Atlas of ecological connectivity and the main barriers in the Dinarides and between Alps and Dinaric Mountains

Deliverable T1.3.2

Peter Laner, Filippo Favilli (Eurac Research)

August 2022

Project:

DINALPCONNECT (865) https://dinalpconnect.adrioninterreg.eu

Funding:

European Regional Development Fund and IPA II fund
https://www.adrioninterreg.eu/

WP, Task and Deliverable:

Deliverable T1.3.1 Report on ecological connectivity assessment within the project area and in transboundary Pilot regions

Authors

Peter Laner, Filippo Favilli
Eurac Research – Institute for Regional Development

Acknowledgements:

We would like to acknowledge the DINALPCONNECT Project partners and external GIS experts for the cooperation and valuable inputs during the elaboration of the spatial model and the evaluation process of ecological linkages.

How to cite

Laner P., Favilli F. (2022): Atlas of ecological connectivity and the main barriers in the Dinarides and between Alps and Dinaric Mountains.EU Interreg Adrion; DINALPCONNECT project.

Date:

August 2022

Content

List of Maps

List of Tables

1 Introduction

1.1 The DinAlpConnect Atlas

This atlas presents a set of maps indicating priority areas for ecological connectivity and the main barriers hindering EC in the Dinarides and between Alps and Dinaric Mountains.

The methodologies for the maps are presented in the following deliverables:

T1.2.1 - Spatial data availability and GIS model used to assess ecological connectivity,
downloadable from Link T1.2.1.

T1.3.1 - Report on ecological connectivity assessment
Downloadable from Link T1.3.1.

Additional to the printed maps presented in this atlas, a WebGIS with the most important results was elaborated. With these online maps, it is possible to discover the ecological connectivity situation more in detail for each country and region.

WebGIS link:

https://maps.eurac.edu/maps/1140/view

The WebGIS will be continuously updated until the project ends. This concerns visualized data, metadata, layer symbology, and permission rights to view and download data. The map is viewable for anyone from the beginning, download permissions will be given to a later stage.

1.2 Spatial focus

The DinAlpConnect project area has a wide north – south extension of 1.300 km and spans from Italy to Greece. It has a bigger area than the Alpine Convention perimeter or the Carpathians and includes eight countries.

Comparison between mountain ranges:

- DinAlpConnect project area: ~275.000 km²
- Carpathians: ~210.000 km²
- Alpine Convention: ~190,700 km²
- Alpine space: ~450.000 km²

The four pilot sites of the project will be presented in the chapter “Transboundary pilot regions”.

DinAlpConnect project area and pilot regions for spatial models

Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 14.09.2021

Sources: Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 1: DinAlpConnect project area and pilot regions for spatial models

2 Ecological connectivity in the macroregional project area

2.1 Landscape permeability & Strategic Connectivity Areas

The following maps (map 2-6) are showing the most important results on landscape permeability at a macro-regional scale, including all eight countries.

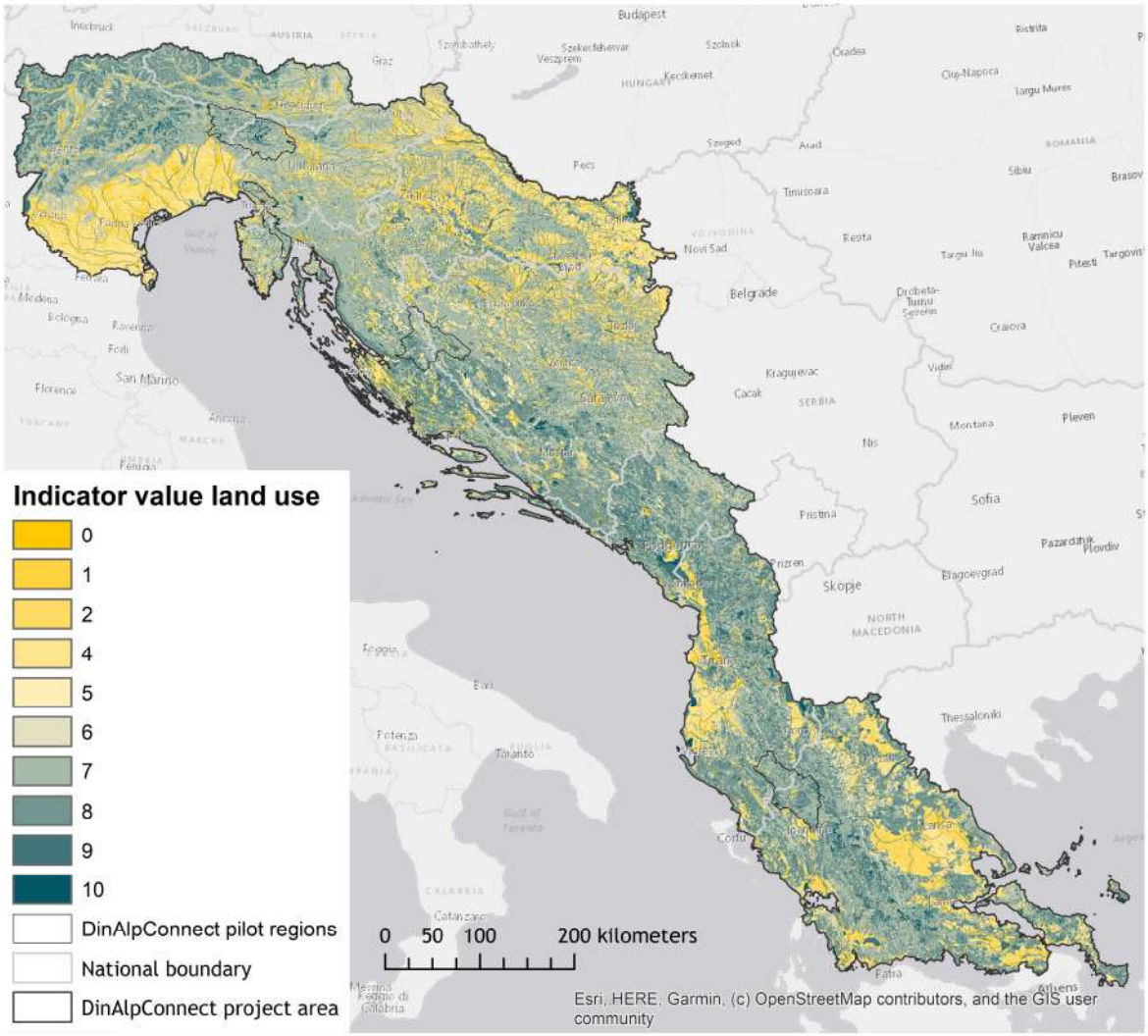
The landscape permeability is firstly shown by five separate indicators: Land use, population, fragmentation, protection, and topography. Among them, Land use and population pressure are the most important ones.

For each indicator, a low permeability is represented in dark yellow (indicator value 0) to light yellow (indicator value 5) and good permeability values are represented in light green (indicator value 6) to dark blue/green (indicator value 10).

The Continuum Suitability Index (CSI) in map 7 is a comprehensive index consisting of the five mentioned indicators for showing which areas are suitable for protection and which are the main barriers for ecological connectivity. Blue/green colors are indicating a high connectivity character of the landscape, yellow areas are indicating artificial areas, which are hindering connectivity.

The following Strategic Alpine Connectivity Areas (SACAs) (map 8) result from the Continuum Suitability Index.
Ecological Conservation Areas (SACA1) are expected to have a high biological value (blue color). Often, they consist of protected areas, but in Bosnia & Herzegovina, Montenegro and Albania, many of them are not yet protected (map 9).
Ecological Intervention Areas (SACA2) are the most important ones for improving connectivity and implementing connectivity measures (light yellow color).
Ecological Restoration Areas (SACA3) are those ones, where ecological movements are not possible at the current stage and where it is necessary to implement restoration measures. These areas are currently the main barriers (dark yellow color).

Land use indicator (LAN)

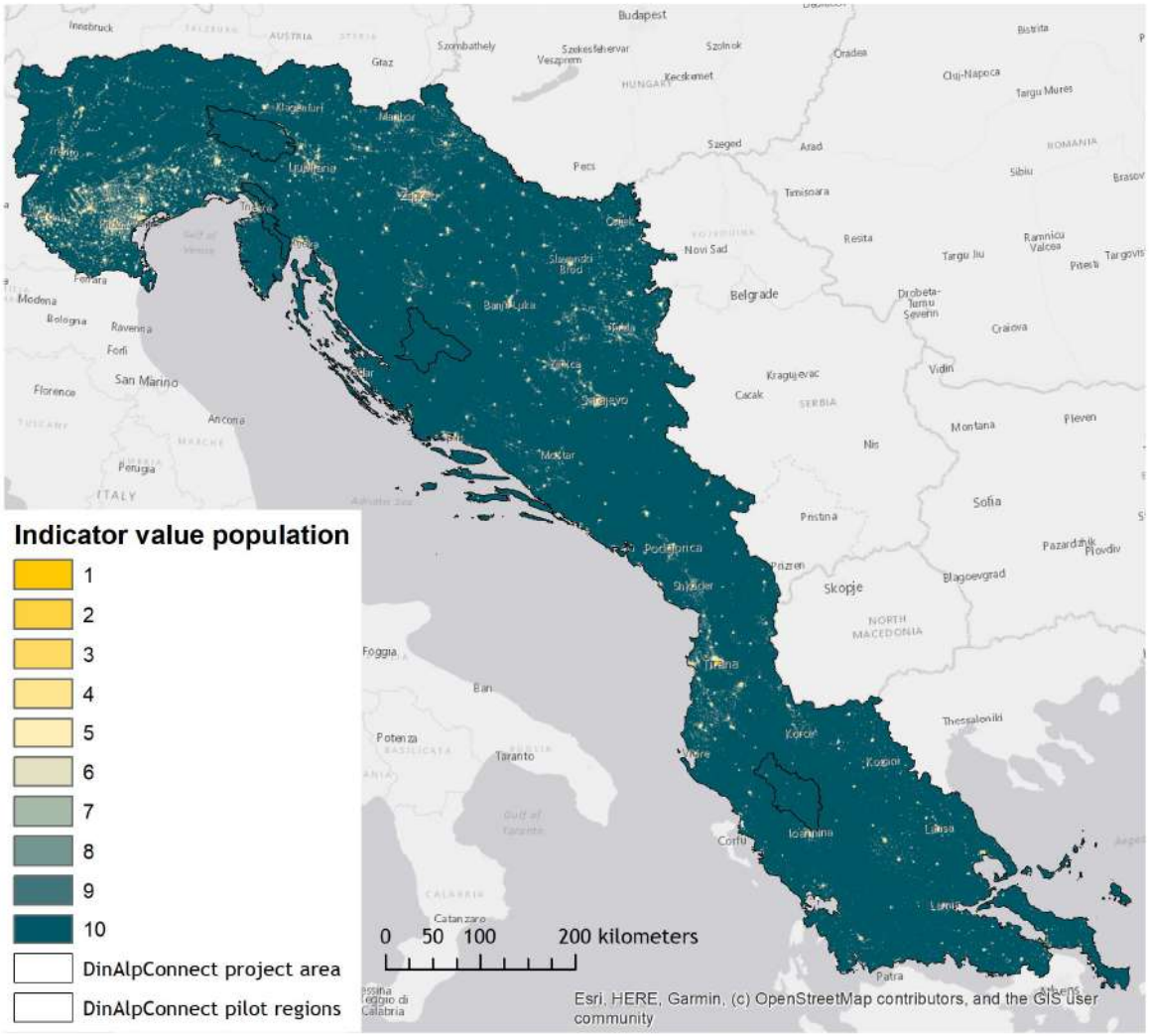


Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 04.11.2021

Sources: Landcover indicator based on Corine Land Cover 2018; Eurogeographics 2019, OpenStreetMap Contributors, Faculty of Natural Science, department of Geography Sarajevo; Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 2: Land use suitability indicator

Population indicator (POP)

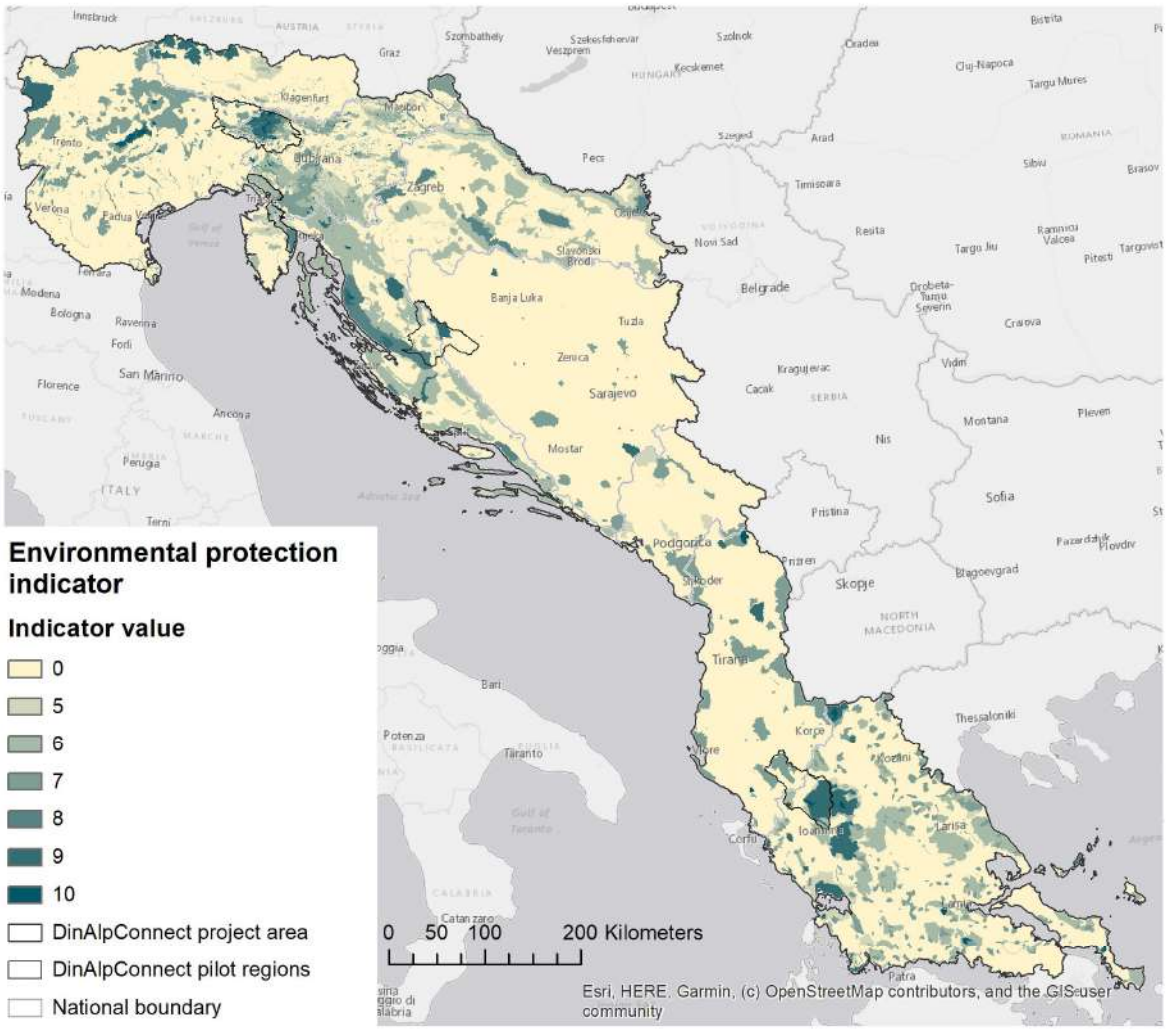


Eurac Research
Institute for Regional Development
Cartography: Peter Laner

Sources: Population pressure based on GESOSTAT Population Grid 2011, DEGURBA dataset 2018 and national statistical offices; Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 3: Indicator for population pressure

Environmental protection indicator (ENV)

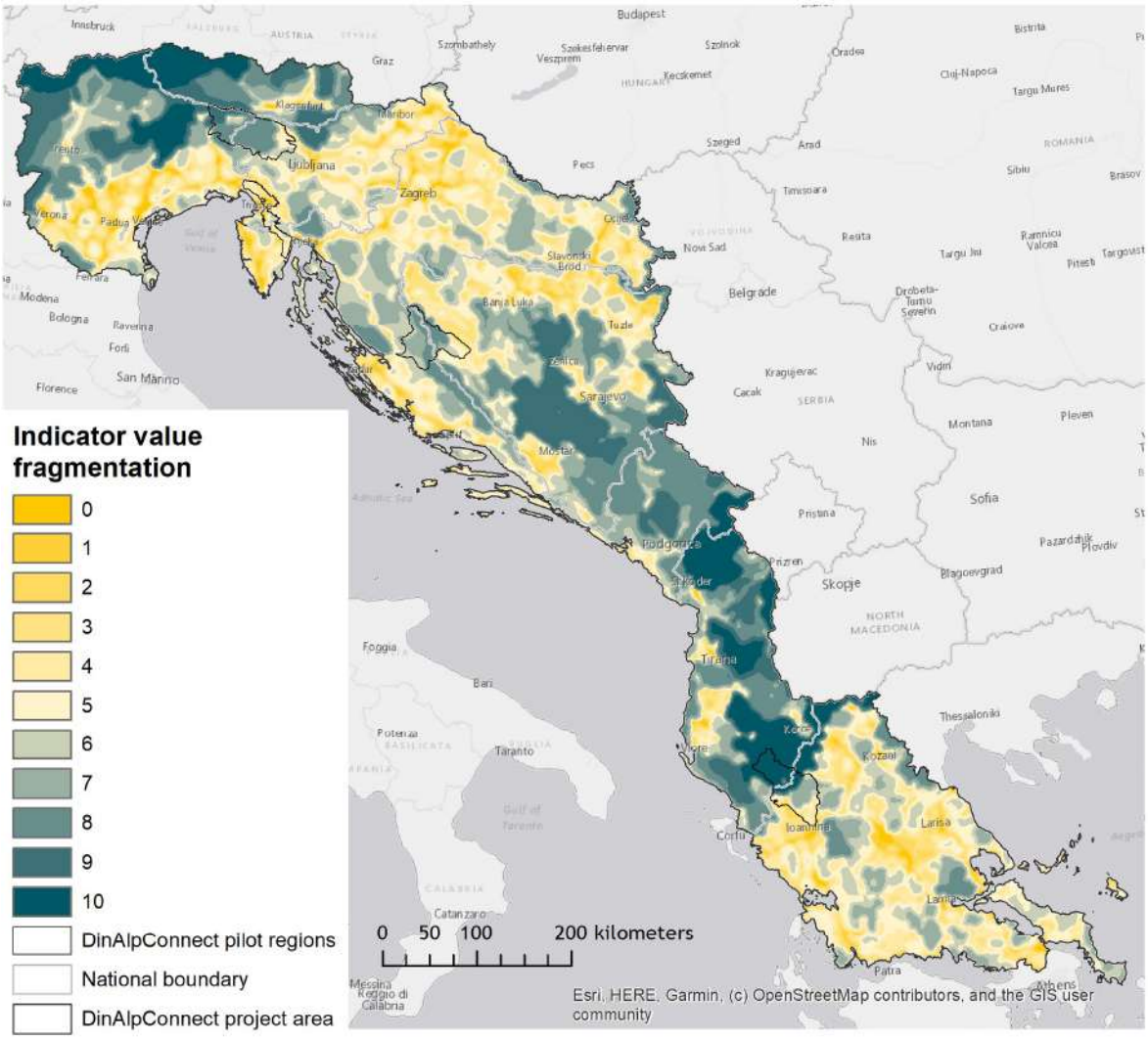


Eurac Research
Institute for Regional Development
Cartography: Peter Laner

Sources: Environmental protection indicator based on World database of protected areas, CDDA and national data repositories; Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 4: Indicator for environmental protection

Fragmentation indicator value (FRA)

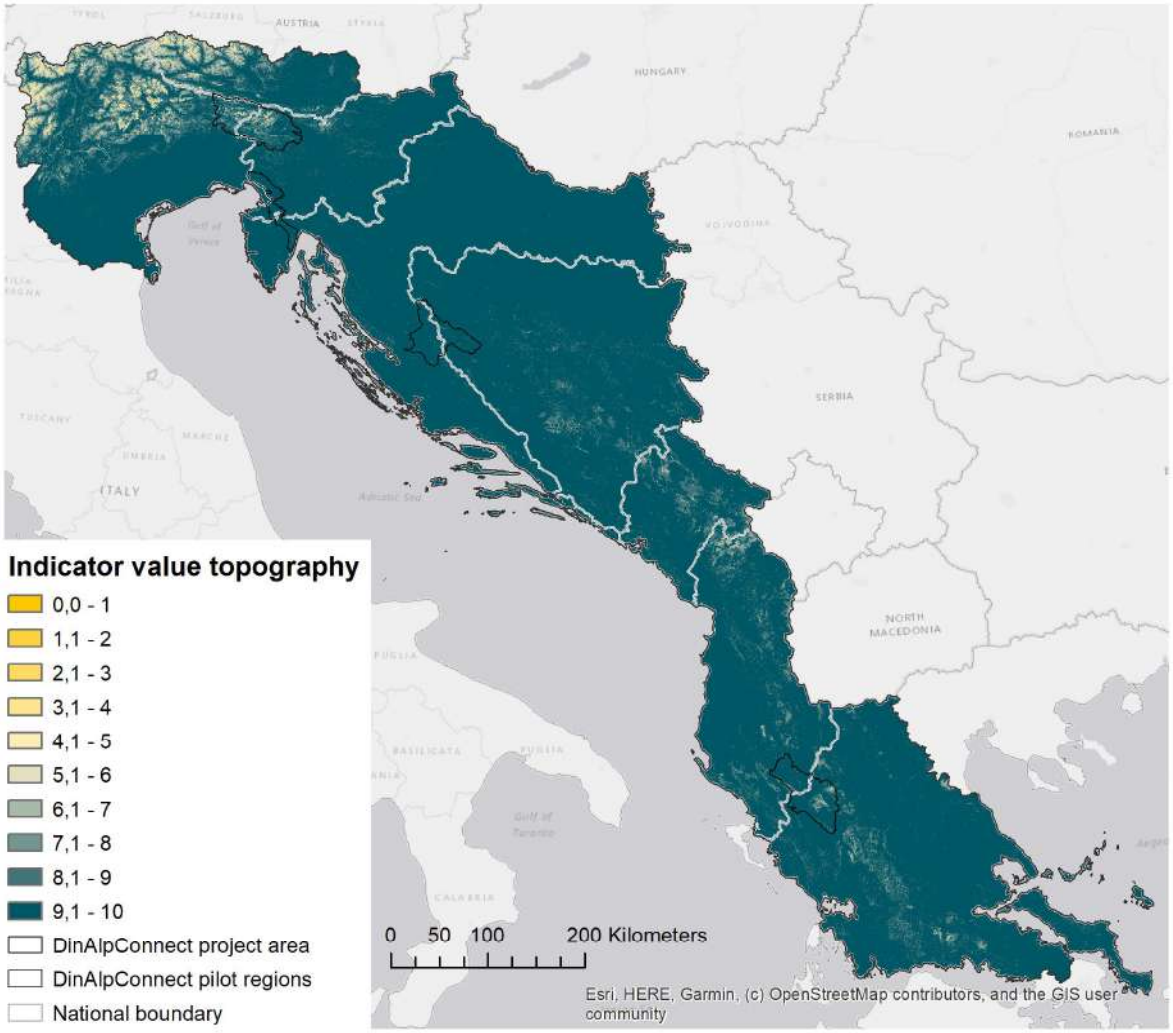


Eurac Research
Institute for Regional Development
Cartography: Peter Laner

Sources: Fragmentation indicator based on European Global Map of Eurogeographics 2019, OpenStreetMap.org & geofabric.de 2020, Repository of Cener21, Corine Land Cover 2018; Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 5: Fragmentation of the landscape

Topography indicator (TOP)

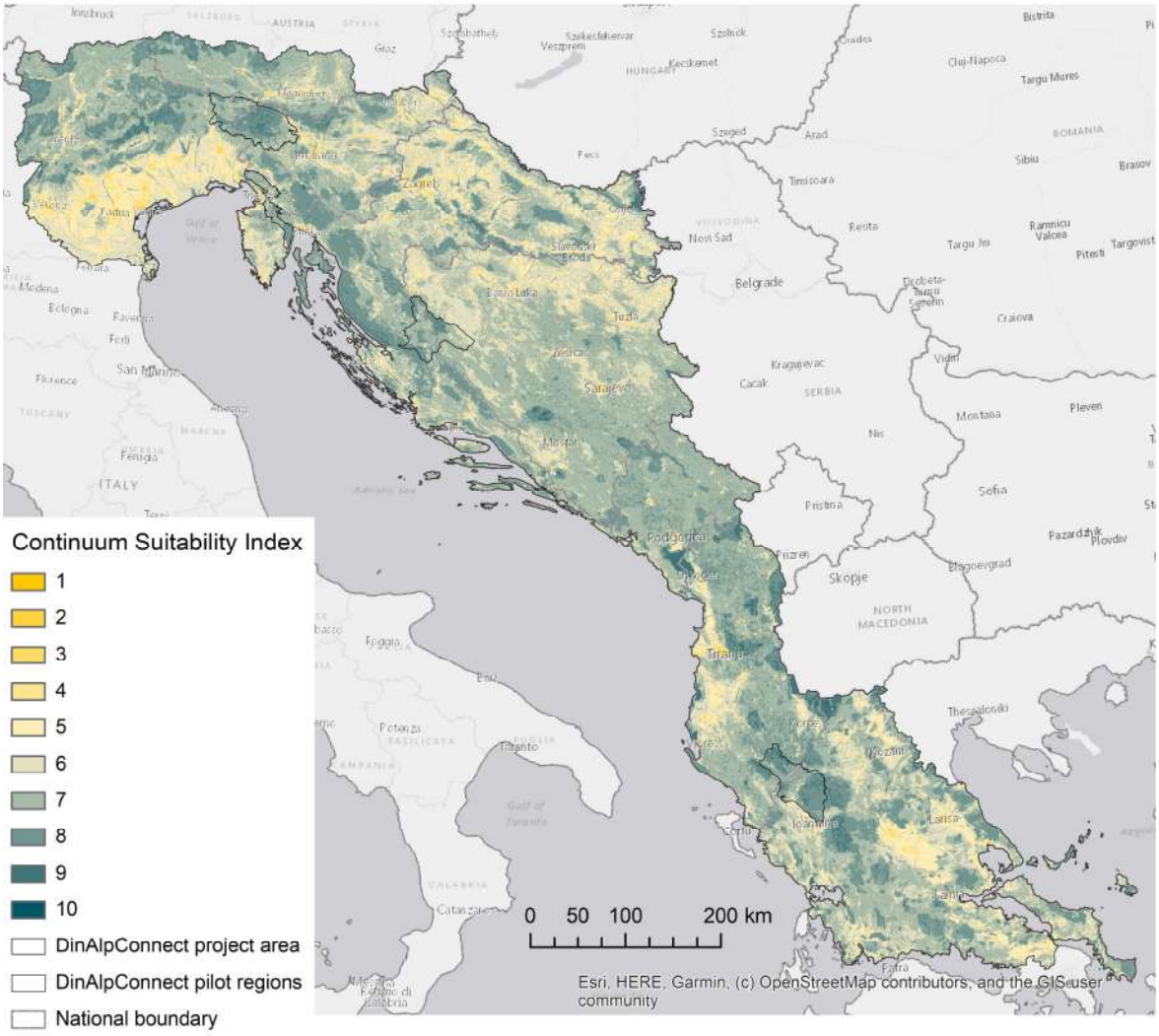


Eurac Research
Institute for Regional Development
Cartography: Peter Laner

Sources: Topography indicator based on European Digital Elevation Model (EU-DEM); Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 6: Topography indicator

Continuum Suitability Index (CSI)

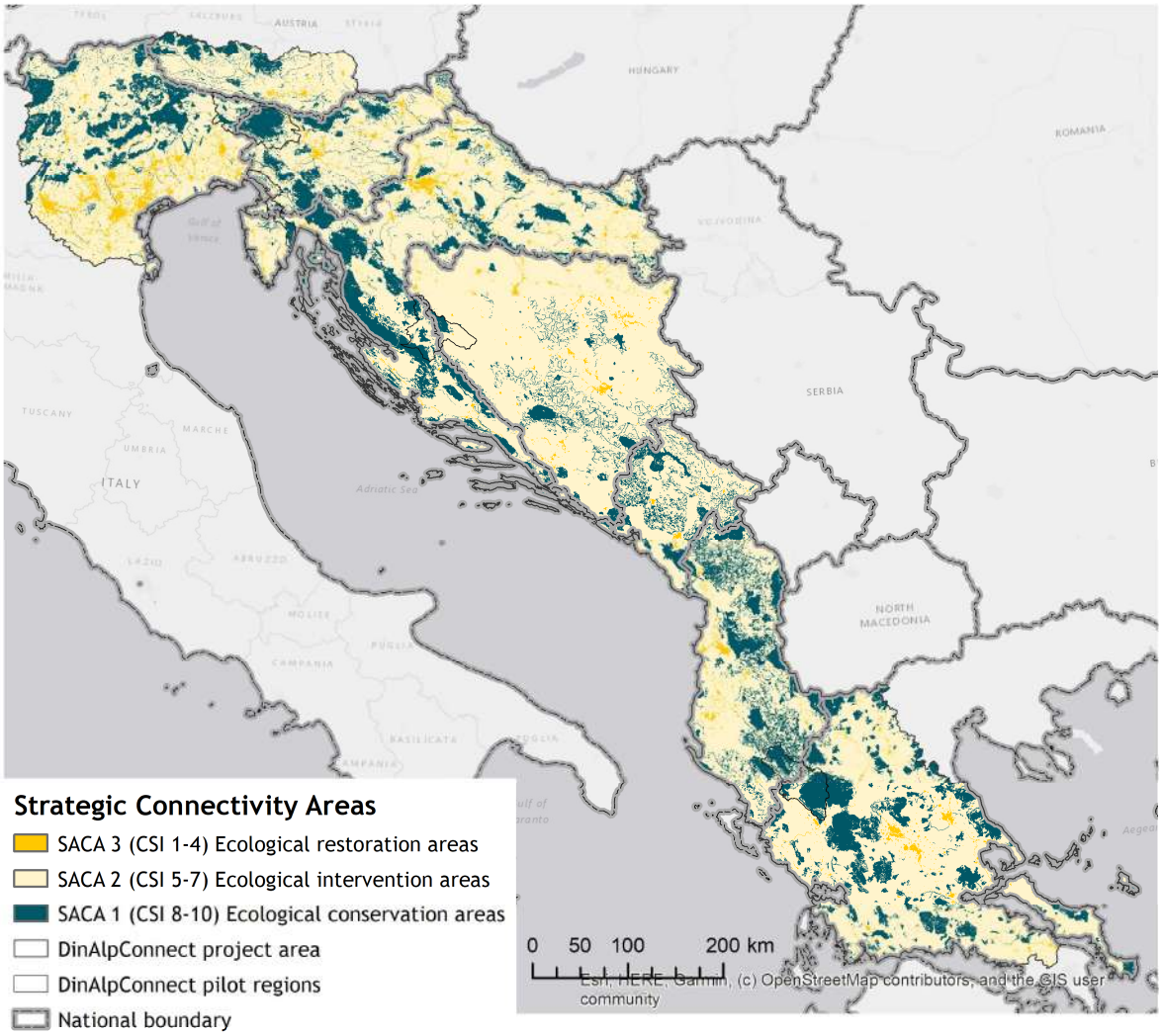


Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 04.11.2021

Sources: Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 7: Continuum suitability index

Strategic Connectivity Areas based on the Continuum Suitability Index (CSI)

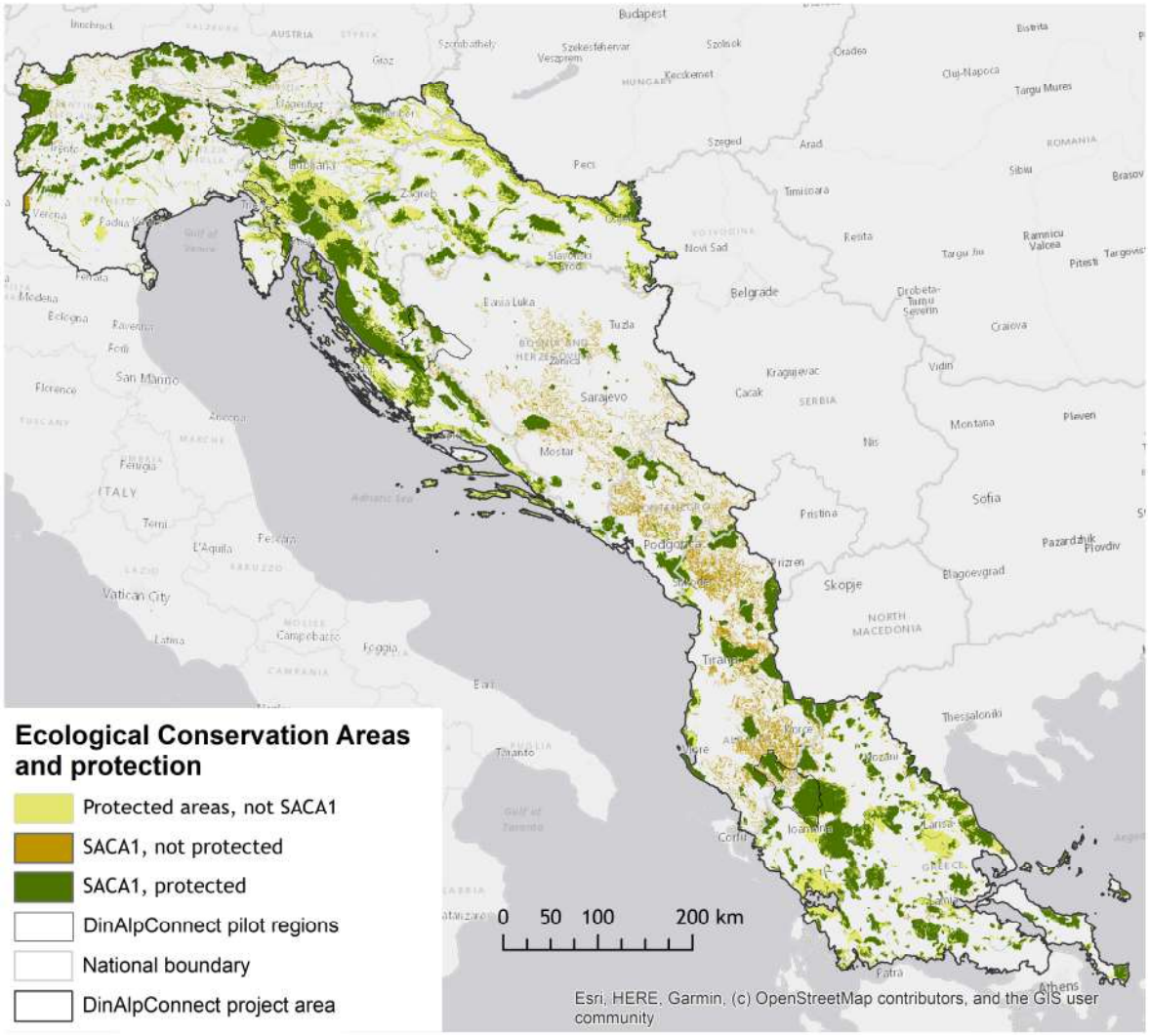


Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 04.11.2021

Sources: Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 8: Strategic Connectivity Areas

Overlay of Ecological Conservation Areas (SACA1) and protected areas



Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 08.11.2021

Sources: Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 9: Ecological Conservation Areas and protected areas

2.2 Ecological linkages and their priorities for protection

Ecological linkages are showing the best path for a variety of species to move between two ecological conservation areas (map 10). The macro-regional corridor in map 11 was a tentative to show which is the best South-North-connection for species on land.

The maps of the priority assessment are showing, on which linkages we should put the focus for protection measures. This consists of two dimensions: firstly, the biological value, and secondly “thread and opportunity”.

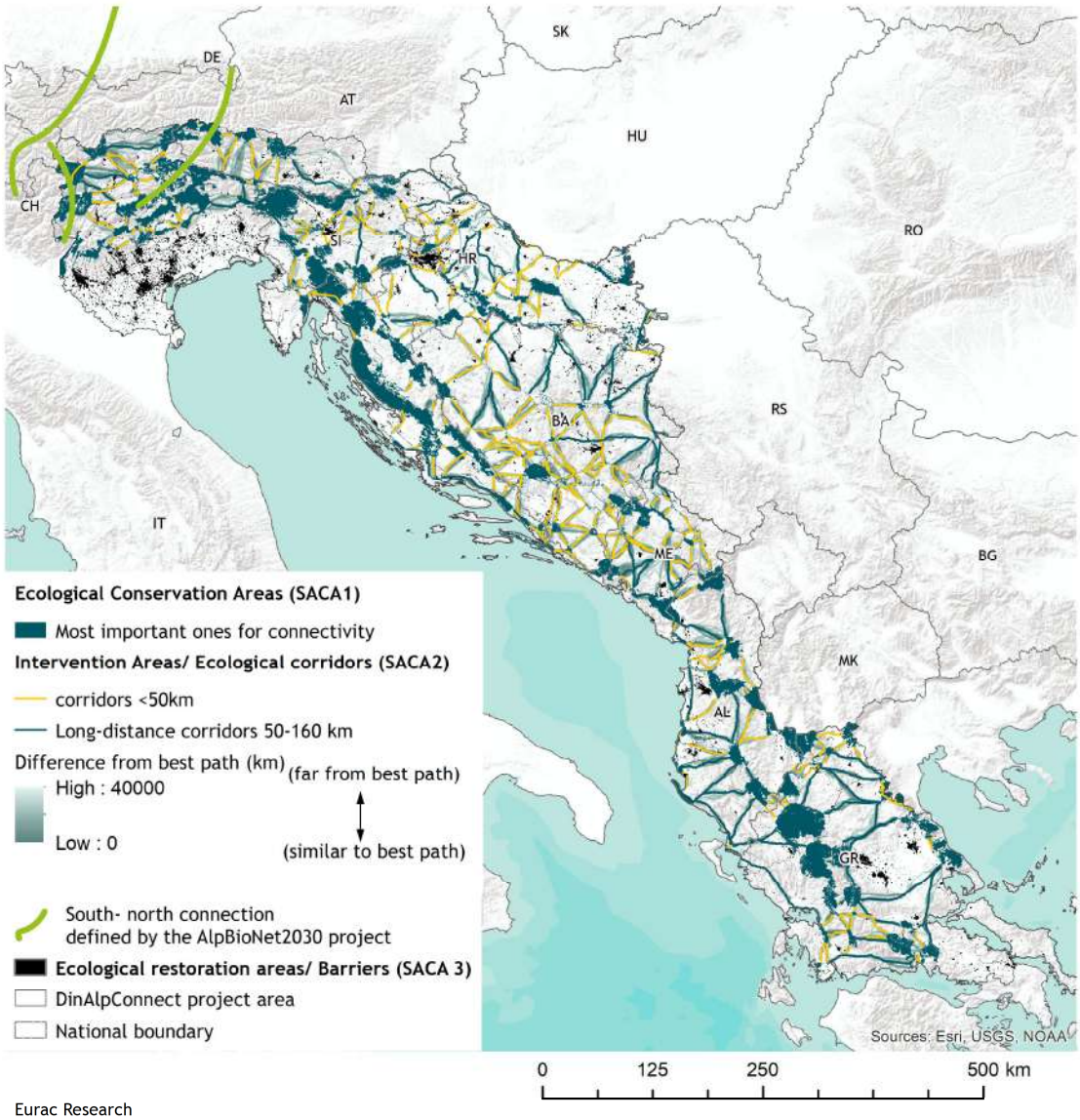
The biological value (map 15) is a combination of the interaction intensity (map 12), the centrality of the linkage within the network (map 13) and the importance for the south-north connection (map 14). It ranges between 0 and 100. A low biological value (23-24) is indicating linkages connecting small ecological conservation areas, far from each other, not important to keep the network together and not on the best path for a straight south- north connection. A high biological value (75-100) is indicating linkages of big ecological conservation areas in near proximity at the center of the network, and with a certain importance for the south-north connection.

Threads and opportunities are showing corridors at risk to get lost and those with an ongoing active conservation effort, which would have a big potential to be conserved in the near future.

Map 16 is showing opportunities for connections with other macro-regional corridors like e.g., the well-known European Green Belt. Map 17 is showing linkages passing through protected areas as assumption of existing conservation efforts. Map 18 shows threatened linkages by highway infrastructure projects or urbanization threads of the identified linkages. Map 19 gives a summary of the dimension “threads and opportunities” dividing the linkages into eight categories.

The final ecological connectivity assessment is represented in map 20. Linkages with the highest priority for conservation are of “Type 1”. These are important corridors at risk or with an already existing conservation effort. Linkages of “Type 3” are rather unimportant because of the low biological value and low protection potential. Linkages of “Type 2” have a small biological value, but big potential for protection. “Type 4” -linkages have a high biological value and no current risks.

Regional corridors connecting most important Ecological Conservation Areas

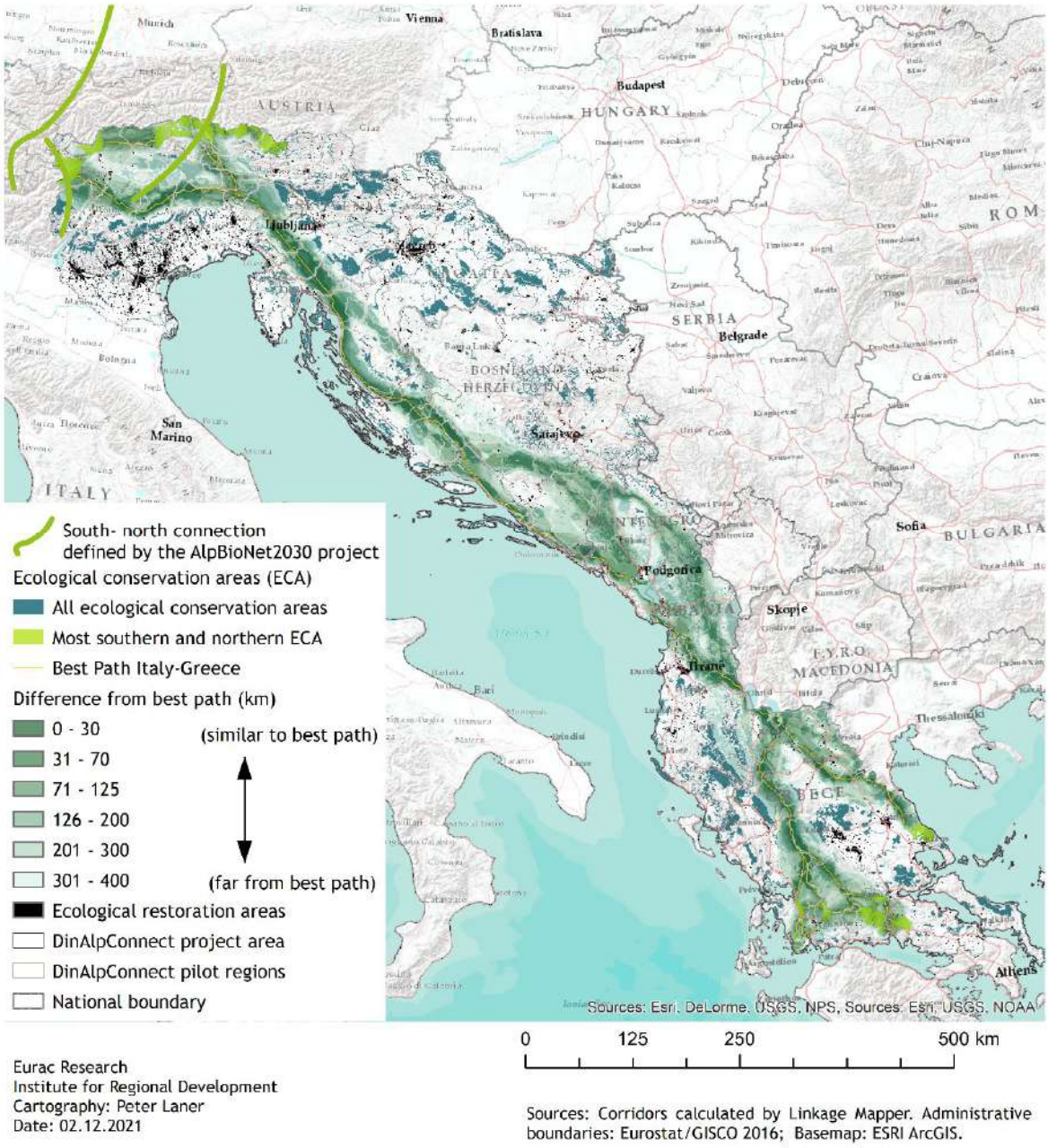


Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 16.02.2021

Sources: Corridors calculated by Linkage Mapper. Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

Map 10: Regional ecological linkages connecting most important Ecological Conservation Areas

Macro-regional corridor for the connection of southern to northern Ecological Conservation Areas

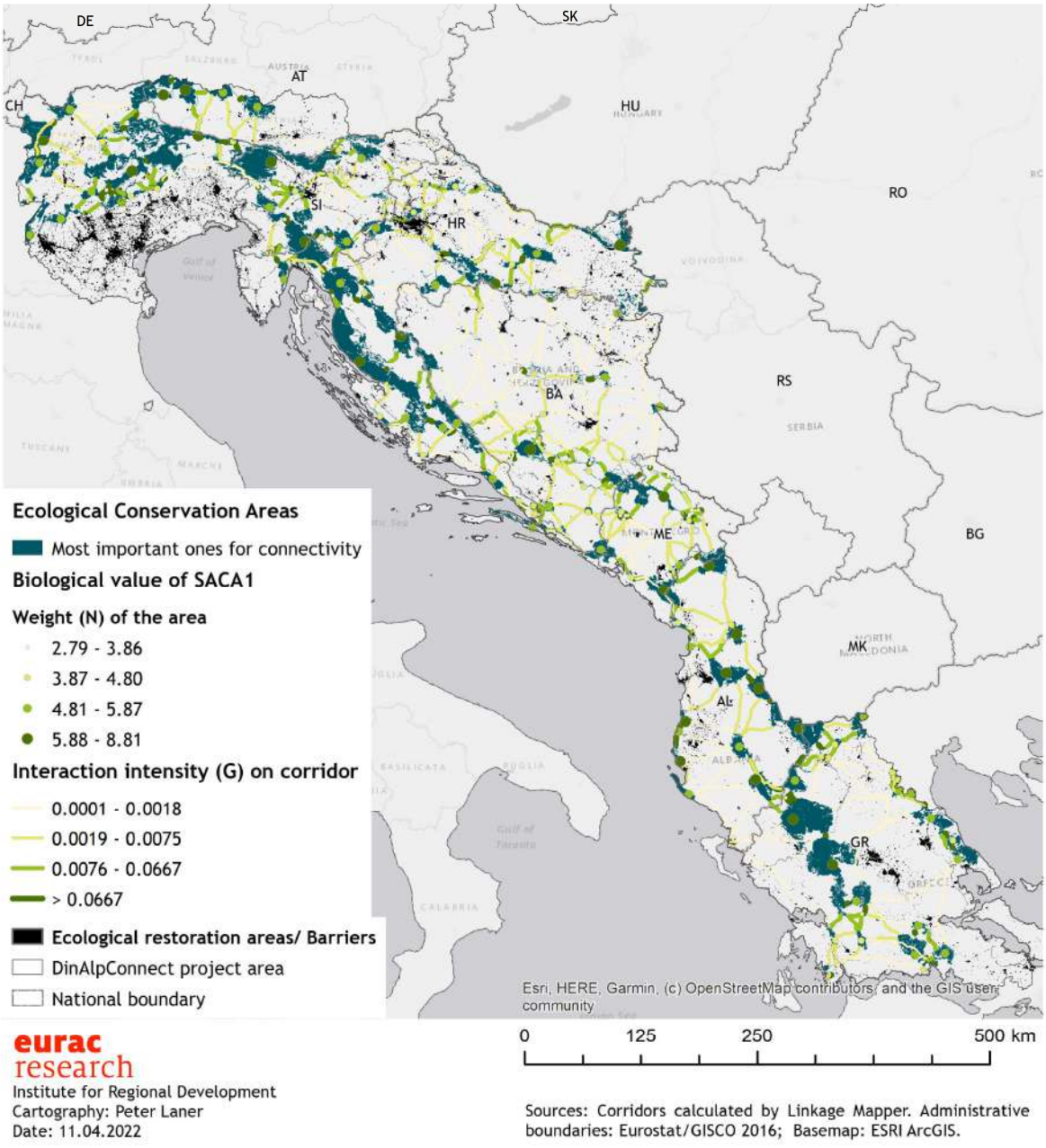


Eurac Research
Institute for Regional Development
Cartography: Peter Laner
Date: 02.12.2021

Sources: Corridors calculated by Linkage Mapper. Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

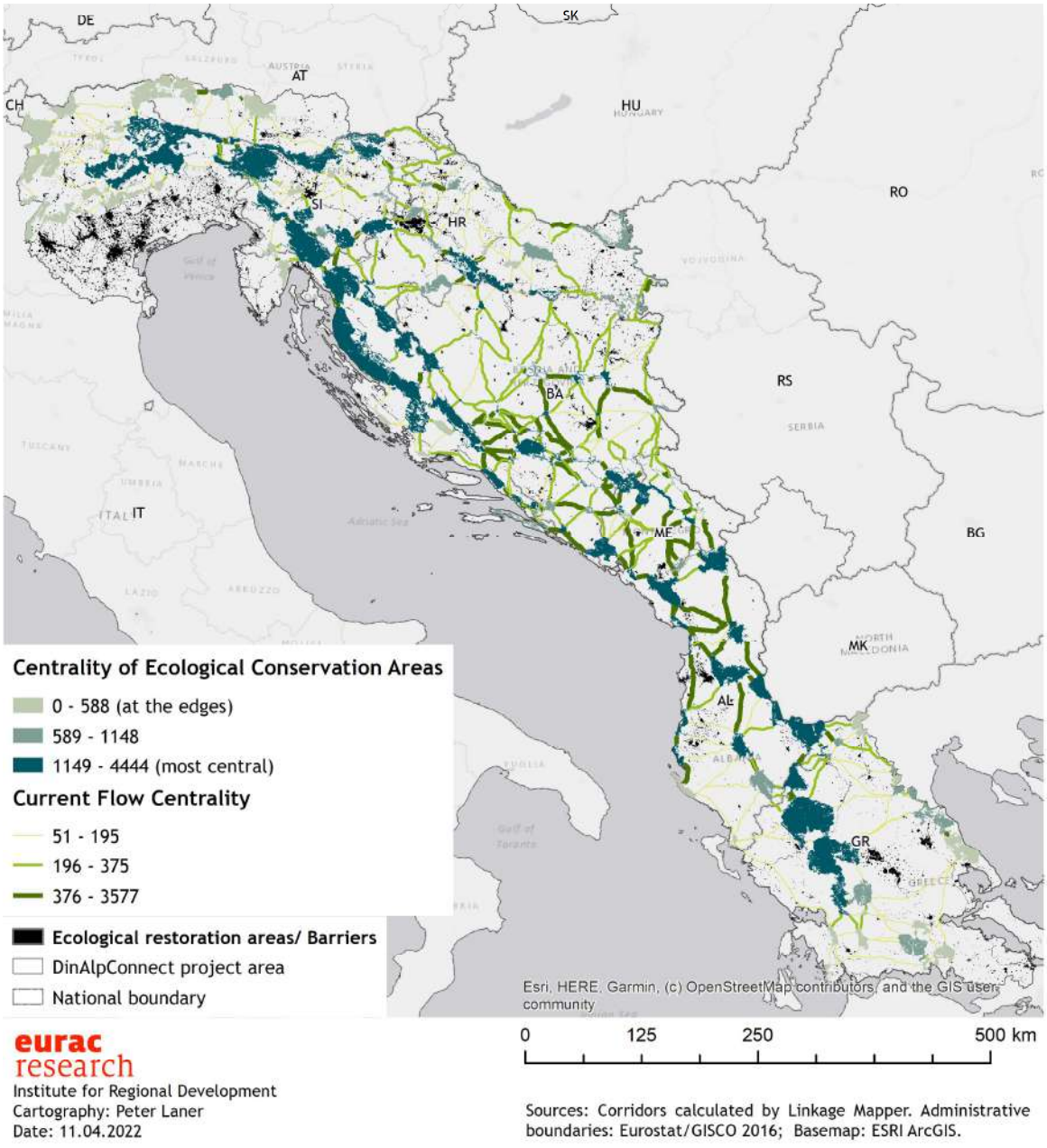
Map 11: Macro- regional corridor

Biological value
Interaction intensity of Ecological Conservation Areas on regional corridors

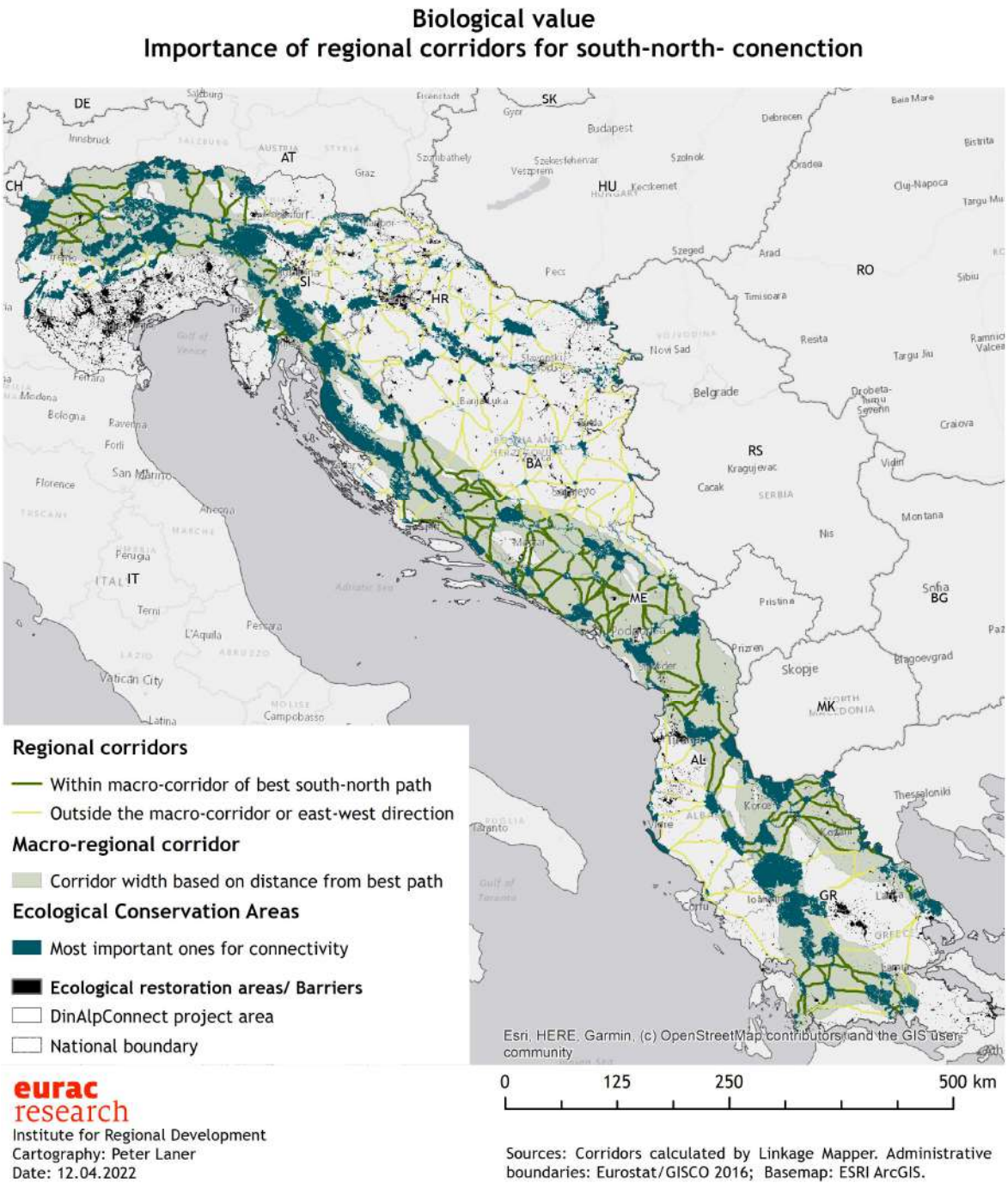


Map 12: Interreg of regional corridors

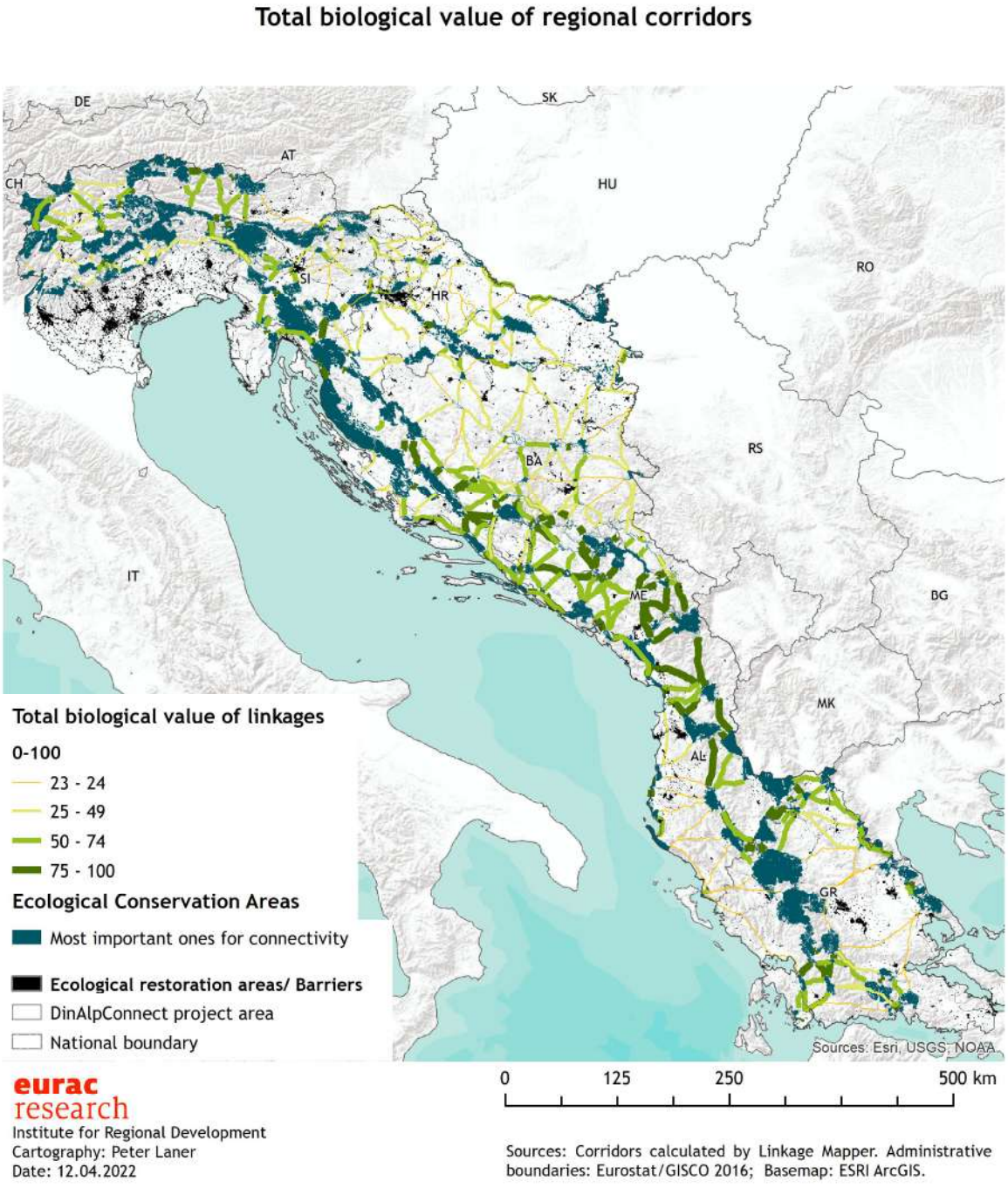
Biological value
Centrality of Ecological Conservation Areas and regional corridors



Map 13: Centrality of regional corridors

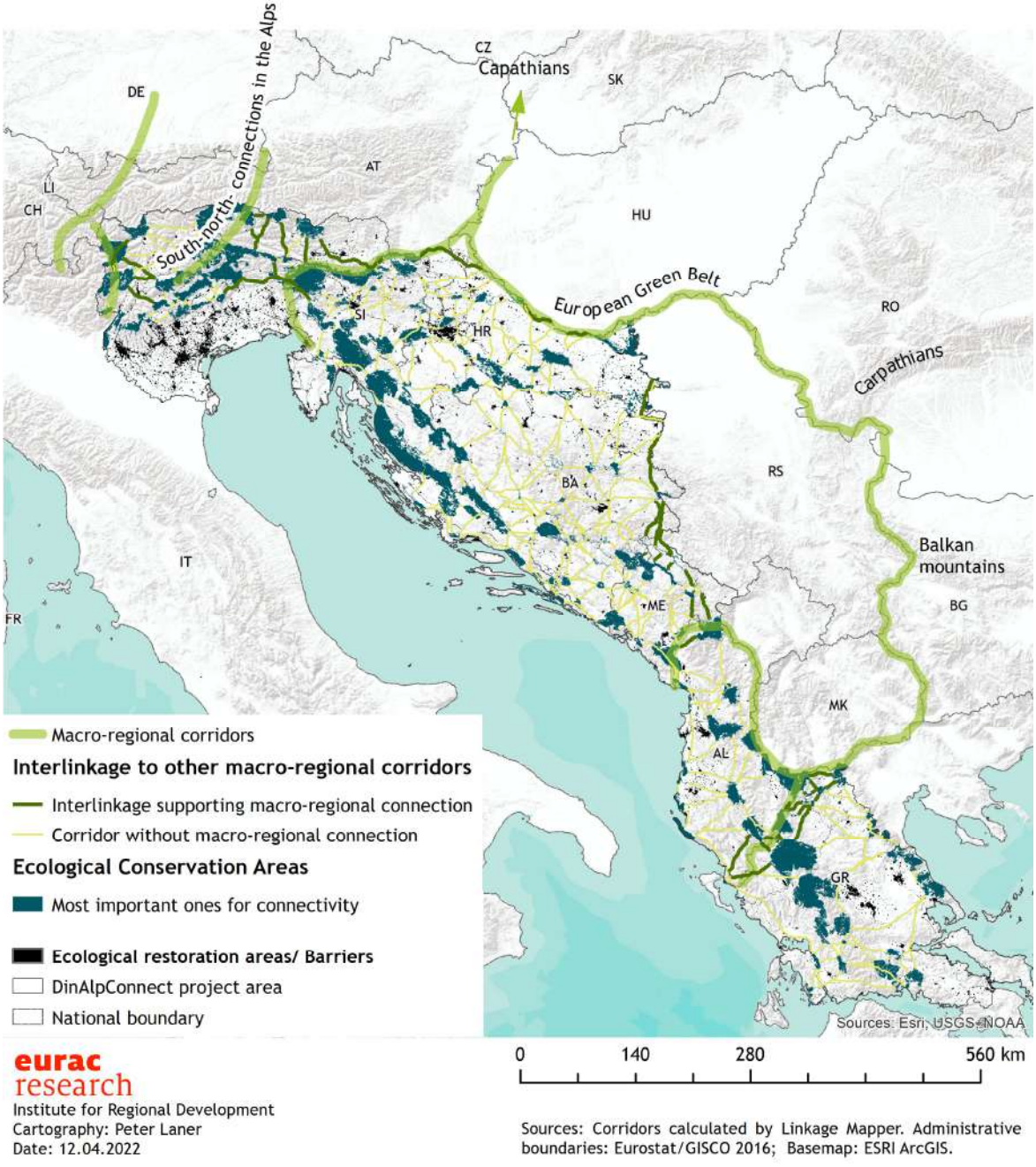


Map 14: Linkages supporting the south-north connection



Map 15: Total biological value of regional corridors

Opportunity of linkages to other macro-regional corridors

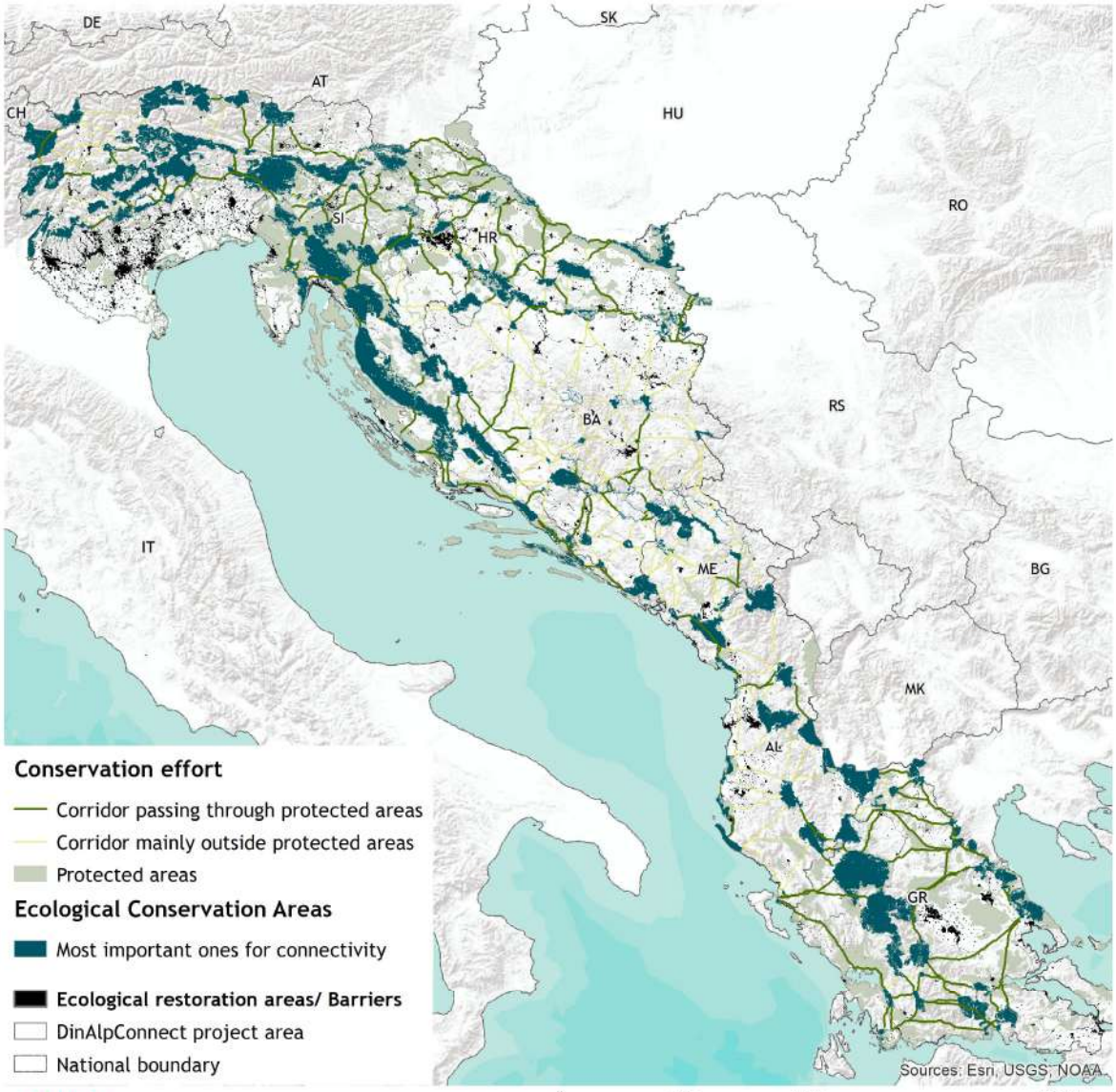


eurac research
Institute for Regional Development
Cartography: Peter Laner
Date: 12.04.2022

Sources: Corridors calculated by Linkage Mapper. Administrative boundaries: Eurostat/GISCO 2016; Basemap: ESRI ArcGIS.

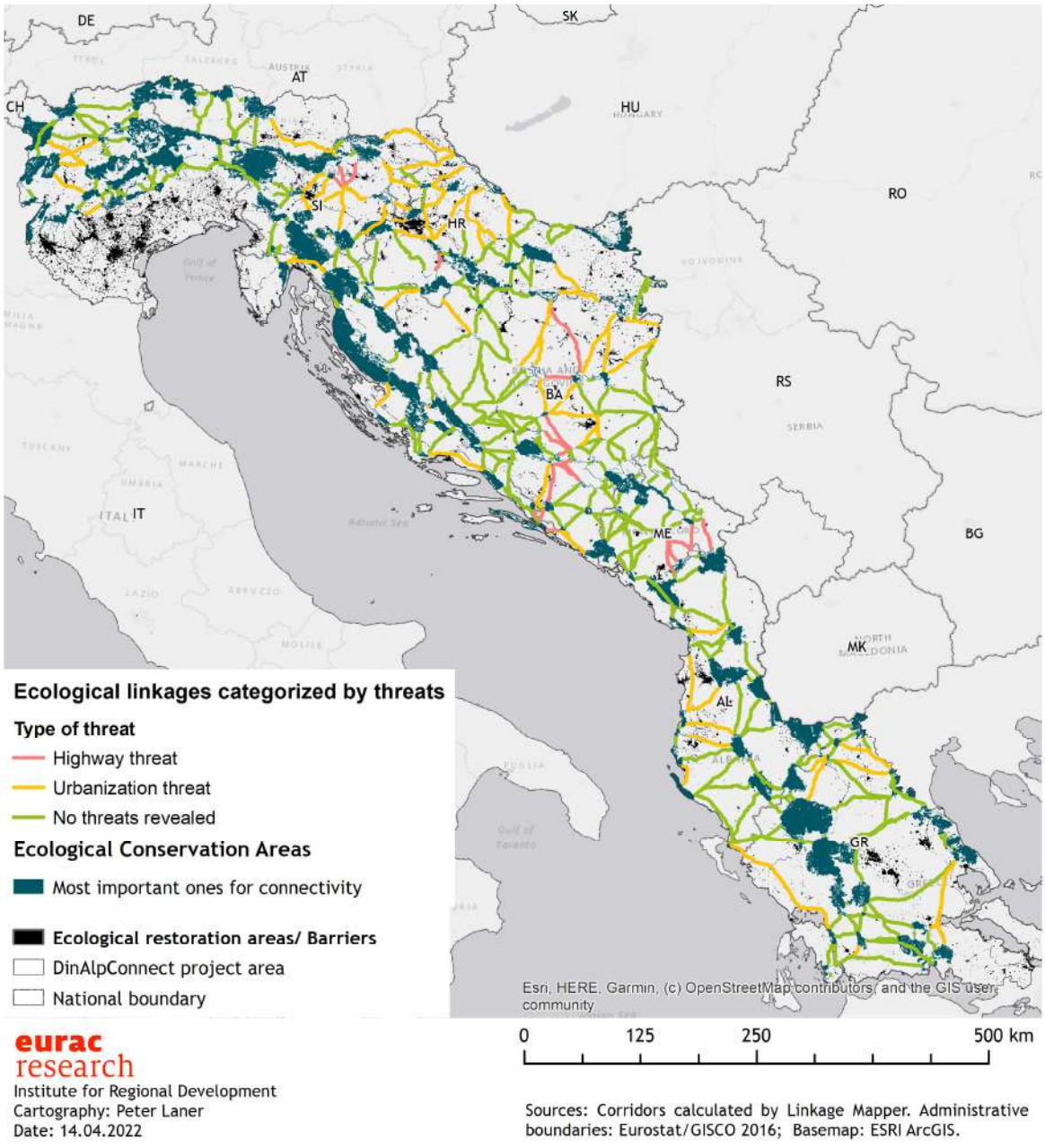
Map 16: Linkages to other macro-regional corridors

Opportunity of existing conservation effort on the corridor



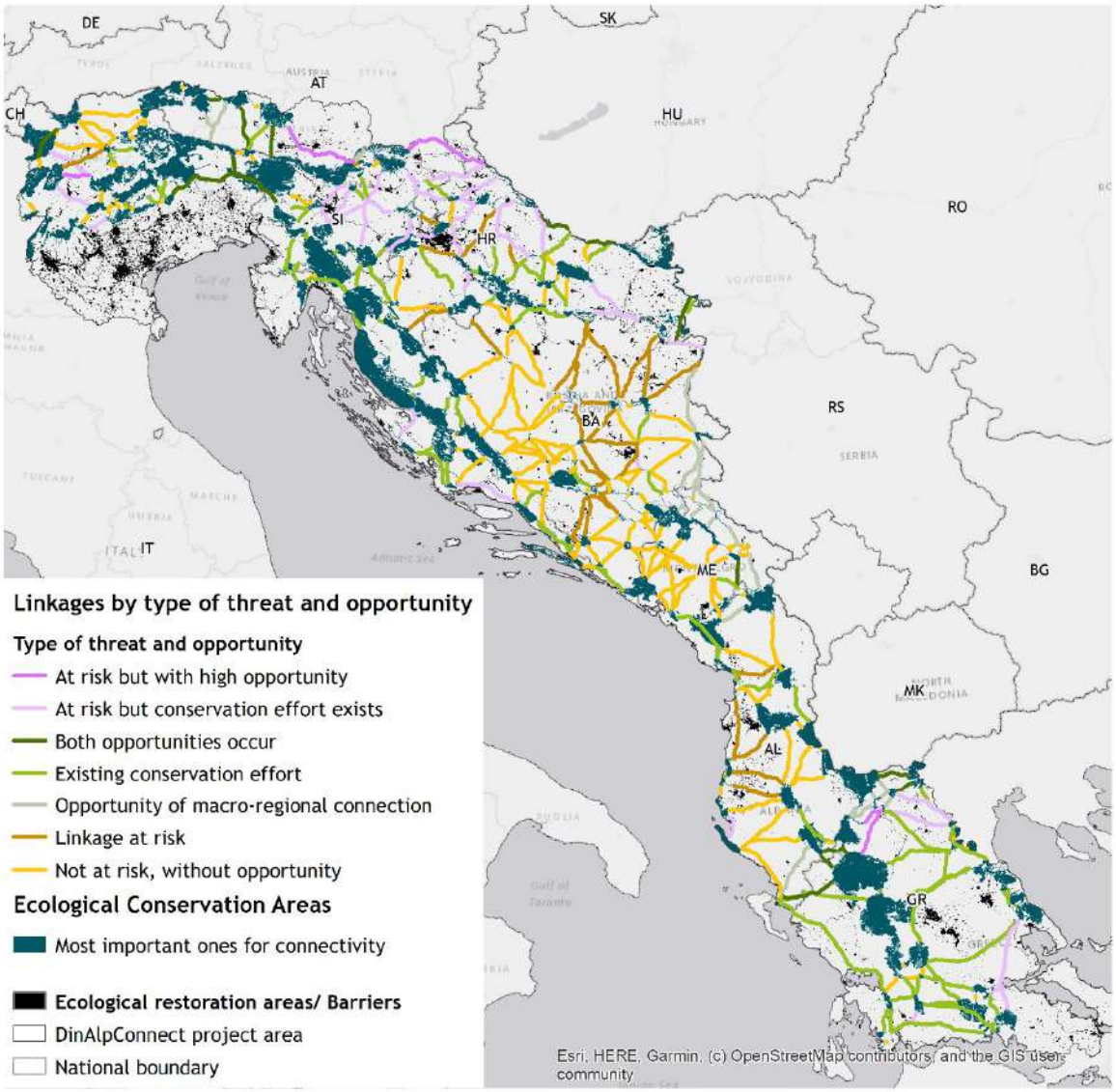
Map 17: Existing conservation effort

Possible threats for ecological interlinkages



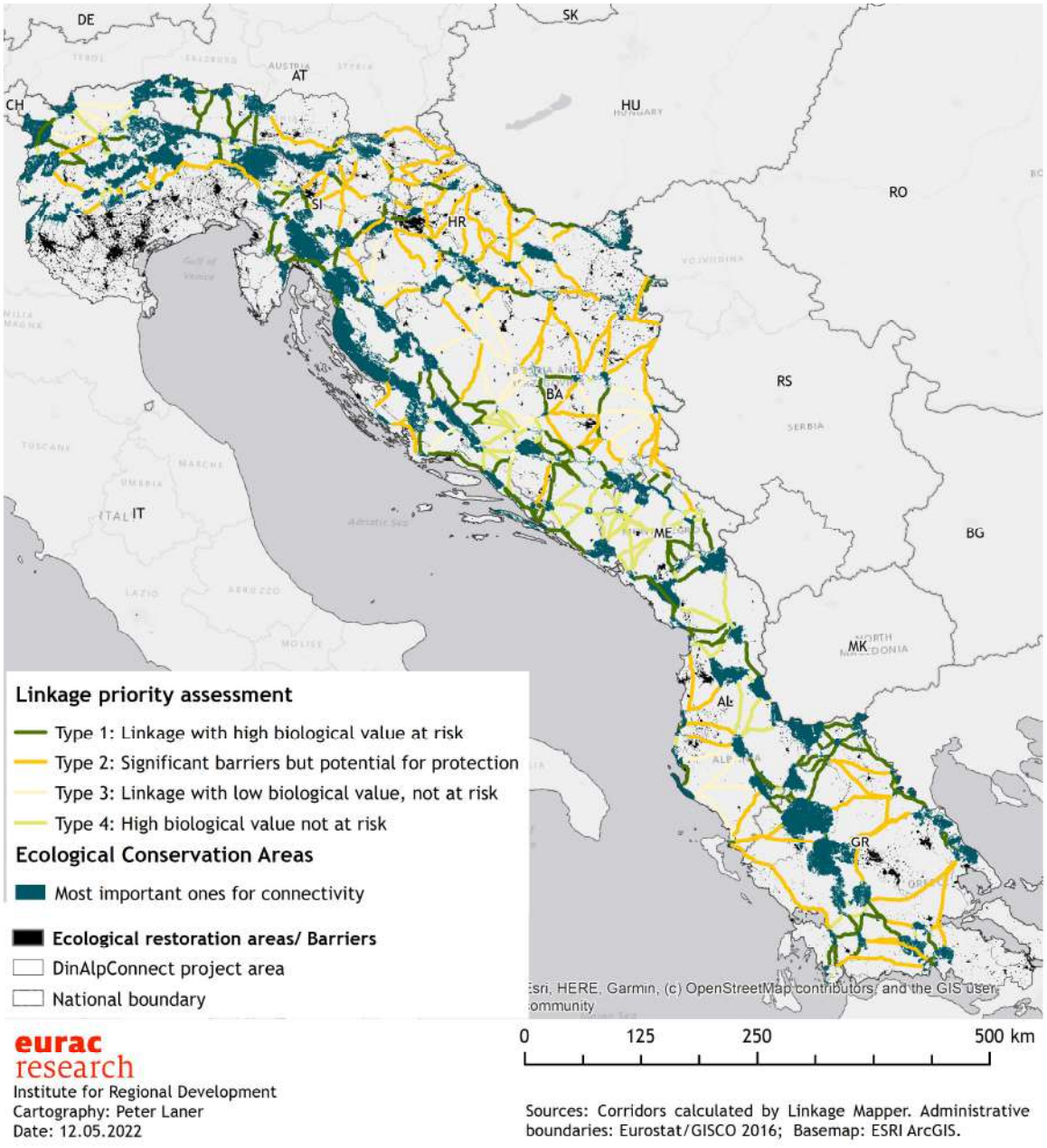
Map 18: Ecological linkages categorized by threats

Ecological linkages by type of threat and opportunity



Map 19: Ecological linkages by type of threat and opportunity

Assessment of ecological linkages
according to the biological value, threats and opportunities



Map 20: Priority assessment of ecological linkages

2.3 Barrier analysis

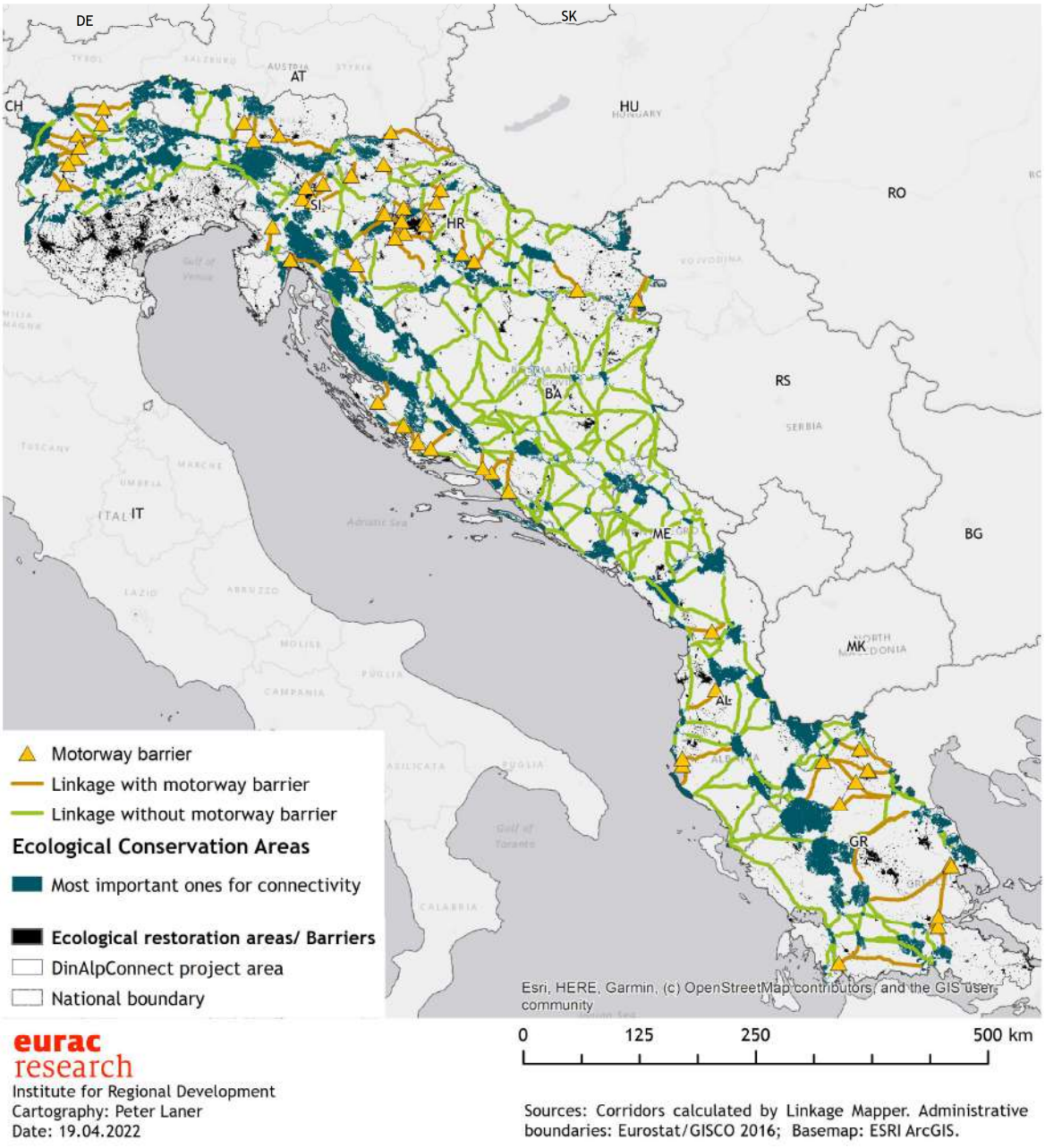
The barrier analysis is showing that 60 linkages are affected by motorway intersections (map 21). Most of them are located in Italy, Slovenia, Croatia and Greece. In Italy, the most problematic motorway is the A22 on the Brenner axis, which is a barrier for ecological East-West- connections.

In Slovenia, motorways around the city of Ljubljana are hindering ecological south-north connections. In Croatia, a similar situation around the city of Zagreb can be found. Motorways that connect the city are hindering connections between Žumberak-Samoborsko gorje, Sljeme mountain, and to Kozjanski Park in Slovenia, as well as to the forests of Turopoljski Lug. Additionally, the E65 between Split and Zadar is hindering ecological south-north connections. In Greece, the motorways E90 and E75 have several intersections with identified linkages, that should be removed.

143 linkages (about 33%) are passing through highly fragmented landscapes (map 22), most of them in Slovenia, Croatia, and Greece. In these areas, actions are still feasible to restore or maintain ecological corridors.

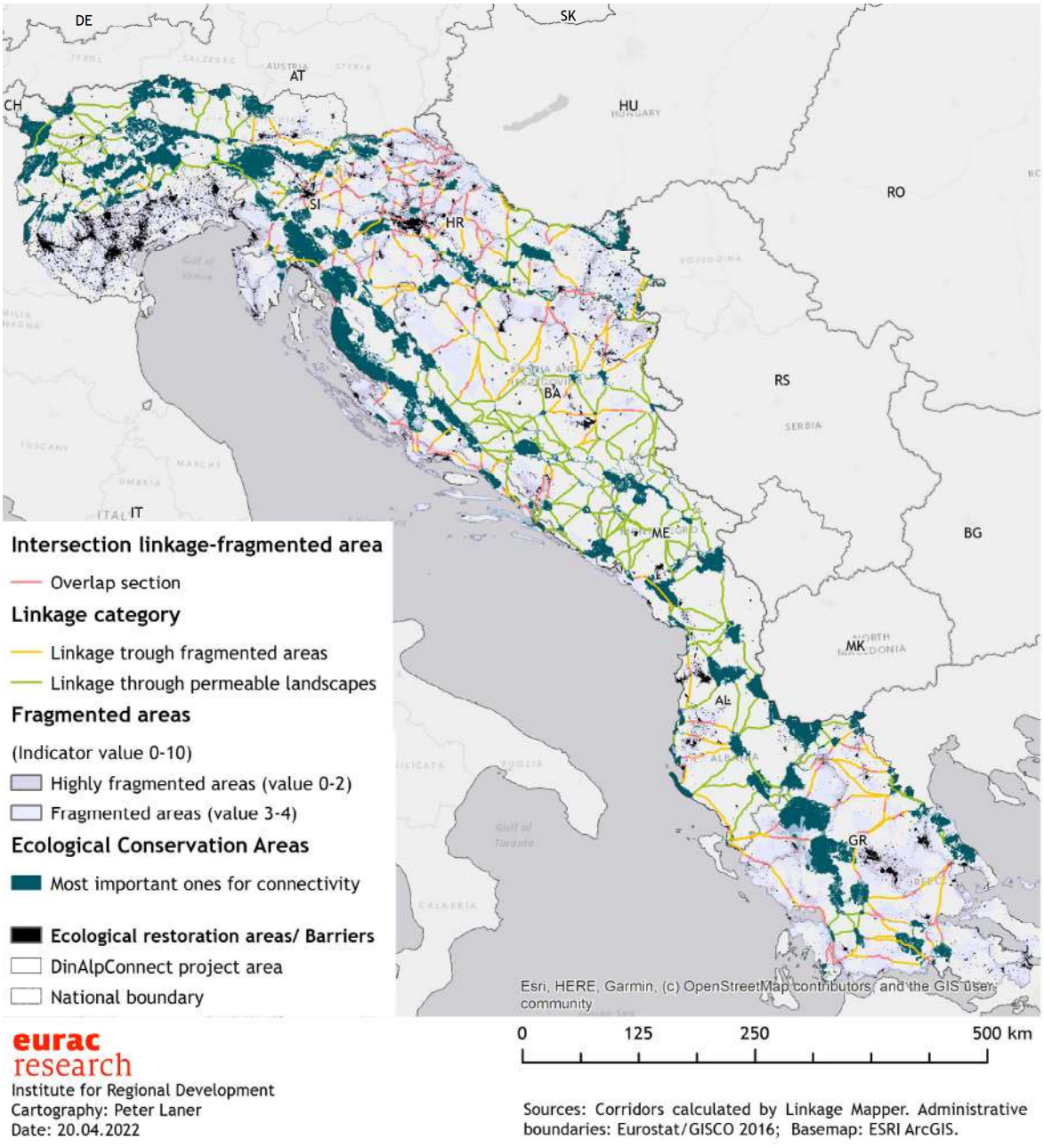
Almost half of the linkages are passing through agricultural areas (map 23). This is showing that it is very important to support sustainable agricultural practices that are enabling ecological connectivity, which is one of the aims of this project.

Intersections of linkages with motorways representing a real physical barrier



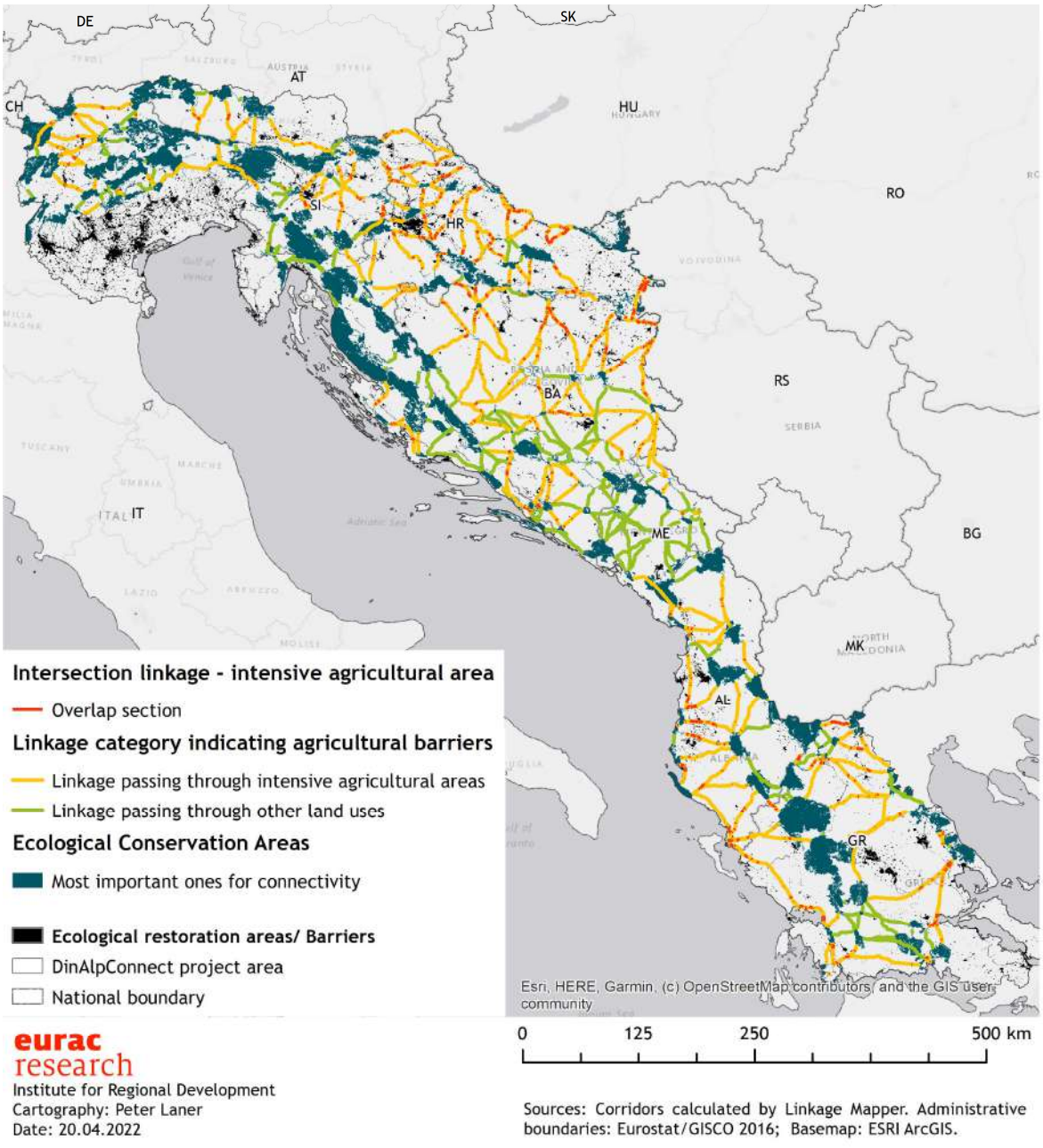
Map 21: Motorway barriers

Intersections of linkages with most impeding fragmented areas



Map 22: Intersection of linkages and fragmented areas

Intersections of linkages with intensive agricultural land uses



Map 23: Agricultural barriers

3 Transboundary pilot regions

The barrier analysis on macro-regional level revealed that agricultural practices which are enabling ecological connectivity are one of the most important factors to improve the ecological network in the Dinaric mountains. The pastoral system and livestock farming plays and important role in the Dinarides and wide agricultural areas are covered with dry or permanent grassland. Therefore, agricultural practices were investigated in detail in three transboundary pilot regions. For the pilot site between Italy and Slovenia which is mainly covered by forests, ecological connectivity for the forest species capercaillie, chamois and ibex is presented in this atlas.

3.1 Grassland analysis

Considering, that grassland is an important habitat for a variety of species, there is a need for stable habitat conditions, which can support ecological connectivity. The grassland analysis is trying to find the factors for improving the maintenance of grassland patches. To counteract shrinking grassland patch sizes by overgrowing forest and avoiding overgrazing areas, suitable areas for grassland preservation were identified. These include the proximity to water sources, farms and roads, the relevance for ecological connectivity and the stability of socioeconomic factors like change in numbers of farms and livestock change. The results are visualized on the following “grassland preservation suitability” maps.

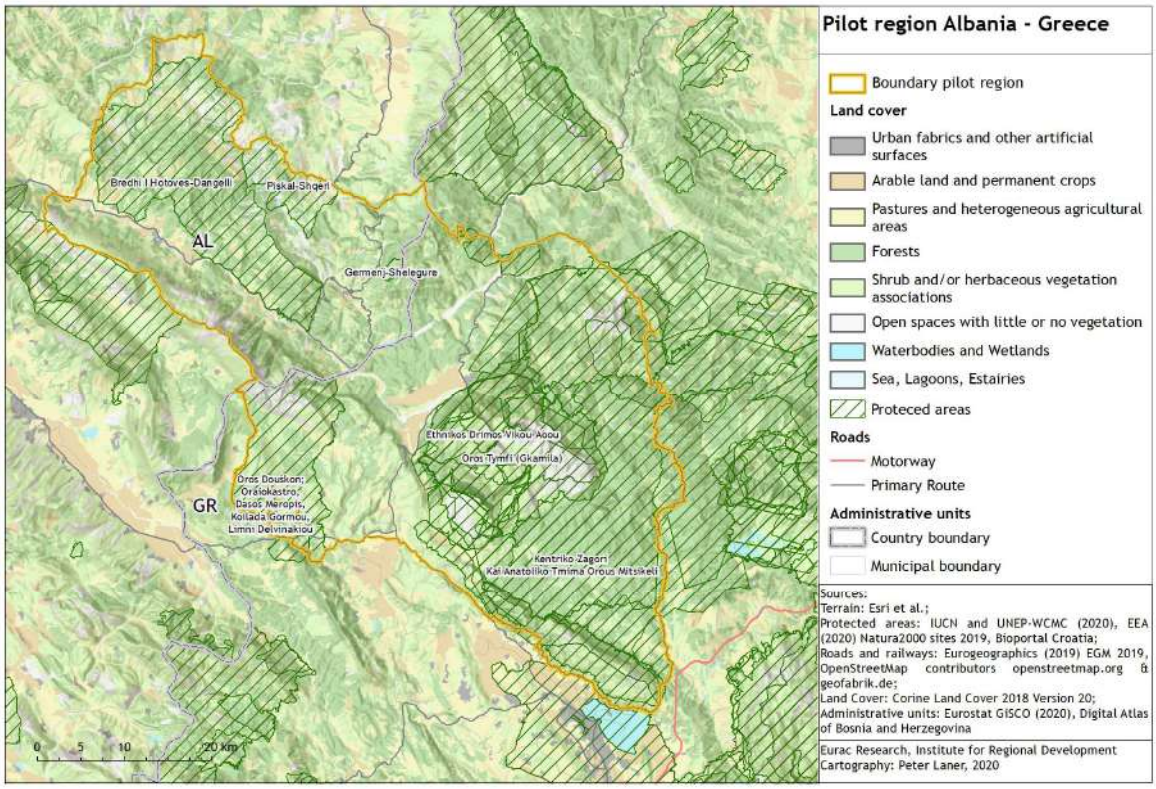
3.1.1 Pilot region Albania – Greece

The transboundary pilot region of Albania – Greece is the result of a combination of three cross- border elements of ecological connectivity: 1) The Aoos-Vjosa river basin, 2) a section of the Balkan Green Belt along the state border, and 3) linkages between protected areas of Albania and Greece.

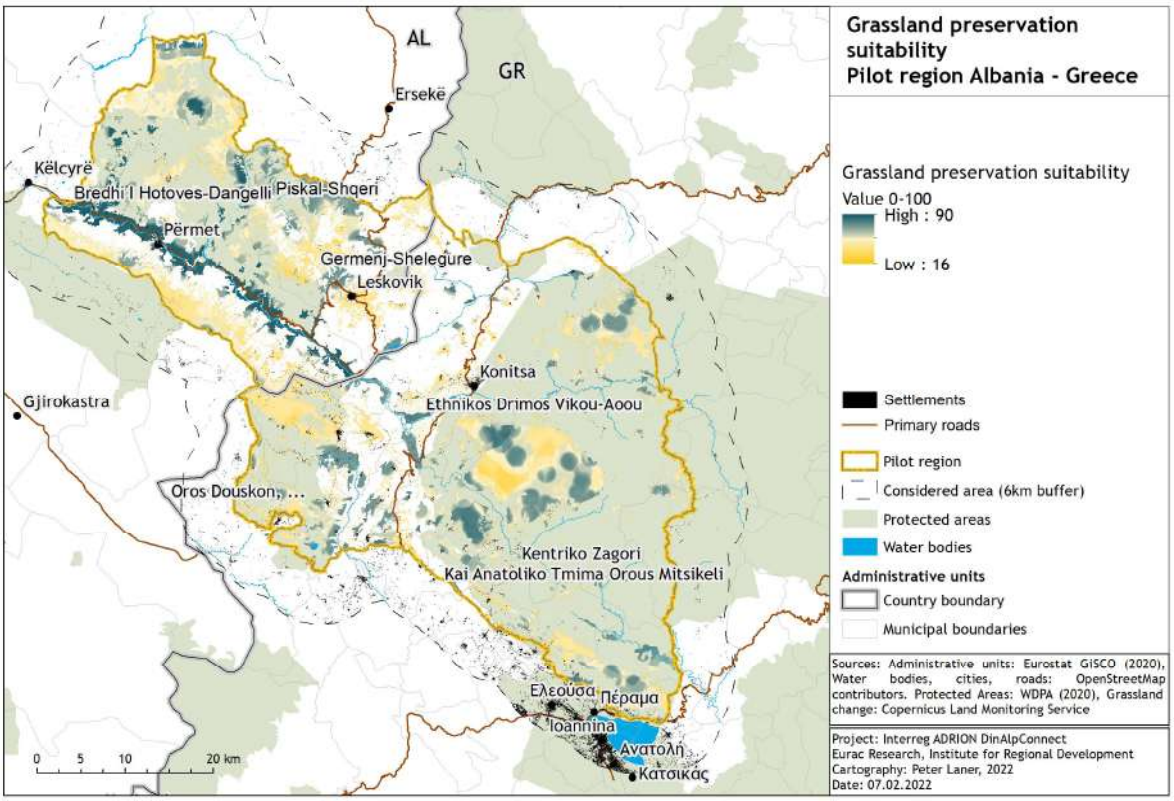
The pilot region connects six protected areas. Two of them are located on the Albanian side. The National Park of Bredhi I Hotoves is part of municipalities Permet (Gjirokaster) on 33.165 ha, Kelcyre (Gjrokaster), Kolonje (Korce) and Skrapar (Berat). The Park is physically connected to the Nature Reserve of Piskal-Shqeri, which is located on the territory of the municipality Kolonje. The non-protected territory of the municipalities Permet and Kolonje from the National Park to the border with Greece are included in the pilot regions. This area includes the nearest settlements to the park access points. The pilot region has a total area of 260.262 ha.

Table 1: Areas of the pilot region Greece - Albania

Country	Site name	Cat.	Site code	Area (ha)
Albania	National Park of Bredhi I Hotoves (Region Gijrokaster)	II		34.361
	Managed Nature Reserve of Piskal-Shqeri	VI		5.400
	Whole administrative area of the municipality Permet (Gjirokaster)			
	Part of the non-protected area in the municipality Kolonje			
Greece	ETHNIKOS DRYMOS VIKOU - AOOU	SCI	GR 2130001	12.794,25
	OROS TYMFI (GKAMILA)	SPA	GR 2130009	27.416,44
	KENTRIKO ZAGORI KAI ANATOLIKO TMIMA OROUS MITSIKELI	SPA	GR 2130011	53.407,84
	OROS DOUSKON, ORAIOKASTRO, DASOS MEROPIS, KOILADA GORMOU, LIMNI DELVINAKIOU		GR 2130010	



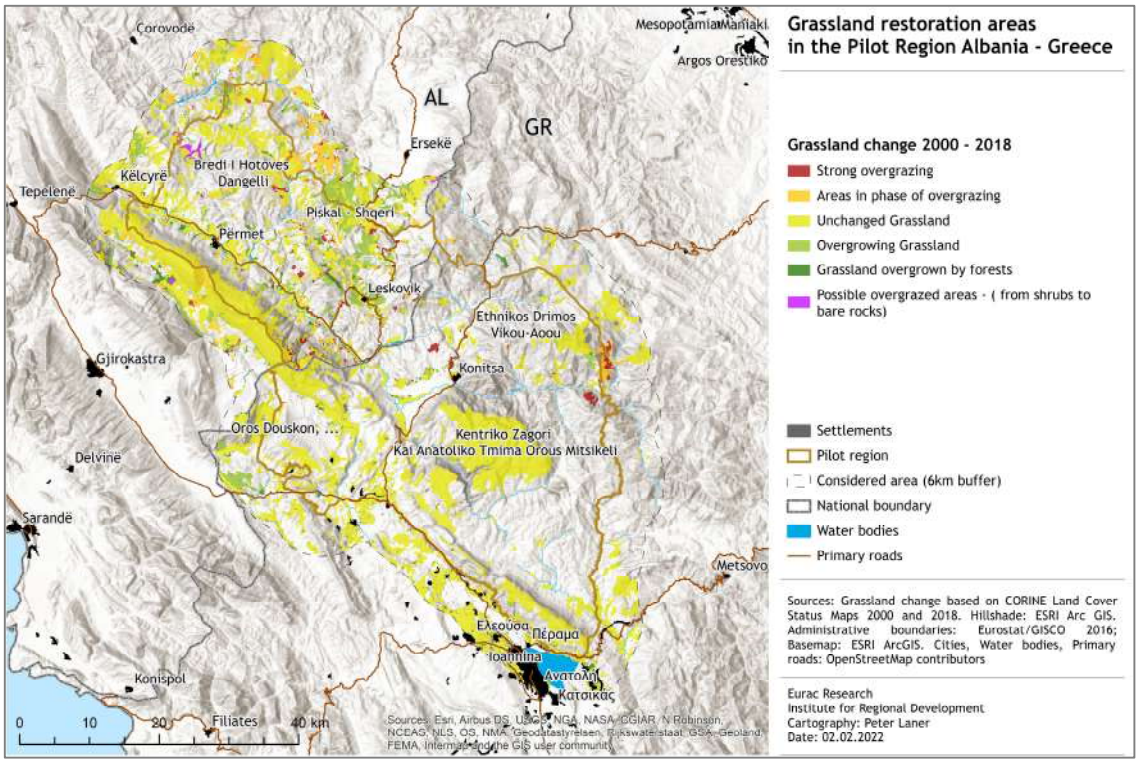
Map 24: Pilot region Albania - Greece



Map 25: Grassland preservation suitability (AL-GR)

Description:

The map shows high grassland preservation suitability along the Vjose – river, in the mountain range Vikos and in the national park Piskal-Shqeri. A low suitability is present on the southwestern hillside of the Vikos river, despite it would be a big continuous grassland patch.



Map 26: Grassland restoration areas (AL-GR)

Description:

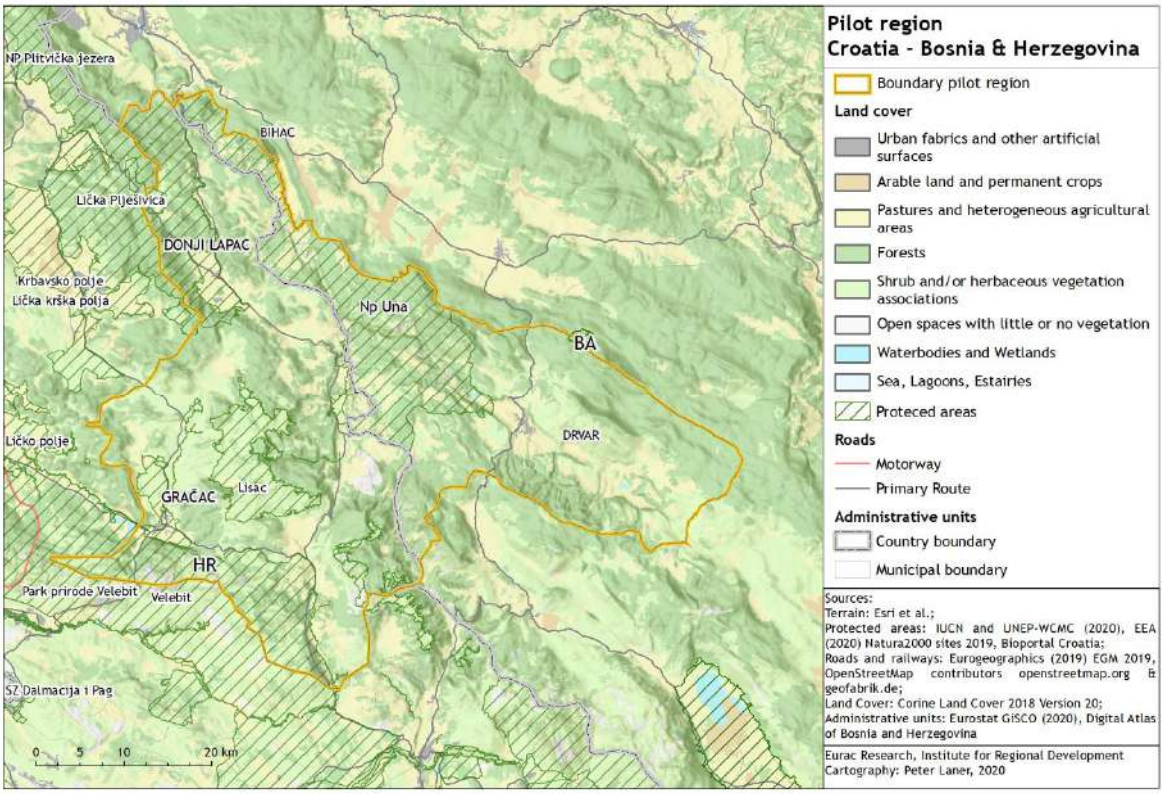
Most of the grassland areas are stable in Greece, despite around the town Konitsa, where overgrowing and overgrazed areas are present. Between Konitsa and Albanian border strong overgrazing is present. Overgrazing is mostly present in the Greek National Park Ethniko Parko Pindou at the East of the pilot region.

3.1.2 Pilot region Croatia - Bosnia & Herzegovina

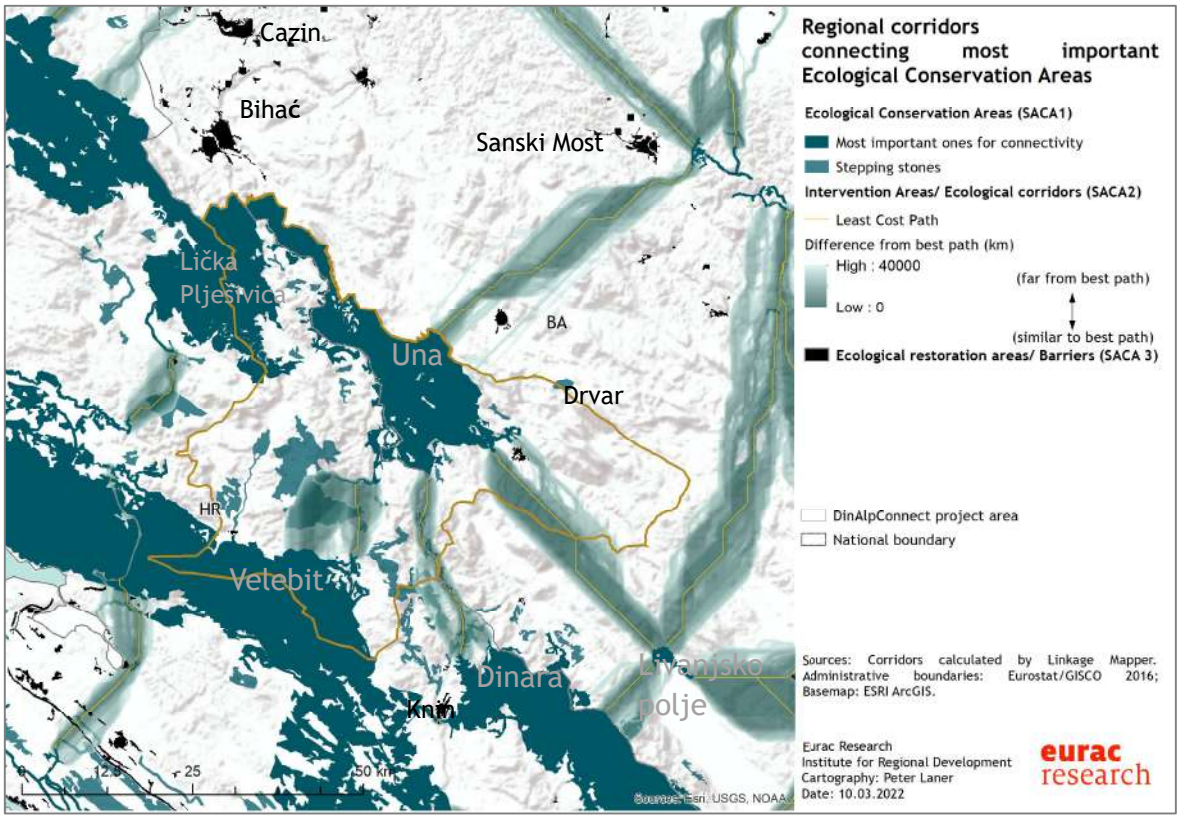
The transboundary pilot region Croatia – Bosnia & Herzegovina consists of the Una National Park and the municipality Drvar on the side of Bosnia & Herzegovina and of the two bordering municipalities Donji Lapac and Gračac on the Croatian side. The latter contains the Natura 2000 site Lisac. The total area amounts 225.212 hectares.

Table 2: Areas of the pilot region Croatia - Bosnia & Herzegovina

Country	Site name	Category	Site code	Area (ha)
Croatia	Lisac	SCI	HR2001373	9.201,58
	Municipality of Donji Lapac and Gračac.			
Bosnia and Herzegovina	Una National Park	National park		
	Municipality of Drvar			



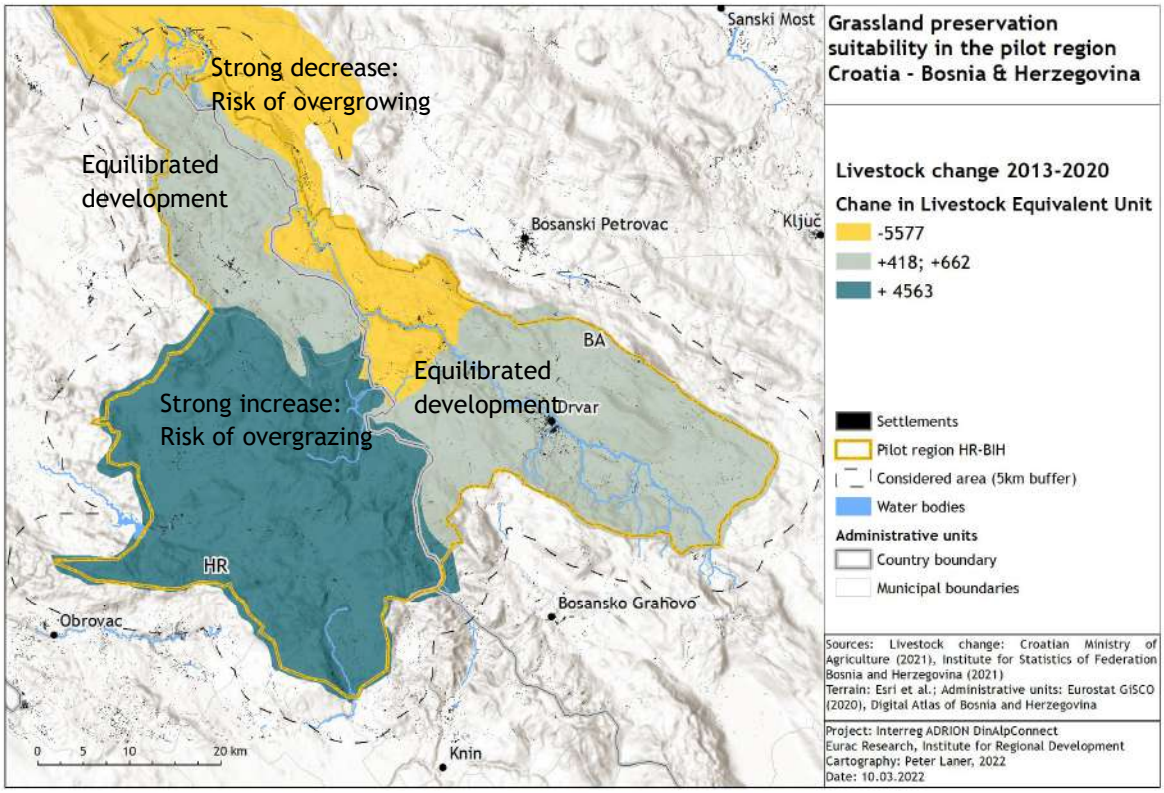
Map 27: Pilot region Croatia - Bosnia & Herzegovina



Map 28: Ecological corridors and ecological conservation areas (HR-BiH)

Description

The map is showing ecological linkages between Ecological Conservation Areas covering Una National Park, nature park Velebit, and Natura 2000 sites Dinara and Lička Plješivica. The Natura 2000 site Lisac is considered as stepping stone.

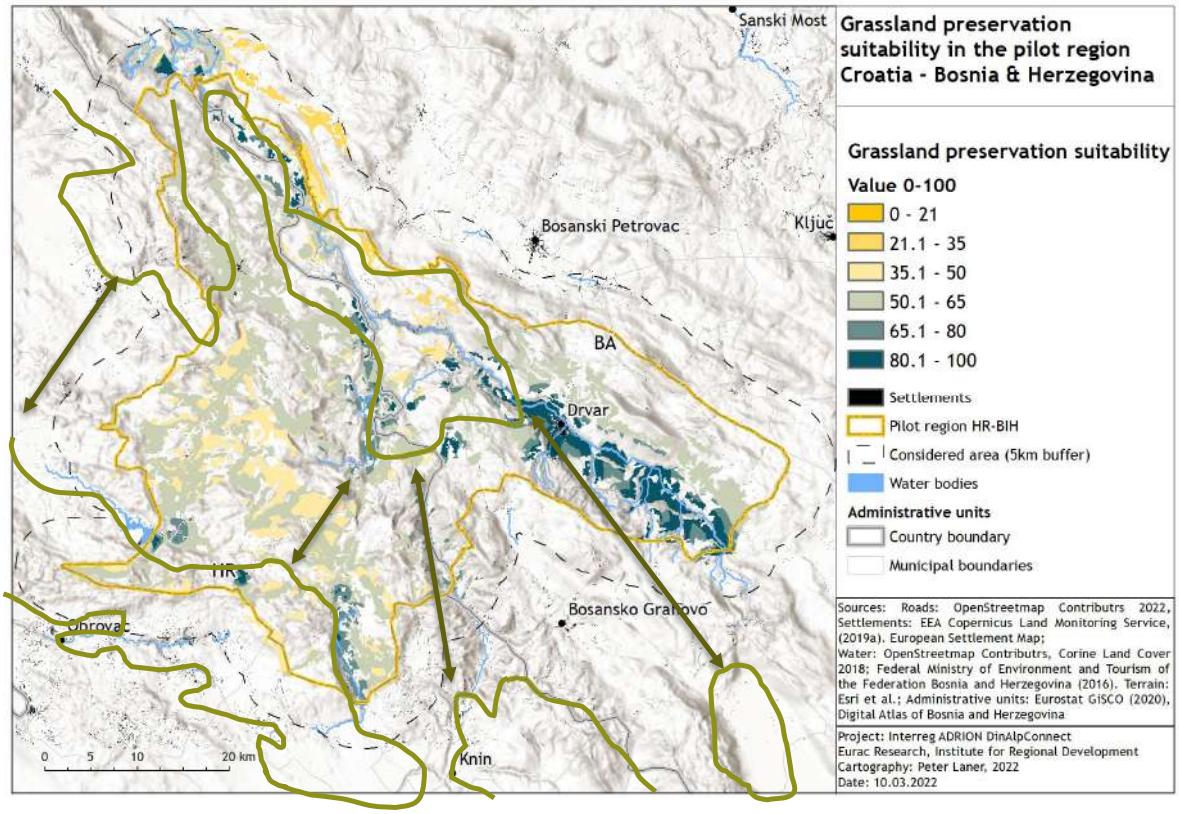


Map 29: Livestock change 2013-2020 (HR-BIH)

Description:

The map is showing the livestock change between 2013 and 2020 as one of the most important factors for grassland preservation in this pilot region and as indicator for risk of overgrazing or overgrowing grassland areas.

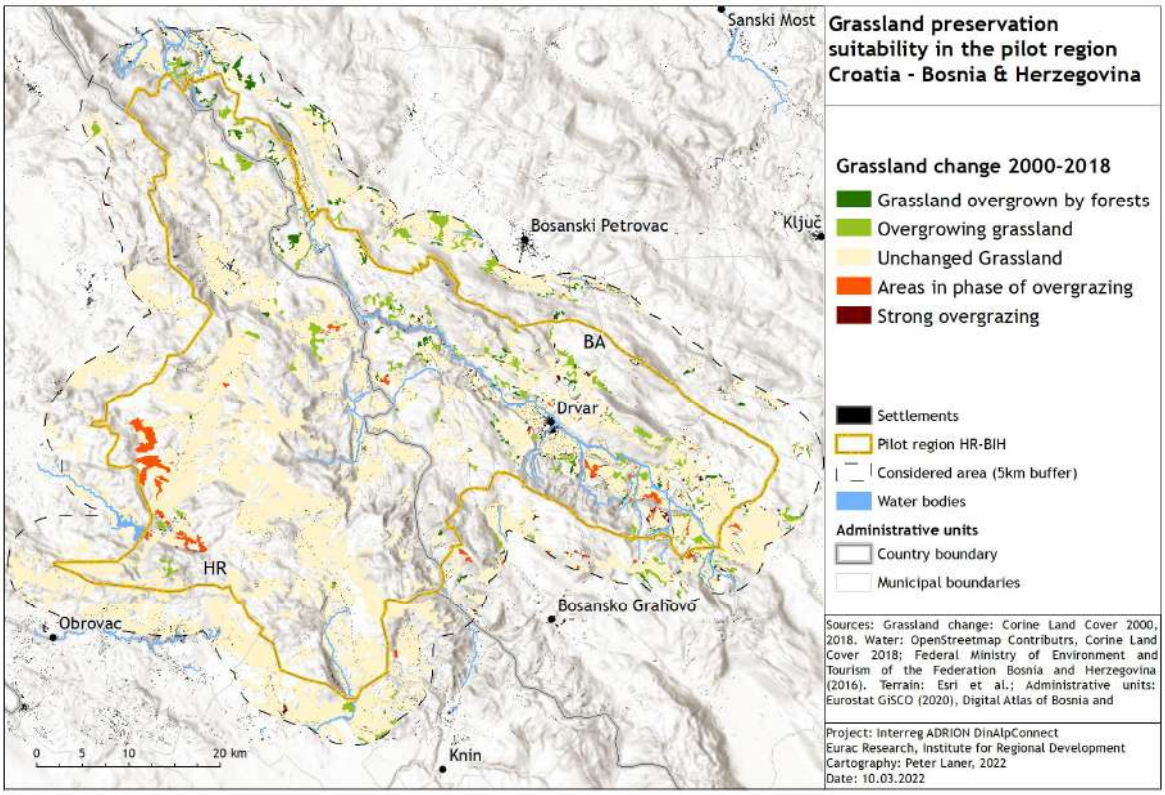
The municipality of Bihac (yellow color) is experiencing a strong decrease of livestock, while in Gračac (blu/green color) has a strong increase. The municipalities Drvar and Donji Lapac (light green) have a rather stable numbers in livestock, which is favorable for grassland preservation.



Map 30: Grassland preservation suitability (HR-BIH)

Description:

Grassland preservation suitability is low between national park Una and nature park Velebit near the protected area of Lisac, because of scattered settlement structure. This brings the risk that livestock is competing with wildlife animals. Very low preservation suitability in the municipality of Bihac resulted due to limited water resources. This might be a factor for decreasing livestock numbers and overgrowing grassland areas. High grassland preservation suitability values are visible near water sources or along rivers.



Map 31: Grassland change 2000-2018 (HR-BIH)

Description:

The map is showing grassland changes between 2000 and 2018. It is visible, that overgrazing is present in the western part of municipality of Gračac, while overgrowing areas are present in Bihac. This seems to correlate with the livestock change in these municipalities.

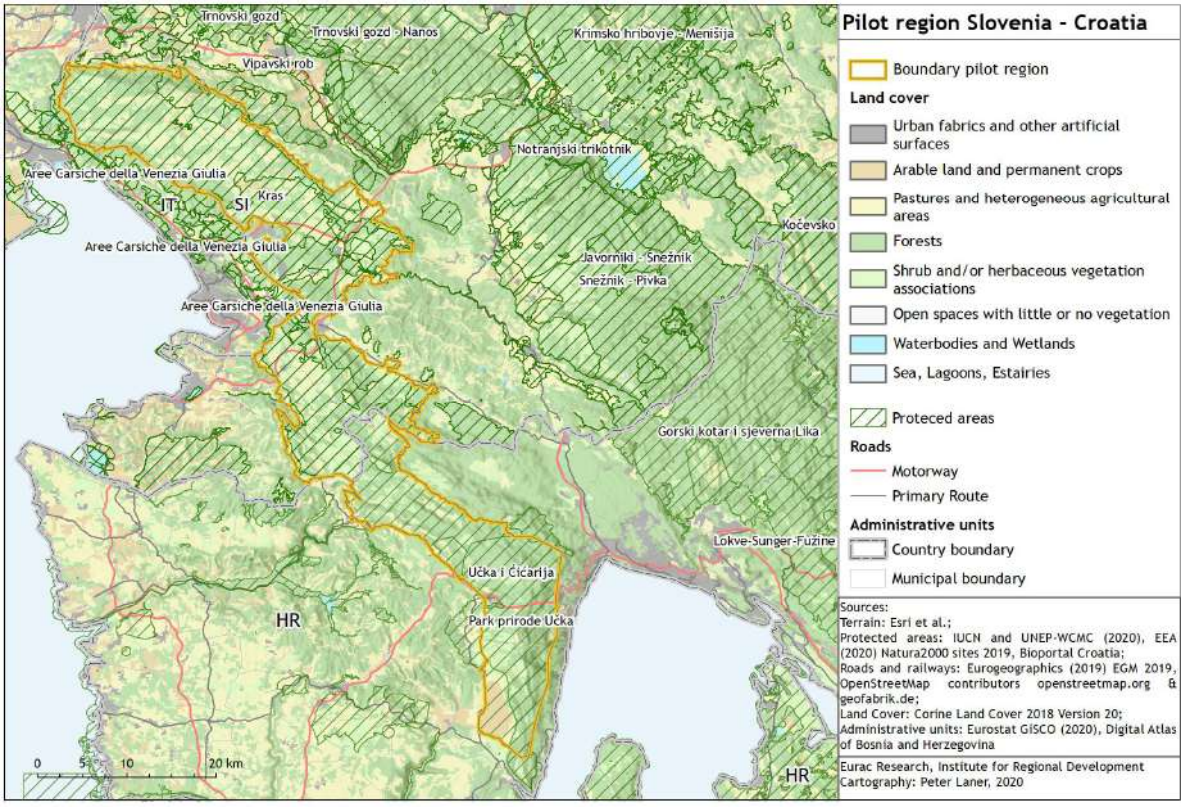
Areas in phase of overgrazing and areas in phase of overgrowing are alternating in the municipalities Drvar & Donji Lapac, which have an equilibrated number of livestock.

3.1.3 Pilot region Slovenia – Croatia

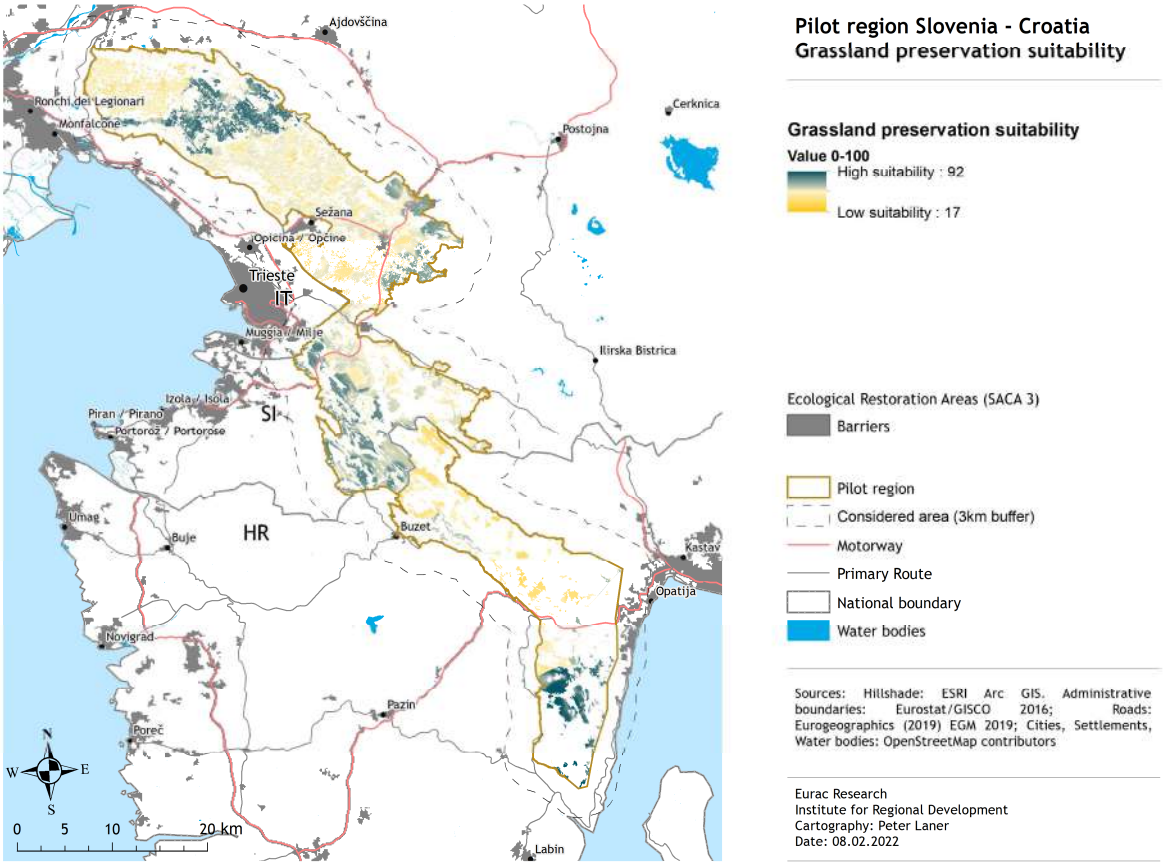
The pilot region consists of Natura 2000 sites that are physically connected with each other but divided by the state boundary. Small gaps between the two areas are included. It has a total area of 93.069 hectares.

Table 3: Areas of the pilot region Slovenia - Croatia

Country	Site name	NATURA 2000 category	Site code	Area (ha)
Slovenia	KRAS	SPA	SI5000023	61.812 ha
	KRAS	SAC	SI3000276	
Croatia	Učka i Ćićarija	SPA	HR1000018	31.012 ha



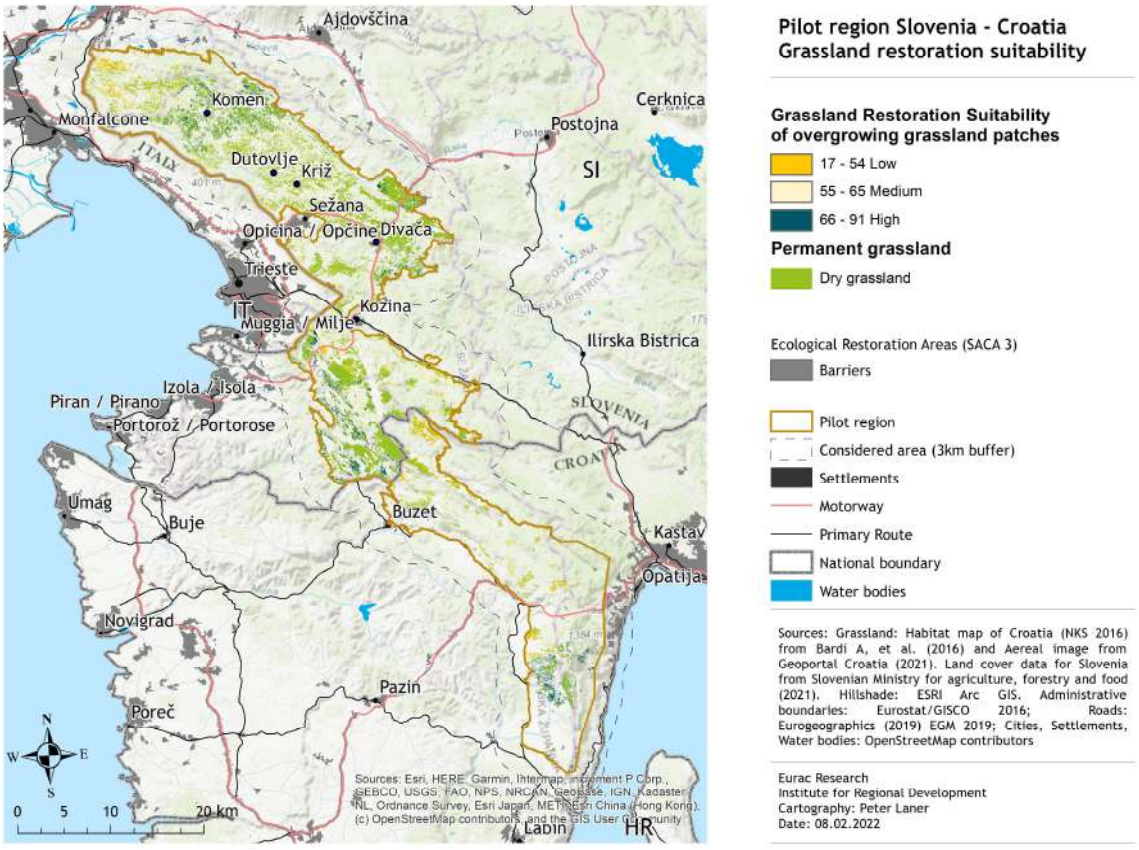
Map 32: Pilot region Slovenia - Croatia



Map 33: Grassland preservation suitability (SI-HR)

Description:

The grassland preservation suitability in the pilot region Učka i Ćićarija seems to be strongly influenced by the socioeconomic situation of municipalities. The Slovenian municipality Sežana (SI) has a strong decrease in number of farms. The northernmost municipality Miren-Kostanjevica (SI) and Lanisce and Lupoglav (HR, yellow color) faced a strong decrease in livestock over the last 10 years. These factors are leading to a low suitability for farming.



Map 34: Overgrowing grassland areas & suitability for restoration (SI-HR)

Description:

The SWOT workshops in the pilot region revealed, that, overgrazing is not the main problem in Kras, Učka & Ćićarija. Therefore, the map is showing dry grassland patches in a stable condition and the restoration suitability of overgrowing grassland patches. The map is showing many permanent grassland areas in Slovenia in a stable condition (green areas). Restoration potentials in Komen and in the countryside of Koper (SI), as well as in the south of nature park Učka (HR) are high.

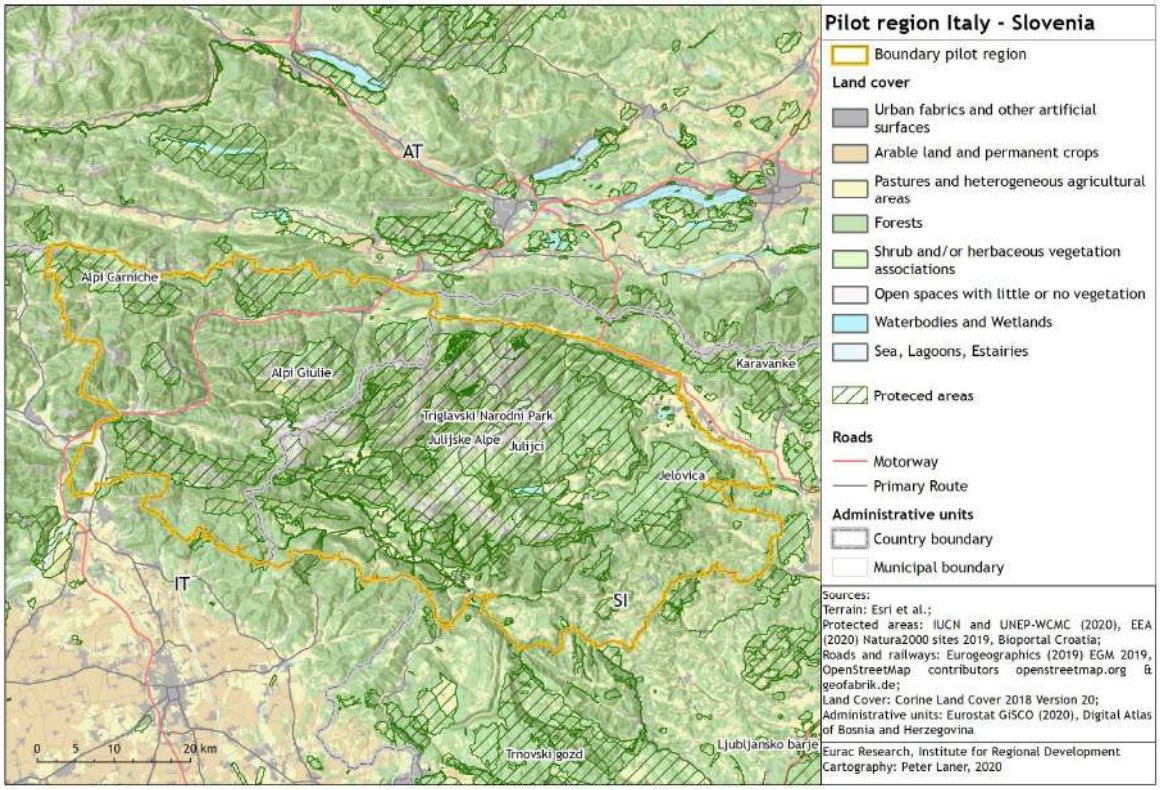
3.2 Species – based analysis in the pilot region Italy – Slovenia

In this pilot region, habitat suitability models were generated for the concerned species by considering land use, topography, and human disturbance factors based on an expert evaluation. Core areas were filtered from these models also considering species presence data. Ecological linkages were defined using specialized software.

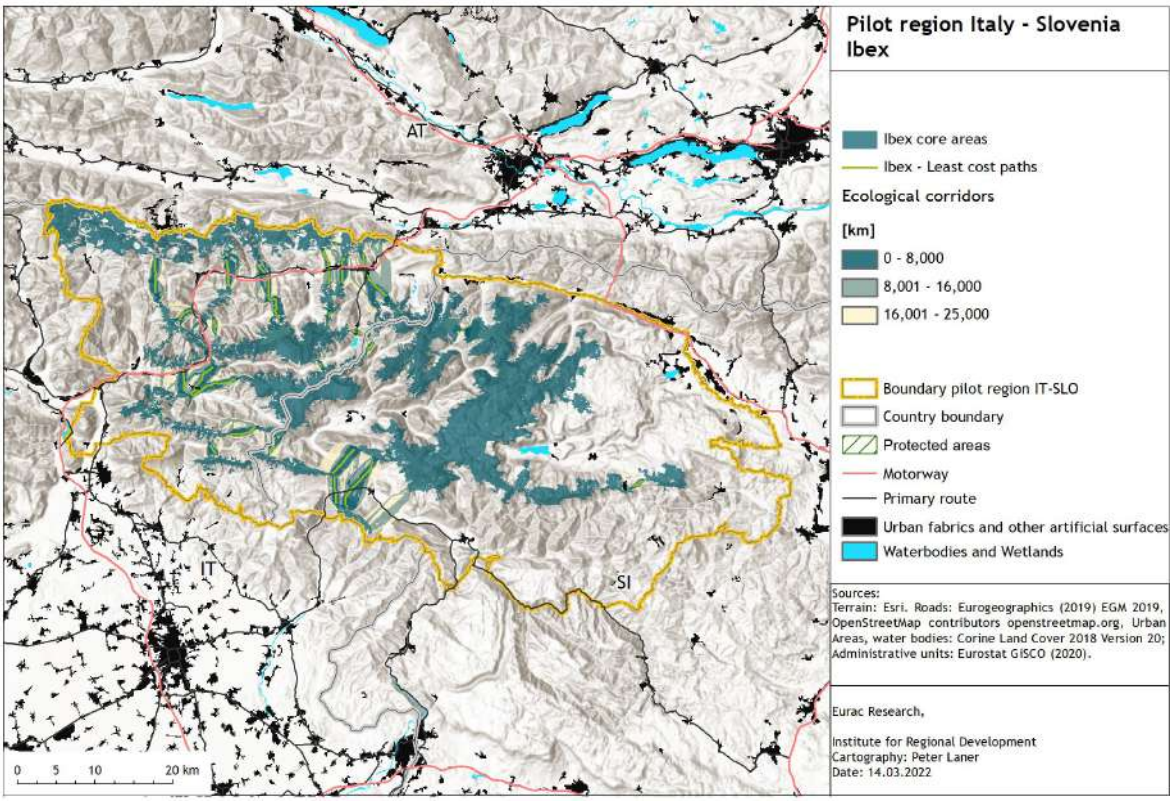
The pilot region Slovenia - Italy was already established in the Interreg Alpine Space project AlpBioNet 2030. It has a total area of 309.022 hectares.

Table 4: Areas of the pilot region Slovenia – Italy

Country	Site name	Area (ha)
Slovenia	Triglav Hunting Management Area	141.461
	Part of the Gorenjska Hunting Management Area	
	Triglav National Park	
Italy	Prealpi Giulie National Park	
	Tarvisiano Hunting District	117.159



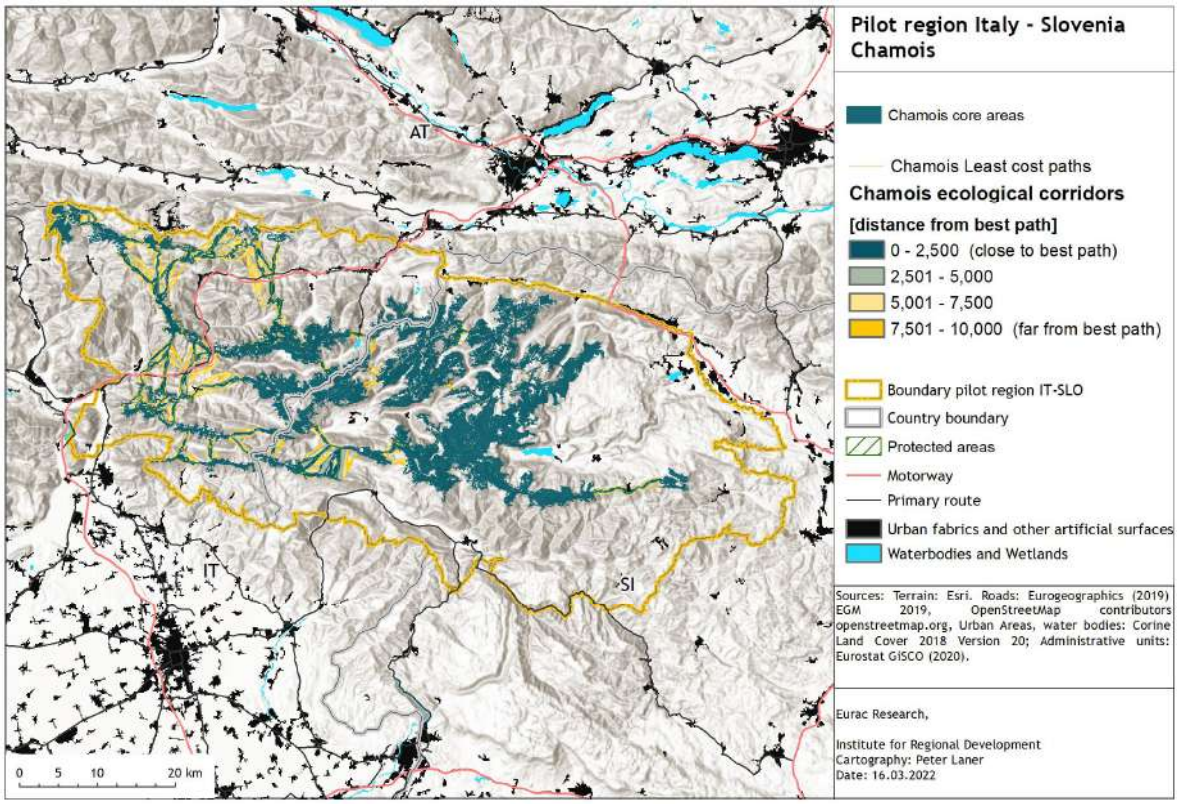
Map 35: Pilot region Italy – Slovenia



Map 36: Core areas and ecological corridors for ibex (IT-SI)

Description:

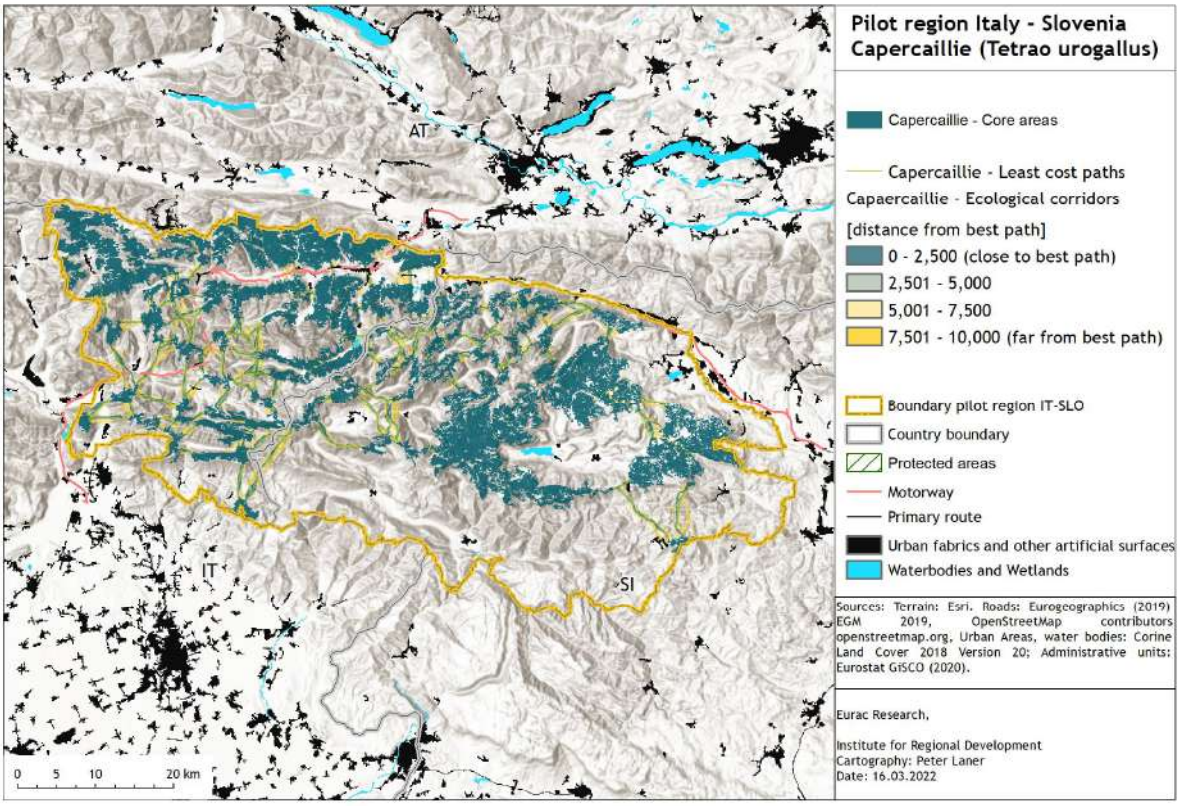
The map is showing most suitable habitats for ibex as core areas (dark green/blue) bigger than 500 ha and 30 ecological linkages (light green) that connect these areas. In total, 15 core areas were revealed with a size between 500 and 29.000 hectares. The biggest core area can be found in Triglav National Park, which is good connected to nature park Preali Giulie. The core areas on the Italian side are more fragmented, hence there are more corridors identified.



Map 37: Core areas and ecological corridors for chamois (IT-SI)

Description:

The map is showing 25 most suitable habitats for chamois as core areas (dark green/blue) bigger than 500 ha and 47 ecological linkages (light green) that connect the biggest core area patches up to 23.000 ha. The structures are similar to the one of Ibex.



Map 38: Core areas and ecological corridors for capercaillie (IT-SI)

Description:

The map is showing 53 most suitable habitats for capercaillie, from 260 ha to 19.000 ha as core areas (dark green/blue) and 120 ecological linkages (light green) with maximal Euclidean distance of 11 km that connect the core area patches.

The DinAlpConnect ATLAS

of ecological connectivity