LUCAS 2015
(Land Use / Cover Area Frame Survey)

Quality Report
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</tr>
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<tr>
<td>CAP</td>
<td>Common Agricultural Policy</td>
</tr>
<tr>
<td>CAPRI</td>
<td>Common Agricultural Policy Regionalised Impact</td>
</tr>
<tr>
<td>CLC</td>
<td>Corine Land Cover</td>
</tr>
<tr>
<td>CV</td>
<td>Coefficient of Variation</td>
</tr>
<tr>
<td>DG</td>
<td>Directorat Général</td>
</tr>
<tr>
<td>DLV</td>
<td>Deliverable</td>
</tr>
<tr>
<td>DMT</td>
<td>Data Management Tool</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>ESDI</td>
<td>European Spatial Data Infrastructure</td>
</tr>
<tr>
<td>ESS</td>
<td>European Statistical System</td>
</tr>
<tr>
<td>Estat</td>
<td>Statistical Office of the European Union</td>
</tr>
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<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>INE</td>
<td>Instituto Nacional de Estatística (Portugal)</td>
</tr>
<tr>
<td>INSPIRE</td>
<td>Infrastructure for Spatial Information</td>
</tr>
<tr>
<td>LAEA</td>
<td>Lambert Azimuthal Equal Area</td>
</tr>
<tr>
<td>LC</td>
<td>Land Cover</td>
</tr>
<tr>
<td>LU</td>
<td>Land Use</td>
</tr>
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<td>LUCAS</td>
<td>Land Use/Cover Area Frame Survey</td>
</tr>
<tr>
<td>MS</td>
<td>Member States</td>
</tr>
<tr>
<td>NACE</td>
<td>Nomenclature statistique des activités économiques dans la Communauté européenne</td>
</tr>
<tr>
<td>NUTS</td>
<td>Nomenclature des Unités Territoriales Statistiques</td>
</tr>
<tr>
<td>PI</td>
<td>Photointerpretation</td>
</tr>
<tr>
<td>QR</td>
<td>Quality Report</td>
</tr>
<tr>
<td>SAS</td>
<td>Statistical Analysis System</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>TW</td>
<td>Transitional Water</td>
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</table>
The scope of this document is to report on the quality of the "Land cover and Land use Area Frame Survey 2015" (LUCAS 2015), including the process, the micro data produced and the derived statistical tables. The structure of the report is defined by the ESS handbook for quality reports\(^1\).

The LUCAS survey in its current form is carried out by Eurostat every 3 years, since 2009, based on standardised definitions and a standardised methodology. A pilot was run in 2006, using a slightly different sample design.

The data collected includes land cover and land use information in the strict sense, as well as territorial information (e.g. irrigation and land management).

The reference area in 2015 is the total area of the 28 EU countries.

The LUCAS survey is divided: an in-situ part or field survey (data is collected in the field) and a part where data are produced by photo-interpretation in the office. Photo-interpretation is used for areas that are difficult to access. The statistical tables derived are based on the data of both parts.

The sample for both parts is stratified by main land cover classes and includes more than 273 000 points for the field sample and some 66 000 for the sample that is photo-interpreted. Around 2/3 of the points are visited in subsequent surveys.

The legal base of the LUCAS survey has evolved over the years. A pilot a "Land Use and Cover Area frame Survey (LUCAS)" was launched by DG Agriculture and Eurostat in 2000, based on Decision 1445/2000/EC of 22/5/2000 of the Council and the European Parliament\(^2\), dealing with the application of area frame techniques. In 2001 (postponed to 2002), the first LUCAS pilot survey was carried out in 13 of the 15 Member States of the European Union. The survey was carried out again in 2003 in all EU-15 Member States plus Hungary, allowing improvement of the data collection system and analyses of land use and land cover changes (2001-2003). The project was extended in duration from 2004 to 2007 by Decision 2066/2003/EC of 10/11/2003\(^3\). The coverage of the EU


Member States and the related financing is laid down by Decision 786/2004/EC of 21/4/2004. In 2006, the survey was carried out on 11 Member States (Luxembourg, Belgium, Czech Republic, Germany, Spain, Poland, Italy, France, the Netherlands, Hungary and Slovakia) to test the methodology at EU level with a restricted budget, by starting the current data collection frequency: every three years. From January 2008 onwards, LUCAS has been part of Eurostat’s activities and budget. As from 2012 it is supported financially by other DGs of the Commission.

According to the handbook on quality reports, this document includes the following chapters:

- Methodology;
- Relevance, assessment of user needs and perception;
- Accuracy and reliability;
- Timeliness and punctuality;
- Coherence and comparability;
- Accessibility and clarity.

This report covers the 2 parts of the LUCAS survey (in-situ, photo-interpretation) as well as the statistical tables.

Main findings

- The sample of points (in-field visited and photo-interpreted points) for collecting land cover/use information has the largest concentration in the strata Woodland and shrubland areas (38%) and Arable Land (33%).
- The majority of points were surveyed at a distance lower than 100 m (85%), while a small percentage (9%) was photo-interpreted (PI) in the field due to accessibility problems.
- The ground survey showed a large variability in terms of:
  - Average number of points per surveyor (from 5 for Luxembourg to 73 for Portugal);
  - Average number of points surveyed per day (from less than 4 to more than 14 for Luxembourg and Portugal);
  - Average time spent per point for the different land cover classes at EU level (the largest amounts are required for Woodland (34%), Cropland (30%) and Grassland (21%)).
- The PI (Photo - Interpreted) points are a relevant percentage (about 28.5%) of the total points used in estimating the target variables in 2009, 2012 and 2015. These points by definition cannot change and so...

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they are a source of stability in the estimates of changes. Hence, LUCAS results could underestimate both
the "estimates of changes and amounts" between the surveys (2009, 2012, 2015). Nevertheless, it is likely
that the bias is reduced because we can suppose that the unreachable points are, for their characteristics,
also the more stable ones. On the other side, this method (that uses the point available information even if
"old"), to handle with missing units was preferred to other methods that assign, by the estimating
procedure, an "averaged value" in the strata or that replace the missing units by selecting from the
"respondent population".

- On each surveyed point: primary (LC1/LU1) and the secondary information (LC2/LU2) are collected for
land cover and land use. Until 2009 and 2012, only LC1 and LU1 are given as estimates, therefore,
implicitly, it is assumed that the secondary variables balance each other out in the final estimates. In order
to ameliorate the results a unique variable for estimating "land cover" and one for "land use" have been
calculated using the mentioned principal and secondary information, and the same methodology is applied
to 2009 and 2012 data.

- To improve comparability with other land cover sources a new variable has been calculated to align
LUCAS and FAO classification for forest classes. A set of mapping rules between the two classifications
systems have been defined based on the semantic analysis of the classes, the changes occurred in the
LUCAS forestry-related classes definition in the periods 2009-2012 and 2012-2015, and the data collection
process during 2009-2015 field campaigns. Finally, an evaluation of the differences between the two
classification for analysing the changes occurred in the period 2009-2015 have been assessed confirming a
good correspondence between the two classification systems.
CHAPTER 2 Methodology

LUCAS surveys are carried out in-situ by collecting information on the ground by field surveyors on a set of points that are visited in subsequent years through a "mixed panel" approach. The surveyor classifies the land cover and the visible land use according to the harmonized LUCAS Survey land cover and land use classifications. The classification system has been defined to obtain a clear separation of land cover and land use, a full hierarchy and a comparability with other existing land cover/use systems.

Surveyors acquire landscape pictures in the four cardinal directions and a 250m transect is walked from the point to the east direction, where all transitions of land cover and existing linear features are recorded. A specific soil module was implemented in 2009, in 2012 (partly) and in 2015. Data collected produce three type of information: micro data, images and statistical tables.

The reference area is the total area of the EU countries included in the survey. Nevertheless, some areas are excluded from field survey (but still included into the final estimates), due to the difficulties to reach points located in very remote areas.

This chapter describes in detail the main components of the LUCAS methodology concerning the main phases from survey design to data post-processing.

2.1 Sampling design

The sampling design of LUCAS 2015 is a two phase sampling with stratification aiming to produce estimates at NUTS2 region level.

The two-phase sampling design is based on the definition of a base and Master sample followed by the extraction of the final sample.

The final sample is divided in 2 parts:

- A field sample selected among points likely to be physically accessible by a surveyor;
- A sample for the photo-interpretation in the office, that covers the areas not likely to be physically accessible.

If there would be only the field sample (points likely to be accessible by a surveyor) the numerous excluded points would be a likely source of bias that needs to be treated. To avoid or to reduce having a bias the excluded areas have been covered with a complementary photo-interpretation in the office. However the photo-interpretation in the office does not allow to collect all the detailed information that can be collected in the field.
The sample design takes into account the experience from previous campaigns (2006, 2009 and 2012) and stabilised at the end of the pilot phase concluded with the 2006 field survey. However in each round some improvements and fine-tuning have been added based on the experience gathered, while aiming to keep comparability with previous surveys.

In 2015, efforts were focused on reducing the points excluded from the second phase sample based on accessibility criteria, through:

- Improving the first phase sample (LUCAS master sample) by updating each point of the grid with the most recent available information (NUTS borders, road network, elevation, Corine Land Cover (CLC2012));
- Fine-tuning of the rules for eligibility of the point introducing an additional new indicator on accessibility based on CLC; the final criteria combine all the auxiliary information (Elevation, Road distance, Slope, CLC indicator).

### 2.1.1 Master

The base list was obtained using the 1 km² grid resulting from the INSPIRE (INfrastructure for SPatial InfoRmation in Europe) recommendations; it included around 4,000,000 points in the entire European Union territory. The projection used is the Lambert Azimuthal Equal-Area coordinate reference system (ETRS 1989 LAEA).

The LUCAS first phase sample or LUCAS master sample is a subset of the base file corresponding to a systematic 2-km grid in the Lambert Azimuthal Equal-Area coordinates.

Each point of the master sample has been photo-interpreted for stratification with a simple classification of 7 classes (1. Arable land, 2. Permanent crops, 3. Grassland, 4. Woodland and shrubland, 5. Bareland, 6. Artificial and 7. Water and wetlands) leading to 7 strata. Most of the points were photo-interpreted in 2005 on images that could not be kept because of copyright limitations. This photo-interpretation was based on the most recent orthophotos or, where orthophotos were not available, on satellite imagery.

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5 A detailed description of the sampling strategy for Lucas 2015 is reported in Gallego et al., 2015.

6 INSPIRE. Available at: http://inspire.ec.europa.eu/about-inspire/563


Table 1: Strata definition

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Description</th>
<th>LUCAS 2005 land cover classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arable land</td>
<td>Cereals, root crops, non-permanent industrial crops, dried pulses, vegetables and flowers (B11-B45); most of temporary artificial grassland (a fraction of E01,E02), and fallow land without vegetation (a fraction of F00)</td>
</tr>
<tr>
<td>2</td>
<td>Permanent crops</td>
<td>Fruit trees and bushes, other permanent crops: vineyards, olive trees, nurseries (B71–B84).</td>
</tr>
<tr>
<td>3</td>
<td>Grassland</td>
<td>Grassland, with or without sparse tree/shrub cover (E01–E02)</td>
</tr>
<tr>
<td>4</td>
<td>Wooded areas and shrub land</td>
<td>Forests, other wooded areas, shrub land (C11-C23, D01-D02)</td>
</tr>
<tr>
<td>5</td>
<td>Bare land, low or rare vegetation</td>
<td>Bare land: areas with no vegetation or areas covered less than 50% by dominant species of vegetation. (F00)</td>
</tr>
<tr>
<td>6</td>
<td>Artificial land</td>
<td>Artificial land (A11-A22)</td>
</tr>
<tr>
<td>7</td>
<td>Water</td>
<td>Surfaces covered by water, either permanently or for most of the year (G01-G05)</td>
</tr>
</tbody>
</table>

After excluding points located on small islands, it includes a total of 1,094,847 points across the 28 EU countries (Table 2)

Table 2: Points of the Master by country and STRATA

<table>
<thead>
<tr>
<th>Country</th>
<th>Arable Land</th>
<th>Permanent Crops</th>
<th>Grassland</th>
<th>Wooded areas and shrubland</th>
<th>Bare Land</th>
<th>Artificial Land</th>
<th>Water</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>3,178</td>
<td>278</td>
<td>3,779</td>
<td>11,925</td>
<td>710</td>
<td>818</td>
<td>294</td>
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<td>BE</td>
<td>2,077</td>
<td>50</td>
<td>2,507</td>
<td>2,117</td>
<td>24</td>
<td>813</td>
<td>91</td>
<td>7,679</td>
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<tr>
<td>BG</td>
<td>9,922</td>
<td>115</td>
<td>3,363</td>
<td>11,684</td>
<td>461</td>
<td>1,643</td>
<td>557</td>
<td>27,745</td>
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<td>CY</td>
<td>655</td>
<td>129</td>
<td>284</td>
<td>948</td>
<td>123</td>
<td>160</td>
<td>15</td>
<td>2,314</td>
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<td>7,660</td>
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<td>2,699</td>
<td>8,205</td>
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<td>739</td>
<td>207</td>
<td>19,717</td>
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<td>DE</td>
<td>33,794</td>
<td>570</td>
<td>14,913</td>
<td>30,912</td>
<td>465</td>
<td>7,681</td>
<td>1,244</td>
<td>89,579</td>
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<td>762</td>
<td>1,675</td>
<td>82</td>
<td>569</td>
<td>119</td>
<td>10,780</td>
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<td>EE</td>
<td>1,833</td>
<td>7</td>
<td>1,853</td>
<td>6,757</td>
<td>192</td>
<td>129</td>
<td>551</td>
<td>11,322</td>
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<td>EL</td>
<td>6,592</td>
<td>2,647</td>
<td>4,048</td>
<td>17,738</td>
<td>387</td>
<td>1,101</td>
<td>409</td>
<td>32,922</td>
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<tr>
<td>ES</td>
<td>32,339</td>
<td>11,638</td>
<td>17,620</td>
<td>55,800</td>
<td>3,101</td>
<td>3,230</td>
<td>933</td>
<td>124,661</td>
</tr>
<tr>
<td>Country</td>
<td>Arable Land</td>
<td>Permanent Crops</td>
<td>Grassland</td>
<td>Wooded areas and shrublands</td>
<td>Bare Land</td>
<td>Artificial Land</td>
<td>Water</td>
<td>TOTAL</td>
</tr>
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<td>-----------------------------</td>
<td>-----------</td>
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<td>FI</td>
<td>5,502</td>
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<td>5,078</td>
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<td>LU</td>
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<td>16</td>
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<td>59</td>
<td>3,716</td>
<td>1,560</td>
<td>162</td>
<td>966</td>
<td>1,024</td>
<td>9,368</td>
</tr>
<tr>
<td>PL</td>
<td>35,351</td>
<td>243</td>
<td>10,923</td>
<td>27,393</td>
<td>201</td>
<td>2,745</td>
<td>1,600</td>
<td>78,456</td>
</tr>
<tr>
<td>PT</td>
<td>4,530</td>
<td>1,967</td>
<td>2971</td>
<td>10,918</td>
<td>594</td>
<td>975</td>
<td>345</td>
<td>22,300</td>
</tr>
<tr>
<td>RO</td>
<td>27,296</td>
<td>867</td>
<td>6,597</td>
<td>20,413</td>
<td>341</td>
<td>2,331</td>
<td>1,912</td>
<td>59,757</td>
</tr>
<tr>
<td>SE</td>
<td>7,045</td>
<td>8</td>
<td>5,520</td>
<td>82,979</td>
<td>4,605</td>
<td>2,112</td>
<td>10,183</td>
<td>112,452</td>
</tr>
<tr>
<td>SI</td>
<td>549</td>
<td>121</td>
<td>671</td>
<td>3,481</td>
<td>55</td>
<td>164</td>
<td>23</td>
<td>5,064</td>
</tr>
<tr>
<td>SK</td>
<td>3,704</td>
<td>110</td>
<td>1,693</td>
<td>6,180</td>
<td>105</td>
<td>367</td>
<td>106</td>
<td>12,265</td>
</tr>
<tr>
<td>UK</td>
<td>14,170</td>
<td>49</td>
<td>22,560</td>
<td>19,373</td>
<td>703</td>
<td>3,488</td>
<td>1,415</td>
<td>61,838</td>
</tr>
<tr>
<td>EU</td>
<td>29,4250</td>
<td>29,486</td>
<td>177,286</td>
<td>493,287</td>
<td>21,952</td>
<td>44,570</td>
<td>34,016</td>
<td>1,094,847</td>
</tr>
</tbody>
</table>

In producing master sample, in case of uncertain classifications or in other cases envisaged in interpretation guidelines, it was possible to classify the point under two different strata. The number of points that are assigned to dual strata may not exceed 10% of total number of the points. Validation procedures were developed and statistical quality controls conducted for providing a quantitative accuracy assessment of the photointerpretation and monitoring each interpreter throughout his/her working order to detect and prevent systematic errors.

In the following Table 3 the main results of the stratification (by photo-interpretation) of the grid 2 by 2 Km are summarised. The percentage of double classification can be considered an indicator of uncertainty in photo-interpretation process; it is in average 6.2% but it is greater for “grassland” and
“arable land” strata that represent respectively the 34.6% and 28.1% of the total double classifications.

Table 3 : LUCAS Master sample - Double classification of STRATA

<table>
<thead>
<tr>
<th>STRATA 1</th>
<th>STRATA 2</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable land</td>
<td>275,021</td>
<td>294,250</td>
</tr>
<tr>
<td>Permanent crops</td>
<td>27,028</td>
<td>29,486</td>
</tr>
<tr>
<td>Grassland</td>
<td>153,670</td>
<td>177,286</td>
</tr>
<tr>
<td>Wooded areas and shrubland</td>
<td>480,632</td>
<td>493,286</td>
</tr>
<tr>
<td>Bare land, low or rare vegetation</td>
<td>17,215</td>
<td>21,951</td>
</tr>
<tr>
<td>Artificial land</td>
<td>40,431</td>
<td>44,570</td>
</tr>
<tr>
<td>Water</td>
<td>32,498</td>
<td>34,011</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,026,495</td>
<td>1,094,840</td>
</tr>
</tbody>
</table>

For the 2015 sampling exercise Eurostat has corrected a number of anomalies in the previous 2-km grid that constitutes the master, including points out of the EU area and missing points inside different countries. Some 2000 points outside EU area correspond to transitional waters (estuaries, intertidal areas, coastal lagoons, etc.). There has been some discussion on the possible exclusion of these points from the set to be sampled for the field survey. Reasons for exclusion could be:

- The combination of different data sources to determine which points is part of transitional waters and/or are associated to a NUTS2 region produces ambiguous results. In fact, by definition, all points in transitional waters should be excluded from the NUTS limits, but in practice this does not occur due to usage of data sources coming from different providers;
- The observation of the distribution of the 1,942 points mentioned above on a map shows that a large number of points in transitional waters appear in the UK, Ireland, Scandinavian countries and Greece, and very few points in Spain, France, Portugal, Italy and Croatia;
- It would be better that the area estimates refer to an officially accepted definition of the territory. This can be the NUTS 2013 boundaries or a further version;
- In general surveyors will not reach the points in transitional waters (except some times in intertidal areas).
The main reason for keeping in the sample points suspected to belong to transitional waters is that there is a request of field information on this category for the validation of maps that include off-boundaries areas. The suggested compromise is that off-boundaries transitional waters are included for the second phase sampling (they will be generally observed from a certain distance), but their weight for the extrapolation should be zero. It might be good to include transitional waters in a photo-interpretation operation for points classified as “non-eligible” because they are difficult to reach.

In the estimation procedure, the points belonging to “transitional water” and related areas are considered in the territorial level “country”, while they are not in the “NUTS0” level. So, for each country two areas are available: the first related to “country” and the second to “NUTS0”. To this last area, moreover, sum up the estimate at level of NUTS1 and NUTS2.

In Table 21 (Annex 1 - Tables and graphs) the number of point of the Master by STRATA and NUTS0 are reported; in the last column the difference between the number of points belonging to country and NUTS0 are given.

**Figure 1 : Percentage distribution of Master’s points by Strata at EU level**

### 2.1.2 Sample for field survey

From the first phase sample, a second phase sample of points, namely the field sample, is extracted to be classified during field visit according to the full land classification. This field sample is sampled...
with a method that allows tuning the sample size per stratum and ensures a certain spatial homogeneity at the same time.

**Table 4: Number of points in the first phase sample**

<table>
<thead>
<tr>
<th>Number of points</th>
<th>1,097,607</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total initial</td>
<td></td>
</tr>
<tr>
<td>Allocated to a NUTS region in the attribute table</td>
<td>1,093,834</td>
</tr>
<tr>
<td>Inside NUTS 2010 regions</td>
<td>1,091,892</td>
</tr>
</tbody>
</table>

Some of the master sample points were excluded for the second phase sample based on the following accessibility criteria:

- Altitude;
- Distance to roads;
- Accessibility indicator from CORINE Land Cover (CLC);
- Rule for eligibility.

Concerning altitude, the points above 1,500 m are deemed difficult to reach; these constitute a set of around 22,500 points. One way to deal with these points is defining separate strata with them. In 2009 a lower threshold had been used, but the experience in 2012 suggests that points between 1,000 and 1,500 do not present specific problems to access unless other circumstances appear (as better defined by the other mentioned criteria). The strata defined by this altitude threshold should be mainly surveyed by photo-interpretation. However points that fall at less than 600 m from the closest road and an altitude difference of less than 100 m are included in the second stage sampling for the field visits. It is clear that these points do not constitute a valid sample for area estimation, but they can provide valuable information for thematic studies.

The second criterion is the distance to the closest road. The distance has been computed on the basis of Tele-atlas road network. The road network generally excludes rural dirt roads used for the access to agricultural fields, usually good enough to allow the access of enumerators by car. All points in agricultural landscapes are deemed reachable thanks to dirt roads, although other obstacles may appear, such as private property delimited by fences.

For the criterion relative to accessibility CORINE Land Cover (CLC), agricultural areas are assumed to be rich in drivable dirt roads, in particular where there is a low density of paved roads. There is also an implicit assumption that the density of drivable dirt roads is much lower in other landscape types: forest, shrub, wetland, etc. To this end, CLC is split into two categories: potentially easy and difficult accessibility. Difficult accessibility includes forest, scrub, non-agricultural bare land, wetland and water. We consider that a point in the master frame is potentially difficult to access if all CLC classes 600 m around are in the above mentioned categories.
Concerning the criterion based on the eligibility rule the CLC-based accessibility is combined with distance to roads and altitude. The following thresholds are defined:

- **a)** Points above 1,500 m (around 22,500 points) and distant > 600 m from the closest roads or with an elevation change >100 m from the closest road. 18,361 points are considered non-eligible with this rule, but almost 90% of them are also non-eligible using the CLC-related rule.

- **b)** Points below 1,500 m with a land cover type neighbourhood (600 m circle) classified as potentially problematic accessibility (forest, shrub, water and wetland) and distant > 600 m from the closest roads or with an elevation change > 100 m from the closest road. 124,191 points fall in this category.

- **c)** Small islands. At the moment this criterion is not considered because the field (No_island), recovered from the master sample 2012 does not correspond to the set of islands that is considered difficult to reach for the 2015 survey. Points in islands are included in the second phase sampling. It should be a task of the contractor to propose and agree with Eurostat which points to photo-interpret because the access to the island is too difficult: no regular ferries or too long trip for a small number of points.

- **d)** Points that would have been eligible with the general rules, but could not be reached in 2009 (OBS_TYPE = 3 or 4) and were considered non-eligible in 2012.

Categories **a)** and **b)** can be merged in a set of strata to be treated with photo-interpretation. Category **c)** can be added to these strata. Category **d)** can be treated as missing data in the regular strata until a photo-interpretation is carried out.

With these rules, the master sample is split, regardless of the altitude, into 927,000 eligible points and 166,900 non-eligible points ca. (Table 5). The sample of points to be visited in the field is drawn from the eligible points, while for the non-eligible points a photo-interpretation operation was launched (see chapter 2.1.3)

### Table 5: Eligible and non-eligible points for the second phase

<table>
<thead>
<tr>
<th>Eligible/Non eligible</th>
<th>Number of points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible</td>
<td>927,566</td>
</tr>
<tr>
<td>Non eligible</td>
<td></td>
</tr>
<tr>
<td>altitude &lt; 1500, CLC-difficult access dist to road &gt; 600 m, difference altitude road &gt; 100 m</td>
<td>124,191</td>
</tr>
<tr>
<td>altitude &lt; 1500, dist to road &gt; 600 m, difference altitude road&gt; 100 m</td>
<td>18,361</td>
</tr>
<tr>
<td>Other non-eligible not reached in 2009 (OBS_type 2009 =3) and excluded for this reason in 2012</td>
<td>23,716</td>
</tr>
</tbody>
</table>

The subsampling method used to determine the sample for the field survey is a systematic procedure with multiple ranked replicates that ensure a certain spatial homogeneity in the distribution. The sampling rate could have been adjusted separately per domain (NUTS2 x Stratum), but the accuracy targets are rather arbitrary. A reasonable criterion is requesting a CV inversely proportional to the square root of the abundance of each class. This criterion is approximately optimized with a
homogeneous sampling rate that has the advantage of simplicity for users (minor impact if users do not use the extrapolation weights).

The only exception made to the homogeneous sampling rate per country is the rule of having a minimum of 2 sample points per stratum in each NUTS 2, unless there are not enough points in the master sample. This rule has introduced 151 points that would not have been selected with the general rule.

Some minor modifications have been introduced on the standard sampling procedure:

- For Cyprus and Malta the full first-stage sample was selected in 2012 and is kept as eligible and sampled for 2015;
- The soil bureau had sampled 24,026 points, most of them already surveyed in 2009. This sample includes 919 points that would not have been sampled for the field survey with the general rule, including 317 points that were classified as difficult to reach in the procedure described above. These 919 points have been in the 2015 sample and should receive extrapolation weight = 1 in the second phase.

In Table 6 the number of selected points in second phase sample is shown as well as the sampling rates. The overall sampling rate is about 29% and it ranges from a minimum of about 21.6% in Hungary to the maximum of 35.6% in Portugal, excluding the particular cases of Cyprus (100%) and Malta (98.8%). The percentage distribution of the points by strata at EU level is depicted in Figure 2 while the number of points selected by strata and by country is reported in Table 23 (Annex 1 - Tables and graphs).
## Table 6: Final sample size, eligible points and sampling rate (%) per country

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Master</th>
<th>Field sample</th>
<th>Eligible</th>
<th>Sampling rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>20,979</td>
<td>6,679</td>
<td>15,704</td>
<td>42.5</td>
</tr>
<tr>
<td>BE</td>
<td>7,682</td>
<td>2,412</td>
<td>7,232</td>
<td>33.4</td>
</tr>
<tr>
<td>BG</td>
<td>27,741</td>
<td>6,623</td>
<td>22,696</td>
<td>29.2</td>
</tr>
<tr>
<td>CY</td>
<td>2,311</td>
<td>1,442</td>
<td>1,442</td>
<td>100.0</td>
</tr>
<tr>
<td>CZ</td>
<td>19,718</td>
<td>5,492</td>
<td>19,195</td>
<td>28.6</td>
</tr>
<tr>
<td>DE</td>
<td>89,501</td>
<td>24,900</td>
<td>85,300</td>
<td>29.2</td>
</tr>
<tr>
<td>DK</td>
<td>10,825</td>
<td>3,447</td>
<td>10,334</td>
<td>33.4</td>
</tr>
<tr>
<td>EE</td>
<td>11,354</td>
<td>2,255</td>
<td>9,594</td>
<td>23.5</td>
</tr>
<tr>
<td>EL</td>
<td>33,045</td>
<td>7,852</td>
<td>24,915</td>
<td>31.5</td>
</tr>
<tr>
<td>ES</td>
<td>124,613</td>
<td>35,231</td>
<td>106,524</td>
<td>33.1</td>
</tr>
<tr>
<td>FI</td>
<td>84,542</td>
<td>13,407</td>
<td>60,302</td>
<td>22.2</td>
</tr>
<tr>
<td>FR</td>
<td>137,306</td>
<td>38,417</td>
<td>125,042</td>
<td>30.7</td>
</tr>
<tr>
<td>HR</td>
<td>14,141</td>
<td>3,533</td>
<td>12,727</td>
<td>27.8</td>
</tr>
<tr>
<td>HU</td>
<td>23,271</td>
<td>4,626</td>
<td>21,429</td>
<td>21.6</td>
</tr>
<tr>
<td>IE</td>
<td>17,557</td>
<td>3,470</td>
<td>15,429</td>
<td>22.5</td>
</tr>
<tr>
<td>IT</td>
<td>75,335</td>
<td>20,931</td>
<td>62,273</td>
<td>33.6</td>
</tr>
<tr>
<td>LT</td>
<td>16,334</td>
<td>3,873</td>
<td>14,875</td>
<td>26.0</td>
</tr>
<tr>
<td>LU</td>
<td>646</td>
<td>206</td>
<td>642</td>
<td>32.1</td>
</tr>
<tr>
<td>LV</td>
<td>16,145</td>
<td>4,498</td>
<td>14,248</td>
<td>31.6</td>
</tr>
<tr>
<td>MT</td>
<td>80</td>
<td>79</td>
<td>80</td>
<td>98.8</td>
</tr>
<tr>
<td>NL</td>
<td>8,864</td>
<td>2,219</td>
<td>8,454</td>
<td>26.2</td>
</tr>
<tr>
<td>PL</td>
<td>78,141</td>
<td>21,721</td>
<td>73,671</td>
<td>29.5</td>
</tr>
<tr>
<td>PT</td>
<td>22,261</td>
<td>7,318</td>
<td>20,542</td>
<td>35.6</td>
</tr>
<tr>
<td>RO</td>
<td>59,610</td>
<td>14,233</td>
<td>51,369</td>
<td>27.7</td>
</tr>
<tr>
<td>SE</td>
<td>112,494</td>
<td>22,340</td>
<td>76,830</td>
<td>29.1</td>
</tr>
<tr>
<td>SI</td>
<td>5,067</td>
<td>1,614</td>
<td>4,705</td>
<td>34.3</td>
</tr>
<tr>
<td>SK</td>
<td>12,263</td>
<td>2,438</td>
<td>10,680</td>
<td>22.8</td>
</tr>
</tbody>
</table>
2.1.3 Sample for office photo-interpretation

Photo-interpretation played an important role during the 2015 data collection. Access to points can be difficult in absence of adequate road network, for the landscape characteristics. The territory was classified in eligible and not eligible for the field survey, using all geographical information available. However, the exclusion of points from the sample is a likely source of bias which has to be treated separately from the field survey. Therefore the non eligible excluded area need to be covered with a complementary photo-interpretation. The survey design of LUCAS 2015 consists in fact of a field sample (273,400) selected from eligible areas \(^7\) (easy to access) and a complementary sample of more than 66,000 points to be photo interpreted in the office according slightly simplified rules.

The photo-interpretation rules, including land use and land cover nomenclatures, were simplified to make them compatible with photo-interpretation. Table 23 (Annex 1 - Tables and graphs) reports the

\(^7\) See chapter on sampling
distribution of points photo-interpreted in the office by strata and country which amount to a total 66409 at EU level.

2.1.4 Full sample (field survey and office PI)

The distribution of the total number of points (field sample and photo-interpretation in the office) by strata at EU level is reported in Figure 3. The total number of points divided points visited in field and points photo-interpreted in the office organized by strata and country are reported in the Table 24 (Annex 1 - Tables and graphs).
2.2 Ground survey

2.2.1 Data collection

Each point belonging to the field sample is investigated by collecting a set of detailed information using a specific field form (LUCAS 2015 – Technical reference document C2 - Field Form and Ground Document (template)) with the guidance of comprehensive instructions for surveyors (LUCAS 2015 – Technical reference document C1 - Instructions for Surveyors). Data collected concern LC/LU, environmental information and “meta information”. In addition to the obligatory fields, the surveyor can - and in specific situations has the obligation - to add comments and remarks. The latter are essential to clarify any decision taken by the surveyor.

The information collected in the field can be grouped into the following categories:

1. Identification of the point
   e) Access to point
   f) Comments on the way to the point
   g) Point observation
Methodology

h) Land cover and land use
i) Land management, special status and special remarks on land cover/use
j) INSPIRE Pure Land Cover Classes
k) Water management on the field
l) Soil
m) Transect
n) Photo (minimum 6 pictures N, E, S, W (4 photos), close-up of crop (not on artificial or vegetation-free areas), point in context (to be able to relocate), end of transect.

For the complete list of fields and the description of each parameter see Annex 1 - Tables and graphs:

The ground document indicates the location of the LUCAS point. The point as drawn on this orthophoto is the reference for locating the LUCAS point in the field. This is the point on which information has to be collected. The LUCAS point location and the real position of the surveyor might not be identical.

While the information of GPS coordinates and precision are referring to the position of the surveyor doing the observation, the information on LC/LU, environmental information and the photos of the point and of the crop/cover have to refer to the LUCAS point itself as determined by the orthophoto, even if it is further away from the real position of the surveyor.

In Lucas 2015 a pilot collection on INSPIRE pure land cover classes was introduced. Data are collected for the points where LC1 is either woodland (CXX), shrub land (DXX), grassland (EXX) or bare land (FXX) and is assessed within the homogeneous plot inside the extended window of observation (20m radius). Unlike what happens in LUCAS classes, where the sum of percentage of combined land cover can be more than 100%, in this case the sum of INSPIRE classes must be 100%. Assessment of the percentages is made using the “birds-eye” view.

Concerning water management, this is only relevant for points where LU = U111 or U112. In case of more than one source of irrigation or delivery system, the surveyor is requested to report the most important source. A note is added if irrigation is visible from the way to the point or along the transect.

It is mandatory that the surveyor does the anonymization directly before sending the photos to the upper level (i.e. the Regional or the Central Office). According to the LUCAS 2015 tender, non-compliance to this rule is considered a breach of contract and will lead to legal consequences.

In addition to the data collected on the field form, and the pictures, the surveyor shall collect point and line data in the GPS.

2.2.2 Implementation and schedule of the field survey

LUCAS 2015 was carried out in all 28 Member States. The territories/islands listed below were not included in the field survey; they are excluded from the reference population and hence the area is
not considered in the estimation process. The area of these territories sums up to less than 2.5 % of the total area of EU:

- ES63 (Ciudad Autonoma de Ceuta);
- ES64 (Ciudad Autonoma de Melilla) (ES63 + ES 64 = 0.03% of ES6 (SUR));
- ES70 (Canarias);
- FR9 (Departements D’outre-Mer);
- PT20 (Região Autónoma dos Açores);
- PT30 (Região Autónoma da Madeira).

All the survey has been conceived and designed by Eurostat with ad hoc technical support from JRC. The Contractors were responsible for the data collection in the 28 countries arranged in 5 lots and one IPA grant, the recruitment and management of the surveyors and the data delivery. The data collection started in field in March 2015 and was completed in office in May 2016, with the last quality checks; in the round more than 700 surveyors were recruited for a total of more than 273 000 points to be visited in the ground (Table 25 in Annex 1 - Tables and graphs).

Points were surveyed with different modalities, the majority were observed directly at a distance less than 100 m, a small percentage (less than 10%) was photo-interpreted in the field due to accessibility problems (Figure 4).

Figure 4: Percentage distribution of surveyed points by type of observation at EU level
2.2.3 Survey performance

In 2015, 729 surveyors were recruited for a total of 273,401 points to be visited in the ground. The average number of points per surveyor was 375 (Table 25 -Annex 1 - Tables and graphs), compared to 366 in 2012 and 405 in 2009. There were however important differences between the countries and the maximum average number of points per surveyor was 732 (Portugal), the minimum was 5 (Luxembourg) (Table 25 -Annex 1 - Tables and graphs).

Figure 5 reports the average number of points visited by surveyor per country, while Figure 6 depicts the average number of points surveyed daily per country. In both cases the two extremes are Luxembourg (minimum) and Portugal (maximum). Figure 7 represents the average time spent per point by country, the two mentioned extremes are clearly reversed. The time spent per point on the field survey varies between 18 and 44 min, the average being 24 min, the same as in 2012.

Figure 5: Average number of points per surveyor by country and EU average
**Methodology**

Figure 6: Average number of points surveyed per surveyor per day by country and EU average

Figure 7: Average time spent per point by country (in minutes) and EU average
The average time needed to visit each point depends on land cover and land use of the point, surroundings and is obviously strongly related to the closeness of the point to the next road. Surveyors first of all have to reach the point and then they had to walk along a transect of 250 m towards the East. In general, points in the forest and wetlands were the most difficult to reach and require more time compared to the others. In the ex-ante photo interpreted points however, the longest time occurs in grassland and bare land points (Table 7).

Table 7: Average time spent during the point survey and photo-interpretation (in the field and ex-ante) by land cover class

<table>
<thead>
<tr>
<th>LAND COVER CLASS</th>
<th>DISTANCE &lt; 100m</th>
<th>DISTANCE &gt; 100m</th>
<th>PI</th>
<th>EX-ANTE PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial land(5.2%)</td>
<td>20:44</td>
<td>17:13</td>
<td>17:13</td>
<td>04:01</td>
</tr>
<tr>
<td>Cropland (30%)</td>
<td>22:44</td>
<td>17:57</td>
<td>15:42</td>
<td>07:00</td>
</tr>
<tr>
<td>Woodland (33.6%)</td>
<td>30:46</td>
<td>20:08</td>
<td>18:41</td>
<td>03:15</td>
</tr>
<tr>
<td>Shrubland (5.2%)</td>
<td>27:11</td>
<td>20:17</td>
<td>17:10</td>
<td>07:50</td>
</tr>
<tr>
<td>Grassland (21.2%)</td>
<td>23:54</td>
<td>18:37</td>
<td>16:24</td>
<td>09:06</td>
</tr>
<tr>
<td>Bare land (1.9%)</td>
<td>21:48</td>
<td>17:29</td>
<td>15:40</td>
<td>09:07</td>
</tr>
<tr>
<td>Water areas(2%)</td>
<td>25:11</td>
<td>18:36</td>
<td>14:29</td>
<td>02:13</td>
</tr>
<tr>
<td>Wetland (0.9%)</td>
<td>30:34</td>
<td>22:33</td>
<td>16:15</td>
<td>02:03</td>
</tr>
</tbody>
</table>

In terms of average distance of observations, the shortest occurs in artificial areas and the longest for wetland and water areas (Figure 9).
Figure 8: Average time spent per point by land cover class and by observation type

(272,903 points) at EU level
2.3 Photo-interpretation in the office

In addition to the "standard" LUCAS survey, a sample of over 66,000 points selected from the areas excluded from the field survey\(^a\), have been photo-interpreted using orthophotos. The activity was carried out by 64 photo interpreters. For the photo-interpretation the number of points per day is considerably larger than in the field survey, as expected (Table 25 -Annex 1 - Tables and graphs). In fact, the average number of points per surveyor was 1,038 (375 in the field survey) and the average number of points per day was 65 (10 in the field survey). The range of variation of the photo-interpreted points is delimited by Luxembourg and France having, respectively, the lowest (46) and largest number of points (4,896).

\(^a\) See chapter 2.1.3
The information derived via photo-interpretation was kept as detailed as possible even though some details can be captured only by field visits. Only a few fields were excluded a priori being information not collectable by photo-interpretation: photos, GPS track and "height of trees at survey".
Figure 10: Average number of points per surveyor photo-interpreted in the office by country and EU average

Figure 11: Average time spent per Ex-ante PI Extension point by land cover class (66,402 points) at EU level
2.4 Quality assurance

Quality assurance is a central component throughout all the phases of the LUCAS survey to assure the quality and the comparability of results. Quality assurance includes a common framework or harmonised approach, automated quality controls implemented in with common IT tools.

2.4.1 The common framework

Quality assurance covers different aspects, first of all the provision of a common framework for all participants. This is especially important as the survey has been split up in several lots, which have been contracted to different entities and a common understanding across the lots needs to be assured. To this end the following actions have been foreseen:

- Common documentation and instructions for all surveyors;
- Common “Frequently Asked Questions and Answers” document updated regularly based on issues raised by the contractors during the running of the survey;
- Standardised and automated Data Management Tool (DMT);
- Common training for all the Survey Managers;
- Common set-up and follow-up visit to each country by a team of experts.

The training for the survey managers includes in-door sessions - covering the overall approach, the survey instructions and the data management tool - as well as a field trip to allow for hands-on experience.

An expert team did follow-up visits in all the countries to identify and correct systematic errors in data collection and survey management as early as possible. Information collected concerned the set-up of the survey, the number of surveyors and their training, communication and quality control. Based on the results a second round of follow-up visits were organised to propose corrective measures where needed.

2.4.2 IT tools – DMT 2015 Suite

In 2015 a significant change was introduced in the Data Management Tool, by creating a central server infrastructure which allowed for the immediate access to the data by the upper levels of control for monitoring purposes. The local client (in MS Access) was kept, and was still used for updating the database: data collection & validation of internal consistency and linked to the visual quality control, including acceptance and rejection of points. Working on the local client requires download and upload of data and files from and to the central database.
2.4.3 Quality control during the field work

Data quality checks run in parallel to the collection of the data. The aim is to identify and correct systematic errors during the data collection as early as possible. These quality checks take place at 2 different levels.

These quality checks take place at 2 different levels:

- Internal quality check;
- External, independent data quality control.

The internal quality check took place at the field work contractor’s regional or central offices and concerned all the data collected for all the LUCAS points in the 28 participating countries.

An independent external data visual quality control on over 1/3 of the points was assured by a separate expert team of data controllers. All available information (ancillary information, ground documents, metadata on the survey, land cover and land use classification, transect data, GPS tracks,
photos, justification for photo-interpretation) is analysed to evaluate the reliability of the results. Point data that clearly requires correction or clarification is rejected and send back to the field work contractors, the other points are transmitted to Eurostat. After a revision by the field work contractors of the points rejected once these points go once more to external quality control.

The second control of the data can lead to acceptance or rejection. In both cases the data was forwarded to Eurostat. Here points rejected twice are checked to guarantee the compliance with the tender specifications (for each country no more than 1% of the points of the survey can be rejected twice).

During these quality controls all available information (ancillary information, ground documents, metadata on the survey, land cover and land use classification, transect data, GPS tracks, photos, justification for photo-interpretation) are analysed to evaluate the reliability of the results.

2.4.4 Eurostat quality control (review, validate and edit)

In Eurostat the quality control first includes the consolidation of the “raw” data set. Further steps of the validation process\(^9\) include for example the consistency checks with other datasets of the same domain (previous years LUCAS data) and consistency with data of other data providers. More details of the state of the art of the validation process can be found in Annex 2.

Eurostat also performs a number of macro and micro editing techniques in order to fine tune the final estimates. The identification of possible influent errors might be fed into the validation process and imply further corrections to the micro data.

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After the activities of data collection and quality assessment during the field work and at Eurostat office, the data were processed to create new variables, to calculate weights, to realign the 2015 classifications to the previous surveys ones, to make the data suitable for statistical analysis and, finally, to produce estimates.

### 3.1 Realignment of classifications

The comparison between the results of different waves of the survey is one of the target of LUCAS project. During the period 2009-2015, classifications of LC/LU were improved; the 2009 classifications was already realigned to the 2012 one, hence only one procedure of realignment (2009/2012 to 2015) is needed. Unfortunately, most of the changes were done only during the field work and so it is quite impossible to change the codes in 2009/2012 data sets according to 2015 classification, because the information needed is not available on the record. Only two rules can be adopted to change the 2009 and 2012 microdata by an automated data processing (Table 8). The first rule is applicable in 2012 data to 2 cases, the second one to 7 cases while no cases have to be corrected in 2009 data.

### Table 8: Analysis of changes in classifications from 2012 to 2015 survey

<table>
<thead>
<tr>
<th>2015 changes</th>
<th>Actions in 2012 data</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land cover class B77j was dropped as it referred to “Abandoned citrus orchards” (“abandoned” is a land use, not a land cover)</td>
<td>If LC1_species = B77j then: LC1_species = 8 and LC1 = B77 and LU1 = 410 and Land_cover=cropland and Land_use= unused and abandoned.</td>
<td>The same rule holds for LC2_species=B77j and the variables LC2 and LU2.</td>
</tr>
<tr>
<td>Cropland, and namely energy crops (B84) are no longer linked to U210</td>
<td>If LC1=B84 and LU1= U210 then LU1= 8</td>
<td>The same rules hold for LC2.</td>
</tr>
</tbody>
</table>
3.2 Others minor data treatments

Minor changes in microdata of the three surveys were made in order to guarantee their comparability, by setting up a common format to process the microdata with the same procedures.

- In the Master 2015 a new NUTS2 corresponding to transitional water is established assigning the code T to NUTS1 and TW to NUTS2;
- The TW code is assigned also to the corresponding points in 2009, 2012 and 2015 survey data;
- The variable names in the three data sets have been made uniform in order to facilitate the sas programming;
- Realignment of 2015 transect information to the 2009/2012 standard; in 2015 data there is only one text variable for all the transects in a specific point while they are reported as distinct variables in 2009 and 2012 data;
- The PI points were extracted from 2015 data and reassigned to the 2009, 2012 and 2015 according to the correspondent flag.

3.3 Weights calculation

The estimating procedure is based on a calibrated estimator. It assures that the estimates of some structural variables are forced to equalize “known totals” in some domains: other than in “administrative entities” (NUTS0, NUTS1 and NUTS2), also two differently aggregated classifications of elevation are taken into account, reported in the following Table 9.

Table 9: Elevation classifications used in weights calculation

<table>
<thead>
<tr>
<th>Elevation</th>
<th>6 classes classification</th>
<th>4 classes classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td>&lt; 100</td>
<td></td>
</tr>
<tr>
<td>100 – 300</td>
<td></td>
<td>100 – 600</td>
</tr>
<tr>
<td>300 – 600</td>
<td></td>
<td>600 – 1,500</td>
</tr>
<tr>
<td>600 – 1,000</td>
<td></td>
<td>&gt;1,500</td>
</tr>
<tr>
<td>1,000 – 1500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;1,500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
So the sum of weights of sampled points are forced to equalize the totals of master points in the domains

- NUTS2*strata (the area of each Nuts 2 was specified from a specific file);
- NUST1*elevation (4 classes);
- NUTS0*strata*elevation(6 classes);
- Country (this marginal could permit the further representation of the area of the Countries);

In every of these domains the estimates sum up to the respective totals in Master. Considering the number of points is equivalent to consider the “area”, because it is obtained multiplying the number of points by a constant, the averaged area in the NUTS2. Because it is obtained from external reliable source, the “known total areas” of NUTS2, NUTS1 and NUTS0 are “true” while the areas of the domains obtained by their combination with “elevation” is an estimate, calculated from the first phase sample, because the corresponding true values are not available. Nevertheless, it is reasonable, given the number of points and the methods of selection that these estimates constitute a good approximation to the true totals

The weight of the single point is obtained, starting from the inverse of probability of selection, by an iterative proportional fitting (IPF) procedure that associates, in each iteration, new weights to each point up to equalize the sum of weights and the known totals of the domains to which the units belong.

The calibrated estimator takes over also the correction for missing units, where the “average collected point” is conceptually averaged taking into consideration the strata and the class of elevation at different level of NUTS.

In general, the estimation, in a NUTS2 region, of an area corresponding to a generic qualitative characteristic $L$, can be provided by

$$\hat{S}_L = \hat{Y}_L \times S$$

where $S$ is the total area in the NUTS2 from an external source, and $\hat{Y}_L$ the estimated percentage of points with characteristic = $L$.

The estimator for a percentage in double sample is

$$\hat{Y}_L = \sum_h W_h \hat{Y}_{hl}$$

where $\hat{Y}_{hl}$ are the related SRS estimates in different strata $h$. We can rewrite (1) as

$$\hat{Y}_L = \sum_h W_h \left( \sum I_{Lhk} y_{kh} / n_h \right)$$

Where

$$I_{Lhk} = \begin{cases} 1 & \text{if } y_{kh} = L \\ 0 & \text{otherwise} \end{cases}$$
with \( h = 1 \) to 7 and \( k = 1 \) to \( n_h \). Formula (2) can be developed as

\[
\hat{Y}_L = \left( \frac{1}{N} \right) \sum_h \left[ \sum_k I_{kh} y_{kh} \right] * \frac{N_h}{n_h} \tag{4}
\]

where \( N_h / n_h \) represent the inverse of inclusion probabilities \( p_{kh} \).

Substituting (4) into (1) we obtain

\[
\hat{S}_L = \left( \frac{S}{N} \right) \sum_h \left[ \sum_k I_{kh} y_{kh} \right] * \frac{N_h}{n_h}
\]

and because \( S / N = \bar{S} \) is the average point area in NUTS2 we can write

\[
\hat{S}_L = \sum_h \left[ \sum_k I_{kh} y_{kh} \right] * \bar{S} * p_{kh} \tag{5}
\]

Starting from the above probability of inclusion, a new weight is calculated by an iterative proportional fitting (IPF) procedure that forces the sum of weights of the units belonging to specific domain to equalize the known totals in the domain. So the (5) becomes

\[
\hat{S}_L = \sum_h \left[ \sum_k I_{kh} y_{kh} \right] * \bar{S} * w_{hk}
\]

where \( w_{hk} \) is obtained as the final result of the following iterations

\[
w_{t+1,v_{i},...,v_{m}} = \frac{N_{v_{i},...,v_{m}}^{t+1}}{N_{v_{i},...,v_{m}}^{t}} w_{t,v_{i},...,v_{m}}
\]

Where:

- \( t^1 \) and \( t^0 \) represent two consecutive iterations;
- \( i \) refers to the \( i \)-th point;
- \( v_1, ..., v_m \) refers to the values observed for the \( 1, ..., m \) variables;
- \( N_{v_1, ..., v_m}^{t} \) are the number of points (derived from the master data set) of the values for the \( 1, ..., m \) variables;
- \( N_{v_1, ..., v_m}^{t+1} \) are the totals of the values for the \( 1, ..., m \) variables as observed in the sample;
- \( w_{t,v_{i},...,v_{m}}^{t+1} \) and \( w_{t,v_{i},...,v_{m}}^{t} \) are, respectively, the new and the old weight for the \( i \)-th point.

In order to evaluate the changes made on the weights for each step of the IPF procedure, it is evaluated the mean square variation of these between each iteration. This corresponds to:

\[
MV = \frac{1}{n} \sum_{i=1}^{n} (w_{t+1} - w_{t})^2
\]

When \( MV \) is less than 0.00001, the IPF procedures is stopped.

According to the above estimator, estimated area (in \( \text{km}^2 \)) and corresponding percentages for LC and LU are reported in Annex 1 – Tables 28-29-30-31.

### 3.4 Calculation of the FAO variable
Several aspects need to be tackled in the alignment of LUCAS and FAO classification for forest classes. First of all the differences in the semantic definition of LUCAS wooded areas and FAO forest definitions: if an area has > 10% of trees (excluding fruit trees in permanent crops) in LUCAS is labelled as "wooded area", FAO takes this into account only if it is greater than 0.5 Ha.

In addition, a further concern arises from the changes occurred in survey protocol for the 2009, 2012 and 2015 LUCAS campaigns. In fact, variations in the definitions may cause inconsistencies when datasets are compared over time. Therefore, an evaluation of the impacts of these changes on the reported figures at different administrative levels is either beneficial for producer or user of the data.

The main changes in the LUCAS Land Cover (LC) and Land Use (LU) classification in the periods 2009-2012 and 2012-2015 that impact on forestry-related classes are reported in the following Table 10 and Table 11.

**Table 10 : Main changes occurred in the classification of forestry-related classes between 2009 and 2012 LUCAS Surveys**

<table>
<thead>
<tr>
<th>LC/LU</th>
<th>Type of change (2012 vs. 2009)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC</td>
<td>New forest classes</td>
<td>Spruce (C21) and pine (C22) dominated coniferous and other coniferous (C23) woodland. This implies introduction of spruce (C31) and pine (C32) dominated as well as other woodland (C33).</td>
</tr>
<tr>
<td></td>
<td>New coding</td>
<td>The prefix “CX” is updated to “CXX”.</td>
</tr>
<tr>
<td></td>
<td>Change of definition</td>
<td>Wet forests are to be classified in CXX and not in HXX.</td>
</tr>
<tr>
<td>LU</td>
<td>Suppression of classes</td>
<td>U364 Nature Reserve has been suppressed (moved to special status in field form).</td>
</tr>
</tbody>
</table>

**Table 11 : Main changes occurred in the classification of forestry-related classes between 2012 and 2015 LUCAS Surveys**

<table>
<thead>
<tr>
<th>LC/LU</th>
<th>Type of change (2015 vs. 2009)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC</td>
<td>Harmonization of definitions</td>
<td>Areas below 10% of trees are to be classified according to the existing land cover. Previously CXX included forest nurseries and young plantations even if they do not reach a canopy of 10%. Forest nurseries included in CXX are now classified under B83</td>
</tr>
<tr>
<td>LU</td>
<td>Change of definition</td>
<td>U120 Forestry now explicitly includes extraction of cork (cork oak trees)</td>
</tr>
</tbody>
</table>

Finally, data collection process during field campaigns can be affected by errors that have an impact on forest areas (Woodland (C00)) figures. For instance, the assessment on the previous surveys revealed that the following errors occurred frequently: 1) it was common to forget to assess the 10%
cover of the canopy on the extended window when not on forest areas; 2) the surveyor used the CXX class when the canopy was less than 10% due to ambiguous instructions on the LUCAS 2012 documentation.

The rules for mapping LUCAS to FAO definition for forestry-related classes has been based on the semantic analysis of the classes reported in the documents FRA 2015 - Forest Resources Assessment Working Paper 180 and in the LUCAS 2015 - Technical reference document C1:Instructions for Surveyors published by FAO and Eurostat, respectively. The key elements and definitions for the forest classes used in LUCAS 2015 and in FAO (FRA 2015) are reported in Table 12 and Table 13, respectively.

### Table 12: Terms, definitions and remarks for the "woodland" class in LUCAS 2015 (Source: Eurostat, 2015)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland (C00)</td>
<td>Areas covered by trees with a canopy of at least 10%. Also woody hedges and palm trees are included in this class.</td>
<td>Height of trees at maturity and width of woody features have to be assessed. The 10% of canopy cover has to be assessed in the extended window of observation (Area 0.13 ha). If the wooded area is larger than 0.5 ha, the height of trees is above 5 m at maturity and the width of the wooded feature is more than 20 m, the surveyor has to indicate the forest cover code in the respective &quot;LC plant species&quot; field, according to the forest type classification of the European Environment Agency. Trees that are known as forest trees can also be grown as an orchard</td>
</tr>
</tbody>
</table>

### Table 13: Terms and definitions of the FAO forestry-related classes (Source: FAO, 2012)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy Cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.</td>
</tr>
<tr>
<td>Other wooded land</td>
<td>Land not defined as &quot;Forest&quot;, spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.</td>
</tr>
<tr>
<td>Other land</td>
<td>All land that is not classified as forest or other wooded land.</td>
</tr>
<tr>
<td>Other land with tree cover (subcategory)</td>
<td>Land considered as &quot;other land&quot;, that is predominantly agricultural or urban lands use and has patches of tree cover that span more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 meters at maturity. It includes both forest and</td>
</tr>
</tbody>
</table>
The mapping procedure can be schematically described as follows:

1. **Semantic analysis of the LUCAS and FAO definition for the forestry-related classes.** Starting from FAO terms, definitions and explanatory a semantic analysis is performed to identify the correspondence with the LUCAS LC/LU classes both individually and in combination. The following FAO classes are taken into account and analyzed, then are coded to streamline the rules implementation:
   a. Forest (Code 1);
   b. Other wooded land (Code 2);
   c. Other land with tree cover - subcategory of the class Other land (Code 3);
   d. Other land (Code 0) excluding "other land with tree cover";
   e. The sum of the above categories equals to "total area";

2. **First definition of the mapping rules,** based on the different combinations of land cover 1 and 2, land use 1 and 2 and some parameters. The parameters concerned are: species, area size, height of trees and special remarks (clear cut, burnt area and fire break);

3. **Exploratory analysis**;

4. **For each rule the single classes or their combination have been analyzed and a visual check of the available LUCAS 2015 points has been performed. The resulting combinations have been checked once again in order to extract a simple set of rules for the selection.** The queries have been fine-tuned to cover for classes/combinations left out in the first round. At this stage, in order to obtain the best matching between the two classifications, the correct sequence for applying the rules has been tested and defined. During the process a significant number of LUCAS 2015 points has been selected for further checks and harmonization;

5. **Final definition of the mapping rules in SQL language.**

A total of 13 rules are reported each one coded by a label and an ordinal number that specify the sequence to be followed when the rules are applied in data elaboration. After verification, the rules have been converted in a executable program that adds to a LUCAS dataset the new variable `FAO_CLASS` related to the FAO forestry classes (0, 1, 2 or 3). Moreover two new variables are calculated: `ALL_VALUES` obtained by linking together the names of all the variables used in FAO forestry coding, and the variable `CONDITION_FAO_CLASS`, that allows to identify which condition was satisfied by the current record, according to the rules properly defined.

In order to guarantee the comparability between the different waves of LUCAS survey, the procedure was also applied to the 2009 and 2012 survey data. The results obtained were analyzed by considering the changes occurred in the LC/LU classification between 2012 and 2015 and by verifying semantically if these changes affect the application of the rules to LUCAS 2012 dataset. In general, from a semantic standpoint, the rules defined for LUCAS 2015 can be deemed applicable backward to
2012 even if some slight changes in the classification occurred between 2012 and 2015 and concerns few of the variables involved.

The estimates with the FAO classification produced for 2009 and 2012 LUCAS dataset have been compared with statistics on forest areas published yearly at country level (NUTS0) by FAO on the FAOSTAT web portal. The area of the "Forest" variable at NUTS0 level, as defined in (Table 4) was extracted from the FAOSTAT database (FAOSTAT Domain: Inputs/Land) for the years 2009 and 2012 and compared with the estimates of the area for the FAO class with code 1 computed with the LUCAS to FAO mapping procedure.

The FAO statistics allow to set up a comparison due to a temporal coherence between FAOSTAT and LUCAS for the years 2009 and 2012. Notwithstanding, the main drawback is the lack of the FAO forest variables "Other wooded land" and "Other land with tree cover" that hinder the comparison with the FAO class coded with 2 and 3 generated by the mapping procedure.

The two missing variables are reported at NUTS0 only in the FAO database of Global Forest Resource Assessment (FRA) that is carried out at specific time intervals not corresponding with the LUCAS reference years (2009 and 2012). In addition, FRA data are a collation of countries reports that provides information often not homogeneous in terms of methods, national data sources and temporal reference (e.g. Italian forests statistics provided for the FRA are produced as follow: 1990 and 2000 estimation was made through a linear interpolation between 1985 and 2005 data; 2010 and 2015 estimation was computed with a linear interpolation between the 2005 and provisional data from the 2015 National Forest Inventory (FAO, 2014)). In general terms, the comparability between LUCAS and FAO statistics can be deemed satisfactory (see more details in Coherence - cross domain).

### 3.5 Calculation of a unique land cover and land use variable and other data treatment

On the sampling units (points) two different modalities for land cover (LC1 - the primary information and LC2 - the secondary one) could be collected. Currently, only LC1 is used in estimating the different land cover typologies; doing so, implicitly, it is assumed that the secondary variables balance each other out in the final estimates. So, in order to refine the estimate of land cover and land use, both the information (the principal and secondary ones) and the percentage of LC1/LC2 collected by LUCAS Survey were used.

**Variable Land cover**

The estimation procedure assigns a weight to each point according to the sample design. The points that present only the primary LC1 variable are inflated with the usual standard method using the assigned weight. When LC1 and LC2 are both available for a point, the record will be replicated and
the associated weight for each of the two new records divided, respectively, by two factors having sum equals to 1. This will permit to not halter the weighted totals of points.

To represent such issue it is possible to consider the two coefficients, p1,i and p2,i that will be associated to the i-th point, so that:

\[ p_{1,i} + p_{2,i} = 1; \]

In the point i the estimates for the two different values (k and j) of Land Cover (i.e LC1 and LC2) will be:

\[ LC1(k)_i = p_{1,i} * W_i \]
\[ LC2(j)_i = p_{2,i} * W_i \]

where \( W_i \) is the initial weight assigned to point i.

For the same point i, according to the field instructions, should be not allowed to have the same modality for LC1 and LC2; but, when a classification more aggregated than the original one is used, this condition does not hold (especially for LC2 code). In any case it will not affect the estimation procedure.

Note that \( LC1(k)_i + LC2(j)_i = W_i \) represent the weight assigned to the i-th point and hence the established total areas at different territorial levels are preserved.

For the points that present a unique land cover (e.g the k modality), the estimates will be

\[ LC1(k)_i = W_i \]

as in the standard procedure.

So the estimate of total for k modality is obtained summing up

\[ \text{Tot}_{- \text{LC}}(k) = \sum_i \{ LC1(k)_i + LC2(k)_i \} \]

where, in the single point, LC1(k)_i or LC2(k)_i or both can be equal to zero; of course in every record at least one land cover modality exists.

**Variable land use**

The variables LU1 and LU2, according to the field instructions, can be referred to LC1 or LC2, but no rule is given to attribute it to one or both the land cover variables. In order to produce consistent land use estimates, we use the same approach above described, dividing every weight by two parameters \( q_{1,i} \) and \( q_{2,i} \) that sum up to 1. But given that no information is available for 2009 and 2012 data (as the class percentages for land cover) while for the 2015 survey the collected information have to be further assessed, we set \( q_{1,i} = q_{2,i} = 0.5 \). So when LU1 and Lu2 are present in a single record

\[ LU1(k)_i = 0.5 * W_i \]
\[ LU2(j)_i = 0.5 * W_i \]

Or for the points that present a unique land use:

\[ LC1(k)_i = W_i \]

The estimate of total for k modality is obtained summing up

\[ \text{Tot}_LU(k) = \sum_i \{ LU1(k)_i + LU2(k)_i \} \]

In case of the existence of the primary and secondary land cover variables, it is expected that also the two classes of percentages are reported in the record. For checking this “rule”, Table 14 has been produced, where all the combinations of existence/missing of the four variables are analytically reported. In the table, the 1 value represent the existence while the 0 value the missing variable.
Table 14: Frequency of different combinations of variables existence

<table>
<thead>
<tr>
<th>LC1</th>
<th>LC2</th>
<th>LC1 percentage</th>
<th>LC2 percentage</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>244,307</td>
<td>73.4%</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3,764</td>
<td>1.1%</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>69,934</td>
<td>21.0%</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>8,268</td>
<td>2.5%</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1,259</td>
<td>0.4%</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5,266</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

33,2798 100.0%

One of the requirements of the above reported estimation method is that the two percentages for LC1 and LC2 must sum up to 1 that is $p_{1,i} + p_{2,i} = 1$. This rule is needed for the procedure, otherwise the total area at country level and the coherence at NUTS1 and NUTS2 levels is no more preserved; but it is rightly not specified in data collection instructions to take into account the actual situations on the field.

Table 15 shows the coherence of LC1_percent and LC2_percent with respect to the rule $p_{1,i} + p_{2,i} = 1$ for the different surveys: in grey are showed the not coherent combinations, in green the coherent ones while in yellow the coherence is limited to only one value.

Table 15: Coherence of the combinations of LC1_percent, LC2_percent with respect of the rule $p_{1,i} + p_{2,i} = 1$
Because no information on the distribution of the percentages inside the class percentages is available, as generating probability function the uniform one was adopted. Two numbers in the interval \((0;1)\) are generated from this function and scaled-down, according to the classes of percentages found in the record; then they are divided by their sum in order to guarantee the \(p_{1,i} + p_{2,i} = 1\).

### 3.6 Procedure for replications of records

The estimation procedure is carried out at the same time for LC/LU and the original information on LC\(_1\), LC\(_2\), LU\(_1\) and LU\(_2\), reported in every point, could be found in one of the following four combinations (Table 16).

<table>
<thead>
<tr>
<th>Combination</th>
<th>LC(_1)</th>
<th>LU(_1)</th>
<th>LC(_2)</th>
<th>LU(_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

For every combination a different number of weights (and hence of percentages \(p\) and/or \(q\)), are needed to inflate both land cover and land use in a coherent way. But, instead of reporting on a single record more than one weight (for example one for LC\(_1\) and one for LC\(_2\)) it is preferable, in order to facilitate the calculations, to generate a number of records equal to the number of different weights needed.

- **Combination(a)**: no generation of percentage is made because land cover and land use coincide with LC\(_1\) and LU\(_1\); only one record is generated with weight = \(W_i\)

- **Combination(b)**: two percentages are generated for LC\(_1\) and LC\(_2\); to both is attributed LU\(_1\); two records are generated:
  - the first one has Land cover = LC\(_1\), Land use = LU\(_1\) and a weight = \(p_{1,i} \times W_i\)
  - in the second one land cover = LC\(_2\), Land use = LU\(_1\) and weight = \(p_{2,i} \times W_i\)

- **Combination(c)**: land cover coincides with LC\(_1\) to which are attributed the two land use with a percentage = 0.5; two records are generated:
  - to the first one is assigned a land cover = LC\(_1\), a Land use = LU\(_1\) and a weight = 0.5* \(W_i\)
  - to the second one land cover = LC\(_1\), Land use = LU\(_2\) and a weight = 0.5* \(W_i\)
combination(d): two percentage are generated for LC1 and LC2; to each land cover both LU1 and LU2 are attributed; four records are generated:

- to the first record are assigned land cover = LC1, land use = LU1 and a weight = 0.5 * p_{1,i} * W_i;
- to the first record are assigned land cover = LC1, land use = LU2 and a weight = 0.5 * p_{1,i} * W_i;
- to the first record are assigned land cover = LC2, land use = LU1 and a weight = 0.5 * p_{2,i} * W_i;
- to the first record are assigned land cover = LC2, land use = LU2 and a weight = 0.5 * p_{2,i} * W_i;

Table 17 summarizes the above rules and the results of the applied procedure.

Table 17: Rules for record applications and results

<table>
<thead>
<tr>
<th>LC1</th>
<th>LU1</th>
<th>LC2</th>
<th>LU2</th>
<th>Weight (W)</th>
<th>Replication of the record</th>
<th>Number of points</th>
<th>% of points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>W</td>
<td>No</td>
<td>30.9306</td>
<td>84.6%</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.5*W</td>
<td>2 records with the same LC and LU equals, respectively, to LU1 and LU2</td>
<td>27.568</td>
<td>7.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5*W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>p*W</td>
<td>2 records with the same LU and LC equals, respectively, to LC1 and LC2</td>
<td>9.800</td>
<td>2.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>q*W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.5<em>p</em>W, 0.5<em>p</em>W, 0.5<em>q</em>W, 0.5<em>q</em>W</td>
<td>4 records with all the combinations: (LC1,LU1), (LC1,LU2), (LC2,LU1), (LC2,LU2)</td>
<td>19.092</td>
<td>5.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5<em>p</em>W, 0.5<em>p</em>W, 0.5<em>q</em>W, 0.5<em>q</em>W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.7 Estimates production

The last step of the statistical production is the output of 49 Tables containing the estimates of the new variables Land cover (LC) and Land use (LU) as well as FAO classifications at different aggregation levels. Estimates of areas, percentages of areas (calculated over the total of corresponding territorial level, e.g. NUTS2 if the Table is related to NUTS2), number of sampled points, coefficients of variation and extremes of confidence intervals are provided. Moreover three auxiliary variables (Type1, Type 2 and Type 3), useful for analyzing the “trend” of estimates are given; Table 18 reports their classifications.
Table 18: Classification of auxiliary variables Type1-Type3

<table>
<thead>
<tr>
<th>Variable</th>
<th>Codes</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type1</td>
<td>0</td>
<td>Not evaluated</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Estimates of 2012 less than 2009 and 2015 (2012 not internal)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Estimates of 2012 less than 2009 and greater than 2015 (2012 internal with a decreasing trend)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Estimates of 2012 greater than 2009 and 2015 (2012 not internal)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Estimates of 2012 greater than 2009 and less than 2015 (2012 internal with an increasing trend)</td>
</tr>
<tr>
<td>Type2</td>
<td>0</td>
<td>Not evaluated</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Estimates of 2012 greater than the upper limit of the confidence interval</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Estimates of 2012 in the confidence interval</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Estimates of 2012 less than the lower limit of the confidence interval</td>
</tr>
<tr>
<td>Type3</td>
<td>0</td>
<td>Not evaluated</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Confidence interval of 2012 inside the confidence interval that considers 2009 and 2015</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Confidence interval of 2012 outside the confidence interval that considers 2009 and 2015</td>
</tr>
</tbody>
</table>

In the tables are considered the following territorial levels; Europe, Country, NUTS0, NUTS1 and NUTS2. The level “Europe” summarizes the estimates of the participant countries in every survey. The level “Country” includes the “transitional water (TW) area” which is not included in NUTS0; so the total areas of the two levels do not coincide if TW are present. The sum of areas of at level of NUTS1 and NUTS2 is the same of NUTS0. The confidence intervals are given at a probability level of 95%.

The tables are provided with an index and some metadata; the structure and the contents of the tables are summarized in the following Table 19.
### Table 19: Structure and contents of Tables produced

<table>
<thead>
<tr>
<th>Variable</th>
<th>Territorial level</th>
<th>Years</th>
<th>Digit code</th>
<th>Estimates</th>
<th>Aux variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land cover</td>
<td>NUTS0 NUTS1 NUTS2 total EU Country</td>
<td>2009 2012 2015</td>
<td>1, 2, 3</td>
<td>Areas area percentage, coefficients of variation, number of sampled points, extremes of confidence intervals</td>
<td>Type 1 Type 2 Type 3</td>
</tr>
</tbody>
</table>

| Land use       | NUTS0 NUTS1 NUTS2 total EU Country | 2009 2012 2015 | 2, 3, 4    | Areas area percentage, coefficients of variation, number of sampled points, extremes of confidence intervals | Type 1 Type 2 Type 3 |

| FAO classification | NUTS0 NUTS1 NUTS2 total EU Country | 2009, 2012, 2015 | 1           | Areas area percentage, coefficients of variation, number of sampled points, extremes of confidence intervals | Type 1 Type 2 Type 3 |

| Land cover     | NUTS0 NUTS1 NUTS2 total EU Country | 2009 2012 2015 | 1, 2, 3    | Areas area percentage, coefficients of variation, number of sampled points, extremes of confidence intervals | Type 1 Type 2 Type 3 |

The main results for the new variables land cover and land use, at level of NUTS0, are reported in terms of absolute values (km2) of different LC modalities by NUTS0 and in terms of percentage distribution of the modalities in Table 28 and Table 29 (Annex 1 - Tables and graphs), respectively. Table 30 and Table 31 (Annex 1 - Tables and graphs) the results in terms of absolute values (km2) and percentage by NUTS0 of the variables LU are given.
CHAPTER 4

Relevance, assessment of user needs and perceptions

LUCAS provides information for monitoring for a range of socio-environmental challenges, such as land take, soil degradation, environmental impact of agriculture or the degree of landscape fragmentation. More specifically data from LUCAS can be used to help analyse and contribute to the development of various EU policy areas:

<table>
<thead>
<tr>
<th>Common Agricultural Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrating environmental concerns into the Common Agricultural Policy;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil thematic strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protecting the soil, as detailed in the soil thematic strategy;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EU biodiversity strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promoting biodiversity and conservation, through the EU’s biodiversity strategy;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Europe 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouraging the efficient use of resources for sustainable growth, as in the resource-efficient Europe initiative;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Copernicus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land monitoring, spatial planning and resource management, as carried out by the Copernicus earth observation programme;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tackling climate change, through monitoring conducted by the European Environment Agency, as well as actions under the European climate change programme.</td>
</tr>
</tbody>
</table>

LUCAS use includes the microdata, the photos, the soil and the statistical tables produced by Eurostat with the microdata.

In the Commission departments the LUCAS micro data is particularly relevant for modelling as can be seen in the collection of use cases presented on the Eurostat website: http://ec.europa.eu/eurostat/web/lucas/publications/use-cases. Examples presented here include the use of LUCAS data as ground control data for the production, verification and validation of Copernicus products derived from satellite data (Corine Land Cover and High Resolution Layers), modelling in the agricultural field (CAPRI) as well as the production of agri-environmental indicators on soil organic matter and soil erosion (AEI 26: Soil quality – CMEF Impact and Context indicator, AEI
21: Soil erosion – CMEF Impact and Context indicator). Information on soil is relevant for agriculture for the environment and for climate change. Eurostat uses the microdata on land cover and land use to produce statistical tables on this topic for the whole of Europe.

User needs of the Commission departments are regularly assessed and basically confirmed the relevance of the currently collected information. Interest in collecting more information on biodiversity was expressed. This aspect could not be picked up in 2015 but has been integrated in LUCAS 2018.

LUCAS data also provides a rich source of information for the research community and requests for access to the LUCAS photos are regularly received. Micro-data is freely accessible and the access to it is not monitored.
The accuracy is tackled at Eurostat level, by eliminating as much as possible non-sampling errors and by calculating sampling errors. The missing data phenomena is almost negligible in the survey. In case surveyors could not reach the points they were obliged to fill in the field form on the basis of the information that he/she could collect from orthophotos interpretation. Estimates are reliable for areas > 500 Km2.

The following paragraphs report the evaluations carried out on:

- Locational accuracy, in terms of distance of observation of the point during the survey;
- Sampling errors and the coefficients of variations associated to the estimation of LC/LU areas by country and LC/LU;
- Points rejected based on the quality check performed by an external company on a third of the points.

### 5.1 Locational accuracy

The locational accuracy is analysed by considering the distance of the surveyor from the point surveyed.
Figure 13: Distance of observation (meters) of the points by country and average at EU level

Figure 14: Distance of observation (meters) of the points by land cover class

5.2 Points rejected
A data quality check was performed by an external company on around 33% of the points. Since the progress of the survey in the various areas was uneven, the final control rate by country is unequal too. In Table 26 (Annex 1 - Tables and graphs), the rejection rate during the external quality control done by the contractor is given; the ratio can be considered an indirect indication of the quality of the results. The percentage of points refused at least once by country is reported in Figure 15, the two extremes are HR (70% ca.) and BG (less than 10%), the EU average is 25.5%.
5.3 Sampling errors

We can consider having the following data set related to the points surveyed in a particular year:

<table>
<thead>
<tr>
<th>Grouping variable</th>
<th>Observed value of the variable of interest</th>
<th>Strata (from master)</th>
<th>Weight of the record</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

The above variables can be represented, for example, by:

<table>
<thead>
<tr>
<th>Nuts0</th>
<th>Land cover</th>
<th>Strata (from master)</th>
<th>Weight from IPF</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Figure 15: Percentage of points rejected at least once by country
In this case, we considered the *Nuts0* (Country) as the grouping variable, while *Land Cover* is the variable for which the estimates will be produced; in other words we are interested in the estimates of the *Land Cover* for each *Nuts0* and to their associated Coefficients of Variation.

First of all, it has to be noted that the variable *Strata* is not necessary to evaluate such estimations; in fact we have that the percentage of *Land cover* for each *Nuts0* can be obtained just by considering the ratio between the sum of the weights for each type of *Land cover* and the sum of the weights.

By means of a mathematical approach, it is possible to consider:

- To have $1,g,G$ different values of the *Grouping variables* (in the example $1,g,...,G$ different *Nuts0*);
- To have $1,...,n$ records, and for each of these it is known its weight: $w_i$;
- To have $x^1,...,x^j,...,x^J$ different values of the variable of interest (in the example $x^1,...,x^j,...,x^J$ different values of *Land cover*);
- For the single record we can assume to refer to the symbol: $x_i^j$ in order to represent its value of the variable of interest (i.e. the *Land cover* observed in it);
- There are $7$ different strata (derived from the Master): $1,..h,...,7$ (the generic strata is associated to the symbol $h$).

In order to evaluate the relative frequencies of the different land covers for the generic *Nuts0* ($g$), it will be possible to consider the following expression (referring to the value $k \in x^1,...,x^j,...,x^J$ of the *Land cover*):

$$x^k(g) = 100 \times \frac{\sum_{i \in g} w_i (if \ x_i^j = k)}{\sum_{i \in g} w_i}$$

To evaluate the related Coefficient of Variation, it is possible to consider that we will have to refer to the calculation of the variance associated to a frequency.

In the following section we will use to the expression derived from Fattorini et al. (2006) and by considering some information derived from the Master; in particular:

- $N_g$ specifies the number of points related to the generic value $g$ of the grouping variable (in our case the number of points for each *Nuts0*);
- $N_g^k$ the number of points related to the generic value $g$ of the grouping variable and of the $h$ strata;
- $n_g^h$ the number of points related to the generic value $g$ of the grouping variable and of the $h$ strata (observed in the sample).

According to the previous notation, it is possible to represent the Variance of the estimated frequency (for the $k$ value of the variable of interest and for the $g$ value of the grouping variable) with:

$$V[x^k(g)] = \frac{1}{N_g} \left[ \frac{1}{N_g} \sum_{h=1}^{7} N_g^h (N_g^h - 1) x^k(g) (1 - x^k(g)) + \frac{1}{N_g} \sum_{h=1}^{7} N_g^h (x^k(g))^2 - \left( \frac{1}{N_g} \sum_{h=1}^{7} N_g^h x^k(g) \right)^2 \right]$$
Once the variance was evaluated, it will be possible to derive the standard deviation and the coefficient of variation considering:

$$CV^k(g) = 100 \times \frac{\sqrt{\text{Var}(x^k(g))}}{x^k(g)}$$

According to the above methodology, in Annex 1 – Tables 31 and 32 the CVs for estimates of LC and LU (2 digits code) by country are reported, respectively.
The first version of the LUCAS microdata is published the summer after the survey, in this case summer 2016. The first statistical tables are published by the end of that same year.

Successive versions of the microdata and/or the statistics may become available after additional quality controls.
Coherence and comparability

CHAPTER 7

7.1 Coherence

7.1.1 Coherence – cross domain

Coherence of statistics is their adequacy to be reliably combined in different ways and for various uses. Various sources of data currently provide information on land uses and agro-environmental topics. They include area sample surveys conducted by member States, NATURA 2000 maps and Corine Land Cover (CLC) among others. These sources are often not completely coherent with LUCAS data.

While reading the results and comparing them with other sources it is important to have in mind that the LUCAS survey clearly distinguishes between land cover and land use. Despite the effort of harmonization of the definitions, some differences (sometimes not negligible) can be observed when comparing different sources. These differences can be due to the following reasons:

- Different methodologies;
- Certain margin of subjectivity in the application of the definitions;
- The (im)possibility to clearly distinguish between coverage and use in the figures available from other domains;
- Variability of the estimates due to the sampling methodology.

Areas of crops and grassland

All the above explanations apply to the comparison between cropland in LUCAS and the figures on crops coming from other sources within Eurostat (for example the Farm Structure Survey or the Crop Statistics). Since the LUCAS survey collects indeed land cover and land use independently, areas covered by 'grassland' not belonging to farms and not used for agriculture are nonetheless classified as grassland. Note that the 'grassland' might be used as private gardens or public parks, but also for agriculture, sport and other uses. Grassland with agricultural use is an important component of the Utilized Agricultural Area and can be derived from the LUCAS classification by combining land cover and use attributes.
FAO forest definitions

In LUCAS, Woodland has been defined in a way that allows providing estimates compatible with the FAO results. In particular the comparability with FAO forest classification has been strengthened with the inclusion of variables area size, height of trees, width of features and percentage of land cover.

However, differences between the semantic definition of LUCAS wooded areas and FAO forest definitions have to be taken into account: if an area has > 10% of trees (excluding fruit trees in permanent crops) in LUCAS is labeled as "wooded area", FAO take this into account only if it is > than 0.5 Ha. Then, woodland in LUCAS includes: 'Forest' and 'Other wooded land' as defined according to FAO standards and other areas covered by trees not respecting FAO definition.

In addition, a further concern arises from the changes occurred in survey protocol for the 2009, 2012 and 2015 LUCAS campaigns. In fact, variations in the definitions may cause inconsistencies when datasets are compared over time. Therefore, an evaluation of the impacts of these changes on the reported figures at different administrative levels is either beneficial for producer or user of the data.

In 2016, Eurostat carried out an analysis to map LUCAS to FAO forest classes, for the 2009, 2012 and 2015 surveys, by developing a set of rules that allowed relating each LUCAS class containing forest related features to FAO forest classes. Results of the mapping procedure was evaluated for each year by comparing LUCAS and FAO statistics for forest related classes in terms of area at country level and coefficient of variation. In addition, the variations of forestry statistics over time was also computed (Figure 16) by comparing LUCAS results with the statistics released by FAO (FAOSTAT (Domain Inputs/Land) and FAO Forest Resource Assessment (FRA) (2010 and 2015).

Figure 16: (from left to right) Comparison of the average changes per country between LUCAS and FAO for the period 2009-2012 / Comparison of the average changes in the period 2015-2009 and 2015-2010 for the LUCAS and Forest Resource Assessment (FRA) dataset
7.1.2 Coherence – internal

The coherence between the total area of the countries and their split according to land cover and land use is guaranteed by definition. A standardized methodology and classification has been applied in all the countries and from one round to another since the 2006 pilot survey. Therefore the internal coherence is perfectly assured.

7.2 Comparability

Different aspects of comparability have been assessed through:

- Comparison of the main features of 2009, 2012 and 2015 surveys by focussing on the following elements: sample design, sample size, countries involved, sampling unit and data collection method;
- Comparison of the information collected with the previous surveys (comparison of the variables reported in the field forms);
- Comparison of the definition of the variables collected with the previous surveys (information reported in the metadata and/or in the Technical Reference Documents).

In general, the LC/LU classification is comparable with others LC/LU systems (e. FAO, CLC), hence compatibility of the adopted definitions with the main international concepts and definitions is guaranteed. Additional parameters have been introduced where needed to allow the match, while keeping an independency and flexibility in the main item classification. This is the reason why the heading "Total woodland" in LUCAS Statistical classification includes: 'Forest' and 'other wooded area' as defined according to FAO standards and other areas covered by trees not respecting FAO definition.

Table 20 : Main features of the LUCAS survey 2009, 2012 and 2015

<table>
<thead>
<tr>
<th>Item</th>
<th>2009</th>
<th>2012</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference population</td>
<td>EU 23</td>
<td>EU 27</td>
<td>EU 28</td>
</tr>
<tr>
<td>Sampling unit</td>
<td>Point</td>
<td>Point</td>
<td>Point</td>
</tr>
<tr>
<td>Sampling scheme</td>
<td>Two-phase design with stratification</td>
<td>Two-phase design with stratification</td>
<td>Two-phase design with stratification</td>
</tr>
<tr>
<td>First Phase Sample - Master Grid (size)</td>
<td>989,951</td>
<td>1,097,607</td>
<td>-1,091,882</td>
</tr>
<tr>
<td>Second phase sample Field Sample (size) (No. of points surveyed)</td>
<td>234,545</td>
<td>270,260</td>
<td>273,153 + 66.604 (P1)</td>
</tr>
<tr>
<td>Number of MSs involved</td>
<td>23</td>
<td>27</td>
<td>28</td>
</tr>
</tbody>
</table>
## Coherence and comparability

<table>
<thead>
<tr>
<th>Item</th>
<th>2009</th>
<th>2012</th>
<th>2015</th>
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<td>Main information collected</td>
<td>Land Cover/Land Use details (i.e. height of trees, width of feature, plant species and degree of coverage (percentage); soil data; water management information and transect data. Soil)</td>
<td>Land use data; land cover details (i.e. height of trees, width of feature, plant species and degree of coverage (percentage); soil data; water management information and transect data.</td>
<td>Land use data; land cover details (i.e. height of trees, width of feature, plant species and degree of coverage (percentage); soil data; water management information and transect data. soil)</td>
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<td>Information collected walking a transect</td>
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<td>Yes</td>
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<td>Estimator(^{10})</td>
<td>H-T for two phase stratified design with post stratification</td>
<td>H-T for two phase stratified design with post stratification</td>
<td>- H-T for two phase stratified design with post stratification</td>
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### 7.2.1 Comparibility – geographical

The survey is fully harmonized and comparable, since the surveyors use the same methodology in all countries.

### 7.2.2 Comparibility – over time

LUCAS Survey is designed in order to achieve harmonization and comparability among campaigns. For these reasons, Eurostat launched a project in order to overcome the problems of comparability among survey from 2009 onward.

In the last two campaigns, one of the main obstacle for comparing the collected data, were the changes done in 2012 classifications of “land cover” and the solution was to recode the 2009 survey data. In some cases it was sufficient to replace the original 2009 code by the new one in 2012 in a deterministic way. When land use is equal to “hunting”, “nature reserve” and “unused and abandoned areas” and in the same time the land cover is changed, the deterministic mode cannot be applied because the uncertainty of the correction and, hence, a specific procedure was implemented. The new land use is derived from a probabilistic imputation that is a random selection of the code among the three most frequent land use codes, given the related land cover; the probabilities are derived by considering the cross distribution of land cover and the land use for those point in common to 2009 and to 2012 (and the points are restricted only to those that, in 2009, had the land use that will be changed).

The 2015 LUCAS classification is not fundamentally different from the one defined in 2012, the main changes are reported below.

---

\(^{10}\) The estimation method used in 2015 is applied to the back series 2009 and 2012
CHAPTER 7

Coherence and comparability

- New class A30 Other built-up: includes all constructions not covered in the other AXX classes;
- Class B77j was dropped as it referred to "Abandoned citrus orchards" (when abandoned is to be classified as a use) 8 / 93;
- Clarified that turnips (as a root crop) are to be classified as B23e and not B23n. Also that B23 refers to species of turnips planted as root crops as opposed to rape and turnip rape (Brassica rapa var. oleifera) which are planted for their seed;
- Clarified that chervil (Anthriscus cerefolium) mentioned in B37d is the aromatic plant also known as "garden chervil". A previous mention to chervil in B43b was removed, as it referred to the root crop B23l - tuberous chervil;
- Clarified that B43f corresponds to cultivated mushrooms (including all cultivated truffle) whereas B43g refers to the collection of wild products (truffles in the wild included);
- B83 Nurseries now includes also forest nurseries. Sub-classification (B83a..f) was created for specialized nursery types;
- Cropland, and namely energy crops (B84) are no longer linked to U210 Energy production;
- Harmonization of the woodland definition: in 2012 CXX included forest nurseries (now to be classified under B83) and young plantations, even if they do not reach a canopy of 10%. In order to have a coherent definition, areas below 10% of trees are to be classified according to the existing land cover;
- Disaggregation of G10 - Inland water bodies into classes G11 - Inland fresh water bodies and G12 - Inland salty water bodies in order to better map to INSPIRE PLC C classes (namely PLCC 017 – Salty waters, which includes inland salty lakes);
- Disaggregation of G20 - Inland running water into classes G21 - Inland fresh running water and G22 - Inland salty running water in order to better map to INSPIRE PLCC classes (namely PLCC 017 – Salty waters);
- Renaming of G30 - Coastal waters to G30 - Transitional waters, since in LUCAS coastal waters (also known as "open sea") are not relevant. In fact, the definition for G30 in 2012 was already compatible with the definition for transitional waters under the Water Framework Directive (Directive 2000/60/EC).

Main changes for land use are the following:

- All NACE categories have been covered;
- U111 Agriculture no longer includes NACE 81.3 Landscape care and maintenance (which is now included in U342);
- U120 Forestry now explicitly includes extraction of cork (cork oak trees);
- U130 Fishing refers only to commercial fishing;
- New class U150 Other primary production;
- For all industrial activities (U22X) it has been specified in which main INSPIRE category it has to be included: raw industry, heavy end product industry or light end product industry (Land use type);
- U226 Machinery and equipment now includes also wooden furniture (formerly U227) and excludes reproduction of recorded media (now U228);
• U227 no longer includes printing and reproduction (now U228), nor manufacture of furniture (U226);
• New class U228 Printing and reproduction (includes NACE 18 and NACE 58);
• Docks are part of the specific transport sector they belong to, as other related infrastructure (they were an exception before and were excluded from the specific transport sector);
• New class U319 Electricity, gas and thermal power distribution (includes parts previously included in U210 Energy production, as far as the network is concerned);
• Split class U340 into U341 Commerce and U342 Financial, professional and information services;
• Included class U363 Holiday camps into U341 Commerce.
All the microdata as well as the statistical tables produced can be accessed via the Eurostat website, either directly, or if this is not possible, the website provides further information on how to access the data.

The microdata is accessible here:


and the photos can be ordered here:


Statistical data can be downloaded here:


A LUCAS photo viewer allows to visualize maps of the data:


EEA. CORINE Land Cover project. Available at: http://www.eea.europa.eu/publications/COR0-landcover


INSPIRE. Available at: http://inspire.ec.europa.eu/about-inspire/563


### Table 21: Number of points of the Master by STRATA and NUTS0 with the difference between the number of points belonging to country and NUTS0

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<th>Grassland</th>
<th>Wooded areas and shrubland</th>
<th>Bare land, low or rare vegetation</th>
<th>Artificial land</th>
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## Annex 1: tables and graphs

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### Table 22: Average number of points per surveyor by country

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### Annex 1: tables and graphs

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Table 23: Number of points selected by country and Strata

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<th>Woodland and Shrubland</th>
<th>Bare Land</th>
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## Annex 1: tables and graphs

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## Annex 1: tables and graphs

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### Annex 1: tables and graphs

#### Table 28: Land cover estimates by NUTS0 (absolute values - km²)

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**Note:** The totals for each NUTS0 region are rounded to the nearest integer.
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Annex 1: tables and graphs
Table 29: Land cover estimates by NUTS0 (percentages)

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<th>D</th>
<th>E</th>
<th>F</th>
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**Annex 1: tables and graphs**

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### Table 30: Land use estimation by NUTS0 (absolute values km²)

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Table 31: Land use estimates by NUTS0 (percentages)

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Table 32: Coefficient of Variations (CVs) relative to the estimates of LC by country

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<th>SHRUBLAND D</th>
<th>GRASSLAND E</th>
<th>BARE LAND AND LICHENS F</th>
<th>WATER AREAS G</th>
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### Annex 1: tables and graphs

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### Table 33: Coefficient of Variations (CVs) relative to the estimates of LU by country

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### Annex 1: tables and graphs

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## Annex 2: Description of the surveyed parameters

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<tr>
<th>Items to be filled in (including the item number in the field form)</th>
<th>Observed feature (including the code in the field form)</th>
<th>Short explanation / description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveyor ID (A)</td>
<td>Value (Char 8)</td>
<td>Unique identity code of surveyor. To be defined by contractors, according to rules.</td>
</tr>
<tr>
<td>Point ID (B)</td>
<td>Value (Char 8)</td>
<td>Unique code of the point as provided by Eurostat.</td>
</tr>
</tbody>
</table>

### Access to point

<table>
<thead>
<tr>
<th>Access to point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date (1)</td>
<td>DD/MM (e.g. 25/03)</td>
</tr>
<tr>
<td>Start time (2)</td>
<td>HH/mm (e.g. 14:02)</td>
</tr>
<tr>
<td>End time (3)</td>
<td>HH/mm (e.g. 14:50 h)</td>
</tr>
<tr>
<td>Car park latitude (4)</td>
<td>DD.dddddd</td>
</tr>
<tr>
<td>Car park longitude (5</td>
<td>6)</td>
</tr>
<tr>
<td>Type of observation (7)</td>
<td>(1) Field survey, Point visible, ≤ 100 m</td>
</tr>
<tr>
<td></td>
<td>Parcel with survey point</td>
</tr>
<tr>
<td></td>
<td>Surveyors position</td>
</tr>
<tr>
<td></td>
<td>Distance surveyor – survey point</td>
</tr>
<tr>
<td></td>
<td>(2) Field survey</td>
</tr>
<tr>
<td></td>
<td>Point visible, &gt;100 m</td>
</tr>
<tr>
<td></td>
<td>Fence, barrier, high crop</td>
</tr>
</tbody>
</table>
Annex 2: Description of the surveyed parameters

<table>
<thead>
<tr>
<th>(3) Photointerpretation, Point not visible</th>
<th>If the point is not accessible and not visible in the field (e.g. the point is located in a large inaccessible forest), an interpretation over the orthophoto has to be done in the field. It is also important to indicate if the surveyor notices major differences (e.g. outdated orthophoto) between the land cover and the orthophotos. Those should be noted in the remarks field. If point is photo interpreted, the reason needs to be noted in the remarks (fence, high crop, etc.).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence, barrier, high crop, hedge etc. impeding the point observation</td>
<td>Point not visible</td>
</tr>
<tr>
<td>(4) Point not observed Photointerpretation not possible</td>
<td>If the point is not accessible in the field (e.g. located in forbidden zone) or the parcel with the point location in it is not visible, and no photointerpretation can be done (no orthophotos or bad quality orthophoto; land cover/use cannot be recorded) the point is coded as not observed. If point is not observed because of inaccessibility, orthophoto unavailability or bad quality, the reason needs to be noted in the remarks.</td>
</tr>
<tr>
<td>(5) Marine sea</td>
<td>The point is located in marine sea.</td>
</tr>
<tr>
<td>(6) Out of national territory</td>
<td>The point is located out of the national territory.</td>
</tr>
<tr>
<td>GPS coordinate system (8)</td>
<td>Normal functioning of GPS using “WGS 84” as coordinate system.</td>
</tr>
<tr>
<td>(1) WGS84</td>
<td>No signal, or bad reception. The reason needs to be noted in the remarks.</td>
</tr>
<tr>
<td>(2) Problem with signal</td>
<td>GPS was not used. The reason needs to be noted in the remarks.</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>GPS was not used. The reason needs to be noted in the remarks.</td>
</tr>
<tr>
<td>Point latitude (9)</td>
<td>GPS position of the location from which observation is done (WGS84)</td>
</tr>
<tr>
<td>DD.dddddd</td>
<td>---</td>
</tr>
</tbody>
</table>
Annex 2: Description of the surveyed parameters

| Point longitude (10 | 11) | W/E DD.dddddd | GPS position of the location from which observation is done (WGS84) |
|-----------------------|--------------|---------------------------------------------------------------|
| Elevation (12)        | Value (in m) | GPS value of elevation of the location from which observation is done (in meters above sea level). |
| Precision (13)        | Value (in m) | Indication of average location error as given by GPS receiver (in meters). |
| Distance to the point (14) | Value (in m) | Indication of the distance between observation location and the LUCAS point as provided by the GPS receiver (in meters). |

**Comments on the way to the point**

<table>
<thead>
<tr>
<th>Description of the way to the point (15)</th>
<th>Structured comments</th>
<th>Free text comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If the point can be accessed without any problem, a specific comment is not necessary. However, in all cases where the way to the point was hampered (long distance to walk), a short comment should be given (proposals for an easier approach to the point etc.). This information helps during the next survey and explains for example the effort required to reach the point (duration of the observation). The structured comments should be used whenever possible. For free text the use of English is mandatory. Special characters are to be avoided.</td>
<td></td>
</tr>
</tbody>
</table>

**Point observation**

<table>
<thead>
<tr>
<th>Remarks about point observation (15)</th>
<th>Structured comments</th>
<th>Free text comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Possible remarks are linked to: Problems in the exact location of the point (radical changes in the field compared to the orthophoto, lack of adequate landmarks for orientation, loss of the GPS signal, wrong instructions from the previous survey, etc.), Restricted access to the point, The necessity to make the observation from far away, Point is photo interpreted, Problems in the coding of land cover or land use (e.g. crop recognition etc.). All such short comments should help to explain why the surveyor has taken a certain decision. For free text the use of English is mandatory. Special characters are to be avoided.</td>
<td></td>
</tr>
</tbody>
</table>
## Annex 2: Description of the surveyed parameters

### Land cover and land use

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction (17)</strong></td>
<td></td>
</tr>
<tr>
<td>(1) On the point</td>
<td>Point regularly observed.</td>
</tr>
<tr>
<td>(2) North</td>
<td>“Look to the North” rule is applied if the point is located on a boundary/edge or a small linear feature (&lt;3 m wide).</td>
</tr>
<tr>
<td>(3) East</td>
<td>“Look to the East” rule is applied if the point is located on a boundary/edge or a small linear feature (&lt;3 m wide) directed North/South.</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radius (18)</strong></td>
<td></td>
</tr>
<tr>
<td>(1) 1.5 m</td>
<td>Simple observation of LC within a radius of 1.5 m.</td>
</tr>
<tr>
<td>(2) 20 m</td>
<td>The extended observation window (20 m radius)</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parcel area (in ha) (19)</strong></td>
<td></td>
</tr>
<tr>
<td>(1) Area &lt; 0.5</td>
<td>Size of the observed parcel is smaller than 0.5 ha.</td>
</tr>
<tr>
<td>(2) 0.5 ≤ area &lt; 1</td>
<td>Size of the observed parcel ranges between 0.5 and 1 ha.</td>
</tr>
<tr>
<td>(3) 1 ≤ area &lt; 10</td>
<td>Size of the observed parcel ranges between 1 and 10 ha.</td>
</tr>
<tr>
<td>(4) Area ≥ 10</td>
<td>Size of the observed parcel is larger than 10 ha.</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land cover 1 (20)</strong></td>
<td>Land cover code</td>
</tr>
<tr>
<td></td>
<td>Coding of land cover according to LUCAS SU LC 2015 classification. BX1 or BX2 are only possible for points with observation type (17) = 3 (photo interpreted)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land cover 1 Plant species (21)</strong></td>
<td>BXXn CXXn</td>
</tr>
<tr>
<td></td>
<td>To be filled for crops (LC1=BXX) classified as “other” in LC1, and also for nurseries (see Annexes and Document C3 for code lists). Also to be filled for Forest Types (LC1=CXX), when parcel area (19) ≥0.5 ha, height of the trees at maturity (27) is above 5 meters and the width of the feature (28) is wider than 20m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of LC1 (22)</strong></td>
<td></td>
</tr>
<tr>
<td>(1) %LC1 &lt; 5%</td>
<td>Coverage of LC1 is less than 5%.</td>
</tr>
<tr>
<td>(2) 5 ≤ % LC1 &lt; 10</td>
<td>Coverage of LC1 ranges between 5%</td>
</tr>
<tr>
<td>Description of the surveyed parameters</td>
<td>Percentage of LC2 (25)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>(1) %LC2 &lt; 5%</td>
<td>Coverage of LC2 is less than 5%</td>
</tr>
<tr>
<td>(2) 5 ≤ % LC2 &lt; 10</td>
<td>Coverage of LC2 ranges between 5% and &lt;10%</td>
</tr>
<tr>
<td>(3) 10 ≤ %LC2 &lt; 25</td>
<td>Coverage of LC2 ranges between 10% and &lt;25%</td>
</tr>
<tr>
<td>(4) 25 ≤ %LC2 &lt; 50</td>
<td>Coverage of LC2 ranges between 25% and &lt;50%</td>
</tr>
<tr>
<td>(5) 50 ≤ %LC2 &lt; 75</td>
<td>Coverage of LC2 ranges between 50% and &lt;75%</td>
</tr>
<tr>
<td>(6) 75 ≤ %LC2 &lt; 90</td>
<td>Coverage of LC2 ranges between 75% and &lt;90%</td>
</tr>
<tr>
<td>(7) %LC2 ≥ 90</td>
<td>Coverage of LC2 is 90% or more</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>If not applicable</td>
</tr>
</tbody>
</table>

### Land cover 2 (23)

**Land cover code**

A second cover can be registered if necessary.

### Plant species (24)

**BXXn**

To be filled for crops (LC1=BXX) classified as “other” in LC1

### Height of trees at the moment of survey (26)

<table>
<thead>
<tr>
<th>Height of trees at the moment of survey (26)</th>
<th>(1) &lt; 5m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applicable only in case area size ≥0.5ha and if the LC is CXX or D10 or E10, assess the height of the trees at the moment of the survey.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Height of trees at maturity (27)</th>
<th>(1) &lt; 5m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applicable only in case area size ≥0.5ha and if the LC is CXX or D10 or E10, assess the height of the trees at maturity.</td>
</tr>
</tbody>
</table>
## Annex 2: Description of the surveyed parameters

### Width of feature (28)

<table>
<thead>
<tr>
<th>Width</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20m</td>
<td>If LC is CX, D10 or E10, the area size ≥0.5 ha and height of trees at maturity is above 5 m, assess the width of the feature.</td>
</tr>
<tr>
<td>≥ 20m</td>
<td></td>
</tr>
</tbody>
</table>

### Land use 1 (29)

<table>
<thead>
<tr>
<th>Land use code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U22Xn</td>
<td>To be filled for the secondary sector (LU1=U22X) and for transport via pipelines (LU1=U315)</td>
</tr>
</tbody>
</table>

### Percentage of LU1 (31)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5%</td>
<td>Coverage of LU1 is less than 5%.</td>
</tr>
<tr>
<td>5 ≤ %LU1 &lt; 10</td>
<td>Coverage of LU1 ranges between 5% and &lt;10%.</td>
</tr>
<tr>
<td>10 ≤ %LU1 &lt; 25</td>
<td>Coverage of LU1 ranges between 10% and &lt;25%.</td>
</tr>
<tr>
<td>25 ≤ %LU1 &lt; 50</td>
<td>Coverage of LU1 ranges between 25% and &lt;50%.</td>
</tr>
<tr>
<td>50 ≤ %LU1 &lt; 75</td>
<td>Coverage of LU1 ranges between 50% and &lt;75%.</td>
</tr>
<tr>
<td>75 ≤ %LU1 &lt; 90</td>
<td>Coverage of LU1 ranges between 75% and &lt;90%.</td>
</tr>
<tr>
<td>≥ 90%</td>
<td>Coverage of LU1 is 90% or more.</td>
</tr>
<tr>
<td>Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

### Land use 2 (32)

<table>
<thead>
<tr>
<th>Land use code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U22Xn</td>
<td>To be filled for the secondary sector (LU2=U22X) and for transport via pipelines (LU2=U315)</td>
</tr>
</tbody>
</table>

### Percentage of LU2 (34)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5%</td>
<td>Coverage of LU2 is less than 5%.</td>
</tr>
<tr>
<td>5 ≤ %LU2 &lt; 10</td>
<td>Coverage of LU2 ranges between 5% and &lt;10%.</td>
</tr>
<tr>
<td>10 ≤ %LU2 &lt; 25</td>
<td>Coverage of LU2 ranges between 10% and &lt;25%.</td>
</tr>
<tr>
<td>25 ≤ %LU2 &lt; 50</td>
<td>Coverage of LU2 ranges between 25% and &lt;50%.</td>
</tr>
</tbody>
</table>
### Annex 2: Description of the surveyed parameters

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(5)</td>
<td>50 ≤ %LU2 &lt; 75</td>
<td>Coverage of LU2 ranges between 50% and &lt;75%.</td>
</tr>
<tr>
<td>(6)</td>
<td>75 ≤ %LU2 &lt; 90</td>
<td>Coverage of LU2 ranges between 75% and &lt;90%.</td>
</tr>
<tr>
<td>(7)</td>
<td>%LU2 ≥ 90</td>
<td>Coverage of LU2 is 90% or more.</td>
</tr>
<tr>
<td>(8)</td>
<td>Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

### Land management, special status and special remarks on land cover/use

<table>
<thead>
<tr>
<th>Land management (35)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Visible signs of grazing</td>
<td>If signs of permanent or occasional grazing of the parcel can be found (e.g. animal tracks).</td>
<td></td>
</tr>
<tr>
<td>(2) No signs of grazing</td>
<td>No signs of grazing can be found on the parcel. Note that this is the parcel where the area is assessed, not the homogeneous plot within the expended window.</td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special Status (31)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Protected</td>
<td>If the area is protected under a special regulation on nature conservation, (e.g. NATURA2000, national schemes). Either signs are visible or local knowledge of the surveyor has to be applied.</td>
<td></td>
</tr>
<tr>
<td>(2) Hunting</td>
<td>If signs of hunting are visible (e.g. hunting reserve signals, signs of hunting, fences around forests, feeding of game, shooting towers, etc.)</td>
<td></td>
</tr>
<tr>
<td>(3) Protected and Hunting</td>
<td>If signs of both special status are visible</td>
<td></td>
</tr>
<tr>
<td>(4) No special status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special remark on land cover / land use (37)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Tilled and/or sowed</td>
<td>THIS REMARK IS FOR THE REGIONAL / CENTRAL OFFICE: If the parcel is tilled and/or sowed and the crop cannot be recognised: the surveyor has to re-visit the point!</td>
<td></td>
</tr>
<tr>
<td>(2) Harvested Field</td>
<td>The field has been harvested during the current season and the crop is not recognisable by residuals. In that case, LC=F40 and LU= U111</td>
<td></td>
</tr>
<tr>
<td>(3) Clear Cut</td>
<td>If most of trees have been cut down uniformly. In this case LC = DXX or EXX or FXX and LU = U120</td>
<td></td>
</tr>
</tbody>
</table>
(4) Burnt Area  | Refers to a burnt area in any LC. Signs of fire need to be observed. The land cover observed is to be noted.

(5) Fire Break  | Man-made gaps in vegetation (cropland, woodland/forests, grassland, shrub land) in order to stop fires.

(6) Nursery  | Refers to nurseries under forestry use, normally found on forest areas that are classified as LC = CXX and LU = U120. Note that this is different from specialized forest nurseries (B83f).

(7) No remark

(8) Not relevant  | If not applicable.

(9) Temporarily dry  | Applies to river beds and lakes which are temporarily dry (lower water level). Normally the limit of the water level should be visible.

(10) Temporarily flooded  | Applies to areas that are flooded at the time of the visit.

**INSPIRE Pure Land Cover Classes**

| (38) Coniferous forest trees | Value (0-100%) in steps of 5%  | Assess the percentage of coniferous trees |
| (39) Broadleaved forest trees | Value (0-100%) in steps of 5%  | Assess the percentage of broadleaved trees |
| (40) Shrubs | Value (0-100%) in steps of 5%  | Assess the percentage of shrubs |
| (41) Herbaceous plants | Value (0-100%) in steps of 5%  | Assess the percentage of herbaceous plants |
| (42) Lichens and mosses | Value (0-100%) in steps of 5%  | Assess the percentage of lichens and mosses |
| (43) Consolidated (bare) surface | Value (0-100%) in steps of 5%  | Assess the percentage of consolidated (bare) surface (e.g. rock outcrops) |
| (44) Unconsolidated (bare) surface | Value (0-100%) in steps of 5%  | Assess the percentage of unconsolidated (bare) surface (e.g. sand) |
| (45) Other | Value (0-100%) in steps of 5%  | Sum of all classes must be 100%. This field covers for the difference, if it exists. |

**Water management on the field**
### Presence of water management (46)

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Irrigation</td>
<td>Indicate if irrigation is present. Irrigation is the process of supplying water to crops by ditches, pipes, sprinklers, or other conduits and conveyances.</td>
</tr>
<tr>
<td>(2) Potential irrigation</td>
<td>When the field is not irrigated but evidence exists that it will be irrigated in the present year, or of having been irrigated during at least the previous years.</td>
</tr>
<tr>
<td>(3) Drainage</td>
<td>Drainage is the removal of excess surface water or groundwater from land by means of ditches, or subsurface drains (if recognizable). Drainage has only to be noted if the ditch bordering the field is linked to the drainage of the field itself and not e.g. only to a road situated next to the field. No photo is needed.</td>
</tr>
<tr>
<td>(4) Irrigation and drainage</td>
<td>Irrigation and drainage are present.</td>
</tr>
<tr>
<td>(5) No visible water management</td>
<td>No visible signs of drainage or irrigation.</td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td>If not applicable. No irrigation photo to be taken.</td>
</tr>
</tbody>
</table>

### Type of irrigation (47)

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Gravity</td>
<td>Water is delivered to the farm and/or field by canals or pipelines open to the atmosphere and water is distributed by the force of gravity down the field by: - Surface irrigation system (border, basin, furrow, corrugation, wild flooding, etc.) or - Subsurface irrigation pipelines or ditches.</td>
</tr>
<tr>
<td>(2) Pressure: Sprinkle irrigation</td>
<td>Water is delivered to the farm and/or field in pump or elevation induced pressure pipelines and water is distributed across the field by sprinklers (centre pivot, linear move, traveling gun, side roll, hand move, big gun, or fixed set sprinklers).</td>
</tr>
<tr>
<td>(3) Pressure: Micro-irrigation</td>
<td>Water is delivered to the farm and/or field by pressure and distributed across the field by micro-irrigation (drip emitters, continuous tube bubblers, micro spray, or micro sprinklers).</td>
</tr>
<tr>
<td>(4) Gravity/Pressure</td>
<td>Farm delivery and field distribution of irrigation water are a combination of gravity and pressure.</td>
</tr>
</tbody>
</table>
facilities. For example, a valve is used to reduce pressurized water delivered to a farm or field for subsequent distribution by a gravity surface irrigation system.

<table>
<thead>
<tr>
<th>Source of irrigation (48)</th>
<th>(1) Well</th>
<th>A hole drilled or bored into the earth providing access to water.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2) Pond/Lake/Reservoir</td>
<td>Still water</td>
</tr>
<tr>
<td></td>
<td>(3) Stream/Canal/Ditch</td>
<td>Running water</td>
</tr>
<tr>
<td></td>
<td>(4) Lagoon/Wastewater</td>
<td>Wastewater</td>
</tr>
<tr>
<td></td>
<td>(5) Other/not identifiable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Delivery system (49)</th>
<th>(1) Canal</th>
<th>An artificial waterway used for irrigation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2) Ditch</td>
<td>A long, narrow trench or furrow dug in the ground, as for irrigation.</td>
</tr>
<tr>
<td></td>
<td>(3) Pipeline</td>
<td>A conduit of pipe used for the conveyance of water.</td>
</tr>
<tr>
<td></td>
<td>(5) Other/not identifiable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil</th>
<th>Is this a soil point? (D)</th>
<th>Indicate whether a point is to be considered for soil collection (Yes) or not (No)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes/No (pre-filled)</td>
<td>If point belongs to triplet (D = Yes) and the soil sample was taken.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Not possible if point belongs to triplet (D = Yes) and it is not possible to collect the soil sample (e.g. point not visible, LU &lt;&gt; U111 or U112, or near a road).</td>
</tr>
<tr>
<td></td>
<td>(3) No, already taken</td>
<td>If point belongs to triplet (D = Yes) but the sample was collected in another point previously visited.</td>
</tr>
<tr>
<td></td>
<td>(4) No sample required</td>
<td>If point does not belong to triplet (D = No)</td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
</tbody>
</table>
### Annex 2: Description of the surveyed parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (Char 5)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil label (51)</td>
<td>Value (Char 5)</td>
<td>The number of the label placed on the plastic bag with the topsoil sample.</td>
</tr>
<tr>
<td>Signs of ploughing (52)</td>
<td>(1) Yes</td>
<td>If there are signs of ploughing in the parcel.</td>
</tr>
<tr>
<td></td>
<td>(2) No</td>
<td>If there are no signs of ploughing in the parcel.</td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable.</td>
</tr>
<tr>
<td>Percentage of residual vegetation on the surface (53)</td>
<td>(1) %RC &lt; 10%</td>
<td>If residual vegetation in the surface (assessed on the soil point: 2m radius circle) are less than 10%</td>
</tr>
<tr>
<td></td>
<td>(2) 10 ≤ %RC &lt; 25</td>
<td>If residual vegetation in the surface (assessed on the soil point: 2m radius circle) ranges between 10% and &lt; 25%</td>
</tr>
<tr>
<td></td>
<td>(3) 25 ≤ %RC &lt; 50</td>
<td>If residual vegetation in the surface (assessed on the soil point: 2m radius circle) ranges between 25% and &lt; 50%</td>
</tr>
<tr>
<td></td>
<td>(4) %RC ≥ 50</td>
<td>If residual vegetation in the surface (assessed on the soil point: 2m radius circle) cover 50 % or more</td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td></td>
</tr>
<tr>
<td>Percentage of stones on the surface (54)</td>
<td>(1) %S &lt; 10%</td>
<td>If stones on the surface (assessed on the soil point: 2m radius circle) are less than 10%</td>
</tr>
<tr>
<td></td>
<td>(2) 10 ≤ %S &lt; 25</td>
<td>If stones on the surface (assessed on the soil point: 2m radius circle) range between 10% and &lt; 25%</td>
</tr>
<tr>
<td></td>
<td>(3) 25 ≤ %S &lt; 50</td>
<td>If stones on the surface (assessed on the soil point: 2m radius circle) range between 25% and &lt; 50%</td>
</tr>
<tr>
<td></td>
<td>(4) %S ≥ 50</td>
<td>If stones on the surface (assessed on the soil point: 2m radius circle) cover 50 % or more</td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td></td>
</tr>
<tr>
<td>Remarks on soil (55)</td>
<td>Structured comments</td>
<td>For free text the use of English is mandatory. Special characters are to be avoided.</td>
</tr>
<tr>
<td></td>
<td>Free text comments</td>
<td></td>
</tr>
<tr>
<td>Transect (56)</td>
<td>Transect codes</td>
<td>All LC codifications possible (except AXX codes, which are marked as &quot;A&quot;).</td>
</tr>
</tbody>
</table>
For all land cover areas ≥ 3 m, use relevant land cover codifications (A, BXX, CXX, DXX, EXX, FXX, GXX, HXX). Coding of linear elements below 3 m, irrespective their width (if not stated otherwise), has to be listed according to the linear feature codes (LUCAS 2015 SU LF).

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>First entry = LC1 (+ LC2)</td>
<td>Normally the transect starts with the LC1 of the point and LC2 (if existing) is the next entry. Nevertheless there are exceptions to this general rule (e.g. if the “look to the North/East” rule was applied and LC1 does not exist to the East of the point, or for certain codes, like AXX, roads and railways).</td>
</tr>
<tr>
<td>First entry = Linear Feature code (LF)</td>
<td>In case the rule “Look to North/East” was applied due to linear feature: 1st entry will be the linear feature code (one or more, as appropriate). In case of roads and railways, the LF code is used even if they are more than 3m wide. Following codes may not include LC1 (this can happen in case the “Look to the North” rule was applied and the LC1 does not exist to the East of the point).</td>
</tr>
<tr>
<td>First entry = B</td>
<td>If no transect has been mapped and the point has been surveyed, explain in remarks (57) why the transect could not be mapped.</td>
</tr>
<tr>
<td>Following entries</td>
<td>Use the transect codes as appropriate. Be aware of exceptions (e.g. roads and railways are always classified as linear features; rivers and streams are always coded, even if within the urban (“A”) areas).</td>
</tr>
<tr>
<td>Entry = PI</td>
<td>Use this code when photointerpretation of a not accessible part of the transect starts and when it ends.</td>
</tr>
<tr>
<td>Entry = BX1 or BX2</td>
<td>When photo interpreting, use BX1 or BX2 for temporary and permanent crops (respectively) if the crop cannot be identified.</td>
</tr>
<tr>
<td>Entry = Z</td>
<td>Use this code if a part of the transect cannot be seen nor photo interpreted (e.g. part of the image is covered by a cloud). Must be used always between the PI tags</td>
</tr>
</tbody>
</table>
## Annex 2: Description of the surveyed parameters

### Last entry = X

Transect could not be finished. Explain in remarks (57) why transect could not be finished.

### Remarks about the transect (57)

<table>
<thead>
<tr>
<th>Remarks about the transect (57)</th>
<th>Structured comments</th>
<th>Free text comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whenever the transect had been (totally or partly) photo interpreted, could not be finished or had not been mapped at all, the reasons have to be noted here. For free text the use of English is mandatory. Special characters are to be avoided.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Photo of the Point (58)

<table>
<thead>
<tr>
<th>Photo of the Point (58)</th>
<th>(1) Photo taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>The photo of the point is needed to find the point in the next survey. Therefore the photo should contain a recognisable and stable landmark. Use the flag when the point is reached. Never use the flag when the point is observed at more than 100m. The point photo is not to be taken when the point is PI.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(2) Photo not taken</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>(8) Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>If not applicable. It is the case of a point not observed or photo interpreted.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Yes/No) To be anonymized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tick the box if in the photo there are either people or vehicle license plates (including the plates of the surveyors’ car!).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Value) Photo ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
</tbody>
</table>

### Photo of Crop/Cover (59)

<table>
<thead>
<tr>
<th>Photo of Crop/Cover (59)</th>
<th>(1) Photo taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo of the crop/cover should allow the identification of the crop and its phenological stage or the land cover. An adequate zoom (or macro) should be selected.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(2) Photo not taken</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>(8) Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>If not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Yes/No) To be anonymized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tick the box if in the photo there are either people or vehicle license plates (including the plates of the surveyors’ car!).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Value) Photo ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
</tbody>
</table>
Annex 2: Description of the surveyed parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Photo taken</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (60) East (61) South (62) West (63)</td>
<td>(1) Photo taken</td>
<td>The landscape photos have to be taken in the four cardinal directions. The obligatory sequence (N-E-S-W) has to be respected.</td>
</tr>
<tr>
<td></td>
<td>(2) Photo not taken</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable (e.g. in the case the point is not observed)</td>
</tr>
<tr>
<td></td>
<td>(Yes/No) To be anonymized</td>
<td>Tick the box if in the photo there are either people or vehicle license plates (including the plates of the surveyors’ car!).</td>
</tr>
<tr>
<td></td>
<td>(Value) Photo ID</td>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
<tr>
<td>Photo of Irrigation (64)</td>
<td>(1) Photo taken</td>
<td>Photo of the irrigation system should allow its identification.</td>
</tr>
<tr>
<td></td>
<td>(2) Photo not taken</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable (e.g. in case point is not observed or LU is other than U111 or 112, or no irrigation equipment is visible from the observation point)</td>
</tr>
<tr>
<td></td>
<td>(Yes/No) To be anonymized</td>
<td>Tick the box if in the photo there are either people or vehicle license plates (including the plates of the surveyors’ car!).</td>
</tr>
<tr>
<td></td>
<td>(Value) Photo ID</td>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
<tr>
<td>Photo of transect (65)</td>
<td>(1) Photo taken</td>
<td>Photo of the transect has to be taken towards the LUCAS point.</td>
</tr>
<tr>
<td></td>
<td>(2) Photo not taken</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) Not relevant</td>
<td>If not applicable (e.g. if the point was not observed or the transect was completely photo interpreted)</td>
</tr>
<tr>
<td></td>
<td>(Yes/No) To be anonymized</td>
<td>Tick the box if in the photo there are either people or vehicle license plates (including the plates of the surveyors’ car!).</td>
</tr>
<tr>
<td></td>
<td>(Value) Photo ID</td>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
</tbody>
</table>
### Annex 2: Description of the surveyed parameters

<table>
<thead>
<tr>
<th>Photo of soil (66)</th>
<th>(1) Photo taken</th>
<th>In case a topsoil sample has been taken, take a photo of the LUCAS point with the bag and as many as possible of the 5 holes clearly visible.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Photo not taken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Not relevant</td>
<td></td>
<td>If not applicable.</td>
</tr>
<tr>
<td>(Yes/No) To be anonymized</td>
<td></td>
<td>Tick the box if in the photo there are either people or vehicle license plates.</td>
</tr>
<tr>
<td>(Value) Photo ID</td>
<td></td>
<td>File name (in the camera). This information is for use as reference by the surveyor. The renaming of the photos by DMT is automatic.</td>
</tr>
</tbody>
</table>

### Additional photos (67)

| Type of photo | These additional pictures can be used to illustrate conflict (why a point has not been reached) or complement the mandatory photos. Types can be: point access, point observation, land cover, land use, transect, soil, water management or other |

### Remarks about photos (68)

| Structured comments | Whenever there were problems in taking of photos the reasons have to be noted here. For free text the use of English is mandatory. Special characters are to be avoided. |
| Free text comments   |                                                                                                                                                                                                 |
Annex 3: Ongoing tasks for the validation of LUCAS’s microdata

Data Validation is an activity verifying whether or not a combination of values is a member of a set of acceptable combinations. (in "Methodology for data validation")

According to the authors, the set of 'acceptable values' may be a set of possible values for a single field. But under this definition it may also be a set of valid value combinations for a record, column, or larger collection of data. We emphasize that the set of acceptable values does not need to be defined extensively. This broad definition of data is introduced to make data validation refer both to micro and macro (aggregated) data. Data validation assesses the plausibility of data: a positive outcome will not guarantee that the data is correct, but a negative outcome will guarantee that the data is incorrect.

The relation with statistical data editing must be clarified. In the Generic Statistical Business Process Model (GSBPM) the process ‘Validate and Review’ is distinguished from the process ‘Edit and Impute’. In the ‘Validate and review phase’ there is data validation as it is previously described, while in the ‘edit and impute phase’ it is placed the action of ‘changing data’. This is the idea underlying the validation definition. (in "Methodology for data validation").

Figure 17: Validation steps according to the ESSNET Validation Manual

Level 0: consistency of the data with their expected IT requirements

For these quality checks only the structure of the file or the format of the variables is necessary as input and no data checks are performed.

<table>
<thead>
<tr>
<th></th>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the file has been sent/prepared by the</td>
<td>Y</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>authorised authority (data sender);</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the column separator / end of record</td>
<td>Y</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>symbol are correctly used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the file has the expected number of</td>
<td>Y</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>columns (agreed format of the file)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the column have the expected format of</td>
<td>Y</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>the data (i.e., alphanumeric, numeric,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the file complies to the naming</td>
<td>Y</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>convention (original)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the file complies to the naming</td>
<td>pending</td>
<td>No naming convention was defined for derived datasets</td>
<td>Define naming convention for derived datasets</td>
</tr>
<tr>
<td>convention (derived datasets)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Level 1: consistency within the data set

Only the (statistical) information included in the file itself is needed. During the LUCAS Survey data collection, the DMT Tool already includes 218 embedded checks. This increases the quality of the data by avoiding systematic errors.

<table>
<thead>
<tr>
<th></th>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records conform to the latest</td>
<td>Pending</td>
<td>Presently not all points have been checked against the latest version of the business rules (U:\LUCAS\010 CONTRACTS\2014\08444.2014.002-2014.408-LUCAS2015-LOT7-A1\003-FollowUp\004-Deliverables\Contrls\LUCAS_DMT_PARAMETER_20160301_19.md). It is known to which version a point was checked against.</td>
<td>A full check has to be run on all records.</td>
</tr>
<tr>
<td>business checks included in the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMT Client Business rules (v.1.1.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the records conform to the checks</td>
<td>Pending</td>
<td>Presently only a minor part of the 149 [update 2016.10.17] bulk checks needed which were identified in the log was performed. U:\LUCAS\010 CONTRACTS\2014\08444.2014.002-2014.000-LUCAS2015\010-QualityChecks\24.Issue_Log.LUCAS2015_ESTATQC.20150618.xlsx</td>
<td>Prioritize, classify (see Annex A of the methodology handbook), and run the checks. Identify further needs for additional checks.</td>
</tr>
<tr>
<td>indicated on the issue log</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Level 2: consistency with other data sets within the same domain and within the same data source
Validation levels 2 is concerned with the check of consistency based on the comparison of the content of the file with the content of "other files" referring to the same statistical system (or domain) and the same data source.

**Level 2A**

In validation level 2A the other files refer to other versions of exactly the same file. In this case the quality checks are meant to detect "revisions" compared to previously sent data. Detection and analysis of revisions can be useful for example to verify if revisions are consistent with outliers detected in previous quality checks (corrections) or to have an estimate of the impact of the revisions in the "to be published" results, for the benefit of the users.

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records in latest version include all the corrections of the previous versions</td>
<td>Not applicable</td>
<td>Presently we are dealing with the raw micro data, not yet edited. May become relevant at a later stage</td>
</tr>
</tbody>
</table>

**Level 2B**

In validation level 2B, "other files" can be versions of the same data set referring to other time periods. These checks are usually referred to as "time series checks" and are meant to verify the plausibility of the time series.

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records are plausible against data from LUCAS SU 2006</td>
<td>pending</td>
<td>Panel points where issues were identified by the surveyor are coded (BP codes), but no action was performed</td>
</tr>
<tr>
<td>the records are plausible against data from LUCAS SU 2009</td>
<td>pending</td>
<td>Panel points where issues were identified by the surveyor are coded (BP codes), but no action was performed</td>
</tr>
<tr>
<td>the records are plausible against data from LUCAS SU 2012</td>
<td>pending</td>
<td>Panel points where issues were identified by the surveyor are coded (BP codes), but no action was performed</td>
</tr>
</tbody>
</table>

**Level 2C**

In validation level 2C the "other files" can refer to other data sets from the same data provider, referring to the same or other correlated time periods. Sometimes a group of data sets (same country, same reference period) is sent at the same time. For example: an enterprise included in the admin data must
be part of the predetermined population (from the Business Register), three files could be sent at the same time, from the same country and referring to the same time period: one file includes data for "females", one for "male", one for "total". Consistency between the results of the three files can be checked. Another example is for results from annual data sets can be compared with the results of the corresponding quarterly data sets.

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records are plausible against data in the Master 2015 (strata)</td>
<td>pending</td>
<td>compare observed data against strata in the Master 2015</td>
</tr>
<tr>
<td>all points in the LUCAS 2015 survey table are part of the Master 2015</td>
<td>Y</td>
<td>Finished</td>
</tr>
</tbody>
</table>

Level 3: consistency within the same domain between different data sources

Validation levels 3 is concerned with the check of consistency based on the comparison of the content of the file with the content of "other files" referring to the same statistical system (or domain) but with a different data source.

For instance the "other files" can refer to the same data set, but from another data provider (e.g., other countries of the ESS). Mirror checks are included in this class. Mirror checks verify the consistency between declarations from different sources referring to the same phenomenon, e.g., export declared by country A to country B should be the same as import declared by country B from country A.

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records are plausible against data in the same domain coming from different data sources</td>
<td>Not applicable</td>
<td>the described case does not apply to LUCAS Survey raw micro data</td>
</tr>
</tbody>
</table>

Level 4: consistency between separate domains in the same data provider

Validation level 4 could be defined as plausibility or consistency checks between separate domains available in the same institution. The availability implies a certain level of "control" over the methodologies by the concerned institution. These checks could be based on the plausibility of results describing the "same" phenomenon from different statistical domains. Examples: unemployment from registers and from Labour Force Survey, or inhabitation of a dwelling (from survey of owners of houses and dwellings vs. from population register)

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records are plausible against data in separate domains in Eurostat</td>
<td>Not applicable</td>
<td>this validation is of interest for aggregated results (e.g. crop statistics, forest statistics, transport networks)</td>
</tr>
</tbody>
</table>

Level 5: consistency with data of other data providers

Validation level 5 could be defined as plausibility or consistency checks between the data available in the data provider (institution) and the data / information available outside the data provider (institution).
This implies no "control" over the methodology on the basis of which the external data are collected, and sometimes a limited knowledge of it.

<table>
<thead>
<tr>
<th>Y/N</th>
<th>OBS</th>
<th>Next action</th>
</tr>
</thead>
<tbody>
<tr>
<td>the records are plausible against data of CLC</td>
<td>pending</td>
<td>possible against existing data of CLC00, CLC06 and CLC12</td>
</tr>
<tr>
<td>the records are plausible against data of OSM</td>
<td>pending</td>
<td>possible but according to previous trials still of low value as there are topological issues in the available OSM datasets</td>
</tr>
<tr>
<td>the records are plausible against data of the Urban Audit</td>
<td>pending</td>
<td>possible but probably of low interest as this is normally an aggregation of CLC classes</td>
</tr>
<tr>
<td>the records are plausible against data from EEA Transitional waters</td>
<td>pending</td>
<td>partly done, issues are identified</td>
</tr>
<tr>
<td>the records are plausible against data from EEA Coastal waters</td>
<td>pending</td>
<td>partly done, issues are identified</td>
</tr>
<tr>
<td>the records are plausible against data from EBM NUTS</td>
<td>pending</td>
<td>partly done, issues are identified</td>
</tr>
</tbody>
</table>