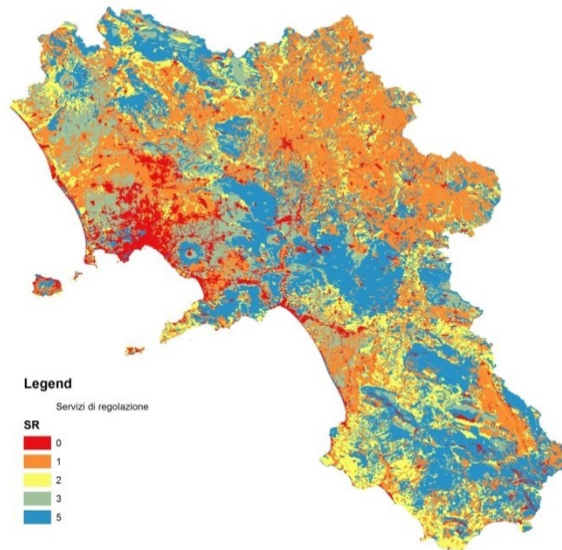131,500 ha of land in very high hazard (P4)

Regarding the P3 and P4 hazardous areas, the wooded areas constitute the most significant land use type (126,279 hectares), equal to 20,5% of the total landslide areas.
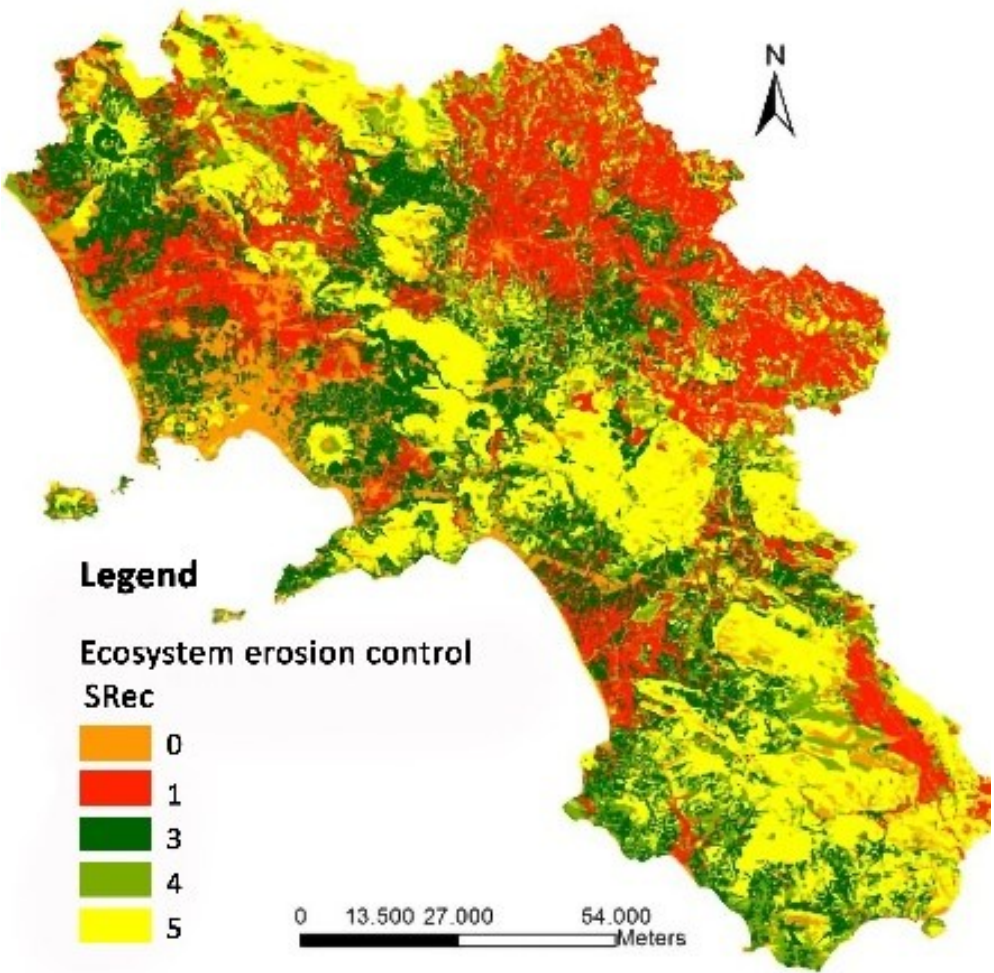
Evaluation of ESs offered by the different types of land use

Ecological Integrity (EI)

Regulating (SR),

Provisioning (SA)

Cultural (SC)

Classification of land uses providing the ecosystem service SRec

Legend

Ecosystem erosion control
SRec
- 0
- 1
- 3
- 4
- 5

0   13.500 27.000   54.000 Meters
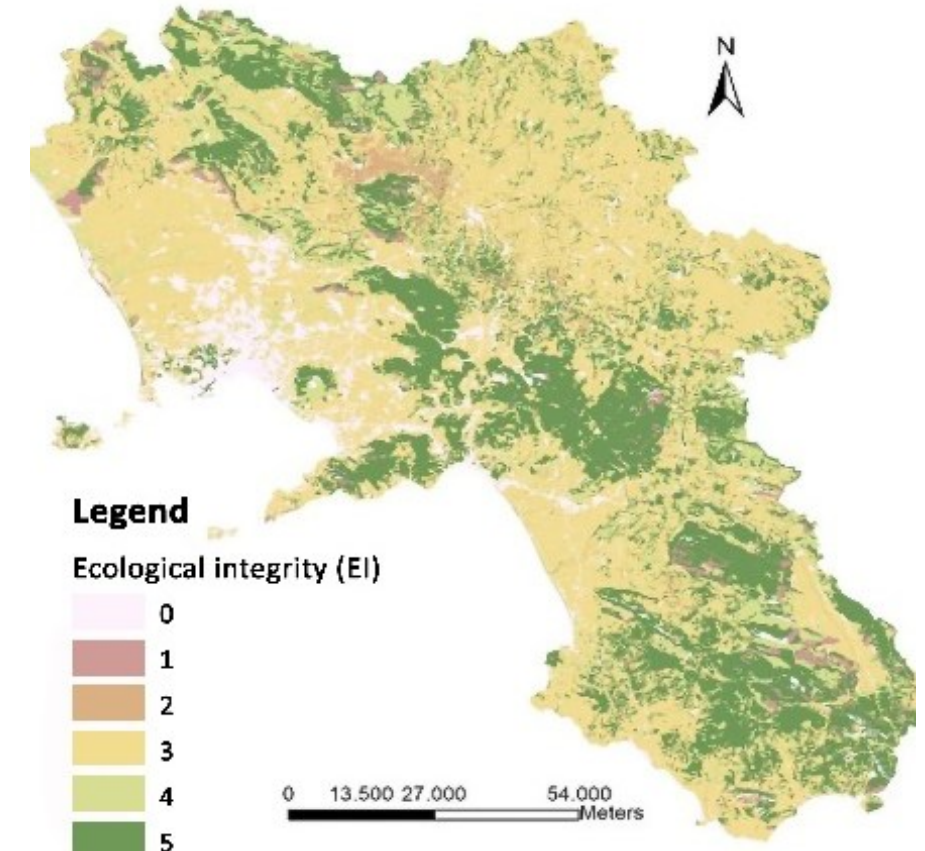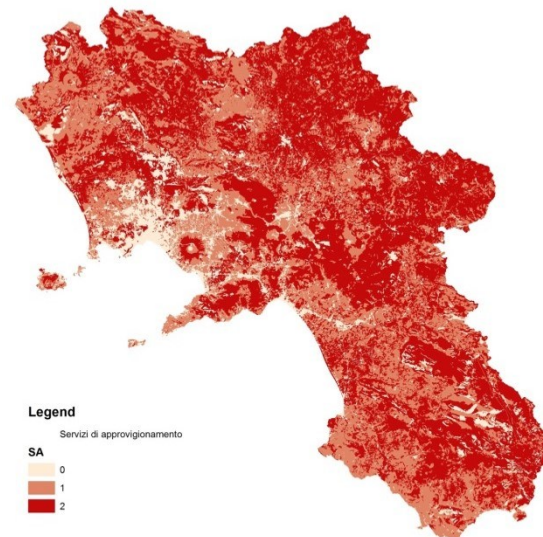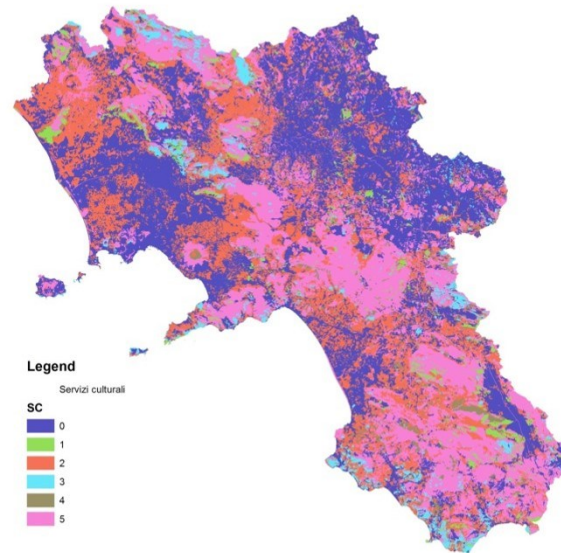
Percentage of attributing score for each soil cover

Level	Capacity	El [%]	SR [%]	Srec [%]	SA [%]	SC [%]
0	no	8	8	11	10	36
1	low	2	33	24	37	3
2	relevant	2	17	-	53	26
3	average	49	14	23	-	4
4	high	11	-	11	-	2
5	very high	28	28	31	-	29

Identification of high (P3) or very high (P4) hazard areas

LEGEND

☐ hydrographic basin of the former 'Central Campania' basin authority

🟥 P3 and P4 hazard areas

0 5 10 km
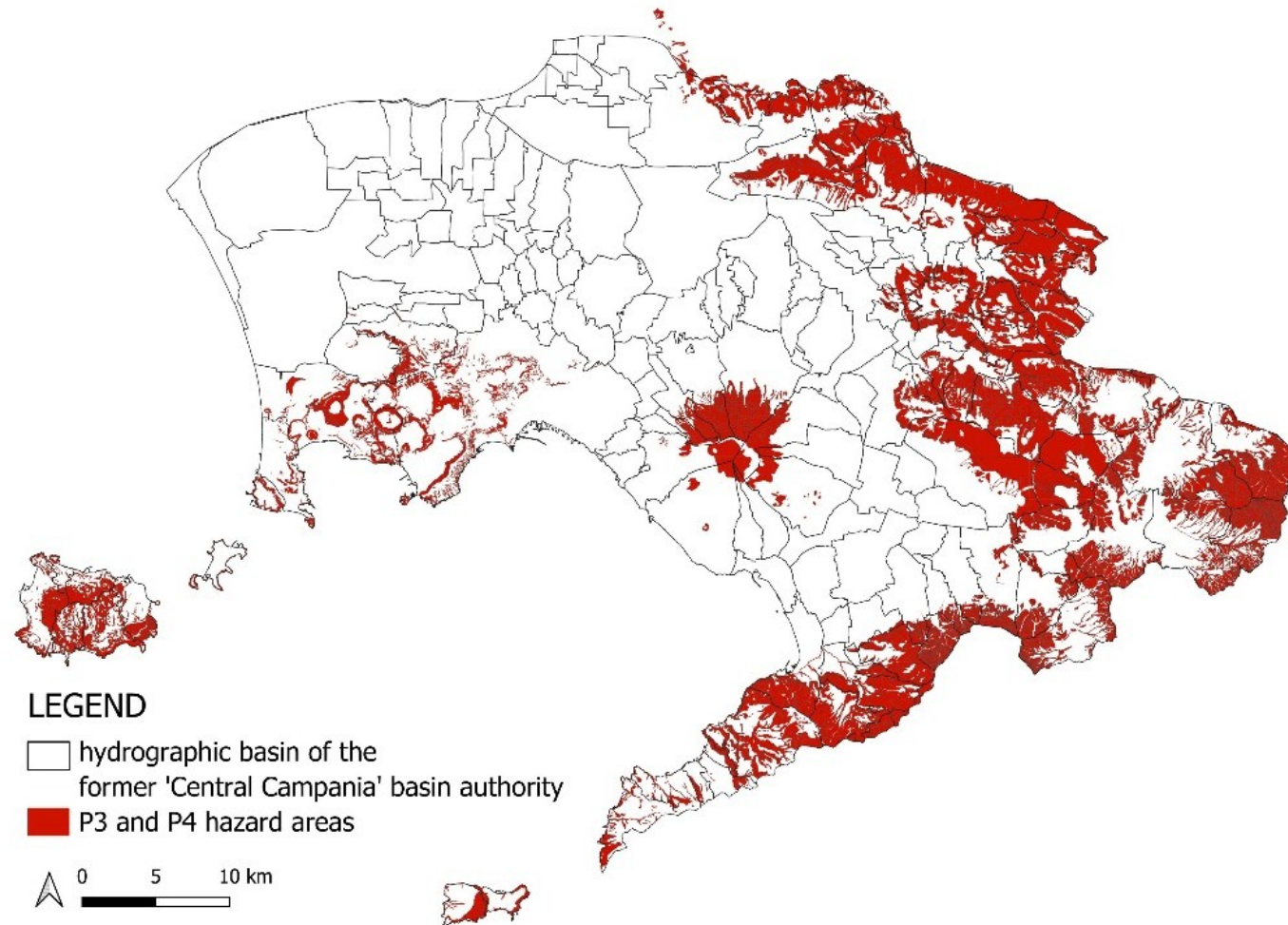
Identification of high (P3) or very high (P4) landslide hazard areas mapped by Hydrogeological Basin Authorities;
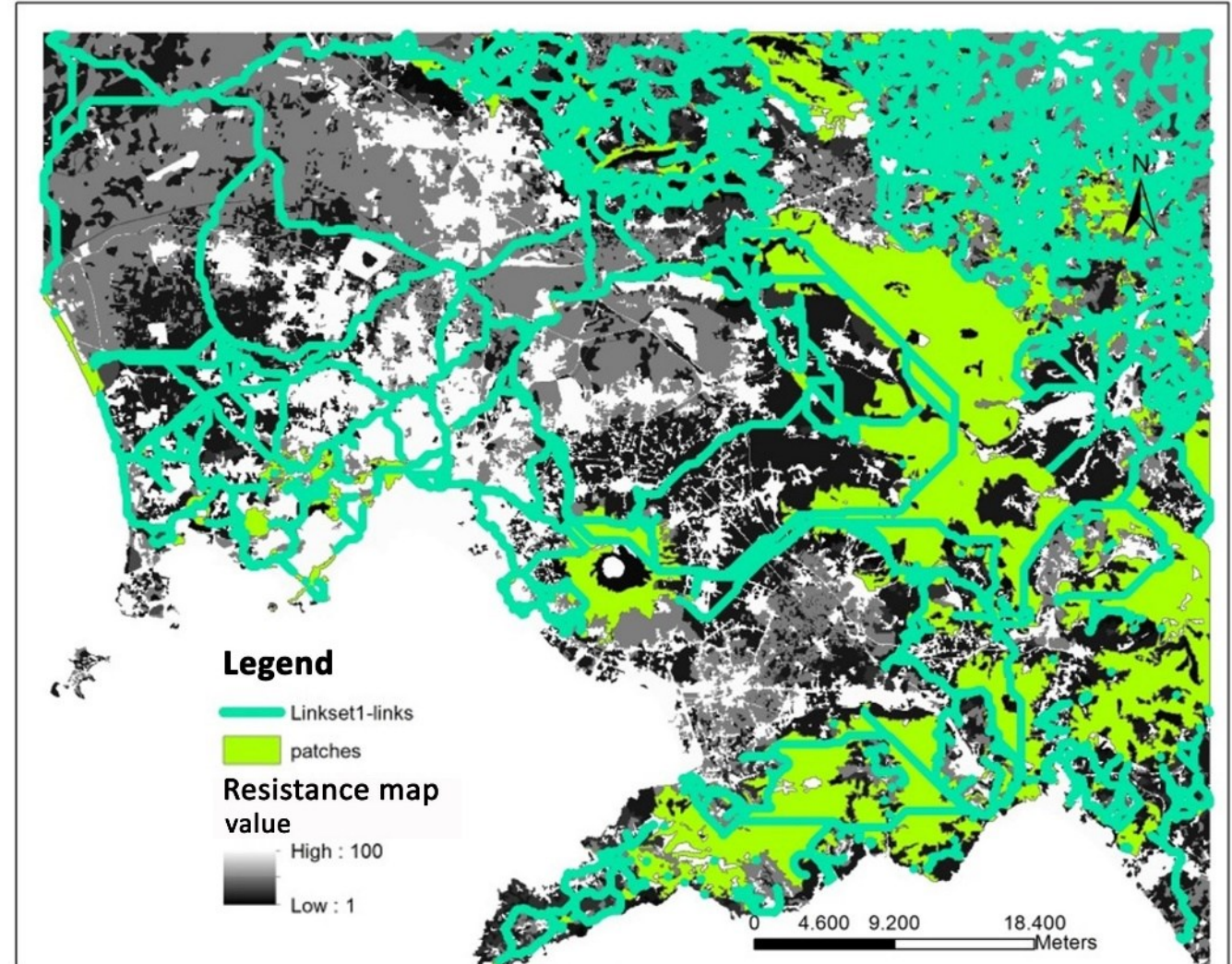
Intersection between the SRec with the P3 and P4 areas
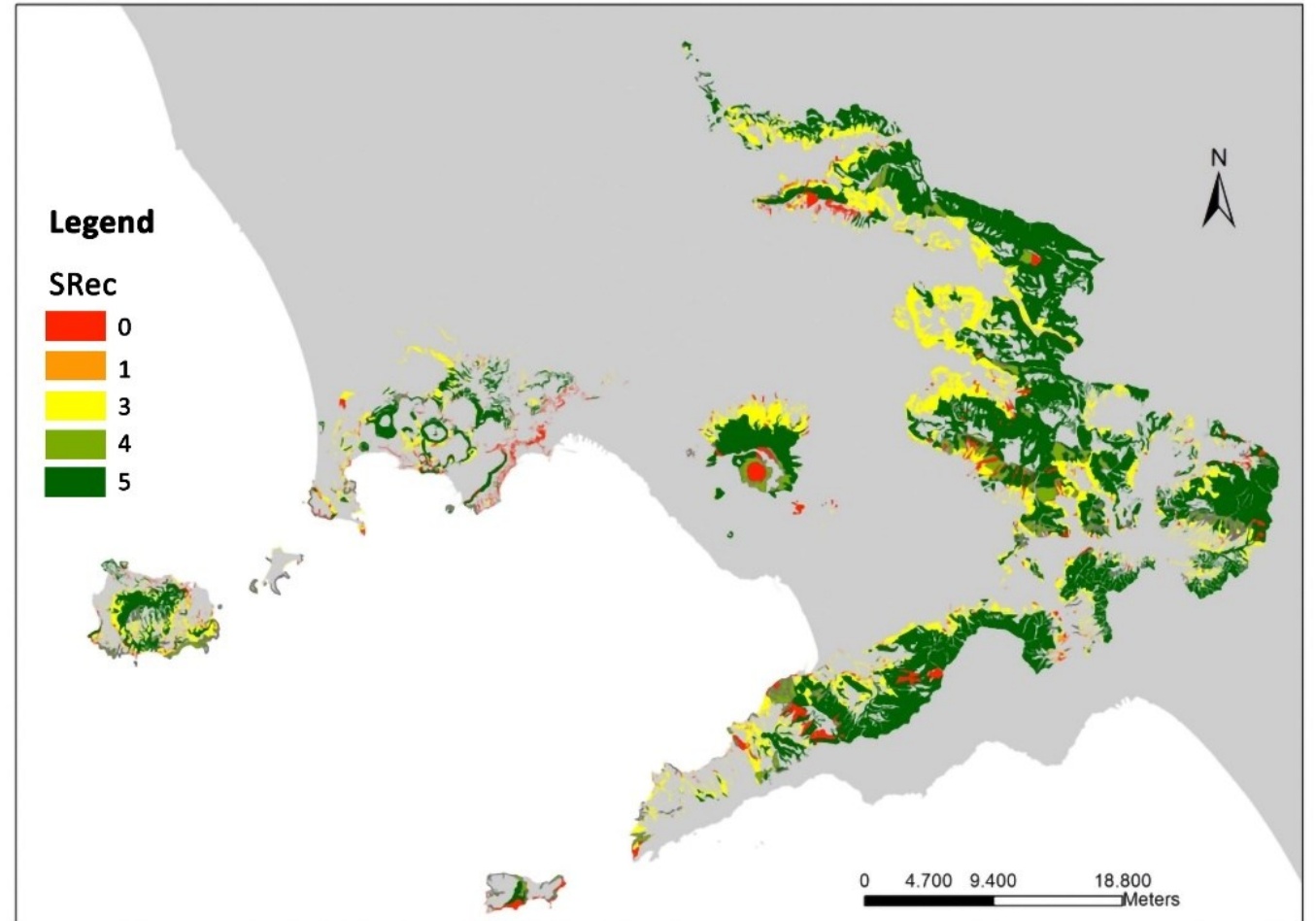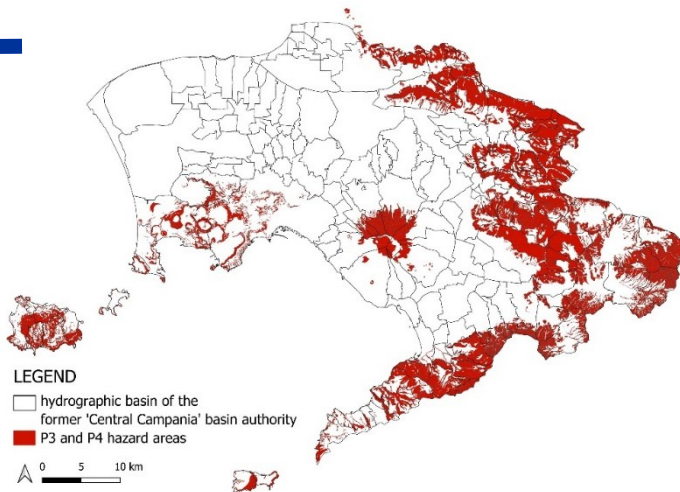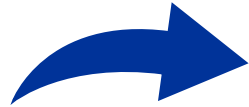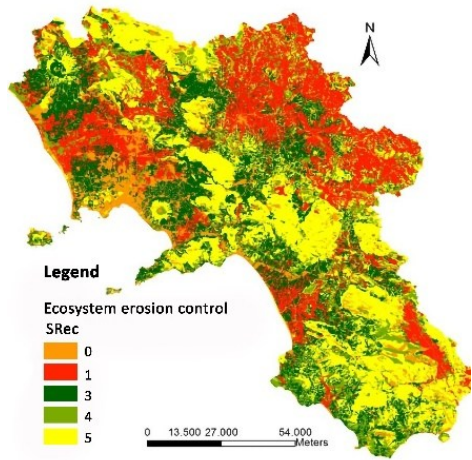
Intersection of the patches that maximize the SRec and the P3 and P4 areas

Map the networks by using cost-distance analysis

Overlap map
network that maximises
the ESs IE - SRec

CONCLUSIONS

- To achieve the resilience of a territory, it is very important to promote the mainstreaming of risk assessments into land-use policy development and implementation, including into urban planning;

- The methodology therefore provides a new way of drawing the GIs;

- The challenge is to ensure that well-planned GIs provide functions that meet numerous planning objectives and become an integral part of public policy.

THE INTERNATIONAL CONFERENCE ON COMPUTATIONAL SCIENCE AND ITS APPLICATIONS

ICCSA 2024

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THANK YOU FOR YOUR KIND ATTENTION!

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