Land Cover and Land Use Diversity Indicators in LUCAS 2009 data

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Abstract

Landscape diversity and changes are connected to land cover and land use. The capability of monitoring those changes is linked to the availability of information on the coverage and the use of the land. The LUCAS survey (Land Use/Cover Statistical Area Frame Survey) was carried out in 23 EU countries in 2009. Field surveyors collected data on land cover/land use in approximately 235,000 geo-referenced points. As part of this exercise linear elements and land cover changes along a 250 meters walk (transect) were recorded. On the basis of the field observations, diversity indicators have been computed in addition to the traditional statistics on the share of land among the various land cover and use classes. The indicators presented in this paper provide insights into the status of the landscape diversity and its changes in Europe. The potentiality of the LUCAS survey as monitoring tool to follow the status of landscapes diversity in Europe is highlighted and discussed in the conclusions.

Introduction

Changes in land cover, biophysical attributes of the earth's surface, and land use, human purpose or intent applied to these attributes, significantly affect key aspects of Earth System functioning. Therefore data on land is widely used for policy planning and evaluation in many domains.

Harmonised land cover and land use data is provided by the LUCAS survey. LUCAS (land use/cover area frame survey) is a field survey carried out on a sample of 235,000 points spread over almost (23 MS[1] in 2009) the entire territory of the European Union. Data on land cover and land use is collected and landscape photographs are taken. In addition linear elements and land cover changes are recorded along a

[1]BG and RO were covered by the LUCAS survey in 2008 with different methodology for the transect; CY and MT were excluded for methodological reason.

transect, a 250 meters walk eastwards from each point (Martino & Fritz, 2008; Martino et al., 2009). The latest survey took place in 2009.

The survey offers a possibility to produce harmonized statistics on land cover and use and to compute comparable indicators on the fragmentation, richness and dominance of the landscape[2]. The potentiality of the LUCAS survey in terms of providing specific diversity information is highlighted in the following paragraphs using examples on selected domains (i.e. woodland).

In paragraph 2 an index, computed on LUCAS data 2009, describing the diversity in selected land cover and land use classes is presented. Paragraph 3, shows a combined analysis of land cover and use and its capability to discriminate among the various EU countries. Paragraph 4 proposes results on selected diversity indicators based on a 250m transect.

Land cover and use diversity

The aggregated results of the LUCAS survey at the European level show that forest and other wooded areas[3] occupy almost 40% of the total area of the EU, cropland nearly a quarter and grassland a further fifth, while built-up and other artificial areas[4] such as roads and railways, account for 4%.

Regarding visible socio-economic use of land as observed by the LUCAS surveyors, over 40% of the EU territory is used for agriculture and almost 30% for forestry. The use of land for residential, commercial and industrial[5] purposes accounts for just over 10% of the total area of the EU (Kasanko et al. 2010).

A more detailed measure of land cover and land use diversity at national and local level can be drawn from the comparison of single

[2] For more information: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-033/EN/KS-SF-08-033-EN.PDF

[3] The definition of "other wooded areas" in the LUCAS survey is slightly wider than the one adopted by the Food and Agriculture Organization of the United Nations (FAO); it includes wooded plots with canopy coverage above 10%, not respecting at least one of the other requirements of FAO definition (plot area above 0.5 ha, height at maturity of 5 m minimum, width of plot above 20 m).

[4] Built-up and other artificial areas include roofed constructions (buildings and greenhouses), non-built up areas (yards, parking, cemeteries) and linear features (roads and rail networks).

[5] Includes commerce, services, residential areas, industry, energy, transport and mining.

country share for each land cover/use class with the European average. An indicator, consisting in the percentage ratio of the land cover/use share for a specific item (i.e. woodland/forestry) of a country normalised to the European value (put to 100), has been computed[6]. Based on this indicator and fixing for example a bound of 15% around the EU level[7] the countries can be classified in three groups:

- those with a share larger than the upper bound (115) ;
- those with a share that is below the lower bound (85);
- those close to the European value (within the range 85-115).

As an example, the ranking of the countries with respect to this indicator for 'woodland' (coverage) and 'forestry' (usage) is shown in Fig. 1. As far as the land cover is concerned, countries over the upper bound (upper red dotted line) are those with the largest share of territory covered by woodland in Europe. They include northern (FI, SE) and Baltic countries (EE, LV) and countries with high presence of hilly/mountainous areas (SI, AT). On the other side lie countries with less woodland area than the European average (NL, IE, UK, DK). On the base of the 15% bound the Czech Republic, Latvia, Luxembourg, Germany, Greece, Italy and Poland can be considered quite close to the European average. It is worthwhile to mention that the range of the indicator for woodland spans between 174 (68% in Finland compared to 39% in Europe) and 31 (12% in the Netherland and Ireland with respect to 39% in Europe).

When it comes to the socio-economic use of land (Fig. 1 – land use: forestry), as for land cover it can be seen that a quite variable picture stands behind the European average shares of land use items. Although the ranking of the countries reflects almost perfectly the one observed for the land covered by woodland, the spread of the values is larger. The index ranges indeed between 10 (The Netherland) and 214 (Finland). This result shows that the difference in the use of the land, even for the same cover, can be leading to a diverse landscape in the various countries.

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[6] The Index can be expressed as: $I_l = S_l^m / \overline{S}_l * 100$;where: l=land cover/use item; m= country; S_l^m =share of land cover/use item l in country m; $\overline{S}_l$ = share of land cover/use item l in Europe. The following land cover classes have been considered: artificial areas; cropland; woodland; shrubland; grassland; bareland; water and wetland.

The following land use classes have been considered: agriculture; forestry; hunting, fishing and no visible use; commerce, services and residential (it also including recreation and sport areas); industry, energy, transport and mining (it also includes water and waste treatment and construction).

7 Further investigation with environmental experts is needed to better define the bound.

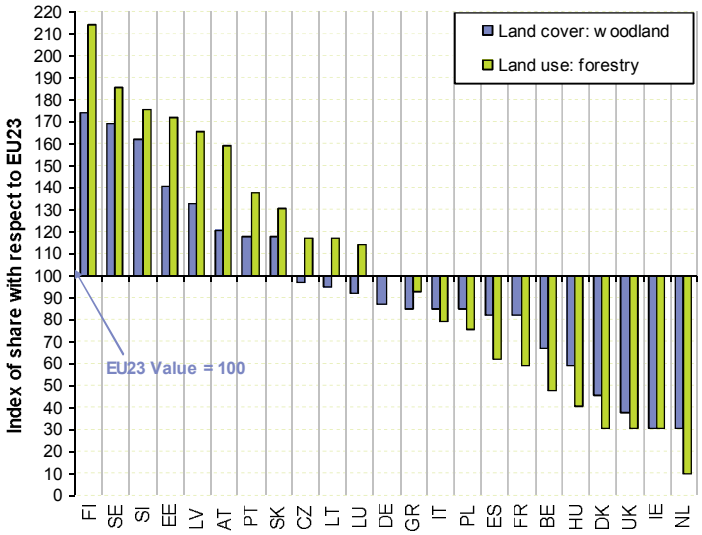


Figure 1. Index of share with respect to the European value (land cover 'woodland'; land use 'forestry'). Source: Eurostat LUCAS 2009.

Diversity in the combination of coverage and use of land

A further characterization of the diversity in the land cover and land use in Europe can be derived from the combined analysis of these two parameters. Fig. 2 shows the percentage of land covered by woodland at NUTS2 level in Europe (LUCAS 2009 data). The dark shading of the areas highlights the regions where woodland has the largest share. Except some homogeneous countries with a very high coverage (Finland and Sweden) and a very low share (United Kingdom and Ireland), the rest of Europe appears at the local level as a puzzle of areas with a varying share of forested areas. Less variability is observed for the artificial cover since for most regions the share does not come over 5%. Exceptions can be found mainly in United Kingdom, Italy, The Netherlands and Germany (Fig. 3).

Combining the previous information on diversity of land cover with the land use some interesting information can be derived. Fig. 4 shows the minimum, the maximum and the quartile of the distributions of land use shares in the various EU23 countries for the territory covered by woodland based on LUCAS 2009 data. It is clear that the use share varies largely among European countries, especially when looking at the use for

forestry, services and commercial, hunting, fishing and no visible use. It is worth noting that the country with the highest rank in the human use of wooded areas (The Netherlands) is the one with the lowest use in term of forestry exploitation.

A similar analysis conducted on the land covered by artificial features shows a certain degree of variability too (Fig. 5). For this coverage the uses at 'heavy environmental impact' and those related to services and commerce are the most affected. An interesting ranking appears among countries for these two main uses, Sweden being the first in high impact use and the last in the use for services and commerce; United Kingdom showing the opposite trend.

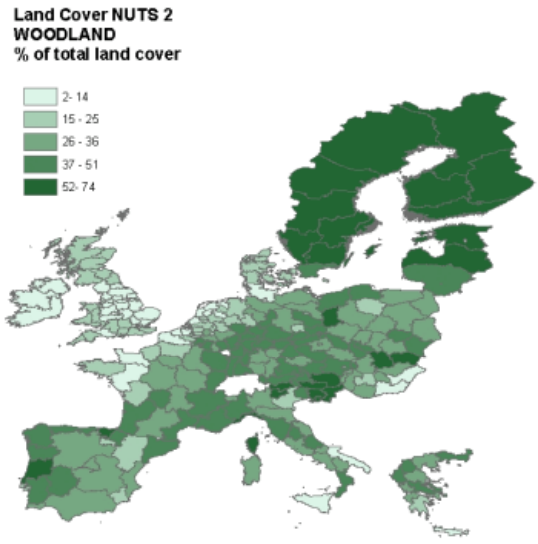


Figure 2. Percentage cover of woodland in EU23 at NUTS2 level.
Source: Eurostat LUCAS 2009.

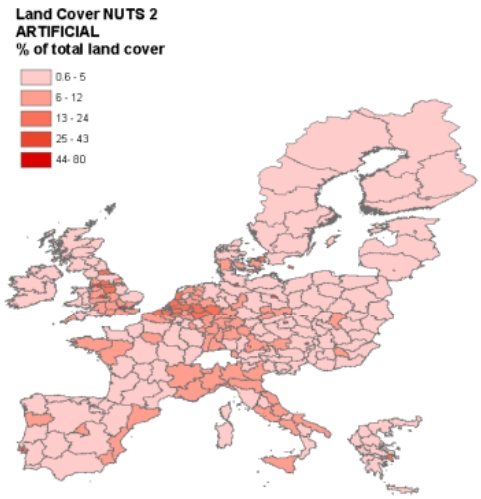


Figure 3. Percentage cover of artificial areas in EU23 at NUTS2 level.
Source: Eurostat LUCAS 2009.

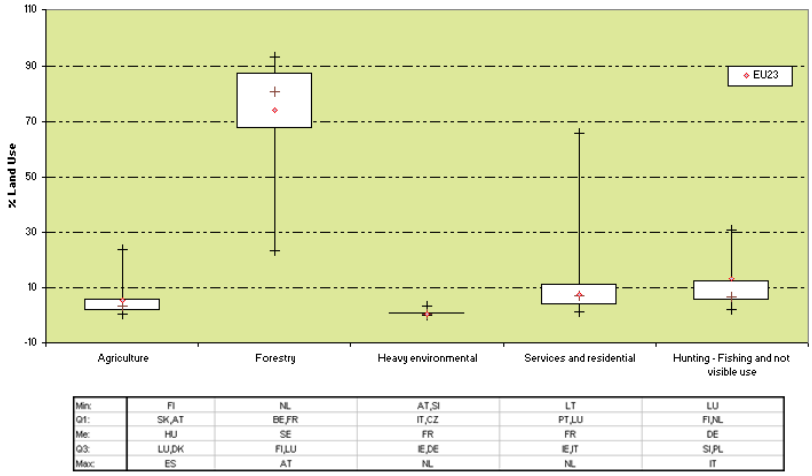
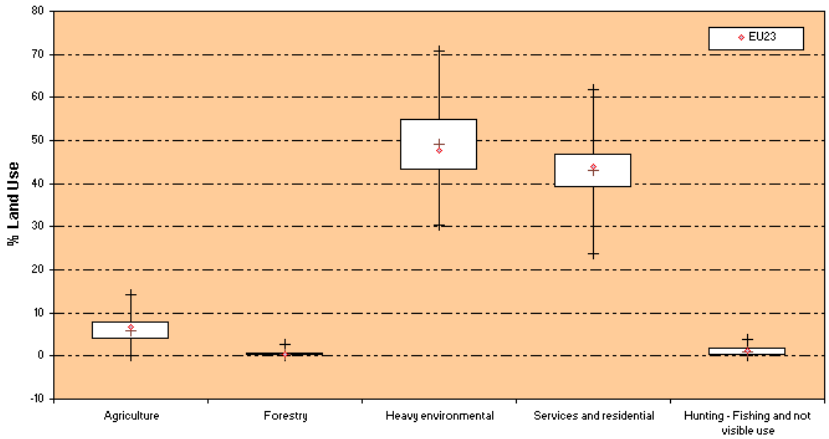


Figure 4. Distribution of the use of wooded areas among EU23.
Source: Eurostat LUCAS 2009.



Min:	EE,LT,LV	BE,EE,GR,IE,LT,LU,LV,NL,SI	UK	SE	DK,EE,LU,NL,SE,SI
Q1:	SE,GR	BE,EE,GR,IE,LT,LU,LV,NL,SI	IE,LT	SI,AT	DK,FI
Me:	DE	IT	ES	IE	DE
Q3:	IT,SK	PT,FI	GR,CZ	LV,IT	PL,CZ
Max:	IE	SK	SE	UK	ES

Figure 5. Distribution of the use of artificial areas among EU23. Source: Eurostat LUCAS 2009.

Landscape diversity

Various diversity indicators, from the simpler "richness indicator" to the more sophisticated "Shannon Evenness indexes" derived from the transect, a 250 meters walk eastward starting from each point in the LUCAS survey, give information on the structure of landscape in terms of homogeneity (Palmieri et al. 2011).

A direct measure of the degree of homogeneity or heterogeneity of land cover can be drawn from the number of different land cover types observed in each of the transect surveyed. This index of "richness" is portrayed in Fig. 6. Natural and anthropical features clearly interact in defining EU landscape structure as, on average, 2.3 different land cover types can be observed along the transect. Across the EU, the average number of different land cover types spans from more than 2.5 in SI, PT, AT, LU, DK and IT, to less than 2.0 in IE, UK and EE.

The information on different land cover types and their relative abundance (i.e. whether the same type of land cover recurs in a transect) can be summarised by means of two Shannon indices: the Shannon Diversity Index (SDI) and the Shannon Evenness Index (SEI). The latter, obtained by dividing the SDI by its maximum value, is of easier reading,

as it varies between 0 (no diversity, i.e. a single land cover type) and 1 (maximum observed diversity combined with complete evenness).

The territorial ordering at the country level according to this multi-level indicator (Fig. 7) confirms the information provided by the average number of different land cover types, although with some differences: for instance, BE enters the group of top-countries in terms of land cover diversity, while SI falls from the first to the sixth position.

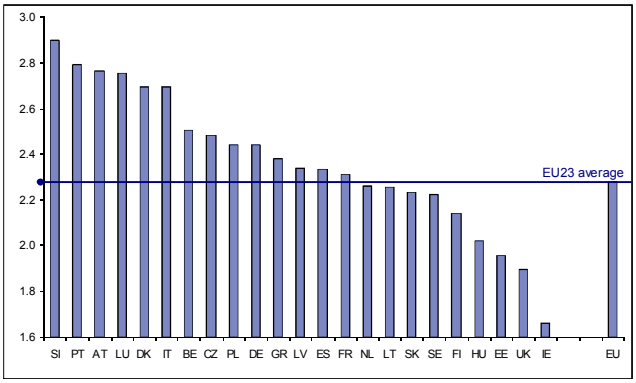


Figure 6. Richness indicator: average number of different land cover types in a 250m transect by country, EU23.
Source: Eurostat LUCAS 2009.

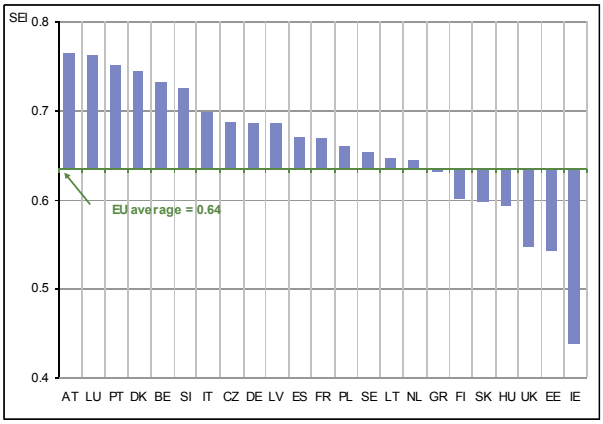


Figure 7. Shannon Evenness Index by country, EU 23.
Source: Eurostat LUCAS 2009.

The SEI computed at the NUTS2 level shows that all the 5 regions of PT rank amongst the top 25%, and the same occurs for 4 out of 5 DK

regions, 6 out of 9 AT regions and for 8 out of the 11 BE regions. At the lower (25%) tail of the distribution are, instead, both Irish regions and 24 of the 37 regions of the UK, six of which are amongst the ten EU regions with the lowest value of the SEI (Fig. 8).

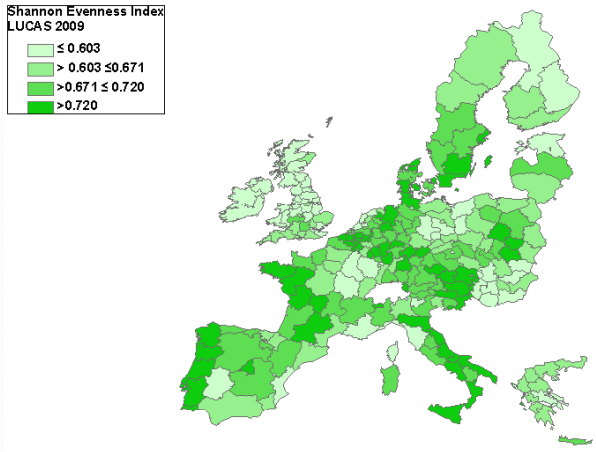


Figure 8. Shannon Evenness index in EU23 by NUTS2 regions.
Source: Eurostat LUCAS 2009.

Conclusion

Land cover/use data forms the basis for spatial and territorial analyses which are increasingly crucial for policy planning in many respects. As an example, art. 17 of the Habitats Directive (Council Directive 92/43/EEC) state the need to monitor the conservation status of the natural sites and their diversity at the global, regional and national levels. Such a commitment implies the need for data comparable in time and space. This kind of data is provided by the LUCAS survey in a harmonized way on some selected parameters. Although they cannot cover the large spectrum of the diversity concept, they might be used for specific purposes like the monitoring of the status of landscape diversity in Europe and its changes.

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