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Landscape Profiles, Urbanization and Environmental Protection in Europe: Is Western the Future Scenario for Eastern?

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Abstract

The paper aims to analyze the macro landscape profiles of Western and Eastern European countries in search of affinities or evolutionary signs that may lead to defining lines of scenario. The landscape mosaic is notoriously very different in different countries, but several common elements can be recognized that emerge from some specifically cut surveys and are not intuitive. In particular, it is of interest to investigate the different configurations of urban patterns together with those of other key landscape units, such as agricultural, forest and semi-natural, trying to ascertain affinities. Interpretive help in this regard is also thought to come from the survey of environmental protection, investigated through national and community instruments, which is a very valid indicator for understanding the level and quality of land management toward which a country is trending. Awarenesses acquired in Western Europe for many years already testify that the settlement development patterns followed in the last half century cannot be considered entirely positive and, therefore, it would be helpful if other Eastern Bloc countries were able to perceive the pathological aspects and not repeat them in their trajectories of, albeit legitimate, economic and social growth. The method used sought to demonstrate the dependence of settlement growth patterns on economic characteristics, but also revealed some unexpected differences in environmental protection policies.

Keywords

Urbanization in Europe, European Environmental Protection, European Landscape, Western and Eastern Europe

1. Introduction

European countries are highly differentiated in relation to morphological, environmental, and climatic features, although in the last 50 years they have been united by the process of hyperurbanization, which, although also with some differences, has been impressive for all. While data on urban population growth in Europe and the world are widespread in the literature, even over many chronological sections (Galloway, 1994; Cheshire & Magrini, 2006; Mokyr & Voth, 2010), information on change detection in land use in the chronosequences between the 1950s and the mid-1990s is very scarce (Barrington-Leigh & Millard-Ball, 2015; Wolff & Wiechmann, 2018; Egidi et al., 2020b). Original elaborations along these lines would also be extremely difficult due to the lack of homogeneous mapping for all member countries, which became available exclusively with the development of satellite surveys beginning with the first Corine Land Cover (Coordination of information on the environment) in 1996 (Büttner et al., 2004). In 2018 Copernicus, the EU's Earth observation program (Buchhorn et al., 2020), completed another phase of the Europe-wide mapping exercise that formed the basis of a detailed analysis by the EEA of land cover and, in part, land use in member countries. The results of the monitoring carried out by Corine reveal that land cover in Europe has remained relatively stable since 2000, with about 25% arable land and permanent crops, 17% grassland and 34% forest. However, a closer look at changes in land cover reveals some particular trends (Büttner, 2014).

Urbanized areas continue inexorably to expand, and man-made areas currently cover a fraction of 5% to 6% of the total land area in the European Union. After strong pressures in that direction in the 50 years between the post-World War II period and 2000, however, the rate of growth of artificial surfaces has slowed down and has been estimated to have fallen from just over 1000 km^2 per year between 2000 and 2006 to about 700 km^2 per year between 2012 and 2018.

It is well known that the most important conversions are recorded in agricultural land (Romano & Zullo, 2013), while total forest area remains more stable with an upward trend (Kaplan et al., 2017), but urbanization of agricultural land also seems to have slowed down a lot in the period 2012-2018 (Kunzmann & Wegener, 1991; Antrop, 2004; De Vries, 2013; EEA, 2019).

It should be noted that in parallel with the swirling urban growth has also been matched by significant environmental protection action, evidently resulting from an increase in collective sensitivity due precisely to the perception of widespread land take and degradation (Shaker, 2015). In fact, the estimated growth of protected areas on the European continent from the 1950s to post-2000 has been about 10 times, taking into account that it currently exceeds well over 10 million km^2.

In the continental section of the Europe of 27 (EU27) alone, according to Eurostat, between 2011 and 2020 protected land areas increased from about 758,000 to 764,000 km^2, an increase of just under 6000 km^2 (+0.50%).

https://ec.europa.eu/eurostat/databrowser/view/env_bio4/default/table?lang=en (Accessed Jan. 9, 2023).

It is now well established at every level that soil is an extremely important resource, renewable only with geologic timescales, and provides critical ecosystem services (Foley et al., 2005; EC, 2020). Sustainable land use underpins all of the United Nations Sustainable Development Goals (SDGs); in fact, soils in good functional condition are essential to achieve the 17 SDGs, including those of a social and economic nature (Folke et al., 2016). As highlighted by the European Commission in the EU Biodiversity Strategy 2030: "*In the EU, land degradation is having significant environmental and economic consequences. Poor land management such as deforestation, overgrazing, unsustainable agricultural and forestry practices, construction activities, and soil sealing are among the main causes of this situation*" (Agrawal, 2005; Emberson et al., 2003; Ruddock & Lopes, 2006; Ashraf et al., 2010; Levers et al., 2018; Falcucci et al., 2007; Prokop et al., 2011; EEA, 2017; Munafò, 2021, Lin & Yang, 2021). The research presented in the paper characterizes the landscape mosaics of European countries, attempting to highlight common features and differences, with a focus on the weight of urbanization and environmental protection (Mayer & Job, 2014; Kati et al., 2015. For this purpose, two macro-types of landscape-environmental mosaics were identified Meeus, 1995; Nolte et al., 2010; Plieninger et al., 2015). The first includes areas with predominantly anthropogenic physiognomy, while the second includes areas of higher environmental quality or transition. The changes that have occurred over time on these areas are partly planned, but in many cases they are spontaneous and influenced by the market, economic crises, and local or global events without specific control. An important content of the work is to compare some of the dynamics between Western and Eastern European countries, to assess whether the soil evolutionary trends already established in Western Europe (EUW) are also developing in the Eastern part (EUE) along similar lines (Enyedi, 1990; Salvati et al., 2018).

2. Material and Methods

The research was designed following a very large body of work focused on the Italian case study and concerning the relationships between landscape configurations and changes in land use caused by excessive urbanization (Ewing, 2008; Romano et al., 2017, 2020). Although different Italian regions show a pronounced latitudinal gradient in terms of socio-economic, landscape and environmental protection, no profound differences have emerged in the results of land transformation and land consumption. For this reason, we wanted to try to investigate the situations manifested at the level of the various European countries. The study analyzed the territories of the EU Member States (EU27) minus the countries of Malta, Luxembourg and Cyprus (**Figure 1**) as very small countries. Starting from the 44 land cover categories defined by the European classification proposed in the Corine Land Cover (CLC) (Büttner, 2014; Bossard et al., 2000). European Landscape Macrosystems (ELM) consisting of artificial areas covered by urbanisation (U), intensive agriculture (IA), extensive agriculture (EA), forests (F), natural and semi-natural areas (SN) and water bodies (W) were

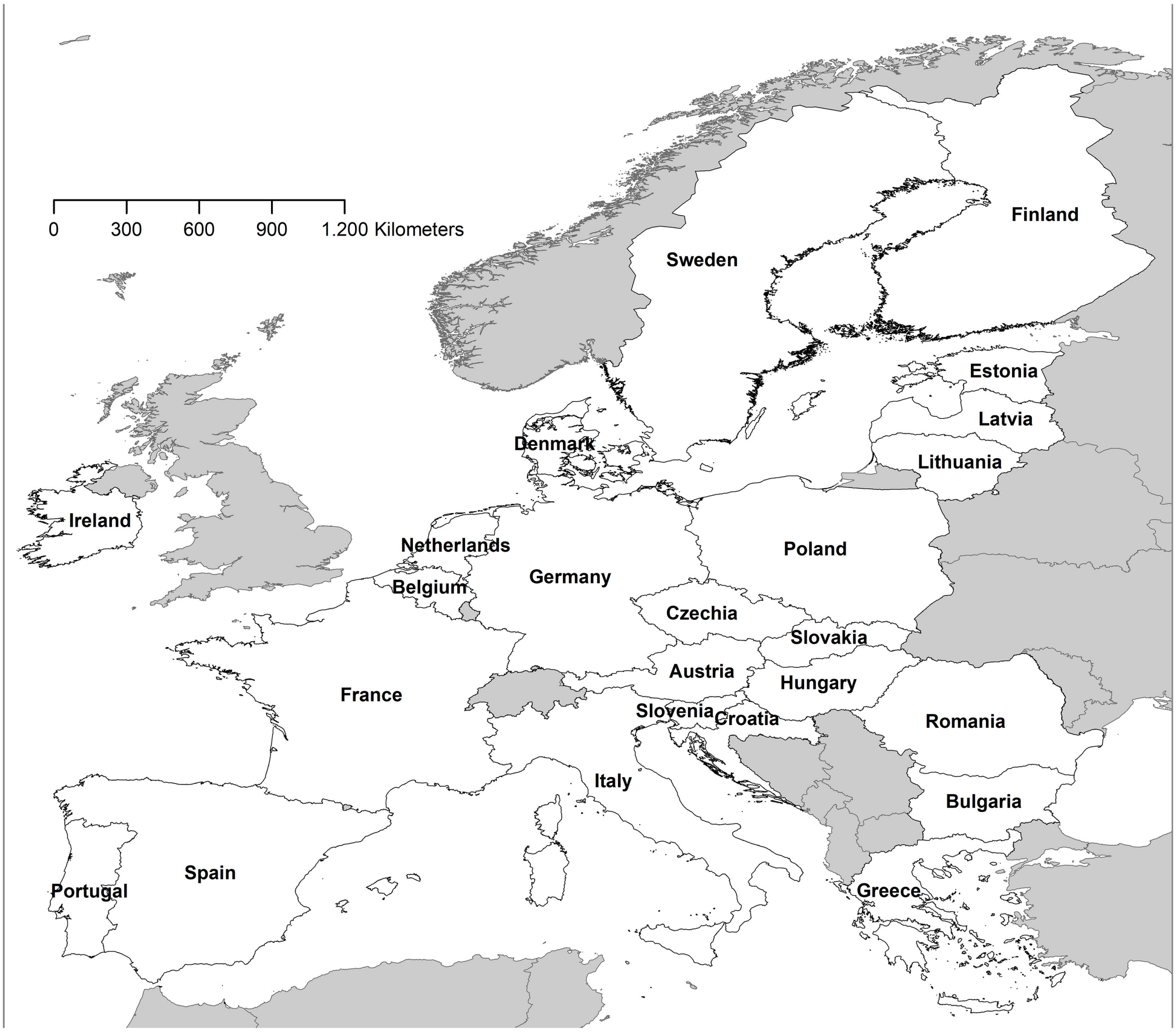

Figure 1. Study area.

extracted (Romano et al., 2020; Zullo et al., 2022). In most cases the assignment is quite automatic, while some clarifications must be made for the inclusion of CLC categories "221", "222", "223" in the ELM "IA" or "EA". These types of land use have different connotations, however for the first two IAs prevail, while EAs predominate for the last one. The ELM mosaics (**Table 1**) were then grouped into two macrosystems: ELM^ = (U + IA + EA) and ELM* = (F + SN + W) with ELM^ comprising mosaics with predominantly terrestrial artificialization and ELM* those with the most important areas in terms of ecological-environmental quality and connection between ecosystems. It is useful to recall that urbanised areas are defined as those intended for urban functions, replacing or maintaining natural soil. They therefore include built-up land and land used for ancillary functions of the settlement, such as public and private gardens, sports facilities, dirt roads and other service areas, excluding the maritime environments.

Table 1. Cluster of ELM systems obtained from CLC classes.

ELM Macrosystem	ELM System	CLC Code	CLC classes
ELM^	U	111	Continuous urban fabric
		112	Discontinuous urban fabric
		121	Industrial or commercial units
		122	Road and rail networks and associated land
		123	Port areas
		124	Airports
		131	Mineral extraction sites
		132	Dump sites
		133	Construction sites
		141	Green urban areas
		142	Sport and leisure facilities
	IA	211	Non-irrigated arable land
		212	Permanently irrigated land
		213	Rice fields
		221	Vineyards
		222	Fruit trees and berry plantations
	EA	223	Olive groves
		231	Pastures
		241	Annual crops associated with permanent crops
		242	Complex cultivation patterns
		243	Land principally occupied by agriculture, with significant areas of natural vegetation
		244	Agro-forestry areas
ELM*	F	311	Broad-leaved forest
		312	Coniferous forest
		313	Mixed forest
	SN	321	Natural grasslands
		322	Moors and heathland
		323	Sclerophyllous vegetation
		324	Transitional woodland-shrub
		331	Beaches, dunes, sands
		332	Bare rocks
		333	Sparsely vegetated areas
		334	Burnt areas
		335	Glaciers and perpetual snow

Continued

	411	Inland marshes
	412	Peat bogs
	421	Salt marshes
	422	Salines
W	423	Intertidal flats
	511	Water courses
	512	Water bodies
	521	Coastal lagoons
	522	Estuaries

As mentioned earlier, we obtained the ELM System using the CORINE Land Cover (CLC) categories that have been a standard for the whole of Europe for thirty years now. At the third level of detail, there are 44 types of land cover from satellite surveys, produced since 1990 and subsequently updated to 1996, 2000, 2006, 2012 and 2018. The data used in this paper is the one updated to 2018 and downloaded from the following website: The land cover maps came from the Copernicus portal-Land Monitoring Service (https://land.copernicus.eu/pan-european/corine-land-cover (accessed on April 2022). The data survey techniques include a minimum mapping unit (MMU) of 25 hectares with a minimum linear element size of 100 meters, while the MMU to record changes over time (LCC) is 5 hectares.

The ELM mosaics were then divided into two macrosystems: ELM^ and ELM* with ELM^ including the mosaics with the greatest land artificialization (51%), and ELM* with the greatest natural parts (49%).

The data relating to the geography of Natura 2000 network sites (N2K) comes from the website of the European Environment Agency (https://www.eea.europa.eu/data-and-maps/data/natura-13 (accessed on April 2022). The network consists of SPAs (Special Protection Areas or SPAs defined by the Birds Directive), SCIs and SACs (Sites of Community Importance and Special Areas of Conservation or SACs defined by the Habitats Directive, respectively) amounting to a total of 1,219,416 km^2 (https://www.eea.europa.eu/data-and-maps/daviz/trend-of-sites-designated-under-4#tab-chart_3, access April 2022).

European protected areas (PAs) come from EUROSTAT elaborations on EEA 2020 data (https://ec.europa.eu/eurostat/databrowser/view/env_bio4/default/table?lang=en access April 2022) that report for EU27 a total of 1,115,435 km^2.

It should be pointed out that on the topic of European land use the availability of data is very wide, even with regard to covers covering different chronosequences. However, with the exception of the CLC used in the present work, these are always sampled analyses and in any case not extended in a homogeneous form to the entire European territory and often limited to certain land cover categories, such as LUCAS or VOLANTE (Alcantara et al., 2013; Jepsen et al., 2015; Plieninger et al., 2016; Estel et al., 2016; Kristensen et al., 2016; van der Sluis et al., 2016), which is why the choice fell precisely on the CLC database.

3. Results

The survey of the territory of the different countries of the European Union of 27 (EU27), shown in the diagrams in **Figure 2**, shows various homogeneities and differences in the consistency of ELM Macrosystems and their ELM System partitions. The intensive agricultural mosaic (IA) is largely prevalent in both Western Europe (EUW) and Eastern Europe (EUE), but in the Western case there are frequent peaks that reach and exceed 60%o generally associated with urbanization rates (U) that are higher than the European average. Also in the EUW, only a few countries (Austria, Greece, Portugal and Spain) can boast residual natural spaces (SN) above 20 percent, and forest cover is also highly differentiated: well above 60% in the Scandinavian countries, but in the other cases generally reduced in complementary line with IA. A greater balance between the two formations (IA and F) occurs in Austria, Greece, Italy, Portugal and Spain, very close as ratios to those of the EU27 average. Rather fluctuating appear the urbanization rates (U) and almost always higher than those of the overall EU27 average: values between 15% and 20% are recorded in the cases of Belgium and Netherlands, but Germany, Denmark and France also show rather high levels. On the other hand, the density of Natura 2000 (N2K) sites appears somewhat independent of that of the more artificial mosaics (ELM^): in most EUW countries N2K areas fluctuate around 20% with at least two cases touching 40%. The relationship with protected areas (PAs), on the other hand, is very different, as their incidence is always very limited (between 2% and 3%) and far from the N2K rate. Only France is an exception to this last rule, testifying to national policies of EUW countries that are probably not very attentive to the conservation needs that, on the contrary, emerge more clearly from European policies (N2K).

The overall picture is quite dissimilar in the EUE section. A comparison of the average values of the two European parts shows a much greater pervasiveness of the intensive agricultural mosaic (IA), which rises from 40% to over 50%, and a strong reduction of seminatural covers (SN), which, in the EUE case, are well below 10%. The overall assessment of the EUE countries, however, sees a greater balance of the different ELM Systems even though agricultural (IA) covers are almost always predominant and semi-natural (SN) covers only rarely emerging (Croatia and Czechia), with forested (F) spaces almost always hovering around 30%, apart from Estonia, Slovakia and Slovenia. Urbanization also appears to be much more homogeneous, always contained at very low levels (2% - 5%), almost all of them aligned on the EUE average, and in this the eastern part of Europe stands out markedly from its western sector for now. In terms of environmental

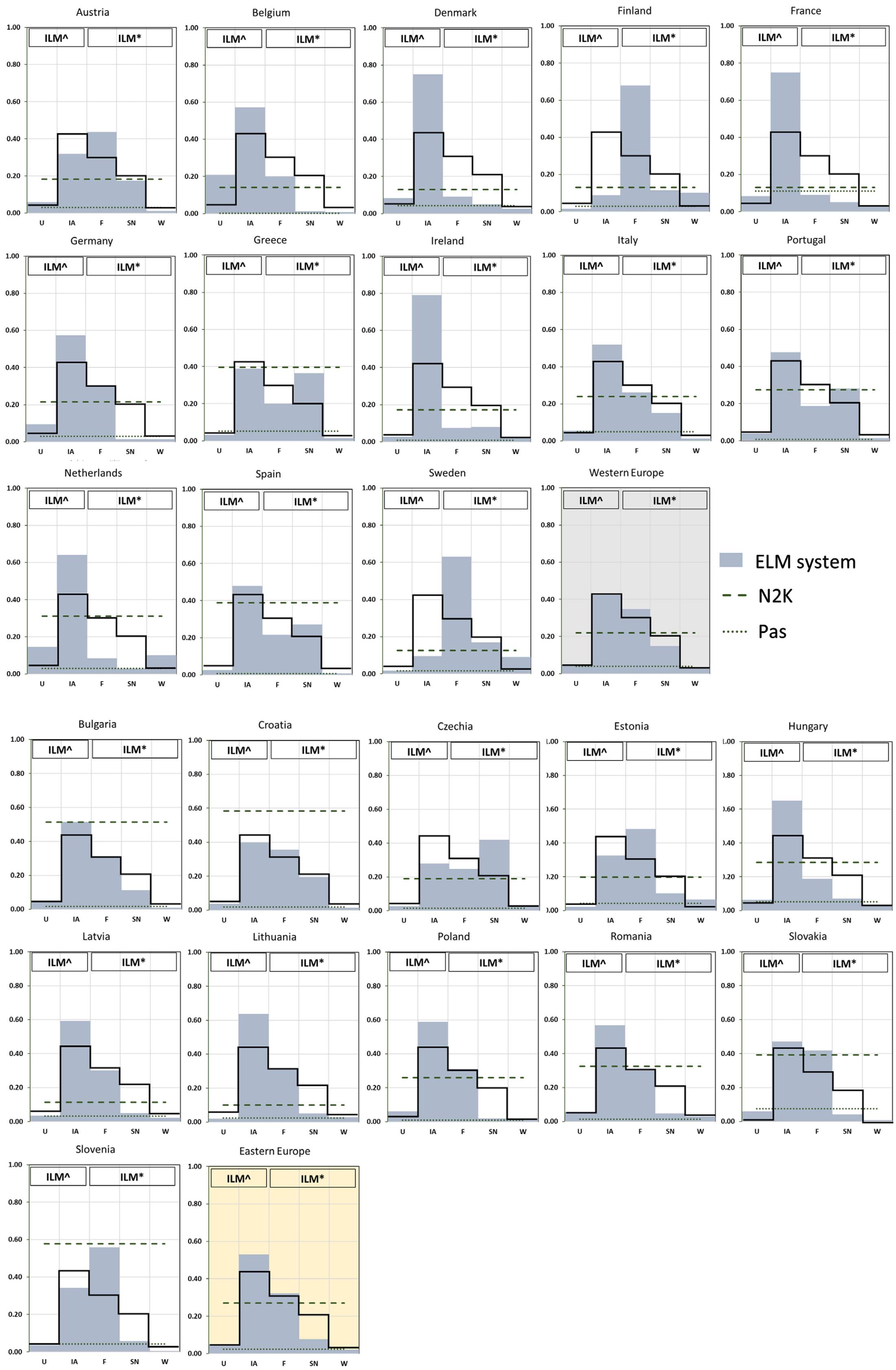

Figure 2. Landscape profiles and nature conservation ratio (N2K and Pas) of European countries.

protection, the incidence of N2K sites is significantly higher, with the EUE averaging close to 30% compared to EUW's 20, where Bulgaria, Croatia, Slovakia and Slovenia's 40% and 60% mark the difference. Remaining entirely similar to the EUW picture, on the other hand, is the limited consistency of PAs, always around values of a few percentage points and always far removed, if Latvia and Lithuania are excluded, from the N2K level.

An overall assessment resulting from the comparison of the ELM Systems between the two European sections thus shows a greater quantitative balance of the eastern macromosaics, with a more balanced role of the agricultural (IA) sections compared to the forest and semi-natural (F and SN) ones, but with a very marked difference on urbanization, which, although on average placed in both conditions in the EU27 average, shows very consistent peak values in EUW that are in fact moderated in the average result substantially by the very small Scandinavian values.

The considerations just made find clearer evidence in the maps in **Figure 3**, made by normalization with respect to thematic averages of the percentage values shown on the y-axes of the ordinates in **Figure 2**, thus making the conditions of the various countries with respect to the consistency of ELM Systems comparable. One figure that shows a very uniform distribution is that inherent in IA coverage, with the vast majority of countries aligned on 1.5 times the average value (42%), but the same uniformity is found for the forestry component (F) with a distribution also consistent with the average (30%). In both cases the Scandinavian countries, which also notoriously mark their difference with respect to water cover (W), definitely stand out. On the other hand, the relationship between the incidence of semi-natural areas (SN) and protected areas (PAs) is rather contradictory. The latter in particular manifest a significant unevenness between countries, with France, Italy, Slovakia, Hungary and Greece standing well above the EU27 average with a much penalized position of Spain at 25% of the average. Dwelling on the urbanized (U) also in this case the sharp inequality between countries is evident: if the Benelux group (Netherlands and Belgium) and also Germany stand at the top of the ranking with values between 1.5 and more than double the EU27 average, France and the bloc of eastern countries appear more aligned. Italy appears to be placed below the EU27 average, but on this neuralgic point, however, it is necessary to spend some considerations on the partial unreliability of the CLC data at least with respect to the Italian case. In fact, the average value that descends from the European database used in the present work is 6%, but we know from the accurate surveys carried out in the national field by ISPRA and other research bodies (Munafò, 2021) that the Italian urban coverage is higher than 7%. If the first figure corresponds to about 16,800 km^2 the real urbanized area is therefore more than 23,000 km^2, with a consistent difference of 6200 km^2 corresponding to a square of almost 80 km side, that is, well over half the width of the Peninsula at its narrowest point. This discrepancy is due to the particular configuration of Italy's urbanized area,

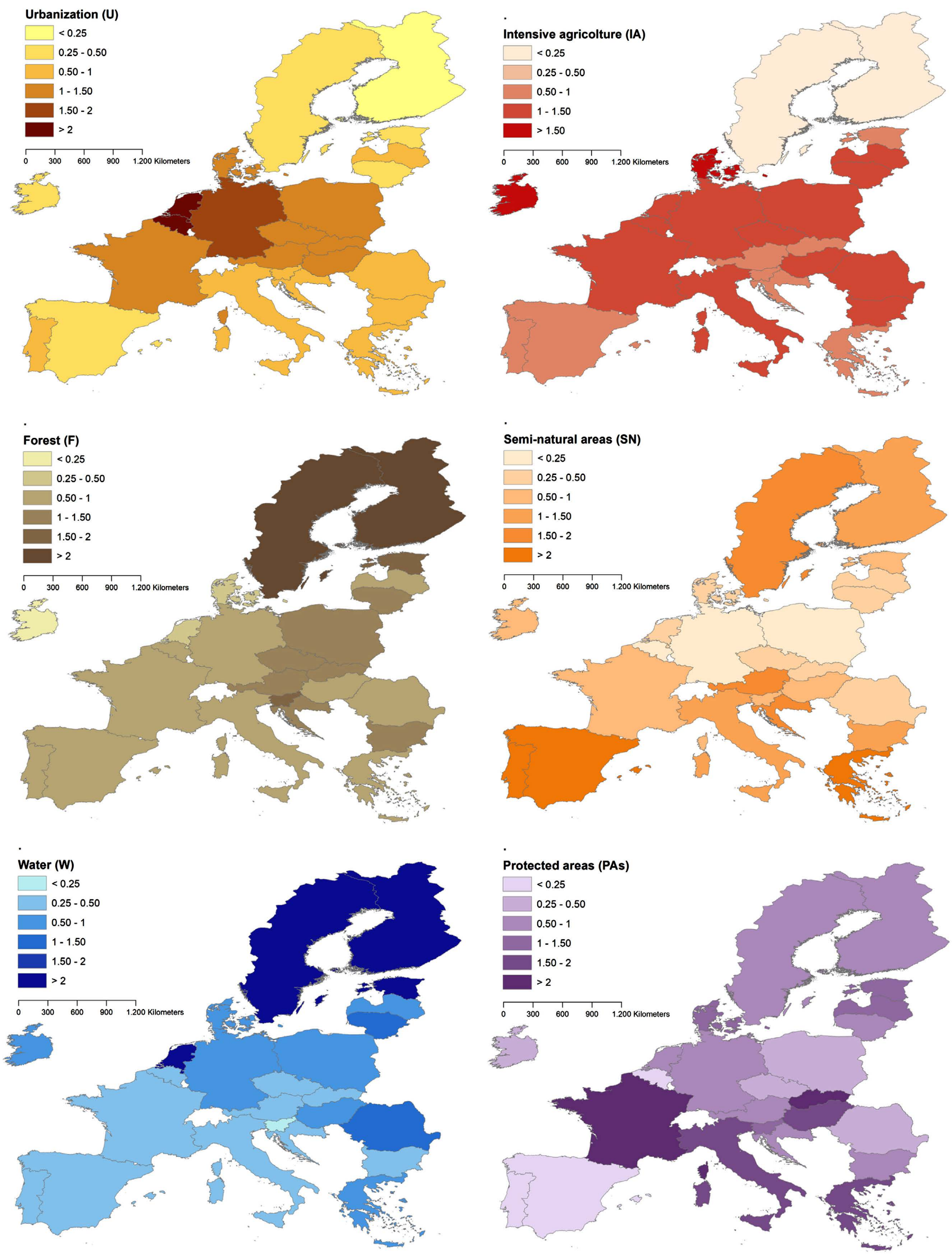

Figure 3. Normalization versus average of ELM system incidence in EU27 countries.

which is highly dispersed mainly in agricultural areas (IA), but with pulverized shapes and sizes (sprinkling, urban dust) that the CLC satellite reading, with its characteristics specified in the Materials and Methods section, although of high detail, fails to capture (Romano et al., 2017).

Figure 4 shows how the EUW countries tend to be shifted toward the part of the diagram with the highest average core sizes (over 1 km²). In any case, the average core size of most EU27 countries is rather homogeneous and lies between 0.8 and 1 km² with only one northern group seeing higher values-Denmark, Finland, Latvia, Netherlands and Belgium-and the EUE average about 8 percent lower than EUW. In fact, the standard deviation is very similar between EUE and EUW (0.21 vs. 0.27 with a deviation of 8%).

It is markedly more unbalanced correspondence with the density of urban nucleous for which the standard deviation between EUE and EUW is much more bifurcated (0.02 vs. 0.03 with 60% variance). The case of Czechia in particular stands out with small cores and relatively high core density demonstrating a significant degree of dispersion. A similar pattern also affects Germany, but much more contained in the spread of the two parameters. The reversed condition is found on the Scandinavian countries and Ireland in which for less than 2 urban cores/100km² the average size of the cores is just above that of the EU27 average.

To better investigate the condition already described, an overall indicator that can be linked to the urban compactness (CI) measure formulated as follows and whose inverse can be called the "Dispersion Index" was used:

$$\mathrm{CI} = \frac{S_{um}}{N_n^2}$$

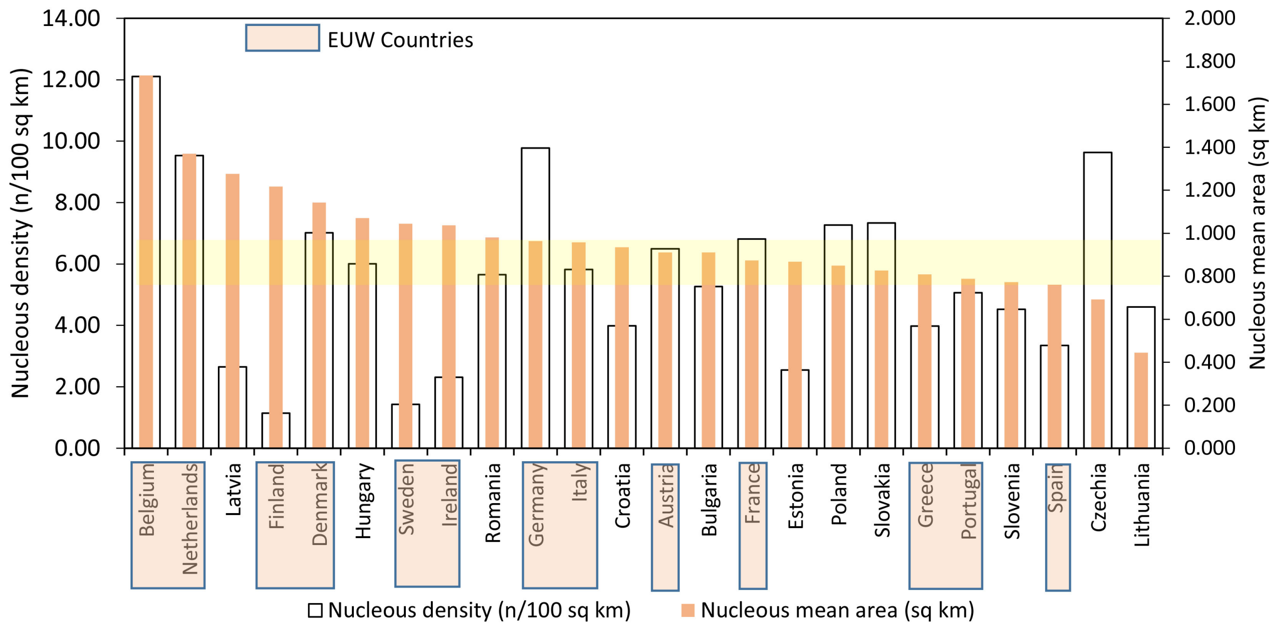

Figure 4. The ranking of EU 27 countries according to average urban area and dispersion density (EU W countries in orange).

where:

S_{um} = Average area of the urban nucleous (km^2)

N_n = Number of urban nucleous per 100 km^2

This indicator was then placed in relation to the GDP per capita 2019 of the various countries (**Figure 5**) (https://www.rgs.mef.gov.it/VERSIONE-I/e_government/amministrazioni_pubbliche/igrue/PilloleInformative/economia_e_finanza/index.html?Prov=PILLOLE#stat2, access April 2022)

The average CI urban compactness index is significantly lower in EUE than it is in EUW (−40%), however, EUW countries manifest a rather homogeneous and on average high level of dispersion, while in EUE a more balanced distribution compared to the average is noted (0.015 vs. 0.018 standard deviation with 17% spread). From the regression analysis, both considering the totality of EU27 countries and individually EUE and EUW, there is a significant correspondence between higher GDP and lower urban compactness, which is also reasonable considering that the very dispersed settlement is definitely more expensive for the public manager and private citizens in terms of overall energy (services, transportation, maintenance, etc.) (Carruthers & Ulfarsson, 2003; Ewing et al., 2003; Wilson & Chakraborty, 2013; Manganelli et al., 2020; Samela et al., 2022). Albeit with tepid indications, the diagram in **Figure 5** shows the tendency of several EUE countries to increase urban dispersion as GDP increases, effectively replicating the behavior of the many EUW countries that in the right-hand side of the diagram show a much sharper trend in this direction.

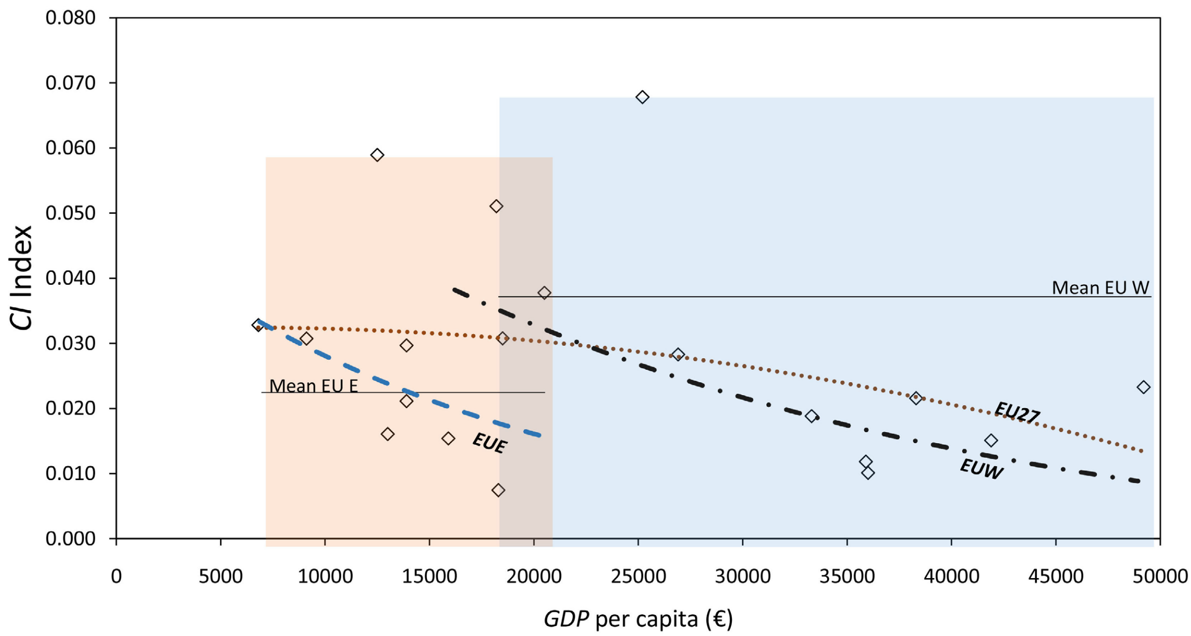

Figure 5. Relationship between urban compactness index (CI) and per capita income (the elaboration excluded CI index values that were outliers because they were due to particular geoclimatic/socioeconomic situations). Overall (EU27) and partial (EUE and EUW) trend curves are shown in the diagram.

Of course, GDP alone cannot be held responsible for urbanization trends and highly dispersed patterns of urbanization. Fundamental roles are played by systems of government, welfare, and the evolutionary history of the economy and society, all of which underlie a picture of high complexity. This paper therefore exposes a sectoral survey, but one that shows signs of reliability that should be confirmed through other indicators with very high set-up complexity (Baumann et al., 2011).

Even within the limitations due to the sectoral slant of the surveys and diagnoses presented, it is quite clearly confirmed how greater economic dispositions of societies push toward more extensive urban development patterns, also typical of the greater propensity for individuality of wealthier communities. It also reveals, however, a political sensitivity to environmental protection that essentially aligns Europe's national policies at rather low levels to compensate for which EU directives intervene.

4. Conclusion

At a scale of enormous magnitude, such as EU27, it is quite evident that the variables conditioning the aspects reported in the article are numerous and, in addition to those of a more deterministic type such as the economy, climate or physical environment, others far more difficult to isolate in the role they play certainly count a great deal. Such are the connotations related to historical evolutions and the social behavior of populations toward land use, the relationship with living, customs and traditions cast on agricultural settlement and production forms and dimensions. For this reason, the proposed article represents an extreme synthesis that gathers some basic indicators to produce various comparisons between the two geographical blocs East and West, but also related to individual member countries. A first framework of interesting information comes from the ELM System survey, which in fact translates a map of historical settlement of various European land uses that propose in perspective a high stability of categories, except urban and forestry.

Particularly from the urban point of view there is a substantial equivalence of average urbanization densities between EUW, EUE and EU27, although the real differences then lie, as seen, in the distributional typology of settlements (Egidi et al., 2020a). Less obvious is the environmental protection weight attributable to Natura 2000 action, which sees EUE by a wide margin of affirmation (average 30%) compared to EUW (20%) (Jones-Walters & Čivić, 2013). Considering that intensive agricultural land accounts for an average of half of the EUE territory, compared to 40% in EUW, with very little incidence of SN covers, a pervasiveness of habitats of community value attested to almost a third of the semi-continental territory has a decidedly significant significance. By contrast, the comparative incidence of PAs between EUW and EUE, which is almost placed on the same values, does not appear very significant, since, quite differently with what happened with N2K, the establishment of protected areas is greatly affected by political attitudes and negotiation processes that are by no means homogeneous.

From the considerations set forth in the article, therefore, the thesis expressed in the title is sufficiently confirmed, that, at least on the characters of urbanization, it seems that an already well-hinted trend of evolution toward patterns of greater dispersion linked to the growth of national economies, which only more specific and detailed investigations could place in the sprawl, sprinkling or urban dust patterns characterized at the international scale. From here may emerge a useful message for EUE policy (Prokopová et al., 2018), which can make use of the lesson learning from EUW that favoring or suffering from excessive urban sprawl causes a wide range of negative consequences, already widely surveyed in the global scientific literature, with increased social energy needs and deterioration of habitat quality and biodiversity being the most unfavorably affected areas.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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