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CO-EVOLVE

Promoting the co-evolution of human activities and natural systems for the development of sustainable coastal and maritime tourism

Deliverable 3.5.4

Atlas of Maps of ecological risks related to main tourism typologies

Activity 3.5

Threats co-evolution - Mediterranean scale: Pollution and Ecosystems

WP3

CNR – ISMAR

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1. Introduction and scope of work

This Atlas aims at depicting the main threat factors to and from coastal tourism through the use of specific threat indicators proposed in the Deliverable 3.5.2. The criteria employed to select the indicators were homogeneity, clarity of information and availability of data at high resolution at Mediterranean scale. In fact, such indicators are built upon data accessible either at NUTS2 or NUTS3 level for the study area. In addition, they are based on official statistical platforms or rigorous studies, which guarantee the soundness of the information expressed.

The maps are built in a way that should allow a rapid detection of the hotspots of risk for the chosen threats. These products will be adopted as baseline for a cumulative impact assessment, which will be described in the synthesis report (Activity 3.7). In view of this, the study area shown in this Atlas reflects the selection of NUTS3 regions listed in the Deliverable 3.16a.

2. Spatial references

One hundred and fifty NUTS3 regions were selected from the northern Mediterranean Basin, according to the Deliverable 3.16.1, in order to get output spatially comparable with the other "Threats & Enabling Factors" (T&EF) analyses of CO-EVOLVE. The names of the NUTS3 regions are listed in Table 1: the NUTS3 regions are classified according to two economic parameters, "average annual growth" and average market share" (see Deliv. 3.16.1 for details). The selected NUTS3 regions belong to the countries Italy, Spain, France, Greece, Slovenia, Croatia, Cyprus, Malta and Montenegro.

However, it's worth noting that some of the selected regions don't have a coastline (e.g. Pordenone) and/or spread more than 100 km inland, covering large mountainous areas (e.g. Udine). With this in mind, a buffer of 10 km from the coastline towards inland was built, to refine some spatial analyses. Such buffer size is in line with the current European Commission's recommendations for defining a terrestrial "coastal zone" (Lavalle et al. 2011). Coastal waters were spatialized according to common practice (12 nautical miles from coastline), since no accordance in literature was found about their spatial definition. The spatial references used to build the maps of ecological risk are shown in Figure 1.

Figure 1: NUTS3 regions selected for the analyses at MED level (mid grey). The coastal buffer of 10 km is shown in dark grey. NUTS0 boundaries and acronyms are reported for all Mediterranean countries.

Table 1: The 150 NUTS3 regions selected for the analyses of Threats and Enabling Factors, classified according to two economic parameters (see Deliv. 3.16.1).

Low Share - Negative Trends	Low Share - Medium Positive Trends	Low Share - High Positive Trends	High Share - Negative Trends	High Share - Medium Positive Trends	High Share - High Positive Trends
Evros	Xanthi	Rodopi	Savona	Cyprus	Zakynthos
Drama	Imathia	Kavala	Salerno	Chalkidiki	Attika
Pella	Pieria	Thessaloniki	Ravenna	Kerkyra	Dodekanisos
Serres	Thesprotia	Kilkis	Forli-Cesena	Barcelona	Irakleio
Larisa	Lefkada	Kefallinia	Rimini	Girona	Lasithi
Magnisia	Aitoloakarnania	Ileia	Lucca	Alicante/Alacant	Rethymni
Arta	Lakonia	Fokida	Roma	Valencia/València	Chania
Preveza	Samos	Argolida		Hérault	Tarragona
Achaia	Chios	Messinia		Alpes-Maritimes	Balears, Illes
Voiotia	Castellón	Lesvos		Bouches-du-Rhône	Granada
Evvoia	Almería	Kyklades		Var	Málaga
Evrytania	Cádiz	Melilla		Genova	Istria
Fthiotida	Murcia	Primorje		Lecce	Napoli
Arkadia	Gard	Lika		Palermo	Malta
Korinthia	Šibenik	Zadar		Messina	
Ceuta	La Spezia	Split		Olbia-Tempio	
Aude	Caserta	Dubrovnik		Venezia	
Pyrénées-Orientales	Foggia	Brindisi		Padova	
Corse-du-Sud	Bari	Potenza		Udine	
Haute-Corse	Crotone	Matera		Livorno	
Imperia	Vibo Valentia	Reggio di Calabria			
Teramo	Trapani	Catania			
Pescara	Caltanissetta	Ragusa			
Chieti	Rovigo	Siracusa			
Campobasso	Gorizia	Sassari			
Benevento	Ferrara	Nuoro			
Avellino	Massa-Carrara	Oristano			
Taranto	Pisa	Ogliastra			
Barletta-Andria-Trani	Grosseto	Treviso			
Cosenza	Pesaro e Urbino	Trieste			

Table 1 (*continues*).

Low Share - Negative Trends	Low Share - Medium Positive Trends	Low Share - High Positive Trends	High Share - Negative Trends	High Share - Medium Positive Trends	High Share - High Positive Trends
Catanzaro	Ancona	Gozo and Comino			
Agrigento	Macerata	Primorsko-notranjska			
Enna	Ascoli Piceno				
Cagliari	Goriška				
Medio Campidano	Obalno-kraška				
Carbonia-Iglesias					
Pordenone					
Fermo					
Viterbo					
Latina					
Frosinone					

3. Maps of ecological risks in the Mediterranean Basin

This Chapter shows the following maps of ecological risk:

1 - Bathing water quality in the EU Mediterranean Basin

2 - Solid waste production in the EU Mediterranean Basin

3 - Road noise in the EU Mediterranean Basin

4 - Light pollution in the EU Mediterranean Basin

5 - Light pollution along the EU Mediterranean Coastline

6 - Artificialization in the EU Mediterranean Basin

7 - Artificialization along the EU Mediterranean Coastline

8 - Habitat loss in the EU Mediterranean Basin

9 - Habitat loss along the EU Mediterranean Coastline

3.1 Bathing water quality

Source

Bathing water quality data were retrieved from the following source: https://www.eea.europa.eu/data-and-maps/data/bathing-water-directive-status-of-bathing-water-9

The EU Bathing Waters Directive requires Member States to identify popular bathing places in fresh and coastal waters and monitor them for indicators of microbiological pollution (and other substances) throughout the bathing season which runs from May to September. The data set presents the latest information as reported by the Member States for the 2016 bathing season.

Indicator

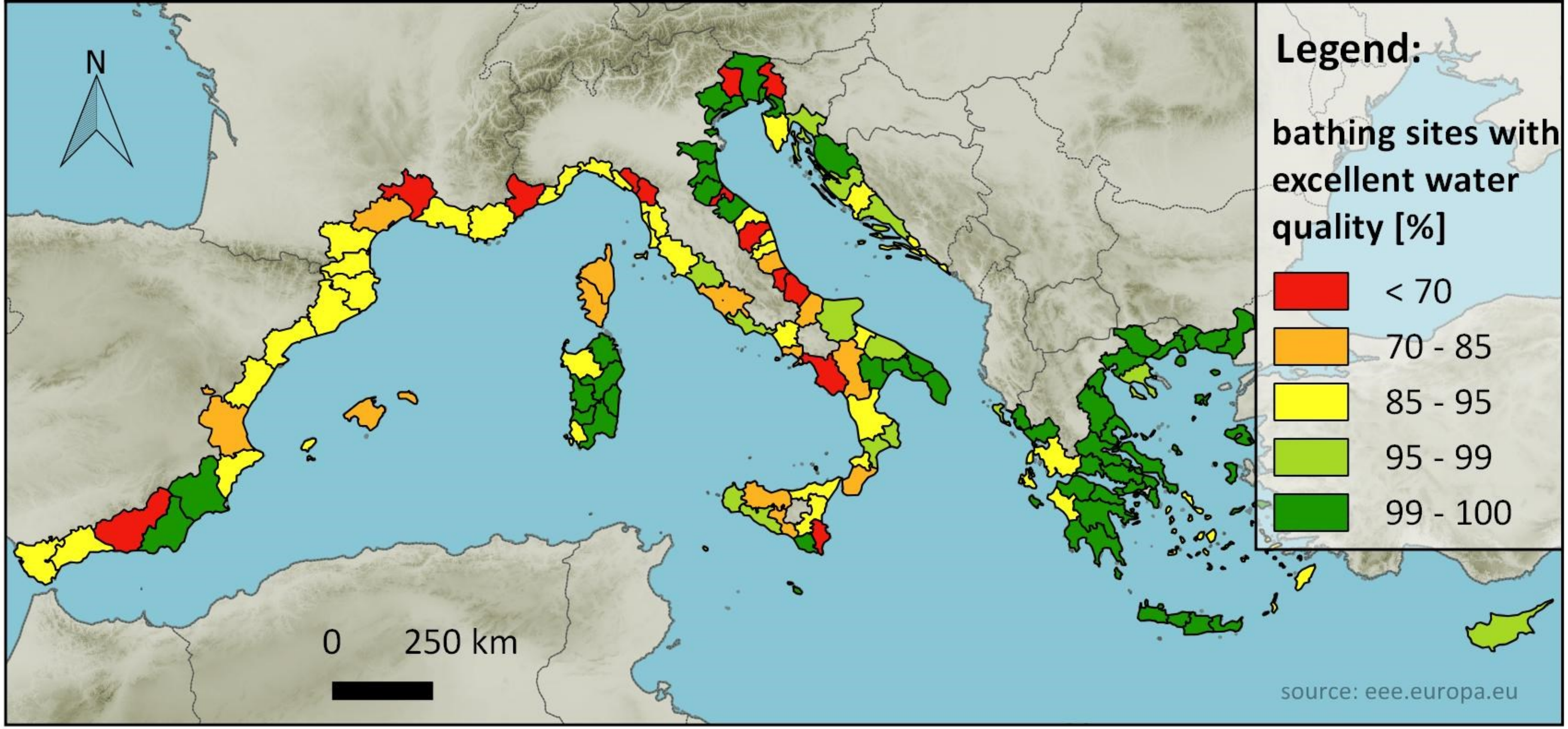
The indicator proposed is: Percentage of bathing sites with excellent water quality.

Results

Most of NUTS3 Greek coastal regions have almost all (99-100%) bathing sites in excellent condition. Dalmatian and Slovenian coastlines are also in middle to good ranking (with the regions of Istria, Šibenik and Dubrovnik showing the worst values). The Italian Peninsula presents a very inhomogeneous situation, with most of Sardinia, NE Adriatic coast and Apulia and Basilicata characterized by excellent water quality in 99-100% of bathing sites, while Tyrrhenian coastlines range from 70% to 95% of excellent bathing sites. The regions characterized by lower values are Salerno and Syracuse. French and Spanish coastal NUTS3 regions have a similar variegated condition to Tyrrhenian coastline, with the exception of Almeria and Murcia (99-100% of excellent water quality sites) and Granada (lowest percentage < 70%). In France, the “worst” regions (< 70% of excellent bathing sites) are Gard and Alpes-Maritimes.

Balearic Islands and Corsica present 70-85% of bathing sites with excellent water quality. In Cyprus, 95-99% of bathing sites have excellent water quality, while Malta is ranked on the top.

Bathing water quality in the EU Mediterranean Basin.



3.2 Solid waste

Source

Solid waste production data were retrieved from the following source: http://ec.europa.eu/eurostat/web/waste/transboundary-waste-shipments/key-waste-streams/municipal-waste

Since a NUTS3 database wasn't available, we chose to map the most comprehensive dataset available for each NUT2 region. Thus, values from year 2012 were selected for Catalonia, Valencian Community, Balearic Islands, Andalusia and Region of Murcia; values data from year 2011 were adopted for Languedoc-Roussillon, Provence-Alpes-Côte d'Azur and Corsica; all the other NUTS2 regions' values refer to year 2013.

Solid waste production was measured in kg/inhabitant, in order to compare the values among regions. This parameter was adopted in combination with the overnight stays, used as proxy for somehow "measuring" the contribution of tourism to total waste generation. In fact, no large scale estimates on tourist waste production exist. The data relative to the overnight stays was retrieved from:

http://appsso.eurostat.ec.europa.eu/nui/setupDownloads.do

through this indicator: "Nights spent at tourist accommodation establishments by NUTS 2 regions"; year 2012.

Indicator

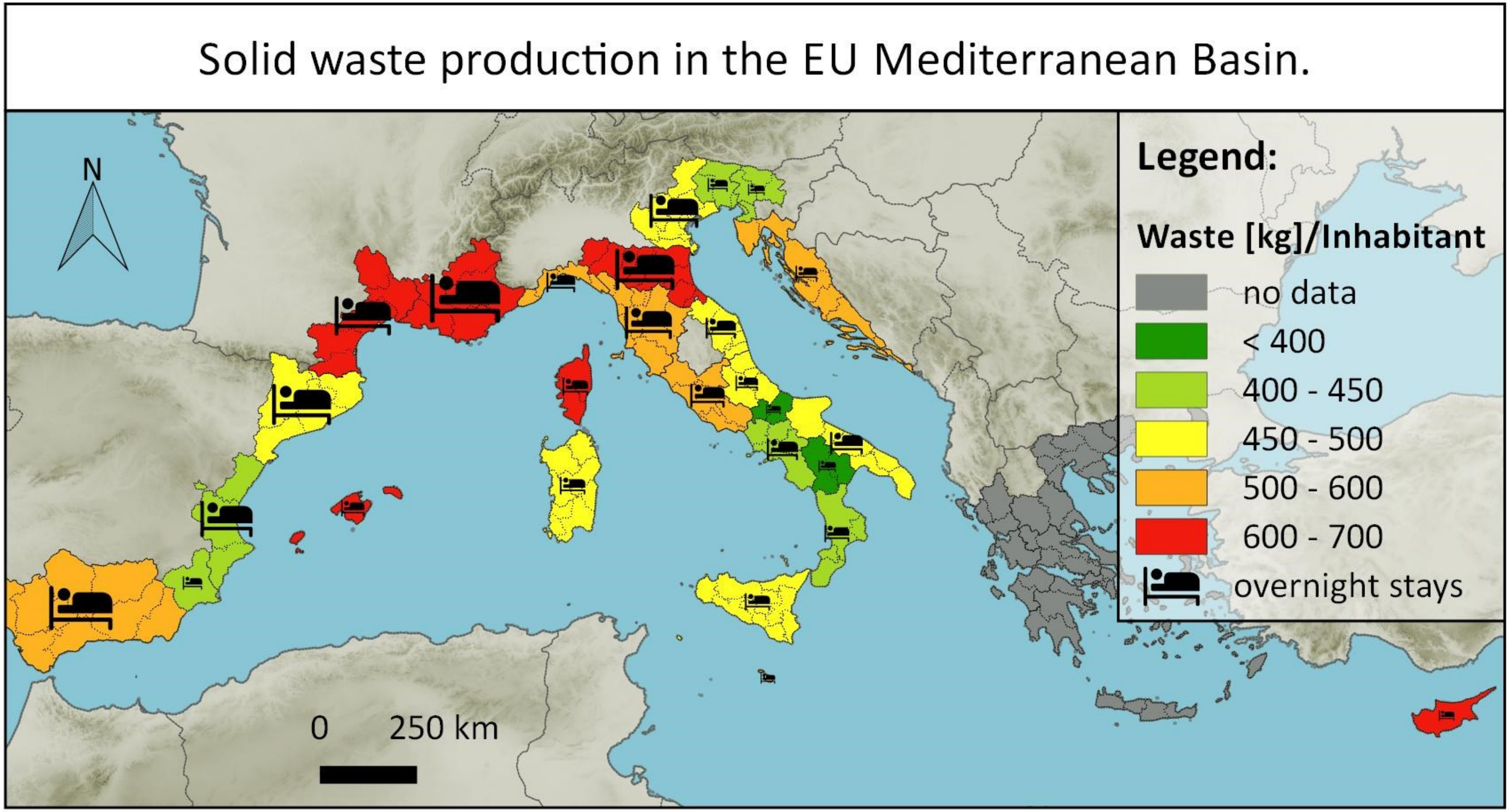
The synthetic indicator proposed is: Annual kg of waste pro inhabitant in relation to overnight stays.

Results

Cyprus, Emilia-Romagna, Corsica, Balearic Islands and all French coast have the highest waste production pro inhabitant (600-700 kg/inhabitant). French coastal regions and Emilia-Romagna (to a lower extent) present also the largest number of overnight stays; this factor could mean that the contribution of coastal tourism to the total amount of waste produced is substantial in these regions. Small islands (e.g. Cyprus, Balearic Islands and Corsica) seem to be more threatened by solid waste production compared to larger regions; the relatively lower number of overnight stays could mean that tourism is not highly responsible for waste generation in the Mediterranean islands. Spanish regions (except Andalusia) and Veneto in Italy display instead a low to mid waste production, coupled with high touristic presence. In this case we could assume that these regions have enabled efficient ways for reducing waste generation.

Regions along the Slovenian coastline, where the influence of tourism is negligible, are well ranked, with average 400-450 kg/inhabitant generated. Instead, Dalmatia's waste production is worrying (500-600 kg/inhabitant), especially considering the low number of tourists in comparison with the other popular Mediterranean regions.

Data on solid waste for the whole Greece was not available at the required scale.


Solid waste production in the EU Mediterranean Basin.
N
Legend:
Waste [kg]/Inhabitant
no data
< 400
400 - 450
450 - 500
500 - 600
600 - 700
overnight stays
0
250 km

3.3 Road noise

Source

Road noise data were retrieved from the following source:

https://www.eea.europa.eu/data-and-maps/data/data-on-noise-exposure-2

This database contains information on the number of people exposed to five decibel (dB) bands for two indicators "Lden: 55-59, 60-64, 65-69, 70-74, >75" and "Lnight: 50-54, 55-59, 60-64, 65-69, >70". We calculated the cumulative percentage of people exposed to the five bands for “Lden”. Parameters were recorded in major cities; therefore we extended these values to the correspondent NUTS3 level.

Indicator

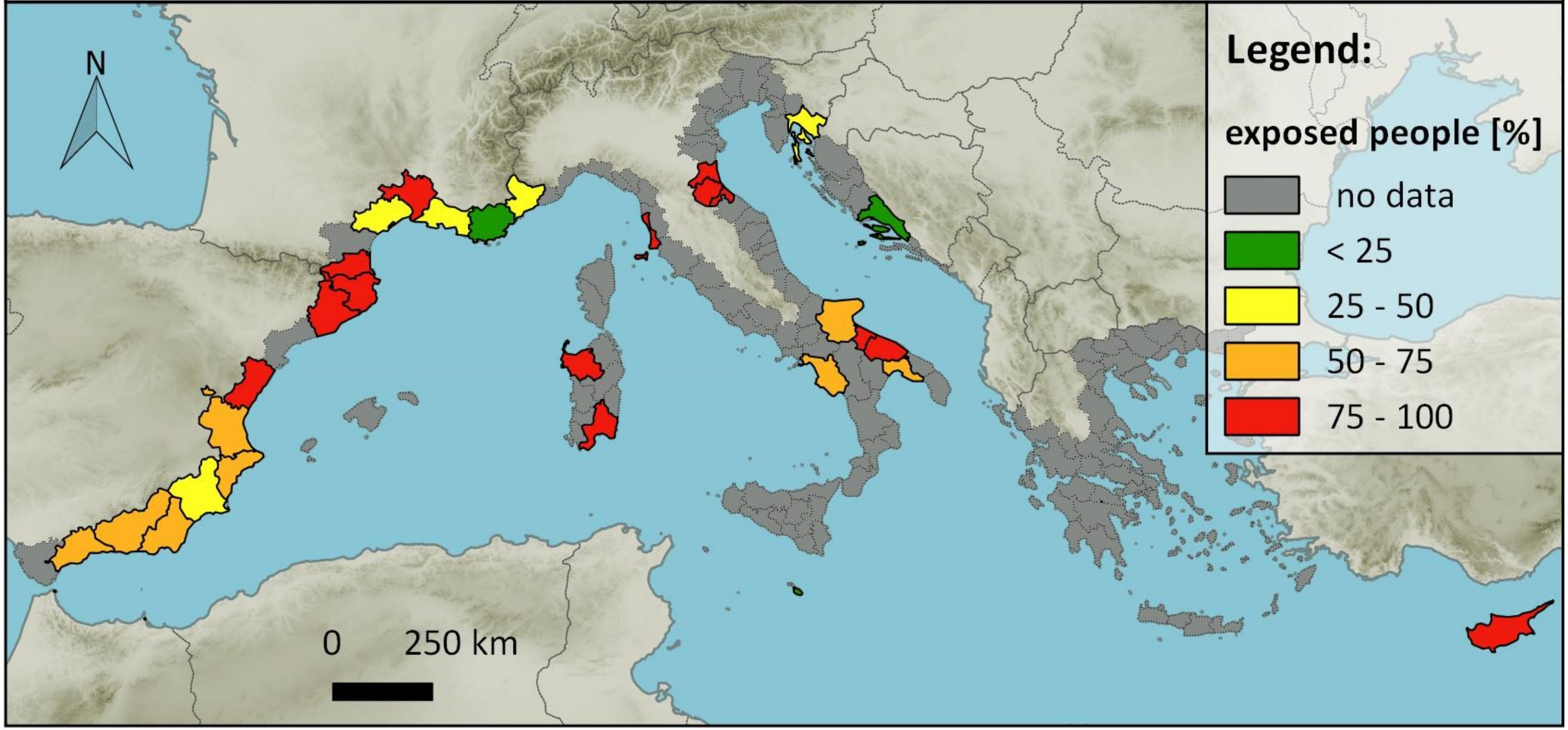
The indicator proposed is: Percentage of people exposed to road noise

Results

Data were available for a minority of NUTS3 regions. In Spain, Murcia is the region showing the most favourable condition (25-50% people are exposed to road noise level >55 dB), while in the other regions but Castellon 50-75% people are exposed to road noise pollution. French coastline has a variegated situation, with the region Var showing the best values (<25%) for all Western EU Mediterranean Basin, while Gard shows the worst values (75-100%). Cyprus and various NUTS3 regions throughout Italy and Sardinia are highly threatened by road noise pollution. The only two NUTS3 in Croatia (Split-Dalmatia and Primorje-Gorski Kotar County) for which data were available seem less affected by this kind of pollution source. Malta’s road noise pollution looks low (<25%). No data for Greece were reported in the database.

Overall, this threat type looks alarming and still underestimated/under-reported, as evidenced by the scarce piece of information available.

Road noise in the EU Mediterranean Basin.



3.4 Light pollution

Source

Data on light pollution were retrieved from the following source:

Falchi F., Cinzano P., Duriscoe D., Kyba C.C.M., Elvidge C.D., Baugh K., Portnov B., Rybnikova N.A., Furgoni R. 2016. Supplement to: The New World Atlas of Artificial Night Sky Brightness. GFZ Data Services. http://doi.org/10.5880/GFZ.1.4.2016.001

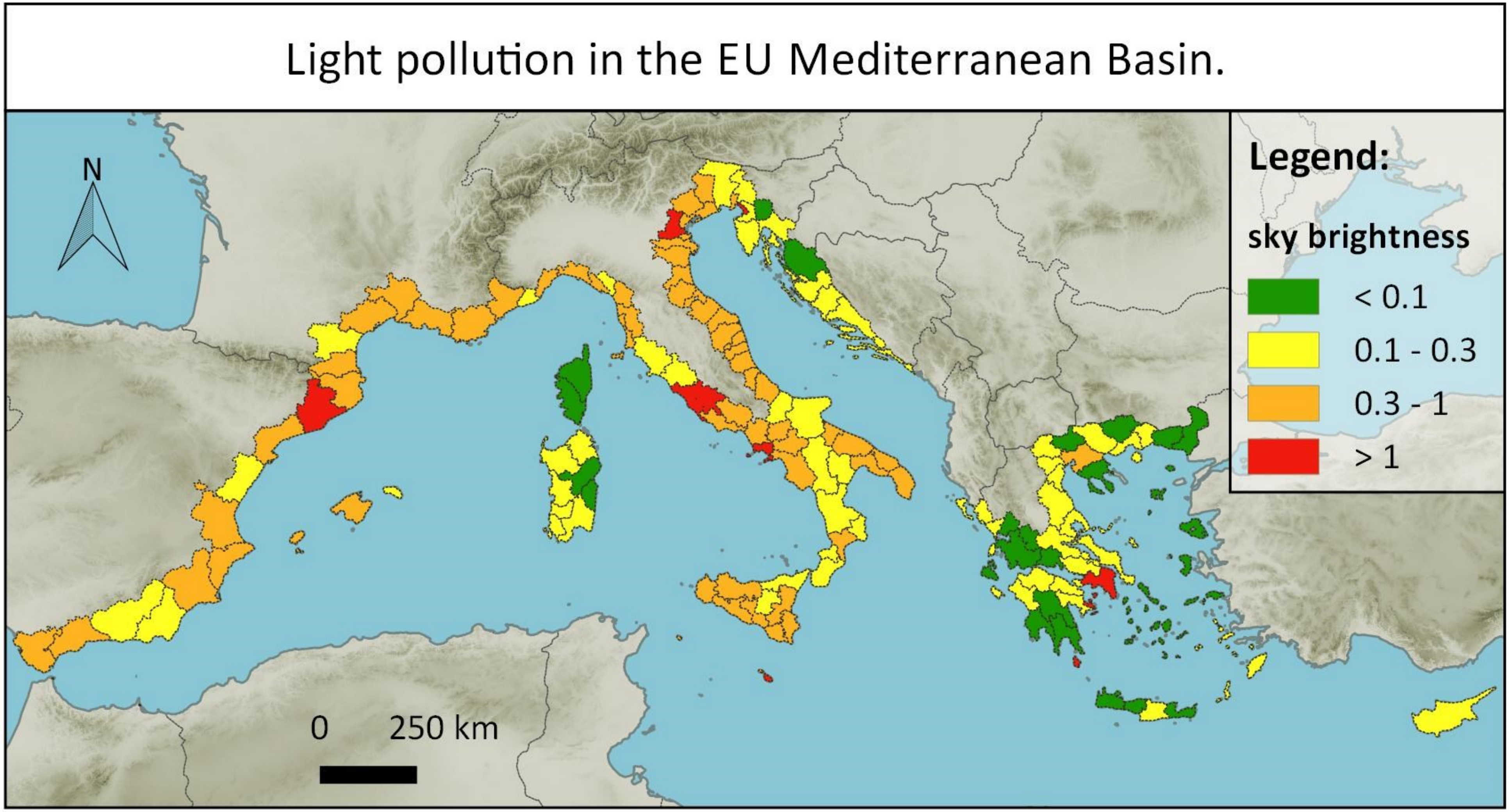
These data are related to artificial light only. The zenith radiance from natural sources such as stars and the Milky Way are not included.

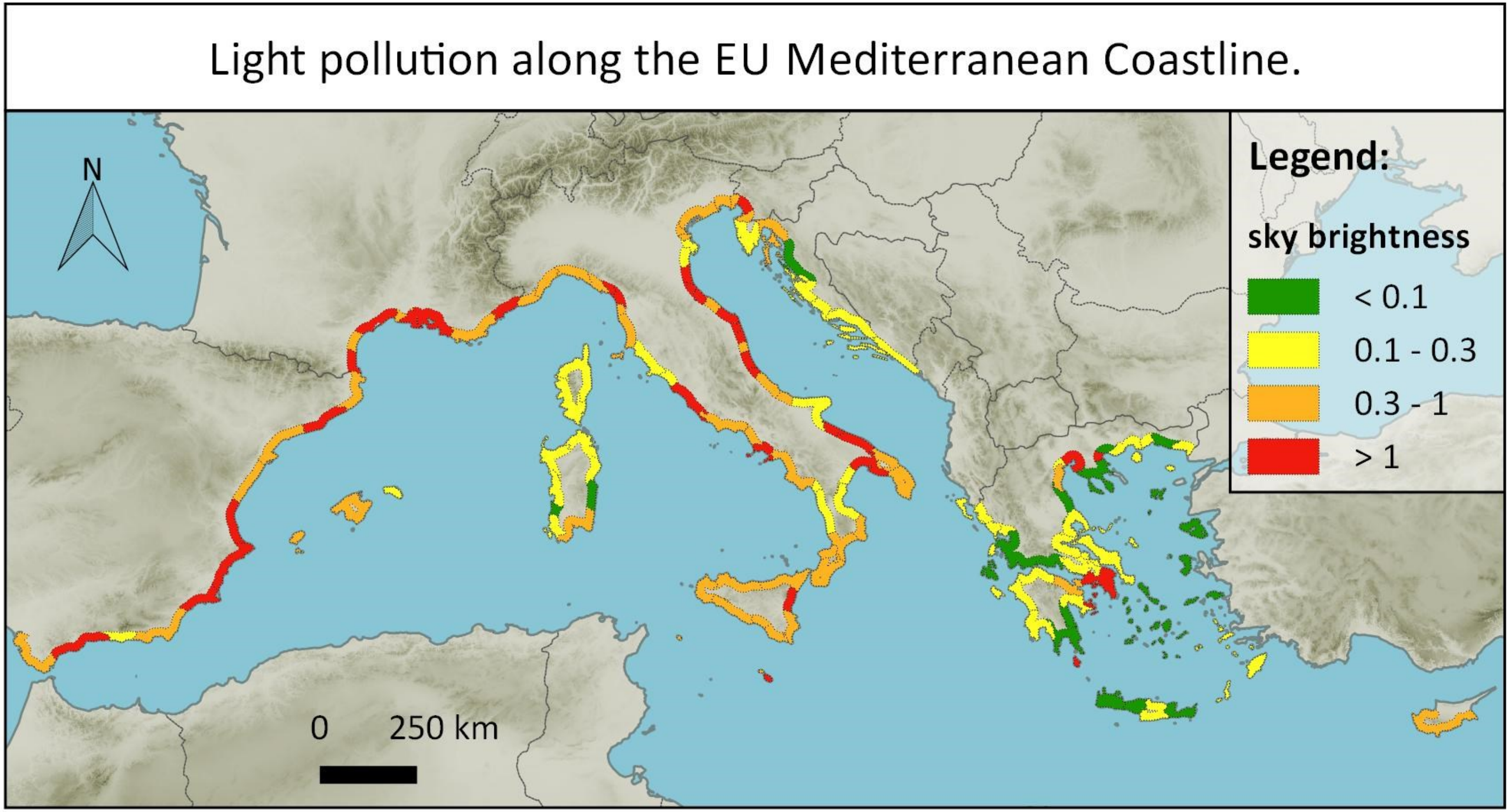
Indicator

The indicator proposed is: Artificial sky brightness (simulated zenith radiance) in mcd/m^2

Results

The map of artificial light pollution built at NUTS3 level and the one considering the coastline level only show different scenarios. Overall, EU Mediterranean coastline appears much more exposed to artificial light brightness than inland. This fact shows how far coastal urbanized areas influence mean values obtained from the assessment at NUTS3 level. While in the map at NUTS3 level only nine “red” regions occur (those with artificial sky brightness > 1), the map at coastline level shows 1/3 of the regions affected by maximum sky brightness values. Each NUTS3 region, when only its coastal fraction is considered, becomes potentially more threatened by light pollution. Overall, in both maps it’s clear that Spain, France and Italy are more affected by artificial night lights than Greece, Slovenia and Croatia. Malta is a hotspot for light pollution, whereas larger islands like Corsica, Sardinia and Crete are much less affected. Cyprus and Sicily are characterized by mid values.


Light pollution in the EU Mediterranean Basin.
N
Legend:
sky brightness
< 0.1
0.1 - 0.3
0.3 - 1
> 1
0
250 km


Light pollution along the EU Mediterranean Coastline.
N
Legend:
sky brightness
< 0.1
0.1 - 0.3
0.3 - 1
> 1
0
250 km

3.5 Air pollution

Source

A possible way to express air pollution is to consider the extent of categories of sources generating air pollutants (such as industries, ports, roads etc.). We adopted therefore land cover information to spatialize this "artificialization" process and its consequent impact on the air quality. Spatial data on land cover information were retrieved from the following source: http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/view

Corine Land Cover (CLC) consists of an inventory of land cover in 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The vector files adopted for this map refer to 2012.

Indicator

The indicator proposed is: Percentage of artificial land cover classes with respect to total NUTS3 surface

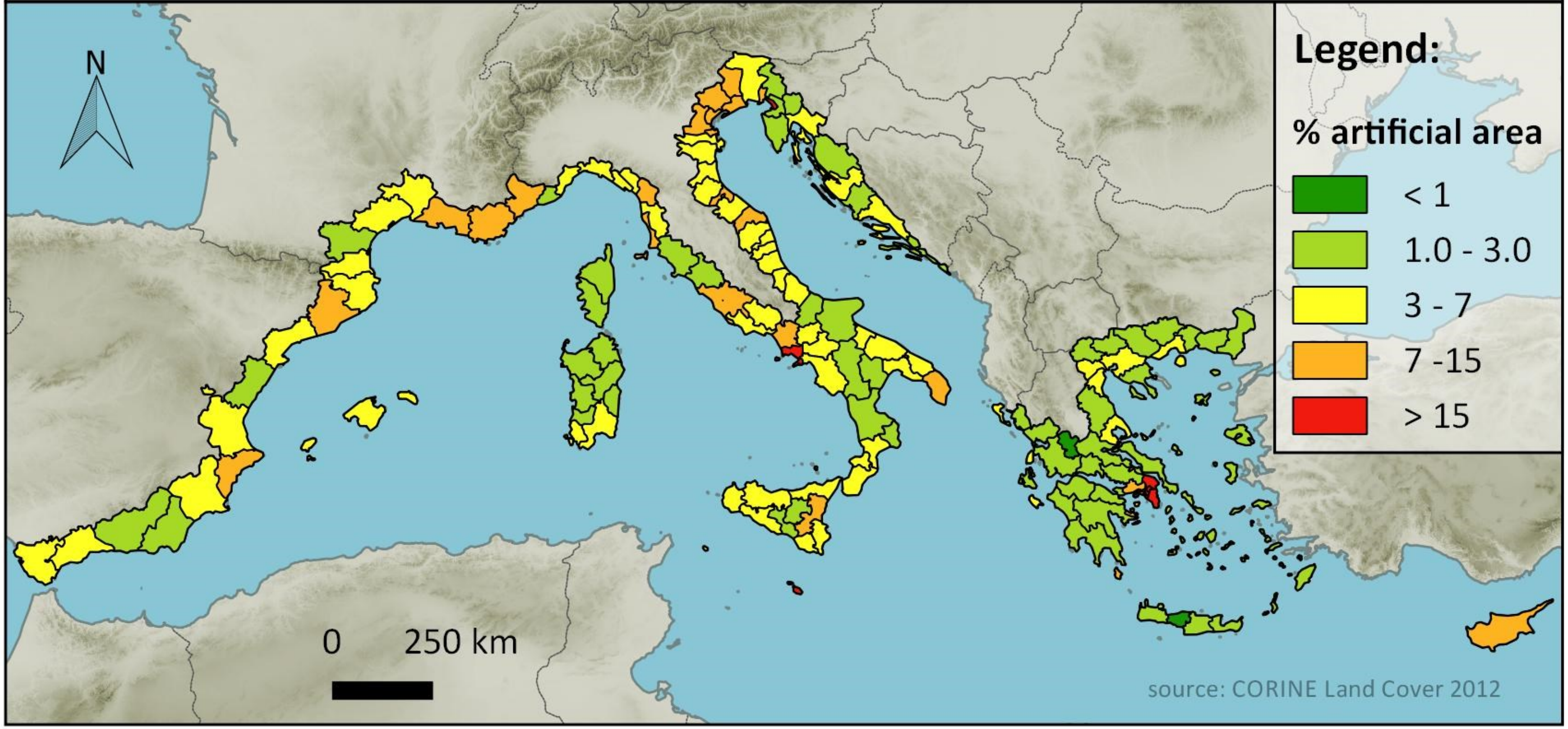
The selected artificial Corine Land Cover classes are the following: 1.1 Urban fabric (it includes continuous and discontinuous urban areas); 1.2 Industrial, commercial and transport units (it includes industrial and commercial areas, airports, and roads).

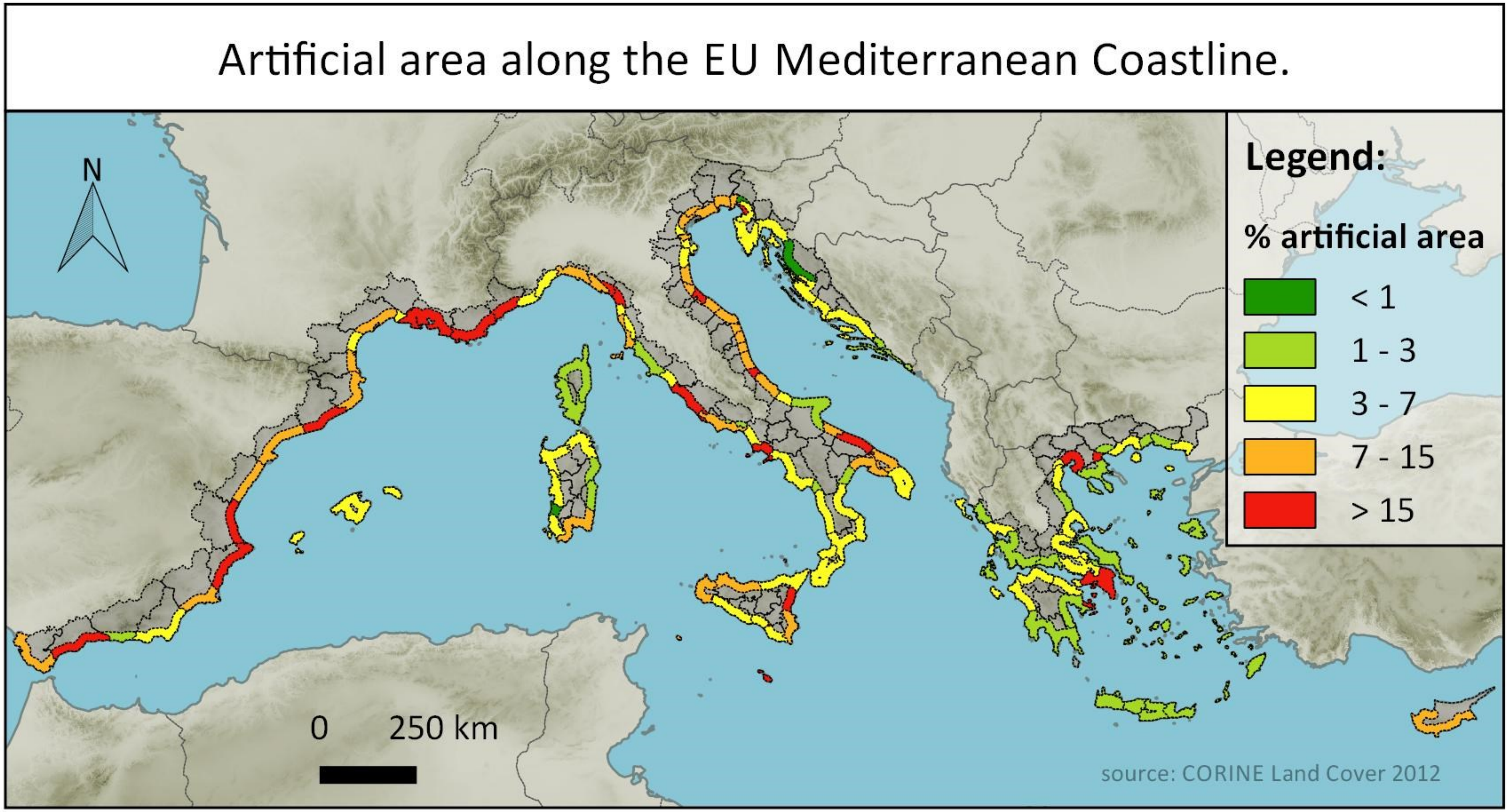
Results

Artificialization measured at NUTS3 level and at coastline level showed different results. As already revealed in the case of light pollution, the comparison between the map at NUTS3 level and the one at coastline level shows the high contribution of coastal development and consequent air pollution to the average regional values. In fact, when taking into account the whole NUTS3 regions, only few of them show more than 15% of the total surface covered by artificial land classes (Malta, Naples, Trieste, and Attica). Instead, when looking at the coastline map, most of the seaside from Gibraltar till Nice is highly represented by artificial land cover classes, being coloured in "red" (>15% of artificial areas) or "orange" (7-15% of artificial areas).

Overall, it's clear that Spain, France and Italy are more affected by artificialization, and thus by air pollution, than Greece, Slovenia and Croatia. The reflections expressed about island size and light pollution are mirrored for artificialization: large islands like Corsica, Sardinia and Crete are less affected than Malta and Cyprus.

Artificial area in the EU Mediterranean Basin.




Artificial area along the EU Mediterranean Coastline.
N
Legend:
% artificial area
< 1
1 - 3
3 - 7
7 - 15
> 15
0 250 km
source: CORINE Land Cover 2012

3.6 Habitat loss

Source

A possible way to express habitat loss is to compare natural areas with artificial areas. As done with artificialization, we adopted land cover information to calculate for each NUTS3 the surface of natural areas over the surface of artificial areas. Spatial data on land cover information were retrieved from the following source: http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/view

Corine Land Cover (CLC) consists of an inventory of land cover in 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The vector files adopted for this map refer to 2012.

Indicator

The indicator proposed is: natural land cover classes/artificial land cover classes

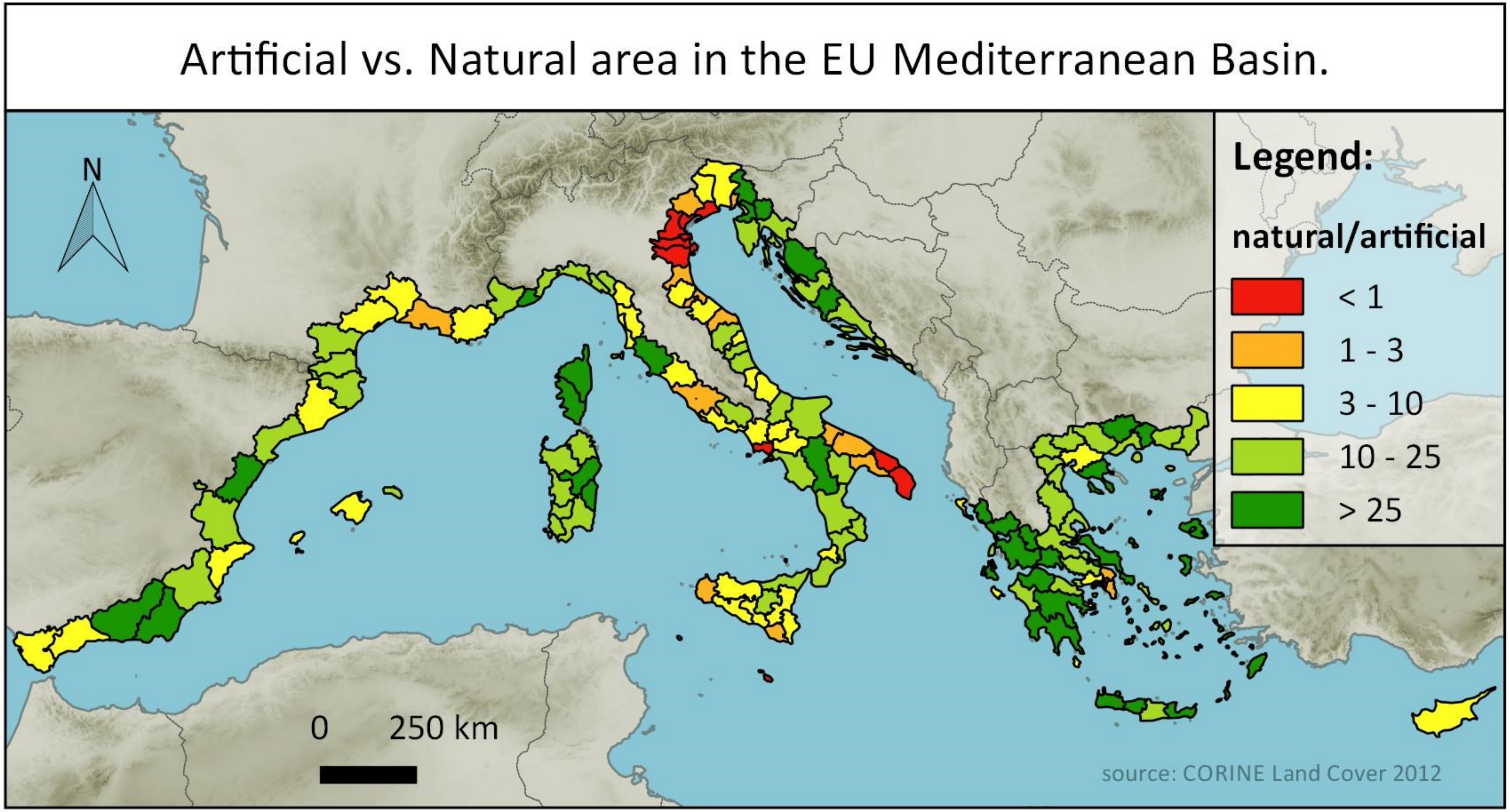
The adopted natural land cover classes are all those terrestrial cover classes belonging to Corine Land Cover class 3 (for a full list refer to Deliv. 3.5.1). The adopted artificial Corine Land Cover classes are the following: 1.1 Urban fabric; 1.2 Industrial, commercial and transport units.

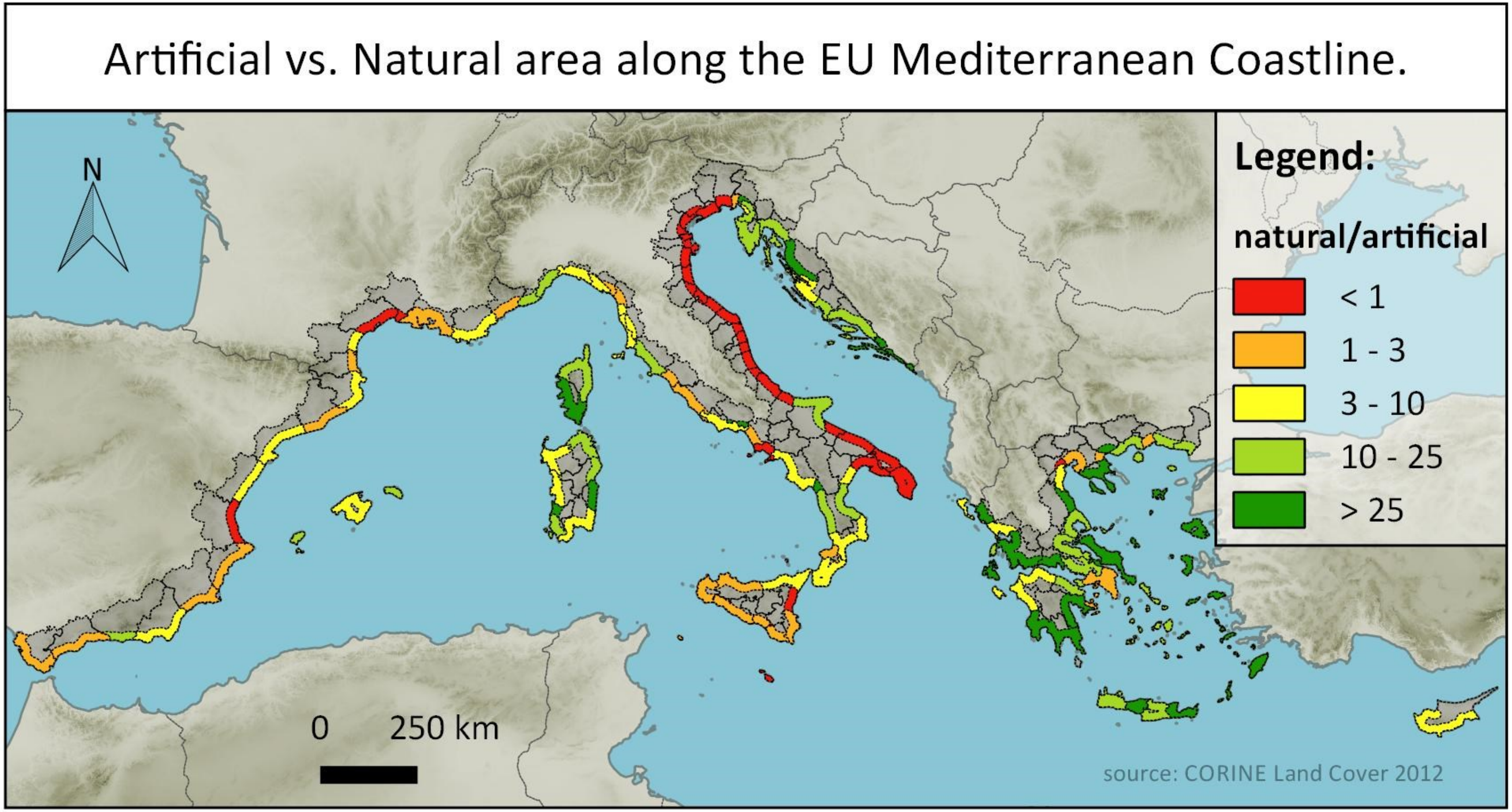
Results

Unlike the previous threats analysed, habitat loss measured at NUTS3 level and at coastline level showed similar results, at least for some regions. This time, the comparison between the map at whole NUTS3 level and the one at coastline level revealed that most of Greek and Dalmatian regions still maintain their natural integrity both on coasts and inland. The exceptions to this in Greece are Thessaloniki, Langadas and Xanthi, whose coastal naturalness is in unfavourable state. The other Greek region where natural habitats have been lost is Attika (the region of Athens).

On the other hand, the Western Mediterranean regions have lost much of their native coastal ecosystems in favour of urbanization. This is particularly true for the entire Adriatic and the Ionian Italian coastlines. In particular, only Foggia in the Gargano region still hosts large natural areas in its coastal territory. The Tyrrhenian coast is variegated, with the highest naturalness in Grosseto and Potenza NUTS3 regions, and the lowest in Naples (the only NUTS3 and related coastline in “red”).

Among the large islands, Corsica, Sardinia and Crete coasts and inland are still in a favourable environmental condition. In France, Herault and Gard are highly threatened by coastal habitat loss, while the most transformed Spanish coastal strip is Valencia. Habitat loss along the Spanish coastline is clearly concentrated along the seaside, whereas NUTS3 inland territories are still well preserved in terms of natural zones' occurrence.
When considering the whole NUTS3 surface, only the Italian NUTS3 regions from Veneto, plus Naples, Bari and Barletta-Andria-Trani show alarming levels of habitat loss, among the whole Northern Mediterranean Basin.


Artificial vs. Natural area in the EU Mediterranean Basin.
N
Legend:
natural/artificial
< 1
1 - 3
3 - 10
10 - 25
> 25
0
250 km
source: CORINE Land Cover 2012


Artificial vs. Natural area along the EU Mediterranean Coastline.
N
Legend:
natural/artificial
< 1
1 - 3
3 - 10
10 - 25
> 25
0
250 km
source: CORINE Land Cover 2012

4. References

Lavalle C., Gomes C.R., Baranzelli C., Batista e Silva F. 2011. Coastal Zones. Policy alternatives impacts on European Coastal Zones 2000 – 2050. JRC Technical Notes