LANDSCAPE INDICATORS

The LUCAS (Land Use/Cover Statistical Area Frame Survey) survey is a field survey based on an area-frame sampling scheme. Data on land cover and land use are collected and landscape photographs are taken, enabling detection of changes in land cover/use and in European landscapes. Moreover the transect, a 250 meters walk along which linear elements and land cover changes are recorded, offers comparable indicators on the fragmentation, richness and dominance of the landscape.

The surveyors walking the transect are requested to register all the land cover changes they can observe according to a list of codes including both areal land cover classes and linear elements (Table 1). In the transect, land cover transition and the linear features are recorded in the sequence of their appearance. The results are then aggregated in such a way that different environments (agricultural areas, forestry areas, grassland, etc.) have approximately the same number of items. This procedure was adopted to avoid a bias in terms of heterogeneity being introduced in the results. For a detailed land cover transect classification, see Table 2.

Table 1: List of transect linear elements, LUCAS 2009

<table>
<thead>
<tr>
<th>Code</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grass margins&lt;3 m</td>
</tr>
<tr>
<td>2</td>
<td>Heath/Shrub, tall herb fringes&lt;3 m</td>
</tr>
<tr>
<td>10</td>
<td>Single tree, single bushes</td>
</tr>
<tr>
<td>11</td>
<td>Avenue trees</td>
</tr>
<tr>
<td>12</td>
<td>Conifer hedges&lt;3 m</td>
</tr>
<tr>
<td>13</td>
<td>Bush/tree hedges/coppices, visibly managed (e.g. pollarded) &lt;3 m</td>
</tr>
<tr>
<td>14</td>
<td>Bush/tree hedges, not managed, with single trees, or shrubland deriving from abandonment&lt;3 m</td>
</tr>
<tr>
<td>15</td>
<td>Grove/Woodland margins (if no hedgerow) &lt;3 m</td>
</tr>
<tr>
<td>21</td>
<td>Dry stone walls</td>
</tr>
<tr>
<td>22</td>
<td>Artificial constructions (other than dry stone walls)</td>
</tr>
<tr>
<td>23</td>
<td>Fences</td>
</tr>
<tr>
<td>24</td>
<td>Electric lines</td>
</tr>
<tr>
<td>31</td>
<td>Ditches, channels&lt;3 m</td>
</tr>
<tr>
<td>32</td>
<td>Rivers, streams&lt;3 m</td>
</tr>
<tr>
<td>41</td>
<td>Ponds, wetland&lt;3 m</td>
</tr>
<tr>
<td>51</td>
<td>Rocks outcrops with some natural vegetation</td>
</tr>
<tr>
<td>61</td>
<td>Tracks</td>
</tr>
<tr>
<td>62</td>
<td>Roads</td>
</tr>
<tr>
<td>63</td>
<td>Railways</td>
</tr>
<tr>
<td>71</td>
<td>Other linear elements</td>
</tr>
<tr>
<td>Code</td>
<td>Label</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>AAA</td>
<td>Artificial land</td>
</tr>
<tr>
<td>BS0</td>
<td>Straw cereals</td>
</tr>
<tr>
<td>B16</td>
<td>Maize</td>
</tr>
<tr>
<td>B17</td>
<td>Rice</td>
</tr>
<tr>
<td>B20</td>
<td>Root crops</td>
</tr>
<tr>
<td>B31</td>
<td>Sunflower</td>
</tr>
<tr>
<td>B32</td>
<td>Rape and turnip seeds</td>
</tr>
<tr>
<td>B33</td>
<td>Soya</td>
</tr>
<tr>
<td>B34</td>
<td>Cotton</td>
</tr>
<tr>
<td>B36</td>
<td>Tobacco</td>
</tr>
<tr>
<td>BC0</td>
<td>Other ind crops</td>
</tr>
<tr>
<td>B40</td>
<td>Dry pulses, vegetables and flowers</td>
</tr>
<tr>
<td>B50</td>
<td>Fodder crops</td>
</tr>
<tr>
<td>B70</td>
<td>Fruit trees and berries</td>
</tr>
<tr>
<td>B81</td>
<td>Olive groves</td>
</tr>
<tr>
<td>B82</td>
<td>Vineyards</td>
</tr>
<tr>
<td>BP0</td>
<td>Other permanent crops</td>
</tr>
<tr>
<td>C10</td>
<td>Broadleaved and evergreen woodland</td>
</tr>
<tr>
<td>C20</td>
<td>Coniferous woodland</td>
</tr>
<tr>
<td>C30</td>
<td>Mixed woodland</td>
</tr>
<tr>
<td>D10</td>
<td>Shrubland with sparse tree cover</td>
</tr>
<tr>
<td>D20</td>
<td>Shrubland without tree cover</td>
</tr>
<tr>
<td>E10</td>
<td>Grassland with sparse tree/shrub cover</td>
</tr>
<tr>
<td>E20</td>
<td>Grassland without tree/shrub cover</td>
</tr>
<tr>
<td>E30</td>
<td>Spontaneous vegetation</td>
</tr>
<tr>
<td>F00</td>
<td>Bare land</td>
</tr>
<tr>
<td>G10</td>
<td>Inland water bodies</td>
</tr>
<tr>
<td>G20</td>
<td>Inland running water</td>
</tr>
<tr>
<td>G30</td>
<td>Coastal water bodies</td>
</tr>
<tr>
<td>G50</td>
<td>Glaciers, permanent snow</td>
</tr>
<tr>
<td>H10</td>
<td>Inland wetlands</td>
</tr>
<tr>
<td>H20</td>
<td>Coastal wetlands</td>
</tr>
</tbody>
</table>

*Source: Eurostat*
A direct measure of the degree of homogeneity or heterogeneity in terms of the physical coverage of the land can be drawn by the number of different land cover types observed in each of the transects surveyed.

**Richness diversity indicator:** it is computed as the number of different land cover codes in each transect. (Tables: lan_lcs_ric)

**Linear feature:** they consist in linear elements of the landscape such as walls, hedges, roads, railways or irrigation channels, etc. intersecting the transect; these features are taken into account if their width is larger than 1 meter (exceptions are walls, ditches, electric lines and fences) and at least 20 m long.

**Structure Linear Elements (SLE):** linear features which structure the countryside: grass and tree margins, shrub, water courses and dry-stone wall. (Tables: lan_lcs_str)

**Dissection Linear Elements (DLE):** dissection of landscape caused by transport infrastructure, artificial constructions (other than dry-stone walls), fences and electric lines. (Tables: lan_lcs_diss)

The information on different types of land cover 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 easier to read, as it varies between 0 (no diversity, i.e. a single land cover type) and 1 (maximum observed diversity combined with complete evenness).

**Shannon Diversity Index:** the Shannon Diversity index (SDI) provides more information about area composition than simply area richness (i.e., the number of types of land cover present). It takes into consideration both the number of different land cover types (m) observed on the point and their relative abundances ($P_i$).

$$SDI = - \sum_{i} (P_i \ln(P_i))$$

(Tables: lan_lcs_sdi)

**Shannon Evenness Index:** The Shannon Evenness index is obtained dividing the Shannon Diversity Index by its maximum \((SDI_{\text{MAX}}) = \ln(m)\). Therefore it varies between 0 and 1 and is easier to interpret.

$$SEI = - \frac{\sum_{i} (P_i \ln(P_i))}{\ln(m)}$$

(Tables: lan_lcs_sei)